West Valley Demonstration Project

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SAFETY ANALYSIS REPORT FOR THE

REMOTE-HANDLED WASTE FACILITY

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WEST VALLEY DEMONSTRATION PROJECT
DOCUMENTED SAFETY ANALYSIS FOR THE

REMOTE-HANDLED WASTE FACILITY

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ACRONYMS AND ABBREVIATIONS

A/E	Architect/Engineer
Å	Angstrom (10^{-8} centimeter)
A&PC	Analytical and Process Chemistry
AA	Atomic Absorption
AAC	Assembly Area Coordinator
AADT	Average Annual Daily Traffic
ABA	Authorization Basis Addendum
ACC	Ashford Community Center
ACFM	Absolute Cubic Feet Per Minute
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
A/E	Architect/Engineer
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AED	Assistant Emergency Director
AEDE	Annual Effective Dose Equivalent
AEOC	Alternate Emergency Operations Center
AES	Atomic Emission Spectrophotometer
AIHA	American Industrial Hygiene Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ALARA	As Low As Reasonably Achievable
ALI	Annual Limit of Intake
ALS	Advanced Life Saving
AMCA	Air Movement and Control Association
AMS	Aerial Measurement System
AMS	Alarm Monitoring Station
ANC	Analytical Cell
ANL	Argonne National Laboratory
ANS	American Nuclear Society
ANSI	American National Standards Institute
AOC	Ashford Office Complex
APOC	Abnormal Pump Operating Condition
AR-OG	Acid Recovery - Off-Gas
ARC	Acid Recovery Cell
ARF	Airborne Release Fraction
ARI	Air-Conditioning and Refrigeration Institute
ARM	Area Radiation Monitor
ARPR	Acid Recovery Pump Room
ARR	Accident Release Rate
ASCE	American Society of Civil Engineers
ASER	Annual Site Environmental Report
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AU	Alfred University
AWS	American Welding Society
B&P	Buffalo & Pittsburgh
BDAT	Best Demonstrated Available Technology
BDB	Beyond Design Basis
BDBA	Beyond Design Basis Accidents
BDBE	Beyond Design Basis Earthquake
BLEVE	Boiling Liquid Expanding Vapor Explosion
BNFL	British Nuclear Fuels Limited
BNL	Brookhaven National Laboratory
Bq	Becquerel
BRP	Big Rock Point
BSW	Bulk Storage Warehouse
BWR	Boiling Water Reactor

ACRONYMS AND ABBREVIATIONS (Continued)

c	Centi, prefix for 10^{-2}
C	Coulomb
CAM	Continuous Air Monitor
CAS	Criticality Alarm System
cc	Cubic Centimeter
CC	Communications Coordinator
CCB	Cold Chemical Building
CCDS	Cold Chemical Delivery System
CCR	Chemical Crane Room
CCS	Chilled Water System
CCSR	Cold Chemical Scale Room
CCSS	Cold Chemical Sump Station
CCTV	Closed-Circuit Television
CDDS	Computer Data Display System
CDS	Criticality Detection System
CEC	Cation Exchange Capacity
CEDE	Committed Effective Dose Equivalent
cfm	Cubic feet per minute
CFMT	Concentrator Feed Make-up Tank
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CGA	Compressed Gas Association
CH_4	Methane
CHT	Condensate Hold Tank
Ci	Curie
CLCW	Closed-Loop Cooling Water
cm	Centimeter
CMA	Contact Maintenance Area
CMAA	Crane Manufacturers Association of America
CMP	Construction Management Procedure
CMR	Crane Maintenance Room
COA	Chemical Operating Aisle
CPC	Chemical Process Cell
CPC WSA	Chemical Process Cell Waste Storage Area
cpm	Counts per minute
CR	Control Room
CRM	Community Relations Manager
CRT	Cathode Ray Tube
Cs	Cesium
CSDM	Cognizant System Design Manager
CSE	Criticality Safety Engineer
CSE	Cognizant System Engineer
CSER	Confined Space Entry Rescue
CSPF	Container Sorting and Packaging Facility
CSR	Confined Space Rescue
CSRF	Contact Size Reduction Facility
CSS	Cement Solidification System
cSv	centi-Sievert
CTS	Component Test Stand
CUA	Catholic University of America
CUP	Cask Unloading Pool
Cv	Column Volume
CVA	Chemical Viewing Aisle
CW	Cooling Tower Water
CY	Calendar Year
D&D	Decontamination and Decommissioning
D&M	Dames & Moore
DAC	Derived Air Concentration
DAS	Data Acquisition System
DAW	Dry Active Waste

ACRONYMS AND ABBREVIATIONS (Continued)

DB	Dry Bulb
DBA	Design Basis Accident
DBE	Design Basis Earthquake
DBT	Design Basis Tornado
DBW	Design Basis Wind
DC	Drum Cell
DC	Design Criteria
DCF	Dose Conversion Factor
DCG	Derived Concentration Guide
DCS	Distributed Control System
DEAR	Department of Energy Acquisition Regulation
DF	Decontamination Factor
DGR	Diesel Generator Room
DOE	Department of Energy
DOE-EM	Department of Energy - Environmental Management
DOE-HQ	Department of Energy - Headquarters
DOE-HQ-EOC	Department of Energy - Headquarters - Emergency Operations Center
DOE-ID	Department of Energy - Idaho
DOE-OCRWM	Department of Energy - Office of Civilian Radioactive Waste Management
DOE-OH	Department of Energy - Ohio Field Office
DOE-PD	Department of Energy - Project Director
DOE-WV	Department of Energy - West Valley Area Office
DOE-WVDP	Department of Energy - West Valley Demonstration Project
DOELAP	Department of Energy Laboratory Accreditation Program
DOSR	DOE On-Site Representative
DOT	Department of Transportation
DP	Differential Pressure
dpm	Disintegrations per minute
DR	Data Recorder
DR	Damage Ratio
DVP	Developmental Procedure
DWS	Demineralized Water System
E-Spec	Equipment Specification
EA&SRP	Engineering Administration & Safety Review Program
EBA	Evaluation Basis Accident
EBE	Evaluation Basis Earthquake
ECN	Engineering Change Notice
ECO	Environmental Control Officer
ED	Emergency Director
EDE	Effective Dose Equivalent
EDR	Equipment Decontamination Room
EDRVA	Equipment Decontamination Room Viewing Aisle
EDS	Electrical Distribution System
EG	Evaluation Guideline
EHS	Employee Health Services
EID	Environmental Information Document
EIP	Emergency Implementing Procedure
EIS	Environmental Impact Statement
EMC	Emergency Management Coordinator
EMOA	East Mechanical Operating Aisle
EMP	Emergency Management Procedure
EMRT	Emergency Medical Response Team
EMS	Environmental Management System
EMT	Emergency Medical Technician
EMT	Environmental Monitoring Team
EMU	Emergency Medical Unit
EOC	Emergency Operation Center
EP	Engineering Procedure
EPA	Environmental Protection Agency
EPD	Elevation Plant Datum
EPI	Emergency Prediction Information

ACRONYMS AND ABBREVIATIONS (Continued)

EPIcode	Emergency Protection Information Code
EPRI	Electric Power Research Institute
EPZ	Emergency Protection Zone
ERO	Emergency Response Organization
ERPG	Emergency Response Planning Guideline
ES&H	Environmental, Safety, and Health
ESA	Endangered Species Act
ESH&QA	Environmental, Safety, Health, and Quality Assurance
ESQA&LO	Environmental, Safety, Quality Assurance, and Laboratory Operations
FACTS	Functional and Checklist Testing of Systems
FACP	Fire Alarm Control Panel
FBR	Fluidized Bed Reactor
FCS	Fire Command Station
FFCA	Federal Facility Compliance Agreement
FGE	Fissile Gram Equivalent
FHA	Fire Hazards Analysis
FM	Factory Mutual
fpm	Feet per minute
fps	Feet per second
FRI	Feed Reduction Index
FRS	Fuel Receiving and Storage
FSAR	Final Safety Analysis Report
FSFCA	Federal and State Facility Compliance Agreement
FSP	Fuel Storage Pool
ft	Feet
FWCA	Fish and Wildlife Coordination Act
g	Gram
g	Gravitational Acceleration Constant
G	Giga, prefix for 10^9
GAC	Granular Activated Carbon
gal	Gallon
GC	Gas Chromatograph
GCR	General Purpose Cell Crane Room
GCS	Gravelly Clayey Soils
GE	General Electric
GET	General Employee Training
GFE	Government Furnished Equipment
gM	Gravelly mud
GM	Geometric Mean
GM	Geiger-Mueller
GOA	General Purpose Cell Operating Aisle
GOALS	General Office Automated Logging System
GOCO	Government-Owned, Contractor-Operated
GPC	General Purpose Cell
gpd	Gallons per day
GPLI	General Purpose LAN Interface
gpm	Gallons per minute
GRS	General Record Schedule
G_s	Specific gravity
GTAW	Gas Tungsten Arc Welding
h	Hour
ha	Hectare
HAC	Hot Acid Cell
HAF	Hot Acid Feed
HAI	Hughes Associates, Inc.
HAPR	Hot Acid Pump Room
HASP	Health and Safety Plan
HAZMAT	Hazardous Materials
HAZWOPER	Hazardous Waste Operations and Emergency Response

ACRONYMS AND ABBREVIATIONS (Continued)

HDC	High Density Concrete
HEC	Head End Cells
HEME	High Efficiency Mist Eliminator
HEPA	High Efficiency Particulate Air
HEV	Head End Ventilation
HFE	Human Factors Engineering
HIC	High Integrity Container
HLDS	High-Level Drainage System
HLW	High-Level Waste
HLWIS	High-Level Waste Interim Storage
HLWISA	High-Level Waste Interim Storage Area
HLWTS	High-Level Waste Transfer System
hp	Horsepower
HPGe	High Purity Germanium
HPLC	High Performance Liquid Chromatography
HPS	High Pressure Sodium
HRA	Human Reliability Analysis
HRM	Human Resources Manager
HV	Heating and Ventilation
HVAC	Heating, Ventilation, and Air Conditioning
HVOS	Heating, Ventilation Operating Station
HWSF	Hazardous Waste Storage Facility
i.d.	Inner Diameter
I&C	Instrumentation and Control
IA	Instrument Air
IC	Incident Commander
ICEA	Insulated Cable Engineers Association
ICP	Inductively Coupled Plasma
ICR	Instrument Calibration Recall
ICRP	International Commission on Radiological Protection
ID	Idaho
IDLH	Immediately Dangerous to Life and Health
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IH&S	Industrial Hygiene and Safety
ILDS	Infrared Level Detection System
in	Inch
INEL	Idaho National Engineering Laboratory
INEEL	Idaho National Engineering and Environmental Laboratory
IRTS	Integrated Radwaste Treatment System
ISMS	Integrated Safety Management System
IV&V	Independent Validation and Verification
IWP	Industrial Work Permit
IWSF	Interim Waste Storage Facility
IX	Ion Exchange
JIC	Joint Information Center
JTG	Joint Test Group
k	Neutron Multiplication Factor
k	Kilo, prefix for 10^3
K_d	Partition Coefficient
k_{eff}	Effective Neutron Multiplication Factor
kg	Kilogram
K_h	Horizontal hydraulic conductivity
kN	Kilo-Newton
kPa	Kilo-Pascal
kPag	Kilo-Pascal gauge
kph	Kilometer per hour
kV	Kilo-Volt
K_v	Vertical hydraulic conductivity

ACRONYMS AND ABBREVIATIONS (Continued)

kVA	Kilovolt-ampere
kW	kilo-Watt
L	Liter
LAH	Level Alarm High
LAN	Local Area Network
LANL	Los Alamos National Laboratory
LAP	Laboratory Accreditation Program
LAP	Lower Annealing Point
LASL	Los Alamos Scientific Laboratory
lb	Pound
LCO	Limiting Condition for Operation
LEL	Lower Explosive Limit
lfpm	Linear feet per minute
LI	Level Indicator
LIMS	Laboratory Information Management System
LLDS	Low-Level Drainage System
LLL	Lawrence Livermore Laboratory
LLNL	Lawrence Livermore National Laboratory
LLRW	Low-Level Radioactive Waste
LLW	Low-Level Waste
LLW2	Low-Level Waste Treatment Replacement Facility
LLWTF	Low-Level Waste Treatment Facility
LLWTS	Low-Level Waste Treatment System
LM	Liaison Manager
LOOP	Loss of Off-site Power
LOS	Level of Service
LOVS	Loss of Voltage Signal
LPF	Leak Path Factor
LPG	Liquid Propane Gas
lpm	Liters per minute
LPM	Liters per minute
LPS	Liquid Pretreatment System
LR	Level Record
LSA	Lag Storage Area
LUNR	Land Use and Natural Resources
LWA	Lower Warm Aisle
LWC	Liquid Waste Cell
LWTS	Liquid Waste Treatment System
LXA	Lower Extraction Aisle
m	Meter
m/s	Meters per second
m	Milli, prefix for 10^{-3}
M	Mega, prefix for 10^{6}
M&O	Maintenance and Operations
M&O	Managing and Operating
M&TE	Maintenance and Test Equipment
MAR	Material at Risk
m_b	Earthquake Magnitude
MBtu	Mega-British Thermal Units
MC	Miniature Cell
MCC	Materials Characterization Center
MCC	Motor Control Center
MCE	Maximum Credible Earthquake
mCi	milli-Curie
MEOSI	Maximally Exposed Off-Site Individual
MeV	Mega-electron Volt
MFHT	Melter Feed Hold Tank
mG	Muddy gravels
mi	Mile
MLLW	Mixed Low-Level Waste

ACRONYMS AND ABBREVIATIONS (Continued)

MMI	Modified Mercalli Intensity
MMI	Man-Machine Interface
M&O	Management and Operating
MOA	Mechanical Operating Aisle
MOI	Maximally Exposed Off-Site Individual
mol	Mole
MOU	Memorandum of Understanding
MPag	Mega-Pascal gauge
MPC	Maximum Permissible Concentration
MPFL	Maximum Possible Fire Loss
mph	Miles per hour
mR/hr	Milli-Roentgen per hour
MRC	Master Records Center
mrem	Millirem
MRR	Manipulator Repair Room
MSDS	Material Safety Data Sheet
msG	Muddy Sandy Gravels
MSM	Master-Slave Manipulator
mSv	milli-Sievert
MT	Metric Ton
MTIHM	Metric Tons Initial Heavy Metal
MTU	Metric Tons Uranium
MUF	Material-Unaccounted-For
MW	Mega-Watt
MWD	Mega-Watt-Day
n	Nano, prefix for 10^{-9}
Na	Sodium
NAD	Nuclear Accident Dosimeter
NARA	National Archives and Records Administration
NCSE	Nuclear Criticality Safety Evaluation
NDA	NRC-Licensed Disposal Area
NDA-LPS	NRC-Licensed Disposal Area - Liquid Pretreatment System
n_e	Effective porosity
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NESHAP	National Emission Standard for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NFS	Nuclear Fuel Services, Inc.
NGVD	National Geodetic Vertical Datum
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
NMC	News Media Center
NMPC	Niagara Mohawk Power Corporation
NNW	North North-West
NOAA	National Oceanic and Atmospheric Administration
NP	North Plateau
NPH	Natural Phenomena Hazard
NPPS	North Plateau Pump System
NPPTS	North Plateau Pump and Treatment System
NQA	Nuclear Quality Assurance
NR	Nonconformance Report
NRC	Nuclear Regulatory Commission
NRRPT	National Registry of Radiation Protection Technology
NWS	National Weather Service
NY	New York
NYCRR	New York Code of Rules and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSERDA	New York State Energy Research and Development Authority

ACRONYMS AND ABBREVIATIONS (Continued)

NYSGS	New York State Geological Survey
o.d.	Outer Diameter
OAAM	Operational Accident Assessment Manager
OAM	Operational Assessment Manager
OB	Office Building
OBE	Operating Basis Earthquake
OEP	On-Site Evaluation Point
OGA	Off-Gas Aisle
OGBR	Off-Gas Blower Room
OGC	Off-Gas Cell
OGMR	Off-Gas Monitoring Room
OGTS	Off Gas Treatment System
OH	DOE, Ohio Field Office
OH/WVDP	Ohio Field Office, West Valley Demonstration Project
OJT	On-the-Job Training
OM	Operations Manager
OOS	Out-of-Service
OR	Occurrence Reports
ORNL	Oak Ridge National Laboratory
ORPS	Occurrence Report and Processing System
ORR	Operational Readiness Review
ORRB	Operational Readiness Review Board
ORT	Operations Response Team
OSC	Operations Support Center
OSHA	Occupational Safety and Health Act
OSHA	Occupational Safety and Health Administration
OSR	Operational Safety Requirement
oz	Ounce
p	Pico, prefix for 10^{-12}
P	Peta, prefix for 10^{15}
P&ID	Piping and Instrument Diagram
Pa	Pascal
PA	Project Appraisals
PAO	Polyalphaolefin
PAG	Protective Action Guideline
PAH	Pressure Alarm High
PBT	Performance-Based Training
PC	Partition Coefficient
PCB	Polychlorinated Biphenyl
PCDOCS	Personal Computer Document Organization and Control Software
pcf	Pounds per cubic foot
PCH	Pressure Control High
PCM	Personal Contamination Monitor
PCR	Process Chemical Room
PD	Project Director
PDAH	Pressure Differential Alarm High
PDAL	Pressure Differential Alarm Low
PDCH	Pressure Differential Control High
PDCL	Pressure Differential Control Low
PDM	Powered Dextrous Manipulator
PDR	Pressure Differential Record
PEL	Permissible Exposure Limit
PF	Personnel Frisker
PGA	Peak Ground Acceleration
PGSC	Pasquill-Gifford Stability Class
PHA	Process Hazards Analysis
PHA	Product Handling Area
PID	Public Information Director
PLC	Programmable Logic Controller
PM	Preventive Maintenance

ACRONYMS AND ABBREVIATIONS (Continued)

PMC	Process Mechanical Cell
PMCR	Process Mechanical Cell Crane Room
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PMP	Project Management Plan
PNL	Pacific Northwest Laboratory
PNNL	Pacific Northwest National Laboratory
PPB	Parts Per Billion
PPC	Product Purification Cell
PPE	Personal Protective Equipment
ppm	Parts Per Million
PPM	Parts Per Million
PPS	Product Packaging and Shipping
PRC	Pressure Record Control
PRM	Process Radiation Monitor
PRS	Powered Roller System
PSAR	Preliminary Safety Analysis Report
psf	Pound per square foot
psi	Pound per square inch
psig	Pound per square inch gauge
PSO	Plant Systems Operations
PSOSS	Plant Systems Operations Shift Supervisor
PSO	Plant Systems Operator
PSR	Process Safety Requirement
Pu	Plutonium
PVC	Polyvinyl chloride
PVS	Permanent Ventilation System
PVU	Portable Ventilation Unit
PWR	Pressurized Water Reactor
PWS	Potable Water System
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Program
QAP	Quality Assurance Plan
QAPD	Quality Assurance Program Description
QARD	Quality Assurance Requirements Document
QCN	Qualification Change Notice
QM	Quality Management
R	Roentgen
R/hr	Roentgen per hour
R&S	Radiation and Safety
R&SC	Radiation and Safety Committee
RAP	Radiological Assistance Plan
RCO	Radiological Controls Operations
RCOS	Radiological Controls Operations Supervisor
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
RCTC	Radiological Control Team Commander
RCTL	Radiation Control Team Leader
REG	Robert E. Ginna
rem	Roentgen Equivalent Man
RER	Ram Equipment Room
RESL	Radiological and Environmental Sciences Laboratory
RF	Respirable Fraction
RH	Remote-Handled
RH-TRU	Remote-Handled Transuranic
RHWF	Remote-Handled Waste Facility
RHWP	Remote-Handled Waste Project
RID	Records Inventory and Disposition Schedule
RMW	Radioactive Mixed Waste

ACRONYMS AND ABBREVIATIONS (Continued)

ROD	Record of Decision
RP	Radiation Protection
rpm	Revolutions per minute
RPM	Revolutions Per Minute
RPM	Radiation Protection Manage
RSAC	Radiological Safety Analysis Computer Code
Rt	Route
RTS	Radwaste Treatment System
RWI	Radiological Worker I
RWII	Radiological Worker II
RWP	Radiation Work Permit
s	Second
S&EA	Safety and Environmental Assessment
SA&I	Safety Analysis and Integration
SAA	Satellite Accumulation Area
SAI	Science Applications International
SAR	Safety Analysis Report
SBS	Submerged Bed Scrubber
SCBA	Self-Contained Breathing Apparatus
scfm	Standard cubic feet per minute
SCR	Selective Catalytic Reduction
SCS	Soil Conservation Service
SCSSCs	Safety-Class Structures, Systems, and Components
SDA	New York State-Licensed Disposal Area
SEAM	Safety and Environmental Assessment Manager
sec	Second
SFCM	Slurry-Fed Ceramic Melter
SFPE	Society of Fire Protection Engineers
SFR	Secondary Filter Room
SGN	Society Generale pour les Techniques Nouvelles
SGR	Switch Gear Room
SI	International System of Units
SIP	Special Instruction Procedure
slpm	Standard liter per minute
SM	Security Manager
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SMS	Safety Management System
SMT	Slurry Mix Tank
SMWS	Sludge Mobilization and Wash System
SNF	Spent Nuclear Fuel
SNL	Sandia National Lab
SNM	Special Nuclear Material
SO	Security Officer
SOG	Seismic Owner’s Group
SOP	Standard Operating Procedure
SPDES	State Pollutant Discharge Elimination System
SPO	Security Police Officer
Sr	Strontium
SR	Surveillance Requirement
SRE	Search and Reentry
SRL	Savannah River Laboratory
SRR	Scrap Removal Room
SRSS	Square-root-of-the-sum-of-the-squares
SS	Stainless Steel
SSC	Sample Storage Cell
SSCs	Structures, Systems, and Components
SSE	Safe Shutdown Earthquake
SSS	Security Shift Supervisor
SSS	Slurry Sample System
SSWMU	Super Solid Waste Management Unit
STC	Sample Transfer Cell

ACRONYMS AND ABBREVIATIONS (Continued)

STD	Standard
STP	Standard Temperature and Pressure
STS	Supernatant Treatment System
Sv	Sievert
SVS	Scale Vitrification System
SWB	Standard Waste Box
SWC	Surge Withstand Capability
SWMU	Solid Waste Management Unit
T	Tera, prefix for 10^{12}
TBP	Tri-butyl phosphate
TE	Test Exception
TEDE	Total Effective Dose Equivalent
TEEL	Temporary Emergency Exposure Limit
Ti	Titanium
TID	Tamper-Indicating Device
TIG	Tungsten Inert Gas
TIP	Test Implementation Plan
TIP	Test In-Place
TIP	Test Instruction Procedure
TLD	Thermoluminescent Dosimeter
TLV	Threshold Limit Value
TN	Transnuclear, Inc.
TPC	Test Procedure Change
TPL	Test Plan
TR	Technical Requirement
TRG	Technical Review Group
TRMS	Training Records Management System
TRR	Test Results Report
TRU	Transuranic
TSB	Test and Storage Building
TSC	Technical Support Center
TSCS	Technical Support Center Staff
TSD	Technical Support Document
TSR	Technical Safety Requirement
TVS	Temporary Ventilation System
UA	Utility Air
UAP	Upper Annealing Point
UBC	Uniform Building Code
UCRL	University of California Research Laboratory
UDF	Unit Dose Factor
UEL	Upper Explosive Limit
UL	Underwriters Laboratories, Inc.
ULO	Uranium Load Out
UPC	Uranium Product Cell
UPS	Uninterruptible Power Supply
UR	Utility Room
USDOE	U.S. Department of Energy
USDOI	U.S. Department of the Interior
USDOL	U.S. Department of Labor
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USNRC	U.S. Nuclear Regulatory Commission
USQ	Unreviewed Safety Question
USQD	Unreviewed Safety Question Determination
UWA	Upper Warm Aisle
UWS	Utility Water Supply
UXA	Upper Extraction Aisle
V	Volt

ACRONYMS AND ABBREVIATIONS (Concluded)

VA	Volt-Ampere
VAC	Volt Alternating Current
VDC	Volt Direct Current
V&S	Ventilation and Service Building
VEC	Ventilation Exhaust Cell
VEMP	Vitrification Expended Materials Process
VF	Vitrification Facility
VFFCP	Vitrification Facility Fire Control Panel
VIV	Variable Inlet Vane
VL	Vitrification Liaison
VOG	Vessel Off-Gas
VOSS	Vitrification Operations Shift Supervisor
VPP	Voluntary Protection Program
VS	Vitrification System
VSR	Ventilation Supply Room
VTF	Vitrification Test Facility
VWR	Ventilation Wash Room
W	Watt
WAPS	Waste Acceptance Product Specifications
WC	Water Column
WCC	Warning Communications Center
WCCC	Warning Communications Center Communicator
WCWRT	Work Cell Washdown Receiving Tank
WDC	Waste Dispensing Cell
WDV	Waste Dispensing Vessel
WGES	Westinghouse Government Environmental Services
WGSG	Westinghouse Government Services Group
WHC	Westinghouse Hanford Company
WHSE	Warehouse
WIPP	Waste Isolation Pilot Plant
WMO	Waste Management Operations
WMO	Westinghouse Maintenance Operation
WMOA	West Mechanical Operating Aisle
WNYNSC	Western New York Nuclear Service Center
WO	Work Order
WQR	Waste Qualification Report
WRPA	Waste Reduction and Packaging Area
WS	Waste Stream
wt%	Weight percent
WTF	Waste Tank Farm
WTFVS	Waste Tank Farm Ventilation System
WVDP	West Valley Demonstration Project
WVNS	West Valley Nuclear Services
WVNSCO	West Valley Nuclear Services Company, Inc.
WVPP	West Valley Policies and Procedures
WVVHC	West Valley Volunteer Hose Company
XC-1	Extraction Cell 1
XC-2	Extraction Cell 2
XC-3	Extraction Cell 3
XCR	Extraction Chemical Room
XSA	Extraction Sample Aisle
y	Year
Y_d	Dry density
YOY	Young of Year
yr	Year
Y2K	Year 2000
°C	Degrees Celsius
°F	Degrees Fahrenheit

ACRONYMS AND ABBREVIATIONS (Concluded)

μ	Micro, prefix for 10^{-6}
χ/Q	Relative concentration

1.0 INTRODUCTION AND OVERALL DESCRIPTION OF THE FACILITY

1.1 Introduction

Facilities in which radioactive wastes can be safely processed in preparation for disposal are required to support completion of the West Valley Demonstration Project (WVDP) mission, which is discussed in Chapter 1 of WVNS-SAR-001, *Safety Analysis Report for Waste Processing and Support Activities*. Some of these wastes currently exist, while others will be generated during ongoing and future project activities. Waste items that have relatively high radiation dose rates require processing and repackaging in facilities with remote handling capability to ensure worker safety. The Remote-Handled Waste Facility (RHWF) has been designed and constructed to meet this need. The primary purposes of the RHWF are to cut up, radiologically analyze, and repackage into appropriate (standard) types of waste containers various solid radioactive wastes. Limited decontamination of select waste items may be performed. Waste streams that are to be processed through the RHWF are shown in Table 1.1-1. Table 1.1-1 lists waste streams 12 through 24. Waste streams 1 through 11 are not relevant to the RHWF, and therefore are not discussed in this Safety Analysis Report (SAR). The location and orientation of the RHWF on the WVDP site are shown in Figure 5.1-1. The RHWF is located in the northwest corner of the WVDP site, northwest of the Supernatant Treatment System (STS) Building and southwest of the Chemical Process Cell Waste Storage Area (CPC WSA).

As stated in 10 CFR 830, *Nuclear Safety Management*, a Documented Safety Analysis (DSA) means “a documented analysis of the extent to which a nuclear facility can be operated safely with respect to workers, the public, and the environment, including a description of the conditions, safe boundaries, and hazard controls that provide the basis for ensuring safety.” This SAR has been developed to fulfill the requirement to develop a documented safety analysis. The scope of this SAR is the RHWF and operations outside the RHWF on the WVDP premises that involve transfer of wastes directly to and from the RHWF.

1.2 Facility Description

The RHWF is a free-standing structure with no structural reliance on other buildings or facilities at the WVDP site. The RHWF is approximately 57.3 m (188 ft) long and 27.7 m (91 ft) wide. The facility has been designed to accommodate the waste streams identified in Table 1.1-1. The RHWF has nine areas that directly or indirectly support waste processing and repackaging operations. These are the Receiving Area, Buffer Cell, Work Cell, Contact Maintenance Area, Sample Packaging and Screening Room, Radiation Protection Operations Area, Waste Packaging Area, Operating Aisle, and Load Out/Truck Bay. The RHWF also has four areas that contain systems or components that serve support functions, namely, the Exhaust Ventilation Filter Room, Exhaust Ventilation Blower Room, Mechanical Equipment Area (including the Stack Monitor Room), and Office Area.

The RHWF includes a reinforced concrete main structure with a Receiving Area extension at the north end, an adjoining Load Out/Truck Bay on the east side, and an adjoining Office Building at the south end. The Receiving Area, Load Out/Truck Bay, and Office Building are pre-engineered structures with a metal wall and roof system. The reinforced concrete structure consists primarily of the Buffer Cell, Work Cell, Waste Packaging Area, Operating Aisle, Contact Maintenance Area, and Heating, Ventilation, and Air Conditioning (HVAC) Areas.

The Receiving Area provides weather protection for the loading and unloading of transfer vehicles. The Receiving Area consists of a rectangular shaped weather-protected area that is approximately 8.2 m (27 ft) wide by 15.8 m (52 ft) long for unloading waste transport vehicles. The Buffer Cell, 6.7 m (22 ft) long by 6.7 m (22 ft) wide by 11.3 m (37 ft) tall, acts as a ventilation confinement boundary between the normally uncontaminated Receiving Area and the highly contaminated Work Cell. The Buffer Cell allows radiologically controlled movement of waste containers and other materials into the Work Cell with some shielding provided. The Buffer Cell may also be used as a radiologically controlled area for surveying waste containers or for contact-handled operations such as repackaging, swipe sampling, or removing

waste containers when radiological conditions do not mandate remote handling operations. The Work Cell, a shielded space approximately 16.8 m (55 ft) long by 6.7 m (22 ft) wide by 11.3 m (37 ft) high, is the primary work zone within the RHWF for fully remote handling, surveying, size reducing, decontaminating, and repackaging operations. The Work Cell walls, floor, and roof are constructed of reinforced concrete. The wall thickness is approximately 0.76 m (2.5 ft), while the roof thickness is approximately 0.30 m (1 ft). A pre-engineered sloped steel roof, erected above the concrete roof of the Work Cell, provides drainage. The floor and the lower portion of the Work Cell walls are lined with stainless steel to facilitate decontamination efforts. The Waste Packaging Area, an area 3.4 m (11 ft) long by 6.1 m (20 ft) wide by 2.4 m (8 ft) high, is located adjacent to the southeast corner of the Work Cell on the first floor of the RHWF. This area provides a confined and shielded space for transferring filled waste drum liners and box liners out of the Work Cell via the Waste Transfer System. The Survey and Spot Decontamination Area, located just beyond the Waste Packaging Area, provides space for decontaminating and/or overpacking containers. The Load Out/Truck Bay is an extension on the east side of the RHWF that provides a weather-enclosed structure to support loading of filled waste containers onto transport vehicles and transfer of empty waste containers into the facility. Descriptive information about all of the areas and cells within the RHWF is provided in Chapter 5.

1.3 Process and Activity Descriptions

The RHWF is designed to receive solid radioactive waste and radioactive mixed waste (RMW) from other locations on the WVDP site and to visually inspect, sort, size reduce, collect samples, and repackage this waste in a manner that meets current or expected disposal requirements. The throughput of the facility depends upon the waste stream being processed and is estimated to range between 0.14 and 1.9 m^3/day (5 and 67 ft^3/day). The wastes processed in the RHWF are a variety of sizes, shapes, and materials, including structural steel, stainless steel, concrete, grout, resins, plastics, filters, Herculite, and wood. These materials are in various forms, including tanks, pumps, piping, fabricated steel structures, light fixtures, conduits, jumpers, reinforced concrete sections, personal protective equipment, general rubble, and debris.

Processing begins as waste containers are transferred to the Receiving Area from various on-site locations by truck, forklift, or other means of transport. Waste containers are unloaded in the Receiving Area onto a remote-controlled Powered Roller System (PRS). The Receiving Area crane, a 20-ton overhead bridge crane, can be used to assist in this off-loading operation. The Receiving Area is isolated from the Buffer Cell by air control and shield doors. After the container arrives at the Receiving Area and is placed on the PRS, the Buffer Cell shield doors are opened and the container is moved into the Buffer Cell via the PRS. The Buffer Cell acts as a barrier and airlock to isolate the contaminated Work Cell from the uncontaminated Receiving Area, allowing radiologically controlled movement of waste containers into the Work Cell. The Buffer Cell is isolated from the Work Cell by shield doors and air control doors. Activities in the Buffer Cell are directly observable and controlled from a shield window in the Operating Aisle. After a waste container is transferred to the Buffer Cell, the shield doors between the Receiving Area and the Buffer Cell are closed and the shield doors between the Work Cell and the Buffer Cell are opened. The container is then moved into the Work Cell using the PRS. As a backup, the Work Cell crane, a 30-ton overhead bridge crane with a 30-ton hoist, can be used for moving waste containers into the Work Cell. In the Work Cell, the waste container is opened and the waste items removed, surveyed, sampled, sorted, size reduced, de-watered if necessary, and possibly decontaminated, as deemed needed for repackaging. Waste processing is performed remotely using equipment controlled by operators behind shield windows and shield walls in the Operating Aisle. Two bridge cranes and one jib crane are provided in the Work Cell. Size reduction is typically accomplished with cutting tools supported by powered dexterous manipulators (PDMs).

Waste items from the RHWF are repackaged into either a B-25 box liner or a 208 liter (55 gal) drum liner. The liner for a B-25 box fits inside the standard B-25 box and is made of 16-gauge carbon steel with reinforcing ribs. Low-level waste is placed in B-25 box liners. Low-level or transuranic waste may be placed in 208 liter (55 gal)

drum liners. The loading of transuranic waste into drum liners will be recorded to provide a verification record for the contents of the transuranic drums. Box and drum liner covers are installed when the containers are filled, and the liners are then transferred to the Waste Packaging Area for placement into waste disposal containers (i.e., B-25 boxes or 208 liter [55 gal] drums). The Waste Packaging Area provides a confined and shielded space for efficiently loading waste disposal containers. Once a box or drum liner has been filled in the Work Cell and its cover installed, it is lowered into a waste disposal container through the Waste Transfer System, which is the interface between the Work Cell and the Waste Packaging Area. Filled waste containers are remotely surveyed for external removable contamination and radiation levels in the Waste Packaging Area. Containers are then removed from the Waste Packaging Area on transfer carts through shield doors to the Survey and Spot Decontamination Area. A monorail transfer hoist is installed on the ceiling of the Survey and Spot Decontamination Area to lift and transport containers onto and off of the respective transfer carts. High dose rate containers are shielded on the transfer carts. The Survey Area provides a space for radiologically surveying, spot decontaminating, and overpacking (if needed) filled waste containers. The floor elevation of the Survey Area is at the same elevation as the Load Out/Truck Bay. A forklift removes waste containers from the Survey Area and takes them to the Load Out/Truck Bay. Once in the Load Out/Truck Bay, filled waste containers are loaded onto transport vehicles for transfer to an on-site interim storage facility or off-site disposal facility. It is estimated that hundreds of 208 liter (55 gal) containers filled with radioactive wastes will be created by operations at the RHWF. It is estimated that several hundred B-25 containers filled with radioactive wastes will be created. Certain nonstandard waste containers that are received in the Work Cell may be decontaminated and processed back through the Buffer Cell and Receiving Area, using the Receiving Area crane and the PRS, as opposed to being processed through the Waste Packaging Area. However, this is expected to be an infrequent operation.

1.4 Identification of Agents and Contractors

The WVDP participants are presented in Section 1.4 of WVNS-SAR-001. Design and construction services for the RHWF were provided by Butler Construction Company, Washington Group International, Quality Inspection Services, Quackenbush Company Incorporated, Ferguson Electric Construction Company Incorporated, and their suppliers and subcontractors.

1.5 Hazard Categorization

Hazard classifications for facilities at the WVDP are provided in WVDP-227, *WVDP Facility Identification and Classification Matrix*. The RHWF is classified as a hazard category 2 facility because credible accidents presented in Chapter 9 of this SAR could produce a dose of at least 1 rem to a receptor located 100 meters (328.1 ft) from the point of the release. 10 CFR 830 stipulates that facility hazard categorization is to be performed in accordance with DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. DOE-STD-1027-92 states that the final hazard categorization of a given facility is to be based on an “unmitigated release” of available hazardous material. The criterion for placing a given facility in hazard category 2 is “essentially possession of quantities of material whose unmitigated release could produce total doses of 1 rem in the range of 100 meters from the facility.”

1.6 Structure of this Safety Analysis Report

The Department of Energy uses SARs to establish the safety basis for nuclear facilities. As stated in 10 CFR 830, safety basis means “the documented safety analysis and hazard controls that provide reasonable assurance that a DOE nuclear facility can be operated safely in a manner that adequately protects workers, the public, and the environment.” This SAR has been developed to fulfill the SAR-related requirements of 10 CFR 830. This SAR has been written in accordance with the methodology provided in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, which is a methodology

acceptable to the DOE per Table 2 of Appendix A of Subpart B of 10 CFR 830. 10 CFR 830 and DOE-STD-3009-94 do not require a specific format for a given SAR. For consistency with previous safety analysis documents at the WVDP, in particular WVNS-SAR-001, the format of this SAR corresponds to the format set forth in Nuclear Regulatory Commission Regulatory Guide 3.26, *Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants*. A listing of DOE-STD-3009-94 chapters and the corresponding or equivalent chapters of this SAR is provided in Table 1.6-1.

REFERENCES FOR CHAPTER 1.0

Code of Federal Regulations. 10 CFR 830. *Nuclear Safety Management*. U.S. Department of Energy.

U.S. Department of Energy. December 1992. Change 1 (September 1997). DOE-STD-1027-92: *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. Washington, D.C.

_____. July 1994. Change 1 (January 2000). DOE-STD-3009-94: *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*. Washington, D.C.

U.S. Nuclear Regulatory Commission. 1975. *Regulatory Guide 3.26: Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants.* Washington, D.C.

West Valley Nuclear Services Co. WVDP-227: *WVDP Facility Identification and Classification Matrix*. (Latest Revision).

_____. WVNS-SAR-001: *Safety Analysis Report for Waste Processing and Support Activities*. (Latest Revision).

TABLE 1.1-1
WASTE STREAMS TO BE PROCESSED IN THE REMOTE-HANDLED WASTE FACILITY[1/3]

Waste Stream ID #	Description	Anticipated Waste Category	Max. Length (ft)	Max. Width (ft)	Max. Height (ft)	Max. Weight (lbs)	Total WS Weight (lbs)
12	CPC Jumper Containers	TRU	12.96	6.92	6.96	11,697	43,325
13	CPC Jumper Containers	LLW	12.96	6.92	6.96	12,193	85,638
14	CPC Dissolver Vessels (includes Boxes 3C-1 and 3C-2)	TRU	19.88	11.79	11.22	35,854	71,708
15	CPC Vessel Containers	TRU	13.72	8.42	8.96	9,942	15,842
16	CPC Vessel Containers	LLW	16.58	11.44	11.02	21,119	65,035
17	Vent Filter Containers	TRU	6.33	7.50	6.0	13,274	296,000
18	Vent Filters in Cement	TRU	11.42	7.42	6.42	53,800	191,300
19	Shield Containers CPC WSA	TRU	12.50	6.50	6.50	9,648	81,883
20	Shielded Containers with Dry Activated Waste (DAW)	LLW	12.0	6.0	6.0	10,500	65,000
21	Shielded Resin Tanks	LLW	6.0	6.0	6.0	25,430	254,300
22	Shielded Containers	LLW	2.0 dia.	Cyl.	3.0	1,390	14,300
23	Waste Tank Farm Pumps[2]	LLW	50.0	4.0	4.0	10,000	149,000
24	Head End Cell Closure Wastes	LLW	12.0	6.0	6.0	11,800	47,280

Notes:

1. Table is derived from of WVNS-IRP-006, *Remote-Handled Waste Facility Integrated Run Plan*. The dimensions shown are for the largest container in a given waste stream (WS). Variations in the total WS weight shown in this table for WS 17 through 24 are acceptable as they do not affect the safety analyses in this SAR.

2. Mechanical arms from the Waste Tank Farm may be included with WS 23.

3. This table represents the Waste Streams that will be processed through the RHWF and for which the facility has been designed. Identification of additional waste streams for processing through this facility will be evaluated pursuant to the requirements of 10 CFR 830, Subpart B (USDOE January 10, 2001), and WV-914, Unreviewed Safety Question Process (USQP) (West Valley Nuclear Services Co.), which implements the Rule. WV-914 provides the guidance for conducting and documenting the review associated with the USQP. Throughout the life cycle of the RHWF, the safety analyses are revised as new information is obtained, as preliminary analyses are replaced with final analyses, as DOE Directives evolve, and as the Project matures.

TABLE 1.6-1

LOCATION OF DOE-STD-3009-94 INFORMATION IN WVNS-SAR-023

DOE-STD-3009-94 Chapter	WVNS-SAR-023 (Reg. Guide 3.26 Chapters)
Executive Summary	1.0 Introduction and Overall Description of the Facility 2.0 Summary Safety Analysis
1.0 Site Characteristics	3.0 Site Characteristics
2.0 Facility Description	4.0 Principal Design Criteria 5.0 Facility Design 6.0 Process Systems
3.0 Hazard and Accident Analyses	9.0 Hazard and Accident Analyses
4.0 Safety Structures, Systems, and Components	5.0 Facility Design 6.0 Process Systems
5.0 Derivation of Technical Safety Requirements	11.0 Technical Safety Requirements
6.0 Prevention of Inadvertent Criticality	8.0 Hazards Protection
7.0 Radiation Protection	8.0 Hazards Protection
8.0 Hazardous Material Protection	8.0 Hazards Protection
9.0 Radioactive and Hazardous Waste Management	7.0 Waste Confinement and Management
10.0 Initial Testing, In-Service Surveillance, and Maintenance	10.0 Conduct of Operations
11.0 Operational Safety	10.0 Conduct of Operations
12.0 Procedures and Training	10.0 Conduct of Operations
13.0 Human Factors	Each Chapter, as appropriate
14.0 Quality Assurance	12.0 Quality Assurance
15.0 Emergency Preparedness Program	10.0 Conduct of Operations
16.0 Provisions for Decontamination and Decommissioning	10.0 Conduct of Operations
17.0 Management, Organization, and Institutional Safety Provisions	10.0 Conduct of Operations

2.0 SUMMARY SAFETY ANALYSIS

A summary of the safety analyses performed for the Remote-Handled Waste Facility (RHWF) is presented in this chapter. In all of the accidents analyzed in this Safety Analysis Report (SAR), no credit was taken for any preventive or mitigative design features to reduce the risk of accidents to an acceptable level. All consequences from analyzed accidents are well below the Evaluation Guidelines (EGs) specified in Section 9.1.3. Worker doses from routine operations are well below the occupational radiation protection limits established in 10 CFR 835, *Occupational Radiation Protection*. No structures, systems, or components in the RHWF are designated as safety class or safety significant. No facility-specific technical safety requirements are required. Additional information regarding the hazards and accidents associated with the RHWF is provided in Chapters 8 and 9 of this SAR.

2.1 Site Analysis

2.1.1 Natural Phenomena

Natural phenomena that can affect the safety of operations include earthquakes, tornadoes, straight line wind, lightning, and floods. For information on natural phenomena that can affect the safety of operations at the West Valley Demonstration Project (WVDP), including the RHWF, see Section 2.1.1 of WVNS-SAR-001, *Safety Analysis Report for Waste Processing and Support Activities*. Natural phenomena design criteria for the RHWF are stated in Chapter 4 of this SAR (WVNS-SAR-023).

2.1.2 Site Characteristics Affecting the Safety Analysis

The pathways by which radiologically and/or toxicologically hazardous materials may be dispersed into the environment may be broadly categorized as airborne or liquid. Only airborne releases are evaluated in the accident scenarios presented in Chapter 9. For airborne releases, the capacity of the atmosphere to dilute and disperse effluents is of prime importance in evaluating the environmental effects of site operations under normal, abnormal, and accident conditions. The dispersive capability of the atmosphere is a function of wind speed and direction, and atmospheric stability. Local climatological data have been and continue to be obtained from an on-site meteorological tower where wind speed, wind direction, and temperature are measured at 10 meters (32.8 ft) and 60 meters (196.9 ft) from the base. See Section 2.1.2 of WVNS-SAR-001 for additional information.

Liquid releases are not evaluated as the site’s topographic setting renders the likelihood of major flooding not credible, and local run-off and flooding is adequately accommodated by natural and man-made drainage systems in and around the WVDP. Detailed technical information on surface hydrology can be found in Chapter 3 of WVNS-SAR-001.

Natural phenomena are considered as potential initiators for abnormal and accident events, as shown in Table 9.1-1 of Chapter 9. For natural phenomena events that are less severe than the RHWF natural phenomena design criteria (provided in Chapter 4), it is expected that no significant quantities of radioactive or chemically hazardous materials would be released to the environment. The potential consequences of severe natural phenomena, such as a beyond design basis earthquake, are presented in Chapter 9. Other site-specific loads (e.g., snow loading) are bounded by more controlling loads and their associated margins of safety.

2.1.3 Effect of Nearby Industrial, Transportation, and Military Facilities

Nearby industrial, transportation, and military facilities do not pose a level of risk to WVDP that warrants detailed, qualified analysis because of the distance of these facilities from the site and the nature of the operations at these facilities. See Section 2.1.3 of WVNS-SAR-001 for a further discussion of nearby industrial, transportation, and military facilities.

2.2 Impacts from Normal Operations

Chapter 8 of this SAR presents occupational and off-site dose assessments that have been developed to assess the radiological impact of normal operations at the RHWF. Occupational exposures are minimized at the WVDP through strict adherence to as low as reasonably achievable (ALARA) principles. Nonradiological impacts were evaluated and determined not to require further assessment.

The WVDP programmatically monitors the surrounding environment and effluent from on-site facilities to fulfill federal and state requirements. The results of this program show that during the course of activities at the WVDP, public health and safety and the environment are being protected. See Section 2.2 of WVNS-SAR-001 for additional information in this regard.

2.3 Impacts from Abnormal Operations

Abnormal operations are events that could occur from malfunctions of systems or operator error. Abnormal events considered in this SAR present relatively little risk and are considered to not have the potential to result in a significant release of radioactive or hazardous material. Qualitative radiological consequences and frequencies of occurrence associated with abnormal operations are provided in the Process Hazards Analysis (PHA) shown in Table 9.1-1.

2.4 Accidents

Accident analyses are performed through the use of established and accepted references and computer codes. Computer codes used in accident analyses are verified per approved procedures prior to use. Those events or scenarios presenting the greatest risk have been identified through the PHA shown in Table 9.1-1. Analyses to evaluate the consequences of airborne radiological releases utilize source terms developed from guidance given in DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Non-Reactor Nuclear Facilities*; site-specific dispersion factors calculated using the PAVAN computer codes (Pacific Northwest Laboratory November 1982); and DOE/EH-0071, *Internal Dose Conversion Factors for Calculation of Dose to the Public*. Dispersion factors associated with prescribed atmospheric conditions (i.e., stability class "F" meteorology and a wind speed 1 m/s [2.2 mph]) are provided in WVDP-065, *Manual for Radiological Assessment of Environmental Releases at the WVDP*. As stated in WVDP-065, the Radiological Safety Analysis Computer Code (RSAC), which was developed at the Idaho National Engineering and Environmental Laboratory, was used to calculate dispersion factors for prescribed atmospheric conditions. A maximum two-hour exposure time for potentially affected individuals is assumed, consistent with the guidance provided in Appendix A of DOE-STD-3009-94. The breathing rate used for potentially affected individuals is 0.333 L/s (0.012 ft^3/s) (ICRP 23, October 1974). See Section 9.2.1 for additional information about accident analysis methodology. Specifically, the requirements of EM-125, *Verification, Validation, and Control of Computer Software*, are implemented for computer codes that are used to perform accident analyses.

There are four design basis accidents analyzed in Section 9.2 of this SAR, all of which have consequences below the EGs. The first credible accident involves the simultaneous damage of all 24 Work Cell exhaust system filter houses. The maximum Total Effective Dose Equivalent (TEDE) at the on-site evaluation point (OEP) for this accident has been calculated to be 0.797 rem, and the TEDE received by the maximally exposed off-site individual (MEOSI) has been calculated to be 0.496 rem. The second credible accident involves the failure of two waste containers. The maximum TEDE at the OEP for this accident has been calculated to be 0.136 rem, and the TEDE received by the MEOSI has been calculated to be 8.49E-02 rem. A third credible accident entails a fire/explosion in the RHWF. The maximum TEDE at the OEP for this accident has been calculated to be 2.10 rem, and the TEDE received by the MEOSI has been calculated to be 1.31 rem. Lastly, a fourth credible accident entails a fire in the Chemical Process Cell Waste Storage Area (CPC WSA) that significantly impacts (i.e., thermally stresses) the contents of a few of the containers of CPC components and debris (which are discussed in Chapter 8). The maximum TEDE at the OEP for this

accident has been calculated to be 1.56 rem, and the TEDE received by the MEOSI has been calculated to be 0.974 rem.

10 CFR 830, *Nuclear Safety Management*, in particular 10 CFR 830.204, states that consideration should be given for “the need for analysis of accidents which may be beyond the design basis of the facility.” Such analyses are intended to provide a perspective of the residual risk associated with the operation of a given facility. Beyond design basis accidents (BDBAs) are not required to provide assurance of public health and safety. Rather, the analysis of BDBAs is intended solely to provide information that can be used to identify additional facility features or operational practices that could prevent a given BDBA or reduce the risk associated with a given BDBA. No comparison to the EGs is required for BDBAs. Two BDBAs are analyzed in this SAR; a beyond design basis earthquake, and a beyond design basis natural gas explosion. The potential consequences associated with these BDBAs are shown in Table 9.2-7. Primarily because no large (e.g., greater than 50 rem TEDE) doses to receptors of interest were calculated, no additional facility features or operational practices were identified from the analyses of BDBAs.

2.5 Conclusions

A summary of the accident analyses contained in this SAR is provided in Table 9.2-8. Consequences of radiological accidents in this SAR are calculated for both on-site and off-site individuals. All accident-related releases evaluated in this SAR are modeled as ground-level releases. There are no elevated release accident scenarios. Consequences are calculated for an on-site and off-site receptors as detailed in Chapter 9.0 of this SAR. The RHWF and CPC WSA are located in close proximity to each other. Hence, consequence analyses for accidents at the CPC WSA use the same distances to receptors as consequence analyses for the RHWF.

All credible accidents that were evaluated are within the EGs given in Section 9.1.3. Calculations yielded a dose to the MEOSI of 1.31 rem TEDE and a dose to a receptor at the OEP of 2.10 rem TEDE due to a fire/explosion in the RHWF. This represents the bounding credible accident scenario.

Routine doses to off-site individuals are well within the requirements of DOE Order 5400.5*, Radiation Protection of the Public and the Environment*.

REFERENCES FOR CHAPTER 2.0

Code of Federal Regulations. 10 CFR 830. *Nuclear Safety Management*. U.S. Department of Energy.

_____. 10 CFR 835. *Occupational Radiation Protection*. U.S. Department of Energy.

U.S. Department of Energy. February 8, 1990. Change 2 (January 7, 1993). DOE Order 5400.5: *Radiation Protection of the Public and Environment*. Washington, D.C.

_____. July 1988. DOE/EH-0071: *Internal Dose Conversion Factors for Calculation of Dose to the Public*. Washington, D.C.

_____. December 1994. DOE-HDBK-3010-94: *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*. Washington, D.C.

_____. July 1994. Change 1 (January 2000). DOE-STD-3009-94: *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*. Washington, D.C.

West Valley Nuclear Services Co. EM-125: *Verification, Validation, and Control of Computer Software* (Latest Revision).

_____. WVDP-065: *Manual for Radiological Assessment of Environmental Releases at the WVDP*. (Latest Revision).

_____. WVNS-SAR-001: *Safety Analysis Report for Waste Processing and Support Activities*. (Latest Revision).

3.0 SITE CHARACTERISTICS

Characteristics of the West Valley Demonstration Project (WVDP) site are discussed in WVNS-SAR-001, *Safety Analysis Report for Waste Processing and Support Activities*, Chapter 3.0, and in accompanying *Technical Support Documents (TSDs) for WVNS-SAR-001*. The TSDs are a compilation of the data and results of numerous past studies and evaluations of site characteristics such as meteorology and geology. The influence of these site characteristics on the design, operation, and safety analysis of the Remote-Handled Waste Facility (RHWF) is described below.

3.1 Geography and Demography

WVNS-SAR-001, Section 3.1, contains a comprehensive description of the geographic and demographic features of the WVDP and surrounding areas. Geographic and demographic information were considered and modeled as appropriate when the consequence assessments of accidents presented in Chapter 9 were developed.

3.2 Nearby Industrial, Transportation, and Military Facilities

A detailed discussion of the effects on the WVDP from nearby facilities is provided in WVNS-SAR-001, Section 3.2. Based on the analyses provided in Chapter 9, it is concluded that no significant impact would result at nearby industrial, transportation, or military facilities due to accidents associated with RHWF operations. Furthermore, no credible accidents or abnormal operations at off-site facilities were identified that would contribute to the potential for an accident at the WVDP (including the RHWF).

3.3 Meteorology

The meteorology of the WVDP and surrounding areas is described in WVNS-SAR-001, Section 3.3. As discussed in other chapters of this Safety Analysis Report (SAR), particularly Chapters 4 and 9, meteorological characteristics of the region were considered in the design of the RHWF. Meteorological phenomena were considered and modeled as appropriate when the consequence assessments of accidents presented in Chapter 9 were developed.

3.4 Surface Hydrology

WVNS-SAR-001, Section 3.4, describes the surface hydrology at, and in the vicinity of, the WVDP. Surface or storm water run-off from the RHWF and adjacent area will use existing drainage features (i.e., ditches, swales, culverts, outfalls, etc.) to the maximum extent practicable. Storm drainage around the facility is designed to accommodate rainfall intensity for a 100-year storm event such that backup of storm water will not flow into the facility.

3.5 Subsurface Hydrology

WVNS-SAR-001, Section 3.5, describes the subsurface hydrology at, and in the vicinity of, the WVDP. The design of the RHWF included consideration of the local subsurface hydrology. The design considers subsurface geologic conditions (e.g., depth to the Lavery till). This geologic unit provides a natural barrier to downward migration of potential contaminants. The RHWF design minimized any disturbance to the Lavery till during excavation and, to the extent possible, precludes the use of support structures that would fully penetrate the thickness of the Lavery till.

3.6 Geology and Seismology

A discussion of the physiography, geologic history, stratigraphy, structure, and hydrology of the WVDP site is provided in WVNS-SAR-001, Section 3.6. As indicated in Chapter 4 of this SAR, regional soil characteristics and seismological factors have been considered in the design of the RHWF.

3.7 Ecological Characterization of the WNYNSC

WVNS-SAR-001, Section 3.7, provides a summary of ecological characteristics at the Western New York Nuclear Service Center (WNYNSC). This section presents the results of historical and recent field investigations, review of publications, and consultation with authorities on the area. Design considerations for WVDP facilities and/or systems are presented based on terrestrial and aquatic ecological characteristics.

3.8 Summary of Site Characteristics Impacting Safety Considerations

WVNS-SAR-001, Section 3.8, provides a tabular summary of site characteristics that impact design of facilities. Factors such as snowfall, wind, temperature, precipitation, earthquakes, and near-surface groundwater were considered in designing the RHWF. As a result, none of these natural phenomena pose an unacceptable risk to the structural integrity of the RHWF or the operations conducted therein.

3.9 Validity of Existing Environmental Analyses

Environmental analyses relevant to the RHWF are contained in the following documents:

- DOE/EIS-0081: *Supplement Analysis II of Environmental Impacts Resulting from Modifications in the West Valley Demonstration Project*
- OH-WVDP-99-03: *Environmental Checklist for the Remote-Handled Waste Project*

No measurable discrepancies exist between the information provided in these documents and the information provided in this SAR.

REFERENCES FOR CHAPTER 3.0

U.S. Department of Energy. June 1998. DOE/EIS-0081: *Supplement Analysis II of Environmental Impacts from Modifications in the West Valley Demonstration Project.* Washington, D.C.

_____. OH-WVDP-99-03*: Environmental Checklist for the Remote-Handled Waste Project.* Letter to B. A. Mazurowski, U.S. Department of Energy Director (WD:1999:0397). West Valley, NY: West Valley Nuclear Services.

West Valley Nuclear Services Co. WVNS-SAR-001: *Safety Analysis Report for Waste Processing and Support Activities*. (Latest Revision).

_____. WVNS-SAR-001 TSD: *WVDP Technical Support Documents for Safety Analysis Report SAR-001: Project Overview and General Information*. (Latest Revision).

4.0 PRINCIPAL DESIGN CRITERIA

The Remote-Handled Waste Facility (RHWF) is a facility at the West Valley Demonstration Project (WVDP) with remote handling capability for radioactive waste processing operations. This chapter identifies and discusses the principal engineering design criteria and design bases for the structures, systems, and components (SSCs) of the RHWF. Functional requirements, design criteria, and applicable codes and standards for the RHWF are provided in WVNS-DC-071, *Remote-Handled Waste Facility Design Criteria*.

4.1 Purpose of the RHWF

The RHWF is designed to receive high activity solid waste and radioactive mixed waste (RMW) from other locations on the WVDP site and to visually inspect, sort, size reduce, collect samples, and repackage this waste in a manner that meets current on-site waste acceptance criteria or anticipated requirements for off-site disposal. The throughput of the facility depends upon the waste stream being processed and is estimated to range between 0.14 and 1.9 m^3/day (5 and 67 ft^3/day).

4.1.1 RHWF Feeds

The waste streams currently identified for processing in the RHWF are listed in Table 1.1-1. Waste items to be fed through the RHWF are comprised of a variety of materials of different sizes and shapes, including structural steel, stainless steel, concrete, grout, resins, plastics, and mechanical filtration media. These materials are in the form of tanks, pumps, piping, steel fabrications, light fixtures, conduits, jumpers, reinforced concrete sections, personal protective equipment, filters, general rubble, and debris. Some of this waste is expected to be contaminated with hazardous constituents such as lead, mercury, and PCBs.

4.1.2 RHWF Products and Byproducts

The RHWF product is radioactive waste packaged into standard waste disposal containers (i.e., B-25 boxes or 208 liter [55 gal] drums). The primary byproducts from RHWF operations are secondary radioactive wastes in the form of dust and small sized particles, liquid effluent (primarily water used for decontamination), contaminated equipment, and process-related samples.

4.1.3 RHWF Functions

The core function of the RHWF is to sort, size reduce, and repackage radiological waste. A brief summary of the RHWF process is given below. Chapters 5 and 6 of this Safety Analysis Report (SAR) provide a detailed discussion of the RHWF design and process systems.

Waste containers are received in the RHWF Receiving Area and transported to the Work Cell in a controlled manner, passing through the Buffer Cell as part of this process. Once in the Work Cell, waste containers are opened and the waste items removed, surveyed, sampled, sorted, de-watered, size-reduced, and decontaminated, as required for repackaging. Waste processing is performed remotely using equipment controlled by operators behind shield windows and shield walls in the Operating Aisle.

Waste repackaging commences after waste components have been sorted, size-reduced, and sufficiently analyzed for radiological and chemical attributes. Waste is placed in drum or box liners, which help control the spread of contamination. Box and drum liners are transferred to the Waste Packaging Area for placement into waste disposal containers. The Waste Packaging Area provides a confined and shielded space for loading waste disposal containers. Filled waste containers are remotely surveyed for external contamination in the Waste Packaging Area and transferred to the Survey and Spot Decontamination Area, which provides a space for surveying, spot decontaminating, and overpacking (as necessary) filled waste containers. Waste disposal containers are then transferred to the Load Out/Truck Bay and loaded onto transport vehicles for transfer to an interim storage facility or final off-site disposal facility.

4.1.4 RHWF Interfaces with Other WVDP Facilities

The RHWF is a new, stand-alone facility. Dependence on existing WVDP facilities has been kept to a minimum to facilitate the shutdown, deactivation, and where applicable, decontamination and decommissioning (D&D) of existing SSCs at the site. Certain RHWF service and utility systems including natural gas, potable water, demineralized water, fire water, sanitary sewer, normal electrical and standby electrical power, and the communications and alarm system are connected to the corresponding site-wide system for the WVDP. Chapter 5 of WVNS-SAR-001, *Safety Analysis Report for Waste Processing and Support Activities*, provides a description of existing service and utility systems at the WVDP. Chapter 5 of this SAR describes the connections and specifications of the RHWF service and utility systems.

Additional information about interfaces between the RHWF and other WVDP facilities is given in Section 7.0 of WVNS-DC-071. In particular, the RHWF receives waste containers from other facilities such as the Chemical Process Cell Waste Storage Area (CPC WSA) and interfaces with the transportation systems that are available on site. The WVDP Lag Storage system and/or the CPC WSA may be used for temporary storage of waste containers filled in the RHWF. The WVDP Liquid Waste Treatment System (LWTS) will be used to process secondary liquid waste that is transferred from the RHWF Liquid Waste Collection and Transfer System. Finally, samples taken from the RHWF process may be transferred to other on-site or off-site analytical laboratories for analysis.

4.2 Structural and Mechanical Safety Criteria

Specific structural, mechanical, and safety-related design criteria for the RHWF are provided in WVNS-DC-071. These design criteria have not been relied upon in the accident analyses presented in Chapter 9 of this SAR to demonstrate that the consequences of all credible accidents associated with RHWF operations are below the Evaluation Guidelines, which are provided in Chapter 9.

4.2.1 Wind Loadings

Building structures, and equipment on the exterior of the structures, are designed for a 100-year wind of 35.8 m/s (80 mph) with a gust response factor of 1.21. Wind pressure is analyzed using the methods specified in ANSI A58.1, *Building Code Requirements for Minimum Design Loads for Buildings and Other Structures*, Exposure Condition C.

4.2.2 Tornado Loadings

No tornado loading is specified for the RHWF in WVNS-DC-071. Based on the guidance contained in DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components,* SSCs associated with the RHWF have been placed in Performance Category 2. Based on the guidance in DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, tornado design criteria are not applicable to Performance Category 2 SSCs.

4.2.3 Flood Design

Intense rainfall is not considered to be a hazard to the RHWF. The RHWF includes an industrial roof system designed with a minimum 20-year life, and incorporates industrial means and methods for waterproofing and sealing to prevent the intrusion of intense rainfall. Storm drainage around the facility is designed to accommodate rainfall intensity for a 100-year storm event such that backup of storm water does not flow into the facility.

The RHWF is situated at an elevation which is not affected by flooding of either Buttermilk Creek or Cattaraugus Creek. Thus, a flood is not considered to be a hazard to the facility. Also, the RHWF is designed so that groundwater intrusion into the facility does not occur. Storm water run-off from the building and adjacent

area utilizes existing drainage features (i.e., ditches, swales, culverts, outfalls, etc.) to the maximum extent practicable.

4.2.4 Tornado Missile Protection

There are no design criteria for tornado missile protection because tornado design criteria are not applicable to the RHWF, as discussed in Section 4.2.2.

4.2.5 Seismic Design

As stated in the DOE-approved RHWF Preliminary Safety Analysis Report (PSAR) (WVNS-SAR-023, Rev. 0, *Preliminary Safety Analysis Report for the Remote-Handled Waste Facility*), and in WVNS-DC-071, the RHWF has been designed to withstand an earthquake with a horizontal peak ground acceleration (PGA) of 0.10 g. Historically, an earthquake with a horizontal PGA of 0.10 g at the WVDP has been associated with an annual frequency of 5.0E-04. However, more recent analyses, as documented in Section 3.6.2.9.5 of WVNS-SAR-001, show that a smaller magnitude earthquake should be associated with an annual frequency of 5.0E-04. Section 3.6.2.9.5 of WVNS-SAR-001 states the following: “Using these publications, the results of a 1992 study by Dames & Moore that applied the EPRI hazard analysis methodology, and the guidance of DOE Standard 1024, the PGA at the 1.0E-03 and 5.0E-04 annual probabilities were estimated to be 0.053 g and 0.078 g, respectively.”

Using the guidance contained in DOE-STD-1021-93, the SSCs associated with the RHWF have been placed in Performance Category 2. DOE-STD-1020-94, the applicable natural phenomena hazard design criteria document during the design of the RHWF and construction of the RHWF structure, shows that an earthquake with a magnitude that corresponds to an annual frequency of 1.0E-03 is applicable to the seismic design of SSCs placed in Performance Category 2. Hence, the RHWF is considered to significantly exceed DOE seismic design guidance. It is noted that WVNS-DC-071 states, “Earthquake loads and evaluation used in the design shall be, at a minimum, in accordance with UBC, 1991 edition for Zone 1, modified with an importance factor of 1.25.” An importance factor of 1.25 is stipulated in DOE-STD-1020-94 for SSCs placed in Performance Category 2.

4.2.6 Snow Loadings

Structures are designed for a snow load of 1,915 Pa (40 lb/ft^2).

4.2.7 Process and Equipment Derived Loads

Process and equipment derived loads are divided into dead loads and live loads. Dead loads include the weight of SSCs. Live loads include floor and roof area loads, equipment dynamic loads (e.g., from the operation of cranes and other processing equipment), lay down loads due to temporary placement of moveable equipment or SSCs, impact loads and other processing loads. Process and equipment derived loads are considered in SDD-R09, *Civil Structural System Design Description for Remote-Handled Waste Facility Buildings* (Butler 2001). The RHWF design has been shown to support all process and equipment derived loads in SDD-R09 and supporting calculation sets.

4.2.8 Combined Load Criteria

Combined load criteria for the RHWF are presented in SDD-R09. The following loads are considered in these calculations: dead load, live load, thermal load, wind load, snow load, seismic load, differential pressure load, and operating internal pressure load. Design loads are combined so as to result in the most unfavorable load combinations during various operating conditions, including normal operating load conditions, severe environmental load conditions, and off-normal operating load conditions. For each of the load combinations, allowable stress limits and structural acceptance criteria are developed. The RHWF design has been shown to meet the derived structural acceptance criteria in SDD-R09 and supporting calculation sets.

4.2.9 Subsurface Hydrostatic Loadings

Subsurface loadings for the RHWF have been developed using accepted engineering practices, including analysis in accordance with established principles of soil mechanics. The RHWF design considers subsurface geologic conditions such as depth to the Lavery till. This geologic unit provides a natural barrier to downward migration of potential contaminants. The RHWF design minimizes any disturbance to the Lavery till and precludes the use of support structures that would fully penetrate its thickness.

4.2.10 Temperature Design Loadings

The RHWF SSCs are designed to withstand thermal loads. The WVDP has a freeze protection program in place to prevent damage to existing equipment and facilities due to cold weather. Requirements for freeze protection are incorporated in the RHWF design. Heating systems and insulation are provided to maintain inside temperatures above freezing. The temperature inside the various areas of the RHWF is normally maintained between 10 and 32°C (50 and 90°F).

4.3 Safety Protection Systems

4.3.1 General

The RHWF is designed for safe operation. Confinement of radioactive contamination and control of worker radiation exposure are the primary safety concerns. As described in WVNS-DC-071, confinement of radioactive materials in the RHWF is accomplished by employing the following primary design principles: 1) use sufficiently air-tight physical boundaries to keep contamination as close to the source as practical; 2) use multiple barriers, such as cells, walls, and double-walled piping; and 3) maintain pressure differentials between each confinement zone so that air flow travels from zones of lesser contamination potential to zones of greater contamination potential. Specific safety protection systems and features are described in the following sections.

4.3.2 Protection Through Defense-in-Depth

The design and operation of the RHWF provide defense-in-depth for public, worker, and environment safety during normal, off-normal, and accident conditions. Implementation of the defense-in-depth philosophy ensures that layers of defense are provided against the release of radiological and hazardous materials such that no one layer by itself is completely relied upon. The primary layers of defense for the RHWF are as follows:

- Passive confinement barriers
- Waste form and inventory
- Active confinement barriers
- Alarms and monitors
- Personnel training
- Administrative planning and controls

Details of the RHWF design and process operations are provided in Chapters 5 and 6 of this SAR, while personnel training, programmatic efforts, and administrative controls are discussed in Chapters 8, 10, and 12. Elements of these design features and controls, as they relate to defense-in-depth, are discussed below.

4.3.2.1 Passive Confinement Barriers

Passive confinement barriers for the RHWF include structural features such as thick concrete walls and sliding shield doors, which are designed to preclude the uncontrolled release of radioactive contamination. In addition, the waste container itself is considered to provide a primary confinement barrier. The Receiving Area and Buffer Cell support the confinement of radioactive materials while a waste container is being transferred into the Work Cell. The physical boundaries (walls, doors, and ceiling) all qualify as a fire barriers capable of stopping the fire

spread to the ex-cell areas. The structural design and features of each area of the RHWF are described in detail in Chapter 5 of this SAR.

Once a waste container has been moved into the Work Cell, the primary confinement barrier is the Work Cell structure (i.e., walls, roof, and floor). The Work Cell floor and the lower portion of the walls are lined with stainless steel, with floor drains leading to collection tanks that provide confinement of liquid releases within the Work Cell. The Work Cell is constructed of reinforced concrete, is designed to withstand the effects of an earthquake with a horizontal peak ground acceleration of 0.1 g, and provides radiation shielding for workers located in other parts of the RHWF.

Waste is processed in the Work Cell and exits the cell via the Waste Packaging Area, after being repackaged into B-25 boxes or 208 liter (55 gal) drums. These waste containers serve as a primary confinement barrier as the waste moves through the remainder of the RHWF process. The structural features of the RHWF provide secondary confinement until the filled waste containers leave the facility through the Load Out/Truck Bay.

4.3.2.2 Waste Form and Inventory

Waste streams 12 through 16 in Table 1.1-1 contain stored components and debris that were generated as the result of the disassembly and removal of various components from the CPC. These wastes are currently stored in the CPC WSA. The CPC was used to dissolve spent nuclear fuel. Hence, CPC components are generally expected to be contaminated with a distribution of radionuclides that is consistent with the distribution of radionuclides found in spent nuclear fuel. These waste streams are considered to contain the bounding set of material at risk (MAR) for design, construction, operation, and accident evaluation of the RHWF.

Waste streams 17 and 18 are predominantly, if not entirely, filters from ventilation system(s) that service areas and cells in the Main Plant. The filters in waste stream 18 are encased in concrete. Waste streams 20 and 22 have content from various projects associated mostly with the Waste Tank Farm and Main Plant. Waste stream 20 is comprised of shielded boxes and waste stream 22 is comprised of shielded drums. These items include anti-contamination clothing and other personal protective equipment, plastic, wood, metal, hoses, tools, rope, piping, weir bags, and solid debris. Waste stream 21 is primarily diatomaceous earth used for the filtering of pool water in the Fuel Receiving and Storage (FRS) facility. The remaining waste streams in Table 1.1-1 were generated primarily from the operation of WVDP facilities including the Main Plant, FRS facility, and Waste Tank Farm (WTF).

Many of the waste streams identified for processing in the RHWF have already undergone substantial decontamination efforts. In addition, the composition of many of the waste streams (e.g., expended ventilation system filters, metal process vessels) tends to promote the retention of particulate matter. Given these facts, it is reasonable to postulate that the vast majority of the radioactive material that passes through the RHWF is not readily dispersible (i.e., does not readily separate from the contaminated item) without the addition of a significant amount of energy, such as through cutting operations or by accidentally dropping. Finally, due to the configuration of the RHWF as a linear, “assembly line” type process, there is an intrinsic limitation on the inventory in the RHWF at any given time.

4.3.2.3 Active Confinement Barriers

The RHWF Heating, Ventilation, and Air Conditioning (HVAC) system ensures positive confinement of airborne radioactive material. The HVAC system progressively draws supply air from less contaminated to more contaminated areas to preclude radioactive contamination of clean areas. The supply air is finally directed to the Work Cell and exhausted to the stack. The RHWF is segregated into HVAC zones, which incorporate multiple physical barriers and utilize differential pressures to control the direction of airflow. The direction of ventilation airflow is maintained from zones of lesser contamination potential to zones of greater contamination potential

under both normal and off-normal conditions. HVAC zones for the RHWF are defined as follows:

- Zone I designates areas that are expected to contain radioactive materials during normal operations. The Work Cell is designated as Zone I.

- Zone II designates the Operating Aisle and other potentially contaminated areas surrounding Zone I. These spaces are normally not contaminated.

- Zone III designates areas that are expected to be free of contamination at all times (e.g., the Office Area).

The HVAC system is designed to ensure the integrity of Zone I and Zone II areas within the RHWF by maintaining their respective design negative pressures (relative to atmosphere), thus containing the spread of airborne radioactivity. Ventilation system exhaust from Zones I and II is high efficiency particulate air (HEPA) filtered. Redundant ventilation exhaust blowers and filter trains are provided, and standby electrical power is provided to the HVAC system to ensure that it remains functional in the event of a loss of off-site power. To ensure that the ventilation system confinement function is maintained even if the exhaust blowers are not available, dampers and/or HEPA filters are provided to prevent or filter inadvertent back flows from contaminated to clean areas.

Further details regarding the RHWF HVAC system are provided in Chapter 5 of this SAR.

The facility is divided into six fire areas based on construction features, common processing functions, and loss prevention considerations as described in WVNS-FHA-014. Two-hour fire/smoke rated barriers and dampers are also provided. The fire barriers are also designed to mitigate the horizontal and vertical spread of radiological contamination due to fire. Fire dampers and damper controls are set to meet three needs:

1. Stop the spread of contamination in the event of a fire.

2. Allow for controlled shut down of a particular fire zone to contain contamination in the event of a fire.

3. Allow for safe, manual override when radiological concerns outweigh fire concerns.

4.3.2.4 Alarms and Monitors

Alarms and monitors are employed throughout the RHWF to notify personnel of abnormal operating conditions. WVDP site communications and alarm systems are discussed in Chapter 10 of WVNS-SAR-001 and in WVDP-022, *WVDP Emergency Plan Manual*.

The RHWF Communications System allows for monitoring from a remote location to detect errors, faults, and power losses. The system is provided with an uninterruptible power supply (UPS) in case of AC power failure. Process-related alarms are provided to alert operators to abnormal process conditions. All alarms are fail-safe with contacts opening to alarm so that broken wires are indicated as a circuit fault rather than preventing alarm conditions.

The RHWF HVAC system is provided with filter differential pressure instrumentation as well as effluent monitoring equipment. Alarms are provided to indicate when pressure differentials are not within a prescribed range. Differential pressure indicating transmitters are provided across each HEPA filter bank to monitor differential pressure and provide input to the Programmable Logic Controller (PLC) system. The RHWF exhaust stack discharge flow is monitored by the Stack Effluent Radiation Monitoring System to demonstrate compliance with EPA 40 CFR, Part 61, Subpart H.

As described in WVNS-FHA-014, *Fire Hazards Analysis - Remote-Handled Waste Facility*, the RHWF Fire Detection System detects smoke and fire and provides local and remote audio and visual alarms for operating personnel to safely shut down the processing

operation and evacuate affected areas, if required. A Fire Alarm Control Panel (FACP) provides the power, annunciation, supervision, and control for the Fire Detection System. Secondary power for all fire alarm functions is supplied by gelled electrolyte batteries.

The RHWF design includes strategic placement of continuous air monitors (CAMs) for detecting the airborne release and presence of radiological materials, and area radiation monitors (ARMs) for detecting radiation levels above the normal operational range.

Additional discussion of alarms and monitors is presented in Chapters 5 and 8 of this SAR.

4.3.2.5 Personnel Training

Qualification standards and/or training requirements are established for all RHWF personnel. RHWF operators are qualified in accordance with documented performance-based training programs. This training includes responsibilities and actions during emergency situations. Periodic emergency exercises are performed, with follow-on critiques, to allow personnel to gain experience and confidence and to ensure that personnel are ready to respond to accident situations. A detailed description of the West Valley Nuclear Services Company (WVNSCO) training program is presented in Chapter 10 of WVNS-SAR-001.

4.3.2.6 Administrative Planning and Controls

Operation of the RHWF is accomplished through a clearly defined organizational structure with well defined responsibilities. The overall WVDP organizational structure is presented in Chapter 10 of WVNS-SAR-001. WVNSCO systematically integrates safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment. This integration is accomplished by implementing an Integrated Safety Management System (ISMS), which is described in WVDP-310, *WVDP Safety Management System (SMS) Description*.

WVDP-011, *WVDP Industrial Hygiene and Safety Manual*, establishes the policies used to control chemical and industrial hazards for all WVDP operations. Safety is ensured through facility and equipment design, protective clothing and equipment selection, personnel training, and administrative controls. WVDP-177, *WVDP Fire Protection Manual,* provides specific administrative controls to assure compliance with fire codes and standards. WVDP-010, *WVDP Radiological Controls Manual*, establishes the control organization, staffing and training requirements, performance goals, control zones and associated levels, posting and labeling requirements, and other administrative control requirements associated with work in radiation and contamination areas. Operations within radiologically contaminated areas require the use of work control practices to maintain exposures as low as reasonably achievable (ALARA). These practices include the use of Radiation Work Permits (RWPs), pre-job briefings, personnel protective equipment and clothing, and dosimetry.

WV-980, *WVNS Environmental Management System,* establishes the WVNSCO environmental management system (EMS) which provides a framework for environmental protection at the WVDP. The EMS is an integral component of the overall Integrated Safety Management System (ISMS) as defined in WV-100, *Integrated Safety Management and Control of Documents*, and as described in WVDP-310, *WVDP Safety Management System Description*. EMS establishes that activities including design, construction, testing, start-up, commissioning, operation, maintenance, and decontamination and decommissioning in a manner appropriate to the nature, scale, and environmental impacts of these activities.

The WVDP uses Process Safety Requirements (PSRs) to reduce worker risk and focus attention on those systems under the direct control of the operator that are important to safe facility operation. These requirements define limiting conditions for operation, surveillance requirements and actions, and provide the associated bases for systems and/or components under the direct control of the operator. PSRs

are identified per the OH/WVDP-approved radiological, nonradiological, and worker risk-reduction criteria defined in WV-365, *Preparation of WVDP Safety Documents*, and are implemented through standard operating procedures and other documentation. WV-365 specifies the approval authority for a PSR, which may be WVNSCO or OH/WVDP, depending upon the criterion that necessitated the requirement.

4.3.3 Protection by Equipment and Instrumentation Selection

A fundamental concern regarding equipment selection is that the structural and/or operational features of the equipment provide confinement of radioactive and hazardous materials, if required. Beyond this first-order objective, ALARA principles apply. Equipment is selected for reliability and, where protection in depth is required, redundant systems are provided to increase the likelihood of functional availability. To provide continuous operation and safety during RHWF processing, there are redundant work stations in the Operating Aisle and redundant filter trains and fans in the HVAC system. During off-normal incidents, normal electrical power is backed up with (1) uninterruptible power supplies to support instrumentation and controls, and (2) standby power supplies to support confinement systems. The RHWF has sufficient instrumentation and controls such that the process can be monitored and shut down from a centralized control panel.

The basic design approach for RHWF equipment and instrumentation is: (1) it must perform its operational function and, if required, its safety functions, and (2) if possible, it should be located in a nonradiation area. If the equipment and instrumentation must be located in the Work Cell, then: (1) appropriate measures are taken to ensure a high degree of reliability, (2) redundancy is used where continuous operations are required, and (3) the equipment and instrumentation should permit remote maintenance or replacement.

Instrumentation is selected on the basis of its applicability, simplicity, reliability and availability, and is standardized wherever possible to simplify the spare parts inventory. Sensitive instruments and devices are designed to mitigate electrical and magnetic signal interferences. Instrumentation located in a radioactive environment is subject to radiological design considerations based on the total radiation exposure potentially affecting the instrument.

Procurement of equipment and instrumentation is performed in compliance with the Quality Assurance Program described in Chapter 12 of this SAR and Chapter 12 of WVNS-SAR-001. Quality Level designations for RHWF SSCs have been determined using DOE Order 420.1A, *Facility Safety*, and criteria established in QM 2, “Quality Assurance Program,” of WVDP-002, *Quality Management Manual*. These designations apply to all facilities and systems that are under the purview of the WVNSCO Quality Assurance Program.

4.3.4 Nuclear Criticality Safety

Nuclear criticality safety is ensured through implementation of WVDP-162, *WVDP Nuclear Criticality Safety Program Manual*, and WV-923, *Nuclear Criticality Safety*. These documents have been written to implement the criticality-related requirements contained in DOE Order 420.1A and referenced ANSI/ANS nuclear criticality safety standards. Criticality concerns in the RHWF are addressed in Section 8.7 of this SAR. As stated in Section 8.7, all areas in the RHWF where fissile materials could be present will remain subcritical under all normal and credible abnormal and accident conditions.

4.3.5 Radiological Protection

A significant safety concern in the RHWF is the direct ionizing radiation hazard posed by gamma radiation from the waste streams. Protection from direct radiation is achieved through shielding, remote handling and processing of waste streams, work planning, administrative controls, and decontamination. Chapter 8 of this SAR provides a detailed discussion of WVDP safety programs that govern the operation of the RHWF and that are designed to maintain personnel radiation exposure ALARA. The principle of ALARA applies to all aspects of RHWF operations and maintenance. The

primary methods used to maintain exposures ALARA are physical design features that, to the extent practicable, ensure minimum exposure of workers to radiation. Administrative controls and procedural requirements are employed only as supplemental methods to control radiation exposure. DOE Order 420.1A is the governing document for facility safety, with personnel exposure levels controlled through the implementation of WVDP-010.

Confinement barriers and systems in the RHWF, such as thick concrete walls and sliding shield doors, are designed to preclude the uncontrolled release of radioactive contamination. These features of the RHWF design are discussed in Chapter 5. The primary confinement system for airborne radioactivity is the RHWF HVAC system. The RHWF design includes CAMs for detecting the airborne release and presence of radiological materials, and ARMs for detecting radiation levels above the normal operational range. The alarm set points for CAMs and ARMs are in accordance with guidance provided in WVDP-010, *WVDP Radiological Controls Manual*.

The RHWF is designed to the following requirements:

- The maximum radiation dose rate for a full-time occupancy area is 0.1 mrem/hr. A full-time occupancy area is one in which individual(s) may be expected to spend all or most of a work day based on a 40-hour work week. The RHWF control areas (where control stations are located) are defined as full-time occupancy areas.

- The maximum radiation dose rate for a full-time access area is 1.0 mrem/t, where "t" is the maximum average time in hours per day that the area is expected to be occupied by any one individual. A full-time access area is one in which no physical or administrative control of entry exists.

If compliance with full-time access area requirements would be economically infeasible, impractical, or prohibitive, higher dose rates may be allowed. However, access to such radiation fields is strictly controlled. In these normally unoccupied areas, the maximum allowed radiation dose rate is 4.0 mrem/hr, except when waste packages are present.

4.3.6 Fire and Explosion Protection

The WVDP Fire Protection Program, as described in Chapter 4 of WVNS-SAR-001, is applicable to the RHWF. This program is based upon the requirements of DOE Order 420.1A and National Fire Protection Association (NFPA) Codes and Standards. The philosophy and requirements of the WVDP Fire Protection Program are presented in WVDP-177, *WVDP Fire Protection Manual.* This manual establishes a formalized fire protection program governing the conduct of all activities at the WVDP to ensure that employees, the public, and the environment are protected from the effects of a fire. Fire protection systems specific to the RHWF are discussed in Chapter 5 of this SAR.

Administrative controls, procedures, and training to prevent fires and explosions are presented in WVDP-177. The RHWF is designed in accordance with applicable NFPA codes. Fire protection for the RHWF is based upon WVNS-FHA-014, *Fire Hazards Analysis - Remote-Handled Waste Facility*. Lightning protection for the RHWF complies with NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

Combustible loading at the WVDP is controlled through procedures and requirements contained in WVDP-177. In compliance with applicable DOE Orders and NFPA codes, combustible materials are stored such that their accumulation does not present an increased risk to facilities or personnel or create a fire hazard. WVDP-177 contains guidance for minimizing and controlling the use of combustible materials, and provides the design and operational requirements and responsibilities for hazardous material storage. Facility inspections, which include control and handling of flammable and combustible materials, are conducted by the Facility Manager or a designee on a schedule consistent with facility use.

4.3.7 Radioactive Waste Handling and Storage

Radioactive waste management at the RHWF is performed in accordance with DOE Order 435.1, *Radioactive Waste Management*. Radioactively contaminated liquids generated by the activities at the RHWF are managed through use of the RHWF Liquid Waste Collection and Transfer System. Liquid secondary waste is collected through floor drains into two waste collection tanks, while a third tank is used for staging collected waste for transfer to the WVDP LWTS. In general, solid secondary wastes are processed through the RHWF in a fashion similar to other waste streams. Gaseous secondary wastes are processed through the RHWF HVAC system, which involves multiple stages of HEPA filtration, and discharged through the RHWF exhaust stack. The stack discharge flow is monitored by the Stack Effluent Radiation Monitoring System to demonstrate compliance with applicable facility discharge criteria. Additional details regarding the confinement and management of radioactive effluents from RHWF operations are provided in Chapter 7 of this SAR.

Chapter 7 of WVNS-SAR-001 provides an overview of radioactive waste storage and handling at the WVDP. Low-level radioactive wastes at the WVDP are addressed in WVDP-019, *Low-Level Waste Management Program Plan.* WVDP-299, *Site Treatment Plan* addresses mixed wastes. The WVDP Transuranic Waste Program is being developed.

4.3.8 Industrial and Chemical Safety

As previously noted, WVDP-011, *WVDP Industrial Hygiene and Safety Manual,* establishes the policies used to control chemical and industrial hazards for all WVDP operations. Safety is ensured through facility and equipment design, protective clothing and equipment selection, personnel training, and administrative controls. WVDP-011 requirements are based upon DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*.

Techniques prescribed in DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, also assist in minimizing and controlling industrial and chemical hazards at the RHWF. The requirements of DOE Order 5480.19 are implemented in WVNSCO Policy and Procedure WV-110, *Conduct of Operations*, and WVDP-106, *West Valley Demonstration Project (WVDP) Conduct of Operations Manual*. Good work practices are required for RHWF operations, including orderly shift turnover, required reading lists, facility surveillances and walk-downs, and use of logbooks. Routine operations are governed by formal procedures. An Industrial Work Permit (IWP) is required whenever non-routine handling operations, such as maintenance, are conducted on equipment with safety hazards. Lockout/tagout procedures are used in conjunction with the IWP and craftsmen and operators are trained in the use of locks and tags. Chapter 4 of WVNS-SAR-001 further addresses established WVDP industrial and chemical safety measures. These measures are employed at the RHWF, where applicable. Hazardous material protection is addressed in Chapter 8 of this SAR.

4.4 Classification of Structures, Systems, and Components

DOE-STD-3009-94 defines the terms “safety-class SSCs” and “safety-significant SSCs.” The accident analyses presented in Chapter 9 of this SAR demonstrate that there is no need for “safety-class SSCs” at the RHWF. For reasons stated in Section 11.3.2, no RHWF SSCs have been designated as “safety-significant.”

4.5 Decontamination and Decommissioning (D&D)

Decontamination of RHWF SSCs involves the removal of sources of hazardous and radioactive materials to acceptable levels or concentrations. The RHWF is listed on the RCRA Part A Permit to store and treat mixed waste. A RCRA Closure Plan will be submitted to NYSDEC 45 days before the expected completion of all activities in the RHWF. The Closure Plan will detail how the facility will be decontaminated before the demolition of the building. Section 4.3 of WVNS-DC-071, *Remote-Handled Waste Facility Design Criteria,* provides a listing of RHWF design features that have been included to facilitate D&D. Chapter 10 of WVNS-SAR-001 provides a discussion of overall WVDP decommissioning planning and related efforts. Chapter 10 of this SAR

provides specific design features and measures that are employed to facilitate D&D of the RHWF.

4.6 Human Factors Engineering

The RHWF is designed to be comfortable and natural for personnel to operate and maintain. Human factors have been considered in positioning equipment, switches, valves, and instruments from both an operating and a maintenance viewpoint. Human factors engineering is integral to the design process of any nuclear facility. Section 10.7 of this SAR lists some of the human factors that were considered during the design of the RHWF.

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5.0 FACILITY DESIGN

5.1 Summary Description

5.1.1 Location and Facility Layout

The location and orientation of the Remote-Handled Waste Facility (RHWF) on the West Valley Demonstration Project (WVDP) site are shown in Figure 5.1-1. The RHWF is located in the northwest corner of the WVDP site, northwest of the Supernatant Treatment System (STS) Building and southwest of the Chemical Process Cell Waste Storage Area (CPC WSA). There is a gradual slope of 67 mm/m (0.8 in/ft) from the northeast to the southwest across the area.

The RHWF is a free-standing structure with no structural reliance on other buildings or facilities at the WVDP site. The RHWF is approximately 57.3 m (188 ft) long and 27.7 m (91 ft) wide. The facility has been designed to accommodate the waste streams identified in Table 1.1-1.

The RHWF has nine major processing areas, as follows:

- Receiving Area
- Buffer Cell
- Work Cell
- Contact Maintenance Area
- Sample Packaging and Screening Room
- Radiation Protection Operations Area
- Waste Packaging Area
- Operating Aisle
- Load Out/Truck Bay

In addition, the RHWF has the following four support system areas:

- Exhaust Ventilation Filter Room
- Exhaust Ventilation Blower Room
- Mechanical Equipment Area and Stack Monitor Room
- Office Area

These are described in Section 5.2.

5.1.2 Principal Features

5.1.2.1 Site Boundary

Section 5.1.2.1 of WVNS-SAR-001, *Safety Analysis Report for Waste Processing and Support Activities*, provides a general discussion of the boundary of the Western New York Nuclear Service Center (WNYNSC).

5.1.2.2 Property Protection Area

The Property Protection Area comprises approximately 220 acres (89 ha) located near the center of the WNYNSC. This area is enclosed by an eight-foot high chain-link fence topped with three strands of barbed wire. Nearly all the Project facilities are located within this area. This area is accessed through gates that are continuously manned by the Project Security Force.

5.1.2.3 Site Utility Supplies and Systems

Section 5.1.2.3 of WVNS-SAR-001 provides a general discussion of site utility supplies and systems.

5.1.2.4 Surface Impoundments and Storage Tanks

No surface impoundments or outside storage tanks are associated with the RHWF.

5.1.2.5 Atmospheric Release Points

The RHWF exhaust stack is located on the roof of the Exhaust Ventilation Blower Room and is anchored to the north side of the RHWF. This stack is the primary discharge point for airborne releases from the facility. The stack discharge flow is monitored by the Stack Effluent Radiation Monitoring System to demonstrate compliance with 40 CFR Part 61, Subpart H, National Emission Standards for Hazardous Air Pollutant - Emission and Radionuclides other than Radon for Department of Energy Facilities and meet ANSI N13.1 1999 Standard for Sampling and Monitoring Requirements. Air handling units that service uncontaminated areas of the RHWF are located at various points on the exterior of the structure and discharge uncontaminated ventilation air.

5.2 Structures, Systems, and Components (SSCs)

5.2.1 RHWF Design Basis and Layout

The RHWF has been designed and constructed using existing technology and standard engineering practices. Engineering codes, construction codes, and standards applicable to the general design and operation of the RHWF are listed in WVNS-DC-071, *Remote-Handled Waste Facility Design Criteria*. A review of the principal design criteria for the RHWF is provided in Chapter 4 of this Safety Analysis Report (SAR). New facility construction and major modifications to existing facilities at the WVDP conform to the criteria dictated in DOE Order 420.1A, *Facility Safety*.

The RHWF includes a reinforced concrete main structure with a Receiving Area extension at the north end, an adjoining Load Out/Truck Bay on the east side, and an adjoining Office Building at the south end. The Receiving Area, Load Out/Truck Bay, and Office Building are pre-engineered structures with a metal wall and roof system. The reinforced concrete structure consists primarily of the Buffer Cell, Work Cell, Waste Packaging Area, Operating Aisle, Contact Maintenance Area and Heating, Ventilation, and Air Conditioning (HVAC) Areas.

The RHWF is designed to have a service life of 20 years. The RHWF structure is capable of sustaining the design loads specified in WVNS-DC-071 and SDD-R09, *Civil Structural System Design Description for Remote-Handled Waste Facility Buildings* (Butler 2001). These documents specify design floor loads, design basis earthquake, design pressure differential, design wind forces, design snow loading, design rainfall, reference design flooding, surface water run-off, and subsurface geology design considerations.

Earthquake loads and evaluation methods used in the RHWF design were performed in accordance with the Uniform Building Code (UBC), 1991 edition for Zone I, modified with an importance factor of 1.25. As stipulated in WVNS-DC-071, the RHWF is seismically designed to an acceleration of 0.1 g at ground level (horizontal loads). Exterior walls and interior walls designated as load bearing shear walls are proportioned and designed to resist the total horizontal shear induced in the building from earthquake or wind loads. Floor slabs are designed to carry vertical loads and act as horizontal diaphragms, transferring lateral and vertical loads to the walls. The seismic design for the RHWF is verified by analysis in SDD-R09 and supporting calculation sets. These analyses demonstrate that the RHWF complies with the design criteria discussed in Chapter 4 of this SAR.

Plan and section drawings of the RHWF are provided in Figures 5.2-1 through 5.2-6. These drawings present the layout and configuration of major equipment in the facility.

5.2.2 Receiving Area

The Receiving Area provides weather protection for the loading and unloading of transfer vehicles. The Receiving Area consists of a rectangular shaped

weather-protected area that is approximately 8.2 m (27 ft) wide by 15.8 m (52 ft) long for unloading waste transport vehicles. There are two roof elevations at approximately 7.6 m (25 ft) and 13.7 m (45 ft) from the concrete floor. The size of the Receiving Area is sufficient to accommodate the containers identified in Table 1.1-1 except for the existing Waste Tank Farm (WTF) transfer pump boxes. The Receiving Area consists of a pre-engineered structure with insulated siding and roofing which allows an uncoupled full length trailer to be parked inside. The floor level of the Receiving Area is 1.2 m (4 ft) below the Buffer Cell floor. This allows containers to be transferred using the Receiving Area roller conveyor system into the Buffer Cell in alignment with and at the elevation of the Buffer Cell roller conveyor. Two personnel access doors, one bi-parting door, and two roll-up doors are provided for personnel and transport vehicle/equipment access. A commercial grade, radio controlled 20-ton bridge crane is provided in the Receiving Area. Sliding equipment doors, one horizontal swinging contamination control door, and one air control door (notched to clear the crane rails) separate the Receiving Area from the Buffer Cell. These doors permit crane access between the Receiving Area and the Buffer Cell. The Buffer Cell shield, air flow, and roll-up door operating mechanisms are located inside the Receiving Area for ease of accessibility and maintenance. Two levels of steel grating platforms are provided for maintenance of the 20-ton bridge crane. Steel ladders are provided for access to these maintenance platforms. Utility air, water, and power are provided in the Receiving Area.

The transfer of the WTF pump boxes from the Receiving Area through the Buffer Area into the Work Cell will require special containment to be built in the Receiving Area. Due to the length of the WTF pump boxes, both of the Buffer Cell shield doors must be open at the same time in order to transfer the WTF pump boxes in the Work Cell. The special containment structure will allow the transfer of the WTF boxes and prevent the spread of airborne contamination. Administrative controls will be in place to control personnel access to the Receiving Area during these transfers because of dose concerns in the Receiving area while both shield doors are open.

The Receiving Area Ventilation System delivers approximately 2.93 m^3/s (6,200 cfm) of ventilation air to the Receiving Area. The supply air handling unit is located outside the Receiving Area and is comprised of low, medium, and high efficiency filters, a centrifugal fan, and a gas fired heater section in the fan discharge. The system operates continuously to maintain the required pressure differential relative to the Buffer Cell. A discussion of the ventilation system is provided in Section 5.4.1.

5.2.3 Buffer Cell

The Buffer Cell, 6.7 m (22 ft) long by 6.7 m (22 ft) wide by 11.3 m (37 ft) tall, acts as a ventilation confinement boundary between the normally uncontaminated Receiving Area and the contaminated Work Cell. This cell allows radiologically controlled movement of waste containers and other materials into the Work Cell with some shielding provided. The Buffer Cell may also be used as a radiologically controlled area for surveying waste containers or for contact-handled operations such as repackaging, swipe sampling, or removing waste containers when radiological conditions do not mandate remote handling operations. The Buffer Cell has sufficient space to accommodate the containers identified in Table 1.1-1, with the exception of the WTF transfer/mobilization pump boxes.

The Buffer Cell walls, floor, and roof are constructed of shielded, reinforced concrete, sealed to facilitate cleanup and decontamination. The wall thickness is approximately 0.76 m (2.5 ft), while the roof thickness is approximately 0.30 m (1 ft). A pre-engineered sloped steel roof, erected above the concrete roof of the Buffer Cell, provides drainage. The cell is equipped with a powered roller system and shares the radio controlled, 20-ton overhead bridge crane with the Receiving Area. The floor of the Buffer Cell is at the same level as the floor of the Work Cell to allow waste containers to be remotely moved inside using the powered roller system. The powered roller system employs floor mounted roller units and a motor driven ball screw drive to move waste containers between the Receiving Area, Buffer Cell, and Work Cell.

Personnel access to the Buffer Cell is accomplished on the first level by means of a double air lock located on the east side of the cell. A shielded window, located in the Operating Aisle west wall at Elevation 120'4½", allows direct observation of operations within the Buffer Cell. Closed circuit television (CCTV) cameras are used to monitor areas not viewable from the window. At the north end of the cell, shielded sliding equipment doors, a horizontal swinging contamination control door, and an air control door (notched to clear the crane rails) separate the Buffer Cell from the Receiving Area. The south end of the Buffer Cell is separated from the Work Cell by sliding shield doors (two levels high), a horizontal swinging contamination control door, and an air control door (notched to clear the crane rails). Operating mechanisms for the sliding shield door, contamination control door, and air control door interfaces between the Buffer Cell and the Work Cell are located inside the Buffer Cell for ease of accessibility and maintenance.

There are sealed curbs on the floor between the Receiving Area and the Buffer Cell, and between the Buffer Cell and the Work Cell, to prevent the spread of contaminated liquids between adjacent areas. A washdown collection trench and drain system is provided in the floor slab running in the north-south direction of the Buffer Cell. The floor of the cell is sloped toward the trench to direct waste liquids, while the trench itself is sloped toward its drain at the south end of the cell. The trench is stainless steel lined for ease of decontamination, and is approximately 15 cm 6 in) wide. The drain hub is 56 cm (22 in) long by 79 cm (31 in) wide by 58 cm (23 in) deep, and contains a replaceable stainless steel screen within a cartridge that is designed to filter out particulates.

5.2.4 Work Cell

The Work Cell, a shielded space approximately 16.8 m (55 ft) long by 6.7 m (22 ft) wide by 11.3 m (37 ft) high [7.9 m (26 ft) high to the bridge crane rail supports], is the primary work zone within the RHWF for fully remote handling, surveying, size reducing, decontaminating, and repackaging operations. The Work Cell walls, floor, and roof are constructed of reinforced concrete. The wall thickness is approximately 0.76 m (2.5 ft), while the roof thickness is approximately 0.30 m (1 ft). A pre-engineered sloped steel roof, erected above the concrete roof of the Work Cell, provides drainage. The floor and the lower portion of the Work Cell walls are lined with stainless steel to facilitate decontamination efforts. Sufficient space is provided to work on the largest and longest waste boxes, including the 16.8 m (55 ft) long WTF transfer and mobilization pump boxes.

At the north end of the Work Cell are sliding shield doors (two levels high), a horizontal swinging contamination control door, and an air control door (notched to clear the crane rails) which provide a means for waste transfer and bridge crane passage between the Work Cell and the Buffer Cell At the south end of the Work Cell are a sliding shield door and an air control door (notched to clear the crane rails) which separate the Work Cell from the Contact Maintenance Area and provide a means for bridge crane passage.

Crane rails designed for a 30-ton capacity extend the full length of the Work Cell. Two bridge cranes are provided. One XYZ bridge crane designed for a 30-ton load is provided with a 30-ton cable hoist. The other Work Cell bridge crane is provided with two telescoping masts, both with 3-ton capacity. The telescoping masts, supported by separate bridge crane trolleys, are capable of utilizing various tools. One 3-ton wall-mounted jib crane with a telescoping mast is also provided and can be moved on a rail along the length of the east cell wall. The jib crane and bridge crane are used for handling of material throughout the cell. In addition, various interchangeable tools can be fitted on the powered dexterous manipulators (PDMs) for cutting and grappling. Some of this equipment may be hydraulically powered. The PDMs and end effectors are interchangeable between the bridge cranes’ telescoping masts and the jib crane’s telescoping mast. The PDMs and cranes are used to operate a full range of fixtures and tools for handling, surveying, sampling, size reducing, and repackaging waste.

The floor of the Work Cell is at the same level as the floor of the Buffer Cell to allow waste containers to be remotely moved inside using conveyors. The conveyor

system employs floor mounted roller units and a motor driven ball screw drive to stage incoming waste containers adjacent to adjustable work platforms. The work platforms allow simultaneous waste processing operations for two operators, at work stations located behind two shield windows in the Operating Aisle wall. Work stations utilize the cranes with PDMs to position and support the tools used to inspect, sample, and cut the waste items for packaging. In addition to the shield windows, CCTV cameras and monitors are available to view operations in the Work Cell.

Additional space is available in the Work Cell for staging incoming waste containers and for temporary storage of waste disposal container liners. Filled container liners are transferred from the Work Cell to the shielded and enclosed Waste Packaging Area via the Waste Transfer System. The Waste Transfer System is designed to minimize the spread of contamination from the Work Cell to the Waste Packaging Area.

A washdown collection trench and drain system is provided in the floor slab running in the north-south direction of the Work Cell. The floor of the cell is sloped toward the trench to direct waste liquids, while the trench itself is sloped toward its drain at the south end of the cell. The trench is stainless steel lined for ease of decontamination, and is approximately 15 cm (6 in) wide. The drain hub is 56 cm (22 in) long by 79 cm (31 in) wide by 66 cm (26 in) deep, and contains a stainless steel screen within a filter cartridge that is designed to remove particulates. Filter cartridges can be remotely removed using the PDMs from the Work Cell equipment to permit replacement of filter screens.

In-cell exhaust ventilation system filter banks are placed in strategic locations within the Work Cell. Each of the four filter banks contains six filter housings, and each filter housing contains one medium efficiency filter and one high efficiency filter. The location of these first stages of filtration near the source of airborne contamination helps confine the majority of the contamination within the Work Cell. A detailed description of the Work Cell ventilation system is provided in Section 5.4.1.

On the Work Cell wall opposite the Operating Aisle, two 6.1 m (20 ft) long by 7.3 m (24 ft) high "knock-out" sections allow for the addition of Expansion Modules. Removable stainless steel lined wall panels serve as an inner confinement barrier until an Expansion Module is installed. Shielding for these "knock-out" sections is provided by an externally removable shield wall consisting of reinforced precast concrete sections.

5.2.5 Contact Maintenance Area

The Contact Maintenance Area, a space approximately 6.7 m (22 ft) wide by 4.6 m (15 ft) long by 11.3 m (37 ft) high, provides a shielded area adjacent to the Work Cell where personnel can perform maintenance on the cranes, PDMs, and other Work Cell equipment. The Contact Maintenance Area is constructed of reinforced concrete.

The Contact Maintenance Area has two main floor levels: the lower level is located on the first floor of the building at Elevation 102’-6" while the upper level is located on the third floor at Elevation 128’-6". The roof is comprised of reinforced concrete and includes a weather-tight roof hatch to allow equipment replacement and access. In addition to the main floor levels, two intermediate level platforms composed of structural steel grating are provided for access and maintenance of the cranes’ telescoping tubes. The cranes enter the maintenance area through slotted openings at the end of the Work Cell. To provide a barrier between the maintenance and work areas, shield and air control doors are provided. Ladders extending through openings in each intermediate level platform and the third (upper) level provide worker access to all levels inside the Contact Maintenance Area without exiting the area. Personnel access to the first level is provided by a double airlock between the Contact Maintenance Area and the Radiation Protection Operations area. At the top level, a second double airlock access is provided from a small room adjacent to the Mechanical Equipment Area.

On the first level, a stainless-steel lined space is provided for liquid waste transfer/recirculation pumps and valves, storage shelves, and a work bench. A floor drain allows drainage of washdown water to the washdown collection tanks, which are located below the floor of the Contact Maintenance Area in the Drain Tank Collection Vault. Access to the tank vault is provided by a 1.2 m (4 ft) by 1.2 m (4 ft) square access hatch and a rung ladder to the floor below at Elevation 93’-0". The vault floor and walls are lined with stainless steel. The Drain Tank Collection Vault contains the Work Cell Washdown Receiving Tank, Buffer Cell/Contact Maintenance Area Washdown Receiving Tank, and Batch Transfer Tank.

The upper level floor is composed of reinforced concrete in the eastern portion and steel framed construction in the western portion. A slotted opening is provided in the floor (enclosed by handrails when not in use) to allow maintenance on all sides of the telescoping tubes. The floor at this level is stainless steel lined and has floor drains to capture bridge crane and PDM washdown water. A bridge mounted maintenance hoist of 5-ton capacity is located above the bridge crane to assist with removal of crane components and for handling heavy items.

5.2.6 Sample Packaging and Screening Room

The Sample Packaging and Screening Room is located on the second level of the RHWF adjacent to the Operating Aisle. To support waste analysis, this area provides the capability to transfer swipes and sample bottles into the Work Cell, to remove samples from the Work Cell, and to place samples in containers for transfer to a laboratory for analysis. A shield window is located in this room to allow operators to view the Work Cell, and a PDM controller and work station controller are provided to permit remote sample transfer operations. A sample shelf is located in the Work Cell below the sample transfer drawer, which is mounted inside the shield wall. Samples are removed from the transfer drawer inside a sample transfer glove box. The packaged sample can be manually transferred to the Radiation Protection Operations Area on the first level, where it may be surveyed and released to a laboratory facility for analysis. Samples can also be pre-screened and counted for gross Beta and gross Alpha activity with counting equipment available in the Sample Packaging and Screening Room. Continuous Air Monitors (CAMs) and Area Radiation Monitors (ARMs) are located in the area.

5.2.7 Radiation Protection Operations Area

The Radiation Protection Operations Area receives Work Cell samples that are transferred from the Sample Packaging and Screening Room. This area is also equipped with a sample transfer glove box, which can receive swipe samples of waste packages that are obtained using the swipe survey reach rods in the adjacent Waste Packaging Area, and a shielded liquid sample glove box with a drain. A hood is also provided to support activities in this area.

5.2.8 Waste Packaging Area

The Waste Packaging Area, an area 3.4 m (11 ft) long by 6.1 m (20 ft) wide by 2.4 m (8 ft) high, is located adjacent to the southeast corner of the Work Cell on the first floor of the RHWF. This area provides a confined and shielded space for efficiently transferring filled waste containers out of the Work Cell via the Waste Transfer System. Controlled and sealed transfer ports mounted on top of the Waste Packaging Area provide the physical boundaries necessary to bring material out of the Work Cell area while maintaining the exterior of the shipping package clean.

The Waste Packaging Area is isolated from the Work Cell by a combination of shield walls, Waste Transfer System port covers, and shield covers. Except during load out operations, the shield covers remain closed in place above the Waste Packaging Area in the Work Cell to prevent accumulation of contamination around the transfer ports. Steel shield doors seal off the rear of the Waste Packaging Area from the Survey and Spot Decontamination Area and provide a contamination and radiation control barrier.

Two manually operated, telescoping reach rods penetrate the Waste Packaging Area east walls. These reach rods are used for radiation probe movement and swipe sampling of

containers. A separate mechanism is available to assist in drum outer lid placement and fastening. A viewing window allows operators to make visual observations while performing transfer and swipe sampling operations. A swipe transfer port leads to a nearby glove box or hood to process swipe samples.

Two transfer systems are installed within the Waste Packaging Area using container transport carts, respectively, mounted on rails. Cart rails extend from the Waste Packaging Area under the transfer ports to the packaging area shield doors. A monorail transfer hoist is installed on the ceiling of the Survey and Spot Decontamination Area to lift and transport a drum or a drum in a shielded overpack onto and off of the drum transfer cart. In addition, the hoist can be used to take shielded overpacks on and off the carts. A forklift will lift B-25 boxes onto and off of the box transfer cart.

The Survey and Spot Decontamination Area provides a space for surveying, spot decontaminating, and overpacking filled waste containers. There is sufficient space to allow a forklift to pick up filled containers. The floor elevation of the Survey and Spot Decontamination Area is at the same elevation as the Load Out/Truck Bay to facilitate moving filled containers to the Load Out/Truck Bay for loading onto vehicles.

A floor drain (plugged when not in use) allows washdown of the Waste Packaging Area. Access to the Waste Packaging Area is provided from the Exhaust Ventilation Filter Room, the Radiation Protection Operations Room, and the Load Out/Truck Bay.

5.2.9 Operating Aisle

The Operating Aisle is a long aisle way outside the Work Cell and Buffer Cell on the second floor of the RHWF that provides a clean, shielded space for remotely operating facility equipment. The Operating Aisle has a clear space area of approximately 4.3 m (14 ft) wide by 29.9 m (98 ft) long, and a clear ceiling height of approximately 3.7 m (12 ft). The Operating Aisle turns 90 degrees at its south end over the Waste Packaging Area location.

Three shield windows are installed in the Operating Aisle wall. Two of the windows provide views into the Work Cell while a third window provides a view into the Buffer Cell. An additional shield window is provided in the Sample Packaging and Screening Area that permits a view down the entire length of the Work Cell. Operator work stations are available at the two shield windows located in the east Work Cell wall. A frame with a concrete shield plug is provided in the Operating Aisle wall as a port for radiological assay of waste items. Preliminary radiological waste analysis will be performed in the Work Cell through the port using a high purity germanium (HPGe) crystal detector. The HPGe detector coupled with software, attenuators, and a computer will measure the activity of Cs-137, which is the predominant scaling isotope to estimate the TRU content in an item of debris. Motor control centers (MCCs) and instrumentation cabinets are also located in the Operating Aisle. A roll-up door and a platform in the east wall leading into the Load Out/Truck Bay are provided to facilitate master slave manipulator (MSM) installation/removal and movement of equipment to and from the Operating Aisle. Access to the Operating Aisle is also provided through the north and south stairwells. From the Operating Aisle, access is provided to the Utility Chase and the Sample Packaging and Screening Room.

5.2.10 Load Out/Truck Bay

The Load Out/Truck Bay is an extension on the east side of the RHWF that provides a weather-enclosed structure to support loading of filled waste containers onto transport vehicles and transfer of empty waste containers into the facility. This area is a clear span pre-engineered metal structure with a metal wall and roof system and is approximately 18.3 m (60 ft) long by 15.2 m (50 ft) wide. The long axis of the Load Out/Truck Bay is oriented in the north-south direction. The Load Out/Truck Bay is positioned such that the center bay is aligned with the Waste Packaging Area.

Access to the Load Out/Truck Bay is through three roll-up doors and three personnel doors provided on the north, east, and south sides. One additional roll-up door is

provided on the west side for access and movement of waste containers into and out of the Waste Packaging Area. Access to the roof is provided on the third level of the RHWF from the Mechanical Equipment Area. A platform is located on the second level for access to and removal of equipment from the Operating Aisle. The Load Out/Truck Bay is sized to allow for side loading of a flat bed vehicle using a forklift. The Load Out/Truck Bay accommodates, with its doors closed, a trailer nearly 15.2 m (50 ft) in length so work may continue during inclement weather or when the loading operation is extended over multiple shifts.

5.2.11 HVAC Areas

5.2.11.1 Mechanical Equipment Area and Stack Monitor Room

The Mechanical Equipment Area and Stack Monitor Room are located on the third level of the RHWF above the Operating Aisle. This area is steel-framed, insulated, and sheet-metal-sided. The Mechanical Equipment Area contains two air compressors and the decontamination system pressurizer. Each compressor has a receiver, dryer, filter, and carbon monoxide monitor and alarm associated with it. One compressor can meet all utility air, instrument air, and breathing air supply requirements. The decontamination system pressurizer increases and regulates the pressure supplied to the RHWF decontamination system. The pressurizer provides demineralized water at a pressure of approximately 1482-1655 kPa (215-240 psig). Fire protection and utility piping reach this area through the Utility Chase.

Stack effluent monitors and samplers are located in the Stack Monitor Room, which is situated on the north end of the Mechanical Equipment Area. The Mechanical Equipment Area and Stack Monitor Room are accessed from the north stairwell and the south stairwell. Access to the roof is provided via a door to a platform over the roof of the Load Out/Truck Bay. From this platform, a ladder provides access to the roof above the Mechanical Equipment Room and Stack Monitor Room. There is also a door from the north stairwell that provides access to the Exhaust Stack Access Platform which is above the Exhaust Ventilation Blower Room.

5.2.11.2 Exhaust Ventilation Filter Room

The Exhaust Ventilation Filter Room is an area approximately 13.4 m (44 ft) long by 4.3 m (14 ft) wide that is located at the north end of the RHWF below the Operating Aisle on the first floor. This area provides a suitable space for changing the filters associated with the ex-cell air cleaning units, which are located in this room. The ex-cell air cleaning units contain two arrays of bag-in bag-out high efficiency particulate air (HEPA) filters in series. There are two trains of ex-cell exhaust ventilation system filtration, of which only one is normally in use. The HEPA filters in the air cleaning unit housings are standard size filters, 0.61 m (2 ft) by 0.61 m (2 ft) by 0.30 m (1 ft), arranged in a three-by-three array. A monorail hoist is provided for movement of equipment and consumables (filters).

The air cleaning units are designed for the bag-in bag-out method of filter replacement. However, the use of in-cell filter banks in the Work Cell is expected to greatly reduce the change-out frequency of the ex-cell HEPA filters. Fail-as-is isolation valves are provided upstream and downstream of each air cleaning unit housing.

The Exhaust Ventilation Filter Room can be accessed from the Survey and Spot Decontamination Area or the north stairwell. A door is also provided in this room for access to the Buffer Cell double airlock.

5.2.11.3 Exhaust Ventilation Blower Room

The Exhaust Ventilation Blower Room is approximately 6.4 m (21 ft) long by 4.6 m (15 ft) wide and is located directly adjacent to the exterior face of the Operating Aisle north wall. It is a one story pre-engineered structure with an insulated metal wall and roof system. The floor of the Exhaust Ventilation Blower Room is at an elevation of approximately 98’6". The HVAC exhaust stack, anchored to the north side of the RHWF, penetrates the roof and has a top elevation of approximately 165’6".

The Exhaust Ventilation Blower Room provides an isolatable space for the large blowers that pull air from the Work Cell through the HEPA filters, and houses other exhaust air system equipment such as motors, dampers, and exhaust filter test equipment.

Each ex-cell filter train housed in the Exhaust Ventilation Filter Room is connected to the blowers in the Exhaust Ventilation Blower Room. The outlets for the two blowers (one operating, the other typically in standby) are connected to the HVAC exhaust stack. The stack access platform is located above the roof of the Exhaust Ventilation Blower Room; a door at the top level of the north stairwell provides access to the stack access platform.

5.2.12 Office Area

The Office Area is an extension on the south side of the RHWF and provides a clean, low-dose-rate area to perform administrative functions. This area is a pre-engineered clear span steel-framed structure approximately 8.5 m (28 ft) wide by 9.4 m (31 ft) long, with insulated siding and roofing. The Office Area consists of two stories and contains the shift supervisor’s office, crew offices, meeting rooms, a kitchenette, and sanitary facilities. A utility/service room is located on the southeast corner of the first floor. Access is provided by personnel access doors on the south and west sides, and three access doors from the east concrete stairwell (ground floor, second level, and roof level). Standard windows are provided on the west and south sides. The Office Area has its own independent HVAC system (described in Section 5.4.1). Access to the HVAC equipment on the roof is provided through the stairwell personnel door on the third level.

5.3 Fire Protection Systems

The fire protection system for the RHWF consists of two systems:

1) The Fire Detection System detects smoke and fire and provides local and remote audio and visual alarms for operating personnel to safely shut down the processing operation and evacuate the areas, if required.

2) The Fire Suppression System consists of a wet sprinkler system, fire extinguishers and yard hydrants placed at designated areas, and other measures designed to contain and extinguish a fire should it occur within the RHWF.

The design and construction of the RHWF uses noncombustible materials such as concrete and steel. Fire and safety steel doors are used to contain and prevent the spread of fire. Administrative control procedures are implemented to minimize the introduction of combustible and flammable materials into the RHWF. Additional information regarding administrative controls is provided in WVNS-FHA-014, *Fire Hazards Analysis - Remote-Handled Waste Facility*.

5.3.1 Fire Detection System

The RHWF Fire Detection System is designed to provide early warning fire detection and to initiate signals. The Fire Detection System provides local audible/visible alarms for evacuation, trouble signals, electric supervision of all circuits, and supervisory devices for all critical functions. The system is intelligent device analog addressable, utilizing multi-criteria smoke detection technology with digital communication techniques. The system is designed to alarm in response to the actuation of a smoke detection system, a flow of water in areas where a sprinkler system is installed, and manual activation of a fire alarm box. To help protect the ventilation filter train, a heat detection system is installed in the ventilation stream of each of the four ventilation intake filter banks in the Work Cell. Upon detection of a fire anywhere in the ventilation system, the operating ventilation train will be dampened down and the variable speed drive for the fan will be adjusted to reduce the air flow. This will reduce the supply of air to a potential fire while maintaining a negative cell pressure for contamination control.

A Fire Alarm Control Panel (FACP) is located on the first floor in the Utility Chase. The FACP provides the power, annunciation, supervision, and control for the Fire Detection System. The FACP has the ability to acknowledge, test, reset, and silence all signals, and is programmed to close both of the fire rated overhead roll-up doors upon activation of an alarm from either fire area bounding the doors. A Keltron data gathering panel is located adjacent to the FACP to report alarm, trouble, and supervisory points to the Main Plant Keltron receiver on the existing communication loop. FCAP functions for the fire/smoke damper, stairwell fans, doors, and other control devices are integrated to allow for the proper sequential shut down of building functions to prevent the spread of fire, smoke, and radiological contamination. A signal from the facility Programmable Logic Controller (PLC)System will monitor all ventilation functions to ensure proper fire damper closure as per the fire zone designation and to initiate ventilation control to ensure that the spread of smoke and radiological contaminants is minimized. Upon detection of a fire anywhere in the ventilation system, the operating supply ventilation train will be shut down and the variable speed drive for the exhaust fan will be adjusted to reduce the air flow. This reduction in air flow will be initiated by the FACP but controlled via the facility PLC. The resulting action will reduce the supply of air to a potential fire while maintaining a negative cell pressure for contamination control.

Pull stations are installed at all personnel doors that exit the RHWF or exit a floor (into a stairwell). This includes personnel doors that exit from rooftop areas into stairwells. Horns/strobes are installed for audible and visual notification and evacuation in all occupied areas. Audible alarm signals are designed to produce a sound level of at least 15 dBA above the ambient sound level or 5 dBA above the maximum sound level (whichever is greater) measured 5 feet above the floor in each occupied area. Visual notification devices are designed to produce a flash rate of one flash per second minimum.

Primary power for the FACP is obtained from 313-MCC-003, which also provides standby power from the Permanent Ventilation System (PVS) diesel generator in the event of a commercial power failure. Secondary power for all fire alarm functions is supplied by gelled electrolyte batteries. The battery supply is designed to operate loads in a supervisory mode for 24 hours with no primary power applied and, after that time, to operate in alarm mode for 15 minutes. Battery-charging circuitry is provided for each standby battery bank in the system. All system battery charge rates and terminal voltages can be read using the FACP display.

Activation of any addressable manual fire pull box, area smoke detector, beam smoke detector, heat detector, or sprinkler water flow switch causes the following actions and indications:

- The “ALARM” notification to the FACP in the utility chase is activated, indicating the device address, device type, device location, time, and date.

- The “ALARM” notification at the Main Plant Keltron receiver is activated, indicating the corresponding fire zone.

- Emergency evacuation audible and visual notification appliances are activated throughout the facility.

- Fire emergency HVAC operational shutdowns and purge requirements are activated in the associated fire zone only. Radiological emergency conditions will allow the Programmable Logic Controller (PLC) System to override fire alarm HVAC outputs.

- The event is recorded to the system historical log.

Trouble conditions such as loss of primary power, low battery voltage, or failure of an addressable device automatically activate an audible signal and flash the general system trouble indicator at the Fire Command Station (FCS). Receipt of a system trouble alarm causes the following actions and indications:

- The “TROUBLE” notification to the FACP in the utility chase is activated, indicating the device address, device type, device location, time, and date.

- The “TROUBLE” notification at the Keltron receiver is activated, indicating the corresponding fire zone.

- The event is recorded to the system historical log.

Pressing the trouble acknowledge key on the FCS silences the audible signal and causes the visual LED indicator to continue to light until the trouble condition is repaired. Subsequent trouble conditions will resound the audible signal and again flash the LED indicator. Each trouble condition must be individually acknowledged.

5.3.2 Fire Suppression System

An automatic “wet pipe” sprinkler system is designed to contain and/or prevent the spread of fire in the normally occupied areas of the RHWF. The system consists of piping, control valves, zone isolation valves, sprinklers, supports and anchors, alarms, and test vales. The sprinkler system provides coverage in all areas of the facility with the exception of the following:

- Buffer Cell

- Work Cell

- Contact Maintenance Area

The exception is based on limited combustible loading, the two-hour fire separation provided by the physical boundaries (walls, doors, and ceiling, and accessibility for testing and maintenance of the in-cell system. Accident analysis of an in-cell fire is provided in Section 9.2.2.3 of this SAR.

In the Buffer Cell, Work Cell, and Contact Maintenance Area, the Fire Hazard Analysis (FHA) has determined that there is a very low fire occurrence risk. The FHA contends that there is low combustible loading and minimal ignition sources. The physical boundaries (walls, doors, and ceiling) all qualify as a fire barriers capable of stopping the fire spread to the ex-cell areas. In addition, the ventilation system is well protected by noncombustible filter elements and heat detection capability interfaced to the ventilation controls. As assessed in the FHA, the maximum credible fire loss scenario postulates that a fire in the Work Cell will self-terminate.

The sprinkler system is designed as a multiple-zone system. Water supply piping for the system is connected to the existing WVDP fire protection water supply distribution system, which is described in Section 5.3 of WVNS-SAR-001. The capacity of the WVDP water storage tank is 1,800,000 L (475,000 gal) with 1,100,000 L (300,000 gal) reserved for fire fighting. An electrically-driven pump provided with a diesel backup is used to pump water from the storage tank through the system. Both pumps are rated at 63 L/s (1,000 gpm) at 690 kPa (100 psi). The electric motor-driven fire pump is arranged to start automatically. The diesel pump starts automatically if the system water pressure continues to drop. Both fire pumps are located in the fire pump house located at the base of water storage Tank 32D-1.

Quick response sprinkler heads are installed in the RHWF Office Area, while standard response sprinkler heads are installed in all other areas. The system layout and pipe sizing are designed to provide the following specified coverage:

- Office Area: 0.10 GPM per ft^2 to the most hydraulically remote 1500 ft^2 per National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems*, Light Hazard.

- All Other Areas: 0.15 GPM per ft^2 to the most hydraulically remote 1500 ft^2 per NFPA 13, Ordinary Hazard Group I.

A fire department connection is provided on the exterior of the RHWF at the riser location in the Utility Chase. Two fire hydrants are located near the road leading to the RHWF and are within 91.4 m (300 ft) of any portion of the facility. Each hydrant is fitted with an isolation valve and a curb box to allow for unit isolation and maintenance accessibility.

Portable fire extinguishers are provided at designated areas, in accordance with site standards and NFPA 10, *Standard for Portable Fire Extinguishers*, for use by building occupants or the WVDP Fire Brigade to contain and extinguish small fires in their incipient stage.

5.4 Description of Service and Utility Systems

5.4.1 HVAC Systems

The HVAC systems for the RHWF include the Contaminated Area Air Cleaning Exhaust System and the Uncontaminated Area Ventilation/Air Conditioning Supply Air Systems.

- The Contaminated Area Air Cleaning Exhaust System is comprised of remotely replaceable in-cell HEPA filters, fully redundant ex-cell filtration units containing two testable bag-in bag-out HEPA filters in series, and redundant exhaust blowers discharging to a common stack. The stack discharge flow is monitored by the Stack Effluent Radiation Monitoring System to demonstrate compliance with applicable discharge criteria. This system is further described in Section 5.4.1.1.

- The Uncontaminated Area Ventilation/Air Conditioning Supply Air Systems supply filtered and heated 100-percent outside air to uncontaminated areas of the RHWF. Air conditioned and heated air is supplied to the Office Area and to various spaces within the processing area. Each of the air supply units contains a centrifugal fan, air filters (low, medium, and high efficiency), and gas fired heating coils within one housing. The main supply air conditioning system has additional cooling coils and a condensing unit. These components are further described in Section 5.4.1.2.

The HVAC systems provide for personnel comfort, maintain a suitable operating environment for equipment, minimize airborne contaminants within the Work Cell, maintain design negative pressure for selected areas, ensure that atmospheric discharges remain within regulatory limits, and effect a controlled response in the event of a fire.

Supply air for the RHWF is progressively drawn from less contaminated to more contaminated areas to preclude radioactive contamination of clean areas. The supply air is finally directed to the Work Cell and exhausted to the stack. This ensures that normal radiological releases are within the limits set by applicable state, DOE, and other Federal requirements.

Transient Operation - opening the shield door between the Buffer Cell and the Work Cell may cause a transient in the pressure within the Work Cell. The transient is not expected to last more than a few minutes. The differential pressure controller that senses Work Cell Pressure will increase the exhaust fan speed to mitigate the transient.

The facility is segregated into HVAC zones, which incorporate multiple physical barriers and utilize differential pressures to control the direction of airflow. The direction of ventilation airflow is maintained from zones of lesser contamination potential to zones of greater contamination potential under both normal and off-normal conditions. Zones for the RHWF are defined as follows:

- Zone I designates areas that are expected to contain radioactive materials during normal operations.

- Zone II designates the operating area and other potentially contaminated areas surrounding Zone I. These spaces are normally not contaminated.

- Zone III designates areas that are expected to be free of contamination at all times.

Pressure conditions and air flow rates for major areas of the RHWF are shown in Figures 5.4-1 through 5.4-3. A summary of pressure conditions and air flow rates for contaminated RHWF zones is provided in Table 5.4-1. The HVAC systems are designed to ensure the integrity of Zone I and Zone II areas within the RHWF by maintaining their respective design negative pressure, thus containing the spread of airborne radioactivity. The pressure differential between adjacent areas of the RHWF is maintained by controlling the Work Cell pressure differential relative to the outdoors, and balancing the leakage paths between the adjacent areas. The Work Cell negative pressure is maintained by a combination of limited in-leakage to the Work Cell and control of the speed of the operating Air Cleaning Unit exhaust fan. Double airlocks are provided as a buffer zone between Zone III and Zone I areas. Alarms are provided to indicate when pressure differentials are not within a prescribed range.

Ventilation system exhaust from Zones I and II is HEPA filtered. To ensure that the ventilation system confinement function is maintained even if the exhaust blowers are not available, dampers and/or HEPA filters are provided to filter or prevent inadvertent back flows from contaminated to clean areas. All Zone I penetrations are positively sealed through means such as nuclear grade dampers or butterfly valves. Ductwork connected to a Zone I space which has the potential for being breached during a design basis accident is fitted with fire-rated, automatic fail-safe isolation dampers to contain the potential spread of contamination. This configuration allows natural ventilation flow from Zone 1, through the HEPA filters, to the stack.

The PLC system controls all supply fans for the RHWF HVAC system, and controls the starting and stopping of the Air Cleaning Unit exhaust fans. In the event of a trip of the operating exhaust fan, the standby exhaust fan starts automatically. The Fire Detection System and Radiation Monitoring System provide alarm inputs to the PLC system. The PLC system incorporates these alarms in a defined logic to control RHWF ventilation supply and exhaust fans, isolation dampers, and fire dampers to provide an optimal response to a fire as discussed in WVNS-FHA-014.

The HVAC system supply and exhaust ductwork must pass through concrete shielding to maintain the contaminated areas at negative pressure relative to the remainder of the facility. Duct and piping penetrations through Zone I shield walls are located to minimize radiation streaming to potentially occupied areas. Equivalent shielding thicknesses are maintained at these penetrations to meet dose rate criteria for the RHWF.

5.4.1.1 Contaminated Area Air Cleaning Exhaust System

The Contaminated Area Air Cleaning Exhaust System is designed to maintain the minimum design negative pressures within the Work Cell, Buffer Cell and the Contact Maintenance Area. Each of the air cleaning units is sized to exhaust 4.25 m^3/s (9,000 cfm) from the Work Cell, and is comprised of two HEPA filter stages in series within a single housing and a direct driven variable speed centrifugal fan external to the housing. Fail-as-is isolation valves are provided upstream and downstream of each of the air cleaning units. Differential pressure indicating transmitters are provided across each HEPA filter bank to monitor differential pressure and provide input to the PLC system. A dual setpoint differential pressure indicating switch is provided for each fan with separate dry contacts for high and low differential pressures.

The air cleaning unit fans are direct driven with variable speed motors for reliability, flexibility, and control capability. Controls are provided to modulate the fan motor speed in response to the differential pressure measurements between the Work Cell and the outdoors. The fans are powered from off-site and backup power supplies. The air cleaning units are provided with the capability to increase total airflow to 133 percent of the design value [i.e., up to a total airflow of 5.66 m^3/s

(12,000 cfm)] by increasing the exhaust fan speed and replacing 0.47 m^3/s (1,000 cfm) rated HEPA filters with 0.71 m^3/s (1,500 cfm) rated HEPA filters.

The in-cell high efficiency filter banks, 313-T-007 through 313-T-010, are placed in strategic locations within the Work Cell. Each of the four filter banks contains six filter housings, and each filter housing contains one medium efficiency filter [30 cm (12 in) wide, 61 cm (24 in) long, 10 cm (4 in) deep] and one high efficiency filter [30 cm (12 in) wide, 61 cm (24 in) long, 29.2 cm (11.5 in) deep]. Thus, in all, the in-cell high efficiency filter banks comprise twenty-four medium efficiency and twenty-four high efficiency filters. Rated airflow per bank of six filters is 1.42 m^3/s (3,000 cfm) normal, 1.89 m^3/s (4,000 cfm) maximum.

The housing design for the in-cell filter banks allows change-out of the medium and HEPA filters using remote manipulators.

Airflow through the Work Cell is not recirculated. The exhaust air from the Work Cell is released through the RHWF exhaust stack and is monitored by the Stack Effluent Monitoring System. The Exhaust Ventilation Filter Room requires area radiation monitoring, as the HEPA filters may become sufficiently contaminated to require replacement to maintain the area dose rate within desired operational limits.

5.4.1.2 Uncontaminated Area Ventilation/Air Conditioning Supply Air Systems

Components of the Uncontaminated Area Ventilation/Air Conditioning Supply Air Systems include the following:

- Main Supply Air Conditioning System. The main air supply system is a 2.91 m^3/s (6,170 cfm) once-through system comprised of an outside air intake louver with wire mesh screen, low, medium, and high efficiency filters, a cooling coil, a gas fired heater section and a centrifugal fan, all within one housing. Differential pressure indicating transmitters and switches are provided to monitor differential pressure across the filters and provide input to the PLC. A dual set point differential pressure indicating switch is provided across the supply fan to alarm abnormally high and low pressure differentials. An air actuated isolation damper is provided on the supply unit discharge, which is interlocked to the fan motor with a time delay. The damper will automatically close on unit shutdown and fail closed on loss of air. The system will also be shut down by the PLC upon receipt of a smoke or fire signal from the Fire Detection Control Panel.

- Receiving Area Ventilation System. The Receiving Area ventilation system delivers approximately 2.93 m^3/s (6,200 cfm) of ventilation air to the Receiving Area. The supply air handling unit is located outside the Receiving Area and is comprised of low, medium, and high efficiency filters, a centrifugal fan, and a gas fired heater section in the fan discharge, all within a single housing. The system operates continuously to maintain the required pressure differential relative to the Buffer Cell. Instrumentation is provided to alarm high differential pressure across the filters. A differential pressure-indicating switch is provided across the supply fan to alarm abnormally high and low pressure differentials. An air actuated isolation damper is provided on the supply unit discharge, which is interlocked to the fan motor with a time delay. The damper will automatically close on unit shutdown and fail closed on loss of air. The system will also be shut down by the PLC upon receipt of a smoke or fire signal from the Fire Detection Control Panel. An exhaust fan with an air operated isolation damper is provided to assure a proper airflow balance. The isolation damper will automatically close on a high airborne radiation signal in the area to minimize the release of radioactive contamination in the event of a spill or container breach.

- Load Out/Truck Bay Ventilation System. The Load Out/Truck Bay ventilation system delivers approximately 1.18 m^3/s (2,500 cfm) of ventilation air to the Load Out/Truck Bay. The supply air handling unit is located outside of the Load Out/Truck Bay and is comprised of low, medium, and high efficiency

filters, a belt-driven centrifugal fan, and a gas fired heater section in the fan discharge, all within a single housing. The system operates continuously to maintain the required pressure differential relative to the Survey and Spot Decontamination Area. Instrumentation is provided to alarm high differential pressure across the filters. A differential pressure-indicating switch is provided across the supply fan to alarm abnormally high and low pressure differentials. An air actuated isolation damper is provided on the supply unit discharge, which is interlocked to the fan motor with a time delay. The damper will automatically close on unit shutdown and fail closed on loss of air. The system will also be shut down by the PLC upon receipt of a smoke or fire signal from the Fire Detection Control Panel. An exhaust fan with an air operated isolation damper is provided to assure a proper airflow balance. The isolation damper will automatically close on a high radiation signal in the area to minimize the release of radioactive contamination in the event of a spill or container breach.

- Office Air Conditioning System. The office air conditioning system delivers approximately 1.93 m^3/s (4,100 cfm) of air-conditioned air to the Office Area. The air conditioning portion of the system is comprised of medium and high efficiency filters, cooling coil, a belt-driven centrifugal fan, and a gas fired heater section in the fan discharge, all within a single housing. The separate condensing unit is air cooled. Both units are located on the roof of the Office Area. An isolation damper is provided to automatically isolate the ventilation supply unit when not in operation. Instrumentation is provided to alarm high differential pressure across the filters. A differential pressure-indicating switch is provided across the supply fan to alarm abnormally high and low pressure differentials.

- Contact Maintenance Area Air Conditioning System. Air is supplied to the Contact Maintenance Area by transfer from the normally-occupied areas served by the Main Supply Air Conditioning System. The air within the Contact Maintenance Area is heated and cooled by a recirculating air conditioning unit. The Contact Maintenance Area air conditioning unit is comprised of a medium efficiency filter, cooling coil, electric heating coil, and a centrifugal fan all within a single housing located on the platform at Elevation 119'-6" of the Contact Maintenance Area. The condensing unit is air cooled and is located on the Office Area roof.

- Stair Tower Pressurization Fans. The RHWF north and south stair towers are each provided with a pressurization fan equipped with an automatic damper. The fans and dampers are actuated through the PLC system in response to any facility fire alarm by the Fire Detection System. The fans are actuated to assure a positive pressurization of the stairwells with outside air to preclude smoke infiltration. These fans are not required to run during normal ventilation system operation.

All of the natural gas piping and heating units containing gas heater sections are located outdoors to preclude potential gas leakage within the facility.

In the event of a power loss, the fan in the Main Supply Air Conditioning System unit is powered from the backup power supply and can be restarted to provide approximately half of the normal Work Cell exhaust flow rate. One of the Air Cleaning Unit exhaust fans is also powered from the backup power supply and can be restarted via the PLC system to provide exhaust flow and maintain a negative pressure in the Work Cell.

5.4.2 Electrical

The RHWF Electrical Distribution System (EDS) provides the required motive, control, and lighting power for operation of RHWF equipment. The EDS provides 480, 240, 208, and 120-Volt AC, 60 Hz, single/three-phase power in three categories: normal, standby, and uninterruptible. Standby power incorporates backup from a diesel generator (50P-01) and is provided to critical loads. Uninterruptible power incorporates battery backup and is provided to critical electrical loads that must

remain functional for a minimum of 30 minutes during loss of normal and standby power.

The EDS receives its normal and standby 480-Volt, 3-phase power from 480-Volt Switchgear B and PVS MCC-A (diesel backed) bus, respectively. The RHWF utilizes the motor control center (MCC) buses 313-MCC-001 (normal power) and 313-MCC-003 (standby power) to provide 480-Volt, 3-phase power to various motor loads, UPS and lighting/distribution panels via transformers. Each MCC is front-accessible National Electrical Manufacturers Association (NEMA) Class 12 with Class 1 Type B wiring. Continuous current ratings for the main and vertical buses are 600 Amp (main) and 600 and 300 Amp (vertical). Each MCC feeds 480-Volt supply to the loads. Lighting systems and other facility equipment that require 120-, 208-, or 240-Volt supply are fed through adequately rated distribution transformers and associated panels. The transformers meet NEMA ST 20 requirements. Motor control center 313-MCC-003 is also provided with a manual breaker to tie with the 313-MCC-001 bus. The MCCs have input/output interfaces with the PLC unit. Input to the PLC unit is provided to monitor system parameters such as line voltages and currents as required. The 208/120V and 240/120V panels are provided with branch circuit breakers.

The EDS is powered from a solidly grounded, 3-phase, 4-wire system. Only 3-phase conductors and reduced-size ground cables are provided to the EDS system. The EDS is connected to the 480-Volt system via adequately sized ground cable and the RHWF grounding network. Ground rods are located at the RHWF building corners and at a maximum interval of 50 feet around the perimeter of the building. The electrical equipment and raceways are connected to the grounding network. The main grid is tied into the common ground system of the WVDP site via the MCC incoming feeder cable ground wire. A separate grounding network is provided for instrument grounding to minimize interference. Electrical protection is provided by the EDS during normal, standby, or uninterruptible power supply modes by proper application of trip devices.

The EDS provides lighting for the RHWF. The required power for lighting is distributed from normal and standby power sources. Approximately 20 percent of facility lighting is provided using the standby power source, distributed uniformly throughout the facility. The remaining 80 percent of lighting is provided using normal power sources. Emergency and “EXIT” light units with built-in battery packs are provided in critical areas such as access and egress routes, including stairways.

Sealed penetrations are provided wherever EDS raceways run through floors or walls in the facility. Fire sealed penetrations are provided for raceways entering into or exiting out of the Work Cell, Buffer Cell, Contact Maintenance Area, and other fire zones. Penetrations for cable entries into shielded areas such as the Work Cell and Buffer Cell are provided with radiation seals.

<u>RHWF Uninterruptible Power Supply</u>

Uninterruptible Power Supply (UPS) equipment, located in the RHWF Operating Aisle on the second level of the facility, consists of a battery, rectifiers, an inverter, a transfer switch, a regulated distribution transformer, a battery charger, a distribution panel, protective devices and interconnecting cables. The UPS receives 3-phase, 480-Volt feed from 313-MCC-001 and 313-MCC-003. The feeder circuit is protected by a circuit breaker in the MCC for control and protection. A transformer in the UPS converts the 480-Volt supply into 208/120-Volt supply for UPS operation and for distribution to the loads. The UPS equipment output is 120V, supplying uninterruptible power via distribution panel 313-PP-005 to critical loads. The distribution panel in the UPS utilizes circuit breakers for switching and short circuit protection of outgoing branch circuits.

When power supply to the UPS is unavailable, the UPS inverter receives DC power from the UPS battery cabinet and converts it into 120V AC power for the supply of critical loads. Once normal or stand-by power is restored, the loads are automatically transferred to the normal or stand-by source. The UPS cabinet is equipped to provide metering, remote monitoring, protective and control functions as required. Surge protection is provided in the UPS distribution panel.

The UPS battery is rated for 20 KVA maximum UPS output for a backup time of 30 minutes minimum. The battery is housed in a cabinet with internal cooling and does not require additional venting to the atmosphere. The cabinet is also provided with a grounding pad and a lead-plated terminal lug suitable for ground cable. The battery is manufactured in accordance with NEMA 1B-1 or replacement standard. Several systems, i.e., fire alarm, etc., have small stand-alone UPS units supplying output for 30-minute backup and their primary feed is the standby power system.

5.4.3 Compressed Air

Compressed air is supplied to the RHWF from two compressors, each equipped with a filter, dryer, carbon monoxide monitor and alarm, and distribution piping and valves. Each compressor is capable of delivering 0.05 m^3/s (100 cfm) at a nominal pressure of 690 kPa (100 psig). Distribution piping provides utility air and instrument air for use within the facility. The utility air system may be used to supply breathing quality air in potentially contaminated areas of the Buffer Cell and Contact Maintenance Area.

Utility air service drops are provided in areas of the facility that are expected to require pneumatic tools for maintenance of facility components. Spare wall penetrations are provided for breathing air hoses at critical access locations. The instrument air distribution piping is a separate piping network and is equipped with a receiver to minimize the effect of utility air system pressure fluctuations. A tight shutoff check valve is also provided upstream of the instrument air receiver to minimize backflow during temporary drops in utility air system pressure. The immediate functionality of the instrument air supply piping is not required during or following a seismic event, since all components are designed to fail to a safe (isolated) position.

The air compressors are skid-mounted units and are located in the Mechanical Equipment Area on the third floor of the RHWF. Distribution piping headers are routed to the other areas via the Utility Chase on the eastern side of the RHWF. Backup power is supplied to one of the compressors to support select facility power outage functions. The controls for the compressors are powered from the UPS supply.

5.4.4 Steam Generation and Distribution

The RHWF does not have a steam supply.

5.4.5 Water Supplies and Water Cooling Systems

Cooling water is not required for the RHWF. Potable water is supplied to the facility from the existing WVDP potable water system, described in Section 5.4.5 of WVNS-SAR-001.

The Demineralized Water Distribution System for the RHWF is manually operated and is dependent on the existing WVDP plant system for the water supply and operating pressure. The demineralized water system at the WVDP is described in WVNS-SAR-001, Section 5.4.5. Demineralized water is supplied to the RHWF at a pressure of 380 kPa (55 psi) and a maximum available flow rate of 190 Lpm (50 gpm). Demineralized water is distributed in contaminated areas of the RHWF for the purpose of decontamination and in uncontaminated areas for the purposes of wash down and flushing. The RHWF Demineralized Water Distribution System is comprised of a distribution header of stainless steel piping and manual isolation valves used to direct the water to the following:

- Decontamination system pressurizer for use as a decontaminating water spray in the Work Cell, Buffer Cell, and Contact Maintenance Area. The decontamination system pressurizer increases and regulates the pressure supplied to the RHWF decontamination system.

- Survey/spot decontamination area for high-pressure washdown.

- Shielded glove box, liquid sample glove box, and swipe glove boxes for washdown.

- Liquid Waste Collection and Transfer System for flushing of the transfer pumps and piping prior to performing maintenance activities.

- Other RHWF areas such as the Load Out/Truck Bay and Receiving Area for washdown.

Local pressure indication is provided on the distribution header at the point of entry to the RHWF. A flow indicator and flow totalizer are provided in the water supply to the decontamination water piping. Piping systems that penetrate Zone 1 areas are designed to prevent the backflow of solution from contaminated to clean areas, and incorporate design features such as elevation differences, pressure differentials, siphon breaks, check and isolation valves, and line flushes or air purges to prevent spreading contamination through facility piping.

5.4.6 Natural Gas Supply and Distribution

Natural gas is supplied to the RHWF HVAC system to heat the facility. A natural gas supply at 28-34 kPa (4-5 psi) with a maximum flow rate of 99 m^3/h (3,500 ft^3/h) is provided for this purpose; approximately 57 m^3/hr (2,000 ft^3/hr) of natural gas will typically be required to heat the facility. The natural gas header is located outside the RHWF. Distribution piping to the gas heaters is external to the RHWF, buried underground, and all heating units containing gas heater sections are located outdoors to preclude potential gas leakage in the facility. Their manifold is located at the corner of the facility away from roads and operational traffic. The heat exchange section of each heater is under the positive pressure of the air delivery fan. Distribution piping is buried underground to the maximum extent possible.

5.4.7 Wastewater Treatment Facility

The RHWF has sanitary facilities located in the Office Area that tie into existing WVDP sanitary sewer lines. A pumping station is located outside the Office Area to pump the sewage into the pressurized force main for processing through the existing WVDP wastewater treatment plant, which is described in Section 5.4.7 of WVNS-SAR-001.

5.4.8 Safety Communication and Alarms

The paging system for the RHWF operates in conjunction with the existing WVDP site-wide paging system. All features and functions of the sitewide paging system are provided, including transmission of the 812 “all page,” 222 plant page, and sheltering alarm signals. WVDP site communications and alarm systems are discussed in Chapter 10 of WVNS-SAR-001 and in WVDP-022, *WVDP Emergency Plan Manual*.

The RHWF Communications System also provides for paging, announcing, and general personnel communication within the facility. All active electronic parts for the RHWF paging system are on a UPS in case of AC power failure. The system allows for monitoring from a remote location to detect errors, faults, and power losses. Process-related alarms are provided to alert operators to abnormal process conditions. All alarms are fail-safe with contacts opening to alarm so that broken wires are indicated as a circuit fault rather than preventing alarm conditions.

5.4.9 Maintenance Systems

Maintenance operations may be performed either remotely or manually. The majority of maintenance activities for the RHWF will be performed manually. Because the duty cycle associated with the operation of most of the equipment in the facility is minimal, it is unlikely that component wear will exceed operating parameters. All equipment within the facility except that located in the Work Cell and the HEPA filters is suitable for manual maintenance. Equipment in the Work Cell cannot be directly accessed for manual repair. Two options are available to maintain equipment in the Work Cell: replace or maintain the equipment by remote/robotic means or spray

down the equipment and move it into the Contact Maintenance Area for manual repair. Repair or replacement of components will typically be performed manually in the Contact Maintenance Area and the component will be returned to service remotely.

The Contact Maintenance Area serves an ancillary or support function for the Work Cell operating and handling equipment. It is isolated from the Work Cell by shield doors and air control doors. Access is provided for the insertion of remote handling equipment and replacement parts such as trolleys, hoists, and telescoping masts through the roof hatch. A workbench and steel storage cabinet are provided to support remote maintenance requirements. Retrieval or back-up drive systems for remote in-cell cranes and PDMs are provided for both normal and off-normal conditions. The 30-ton Work Cell bridge crane is retrieved using redundant drive motors. A towing latch is provided to retrieve the bridge crane with dual telescoping masts. The wall-mounted jib crane is retrievable using the Work Cell bridge cranes. The jib can be removed from its support, disassembled and transported to the Contact Maintenance Area.

Connectors, bolts, flanges, wrenches, sockets, extensions, etc. are standardized to the maximum extent practical in the RHWF design to reduce the need for multiple tools and frequent tool changes. Unique tooling is required for tasks such as bolt and nut removal and interfaces with the PDMs to remotely disassemble and maintain equipment in the Work Cell. Equipment is removable, maintainable and replaceable with minimum disturbance to adjacent equipment. In-cell equipment "sky-rights" ensure accessibility with overhead handling equipment.

Planned maintenance activities for the facility have been kept to a minimum. Radiation levels outside the Work Cell are generally low and, therefore, have minimal effect on the life of non-metallic components. Specific consideration of radiation effects was included in the design of the PDMs, shield door drives, crane drives, and CCTVs. With the exception of cutting tools, the degradation of components due to radiation and wear is low and does not warrant routine maintenance. In most cases, it will be more cost-effective to replace components as they fail. However, several critical routine maintenance operations have been identified for the RHWF. These include routine inspections of the bridge and jib cranes (including testing of the end of travel limit switches), calibration of the radiation monitors, scales, control system gauges, and radiation survey detectors per manufacturer recommendations, and replacement of the In-Cell filters. Replacement of the In-Cell filters will be carried out by remote operations external to the Work Cell. Replacement intervals for filters may be decided during operation based upon differential pressure readings, radiation levels, and/or time.

5.4.10 Cold Chemical Systems

There are no cold chemical systems associated with the RHWF.

REFERENCES FOR CHAPTER 5.0

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National Fire Protection Association. 1998. NFPA 10: *Standard for Portable Fire Extinguishers*.

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_____. WVNS-DC-071: *Remote-Handled Waste Facility Design Criteria*. (Latest Revision).

_____. WVNS-FHA-014: *Fire Hazards Analysis - Remote-Handled Waste Facility*. (Latest Revision).

_____. WVNS-SAR-001: *Safety Analysis Report for Waste Processing and Support Activities*. (Latest Revision).

TABLE 5.4-1

SOURCES OF AIR FLOW TO CONTAMINATED RHWF ZONES

Facility Area	Nominal Flow Rate	Relative Pressure inches w.g. (Pa)	Sources
Buffer Cell	1.87 m^3/s (3,970 cfm)	-0.5 (-125)	• Receiving Area • Exhaust Ventilation Filter Room via the airlock
Contact Maintenance Area	2.10 m^3/s (4,440 cfm)	-0.5 (-125)	• Sample Packaging and Screening Area • Radiation Protection Ops Area via the first floor airlock • Third Floor Hallway via the third floor airlock
Waste Packaging Area	0.25 m^3/s (530 cfm)	-0.5 (-125)	• Survey and Spot Decontamination Area
Work Cell	4.25 m^3/s (9,000 cfm)	-1.5 (-375)	• Waste Packaging Area • Contact Maintenance Area • Buffer Cell

Figure 5.1-1 Location of Facilities

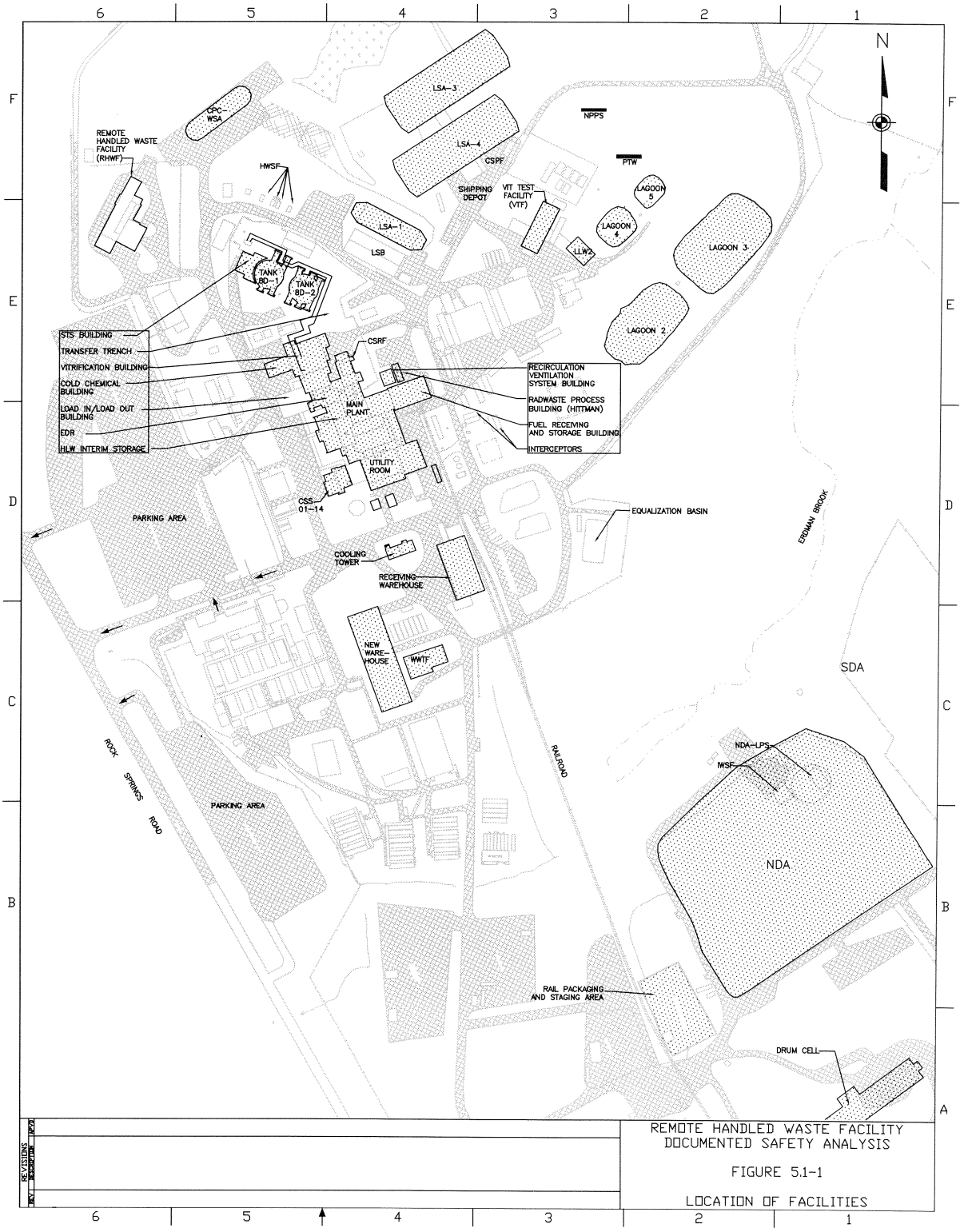


Figure 5.2-1 General Arrangement - First Level

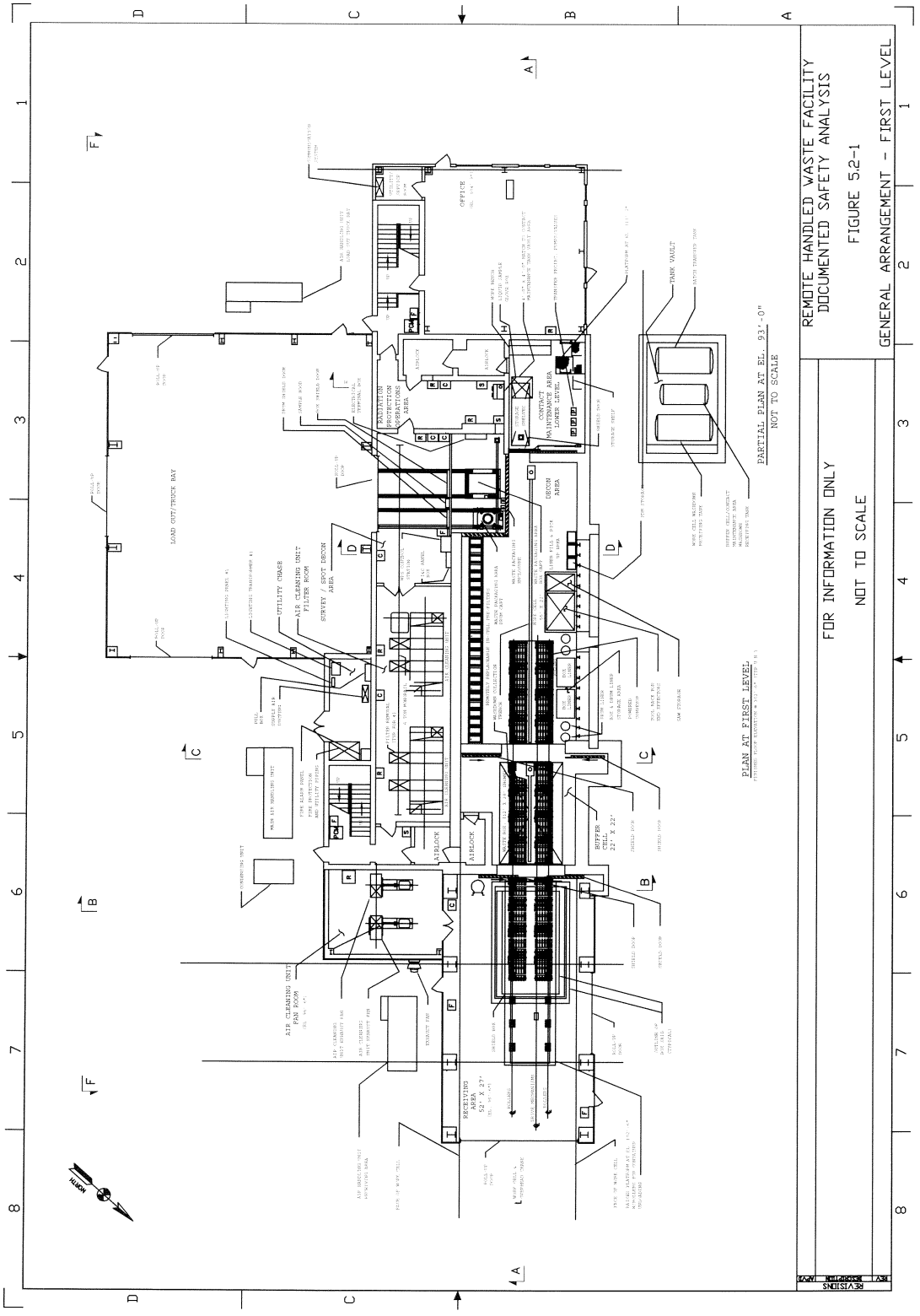


Figure 5.2-2 General Arrangement - Second Level

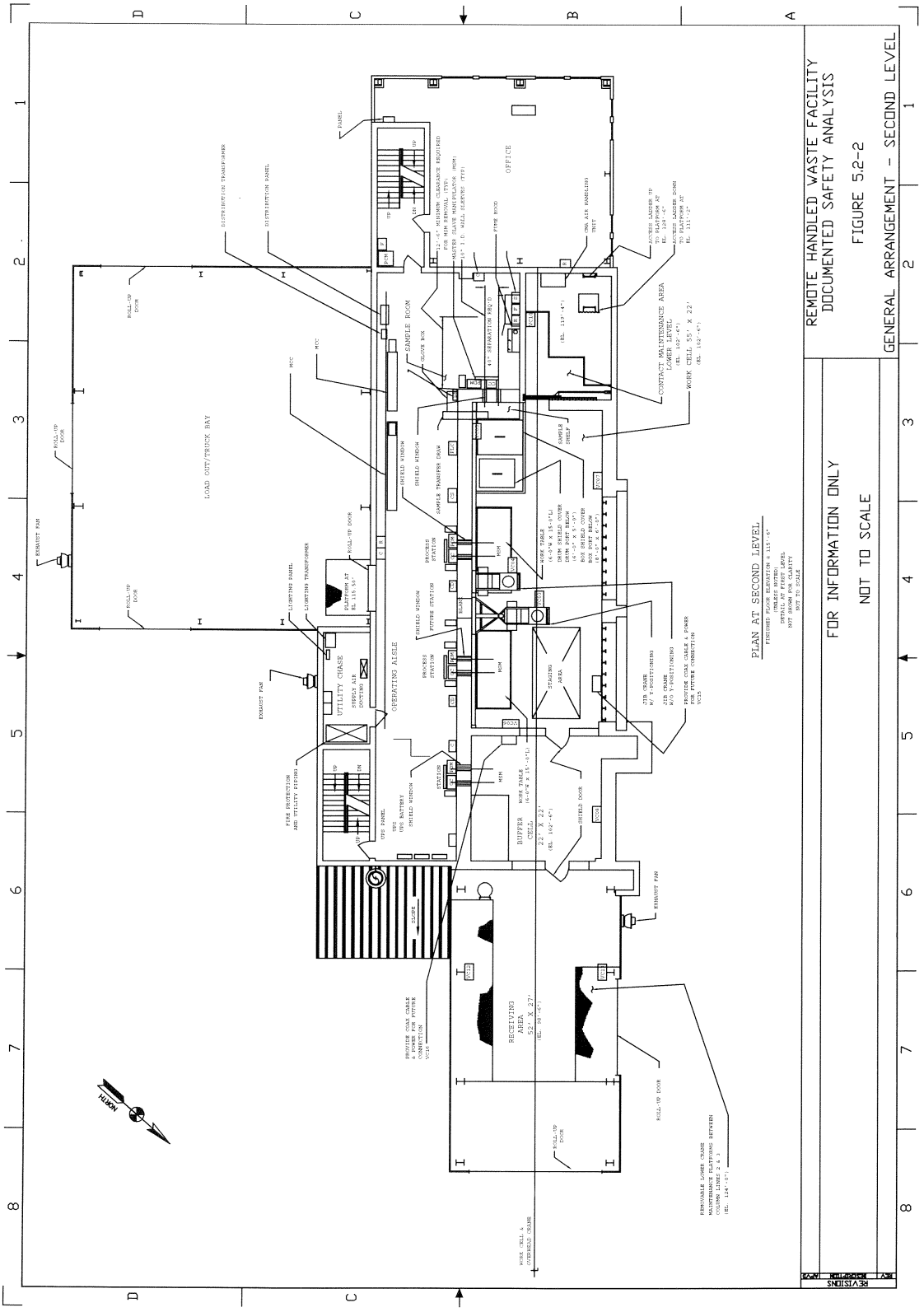


Figure 5.2-3 General Arrangement - Third Level

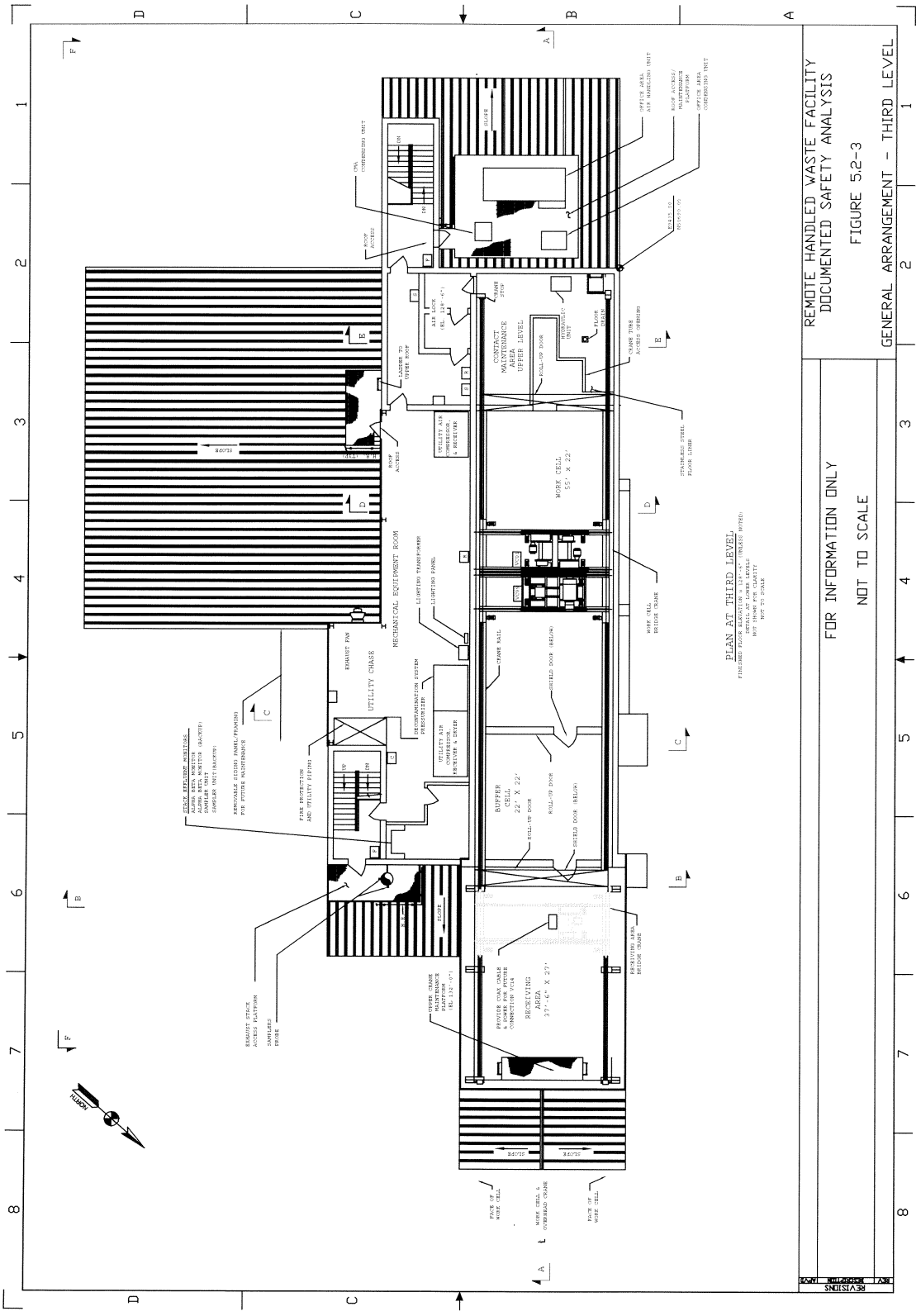


Figure 5.2-4 General Arrangement Sections A, D, & E

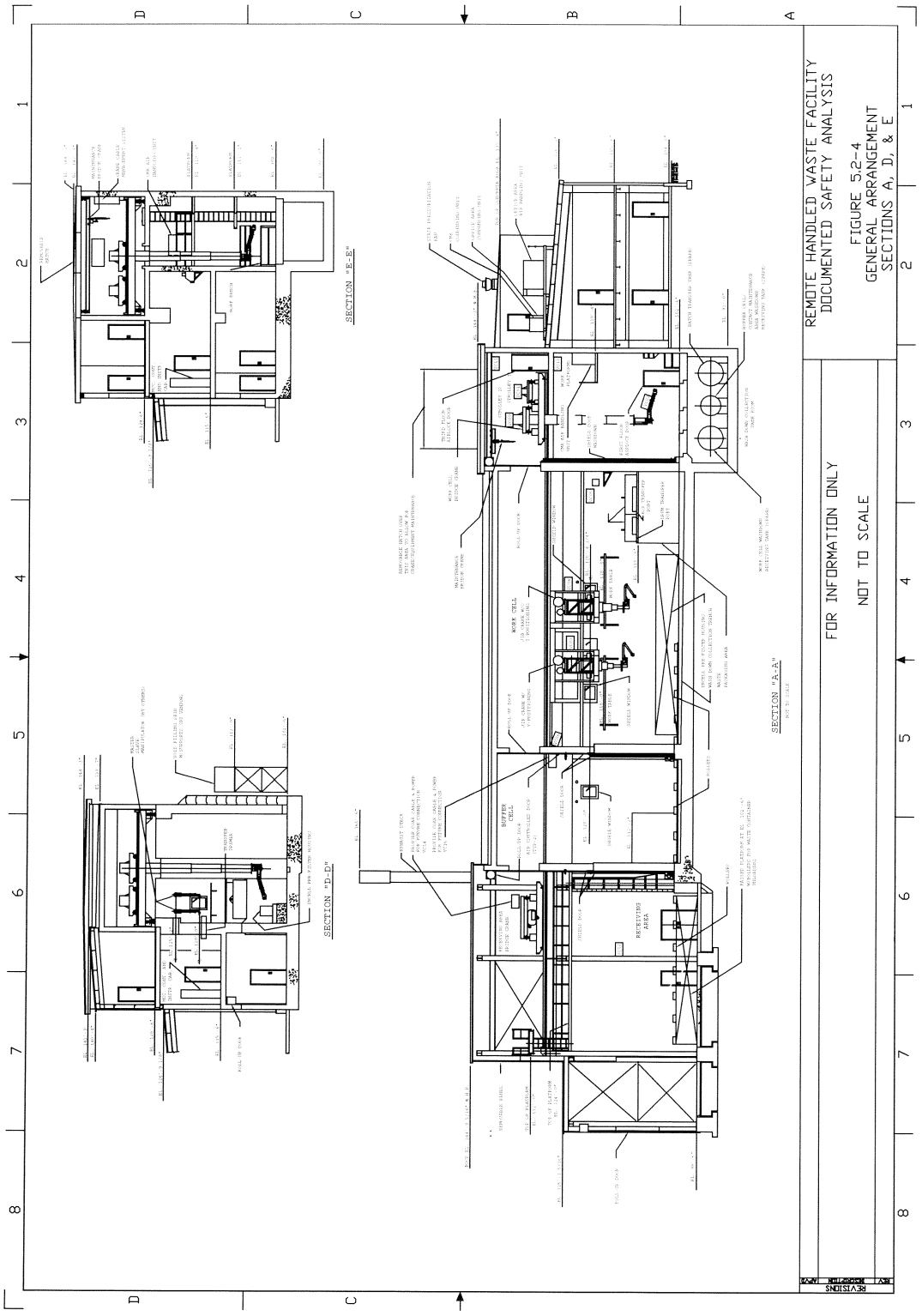


Figure 5.2-5 General Arrangement Sections B & C

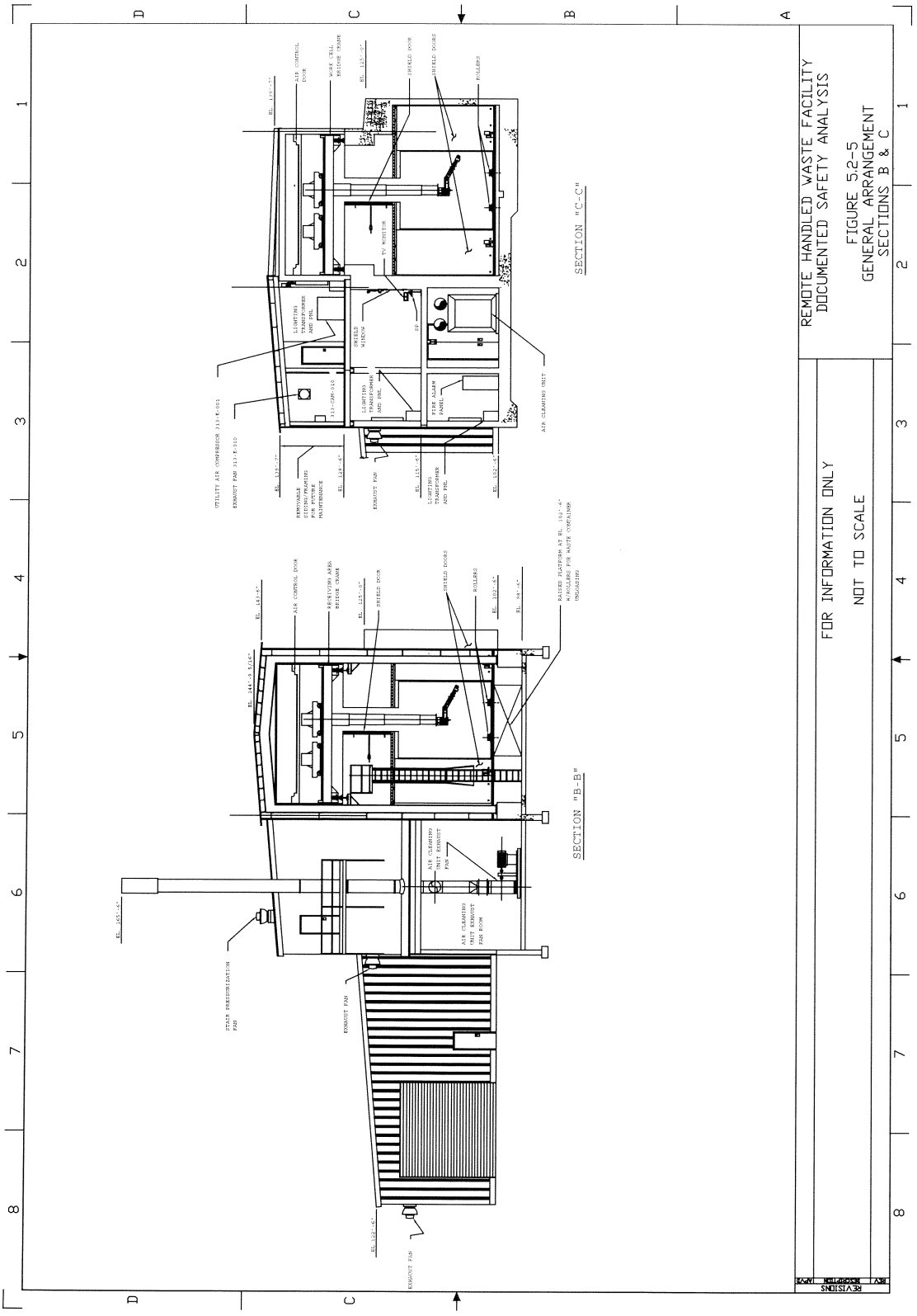


Figure 5.2-6 General Arrangement Section F

Figure 5.4-1 Air Flow Diagram - Sheet 1

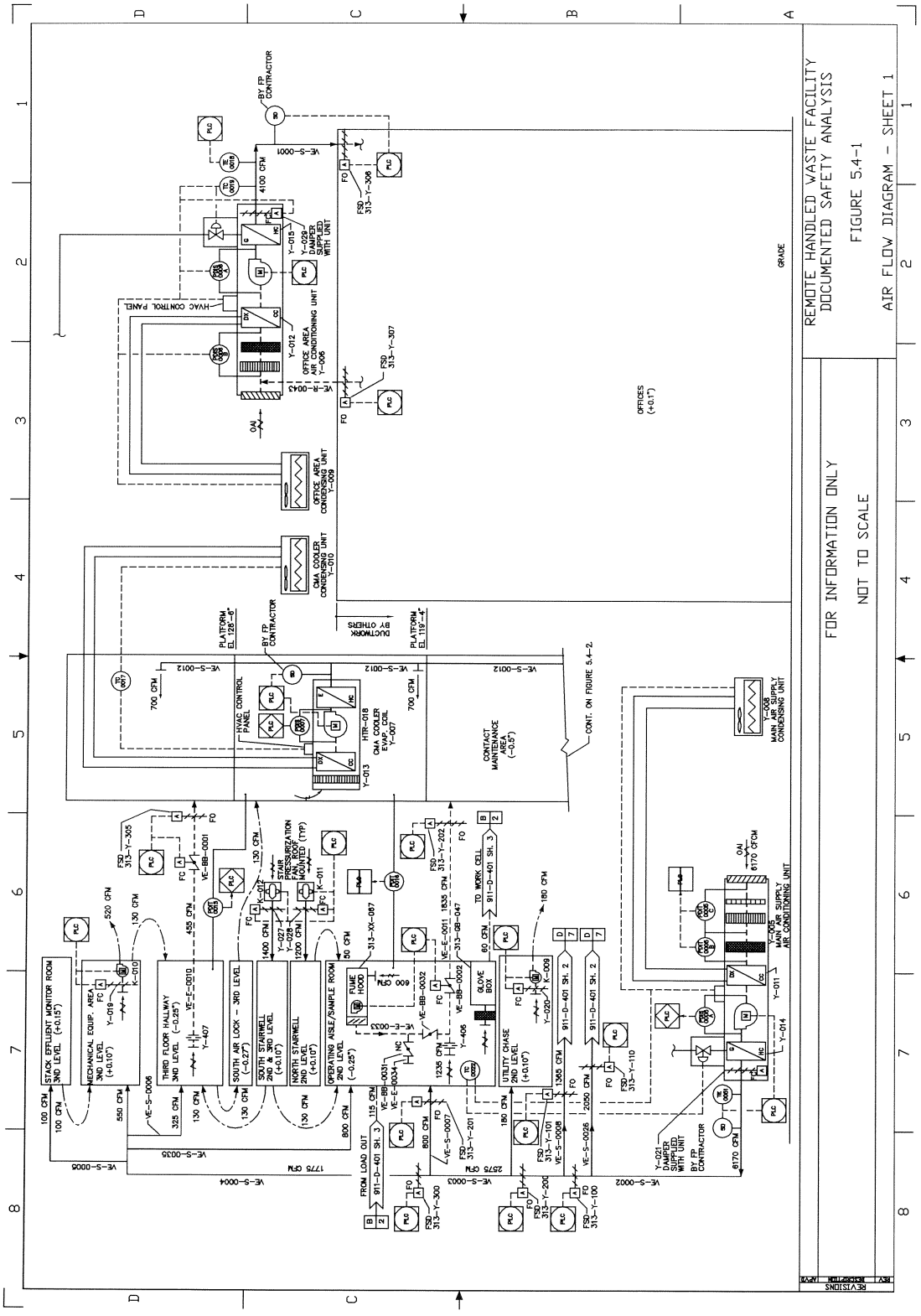


Figure 5.4-2 Air Flow Diagram - Sheet 2

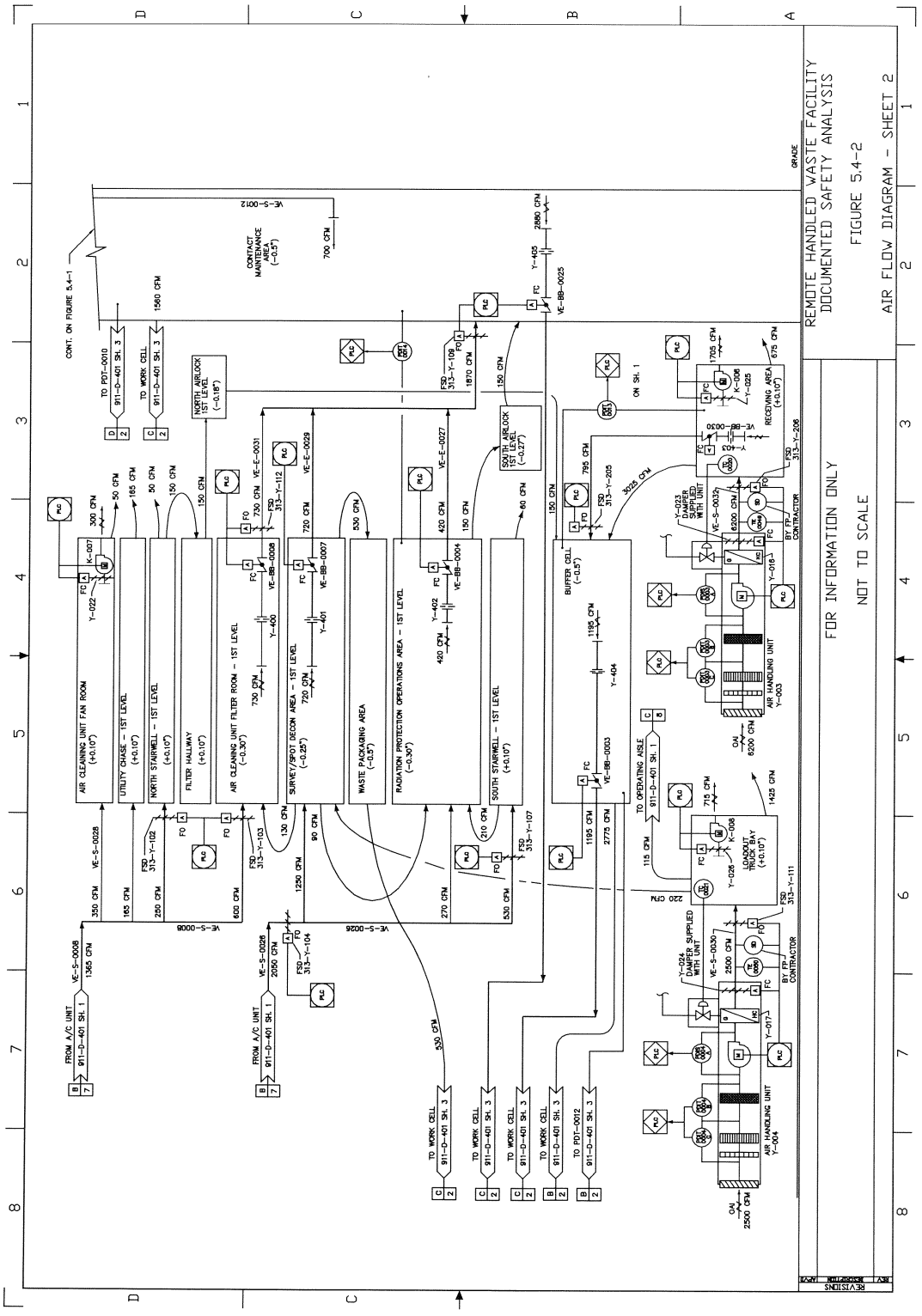
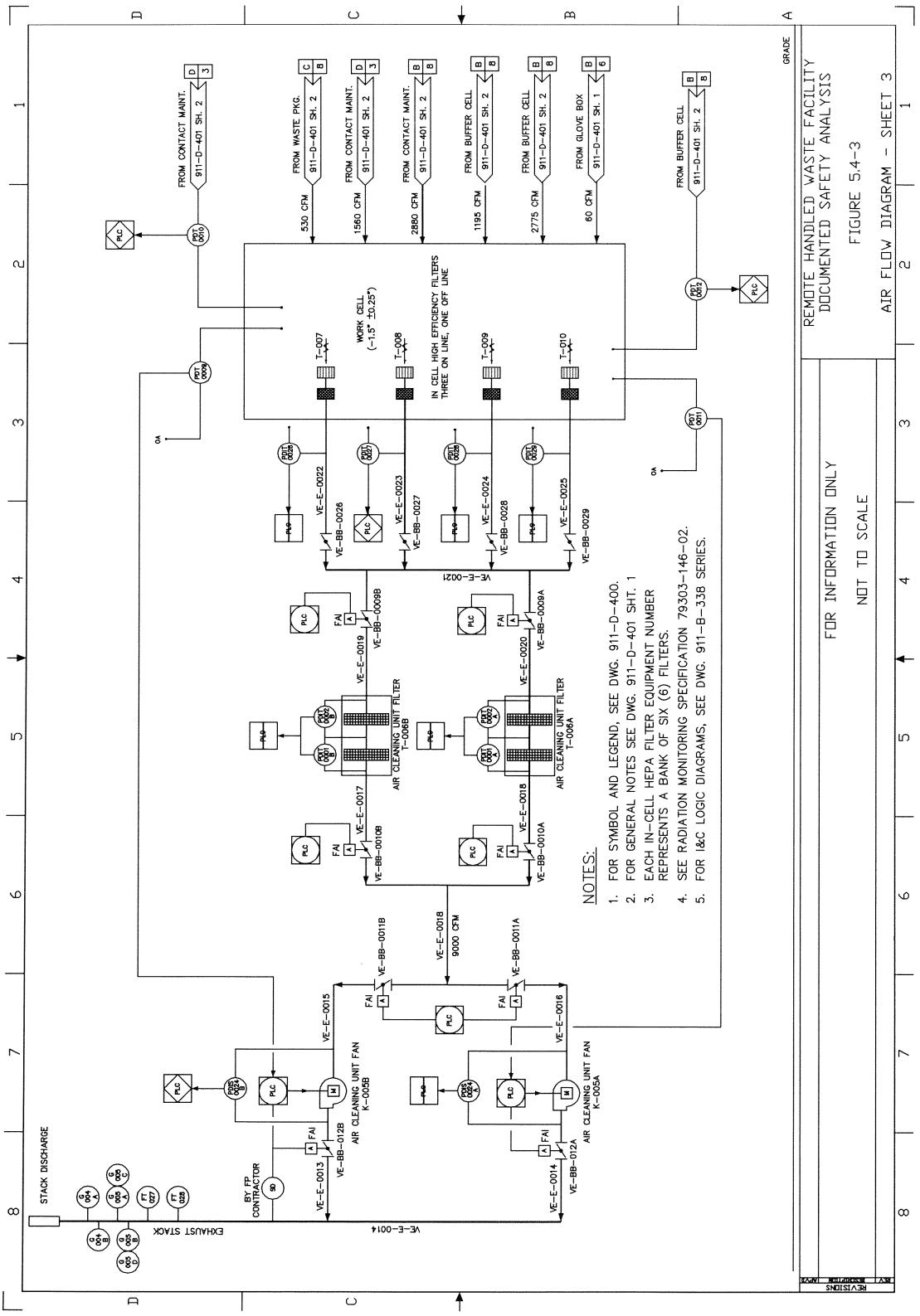


Figure 5.4-3 Air Flow Diagram - Sheet 3



6.0 PROCESS SYSTEMS

6.1 Process Description

6.1.1 Narrative Description

The Remote-Handled Waste Facility (RHWF) is a facility at the West Valley Demonstration Project (WVDP) with remote handling capability for radioactive waste processing operations. The RHWF is designed to receive high activity solid waste from other locations on the WVDP site and to visually inspect, sort, size reduce, collect samples, and repackage this waste in a manner that meets current or expected disposal requirements. The throughput of the facility depends upon the waste stream being processed and is estimated to range between 0.14 and 1.9 m^3/day (5 and 67 ft^3/day).

Process activities begin as waste containers are transferred to the Receiving Area from various on-site locations by truck, forklift, or other means of transport. Waste containers are unloaded in the Receiving Area onto a remote-controlled Powered Roller System (PRS). The Receiving Area crane, a 20-ton overhead bridge crane, can be used to assist in this off-loading operation. After the container is placed on the PRS, the Buffer Cell shield doors are opened and the container is moved into the Buffer Cell via the PRS. Procedural controls stop the PRS when the waste container is in the Buffer Cell with sufficient clearance to close the shield doors.

The Buffer Cell acts as a barrier and airlock to isolate the contaminated Work Cell from the uncontaminated Receiving Area, allowing radiologically controlled movement of waste containers into the Work Cell. Activities in the Buffer Cell are directly observable and controlled from a shield window in the Operating Aisle. After a waste container is transferred to the Buffer Cell, the shield doors between the Receiving Area and the Buffer Cell are closed and the shield doors between the Work Cell and the Buffer Cell are opened. The container is then moved into the Work Cell using the PRS. As a backup, the Work Cell crane, an overhead bridge crane with a 30-ton hoist, can be used for moving waste containers into the Work Cell.

In the Work Cell, the waste container is opened and the waste items removed, surveyed, sampled, sorted, de-watered, and decontaminated as required for repackaging. Waste processing is performed remotely using equipment controlled by operators behind shield windows and shield walls in the Operating Aisle. Two bridge cranes and one jib crane are provided in the Work Cell. Size reducing is typically accomplished with cutting tools supported by powered dexterous manipulators (PDMs).

Waste repackaging commences once waste components have been sorted, size reduced, and sampled for radiological and chemical attributes. Waste is placed in container liners, which help control the spread of contamination. Container liner covers are installed after the containers are filled, and the liners are then transferred to the Waste Packaging Area for placement into waste disposal containers. Certain nonstandard waste containers that are received in the Work Cell may be decontaminated and processed back through the Buffer Cell and Receiving Area, using the Receiving Area crane and the PRS; however, most are expected to be processed through the Waste Packaging Area.

Once a container liner has been filled in the Work Cell and its cover installed, it is lowered into a waste disposal container through the Waste Transfer System. Filled waste containers are remotely surveyed for external removable contamination and radiation levels in the Waste Packaging Area. Containers are then removed from the Waste Packaging Area on transfer carts through double shield doors to the Survey and Spot Decontamination Area. A monorail transfer hoist is installed on the ceiling of the Survey and Spot Decontamination Area to lift and transport containers onto and off of the respective transfer carts. High dose rate containers are shielded on the transfer carts.

A forklift removes waste containers from the Survey and Spot Decontamination Area and takes them to the Load Out/Truck Bay. In the Load Out/Truck Bay, filled containers

are loaded onto transport vehicles for transfer to an on-site interim storage facility or off-site disposal facility.

6.1.2 Facility Process Flow

Waste Process flow through the RHWF begins in the Receiving Area. Waste containers move into the Buffer Cell and then into the Work Cell. After waste is size reduced, sampled, and packaged in appropriate liners. The liners are moved into the Load Out/Truck Bay using the Waste Packaging System.

6.1.3 Identification of Items for Safety Analysis Concern

The concentrations of radioactivity in the RHWF waste streams require that waste processing be conducted in a manner that minimizes doses to both occupational personnel and off-site individuals. Nonradioactive hazardous elements and chemicals associated with RHWF operations are few and limited in quantity. The major items of safety analysis concern for the RHWF are:

- protecting workers from direct (gamma) radiation;
- maintaining confinement of radioactive materials; and
- minimizing the risk of accidents through sound engineering design and adherence to established policies and procedures.

6.1.3.1 Radiation Protection

A detailed discussion of radiation protection measures for the RHWF is provided in Chapter 8 of this SAR. Confinement barriers and systems in the RHWF, such as thick concrete walls and sliding shield doors, are designed to preclude the uncontrolled release of radioactive contamination. These features of the RHWF design are discussed in Chapter 5 of this SAR. The primary confinement system for airborne radioactivity is the RHWF Heating, Ventilation, and Air Conditioning (HVAC) system, which is detailed in Chapter 5. The RHWF is segregated into HVAC zones, which incorporate multiple physical barriers and utilize differential pressures to control the direction of airflow. The direction of ventilation airflow is maintained from zones of lesser contamination potential to zones of greater contamination potential under both normal and off-normal conditions. Normal airborne radiological releases from the RHWF are maintained within the limits set by applicable state, DOE, and other Federal requirements. Radioactively contaminated liquids (primarily washdown water) are collected in floor drains and transferred by gravity to washdown collection tanks. Additional details regarding the confinement and management of radioactive effluents from RHWF operations are provided in Chapter 7 of this SAR.

A principle safety concern in the RHWF is the direct ionizing radiation hazard posed by gamma radiation from the waste streams. Protection from direct radiation is achieved through shielding, remote processing of waste streams, work planning, administrative controls, and decontamination. Chapter 8 provides a detailed discussion of WVDP safety programs that govern the operation of the RHWF and that are designed to maintain personnel radiation exposure as low as reasonably achievable.

6.1.3.2 Criticality Prevention

Chapter 8 of this SAR provides a discussion as to inadvertent criticality concerns in the RHWF. Table 7.7-4 of WVNS-SAR-001 also provides an estimate of the Cs-137 activity in each of the subject 22 boxes. An inadvertent criticality event is not credible because (1) there is a very limited amount of fissile material estimated to be present in the Table 1.1-1 waste streams (i.e., an amount less than the single parameter limit of 760 grams of U-235 for a uniform aqueous solution per ANSI/ANS-8.1, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*); (2) the fissile material is distributed through a very large volume and mass of waste materials, only a small percentage of which will be in the RHWF at any given time; (3) the fissile material in the waste streams is by-and-large physically and/or chemically fixed or bound to the items that comprise the waste streams; and

(4) there are no normal operations or credible accidents that are considered to have the potential to redistribute (and aggregate) a significant amount of the fissile material, especially in a (water) moderated environment. All areas in the RHWF where fissile materials could be present will remain subcritical under normal and credible abnormal and accident conditions.

6.1.3.3 Management, Organization, and Institutional Safety Provisions

All personnel at the WVDP receive extensive training in safety aspects associated with their responsibilities. Operations involving radioactive or hazardous materials are conducted in a manner consistent with the requirements of 10 CFR 835, *Occupational Radiation Protection,* and DOE Orders 420.1A, *Facility Safety,* and 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*. Additionally, an overall safety culture has been developed at the WVDP through comprehensive implementation of the principles of the DOE Conduct of Operations philosophy as given in DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*. The implementation of DOE Order 5480.19 at the WVDP, as given in WVDP-106, *West Valley Demonstration Project (WVDP) Conduct of Operations,* is summarized in Chapter 10 of WVNS-SAR-001, *Safety Analysis Report for Waste Processing and Support Activities*. Operations personnel are trained per the requirements of DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, which is also discussed in Chapter 10 of WVNS-SAR-001. In accordance with DOE P 450.4, *Safety Management System Policy*, WVNSCO has established an Integrated Safety Management System (ISMS) to ensure a safe workplace for the worker, the public, and the environment. The ISMS is discussed in detail in Chapter 10 of WVNS-SAR-001.

6.1.3.4 Hazardous Material Protection

Operations associated with hazardous materials are conducted per the guidance of WVDP-011, *WVDP Industrial Hygiene and Safety Manual,* and WV-996, *Hazardous Waste Management Program*. Nonradioactive hazardous elements and chemicals associated with the waste streams processed through the RHWF are few, and with the exception of lead which may have been used as a shielding material during the packaging of some containers, each is very limited in quantity. Examples of hazardous constituents that may be present include mercury (in mercury-vapor light bulbs) and PCBs (in residual oil). Hazardous chemicals are not used (i.e., introduced) during processing of the waste streams. Small amounts of chemicals may be used to facilitate analysis of waste samples in laboratory areas outside the RHWF. Chapter 8 of this Safety Analysis Report (SAR) provides a more extensive discussion of nonradioactive hazardous elements and chemicals.

6.2 Process Systems

6.2.1 Receiving Area

Containers of waste from various on-site locations are transferred to the Receiving Area by truck, forklift, or other means of transport. ~~Waste containers from the CPC WSA and certain other areas are typically transported to the RHWF by a customized, diesel-powered forklift.~~ A specialized diesel-powered, shielded forklift will be used for the retrieval and transfer of the CPC WSA waste boxes to the RHWF. This shielded fork-lift will perform all necessary container transfer functions including repositioning of the shield boxes and SurePaks within the CPC WSA and the off-loading of containers to the Receiving Area of the RHWF.

The shielded forklift incorporates the following special features:

- A hydraulic horizontal boom along with standard forklift features.
- Hands-off radio frequency communications system to allow the operator to communicate with operations personnel.
- Two-inch-thick steel plating to the front of the cab and one-inch steel plating to the sides of the cab for radiation shielding.

- Four video cameras and color monitor system to allow the operator to view the outside corners of the load, the path of travel of the load, and the position of the load relative to the conveyor system onto which the load will be lowered in the Receiving Area.

Transfer vehicles are unloaded in the Receiving Area and the waste containers are moved into the Buffer Cell using a remote-controlled PRS. The Receiving Area crane, a 20-ton overhead bridge crane, can be used to assist in this off-loading operation. Operation of the Receiving Area crane is from a radio-remote manual transmitter. Storage and maintenance of the Receiving Area crane is performed in the Receiving Area.

The PRS can be controlled from the Operating Aisle. The size of the container and the structural configuration of the base determines how the container is positioned on the PRS. Activities in the Receiving Area may be monitored using remote cameras and CCTV monitors. The Receiving Area is isolated from the Buffer Cell by air control and shield doors. The Receiving Area shield doors are designed to be operator controlled from the Operating Aisle or the Receiving Area.

6.2.2 Buffer Cell

The Buffer Cell allows radiologically controlled movement of waste containers into the Work Cell. As the term implies, the Buffer Cell acts as a barrier and airlock to isolate the contaminated Work Cell from the uncontaminated Receiving Area. The Buffer Cell may also be used as a radiologically controlled area for contact handled operations such as overpacking or for the removal of nonstandard or oversized waste containers from the Work Cell. The Buffer Cell is isolated from the Work Cell by shield doors and air control doors.

A shield window in the Operating Aisle wall permits a view of activities in the Buffer Cell. The shield doors between the Receiving Area and Buffer Cell are opened and the PRS is activated to move waste containers into the Buffer Cell. Alternatively, the Receiving Area crane may be used to lift and position waste containers as needed. Non-standard containers may be processed back through the Receiving Area.

Waste containers are transferred from the Buffer Cell into the Work Cell by the PRS. As a backup, the Work Cell crane, a 30-ton overhead bridge crane, can be used for moving waste containers into the Work Cell.

6.2.3 Work Cell

Incoming waste containers are processed in the Work Cell, which provides capabilities for remote handling, surveying, sampling, sorting, size reducing, washdown, and repackaging. All activities in the Work Cell are remotely controlled from the Operating Aisle. To move waste containers into the Work Cell, the shield doors between the Buffer Cell and the Work Cell are opened and the PRS is used. Procedural controls stop the PRS when the waste containers are completely in the Work Cell with sufficient clearance to close the shield doors.

Two bridge cranes and one jib crane are provided in the Work Cell. One bridge crane is equipped with two telescoping masts equipped with powered dextrous manipulators for waste cutting operations. The Work Cell bridge cranes are designed to lift and handle incoming waste containers and to size reduce the contents of the waste containers. One of the Work Cell bridge cranes can serve as a backup for the PRS to move containers into the Work Cell from the Buffer Cell.

Two work stations designed for operating the Work Cell equipment are located in the Operating Aisle. Each station includes a shield window, a console to operate handling and cutting equipment, and CCTV monitors. A third work station is provided in the Sample Packaging and Screening Area with a shield window to allow an end view of the entire Work Cell length. This work station also performs sampling and maintenance operations using Master-Slave Manipulators (MSMs). All activities in the Work Cell are directly controlled and observable from the two shield windows in the

Operating Aisle wall and the shield window in the Sample Packaging and Screening Area.

Once inside the Work Cell, waste containers may be purged and de-watered if necessary. Unless the containers are equipped with special vent and drain plugs which can be remotely removed, purging can be accomplished by piercing the container and using utility air for purging. De-watering can be accomplished by piercing the container near the bottom. Water from the container will drain to the Work Cell trench and then to a liquid waste collection tank. The waste container is then opened and/or disassembled, and its contents de-watered if required.

Various options are available to open waste containers in the Work Cell. The container lid can be removed mechanically or cut off if the original closure devices are not operable. In many cases, use of the Work Cell bridge crane with dual telescoping masts and PDMs is required to facilitate holding and cutting operations. Actual tool choice and operation depend upon container types and operational experience in using the tools.

After the waste container is opened, its contents are inspected, surveyed, and sampled. Sampling is typically performed for an array of radiological and hazardous contaminants; techniques may include smear samples, coupons, and vacuuming. In addition, an overall gamma scan and dose-rate survey is performed. The purpose of these steps is to provide data sufficient for planning, including: (1) selection of an appropriate waste disposal site, if feasible; (2) selection of the containers to be used for repackaging; (3) waste size reduction planning; and (4) container loading planning including calculation of waste amounts and placement.

Waste components are removed by one of the Work Cell cranes and positioned on work tables for further processing. Work tables are designed to be height adjustable and are wall mounted above the floor of the Work Cell. Large cutting tools, such as a band saw or abrasive cut-off saw, can be mounted directly to the work tables. Clamping devices may be used to secure waste components while cutting is performed. Size reduction may also be accomplished with cutting tools supported by powered dexterous manipulators (PDMs) that are attached to the cranes. Different types of end effectors may be used by the PDMs to perform tasks such as cutting, gripping, and surveying. For example, a PDM gripper can be employed to hold and use light-duty cutting tools. Some of the cutting and shearing equipment in the Work Cell may use hydraulic fluid; hydraulic power units associated with this equipment may contain several gallons of hydraulic fluid.

Waste components are sorted and size reduced, as needed, into sizes whose geometry is consistent with repackaging requirements. The key control parameters in these processes include weight, radioactivity concentrations and isotopes, expected contact dose rates, and liner loading arrangements. The waste container itself is typically cut into pieces for packaging. A portable vacuum system located in the Work Cell is used to collect cutting fines and small debris. The storage volume for the vacuum system is a 208 L (55 gal) drum liner.

Operations in the Work Cell can be monitored using in-cell cameras and shield windows. Both wall-mounted and crane-mounted cameras are available with zoom capabilities. Radiation surveying can be performed by bringing a PDM-controlled survey meter to the material, or by bringing components or samples to radiation detectors at two shield wall ports. Samples can also be taken out of the Work Cell through a transfer drawer. These samples are handled in a glove box or fume hood where radiation surveying can be done using hand held meters. Additional instrumentation is located in the Sample Packaging and Screening Room which may be used to determine whether the sampled material can be expected to be low-level waste (LLW) or transuranic (TRU) waste. Laboratory facilities are also available outside of the RHWF.

Waste repackaging commences once waste components have been sorted, size reduced, and sufficiently analyzed for radiological and chemical attributes. Waste is placed in a container liner, which help control the spread of contamination. During cutting and sorting activities, container liners are stored in the Work Cell. B-25 liners are

used to package LLW items. Drum liners are sized to fit into 208 L (55 gal) waste drums and are positioned near the work tables for filling. The Work Cell bridge crane is available to lift and move liners. Dose rate surveys of liners can be performed using a PDM-controlled survey meter. Container liner covers are installed when the containers are filled. A remote-operated, spray decontamination system is designed to be used for overall Work Cell decontamination or for local decontamination of waste components and liners.

Filled container liners with covers installed are transferred to the Waste Packaging Area for placement into waste disposal containers. Certain nonstandard waste containers that are received in the Work Cell may be decontaminated and processed back through the Buffer Cell and Receiving Area, using the Receiving Area crane and the PRS, rather than being processed through the Waste Packaging Area.

6.2.4 Waste Packaging Area

The Waste Packaging Area provides a confined and shielded space for efficiently loading waste disposal containers. The Waste Packaging Area is isolated from the Work Cell by a combination of shield walls, Waste Transfer System port covers, and shield covers. Except during load-out operations, the shield covers remain closed in place above the Waste Packaging Area in the Work Cell to prevent accumulation of contamination around the transfer ports. Steel shield doors seal off the rear of the Waste Packaging Area from the Survey and Spot Decontamination Area and provide a contamination and radiation control barrier.

Once a box or drum liner has been filled in the Work Cell and its cover installed, it is lowered into a waste disposal container through the Waste Transfer System, which is the interface between the Work Cell and the Waste Packaging Area. The Waste Transfer System is mounted on top of the Waste Packaging Area and provides the physical boundaries necessary to bring material out of the highly contaminated Work Cell, while maintaining the exterior of the waste disposal containers clean.

Filled waste containers are remotely surveyed for external removable contamination and radiation levels in the Waste Packaging Area. Two manually operated, telescoping reach rods penetrate the Waste Packaging Area east walls. One reach rod is used for radiation probe movement and swipe sampling of containers, while a second rod is used for swipe sampling of drums and to assist in drum outer lid placement and fastening. A swipe transfer port leads to a nearby glove box or hood to process swipe samples.

Filled and surveyed waste containers are then removed from the Waste Packaging Area on transfer carts through double shield doors to the Survey and Spot Decontamination Area. Two transfer systems are installed within the Waste Packaging Area using container transport carts, respectively, mounted on rails. Cart rails extend from the Waste Packaging Area under the transfer ports to outside the Waste Packaging Area shield doors. A monorail transfer hoist is installed on the ceiling of the Survey and Spot Decontamination Area to lift and transport containers onto and off of the respective transfer carts. High dose rate containers are shielded on the transfer carts and the monorail hoist can also be used to take transfer shields on and off the carts.

The Survey and Spot Decontamination Area provides a space for surveying, spot decontaminating, and overpacking (as necessary) filled waste containers. The floor elevation of the Survey and Spot Decontamination Area is at the same elevation as the Load Out/Truck Bay. A forklift removes waste containers from the Survey and Spot Decontamination Area and takes them to the Load Out/Truck Bay.

6.2.5 Load Out/Truck Bay

In the Load Out/Truck Bay, filled containers are loaded onto transport vehicles for transfer to an on-site interim storage facility or off-site disposal facility. The Load Out/Truck Bay is sized to allow for side loading of a flat bed vehicle using a forklift. The Load Out/Truck Bay accommodates, with its doors closed, a trailer of nearly 15.2 m (50 ft) in length. Although this area is primarily used to load filled waste containers onto transport vehicles, it can also be used to transfer empty waste

containers into the RHWF, and for the (short-term) temporary storage of liners, containers, and repackaged wastes. Radiological assay equipment may also be located in the Load Out/Truck Bay to support the radiological analysis of filled waste containers.

6.2.6 Operating Aisle

The Operating Aisle is located on the second floor of the RHWF outside the Work Cell and Buffer Cell and provides a radiologically clean, shielded space for operations personnel to remotely operate facility equipment. The Operating Aisle turns 90 degrees at its south end over the Waste Packaging Area location. One shield window is installed in the Buffer Cell wall and two shield windows are installed in the Work Cell walls to provide a view into the cell from the Operating Aisle. Operator workstations are available at the two shield windows located in the east Work Cell wall. These windows allow direct observation of all operations to be performed by the remote handling equipment within the Work Cell. Also located in the Operating Aisle is the far-field radiological assay equipment that performs the preliminary waste analysis to sort the waste according to its low-level or TRU characteristics.

6.2.7 Sample Packaging and Screening Room

The Sample Packaging and Screening Room is located on the second level of the RHWF adjacent to the Operating Aisle. To support the analysis of waste streams being processed in the Work Cell, this area provides the capability to transfer swipes and sample bottles into the Work Cell, to remove samples from the Work Cell, and to place samples in containers for transfer to a laboratory for analysis. A shield window is located in the Sample Packaging and Screening Room to allow operators to view the full length of the Work Cell, and a PDM controller and work station controller are provided to permit remote sample transfer operations. A sample shelf is located in the Work Cell below the sample transfer drawer, which is mounted inside the shield wall. Samples are removed from the transfer drawer inside a sample transfer glove box. The packaged sample can be manually transferred to the Radiation Protection Operations Area on the first level, where it may be surveyed and released to a laboratory facility for analysis. Samples can also be pre-screened and counted for gross Beta and gross Alpha activity with counting equipment available in the Sample Packaging and Screening Room.

6.2.8 Radiation Protection Operations Area

The Radiation Protection Operations Area receives Work Cell samples that are transferred from the Sample Packaging and Screening Room. This area is also equipped with a sample transfer glove box, which can receive swipe samples of waste packages that are obtained using the swipe survey reach rods in the adjacent Waste Packaging Area, and a shielded liquid sample glove box with a drain. Samples are surveyed prior to release to an off-site laboratory facility for analysis. A hood is also provided to support activities in this area.

6.2.9 Contact Maintenance Area

The Contact Maintenance Area provides a shielded space adjacent to the Work Cell where personnel can perform maintenance and repairs on the crane, PDMs, and other Work Cell equipment. This area is also used for maintenance of the lifting and cutting equipment in the Work Cell.

Shield and air control doors provide a barrier between the Work Cell and the Contact Maintenance Area. The crane enters the Contact Maintenance Area through slotted openings at the end of the Work Cell. A 5-ton bridge-mounted maintenance hoist is available to assist in removing crane components and for handling heavy items. On the first level, a stainless-steel lined space is provided for washdown of pumps and valves, storage shelves, and a work bench. A floor drain allows drainage of washdown water to a washdown collection tank. A slotted opening is provided in the upper level floor for traversing of the crane’s telescoping tube. The floor at this level

is stainless steel lined and has floor drains to capture bridge crane and PDM washdown water.

6.3 Sampling-Analytical

6.3.1 Sampling

The RHWF has the capability to take various types of samples in support of waste stream analysis, processing, and packaging. Most sampling activities are performed in the Work Cell to support the analysis and segregation of waste.

The Sample Packaging and Screening Room is used to remove samples from the Work Cell and prepare them for transfer to an analytical laboratory. The major components associated with this area are the sample transfer drawer, shielded glove box, laboratory hood, and work table. The sample transfer drawer, which is manually operated, is mounted inside the wall between the Work Cell and the Sample Packaging and Screening Room. The sample transfer drawer opens into the glove box in the Sample Packaging and Screening Room. The glove box provides sufficient space for the sample drawer, alpha and beta contamination monitoring equipment, clean containers for samples, and airlocks for transferring the samples into and out of the glove box. Power connections for detectors are available inside the glove box for prescreening the samples and performing alpha/beta contamination and dose rate surveys.

Sampling equipment is also located in the Radiation Protection Operations Area on the first floor of the facility. The sample transfer glove box receives swipe samples of waste packages that are obtained using the swipe survey reach rods in the adjacent Waste Packaging Area. The reach rods are capable of obtaining a swipe sample from a container and encapsulating the swipe to prevent the loss of radioactive material. The swipe capsule is released into a drop chute and drops by gravity into the connected swipe sample glove box. The swipe sample may then be counted or transferred to another facility for analysis.

A liquid sample glove box, capable of receiving liquid samples from the washdown collection tanks, is also located in the Radiation Protection Operations Area. The RHWF Liquid Waste Collection and Transfer System is used to provide a well-mixed flow to the sampling system. Once the sample is obtained, a portable detector may be inserted into the glove box to measure radiation levels prior to removal from the glove box. Samples are removed through a sample transfer port and transported to another facility for analysis.

6.3.2 Analysis

Sample analyses are performed in other on-site or off-site analytical facilities. The results of laboratory analyses are used to support compliance efforts related to regulatory requirements for the classification, transportation, and disposal of repackaged wastes. Analytical laboratory facilities and capabilities at the WVDP are described in Chapter 6 of WVNS-SAR-001.

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7.0 WASTE CONFINEMENT AND MANAGEMENT

This chapter addresses the handling, treatment, storage, and disposal of radiological and hazardous waste associated with liquid, and solid waste streams that are generated incidental to the mission of the Remote-Handled Waste Facility (RHWF). The "management of radioactive wastes" is the primary mission of the RHWF, and hence information pertinent to the radioactive wastes that are processed through the RHWF is provided in other chapters (e.g., Chapters 1 and 8) of this Safety Analysis Report (SAR).

7.1 Waste Management Criteria

Department of Energy (DOE) Order 435.1, *Radioactive Waste Management*, governs radioactive waste management efforts at the West Valley Demonstration Project (WVDP). WVDP-370, *WVDP Radioactive Waste Acceptance Program*, serves a key role in implementing DOE Order 435.1 at the WVDP.

The RHWF has been designed to ensure environmental effluent releases are maintained within discharge guidelines given in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, DOE Order 450.1, *Environmental Protection Program,* and 40 CFR 261, *Identification and Listing of Hazardous Waste*.

The WVDP has developed comprehensive waste management plans to ensure that radioactive, hazardous, mixed, and industrial wastes are handled and stored in compliance with applicable state and federal regulations. A summary of WVDP waste management plans is given in Table 7.1-1 of WVNS-SAR-001, *Safety Analysis Report for Waste Processing and Support Activities*.

Fundamental waste management objectives are considered prior to the design and operation of all WVDP facilities and systems for handling, treatment, storage, and disposal of waste. These objectives include:

- Protection of the worker, public health, and the environment;
- Conformance to applicable federal and state laws, rules and regulations, and DOE orders;
- Application of the as low as reasonably achievable (ALARA) philosophy;
- Waste minimization including volume reduction, segregation, and preferential use of less toxic material; and
- Provisions of flexibility in facility designs to accommodate future needs.

7.2 Low-Level, Mixed Low-Level, and TRU Wastes

DOE 435.1 is used for the characterization of radioactive wastes prior to NRC classification of LLW. Radioactive wastes generated incidental to the mission of the RHWF include dust and small sized particles, waste containers that currently contain the radioactive wastes to be processed in the RHWF, anti-contamination clothing and other personnel protective equipment, contaminated process hardware (e.g., cutting equipment) and support system hardware (e.g., high efficiency particulate air [HEPA] filters and liquid drain system components), equipment associated with radiation survey and sampling activities, solid waste associated with repackaging activities, and liquid waste generated primarily through decontamination efforts with water.

The radioactive wastes generated incidental to the mission of the RHWF are handled, sorted, and packaged in the same manner as the waste streams identified to be processed by the facility. See Table 1.1-1.

The RHWF does not possess any mechanisms for the generation of mixed low-level waste (MLLW) incidental to the mission of the RHWF, with the possible exception of small

quantities being generated by laboratory analysis of waste samples. (Mixed waste contains both radioactive and hazardous constituents as defined by the Resource Conservation and Recovery Act [RCRA]). Mixed waste management operations are conducted in accordance with the Federal Facility Compliance Agreement (FFCA). Pursuant to this agreement, the WVDP has developed WVDP-299, *Site Treatment Plan,* a mixed waste "Site Treatment Plan" that provides plans and schedules for treatment of MLLW either on or off-site, to meet Land Disposal Restriction standards.

Radiological wastes generated incidental to processing will be characterized in accordance with WVDP programs which meet DOE O 435.1. Some of the radiological wastes generated incidental to processing are likely to be classified as solid transuranic (TRU) waste. There is currently no approved disposal site for TRU waste generated at the WVDP. Per the requirements of DOE Order 435.1, only TRU waste categorized as defense waste is acceptable for disposal at the Waste Isolation Pilot Plant (WIPP). Since WVDP TRU waste resulted from reprocessing of spent fuels from both commercial and defense sources, TRU WVDP waste is not currently scheduled to be shipped to WIPP. However, the WVDP is currently developing a TRU waste program and is working to obtain certification from WIPP to ship its TRU waste.

7.3 Nonradiological Wastes

Nonradiological wastes generated at the WVDP are of the following basic types:

- hazardous liquid and solid wastes (e.g., oils and wipes from maintenance activities)
- nonhazardous, solid wastes (e.g., construction and demolition debris, non-construction debris, scrap equipment, maintenance wastes, office trash, packing material)
- nonhazardous, nonradioactive effluent (e.g., sewage, utility room effluent).

Nonradioactive wastes are produced incidental to RHWF operations and maintenance activities. Maintenance and miscellaneous activities generate some nonradiological, nonhazardous wastes (e.g., office trash, packing materials, scrap equipment, sewage, etc.). Nonhazardous, nonradioactive solid wastes are disposed of off-site at a licensed landfill facility. Liquid effluents are regulated by the New York State Department of Environmental Conservation (NYSDEC) for nonradiological parameters.

RHWF operations generally do not require the use of hazardous chemicals. Small quantities of reagents and cleaning solutions may be used periodically for various cleaning, analytical chemistry, or maintenance activities. WV-996, *Hazardous Waste Management Program*, governs all WVDP operations that "generate, classify, treat, store, transport, or dispose of hazardous waste." There is no on-site disposal of hazardous waste at the WVDP. Hazardous waste is shipped off-site for treatment and disposal by licensed and approved transporters to permitted commercial treatment, storage, and disposal facilities.

7.4 Off-Gas Treatment and Ventilation

The RHWF ventilation system is described in Chapter 5 of this SAR. Pressure differentials are maintained between confinement zones within the RHWF so that air flow travels from zones of lesser contamination potential to zones of greater contamination potential. Ventilation system exhaust from contaminated zones or potentially contaminated zones is HEPA filtered and released to the atmosphere through a sampled stack.

There is no off-gas system associated with the RHWF. The waste water tanks (described in Section 7.5, below) are vented to the Work Cell.

Chapter 8 of this SAR provides information related to doses associated with routine effluent releases from the RHWF.

7.5 Liquid Waste Treatment and Retention

RHWF waste acceptance criteria indicates that the RHWF does not accept liquid waste as a primary waste stream. However, liquid waste is generated incidental to processing through periodic washdowns of the Work Cell and in-cell process equipment, as well as occasional washdowns of certain waste forms to reduce potential airborne contamination or for other reasons. Additionally, the Buffer Cell, Contact Maintenance Area, and Waste Packaging Area may receive a washdown.

The waste streams processed through the RHWF are comprised primarily of contaminated metal objects that in many instances have already undergone substantial decontamination efforts, or objects that by their nature do not lend themselves to washdown-type decontamination efforts (e.g., expended ventilation system filters). This tends to limit the extent to which the washdown water becomes contaminated. It is estimated that for any given year of operations conducted in the RHWF, approximately 20% of in-cell surfaces and equipment surface areas will be decontaminated, generating an average volume of 4.73E+05 liters (125,000 gal) of liquid waste to be treated each year. Demineralized water, at a pressure up to 1,655 kPag (240 psig) and a flow rate up to 1.89 liters per second (30 gpm), is used to facilitate decontamination efforts in the Work Cell.

Demineralized water used for decontamination purposes in the RHWF drains to collection tanks via trenches and drain hubs. The water is then transferred to the site-wide Liquid Waste Treatment System (LWTS) for batch processing. Three tanks, located inside a tank vault underneath the Contact Maintenance Area, are provided for liquid collection and transfer purposes. A 2,839 liter (750 gal) liquid waste receiving tank, vented to the Work Cell, is provided for the drains from the Buffer Cell and the Contact Maintenance Area upper and lower levels. A 5,678 liter (1,500 gal) liquid waste receiving tank, vented to the Work Cell, is provided for the Work Cell drain, and another 5,678 liter (1,500 gal) liquid waste tank, also vented to the Work Cell, is provided for batch sampling prior to transfer to the LWTS through double-walled piping. In select instances, wastewater may be processed through ion exchange columns (located in the Work Cell) prior to transfer to the LWTS. The columns are placed in service when the need to reduce wastewater activity levels exists so that the wastewater meets radiological criteria associated with the operation of the LWTS. Cs-137 is the primary radionuclide being removed by the ion exchange columns. The ion exchange columns, which will be located in the Work Cell, are considered to present an essentially negligible hazard to on-site receptors (evaluated at 640 meters) and off-site receptors. The Cs-137 (Ba0137m) is primarily a RHWF worker hazard to be controlled by RHWF staff and radiation protection personnel. (The thick walls of the Work Cell will provide substantial radiation protection and facilitate maintaining dose rates in occupied areas below design objectives.)

Decontamination wastewater is further processed through the LWTS and the Low-Level Waste Treatment Replacement Facility (LLW2). From the batch transfer tank, wastewater is routed to the LWTS hold tank (5D-15B) and subsequently through the evaporator, with the concentrates being held in the interim concentrates storage tanks (5D-15A1 and 5D-15A2) pending final treatment by batch immobilization. See WVNS-SAR-001 for more information about the LWTS and LLW2.

Liquid wastes from the RHWF that are processed through existing site treatment systems are expected to result in a negligible increase in dose to the maximally exposed off-site individual. Current estimates of dose from liquid effluent pathways are provided in Section 8.6.3.6 of WVNS-SAR-001.

7.6 Liquid Waste Solidification

No liquid waste solidification is performed in association with RHWF operations or maintenance activities.

7.7 Solid Wastes

Radioactive solid wastes generated incidental to the mission of the RHWF are addressed in Section 7.2. Solid radioactive wastes generated within the Work Cell (e.g., small sized particles captured on screen(s) in liquid waste flowpaths, exhaust ventilation filters located in the Work Cell, expended or broken equipment located in the Work Cell, and waste containers that currently contain the radioactive wastes) are processed in the same manner as the radioactive wastes being fed through the RHWF. This means that these incidentally generated solid radioactive waste items are, as appropriate for a given item, cut up, decontaminated to a limited extent, sorted, sampled, and packaged into appropriate (standard) types of waste containers. By mass and likely by volume, waste containers that currently contain the radioactive wastes are the largest solid radioactive waste stream generated during routine RHWF operations.

Packaged solid radioactive wastes that are generated incidental to the mission of the RHWF are (temporarily) stored on-site until shipped to a licensed repository. Types of waste and available storage locations are summarized in WVNS-SAR-001, Table 7.7-2. There is currently no designated on-site storage location for Remote-Handled Transuranic (RH TRU) waste. To address this issue, RH-TRU waste drums are placed in shielded overpacks that meet on-site storage area requirements for facilities described in Section 7.7.6 of WVNS-SAR-001. The Load Out/Truck Bay Area of the RHWF does not serve as an intermediate or long term waste storage area. See Chapter 7 of WVNS-SAR-001 for a more detailed overview and understanding of solid radioactive waste storage capabilities and handling practices at the WVDP.

7.8 Hazardous and Mixed Wastes

Hazardous wastes generated at the WVDP include nonradioactive solid and liquid hazardous wastes and solid and liquid MLLW. Programs and facilities at the WVDP provide for the safe interim storage of these wastes prior to shipment for off-site treatment and disposal. Radioactive mixed wastes (RMW) that cannot be treated either on-site or off-site are identified in WVDP-299 under the FFCA. The use of hazardous chemicals in association with the RHWF is addressed in Section 7.3. See Section 7.8 of WVNS-SAR-001 for more information about the handling and storage of hazardous and mixed wastes at the WVDP.

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8.0 HAZARDS PROTECTION

8.1 Assuring That Occupational Hazards Exposures Are ALARA

This chapter identifies the hazards associated with operations at the Remote-Handled Waste Facility (RHWF); design features and programs that are in place to ensure that workers and the public are adequately protected from those hazards; an occupational and off-site receptor dose assessment; and a discussion of controls to assure exposures to radiological and hazardous materials are kept as low as reasonably achievable (ALARA).

8.1.1 Policy Considerations

A formal documented program directed toward maintaining personnel radiation doses ALARA has been established in West Valley Nuclear Services Company (WVNSCO) Policy and Procedure WV-984, *ALARA Program*. The ALARA program is based on requirements set forth in 10 CFR 835, *Occupational Radiation Protection*, DOE-STD-1098-99, *Radiological Control,* and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. The radiation protection program and the ALARA program site-specific requirements are outlined in WVDP-010, *WVDP Radiological Controls Manual*, WVDP-076, *WVDP Environmental Protection Implementation Plan*, and WVDP-163, *WVDP ALARA Program Manual*. WVDP-131, *Radiological Controls Procedures*, Standard Operating Procedures (SOPs), and other departmental procedures are used to provide more detailed instructions for workers and technical personnel. A discussion of the ALARA program is provided in WVNS-SAR-001, *Safety Analysis Report For Waste Processing And Support Activities*.

In addition to radiation protection programs, the WVDP has established a comprehensive industrial hygiene and safety program for the identification, assessment, and monitoring of nonradiological hazards. Administration of the industrial hygiene and safety program is through WVDP-011, *WVDP Industrial Hygiene and Safety Manual*, which incorporates applicable DOE requirements as well as DOE-adopted Occupational Safety and Health Administration (OSHA) Standards 29 CFR 1910, *Occupational Safety and Health Standards*, and 29 CFR 1926, *Safety and Health Regulations for Construction*. WVNSCO systematically integrates safety into management and work practices at all levels via an Integrated Safety Management System (ISMS)as presented in Chapter 10 of WVNS-SAR-001.

8.1.2 Design Considerations

The prime consideration in maintaining radiation and hazardous material exposures ALARA is ensuring that positive control of these materials is maintained. The RHWF design features that ensure the confinement of radiation, radioactive materials, and hazardous materials to achieve exposure level objectives include the following:

Radioactive waste containers are remotely opened, and radioactive wastes are remotely processed (e.g., cut up) and repackaged, in a shielded cell (i.e., the Work Cell).

- Shield walls, shield windows, shield doors, and administrative controls are used to maintain the radiological dose to operators to less than 500 mrem/yr, unless appropriate WVNSCO management approval is obtained that allows for a higher annual dose to a given operator. As part of meeting this objective, the maximum radiation dose rate for a full-time occupancy area is 0.1 mrem/hr, and the maximum radiation dose rate for a full-time access area is 1.0 mrem/t, where "t" is the maximum average time in hours per day that the area is expected to be occupied by any one individual. A full-time occupancy area is one in which individual(s) may be expected to spend all or most of a work day.

- The Buffer Cell is physically separated from the Work Cell and provides a lower dose, less contaminated area for surveys and other work prerequisite to processing in the Work Cell.

- The Contact Maintenance Area is physically separated from the Work Cell and provides for maintenance of the cranes, Powered Dextrous Manipulators (PDMs), and other Work Cell equipment in a lower dose, less contaminated area.

- Means are provided to permit remote waste transfer from the highly contaminated Work Cell into externally “clean” containers in a contamination free zone.

- Pressure differentials are maintained between each confinement zone so that air flow travels from zones of lesser contamination potential to zones of greater contamination potential as described in Chapter 5 of this Safety Analysis Report (SAR).

- The RHWF ventilation system ensures that exhaust from contaminated zones or potentially contaminated zones is high efficiency particulate air (HEPA) filtered prior to release to the environment.

- The RHWF ventilation system incorporates dampers and/or HEPA filters to ensure that inadvertent back flows from contaminated areas are prevented or filtered.

- Exhaust ventilation system filters are installed in the Work Cell to minimize the amount of contamination on downstream (i.e., ex-Work Cell) components and ducting.

- Redundancy has been incorporated into the ventilation system to allow for filter changeout without the loss of pressure differentials between various cells/areas within the RHWF.

- Liquid spills and water used for decontamination purposes drain to a collection tank, from which they are routed to the Liquid Waste Treatment System (LWTS) for processing.

- Curbs are provided at the base of doorways, and floors are sloped in the Work Cell and elsewhere to a trench to prevent the spread of contaminated liquids.

- Double-wall piping with a built-in leak detection device is used to transfer contaminated liquids.

- The RHWF includes continuous air monitors (CAMs) in strategic locations for detecting the airborne release and presence of radiological materials, and area radiation monitors (ARMs) for detecting radiation levels above the normal operational range.

- Redundant equipment, sensors, and controls are employed in the key aspects of operations.

8.1.3 Operational Considerations

In addition to design features of the RHWF, administrative procedures and controls are necessary to ensure that personnel exposures to hazards are maintained ALARA. Administrative and procedural controls are maintained in accordance with WVDP-010, WVDP-011, and specific SOPs. RHWF workers are fully trained in elements of the radiation protection and industrial hygiene programs as appropriate for a given individual's responsibilities. See Section 8.1.3 of WVNS-SAR-001 for other operations-related techniques that are used to ensure that exposures are maintained ALARA.

8.1.4 Defense-In-Depth

Defense-in-depth entails the concept that layers of defense are provided against the release of radiological and hazardous materials such that no one layer by itself, no matter how effective, is completely relied upon.

The primary layers of defense for the RHWF are given below in order of relative importance to protect the public, workers, and the environment:

- Passive confinement barriers such as curbs, shield walls, shield windows, and similar features;
- Waste form and limited minimum inventory established in Table 1.1-1;
- Active confinement barriers such as shield doors, contaminated air cleaning systems including high-efficiency filters, decontamination system, glove box, redundant equipment/controls/sensors, and similar features;
- Alarms and monitors such as those provided in fire, contamination, and radiation detection systems;
- Personnel training;
- Administrative planning and controls.

These are discussed in Chapters 4, 5, 6, and 10 of this SAR, as well as in other sections of this chapter.

8.2 Sources of Hazards

The waste streams being processed in the RHWF are shown in Table 1.1-1. These waste streams provide the radiologically hazardous materials associated with RHWF operations. Waste streams 12 through 16 encompass the containers of components and debris that were generated as the result of the disassembly and removal of various components from the Chemical Process Cell (CPC). The CPC was used to dissolve spent nuclear fuel. Hence, CPC components are generally expected to be contaminated with a distribution of radionuclides that is consistent with the distribution of radionuclides that is found in spent nuclear fuel. Table 7.7-4 of WVNS-SAR-001 provides an estimate of the Cs-137 activity in each of the subject containers. The 274.29 curies of Cs-137 shown in Table 7.7-4 of WVNS-SAR-001 was assumed to exist as of July 1, 1986. The ORIGEN-S computer code was used to decay 274.29 curies of Cs-137 for 6.75 years. A radionuclide distribution (corrected to the year 1993) for the spent nuclear fuel processed at West Valley is provided in Attachment 1 of *Estimation of Activity in the Former Nuclear Fuel Services Reprocessing Plant* (Wolniewicz, March 1993). Hence, the decay period of 6.75 years corresponds to the time from July 1, 1986 to April 1, 1993. The decay corrected value, 235 curies of Cs-137, was divided by the Cs-137 activity shown in Attachment 1 of *Estimation of Activity in the Former Nuclear Fuel Services Reprocessing Plant*, and that value was multiplied by the activity given for the other 51 radionuclides listed in Attachment 1 of *Estimation of Activity in the Former Nuclear Fuel Services Reprocessing Plant*. Subsequently, by use of the ORIGEN-S computer code, these 52 radionuclides were decayed 11.25 years, which corresponds to the time from April 1, 1993 to July 1, 2004. The results of this effort are shown in Table 8.2-1. The inventory of radionuclides shown in Table 8.2-1 is considered to provide a reasonably bounding material at risk (MAR) for credible accidents associated with the RHWF. Because of the significant half-life of the radionuclides that make the dominant contributions to the dose to potential receptors during credible accident scenarios, starting RHWF operations a few months before July 1, 2004 (e.g., in March 2004 or April 2004), has a negligible impact on accident consequence assessments presented in Chapter 9.

As previously stated, the CPC was used to dissolve spent nuclear fuel. Hence, CPC components are generally expected to be contaminated with a distribution of radionuclides that is consistent with the distribution of radionuclides that is found in spent nuclear fuel. Exceptions to this expectation may exist, particularly in hardened sludge deposits, which are limited. DOE/NE/44139-41, *Decontamination and Decommissioning of the Chemical Process Cell*, Section 4.3, which addresses “sampling of floor debris,” states “isotope ratios indicated that the debris were primarily spent fuel in nature.” *Decontamination and Decommissioning of the Chemical Process Cell* also states the following regarding “preparations for vessel removal:” “After steam cleaning, the CPC vessels received a clear fixative coating, the vessel internals were inspected using a crane suspended video camera, vessel heel dewatering was performed if needed with an air operated jet, and all cooling water nozzles were sealed with rubber plugs. Vessel inspections showed most vessels to be relatively clean inside. The exceptions were the recycle evaporator and the low-level waste

accountability tank. Each of these two vessels removed from the CPC has an approximate one-inch layer of “dried, caked debris” on the bottom. This “dried, caked debris” on the bottom of each vessel has not been analyzed for radiological or chemical attributes. Originally, about a foot of sludge existed on the bottom of these vessels. “The sludge was mobilized and pumped dry and air was blown in; an approximate one-inch layer of “dried, caked debris” remained on the bottom of each vessel.” Hence, the form of this MAR renders it very unlikely that routine operations or credible accident phenomena could disperse a significant amount of it. Regardless of the uncertainty associated with the composition of these one-inch layers, Table 8.2-1 is considered to provide a reasonably bounding MAR for credible accidents.

Waste streams 17 and 18 are predominantly, if not entirely, filters from ventilation system(s) that service areas and cells in the Main Plant. Waste streams 20 and 22 have similar content, namely items from various projects associated mostly with the Main Plant. These items include anti-contamination clothing and other personnel protective equipment, plastic, wood, metal, hoses, tools, rope, piping, and solid debris.

Waste stream 21 contains diatomaceous earth, clay absorbent, and a relatively small amount of Zeolon 100 used for the filtering of pool water in the Fuel Receiving and Storage (FRS) facility. It has been determined that the containers that comprise waste stream 21 (theoretically) have the potential to contain hydrogen in a quantity that is at or above the lower explosive limit for hydrogen (4% by volume in air). The analysis that lead to this determination assumed that the containers (more specifically the tanks in the containers) are sealed air-tight, which may well not be a true assumption. Nevertheless, these items are to be opened in a manner that minimizes, to the maximum extent reasonably possible, the likelihood of an energetic event involving hydrogen during the opening of the these containers and associated tanks. It is noted that an explosion in the RHWF is one of the credible accidents evaluated in Chapter 9.

Waste stream 24 consists of crane components from the Main Plant. The items associated with these waste streams (i.e., waste streams 17, 18, 20, 21, 22, and 24) are considered to have a limited radiological material inventory (relative to the bounding MAR presented above) in consideration of their service/function and measured dose rates (which, as is understood to be true in some instances, is being affected by shielding materials inside the containers). A very modest radiological material inventory is expected to be associated with waste stream 19. The waste storage boxes that comprise waste stream 19 were packaged in late 1984 and early 1985 and contain contaminated items: a monorail crane leg, analytical sludge samples, vessels, manipulators, beams, glove boxes, and general contaminated waste. The waste containers associated with waste stream 19 are estimated to contain a total of 1.2 curies of Cs-137, and a fissile mass (U-235 equivalent) of 2.15 grams (4.7E-03 lbs).

Waste stream 23 consists of Waste Tank Farm (WTF) HLW transfer and mobilization pumps (specifically, four transfer pumps, 13 mobilization pumps, two STS floating suction pumps, and four containers of sluicing arms and associated equipment). In comparing WTF pumps, the mobilization pump is certainly the bounding case since it is 14 inches in diameter and approximately 50 feet long. A transfer pump has a three-inch diameter column and is approximately 40 feet long. The exterior surface area of a mobilization pump is nearly three times larger than the combined interior and exterior surface areas of a transfer pump. The selection of the mobilization pump as the bounding case is also consistent with the observed dose readings taken on the pumps that have been removed to date. The mobilization pump had a maximum dose of 8 R/hr whereas the transfer pump has a maximum dose of only 2 R/hr. In comparing the WTF pumps to the CPC WSA boxes, Section 8.2 states that the pumps are contaminated with a distribution of radionuclides consistent with HLW and that this HLW distribution has only 1% of the actinide levels that the CPC WSA waste would have since they have a spent nuclear fuel distribution. The mobilization pump is the bounding case for Waste Stream #23 and CPC WSA waste is bounding overall. Each mobilization pump is supported from a 15.2 m (50 ft) long stainless steel pipe column 0.35 m (14 inches) in diameter. These columns house the pump drive shaft. Each

column is filled with water to lubricate the shaft bearings and to provide radiation shielding. The column of water puts static pressure on its lower seal to inhibit the tank contents from entering the pump columns.

The total mass of radionuclides associated with waste streams 12 through 16 is about 2.17E+04 grams (47.8 lbs). (The vast majority of this mass is constituted as U-238. The amount of mass contributed by light elements and fission products such as Cs-137 is very small, about 16 grams [3.5E-02 lbs].) Using the dimensions noted above, and modeling a WTF pump as a circular cylinder, each pump occupies a volume of 1.51E+06 cubic centimeters (53.3 cubic feet). The “normal” specific gravity of “Tank 8D-2 combined waste” is 1.2 grams per cubic centimeter (74.9 lbs per cubic foot). Using this specific gravity, a pump would need to have slightly over 0.1 cm (3.9E-02 in) of contamination (i.e., radioactive material) on its outer surfaces to yield a mass of 2.17E+04 grams (47.8 lbs). (For reasons noted in the previous paragraph, the inner surfaces should not be significantly contaminated.) Since a significant portion of a WTF pump is not submerged in tank waste, and since a high pressure water spray is used to decontaminate a WTF pump as it is removed from a given tank, it is considered very likely that a given pump would have a mass of radioactive material contamination that is much less than that which corresponds to a layer 0.1 cm (3.9E-02 in) thick over its outer surfaces. More importantly, WTF pumps are expected to be contaminated with a distribution of radionuclides that is consistent with high-level waste (HLW). For a given quantity of radionuclides, a HLW distribution would yield a very small fraction (e.g., 0.01) of the actinides that a spent nuclear fuel distribution would yield. In general, actinides are much more harmful to human health via the inhalation pathway than non-actinides.

Nonradioactive hazardous elements and chemicals associated with the waste streams processed through the RHWF are few, and with the exception of lead which may have been used as a shielding material during the packaging of some drums and/or boxes, each is very limited in quantity. Twelve of the containers of waste generated from the disassembly and removal of CPC components are characterized as mixed waste because of the suspected presence of lead counterweights and/or mercury vapor bulbs. Additionally, one of these containers is characterized as mixed waste because it has been assumed to contain small residual amounts of barium, cadmium, chromium, lead, mercury, selenium, and silver from spent fuel reprocessing sludge. There is a possibility of some capacitors containing PCBs inside the boxes. Elemental lead counterweights were attached to removed CPC process jumpers, and mercury vapor lamps were removed during refurbishment of the CPC. Each mercury vapor bulb is considered to contain on the order of tens of milligrams of mercury, perhaps as much as 100 milligrams (2.2E-04 lbs). The total number of lead counterweights and mercury vapor bulbs is unknown. Nevertheless, the total mass of lead and mercury is estimated to be relatively small (i.e., a few kilograms of lead, and up to five grams (1.1E-02 lbs) of mercury). It is noted that two of the vessels removed from the CPC have an approximate 2.54 cm (1.0 in) layer of “dried, caked debris” on the bottom. This “dried, caked debris” on the bottom of each vessel has not been analyzed for radiological or chemical attributes. (See earlier discussion of these vessels.) Based on available information, other waste streams processed through the RHWF contain negligible quantities of nonradioactive hazardous elements and chemicals. However, lead may have been used as a shielding material during the packaging of some drums and/or boxes. Lead processed through the RHWF does not pose a significant hazard to workers or the public during routine operations or accident conditions. Waste handling operations are performed remotely, and lead has a very low vapor pressure at temperatures associated with a well developed combustible material fire (i.e., 800°C [1,472°F] to 1,000°C [1,832°F]). Lead has a low melting point temperature relative to many other metals, namely 327.5°C (621.5°F), but it has a significantly high boiling point temperature of 1,740°C (3,164°F). Hazardous chemicals are not used (i.e., introduced) during processing of the waste streams. Small amounts of chemicals may be used to facilitate laboratory analysis of waste samples. In consideration of the information contained within this paragraph, the Process Hazards Analysis (PHA) provided in Chapter 9 and the consequence assessments that are provided in Chapter 9 do not include MAR that is nonradioactive.

8.3 Hazard Protection Design Features

Hazards protection features basic to the design of the RHWF are dedicated to maintaining exposures to members of the general public and the work force ALARA.

8.3.1 Radiation Protection Design Features

To maintain radiation exposures ALARA, the RHWF design utilizes process isolation and confinement, structural barriers, ventilation, and continuously operating instrumentation that verifies radioactivity confinement. The design includes technology gleaned from over decades of experience at commercial and federal installations. Effective control of radiation exposure depends primarily on design features that provide for adequate shielding from all sources of radiation, remote operations and maintenance, confinement of radioactive materials within designated process areas, proper ventilation, effluent control, and overall monitoring and surveillance to verify design controls. These physical design features, as well as strict adherence to the operational requirements given in WVDP-010, provide effective radiation control. Incorporated into the RHWF design are the many specific hazard protection design features mentioned in Chapter 4 and in Section 8.1.2 of this SAR.

8.3.2 Shielding

The design of the Work Cell shield walls was based on a 3.05 m (10 ft)long line source geometry producing a dose rate of 5.7 rem/hr at a distance of 0.42 m (16.5 in) from the center of the line. Cs-137 (and its daughter, Ba-137m) are the radionuclides on which the shielding design was based. The Work Cell design also assumes contamination levels exceeding 1E+12 dpm/100cm^2 and the presence of fine, loose contamination in the waste containers and work areas. The operating aisle shielding was also evaluated for a dissolver bottom source with a 107 rem/hr on-contact dose rate.

The shielding system for the RHWF is a combination of shield walls, shield doors, localized shielding structures, airlocks, and shield windows. The shielding system provides protection from direct and scatter radiation by the use of structural shield walls and remotely operated shield doors to satisfy shielding requirements presented in Section 8.1.2. Shield penetrations associated with the waste packaging system, viewing windows, glove boxes, Heating, Ventilation, and Air Conditioning (HVAC) duct penetrations, manipulators, small pipe and electrical penetrations, and cables have been designed to provide the shielding equivalent of the effective wall thickness and to minimize scattered radiation transmission. Spare wall penetrations are equipped with shield plugs. A system of support for modular add-on shielding is included in the design features of the RHWF in the event that radiation levels are higher than anticipated during the processing of a few of the waste containers. However, the need for specific temporary shielding has been evaluated based on “worst case” sources (e.g., the dissolver bottom source). The result of these evaluations indicate that these sources can be processed with existing operating aisle shielding and limited administrative controls for other areas while maintaining dose rates within the design criteria.

The materials used for construction of the shielding system are durable and capable of performing their function for the 20 year design life of the facility. Minimum density specifications for concrete were used to envelope the various mixes that were used during construction. Concrete shielding is designed in accordance with ANSI/ANS-6.4, *Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants*. The shielding calculations for doors used the density of iron to provide assurance that the calculations adequately enveloped the various steels that were selected. The shield windows are lead glass that meet the shield equivalent of the wall in which they are embedded.

The approach that was used to determine the shielding for the RHWF was based on conservative assumptions and inputs. This conservative approach was implemented by rounding up the source term concentration when calculating the shielding, selecting a dose point and source orientation for analysis that provided conservative shielding

requirements, and ensuring that the selected location of waste containers or items within the Work Cell maximized the shielding requirements.

The Work Cell and Buffer Cell shielding is adequate to radiologically protect RHWF personnel located in the Receiving Area, Operating Aisle, and Waste Packaging Area during normal operations. The Work Cell has been designed for remote operation with no planned manned entry of the Work Cell during radioactive operations.

A methodology was employed using computer codes to determine the shield thicknesses required to meet the design criteria. Testing with a radiation source is not required when using these codes to determine the shield thicknesses necessary to meet the design criteria. However, a Quality Assurance/Quality Control program (see Section 12.2) that includes inspection and testing has been implemented to ensure that the minimum densities and minimum thicknesses with no void spaces are provided. The shield design will be verified in accordance with ANSI 6.3.1, *"Program for Testing Radiation Shields in Light Water Reactors,"* Section 5, Radiation Shield Testing Program. QA verified the shielding as it was being installed per Section 5.1 and 5.4.1. The final design will be tested during operations using the sources that are introduced (THE WASTE). The waste is used due to the hazards that would be involved with bringing in a source large enough to test the facility shielding and is recommended in accordance with Section 5.4, Shield Testing Phase of ANSI 6.3.1. The MicroShield computer code was used for direct dose calculations. An orientation of the source to the dose point was used which would produce the greatest shielding requirement. MicroShield was used only in situations where it could reliably "handle" shield thickness and geometries with near normal angles of incidence. For more complex dose analyses, the Monte Carlo N-Particle Transport Code System (MCNP-4A) computer code was used. This code employs a Monte Carlo method to analyze the transport of gamma radiation through oblique angles and other complex geometries, such as openings and penetrations around the Work Cell. The Monte Carlo method consists of tracking gamma particles from the source to selected detector locations. The number of particles collected at the detector point determines the average gamma flux. This method was also used to estimate the dose rate contribution to personnel in the Operating Aisle through concrete from a line source at various locations in the Work Cell.

Shielded overpacks are used as necessary for repackaged waste items to achieve desired dose rates for newly filled waste containers. For the overpacking of a 208 liter (55 gal) drum, there is a weight limit of 2,268 kilograms (5,000 lbs). For a B-25 box, the weight limit is 4,990 kilograms (11,000 lbs). Overpacking operations are typically performed in the Survey and Spot Decontamination area, but may also occur elsewhere in the RHWF (e.g., the Buffer Cell).

8.3.3 Ventilation

The RHWF HVAC system is described in Chapter 5. This system has been designed to ensure the confinement of airborne radioactive materials during normal operations, and to minimize the spread of contamination during abnormal or accident conditions. This RHWF HVAC system maintains the release of radioactive material to the environment within the limits specified in applicable DOE Orders. Remotely replaceable high-efficiency filters have been installed in the Work Cell to minimize contamination in downstream ducting, and on filters located outside of the Work Cell. Radiation and airborne radioactivity monitoring system design features to ensure personnel safety are described in Section 8.3.4.

Airlocks are provided for personnel entry into areas where airborne contamination is possible. Airlocks (double chamber) are provided on the first level of the RHWF for entry into the Buffer Cell and Contact Maintenance Area Lower Level, and on the third level for entry into the Contact Maintenance Area Upper Level. Each of the airlocks has an outer chamber in a low dose rate area that enables isolation of personnel from airborne activity prior to removal of protective equipment.

8.3.4 Radiation and Airborne Radioactivity Monitoring Instrumentation

The Radiation Monitoring System is an integral part of the Radiation Protection System. The Radiation Monitoring System complies with various codes and standards, including 10 CFR 835 and 40 CFR 61, Subpart H, *National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities*. The subject system has airborne effluent radiation monitors that sample and monitor the effluent air from the RHWF for contamination, and alarm if the contamination exceeds administrative limits. Air samplers draw air from locations in the RHWF so that air filters can be counted for alpha and beta activities, and ARMs measure dose rates due to gamma radiation. These ARMs alarm if the measured dose rate exceeds administrative limits. There are also personnel contamination monitors (PCMs) and hand held friskers that are used to detect personnel radioactive contamination and alarm if contamination exceeds administrative limits.

The Radiation Monitoring System is powered by the diesel-backed electric bus which is fed from two independent sources: a transformer in the substation, and the diesel generator (50P-01). Exceptions to this method of power supply are the portable stand-alone instruments (i.e., friskers) that are plugged into 120 V AC wall outlets which may be fed from any bus, and the Stack Effluent Radiation Monitor System that has two trains which are redundant to each other. One train is fed from the diesel-backed electrical bus and the other is connected to a transfer switch which normally receives its power from the non-diesel-backed bus, but can be switched manually to the diesel-backed bus.

The Radiation Monitoring System is comprised of three subsystems. The Effluent Radiation Monitoring System, the Personnel Protection Radiation Monitoring System, and the Process Control Radiation Monitoring System. The principal function of the Effluent Radiation Monitoring System involves the monitoring and sampling of RHWF airborne effluents for radioactive contamination. Process ventilated air is directed through HEPA filters and discharged through the RHWF stack. A stack monitoring and sampling system, which is able to detect and initiate an alarm due to the presence of radioactive materials above the normal operational range, is incorporated into the design of the RHWF. The principal function of the Personnel Protection Radiation Monitoring System is to monitor the RHWF for airborne contamination, area radiation levels, and personnel contamination for personnel protection. The radiation monitors used for personnel protection operate whenever radioactive material is present or anticipated to be present in the RHWF. The Personnel Protection Radiation Monitoring System consists of approximately ten CAMs and approximately twelve ARMs. (The exact number in service at any given time is determined by radiological control personnel.) PCMs and friskers are located at appropriate locations. The principal function of the Process Control Radiation Monitoring System is to remotely survey waste or other articles to determine radiation and contamination levels. Radiation surveys can be used to support preliminary radiological analysis of waste items. The process control monitors include: a fixed location dose rate monitor, a fixed location high purity germanium (HPGe) detector, a portable dose rate monitor (inside the Work Cell), and a glove box dose rate monitor. Instrumentation located in radioactive environments is retrievable for repair or replacement. Whenever possible, human interface points are located in nonradiation areas, and only the instrument-sensing device is located in the radiation field. The Process Control Radiation Monitoring System equipment is used to acquire radiological information about waste or other objects. Therefore, the primary function of the equipment is not for personnel protection.

8.4 Occupational Dose Assessment

As previously noted, shield walls, shield windows, shield doors, and administrative controls are the primary means used to reduce the radiological dose to RHWF workers to less than 500 mrem/yr, unless appropriate WVNSCO management approval is obtained that allows for a higher annual dose to a given worker. As part of meeting this objective, the RHWF was designed to ensure that the maximum radiation dose rate for a full-time occupancy area is 0.1 mrem/hr, and the maximum radiation dose rate for a full-time access area is 1.0 mrem/t, where "t" is the maximum average time in hours per day that the area is expected to be occupied by any one individual. If

compliance with full-time access area requirements would be economically infeasible, impractical, or prohibitive, higher dose rates may be allowed. However, access to such radiation fields is strictly controlled. In these normally unoccupied areas, the maximum allowed radiation dose rate is 4.0 mrem/hr, except when waste packages are present. Full-time occupancy areas, such as the Operating Aisle, have been evaluated for shielding requirements. The design dose rate objective is met for the design basis gamma source within the Work Cell, with consideration for both direct and scattered dose rate to personnel within the Operating Aisle (WVNS, July 2000).

Operations are conducted in accordance with the requirements of WVDP-010, which ensures that occupational doses are maintained ALARA. The occupational dose for the entire waste management campaign to be performed at the RHWF is estimated to be 48 person-rem. This estimate is based on an annual limit of 500 mrem and an average of 16 workers per year over a six-year campaign.

Because of the radioactive material confinement features and required use of CAMs, internal radiation dose hazards are not expected to be significant or result in appreciable doses. Appropriate respiratory protection devices are required for entry into areas where airborne radioactive material could be present, as determined by radiation protection personnel. Per WVDP-179, *Respiratory Protection Program Plan*, respirators are issued only to personnel who are trained, fitted, and medically qualified to wear the specific type of respirator.

8.5 WVDP Hazards Protection Programs

A formally documented health physics program for the WVDP has been established in WVNSCO Policy and Procedure WV-905, *Radiation Protection*. Site-specific requirements for the health physics program are promulgated in WVDP-010, and the RHWF is operated in compliance with the requirements given in that document. An extensive discussion of the health physics program is presented in Section 8.5.2 of WVNS-SAR-001.

Elements of the hazardous material protection program ensure that hazardous materials are identified, stored, and handled in a manner consistent with the ALARA philosophy. WV-921, *Hazards Identification and Analysis*, establishes the policy and means “to conduct hazards analyses for all WVNSCO activities during the work planning process, prior to commencement of work.” WV-921 provides the mechanism for the Work Originator, Work Group Supervisor, and/or Work Review Group to determine when the Hazards Controls Specialists shall be included in the work planning process at a task level. WVDP-241, *Site Health and Safety Plan*, has been prepared to document the WVDP Hazardous Waste Operations and Emergency Response (HAZWOPER) Program, assign responsibilities, establish personnel protection standards, prescribe mandatory health and safety practices and procedures, and provide for contingencies that may arise during the performance of hazardous waste operations work activities at the WVDP. As prescribed by WVDP-011, the site "Right-to-Know" Program is included in the general employee training required for all employees.

8.6 Off-Site Dose Assessment

Calculations performed in accordance with 40 CFR 61, *National Emissions Standards for Hazardous Air Pollutants*, Appendix D methodology, estimate the maximum abated (potential) effective dose equivalent (EDE) of 3.0E-03 mrem/yr to a maximally exposed off-site individual (MEOSI). This represents 3.0% of the Environmental Protection Agency (EPA) limit requiring an application to modify or a notification of start-up to be filed. Therefore, no application to the EPA is required for the RHWF. These calculations are presented in Attachment A to Approval Request Number 2001-356, “Summary of Dose Assessment” (WVNS, August 2001) in WVNS Purchase Order #19-85968-C-VS. The potential EDE to the MEOSI from “realistic abated” facility emissions is estimated to be 2.9E-03 mrem/yr. Table 8.6-1 presents the estimated potential radionuclide emissions associated with the RHWF.

Other calculations presented in Attachment A to Approval Request Number 2001-356, which were performed in accordance with applicable 40 CFR 61 requirements, demonstrate that the realistic unabated radionuclide emissions from the RHWF ventilation system exhaust stack must have continuous (realtime) monitoring in

accordance with 40 CFR, Section 61.93, "Emission monitoring and test procedures," and DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*.

Liquid wastes and the Liquid Waste Collection and Transfer System associated with the RHWF are discussed in Chapter 7. Any RHWF liquid wastes processed through existing site systems are expected, based on engineering judgment, to provide a very small to negligible increase in the estimated dose to the MEOSI due to liquid releases from the site as reported in Section 8.6.3.6 of WVNS-SAR-001. Contaminated liquids that are generated by WVDP activities are processed through the Low-Level Waste Treatment System (LLWTS) before discharge to the environment. Effluent from this system is monitored as discussed in Section 8.6.1.1.2 of WVNS-SAR-001.

8.7 Prevention of Inadvertent Criticality

Criticality analyses for the RHWF are provided in *Nuclear Criticality Safety Evaluation for the Remote-Handled Waste Facility*, hereafter referred to as the RHWF WVNS-NCSE-005. The subject document was developed in accordance with the guidance provided in DOE-STD-3007-93, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities*. Table 7.7-4 of WVNS-SAR-001 shows an estimated 490.81 grams (1.08 lbs) (U-235 equivalent) are contained in waste streams 12 through 16 of Table 1.1-1. Table 7.7-4 of WVNS-SAR-001 also provides an estimate of the Cs-137 activity in each of the subject 22 boxes. The total Cs-137 activity shown in Table 7.7-4 is 274.29 curies. Analyses contained in the RHWF WVNS-NCSE-005 show that the 274.29 curies of Cs-137 estimated to be contained in the 22 boxes provide the basis for calculating a fissile material inventory of 461 grams (1.02 lbs). The other waste streams, which are discussed in Section 8.2, are considered to contain substantially less fissile material than that estimated for the subject 22 boxes.

Though some of the SSCs in the RHWF may have been designed with consideration for preventing a criticality event, the RHWF WVNS-NCSE-005 establishes that no passive or active SSCs are required to ensure that a criticality event in the RHWF is not a credible event. The analyses presented in the RHWF WVNS-NCSE-005 are considered to demonstrate that for the waste streams proposed to be processed through the RHWF, it is not credible for a criticality event to occur during normal operations or because of credible accident scenarios. An inadvertent criticality event is not credible because (1) there is a very limited amount of fissile material estimated to be present in the waste streams (i.e., an amount less than the single parameter limit of 760 grams (1.67 lbs) of U-235 for a uniform aqueous solution per ANSI/ANS-8.1, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*); (2) the fissile material is distributed through a very large volume and mass of waste materials, only a small percentage of which will be in the RHWF at any given time; (3) the fissile material in the waste streams is by-and-large physically and/or chemically fixed/bound to the items that comprise the Table 1.1-1 waste streams; and (4) there are no normal operations or credible accidents that are considered to have the potential to redistribute (and aggregate) a significant amount of the fissile material, especially in a (water) moderated environment. All areas in the RHWF where fissile materials could be present will remain subcritical under all normal and credible abnormal and accident conditions.

Liquid transfers from the RHWF Liquid Waste Collection and Transfer System to other facilities or systems at the WVDP must comply with PSR-1, *Requirements for Liquid Transfers of Fissile Material*.

Only 208 liter (55 gal) drums or Standard Waste Boxes (SWBs) are used for packaging transuranic (TRU) wastes. Waste containing fissile material (which includes waste designated as TRU waste) are packaged and managed in a manner that complies with the requirements given in PSR-6, *Fissile Material Packaging and Storage Requirements*. The fissile material loading limits given in PSR-6 are more restrictive than those given in DOE/WIPP-02-3122, *Contact-Handled Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*. Hence, the fissile loading of 208 liter (55 gal) drums or SWBs in accordance with PSR-6 will not preclude shipping of those containers

to the Waste Isolation Pilot Plant (WIPP) should their shipment to that repository be authorized.

8.8 Fire Protection

Chapter 5 of this SAR describes the fire detection and suppression systems in the RHWF. The WVDP fire and explosion protection program is discussed in Section 4.3.6 of WVNS-SAR-001. The WVDP fire protection program, delineated in WVDP-177, *WVDP Fire Protection Manual*, is based on the fire protection-related requirements in DOE Order 420.1A, *Facility Safety*. DOE Order 420.1A requires a Fire Hazards Analysis (FHA) document to be developed for all nuclear facilities. Administrative controls, procedures, and training to prevent fires and explosions are presented in WVDP-177. Requirements to test and maintain fire protection systems in an operationally ready status are also addressed.

WVNS-FHA-014, *Fire Hazards Analysis Remote-Handled Waste Facility* concludes that the passive and active features and fire protection features of the RHWF will provide sufficient protection against the hazards associated with the facility.

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TABLE 8.2-1
BOUNDING MATERIAL AT RISK FOR CREDIBLE ACCIDENTS

Radionuclide	Activity (Ci)[1]
C-14	4.67E-03
Fe-55	6.57E-04
Ni-59	3.39E-03
Co-60	1.89E-01
Ni-63	2.67E-01
Se-79	1.37E-03
Sr-90	1.65E+02
Y-90	1.65E+02
Zr-93	8.39E-03
Nb-93m	7.28E-03
Tc-99	5.80E-02
Ru-106	3.62E-08
Rh-106	3.62E-08
Pd-107	4.54E-05
Sb-125	2.12E-03
Te-125m	5.17E-04
Sn-126	1.48E-03
Sb-126	2.08E-04
Sb-126m	1.48E-03
Cs-134	2.04E-03
Cs-135	5.49E-03
Cs-137	1.81E+02
Ba-137m	1.71E+02
Ce-144	1.05E-10
Pr-144	1.03E-10
Pm-147	1.14E-01
Sm-147	5.24E-11
Sm-151	6.41E+00
Eu-152	6.56E-03
Eu-154	1.12E+00
Eu-155	6.38E-02
Tl-208	1.84E-02
Tl-209	1.66E-06
Pb-209	7.89E-05
Pb-212	5.12E-02
Bi-212	5.12E-02
Bi-213	7.89E-05
Po-212	3.28E-02
Po-213	7.73E-05
Po-216	5.12E-02
At-217	7.89E-05

Radionuclide	Activity (Ci) [1]
Rn-220	5.12E-02
Fr-221	7.89E-05
Ra-224	5.12E-02
Ra-225	7.89E-05
Ra-226	9.65E-09
Ac-225	7.89E-05
Ac-227	3.23E-08
Th-228	5.11E-02
Th-229	7.89E-05
Th-230	3.97E-06
Th-231	8.49E-04
Th-234	7.13E-03
Pa-231	2.02E-07
Pa-233	9.14E-04
Pa-234m	7.13E-03
Pa-234	9.27E-06
U-232	5.06E-02
U-233	7.98E-02
U-234	3.86E-02
U-235	8.49E-04
U-236	2.52E-03
U-237	1.68E-03
U-238	7.13E-03
Np-237	9.14E-04
Np-238	1.22E-04
Np-239	1.71E-01
Pu-238	1.15E+01
Pu-239	3.21E+00
Pu-240	2.44E+00
Pu-241	7.01E+01
Pu-242	3.20E-03
Am-241	5.31E+00
Am-242m	2.72E-02
Am-242	2.71E-02
Am-243	1.71E-01
Cm-242	2.24E-02
Cm-243	7.00E-04
Cm-244	3.52E-01
Cm-245	8.25E-05
Cm-246	1.30E-05

Note:
[1] As contained in waste streams 12 through 16 identified in Table 1.1-1.

TABLE 8.6-1

ESTIMATED POTENTIAL AIRBORNE RADIOACTIVE EMISSIONS FROM THE RHWF

Radionuclide	Maximum Abated (Ci) (Permitting)	Bounding Realistic Unabated (Ci)[1] (Monitoring)	Realistic Abated (Ci)
H-3	1.36E-02	1.36E-02	1.36E-02
C-14	5.55E-02	5.55E-02	5.55E-02
Co-60	1.38E-09	1.38E-03	3.44E-12
Sr-90	1.80E-06	1.80E+00	4.50E-09
I-129	8.52E-05	8.52E-05	8.52E-05
Cs-137	1.98E-06	1.98E+00	4.95E-09
Pm-147	5.04E-10	5.04E-04	1.26E-12
Sm-151	7.42E-08	7.42E-02	1.85E-10
Eu-154	1.01E-08	1.01E-02	2.53E-11
Pu-238	1.32E-07	1.32E-01	3.30E-10
Pu-239	3.80E-08	3.8E-02	9.50E-11
Pu-240	2.90E-08	2.90E-02	7.25E-11
Pu-241	6.98E-07	6.98E-01	1.74E-09
Am-241	4.31E-08	4.31E-02	1.08E-10
Am-243	2.03E-09	2.03E-03	5.07E-12
Cm-244	3.64E-09	3.64E-03	9.09E-12

Note:

[1] The realistic unabated emission was calculated solely on the basis of the inventory and airborne release factor. No credit was taken for effluent controls.

9.0 HAZARD AND ACCIDENT ANALYSES

9.1 Hazard Analysis

The systematic analysis of hazards associated with the Remote-Handled Waste Facility (RHWF) has been accomplished through the completion of a Process Hazards Analysis (PHA), which is presented in Table 9.1-1. The PHA provides a qualitative analysis of the hazards associated with the RHWF and relevant preventive and mitigative features. Information gained through this analysis is then used in selecting accidents to be further analyzed in a more rigorous quantitative fashion (in Section 9.2) and in applying the graded approach to facility and process descriptions provided throughout this Safety Analysis Report (SAR).

9.1.1 Methodology

A PHA has been developed for the RHWF that is consistent with hazard analysis guidelines provided in DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*. A hazard should be understood as “a source of danger, with the potential to cause illness, injury, or death to personnel.” A PHA consists of two primary steps, namely, hazard identification and hazard evaluation.

9.1.1.1 Hazard Identification Methodology

The process of accomplishing the PHA identifies the hazards in terms of quantity, form, location, potential initiating events, and other events that could result in an undesirable consequence. To ensure a comprehensive, systematic analysis was performed, a thorough review of many of the RHWF design-related documents was performed. Additionally, the RHWF Preliminary Safety Analysis Report (PSAR) provided a useful basis for developing the PHA presented in Table 9.1-1.

9.1.1.2 Hazard Evaluation Methodology

Evaluation of hazards for the PHA required the qualitative assessment of event consequences and frequencies. Qualitative consequence and frequency classifications used in Table 9.1-1 are as follows.

Qualitative Consequence Classification:

Negligible	Negligible on-site and off-site impact on people or the environs.
Low	Minor on-site and negligible off-site impact on people or the environs.
Moderate	Considerable on-site impact on people or the environs; only minor off-site impact.
High	Considerable on-site and off-site impacts on people or the environs.

Qualitative Frequency Classification:

Anticipated	($10^{-1} \geq f > 10^{-2}$) Incidents that may occur several times during the lifetime of the facility.
Unlikely	($10^{-2} \geq f > 10^{-4}$) Accidents that are not anticipated to occur during the lifetime of the facility.
Extremely Unlikely	($10^{-4} \geq f > 10^{-6}$) Accidents that will probably not occur during the life cycle of the facility.
Incredible	($10^{-6} \geq f$) Accidents that are not credible.

(“f” is the frequency of a given event per year.)

For each event in Table 9.1-1, a risk factor has been developed that is based on the consequence and frequency for the event. The value of the risk factor is determined from a three-by-three frequency and consequence-ranking matrix which is shown in Figure 9.1-1. Events with negligible consequences or a frequency of occurrence of less than or equal to 1E-06 per year were assigned a risk factor of zero (0). Incredible events that have been further evaluated as an accident in Section 9.2 are assigned a risk factor of “IE” (incredible but evaluated).

9.1.2 Hazard Analysis Results

9.1.2.1 Hazard Identification

With the exception of lead, only minor amounts of nonradioactive hazardous elements and chemicals are expected to be present in the waste streams that are processed through the RHWF. Chapter 8 addresses the limited extent to which nonradioactive hazardous elements and chemicals are expected to be associated with RHWF operations. Chapter 8 also addresses the reasons that lead does not pose a significant hazard to workers or the public during routine operations or accident conditions. In consideration of the information in Chapter 8, the PHA provided in Table 9.1-1 and the accidents analyzed in Section 9.2 only address radiological hazards.

In developing potential initiating events, energy sources were identified. The activities conducted in the RHWF are primarily physical in nature (e.g., waste handling, size reducing, and repackaging), presenting low inherent operational energy sources. Therefore, the primary potentially substantial energy sources associated with credible accident scenarios are those that either (1) involve mechanical processes such as lifting or transporting/transferring a heavy object such as a waste container or, (2) involve flammable fluids used to achieve mechanical processes (e.g., the diesel fuel and hydraulic fluid in a transport vehicle such as a forklift, or the hydraulic fluid that may be used to operate select cutting and shearing equipment in the Work Cell). Additionally, there is a theoretical potential that hydrogen exists above the lower explosive limit in a few of the waste containers. Other energy sources such as compressed air and pressurized water were identified, but these energy sources are not considered to have the potential to serve as initiators of accident sequences with other than non-trivial radiological consequences to receptors of interest.

The radiologically contaminated waste streams identified in Table 1.1-1 present the hazardous material associated with RHWF operations. Some of these waste streams have high gamma activity associated with them, and hence have relatively large dose rates associated with them. Maintaining adequate shielding between these waste streams and workers is an important safety consideration, as is maintaining confinement to avoid an uncontrolled release of radioactive material.

9.1.2.2 Hazard Categorization

The hazard category for the RHWF is discussed in Section 1.5. The RHWF is a hazard category 2 nuclear facility.

9.1.2.3 Hazard Evaluation

9.1.2.3.1 Summary of Significant Worker-Safety Features

Section 8.1.4 itemizes features included in the RHWF in order to provide reasonable assurance of public, worker, and environmental protection in normal, off-normal, and accident conditions. The concrete walls in the cell areas and the shield windows are the most significant element of the worker-safety features included in the facility because they are passive in nature. Engineered safety features that are active in nature (see Section 8.1.4 for description) and administrative controls are additional features protective of workers. Since radiological hazards are the primary concern in the RHWF, requirements in WVDP-010, *WVDP Radiological Controls Manual*, are key

worker-safety features among the set of administrative controls though controls to protect workers from nonradiological hazards also apply.

9.1.2.3.2 Accident Selection

The identification of accidents presenting the greatest risk to on-site individuals and the off-site public is one of the primary goals of the PHA. These accidents present the greatest risks based on accident consequence and frequency considerations. The credible accidents listed below were selected for further evaluation because they were identified in the PHA as having a risk factor greater than or equal to three (3).

1) An “extremely unlikely” scenario that damages (e.g., crushes) all of the exhaust ventilation system filter houses located in the Work Cell
2) An “anticipated” container rupture, breach, or fluid leak resulting in a substantial release occurring in the Receiving Area, Buffer Cell, or External Area such as the Chemical Process Cell Waste Storage Area (CPC WSA)
3) An “unlikely” fire/explosion resulting in a substantial release occurring in the Receiving Area, Buffer Cell, Work Cell, Waste Packaging Area, or Load Out/Truck Bay Area
4) An “extremely unlikely” fire resulting in a substantial release occurring in an External Area such as the CPC WSA.

Two Beyond Design Basis Accidents (BDBAs) were selected for further evaluation during development of the PHA. These three accidents have a risk factor of “IE” (incredible but evaluated).

1) A beyond design basis seismic event.

2) An explosion in the Work Cell resulting in a substantial release, hypothesized to occur due to entrance of natural gas into the Work Cell and entailing the complete destruction of the RHWF.

9.1.3 Evaluation Guidelines (EGs)

The EGs used at the West Valley Demonstration Project (WVDP) are presented in WVNS-SAR-001, *Safety Analysis Report for Waste Processing and Support Activities*, Section 9.1.3. The radiological EGs are as follows:

<u>Public Radiological EG</u>: Manmade Design Basis Accidents (DBAs)/Evaluation Basis Accidents (EBAs) shall not cause doses to the maximally exposed off-site individual (MEOSI) greater than: (1) 0.5 rem for accidents with estimated frequencies ≤1E-01 per year but >1E-02 per year; (2) 5 rem for accidents with estimated frequencies ≤1E-02 per year but >1E-04 per year; and (3) 25 rem for accidents with estimated frequencies ≤1E-04 per year but >1E-06 per year. The value of 25 rem is not to be used as a “hard” pass/fail level. Radiological consequences should be compared against this EG to determine whether they challenge the EG, rather than exceed it. This is because consequence calculations are highly assumption driven and uncertain. Manmade DBAs/EBAs with estimated frequencies ≤1E-06 per year are not considered credible. These EGs are depicted graphically in Figure 9.1-2.

<u>On-Site Radiological EG</u>: Manmade DBAs/EBAs shall not result in calculated doses at the On-site Evaluation Point (OEP) (640 m [2,100 ft]) greater than: (1) 5 rem for accidents with estimated frequencies ≤1E-01 per year but >1E-02 per year; (2) 25 rem for accidents with estimated frequencies ≤1E-02 per year but >1E-04 per year; and (3) 100 rem for accidents with estimated frequencies of ≤1E-04 per year but >1E-06 per year. Manmade DBAs/EBAs with estimated frequencies ≤1E-06 per year are not considered credible. These EGs are depicted graphically in Figure 9.1-3.

Natural phenomena induced DBAs/EBAs with frequencies of occurrence defined by applicable design criteria documents are compared against the following EGs.

Public Radiological EG: Natural phenomena induced DBAs/EBAs shall not cause doses to the MEOSI greater than 25 rem. The value of 25 rem is not to be used as a “hard” pass/fail level. Radiological consequences should be compared against this EG to determine whether they challenge the EG, rather than exceed it. This is because consequence calculations are highly assumption driven and uncertain.

On-Site Radiological EG: On-site numerical EGs are not required for safety assurance in the analysis of accidents induced by natural phenomena. Severe natural phenomena present hazards to on-site personnel that are dominated by nonradiological concerns. If the natural phenomena resistance capabilities for structures, systems, and components are exceeded, then the consequences of the natural phenomenon itself pose a greater risk to worker health and safety than any exposure to radioactive material released by the event.

9.2 Accident Analyses

9.2.1 Methodology

Accident analyses are performed through the use of established and accepted references and computer codes. Computer codes used in accident analyses are verified per approved procedures prior to use. Specifically, the requirements of EM-125, *Verification, Validation, and Control of Computer Software,* are implemented for computer codes that are used to perform accident analyses. Accidents analyzed in this SAR represent the bounding accident for a particular event type (e.g., container failure, filter damage, fire, explosion). Events presenting the greatest risk have been identified through the PHA previously discussed.

Analyses to evaluate the consequences of airborne radiological releases utilize source terms developed from guidance given in DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Non-Reactor Nuclear Facilities*; site-specific dispersion factors calculated using the PAVAN computer codes (Pacific Northwest Laboratory November 1982); and radiological dose conversion factors given in DOE/EH-0071, *Internal Dose Conversion Factors for Calculation of Dose to the Public*. Dispersion factors associated with prescribed atmospheric conditions (i.e., stability class "F" meteorology and a wind speed 1 m/s [2.2 mph]) are provided in WVDP-065, *Manual for Radiological Assessment of Environmental Releases at the WVDP*. A maximum two-hour exposure time for potentially affected individuals is assumed, consistent with the guidance provided in Appendix A of DOE-STD-3009-94. The breathing rate used for potentially affected individuals is 0.333 L/s (0.012 ft^3/s) (ICRP 23, October 1974).

Site-specific dispersion factors (χ/Q values) are calculated using the PAVAN computer code, which implements the guidance provided in Regulatory Guide 1.145, *Atmospheric Dispersion Models for Potential Accident Consequences Assessments at Nuclear Power Plants*. The χ/Q calculations are based on the theory that material released to the atmosphere will be normally distributed (Gaussian dispersion) about the plume center-line. A straight-line trajectory is assumed between the point of release and all distances for which the χ/Q values are calculated.

The PAVAN program uses meteorological data in the form of joint frequency distributions of hourly averages of wind direction and wind speed by atmospheric stability class. Wind direction is distributed into 16 sectors (N, NNE, NE,...) and atmospheric stability is distributed into 7 classes (A-G). For each of 16 downwind sectors, the program calculates χ/Q values for each combination of wind speed and atmospheric stability at the site boundary for the respective sector. The χ/Q values calculated for each sector are then ordered from greatest to smallest and an associated cumulative frequency distribution is derived based on the frequency distribution of wind speed and stabilities for that sector. The program then determines for each sector an upper envelope curve based on these data such that no plotted point is above the curve. From this upper envelope, the χ/Q value which is equaled or exceeded 0.5% of the total time is obtained. The maximum 0.5% χ/Q value

from the 16 sectors becomes the maximum sector χ/Q value, which has been used in consequence analyses in this SAR. See WVDP-065 for additional information.

Another technique that can be employed to develop conservative χ/Q values is directionally independent (i.e., determined on an "overall site basis"), as opposed to the 0.5% directionally dependent technique discussed in the previous paragraph. Regarding the directionally independent technique, Regulatory Guide 1.145 states the following: "An overall cumulative probability distribution for all directions combined should be constructed. A plot of χ/Q versus probability of being exceeded should be made, and an upper bound curve should be drawn. The 2-hour χ/Q value that is exceeded 5 percent of the time should be selected from this curve as representing the dispersion condition indicative of the type of release being considered." Based on guidance presented in Regulatory Guide 1.145, the higher value of the maximum sector χ/Q (0.5% value) or the 5 percent overall site χ/Q should be used in evaluations. WVDP-065 used the guidance presented above to determine that the maximum sector 0.5% χ/Q value would be used for the maximally exposed individual dose calculations. The expression "site-specific 95% meteorology" is often used to communicate the 5% directionally independent technique, although maximum sector 0.5% χ/Q values are used for dose calculations in this SAR. The rationale for this is established in Regulatory Guide 1.145, which states that "selection of the 0.5 percent level is based on an equality, without consideration of plume meander, between the 5 percent directionally independent evaluation of χ/Q and the 0.5 percent directionally dependent evaluation of χ/Q averaged over a reasonably representative number of existing nuclear power plant sites." Given the established equality between the two techniques, and given the fact that the expression "site-specific 95% meteorology" is often used to communicate the 5% directionally independent technique, the terminology "site-specific 95% meteorology" is used in this SAR to communicate conservatively developed site-specific χ/Q values.

9.2.1.1 Initiating Event Summary

Initiating event summaries have not been provided for accident evaluations in this SAR as all assessments deterministically assume the occurrence of a particular accident event, with no regard for the mechanisms or chains of events necessary to arrive at the analyzed event. Exceptions to this general rule are made only to the extent necessary to adequately "define" a given accident for calculational purposes.

9.2.1.2 Scenario Development

Accident scenarios have been provided in sufficient detail to support the evaluation of source terms used in the calculations. Scenario developments deterministically assume the occurrence of a particular accident event, with no regard for the mechanisms or chains of events necessary to arrive at the analyzed event. Exceptions to this rule are made only to the extent necessary to adequately "define" a given accident for calculational purposes.

9.2.1.3 Source Term Analysis

For radiological accident scenarios, source terms are calculated based on the method described in DOE-HDBK-3010-94. This calculation requires quantification of Material-at-Risk (MAR), Damage Ratio (DR), Airborne Release Fraction (ARF) or Accident Release Rate (ARR), Respirable Fraction (RF), and Leakpath Factor (LPF) and is given as: Source Term = MAR x DR x ARF x RF x LPF. For all evaluations, the DR and LPF are set to a value of one.

With the exception of the beyond design basis criticality accident, the estimates of MAR for each accident evaluated in this SAR are based on a WVDP-specific spent nuclear fuel distribution of radionuclides. For each accident, the potential accident source term is calculated for all radionuclides, with due consideration for the ARFs and RFs that are appropriate for each radionuclide type (i.e., non-volatile, semi-volatile, and volatile) given the nature of the energetics associated with a given accident. From this list, only those radionuclides that contribute greater than 0.1% of the total effective dose equivalent (TEDE) are shown in the accident

summary tables (i.e., Tables 9.2-1 through 9.2-7). The only exception is for Table 9.2-6, where it was considered appropriate to show all of the radionuclides included in the evaluation of a beyond design basis criticality accident.

9.2.1.4 Consequence Analysis

Consequences of radiological accidents in this SAR are calculated for both on-site and off-site individuals. All accident-related releases evaluated in this SAR are modeled as ground-level releases. Consistent with relevant guidance for modeling accidents, there are no elevated release accident scenarios because the RHWF stack is of insufficient height to credit when performing accident consequence analyses. Consequences are calculated for an on-site and off-site receptor with stability class "F" meteorology and a wind speed 1 m/s (2.2 mph). On-site doses are calculated at the OEP which is located 640 m (2,100 ft)from the center of the accident release. Doses to off-site receptors are calculated at the nearest site boundary from the RHWF exhaust ventilation stack. This corresponds to a distance of 850 m (2,790 ft). Doses are also calculated for off-site receptors using site-specific 95% meteorology. For the RHWF, the distance and direction associated with site-specific 95% meteorology is 1,300 m (4,265 ft) north north-west (NNW).

The RHWF and CPC WSA are located in close proximity to each other. Hence, consequence analyses for accidents at the CPC WSA use the same distances to receptors as consequence analyses for the RHWF.

9.2.1.5 Comparison to Guidelines

Guidelines used for the comparison to accident analysis consequences are given in Section 9.1.3. Guidelines for radiological consequences due to operating and natural phenomena-induced accidents are provided. The maximum allowed consequences for radiological accidents are given in Figures 9.1-2 and 9.1-3. For the purposes of evaluation of Unreviewed Safety Questions, the EGs present the safety basis risk for RHWF-related operations and activities, including on-site transfer of wastes to and from the RHWF.

9.2.2 Design Basis Accidents

Operational accidents are those events having internal initiators, such as fires, explosions, or spills. Consequences of these accidents are evaluated against EGs given in Section 9.1.3 based on the frequency of occurrence.

9.2.2.1 Damage to Exhaust System Filters Located in the Work Cell

9.2.2.1.1 Scenario Development

The contaminated area exhaust ventilation system includes 24 filter houses located along the east wall of the inside of the Work Cell. Each house contains one medium efficiency filter and one high efficiency filter. The medium efficiency filter is 30.48 cm x 60.96 cm x 10.16 cm (12 in x 24 in x 4 in), and the high efficiency filter is 30.48 cm x 60.96 cm x 29.21 cm (12 in x 24 in x 11.5 in). There are four banks of filters, with each bank containing six filter housings. An “extremely unlikely” accident such as simultaneous crushing of the 24 filter banks is postulated. No credit is taken for the ventilation system filters located downstream of these in-cell filters in the Exhaust Ventilation Filter Room.

9.2.2.1.2 Source Term Analysis

To determine a reasonably bounding MAR in the 24 filter housings, the two filters contained in each filter housing were modeled as one filter that has a dose rate of 15 R/hr at 15.24 cm (6 in) from the midpoint of the filter's face. From this modeling, which entailed the use of the computer code MicroShield 5.05, a Cs-137 loading was calculated, which in turn was used to calculate the amount of activity of other radionuclides on the filter. (In equilibrium, for each curie of Cs-137, a beta particle emitter, there exists 0.946 curies of Ba-137m, a gamma ray emitter.) A

factor in selecting the analyzed dose rate was operating experience in similar facilities at the WVDP. Another factor is that Section 3.6 of Specification 79303-236-01, *In-Cell Filters Specification*, stipulates a design operating environment for the filters of "15 R/hr maximum dose rate over 20 years." If a filter is producing a dose rate of 15 R/hr at a distance of 15.24 cm (6 in) from its face, the filter media is being exposed to a substantially higher dose rate. In consideration of these facts, and the fact that the accident is postulated to affect all 24 filter housings, modeling 48 filters (i.e., the medium efficiency filter and high efficiency filter within each of the 24 filter housings) with a dose rate of 15 R/hr at 15.24 cm (6 in) as the basis for the MAR is considered to represent a situation that is not credible. It was determined through the use of MicroShield 5.05 that one curie of Cs-137 (0.946 curies of Ba-137m) produces a dose rate of 6.54 R/hr, and hence 2.29 curies of Cs-137 (2.17 curies of Ba-137m) would produce a dose rate of 15 R/hr. Twenty-four filters multiplied by 2.29 curies of Cs-137 per filter yields 54.96 curies of Cs-137. To determine the MAR in 24 filter housings, 54.96 curies of Cs-137 was divided by the Cs-137 activity (181 curies) shown in Table 8.2-1. That value, 0.304, was multiplied by the activity given for each of the other 80 radionuclides shown in Table 8.2-1. Hence, the MAR in the 24 filter houses corresponds to 30.4% of the activity estimated to be present in the containers of CPC components and debris (discussed in Chapter 8).

The bounding ARF of 5.0E-04 and RF of 1.0 for "crush-impact stresses" on high efficiency particulate air (HEPA) filters are taken from Section 5.4.4.1 of DOE-HDBK-3010-94. It is noted that the ARF value is larger than that for the thermal stress of HEPA filters. Section 5.4.1 of DOE-HDBK-3010-94 provides a bounding ARF of 1.0E-04 and RF of 1.0 for "the impact of heat upon loaded HEPA filters."

9.2.2.1.3 Analysis of Results

Table 9.2-1 presents the dose at the OEP and to the MEOSI from the simultaneous damage of all 24 Work Cell exhaust system filter houses. The maximum TEDE at the OEP has been calculated to be 0.797 rem, as shown in Table 9.2-1. The TEDE received by the MEOSI has been calculated to be 0.496 rem.

9.2.2.1.4 Comparison with Guidelines

The dose to the MEOSI of 0.496 rem TEDE and the dose to a receptor at the OEP of 0.797 rem TEDE due to the simultaneous damage of the 24 exhaust system filter houses located in the Work Cell are below the radiological EGs for an "extremely unlikely" accident as presented in Section 9.1.3.

9.2.2.2 Waste Container Failure

9.2.2.2.1 Scenario Development

Numerous waste containers must be transported to the RHWF. Some of these containers may be in a degraded condition. Transport operations may entail the lifting of waste containers to place them on a truck bed or forklift. Additionally, containers must be transferred from a forklift or other vehicle onto the powered rollers in the Receiving Area. An accident involving container rupture, breach, or fluid leak, resulting in a substantial release, is postulated to occur in the Receiving Area, Buffer Cell, or External Area such as the CPC WSA. The specific accident scenario envisioned assumes that one of the 22 CPC WSA containers (i.e., waste streams 12 through 16 in Table 1.1-1) structurally fails during lifting, allowing its contents to free fall onto the top of another container which is assumed to catastrophically fail. Each of the containers involved in the accident is assumed to contain a quantity of radioactive material that is equal to the amount estimated to be contained in Container 3C-2 (which is one of the two containers that comprise waste stream 14 as shown in Table 1.1-1). Of the containers of components and debris that were generated as the result of the disassembly and removal of various components from the CPC, Container 3C-2 is estimated to contain the largest inventory of radioactive material. This accident is considered an "anticipated" event.

9.2.2.2.2 Source Term Analysis

As shown in Table 7.7-4 of WVNS-SAR-001, Container 3C-2 is estimated to contain the largest Cs-137 inventory of 22 CPC WSA containers that were generated as the result of the disassembly and removal of various components from the CPC. Decay correction of the Cs-137 inventory in Container 3C-2 yields 23.5 curies of Cs-137 in Container 3C-2 as of July 2004. (The decay period of 18 years corresponds to the time from July 1, 1986 to July 1, 2004.) The Cs-137 activity is doubled to 47.0 curies to account for the fact that the scenario envisions two containers being involved in the accident. To determine the MAR involved in the accident, 47.0 curies of Cs-137 was divided by the Cs-137 activity (181 curies) shown in Table 8.2-1. That value, 0.26, was multiplied by the activity given for each of the other 80 radionuclides shown in Table 8.2-1. Hence, the MAR in the subject accident scenario corresponds to 26.0% of the activity estimated to be present in the containers of CPC components and debris (discussed in Chapter 8).

The bounding ARF of 1.0E-03 and RF of 0.1 for free fall impact stresses are taken from Sections 5.2.3.2 and 4.4.3.3.2 of DOE-HDBK-3010-94.

9.2.2.2.3 Analysis of Results

Table 9.2-2 presents the dose at the OEP and to the MEOSI from the failure of two waste containers. The maximum TEDE at the OEP has been calculated to be 0.136 rem, as shown in Table 9.2-2. The TEDE received by the MEOSI has been calculated to be 8.49E-02 rem.

9.2.2.2.4 Comparison with Guidelines

The dose to the MEOSI of 8.49E-02 rem TEDE and the dose to a receptor at the OEP of 0.136 rem TEDE due to the failure of two waste containers are below the radiological EGs for an “anticipated” accident as presented in Section 9.1.3.

9.2.2.3 Fire/Explosion in the RHWF

9.2.2.3.1 Scenario Development

A fire/explosion is postulated that results in a substantial release occurring in the Receiving Area, Buffer Cell, Work Cell, Waste Packaging Area, or Load Out/Truck Bay Area. Examples of envisioned scenarios include a hydrocarbon fuel-based fire/explosion in the Load Out/Truck Bay Area, and a fire/explosion in the Work Cell due to a hydrogen-air mixture in a waste container being ignited while opening the container. This accident is considered an “unlikely” event.

9.2.2.3.2 Source Term Analysis

The MAR for the subject accident scenario is considered to be reasonably bounded by twice the estimated radiological inventory contained in Box 3C-2. Of the containers of components and debris that were generated as the result of the disassembly and removal of various components from the CPC, Box 3C-2 is estimated to contain the largest inventory of radioactive material. Hence, as presented above in Section 9.2.2.2.2, the MAR in the subject accident scenario corresponds to 26.0% of the activity estimated to be present in the containers of CPC components and debris (discussed in Chapter 8). The MAR postulated for this scenario is considered to be reasonably bounding since the RHWF is designed and operated to maintain a steady throughput, and the Load Out/Truck Bay Area is not to be used for interim or long-term storage of (newly filled) waste containers.

The bounding ARF for nonvolatile radionuclides of 5.0E-03 and RF of 0.3 for explosion-related forces are taken from Section 4.4.2.2.2 of DOE-HDBK-3010-94. The bounding ARF for semivolatile radionuclides of 9.2E-02 and RF of 1.0 are taken from Section 4.3.1.3.3 of DOE-HDBK-3010-94. Semivolatile elements include carbon, selenium, ruthenium, tellurium, cesium, and polonium. The bounding ARF for volatile

radionuclides of 0.85 and RF of 1.0 are also taken from Section 4.3.1.3.3 of DOE-HDBK-3010-94. It is assumed that the source term is not reduced by filtration.

9.2.2.3.3 Analysis of Results

Table 9.2-3 presents the dose at the OEP and to the MEOSI from a fire/explosion in the RHWF. The maximum TEDE at the OEP has been calculated to be 2.10 rem, as shown in Table 9.2-3. The TEDE received by the MEOSI has been calculated to be 1.31 rem.

9.2.2.3.4 Comparison with Guidelines

The dose to the MEOSI of 1.31 rem TEDE and the dose to a receptor at the OEP of 2.10 rem TEDE due to a fire/explosion in the RHWF are below the radiological EGs for an “unlikely” accident as presented in Section 9.1.3.

9.2.2.4 Fire in an Area External to the RHWF (CPC WSA)

9.2.2.4.1 Scenario Development

A fire is postulated that results in a substantial release occurring in an External Area such as the CPC WSA. The specific scenario considered entails a diesel fuel pool fire occurring in the CPC WSA as a result of a leak in the fuel tank or fuel line of a transport vehicle (e.g., a forklift or truck). The envisioned accident scenario includes the concept that the contents of a few of the containers of CPC components and debris could be meaningfully “thermally stressed” by the fire. It is not considered credible that a fire could significantly “thermally stress” the contents of all containers given (1) the amount of diesel fuel potentially involved in the accident; (2) the area covered by the containers; (3) the nature of the floor in the CPC WSA (i.e., a gravel pad with soil below); (4) the substantial heat sink provided by the large carbon steel containers; and (5) the construction material of the CPC WSA structure (i.e., 12-gauge galvanized steel panels). This accident is considered an “extremely unlikely” event.

9.2.2.4.2 Source Term Analysis

It is conservatively assumed that the MAR for the subject accident scenario is equivalent to the estimated radiological inventory in the containers of components and debris that were generated as the result of the disassembly and removal of various components from the CPC. Hence, the inventory of radioactive materials shown in Table 8.2-1 is the MAR.

Primarily because of the potential for in-leakage of precipitation into one or more of the containers, it is conservatively assumed that 10% of the MAR is in solution. The bounding ARF for nonvolatile radionuclides of 2.0E-03 and RF of 1.0 for the “boiling of aqueous solutions” are taken from Section 3.2.1.3 of DOE-HDBK-3010-94. The bounding ARF for nonvolatile radionuclides of 6.0E-03 and RF of 1.0E-02 for the thermal stress of metal and other noncombustible surfaces are taken from Section 5.3.1 of DOE-HDBK-3010-94. Hence, the effective ARF x RF for nonvolatile radionuclides is 2.54E-04. The bounding ARF for semivolatile radionuclides of 9.2E-02 and RF of 1.0 are taken from Section 4.3.1.3.3 of DOE-HDBK-3010-94. Semivolatile elements include carbon, selenium, ruthenium, tellurium, cesium, and polonium. The bounding ARF for volatile radionuclides of 0.85 and RF of 1.0 are also taken from Section 4.3.1.3.3 of DOE-HDBK-3010-94.

9.2.2.4.3 Analysis of Results

Table 9.2-4 presents the dose at the OEP and to the MEOSI from a fire in the CPC WSA that significantly impacts (i.e., thermally stresses) the contents of a few of the containers of CPC components and debris. The maximum TEDE at the OEP has been calculated to be 1.56 rem, as shown in Table 9.2-4. The TEDE received by the MEOSI has been calculated to be 0.974 rem.

9.2.2.4.4 Comparison with Guidelines

The dose to the MEOSI of 0.974 rem TEDE and the dose to a receptor at the OEP of 1.56 rem TEDE due to a fire in the CPC WSA that significantly impacts (i.e., thermally stresses) the contents of a few of the containers of CPC components and debris are below the radiological EGs for an “extremely unlikely” accident as presented in Section 9.1.3.

9.2.3 Beyond Design Basis Accidents

10 CFR 830, *Nuclear Safety Management*, in particular 10 CFR 830.204, states that consideration should be given for “the need for analysis of accidents which may be beyond the design basis of the facility.” Such analyses are intended to provide a perspective of the residual risk associated with the operation of a given facility. Beyond design basis accidents (BDBAs) are not required to provide assurance of public health and safety. Rather, the analysis of BDBAs is intended solely to provide information that can be used to identify additional facility features or operational practices that could prevent a given BDBA or reduce the risk associated with a given BDBA. Therefore, no comparison to the EGs is provided.

9.2.3.1 Beyond Design Basis Seismic Event

9.2.3.1.1 Scenario Development

A seismic event that is beyond the design basis of the RHWF is postulated to occur. Such an earthquake would likely also have a severe negative impact on the CPC WSA and the waste containers that are stored there. Chapter 4 provides information about the seismic design criteria for the RHWF.

9.2.3.1.2 Source Term Analysis

It is assumed that the MAR for the subject accident scenario is equivalent to the estimated radiological inventory in the containers of components and debris that were generated as the result of the disassembly and removal of various components from the CPC. Hence, the inventory of radioactive materials shown in Table 8.2-1 is the MAR.

The bounding ARF of 1.0E-03 and RF of 1.0 for “free fall spill and impaction stress” are taken from Section 5.3.3.2.2 of DOE-HDBK-3010-94.

9.2.3.1.3 Analysis of Results

Table 9.2-5 presents the dose at the OEP and to the MEOSI from a beyond design basis seismic event. The maximum TEDE at the OEP has been calculated to be 5.25 rem, as shown in Table 9.2-5. The TEDE received by the MEOSI has been calculated to be 3.27 rem.

9.2.3.2 Beyond Design Basis Natural Gas Explosion in the Work Cell

9.2.3.2.1 Scenario Development

An explosion in the Work Cell, that results in a substantial release, is hypothesized to occur due to the entrance of natural gas into the Work Cell. Complete destruction of the RHWF is assumed. Chapter 5 discusses the use of natural gas for heating areas within the RHWF. All gas lines and gas-fired heating chambers are located outside of the RHWF. Combustion products (and any uncombusted natural gas) from the combustion chamber are directed away from RHWF air supply intakes. Natural gas will rise when released, because natural gas has a (typical) specific gravity of 0.6.

The composition of natural gas is not a constant, though methane (CH_4) is clearly the dominant component of natural gas. By volume, natural gas is (typically) composed of methane (94.8%), ethane (2.9%), propane (0.8%), butane (0.2%), carbon dioxide (0.1%), and nitrogen (1.2%). Natural gas has a lower explosive limit (LEL) of about 4% and an upper explosive limit (UEL) of 14%. In its pure state, natural gas is odorless,

colorless, and tasteless. For safety reasons, mercaptan is added to commercial natural gas to give it a highly pungent odor.

For a natural gas explosion to occur in the RHWF, the following events would all need to occur: (1) There is a demand for natural gas; (2) The pilot ignition source fails to ignite; (3) The gas supply valve fails such that lack of ignition source allows the valve to open; (4) The heat exchanger has a leak of meaningful size, with a location and configuration such that natural gas is drawn into the air stream entering the RHWF at a concentration greater than the LEL; (5) The natural diffusion of natural gas into the atmosphere within the RHWF, and subsequent escape from within the facility via openings, cracks, vents, and door leakage, fails to reduce the concentration to below the LEL within the facility; and (6) An ignition source is present in the gas-air mixture that remains above the LEL.

The following accident scenario frequency estimate does not credit any active preventive features or detection capabilities (some of which are discussed above), such as thermocouple controlled gas supply valve, automatic (temperature interlock based) shutdown of the air supply blower motor, RHWF ventilation system gas mixing and removal effects, or detection of a gas leak by RHWF personnel based on the smelling of natural gas or the feeling of inadequate heating. Point estimates, based on engineering judgment, are 0.07/yr for pilot ignition failure (which includes the fact that there will be a “demand” for gas of about 0.7 of a given year), and conditional probabilities of 1.0E-04 for a heat exchanger breach of the necessary size, shape, and location, and 0.1 for failure to reduce the natural gas concentration below the LEL by diffusion and escape from the facility, and 0.1 for an ignition source being present within the (at least LEL) gas mixture. It should be noted that the energy required to ignite a flammable gas-air mixture is relatively small when the gas-air mixture is at or near stoichiometric concentrations; the necessary energy increases rapidly as the gas-air mixture moves toward the upper or lower flammable limits. The resulting annual frequency estimate is 7E-08/yr.

Occurrence Reports (ORs) contained in DOE’s Occurrence Report and Processing System (ORPS) were reviewed during development of the RHWF PSAR for natural gas related events. Based on this review, it can be stated that most natural gas accidents occur outside of facilities/buildings and involve the breaking of a natural gas line by a backhoe, auger, bulldozer, or hand tools during construction or “trenching” activities. A few ORs document human error within a building as the mechanism for a natural gas leak (e.g., a forklift striking an overhead natural gas line, or initiation of gas supply to uncapped lines), while a few other ORs document various failure modes of various pieces of gas system hardware (e.g., valves, unions, elbows, and piping) located within a building. These types of initiators are not applicable to the RHWF since no gas system hardware/components are located in the RHWF. Regarding explosions, one OR documented an event that is not pertinent to the RHWF, namely a “small explosion” in a natural gas fueled boiler installed in a mechanical equipment room. ORPS contains ORs accrued over approximately the past 10 years. The results of the review of natural gas related events contained in ORPS are considered to reinforce an extremely small natural gas explosion frequency estimate for the RHWF.

9.2.3.2.2 Source Term Analysis

It is assumed that the MAR for the subject accident scenario is equivalent to the estimated radiological inventory in the containers of components and debris that were generated as the result of the disassembly and removal of various components from the CPC. Hence, the inventory of radioactive materials shown in Table 8.2-1 is the MAR.

The bounding ARF for nonvolatile radionuclides of 5.0E-03 and RF of 0.3 for explosion-related forces are taken from Section 4.4.2.2.2 of DOE-HDBK-3010-94. The bounding ARF for semivolatile radionuclides of 9.2E-02 and RF of 1.0 are taken from Section 4.3.1.3.3 of DOE-HDBK-3010-94. Semivolatile elements include carbon, selenium, ruthenium, tellurium, cesium, and polonium. The bounding ARF for volatile radionuclides of 0.85 and RF of 1.0 are also taken from Section 4.3.1.3.3 of DOE-HDBK-3010-94.

9.2.3.2.3 Analysis of Results

Table 9.2-6 presents the dose at the OEP and to the MEOSI from a beyond design basis natural gas explosion in the Work Cell. The maximum TEDE at the OEP has been calculated to be 8.10 rem, as shown in Table 9.2-6. The TEDE received by the MEOSI has been calculated to be 5.05 rem.

9.2.4 Accident Analysis Summary

A summary of the accident analyses that are contained in this chapter is provided in Table 9.2-7. All credible accidents that were evaluated are within the EGs given in Section 9.1.3. Calculations yielded a dose to the MEOSI of 1.31 rem TEDE and a dose to a receptor at the OEP of 2.10 rem TEDE due to a fire/explosion in the RHWF. This represents the bounding credible accident scenario.

REFERENCES FOR CHAPTER 9.0

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TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY

Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
Receiving Area							
Radioactive Material (Airborne or Otherwise Uncontrolled Release)	1) Container rupture, breach, or fluid leak resulting in a minor release 2) Container rupture, breach, or fluid leak resulting in a substantial release 3) Fire/explosion resulting in a minor release 4) Fire/explosion resulting in a substantial release	- Seismic event - Strong straight winds or tornado - Lightning strike - Corrosion - Operator error (e.g., improper positioning of container on rollers causes container to fall, forklift punctures or crushes container) - Mechanical or electrical failure/malfunction (e.g., crane drops container, wiring short/defect leads to overheating and fire, forklift or other transport vehicle leaks diesel fuel or hydraulic fluid with fire ensuing) - Container crushed by shield doors between Receiving Area and Buffer Cell	- Forklift and truck care/maintenance to ensure proper operation - Administrative controls on forklift and truck operation - Established procedures and training for forklift and truck operators, powered roller system and shield door operators - Containers normally not lifted by Receiving Area crane (i.e., most commonly, a forklift places container on rollers) - Robust crane design, coupled with required load testing and periodic maintenance - Structural strength of containers and many of the waste items within the containers - General lack of ignition sources - Extremely limited amount of combustible materials routinely located in Receiving Area - Preventive maintenance on electrical and mechanical components	- Leak confinement design features - Fire detection and alarm system - Wet-pipe sprinkler system - Portable fire extinguishers - Receiving Area is UBC designated “Type II - Fire Resistive” - West Valley Volunteer Hose Company	1) Neg 2) Low 3) Low 4) Mod	1)A 2)A 3)U 4)U	1) 0 2) 4 3) 2 4) 5

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Continued)

	Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
10 11	High Radiation Exposure Rate	1) Gamma dose rate substantially underestimated, or shielding reconfigured in undesired manner, resulting in dose to workers on the order of a few rem 2) Gamma dose rate substantially underestimated, or shielding reconfigured in undesired manner, resulting in dose to workers on the order of tens of rem	- Dose rate device provides erroneous output or is misread - Equipment failure or other mishap results in partial or complete loss of shielding	- Training for performing dose rate surveys - Periodic calibration of radiation instruments - Design features of shielding installation - Established procedures and training for waste container and related shielding handling operations	- Area radiation monitor(s) in Receiving Area - Operator radiological work environment training	1) Low 2) Mod	1)U 2)I	1) 2 2) 0

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Continued)

Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
Buffer Cell							
Radioactive Material (Airborne or Otherwise Uncontrolled Release)	1) Container rupture, breach, or fluid leak resulting in a minor release 2) Container rupture, breach, or fluid leak resulting in a substantial release 3) Fire/explosion resulting in a minor release 4) Fire/explosion resulting in a substantial release 5) Loss of confinement while processing Waste Tank Farm Pump (with shield doors to Receiving Area and to Work Cell open)	- Seismic event - Strong straight winds or tornado - Lightning strike - Corrosion - Operator error - Mechanical or electrical failure/malfunction (e.g., crane drops container (though crane normally does not handle a container once in Buffer Cell) possibly due to cranes colliding in Buffer Cell, wiring short/defect leads to overheating and fire, forklift or other transport vehicle in Receiving Area catches fire which subsequently impacts Buffer Cell) - Container crushed by shield doors between Buffer Cell and Receiving Area or Buffer Cell and Work Cell - For WTF pumps, shield doors to Receiving Area and to Work Cell both opened before confinement structure fully sealed, or confinement structure breached due to inadequate design or operational mishap	- Established procedures and training for powered roller system operators, and shield door operators - Containers normally not lifted by Receiving Area crane once in Buffer Cell - Structural strength of containers and many of the waste items within the containers - General lack of ignition sources - Extremely limited amount of combustible materials routinely located in Buffer Cell - Preventive maintenance on electrical and mechanical components	- Liquid collection system (i.e., sloped floor, trench, drain hub) in Buffer Cell - Fire detection and alarm system (i.e., heat detection devices in the exhaust ventilation system) - Buffer Cell is UBC designated “Type II - Noncombustible” - West Valley Volunteer Hose Company (if shield doors from Receiving Area opened)	1) Neg 2) Low 3) Low 4) Mod 5) Low	1)A 2)A 3)U 4)U 5)U	1) 0 2) 4 3) 2 4) 5 5) 2

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Continued)

	Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
18 19	High Radiation Exposure Rate	1) Gamma dose rate substantially underestimated, or shielding reconfigured in undesired manner, resulting in dose to workers on the order of a few rem 2) Gamma dose rate substantially underestimated, or shielding reconfigured in undesired manner, resulting in dose to workers on the order of tens of rem	- Dose rate device provides erroneous output or is misread - Equipment failure or other mishap results in partial or complete loss of shielding	- Training for performing dose rate surveys - Periodic calibration of radiation instruments - Design features of shielding installation - Established procedures and training for waste container and related shielding handling operations	- Area radiation monitor(s) in Receiving Area (which would serve mitigative function if shield door between Receiving Area and Buffer Cell is open) - Operator radiological work environment training	1) Low 2) Mod	1)U 2)I	1) 2 2) 0

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Continued)

Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
Work Cell							
Radioactive Material (Airborne or Otherwise Uncontrolled Release)	1) Uncontrolled (liquid) release from container, waste item, or ion exchange system 2) Fire resulting in a minor release 3) Fire resulting in a substantial release 4) Explosion resulting in a minor release 5) Explosion resulting in a substantial release 6) In-cell exhaust ventilation system filter(s) damaged (e.g., crushed) resulting in a minor release 7) In-cell exhaust ventilation system filter(s) damaged (e.g., crushed) resulting in a substantial release 8) Failure/blowout of ex-cell exhaust ventilation system HEPA filter(s), but not the in-cell filters 9) Design basis tornado generated missile breaches Work Cell window	- Seismic event - Strong straight winds or tornado - Corrosion - Operator error with waste item handling or cutting equipment - Mechanical or electrical failure/malfunction (e.g., crane drops item(s) (possibly due to cranes colliding), robotic arm falls, wiring short/defect leads to overheating and fire, hydraulic fluid (if used by Work Cell equipment) leaks with fire ensuing) - Ignition of combustible waste by size reduction equipment, including by generated sparks and hot metal particles - Ignition of flammable/combustible dust - Ignition of pockets of flammable gas by size reduction equipment - Container crushed by shield doors between Buffer Cell and Work Cell	- Established procedures and training for operations conducted in the Work Cell - Robust crane design, coupled with required load testing and periodic maintenance - Limited amount of combustible materials routinely located in Work Cell - Preventive maintenance on electrical and mechanical components - Only means even hypothetically capable of explosion able to result in a substantial release involves introduction of natural gas into Work Cell - Controlled/specialized venting methods (and subsequent gas purging) of waste containers (and vessels inside of containers) in select instances	- Liquid collection system (i.e., sloped floor, trench, drain hub) in Work Cell - Steel lining of walls and floor - Fire detection and alarm system (i.e., heat detection devices in the exhaust ventilation system) - Work Cell is UBC designated “Type II - Noncombustible” - Thick reinforced concrete construction of Work Cell, thick shield windows, and formidable filtered ventilation system that services the Work Cell (including redundant ex-cell HEPA filtered exhaust ventilation train) - Remote handling of demineralized water lines to extinguish fire	1) Neg 2) Low 3) Mod 4) Low 5) Mod 6) Low 7) Mod 8) Low 9) Neg	1)A 2)U 3)U 4)U 5)I 6)U 7)EU 8)EU 9)I	1) 0 2) 2 3) 5 4) 2 5) IE 6) 2 7) 3 8) 1 9) 0

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Continued)

	Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
26	Fissile Material	1) Criticality	- Accumulation/ concentration of fissile material into a critical configuration in a moderated (e.g., water) environment	- Limited fissile mass processed through RHWF - Fissile mass is distributed through a very large volume and mass of waste materials, and is by-and-large physically and/or chemically fixed/bound to the materials	- Thick reinforced concrete construction of Work Cell, thick shield windows, and formidable ventilation system that services the Work Cell	1) Mod	1) I	1) 0
27	**Contact Maintenance Area (Including Liquid Waste Collection Tanks and Associated Transfer/Recirculation Pumps)**							
28 29 30 31 32	Radioactive Material (Airborne or Otherwise Uncontrolled Release)	1) Mechanical mishap (not involving fire) during maintenance activity 2) Localized fire during maintenance activity 3) Non-localized fire during maintenance activity 4) Loss of line/pump integrity resulting in a minor release 5) Loss of line/pump integrity resulting in a substantial release 6) Leak/rupture of one or more than one of the waste collection tanks	- Seismic event - Strong straight winds or tornado - Corrosion - Erosion - Operator error (e.g., crane-related error, “hot” operation not performed properly, improper valve alignment) - Mechanical or electrical failure/malfunction (e.g., wiring short/defect leads to overheating and fire) - Mishap involving shield doors between Work Cell and Contact Maintenance Area - Pump operation with line plugging (i.e., sustained dead heading of a pump)	- Established procedures and training for crane and shield door operators, and liquid waste transfer and recirculation system operators - Established procedures and training for maintenance personnel - Administrative controls on “hot” work - General lack of ignition sources - Extremely limited amount of combustible materials routinely located in Contact Maintenance Area - Preventive maintenance on electrical and mechanical components - Tanks should normally contain non-corrosive liquids (i.e., it is not intended that hazardous chemicals be directed to the liquid waste collection tanks)	- Fire detection and alarm system (i.e., heat detection devices in the exhaust ventilation system) - Contact Maintenance Area is UBC designated “Type II - Noncombustible” - Thick reinforced concrete construction of Contact Maintenance Area, and formidable ventilation system that services the Contact Maintenance Area - Tank vault lined with stainless steel	1) Neg 2) Neg 3) Low 4) Neg 5) Low 6) Neg	1)A 2)U 3)EU 4)A 5)U 6)EU	1) 0 2) 0 3) 1 4) 0 5) 2 6) 0
33	Fissile Material	1) Criticality	- Accumulation/ concentration of fissile material into a critical configuration in a liquid waste collection tank	- Limited fissile mass processed through RHWF - Fissile mass is distributed through a very large volume and mass of waste materials, and is by-and-large physically and/or chemically fixed/bound to the materials - Though not credited for criticality safety, strainers keep particulate matter over approximately 120 microns out of tanks	- Thick reinforced concrete construction of Contact Maintenance Area, and formidable ventilation system that services the Contact Maintenance Area	1) Mod	1) I	1) 0

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Continued)

	Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
34 35	High Radiation Exposure Rate	1) Gamma dose rate substantially underestimated, or shielding reconfigured in undesired manner, resulting in dose to workers on the order of a few rem 2) Gamma dose rate substantially underestimated, or shielding reconfigured in undesired manner, resulting in dose to workers on the order of tens of rem	- Dose rate device provides erroneous output or is misread - Equipment failure or other mishap results in partial or complete loss of shielding	- Training for performing dose rate surveys - Periodic calibration of radiation instruments - Design features of shielding installation - Established procedures and training for waste container and related shielding handling operations	- Area radiation monitor(s) in Receiving Area - Operator radiological work environment training	1) Low 2) Mod	1)U 2)I	1) 2 2) 0

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Continued)

	Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
36	**Waste Packaging Area, Survey/Spot Decontamination Area, and Radiation Protection Operations Area**							
37 38 39 40 41	Radioactive Material (Airborne or Otherwise Uncontrolled Release)	1) Container rupture or breach resulting in a minor release 2) Container rupture or breach resulting in a substantial release 3) Fire/explosion resulting in a minor release 4) Fire/explosion resulting in a substantial release	- Seismic event - Strong straight winds or tornado - Operator error - Mechanical or electrical failure/malfunction (e.g., wiring short/defect leads to overheating and fire, box or drum transport cart malfunction)	- Established procedures and training for waste packaging system and cart operators - Structural strength of (new) containers - General lack of ignition sources - Extremely limited amount of combustible materials routinely in Waste Packaging Area and Survey/Spot Decontamination Area - Preventive maintenance on electrical and mechanical components	- Continuous Air Monitors - Area Radiation Monitors - Fire detection and alarm system - Wet-pipe sprinkler system - Portable fire extinguishers - West Valley Volunteer Hose Company	1) Neg 2) Low 3) Low 4) Mod	1)A 2)U 3)U 4)U	1) 0 2) 2 3) 2 4) 5
42	**Load Out/Truck Bay**							
43 44 45 46 47	Radioactive Material (Airborne or Otherwise Uncontrolled Release)	1) Container(s) rupture or breach resulting in a minor release 2) Container(s) rupture or breach resulting in a substantial release 3) Fire/explosion resulting in a minor release 4) Fire/explosion resulting in a substantial release	- Seismic event - Strong straight winds or tornado - Lightning strike - Operator error (e.g., forklift punctures, drops, or crushes container) - Mechanical or electrical failure/malfunction (e.g., wiring short/defect leads to overheating and fire, forklift or other transport vehicle leaks fuel or hydraulic fluid with fire ensuing)	- Forklift and truck care/maintenance to ensure proper operation - Administrative controls on forklift and truck operation - Established procedures and training for forklift and truck operators - Structural strength of (new) containers - General lack of ignition sources - Extremely limited amount of combustible materials routinely located in Load Out/Truck Bay - Preventive maintenance on electrical and mechanical components	- Fire detection and alarm system - Wet-pipe sprinkler system - Portable fire extinguishers - Load Out/Truck Bay is UBC designated “Type II - Fire Resistive” - West Valley Volunteer Hose Company	1) Neg 2) Low 3) Low 4) Mod	1)A 2)U 3)U 4)U	1) 0 2) 2 3) 2 4) 5

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Continued)

	Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
48	Fissile Material	1) Criticality	- Fissile mass loading of one or more containers far beyond procedurally allowed amounts and introduction of significant quantities of moderator (such as water)	- Limited fissile mass processed through RHWF - Fissile mass is distributed through a very large volume and mass of waste materials, and is by-and-large physically and/or chemically fixed/bound to the materials - Fissile mass allowed per container is limited by procedure - Liquids normally sorted from solid wastes during operations in the Work Cell	- None	1) Mod	1) I	1) 0
49 50	High Radiation Exposure Rate	1) Gamma dose rate substantially underestimated, or shielding reconfigured in undesired manner, resulting in dose to workers on the order of a few rem 2) Gamma dose rate substantially underestimated, or shielding reconfigured in undesired manner, resulting in dose to workers on the order of tens of rem	- Dose rate device provides erroneous output or is misread - Equipment failure or other mishap results in partial or complete loss of shielding	- Training for performing dose rate surveys - Periodic calibration of radiation instruments - Design features of shielding installation - Established procedures and training for waste container and related shielding handling operations	- Area radiation monitor(s) in Load Out/Truck Bay - Operator radiological work environment training	1) Low 2) Mod	1)U 2)I	1) 2 2) 0

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Continued)

	Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
51	**Operating Aisle, Mechanical Equipment Area, and Stack Monitor Room**							
52 53 54	Radioactive Material from the Work Cell or Buffer Cell	1) Airborne contamination due to ventilation system unavailability or operational transient 2) Localized fire of short duration 3) Non-localized fire 4) Radioactive material enters Operating Aisle or Mechanical Equipment Area via line(s) or equipment that penetrate into/interface with Work Cell or Buffer Cell 5) Confinement not maintained during maintenance/repair operations on line(s) or equipment in Operating Aisle or Mechanical Equipment Area that penetrate into/interface with Work Cell or Buffer Cell	- Seismic event - Strong straight winds or tornado - Loss of off-site power (LOOP) with prolonged unavailability of backup diesel generator power - Ventilation system controls malfunction or high pressure compressed inert gas bottle(s) (e.g., used during maintenance) discharge very rapidly into Work Cell or Buffer Cell - Operator error - Mechanical or electrical failure/malfunction (e.g., motor overheats and leads to a fire, isolation valve or check valve fails to seat properly, seal around a shield window becomes defective, shield window cracks/breaks due to collision with in-cell equipment)	- General lack of ignition sources - Extremely limited amount of combustible materials in Operating Aisle, Mechanical Equipment Area, and Stack Monitor Room - Preventive maintenance on electrical and mechanical components - Isolation dampers throughout the ventilation system to prevent or minimize the backflow of contaminated air (i.e., flow of air from Work Cell or Buffer Cell into adjacent areas) - Isolation valves, check valves, or other backflow prevention devices for utilities (e.g., demineralized water lines, compressed air lines) used in Work Cell or Buffer Cell - Cover glass over shield windows	- Continuous Air Monitors - Area Radiation Monitors - Fire detection and alarm system - Wet-pipe sprinkler system - Portable fire extinguishers - West Valley Volunteer Hose Company	1) Low 2) Neg 3) Low 4) Neg 5) Neg	1)U 2)U 3)EU 4)A 5)A	1) 2 2) 0 3) 1 4) 0 5) 0

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Continued)

Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
Sample Packaging and Screening Room							
Radioactive Material from the Work Cell	1) Airborne contamination due to ventilation system unavailability or operational transient 2) Fire involving waste sample 3) Limited uncontrolled release (i.e., a small spill or a little airborne without a spill) 4) Uncontrolled release (i.e., spill) of most or all of waste sample	- Seismic event - Strong straight winds or tornado - Loss of off-site power (LOOP) with prolonged unavailability of backup diesel generator power - Ventilation system controls malfunction or high pressure compressed inert gas bottle(s) (e.g., used during maintenance) discharge very rapidly into Work Cell - Operator error (e.g., operator improperly seals sample container and subsequently drops it) - Mechanical or electrical failure/malfunction (e.g., wiring short/defect leads to overheating and fire, sample transfer lift system to Radiation Protection Operations Area malfunctions)	- Operator training for sample-related operations - General lack of ignition sources - Extremely limited amount of combustible materials - Preventive maintenance on electrical and mechanical components - Isolation dampers throughout the ventilation system to prevent or minimize the backflow of contaminated air (i.e., flow of air from Work Cell into adjacent areas) - High efficiency filter on glove box minimizes airborne contamination if backflow conditions occur (approximately 60 cfm flows through glove box into Work Cell under normal conditions)	- Continuous Air Monitors - Area Radiation Monitors - Fire detection and alarm system - Wet-pipe sprinkler system - Portable fire extinguishers - West Valley Volunteer Hose Company - Size of samples is limited (i.e., samples greater than approximately one kilogram (2.2 lbs) in mass, one liter (0.26 gal) in volume, or reading over 50 mR/hr are not conveyed through the Sample Packaging and Screening Room)	1) Low 2) Low 3) Neg 4) Low	1)U 2)U 3)A 4)U	1) 2 2) 2 3) 0 4) 2

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Continued)

	Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
58	**External Areas (e.g., Chemical Process Cell Waste Storage Area (CPC WSA))**							
59 60 61 62 63	Radioactive Material (Airborne or Otherwise Uncontrolled Release)	1) Container rupture, breach, or fluid leak resulting in a minor release 2) Container rupture, breach, or fluid leak resulting in a substantial release 3) Fire resulting in a minor release 4) Fire resulting in a substantial release 5) Beyond design basis seismic event 6) Breach of double walled piping during liquid waste transfer	- Seismic event - Strong straight winds or tornado - Lightning strike - Corrosion - Operator error (e.g., forklift punctures, drops, or crushes container; container drops off truck in transit to RHWF because improperly secured) - Mechanical or electrical failure/malfunction (e.g., forklift or truck brakes fail, forklift leaks diesel fuel or hydraulic fluid with fire ensuing) - Trench containing double walled piping collapses	- Forklift and truck care/maintenance to ensure proper operation - Administrative controls on forklift and truck operation - Established procedures and training for forklift and truck operators - Structural strength of containers and many of the waste items within the containers - Waste items often enclosed in contamination barrier (i.e., Herculite) - General lack of ignition sources - Extremely limited amount of combustible materials in CPC WSA and other areas where waste containers are retrieved from	- West Valley Volunteer Hose Company	1) Neg 2) Low 3) Low 4) Mod 5) Mod 6) Low	1)A 2)A 3)U 4)EU 5)I 6)EU	1) 0 2) 4 3) 2 4) 3 5) IE 6) 1

TABLE 9.1-1
PROCESS HAZARDS ANALYSIS FOR THE REMOTE-HANDLED WASTE FACILITY
(All footnotes are located at the end of the table) (Concluded)

Hazard	Event	Initiator	Preventive Features	Mitigative Features	Conseq. [1]	Freq. [2]	Risk Factor [3]
High Radiation Exposure Rate	1) Gamma dose rate substantially underestimated, or shielding reconfigured in undesired manner, resulting in dose to workers on the order of a few rem 2) Gamma dose rate substantially underestimated, or shielding reconfigured in undesired manner, resulting in dose to workers on the order of tens of rem	- Dose rate device provides erroneous output or is misread - Equipment failure or other mishap results in partial or complete loss of shielding	- Training for performing dose rate surveys - Periodic calibration of radiation instruments - Design features of shielding installation - Established procedures and training for waste container and related shielding handling operations	- Operator radiological work environment training	1) Low 2) Mod	1)U 2)I	1) 2 2) 0

Notes:

[1] Consequences are discussed in Section 9.1.1.2: Neg = Negligible; Low; Mod = Moderate; High
[2] Frequencies are discussed in Section 9.1.1.2: A = Anticipated; U = Unlikely; EU = Extremely Unlikely; I = Incredible
[3] See Section 9.1.1.2 and Figure 9.1-1 for an explanation of Risk Factor.

TABLE 9.2-1

DAMAGE TO EXHAUST SYSTEM FILTERS LOCATED IN THE WORK CELL

Assumptions:

Airborne Release Fraction (ARF)[1]	5.0E-4	Respiratory Fraction (RF)[1]	1.0
Leakpath Factor (LPF)	1.0	Damage Ratio (DR)	1.0
Release Height	Ground Level		

Receptor Location				**640 m**	**850 m**	**1300 m NNW**	
Stability Class, Wind Speed				**F, 1.0 m/s**	**F, 1.0 m/s**	**95%**	
Dispersion (χ/Q)				**1.30E-03 s/m³**	**8.10E-04 s/m³**	**4.97E-04 s/m³**	
Nuclide	**MAR (Ci)**	**Source Term (Ci)**	**DCF 0071 rem/uCi**	**On-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Percent Dose Contribution**
Pu-238	3.49E+00	1.75E-03	4.60E+02	3.48E-01	2.17E-01	1.33E-01	43.6%
Am-241	1.61E+00	8.06E-04	5.20E+02	1.81E-01	1.13E-01	6.94E-02	22.8%
Pu-239	9.75E-01	4.87E-04	5.10E+02	1.08E-01	6.70E-02	4.11E-02	13.5%
Pu-240	7.41E-01	3.70E-04	5.10E+02	8.18E-02	5.10E-02	3.13E-02	10.3%
Pu-241	2.13E+01	1.06E-02	1.00E+01	4.61E-02	2.87E-02	1.76E-02	5.8%
Sr-90	5.01E+01	2.51E-02	1.30E+00	1.41E-02	8.78E-03	5.39E-03	1.8%
Cm-244	1.07E-01	5.34E-05	2.70E+02	6.25E-03	3.89E-03	2.39E-03	0.8%
Am-243	5.19E-02	2.60E-05	5.20E+02	5.84E-03	3.64E-03	2.23E-03	0.7%
U-232	1.54E-02	7.68E-06	6.70E+02	2.23E-03	1.39E-03	8.52E-04	0.3%
Th-228	1.55E-02	7.76E-06	3.10E+02	1.04E-03	6.49E-04	3.98E-04	0.1%
Am-242m	8.26E-03	4.13E-06	5.10E+02	9.12E-04	5.68E-04	3.49E-04	0.1%
U-233	2.42E-02	1.21E-05	1.30E+02	6.82E-04	4.25E-04	2.61E-04	0.1%
			Total TEDE	**7.97E-01**	**4.96E-01**	**3.05E-01**	**100.0%**

Note:
[1] ARF and RF are from DOE-HDBK-3010-94, Section 5.4.4.1.

TABLE 9.2-2

WASTE CONTAINER FAILURE

Assumptions:

Airborne Release Fraction (ARF)[1]	1.0E-3	Respiratory Fraction (RF) [1]	0.1
Leakpath Factor (LPF)	1.0	Damage Ratio (DR)	1.0
Release Height	Ground Level		

Receptor Location				**640 m**	**850 m**	**1300 m NNW**	
Stability Class, Wind Speed				**F, 1.0 m/s**	**F, 1.0 m/s**	**95%**	
Dispersion (χ/Q)				**1.30E-03 s/m³**	**8.10E-04 s/m³**	**4.97E-04 s/m³**	
Nuclide	**MAR (Ci)**	**Source Term (Ci)**	**DCF 0071 rem/uCi**	**On-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Percent Dose Contribution**
Pu-238	2.99E+00	2.99E-04	4.60E+02	5.95E-02	3.71E-02	2.27E-02	43.6%
Am-241	1.38E+00	1.38E-04	5.20E+02	3.10E-02	1.93E-02	1.19E-02	22.8%
Pu-239	8.34E-01	8.34E-05	5.10E+02	1.84E-02	1.15E-02	7.04E-03	13.5%
Pu-240	6.34E-01	6.34E-05	5.10E+02	1.40E-02	8.72E-03	5.35E-03	10.3%
Pu-241	1.82E+01	1.82E-03	1.00E+01	7.88E-03	4.91E-03	3.01E-03	5.8%
Sr-90	4.28E+01	4.28E-03	1.30E+00	2.41E-03	1.50E-03	9.22E-04	1.8%
Cm-244	9.14E-02	9.14E-06	2.70E+02	1.07E-03	6.66E-04	4.08E-04	0.8%
Am-243	4.44E-02	4.44E-06	5.20E+02	1.00E-03	6.23E-04	3.82E-04	0.7%
U-232	1.31E-02	1.31E-06	6.70E+02	3.81E-04	2.37E-04	1.46E-04	0.3%
Th-228	1.33E-02	1.33E-06	3.10E+02	1.78E-04	1.11E-04	6.81E-05	0.1%
Am-242m	7.06E-03	7.06E-07	5.10E+02	1.56E-04	9.72E-05	5.96E-05	0.1%
U-233	2.07E-02	2.07E-06	1.30E+02	1.17E-04	7.27E-05	4.46E-05	0.1%
			Total TEDE	**1.36E-01**	**8.49E-02**	**5.21E-02**	**100.0%**

Note:

[1] ARF and RF are from DOE-HDBK-3010-94, Section 4.4.3.3.2 and Section 5.2.3.2.

TABLE 9.2-3

FIRE/EXPLOSION IN THE RHWF

Assumptions:

Nonvolatile:	Airborne Release Fraction (ARF)[1]	5.0E-3	Respiratory Fraction (RF)[1]	0.3
Semivolatile:	Airborne Release Fraction (ARF)[2]	9.2E-2	Respiratory Fraction (RF)[2]	1.0
Volatiles:	Airborne Release Fraction (ARF)[2]	8.5E-1	Respiratory Fraction (RF)[2]	1.0
Leakpath Factor (LPF)		1.0	Damage Ratio (DR)	1.0
Release Height		Ground Level		

Receptor Location				**640 m**	**850 m**	**1300 m NNW**	
Stability Class, Wind Speed				**F, 1.0 m/s**	**F, 1.0 m/s**	**95%**	
Dispersion (χ/Q)				**1.30E-03 s/m³**	**8.10E-04 s/m³**	**4.97E-04 s/m³**	
Nuclide	**MAR (Ci)**	**Source Term (Ci)**	**DCF 0071 rem/uCi**	**On-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Percent Dose Contribution**
Pu-238	2.99E+00	4.48E-03	4.60E+02	8.92E-01	5.56E-01	3.41E-01	42.4%
Am-241	1.38E+00	2.07E-03	5.20E+02	4.66E-01	2.90E-01	1.78E-01	22.1%
Pu-239	8.34E-01	1.25E-03	5.10E+02	2.76E-01	1.72E-01	1.06E-01	13.1%
Pu-240	6.34E-01	9.50E-04	5.10E+02	2.10E-01	1.31E-01	8.02E-02	10.0%
Pu-241	1.82E+01	2.73E-02	1.00E+01	1.18E-01	7.36E-02	4.52E-02	5.6%
Cs-137	4.70E+01	4.32E+00	3.20E-02	5.99E-02	3.73E-02	2.29E-02	2.8%
Sr-90	4.28E+01	6.43E-02	1.30E+00	3.62E-02	2.25E-02	1.38E-02	1.7%
Cm-244	9.14E-02	1.37E-04	2.70E+02	1.60E-02	9.98E-03	6.13E-03	0.8%
Am-243	4.44E-02	6.66E-05	5.20E+02	1.50E-02	9.34E-03	5.73E-03	0.7%
U-232	1.31E-02	1.97E-05	6.70E+02	5.72E-03	3.56E-03	2.19E-03	0.3%
Th-228	1.33E-02	1.99E-05	3.10E+02	2.67E-03	1.66E-03	1.02E-03	0.1%
Am-242m	7.06E-03	1.06E-05	5.10E+02	2.34E-03	1.46E-03	8.94E-04	0.1%
U-233	2.07E-02	3.11E-05	1.30E+02	1.75E-03	1.09E-03	6.69E-04	0.1%
			Total TEDE	**2.10E+00**	**1.31E+00**	**8.04E-01**	**100.0%**

Notes:

[1] ARF and RF for nonvolatile radionuclides are from DOE-HDBK-3010-94, Section 4.4.2.2.2.

[2] ARF and RF for semivolatile and volatile radionuclides are from DOE-HDBK-3010-94, Section 4.3.1.3.3.

TABLE 9.2-4

FIRE IN AN AREA EXTERNAL TO THE RHWF (CPC WSA)

Assumptions:

Nonvolatile:	Effective ARF x RF[1]	2.54E-4		
Semivolatile:	Airborne Release Fraction (ARF)[2]	9.2E-2	Respiratory Fraction (RF)[2]	1.0
Volatiles:	Airborne Release Fraction (ARF)[2]	8.5E-1	Respiratory Fraction (RF)[2]	1.0
Leakpath Factor (LPF)		1.0	Damage Ratio (DR)	1.0
Release Height		Ground Level		

Receptor Location				**640 m**	**850 m**	**1300 m NNW**	
Stability Class, Wind Speed				**F, 1.0 m/s**	**F, 1.0 m/s**	**95%**	
Dispersion (χ/Q)				**1.30E-03 s/m³**	**8.10E-04 s/m³**	**4.97E-04 s/m³**	
Nuclide	**MAR (Ci)**	**Source Term (Ci)**	**DCF 0071 rem/uCi**	**On-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Percent Dose Contribution**
Pu-238	1.15E+01	2.92E-03	4.60E+02	5.82E-01	3.62E-01	2.22E-01	37.2%
Am-241	5.31E+00	1.35E-03	5.20E+02	3.04E-01	1.89E-01	1.16E-01	19.4%
Cs-137	1.81E+02	1.67E+01	3.20E-02	2.31E-01	1.44E-01	8.82E-02	14.8%
Pu-239	3.21E+00	8.15E-04	5.10E+02	1.80E-01	1.12E-01	6.88E-02	11.5%
Pu-240	2.44E+00	6.20E-04	5.10E+02	1.37E-01	8.53E-02	5.23E-02	8.8%
Pu-241	7.01E+01	1.78E-02	1.00E+01	7.71E-02	4.80E-02	2.95E-02	4.9%
Sr-90	1.65E+02	4.19E-02	1.30E+00	2.36E-02	1.47E-02	9.02E-03	1.5%
Cm-244	3.52E-01	8.94E-05	2.70E+02	1.05E-02	6.51E-03	4.00E-03	0.7%
Am-243	1.71E-01	4.34E-05	5.20E+02	9.78E-03	6.09E-03	3.74E-03	0.6%
U-232	5.06E-02	1.29E-05	6.70E+02	3.73E-03	2.32E-03	1.43E-03	0.2%
Th-228	5.11E-02	1.30E-05	3.10E+02	1.74E-03	1.09E-03	6.66E-04	0.1%
Am-242m	2.72E-02	6.91E-06	5.10E+02	1.53E-03	9.50E-04	5.83E-04	0.1%
U-233	7.98E-02	2.03E-05	1.30E+02	1.14E-03	7.11E-04	4.36E-04	0.1%
			Total TEDE	**1.56E+00**	**9.74E-01**	**5.98E-01**	**100.0%**

Notes:

[1] The effective ARF x RF for nonvolatile radionuclides is taken from Sections 5.3.1 and 3.2.1.3 of DOE-HDBK-3010-94. Ten percent of the MAR is assumed to be in solution, and an ARF x RF of 2E-03 is associated with that MAR. An ARF x RF of 6E-05 is associated with the remaining MAR.

[2] ARF and RF for semi-volatile and volatile radionuclides are from DOE-HDBK-3010-94, Section 4.3.1.3.3.

TABLE 9.2-5

BEYOND DESIGN BASIS SEISMIC EVENT

Assumptions:

Airborne Release Fraction (ARF)[1]	1.0E-3	Respirable Fraction (RF)[1]	1.0
Damage Ration (DR)	1.0	Leakpath Factor (LPF)	1.0
Release Height	Ground Level		

Receptor Location				**640 m**	**850 m**	**1300 m NNW**	
Stability Class, Wind Speed				**F, 1.0 m/s**	**F, 1.0 m/s**	**95%**	
Dispersion (χ/Q)				**1.30E-03 s/m³**	**8.10E-04 s/m³**	**4.97E-04 s/m³**	
Nuclide	**MAR (Ci)**	**Source Term (Ci)**	**DCF 0071 rem/uCi**	**On-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Percent Dose Contribution**
Pu-238	1.15E+01	1.15E-02	4.60E+02	2.29E+00	1.43E+00	8.76E-01	43.6%
Am-241	5.31E+00	5.31E-03	5.20E+02	1.20E+00	7.45E-01	4.57E-01	22.8%
Pu-239	3.21E+00	3.21E-03	5.10E+02	7.09E-01	4.42E-01	2.71E-01	13.5%
Pu-240	2.44E+00	2.44E-03	5.10E+02	5.39E-01	3.36E-01	2.06E-01	10.3%
Pu-241	7.01E+01	7.01E-02	1.00E+01	3.03E-01	1.89E-01	1.16E-01	5.8%
Sr-90	1.65E+02	1.65E-01	1.30E+00	9.29E-02	5.79E-02	3.55E-02	1.8%
Cm-244	3.52E-01	3.52E-04	2.70E+02	4.11E-02	2.56E-02	1.57E-02	0.8%
Am-243	1.71E-01	1.71E-04	5.20E+02	3.85E-02	2.40E-02	1.47E-02	0.7%
U-232	5.06E-02	5.06E-05	6.70E+02	1.47E-02	9.14E-03	5.61E-03	0.3%
Th-228	5.11E-02	5.11E-05	3.10E+02	6.86E-03	4.27E-03	2.62E-03	0.1%
Am-242m	2.72E-02	2.72E-05	5.10E+02	6.01E-03	3.74E-03	2.30E-03	0.1%
U-233	7.98E-02	7.98E-05	1.30E+02	4.49E-03	2.80E-03	1.72E-03	0.1%
			Total TEDE	**5.25E+00**	**3.27E+00**	**2.01E+00**	**100.0%**

Note:
[1] ARF and RF are from DOE-HDBK-3010-94, Section 5.3.3.2.2.

TABLE 9.2-6

BEYOND DESIGN BASIS NATURAL GAS EXPLOSION IN THE WORK CELL

Assumptions:

Non-Volatile:	Airborne Release Fraction (ARF)[1]	5.0E-3	Respiratory Fraction (RF)[1]	0.3
Semi-Volatile:	Airborne Release Fraction (ARF)[2]	9.2E-2	Respiratory Fraction (RF)[2]	1.0
Volatiles:	Airborne Release Fraction (ARF)[2]	8.5E-1	Respiratory Fraction (RF)[2]	1.0
Leakpath Factor (LPF)		1.0	Damage Ratio (DR)	1.0
Release Height		Ground Level		

Receptor Location				**640 m**	**850 m**	**1300 m NNW**	
Stability Class, Wind Speed				**F, 1.0 m/s**	**F, 1.0 m/s**	**95%**	
Dispersion (χ/Q)				**1.30E-03 s/m³**	**8.10E-04 s/m³**	**4.97E-04 s/m³**	
Nuclide	**MAR (Ci)**	**Source Term (Ci)**	**DCF 0071 rem/uCi**	**On-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Off-Site Dose (Rem)**	**Percent Dose Contribution**
Pu-238	1.15E+01	1.73E-02	4.60E+02	3.44E+00	2.14E+00	1.31E+00	42.4%
Am-241	5.31E+00	7.96E-03	5.20E+02	1.79E+00	1.12E+00	6.85E-01	22.1%
Pu-239	3.21E+00	4.82E-03	5.10E+02	1.06E+00	6.62E-01	4.06E-01	13.1%
Pu-240	2.44E+00	3.66E-03	5.10E+02	8.08E-01	5.03E-01	3.09E-01	10.0%
Pu-241	7.01E+01	1.05E-01	1.00E+01	4.55E-01	2.84E-01	1.74E-01	5.6%
Cs-137	1.81E+02	1.67E+01	3.20E-02	2.31E-01	1.44E-01	8.82E-02	2.8%
Sr-90	1.65E+02	2.48E-01	1.30E+00	1.39E-01	8.68E-02	5.32E-02	1.7%
Cm-244	3.52E-01	5.28E-04	2.70E+02	6.17E-02	3.85E-02	2.36E-02	0.8%
Am-243	1.71E-01	2.57E-04	5.20E+02	5.77E-02	3.60E-02	2.21E-02	0.7%
U-232	5.06E-02	7.59E-05	6.70E+02	2.20E-02	1.37E-02	8.42E-03	0.3%
Th-228	5.11E-02	7.67E-05	3.10E+02	1.03E-02	6.41E-03	3.93E-03	0.1%
Am-242m	2.72E-02	4.08E-05	5.10E+02	9.01E-03	5.61E-03	3.44E-03	0.1%
U-233	7.98E-02	1.20E-04	1.30E+02	6.74E-03	4.20E-03	2.58E-03	0.1%
			Total TEDE	**8.10E+00**	**5.05E+00**	**3.10E+00**	**100.0%**

Notes:

[1] ARF and RF for nonvolatile radionuclides are from DOE-HDBK-3010-94, Section 4.4.2.2.2.

[2] ARF and RF for semivolatile and volatile radionuclides are from DOE-HDBK-3010-94, Section 4.3.1.3.3.

TABLE 9.2-7

SUMMARY OF ACCIDENT ANALYSES

Accident	On-Site Evaluation Point (rem)	Maximally Exposed Off-Site Individual (rem)	Evaluation Guideline
Damage to Exhaust System Filters Located in the Work Cell	7.97E-01	4.96E-01	On-Site - 100 rem
			Off-Site - 25 rem
Waste Container Failure	1.36E-01	8.49E-02	On-Site - 5 rem
			Off-Site - 0.5 rem
Fire/Explosion in the RHWF	2.10E+00	1.31E+00	On-Site - 25 rem
			Off-Site - 5 rem
Fire in an Area External to the RHWF (CPC WSA)	1.56E+00	9.74E-01	On-Site - 100 rem
			Off-Site - 25 rem
Beyond Design Basis Seismic Event	5.25E+00	3.27E+00	Not Applicable
Beyond Design Basis Criticality Accident	2.29E+01	1.43E+01	Not Applicable
Beyond Design Basis Natural Gas Explosion in the Work Cell	8.10E+00	5.05E+00	Not Applicable

Figure 9.1-1 Process Hazards Analysis Risk Bins

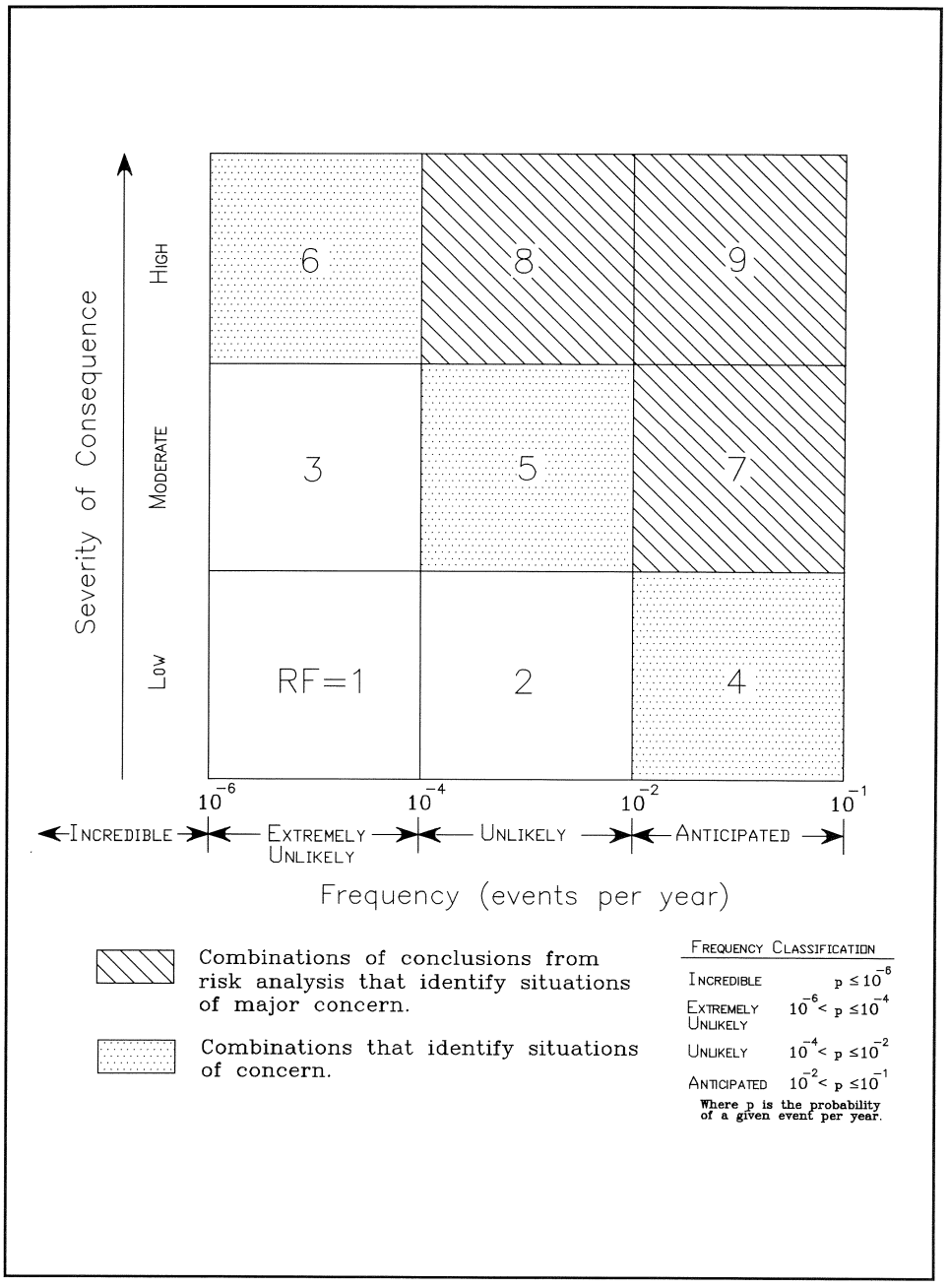

Figure 9.1-1 Process Hazards Analysis Risk Bins

Figure 9.1-2 Evaluation Guidelines for the Off-site Evaluation Point for Radiological Accidents

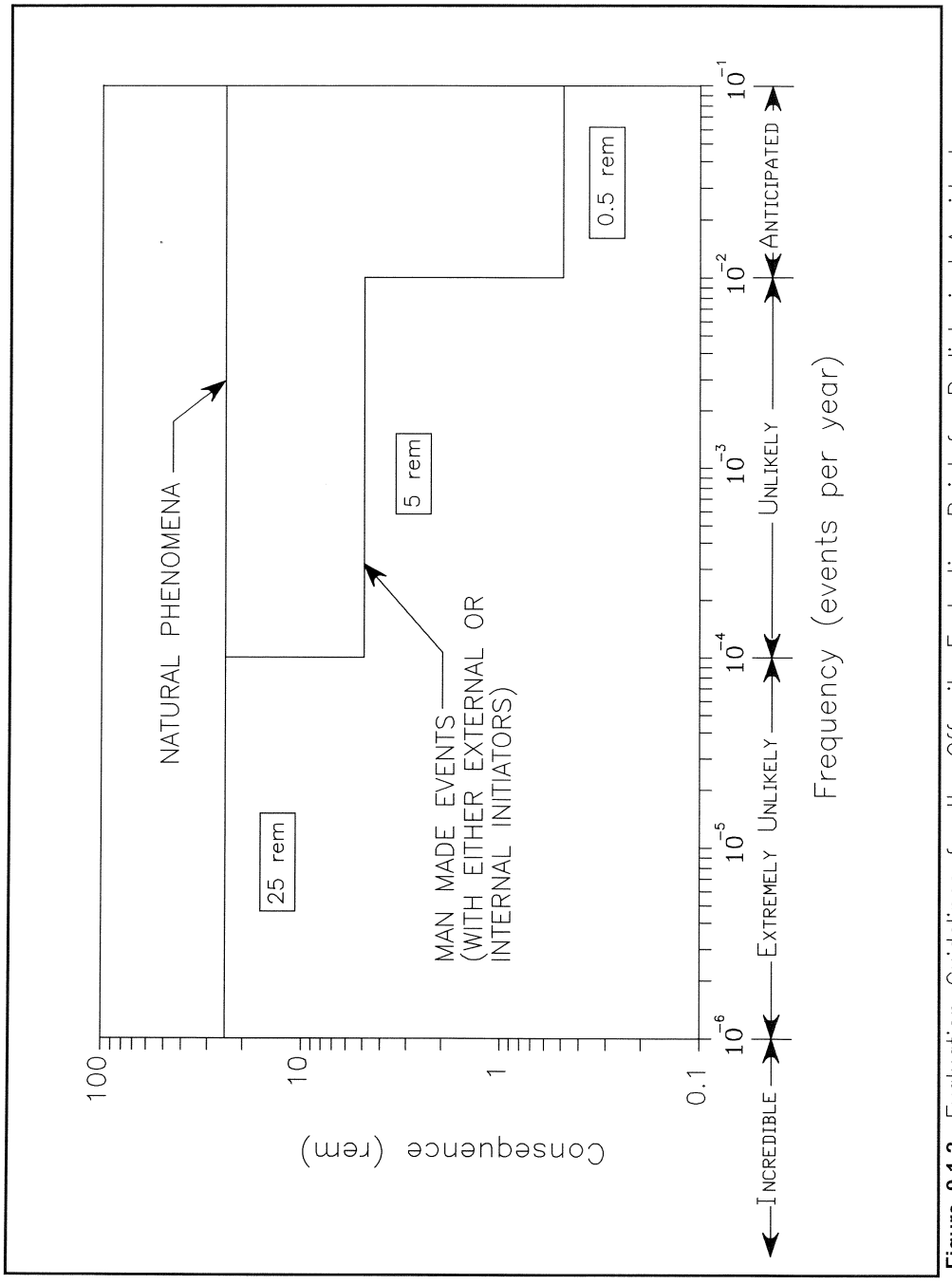

Figure 9.1-2 Evaluation Guidelines for the Off-site Evaluation Point for Radiological Accidents

Figure 9.1-3 Evaluation Guidelines for the On-site Evaluation Point for Radiological Accidents

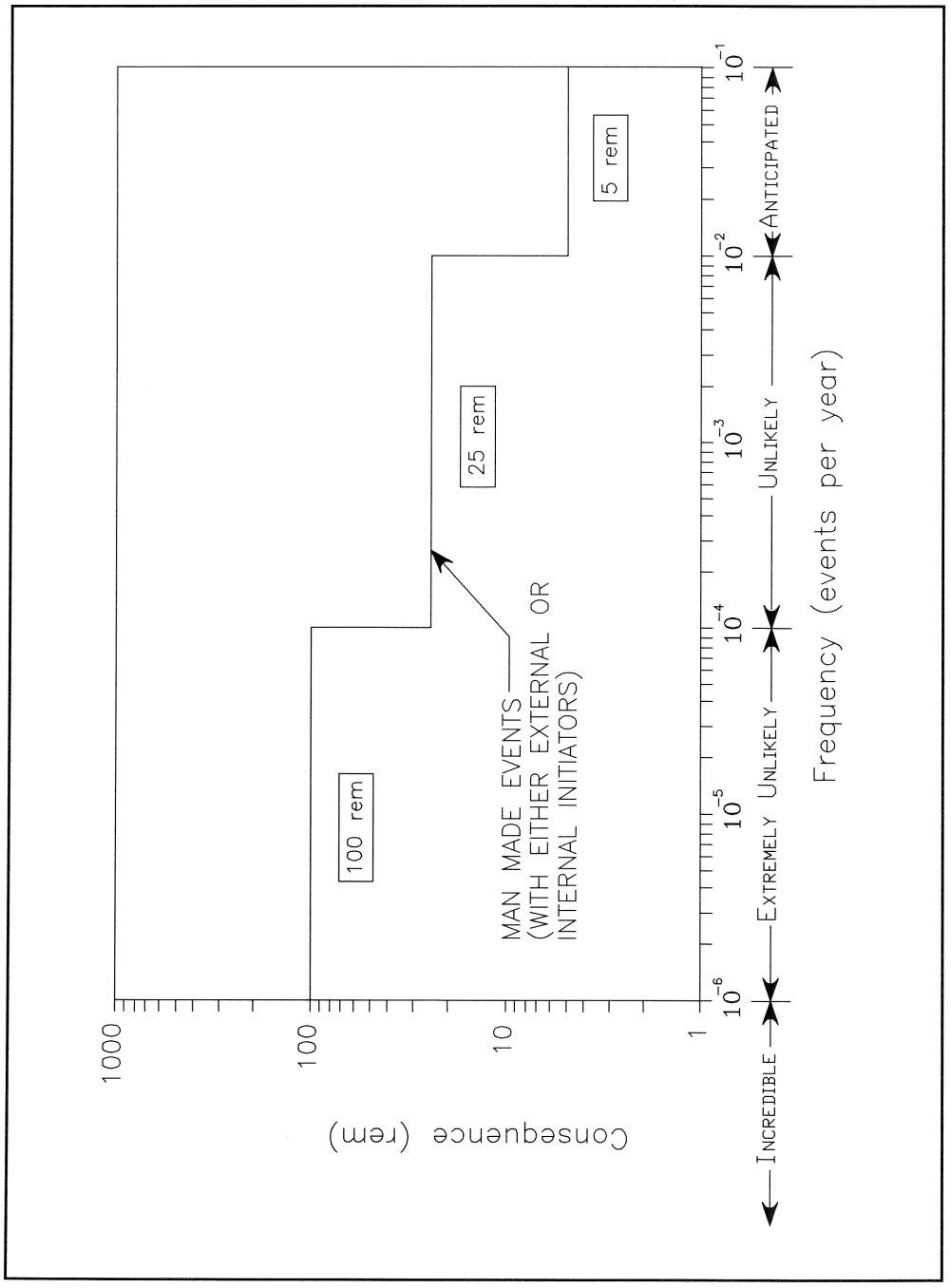

Figure 9.1-3 Evaluation Guidelines for the On-site Evaluation Point for Radiological Accidents

10.0 CONDUCT OF OPERATIONS

Conduct of Operations at the West Valley Demonstration Project (WVDP) is a philosophy for achieving excellence. To enhance safe operations and deliver a high quality product, the West Valley Nuclear Services Company (WVNSCO) follows WVDP-106, *West Valley Demonstration Project Conduct of Operations Manual,* which implements and augments Department of Energy (DOE) Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*. The manual, which is based on the eighteen chapters of DOE Order 5480.19 in sequence, provides guidance for uniform and consistent compliance with the Order. The principles and philosophy of the manual apply to all WVDP activities and are implemented on-site in a graded fashion. The goal of the manual is to promote greater accountability of each individual for their cognizant site activities.

The WVDP Conduct of Operations program is presented in detail in Chapter 10.0 of WVNS-SAR-001, *Safety Analysis Report for Waste Processing and Support Activities*. References to specific sections of WVNS-SAR-001 are provided below, as appropriate.

10.1 Organizational Structure

The overall WVDP organizational structure is presented in Section 10.1 of WVNS-SAR-001. This section identifies and defines the responsibilities of major project stakeholders, customers, governing and regulatory agencies, as well as the key Management & Operating (M&O) Contractor, their affiliates, technical support organizations, and subcontractors.

10.1.1 Organization

WVNSCO, the prime Contractor at the WVDP, is owned by a joint venture of Washington Group International, Inc., and BNFL Inc. (a U.S. subsidiary of British Nuclear Fuels). Corporate assistance is provided on an as-needed basis when specialized expertise and services are required.

10.1.2 WVNSCO Organization

As of January 2003, the WVNSCO Remote-Handled Waste Project (RHWP) Manager reports to the WVNSCO Executive Vice President & Projects Manager, who reports to the President of WVNSCO. Section 10.1.2 of WVNS-SAR-001 provides additional definition of the WVNSCO Organization, including minimum staffing requirements for safe operation of Hazard Category 2 or 3 facilities, and key organizational roles and responsibilities.

Specific requirements pertaining to the operational classification of the RHWF can be found in WVNSCO policy and procedure WV-110, *Conduct of Operations.*

10.1.3 Personnel Qualification Requirements

WVNSCO personnel qualification requirements are discussed in Section 10.1.3 of WVNS-SAR-001.

10.1.4 Liaison with Outside Organizations

The various organizations associated with the WVDP and their interrelationships are illustrated in Figure 10.1-1 of WVNS-SAR-001. All government agencies deal directly with representatives from the on-site area DOE-Ohio Field Office/West Valley Demonstration Project (DOE-OH/WVDP) in a manner controlled by Cooperative Agreements or Memoranda of Understanding (MOU). All subcontractors interface through the WVNSCO Purchasing Department and a WVNSCO technical liaison. To resolve specialized questions on technical subcontracts, the Purchasing Department coordinates contacts within the appropriate departments at WVNSCO. WVDP-117, *WVNS Policies and Procedures Manual,* provides specific direction for interfacing with subcontractors and suppliers in accordance with DOE directives and federal acquisition regulations.

10.2 Preoperational Testing

10.2.1 Administrative Procedure for Conducting the Test Program

The Start-up and Testing phase for structures, systems, or components (SSCs) starts with construction turnover and continues until the facility or system has been turned over. An Engineering Procedure (EP) contained in WVDP-114, *WVNS Engineering Procedures*, provides instructions on how to identify and control the start-up and testing of SSCs used at the WVDP to verify performance to the specified design and performance requirements. As described in the procedure, Design Criteria, System Descriptions, Construction Specifications, Equipment Specifications, the WVDP Quality List, and Test Plans (TPLs) are documents used to identify and control the testing. The EP also provides the responsibilities of the organizations which ensure that testing is developed, approved, and performed in compliance with all elements of the test program.

Inspection and test control, as they relate to Quality Assurance, are discussed in Chapter 12 of this SAR.

WV-368, *Operational Readiness Determination for Start-up/Restart*, defines the processes necessary for compliance with start-up and restart requirements as they pertain to unreviewed safety questions (USQs), new processes and/or facilities, and pertinent restart actions. This procedure identifies necessary approvals, authorizations, and requirements for performing readiness activities, developing related readiness documentation, and conducting required reviews, verifications, and reporting in accordance with DOE Order 425.1B, *Start-up and Restart of Nuclear Facilities*. WV-368 is supplemented by WVDP-342, *Operational Readiness Determination Manual for Start-up and Restart of WVDP Facilities*.

All procedures and instructions for conducting the test program and evaluating, documenting, and approving the results are prepared, reviewed, and approved in accordance with WVDP-114 and WVDP-117, *WVNS Policies and Procedures Manual*. Operating records, including procedures, data sheets, and logbooks are maintained for the life of the Project in accordance with WVDP-262, *WVNS Manual for Records Management and Storage*.

Pre-commissioning, commissioning, and performance system tests will be completed for equipment, components, systems, and subsystems installed in the Remote-Handled Waste Facility (RHWF) prior to radioactive operations. WVNS-TPL-313-001, *Remote-Handled Waste Facility Start-up Test Program Plan,* defined the scope, responsibilities, requirements, objectives, acceptance criteria, and prerequisites for conducting the RHWF Start-up Test Program. The design-build contractor of the RHWF was responsible for performing and documenting all pre-commissioning and commissioning tests. Performance testing was performed by WVNSCO and documented by start-up work documents.

Pre-commissioning and commissioning tests included rotational checks on rotating equipment, leak testing pressurized lines, and air flow and balance tests on air handling systems. In addition to the facility system functional testing, the design-build contractor performed shielding integrity verification in accordance with ANS-6.4, *Guidelines on the Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants*. Control systems were tested and calibrated, and control set point adjustments made and confirmed. All systems and components were placed in an operational readiness state.

Once the construction, pre-commissioning, and commissioning tests were satisfactorily completed by the contractor, a given SSC was turned over to WVNSCO for performance testing.

Operation of the facility was demonstrated using all the equipment in mock-up tests to show that the systems perform as specified. The mock-up tests were conducted with materials similar, but nonradioactive, to those that are to be processed at the RHWF. Building utility systems, remotely operated material handling and processing

equipment (e.g., cranes, Powered Dexterous Manipulators (PDMs), roller conveyors, and transfer carts), facility ventilation and filtration systems, shield doors, electrical safety control interlocks, and all emergency systems (e.g., radiation monitoring, fire protection, and all alarm systems) were demonstrated to be operational and able to perform their designated functions.

After the successful completion of pre-commissioning, commissioning, and performance system tests, WVNSCO trained Operations, Maintenance and Technical support staff in the operation and maintenance of RHWF SSCs.

10.3 Training Program

10.3.1 Program Description

The overall objective of the qualification program is to provide qualified personnel to operate facilities safely in such areas as equipment operation, process flows, control instrumentation, radiological/industrial safety, and emergency response in accordance with DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*. Operator candidates who meet the prerequisites for the qualification programs are trained and tested to provide qualified operations personnel. The operator training program for facility operators fulfills the specific needs determined for personnel to operate the facility and process in a safe and efficient manner. At the completion of the training/qualification program, the operator is able to:

- Explain the theory and function of the system process, equipment, and controls for generation of an acceptable product;
- Perform the normal modes of operation per Standard Operating Procedures (SOPs);
- Detect abnormal or emergency conditions using the instrumentation available and visual monitoring of the components;
- Mitigate emergency situations using appropriate procedures and place the system into a safe condition; and
- Operate the facility safely in accordance with approved procedures.

A more detailed discussion of the WVNSCO training program is presented in Sections 10.3.1.1 through 10.3.1.7 of WVNS-SAR-001.

10.3.2 Continuing Training Programs

WVNS-SAR-001, Section 10.3.2, discusses the WVNSCO Continuing Training and Requalification Programs. These programs apply to all WVDP employees, including those responsible for the safe operation of the RHWF.

10.3.3 Administration and Records

Training materials are reviewed for technical accuracy and approved by the cognizant functional manager. Before training materials are released for use, the Training and Development Department reviews them to assure that they satisfy established training criteria in terms of complying with WVDP-126, *Performance-Based Training Program Manual*.

The Records & Information Department is responsible for maintaining the training records management system for the program, and maintaining individual training records in an auditable manner. Training records are maintained in accordance with ASME NQA-1-1989, Supplement 17S-1 requirements as lifetime quality assurance records. Training records are stored in one-hour fire-rated file cabinets. Records & Information is also responsible for maintenance of the training records management system (TRMS) database, which contains the information for completion of initial and

requalification training of WVDP personnel. Training record activities are conducted in accordance with WVDP-126, and WVDP-262, *WVNS Manual for Records Management Storage*.

10.4 Normal Operations

10.4.1 Procedures

WVDP procedures ensure safe operations under routine, abnormal, or emergency conditions. Different types of procedures used for the various site activities are contained in appropriate site and department procedures manuals. Facility operating procedures are of one basic type: SOPs, which are used to conduct normal operations. WVDP-022, *WVDP Emergency Plan*, WVDP-139, Volume I, *Emergency Management Implementing Procedures*, and WVDP-139, Volume II, *Emergency Management Administrative Procedures* provide the basis for a timely and effective response to potential or actual emergency events at the WVDP. Work instructions are used primarily for non-routine maintenance activities. The development and maintenance of procedures is discussed in Section 10.4.1 of WVNS-SAR-001.

SOPs have been developed to ensure safe, normal operations of the RHWF.

10.4.2 Safety Management Policies and Programs

A brief overview of safety performance assessment, configuration and document control, event reporting, and safety culture are provided below. A more complete discussion is provided in Section 10.4.2 of WVNS-SAR-001.

10.4.2.1 Safety Performance Assessment

Safety performance appraisal of those organizations involved in the management of safety is performed in accordance with WV-121, *Self-Assessment Program*, which covers all disciplines related to safety and includes such functional areas of inquiry as nuclear safety, emergency management, fire protection, occupational safety and health, radiological protection, and environmental protection. This program complies with applicable DOE Directives governing assessment at DOE facilities, including DOE P 450.5, *Line Environment, Safety, and Health Oversight*, and DOE Order 5480.19.

WVDP-242, *Event Investigation and Reporting Manual*, contains procedures which provide for root cause analysis of site Environmental, Safety, & Health (ES&H) performance. Other formal programs such as the Conduct of Operations Surveillance Program, implemented by WVDP-106, and the Operational Readiness Review (ORR) Program, implemented by WV-368, *Operational Readiness Determination for Start-up/Restart of WVDP Facilities*, complement the formal self-assessment process described in WV-121.

10.4.2.2 Configuration and Document Control

The WVNSCO configuration and document control program is composed of five major elements: Program Management, Design Requirements, Document Control, Change Control, and Assessment/Review. Combined, these elements establish and maintain consistency in design requirements, physical configuration, modifications to the facility or its operation, and facility documentation.

10.4.2.3 Event Reporting

Abnormal events at the WVDP are investigated and reported in accordance with WVDP-242, *Event Investigation and Reporting Manual*. WVDP-242 implements the requirements of DOE Order 232.1A, *Occurrence Reporting and Processing of Operations Information*, DOE Manual 232.1-1A, *Occurrence Reporting and Processing of Operations Information*, and DOE Order 5480.19. This policy establishes the requirement for WVNSCO to develop and implement a process for determining, evaluating, reporting, and correcting events and conditions at the WVDP, including those occurrences involving WVNSCO subcontractors. The types of events covered by this process include, but are

not limited to, events related to safety, health, security, operations, property, quality assurance, and the environment.

10.4.2.4 Safety Culture

WVNSCO has implemented a comprehensive program for worker protection, based on a safety policy that states: "Exceed customer expectations without injury or illness." WVNSCO has formatted its safety program to be an Integrated Safety Management System (ISMS) which is implemented by the guiding principles of the Occupational, Safety, and Health Administration (OSHA) Safety and Health Management Guidelines. These guidelines are the precursor to DOE Policy 450.4, *Safety Management System Policy*. WVNSCO Policy and Procedure WV-100, *Integrated Safety Management and Control of Documents*, establishes WVNSCO policy in this regard. Documents that implement the WVDP integrated safety management system are identified in WVDP-310, *WVDP Safety Management System Description.*

WVNSCO systematically integrates safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment. This integration is accomplished by implementing the ISMS. The DOE has developed seven guiding principles to provide the focus for implementing an ISMS. These principles are:

1) Line Management Responsibility for Safety
2) Clear Roles and Responsibilities
3) Competence Commensurate with Responsibilities
4) Balanced Priorities
5) Identification of Safety Standards and Requirements
6) Hazards Control
7) Operations Authorization

While these principles guide the implementation of an ISMS, five core functions define its make-up. These functions comprise a cycle of activities which, although different in detail, are the same for activities on a program or site level and a facility and work task level. The core functions are:

1) <u>Define the Scope of Work</u> - This function includes identifying all tasks associated with the activity and identifying resources needed to perform the activity.
2) <u>Analyze the Hazards</u> - On a work task level, this function includes identifying the physical and environmental hazards involved in an activity (radiation level, heat, or the potential for release of contaminants). On a facility or program level, this includes developing and maintaining safety analysis documentation.
3) <u>Develop Hazards Controls</u> - This function includes administrative and engineering controls, design controls, and training. As examples, the controls can take the form of personal protective equipment or technical safety requirements.
4) <u>Perform Work Within Controls</u> - This function provides the means to ensure that once the controls are developed, the work is performed within the controls.
5) <u>Provide Feedback and Continuous Improvement</u> - This function closes the loop for the work activity. Lessons-learned from one activity are identified so that they may be incorporated into subsequent activities. This feedback includes both things that went right as well as things that went wrong.

10.4.3 Maintenance and In-Service Surveillance Program

A description of the WVDP In-Service Surveillance and Maintenance program is presented in Section 10.4.3 of WVNS-SAR-001.

10.4.4 Conduct of Operations

The WVDP Conduct of Operations Program is presented in Section 10.4.4 of WVNS-SAR-001. The RHWP has incorporated features and configurations into the RHWF that enhance the conduct of operations. Specific areas to which conduct of operations apply include the following:

- Shift Routines and Operating Practices

Practices for the safe operation of the RHWF are consistent with the guidance given in WVDP-106 and have been developed and implemented through approved facility procedures. These practices include regular meetings to brief operations personnel on near-term activities affecting the facility, routine surveillance requirements to ensure regular and systematic appraisals of facility conditions, and equipment status boards to indicate the operating status of major equipment, as appropriate.

- Operating Aisle Activities

Access to the RHWF is maintained through WVDP security restrictions. Personnel access to areas such as the Operating Aisle may be further restricted if deemed necessary by the facility operations supervisor. The Operating Aisle is manned as facility operations warrant.

- Communications

The WVDP communications system includes a public address system, emergency all-page system, and radio and telephone communication system. These systems are tested frequently to ensure continuous operability for routine and emergency conditions throughout the site. These communication systems are further discussed in Section 10.5.1.5 of WVNS-SAR-001.

- Control of On-Shift Training

All facility operations personnel receive on-the-job training as a supplement to formal classroom training. On-the-job training provides trainees direct supervision by qualified trainers/instructors as they perform their actual job function. This training has been factored into the formal operations training programs described in Section 10.3 of this SAR.

- Control of Equipment and System Status

Formal approved procedures, consistent with the guidance given in WVDP-106, have been developed for indication and control of the status of RHWF equipment and systems. Routinely-updated status boards indicate the status of major equipment.

- Lockouts and Tagouts

Formal approved procedures, consistent with the guidance in WVDP-106, implement a site lock and tag program. This program ensures that systems and equipment are locked and tagged to the degree necessary to assure the protection of personnel during construction, maintenance, repair, decommissioning, and any other operation.

- Independent Verification Practice

Guidance for performing independent verification of facility equipment is provided in WVDP-106. Procedures governing critical equipment are evaluated against independent verification criteria.

- Log Keeping

Operating logs are maintained, used, reviewed, and stored in a manner consistent with WVDP-106. Logbooks are maintained for the life of the facility in accordance with WV-730, *Records Management and Storage*.

- Operations Turnover

The WVDP has developed a procedure, consistent with the operations turnover protocol given in WVDP-106, that provides instructions for conducting an orderly and accurate transfer of information regarding a facility's overall status at shift turnover. The information necessary for operations turnover is in the form of a standard checklist and discussion between off-going and on-coming operators. Significant events such as changes in equipment operational status and shift activities are recorded in formal logbooks which are maintained in operations facilities.

- Operations Aspects of Facility Chemistry and Unique Processes

Activities consistent with WVDP-106 are implemented for those aspects of operations involved in chemistry and unique processes.

- Required Reading

A required reading program has been implemented in a manner consistent with the guidance given in WVDP-106. Additional guidance for required reading is given in WV-552, *Required Reading for WVNSCO Personnel*.

- Timely Orders to Operators

Timely orders to operators are issued, reviewed, and maintained in a manner consistent with WVDP-106 guidance.

- Operator Aid Postings

Operators aids are developed, reviewed, posted, and logged in a manner consistent with WVDP-106 guidance.

- Equipment and Piping Labeling

A formal approved procedure, consistent with WVDP-106, has been developed for system and component labeling. This procedure ensures consistent, readable, and permanent identification of RHWF areas, valves, pipes, instruments, breakers, switches, electrical and control panels, and electrical components inside panels.

10.5 Emergency Preparedness Program

The WVDP Emergency Preparedness Program is presented in detail in Section 10.5 of WVNS-SAR-001.

10.6 Decommissioning

10.6.1 Decommissioning Program

Planning for decommissioning of WVDP facilities is in progress. This includes the eventual deactivation, decontamination, and decommissioning of the RHWF. Once the environmental review process has been completed and the conceptual approach to decommissioning determined, the details of implementation will be developed.

Final decontamination and decommissioning (D&D) plans are dependent on facility closure plans that are yet to be determined. Safety analyses and Unreviewed Safety Question Determinations (USQDs) associated with site decommissioning activities will be performed as appropriate.

10.6.2 Decontamination

Decontamination of RHWF SSCs involves the removal of sources of hazardous and radioactive materials to acceptable levels or concentrations. Section 4.3 of WVNS-DC-071, *Remote-Handled Waste Facility Design Criteria*, provides a listing of RHWF design features that have been included to facilitate RHWF decontamination. Additionally, substantial D&D-related information for the RHWF is provided in *Closure Report on the Deactivation and Decommissioning of the Stand-Alone Alternative to the RHWF* (Scientech 1999). Specific design features and measures cited in the subject report that have been employed to facilitate D&D of the RHWF are as follows:

- The floor of the Work Cell, as well as its walls, to a height below the crane rails, are lined with stainless steel. In addition, all surfaces in the Work Cell not lined with stainless steel, as well as all surfaces of the Buffer Cell, are sealed with an epoxy coating. These coverings minimize or prevent the infiltration of radioactive materials into the concrete floors and walls, thereby reducing the amount of structural material (concrete) required to be removed and processed as radioactive waste.

- The work tables, at which waste size reducing takes place, incorporate a down draft ventilation system. This is important in that the work station becomes the “first line of defense” in preventing the spread of radioactive contaminants. There is also a portable vacuum pick-up system that can be used to reduce the spread of radioactive contaminants.

- Joints or seams, such as at the liner-wall interface, are caulked or sealed so as to prevent the spread of contaminants behind the liner. Similarly, construction joints are sealed.

- Curbs, dikes, trenches, sumps, or other barriers are used to confine or direct the flow of water in areas that could be decontaminated using a water wash system, or in areas where waste water is collected (e.g., the waste water tank vault). The tank vault has a steel liner so the vault itself becomes the secondary confinement for the water in the tanks.

- Floors are sloped toward floor drains.

- Wall, floor, and ceiling penetrations in the Work Cell have been kept to a minimum and are sealed so as to prevent the migration of radioactive contaminants.

- Waste collection tanks are not buried but located in a steel lined vault. Overflow from the tanks is to the vault, which has sensors to detect an overflow condition. Provisions have been made to permit liquids to be taken directly from the vault using a portable pump.

- Crud traps (i.e., those features in the design of fluid systems that promote the buildup of radioactive material) have been eliminated to the greatest degree possible in the drain system. The drain lines have smooth long radius bends to prevent crud buildup. In addition, fine mesh strainers located in drain hubs exist to capture radioactive materials. The strainers are changed out as needed, sampled, and disposed of with the rest of the processed waste.

- Measures exist to prevent significant imbalances in the ventilation system when transferring waste to and from the Work Cell.

- The exhaust ventilation system filters located in the Work Cell are located along one wall of the Work Cell and below the work platforms. This design facilitates the capture of airborne radioactive material and greatly reduces the amount of contamination on exhaust ventilation system components located outside the Work Cell.

- Runs of electrical wires and instrumentation and control wires in contaminated areas are in conduits.

- The Buffer Cell, Work Cell, and Contact Maintenance Area (CMA) possess remote, water washdown capabilities to wash down SSCs located in them, including the Work Cell crane and manipulators to reduce the dose rate and contamination levels on the crane and manipulators before they are moved to the CMA.

- Corrodible structures or surfaces such as exposed carbon steel have been covered with protective, decontaminatable coatings.

10.6.3 Agreements with Outside Organizations

The DOE, as dictated in the WVDP Act, Public Law 96-368, entered into agreements, which include the D&D program, with the Nuclear Regulatory Program (NRC) and New York State. The agreement between the DOE and the NRC is in the form of a MOU, which defines the relationships between these two organizations. The MOU indicated that the DOE will D&D the Project facilities at the end of the Project according to criteria prescribed by the NRC. D&D criteria for WVDP completion is contained in the NRC’s Final Policy Statement (67-FR-5003) dated 2/1/02.

DOE also entered into a Cooperative Agreement with New York State Energy Research Development Authority (NYSERDA). The Cooperative Agreement and the WVDP Act establish a 90%/10% cost-sharing arrangement between the federal and New York State governments for costs directly related to the Project scope as defined by the Act. All D&D costs associated with non-project facilities are the responsibility of New York State. Negotiations are currently underway between DOE and NYSERDA regarding cost-sharing for final D&D of the Western New York Nuclear Service Center (WNYNSC).

10.6.4 Arrangements for Funding

Decontamination of Project facilities is a requirement of the WVDP Act, the MOU, and the Cooperative Agreement. The total scope of D&D cannot be determined until after the Record of Decision (ROD) for the final Environmental Impact Statement (EIS) on Project completion. The total cost also cannot be estimated until final D&D criteria are approved by the NRC. However, the cost of the WVDP, including the D&D of the Project premises only, will be shared by the federal and New York State governments.

After the completion of the WVDP, operational control of the Project premises will revert back to the State of New York for institutional control, including continued monitoring and maintenance, if required.

10.7 Human Factors

The discipline of human factors is directed towards the application of behavioral and social science principles to system settings to optimize both human and system performance. Section 10.7 of WVNS-SAR-001 provides more information regarding human factors.

The RHWF has been designed to be comfortable and natural for personnel to operate and maintain. Human factors have been considered in positioning equipment, switches, valves, and instruments from both an operating and a maintenance viewpoint. The following human factors were considered during the design of the RHWF:

- Instrument readouts are located at average eye elevation for ease of reading. The instruments controls are located to permit visual monitoring without drastic shifts of body position.

- Equipment is accessible for ease of operation and maintenance.

- Valves are properly sized and located for ease of operation without using ladders, platforms, or over extending the body beyond normal reach.

- Manipulators and viewing equipment have been properly located for ease of remote operation and maintenance.

- Accommodations for operators with a range of physical sizes and ability have been considered.

- Operations requiring special skills or special attention have been minimized or automated, where possible.

- Audible and visual alarms have been included to warn operators in advance of conditions exceeding limits.

- Communication systems exist during normal and off-normal operating conditions (e.g., emergency communication systems such as the "812" All Page, intercoms, and hand-held radios).

- System control, display devices, component arrangement, vibration, noise, lighting, emergency lighting, ventilation, temperature, humidity, human dimensions, protective equipment, warning and annunciator systems, and maintainability were considered during the design of the operating aisle and other areas where activities are routinely performed.

- Storage areas for equipment were located in the appropriate locations.

- Provisions were included inside the RHWF and in the office area for personnel accommodations (e.g., meeting room, lunchroom, men's and women's restrooms).

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11.0 TECHNICAL SAFETY REQUIREMENTS

11.1 Introduction

The objective of this chapter is to provide information that satisfies the requirements of 10 CFR 830.204(b)(4). This chapter is intended to link the accident analyses, through descriptions of the safety structures, systems, and components (SSCs), to a Technical Safety Requirement (TSR) document. The TSR document is intended to constitute an agreement or contract between the Department of Energy (DOE) and the applicable managing and operating (M&O) contractor (in this case, West Valley Nuclear Services Company [WVNSCO]) regarding the safe operation of a given West Valley Demonstration Project (WVDP) facility, activity, or operation.

Safety Class SSCs are those SSCs whose preventive and/or mitigative functions are necessary to maintain the consequence of an accident below the off-site Evaluation Guidelines (EGs) provided in Section 9.1.3. Because the accidents analyzed in Chapter 9 do not rely on protective or mitigative features to maintain dose consequences below the EGs, no TSRs are mandated for the Remote-Handled Waste Facility (RHWF). DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, indicates that, with the exception of Safety Class SSCs, there is significant latitude as to the content of a given facility’s TSRs. For reasons provided in this Chapter, this latitude has been used in concluding that no TSRs are needed for the RHWF.

11.2 Requirements

This Safety Analysis Report (SAR) meets the requirements in 10 CFR 830.204 and 830.205 with respect to TSRs.

11.3 Technical Safety Requirement Input

There are no Design Basis Accidents (DBAs) that have consequences that would exceed the EGs. There are no active Safety Class SSCs in the RHWF nor are there any Safety Class SSCs that are under the direct control of operators within the RHWF.

11.3.1 Safety Limits and Limiting Conditions for Operation

There are no DBAs that require active Safety Class SSCs, nor are there Safety Class SSCs under the direct control of RHWF operators to mitigate the consequences or prevent the occurrence of an accident to meet the EGs. Accidents have been evaluated with a reasonably bounding radiological material at risk. Therefore, no TSR Safety Limits or Limiting Conditions for Operation (LCOs) are required for the RHWF.

11.3.2 Design Features

The primary passive safety features in the RHWF are the thick reinforced concrete shield walls, steel shield doors, and shield windows. Consequence analyses presented in Chapter 9 did not take credit for high efficiency particulate air (HEPA) filtration of releases.

Barriers for RHWF worker protection constitute one of the (if not the) primary contributors to defense in depth. Chapter 8 of this SAR contains a discussion of defense in depth as it pertains to the RHWF. DOE-STD-3009-94 states that SSCs that are "major contributors to defense in depth are designated as safety-significant SSCs" and "Estimates of worker consequences for the purpose of safety-significant SSC designation are not intended to require detailed analytical modeling. Considerations should be based on engineering judgment of possible effects and the potential added value of safety-significant SSC designation." Based on "engineering judgment of possible effects and the potential added value of safety-significant SSC designation," no RHWF SSCs have been designated as safety-significant SSCs (even though they may contribute to defense in depth).

RHWF design criteria and design features are described in Chapters 4, 5, and 6.

11.3.3 Administrative Controls

Administrative controls are defined in 10 CFR 830.3 as “the provisions relating to organization and management, procedures, record keeping, assessment, and reporting necessary to ensure safe operation of a facility.”

TSRs are not based upon maintaining worker exposures below some acceptable level following an uncontrolled release of hazardous or radioactive material, or inadvertent criticality. Rather, the risk to workers is reduced through the reduction of the likelihood and potential impact of such events. Because of the necessary and inherent presence of hazardous and radioactive materials at WVDP nuclear facilities (such as the RHWF) and the workers' proximity to these materials, it is impractical to reduce worker risk to an insignificant level through selection of operating limits in TSRs. DOE-STD-3009-94 reinforces this position, stating: "It is important to develop TSRs judiciously. TSRs should not be used as a vehicle to cover the many procedural and programmatic controls inherent in any operation." The likelihood of uncontrolled releases of hazardous and radioactive materials at the WVDP (including the RHWF), and the consequences of occupational exposures resulting from such releases are reduced through the implementation of industrial hygiene and radiation protection programs that have been developed to be consistent with guidance given in relevant DOE Orders.

Worker protection at the WVDP is achieved through administration of DOE-required radiological protection and occupational safety and health programs. In regard to worker safety, the DOE acknowledges that the impact from the release of hazardous and radioactive materials is reduced through industrial hygiene and radiation protection oversight (e.g., monitoring of worker exposures, use of personnel protective equipment [PPE], and emergency evacuation planning), as well as the use of TSRs. Hence, formal measures other than TSRs are recognized by the DOE as being acceptable for ensuring worker safety. Also, as previously noted, DOE-STD-3009-94 states: "It is important to develop TSRs judiciously. TSRs should not be used as a vehicle to cover the many procedural and programmatic controls inherent in any operation." Consistent with relevant DOE Orders and federal and state regulations with which WVNSCO is currently contractually obligated to comply, the control of the levels of hazardous and radioactive materials to which workers may, at any time, be exposed, is addressed in WVDP radiological protection and occupational safety and health programs. Furthermore, worker exposure to hazardous materials and/or conditions is regulated under the provisions of the Occupational Safety and Health Act administered by the Occupational Safety and Health Administration (OSHA).

The DOE recognizes the measures provided by existing site programs for protecting the health and safety of workers. In consideration of this fact, TSR administrative controls would not further contribute to worker safety at the WVDP (including the RHWF).

In consideration of the above discussion, no TSR administrative controls are required for the RHWF.

11.4 Interface with TSRs from Other Facilities

There are no TSRs from other facilities that interface with the RHWF.

REFERENCES FOR CHAPTER 11.0

Code of Federal Regulations. 10 CFR 830. *Nuclear Safety Management*. U.S. Department of Energy.

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12.0 QUALITY ASSURANCE

This chapter presents the West Valley Nuclear Services Company (WVNSCO) Quality Assurance Program (QAP), summarizes the implementing Quality Assurance (QA) policies and procedures, lists the Department of Energy (DOE) Orders and requirements fulfilled by the QAP, and summarizes the specific application of the program to the design, construction, and operation of the Remote-Handled Waste Facility (RHWF).

The QAP at the West Valley Demonstration Project (WVDP) is implemented on a site-wide basis and is applied in compliance with 10 CFR 830, Subpart A, *Quality Assurance Requirements*. The DOE-approved WVNSCO QAP has been established, approved, and implemented to ensure that site missions are accomplished while minimizing potential hazards to the public, facility workers, and the environment. The program applies to work performed by WVNSCO and its contractors for all activities affecting quality at the WVDP site. This includes the design, procurement, construction, operation, and eventual decontamination and decommissioning of the RHWF.

A definition and description of the WVNSCO QAP is provided in WVDP-111, *Quality Assurance Program*, which also implements the requirements of DOE O 414.1A, *Quality Assurance.*

The QAP is used for determining the graded applicability of QA standards to items, systems, and services. The program incorporates grading through the use of Quality Levels established by risk-based evaluations of safety, environmental, health, and other programmatic considerations. An important feature of the WVNSCO graded approach is that the level of effort or degree of program application is determined by review of items or activities. For example, the design, procurement, construction, and operation of RHWF structures, systems, and components (SSCs) are covered by flow-down of requirements in the QAP and are graded and identified by Quality Level. The assigned Quality Level provides a basis for the extent to which QA requirements are applied in accordance with factors influencing responsible work process control and work acceptance such as complexity, consequence of failure, and degree of uncertainty. The methodology for classification, and rationale for establishment of Quality Levels are contained in WVDP-204, *WVDP Quality List (Q-List)*. As documented in WVDP-204, all RHWF SSCs are Quality Level “C” or “N”. The criteria for determining Quality Level designations are provided in WVDP-002, *Quality Management Manual*. These criteria are summarized in Section 12.3 of WVNS-SAR-001, *Safety Analysis Report for Waste Processing and Support Activities*. The WVNSCO graded implementation of QA is consistent with the definition of “graded approach” provided in 10 CFR 830.3.

A synopsis of the WVNSCO QAP defined in WVDP-111 is presented in Chapter 12.0 of WVNS-SAR-001.

12.1 Organization

Organizational information is shown in Figures 10.1-1 and 10.1-2 of WVNS-SAR-001, and described in associated text in Chapter 10 of WVNS-SAR-001. Other participants, including suppliers, consultants, subcontractors, and laboratories are a part of the overall WVNSCO program by virtue of WVNSCO-delegated QAP elements. All such delegated QA functions are identified by appropriate contractual requirements with accountability for acceptable implementation retained by WVNSCO. WVNSCO performs initial approval of the organizational structure and QA programs of all major project participants. WVNSCO also performs scheduled, periodic overviews of these organizational structures and QA programs via audits, surveillance, or other appropriate methods.

12.1.1 Responsibilities

WVDP-117, *WVNS Policy and Procedures Manual,* and WVDP-002, *Quality Management Manual* document the responsibilities and authority of persons and organizations that: 1) perform safety functions, 2) ensure that the QAP is established and implemented, and 3) verify that activities have been correctly performed and documented in accordance with WVNSCO implementing procedures. The specific responsibilities are listed in Section 12.1.1 of WVNS-SAR-001.

12.2 Quality Assurance Program

The WVNSCO QAP (WVDP-111) describes responsibilities, authorities, policies, and requirements, and provides for the management, performance, and assessment of work. The QAP provides the framework and criteria for implementing a QA program to plan, perform, and assess the effectiveness of all project activities such as design, procurement, construction, and operation of the RHWF in accordance with DOE QA requirements (DOE O 414.1A).

The core policy documents which implement the QAP are WVDP-002, WV-120, and select policy/procedure documents. They establish and outline the policies and requirements for the site QAP and establish the line organizations' responsibility for implementing the QAP. Each section of WVDP-002 is approved by the President of WVNSCO, thus establishing its applicability for all work performed at the WVDP. The QAP is reviewed and approved by the DOE-Ohio (DOE-OH) Field Office Manager. Performance against this QAP is periodically evaluated by DOE-OH/WVDP.

12.2.1 Design Control

WVNSCO has established and implemented a formal design control program for the RHWF that requires engineered items and systems to be designed using sound engineering and scientific principles and appropriate standards. The formal design process defines the control of design inputs, processes, outputs, changes, lines of communication, interfaces, and records. This process provides for timely and correct translation of design inputs into design outputs, effective coordination and interfacing of organizations participating in the design process, and acceptable and verified design outputs.

Design controls are determined through a risk-based control process that considers Environmental, Safety, Health (ES&H), quality impact, and programmatic risk. The extent of design verification and validation is based on complexity, risk, and uniqueness of design.

The RHWF also utilizes a formal design verification process that confirms design adequacy by persons other than those who designed the system or item where appropriate. Verification is completed and documented before implementation of the design. Complex designs are verified at critical stages of development to enable timely correction of deficient conditions.

RHWF design documents specify the technical and quality acceptance criteria and the information required to verify acceptable construction and operation. Design changes, including field changes, are governed by control measures commensurate with those applied to the original design.

12.2.2 Procurement Document Control

DOE-OH/WVDP has delegated prime authority for the procurement and the administration of contracts to WVNSCO. The preparation and processing of procurement documents are performed in accordance with policies and requirements of WVDP-117 and WVDP-002. These policies ensure that procurement documents contain appropriate technical and quality requirements. To the extent necessary, procurement documents require

contractors and suppliers to have QAPs that are adequate to control the quality of the items or services.

The procurement documents specify the scope of work, technical requirements, and application of QA requirements. The appropriate procurement documents with QA requirements specified therein are reviewed and approved by the WVNSCO QA organization. Procurement documents are controlled by WVNSCO's standard procurement procedures and practices. Changes to procurement documents are controlled by written WVNSCO procedures.

To the extent of an item's importance to safety and quality, procurement documents require that suppliers and their subtier suppliers have QAPs consistent with the requirements contained in the purchase documents. The requirements are commensurate with the Quality Level of the item or activity. Suppliers are surveyed and evaluated to assure that sufficient and appropriate systems, procedures, and personnel are available to meet the programmatic and technical requirements of the purchase order prior to the initiation of work activities affecting quality. Records are maintained on suppliers surveyed to show those QA attributes available within their QAP. The WVNSCO Purchasing organization obtains approval of potential suppliers from the Engineering and QA organizations.

Following the preparation and approval of a procurement document and selection of an acceptable supplier, the purchase order is prepared and issued along with the supporting procurement documents. If verification of the quality of supplied items cannot be performed at receiving inspection, work performed by the supplier is verified by WVNSCO during the course of procurement, ensuring that the purchase order requirements are met. Verification activities conducted by the QA organization may include auditing, receiving inspection, surveillance, testing, performance evaluation, or inspection at mandatory witness/hold points during processing, final inspection, and shipping.

12.2.3 Instructions, Procedures, and Drawings

Components, systems, structures, and associated services that are important to the safe and reliable operation of the RHWF are designed, fabricated, erected, inspected, and tested in accordance with approved specifications and drawings. Instructions, procedures, and drawings are issued and controlled for the performance of the work scope in accordance with the considerations specified in appropriate QA programmatic requirements. The prepared documents are approved by the WVNSCO QA organization and other interfacing organizations. Where appropriate, the documents contain quantitative and qualitative acceptance criteria that form the basis for verifying that all quality-related activities are satisfactorily accomplished.

12.2.4 Control and Identification of Purchased Material, Equipment, and Services

Measures have been established and implemented at the WVDP to ensure that purchased materials, equipment, and services conform to the requirements outlined in the procurement documents. Section 12.2.4 of WVNS-SAR-001 provides a discussion of these measures.

Processes that affect the quality of final items or services are controlled in accordance with their Quality Level classifications, as discussed in Section 12.3 of WVNS-SAR-001. Special processes that control or verify quality are performed by qualified personnel using qualified procedures in accordance with applicable requirements.

Requirements for control of supplier processes are included in the procurement documents.

12.2.5 Inspection, Surveillance, and Testing

It is WVNSCO policy to perform inspection, acceptance testing, and routine surveillance of specified items and processes using established acceptance and performance criteria, and to require calibration and maintenance of equipment used for acceptance of inspections and tests.

Required inspections and tests are established and conducted according to a graded program. Acceptance parameters and other requirements are specified in design documentation. For example, inspection hold points beyond which work is not to proceed are incorporated into work and procurement documents.

The test control program includes, as appropriate, bench tests and proof tests before installation, pre-operational tests, post-maintenance tests, post-modification tests, and operational tests.

When acceptance criteria are not met, deficiencies are documented, resolved, causes are identified, and corrected areas are reinspected.

12.2.6 Nonconforming Materials, Components, and Fabrication and Construction Features

Materials, parts, components, equipment, structures, and systems that deviate from approved specifications, drawings, codes, or other applicable documents are considered nonconforming items and are identified and controlled to prevent inadvertent use or installation. Nonconformance/noncompliance data is analyzed to identify trends that adversely impact quality and to identify opportunities to improve items, services, and processes. All personnel are encouraged to identify opportunities for improvement and to promote continuous improvement. This includes the identification and reporting of nonconforming items, and encouraging recommendations for process improvements.

12.2.7 Corrective Action

Measures are established and implemented to ensure that adverse conditions such as failures, malfunctions, deficiencies, deviations, or defective material or equipment are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures ensure that the cause is determined and that appropriate corrective action is taken to prevent repetition or recurrence.

Identification of situations that may require corrective action are accomplished through periodic review of supplier surveillance activities, QA surveillance and monitoring programs, QA audits, and issue reports. Issue reports for significant conditions document the identification of all significant conditions adverse to quality, including consideration for root cause analysis and/or stop work. Corrective actions are reported to appropriate levels of management. Final verification or follow-up is documented by responsible parties.

12.2.8 Quality Assurance Records

The WVNSCO QA Records Program includes requirements and responsibilities for identification, filing, transmittal, receipt, storage, retention, maintenance, retrieval, and disposition of QA records. The system addresses the records associated with design, operational procedures, QA, and procurement, including duration for each type of record. Sufficient information is provided to enable traceability to the item or activity to which it is associated.

QA records are classified as either lifetime or nonpermanent. Criteria for classifying records are contained in WVDP-262, *WVNS Manual for Records Management and Storage*.

12.2.9 Audits

A comprehensive program of planned and periodic WVNSCO audits is conducted under the direction of the QA organization to verify compliance with aspects of the QAP and to determine the effectiveness of the program. The audits include review of indoctrination and training activities, processes and items, and review of documents and records of corrective actions, calibrations, and nonconforming items control. Audits of the RHWF were conducted during design, procurement, construction, installation, and system acceptance testing, and are performed periodically during the operational phase of the facility.

Audits are performed in accordance with written procedures or checklists by trained and qualified personnel within the QA organization and/or qualified audit representatives from other organizations who do not have direct responsibility for the areas being audited. Audit results are documented and reviewed by management personnel having responsibility for the area being audited. Responsible management personnel ensure timely and appropriate action to correct and prevent recurrence of deficiencies revealed by the audit.

REFERENCES FOR CHAPTER 12.0

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_____. WVDP-204: *WVDP Quality List (Q-List)*. (Latest Revision).

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_____. WVNS-SAR-001: *Safety Analysis Report for Waste Processing and Support Activities*. (Latest Revision).

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