CHAPTER 3

PLANT DESCRIPTION

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Section Title Page

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
µgm/m^3	micrograms per cubic meter
/Q	relative air concentration
AADT	annual average daily traffic
A/B	auxiliary building
ac	acre
AC	alternating current
ac-ft	acre-feet
ACFT	acre-feet
ACRS	advisory committee on reactor safeguards
ACSR	aluminum-clad steel reinforced
ADFGR	Alaska Department of Fish and Game Restoration
AEA	Atomic Energy Act
AEC	U.S. Atomic Energy Commission
AHD	American Heritage Dictionary
agl	above ground level
ALA	American Lifelines Alliance
ALARA	as low as reasonably achievable
AMUD	Acton Municipal Utility District
ANL	Argonne National Laboratory
ANSI	American National Standards Institute
AOO	anticipated operational occurrences
APE	areas of potential effect
APWR	Advanced Pressurized Water Reactor

ACRONYMS AND ABBREVIATIONS

ARLIS	Alaska Resources Library and Information Services
ARRS	airborne radioactivity removal system
AS	ancillary services
ASCE	American Society of Civil Engineers
AVT	all volatile treatment
AWG	American wire gauge
BAT	best available technology
bbl	barrel
BC	Business Commercial
BDTF	Blowdown Treatment Facility
BEA	U.S. Bureau of Economic Analysis
BEG	U.S. Bureau of Economic Geology
bgs	below ground surface
BLS	U.S. Bureau of Labor Statistics
BMP	best management practice
BOD	Biologic Oxygen Demand
BOP	Federal Bureau of Prisons
BRA	Brazos River Authority
bre	below reference elevation
BRM	Brazos River Mile
BSII	Big Stone II
BTI	Breakthrough Technologies Institute
BTS	U.S. Bureau of Transportation Statistics
BTU	British thermal units
BUL	Balancing Up Load

ACRONYMS AND ABBREVIATIONS

BW	Business Week
BWR	boiling water reactor
CAA	Clean Air Act
CBA	cost-benefit analysis
CBD	Central Business District
CCI	Chambers County Incinerator
CCTV	closed-circuit television
CCW	component cooling water
CCWS	component cooling water system
CDC	Centers for Disease Control and Prevention
CDF	Core Damage Frequency
CDR	Capacity, Demand, and Reserves
CEC	California Energy Commission
CEDE	committed effective dose equivalent
CEED	Center for Energy and Economic Development
CEQ	Council on Environmental Quality
CESQG	conditionally exempt small quantity generator
CFC	chlorofluorocarbon
CFE	Comisin Federal de Electricidad
CFR	Code of Federal Regulations
cfs	cubic feet per second
CFS	chemical treatment system
CG	cloud-to-ground
CGT	Cogeneration Technologies
CHL	Central Hockey League

ACRONYMS AND ABBREVIATIONS

CO	carbon monoxide
CO_2	carbon dioxide
COD	Chemical Oxygen Demand
COL	combined construction and operating license
COLA	combined construction and operating license application
CORMIX	Cornell Mixing Zone Expert System
CPI	Consumer Price Index
CPP	continuing planning process
CPS	condensate polishing system
CPNPP	Comanche Peak Nuclear Power Plant
CPSES	Comanche Peak Steam Electric Station
CRDM	control rod drive mechanism cooling system
CRP	Clean Rivers Program
CS	containment spray
Cs-134	cesium-134
Cs-137	cesium 137
CST	Central Standard Time
CST	condensate storage tank
CT	completion times
CT	cooling tower
cu ft	cubic feet
C/V	containment vessel
CVCS	chemical and volume control system
CVDT	containment vessel coolant drain tank
CWA	Clean Water Act

ACRONYMS AND ABBREVIATIONS

CWS	circulating water system
DAW	dry active waste
dBA	decibels
DBA	design basis accident
DBH	diameter at breast height
DC	direct current
DCD	Design Control Document
DDT	dichlorodiphenyltrichloroethane
DF	decontamination factor
DFPS	Department of Family and Protective Services
DFW	Dallas/Fort Worth
DO	dissolved oxygen
DOE	U.S. Department of Energy
DOL	Department of Labor
DOT	U.S. Department of Transportation
DPS	Department of Public Safety
D/Q	deposition
DSHS	Department of State Health Services
DSM	Demand Side Management
DSN	discharge serial numbers
DSWD	Demand Side Working Group
DVSP	Dinosaur Valley State Park
DWS	demineralized water system
DWST	demineralized water storage tank
E	Federally Endangered

ACRONYMS AND ABBREVIATIONS

EA	Environmental Assessment
EAB	exclusion area boundary
E. coli	Escherichia coli
EDC	Economic Development Corp.
EDE	effective dose equivalent
EEI	Edison Electric Institute
EERE	Energy Efficiency and Renewable Energy
EFH	Energy Future Holdings Corporation
EFW	energy from waste
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EJ	environmental justice
ELCC	Effective Load-Carrying Capacity
EMFs	electromagnetic fields
EO	Executive Order
EOF	emergency operation facility
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
ER	Environmental Report
ERA	Environmental Resource Associates
ERCOT	Electric Reliability Council of Texas
ESA	Endangered Species Act
ESP	Early Site Permit
ESRP	Environmental Standard Review Plan

ACRONYMS AND ABBREVIATIONS

ESW	essential service cooling water
ESWS	essential service water system
F&N	Freese & Nicholas, Inc.
FAA	U.S. Federal Aviation Administration
FAC	flow-accelerated corrosion
FBC	fluidized bed combustion
FCT	Fuel Cell Today
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FFCA	Federal Facilities Compliance Act
FLMNH	Florida Museum of Natural History
FM	farm-to-market
FP	fire protection
FPL	Florida Power and Light
FPS	fire protection system
FPSC	Florida Public Service Commission
FR	Federal Register
FSAR	Final Safety Analysis Report
FSL	Forecast Systems Laboratory
ft	feet
FWAT	flow weighted average temperature
FWCOC	Fort Worth Chamber of Commerce
FWS	U.S. Fish and Wildlife Service
gal	gallon
GAM	General Area Monitoring

ACRONYMS AND ABBREVIATIONS

GAO	U.S. General Accountability Office
GDEM	Governor’s Division of Emergency Management
GEA	Geothermal Energy Association
GEIS	Generic Environmental Impact Statement
GEOL	overall geological
GFD	ground flash density
GIS	gas-insulated switchgear
GIS	Geographic Information System
GMT	Greenwich Mean Time
gpd	gallons per day
gph	gallons per hour
gpm	gallons per minute
gps	gallons per second
GRCVB	Glen Rose, Texas Convention and Visitors Bureau
GST	gas surge tank
GTC	Gasification Technologies Conference
GTG	gas turbine generators
GWMS	gaseous waste management system
H-3	radioactive tritium
HC	Heavy Commercial
HCl	Hydrochloric Acid
HCP	Ham Creek Park
HEM	hexane extractable material
HEPA	high efficiency particulate air
HIC	high integrity container

ACRONYMS AND ABBREVIATIONS

HL	high-level
HNO_3	Nitric Acid
hr	hour(s)
HRCQ	highway route-controlled quantity
H_2SO_4	Sulfuric Acid
HT	holdup tank
HTC	Historic Texas Cemetery
HUC	hydrologic unit code
HUD	U.S. Department of Housing and Urban Development
HVAC	heating, ventilating, and air-conditioning
I	Industrial
I-131	iodine-131
IAEA	International Atomic Energy Agency
I&C	instrumentation and control
IEC	Iowa Energy Center
IGCC	Integrated Gasification Combined Cycle
IH	Interim Holding
in	inch
INEEL	Idaho National Engineering and Environmental Laboratory
IOUs	investor-owned electric utilities
IPE	individual plant examination
ISD	Independent School District
ISFSI	independent spent fuel storage installation
ISO	independent system operator
ISO rating	International Standards Organization rating

ACRONYMS AND ABBREVIATIONS

ISU	Idaho State University
JAMA	Journal of the American Medical Association
K-40	potassium-40
KC	Keystone Center
JRB	Joint Reserve Base
km	kilometer
kVA	kilovolt-ampere
kWh	kilowatt hour
L	LARGE
LaaR	Load Acting as a Resource
LANL	Los Alamos National Laboratory
lb	pounds
LC	Light Commercial
LG	Lake Granbury
LL	low-level
LLD	lower limits of detection
LLMW	low-level mixed waste
LNG	liquid natural gas
LOCA	loss of coolant accident
LPSD	low-power and shutdown
LPZ	low population zone
LQG	large-quantity hazardous waste generators
LRS	load research sampling
LTSA	long term system assessment
Luminant	Luminant Generation Company LLC

ACRONYMS AND ABBREVIATIONS

LVW	low volume waste
LWA	Limited Work Authorization
LWMS	liquid waste management system
LWPS	liquid waste processing system
LWR	light water reactor
M	MODERATE
ma	milliamperes
MACCS2	Melcor Accident Consequence Code System
MCES	Main Condenser Evacuation System
Mcf	thousand cubic feet
MCPE	Market Clearing Price for Energy
MCR	main control room
MD-1	Duplex
MDA	minimum detected activity
MDCT	mechanical draft cooling tower
MEIs	maximally exposed individuals
MF	Multi-Family
mG	milliGauss
mg/l	milligrams per liter
mg/m^3	milligrams per cubic meter
MH	Manufactured Housing
MHI	Mitsubishi Heavy Industries
mi	mile
mi^2	square miles
MIT	Massachusetts Institute of Technology

ACRONYMS AND ABBREVIATIONS

MMbbl	million barrels
MMBtu	million Btu
MNES	Mitsubishi Nuclear Energy Systems Inc.
MOU	municipally-owned utility
MOV	motor operated valve
MOX	mixed oxide fuel
mph	miles per hour
MSDS	Materials Safety Data Sheets
msl	mean sea level
MSR	maximum steaming rate
MSW	municipal solid waste
MT	Main Transformer
MTU	metric tons of uranium
MW	megawatts
MW	monitoring wells
MWd	megawatt-days
MWd/MTU	megawatt–days per metric ton uranium
MWe	megawatts electrical
MWh	megawatt hour
MWS	makeup water system
MWt	megawatts thermal
NAAQS	National Ambient Air Quality Standards
NAPA	Natural Areas Preserve Association
NAP	National Academies Press
NAR	National Association of Realtors

ACRONYMS AND ABBREVIATIONS

NARM	accelerator-produced radioactive material
NAS	Naval Air Station
NASS	National Agricultural Statistics Service
NCA	Noise Control Act
NCDC	National Climatic Data Center
NCDENR	North Carolina Department of Environmental and Natural Resources
NCES	National Center for Educational Statistics
NCI	National Cancer Institute
NCTCOG	North Central Texas Council of Governments
ND	no discharge
NDCT	natural draft cooling towers
NEI	Nuclear Energy Institute
NELAC	National Environmental Laboratory Accreditation Conference
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation/Council
NESC	National Electrical Safety Code
NESDIS	National Environmental Satellite, Data, and Information Service
NESW	non-essential service water cooling system
NESWS	non-essential service water system
NETL	National Energy Technology Laboratory
NHPA	National Historic Preservation Act
NHS	National Hurricane Center
NINI	National Institute of Nuclear Investigations
NIOSH	National Institute for Occupational Safety and Health

ACRONYMS AND ABBREVIATIONS

NIST	U.S. National Institute of Standards and Technology
NJCEP	NJ Clean Energy Program
NLDN	National Lightning Detection Network
NOAA	National Oceanic and Atmospheric Administration
NOAEC	no observable adverse effects concentration
NOI	Notice of Intent
NOIE	non-opt-in entities
NO_x	oxides of nitrogen
NP	Nacogdoches Power
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NR	not required
NRC	U.S. Nuclear Regulatory Commission
NREL	U.S. National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NRRI	National Regulatory Research Institute
NSPS	New Source Performance Standards
NSSS	nuclear steam supply system
NTAD	National Transportation Atlas Database
NVLAP	National Voluntary Laboratory Accreditation Program
NWI	National Wetlands Inventory
NWS	National Weather Service
NWSRS	National Wild and Scenic Rivers System
O_2	Oxygen
O_3	Ozone

ACRONYMS AND ABBREVIATIONS

ODCM	Off-site Dose Calculation Manual
OECD	Organization for Economic Co-operation and Development
O&M	operations and maintenance
ORNL	Oak Ridge National Laboratory
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Act
OW	observation well
P&A	plugging and abandonment
PAM	primary amoebic meningoencephalitis
PD	Planned Development
PDL	Proposed for Delisting
PE	probability of exceedances
percent g	percent of gravity
PET	Potential Evapotranspiration
PFBC	pressurized fluidized bed combustion
PFD	Process Flow Diagram
PGA	peak ground acceleration
PGC	power generation company
PH	Patio Home
P&ID	piping and instrumentation diagram
PM	particulate matter
PM_{10}	particulate matter less than 10 microns diameter
$PM_{2.5}$	particulate matter less than 2.5 microns diameter
PMF	probable maximum flood
PMH	probable maximum hurricane

ACRONYMS AND ABBREVIATIONS

PMP	probable maximum precipitation
PMWP	probable maximum winter precipitation
PMWS	probable maximum windstorm
PPE	plant parameter envelope
ppm	parts per million
PPS	preferred power supply
PRA	probabilistic risk assessment
PSD	Prevention of Significant Deterioration (permit)
PSWS	potable and sanitary water system
PUC	Public Utility Commission
PUCT	Public Utility Commission of Texas
PURA	Public Utilities Regulatory Act
PWR	pressurized water reactors
QA	quality assurance
QC	quality control
QSE	qualified scheduling entities
R10	Single-Family Residential
R12	Single-Family Residential
R7	Single-Family Residential
R8.4	Single-Family Residential
RAT	Reserve Auxiliary Transformer
RB	reactor building
R/B	reactor building
RCDS	reactor coolant drain system
RCDT	reactor coolant drain tank

ACRONYMS AND ABBREVIATIONS

RCRA	Resource Conservation and Recovery Act
RCS	reactor coolant system
RDA	Radiosonde Database Access
REC	renewable energy credit
REIRS	Radiation Exposure Information and Reporting System
RELFRC	release fractions
rem	roentgen equivalent man
REMP	radiological environmental monitoring program
REP	retail electric providers
REPP	Renewable Energy Policy Project
RFI	Request for Information
RG	Regulatory Guide
RHR	residual heat removal
RIMS II	regional input-output modeling system
RMR	Reliability Must-Run
Rn_{222}	Radon-222
RO	reverse osmosis
ROI	region of interest
ROW	right of way
RPG	regional planning group
RRY	reactor reference year
RTHL	Recorded Texas Historic Landmarks
RTO	regional transmission organization
Ru-103	ruthenium-103
RW	test well

ACRONYMS AND ABBREVIATIONS

RWSAT	refueling waste storage auxiliary tank
RWST	refueling water storage tank
RY	reactor-year
S	SMALL
SACTI	Seasonal/Annual Cooling Tower Impact Prediction Code
SAL	State Archaeological Landmark
SAMA	severe accident mitigation alternative
SAMDA	severe accident mitigation design alternative
SB	Senate Bill
SCR	Squaw Creek Reservoir
SCDC	Somervell County Development Commission
scf	standard cubic feet
SCWD	Somervell County Water District
SDS	sanitary drainage system
SECO	State Energy Conservation Office
SER	Safety Evaluation Report
SERC	SERC Reliability Corporation
SERI	System Energy Resources, Inc.
SFPC	spent fuel pool cooling and cleanup system
SG	steam generator
SGBD	steam generator blow-down
SGBDS	steam generator blow-down system
SGs	steam generators
SGTR	steam generator tube rupture
SH	State Highway

ACRONYMS AND ABBREVIATIONS

SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SMP	State Marketing Profiles
SMU	Southern Methodist University
SOP	Standard Operations Permit
SO_2	sulfur dioxide
SO_x	sulfur
SPCCP	Spill Prevention Control and Countermeasures Plan
SPP	Southwest Power Pool
SQG	small-quantity generators
sq mi	square miles
SRCC	Southern Regional Climate Center
SRP	Standard Review Plan
SRST	spent resin storage tank
SSAR	Site Safety Analysis Report
SSC	structures, systems, and components
SSI	Safe Shutdown Impoundment
SSURGO	Soil Survey Geographic
SWATS	Surface Water and Treatment System
SWMS	solid waste management system
SWPC	spent fuel pool cooling and cleanup system
SWP3	Storm Water Pollution Prevention Plan
SWS	service water system
SWWTS	sanitary wastewater treatment system
T	Federally Threatened

ACRONYMS AND ABBREVIATIONS

t	ton
TAC	technical advisory committee
TAC	Texas Administrative Code
TB	turbine building
Tc_{99}	Technetium-99
TCEQ	Texas Commission on Environmental Quality
TCPS	Texas Center for Policy Studies
TCR	transmission congestion rights
TCS	turbine component cooling water system
TCWC	Texas Cooperative Wildlife Collection
T&D	transmission and distribution utility
TDCJ	Texas Department of Criminal Justice
TDOH	Texas Department of Health
TDOT	Texas Department of Transportation
TDPS	Texas Department of Public Safety
TDS	total dissolved solids
TDSHS	Texas Department of State Health Services
TDSP	transmission and distribution service provider
TDWR	Texas Department of Water Resources
TEDE	total effective dose equivalent
TGLO	Texas General Land Office
TGPC	Texas Groundwater Protection Committee
TH	Townhome
THC	Texas Historical Commission
THPOs	tribal historic preservation officers

ACRONYMS AND ABBREVIATIONS

TIS	Texas Interconnected System
TLD	Thermoluminescence Dosemeter
TMDLs	total maximum daily loads
TMM	Texas Memorial Museum
TOs	Transmission Owners
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
tpy	tons per year
TRAGIS	Transportation Routing Analysis Geographic Information System
TRB	Transportation Research Board
TRC	total recordable cases
TRE	Trinity Railway Express
TSC	technical support center
TSD	thunderstorm days per year
TSD	treatment, storage, and disposal
TSDC	Texas State Data Center
TSHA	Texas State Historical Association
TSP	transmission service provider
TSWQS	Texas Surface Water Quality Standards
TSS	total suspended sediment
TTS	The Transit System (Glen Rose)
TUGC	Texas Utilities Generating Company
TUSI	Texas Utilities Services Inc.
TWC	Texas Workforce Commission
TWDB	Texas Water Development Board

ACRONYMS AND ABBREVIATIONS

TWR	Texas Weather Records
TWRI	Texas Water Resources Institute
TxDOT	Texas Department of Transportation
TXU	Texas Utilities Corporation
TXU DevCo	TXU Generation Development Company LLC
UC	University of Chicago
UFC	uranium fuel cycle
UHS	Ultimate Heat Sink
UIC	Uranium Information Center
UO_2	uranium dioxide
USACE	U.S. Army Corps of Engineers
US-APWR	(MHI) United States-advanced pressurized water reactor
USC	U.S. Census
USCA	United States Court of Appeals
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
USHCN	United States Historical Climatology Network
USHR	U.S. House of Representatives
USNPS	U.S. National Park Service
UTC	Universal Time Coordinated
UV	ultra-violet
VCIS	Ventilation Climate Information System

ACRONYMS AND ABBREVIATIONS

VCT	volume control tank
VERA	Virtus Energy Research Associates
VFD	Volunteer Fire Department
VOC	volatile organic compound
VRB	variable
WB	Weather Bureau
WBR	Wheeler Branch Reservoir
WDA	work development area
WDFW	Washington Department of Fish and Wildlife
weight percent	wt. percent
WHT	waste holdup tank
WMT	waste monitor tank
WNA	World Nuclear Association
WPP	Watershed Protection Plan
WQMP	Water Quality Management Plan
WRE	Water Resource Engineers, Inc.
WWS	wastewater system
WWTP	wastewater treatment plant
yr	year

CHAPTER 3

PLANT DESCRIPTION

3.0 PLANT DESCRIPTION

This chapter discusses the construction and operation of Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4, and is written for single unit operation unless otherwise stated. The parameters associated with appearance, water use, cooling systems, transmission facilities, and the relationship of CPNPP Units 3 and 4 to their surroundings are described in the following sections:

- External Appearance and Plant Layout (Section 3.1)
- Reactor Power Conversion System (Section 3.2)
- Plant Water Use (Section 3.3)
- Cooling System (Section 3.4)
- Radioactive Waste Management System (Section 3.5)
- Nonradioactive Waste Systems (Section 3.6)
- Power Transmission System (Section 3.7)
- Transportation of Radioactive Materials (Section 3.8)
- Construction Activities (Section 3.9)
- Workforce Characterization (Section 3.10)

This Environmental Report (ER) identifies and describes the interfaces of CPNPP Units 3 and 4 with the environment. For the purposes of this ER, the site, vicinity, and region are defined in Section 2.0.

3.1 EXTERNAL APPEARANCE AND PLANT LAYOUT

Comanche Peak Nuclear Power Plant (CPNPP) is located on a site adjacent to the Squaw Creek Reservoir and near Lake Granbury. CPNPP is located in Somervell and Hood counties near Glen Rose, Texas and approximately 40 mi from Fort Worth, Texas. Distances from local cities and natural features are described in Sections 2.1 and 2.2.

The site boundary line is illustrated in Figure 1.1-3. The station property lines are the same as the site boundary lines. The exclusion area boundary is illustrated in Final Safety Analysis Report (FSAR) Figure 2.1-205. The access highway and railroad to the site, as well as the highways, railways, and waterways in the vicinity of CPNPP are illustrated in Figure 1.1-2.

Figures depicting site features and structures include:

- The gaseous release points and their elevations are discussed in Sections 3.5 and 3.6. Structure locations are depicted in Figure 3.1-1.
- The liquid release points and their elevations are discussed in Section 3.6. Structure locations are depicted in Figure 3.1-1.
- The location of the meteorological tower is illustrated in Figure 6.4-1.
- The construction zone is illustrated in Figure 3.1-2
- The land to be cleared is illustrated in Figure 4.3-1.

The plant layout, including existing structures, is illustrated in Figure 3.1-1. The proposed units are comprised of five principal types of building structures, each consisting of the reactor building, power source buildings, auxiliary building, access building, and turbine building.

The reactor building consists of the following five functional areas:

- Containment facility and inner structure.
- Safety system pumps and heat exchangers area.
- Fuel handling area.
- Main steam and feed water area.
- Safety-related electrical area.

Two safety power source buildings are arranged adjacent to the reactor building. These buildings are freestanding on reinforced concrete mats, and each building contains two identical emergency power sources, which are separated from each other by physical barriers.

The auxiliary building is located adjacent to the reactor building. The auxiliary building contains the main components of the waste disposal systems and the nonsafety-related electrical area.

The access building is located adjacent to the auxiliary building. The access building houses the access control area, the chemical sampling and laboratory area, and the nonsafety chillers.

The turbine building houses the nonsafety-related equipment of the turbine generator and its auxiliary systems, such as the main condenser, feedwater heaters, moisture separator reheaters, etc. The turbine building is a steel structure which is designed to withstand all loads, including the load of the overhead traveling crane. The foundation of the building is made of concrete.

The circulating water system (CWS) and service water system (SWS) for CPNPP Units 3 and 4 use wet mechanical draft cooling towers. The four CWS cooling towers are located approximately 1800 feet northwest of CPNPP Unit 4, in a side-by-side configuration. The long centerline of the buildings run along a north-northwest – south-southeast axis, covering a collective area of 2400 feet by 1200 feet. The elevation of the towers is approximately 850 feet, which is 75 feet above the level of the reservoir. The UHS cooling towers are located 300 feet plant north from CPNPP Units 3 and 4. The eight towers exist inline, running from east to west. The east-most tower of CPNPP Unit 3 is closest to the reservoir at a distance of 112 feet. The tower furthest from the reservoir is the west-most tower of CPNPP Unit 3, which is 487 feet from the edge of the reservoir at its closest point. Tower locations are illustrated in Figure 3.1-1.

The overall plant arrangement for CPNPP Units 3 and 4 is such that building configurations and structural designs (1) minimize the building volumes and quantities of bulk materials, including concrete, structural steel, and rebar, (2) are consistent with safety, operational, maintenance, and structural needs, and (3) provide an aesthetically pleasing effect.[1] Substantial consideration is given to the preservation of natural features. Plans for their preservation are integrated with construction and operations plans to reduce the station's impact on the environment.

Figure 3.1-3 is an architectural rendering of CPNPP Units 3 and 4 superimposed on a low, oblique aerial photograph that illustrates the aesthetics of the additional units. Photographs that show the station from several vantage points where a visual impact can be expected are included in Figures 3.1-4, 3.1-5, 3.1-6, and 3.1-7. Figures 3.1-4, 3.1-5, and 3.1-6 illustrate the visual impact from local transportation corridors, Routes 56, 144, and 321, respectively. Figure 3.1-7 illustrates the visual impact from a cultural vantage point of CPNPP.

---

[1] Figure 3.1-3 shows that the containment building is integrated into the design of the turbine and reactor building to provide an architecturally pleasing structure. The containment building is of similar stature to the turbine and reactor building and is approximately 38 feet (ft) shorter than the existing containment buildings. The facade of CPNPP Units 3 and 4 matches the surrounding area and the existing structures.

3.2 REACTOR POWER CONVERSION SYSTEM

Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4 utilize Mitsubishi Heavy Industries (MHI) U.S. advanced pressurized water reactors (US-APWR). The vendor, architect-engineer, and contractor are addressed in FSAR Section 1.4. Each unit has a reactor vessel, four steam generators (SGs), and four reactor coolant pumps. The reactor-produced thermal energy is carried in the primary coolant to the SGs where it is transferred to the secondary side to produce steam. The steam flows through the steam turbine, creating rotational mechanical work, which in turn rotates the electric generator to produce electricity. Figure 3.2-1 is a simplified flow diagram for the reactor power conversion system. The steam turbine is a tandem compound type, consisting of one high-pressure turbine and three low-pressure turbines.

The rated and design core thermal power of each reactor is 4451 megawatts thermal (MWt). The rated and design nuclear steam supply system (NSSS) power is 4466 MWt, the core power plus reactor coolant pump thermal input. The rated and design net output of each electric generator is approximately 1600 megawatts electrical (MWe).

The reactor contains 257 fuel assemblies. Each fuel assembly is a 17x17 square array consisting of 264 fuel rods, as well as 24 control rod guide thimbles, and one instrumentation guide tube. The fuel rods are comprised of cylindrical pellets of sintered uranium dioxide housed in ZIRLO^{TM} tubing.

The reference equilibrium core cycle enrichment is 4.55 weight (wt.) percent U-235. The total weight of uranium dioxide is 305,830 pounds (lb) (1190 lb per fuel assembly). The core design is expected to operate 24 months between refueling, with an average burnup of 46,200megawatt-days per metric ton uranium (MWd/MTU). The maximum burnup is 54,200 MWd/MTU.

The US-APWR reactor is connected to four SGs by means of four primary hot leg pipes and four primary cold leg pipes. A reactor coolant pump is located in each of the four cold leg pipes to circulate the pressurized reactor coolant through the reactor core. The reactor coolant flows through the reactor core, making contact with the fuel rods that contain the enriched uranium dioxide fuel. As the reactor coolant passes through the reactor core, heat from the nuclear fission process is removed from the reactor. This heat is transported to the SGs by the circulating reactor coolant and passes through the tubes of the SGs to heat the feedwater from the secondary system. The reactor coolant is pumped back to the reactor by the reactor coolant pumps, where it is reheated to start the heat transfer cycle over again. Inside the SGs, the reactor heat from the primary system is transferred through the walls of the tubes to convert the incoming feedwater from the secondary system into steam. The steam is transported from the SGs by main steam piping to drive the high-pressure and low-pressure turbines connected to an electric generator to produce electricity. After passing through the three low-pressure turbines, the steam is condensed back to water by cooled circulating water inside titanium tubes located in the condenser. The condensate is then preheated and pumped back to the SGs as feedwater to repeat the steam cycle.

3.2.1 ENGINEERED SAFETY FEATURES

Engineered safety features protect the public in the event of an accidental release of radioactive fission products from the reactor coolant system. The following subsections define the engineered safety features. The engineered safety features are explained in detail in DCD Chapter 6.

3.2.1.1 Containment System

The containment vessel is a cylindrical structure with a hemispherical dome made of prestressed, post-tensioned concrete. The inside of the structure is lined with carbon steel. The structure sits on a flat reinforced concrete foundation slab. The containment vessel completely encloses the reactor and reactor coolant system and is designed to minimize leakage.

3.2.1.2 Containment Heat Removal System

The containment heat removal system consists of four independent trains with four containment spray (CS)/residual heat removal (RHR) pumps and four CS/RHR heat exchangers. The CS reduces temperature and pressure in containment to acceptable levels, and provides long-term containment cooling following a loss of coolant accident (LOCA). This system automatically actuates following a CS signal and draws water from the refueling water storage pit. The refueling water storage pit provides a continuous source of water for the CS/RHR pumps. The RHR removes reactor core decay heat and other residual heat from the reactor coolant. This system also transfers refueling water between the reactor cavity and the refueling water storage pit at the beginning and end of refueling operations. All pumps, motor operated valves (MOVs), and instruments have emergency power backups.

3.2.1.3 Containment Isolation System

The containment isolation system provides isolation of lines penetrating containment to preserve the integrity of the containment boundary and prevent the release of radioactive products to the environment following a postulated accident.

3.2.1.4 Emergency Core Cooling System

The primary function of the emergency core cooling system is to provide emergency core cooling following a postulated LOCA. The system also mitigates accidents and ensures safe shutdown by performing emergency boration, letdown, and emergency makeup.

3.2.1.5 Control Room Habitability System

The control room habitability system maintains habitable conditions in the main control room envelope to protect the operators from airborne radioactivity, smoke, and toxic gas. The habitability system has a heating, ventilating, and air-conditioning (HVAC) system with dedicated redundant air handling units, filters, fans, and airtight isolation dampers.

3.2.1.6 Fission Product Removal and Control System

The fission product removal and control system consists of the pH control system and the annulus air cleanup system. To control pH, a buffer agent is added to provide sump water pH adjustment following a LOCA. The annulus air cleanup system prevents uncontrolled release of radioactivity to the environment from the containment penetration area and the safeguards components area. These areas are maintained at negative pressure during an accident. This system is also used for containment depressurization during normal operations. The annulus air cleanup system initiates automatically on a safety injection signal.

3.2.1.7 Emergency Feedwater System

The emergency feedwater system provides makeup water to the SGs to sustain their ability to remove heat from the reactor coolant system by converting it to steam that is discharged to the condenser or to the atmosphere. This system is automatically initiated during a significant transient.

3.2.2 TURBINE GENERATOR AND CONDENSER

The turbine generator consists of the turbine, generator, moisture separator and reheaters, steam valves, and their auxiliary systems. The turbine generator system is designed to change the thermal energy of the steam flowing through the turbine into rotational mechanical work, which rotates an electric generator to provide electrical power. The turbine generator consists of a double-flow, high-pressure turbine and three double-flow, low-pressure turbines. It is a tandem compound type, 1800 rpm machine. The design is provided in DCD Section 10.2.

Each turbine generator has a rated and design net output of approximately 1600 MWe for each reactor thermal output of 4451 MWt. The generator rating is 1,900,000 kilovolt-amperes (kVA) with a power factor of 0.9. Plant electrical consumption is approximately 90 MWe, or about 5.5 percent of generator output at rated power.

The significant design features and performance characteristics for the major power conversion system components are listed in DCD Table 10.1-1. Turbine generator and auxiliary design parameters are listed in DCD Table 10.2-1.

The main condenser is a single-pressure, surface cooling, radial flow type unit with a total heat transfer surface area of 1.437 x 10^6 square feet (ft^2). The condenser-designed heat duty is 9.90 x 10^9 British thermal units per hour (Btu/hr). The condenser is equipped with titanium tubes.

Main condenser design data are presented in DCD Table 10.4.1-1.

3.3 PLANT WATER USE

Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4 require water for both plant cooling and operational uses. The plant water consumption and water treatment are determined from the U.S. Advanced Pressurized Water Reactor (US-APWR) Design Control Document, site characteristics, and engineering evaluations.

Raw water is required to support the needs of the facility during construction and operation, including the requirements of the main circulating water system (CWS) and cooling water systems for plant auxiliary components, e.g., essential service water. Raw water also supplies the FPS and demineralized water systems. Potable water from the municipal supply is required for human consumption, sanitary, and other domestic purposes.

Subsection 3.3.1 discusses the quantities of water required and consumed by the various cooling and other water use systems, and the discharges from these systems. This discussion includes variation in water requirements and consumption on a temporal basis and as a function of plant operating modes.

Subsection 3.3.2 discusses the water treatment needed for the plant water streams. A discussion of the methods of treatment of the plant water streams, including an identification and quantification of chemicals used, is given in Section 3.6.

3.3.1 WATER CONSUMPTION

This section describes the water consumption needs of CPNPP Units 3 and 4. The water use diagram in Figure 3.3-1 provides a water balance summary during normal plant operations for CPNPP Units 3 and 4. Table 3.3-1 provides estimates of water use. Monthly stream flow values, as well as the maximum and minimum stream flows, are given in Tables 2.3-7, 2.3-8, 2.3-9, 2.3-10, 2.3-11, 2.3-12, 2.3-13, 2.3-14, 2.3-15, 2.3-16, 2.3-17, 2.3-18, and 2.3-19 for the U.S. Geological Survey (USGS) gage stations identified in Table 2.3-6.

Detailed water use by operating mode is given in Table 3.4-2. Subsection 3.4.1.2 gives the anticipated duration of each normal operating mode, i.e., power operation, start up, hot standby, safe shutdown, cold shutdown, and refueling. Water use information is derived from the information for each operating mode provided in Section 3.4 and from the flow rates provided in Section 2.3.

The plant systems that consume water include the CWS, essential service water, demineralized water, potable and sanitary water, and fire water systems. A discussion of each plant system is provided in the subsections that follow.

There are no additional station water uses due to facilities not associated with the proposed plant.

3.3.1.1 Circulating Water System

Waste heat is transferred from the main condenser to the atmosphere through the CWS. The CWS system uses mechanical draft cooling towers (MDCT) to dissipate this heat to the environment. The MDCT process consumes water through evaporation, drift, and blowdown of the CWS tower basins. Makeup water from Lake Granbury is used to replace these losses. Flow rates are as shown in Figure 3.3-1 and are tabulated in Table 3.3-1. The blowdown from the CWS tower basins discharges back to Lake Granbury.

A more detailed description of the CWS, including estimated water consumption by plant operating mode, is presented in Section 3.4.

3.3.1.2 Essential Service Water System

As discussed in DCD Section 9.2, the essential service water system (ESWS) provides cooling water to remove the heat from the component cooling water system (CCWS), and the essential chiller units. The ESWS draws water from the intake basin and returns water to the ultimate heat sink (UHS) after passing through the CCW heat exchangers and the essential chiller units. The UHS is the source of water to the intake basin. The rejected heat is discharged to the UHS through the use of wet mechanical draft cooling towers. Flow rates are as shown in Figure 3.3-1 and are tabulated in Table 3.3-1.

The ESWS draws water from the essential service water intake basin and returns water to the UHS after passing through the CCW heat exchangers and the essential chiller units. The UHS is comprised of a set of wet mechanical draft cooling towers located over the essential service water intake basin (also known as the cooling tower basin). The cooling tower and its basin are part of the UHS, which provides the safety-related source of cooling for the normal essential components and removes reactor decay heat during and after an accident. The ESWS removes heat from the reactor coolant system (RCS) and associated systems/components using the CCWS as an intermediate. In other words, the ESWS cools the component cooling water, which in turn cools the RCS fluid. This arrangement provides an additional cooling loop between the radioactive fluid from the RCS and the environment to guard against direct environmental releases in the event of a primary to secondary side leak in the heat exchanger.

As discussed in DCD Subsection 9.2.1.2.1, the ESWS is arranged into four independent trains, each train consisting of one ESWS pump, one CCW heat exchanger, one essential chiller unit, strainers, piping, valves, and instrumentation.

Piping and isolation valves are provided around each CCW heat exchanger to facilitate back flushing of the heat exchanger when required. The heat from the reactor auxiliaries is removed in the CCW heat exchangers, and the heated service water flows to the cooling towers (UHS) via independent headers. Heated service water is cooled by the forced airflow in the cooling tower and returned to the ESWS intake basin.

A more detailed discussion of the ESWS, including estimated water consumption by month and by plant operating mode, is presented in Section 3.4.

3.3.1.3 Demineralized Water Treatment System

The demineralized water treatment system will supply CPNPP Units 1, 2, 3, and 4. The system receives water from on-site raw water storage tanks, which are filled from Lake Granbury and/or the Wheeler Branch municipal supply. The demineralized water treatment system processes this water to filter solids and remove ionic impurities. Discharge from the demineralized water treatment system is used for makeup water to the refueling water storage tank or the chemical and volume control system, as well as many smaller uses. Flow rates are shown in Figure 3.3-1 and tabulated in Table 3.3-1.

Additional information on the demineralized water treatment system, including estimated water consumption by plant operating mode, is presented in Section 3.4 and Section 3.6.

3.3.1.4 Potable and Sanitary Water System

The objective of the potable and sanitary water system (PSWS) is to provide clean and potable water for domestic use and human consumption, and to collect site sanitary waste for treatment and discharge during normal operation and accidents. Potable and sanitary water is supplied by the Wheeler Branch municipal supply. Flow rates are shown in Figure 3.3-1 and tabulated in Table 3.3-1. The sanitary drainage system collects sanitary waste and carries the wastewater for processing to the treatment facility. The processed water is discharged to the Squaw Creek Reservoir.

The sanitary wastewater treatment system (SWWTS) is described in Section 3.6.

3.3.1.5 Fire Protection System

The fire protection system (FPS) provides water to points throughout the plant where wet system type fire suppression, e.g., sprinkler, deluge, etc., may be required. The FPS is designed to supply fire suppression water at a flow rate and pressure sufficient to satisfy the demand of any automatic sprinkler system plus 500 gallons per minute (gpm) for fire hoses for a minimum of 2 hours. Initial fill water for the FPS is provided by the Wheeler Branch municipal supply. Makeup water comes from the Intermediate Product Storage Tank. The Intermediate Product Storage Tank contains partially treated raw water or Wheeler Branch water, as discussed in Subsection 3.3.2.4.

3.3.2 WATER TREATMENT

This section describes the treatments needed for the plant water streams described in Subsection 3.3.1. A more detailed description of the treatment systems, including the frequency of treatment for each of the normal modes of operation, as well as the identification, quantities, and points of addition of the chemical additives, is provided in Section 3.6.

3.3.2.1 Circulating Water System

The CWS chemistry is controlled by the CWS chemical treatment system. Biocide, algaecide, pH adjuster, corrosion inhibitor, and silt dispersant are injected into the CWS by the chemical injection system to maintain a non-scale forming condition and to limit biological growth. The chemicals are fed by metering pumps. Chlorine concentration is measured by grab samples. Residual chlorine is measured to monitor the effectiveness. Chemical injection is interlocked with each circulating water pump to prevent chemical injection when the CWS pumps are not running.

A portion of the blowdown from the CWS and UHS cooling towers is routed to a Blowdown Treatment Facility (BDTF) prior to discharge to Lake Granbury. This facility produces a clean permeate stream, which is then blended with the remaining untreated blowdown and routed to Lake Granbury. The concentrated reject waste stream is sent to the reject sump and then pumped to the evaporation pond. The BDTF is further described in Subsection 3.6.1.1.

3.3.2.2 Essential Service Water System

The ESWS water is the same water as the CWS; the water treatment is described in Subsection 3.3.2.1.

3.3.2.3 Potable and Sanitary Water System

Potable and sanitary water is provided by the Wheeler Branch municipal supply, which is subject to state drinking water quality standards. No further treatment is required. The SWWTS is described in Subsection 3.6.2.

3.3.2.4 Demineralized Water System

The raw water, taken from Lake Granbury and/or Wheeler Branch, which supplies the demineralized water system, undergoes three major water treatment processes, which are the Pretreatment/Filtration, Reverse Osmosis (RO), and Demineralization. Biocide is used to remove algae, slime, and bacteria. Suspended matter and bacteria are further removed by filters. The water is treated with sodium hypochlorite to eliminate biological/bacterial impurities. Additionally, bisulfite and anti-scalant dosing is injected to further protect the RO units from residual chlorine and scale. Water is then treated for dissolved solids removal through a two-stage RO system that forces water molecules to flow against a net osmotic pressure, which partially separates dissolved impurities from the water.

A 300,000 – 400,000 gallon Intermediate Product Storage Tank is provided outside the water treatment building to store a reserve of RO quality water and/or Wheeler Branch water (direct), which only gets mixed bed treatment. Final treatment occurs in the mixed bed demineralizers to further remove the remaining dissolved impurities.

Final high-quality demineralized water is sent to the demineralized water storage tank(s) (DWST) for plant normal makeup.

3.3.2.5 Fire Protection System

The water which provides the initial fill for the FPS is taken from the Wheeler Branch municipal supply and does not require treatment. The makeup water for the FPS is taken from the Intermediate Product Storage Tank. The Intermediate Product Storage Tank contains partially treated raw water or Wheeler Branch water, as discussed in Subsection 3.3.2.4.

TABLE 3.3-1
PLANT WATER USE

	Normal Flow Per Unit (gpm)	*Maximum Flow Per Unit (gpm)*
Circulating Water System	1,317,720	1,317,720
Evaporation Rate	18,292(c)	18,292(c)
Blowdown Rate	12,900	12,900
CWS Makeup Rate	31,200	31,200
Essential Service Water System	24,000(a)	48,000(a)
Evaporation Rate	165	735
Blowdown Rate	109	515
ESWS Makeup Rate	274	1260
Raw Water (for Demineralized Water)	1,100(b)	1,100(b)
Fire Water Makeup Rate	125(b)	125(b)
Potable Water	50	50

---

a) ESWS normal flow based on two ESWS trains continuous operation. Maximum ESWS flow based on four ESWS trains operation during cooldown by CS/RHRS for duration of 4 hours.

b) Fire Water makeup flow of 125 gpm is included in the Raw Water flow of 1,100 gpm.

c) Evaporation rate of 18,292 gpm is included in the drift loss of 132 gpm.

3.4 COOLING SYSTEM

Comanche Peak Nuclear Power Plant (CPNPP) cooling systems and their anticipated modes of operation are described in Subsection 3.4.1. Design data and performance characteristics for these cooling system components are presented in Subsection 3.4.2. The parameters provided are used to evaluate the impacts to the environment from cooling system operation. The environmental interfaces of these systems are the plant intake and discharge structures as well as the cooling towers. The basic system configuration is illustrated in Figure 3.4-1.

3.4.1 DESCRIPTION AND OPERATIONAL MODES

CPNPP Units 3 and 4 are provided with three cooling systems that transfer heat to the environment during normal modes of plant operation. These systems are the essential service water system (ESWS), the non-essential service water system (NESWS), and the circulating water system (CWS). There are six anticipated plant operational modes.

- Power operation
- Startup
- Hot standby
- Hot shutdown
- Cold shutdown
- Refueling

Heat generated during each operational mode is released to the atmosphere and to Lake Granbury from the CWS, ESWS, and NESWS. The amount of heat released to the atmosphere and Lake Granbury during each mode of operation is documented in Table 3.4-1.

The CWS and ESWS are supplied with raw water from the intake structure on Lake Granbury to makeup for water which has been consumed and discharged as part of the system operations. The makeup water supply to the NESWS comes from the CWS. The quantities of water withdrawn, consumed, and discharged for the CWS and the ESWS are documented in Table 3.4-2. Chemicals added to the makeup water are listed in Table 3.6-1.

Luminant has an established process for acquiring and complying with the required permits, as necessary, for CPNPP Units 3 and 4 as described in Section 1.2. This process includes provisions for amending the existing Texas Pollutant Discharge Elimination System (TPDES) permit (in place of a National Pollutant Discharge Elimination System permit) to include CPNPP Units 3 and 4 prior to the performance of any activities which would be regulated by the TPDES permit specifications.

3.4.1.1 System Description

Circulating Water System

The CWS supplies cooling water to remove heat from the main condensers under varying conditions of power plant operation and site environmental conditions. The CWS is arranged into two cooling tower basins for each unit, each with four 12.5 percent capacity, vertical, wet pit type, single-stage mixed flow circulating water pumps located in each cooling tower basin. Two CWS cooling towers provide 100 percent cooling for normal power operation. Each pump provides a flow rate of 164,715 gallons per minute (gpm) into the main condensers removing heat by transferring heat to the CWS water and then the heated CWS water is returned to the mechanical draft cooling tower. Once in the cooling tower, the water is cooled by the counterflow principal of heat transfer to the rising air and evaporative cooling. The heat removed is rejected to the atmosphere, and the cooled water returns to the cooling tower basin. The system is provided with a blowdown capability to maintain the system performance by elimination of contaminants that build up as a result of the evaporation process. The maximum blowdown temperature to Lake Granbury is 93°F. The makeup water system (MWS) supplies water to the CWS cooling towers to make up for water consumed as the result of evaporation, drift, and blowdown. The chemical concentration factor for the CWS cooling tower is 2.4 cycles of concentration.

Non-Essential Service Water System

The NESWS provides cooling water to remove heat from the turbine component cooling water system (TCS). The heat is removed via the TCS heat exchanger and discharged to the cooling towers via the CWS.

The NESWS consists of three 50 percent capacity pumps, three 50 percent capacity TCS heat exchangers, two 100 percent capacity strainers, and associated piping, valves, instrumentation, and controls. The NESWS pumps are single-stage horizontal, centrifugal, constant speed, electric motor driven, and are located in the turbine building. Each pump is designed to provide approximately 13,500 gpm, which meets the maximum flow requirements for normal power operation (based on two pump operation); therefore, one pump can be out of service for maintenance during power operation. The temperature rise across the heat exchangers varies with each mode of operation. The NESWS is in operation during several modes of plant operation, as described in Subsection 3.4.1.2. During normal operation with a maximum heat load, the temperature rise is approximately 10°F – 1°F during cold shutdown, safe shutdown, and hot standby; 0.4°F during refueling; and 8°F during plant startup.

The NESWS is arranged in such a way that any two of the three pumps can operate in conjunction with any two of three TCS heat exchangers to meet the system flow requirements. One out of two 100 percent capacity strainers is used. Each non-essential service water pump takes suction from a common header in the CWS piping and the discharge from the TCS heat exchangers combines into a common header.

Essential Service Water System

The ESWS provides cooling water to remove the heat from the component cooling water system (CCWS) heat exchangers and the essential chiller units. The ESWS transfers the heat from these components to the ultimate heat sink (UHS).

The ESWS consists of four 50 percent capacity pumps. The ESWS is arranged into four independent trains (A, B, C, and D). Each train consists of one ESWS pump, two 100 percent strainers in the pump discharge line, one 100 percent strainer upstream of the CCWS heat exchanger, one CCWS heat exchanger, one essential chiller unit, associated piping, valves, instrumentation, and controls. Heat is dissipated via the UHS, which consists of four 50 percent wet mechanical draft cooling towers. The ESWS pumps are vertical, wet-pit, centrifugal, constant speed, electric motor driven, and are located at the essential service water intake basin. Essential service water is pumped through the strainers to the CCWS heat exchangers for heat removal. The temperature rise across the heat exchangers varies with each mode of operation. For Trains A and B during normal operation with a maximum heat load, the temperature rise is approximately 11.6°F – 31.6°F during cool down, 11.0°F during refueling, 8.0°F during plant startup, and 31.6°F during safe shutdown. For Trains C and D during normal operation with a maximum heat load, the temperature rise is approximately 5.6°F – 31.6°F during cool down, 6.7°F during refueling, 6.9°F during plant startup, and 31.6°F during safe shutdown. The heated essential service water returns to the UHS where the heat is then rejected to the atmosphere.

The essential service water blowdown is diverted to Lake Granbury via the CWS blowdown pipe. This blowdown is used to control levels of solids concentration in the ESWS.

The MWS supplies water to the ESWS cooling tower to make up for water consumed as the result of evaporation, drift, and blowdown. The chemical concentration factor for the ESWS cooling tower is 2.4 cycles of concentration.

Makeup Water System

The MWS supplies makeup water from Lake Granbury to the CWS and ESWS and consists of five 50 percent capacity pumps, two for each unit and one spare pump in standby, common for both units. The intake structure is described in Subsection 3.4.2.1.

3.4.1.2 Operational Modes

Circulating Water System

The CWS provides cooling during the power operation mode. The power operation mode rejects the most heat as the CWS removes heat rejected from the turbine by way of the condenser. The CPNPP Units 3 and 4 are in power operation mode for an estimated 97 percent of the operating cycle. During startup and hot standby, a smaller amount of heat is rejected by way of the condenser. The CPNPP Units 3 and 4 are estimated to be in the startup mode for less than 1 percent of the operating cycle, in refueling for 2 percent of the operating cycle, in the hot standby mode for less than 1 percent of the operating cycle, and in the safe shutdown mode for less than 1 percent of the operating cycle. These estimates do not include forced outages as they cannot be predicted. The power operating mode is paramount, operating for over 23 months out of a 24-month cycle and consuming the most flow. Therefore, all other modes are bounded by the power operation.

Non-Essential and Essential Service Water Systems

As noted in Subsection 3.4.1.1, the NESWS provides heat removal from the TCS during power operation while the ESWS provides cooling water for heat removal from the CCWS during all six modes of normal operation. During refueling, the ESWS also supports a full core offload.

As previously stated, CPNPP Units 3 and 4 are estimated to be in the power operation mode for 97 percent of the operating cycle. The time estimates for the remaining modes are as given above and do not include forced outages as they cannot be predicted. The power operating mode is paramount, operating for over 23 months out of a 24-month cycle and consuming the most flow. Therefore, all other modes are bounded by the power operation.

3.4.1.3 Heat Generated, Dissipated to the Atmosphere, and Released in Liquid Discharges

Circulating Water System

In the power operation and startup modes, heat is generated, dissipated to the atmosphere, and released in liquid discharges from the CWS. The CWS releases heat to the atmosphere via the CWS cooling tower and to Lake Granbury liquid discharges via blowdown. The quantities of heat released are summarized in Table 3.4-1.

Essential Service Water System

The ESWS operates in all six modes of plant operation and releases heat to the atmosphere via the UHS cooling towers, and in liquid discharges to Lake Granbury in the form of blowdown. The amount of heat released during each of these modes of operation in the CWS and the ESWS is shown in Table 3.4-1.

3.4.1.4 Water Source and Quantities of Water Withdrawn, Consumed, and Discharged

Circulating Water System

During power operation, the CWS requires makeup water from Lake Granbury. This water is provided to the CWS by the MWS. To provide for the CWS requirements, the MWS must provide sufficient capacity to make up for cooling tower losses due to evaporation, drift, and blowdown. The CWS operation results in the release of this water back to the environment. Evaporation from the cooling tower to the atmosphere is the major consumptive water use. The blowdown operations provide a discharge path to Lake Granbury. Approximately 6000 gpm of the total raw blowdown per unit will be treated in the blowdown treatment facility. After treatment, approximately 4800 gpm will return to the blowdown line and flow back to Lake Granbury. The remaining 1200 gpm will flow to the evaporation pond. The amount of water supplied by the system from Lake Granbury along with the discharge quantities for each of the six modes is provided in Table 3.4-2.

Non-Essential and Essential Service Water Systems

The NESWS is in operation during the startup, power operation, and shutdown modes of plant operation. During each of these modes of operation, the NESWS requires makeup water from Lake Granbury via the CWS. The MWS must provide sufficient capacity to supply the NESWS with makeup for cooling tower losses due to evaporation, drift, and blowdown. The cooling tower losses provide the major discharge source to the atmosphere via evaporation. The blowdown system provides a discharge path to Lake Granbury via the CWS cooling tower basin.

The ESWS is in operation during all six modes of plant operation and requires makeup water from Lake Granbury. The MWS must provide sufficient capacity to supply the ESWS with makeup for UHS cooling tower losses due to evaporation, drift, and blowdown. Evaporation from the cooling tower to the atmosphere is the major consumptive water use. The blowdown operations provide a discharge to Lake Granbury. The amount of water supplied by the system from Lake Granbury along with the discharge quantities for each of the six modes is provided in Table 3.4-2.

Makeup Water System

During normal operation, Lake Granbury provides 31,200 gpm makeup to the CWS, and 274 gpm as makeup for the ESWS, for a total of 31,474 gpm per unit, plus 1,100 gpm to the raw water storage tanks, or a total of 65,400 gpm for both units. The estimated monthly water need from Lake Granbury is 2.83 x 10^9 gallons (gal) to operate both CPNPP Units 3 and 4. Normal operation is at 100 percent power operation, which is at a maximum makeup demand; therefore, the maximum is approximated to be the same as the normal need. The minimum demand is during an outage when the only flow being pulled from Lake Granbury for that unit is the ESWS makeup (331 gpm per unit). The estimated monthly minimum water demand from Lake Granbury is 1.43 x 10^7 gal per unit. Therefore, the minimum demand occurs when one unit is in an outage and the other is in power operation.

During normal operation, Wheeler Branch supplies up to 300 gpm This water supply includes up to 50 gpm for daily potable water use for the entire site and from 0 to 250 gpm to the raw water storage tanks, which in turn supply water to the demineralized water system (DWS). The amount of water needed from Wheeler Branch is bounded by the maximum need of 300 gpm, with the estimated monthly maximum being 1.3 x 10^7 gal.

3.4.2 COMPONENT DESCRIPTIONS

CPNPP Units 3 and 4 are designed with a common intake structure that supplies the necessary raw water to the plant. The MWS consists of approximately 13 miles (mi) of 42-inch prestressed reinforced concrete piping, valves, and instrumentation. This system is described in Subsection 3.4.2.1.

CPNPP Units 3 and 4 are also designed with two discharge systems, one per unit. For each unit, approximately 13 mi of 42-inch piping runs to Lake Granbury. The discharge system is described in Subsection 3.4.2.2.

3.4.2.1 Intake System

The intake system is designed to provide the raw water requirements for the plant. The intake pumping station is located adjacent to the existing makeup pumping station for CPNPP Units 1 and 2. The intake pumping station is protected by passive screens, two per unit. The passive screens eliminate the need for traveling screens and fish return systems. The intake pumping station with respect to the water surface, bottom geometry, and shoreline is illustrated in Figures 3.4-2 and 3.4-3.

Five 50 percent pumps are located in the intake pumping station. These five pumps include two pumps that supply makeup to the CWS and NESWS, as well as the ESWS per unit, and one spare pump. The pump discharge lines and valves are arranged so that the spare pump can be aligned to either unit in the event that one of the pumps is not available. At any given time, no more than four pumps are operating, two per unit. The flow rates for these pumps vary based on system demand; however, during normal operating conditions, each of the operating pumps is designed to supply a maximum of 18,000 gpm, for a total of 36,000 gpm for each unit. The passive screening system consists of a traditional well-screen design and are spiral wound, wedge-shaped wire drum modules with a 6.5-foot (ft) diameter. Each module is 6 ft long and mounted in a tee arrangement such that each tee has 12 ft of screen drum, and is 16.33 ft long, with a total area of 245 square feet (ft^2) per tee. There are a total of four tees. This provides a total screen area of 490 ft^2 per unit, and twice that area, or a total of 980 ft^2 of screen area, for CPNPP Units 3 and 4. As noted in Subsection 3.4.2, the MWS consists of approximately 13 mi of 42-inch prestressed, reinforced concrete piping, valves, and instrumentation. The makeup water discharges into each CWS and UHS cooling tower basin via a 24-inch and a 6-inch-diameter carbon steel piping, respectively. Each 50 percent capacity vertical, wet-pit makeup water pump provides 16,350 gpm. The makeup water intake structure floor plan is shown in Figure 3.4-4.

The maximum velocity through clean screens is approximately 0.38 feet per second (fps) at a normal water level of 693 ft and 0.42 fps at a high water level of 712.8 ft. The maximum velocity through screens that are 15 percent clogged is 0.44 fps at a normal water level of 693 ft and 0.49 fps at a high water level of 712.8 ft. Historical water temperatures show the average temperature of Lake Granbury is approximately 62.13°F, as shown in Table 2.3-23, and rarely falls below freezing; therefore, there is not significant icing at the intake structure as the intake is below the frozen surface.

During each operational mode, the raw water requirements vary; therefore, the flow ratesalso vary. During power operation, the CWS, NESWS, and the ESWS require makeup water. Flow rates for all modes of operation are shown in Table 3.4-2.

3.4.2.2 Discharge

The primary purpose of the discharge system is to disperse cooling tower blowdown into Lake Granbury to limit the concentration of dissolved solids in the cooling water systems. For each unit, a 24-inch carbon steel blowdown pipe from each of the two CWS cooling tower basins is headered together to a 42-inch prestressed reinforced concrete pipe. The 42-inch piping runs approximately 13 mi to Lake Granbury where the water is discharged through diffusers. The 42-inch piping also receives blowdown water from the UHS basins via 4-inch piping. The physical layout and connection of the CWS cooling tower basins blowdown piping and UHS cooling tower basins blowdown piping is such that the water from the CWS blowdown cannot flow into that of the UHS. The location of the discharge relative to the intake structure and other major plant structures is illustrated in Figure 3.4-3, Sheets 1, 2 and 3.

During each operational mode, the raw water requirements vary. The discharge flow rates and velocities also vary. The CWS, the NESWS, and the ESWS are in service during power operation, and the discharge velocity is at the maximum and bounding rate of 19.95 fps. Flow rates for all modes of operation are shown in Table 3.4-2.

Normal blowdown from the mechanical draft CWS cooling towers and UHS is discharged into Lake Granbury through a diffuser at an approximate rate of 13,050 gpm per unit. The maximum blowdown temperature is 93°F.

3.4.2.3 Heat Dissipation

The CWS has two mechanical draft cooling towers per unit, which discharge via the blowdown pipe to the outfall structure on Lake Granbury. The outfall structure is approximately 1.2 mi downstream of the intake structure, as illustrated in Figure 2.3-13. The CWS cooling towers have 30 cells per tower, are made of FRP with polyvinyl chloride (PVC) fill, are 54.7 ft high and each has a basin with an area of 105,900 ft^2. The rated heat-dissipation capacity of each cooling tower is 9.97×10^9 British thermal units per hour (Btu/hr). For average monthly meteorological conditions, water from the condenser enters the cooling tower at a temperature and flow rate of 104°F and 31,200 gpm, and discharges at 88.5°F and 12,900gpm. The average discharge temperatures for each month are bounded by summer loading conditions. The mechanical draft cooling tower uses fans to force convection within the cooling tower. The volumetric flow of air in the tower varies with the mode of operation. For power operation, the flow rate is 1.55×10^6 cubic feet per minute (cfm). The power consumption for the fans is 250 horsepower (hP) for each cell's fan. Drift rate of the plume coming off each tower is 0.0005 percent of CWS flow. It is estimated that the mechanical draft cooling tower produces 65 dBA (decibels) at 400 ft. The wet-bulb temperature is 76°F, the approach to wet-bulb is 10.5°F, and the range is 15.2°F. Performance curves for the mechanical draft cooling towers are not available at the time of submittal as they have not yet been procured.

The ESWS dissipates heat via the UHS, which is comprised of four, 50 percent capacity mechanical draft cooling towers per unit that blow down to Lake Granbury via the CWS blowdown pipes. The UHS cooling towers have two cells per tower, are made of reinforced concrete, with a ceramic tile fill, are 60 ft high and have an inside basin dimension of 66 ft x 30 ft (1980 ft^2) each. The rated heat-dissipation capacity of each cooling tower is 1.96×10^8 Btu/hr. For average monthly meteorological conditions, water enters the cooling tower at a temperature and flow rate of 104°F and 274 gpm, and discharges at 93°F and 109 gpm. The mechanical draft cooling tower uses fans to force convection within the cooling tower. The volumetric flow of air in the tower varies with the modes of operation. For power operation, the flow rate is 6.86×10^6 cfm. The power consumption for the fans is 200 hP for each cell's fan. Drift rate of the plume coming off the cooling tower is approximately 0.0010 percent of UHS flow The mechanical draft cooling tower produces an estimated 45 dBA at 400 ft perpendicular distance. The wet-bulb temperature is 80°F, the approach to wet bulb is 15°F, and the range is 33°F. Performance curves for the UHS cooling towers are not available at the time of submittal as they have not yet been procured.

TABLE 3.4-1
HEAT TRANSFER TO THE ENVIRONMENT AND RELEASE IN LIQUID DISCHARGE

Modes of Operation	Total Heat Transferred ESWS+CWS Btu/hr	Heat Dissipated to Atmosphere by ESWS Btu/hr	Heat Released in Liquid Discharges by ESWS Btu/hr(a)	Heat Dissipated to Atmosphere by CWS Btu/hr	Heat Released in Liquid Discharges by CWS Btu/hr(b)
Power Operation	103.40×10^8	100.0×10^6	2.62×10^6	$9{,}970 \times 10^6$	267.6×10^6
Startup	659.7×10^6	144.1×10^6	3.71×10^6	498.5×10^6(c)	13.38×10^6(c)
Hot Standby	102.62×10^6	100.0×10^6	2.62×10^6	NA	0
Safe Shutdown	390.6×10^6	390.6×10^6	0(d)	NA	0
Cooldown by CS/RHRS(e)	471.5×10^6	459.1×10^6	12.4×10^6	NA	0
Refueling (Full Core Offload)	120.6×10^6	117.54×10^6	3.04×10^6	NA	0
				NA	0

---

a) ESWS heat released in blowdown discharge is based on ESW blowdown water temperature of 95°F, and lake water temperature of 47°F.

b) CWS heat released in blowdown discharge is based on CWS blowdown temperature of 88.5°F, and lake water temperature 47°F.

c) The startup mode is based on 5% of rated power condition. The 5 percent heat value is prorated from the heat value of rated power operation (normal operation).

d) ESW Blowdown control valve is closed during safe shutdown.

e) ESW cool down by CS/RHRS operation is based on all four ESW trains operating for duration of 4 hours.

TABLE 3.4-2
RAW WATER WITHDRAWN, CONSUMED AND DISCHARGED PER UNIT

Modes of Operation	Water Source	Quantity Withdrawn gpm	Quantity Consumed (CWS) gpm	Quantity Discharged (CWS) gpm	Quantity Consumed (ESWS) gpm	Quantity Discharged (ESWS) gpm	Quantity Discharged into Lake Granbury gpm
Power Operation	Lake Granbury	31,466	18,292	12,900	165	109	13,050
Startup	Lake Granbury	2,958	1,506	1,057	240	155	1,212
Hot Standby	Lake Granbury	1,178	531	373	165	109	482
Safe Shutdown	Lake Granbury	630(a)	0	0	630(a)	0(a)	0(a)
Cold Shutdown	Lake Granbury	1,283	14	10	744	515	525
Refueling (Full Core Offload)	Lake Granbury	331	5	4	195	127	131

---

a) During accident conditions, including loss-of-cooling accident and loss of off-site power, blowdown control valves close automatically upon receipt of low water level signal or ECCS actuation signal. Make-up water may be available, but design basis of UHS does not require make-up.

General Note: The conceptual design of the Blowdown Treatment Facility assumes that approximately 1200 gpm will be routed to the evaporation pond, increasing the quantity consumed and decreasing the quantity discharged into Lake Granbury.

3.5 RADIOACTIVE WASTE MANAGEMENT SYSTEM

Radioisotopes are produced during the normal operation of nuclear reactors, primarily through the processes of fission and activation. Fission products may enter the reactor coolant by diffusing from the fuel then passing through the fuel cladding either through leaks or by diffusion. The primary cooling water may contain dissolved or suspended corrosion products and nonradioactive materials leached from plant components. These products and materials can be activated by the neutrons in the reactor core as the water passes through the core. These radioisotopes leave the reactor coolant system (RCS) boundaries either by plant systems designed to remove impurities, by small leaks that occur in the RCS and auxiliary systems, or by breaching of systems for maintenance. Therefore, each plant generates radioactive waste that can be liquid, solid, or gaseous.

Radioactive waste management systems are designed to minimize exposures from the reactor operations in compliance with the as low as reasonably achievable (ALARA) principle. These systems are designed and maintained to meet the requirements of 10 Code of Federal Regulations (CFR) 20 and 10 CFR 50, Appendix I.

The discussions that follow provide a description of the systems designed to provide radioactive waste management and effluent control systems for Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4. These descriptions include discussions regarding the quantities of waste as well as system features that control the discharge of this waste to ALARA. The concluding section provides information requested by Regulatory Guide (RG) 1.112.

3.5.1 LIQUID RADIOACTIVE WASTE MANAGEMENT AND EFFLUENT CONTROL SYSTEMS

The liquid waste management system (LWMS) is designed to safely monitor, control, collect, process, handle, store, and dispose of liquid radioactive waste generated as a result of normal operation, including anticipated operational occurrences (AOOs). AOOs are events in which the reactor plant conditions are disturbed beyond the normal operating range and are expected to occur one or more times during the lifetime of the plant. The LWMS is broadly classified into the liquid waste processing system (LWPS) and the reactor coolant drain system (RCDS). The LWMS includes the following:

- The equipment and floor drain processing subsystem.
- The detergent drain subsystem.
- The chemical drain subsystem.
- The reactor coolant drain subsystem.

The LWMS has cross-connections, adequate storage capabilities, and the ability to connect to mobile systems to provide for anticipated waste surge volumes. It is also designed to process liquid waste generated from normal operation.

The LWMS has sufficient capacity, redundancy, and flexibility to process incoming waste streams to meet the concentration limits of 10 CFR 20 and 10 CFR 20, Appendix B, Table 2 during periods of equipment downtime, normal operation, and during operation at design basis fission product leakage levels, i.e., leakage from fuel producing 1 percent of the reactor thermal power level.

The LWMS is designed in compliance with the ALARA principle for occupational exposures, and is designed such that no potentially radioactive liquids can be discharged to the environment unless they have first been permitted, monitored, and confirmed to be within acceptable limits. Off-site radiation exposures measured on an annual basis are expected to be within the limits of 10 CFR 20 and 10 CFR 50, Appendix I. Radiation detection equipment and sampling features are provided at key locations. Protection against inadvertent discharge of noncompliant waste is provided through the detection and alarm systems, and by administrative controls.

The LWMS provides segregated collection of floor drains and equipment drains, permanently installed process equipment to treat the influent, and the ability to sample system contents. Sample analysis is then used to determine treatment requirements and product specifications. The process equipment includes the use of filtration systems to remove suspended solids, activated charcoal to remove organic contaminants, and ion exchange resin to remove dissolved solids and nuclides. Waste monitor tanks (WMTs) are provided with sample ports and with mixing nozzles inside the tank to allow thorough mixing for representative samples. Analysis of samples is used so that treated waste meets recycle and/or release limits.

The LWMS has different subsystems so that the liquid wastes from various sources can be segregated and processed separately in the most appropriate manner for the type of waste. These systems are interconnected in order to provide additional flexibility in processing the wastes and to provide redundancy.

Subsystems and components of the LWMS are not shared between units. The LWMS is designed for individual unit operation, where CPNPP Unit 3 is separate from CPNPP Unit 4. The information provided below pertains to the LWMS for each unit.

3.5.1.1 System Description and Operation of the LWMS

The LWMS is broadly classified into the LWPS and the RCDS.

3.5.1.1.1 Liquid Waste Processing System

The LWPS collects radioactive liquid wastes from various collection tanks located within the auxiliary building (A/B) and reactor building (R/B). The wastes entering these tanks are transferred from a number of locations within the plant, including:

- Equipment drains.
- Floor drains and other waste sources with potentially high suspended solid content.
- Detergent wastes, generally from plant sinks and showers that contain soaps and detergent which are not compatible with ion exchange resins.

- Chemical wastes (generated in very low volumes).
- Steam generator blowdown (SGBD), when radioactivity above a setpoint is detected.

The processing flow rate is selected based on the completion of sampling and processing of one tank volume during each operations crew shift. Treated water is collected in one of two WMTs. When a tank is filled, the tank is isolated and the monitor tank pump is turned on to circulate the tank content for sampling and analysis to confirm that the quality of the treated water is suitable for recycle and/or discharge. The discharge is not a continuous process, and the discharge valves are under supervisory control. Although the LWMS is designed with four waste holdup tanks (WHTs), each with 24,000-gallon (gal) batch capacity, expected to be the maximum volume for a day of operation during AOO, the average daily input is approximately 4000 gal. Based on the above, the sampling and analysis for the LWMS is intermittent and does not need to be a continuous process.

Radiation detection equipment and provisions for sampling features are provided at key locations. Protection against inadvertent discharge of noncompliant waste is provided through the detection and alarm systems and by administrative controls. Design features that protect against inadvertent discharge meet 10 CFR 50, Appendix A, Criteria 60 and 64.

Tanks, equipment, pumps, etc., used for storing and processing radioactive material are located in controlled areas and shielded in accordance with their design basis source term inventories. As a result, occupational doses comply with dose limits and are ALARA. After the waste has been processed, it is temporarily stored in WMTs where it is sampled prior to recycle or discharge.

Depending on the sample results and other plant conditions, such as condensate inventory, the treated fluid is either:

- Returned to the WHTs for further processing.
- Reused for resin sluicing application or flushing lines.
- Discharged when compliance with 10 CFR 20, 10 CFR 50, and site-specific Texas Pollution Discharge Elimination System (TPDES) permit requirements are demonstrated.

3.5.1.1.1.1 Equipment and Floor Drain Processing Subsystem

The LWPS equipment drains and floor drains processing subsystem consists of:

- Four WHTs
- Two WHT pumps.
- Two liquid filters.
- An activated charcoal filter.

- Four ion exchange columns.
- Two WMTs.
- Two WMT pumps to collect treated fluid for analysis.

These components are located in the A/B. A process flow diagram (PFD) is presented in DCD Figure 11.2-1, Sheet 1. A piping and instrumentation diagram (P&ID) is presented in FSAR Section 11.2.

The four WHTs are divided into two sets: two are designed to collect high-quality liquid from equipment drains and the other two are designated to collect liquid from floor drains. A common header with an isolation valve is provided to segregate collection from equipment drains and floor drains; but the WHTs can be used interchangeably in the event that excess equipment drains or excess floor drain waste is generated in anticipated operations.

Two filters are connected in parallel to provide redundancy. Normally, one filter is used while the other one is on standby or being maintained.

The charcoal filter is sized to handle the entire effluent inventory. It is used to remove organics, which could foul the ion exchange columns. The charcoal filter is designed to operate occasionally and only when there is a high level of organic contaminants. It is expected that the charcoal filter medium will not need to be replaced frequently. However, in case of severe fouling, the charcoal can be replaced in a similar manner to spent resin. Four ion exchange columns are provided to operate in separate trains: two columns in series, each with mixed resins for optimum performance. During normal operation, including AOOs, only one of the two trains of columns is required to operate, while the other set is standing-by. When high nuclide concentration is detected, such as during operation at design-basis failed fuel level, the four columns can be arranged to operate in series so that the treated liquid meets recycle and release specifications. Two WMTs are provided; while one is in the receiving mode, the other monitor tank can be standing by, in sampling and analysis, or in transferring mode.

Two WHT pumps and two WMT pumps are provided for processing and transfer operations. Normally, only one of each is required for recirculation and processing, and transferring.

3.5.1.1.1.2 Detergent Waste Processing Subsystem

The detergent waste processing subsystem consists of one detergent drain tank, one detergent drain tank pump, one filter, one detergent drain monitor tank, and one detergent drain monitor tank pump. A PFD for this subsystem is presented in DCD Figure 11.2-1, Sheet 2. A P&ID is presented in FSAR Section 11.2.

Detergent waste is collected in the detergent drain tank. The detergent drain tank is based on a maximum daily input, 2000 gal. The tank is sized not to include collection of laundry waste as contaminated laundry is sent off-site for cleaning or disposal. This tank is sufficient for anticipated operations. This waste stream consists primarily of material from sinks, showers, emergency showers, etc. This stream does not typically contain any significant levels of radioactive contaminants. This stream is filtered and released through the discharge header to the monitor tank.

After processing, the waste is held in the monitor tank where a sample is taken, and if discharge standards are met, the waste is discharged to the Squaw Creek Reservoir (SCR). Any waste not meeting discharge requirements is transferred to the WHT for further processing.

3.5.1.1.1.3 Chemical Drain Subsystem Processing

The chemical drain subsystem consists of a chemical drain tank with pH adjustment, waste analysis features, and a chemical drain tank pump. A PFD for this subsystem is presented in DCD Figure 11.2-1, Sheet 2. A P&ID is presented in FSAR Section 11.2. This system is located in the A/B.

The chemical drain subsystem collects laboratory wastes and some of the decontamination solutions. To the greatest extent practicable, all decontamination solutions and process liquids are inherently free of hazardous materials and toxic substances. Use of these decontamination solutions and process liquids must not generate mixed waste. Additionally, laboratory wastes are collected for treatment and disposed in appropriate portable containers. Only small amounts of laboratory wastes, basically those associated with the cleaning of glassware and similar activities, are expected to be in the chemical drain subsystem. Any such wastes that do not contain significant quantities of chemical constituents may be transferred to the floor drain processing subsystem.

Dilute acids and bases, along with heavy metals, are captured by the chemical drain subsystem. When the tank is full, the contents are neutralized, sampled, and characterized. This content is then transferred to disposal containers (drums) for transfer to approved off-site processing facilities. Alternatively, absorbing agents are added to stabilize the waste for disposal.

3.5.1.1.1.4 Steam Generator Blowdown

The SGBD monitor measures the radiation level in the SGBD water after it is treated and before it is returned to the condenser. A sample from the SGBD mixed bed demineralizers is monitored for radiation. Normally, the treated SGBD water is not radioactive. In the event of significant primary-to-secondary system leakage due to a steam generator tube leak, the SGBD liquid may be contaminated with radioactive material. Detection of radiation above a predetermined setpoint automatically initiates an alarm in the main control room for operator actions, and automatically turns off the valve through which treated liquid is sent to the condenser. Plant personnel are required to manually sample the SGBD water for analysis. When it is confirmed that the liquid is contaminated, the liquid is routed to the LWMS for processing. A PFD is presented in DCD Figure 10.4.8-1, Sheets 1 and 2. A P&ID is presented in FSAR Section 10.2.

3.5.1.1.2 Reactor Coolant Drain System

The RCDS consists of a containment vessel reactor coolant drain tank (CVT) and two pumps. The RCDS is inside the containment vessel (C/V). A PFD for this subsystem is presented in DCD Figure 11.2-1, Sheet 3. A P&ID is presented in FSAR Section 11.2.

The RCDS provides a collection system for reactor coolant depending on the operating condition of the plant, i.e., normal operation, other anticipated operations, and maintenance/refueling operations. Under normal plant operation, relatively small quantities of reactor-grade water are collected from many sources including the following locations:

- Reactor coolant pumps seal leakage.
- Excess letdown water.
- Leakage from reactor vessel R/V flanges.
- Reactor coolant loop drains.
- Leakage from valves inside the C/V.
- RCS vents and drains.
- Accumulator tank drains.
- Pressurizer relief tank drains.

This liquid drains to the CVDT. A nitrogen cover gas is maintained over the liquid in the tank to preserve the quality of the water (exposure to air would degrade the quality of the water) and to prevent the buildup of a flammable mixture from radiolytic decomposition of water. The water entering the tank can be at a relatively high temperature (up to 200°F); therefore, the tank is equipped with instrumentation to monitor the temperature. Prior to transferring the water to the chemical and volume control system (CVCS) holdup tank (HT) via one of two installed reactor coolant drain pumps, the water temperature is lowered to below 200°F by the addition of primary makeup water. The tank is generally maintained at a near constant level to minimize both the amount of gas sent to the gaseous waste management system (GWMS) and the amount of nitrogen cover gas required. In the event that the liquid collected in the CVDT is either oxygenated or above specified radiation limits, it is sent to the LWMS WHT for processing.

During refueling, the reactor coolant drain pumps are used to drain water from the reactor cavity and the fuel transfer canal to the refueling water storage auxiliary tank (RWSAT). In this case, typically both pumps are used to speed up the transfer of water from these areas. In this mode, the water is transferred directly to the RWSAT without entering the CVDT. During maintenance or outages, any remaining gas is purged from the system to the GWMS using nitrogen.

3.5.1.2 Identification of Sources of Radioactive Liquid Waste Material

As explained in Subsection 3.5.1.1 above, the LWMS is broadly classified into the LWPS and the RCDS. The sources of liquid waste material for the LWPS are equipment drains and floor drains, detergent drains, chemical drains, and potentially SGBD. The sources of liquid waste material for the RCDS are:

- Reactor coolant pumps seal leakage.
- Excess letdown water.
- Leakage from R/V flanges.
- Reactor coolant loop drains.
- Leakage from valves inside the C/V.
- RCS vents and drains.
- Accumulator tank drains.
- Pressurizer relief tank drains.

DCD Table 11.2-19 documents the expected inputs to the LWMS, processing time, and number of days of holdup.

3.5.1.3 Identification of Principal Release Points

The LWMS removes radioactive constituents from the waste streams. The treated liquid is either recycled for plant use or discharged, providing that the activity concentrations are consistent with the concentration limits of 10 CFR 20, Appendix B, Table 2 and the dose commitment in 10 CFR 50, Appendix I.

The radioactive constituents of the waste stream are removed by the processing equipment such as filters, ion exchange, etc. Each processing equipment has an associated decontamination factor (DF), which is a measure of the removal efficiency of the particular equipment. The DFs are presented in DCD Table 11.2-7 and are taken from the Pressurized Water Reactors (PWR) GALE Code user manual that is used to determine anticipated radioactive discharges. The PWR-GALE DF values are conservative with respect to the actual DFs. The level of decontamination expected in actual operation would result in significantly lower quantities of radioactive material in effluents. Spent filters, ion exchange media, charcoal media, etc., are sent to the solid waste management system (SWMS) for further processing and packaging.

The releases are controlled by the Off-site Dose Calculation Manual. Parameters used by the PWR-GALE Code to calculate releases of materials in liquid effluents are provided in DCD Table 11.2-9, and the results are summarized in DCD Tables 11.2-10 and 11.2-11. The calculated concentrations are then compared against concentration limits of 10 CFR 20 in DCD Tables 11.2-12 and 11.2-13, and are shown to be acceptable even using the conservative DF values discussed above.

The liquid radioactive waste discharge from CPNPP Units 3 and 4 are directed to either CPNPP Units 1 or 2 circulating water discharge, which is then combined and diluted prior to discharge to the SCR. Discharge is directed to the radioactive evaporation ponds, if tritium levels in the SCR requires it.

3.5.1.4 Maximum Individual and Population Doses

The calculated maximum individual and population doses for normal plant operation are addressed in Section 5.4.

3.5.1.5 Components and Parameters Considered in the Benefit-Cost Balance

The LWMS is designed for use at any site. The design is flexible so that site-specific requirements such as preference of technologies, degree of automated operation, and radioactive liquid waste storage can be incorporated with minor modifications to the design.

RG 1.110 outlines compliance with 10 CFR 50, Appendix I numerical guidelines for off-site radiation doses as a result of radioactive liquid effluents during normal operations, including AOOs. The cost-benefit numerical analysis as required by 10 CFR 50, Appendix I, Section II, Paragraph D demonstrates that the addition of items of reasonably demonstrated technology does not provide a more favorable cost benefit. The LWMS provided in this design is considered to meet the numerical guides for dose design objectives. The site-specific cost-benefit analysis regarding population doses due to liquid effluents during normal plant operation is addressed in FSAR Section 11.2.3.

3.5.2 GASEOUS RADIOACTIVE WASTE MANAGEMENT AND EFFLUENT CONTROL SYSTEMS

The GWMS is designed to monitor, control, collect, process, handle, store, and dispose of gaseous radioactive waste generated as the result of normal operation, including AOOs, using the guidance of NUREG-0017 and RG 1.143 as it applies to the GWMS.

The GWMS is designed to process radioactive materials in the gaseous waste for release to the environment. The GWMS manages radioactive gases collected from the off-gas system, including charcoal delay beds, HTs and gas surge tanks (GSTs), and other tank vents containing radioactive materials. The gaseous wastes from the above sources are processed to reduce the quantity of radioactive material prior to release to the environment.

During normal operation, radioactive isotopes including xenon, krypton, and iodine are generated as fission products. A portion of these nuclides are present in the primary coolant due to fuel cladding defects. These nuclides are stripped out of the coolant in the volume control tank (VCT) and the HTs into the cover gas and form the input to the GWMS. Charcoal bed adsorbers are used to control and minimize the release of radioactive nuclides into the environment by delaying the release of the radioactive noble gases. The charcoal bed adsorbers contain activated charcoal that has been used extensively to remove radioactive iodine.

Subsystems and components of the GWMS are not shared between units. The GWMS is designed for individual unit operation, where CPNPP Unit 3 is separate from CPNPP Unit 4. The information provided below pertains to the GWMS for each unit.

3.5.2.1 System Description and Operation of the GWMS

The GWMS consists of two gas compressors, a gas dryer skid, four charcoal delay beds, four GSTs, two hydrogen analyzer units each with one hydrogen and one oxygen analyzer, and an oxygen analyzer unit containing dual oxygen analyzers.

1. One of the two gas compressors operates continuously to draw gaseous waste from the CVCS HT and the RCDT, and directs the gaseous waste into the GST.
2. Upon completion of decay, or at operator discretion, the gaseous waste is processed through the dryer, the charcoal bed adsorbers, and sent to the plant stack for release.
3. When the gas pressure in the VCT reaches the predetermined setpoint, the pressure control valve opens and the gas is released into gas dryer and charcoal bed adsorbers for process, sampling, and release.
4. A recycle line to the suction side of the gas compressors is provided to direct the gaseous waste from the VCT to go to the GSTs.

A list containing the design information for the major equipment in the GWMS is provided in DCD Table 11.3-2. A P&ID is presented in DCD Figure 11.3-1, Sheets 1 through 3.

The charcoal bed adsorbers are used to control and minimize the release of radionuclides into the environment by delaying the release of the radioactive noble gases, including krypton and xenon. The charcoal bed adsorbers contain activated charcoal that has been used extensively to remove radioactive iodine and other noble gases before the gaseous waste is routed to the discharge structure. The charcoal bed adsorbers provide up to 45 days of delay time for these gases at the design flow conditions.

Any liquid generated from the operation of the GWMS is collected and routed to the LWMS for processing. The equipment drains from GWMS are routed to the WHTs in LWMS for further processing.

Some hydrogen and oxygen are generated from the hydrolysis and radiolysis of the coolant water. At sufficiently high concentrations, these gases can form flammable and explosive mixtures. Streams in the GWMS are monitored for both hydrogen and oxygen contents so that a flammable limit will not be reached. The GWMS provides sufficient dilution of nitrogen gas to maintain a hydrogen concentration below 4 percent by volume and oxygen concentration below 4 percent by volume before the gaseous waste is sent to the plant stack. This gas is further diluted with the A/B ventilation flow in the plant vent stack before it is discharged to the atmosphere.

Initially, the waste gas from the HTs and the RCDT is compressed, cooled, moisture separated, and then routed to be released to the atmosphere via the plant vent stack. Component cooling water (CCW) is supplied to the gas cooler located downstream from the compressors, and is designed to cool the gaseous waste stream to separate the moisture from the gas stream in the moisture separator. The moisture separator has level control and automatically activates the valve to drain the moisture into the LWMS WHTs. The gaseous waste stream is then routed to the molecular sieve tank to remove the remaining moisture with desiccant before the gas is forwarded to the GST for decay, and later to the charcoal bed adsorbers for removal of the radioactive nuclide gases.

3.5.2.2 Identification of Sources of Radioactive Gaseous Waste Material

The main sources of plant radioactive gaseous inputs to the GWMS are the waste gases from the VCT, the RCDT, boric acid evaporator, and the CVCS HTs. Because nitrogen is used as a cover gas for the HTs, the gas is returned back to the HT for reuse. Otherwise, the nitrogen gas is treated and discharged. The majority of waste gas entering the GWMS during normal operation is composed of cover nitrogen gas, a small amount of radioactive gaseous isotopes of krypton and xenon, and to a lesser extent hydrogen and oxygen.

3.5.2.3 Identification of Principal Release Points

The GWMS processes and releases radioactive gaseous waste generated from normal operation, including AOO. Typical gaseous release data, isotope, and activity, are presented in DCD Tables 11.3-5, Sheets 1 through 6. There are no liquid or solid waste releases from the GWMS.

The GWMS is designed to process potentially radioactive gas to meet the concentration and dose limits of 10 CFR 20, the dose limits of 10 CFR 50, Appendix I, and 10 CFR 50 Appendix A 64. The main sources of plant radioactive gaseous inputs to the GWMS are the waste gases from the VCT, RCDT, boric acid evaporator, and CVCS HTs. Their flow rates are presented in DCD Figure 11.3-1, Sheet 3. The release rates and isotopic compositions are calculated using the NUREG-0017 GALE Code. Other parameters for the PWR-GALE Code calculation are listed in DCD Section 11.1. Results of the calculation are tabulated in DCD Tables 11.3-6 and 11.3-7, and are compared to the concentration limits of 10 CFR 20. The comparison indicates that the overall expected release is a small fraction, 0.9 percent, of the release limit, and the maximum release is about 91 percent of the release limit. The processed gaseous waste is further diluted by heating, ventilating and air conditioning (HVAC) ventilation flow before the gases are released from the plant stack.

The plant stack is the only GWMS release point for both the gaseous system and the HVAC systems associated with the R/B, A/B, power source building, and the access building. The plant stack runs alongside the C/V with the release point above the top of the C/V. Radiation monitors are provided before the discharge valve, on the GWMS, so that release limits are not exceeded. The discharge valves remain open when the radiation setpoint is not exceeded. The plant stack design is provided in Subsection 3.5.4.

3.5.2.4 Maximum Individual and Population Doses

The calculated maximum individual and population doses for normal plant operation are addressed in Section 5.4.

3.5.2.5 Components and Parameters Considered in the Benefit-Cost Balance

The GWMS is designed to be used for any site. The design is flexible so that site-specific requirements such as preference and upgrade of technologies, degree of automated operation, and radioactive waste storage can be incorporated into the design with minor modifications.

RG 1.110 provides compliance with 10 CFR 50, Appendix I numerical guidelines for off-site radiation doses as a result of gaseous or airborne radioactive effluents during normal operations, including AOOs. The cost-benefit numerical analysis as required by 10 CFR 50, Appendix I, Section II, Paragraph D demonstrates that the addition of items of reasonably demonstrated technology is not favorable or cost beneficial. The GWMS provided in this design is considered to meet the numerical guides for dose design objectives.

3.5.3 SOLID RADIOACTIVE WASTE MANAGEMENT SYSTEM

The SWMS is designed to provide collection, processing, packaging, and storage of radioactive wastes produced during normal operation and AOO, including startup, shutdown, and refueling operations. The SWMS also provides storage of the packaged wastes, as required, in the A/B.

The design objective of the SWMS is to provide capability for processing, packaging, and storing radioactive wastes generated from the LWMS, the CVCS, the spent fuel pool cooling and cleanup system (SFPC), the condensate polishing system (CPS), and the SGBD treatment system. Wastes from these systems are wet solid wastes and mainly consist of spent resin, spent activated charcoal, oily waste, and sludge.

Subsystems and components of the SWMS are not shared between units. The SWMS is designed for individual unit operation, where CPNPP Unit 3 is separate from CPNPP Unit 4. There are no anticipated direct radiation sources stored on-site out-of-plant as solid waste, such as independent fuel storage.

3.5.3.1 System Description and Operation of SWMS

The SWMS controls, collects, handles, processes, packages, and temporarily stores dry and wet solid waste (wet solid waste is usually dewatered prior to shipping) generated by the plant prior to off-site shipping and disposal resulting from normal operations, including AOOs. The SWMS processes and packages waste from the LWMS, the CVCS, the SFPC system, and a variety of contaminated wastes from plant operations (cloth, mops, paper, plastic, etc.). The SWMS also can receive solid waste from the CPS and the SGBD when the waste becomes radioactive. Waste from these systems consists of spent resin, spent charcoal, sludge, general contaminated plant debris, and spent filter elements. As these waste types differ in characteristics and contamination levels, the SWMS contains five subsystems as follows.

- Dry active waste (DAW).
- Spent filter elements.
- Spent resin.

- Spent activated charcoal.
- Oil and sludge.

Dry solid waste includes DAW and spent filter elements. Both of these wastes are handled separately as described below in Subsections 3.5.3.1.1 and 3.5.3.1.2. DCD Table 11.4-2 provides an estimate of expected annual dry solid wastes and anticipated waste classification based on operating experience and industry practices in similar PWR plants. The nuclide contamination, i.e., isotopes and activities, for these wastes is consistent with the realistic source term provided in DCD Section 11.2. During some AOOs, such as a refueling condition, the rate of DAW generation is higher than the normal operation. For design purposes, a margin of 40 percent is included in the design of DAW generation and storage. During the peak generation rate, additional waste handling and shipping operation can be planned to support operational needs. Maintenance activities may generate large-size DAW, such as scaffolding and broken equipment. Handling of large-size waste must comply with the radiation protection program established for plant operation.

Wet solid wastes include spent resin, spent charcoal, sludge, and oily waste. Each of these wastes is handled separately as described below in Subsections 3.5.3.1.3, 3.5.3.1.4, and 3.5.3.1.5. DCD Table 11.4-1 provides an estimate of expected annual wet solid wastes based on operating experience and industry practices in similar PWR plants. During some AOOs, such as a refueling condition, the rate of wet solid waste generation is higher than the normal operation. For design purposes, a margin of 40 percent is included in the design of the total generation and storage. During the peak generation rate, additional waste handling and shipping operation can be planned to support operational needs.

3.5.3.1.1 Dry Active Waste

The DAW handling subsystem consists of an on-site storage area equipped with an overhead crane and a truck bay to load packaged waste for off-site transportation and disposal. The DAW is normally separated into three categories: (1) noncontaminated wastes (clean), (2) contaminated metal wastes, and (3) the other wastes, i.e., clothing, plastics, high efficiency particulate air (HEPA) filters, components, etc. Noncontaminated wastes, i.e., clean, are not processed in the SWMS and are handled separately.

DAW consists of contaminated air filters, contaminated equipment and equipment parts, solid laboratory wastes, and general plant waste that cannot be effectively decontaminated. The process control program contains plant-specific actions and procedures to handle and manage these wastes. The radioactivity of much of the DAW is low enough to permit contact handling and temporary storage in unshielded areas. DAW is sorted and packaged in suitably sized containers that meet U.S. Department of Transportation (DOT) requirements for shipment either to an off-site processor or for final disposal. Higher activity DAW is separated from the low-activity waste, handled remotely, and transported in shielded containers.

General DAW consisting of contaminated clothing, broken and small contaminated tools and parts, contaminated maintenance pieces, glass, and other materials is collected at the point of generation, surveyed, and segregated according to contamination types and radioactivity levels before it is transferred to the SWMS for packaging. The DAW handling and storage operation is outlined in DCD Figure 11.4-1.

3.5.3.1.2 Spent Filter Element

The spent filters that are handled by this subsystem mainly come from the LWMS, CVCS, SFPC, SGBD, and the CPS.

The spent filter element handling subsystem consists of a spent filter transfer cask, a hoist, and a laydown area for spent filter handling. To access the spent filter element, the shield plug and the filter-housing flange have to be removed manually before the filter can be accessed remotely. Spent filter elements are handled remotely using a mobile spent filter transfer cask that provides remote changing of filter cartridges, dripless transport to the storage area, transfer of the filter cartridges into and out of filter storage, and loading of filter cartridges into disposal containers. DCD Figure 11.4-1 is a PFD of the spent filter handling subsystem.

3.5.3.1.3 Spent Resin

The spent resin handling and dewatering subsystem consists of two spent resin storage tanks (SRSTs) and a mobile dewatering station (includes modular skids designed to be readily mobile and flexible) consisting of a control console, a fillhead, and a dewatering pump. The SRSTs are located in the basement of the A/B and are individually located in shielded cubicles. The dewatering equipment is in a shielded cubicle at the grade level near the storage area. The SRSTs receive spent resin from various plant sources including the LWMS, CVCS, SFPC, SGBD treatment system, and the CPS ion exchange columns.

The SRSTs provide staging for decay and transfer capability into disposal containers for off-site disposal. There are two SRSTs: one tank for low-level radioactive resin/charcoal such as those from the LWMS, SGBD treatment system, and the condensate polisher (Class A waste), and the other tank for high-level radioactive resin such as those from the CVCS and SFPC (potentially Class B or C waste). The two SRSTs are cross-tied to provide redundancy for operational flexibility. DCD Figure 11.4-2 is a PFD of the spent resin handling subsystem.

Nitrogen gas is used as a motive force to transfer resin from the SRSTs to a high integrity container (HIC) via a fillhead. The fillhead is lifted from the stand to the HIC with a hoist and placed into position by aligning the fillhead and the HIC. The fillhead is designed to be mounted manually on top of the HIC and disengaged automatically when it is lifted after the sluicing. This design keeps the operator's dose ALARA.

Proper controls, including flow elements and level and temperature indicators, and interlocks are provided with the fillhead to control slurry flow so that only the required amount of spent resin is transferred into the HIC. The resin transfer automatically stops when high level or high temperature setpoints are reached in the HIC. The operator also can stop this operation manually when the closed-circuit television (CCTV) camera indicates a high level. The CCTV camera is used in case of level transmitter failure to minimize the potential for an overflow condition. The dewatering pump serves to remove and reduce the standing water in the HIC to less than 0.5 percent by volume to meet the transportation requirements (49 CFR 173, Subpart I).

Normally, no effluent is released from the SWMS. Water removed from the spent resin is transferred via the vacuum pump back to the WHTs for further processing in the LWMS. Plant makeup water is used for spent resin sluicing. The water extracted from the spent resin dewatering operation does not contain any chemical impurities. It is contaminated with resin fines and also some dissolved nuclides due to the liquid-solid equilibrium phenomenon. However, the contamination is bounded by the design basis source term used for the LWMS treatment design. The dewatering area is designed with area drainage collection of decontamination water. In the event that spillage occurs, or that the waste container drops and spills, decontamination water is available to clean the area. The drainage is directed to the WHTs for processing.

3.5.3.1.4 Spent Activated Charcoal

The equipment drains and floor drains processing subsystem of the LWPS contains an activated charcoal filter. This filter is a column holding charcoal media designed to remove organic content, which serves to protect the downstream ion exchange media from fouling.

The spent charcoal handling subsystem shares the use of the spent resin tanks and the dewatering equipment as described above. Mixing waste is not recommended; therefore, the spent activated charcoal from the LWMS normally is sent directly into disposal containers. Dewatering of the spent charcoal uses the same process as for spent resin. If the SRST is empty, the spent charcoal can also be sent to the SRST for temporary storage until further processing is warranted. The PFD of the spent charcoal handling subsystem is presented in DCD Figure 11.4-2.

3.5.3.1.5 Oil and Sludge

In areas where rotating equipment requires the use of oil for lubrication and decontamination for maintenance, the area drainage may contain lubricants and waste solvents. This drainage is collected in the area sump tanks, which are specially designed to provide staging and oil separation by gravity. The separated oils are transferred directly into disposable drums. This waste may contain a low level of radioactive contaminants and is forwarded to an off-site vendor for final treatment and disposal. Operating procedures control all the chemicals that are used in the plant. The sump tank is designed to separate suspended solids. The suspended solids are extracted from the sump tank and transferred into the disposal container as sludge. The PFD of the oily waste and sludge subsystem is presented in DCD Figure 11.4-3.

3.5.3.2 Shipment of Solid Radioactive Waste

The SWMS contains 30-day storage for processed wastes in accordance with the guidance set forth in American National Standards Institute (ANSI)/ANS 55.1. Storage facilities are designed with adequate shielding to minimize the radiation dose to the operators.

The SWMS is designed to use DOT-approved containers for packaging of radioactive wastes. Specific container types are determined by the facility operating procedures. To estimate the number of containers and the number of potential shipments, typical HICs with useful volumes of about 100 cubic feet (cu ft) for Class B or C waste, and 174 cu ft for Class A waste were assumed. However, the design is flexible to allow the use of other DOT-approved containers.

Spent resin, spent charcoal, and spent filter packaging is performed remotely, and the operation is controlled from the radwaste control room or local control console for filter replacement and spent resin dewatering. The filling and dewatering area and the waste staging area are shielded, and ventilation is provided to ensure that airborne activity in this area is controlled and not spreading to other areas. This approach keeps radiation doses ALARA. Waste is classified as A, B, C, or greater than Class C in accordance with 10 CFR 61.55 and 61.56. The expected annual volumes of solid radwaste and its classification to be shipped off-site are estimated in DCD Table 11.4-3. The packaging and shipment of radioactive solid waste for disposal complies with 10 CFR 20, Appendix G, and 49 CFR 173, Subpart I. Waste to be packaged is sampled and analyzed; the radioactivity level of the waste is also monitored during the filling operation to ensure meeting disposal requirements for the licensed land disposal facility. Each container of processed waste is classified as Class A, B, or C waste using a site-specific 10 CFR 61 waste form, in compliance with the site-specific process control program.

Some of the DAW is only slightly contaminated and permits contact handling. The SWMS design does not include compaction equipment but provides the flexibility to add compaction equipment or to adopt contract services from specialized facilities.

Storage for packaged radioactive wastes is provided in a shielded area. The storage area is conveniently located next to the truck bay. An overhead crane is provided to move the waste from the dewatering area to the storage area and to retrieve waste from storage for loading onto trucks for shipment off-site for disposal. It is conservatively estimated that for 30 days of operation, about three containers of Class B waste and 20 containers of Class A waste are expected to be generated. The number of shipments is based on support of plant operations.

Normally, filled waste containers are shipped promptly after they are filled. If shipment cannot be promptly arranged, or if a single shipment is not cost-effective, the waste containers are staged in the shielded waste storage area. Waste containers can be retrieved from the storage area when shipment is arranged. Waste containers are loaded for shipment inside the truck bay area in a controlled environment, minimizing radiation doses.

Operating procedures and administrative controls are implemented to prevent or minimize the use of listed or characteristic chemicals. If mixed waste is generated, it is collected primarily in 55-gal drums and sent off-site to an appropriately permitted vendor processor. When circumstances dictate the storage or disposal of mixed waste, those operations are in accordance with the applicable regulatory requirements and associated permits.

The volume and classification of annual dry solid wastes are shown in DCD Table 11.4-2.

The volume and classification of shipped solid wastes are shown in DCD Table 11.4-3.

At this time there is no disposal facility available for Class B or C radioactive waste from Comanche Peak Nuclear Power Plant Units 3 and 4. However, the Texas Commission on Environmental Quality has issued a draft license for a facility to be located in Andrews County that is expected to open in about December of 2010. Because CPNPP Units 3 and 4 are not expected to begin generating wastes before 2016, it is reasonable to assume that the site will be available by that time. In addition, a common radwaste interim storage facility, located between Units 3 and 4 and designed to store classes A, B, and C wastes generated from all four CPNPP units for up to ten years, will be provided. If only Class B and C wastes were to be stored in that facility, the facility could store the waste for a proportionally longer period of operation. This issue is also discussed in FSAR Section 11.4.2.3, Packaging, Storage, and Shipping.

3.5.4 CONFORMANCE TO REGULATORY GUIDE 1.112, REV 1

This section provides the information identified in Appendix B of the U.S. Nuclear Regulatory Commission (NRC) RG 1.112, Rev. 1, Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors. The information provided in this subsection is for each unit.

a. General

1. The maximum core thermal power evaluated for safety considerations in the SAR is 4451 megawatts thermal (MWt). DCD Section 10.1 contains additional system information.

2. The quantity of tritium released in liquid effluents is 1600 Ci/yr. The quantity of tritium released in gaseous effluents is 180 Ci/yr. DCD Sections 11.2 and 11.3 contain additional system information.

b. Primary System

1. The total mass of coolant in the primary system, excluding the pressurizer and primary coolant purification system, at full power is 646,000 pounds (lb).

2. The average primary system letdown rate to the primary coolant purification system is 180 gallons per minute (gpm.)

3. The average flow rate through the primary coolant purification system cation demineralizers is 7 gpm.

4. The average shim bleed flow is approximately 2 gpm (2875 gallons per day [gpd]). DCD Sections 5.1 and 9.3 contain additional system information.

c. Secondary System

1. The system includes four steam generators.

   Each steam generator is a Model 91-TT-1 and is a vertical inverted U-tube recirculation-type heat exchanger. Steam is produced on the outer surface of the U-tubes, and the steam-water mixture from the tube bundle rises inside of the wrapper and reaches to the upper shell where individual moisture separators remove the entrained water from the steam. The separated water from the moisture separators is mixed with the feedwater to flow down the annulus between the wrapper and shell. The dry steam exits from the steam generator through the outlet nozzle that has a steam flow restrictor.

The type of chemistry used is an all volatile treatment (AVT) method to minimize general corrosion in the feedwater system, steam generators, and main steam piping. A pH adjusting chemical and an oxygen scavenger are injected into the condensate water downstream of the condensate polisher. To reduce the general corrosion and flow-accelerated corrosion (FAC) rate of ferrous alloys, a volatile pH adjustment chemical is injected to maintain a noncorrosive environment. A pH of 9.2 or more provides sufficient iron reduction effect. A combination of hydrazine (or equivalent oxygen scavenger) is added to scavenge the dissolved oxygen and reduce it within the specified limits in the feedwater for each mode of operation.

Secondary side water chemistry guidelines are provided in DCD Table 10.3.5-1.

The maximum moisture carryover (weight percent) is 0.1 percent.

2. The total steam flow in the secondary system is 2.02 E7 pounds per hour (lb/hr).

3. The mass of liquid in each steam generator at full power is 1.35 E5 lb.

4. The primary-to-secondary leakage rate used in the evaluation is 150 gpd (approximately 1250 pounds per day [lb/day]).

5. Description of the SGBD and blowdown purification systems:

The SGBD system P&IDs are shown in DCD Figures 10.4.8-1 and 10.4.8-2.

The SGBD system consists of a flash tank, regenerative heat exchangers, nonregenerative coolers, filters, demineralizers, piping, valves, and instrumentation. The flash tank, regenerative heat exchangers, and nonregenerative coolers are provided to cool the blowdown water with heat recovery, while the filters and demineralizers are provided to purify the blowdown water.

One blowdown line per steam generator is provided. The blowdown from each steam generator flows independently to the flash tank. The blowdown water from the flash tank flows via one common line to regenerative heat exchangers and nonregenerative coolers. Blowdown is split in two trains ahead of the heat exchangers. Common discharge from the coolers flows to the filter demineralizers, where the flow splits into two trains. The purified water from the demineralizers flows to the condenser via a common discharge line.

The blowdown line from each steam generator is provided with two flow paths, one purify and recovery line for normal plant operation, and one line discharging to the wastewater facility or condenser used during startup and abnormal water conditions. The blowdown water is drawn from each steam generator from a location above the tube sheet where impurities are expected to accumulate. The blowdown from each steam generator is depressurized by a throttle valve located downstream of the containment isolation valves. The throttle valves can be manually adjusted to control blowdown rate.

The depressurized blowdown water flows to the flash tank, where water and flashing vapor are separated. The vapor flows to a deaerator, and the water is transferred to regenerative and nonregenerative heat exchangers for further cooling. During startup when the pressure in the flash tank is low, the vapor flows to the condenser. The condensate system provides cooling in the regenerative heat exchanger to capture thermal energy.

Prior to purification, the turbine closed cooling water system cools blowdown water in the nonregenerative heat exchanger. The temperature is reduced to approximately 113°F. The impurities from the cooled blowdown water are removed by flowing through the inlet filters, demineralizers, and outlet filters. SGBD demineralizers consist of two cation demineralizers and two mixed bed demineralizers. The purified water is recovered through the SGBD filters and returned to the condenser.

Regenerative heat exchangers and nonregenerative coolers consist of two 50 percent capacity trains. When blowdown flow rate is less than 0.5 percent maximum steaming rate (MSR), one regenerative heat exchanger and one nonregenerative cooler are in operation while the other regenerative heat exchanger and nonregenerative cooler can remain on standby or isolated for maintenance.

Demineralizers include two 100 percent trains. Each demineralizer train includes a cation demineralizer and mixed bed demineralizer.

During startup and with abnormal water chemistry, blowdown rate is expected to be up to approximately 3 percent of full power MSR. In this mode, blowdown liquid flows directly either to the condenser for processing in the condensate demineralizers or to the wastewater facility for processing before discharging to the environment. When the blowdown is directed to the condenser, condensate demineralizers are used for purification. During normal operation, the blowdown rate is approximately 0.5 to 1 percent of full power MSR. With 1 percent rate or higher, both cooling trains are used.

A blowdown sample line from each steam generator is provided for samples. A sample cooler is located in each of these lines for cooling blowdown liquid to a temperature suitable for analyzers. Cooled liquid flows to secondary water quality analyzers, through a radiation monitor, and sample sink for taking grab samples.

Water quality analyzers measure pH, specific conductivity, cation conductivity, sulfate ion, chloride ion, and sodium ion concentrations. The radiation monitor is continuously utilized for primary-to-secondary SG tube leak detection.

Blowdown system is isolated from the steam generator under normal operating and transient conditions by two isolation valves located in the main steam piping room.

The average SGBD rate used in the evaluation is 155,400 lb/hr.

6. The fraction of the steam generator feedwater processed through the condensate demineralizers is one-third. The CPS is planned to be completely bypassed during normal power operation. If the secondary water quality cannot be met with the maximum flow of the SGBD, an abnormal condition, 33 percent of the maximum condensate flow is planned to be processed through the CPS until normal water chemistry is restored.

   DCD Tables 11.1-4, 11.2-7, and 11.2-9 show DFs used in the evaluation for the condensate demineralizer system.

7. The following information is provided for the condensate demineralizers:

   The average flow rate is 1.24 to 1.88 E6 lb/hr. (DCD Table 10.4.6-1 has design flow rate per vessel of 3750 gpm).

   The demineralizer type is a deep mixed bed demineralizer containing anion and cation resins.

   There are four demineralizer vessels with a size of 230 cu ft per vessel.

   Spent resin is removed from the polishing vessel and replaced with fresh resin. Resin replacement requires the polisher vessel to be taken out of service. Spent resin is transferred hydropneumatically to the spent resin holding vessel until it can be removed off-site for regeneration. In the event of radioactive contamination of the resin in a vessel, temporary shielding is installed if required, and the resin is transferred to the SRST. The replacement frequency of the resin is once every operating cycle.

   The use of ultrasonic resin cleaning is not used on-site as the resin is replaced, and the spent resin is regenerated at an off-site facility.

   DCD Sections 5.1, 5.4, 10.3, 10.4 and 15.1 contain additional system information.

d. Liquid Waste Processing System

   1. For each LWPS, including the shim bleed, SGBD, and detergent waste processing systems, the following information is provided:

      i. The sources, flow rates (gpd) and expected activities (fraction of primary coolant activity for all inputs to each system) are provided in DCD Table 11.2-2.

      ii. The holdup times associated with the collection, processing, and discharge times of all liquid streams are provided in DCD Table 11.2-19.

      iii. The capacities of all tanks (gal) and processing equipment (gpd) considered in calculating the holdup times are provided in DCD Table 11.2-3.

iv. The DFs for each processing step are provided in DCD Table 11.2-7.

v. The fraction of each processing stream expected to be discharged over the life of the plant is provided as follows:

DCD Table 11.2-10 lists the annual average nuclide release concentrations and DCD Table 11.2-12 the fraction of the effluent concentration limits using base GALE code assumptions (DCD 11.2.3). As shown in DCD Table 11.2-12, the overall fraction of the effluent concentration limit is 0.081, which is well below the allowable value of 1.0, 1 percent of the reactor thermal power level.

DCD Table 11.2-11 lists the annual average nuclide release concentrations and DCD Table 11.2-13 lists the fractions of the effluent concentration limits for the maximum defined fuel defects. As shown in Table 11.2-13, the overall fraction of the effluent concentration limit for the maximum defined fuel defect level is 0.309, which is well below the allowable value of 1.0 (based on leakage from maximum defined fuel defects).

vi. For the demineralizers, regeneration is not performed on-site.

vii. The liquid source term by radionuclide for normal operation, including AOOs, is shown in DCD Table 11.2-10.

2. The PFDs for the liquid radwaste systems and for all other systems influencing the source term calculations are shown in Figure 11.2-1, Sheets 1, 2, and 3, of the DCD.

The P&IDs for the liquid radwaste systems are shown in FSAR Section 11.2.

DCD Section 11.2 contain additional system information.

e. Gaseous Waste Processing System

1. The stripping rate from the primary coolant is 631,152 cubic feet per year (cu ft/yr) or 1.2 cubic feet per minute (cfm).

2. A description of the process used to hold up gases stripped from the primary system during normal operations and reactor shutdown are discussed in DCD Subsection 11.3.2 and Subsection 3.5.2.1 above.

A PFD of the system indicating the capacities (cu ft), number, and design and operating storage pressures of the storage tanks is shown in DCD Figure 11.3-2.

3. A description of the normal operation of the system is provided in DCD Subsection 11.3.2 and Subsection 3.5.2.1 above.

The minimum holdup time used in the evaluation and the basis for this value is 45 days.

4. There are no HEPA filters used in this system.

5. A description of the charcoal delay system is provided in DCD Subsection 11.3.2 and Subsection 3.5.2.1 above.

   The minimum holdup time for each radionuclide considered in the evaluation is 45 days for xenon.

   A list of all parameters, including mass of charcoal (lb), flow rate (cu ft/min), operating and dew point temperatures, and dynamic adsorption coefficients for xenon and krypton used in calculating the holdup times is shown in DCD Tables 11.3-1 and 11.3-2, and DCD Figure 11.3-1.

6. The PFDs and the P&IDs for the gaseous radioactive waste systems and other systems influencing the source term calculations are shown in DCD Figure 11.3-1, Sheets 1, 2, and 3.

   DCD Section 11.3 contains additional system information.

f. Ventilation and Exhaust Systems

The information provided below describes the information pertaining to radioactive releases, release rates, DFs, and description of the release points for the SGBD system vent exhaust, the plant vent, and the main condenser air removal system. Also, information is provided below for the containment building pertaining to the building free volume, a description of the internal recirculation system, purge and venting frequencies, and purge rates.

1. SGBD System Vent Exhaust

   The SGBD water from the steam generators exits containment and is directed to the SGBD flash tank located in the turbine building at 25-ft elevation above plant grade. The vent on the blowdown flash tank vents to the condenser. On a high radiation signal, the SGBD lines are isolated. After recovery from this failure, SGBD water is initially directed to the condenser, and after the blowdown water quality becomes stable, SG blowdown demineralizers start purifying the blowdown water.

   There is one blowdown line per steam generator. The blowdown from each steam generator flows independently to the flash tank. Blowdown flow is routed via one common line to regenerative heat exchangers and nonregenerative coolers. Blowdown is split into two trains ahead of the heat exchangers. Common discharge from the coolers flows to the filters and demineralizers, where the flow is split into two trains. The purified water from the demineralizers flows to the condenser via a common discharge line.

The DF for the containment atmosphere is achieved by a containment spray system which is time dependent. Credit for elemental iodine removal is assumed to continue until the DF of 200 is reached in the containment atmosphere.

The release rates for radioiodine, noble gases, and radioactive particulates and their bases are presented in DCD Table 11.3.5.

2. Plant Vent Stack

The plant vent stack is the only GWMS release point for both the gaseous system and the HVAC system.

The GWMS is discussed in Subsection 3.5.2 above.

The provisions incorporated to reduce radioactive releases through the GWMS to the plant vent stack are as follows:

- The charcoal bed adsorbers are used to control and minimize the release of radioactive nuclides into the environment by delaying the release of the radioactive noble gases, including krypton and xenon. The charcoal bed adsorbers contain activated charcoal that has been used extensively to remove radioactive iodine before the gaseous waste is routed to the discharge structure. The charcoal bed adsorbers provide up to 45 days of delay time for these gases at the design flow conditions.
- The plant stack is the only GWMS release point for both the gaseous system and the HVAC systems associated with the R/B, A/B, and access building.

There are no DFs assumed and their bases in the design.

The HVAC system is the A/B area's main ventilation system. It is a single pass type system and consists of main supply and exhaust air systems. The A/B area’s main ventilation system is shown in DCD Figure 9.4.3-1, and system components design data are presented in DCD Tables 9.4.3-1, 9.4.4-1, 9.4.5-1, and 9.4.6-1.

The supply air system encompasses two air handling units, each sized for 50 percent of the total system air flow and consisting of an outside air intake damper, low efficiency prefilter, medium efficiency filter, electric preheating coil, chilled water cooling coil, and supply fan section. The air handling units are connected to a common air distribution ductwork system supplying air to all areas of the A/B.

Exhaust air flows from the served areas are drawn through exhaust air ductwork by three exhaust units, each sized for 50 percent of the total system air flow. Each exhaust unit is equipped with variable inlet vanes, and isolation damper and discharge ductwork leading to the plant vent stack. There are no charcoal adsorber or HEPA filters in this system. During plant normal operation, the two air handling units and two exhaust air filtration units are placed in operation.

The areas supplied by the A/B area’s ventilation system also contain other systems that provide specific cooling and ventilation requirements. These include the radwaste control room HVAC system, the nonsafety electrical, instrumentation and control (I&C) room, battery and plant computer rooms' HVAC systems, main steam and feed water rooms' fan coolers, safety related fan coolers serving the ESF equipment rooms and areas, and the technical support center HVAC system.

Airborne radioactivity is monitored inside the radwaste and fuel handling areas of the building by general area radiation monitors, which measure the radiation level and activate local audio/visual alarms, and provide indication and alarm in the plant control room if the radiation levels exceeded a predetermined value.

Redundant safety related isolation leak tight dampers in series are provided on the branch supply and exhaust ducts penetrating the control room envelope to insure the envelope is isolated from the nonsafety main ventilation system, following the receipt of high radiation or containment isolation actuation signal.

The provisions incorporated to reduce radioactive releases through this exhaust system are radiation monitors inside the radwaste and fuel handling areas of the building, which measure the radiation level and activate local audio/visual alarms, and provide indication and alarm in the plant control room if the radiation levels exceeded a predetermined value.

3. Main Condenser Evacuation System (MCES)

The MCES consists of three vacuum pumps. The vacuum pumps remove noncondensable gases from the three condenser shells during normal operation and are used for condenser hogging during plant startup. The noncondensable gases with a quantity of vapor are drawn from the condenser shell to the suction of the vacuum pumps. Air and nitrogen are mainly included in these noncondensable gases. Therefore, hydrogen buildup is not expected in the MCES.

The noncondensable gases exhausted to the environment from the MCES are not normally radioactive. However, it is possible for them to become contaminated in the event of a primary-to-secondary system leakage.

The provisions incorporated to reduce radioactive releases through this exhaust system include the use of charcoal bed and gas storage tanks to delay and decay the gas before discharge. MCES uses dilution techniques by the plant stack flow to further dilute the gas. Full details are presented in DCD Section 11.3.

4. Plant Stack

The description of this release point is located in DCD Section 11.3.2. The plant stack is located along side of the C/V. The discharge point is above the top of the C/V. Radiation monitors are provided before the discharge valve so that release limits are not exceeded.

The following information is provided in FSAR Chapter 11:

- The height above grade for this release point.
- The location relative to adjacent structures for this vent is above containment (FSAR Figure 11.3-1).
- The expected average temperature difference between this effluent and the ambient air.
- The flow rate through this vent is 1.2 standard cubic feet per minute (scfm).
- The exit velocity at this vent.
- The shape of the flow orifice for this vent.

5. Containment

The containment building free volume is 2.74 E6 cu ft.

The containment ventilation and cooling systems are provided to control and maintain the environment, temperature, and radioactivity concentration within the containment at a level suitable for the plant equipment operation and to allow the safe access to the containment for the operating personnel during inspection and maintenance periods.

Internal to containment is a containment fan cooler system, a reactor cavity and reactor support cooling system, an airborne radioactivity removal system (ARRS), and a control rod drive mechanism cooling system (CRDM). Also serving containment is the annulus emergency exhaust air filtration system and the containment vent and purge system.

The containment fan cooler system consists of four fan coolers, each sized for 33 percent of the total containment heat load. Three units are required to operate while the other unit remains on standby. Each fan cooler consists of cooling coils and an isolation damper. Containment air is drawn over the chilled water cooling coils of the operating containment fan coolers where the heat dissipated in the containment is transferred from the containment air to the chilled water system. This system operates continuously. There are no charcoal or HEPA filters. The containment fan cooler system air flow diagram is shown in DCD Figure 9.4.6-1. Design data for the principal components of the system are presented in DCD Table 9.4.6-1.

The reactor cavity and reactor support cooling system consists of two exhaust air fans, each sized for 100 percent of the required air flow rate; one fan is required for operation, while the other fan is placed in standby. The system air flow diagram is shown in DCD Figure 9.4.6-1. The design data for the principal components are presented in DCD Table 9.4.6-1.

The ARRS consists of two airborne radioactivity removal air-cleaning units, each sized for 100 percent capacity, and a medium-efficiency filter, HEPA filter, charcoal adsorber, and centrifugal fan. Airborne radioactivity removal units are manually started from the control room. The operator is expected to operate the units individually or in combination on a regular schedule to limit buildup of the airborne radioactivity in the containment atmosphere.

The frequency of operation depends on the concentration of particulate activities present in the containment, as measured by the radiation monitors. Air flow of each unit is automatically modulated by respective variable inlet vane dampers at a constant rate to assure a fairly constant residence time of 0.50 seconds, irrespective of the fluctuation of the system resistance through the filter banks. The ARRS air flow diagram is shown in DCD Figure 9.4.6-1. The design data for the principal components of the system are presented in DCD Table 9.4.6-1.

The CRDM cooling system is sized to remove the heat generated and dissipated by the CRDMs and transfer the heat borne by the exhausted air to the chilled water system without imposing additional thermal load on the containment fan cooler system. The system consists of chilled water cooling coils, two motorized dampers, and two centrifugal fans, each driven by an independent motor. Each fan is sized for 100 percent capacity of the required air flow; one fan is required for operation, while the other is placed in standby. Containment air, during normal operation, is drawn through the CRDM shroud, over the CRDM mechanisms through air leak-tight ductwork through the cooling coil then discharged by the fan to the containment atmosphere. The CRDM cooler is supplied with chilled water from the nonessential chilled water system. The CRDM cooler is manually started from the control room with fan intake dampers electrically interlocked with their respective fan motor starters to open when the fans are energized. The CRDM cooling system air flow diagram is shown in DCD Figure 9.4.6-1. The design data for the principal components are presented in DCD Table 9.4.6-1.

The annulus emergency exhaust air filtration system consists of two units of a fan and a filtration unit containing a HEPA and charcoal adsorber filters. Each unit provides 12,000 cfm and discharges to the plant vent. The annulus emergency exhaust air filtration system is shown in DCD Figure 9.4.6-1. The design data for the principal components are presented in DCD Table 9.4.5-1.

The containment vent system consists of one makeup air unit consisting of filter banks, electric heating coil, chilled water cooling coil, and supply air centrifugal fan; the unit is sized for 100 percent capacity. The makeup air unit draws outdoors filtered and treated air and discharges it into containment. The containment vent exhaust air is drawn through a containment penetration isolation valves assembly to an air-cleaning exhaust unit. The vent exhaust air flow passes through HEPA filter banks and charcoal adsorber prior to discharge to the atmosphere through the plant vent stack. The exhausted air from the turbine vacuum pump is routed to the containment vent exhaust air filtration unit for filtration prior to release to the atmosphere through the plant vent stack. The capacity of the containment vent system is sized to maintain, in conjunction with the operation of the ARRS, an acceptable limit of radioactivity, including noble gases, during normal operation of the plant.

The containment purge system consists of a containment purge makeup air unit consisting of filter banks, electric heating coil, chilled water cooling coil, and supply air centrifugal fan; the unit is sized for 100 percent capacity. An atmospheric air-cleaning unit is provided to exhaust the purged air through HEPA filter banks and charcoal adsorber prior to discharge to the plant vent stack.

During containment purge operation, outside air is drawn by a makeup air unit, where the air is filtered, cooled, or heated as required and discharged into the containment through the supply ductwork and the containment penetration protected by three containment isolation valves. Supply air temperature from the makeup unit is tempered or cooled by the unit's electric heating coil or chilled water cooling coil to attain an acceptable supply air temperature between 55°F and 65°F.

The containment purge exhaust air is drawn through the containment penetration protected by three containment isolation valves and exhaust ductwork, leading to the air-cleaning unit where the exhaust air is filtered and discharged to the atmosphere through the plant vent stack. The initiation of the purge operation and the starting of the makeup air unit and air-cleaning unit are manually initiated from the control room.

The containment vent and purge system is shown in DCD Figure 9.4.6-1. The design data for the principal components are presented in DCD Table 9.4.6-1.

3.6 NONRADIOACTIVE WASTE SYSTEMS

This section describes nonradioactive waste streams that are expected at Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4. These streams include nonradioactive effluent treatment facilities that may contain water-treatment chemicals or biocides, water-treatment wastes, floor and equipment drains, stormwater runoff, and laboratory waste. The sanitary effluent systems are described, including the systems operating during plant construction, operation, and disposal of the effluents. This section also describes miscellaneous gaseous, liquid, and solid effluents.

This section is divided into three subsections that evaluate these nonradioactive waste systems as follows:

- Subsection 3.6.1 - Effluents Containing Chemicals or Biocides
- Subsection 3.6.2 - Sanitary System Effluents
- Subsection 3.6.3 - Other Effluents

3.6.1 EFFLUENTS CONTAINING CHEMICALS OR BIOCIDES

This section includes the identification and quantification of each chemical and biocide added to the receiving water by the discharge stream. These chemicals are typically used to control water quality, scale, corrosion, and biological fouling in the various systems.

The chemical concentration within effluent streams from this facility is controlled through engineering and operational/administrative controls in order to meet the Texas Pollutant Discharge Elimination System (TPDES) requirements at the time of construction and operation. The TPDES permit for CPNPP Units 3 and 4 is discussed in Section 1.2.

Table 3.6-1 lists the projected chemicals used in each system, the amount used per year, the frequency of use, and the concentrations in the effluent streams. The waste streams are combined and processed within the wastewater system (WWS) before they are discharged to the environment. Section 3.4 shows the locations of the liquid discharges from the site.

The planned intake and receiving water for the cooling water for CPNPP Units 3 and 4 is Lake Granbury. The average, maximum, and seasonal variations of the principal constituents, including minor or trace materials of the waters at the intake and effluent locations in Lake Granbury, are provided in Subsection 2.3.3. The average and maximum concentrations of the natural materials in the effluent streams are also provided in Subsection 2.3.3. Some process waste is discharged to existing CPNPP Units 1 and 2 waste treatment system, then to the Squaw Creek Reservoir (SCR).

The principal constituents, such as chemicals and trace materials, in the intake water are concentrated up to a minimum of 2.4 times in the circulating water system (CWS) and up to a minimum of 2.4 times in the service water system (SWS).

3.6.1.1 Circulating Water, Service Water, Potable and Sanitary Water, Demineralized Water, and Fire Protection Systems

Each unit has a CWS, essential service water system (ESWS), non-essential service water system (NESWS), potable and sanitary water system (PSWS), demineralized water system (DWS), and fire protection system (FPS). The description of the chemicals injected into these systems and the effect on the effluent discharged to Lake Granbury and SCR is discussed below.

The operation of the CWS is described in Sections 3.3 and 3.4. The operation cycle for this system for normal modes of operation is described in Section 3.4. The chemicals that are needed to maintain proper operation of the system are injected by the chemical treatment system (CTS) during the power operation, startup, hot standby, and safe shutdown modes of operation. The chemicals injected into the CWS, the amount used per year, the frequency of use, and the concentration in the waste stream are shown in Table 3.6-1. A stream of water (blowdown) is removed from each of the CWS and ultimate heat sink (UHS) cooling tower (CT) basins to control the water chemistry. For each plant unit, 24-in carbon steel blowdown piping from the two CWS CT basins is headered into a 42-in prestressed, reinforced concrete piping. The 42-in concrete piping runs approximately 13 mi to the Lake Granbury blowdown discharge outfall where water is dissipated into the lake through diffusers at a rate of 13,050 gallons per minute (gpm) per plant unit. The concentration factor for this evaporative cooling system is provided in Subsection 3.4.1. Prior to discharge to Lake Granbury, approximately 46 percent of the blowdown is routed to a Blowdown Treatment Facility (BDTF). Sump pumps feed raw blowdown to the BDTF. The facility equipment produces a clean permeate stream and a concentrated waste reject stream. The clean permeate is sent to a holding sump and then pumped to blend with the remaining raw blowdown flow to produce a 2500 milligram per liter (mg/l) total dissolved solid (TDS) effluent to Lake Granbury, assuming the inlet TDS concentration is 1680 mg/l. The concentrated reject waste stream is sent to the reject sump and then pumped to the evaporation pond.

The evaporation pond operates at a depth of approximately 2 feet (ft), with 2 ft of freeboard, and is interconnected with a three-month storage pond equipped with pumps to recirculate to water misters for forced evaporation. The evaporation pond is sectionalized to alternate dry portions for salt removal. Waste material generated from the BDTF is planned to be disposed at an off-site non-hazardous landfill.

The operations of the SWS, both ESWS and NESWS, are described in Sections 3.3 and 3.4. The operating cycle for these systems for normal modes of operation is described in Section 3.4. The chemicals that are needed to maintain proper operation of the systems are injected by the CTS during the modes of operation that include power operation, startup, hot standby, safe shutdown, cold shutdown, and refueling. The chemicals injected into the ESWS and NESWS, the amount used per year, the frequency of use, and the concentration in the waste stream are shown in Table 3.6-1. The blowdown effluent, which combines with effluent from CWS, and the backwash strainer effluent are discharged to Lake Granbury through a system of multiport diffusers.

The operation of the PSWS is designed to continuously furnish water for domestic use and human consumption. The operation of this system is not dependent on the modes of operation of the plant. The source of potable water is provided by the Wheeler Branch Municipal Reservoir through the Somervell County Water District. The water supplied by this municipal water system is treated at an off-site location to applicable drinking water quality standards. No further treatment is performed on-site. The water is discharged to the sanitary drainage system (SDS) that carries the water to the treatment plant. Subsection 3.6.2 describes the sanitary system effluents.

The operation of the DWS is described in Sections 3.3 and 3.4. The capacity of the DWS is sufficient to supply the plant makeup demand during startup, shutdown, and power operation. The operation of the DWS is on an as-needed basis. The chemicals that are needed to maintain proper operation of the DWS are injected by the CTS and are not dependent on the modes of operation of the plant. The waste effluent processed from the DWS is discharged into the waste treatment building sump.

The operation of the FPS is described in Section 3.3. The FPS provides water to points throughout the plant where wet system type fire suppression, e.g., sprinkler, deluge, etc., may be required. The FPS also provides the capability to extinguish fires in any plant area, to protect site personnel, limit fire damage, and enhance safe shutdown capabilities. Fire protection water is supplied by the Wheeler Branch Municipal Reservoir. The water supplied by this municipal water system is treated, at an off-site location, to applicable drinking water quality standards. Fire protection makeup water comes from the Intermediate Product Storage Tank. The Intermediate Product Storage Tank contains partially treated raw water from the DWS.

3.6.1.2 Steam Generator Blowdown System

Each unit has a steam generator blowdown system (SGBD). The SGBD assists in maintaining secondary side water chemistry within acceptable limits during normal plant operation and during anticipated operational occurrences (AOO) due to main condenser leakage, or primary-to-secondary steam generator tube leakage. The SGBD removes impurities that are concentrated in the steam generator by continuous blowdown of secondary side water from the steam generators. The system processes blowdown water from all steam generators, as required.

The SGBD consists of a flash tank, regenerative heat exchangers, nonregenerative coolers, filters, demineralizers, piping, valves, and instrumentation. The flash tank, regenerative heat exchangers, and nonregenerative coolers are provided to cool the blowdown water with heat recovery, while the filters and demineralizers are provided to purify the blowdown water. One blowdown line per steam generator is provided. The blowdown from each steam generator flows independently to the flash tank. The blowdown water from the flash tank flows via one common line to regenerative heat exchangers and nonregenerative coolers. Blowdown is split into two trains ahead of the heat exchangers. Common discharge from the coolers flows to the filters and demineralizers, where the flow is split into two trains. The purified water from the demineralizers CTS flows to the condenser via a common discharge line.

The blowdown line from each steam generator is provided with two flow paths, a line for purifying blowdown water used during normal plant operation and a line for discharging the blowdown water to the WWS, or the condenser used during startup and abnormal water conditions. The blowdown water is drawn from a location above the tube sheet of each steam generator where impurities are expected to accumulate. The blowdown from each steam generator is depressurized by a throttle valve located downstream of the isolation valves.

The turbine closed cooling water system (TCS) cools blowdown water in the nonregenerative heat exchanger to protect the demineralizer resin prior to purifying the blowdown water. The impurities from the cooled blowdown water are removed by the inlet filters, demineralizers, and outlet strainers. SGBD demineralizers consist of two cation demineralizers and two mixed bed demineralizers. The purified water is returned to the condenser. A local grab sample point is provided downstream of each demineralizer to measure the impurities' concentration, a radiation monitor is provided downstream of the demineralizers outlet strainers, and a radiation monitor is provided in the sample line to measure the radioactivity level in the blowdown water. In case of steam generator tube leakage, and when abnormally high radiation level is detected, the blowdown lines are isolated, and the blowdown water included in the SGBD is transferred to a waste holdup tank in the liquid waste management system (LWMS).

3.6.1.3 Wastewater

For each unit, the WWS collects and processes wastewater from equipment and floor drains from nonradioactive building areas.

The WWS collects:

- System flushing wastes during startup prior to treatment and discharge.
- Fluid drained from equipment or systems during maintenance or inspection activities, and other process fluids.
- Waste from nonradioactive equipment and floor drains from the turbine building and other nonnuclear island buildings that may contain oily waste, makeup water treatment plant effluents, sampling sinks, and nonrecoverable SGBD.

Wastewater from the proposed project is expected to be piped to the CPNPP Units 1 and 2 wastewater retention ponds for treatment and disposal.

3.6.2 SANITARY SYSTEM EFFLUENTS

This section describes the nature and quantity of the sanitary waste contribution, and the treatment facilities during construction and operation of the plant. The primary purpose of the sanitary wastewater treatment system (SWWTS) is to collect sanitary waste from various plant areas such as restrooms, locker rooms, etc., for processing through the treatment facility, and to produce high-quality effluent that is acceptable for discharge to the environment. The sanitary wastewater facility consists of a SWWTS and a filter press system for sludge dewatering.

The SWWTS is a 100,000-gallon per day (gpd) wastewater treatment plant (WWTP) with a 15-cubic foot (cu ft) filter press system designed to process sanitary waste and sludge dewatering, respectively, generated during construction and normal operations of the proposed project.

The WWTP is comprised of several major components such as an equalization tank, aeration chamber, clarifier, sludge digester tank and post ultraviolet (UV) disinfection treatment, feed and transfer pumps, and air blowers. Sanitary wastewater collected in the sanitary lift stations from construction and operating buildings of the proposed project is lifted by grinder pumps to the equalization chamber where the wastewater is stored with a retention time then pumped forward. The sanitary wastewater is airlifted by two duplex equalization pumps to the aeration chamber that uses the extended aeration technique of using a blower for biological oxygen demand (BOD) reduction. The effluent from the aeration chamber then flows to the clarifier for solids removal. The clarifier effluent is passed through the UV disinfection system via a booster pump, to disinfect water and oxidize chemicals in process streams. The effluent is discharged to SCR directly, without dilution from any other source. The treated effluent meets the following permit discharge limit requirements:

- pH – 6 – 9.
- TSS – 20 parts per million (ppm) monthly average, 45 ppm daily maximum.
- BOD – 20 ppm monthly average, 45 ppm daily maximum.
- Coliform Count – 200 per 100 ml monthly average, 400 daily maximum.

No nutrients or pH adjustment chemical are needed for the treatment of sanitary wastewater. After the UV disinfection, there is no need to add any chemical to the effluent to SCR.

The chemical concentration within effluent streams from this facility is controlled through engineering and operational/administrative controls in order to meet the TPDES requirements at the time of construction and operation. The TPDES permit for CPNPP Units 3 and 4 is discussed in Section 1.2.

A portion of the settled sludge of the clarifier is returned to the aeration chamber via two airlift pumps. Any excess sludge from the clarifier bottom would be lifted by an airlift pump to the sludge digester tank for further reduction. The digester tank is expected to be an aerated chamber type. Digested sludge from the holding tank is airlifted to the sludge conditioning tank of the filter press system for sludge dewatering. Future connections are expected to be established to transfer the excess sludge via a sludge discharge pump to the existing CPNPP Units 1 and 2 sludge holdup tank, which collects the sludge of the existing CPNPP Units 1 and 2. This sludge would then be pumped via the sludge forwarding pump into the sludge conditioning tank of the filter press system.

The 15-cu ft filter press system for sludge dewatering consists of a filter press, filter press feed pump, lime feed tank and feed pump, sludge conditioning tank, ferric chloride drum and feed pump, and cake carts. Sanitary sludge from the sludge digester tank is transferred to the sludge conditioning tank. Lime and ferric chloride is added to the sludge conditioning tank. These two admixture chemicals tend to improve the sludge dewatering flow rate through the filter press and the filter cake characteristic. The sludge from the conditioning tank is fed to the filter press by the filter press feed pump. The dry sludge is discharged and collected on a mobile cake cart below the filter press, which is then transferred to a dumpster for disposal to a Class 1 landfill.

The sanitary drainage system collects sanitary waste from various plant areas such as restrooms, locker rooms, etc., and carries the wastewater for processing to the treatment facility. The sanitary drainage system does not serve any facilities in the radiologically-controlled areas.

Preconstruction and construction activities of the plant include portable toilets supplied and serviced by an off-site contracted vendor that may be used to accommodate approximately 1000 construction personnel. These portable toilets are used until the sanitary system is functional.

The existing sanitary wastewater treatment plant (SWTP) data indicate that the sanitary wastewater generation is approximately 50 gallons (gal) per person per 24-hr shift. Based on this and the numbers of construction and plant personnel forecasted during the construction phase of CPNPP Units 3 and 4, a maximum of 100,000 gpd of new sanitary wastewater is expected to be generated by the construction personnel. This is in addition to 25,000 – 50,000 gpd of sanitary wastewater generated from CPNPP Units 1 and 2. Therefore, during the construction of CPNPP Units 3 and 4, approximately 125,000 – 150,000 gpd of sanitary wastewater is anticipated to be produced for the entire site. Thus the operation of both the existing SWTP and the new WWTP is expected to be required during construction because the upper design treatment limit of the existing SWTP is 90,000 – 100,000 gpd.

3.6.3 OTHER EFFLUENTS

This section includes the identification and quantification of other miscellaneous nonradioactive gaseous, liquid, and solid effluents that are discharged to the environment.

3.6.3.1 Gaseous Effluents

Each unit contains four Class 1E gas turbine generators (GTG), two non-Class 1E GTGs as alternate alternating current (AC) power sources, two auxiliary boilers, and one diesel-driven fire pumps. During normal operation of the plant, the operation of this equipment is used infrequently and is typically limited to periodic testing. There is no treatment of the gaseous emissions from the GTGs or diesel driven fire pump. The equipment will meet applicable U.S. Environmental Protection Agency (EPA) emission standards for new equipment.

Six on-site GTG units, each furnished with its own support subsystems, provide power to the selected plant AC loads. The GTG units are housed in the emergency power supply building. Each engine's exhaust gas circuit consists of the engine exhaust gas discharge pipes from the turbocharger outlets to a single vertically mounted outdoor silencer that discharges to the atmosphere at an approximate elevation of 855 ft.

The primary fuel storage for each GTG and its associated transfer pumps is located in the yard area and is below grade within a substantial concrete vault confinement. Potential fuel leaks or spills from the storage tanks are confined within the compartment surrounding the tanks. Each GTG day tank located within its GTG room is provided with a spill confinement enclosure capable of holding 110 percent of the day tank capacity.

The auxiliary boilers provide auxiliary steam during plant startup and shutdown. The auxiliary steam boilers are oil-fired package boilers with storage tanks capable of storing 300,000 gal of oil and day tanks storing 12,000 gal. The auxiliary boiler and associated equipment are located outside in the yard. The steam converter and associated equipment are located in the turbine building and the common equipment is located in the auxiliary building. The exhaust for the auxiliary boiler and the vent(s) for the auxiliary boiler oil storage tank have not been located at this time. However, these will be configured and located in accordance with all applicable state and federal regulations.

Two 100 percent capacity fire pumps are provided. Each pump is rated for 2500 gpm. The lead pump is electric motor driven, and the second pump is diesel engine driven. The exhaust for the diesel-driven pump and the vent(s) for the diesel-driven fire pump oil storage tank have not been located at this time. However, these will be configured and located in accordance with all applicable state and federal regulations. The fuel tank for the diesel-driven pump holds enough fuel to operate the pump for at least 2 hours.

Table 3.6-2 shows the annual emissions (lb/yr) from the gas turbine generators. Table 3.6-3 shows the annual hydrocarbon emissions (lb/yr) from the diesel fuel oil storage tanks for the diesel generators. Table 3.6-4 shows the annual emissions (lb/yr) from the diesel-driven fire pump. Table 3.6-5 shows the annual hydrocarbon emissions (lb/yr) from the diesel fuel oil storage tank for the diesel fire pump. Table 3.6-6 shows the annual emissions (lb/yr) from the auxiliary boilers, and Table 3.6-7 shows the annual hydrocarbon emissions (lb/yr) from the diesel fuel oil storage and day tanks for the auxiliary boilers.

The applicable regulations, permits, and consultation required by federal, state, regional, local, and potentially affected American Indian tribal agencies are addressed, and the results are presented in Section 1.2.

Applicable procedures, by which effluents to the atmosphere are treated, controlled, and discharged to meet the applicable emissions standards, are completed prior to startup of the applicable plant system. FSAR Section 13.5 provides guidance on development of these procedures.

3.6.3.2 Stormwater

FSAR Subsection 2.4.2 discusses floods, including the probable maximum precipitation (PMP) event and the flood design consideration for the site. Stormwater runoff is divided into two categories: "clean" and potentially "contaminated." Clean runoff is directed to SCR. Potentially contaminated stormwater is runoff that may have come into contact with contaminants such as oil, sediments, and chemicals. Potentially contaminated water is to be directed to the appropriate waste stream prior to discharge. Stormwater and roof drains for the CPNPP Units 3 and 4 nuclear island and power block will be routed to common retention/sedimentation basins located northeast of CPNPP Unit 3 and northwest of CPNPP Unit 4. Stormwater to surface water discharges associated with land disturbance, construction, and industrial operation is in accordance with the Stormwater permit.

3.6.3.3 Other Wastes

The reactor building (RB) nonradioactive drain sump collects all nonradioactive equipment and floor drainage by gravity. The sump pumps normally discharge to the turbine building (TB) sump. The TB drain sump collects drains from all equipment and floor drainage in the TB and nonradioactive drain sump. This sump normally discharges to the WWS for treatment. However, if this drainage should be contaminated, the discharge is automatically diverted to the LWMS. A radiation monitor located in the TB sump alarms in the main control room (MCR) when a predetermined contamination level is reached. Upon receipt of the radiation signal, the discharge valve is automatically closed, and the wastewater of the sump is pumped to the LWMS for treatment. The oily waste system collects liquid waste that enters floor drains located in areas that are normally not sources of potentially radioactive waste and where the possibility for oil spillage, especially from equipment, exists. The LWMS conveys the waste to the sump via an oil separator that separates the oil in the sumps prior to processing. The separated oil is collected for off-site disposal.

Nonradioactive solid wastes include typical industrial wastes such as metal, wood, and paper, as well as process wastes such as nonradioactive resins, filters, and sludge. These nonradioactive wastes are disposed in a permitted off-site landfill as discussed in Section 1.2. The proposed project is classified as a small quantity generator of hazardous waste. Any waste is disposed of off-site by contract at a licensed permitted facility. CPNPP Units 3 and 4 are expected to produce similar amounts of waste per year as CPNPP Units 1 and 2. Annual waste production for CPNPP Units 1 and 2 for the year 2007 is presented in Table 3.6-8. On a periodic basis, the BDTF evaporation ponds are drained for salt and solid removal. Waste material such as salts and solids are planned to be disposed at an off-site non-hazardous landfill.

There are no other hazardous wastes stored on-site. There are no other hazardous wastes discharged from the site. Applicable procedures for off-site disposal of wastes are completed prior to construction.

Applicable procedures, by which all effluents are treated, controlled, and discharged to meet state and EPA effluent limitation guidelines, are completed prior to construction or turnover of applicable plant system as FSAR Section 13.5 provides guidance on development of procedures.

TABLE 3.6-1
CHEMICALS ADDED TO LIQUID EFFLUENT STREAMS FROM TWO UNITS

System	Chemical-Type/specific	Amount Used per Year	Frequency of Use	Concentrations in Waste Stream
ESW	Biocide/sodium hypochlorite NaOCl (10-12 wt. %)	12,000 gal/year/unit	Continuous	<0.2 ppm residual or free chlorine
ESW	pH/LSI/adjustment/sulfuric acid H_2SO_4 (93 wt. %)	12,000 gal/year/unit	Continuous	<2.2 ppm H_2SO_4
ESW	Corrosion inhibitor/antiscalant proprietary ortho-polyphosphate and phosphonate	1200 gal/year/unit	Continuous	PO_4 or proprietary agent to permit limit
CWS[a]	Biocide/sodium hypochlorite NaOCl (10-12 wt. %)	120,000 gal/year/unit	Continuous	<0.2 ppm residual or free chlorine
CWS[a]	pH/LSI/adjustment/sulfuric acid H_2SO_4 (93 wt. %)	120,000 gal/year/unit	Continuous	<2.2 ppm H_2SO_4
CWS[a]	Corrosion inhibitor/antiscalant proprietary ortho-polyphosphate and phosphonate	12,000 gal/year/unit	Continuous	PO_4 or proprietary agent to permit limit
CWS[a]	De-chlorination of Blow Down/sodium bisulfite $NaHSO_3$ (10 wt. %)	1200 gal/year/unit	Intermittent	Sufficient to reduce residual chlorine to <0.2 ppm

---

a) The CWS supplies water to the CWS and the NESWS as described in Section 3.4.

TABLE 3.6-2
EMISSION RATES FROM EMERGENCY AND NON-EMERGENCY STATION BLACKOUT GAS TURBINE GENERATORS

Fuel Consumption (per GTG)	gallons/hr	541.6
% Sulfur in Fuel	%	0.05

Pollutant	Emission Factor[(a)(b)]	Normal Operation			Abnormal Operation
		Emission Rate (per GTG)			Emission Rate (per GTG)
	(lb/MMBtu)	(lb/hr)	(lb/24-hr)	(lb/2-yrs[(c)])	(lb/7-days)
NO_x (Uncontrolled)	8.80E-01	66.25	1589.96	3179.93	11129.75
NO_x (Water-Steam Injection)	2.40E-01	18.07	433.63	867.25	3035.39
CO (Uncontrolled)	3.30E-03	0.25	5.96	11.92	41.74
CO (Water-Steam Injection)	7.60E-02	5.72	137.32	274.63	961.21
SO_2[(d)]	0.0505	3.80	91.24	182.48	638.70
Filterable Particulate Matter[(e)]	4.30E-03	0.32	7.77	15.54	54.38
Condensable Particulate Matter[(e)]	7.20E-03	0.54	13.01	26.02	91.06
Total Particulate Matter[(e)]	1.20E-02	0.90	21.68	43.36	151.77
Total Hydrocarbons[(e)]	4.00E-03	0.30	7.23	14.45	50.59

---

a) Emission factors obtained from AP 42, Fifth Edition, Volume I, Chapter 3: Stationary Internal Combustion Sources, Section 3.1: Stationary Gas Turbines; U.S. EPA.

b) Based on average distillate oil heating value of 139 MMBtu/10^3 gallons. To convert from (lb/MMBtu) to (lb/10^3 gallons), multiply by 139.

c) Value based on operation 1 hour per month and one additional 24-hour period every 24 months.

d) Emission Factor = 1.01S, where S=percent sulfur in fuel. Example if sulfur content in the fuel is 3.4 percent, then S=3.4. All sulfur in the fuel is assumed to be converted to SO_2.

e) Emission factor is based on combustion turbines using water-steam injection, which is not expected to have a large effect on particulate matter emissions. Particulate matter data for uncontrolled gas turbines were not available.

TABLE 3.6-3
ANNUAL HYDROCARBON EMISSIONS (LB/YR) FROM DIESEL FUEL OIL STORAGE TANKS FOR TWO UNITS

Pollutant Discharged	One Fuel Oil Storage Tank (lb/yr)	Four Fuel Oil Storage Tanks (lb/yr)
Hydrocarbons	108.33	433.2

Based on total fuel throughput of 4,744,530 gallons per year per tank.

TABLE 3.6-4
EMISSION RATES FROM DIESEL DRIVEN FIRE PUMP

Pollutant Discharged	Emissions
	One Diesel Driven Fire Pumps (lb/yr)
Non-methane hydrocarbons and NO_x	87.6
CO	16.08
Total Particulate Matter	3.6

Based on a projected yearly operation of 12 hr per pump similar to that of CPNPP Units 1 and 2.

TABLE 3.6-5
EMISSION RATES FROM DIESEL DRIVEN FIRE PUMP FUEL OIL STORAGE TANK

Pollutant Discharged	Fire Pump Fuel Oil Storage Tank (lb/yr)
Hydrocarbons	0.29

Based on total fuel throughput of 500 gallons per year per tank.

TABLE 3.6-6
EMISSION RATES FROM AUXILIARY BOILERS

Pollutant Discharged	Emissions
	Two Auxiliary Boilers (lb/yr)
CO_2	1,555,895
H_2O	1,664,131
N_2	9,957,727
O_2	338,238
SO_2	0.0

Based on three start ups per cycle with a maximum boiler running time of 24 hours per start up, for a total boiler running time of 72 hours per year.

TABLE 3.6-7
EMISSION RATES FROM AUXILIARY BOILER FUEL OIL STORAGE TANK

Pollutant Discharged	Auxiliary Boiler Fuel Oil Storage Tank[(a)] (lb/yr)	Auxiliary Boiler Fuel Oil Day Tank[(b)] (lb/yr)
Hydrocarbons	66.71	8.13

---

a) Based on total fuel throughput of 300,000 gallons per year per tank

b) Based on total fuel throughput of 12,000 gallons per year per tank

TABLE 3.6-8
ANNUAL RECYCLE SHIPMENTS TO SYSTEMS OPERATION SERVICE FACILITY (S.O.S.F.) FOR 2007 (IN POUNDS)

	Lube Oil	Metal Drums	Plastic Drums	Batteries	Light Bulbs	Spent Diesel	Aerosol Cans	Oil Filters	Pop Cans	Capacitors	Metal	Paper	Wood Rolloffs	Cardboard Rolloffs
Annual Total	38,000	4,960	4,060	21,150	300	5,600	2,400	4,000	150	600	1,702,200	126,180	398,940	17,040

3.7 POWER TRANSMISSION SYSTEM

Regulated power transmission and distribution operations are handled through Oncor Electric Delivery Company (Oncor Electric Delivery). Oncor Electric Delivery is a regulated electric distribution and transmission business that provides reliable electricity delivery to consumers. Oncor Electric Delivery is responsible for operating, maintaining, building, dispatching, and marketing the electric transmission system from the generator bus bars through the distribution substations. Oncor Electric Delivery has an additional responsibility to provide a transmission system that supplies off-site power for startup and normal shutdown of nuclear reactors through the transmission switchyards. Oncor Electric Delivery is the transmission service provider (TSP) for Comanche Peak Nuclear Power Plant (CPNPP).

Oncor Electric Delivery is a member of the Electric Reliability Council of Texas (ERCOT). The ERCOT, which comprises members engaged in generation, transmission, distribution and marketing of electric energy in the state of Texas, is an independent not-for-profit corporation that is one of eight electric reliability regions in North America operating under the reliability and safety standards set by the North American Electric Reliability Council (NERC). The ERCOT is the independent system operator (ISO) that oversees all generation and transmission functions for its reliability region, which includes about 85 percent of the electrical load in Texas. The ERCOT region has an overall generating capacity of approximately 78,000 MW. The ERCOT, under the jurisdictional authority of the Public Utility Commission of Texas (PUC), is responsible, in part, for ensuring the adequacy and reliability of electricity across the state's main interconnected power grid. The ERCOT is not under the jurisdiction of the Federal Energy Regulatory Commission (FERC). Additional discussion of the grid structure and responsible parties is found in FSAR Section 8.2.

3.7.1 TRANSMISSION SYSTEM

Luminant plans to construct two new generating units, CPNPP Units 3 and 4, at the CPNPP site. The two existing units, CPNPP Units 1 and 2, are expected to remain in service when the new generating units reach commercial operation. (Oncor 2008)

FSAR Section 8.1 describes the interconnections between the plant on-site power system and a new Oncor Electric Delivery Plant Switching Station, less than one mile away, which will be constructed prior to fuel loading. The unit interface with the Oncor-controlled electrical systems is at the connection to the 345 kV overhead transmission tie line in the unit switchyards. FSAR Section 8.1 identifies the applicable electric power system design criteria and guidelines for CPNPP Units 3 and 4.

CPNPP Units 3 and 4 will have a dedicated switchyard, independent of CPNPP Units 1 and 2. The design for CPNPP Units 3 and 4 includes four unit switchyards, four transmission tie lines between the unit switchyards and the Plant Switching Station, and four transmission lines between the Plant Switching Station and remote substations. The interconnections with the Plant Switching Station are described further in FSAR Section 8.2.

Oncor Electric Delivery, as the TSP for CPNPP, owns and operates the transmission lines between the new switchyard and the Plant Switching Station. Luminant connects at a delivery voltage of 345 kV.

3.7.2 TRANSMISSION LINE CORRIDORS (RIGHTS-OF-WAY)

As indicated in Subsection 4.1.3.2.2, Oncor Electric Delivery selects the transmission and distribution line corridors, constructs the lines, and owns and operates the lines from the CPNPP site to various new and existing end users. As discussed in FSAR Section 8.2, the new Plant Switching Station will be constructed prior to fuel loading and will have four outgoing transmission circuits to remote switching stations. The rights-of-way (ROWs) for the below-listed transmission lines will be established and all four lines will be constructed prior to fuel loading. These ROWs will commence at the CPNPP property and continue toward the switching stations. The widths of the ROWs will be adequate for the planned transmission lines. Any existing ROWs will be utilized without compromising design bases criteria.

The new transmission circuits are listed below. (All lengths are estimated.) (Oncor 2008)

- A new 45-mile circuit within a new ROW (hereafter referred to as Whitney) utilizing Oncor Electric Delivery's Standard 345 kV double circuit lattice steel tower structure family between the Plant Switching Station and the Whitney 345 kV Switching Station. The exact routing of this new line will be determined during a transmission routing study.

- A new 22.4-mile circuit (hereafter referred to as Johnson) utilizing a vacant circuit position on an existing 345 kV double circuit lattice steel tower structure line between Plant Switching Station and the Johnson Switch 345 kV Switching Station.

- A new 17-mile circuit within a new ROW (hereafter referred to as DeCordova) utilizing Oncor Electric Delivery's Standard 345 kV double circuit lattice steel tower structure family between the Plant Switching Station and the DeCordova 345 kV Switching Station. The exact routing of this new line will be determined during a transmission routing study.

- A new 41.6-mile circuit (hereafter referred to as Parker) utilizing a vacant circuit position on an existing 345 kV double circuit lattice steel tower structure line between Plant Switching Station and the Parker 345 kV Switching Station.

In addition to the transmission lines listed above, a new 22.4-mile circuit (hereafter referred to as Johnson-Everman) will be constructed, utilizing a vacant circuit position on an existing 345 kV double circuit lattice steel tower structure line between Johnson Switch 345 kV Switching Station and the Everman 345/138 kV Switching Station. (Oncor 2008)

CPNPP Units 3 and 4 will be connected to the new Plant Switching Station, with four independent 345 kV transmission tie lines, two for CPNPP Unit 3 and two for CPNPP Unit 4, as listed below. (All lengths are estimated.) (Oncor 2008)

- A new 0.55-mile circuit on a new ROW provided by Luminant (hereafter referred to as Unit #4 Main Transformer (MT)) between the Plant Switching Station and the CPNPP Unit #4 MT Switchyard.

- A new 0.66-mile circuit on a new ROW provided by Luminant (hereafter referred to as Unit #4 RAT) between the Plant Switching Station and the CPNPP Unit #4 Reserve Auxiliary Transformer (RAT) Switchyard.

- A new 0.3-mile circuit on a new ROW provided by Luminant (hereafter referred to as Unit #3 MT) between the Plant Switching Station and the CPNPP Unit #3 MT Switchyard.
- A new 0.42-mile circuit on a new ROW provided by Luminant (hereafter referred to as Unit #3 RAT) between the Plant Switching Station and the CPNPP Unit #3 RAT Switchyard.

The existing 345-kV and 138-kV transmission line ROWs and proposed 345-kV transmission line ROWs also are described in Subsection 2.2.2. The existing CPNPP 345-kV transmission ROWs are shown in Figure 3.7-1, as originally depicted in Section 3.9 of the CPNPP Units 1 and 2 Environmental Report (CPSES 1974). The proposed 345-kV transmission ROWs for CPNPP Units 3 and 4 are shown in Figure 1.1-5 and Figure 3.7-4.

Oncor Electric Delivery's typical ROW width is 160 feet, with the centerline typically in the center of the ROW. (Oncor 2008) Some ROWs are wider to accommodate additional facilities. (CPSES 1974) Actual ROW widths and areas will not be known until the final ROWs are determined. The design parameters of the proposed transmission lines are discussed in Subsection 3.7.3.

3.7.3 TRANSMISSION SYSTEM DESIGN PARAMETERS

3.7.3.1 Basic Electrical Design Parameters

Luminant plans to construct and operate two Mitsubishi Heavy Industries (MHI) U.S. Advanced Pressurized Water Reactor (US-APWR) units for CPNPP Units 3 and 4. The CPNPP Units 3 and 4 site has a rated output of approximately 3200 MWe (1600 MWe for each unit), less site loads. The off-site power system is designed and constructed with sufficient capacity and capability to assure that specified acceptable fuel design limits and conditions are not exceeded as a result of anticipated operational occurrences.

A 2515 American wire gauge (AWG) aluminum-clad steel reinforced (ACSR) 76/19 stranding conductor with horizontal phase spacing of 35 ft to 49.5 ft is required for 345-kV lines. The minimum ground clearance for maximum sag condition is 45 ft. The maximum operating temperatures of the line are 100°C (212°F) Normal and 120°C (248°F) Emergency. The span is based on loading. The tangent tower is designed for a 1200-ft wind span and a 1400-ft weight span at a 0-degree angle. Wind span is determined by the wind loading on half of the span leading into a tower plus the wind loading on half of the span leading away from a tower. Weight span is determined by the total weight loading of wire measured between the low points of the spans entering and leaving the tower. Typical spans are expected to be in the 1000-ft to 1100-ft range. The lines are designed to meet or exceed the requirements of the National Electrical Safety Code (NESC) and the American National Standards Institute (ANSI). The 345-kV line is designed to keep the electric field at the conductor surface significantly below corona inception.

The final phasing of the 345 kV lines will be determined at a later date. The required phasing is expected to be accommodated easily, given the vertical conductor configuration of the lines. It is assumed that the phasing of the CPNPP Units 3 and 4 lines will match the phasing of CPNPP Units 1 and 2.

A fiber optic shield wire will be installed on each of the four 345 kV lines between CPNPP Units 3 and 4 Switching Station and the CPNPP Units 3 and 4 switchyard. These fibers will be used for relay protection and for sending generator information to Oncor Electric Delivery.

New transmission lines are routed in accordance with the PUC's "policy of prudent avoidance" whereby Oncor Electric Delivery is tasked with reasonably avoiding population centers and other locations where people gather in order to limit exposure to electromagnetic fields (EMFs). As indicated in Subsection 5.6.3.2, EMFs diminish rapidly with distance. Readings on the strength of EMFs directly under existing 230-kV and 525-kV lines typically range from 15 - 25 milliGauss (mG). At 75 ft from the ROW fence, these levels decrease to a range of 3 - 7 mG.

The basic electrical design parameters for the new transmission circuits listed in Subsection 3.7.2 are given below. (Oncor 2008) The thermal ratings are as shown in FSAR Section 8.2.

- The Whitney circuit will be constructed utilizing Oncor Electric Delivery's Standard 345 kV double circuit lattice steel tower structure family. The new circuit will have a thermal rating of 1631 MVA and will be constructed with 2-1590 kcmil, 54/19 strand, ACSR conductors per phase, utilizing one circuit position of the double circuit tower structures. Oncor Electric Delivery's transmission lines may come near, or cross, and require modifications to Oncor Electric Delivery's or others' transmission line(s), distribution line(s), or other overhead or underground facilities. The scope of any crossings of, or modifications to, Oncor Electric Delivery's or others' facilities has not been determined at this time.

- The Johnson circuit will have a thermal rating of 1631 MVA and will be constructed utilizing 2-1590 kcmil, 54/19 strand, ACSR conductors per phase.

- The DeCordova circuit will be constructed utilizing Oncor Electric Delivery's Standard 345 kV double circuit lattice steel tower structure family. The new circuit will have a thermal rating of 1969 MVA and will be constructed with 2-1926.9 kcmil, type 13, ACSS/TW conductors per phase, utilizing one circuit position of the double circuit tower structures. Oncor Electric Delivery's transmission lines may come near, or cross, and require modifications to Oncor Electric Delivery's or others' transmission lines, distribution lines, or other overhead or underground facilities. The scope of any crossings of, or modifications to, Oncor Electric Delivery's or others' facilities has not been determined at this time.

- The Parker circuit will have a thermal rating of 1631 MVA and will be constructed utilizing 2-1590 kcmil, 54/19 strand, ACSR conductors per phase.

- The Johnson-Everman circuit will be constructed utilizing 2-1590 kcmil, 54/19 strand, ACSR conductors per phase.

- The Unit #4 MPT circuit, which is an alternate Preferred Power Supply (PPS), will be constructed utilizing a combination of a vacant circuit position on the existing 345 kV double circuit lattice steel tower structure line between CPNPP Units 1 and 2 Switching Station and the Parker 345 kV Switching Station and Oncor Electric Delivery's Standard 345 kV single circuit structure family. The new circuit will be constructed utilizing 2-1926.9 kcmil, Type 13, ACSS/TW conductors per phase. This line will be designed such that any single catastrophic failure will not interrupt the other three 345 kV PPS circuits to CPNPP Units 3 and 4.

- The Unit #4 RAT circuit, which is a normal PPS, is to be constructed utilizing Oncor Electric Delivery's Standard 345 kV single circuit structure family. The new circuit will be constructed utilizing 2-795 kcmil, 26/7 strand, ACSR conductors per phase. This line will be designed such that any single catastrophic failure will not interrupt the other three 345 kV PPS circuits to CPNPP Units 3 and 4.

- The Unit #3 MPT circuit, which is an alternate PPS, will be constructed utilizing Oncor Electric Delivery's Standard 345 kV single circuit tubular steel pole structure family. The new circuit will be constructed utilizing 2-1926.9 kcmil, Type 13, ACSS/TW conductors per phase. This line will be designed such that any single catastrophic failure will not interrupt the other three 345 kV PPS circuits to CPNPP Units 3 and 4.

- The Unit #3 RAT circuit, which is a normal PPS, will be constructed utilizing Oncor Electric Delivery's Standard 345 kV single circuit structure family. The new circuit will be constructed utilizing 2-795 kcmil, 26/7 strand, ACSR conductors per phase. This line will be designed such that any single catastrophic failure will not interrupt the other three 345 kV PPS circuits to CPNPP Units 3 and 4.

The design of the off-site power system is discussed in FSAR Section 8.2.

3.7.3.2 Basic Structural Design Parameters

The CPNPP Units 3 and 4 Switching Station will have two 25' X 65' control buildings. Each building will house a single large set of batteries and battery charger in its own battery room separate from the relay panel room, plus other equipment. One building will house DC Source #1 and the other will house DC Source #2. (Oncor 2008)

The transmission line structures are self-supporting steel towers. This self-supporting design eliminates the need for guy wires, while ensuring the adequacy of lines to withstand wind and icing conditions in excess of those expected in this area. The transmission line structures are designed to withstand standard loading conditions for the specific site. Each structure design is required to ensure that the unit stress in any part of the structure will not be greater than the minimum yield strength of the material for any of the design loading conditions, with the appropriate factor of safety applied to design loads (Oncor 730-001). Figure 3.7-2 depicts standard transmission tower configurations.

Oncor Electric Delivery’s transmission engineering standards require that all material and workmanship conform in all respects to the latest revisions of the applicable specifications of the American Society for Testing and Materials (ASTM). Structural steel is required to conform to ASTM A-36 or A-36 Modified. High strength structural steel is required to conform to ASTM A-36 Modified (50 ksi yield) or A-572 (50 ksi yield). Structural steel for welding is required to conform to ASTM A-373. Rolled steel plates, shapes, sheet piling, and bars for structural use are required to conform to ASTM A-6. Castings are required to be malleable and to conform to ASTM A-47, Grade 35018. (Oncor 730-001)

Zinc coatings (hot-dipped) on iron and steel hardware are required to conform to ASTM A-153. Zinc coatings on products fabricated from rolled, pressed and forged steel shapes, plates, bars, and strip are required to conform to ASTM A-123. The uniformity of coating on zinc-coated (galvanized) iron or steel articles, using the Preece Test (copper sulfate dip), is required to conform to ASTM A-239. The recommended practice for safeguarding against embrittlement of hot galvanized structural steel products and procedures for detecting embrittlement are required to conform to ASTM A-1243. (Oncor 730-001)

3.7.4 PREDICTED NOISE LEVELS FROM TRANSMISSION SYSTEM OPERATION

As discussed in the Oncor Electric Delivery standard addressing transmission line noise (Oncor TLD&RM), noise impacts associated with 345 kV transmission systems may be attributed to corona discharge, radio and television interference (RTI), and audible noise. Corona discharge is a luminous discharge caused by the ionization of the air surrounding a conductor due to the existing surface voltage gradient (electric field intensity) exceeding a certain critical level. Insulators and line hardware energized to the same potential as the conductor will produce a similar corona discharge. Corona discharge will appear as visible light and can cause an audible hiss or crackling sound as well.

Corona discharge, due to its pulsating nature, also may cause RTI. Because it is not economically feasible to build overhead transmission lines with conductors so large that no corona generation occurs under any weather conditions, each line must be considered a potential source of RTI. The transmission line interference level cannot be used alone to determine whether or not the interference is acceptable. The strength of the received signal as well as the ambient interference level must also be considered. A transmission line which seems to have a high level of interference in a suburban area with low ambient interference might be considered very quiet in an area of high ambient interference such as an industrial area. Therefore, a relative measure, the signal-to-noise ratio (SNR), is used rather than using the absolute value of field strength as the criterion for rating the interference levels. The SNR is the ratio of the signal strength to the interference field strength, both being measured with the same SNR instrument at the same location.

Typical transmission systems contribute very little audible noise when compared to more common environmental sources such as vehicles, aircraft, and industrial plants. However, with increasing transmission system voltages, audible noise produced by corona on transmission line conductors has emerged as an issue. At lower operating voltages, noise levels are sufficiently low to be of little concern. Audible noise from transmission lines primarily occurs during foul weather. In dry conditions, the conductors usually operate below the corona inception level and few corona sources are present. In wet conditions, however, water drops striking or collecting on the conductors may produce corona discharge, causing audible noise.

Chapter 10 of the EPRI AC Transmission Line Reference Book (EPRI “Red Book”) discusses the causes and methods to address transmission line noise in more detail.

Section 5.6 provides an analysis of the environmental impacts associated with transmission system use during the operational stage of the project. Transmission line noise is discussed further in Subsection 2.5.5 and Section 5.8.

3.7.5 GENERAL METHODS OF CONSTRUCTION

The transmission system addition for CPNPP Units 3 and 4 is being developed as required by ERCOT and the PUC. The ERCOT and the PUC follow regulatory standards to determine the legal and regulatory process necessary to construct the additions to the existing transmission system. All organizations that operate, access, or perform work within the CPNPP site 345-kV, 138-kV switchyard, or on the 25-kV CPNPP site support power system are to follow the guidelines of CPSES Station Administration Manual Procedure No. STA-629. (CPSES 2007)

Figure 3.7-3 depicts standard transmission tower foundations.

Installation of wires (i.e., “stringing”) is performed using the Tension Method, as described in IEEE Standard 524 (IEEE 524). Proposed span lengths are expected to be in the range of 1000 to 1100 feet.

Clearing of transmission corridors is performed in accordance with an Oncor Electric Delivery transmission engineering standard for construction (Oncor 720-003). This standard specifies that the construction of access roads shall be minimized and that necessary access roads shall be constructed in a manner which prevents damage or erosion to the ROW and/or adjacent property. In addition, the standard requires that use of existing cleared areas shall be maximized for both work areas and construction access requirements.

Subsection 4.1.3.2.2 describes the impact of construction on historic properties within the proposed transmission corridors. The environmental impacts associated with the construction of the facility are discussed and evaluated in Subsections 4.1.2, 5.1.2, and 5.6.3. Subsection 2.5.3 describes the surveys of archeological, historic and cultural sites conducted in connection with transmission facility siting. The engineering surveys for the transmission facilities for the CPNPP site are completed with field reconnaissance of the routes made by qualified archaeologists. In addition to the engineering field surveys, inventories of structures in the vicinity of the transmission lines are evaluated and sent to the state of Texas Historical Commission. Oncor Electric Delivery has been in contact with the Texas Historical Commission about needs and requirements for the protection of cultural resources, including historical and prehistoric resources, places eligible for inclusion on the National Register of Historic Places, Native American and minority population concerns and archeological inventory requirements as specified by state and federal guidelines.

3.7.6 REFERENCES

(CPSES 2007) CPSES Station Administration Manual, Procedure No. STA-629. January 1, 2007.

(Oncor 2008) Facilities Study Report for the Addition of Luminant Generation Company, LLC 3280 MW Generation Facility at Oncor Electric Delivery Company LLC CPNPP Units 3 and 4 Switching Station in Somervell County, Texas, June 13, 2008 and Draft Attachment "A" to Facilities Study Report Generation Interconnection Request - 15INR0002 Luminant Generation Company LLC - Somervell County, June 13, 2008.

(CPSES 1974) Comanche Peak Steam Electric Station Environmental Report, Volume II.

(Oncor TLD&RM) Oncor Transmission Engineering Standard TLD&RM, May 14, 2007.

(Oncor 720-003) Oncor Transmission Engineering Standard 720-003, Construction Spec for T-Line ROW Clearing, August 7, 2007.

(Oncor 730-001) Oncor Transmission Engineering Standard, Lattice Steel Transmission Structures, May 2, 2007.

(EPRI “Red Book”) EPRI AC Transmission Line Reference Book - 200 kV and Above, Third Edition.

(IEEE 524) IEEE Standard 524 - 2003 - IEEE Guide to the Installation of Overhead Transmission Line Conductors (Revision of IEEE Std 524 - 1992).

3.8 TRANSPORTATION OF RADIOACTIVE MATERIALS

This section addresses transportation of radioactive materials from the Comanche Peak Nuclear Power Plant (CPNPP) site and the alternative site locations. Postulated accidents due to transportation of radioactive materials are discussed in Section 7.4.

3.8.1 TRANSPORTATION ASSESSMENT

The NRC in §51.52 determined that the environmental impact of transportation of fuel and waste to and from a light-water cooled nuclear power reactor was small based on the conditions presented in §51.52(a). As stated in §51.52:

> “Under § 51.50, every environmental report prepared for the construction permit stage or early site permit stage or combined license stage of a light-water-cooled nuclear power reactor, and submitted after February 4, 1975, shall contain a statement concerning transportation of fuel and radioactive wastes to and from the reactor. That statement shall indicate that the reactor and this transportation either meet all of the conditions in paragraph (a) of this section or all of the conditions of paragraph (b) of this section.”

The NRC technical evaluation which supports this regulation is given in WASH-1238 (AEC 1972) and NUREG-75/038. These evaluations found the environmental impacts of fuel and waste transport to be SMALL. These NRC analyses provided the basis for Table S-4 in 10 Code of Federal Regulations (CFR) 51.52, which summarizes the environmental impacts of transportation of fuel and radioactive wastes to and from a reference reactor. The table addresses both normal conditions of transport and accidents in transport.

The fuel characteristics for the US-APWR were normalized to a reference reactor-year (RRY) to provide a comparison of the environmental impacts of transporting US-APWR fuel to and from the CPNPP site with the environmental impacts listed in Table S-4. The reference reactor, as presented in WASH-1238, is an 1100 MWe reactor that has an 80 percent capacity factor, for an electrical output of 880 MWe per year. The US-APWR reactor is rated at 1600 MWe, with an assumed annual capacity factor of 93 percent.

Subparagraphs 10 CFR 51.52(a)(1) through (5) delineate specific conditions the reactor licensee must meet to use Table S-4 as part of its environmental report. For reactors not meeting all of the conditions in paragraph (a) of 10 CFR 51.52, paragraph (b) of 10 CFR 51.52 requires a further analysis of the transportation effects.

The conditions in paragraph (a) of 10 CFR 51.52 establishing the applicability of Table S-4 are reactor core thermal power, fuel form, fuel enrichment, fuel encapsulation, average fuel irradiation, time after discharge of irradiated fuel before shipment, mode of transport for unirradiated fuel, mode of transport for irradiated fuel, radioactive waste form and packaging, and mode of transport for radioactive waste other than irradiated fuel.

The following sections describe the characteristics of the US-APWR relative to the conditions of 10 CFR 51.52(a). Information for the US-APWR fuel is taken from the US-APWR Design Control Document.

3.8.1.1 Reactor Core Thermal Power

Subparagraph 10 CFR 51.52(a)(1) requires that the reactor have a core thermal power level not exceeding 3800 MW. The US-APWR rated core thermal power is 4451 MWt which exceeds the requirements of 10 CFR 51.52(a)(1).

The core power level was established as a condition in paragraph 51.52(a)(1) because higher power levels typically indicated the need for more fuel and therefore more fuel shipments than were evaluated in the basis for Table S-4. This is not the case for the new LWR designs due to the higher unit capacity and higher burnup for these reactors. The annual fuel reloading for the reference reactor analyzed in WASH-1238 was 30 metric tons of uranium (MTU) while the average annual fuel loading for the US-APWR is approximately 35 MTU. When normalized to equivalent electric output, the annual fuel requirement for the US-APWR is approximately 21 MTU or less than two-thirds that of the reference LWR. Although the rated core thermal power level of the US-APWR exceeds the criteria of §10 CFR 51.52(a)(1), the number of annual fuel shipments is less resulting in a lower environmental impact.

3.8.1.2 Fuel Form

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel be in the form of sintered UO2 pellets. As presented in the DCD, the US-APWR has a sintered UO2 pellet fuel form.

3.8.1.3 Fuel Enrichment

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel have a uranium-235 enrichment not exceeding 4 percent by weight. The maximum fuel enrichment for the US-APWR is less than five percent by weight and the equilibrium cycle fuel enrichment is 4.55 percent by weight. The US-APWR fuel enrichment exceeds the 4 percent U-235 condition in §10 CFR 51.52(a)(2).

3.8.1.4 Fuel Encapsulation

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel pellets be encapsulated in zircaloy rods. The acceptance criteria for emergency core cooling systems for light-water nuclear power reactors given in 10 CFR 50.46 addresses uranium oxide pellets within cylindrical zircaloy or ZIRLO cladding as being equivalent. According to the DCD, the US-APWR uses ZIRLO clad fuel rods and, therefore, meets the intent of §10 CFR 51.52(a)(2).

3.8.1.5 Average Fuel Burnup

Subparagraph 10 CFR 51.52(a)(3) requires that the average burnup not exceed 33,000 megawatt-days per MTU. The US-APWR fuel rod burnup exceeds 33,000 megawatt-days per ton specified in 10 CFR 51.52 but is bounded by 62,000 megawatt days per ton as considered by the NRC in NUREG-1437 (Addendum 1, page 30). Therefore, the US-APWR does not meet this evaluation condition. Section 3.2 of the CPNPP Environmental Report lists an average discharged burnup of 46,200 MWd/MTU and the maximum burnup as 54,200 MWd/MTU for a reference equilibrium core. This section uses a burnup of 62,000 MWd/MTU to generate a bounding decay heat load and source term.

3.8.1.6 Time after Discharge of Irradiated Fuel before Shipment

Subparagraph 10 CFR 51.52(a)(3) requires that no irradiated fuel assembly be shipped until at least 90 days after it is discharged from the reactor. WASH-1238 assumed 150 days of decay time prior to shipment of any irradiated fuel assemblies. NUREG/CR-6703, which updated the analysis in WASH-1238, considered burnups of up to 75,000 megawatt-days per MTU assuming a minimum of five years decay between removal from the reactor and shipment.

For the US-APWR, five years is the minimum decay time expected before shipment of irradiated fuel assemblies. This agrees with the five year minimum cooling time specified in 10 CFR 961.11, Appendix E, of the standard U.S. Department of Energy (DOE) contract for spent fuel disposal with existing reactors. In addition, NUREG-1437 specifies five years as the minimum cooling period for certificates of compliance for casks used for shipment of power reactor fuel.

The US-APWR design provides a spent fuel pool capable of storing 900 fuel assemblies corresponding to 10 years of operation plus one full core offload (7/2 cores). This design provides more than enough capacity for the assumed 5 years of spent fuel storage.

3.8.1.7 Transportation of Unirradiated Fuel

Subparagraph 10 CFR 51.52(a)(5) requires that unirradiated fuel be shipped to the reactor site by truck. New fuel shipments for CPNPP (or the alternative sites being considered) will be by truck.

Table S-4 includes a condition that the truck shipments not exceed 73,000 pounds as governed by federal or state gross vehicle weight restrictions. The fuel shipments to CPNPP or the alternative sites will comply with federal or state weight restrictions.

3.8.1.8 Radioactive Waste Form and Packaging

Paragraph 10 CFR 51.52(a)(4) requires that, with the exception of spent fuel, radioactive waste shipped from the reactor is to be packaged and in a solid form. As reported in the DCD, radioactive waste will be solidified and packaged.

Dry active waste is placed in an appropriate transport container and then surveyed to ensure it meets all applicable DOT criteria. This waste may be shipped to an off-site facility for volume reduction and ultimate shipment to an approved disposal site or shipped directly to the approved disposal site.

3.8.1.9 Transportation of Irradiated Fuel

Subparagraph 10 CFR 51.52(a)(5) allows for truck, rail, or barge transport of irradiated fuel. Irradiated fuel shipments from CPNPP (or the alternate sites) will comply with this requirement. However, for the impact analysis described in Subsection 3.8.2, it is assumed that all spent fuel shipments will be made using legal weight trucks. DOE is responsible for spent fuel transportation from reactor sites to the repository and will make the decision on transport mode (10 CFR 961.1).

3.8.1.10 Transportation of Radioactive Waste

Subparagraph 10 CFR 51.52(a)(5) requires that the mode of transport of low-level radioactive waste be either truck or rail. Shipment of radioactive waste from the CPNPP (or the alternative sites) will comply with this requirement.

Radioactive waste shipments are subject to a weight limitation of 73,000 pounds per truck and 100 tons per cask per rail car. Radioactive waste will be shipped in compliance with federal or state weight restrictions.

3.8.1.11 Decay Heat

The decay heat load of one spent fuel assembly is 1970 watts. Therefore, the total decay heat of one spent fuel container (four assemblies) is 7880 watts (26,888 BTU/hr). This is less than the value of 250,000 BTU/hr given in Table S-4 of 10 CFR 51.52.

3.8.1.12 Number of Truck Shipments

As a method of limiting the environmental impact of transportation, Table S-4 limits traffic density to less than one truck shipment per day or three rail cars per month. The number of truck shipments that will be required has been estimated assuming that all radioactive materials (fuel and waste) are received at the site or transported offsite via truck.

Table 3.8-1 summarizes the number of truck shipments of unirradiated fuel. The table also normalizes the number of shipments to the electrical output for the reference reactor analyzed in WASH-1238. When normalized for electrical output, the number of truck shipments of unirradiated fuel for the US-APWR is less than the number of truck shipments estimated for the reference LWR.

The numbers of spent fuel shipments were estimated as follows. For the reference LWR analyzed in WASH-1238, it was assumed that 60 shipments per year will be made, each carrying 0.5 MTU of spent fuel. This amount is equivalent to the annual refueling requirement of 30 MTU per year for the reference LWR.

For this transportation analysis, the shipment rate for the US-APWR was equal to the annual refueling requirement. The equilibrium cycle core reload is 128 assemblies and the shipping cask was assumed to hold 12 assemblies resulting in 5.3 shipments per year. After normalizing for electrical output, and adding in the initial core loading of 257 assemblies, the average number of new fuel shipments is 3.4 per year over the 40 year lifetime of the plant.[((257/12+64/12*39)/1.69)/40] The normalized spent fuel shipments will be less than the reference reactor that was the basis for Table S-4.

The solid waste management system (SWMS) provided to collect, package, and ship solid waste is described in Section 11.4 of the US-APWR DCD. This system prepares all solid waste for transport to offsite storage facilities. The SWMS is designed to use DOT-approved containers for the packaging of radioactive wastes. These containers include drums, high-integrity containers, B-25 boxes, and other containers that are DOT-approved and accepted by waste disposal facilities. The packaging and shipment of radioactive solid waste for disposal complies with

10 CFR 20 Appendix G and 49 CFR 173 Subpart I. 10 CFR 51.52 states that all radwaste must be shipped in solid form. As stated in chapter 11 of the US-APWR DCD, any “wet” waste will have absorbing material added to it so that the form will be solid. Truck shipments of radwaste are evaluated with a capacity of approximately 82.6 cubic feet per shipment for consistency with NUREG-1817. Table 3.8-2 presents estimates of annual waste volumes and numbers of truck shipments. The values are normalized to the reference LWR analyzed in WASH-1238. The normalized annual waste volumes and waste shipments for the US-APWR exceed the annual volume and number of shipments for the reference reactor that was the basis for Table S-4.

Shipment of spent fuel is based on 128 spent fuel assemblies per equilibrium cycle core and assumes four assemblies per shipment. This gives 16 shipments of irradiated fuel per year. The total numbers of truck shipments of fuel and radioactive waste to and from the reactor are therefore estimated at approximately 250 per year. These radioactive material transportation estimates are below the one truck shipment per day condition given in 10 CFR 51.52, Table S-4.

3.8.1.13 Summary

Table 3.8-3 summarizes the reference conditions in paragraph (a) of 10 CFR 51.52 for use of Table S-4, and the values for the US-APWR. The US-APWR does not meet the conditions for power level, average fuel enrichment, or average fuel burnup. Therefore, Subsection 3.8.2 and Section 7.4 present additional analyses of fuel transportation effects for normal conditions and accidents, respectively. Transportation of radioactive wastes meets the applicable conditions in 10 CFR 51.52 and no further analysis is required.

3.8.2 INCIDENT-FREE TRANSPORTATION IMPACTS ANALYSIS

Environment impacts of incident-free transportation of fuel are discussed in this section. Transportation accidents are discussed in Section 7.4.

3.8.2.1 Transportation of Unirradiated Fuel

Table S-4 of 10 CFR 51.52 includes conditions related to radiological doses to transport workers and members of the public along transport routes. These doses, based on calculations in WASH-1238, are a function of the radiation dose rate emitted from the unirradiated fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time of transit (including travel and stop times), and the number of shipments to which the individuals are exposed.

Calculation of worker and public doses associated with annual shipments of unirradiated fuel were performed using the RADTRAN 5 computer code (Sand 2007). One of the key assumptions in WASH-1238 for the reference LWR unirradiated fuel shipments is that the radiation dose rate at 1 meter from the transport vehicle is about 0.1 millirem/hr. This assumption is reasonable for the US-APWR because the fuel materials will be low-dose rate uranium radionuclides and will be packaged similarly. For unirradiated fuel shipments, highway routes were analyzed using the routing computer code TRAGIS Version 4.6.2 (Johnson 2003) and 2000 census data.

Routes were estimated by minimizing, as much as possible considering materials being transported, the total impedance of a route, which is a function of distance and driving time between the origin and destination. The TRAGIS computer code also can estimate routes that maximize the use of interstate highways. For unirradiated fuel the commercial route setting was used to generate highway routes generally used by commercial trucks. However, the routes chosen may not be the actual routes used in the future. The population summary module of the TRAGIS computer code was used to determine the exposed populations within 800 m (i.e., 0.5 mi, either side) of the route.

Unirradiated fuel was assumed to be shipped from a port on the western seaboard to the site (or alternate sites), because the new fuel is assumed to be shipped from Japan. The ports used for this analysis included those proximate to the cities of San Francisco, Los Angeles, and San Diego. These ports provide three of the closest coastal nodes along the West Coast, but allow for slightly longer, more populous, and more conservative route characteristics than would be expected along the Gulf of Mexico. Because the source of the fuel has not yet been identified, this conservatism was considered appropriate. The highway mode and commercial routing option were used for this calculation.

The route commencing at the port at San Diego was determined to be the most efficient and least populous route to CPNPP Units 3 and 4. As such, this route was chosen as the best route for transportation of new fuel. In addition to the proposed CPNPP site, three alternate sites were evaluated. These sites and starting locations are provided in Table 3.8-4. Summary data produced by the TRAGIS computer code are provided in Table 3.8-5 for unirradiated and irradiated fuel.

Other input parameters used in the radiation dose analysis for the US-APWR unirradiated fuel shipments are summarized in Table 3.8-5. The results for the unirradiated fuel shipment based on the RADTRAN 5 analyses are provided in Table 3.8-6.

These unit dose values were used to estimate the impacts of transporting unirradiated fuel to the CPNPP and alternative sites. Based on the parameters used in the analysis, these per-shipment doses are expected to conservatively estimate the impacts for fuel shipments. The per trip dose values were combined with the average annual number of shipments of unirradiated fuel to calculate annual doses to the public and workers for comparison to Table S-4 dose values.

The numbers of unirradiated fuel shipments were normalized to the reference reactor analyzed in WASH-1238. The numbers of shipments per year were obtained from Table 3.8-1. The results are presented in Table 3.8-7. As shown, the calculated radiation doses for transporting unirradiated fuel to the CPNPP and alternative sites are bounded by Table S-4 dose values.

3.8.2.2 Transportation of Spent Fuel

This section provides the environmental impacts of transporting spent fuel from CPNPP (or alternative sites) to a spent fuel disposal facility using Yucca Mountain, Nevada as a possible location for a geologic repository. The impacts of the transportation of spent fuel to a possible repository in Nevada provides a reasonable bounding estimate of the transportation impacts to a monitored retrievable storage facility because of the distances involved and the representative exposure of members of the public in urban, suburban, and rural areas (NUREG-1811, NUREG-1815, NUREG-1817).

Incident-free transportation refers to transportation activities in which the shipments reach their destination without releasing any radioactive cargo to the environment. Impacts from these shipments will be from the low levels of radiation that penetrate the heavily shielded spent fuel shipping cask. Radiation doses will occur to (1) persons residing along the transportation corridors between CPNPP (or alternative sites) and the proposed repository; (2) persons in vehicles passing a spent fuel shipment; (3) persons at vehicle stops for refueling, rest, and vehicle inspections; and (4) transportation crew workers. The radiation doses are a function of many parameters, including vehicle speed, traffic count, dose rate at 1 m from the vehicle, packaging dimensions, number in the truck crew, stop time, and population density at stops.

This analysis is based on shipment of spent fuel by legal-weight trucks in casks with characteristics similar to casks currently available (i.e., massive, heavily shielded, cylindrical metal pressure vessels). Each shipment is assumed to consist of a single shipping cask loaded on a modified trailer. These assumptions are consistent with assumptions made in evaluating environmental impacts of spent fuel transportation in Addendum 1 to NUREG-1437. As discussed in NUREG-1437, these assumptions are conservative because the alternative assumptions involve rail transportation or heavy-haul trucks, which will reduce the overall number of spent fuel shipments.

The transportation route selected for a shipment determines the total potentially exposed population and the expected frequency of transportation-related accidents. For truck transportation, the route characteristics most important to the risk assessment include the total shipping distance between each origin-destination pair of sites and the population density along the route.

Routing and population data used in RADTRAN 5 for truck shipments were obtained from the TRAGIS computer code routing module (Johnson 2003). The population data in the TRAGIS computer code were based on the 2000 census. These population densities were scaled to the year 2050 by use of a multiplication factor of 1.49 (projected 2050 U.S. population divided by the 2000 U.S. population). All spent fuel shipments will be transported by legal weight trucks to the potential Yucca Mountain site over designated highway route-controlled quantity (HRCQ) routes. In addition, the six alternate Nevada routes provided in the TRAGIS computer code were evaluated.

Representative shipment routes for CPNPP (or alternative sites) were identified using the TRAGIS computer code routing model (Johnson 2003) for the truck shipments. The Highway data network in the TRAGIS computer code is a computerized road atlas that includes a complete description of the interstate highway system and of all U.S. highways. This transportation route information is summarized in Table 3.8-8.

Although shipping casks have not been designed for the advanced LWR fuels, the advanced LWR fuel designs will not be significantly different from existing LWR designs. Current shipping cask designs were used for analysis.

Other input parameters used in the radiation dose analysis for the US-APWR spent nuclear fuel shipments are summarized in Table 3.8-9. The results for the incident free spent fuel shipments are presented in Table 3.8-10.

The numbers of spent fuel shipments for the transportation impacts analysis were based on 128 assemblies per 24 month refueling cycle and 4 assemblies per shipment. The normalized annual shipments values and corresponding population dose estimates per reactor-year are presented in Table 3.8-11. The population doses were calculated by multiplying the number of spent fuel shipments per year by the per-shipment doses. For comparison to Table S-4, the population doses were normalized to the reference LWR analyzed in WASH-1238.

As shown in Table 3.8-11, population doses to the onlookers for the US-APWR exceed Table S-4 values. One of the key reasons for these higher population doses relative to Table S-4 is the shipping distances assumed for these analyses relative to the assumptions used in WASH-1238. The analyses in WASH-1238 used a "typical" distance for a spent fuel shipment of 1609 km (1000 mi). The shipping distances used in this assessment were between 2568 km (1596 mi) and 3095 km (1923 mi) as presented in Table 3.8-8.

Use of the newer shipping cask designs will reduce the number of spent fuel shipments and decrease the associated environmental impacts because the dose rates used in the impacts analysis are fixed at the regulatory limit rather than actual dose rates based on the cask design and contents. If the population doses were adjusted for the longer shipping distance and larger shipping cask capacity, the population doses from incident-free spent fuel transportation from the CPNPP and the alternative sites should fall within Table S-4 requirements.

Other conservative assumptions in the spent fuel transportation impacts calculation include:

- The shipping casks assumed in the Yucca Mountain EIS transportation analyses were designed for spent fuel that has cooled for 5 years (DOE 2002). In reality, most spent fuel will have cooled for much longer than 5 years before it is shipped to a possible geologic repository. The NRC developed a probabilistic distribution of dose rates based on fuel cooling times that indicates that approximately three-fourths of the spent fuel to be transported to a possible geologic repository will have dose rates less than half of the regulatory limit (NUREG/CR-6672). Consequently, the estimated doses in Table 3.8-11 could be divided in half if more realistic dose rate projections are used for spent fuel shipments from the CPNPP and the alternative sites.

- Use of 30 minutes as the average time at a truck stop in the calculations is conservative. Many stops made for actual spent fuel shipments are short duration stops (i.e., 10 minutes or less) for brief visual inspections of the cargo (checking the cask tie-downs). These stops typically occur in minimally populated areas, such as under an overpass or on a freeway ramp in an unpopulated area. Based on data for actual truck stops, the NRC concluded that the assumption of a 30 minute stop for every 4 hours of driving time used to evaluate other potential ESP sites will overestimate public doses at stops by at least a factor of two (NUREG-1811, NUREG-1815, NUREG-1817). This analysis used 0.0014 hours per km as the stop time, which is conservative.

Consequently, the doses to onlookers given in Table 3.8-11 could be reduced by a factor of at least two to reflect more realistic truck shipping conditions.

The impact of accident free transportation of unirradiated and spent fuel will be SMALL and does not warrant additional mitigation.

3.8.3 REFERENCES

(AEC 1972) U.S. Atomic Energy Commission. "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants." WASH-1238, December 1972.

(Johnson 2003) Transportation Routing Analysis Geographic Information System (TRAGIS) User's Manual, Johnson and Michelhaugh, June 2003

(Sand 2007) RadCat 2.3 User Guide, SAND2006-6315, December 2007, Ruth F. Weiner, Douglas M. Osborn, Daniel Hinojosa, Terence J. Heames, Janelle Penisten, and David Orcutt.

(DOE 2002) U.S. Department of Energy, Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada, DOE/EIS-0250, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, Washington, D.C., February, 2002.

TABLE 3.8-1
NUMBER OF TRUCK SHIPMENTS OF UNIRRADIATED FUEL (PER UNIT)

Reactor Type	Number of Shipments/Unit			Unit Electric Generation MWe	Capacity Factor	Normalized Shipments Total(a)	Normalized Shipments Annual(b)
	Initial Core(c)	Annual reload	Total(d)				
Reference LWR	18(e)	6.0	252	1100	0.8	252	6.3
US-APWR	22(f)	5.3(f)	230	1600(g)	0.93(h)	136(i)	3.4(i)

---

a) Normalized to electric output for WASH-1238 reference plant (i.e., 1100 MWe) plant at 80 percent factor (or a net electrical output of 880 MWe).

b) Annual average for 40-year plant lifetime.

c) Shipments of the initial core have been rounded up to the next highest whole number.

d) Total shipments of fresh fuel over 40-year plant lifetime (i.e., initial core load plus 39 years of average annual reload quantities).

e) The initial core load for the reference PWR in WASH-1238 was 100 MTU resulting in 18 truck shipments of fresh fuel per reactor.

f) Initial core load is 257 assemblies, with 12 assemblies per shipment assumed. Reload for an equilibrium cycle core is 128 assemblies every two years.

g) Unit generating capacities from the US-APWR DCD.

h) Capacity factor was assumed.

i) Normalization factor is (1600*0.93)/(1100*0.80)=1.69

TABLE 3.8-2
NUMBER OF RADIOACTIVE WASTE SHIPMENTS (PER UNIT) ANNUAL ESTIMATED SOLID WASTE INVENTORY

Waste Type	Shipped Volume (ft^3)	Waste Classification
Low Activity Spent Resin	250	A
High Activity Spent Resin	290	B
High Activity Spent Filter	17	B
Low Activity Spent Filter	35	A
Spent Carbon	14	A
Sludge	42	A
High Activity Dry Active Waste	1430	B
Low Activity Dry Active Waste	13,200	A

Reactor Type	Waste Volume, ft^3/yr, per unit	Electrical Output, MWe, per site	Capacity Factor	Normalized Waste Volume Rate, ft^3/ reactor-year[(a)]	Normalized Shipments/ reactor-year[(b)]
Reference LWR	3800	1100	0.80	3800	46
US-APWR	15,278	1600	0.93	9035	109.4

---

a) Annual waste generation rates normalized to equivalent electrical output of 880 MWe for reference LWR (1100-MWe plant with an 80 percent capacity factor) analyzed in WASH-1238.

b) The number of shipments was calculated assuming the average waste shipment capacity of 82.6 ft^3 per shipment. The number of waste shipments, before normalization, is equal to 15,278 cuft/yr / 82.6 cuft/shipment = 185 shipments/yr.

TABLE 3.8-3 (Sheet 1 of 2)
US-APWR COMPARISONS TO TABLE S-4 REFERENCE CONDITIONS

Characteristic	Table S-4 Condition	US-APWR[(a)] Single Unit 1600 MWe
Reactor Power Level (MWt)	Not exceeding 3800 per reactor	4451
Fuel Form	Sintered UO_2 pellets	Sintered UO_2 pellets
U235 Enrichment (%)	Not exceeding 4	<5%[(d)]
Fuel Rod Cladding	Zircaloy rods	ZIRLO
Average burnup (MWd/MTU)	Not exceeding 33,000	(e)
Unirradiated Fuel		
Transport Mode	Truck	Truck
No. of shipments for initial core loading		22
No. of reload shipments per year		5.3
Irradiated Fuel		
Transport mode	Truck, rail or barge	Truck, rail
Decay time prior to shipment	Not less than 90 days is a condition for use of Table S-4	5 years
No. of spent fuel shipments by truck		16 per year
No. of spent fuel shipments by rail		Not analyzed
Radioactive Waste		
Transport mode	Truck or rail	Truck
Waste form	Solid	Solid
Packaged	Yes	Yes
No. of waste shipments by truck		185[(b)] per year
Heat Decay (per irradiated fuel cask in transit)	250,000BTU/hr	26,888 BTU/hr
Traffic Density		
Trucks per day[(b)]	Less than 1	<1

TABLE 3.8-3 (Sheet 2 of 2)
US-APWR COMPARISONS TO TABLE S-4 REFERENCE CONDITIONS

Characteristic	Table S-4 Condition	US-APWR[(a)] Single Unit 1600 MWe
(normalized total)		(122 per year)[(f)]
Rail cars per month	Less than 3	Not analyzed

---

a) US-APWR DCD.

b) Total truck shipments per year calculated after normalization of estimated fuel and waste shipments for equivalent electrical output to the reference reactor analyzed in WASH-1238.

d) The maximum fuel enrichment is less than five percent by weight and the equilibrium cycle fuel enrichment is 4.55 percent by weight.

e) The US-APWR fuel rod burnup exceeds 33,000 MWd/t specified in 10 CFR 51.52. Average burnup of 46,000 MWd/MTU for discharged fuel from a reference equilibrium cycle core.

f) Normalized total shipments are based on: 109 waste shipments (Table 3.8-2) + 3.4 new fuel shipments (Table 3.8-1) + 9.5 spent fuel shipments (Table 3.8-11)=122 shipments/yr.

TABLE 3.8-4
PRIMARY AND ALTERNATIVE SITES FOR CPNPP UNITS 3 AND 4

Site	Location	TRAGIS Origin Location
CPNPP Units 3 and 4	Glen Rose, TX	Glen Rose, TX
Alternate Site A	Victoria, TX	Victoria, TX
Alternate Site B	Lufkin, TX	Jasper, TX
Alternate Site C	Waco, TX	Waco, TX

TABLE 3.8-5 (Sheet 1 of 3)
RADTRAN 5 INPUT PARAMETERS FOR ANALYSIS OF UNIRRADIATED FUEL SHIPMENTS

Parameter	Parameter Value	Comments and Reference
Package		
Package dimension	5.2 meters	NUREG/CR-6672
Dose rate at 1 meter from vehicle	0.1 mrem/hr	(AEC 1972)
Fraction of emitted radiation that is gamma	1.0	Assumed the same as for spent nuclear fuel
Crew		
Number of crew	2	(AEC 1972), and (DOE 2002)
Distance from source to crew	2.0 meters	(Sand 2007)
Crew shielding factor	1.0	No shielding - Analytical assumption
Route-specific parameters		
Rural Suburban Urban	55 mph	Conservative in-transit speed of 55 mph assumed (predominately interstate highways used).
Number of people per vehicle sharing route	2.0	The bureau of transportation services suggests a value of 1.2 persons per vehicle. 2 persons per vehicle is chosen for conservatism based on direction in the RADTRAN manual.
One-way traffic volumes	Varies	Vehicle densities from Appendix D of the RADTRAN manual. National averages used for Texas and Nevada.
Minimum and maximum distances to exposed resident off-link population	10 to 800 meters	NUREG/CR-6672

TABLE 3.8-5 (Sheet 2 of 3)
RADTRAN 5 INPUT PARAMETERS FOR ANALYSIS OF UNIRRADIATED FUEL SHIPMENTS

Parameter	Parameter Value	Comments and Reference
Truck Stop Parameters		
Min/Max radii of annular area around vehicle at stops	1 to 10 meters	NUREG/CR-6672
Population density surrounding truck stops	64,300 persons/km^2	NUREG-1817
Shielding factor applied to annular area around vehicle at stops	1.0	NUREG/CR-6672
Stop time	8 stops of 30 minutes duration	Based on 0.0014 hours of stop time per km of travel
Shipments per year	3.4 (normalized)	Table 3.8-1

Routing Characteristics for Transport of New Fuel
from Port at San Diego to CPNPP and Alternative Sites From the TRAGIS Computer Code

	Population				Distance				Time
Port Node	Rural (person / sq km)	Suburban (person / sq km)	Urban (person / sq km)	Total (within 800m of route)	Rural (km)	Suburban (km)	Urban (km)	Total (km)	Total (hours:minutes)
Comanche Peak	8.6	334.2	2571.7	387,287	1754.5	308.8	60.3	2123.6	24:12
Luminant A - Coastal	8.0	359.6	2528.8	443,332	1880.7	300.3	73.4	2254.4	25:56
Luminant B - Pineland	8.6	358.1	2477.5	548,075	2078.3	409.7	86.7	2574.6	29:29

TABLE 3.8-5 (Sheet 3 of 3)
RADTRAN 5 INPUT PARAMETERS FOR ANALYSIS OF UNIRRADIATED FUEL SHIPMENTS

Parameter				Parameter Value			Comments and Reference		
Luminant C - Trading House	8.6	335.6	2577.1	400,900	1812.1	324.5	61.5	2198.1	25:16

TABLE 3.8-6
RADIOLOGICAL IMPACTS OF TRANSPORTING UNIRRADIATED FUEL

	Dose person-rem/shipment			
Population Component	CPNPP	Alternate Site A	Alternate Site B	Alternate Site C
Transport workers	2.74E-03	2.91E-03	3.32E-03	2.83E-03
General public (Onlookers – persons at stops and sharing the highway)	4.76E-03	4.78E-03	4.86E-03	4.77E-03
General public (Along Route – persons living near a highway)	2.84E-05	2.96E-05	3.93E-05	2.98E-05

Note: Analysis assumes transport to CPNPP and Alternative Sites is by truck.

TABLE 3.8-7
CUMULATIVE RADIOLOGICAL IMPACTS OF TRANSPORTING UNIRRADIATED FUEL

		Cumulative Annual Dose, person-rem per reference reactor year		
Reactor Type	Normalized Average Annual Shipments	Transport Workers	General Public-Onlookers	General Public-Along Route
Reference LWR[a]	6.3	0.0110	0.0420	0.0010
CPNPP	3.4	9.31E-03	1.62E-02	9.66E-05
Luminant A - Coastal	3.4	9.89E-03	1.63E-02	1.01E-04
Luminant B - Pineland	3.4	1.13E-02	1.65E-02	1.34E-04
Luminant C - Trading House	3.4	9.62E-03	1.62E-02	1.01E-04
10 CFR 51.52	365	4	3	3
Table S-4 Condition	<1 per day			

---

a) Table 6-5 of NUREG-1817

Note: Doses are on a per unit basis.

TABLE 3.8-8
TRANSPORTATION ROUTE INFORMATION FOR SPENT FUEL SHIPMENTS TO THE YUCCA MOUNTAIN DISPOSAL FACILITY

Routing Characteristics for Transport of Spent Fuel from CPNPP and Alternative Sites to Yucca Mountain Repository

	Population				Distance				Time
Site Node	Rural (person / sq km)	Suburban (person / sq km)	Urban (person / sq km)	Total (within 800m of route)	Rural (km)	Suburban (km)	Urban (km)	Total (km)	Total (hours:minutes)
Comanche Peak	8.1	344.6	2268.0	347748	2198.3	316.6	52.6	2567.5	32:23
Site A	7.3	346.5	2362.5	350545	2479.7	316.0	52.6	2848.4	34:14
Site B	8.5	380.3	2393.3	674606	2501.8	488.6	104.8	3095.2	37:53
Site C	8.1	341.7	2243.7	353191	2226.9	324.0	54.4	2605.3	32:30

TABLE 3.8-9
RADTRAN 5 INPUT PARAMETERS FOR ANALYSIS OF SPENT NUCLEAR FUEL SHIPMENTS

Parameter	Parameter Value	Comments and Reference
Package		
Package dimension	5.2 meters	NUREG/CR-6672
Dose rate at 1 meter from vehicle	13 mrem/hr	NUREG/CR-6672. Higher values cannot be chosen in RADTRAN due to the 10 mrem/hr limit at 2 meters per 49 CFR 173.441.
Fraction of emitted radiation that is gamma	1.0	Escape probability is higher for Gamma Rays than neutrons
Crew		
Number of crew	2	(AEC 1972) and (DOE 2002)
Distance from source to crew	2.0 meters	Minimum distance away from the cask that the drivers can be from the RADTRAN manual
Dose Rate to Crew	2 mrem/hr	49 CFR 173.441
Stop times	8 stops of 30 minutes duration	Based on 0.0014 hours of stop time per km of travel (9 stops for Alternate B site location)
Route-specific parameters		
Rural Suburban Urban	55 mph	Conservative in-transit speed of 55 mph assumed: predominately interstate highways used.
Number of people per vehicle sharing route	2.0	The bureau of transportation services suggests a value of 1.2 persons per vehicle. 2 persons per vehicle is chosen for conservatism based on direction in the RADTRAN manual.
One-way traffic volumes	Varies	Vehicle densities from Appendix D of the RADTRAN manual. National averages used for Texas and Nevada.
Minimum and maximum distances to exposed resident off-link population	10 meters to 800 meters	NUREG/CR-6672
Shipments per year per reactor	16 Average 9.5 (normalized)	128 assemblies per refueling and 4 assemblies per shipment assumed.

TABLE 3.8-10
RADIOLOGICAL IMPACTS OF TRANSPORTING SPENT FUEL TO YUCCA MOUNTAIN (PER UNIT)

Population Component	Dose person-rem/shipment			
	CPNPP	Alternate Site A	Alternate Site B	Alternate Site C
Transport workers	1.18E-01	1.31E-01	1.42E-01	1.19E-01
General public (Onlookers – persons at stops and sharing the highway)	5.93E-01	5.99E-01	6.79E-01	5.94E-01
General public (Along Route – persons living near a highway)	3.93E-03	3.96E-03	6.42E-03	3.99E-03

TABLE 3.8-11
POPULATION DOSES FROM SPENT FUEL TRANSPORTATION, NORMALIZED TO REFERENCE LWR

			Reactor Type	
			Reference LWR[a]	One US-APWR
			Number of Spent Fuel Shipments/year	
			60	9.5[b]
Reactor Site	Exposed Population	Cumulative Dose Limit Specified in Table S-4 Person-rem/RRY	Environmental Effects Person-rem/RRY	
CPNPP	Crew	4	1.2	1.12E+00
	Onlookers	3	0.8	5.64E+00
	Along Route	3	1.0	3.73E-02
Alternate Site A	Crew	4	1.2	1.24E+00
	Onlookers	3	0.8	5.69E+00
	Along Route	3	1.0	3.76E-02
Alternate Site B	Crew	4	1.2	1.35E+00
	Onlookers	3	0.8	6.45E+00
	Along Route	3	1.0	6.10E-02
Alternate Site C	Crew	4	1.2	1.13E+00
	Onlookers	3	0.8	5.65E+00
	Along Route	3	1.0	3.79E-02

---

a) WASH-1238, Table 2

b) Normalized

3.9 CONSTRUCTION ACTIVITIES

As discussed in Section 1.1, Luminant Generation Company LLC (Luminant) proposes to construct and operate two Mitsubishi Heavy Industries (MHI) design U.S. advanced pressurized water reactor (US-APWR) units at the Comanche Peak Nuclear Power Plant (CPNPP) site. NUREG-1555 does not require a description of construction activities in the Environmental Report. Luminant has elected to provide a description of construction activities for CPNPP Units 3 and 4. The description of activities is pertinent to addressing potential impacts of plant construction as discussed in Chapter 4. Both preconstruction and construction activities, processes, and procedures are discussed in the following paragraphs.

Luminant anticipates that site activities would be performed in the following sequence:

- Preconstruction planning and exploration activities would include such site activities as soil boring, sampling, and monitoring wells, or additional geophysical borings as allowed by 10 Code of Federal Regulations (CFR) 50.10(a)(1) and the removal or relocation of existing facilities at the CPNPP site.

- Site preparation activities would include installation of temporary facilities, construction support facilities, service facilities, utilities, docking and unloading facilities, excavations for facility structures and foundations, and construction of structures, systems, and components (SSCs) that do not constitute limited work authorization (LWA) activities as discussed in 10 CFR 50.10(a)(1).

- Subsurface preparation, placement of backfill and concrete within an excavation, and installation of foundations would be performed under the combined construction and operating license (COL).

- Construction activities would include the major power plant construction activities under the COL.

For the purposes of analysis in the Environmental Report, Luminant would assume a construction schedule based on providing additional commercial electric generation beginning in 2017, for CPNPP Unit 3, and 2018, for CPNPP Unit 4. The description of site preparation and construction activities in this section would assume that construction on CPNPP Unit 3 would begin following the site preparation for CPNPP Units 3 and 4, and construction of CPNPP Unit 4 would begin 12 months following commencement of CPNPP Unit 3 construction (Table 1.1-1). The schedule assumes a 36-month duration for site preparation activities for CPNPP Unit 3 and 18 months for CPNPP Unit 4, if performed, with the start of major power plant construction activities after the COL is issued. A time period of 51 months from issuance of the COL to fuel load is assumed for CPNPP Unit 3, 12 months from finish of fuel load to commercial operation for CPNPP Unit 3, and 8 months between start of commercial operation of CPNPP Units 3 and 4.

Temporary construction fabrication facilities and laydown space for staging of long lead-time module components to support the construction schedule will be provided. These components would be assembled on-site into modules as part of the preconstruction activities. The impacts from locating these facilities on-site are evaluated as part of this Environmental Report.

3.9.1 CONSTRUCTION PROCEDURES AND PROCESSES

As part of the overall construction program for CPNPP Units 3 and 4, procedures and processes are necessary to ensure protection of the local environmental conditions during construction. As part of the permit applications, the site would develop the necessary construction procedures and processes to support plant construction. These procedures and processes include developing a construction environmental controls plan.

3.9.1.1 Construction Environmental Controls Plan

The Construction Environmental Controls Plan contains descriptions of the environmental management controls that may be used at the CPNPP site to assist in meeting the overall environmental management objectives for the project.

The processes for achieving these objectives include:

- Summary matrix of environmental and permit requirements for construction.

  A summary matrix of environmental requirements for construction would be prepared for the relevant construction phase environmental requirements. The summary may include a listing of the specific permit requirements for CPNPP Units 3 and 4, the titles of the individuals responsible for ensuring compliance with each requirement, and the calendar or scheduled activity start dates by which compliance with each requirement must be completed and the current status of each action item. Section 1.2 generally describes the permits required for construction.

- Environmental awareness training.

  The training would be provided before construction personnel perform work at the CPNPP site. The training would be based on the environmental requirements applicable to CPNPP Units 3 and 4 and would cover such topics as general site maintenance and housekeeping control, erosion and sediment control, protection of sensitive areas, management of chemicals/consumables, hazardous material/waste handling, and spill prevention and response. The training sessions would stress the importance of maintaining environmental awareness as part of the employee's everyday duties. Environmentally sensitive areas on and adjacent to the site, as well as construction exclusion zones, would be described and located on project drawings.

- Environmental compliance reviews and coordination meetings.

  Periodic site environmental compliance reviews and coordination meetings between environmental and other site project personnel would be conducted to discuss current and future construction work activities as they relate to maintaining environmental compliance. The meetings would also provide a forum to discuss and resolve any outstanding environmental corrective actions or issues. Environmental issues would be captured in the station’s corrective action program (CAP) to ensure appropriate resolution.

- Environmental compliance inspections and documentation.

  Periodic environmental compliance field inspections of site preparation and construction activities would be performed by CPNPP personnel. The field inspections would be conducted and documented to confirm that the site activities remain in compliance with the applicable environmental requirements for the project. On-site areas and activities covered during the inspections include:

  - Adherence with approved clearing limits, buffers, and exclusion zones.
  - Adequate installation and maintenance of erosion and sediment control measures.
  - Correct implementation of required mitigation measures for work in and around environmentally sensitive resources as discussed in Section 4.1; for example, reservoir shoreline, wetlands, rivers and streams, and potential archeological sites.
  - Proper solid waste management activities to ensure sufficient number of trash containers, waste segregation, use of designated storage areas, and labeling.
  - Proper chemical/consumable materials management activities for storing hazardous materials to minimize spills, reduce exposure, and prevent fires or explosions.
  - Proper hazardous and non-hazardous waste management activities for handling, managing and transporting non-hazardous waste.
  - Implementation of fugitive dust control measures such as watering roads and covering truck loads.

  Environmental inspection reports would be used to document the results of each site inspection, and to note and describe any areas of concern requiring corrective actions. Issues identified would be captured in the station's CAP.

3.9.2 ENVIRONMENTAL PROCEDURES

Existing CPNPP site environmental procedures address regulatory and permit requirements. Additional permit requirements may be incorporated that address specific measures for mitigation of environmental impacts during the construction phase. Various types of environmental procedures for the construction of CPNPP Units 3 and 4 are discussed in the following paragraphs.

3.9.2.1 Noise and Vibration

Procedures related to mitigating noise and vibration impacts from construction activities may include measures such as (1) restricting noise- and vibration-generating activities to daylight hours, (2) prohibiting construction activities from specific roads and neighborhoods, and reducing the effects of vibration-producing equipment or methods; e.g., by utilizing dampeners or staggering activities, and (3) verifying that noise control equipment on vehicles and equipment is in proper working order. Notifications to regulatory agencies and nearby residents regarding atypical noise and vibration events (e.g., pile driving, or steam or air blows) may also be performed.

3.9.2.2 Air Quality (Fugitive and Vehicular Emissions)

Air quality protection procedures would describe the techniques that would be used to minimize the generation of fugitive dust from construction activities and reduce the release of emissions from construction equipment and vehicles. Fugitive dust control measures such as watering of roads, covering truck loads and material stockpiles, reducing materials handling activities, and limiting vehicle speed are typically required. Visual inspection of emission control equipment is also a common requirement.

3.9.2.3 Erosion and Sedimentation Control

Erosion and sedimentation control procedures would describe the measures to be taken during the course of construction to implement Best Management Practices. These measures would cover temporary and permanent measures and all relevant detailed engineering drawings illustrating the permanent plant design. Depending on conditions and permit requirements for construction of CPNPP Units 3 and 4, the measures may include:

- Clearing limits and maintenance of existing vegetative cover.
- Site grading.
- Topsoil stripping and stockpiling.
- Temporary erosion controls; for example, silt fencing, mulching, erosion control blankets, and temporary seeding.
- Permanent erosion controls such as reestablishing natural drainage patterns, vegetated swales, and permanent seeding and plantings.
- Checking dams, rip-rap, retention and detention basins, and sediment barriers.
- Slope restoration and protection.
- Roads and equipment crossings.
- Maintaining drainage patterns.

3.9.2.4 Construction Stormwater Management

Construction stormwater management procedures would be established to describe the measures used to institute Best Management Practices to manage stormwater runoff from construction areas, and to prevent or minimize contamination of stormwater due to project activities involving, for example, chemical/consumable material storage, waste management, and material stockpiles.

Upon completion of the detailed design, the temporary and permanent stormwater management measures would be addressed in the CPNPP Units 3 and 4 Erosion and Sediment Control Plan and Stormwater Management Plan. These plans and the relevant detailed design drawings would be referenced therein, and would address the erosion and sedimentation control measures to be used to control stormwater runoff, and to prevent or minimize contamination of stormwater from construction activities.

3.9.2.5 Protection of Sensitive Resources

Procedures would be established to describe the mitigation measures for environmentally sensitive resources either within the CPNPP site or in the immediate surrounding areas that have the potential to be adversely impacted during construction. These areas have been identified during preconstruction surveys of the site area as part of the overall development and permitting effort. Mitigation measures, if any are required, are discussed in Section 4.0.

Some environmentally sensitive resources that may be encountered during construction activities at the CPNPP site, along with the typical mitigation measures required to eliminate or minimize impacts on the resources include:

- Wetlands. Some activities may require temporary impacts to wetlands. These impacts would be mitigated by following permit conditions that may include:
    - Reduced clearing limits and preservation of existing vegetative cover.
    - Maintenance of existing drainage patterns.
    - Prohibitions and restrictions on equipment and vehicular travel.
    - Prohibition of maintenance or refueling near wetland boundaries.

  The requirements for restoring disturbed areas would also be addressed.

- Rivers and streams. Mitigation measures for direct impacts to waterways such as crossing a pipeline, constructing an access road, or installing a discharge pipe may be spelled out in permits. Mitigation measures may include:
    - Limits on the length of time of the disturbance.
    - Seasonal limits and restrictions for in-water work.
    - Reduced clearing limits and preservation of existing vegetative cover near the stream banks.
    - Installing only specified crossings such as mat bridges.

  - Using silt curtains and other sediment transport barriers, or restrictions on fill activities and materials.
  - Restoring stream beds, banks, and natural vegetation.

- Areas of special status wildlife habitats or vegetation. In rare instances, construction activities may inadvertently encounter special status wildlife species, their habitat, or vegetation, in which case work in the immediate area would be halted, and appropriate state agency officials and environmental consultants would be contacted to determine proper mitigation measures so that work may resume.
- Archeological and cultural resource areas. In rare instances, construction activities may inadvertently encounter buried archeological or cultural resources, in which case work in the immediate area would be halted and archeological experts, such as representatives from the State Historical Preservation Office, would be contacted to determine proper mitigation measures so that work may resume.

3.9.2.6 Unanticipated Discoveries

Procedures addressing unanticipated discoveries would be developed to describe the process to be followed in the event such discoveries are made during construction. The procedures would address on- and off-site notifications. Unanticipated discoveries may include:

- Contaminated or suspect soils and groundwater.
- Drums and tanks.
- Building foundations.
- Cultural artifacts.
- Bones.

In the event this discovery occurs, construction personnel would be required to immediately stop work in the area of the unanticipated discovery and to immediately report the situation. For unanticipated discoveries that may be immediately hazardous to human health, the site safety representative would also be immediately notified. Additional investigations, sampling, analysis, and notifications to appropriate agencies may be required.

3.9.2.7 Chemical/Consumable Materials Management

The chemical/consumable materials management procedures would describe the management program that would be implemented on how petroleum products and chemical substances, termed “chemical/consumable materials,” would be managed to minimize the potential for threats to human health and the environment or misuse. The management program would address the need for Material Safety Data Sheets for all materials brought on-site, and requirements regarding handling, storage, use, and disposal.

3.9.2.8 Solid Waste Management (Hazardous/Non-hazardous Wastes)

The management program would address both non-hazardous wastes and hazardous wastes. In all cases, the management program would be compliant with the relevant state and federal environmental requirements including county and state-specific waste handling management and transportation practices and approvals, waste minimization activities, and off-site recycling of certain common construction wastes such as used oil, used batteries, antifreeze, scrap metal, paper, and wood.

3.9.2.9 Asbestos and Lead-Based Paint

In the event that hazardous materials are encountered such as asbestos, asbestos-containing material, and lead-based paint, a process would be established to address the regulatory requirements; e.g., the Occupational Safety and Health Administration (OSHA), Texas Commission on Environmental Quality (TCEQ) requirements for containment or removal of such materials by trained, authorized personnel. Site-specific procedures would also address regulations governing the overall management of the removal and abatement work including:

- Prework notifications.
- Removal by certified contractors.
- Handling prior to disposal.
- Transport to and disposal at licensed facilities.
- Post-work closure reports.

3.9.2.10 Spill Prevention and Response

The spill prevention and response procedures would address how to manage all chemical/consumable materials and wastes in such a manner to prevent releases and to minimize the potential for threats to human health and the environment in the event of a release. The management program would address the need for secondary containment, spill response materials and storage location, spill thresholds for regulatory reporting of releases to the environment (e.g., reportable quantities), emergency response actions, and notification requirements for project personnel and county and state agencies.

3.9.2.11 Cleanup and Restoration

Procedures would be established to describe the requirements for cleanup and restoration of the CPNPP site and any other areas used during construction. Contractors would clean up and remove unused construction materials and debris, restore all surface (e.g., swales, roads, fences, gates, and walls) and subsurface (e.g., drainage tiles, wells, and utilities) features and adhere to the environmental procedures regarding permanent stabilization, including revegetation of disturbed areas.

3.9.3 SITE PREPARATION ACTIVITIES

The site preparation activities and approximate durations are described in the following sections. Beginning site preparation activities 36 months before the first major construction activity allows time for Luminant to acquire the necessary permits (as discussed in Section 1.2), to install temporary facilities (e.g., storage warehouses, concrete batch plant), relocate items within the CPNPP site, stage equipment, begin module assembly, and complete preparation activities to support power plant construction. These types of activities are intended to prepare the site for construction of CPNPP Units 3 and 4.

3.9.3.1 Installation and Establishment of Environmental Controls

The construction activities would comply with federal, state, and local environmental regulations and permit requirements. In addition, best management practices (BMPs), such as silt fencing, would be used to minimize impacts during construction. Construction activities would be performed in accordance with the Construction Environmental Controls Plan previously discussed in Subsection 3.9.1.1.

3.9.3.2 Road and Rail Construction

Construction access to the CPNPP site would be via a paved road, Farm-to-Market (FM) 56. To the extent practical, Luminant would use the existing site road system and drainage systems installed during construction of CPNPP Units 1 and 2 that are still in use. The new switchyard for CPNPP Units 3 and 4 would be located south of the existing access road from FM 56, and a road system into the switchyard would be built.

A heavy haul route would be built on-site to support the transport of heavy modules and components from the existing heavy haul route. Adequate temporary traffic surfacing would be installed, as needed, as part of the heavy haul route. A temporary construction parking lot would be created. Construction laydown and fabrication areas would be cleared, grubbed, graded, and graveled or paved with a road system to accommodate the site construction traffic. The existing rail line on-site would be upgraded. The upgrades would include the installation of ballast or rail sections on the existing rail bed. Figures 4.1-1, 4.2-1 and 4.3-1 depict the construction utilization plan, along with plant access roads, heavy haul roads, and other construction planning features.

3.9.3.3 Security Construction

Security features would be installed during the early part of site preparation activities. Security structures would include access control points, fencing, lighting, physical barriers, and guardhouses.

3.9.3.4 Temporary Utilities

Temporary utilities would include aboveground and underground infrastructure for power, communications, potable water, wastewater and waste treatment facilities, fire protection, and construction gas and air systems. The temporary utilities would support the entire construction site and associated activities, including construction offices, warehouses, storage and laydown areas, fabrication and maintenance shops, the power block, the batch plant facility, measuring and testing equipment, and intake and discharge areas.

3.9.3.5 Temporary Construction Facilities

Temporary construction facilities, including offices, warehouses for receiving and storage, temporary workshops, sanitary toilets, training and personnel access facilities would be constructed. The site of the concrete batch plant would be prepared for aggregate unloading and storage, and the cement storage silos and concrete batch plant would be erected.

3.9.3.6 Laydown, Fabrication, Shop Area Preparation

Activities to support preparation of the laydown, fabrication, and shop areas include:

- Performing a construction survey to establish local coordinates and benchmarks for horizontal and vertical control.
- Grading, stabilizing, and preparing the laydown areas.
- Installing construction fencing.
- Installing shop and fabrication areas including the concrete slabs for formwork laydown, module assembly, equipment parking and maintenance, fuel and lubricant storage, and rigging loft.
- Installing concrete pads for cranes and crane assembly.

3.9.3.7 Clearing, Grubbing, and Grading

Clearing and grubbing of the site would begin with the removal of vegetation. Topsoil would be moved to a storage area for later use in preparation for excavation. The general plant area, including the switchyard and ultimate heat sink (UHS) areas would be brought to plant grade at an approximate elevation of 822 ft mean sea level (msl) in preparation for foundation excavation. Existing buried utilities in the site area would be removed. The site utilization plans illustrate the areas to be cleared and graded.

Approximately 5.3 million cubic yards of soil and rock will be excavated (cut material) during construction of CPNPP Units 3 and 4 footprint. Cut material that cannot be reused in the footprint will be retained on-site in two excavated soil retention areas located in the south portion of the site. One 30-acre area is bounded by the property line and the transmission line on the west and the security training facility and gun range on the northeast. It can accommodate approximately 367,000 cubic yards of material. East of this area is a 149-acre site, which includes the location of the blowdown treatment facility (BDTF), and can accommodate up to 3.3 million cubic yards of material.

The excavated soil retention areas were selected based on the following: habitat for endangered species, potential wetland impacts, potential storm water runoff impacts, existing and proposed transmission line locations, transport distances, existing or planned area usage, beneficial reuse, and potential impacts to Squaw Creek Reservoir.

Emphasis will be placed on providing beneficial reuse of the cut material. It is estimated that approximately 1 million cubic yards of the cut material will be available for reuse as site excavation backfill material to help achieve final grade elevation of the footprint. Approximately 3.3 million cubic yards can be beneficially reused to prepare the BDTF area for development. Approximately 367,000 cubic yards can be beneficially reused in the expansion of the security training facility and gun range. In addition, suitable rock material will be used in swales and other applications. Any remaining soil that can not be suitably located in one of the two areas will be transported offsite to a construction/demolition landfill or permitted landfill in accordance with state and federal regulations.

CPNPP will comply with applicable regulations and the existing Stormwater Pollution Prevention Plan will be revised to include the excavated soil retention areas. BMPs will be employed throughout the site including use of hay bales, fencing, dust control, sod, mulch, retention ponds, etc. throughout all phases of the project to reduce sediment runoff and minimize impacts to the environment as a result of these activities.

3.9.3.8 Underground Installations

Non-safety-related underground fire protection, water supply piping, sanitary system, compressed air and gas piping, and electrical power and lighting duct bank would be installed and backfilled.

3.9.3.9 Unloading Facilities Installation

The existing rail line would be upgraded with adjacent construction laydown areas to support receipt of the bulk commodities. A spur into the batch plant area to support concrete materials unloading may also be installed during the upgrade. Concurrently, any crane foundations would be placed, and a heavy lift crane would be erected.

3.9.3.10 Intake/Discharge Coffer Dams and Piling Installation

Excavation and dredging of the intake structure, the pump house erection, and the installation of mechanical, piping, and electrical systems would follow the sheet pile installation, bracing system, and dewatering, and would continue through site preparation into plant construction. Excavated and dredged material would be transported to a designated area.

3.9.3.11 Power Block Earthwork (Excavation)

The power block consists of an area encompassing the nuclear island and turbine building areas, which include the following buildings for each unit (Figure 3.1-1):

- Reactor building, including the prestressed concrete containment vessel.

- Power source buildings.
- Power source fuel storage vaults.
- Essential service water pipe tunnel.
- UHS related structures.
- Auxiliary building.
- Access building.
- Turbine building.

In accordance with Regulatory Guide 1.165, the open excavations would be geologically mapped, and the NRC would be notified when the excavations are open for inspection.

3.9.3.12 Power Block Earthwork (Backfill)

The installation of safety-related Category 1 structural backfill material placed under safety-related structures or systems would occur as part of the site preparation activities. Backfill material would come from the concrete batch plant, qualified on-site borrow pits, or qualified off-site sources. The backfill would be installed up to the building's foundation grades in overexcavated areas, and would continue around foundations upward as the buildings rise from the excavation up to plant grade.

3.9.3.13 Reactor Building Base Mat Foundation

After the subsurface preparations are completed, the next sequential work operation would be the installation of foundations. The reactor building base mat would be the first to be installed. The detailed steps include:

- Installing the grounding grid.
- Forming the mud-mat concrete work surface.
- Reinforcing steel and civil, electrical, mechanical/piping embedded items (base mat module), and forming, concrete placement and curing.

The activities associated with the nuclear island foundations are safety-related and would be performed in accordance with applicable requirements under 10 CFR 50, Appendix B.

3.9.4 COL CONSTRUCTION ACTIVITIES

Major power plant construction of safety-related structures, systems, and components would begin after issuance of the COL by the NRC. Each US-APWR unit is a series of buildings and structures with systems installed within the structures. Power plants are constructed from the "bottom up," with elevations remaining open until the major mechanical and electrical equipment and piping are placed on each elevation as the civil construction continues upward. The five major buildings in each power block, along with a brief description of finished elevation (above plant grade) are as follows:

- The Reactor Building has five main floors and rises approximately 230 ft above plant grade. The building contains the reactor vessel at its center and is founded on a common mat.

  The reactor building consists of the following five functional areas:

  - Containment facility and inner structure.
  - Safety system pumps and heat exchangers area.
  - Fuel handling area.
  - Main steam and feed water area.
  - Safety-related electrical area.

- The access building has four main floor elevations and rises approximately 45 ft above plant grade.
- The turbine building has five main floor elevations and rises approximately 162 ft above grade.
- The auxiliary building has four main floor elevations and rises approximately 74 ft above grade.
- The power source building rises about 37 ft above grade.

Much of the commodity installation would consist of the setting of prefabricated civil or structural, electrical, mechanical, and piping modules with field connections. The balance of the field installations consists of bulk commodity installation. The descriptions of major activities for the power block buildings construction are discussed in the following subsections.

3.9.4.1 Power Block Construction Descriptions

3.9.4.1.1 Reactor Building

The reactor building has the longest construction duration. The reactor building, which includes the reactor vessel as an integrated structure, is a steel and concrete structure with one floor elevations below plant grade, and four elevations above grade in an area approximately 309 ft by 210 ft. The major activities associated with the reactor building construction following the base-mat foundation placement include:

- Erecting the reactor concrete containment vessel shell modules.

- Placing walls and slabs, and reactor pedestal.

- Installing the reactor vessel and pool modules.

- Setting the polar crane and setting the upper reactor building roof structure.

The mechanical, piping, heating, ventilation, and air conditioning systems (HVAC), and electrical installations would begin in the lower elevations and continue to the upper elevations, as is also the case with each of the other buildings.

3.9.4.1.2 Turbine Building

The turbine building is a concrete and steel structure with an area of approximately 180 ft by 355 ft. The turbine building has one floor below grade and four floor elevations above grade. The turbine building construction would begin with the pedestal base mat and buried circulating water piping installation. Installation of the pedestal columns, condenser modules, and pedestal deck would then proceed. The building exterior to the turbine pedestal would be erected, installation of the turbine building crane and the exterior walls and roof installation would then occur. The mechanical, piping, HVAC, and electrical installations would begin in the lower elevations and continue to the upper elevations. Construction would then proceed through the turbine and generator erection.

3.9.4.2 Other Facilities

Other facilities to be constructed include:

- The switchyard and installation of the main transformers.

- The administrative simulator and training facility buildings.

- The circulating water intake and discharge structures.

- Circulating water cooling towers

- Safety-related tunnels.

- The UHS cooling tower.

- Basin and pump houses.

- Machine shop.

- Sewage treatment facility.

- Fire protection pump house.

- Makeup water treatment building.

- Various yard tanks.
- Laboratories for radiological and chemical analyses to support plant operations.

The common yard area construction occurs from the start of site preparation. Luminant would acquire the necessary permits and authorizations to ensure compliance with all applicable rules and regulations (Section 1.2).

3.9.5 ACTIVITIES ASSOCIATED WITH CONSTRUCTION

Construction activities would involve the movement of workers and construction equipment. Construction shifts would commute to and from the site on local roads. Deliveries to the construction site would be by truck and rail, and would normally occur during daylight hours.

The installation contractors would have procedures in place for spill prevention, control, and countermeasures to include the control of potential petroleum product leaks from construction equipment, and remedial actions in the event of such a leak. Response to major spills from construction equipment would also be addressed. Measures would be put in place to control stormwater discharges associated with construction activity. An erosion, sedimentation, and pollution prevention plan specific to the construction activities would be prepared.

During CPNPP Units 3 and 4 site preparation and plant construction, air quality protection procedures as discussed in Subsection 3.9.2.2 would be used to minimize and control the generation of fugitive dust from construction activities and vehicular traffic. Fugitive dust control measures such as watering of roads, covering truck loads and material stockpiles, reducing material handling activities and limiting vehicle speed are anticipated to effectively control fugitive dust generation during construction. Fugitive dust generation from the aggregate surface of the heavy haul roadway is expected to be minimal based on the infrequent traffic, slow transportation speeds and air quality protection procedures discussed above. Therefore, no adverse impacts on the site meteorological measurements due to plant construction generated dust are anticipated.

Peak and attenuated noise (in dBA) levels are expected to be generated from operations of construction equipment including earthmoving equipment, trucks, cranes, portable generators, pile-drivers, pneumatic equipment, and hand tools. Table 3.9-1 summarizes the expected noises from several types of anticipated construction equipment to be used for CPNPP Units 3 and 4.

3.9.6 REFERENCES

(EIDB 1980) Environmental Impact Data Book. Chapter 8: Noise. Golden, J., Ouellette, R. P., Saari S., and Cheremisinoff, P. N. 2nd Printing. Ann Arbor Science Publishers, Inc. Ann Arbor, Michigan. 1980.

TABLE 3.9-1
PEAK AND ATTENUATED NOISE (IN DBA) LEVELS EXPECTED FROM OPERATIONS OF CONSTRUCTION EQUIPMENT

Source	Noise Level (peak)	Distance from Source			
		50 ft	100 ft	200 ft	400 ft
Heavy Trucks	95	84-89	78-83	72-77	66-71
Dump trucks	108	88	82	76	70
Concrete mixer	105	85	79	73	67
Jackhammer	108	88	82	76	70
Scraper	93	80-89	74-82	68-77	60-71
Dozer	107	87-102	81-96	75-90	69-84
Generator	96	76	70	64	58
Crane	104	75-88	69-82	63-76	55-70
Loader	104	73-86	67-80	61-74	55-68
Grader	108	88-91	82-85	76-79	70-73
Dragline	105	85	79	73	67
Pile driver	105	95	89	83	77
Forklift	100	95	89	83	77

(EIDB 1980)

3.10 WORKFORCE CHARACTERIZATION

This is a supplemental Environmental Report (ER) section and, therefore, is not covered by a NUREG-1555, Environmental Standard Review Plan (ESRP). The following subsections provide a description of the workforce required to construct and operate Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4, including how the workforce is anticipated to change over the course of construction. The subsections also discuss availability of workers in the local area, and the potential for workers relocation and commuting constraints.

3.10.1 CONSTRUCTION WORKFORCE

The construction workforce comprises of field craft labor and field supervisor labor. Table 4.4-1 illustrates the percentage of the total workforce for craft and field supervisor labor makeup that is anticipated during the construction of the US-APWR nuclear power plant. The socioeconomic impacts during construction of CPNPP Units 3 and 4 are discussed in Subsection 4.4.2.

The influx of workers into the plant vicinity is reduced from the total requirements by workers from outside the 50-mi region. This is estimated to be approximately 70 percent of the total workforce and the basis for this estimate is further discussed in Subsection 4.4.2. Field Supervisor personnel are anticipated to come primarily from outside the 50-mi region.

The construction of CPNPP Units 3 and 4 would incorporate a number of large prefabricated modules. Modularization shifts some of the work to other locations that could be outside the 50-mi region, and thus supports the low on-site construction workforce and duration. The estimated construction on-site workforce present assumes a high degree of off-site fabrication.

The schedule assumes approximately 36 months for site preparation, 51 months from combined construction and operating license (COL) issuance to CPNPP Unit 3 fuel load, and 12 months for startup. The CPNPP Unit 4 Commercial Operation is scheduled eight months after CPNPP Unit 3. Based on this schedule, the peak on-site construction workforce for CPNPP Units 3 and 4 is approximately 4300 people. Table 4.4-2 summarizes the on-site construction workforce by year of the project.

3.10.2 WORKER RELOCATION AND COMMUTING

Construction workers typically commute up to 50 mi to a jobsite. Assuming that 30 percent of the construction craft workforce is recruited from within the 50-mi radius, approximately 1290 local craft people could be employed in the construction of CPNPP Units 3 and 4. The balance of the construction workforce is anticipated to come from outside the 50-mi radius. For the analysis of the construction impacts in Chapter 4, it is assumed that the field supervisor workforce would relocate to the area from outside the 50-mi radius. Seventy to 80 percent of the construction workforce is expected to be employed for more than four years. Most of the craft labor from outside the 50-mi radius would seek temporary housing, and most of the supervisor staff would relocate to the area and seek permanent housing. Construction employees typically locate to within 50-mi of the construction area.

3.10.3 OPERATION WORKFORCE

A discussion regarding the operation workforce of the CPNPP Units 3 and 4 is described in Subsection 5.8.2.1. It is estimated that the on-site operations workforce would be approximately 550 people for CPNPP Units 3 and 4. The operations staff for each unit would be put in place approximately two years before fuel load of the unit, to allow time for simulator training and startup testing. It is assumed the operations workforce would be recruited from outside the 50-mi radius. If some operators from CPNPP Units 1 and 2 transfers to the operations staff for CPNPP Units 3 and 4, it is assumed the replacements for the CPNPP Units 1 and 2 operators would be recruited from outside the 50-mi radius. Socioeconomic impacts during operation of CPNPP Units 3 and 4 are discussed in Subsection 5.8.2.