Zion*Solutions*, LLC.
Technical Support Document

TSD 17-004

OPERATIONAL DERIVED CONCENTRATION GUIDELINE LEVELS FOR FINAL STATUS SURVEY

Revision 2

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1. PURPOSE

Derived Concentration Guideline Levels (DCGL) are established to demonstrate compliance with the 25 mrem/yr unrestricted release criterion. DCGLs are calculated by analysis of various pathways (direct radiation, inhalation, ingestion, etc.), media (e.g., concrete, pipe, soils and groundwater) and scenarios through which exposures could occur. Chapter 6 of the Zion License Termination Plan (LTP) (Reference 1) describes the approach, modeling parameters and assumptions used to develop the DCGLs (referred to as Base Case DCGLs) for each Radionuclide-of-Concern (ROC) that will be used for the Final Status Survey (FSS) of the Zion Nuclear Power Station (ZNPS). Each Base Case DCGL represents a concentration that would be equivalent to a total dose of 25 mrem/yr. At ZNPS, compliance is demonstrated through the summation of dose from four distinct source terms for the end-state (basements, soils, buried pipe and groundwater). Basements are comprised of the summation of four structural source terms (surfaces, embedded pipe, penetrations and fill). To ensure that the summation of dose from each source term is 25 mrem/yr or less after all FSS is completed, the Base Case DCGLs are reduced based on an expected, or *a priori*, fraction of the 25 mrem/yr dose limit from each source term. These reduced DCGLs will be called Operational DCGLs. This Technical Support Document (TSD) details how the Operational DCGLs were derived for each dose component and the basis for the applied *a priori* dose fractions.

2. COMPLIANCE DOSE CALCULATIONS

Each radionuclide-specific Base Case DCGL is equivalent to the level of residual radioactivity (above background levels) that could, when considered independently, result in a Total Effective Dose Equivalent (TEDE) of 25 mrem per year to an Average Member of the Critical Group (AMCG). When applied to backfilled basement surfaces below 588 foot elevation, embedded pipe and penetrations, the DCGLs are expressed in units of activity per unit of area (pCi/m^2). When applied to soil, the DCGLs are expressed in units of activity per unit of mass (pCi/g). For buried piping, DCGLs are calculated and expressed in units of activity per surface area ($dpm/100\ cm^2$).

The “unity rule” is applied when there is more than one ROC. The measurement results for each singular ROC present in the mixture are compared against their respective DCGL to derive a dose fraction. The summation of the dose fractions for each ROC produces a Sum-of-Fractions (SOF) for the measurement. When compared against the Base Case DCGL, the term is defined as BcSOF. When compared against the Operational DCGL, the term is defined as OpSOF.

There are four distinct source terms for the end-state at Zion: backfilled basements, soil, buried piping and groundwater. Demonstrating compliance with the dose criterion requires the summation of dose from the four source terms as shown in Equation 1 (reproduced from Equation 6-11 from LTP Chapter 6, section 6-17).

The final compliance dose will be calculated using Equation 1 after FSS has been completed in all survey units. The results of the FSS performed for each FSS unit will be reviewed to determine the maximum dose from each of the four source terms (e.g., basement, soil, buried pipe and existing groundwater if applicable) using the mean BcSOF of FSS systematic results plus the dose from any identified elevated areas. For all media except soils, areas of elevated activity are defined in this context as any area identified by measurement/sample (systematic or judgmental) that exceeds the Operational DCGL but is less than the Base Case DCGL. The OpSOF (based on the Operational DCGL) for a systematic or a judgmental measurement/sample(s) may exceed one without remediation as long as the survey unit passes the Sign Test and, the mean OpSOF for the survey unit does not exceed one when using the Operational DCGLs. For all media except soils, if the BcSOF for a sample/measurement(s) exceeds one when using Base Case DCGLs, then remediation is required. For soils, the Elevated Measurement Comparison (EMC) as described in section 8.5.1 of NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" (Reference 2) will apply.

In all media, locations identified by measurement or sample analyses which exceed the Operational DCGL will be subject to additional surveys to bound the elevated area. If the elevated area is identified by an ISOCS measurement, then the Field-of-View (FOV) of the ISOCS measurement can be used as the size of the elevated area, assuming that the surrounding ISOCS measurements are less than the Operational DCGL.

The compliance dose must be less than 25 mrem/yr. The dose contribution from each ROC is accounted for using the BcSOF to ensure that the total dose from all ROC does not exceed the dose criterion.

Equation 1

$$\text{Compliance Dose} = (\text{Max BcSOF}_{\text{BASEMENT}} + \text{Max BcSOF}_{\text{SOIL}} + \text{Max BcSOF}_{\text{BURIED PIPE}} + \text{Max SOF}_{\text{GROUNDWATER}}) \times 25 \text{ mrem/yr}$$

where:

Compliance Dose	=	must be less than or equal to 25 mrem/yr,
Max $\text{BcSOF}_{\text{BASEMENT}}$	=	Maximum BcSOF (mean of FSS systematic results plus the dose from any identified elevated areas) for backfilled Basements (including surface, embedded pipe, penetrations and fill [if required]),
Max $\text{BcSOF}_{\text{SOIL}}$	=	Maximum BcSOF (mean of FSS systematic results plus the dose from any identified elevated areas) for open land survey units,
Max $\text{BcSOF}_{\text{BURIED PIPE}}$	=	Maximum BcSOF (mean of FSS systematic results plus the dose from any identified elevated areas) from buried piping survey units,
Max $\text{SOF}_{\text{GROUNDWATER}}$	=	Maximum SOF from existing groundwater

2.1. MAX $SOF_{GROUNDWATER}$ TERM

The dose for the "Max $SOF_{GROUNDWATER}$" term will be determined based on the analysis of water samples taken from eleven active sample wells established at and around Zion which are monitored on a routine frequency. These wells will remain active and will be monitored through license termination. The two years of monitoring prior to Final Report submittal will be used to establish the Max $SOF_{GROUNDWATER}$. . No groundwater contamination has been identified by groundwater monitoring performed as of the date of this TSD and is not expected to be present at the time of license termination. However, if groundwater contamination is identified during decommissioning (during the period when the wells are active and monitored), then the dose will be calculated using the Basement Fill Model (BFM) Groundwater Exposure Factors in LTP Chapter 6, Table 6-18. Table 6-18 was developed as a part of the BFM, but the Groundwater Exposure Factors presented in Table 6-18 are fully applicable to any groundwater contamination, regardless of the location.

The maximum SOF for groundwater "Max $SOF_{GROUNDWATER}$" will be calculated if radionuclides are positively identified by groundwater monitoring. If groundwater contamination is identified by groundwater monitoring, the maximum SOF will be calculated from the maximum concentration from groundwater sampling for each positively identified ROC in units of pCi/L in accordance with the following equation:

Equation 2

$$Max\ SOF_{GROUNDWATER} = \sum_{i=1}^{n} \frac{Conc_{ROC_i} * EF_{GW_i}}{25}$$

where:

$Max\ SOF_{GROUNDWATER}$	=	Maximum SOF for groundwater
$Conc_{ROCi}$	=	Maximum concentration from all groundwater sampling wells collectively for each positively identified ROC_i in units of pCi/L within the most recent 2 years (8 months) of sampling. (Note that this has the potential of combining results from various wells if different ROC are positively identified in different wells)
EF_{GWi}	=	Groundwater Exposure Factors for ROC_i in units of mrem/yr per pCi/L

2.2. MAX $BcSOF_{SOIL}$ TERM

$BcSOF_{SOIL}$ will be derived for each open land survey unit in accordance with the following equation. This equation is equivalent to Equation 8-2 from section 8.5.2 of

NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" (Reference 2);

Equation 3

$$BcSOF_{Soil} = \sum_{i=1}^{n} \frac{Mean\ Conc\ Soil_{ROC_i}}{Base\ Case\ Soil\ DCGL_{ROC_i}} + \frac{\left(Elev\ Conc\ Soil_{ROC_i} - Mean\ Conc\ Soil_{ROC_i}\right)}{\left[Base\ Case\ Soil\ DCGL_{ROC_i} \times \left(\frac{SA_{SU}}{SA_{Elev}}\right)\right]}$$

where:

$BcSOF_{SOIL}$	=	SOF for open land survey unit using Base Case DCGLs
$Mean\ Conc\ Soil_{ROCi}$	=	Mean concentration for the systematic measurements taken during the FSS of soils in survey unit for each ROC_i
$Base\ Case\ Soil\ DCGL_{ROCi}$	=	Base Case DCGL for soils (surface soils [$DCGL_{SS}$] or subsurface soils [$DCGL_{SB}$] as applicable) for each ROC_i
$Elev\ Conc\ Soil_{ROCi}$	=	Concentration for ROC_i in elevated area
SA_{Elev}	=	surface area of the elevated area
SA_{SU}	=	surface area of FSS unit

The "Max $BcSOF_{SOIL}$" term will be the highest $BcSOF_{SOIL}$ determined in accordance with Equation 3 from the FSS of all open land survey units.

2.3. MAX $BcSOF_{BURIED\ PIPE}$ TERM

$BcSOF_{BURIED\ PIPE}$ for buried pipe will be derived for each buried pipe survey unit in accordance with the following equation. Again, this equation is equivalent to Equation 8-2 from section 8.5.2 of MARSSIM;

Equation 4

$$BcSOF_{BURIED\ PIPE} = \sum_{i=1}^{n} \frac{Mean\ Conc\ BP_{ROC_i}}{Base\ Case\ BP\ DCGL_{ROC_i}} + \frac{\left(Elev\ Conc\ BP_{ROC_i} - Mean\ Conc\ BP_{ROC_i}\right)}{\left[Base\ Case\ BP\ DCGL_{ROC_i} \times \left(\frac{SA_{SU}}{SA_{Elev}}\right)\right]}$$

where:

$BcSOF_{BURIED\ PIPE}$	=	SOF for buried pipe survey unit using Base Case DCGLs
$Mean\ Conc\ BP_{ROCi}$	=	Mean concentration for the systematic measurements taken during the FSS of buried pipe in survey unit for each ROC_i

Base Case BP DCGL$_{ROCi}$	=	Base Case DCGL for buried pipe ($DCGL_{BP}$) for each ROC_i
Elev Conc BP$_{ROCi}$	=	Concentration for ROC_i in elevated area
SA_{Elev}	=	surface area of the elevated area
SA_{SU}	=	surface area of FSS unit

The "Max $BcSOF_{BURIED\ PIPE}$" term will be the highest $BcSOF_{BURIED\ PIPE}$ determined in accordance with Equation 4 from the FSS of all buried pipe survey units.

2.4. MAX $BcSOF_{BASEMENT}$ TERM

The "$BcSOF_{BASEMENT}$" term for each Basement includes the dose contributions from wall and floor survey units within the Basement, the dose contributions from embedded pipe survey units within the Basement, the dose contributions from penetration survey units within the Basement and the dose contributions from concrete fill in Basements where clean concrete debris will be used as fill. Each of these survey units (structural surfaces, embedded pipe and penetrations) are surveyed separately during FSS. The dose from clean concrete fill assumed in this TSD is predetermined in accordance with LTP Chapter 5, Table 5-16, which is conservatively based on a maximum allowable Minimum Detectable Concentration (MDC) of 5,000 dpm/100cm^2. The calculation of $BcSOF_{BASEMENT}$ includes the summation of these components as shown in Equation 5;

Equation 5

$$BcSOF_{BASEMENT} = BcSOF_B + BcSOF_{EP} + BcSOF_{PN} + BcSOF_{CF}$$

where:

$BcSOF_{BASEMENT}$	=	BcSOF (mean of FSS systematic results plus the dose from any identified elevated areas) for backfilled Basements
$BcSOF_B$	=	BcSOF for structural survey unit(s) within the Basement (mean of FSS systematic results plus the dose from any identified elevated areas)
$BcSOF_{EP}$	=	BcSOF for embedded pipe survey unit(s) within the Basement (mean of FSS systematic results plus the dose from any identified elevated areas)
$BcSOF_{PN}$	=	BcSOF for penetration survey unit(s) within the Basement (mean of FSS systematic results plus the dose from any identified elevated areas)
$BcSOF_{CF}$	=	BcSOF for clean concrete fill (if applicable) based on maximum MDC during Unrestricted Release Survey (URS)

2.4.1. Basement Surfaces ($BcSOF_B$) TERM

A structural surface survey unit is comprised of the concrete walls and floors of a Basement. The areal extent of the walls and floors is the "surface area" and includes both volumetric and surface contamination, within the defined area.

Basement surface area adjustments (i.e. increases) were required for the structure surface DCGL calculation to ensure that the DCGLs account for the contribution of residual radioactivity from basements/structures that cannot, on their own, support a water supply well but are hydraulically connected to a basement that can support a well. These include the Circulating Water Intake Pipes, Circulating Water Discharge Tunnels (and associated piping), Buttress Pits/Tendon Tunnels, and the SFP/Transfer Canal. The surface area adjustments result in lowering the DCGL concentrations (pCi/m^2) in the affected basements and structures, from that which would be calculated for each individually, by requiring the allowable total activity to be uniformly distributed over the larger, combined surface areas.

The first area adjustment was to the Turbine Basement and Crib House/Forebay. The activity in the Circulating Water Intake Pipes is included in both the Crib House/Forebay and the Turbine Basement. The activity in the Circulating Water Discharge Tunnels is included with the Turbine Basement. The Intake Pipe has been grouted essentially eliminating the hydraulic connections. The major hydraulic connections between the Discharge Tunnels and the Turbine basement will be isolated as a part of the decommissioning process but two 48 inch diameter service water pipes that run between the Turbine Basement and the Discharge Tunnels will remain open and maintain the hydraulic connection, at least to some extent. In calculating the Base Case DCGLs, the hydraulic connections to the Intake Pipe and Discharge Tunnels were assumed to be fully regained in the future after degradation of the isolation barriers and grout.

The Base Case DCGLs account for the activity in the Intake Pipes and Discharge Tunnels by summing the surface areas with the connected structures. The Intake Pipe surface area was added to the Crib House/Forebay. The Intake Pipe was also connected to the Turbine basement and therefore, the Intake Pipe surface area was also added to the Turbine Basement. The modeled activity in the Intake Pipe is conservatively assumed to be in both basements simultaneously. The Discharge Tunnel surface area was added to the Turbine Basement. There is also a group of pipes that are within the Turbine building and connected to the Discharge Tunnels including the remaining portions of the 12 foot diameter down-comer pipes, the 36 inch and 48 inch diameter standpipes, and the 48 inch diameter service water return pipes. There are also large diameter pipes on the east side of the Discharge Tunnel Valve House. The internal surface areas of these "Circulating Water

Discharge Pipes" were also added to the summed area used for the Turbine Basement Base Case DCGL.

The summed areas were then used to calculate the Base Case DCGLs for the Crib House/Forebay and Turbine Basement. Increasing the surface area decreases the Base Case DCGLs. The lower of the Base Case DCGLs calculated for the Crib House/Forebay and Turbine Basement were applied to the Intake Pipes and Discharge Tunnels. However, this is a minor distinction given that FSS measurements in the Intake Pipe have all been below detection limits which are orders of magnitude below the DCGLs. The Discharge Tunnel will be included in the dose assessment for the Turbine Basement. The Intake Pipe FSS results will be included with both the Crib House/Forebay and Turbine Basement dose assessments. As discussed above, the surface area adjustment, and corresponding Base Case DCGL calculations, conservatively assume that the activity in the Intake Pipe is in both the Turbine and Crib House/Forebay Basements simultaneously. The Buttress Pits and Tendon Tunnels are hydraulically connected to the Steam Tunnels. The surface areas of these structures were therefore added to the Turbine Basement.

An area adjustment was also performed to account for the contribution of residual radioactivity in the SFP/Transfer Canal to the groundwater pathway. The potential for the residual radioactivity in the SFP/Transfer Canal to contribute to the groundwater pathway is accounted for by adding the SFP/Transfer Canal surface area to the Containment Basement and Auxiliary Basement surface areas. The surface area adjustment, and corresponding Base Case DCGL calculations, conservatively assume that the modeled activity in the SFP/Transfer Canal is in both the Containment and Auxiliary Basement simultaneously.

Table 1, which is reproduced from LTP Chapter 6, Table 6-23, lists the structural surface survey units that contribute to each Basement. Area weighting (using Equation 6, which is reproduced from Equation 5-9 from LTP Chapter 5) will be used to account for the activity in the SFP/Transfer Canal, which is added to Containment and Auxiliary Basements to account for the fact that the SFP/Transfer Canal cannot, on its own, support a water supply well but is hydraulically connected to Containment and Auxiliary Basements that can support a well.

The area-weighted SOF for Basements that have dose contributions from multiple surface survey units is calculated in accordance with the following equation.

Equation 6

$$BcSOF_{B,B} = \sum_{i=1}^{n} \frac{SA_{SUi,B}}{SA_{Adjust,B}} * BcSOF_{Bi,B}$$

where:

$BcSOF_{B,B}$ = total surface SOF including all surface survey units in basement (B)

$SA_{SUi,B}$ = surface area of survey unit (i) in basement (B)

$SA_{Adjust,B}$ = adjusted surface area for DCGL calculation (Table 1) for basement (B)

$BcSOF_{Bi,B}$ = SOF_B for survey unit (i) in basement (B)

Table 1 Adjusted Basement Surface Areas for DCGL Calculation – (from LTP Chapter 6, Table 6-23)

Basement	Structures Included in Calculation	Total Adjusted m^2
Containment	Containment (above 565 ft elevation + Under-Vessel Area) + SFP/Transfer Canal	3,482
Auxiliary	Auxiliary + SFP/Transfer Canal	7,226
Turbine	Turbine + Circulating Water Discharge Tunnel + Circulating Water Intake Pipe + Circulating Water Discharge Pipes + Buttress Pits/Tendon Tunnels	27,135
Crib House/Forebay	Crib House/Forebay + Circulating Water Intake Pipe	18,254
SFP/Transfer Canal	SFP/Transfer Canal	723
WWTF	WWTF	1,124

As a hypothetical example, assume FSS is performed on Unit 1 Containment structural surface survey units. FSS results in a SOF_B for the Containment survey unit above the 565 ft elevation of 0.1 and a SOF_B for the Under-vessel Area survey unit of 0.25. In addition, FSS results in a SOF_B for the SFP/Transfer Canal survey unit of 0.25. In accordance with Table 5-12 from LTP Chapter 5, the area of the Containment survey unit above the 565 ft. elevation is 2,465 m^2, the area of the Under-Vessel Area survey unit is 294 m^2 and the area of the SFP/Transfer Canal is 723 m^2. The SOF_B for each survey unit would be summed as follows using Equation 6 to derive a SOF_B that represents the Unit 1 Containment Basement;

$$\left(\frac{2{,}465}{3{,}482} \times 0.1\right) + \left(\frac{294}{3{,}482} \times 0.25\right) + \left(\frac{723}{3{,}482} \times 0.25\right) = 0.143$$

A value for "$BcSOF_B$" will be derived for each structural surface survey unit within a Basement in accordance with the following equation. This value will then be used for the $BcSOF_B$ term in Equation 5;

Equation 7

$$BcSOF_B = \sum_{i=1}^{n} \frac{Mean\ Conc_{B_{ROC_i}}}{Base\ Case\ DCGL_{B_{ROC_i}}} + \frac{\left(Elev\ Conc_{B_{ROC_i}} - Mean\ Conc_{B_{ROC_i}}\right)}{\left[Base\ Case\ DCGL_{B_{ROC_i}} \times \left(\frac{SA_{SU}}{SA_{Elev}}\right)\right]}$$

where:

$BcSOF_B$	=	SOF for structural surface survey unit within a Basement using Base Case DCGLs
$Mean\ Conc_{B\ ROC_i}$	=	Mean concentration for the systematic measurements taken during the FSS of structural surface in survey unit for each ROC_i
$Base\ Case\ DCGL_{B\ ROC_i}$	=	Base Case DCGL for structural surfaces ($DCGL_B$) for each ROC_i
$Elev\ Conc_{B\ ROC_i}$	=	Concentration for ROC_i in elevated area
SA_{Elev}	=	surface area of the elevated area
SA_{SU}	=	adjusted surface area of FSS unit for DCGL calculation from Table 1

2.4.2. Embedded Pipe ($BcSOF_{EP}$) and Penetrations ($BcSOF_{PN}$) Terms

As indicted in Equation 5, the end states for several Basements also include embedded piping and penetrations. Embedded pipe and penetrations have separate Base Case DCGLs. The survey units for embedded pipe and penetrations are presented in Table 2, which is reproduced from Table 5-15 from LTP Chapter 5.

Table 2 Embedded Pipe and Penetration Survey Units – (from LTP Chapter 5, Table 5-15)

Basement FSS Unit	Embedded Pipe	Penetrations
Auxiliary Building Basement	• Basement Floor Drains (542 ft. elevation)	• Auxiliary Building Penetrations
Containment Basement	• Unit 1 and Unit 2 In-Core Sump Drains (541 ft. elevation) • Unit 1 and Unit 2 Tendon Tunnel Drains (1)	• Containment Penetrations
SFP/Transfer Canal	N/A	• SFP/Transfer Canal Penetrations
Turbine Building Basement	• Unit 1 and Unit 2 Basement Floor Drains (560 ft. elevation) • Unit 1 and Unit 2 Steam Tunnel Floor Drains (570 ft. elevation) • Unit 1 and Unit 2 Tendon Tunnel Drains (1)	• Turbine Penetrations

(1) Buttress Pits/Tendon Tunnels hydraulically connected to Steam Tunnel/Turbine Building so include with Turbine Building as well as Containment

A "$BcSOF_{EP}$" will be calculated for each embedded pipe survey unit within a Basement in accordance with the following equation:

Equation 8

$$BcSOF_{EP} = \sum_{i=1}^{n} \frac{Mean\ Conc_{EP_{ROC_i}}}{Base\ Case\ DCGL_{EP_{ROC_i}}} + \frac{\left(Elev\ Conc_{EP_{ROC_i}} - Mean\ Conc_{EP_{ROC_i}}\right)}{\left[Base\ Case\ DCGL_{EP_{ROC_i}} \times \left(\frac{SA_{SU}}{SA_{Elev}}\right)\right]}$$

where:

$BcSOF_{EP}$	=	SOF for embedded pipe survey unit within a Basement using Base Case DCGLs
$Mean\ Conc_{EP\ ROC_i}$	=	Mean concentration for the systematic measurements taken during the FSS of embedded pipe in survey unit for each ROC_i
$Base\ Case\ DCGL_{EP\ ROC_i}$	=	Base Case DCGL for structural surfaces ($DCGL_{EP}$) for each ROC_i
$Elev\ Conc_{EP\ ROC_i}$	=	Concentration for ROC_i in elevated area
SA_{Elev}	=	surface area of the elevated area
SA_{SU}	=	surface area of FSS unit

A "SOF_{PN}" will be derived for each penetration survey unit within a Basement in accordance with the following equation.

Equation 9

$$BcSOF_{PN} = \sum_{i=1}^{n} \frac{Mean\ Conc_{PN_{ROC_i}}}{Base\ Case\ DCGL_{PN_{ROC_i}}} + \frac{\left(Elev\ Conc_{PN_{ROC_i}} - Mean\ Conc_{PN_{ROC_i}}\right)}{\left[Base\ Case\ DCGL_{PN_{ROC_i}} \times \left(\frac{SA_{SU}}{SA_{Elev}}\right)\right]}$$

where:

$BcSOF_{PN}$	=	SOF for penetration survey unit within a Basement using Base Case DCGLs
$Mean\ Conc_{PN\ ROCi}$	=	Mean concentration for the systematic measurements taken during the FSS of penetrations in survey unit for each ROC_i
$Base\ Case\ DCGL_{PN\ ROCi}$	=	Base Case DCGL for penetrations ($DCGL_{PN}$) for each ROC_i
$Elev\ Conc_{PN\ ROCi}$	=	Concentration for ROC_i in elevated area
SA_{Elev}	=	surface area of the elevated area
SA_{SU}	=	surface area of FSS unit

Once FSS has been performed on all survey units within a Basement (structural surface, embedded pipe and penetrations), the SOF are summed to derive a $SOF_{BASEMENT}$ in accordance with Equation 5. The "Max $SOF_{BASEMENT}$" term will in Equation 1 be the highest $SOF_{BASEMENT}$ determined in accordance with Equation 5 from the FSS of each Basement.

3. OPERATIONAL DCGLS

Each Base Case DCGL equates to 25 mrem/yr. To ensure that the summation of dose from each source term in Equation 1 is less than the 25 mrem/yr dose criteria after all FSS is completed, the Base Case DCGLs for each source term is reduced to correspond to an expected, or *a priori*, fraction of 25 mrem/yr. The summation of the assigned *a priori* fractions is one, i.e., 25 mrem/yr. These derived lower DCGLs are identified as the Operational DCGLs. Since Operational DCGLs by definition are a fraction of the Base Case DCGLs, compliance with the Operational DCGLs will ensure compliance with the Base Case DCGLs.

To demonstrate that each survey unit satisfies the Operational DCGL, the ROC concentration for each systematic sample/measurement taken in each Basement (includes structural surfaces, embedded pipe and penetrations) soil and buried pipe FSS units will be divided by its applicable Operational DCGL ($OpDCGL_B$ for structural surfaces, $OpDCGL_{EP}$ for embedded pipe and $OpDCGL_{PN}$ for penetrations, $OpDCGL_{SS}$ for surface soil, $OpDCGL_{SB}$ for subsurface soil and $OpDCGL_{BP}$ for buried pipe) to derive a OpSOF for the ROC. The actual recorded value will be used as the recorded FSS result for all measurement and/or sample values including those that are less than MDC. The OpSOF for each ROC will be summed to determine the total OpSOF for all ROC that represents the sample/measurement and will be used as the summed value (W_s) for performing the Sign Test. The Sign Test will be performed separately on each survey unit.

The *a priori* dose fraction assumed for groundwater is based on the MDC for groundwater analysis, which results in a dose of 1 mrem/yr (or a dose fraction of 0.040 which equates to 1 mrem/yr ÷ 25 mrem/yr).

The *a priori* dose from clean concrete fill is predetermined in accordance with LTP Chapter 5, Table 5-16, and is currently based on a maximum allowable MDC of 5,000 dpm/100cm^2, which is a conservative assumption. This is solely a bounding value and not indicative of the actual MDC values experienced when URS were performed on the concrete, which were significantly lower. After all URS have been completed on the remainder of the concrete that will be reused as clean fill, the dose from fill in Table 5-16 will be recalculated based on the actual maximum MDC observed during the performance of the URS.

With the exception of the Turbine and Crib House/Forebay Basements described below, for all dose components (basements, soil and buried pipe), if the OpSOF for a systematic sample/measurement (based on the Operational DCGL) exceeds “one” in a Class 1 or Class 2 survey unit, or “0.5” in a Class 3 survey unit, then an investigation will be initiated in accordance with LTP Chapter 5, section 5.6.4.6 (Table 5-20). For basement surfaces, the MDC of the *In Situ* Object Counting System (ISOCS) is more than adequate to detect the ROC at the investigation levels. In Class 3 and Class 2 FSS units, the result of the investigation (confirmed OpSOF greater than 0.5 in a Class 3 FSS unit or greater than one in a Class 2 FSS unit) will prompt the reclassification of the survey unit (or a portion of the survey unit).

The FSS of the Turbine Basement walls and floors (which includes the Discharge Tunnels) and the Crib House/Forebay Basement walls and floors was completed prior to issuance of this TSD or LTP Rev 1. The areas have been backfilled and are no longer accessible. Therefore, investigation levels applicable to the FSS of the Turbine Basement and Crib House/Forebay basement walls and floors were based on the Base Case DCGL and the LTP Revision 0 surrogate ratios used for FSS data assessment prior to backfill (i.e. mean values as opposed to very conservative maximum values presented in LTP Revision 1). However, the compliance dose from these areas will be calculated using the methods and surrogate ratios described in LTP Revision 1 and this TSD. Although the release records for these areas have not been finalized, the estimated dose from the FSS results for Turbine and Crib House/Forebay walls and floors is 0.727 mrem/yr and 0.002 mrem/yr, respectively.

In a Class 1 FSS unit, the OpSOF (based on the Operational DCGL) for a systematic sample/measurement(s) may exceed one without remediation as long as the survey unit passes the Sign Test, the mean OpSOF for the survey unit does not exceed one when using the Operational DCGLs and the BcSOF for the sample/measurement(s) does not exceed one when using the Base Case DCGLs. If the survey does not pass the Sign Test (using Operational DCGLs), then further remediation will be performed.

The results of any judgmental sample/measurements will also be compared to the Operational DCGL. As with a systematic sample/measurement, any judgmental sample/measurement that exceeds a SOF of one in a Class 1 or Class 2 survey unit, or 0.5 in a Class 3 survey unit, will prompt an investigation, reclassification and/or resurvey as applicable. However, remediation will not be required unless the sample/measurement exceeds unity when compared to the applicable Base Case DCGLs.

In Class 1 open land FSS units, any areas of elevated residual radioactivity above the $DCGL_{EMC}$ will be remediated. The $DCGL_{EMC}$ calculation for soils will use Base Case DCGLs ($DCGL_{SS}$ from Table 4 and/or $DCGL_{SB}$ from Table 5), Area Factors (Tables 5-10 and 5-11 from LTP Chapter 5) and the EMC comparison in accordance with LTP Chapter 5, section 5.10.4. Note that the soil FSS unit must pass the Sign Test using Operational DCGLs for this to occur. In Class 1 buried pipe, any residual radioactivity greater than the Base Case DCGL for buried pipe ($DCGL_{BP}$ from Table 6) will be remediated. In all Class 1 structural surfaces, any residual radioactivity greater than the Base Case DCGLs for structures ($DCGL_B$ from Table 3) will be remediated. For all Class 1 embedded pipe and penetrations, any residual radioactivity greater that the Base Case DCGLs for embedded pipe ($DCGL_{EP}$ from Table 7) or penetrations ($DCGL_{PN}$ from Table 8) will be remediated. Any residual radioactivity in Class 1 embedded pipe and penetrations greater than the Base Case DCGLs for the structural surfaces ($DCGL_B$ from Table 3) where the pipe or penetration interfaces will require further remediation and/or grouting of the pipe (see LTP Chapter 5, section 5.5.6).

4. BASIS FOR DETERMINING OPERATIONAL DCGLS

The Base Case DCGLs from LTP Chapter 5 are reproduced as follows;

Table 3 Base Case Basement DCGLs ($DCGL_B$) – (from LTP Chapter 5, Table 5-3)

Nuclide	Auxiliary Building (pCi/m^2)	Containment (pCi/m^2)	SFP/Transfer Canal (pCi/m^2)	Turbine Building (pCi/m^2)	Crib House /Forebay (pCi/m^2)	WWTF (pCi/m^2)
H-3	5.30E+08	2.38E+08	2.38E+08	1.29E+08	1.93E+08	1.71E+07
Co-60	3.04E+08	1.57E+08	1.57E+08	7.03E+07	5.52E+07	2.83E+07
Ni-63	1.15E+10	4.02E+09	4.02E+09	2.18E+09	3.25E+09	2.89E+08
Sr-90	9.98E+06	1.43E+06	1.43E+06	7.74E+05	1.16E+06	1.03E+05
Cs-134	2.11E+08	3.01E+07	3.01E+07	1.59E+07	2.13E+07	2.31E+06
Cs-137	1.11E+08	3.94E+07	3.94E+07	2.11E+07	2.96E+07	2.93E+06
Eu-152	6.47E+08	3.66E+08	3.66E+08	1.62E+08	1.23E+08	7.55E+07
Eu-154	5.83E+08	3.19E+08	3.19E+08	1.43E+08	1.12E+08	5.74E+07

Note 1: The DCGL for the SFP/Transfer Canal was set equal to the lower of either the Auxiliary Building or Containment DCGLs. The Containment DCGLs were lower for all ROC; therefore, the SFP/Transfer Canal DCGLs were set equal to Containment DCGLs.

Table 4 Base Case DCGLs for Surface Soils ($DCGL_{SS}$) – (from LTP Chapter 5, Table 5-4)

Radionuclide	Surface Soil DCGL (pCi/g)
Co-60	4.26
Cs-134	6.77
Cs-137	14.18
Ni-63	3572.10
Sr-90	12.09

Table 5 Base Case DCGLs for Subsurface Soils ($DCGL_{SB}$) – (from LTP Chapter 5, Table 5-5)

Radionuclide	Subsurface Soil DCGL (pCi/g)
Co-60	3.44
Cs-134	4.44
Cs-137	7.75
Ni-63	763.02
Sr-90	1.66

Table 6 Base Case DCGLs for Buried Pipe ($DCGL_{BP}$) – (from LTP Chapter 5, Table 5-6)

Radionuclide	Buried Piping DCGL (dpm/100 cm^2)
Co-60	2.64E+04
Cs-134	4.54E+04
Cs-137	1.01E+05
Ni-63	4.89E+07
Sr-90	4.50E+04

Table 7 Base Case DCGLs for Embedded Pipe ($DCGL_{EP}$) – (from LTP Chapter 5, Table 5-7)

Radionuclide	Auxiliary Bldg. Basement Embedded Floor Drains (pCi/m^2)	Turbine Bldg. Basement Embedded Floor Drains (pCi/m^2)	Unit 1 & Unit 2 Containment In-Core Sump Embedded Drain Pipe (pCi/m^2)	Unit 1 & Unit 2 Steam Tunnel Embedded Floor Drains (pCi/m^2)	Unit 1 & Unit 2 Tendon Tunnel Embedded Floor Drains (pCi/m^2)
H-3	N/A	N/A	8.28E+09	N/A	1.61E+10
Co-60	7.33E+09	6.31E+09	5.47E+09	4.07E+10	1.06E+10
Ni-63	2.78E+11	1.96E+11	1.40E+11	1.26E+12	2.72E+11
Sr-90	2.41E+08	6.94E+07	4.98E+07	4.48E+08	9.70E+07
Cs-134	5.10E+09	1.43E+09	1.05E+09	9.22E+09	2.04E+09
Cs-137	2.68E+09	1.89E+09	1.37E+09	1.22E+10	2.67E+09
Eu-152	N/A	N/A	1.28E+10	N/A	2.48E+10
Eu-154	N/A	N/A	1.11E+10	N/A	2.16E+10

Table 8 Base Case DCGLs for Penetrations ($DCGL_{PN}$) – (from LTP Chapter 5, Table 5-8)

Nuclide	Auxiliary Bldg. (pCi/m^2)	Containment (pCi/m^2)	SFP/ Transfer Canal (pCi/m^2)	Turbine Bldg. (pCi/m^2)	Crib House/ Forebay (pCi/m^2)	WWTF (pCi/m^2)
H-3	3.99E+09	3.42E+09	4.84E+16	3.23E+09	N/A	N/A
Co-60	8.82E+07	2.26E+09	4.45E+08	1.76E+09	N/A	N/A
Ni-63	6.79E+10	5.78E+10	1.86E+14	5.48E+10	N/A	N/A
Sr-90	2.41E+07	2.06E+07	9.26E+10	1.94E+07	N/A	N/A
Cs-134	3.28E+08	4.32E+08	7.48E+08	4.00E+08	N/A	N/A
Cs-137	6.17E+08	5.66E+08	1.46E+09	5.29E+08	N/A	N/A
Eu-152	3.29E+08	5.26E+09	9.44E+08	4.06E+09	N/A	N/A
Eu-154	2.33E+08	4.58E+09	8.53E+08	3.58E+09	N/A	N/A

As the Base Case DCGLs represent the dose criterion, a reduction is required to ensure compliance with Equation 1. The reduced DCGLs, or "Operational" DCGLs can be related to the Base Case DCGLs as an expected fraction of dose based on an *a priori* assessment of what the expected dose should be based on the results of site characterization, process knowledge and the extent of planned remediation.

Equation 10

$$f = \frac{D_{exp}}{25}$$

where:

f	=	*a priori* expected fraction of dose
D_{exp}	=	*a priori* expected dose based on characterization, process knowledge and the extent of planned remediation
25	=	25 mrem/yr dose criteria for unrestricted release

4.1. Operational DCGLs for Basement FSS Units

An *a priori* fraction of dose will be applied to each source term in a basement FSS unit (structural surfaces, embedded pipe and penetrations). The *a priori* fraction of dose for the fill variable is determined by dividing the appropriate assigned dose from fill in LTP Chapter 5, Table 5-16, by 25 mrem/yr.

The sum of the *a priori* fraction of allowable dose for a basement FSS unit ($f_{Basement}$), including the dose assigned from the use of concrete debris as fill (Table 5-16) is;

Equation 11

$$f_{Basement} = f_B + f_{PN} + f_{EP} + f_{CF}$$

where:

f_B	=	*a priori* fraction of dose for structure surfaces
f_{PN}	=	*a priori* fraction of dose for penetrations
f_{EP}	=	*a priori* fraction of dose for embedded pipe
f_{CF}	=	*a priori* fraction of dose for concrete fill (LTP Chapter 5, Table 5-16)

Operational DCGLs for Basement survey units are derived by multiplying the applicable Base Case DCGL ($DCGL_B$ from Table 3, $DCGL_{EP}$ from Table 7 or $DCGL_{PN}$ from Table 8) by the *a priori* fraction of allowable dose for each basement dose component with area considerations indicated by LTP Chapter 5, Equation 5-9 incorporated as applicable. The Operational DCGL is then used as the DCGL for the FSS design of the survey unit (calculation of surrogate DCGLs, investigations levels, etc.).

As stated previously, the dose from fill is currently based on a maximum allowable MDC of 5,000 dpm/100cm^2. After all URS have been completed on the remainder of the concrete that will be reused as clean fill, the dose from fill in Table 5-16 will be recalculated based on the actual maximum MDC observed during the performance of the URS. At that time, this TSD will be revised to incorporate the revised fraction for fill for the $f_{Basement}$ term using the actual maximum observed MDC.

4.2. Operational DCGLs for Soil and Buried Pipe FSS Units

The same process described above for the determination of operational DCGLs for Basements will also be applied to the site compliance equation. An *a priori* fraction of dose will be applied to soils and buried pipe such that the sum of the expected fraction of allowable dose for soils, buried pipe and groundwater, when added to the maximum *a priori* dose from basement structures, is less than or equal one.

Equation 12

$$1 \geq f_{Basement} + f_{Soil} + f_{BP} + f_{GW}$$

where:

$f_{Basement}$	=	*a priori* fraction of dose for maximum basement survey unit
f_{soil}	=	*a priori* fraction of dose for maximum soil survey unit
f_{BP}	=	*a priori* fraction of dose for maximum buried pipe survey unit
f_{GW}	=	*a priori* fraction of dose for maximum groundwater

Once the FSS of basements is complete, an actual fraction of allowable dose will be calculated for each Basement FSS unit based on the measured mean BcSOF for each ROC including the dose from elevated systematic and/or judgmental measurements. The actual fraction of allowable dose from the Basement FSS unit with the highest dose will be used in Equation 12 for the $f_{Basement}$ term. It is anticipated that the actual maximum dose fraction will be significantly less than the *a priori* fraction used to derive the Operational DCGLs, mostly due to conservative assumptions used for remediation effectiveness. If the actual maximum dose fraction for basements exceeds the *a priori* fraction, then additional remediation will be required to reduce the actual maximum dose fraction to a level less than or equal to the *a priori* fraction value.

When Basement FSS is completed, the actual fraction of allowable dose from the Basement with the highest dose will be subtracted from the *a priori* fraction assigned to basements and the difference will be allocated to the *a priori* fractions for soil (f_{soil}) and/or buried pipe (f_{BP}). This TSD (Revision 1) will be revised at that time to reflect the new *a priori* dose fractions and new Operational DCGLs for soil and buried pipe (Revision 2). All FSS performed on soil and buried pipe survey units prior to the completion of FSS of all Basements will comply with the Operational DCGLs documented in Revision 1 of this TSD.

5. DETERMINATION OF *A PRIORI* DOSE FRACTIONS

Using the results of characterization data, process knowledge and the extent of expected remediation, the *a priori* dose fractions assigned to each basement dose component are presented in Table 9. The fractions were determined based on URS survey results for backfilled materials or the mean concentrations for each ROC measured during characterization or FSS and also takes into account anticipated remediation for ALARA purposes. These fractions will be used as the *a priori* fractions for determining operational DCGLs for basements (structural surfaces, embedded pipe and penetrations).

The maximum *a priori* total dose fraction for a basement FSS unit when summing each dose component fraction within each basement is 0.448. This is the value that will be currently applied to the site compliance equation for the expected fraction of dose for the maximum basement survey unit variable ($f_{Basement}$). The remaining dose fraction for the compliance equation, assuming $f_{Basement}$ at 0.448, is 0.552. The expected fraction of dose for the groundwater term (f_{GW}) due to instrument MDC is assumed to be 0.040. The remaining dose fraction of 0.512 is distributed between soil and buried pipe at 0.256 each. FSS surveys of open land and buried pipe survey units performed prior to the completion of the FSS of structures will be performed using these *a priori* fractions and the resulting Operational DCGLs (Revision 1 of this TSD). Once the FSS of structures is complete, the soil and buried pipe Operational DCGLs will be revised by incorporating the difference between the *a priori* fraction of dose for the maximum basement ($f_{Basement}$) and the actual fraction of dose for the maximum basement as measured by FSS results.

For example, if following FSS, the maximum dose attributed to a backfilled basement based on the mean SOF for each ROC equals 10 mrem/yr (summation of mean dose from structures, embedded pipe, penetrations and fill), with a corresponding actual fraction of allowable dose of 0.400. The *a priori* dose fraction for structures ($f_{Basement}$) was 0.448. In this example, the difference between the *a priori* dose fraction (0.448) and the measured dose fraction (0.400) would be 0.048. This difference would then be added to increase the *a priori* dose fraction for soils (f_{soil}), the *a priori* dose fraction for buried pipe (f_{BP}), or a combination of both by 0.048.

The establishment of final soil and buried pipe Operational DCGLs will be documented in a revision to this TSD and in subsequent FSS survey design packages and release records. Revision of any completed release records for any FSS performed prior to the establishment of final soil and buried pipe Operational DCGLs will not be necessary as the Operational DCGLs used will be based on a lower *a priori* dose fraction (in accordance with Revision 1 of this TSD).

Table 9 *a priori* Dose Fractions (*f*) for Basements

Basement FSS Unit	Surfaces (f_B)		Embedded Pipe (f_{EP})		Penetrations[5] (f_{PN})		Fill (f_{CF})		Total ($f_{Basement}$)
	Dose Component	**Fraction of 25 mrem/yr dose limit**	**Dose Component**	**Fraction of 25 mrem/yr dose limit**	**Dose Component**	**Fraction of 25 mrem/yr dose limit**	**Dose Component**	**Fraction of 25 mrem/yr dose limit**	
Auxiliary Building Basement	Floors and Walls	0.323	Floor Drains	0.007[1]	Penetrations	0.078	Fill	0.040	0.448
Unit 1 Containment Basement	Floors and Walls (Total)	0.209	In-Core Sump Drain	0.080	Penetrations	0.068	Fill	0.071	0.448
	(Dose Fraction Allocation by Area)								
	Floors and Walls Above 565 ft.	0.125	Tendon Tunnel Drain	0.020					
	Under-Vessel Area	0.084							
Unit 2 Containment Basement	Floors and Walls (Total)	0.209	In-Core Sump Drain	0.080	Penetrations	0.068	Fill	0.071	0.448
	(Dose Fraction Allocation by Area)								
	Floors and Walls Above 565 ft.	0.125	Tendon Tunnel Drain	0.020					
	Under-Vessel Area	0.084							
SFP/Transfer Canal	Floors and Walls[2]	0.209	N/A	N/A	Penetrations[3]	0.233	Fill	0.006	0.448
Turbine Building Basement[4]	Floors and Walls, Circulating Water Intake Pipe, Circulating Water Discharge Pipe (Total)	0.145	560 ft Floor Drains	0.040	Penetrations	0.080	Fill	0.063	0.448
	(Dose Fraction Allocation by Area)		U1 Steam Tunnel Drains	0.040					
	Discharge Tunnel Wall/Floor	0.075	U2 Steam Tunnel Drains	0.040					
	Turbine Walls/Floors, Buttress Pit/Tendon Tunnels, Circulating Water Intake Pipe, Circulating Water Discharge Piping	0.070	U1Tendon Tunnel Drain	0.020					
			U2 Tendon Tunnel Drain	0.020					
Crib House/Forebay[4]	Floors and Walls[3]	0.385	N/A	N/A	N/A	N/A	Fill	0.063	0.448
WWTF	Floors and Walls[3]	0.192	N/A	N/A	N/A	N/A	Fill	0.256	0.448

(1) The FSS of the Auxiliary Building 542 ft. embedded floor drain has been completed. The FSS results produced a mean SOF of 0.1696, equating to a dose of 4.2410 mrem/yr. Following FSS, the Auxiliary Building 542 ft. embedded floor drains were grouted to refusal. The *a priori* dose fraction is based on a conservative estimate of diffusion release through the grout and the FSS dose. This is the only a priori fraction in Table 9 that is based on the actual assignment of dose from FSS.

(2) SFP/Transfer Canal Floor/Wall dose set equal to Containment Floor/Wall dose to ensure Operation DCGL is equal to the lesser of Containment or Auxiliary Basement Operational DCGL, consistent with approach used to calculate SFP/Transfer Canal DCGL in LTP Rev 1 section 6.6.8.1 and Footnote (1) to LTP Rev 1 Table 6-26.

(3) Dose fraction by calculation only to add margin allowed to sum basement dose to maximum basement dose of 0.448. Actual dose estimate is less.

(4) At the time when this table was generated, the data collection portion of the FSS of the Turbine Building floors and walls, the 560 foot floor drains, Crib House and Circulating Water Discharge Tunnel has been completed, however the Release Records have not been completed. Note that although the release records for these areas have not been finalized, the estimated dose from the FSS results for Turbine and Crib House/Forebay walls and floors is 0.727 mrem/yr and 0.002 mrem/yr, respectively.

(5) Because a given penetration interfaces two basements, the lesser $OpDCGL_{PN}$ of the two basements will be used for FSS design and implementation.

6. OPERATIONAL DCGL VALUES

Operational DCGLs are derived by multiplying the Base Case DCGLs (Table 3 through Table 8) by the applicable *a priori* fraction of dose in Table 9.

The structural surface dose component for Unit 1 and Unit 2 Containment structural surfaces are further divided into two distinct areas, the surface area above the 565 ft. elevation and the Under-vessel Area below the 565 ft. elevation. The 565 ft. elevation is the location of the steel liner once the 3 feet of concrete has been removed from the Containment 568 ft. floor. The structural surfaces in the Turbine Building are also divided into two distinct areas, the summation of the surface area for the floors and walls, the buttress pits, the tendon tunnels, the Circulating Water Discharge Pipe and the Circulating Water Intake Pipe and the surface area attributed to the Circulating Water Discharge Tunnels (see Tables 1 and 2). In these cases, the Operational DCGLs were calculated using a weighted average approach using the following equation.

Equation 13

$$DCGL_{OP} = DCGL_{BC} * f_B * \left(\frac{Area_{Total}}{Area_{Surf}}\right)$$

where;

$DCGL_{OP}$ = Operational DCGL

$DCGL_{BC}$ = Base Case DCGL

f_B = *a priori* Dose Fraction for Structural Surface area (from Table 9)

$Area_{Total}$ = Total Area of all Structural Surfaces in Basement FSS unit (from LTP Chapter 6, Table 6-23) in m^2

$Area_{Surf}$ = Surface Area of the specific structural surface area (e.g. In-Core Area = 294 m^2, Discharge Tunnel = 4,868 m^2) or, the Total Area minus the Surface Area of the specific structural surface area (e.g. total Containment Area of 3,482 m^2 minus the In-Core Area of 294 m^2 = 3,188 m^2 or, total Turbine Area of 27,135 m^2 minus the Discharge Tunnel Area of 4,868 m^2 = 22,267 m^2

The operational DCGLs for FSS at Zion are presented in the following tables;

Table 10 Operational Basement DCGLs ($OpDCGL_B$) (pCi/m^2)

ROC	Auxiliary Building	Unit 1 & Unit 2 Containment		SFP/ Transfer Canal	Turbine Building		Crib House/ Forebay	WWTF
		(above 565 ft)	Under-vessel		(Floors & Walls) (1)	(Circ Water Discharge Tunnel)		
H-3	1.71E+08	3.25E+07	2.37E+08	4.98E+07	1.10E+07	5.39E+07	7.43E+07	3.28E+06
Co-60	9.81E+07	2.15E+07	1.56E+08	3.28E+07	5.98E+06	2.94E+07	2.13E+07	5.43E+06
Ni-63	3.71E+09	5.50E+08	4.00E+09	8.41E+08	1.85E+08	9.11E+08	1.25E+09	5.55E+07
Sr-90	3.22E+06	1.96E+05	1.42E+06	2.99E+05	6.58E+04	3.24E+05	4.47E+05	1.98E+04
Cs-134	6.81E+07	4.12E+06	2.99E+07	6.30E+06	1.35E+06	6.65E+06	8.20E+06	4.44E+05
Cs-137	3.58E+07	5.39E+06	3.92E+07	8.24E+06	1.79E+06	8.82E+06	1.14E+07	5.63E+05
Eu-152	2.09E+08	5.00E+07	3.64E+08	7.66E+07	1.38E+07	6.77E+07	4.74E+07	1.45E+07
Eu-154	1.88E+08	4.36E+07	3.17E+08	6.67E+07	1.22E+07	5.98E+07	4.31E+07	1.10E+07

(1) The Operational DCGLs for Floors & Walls will be applied to the surfaces in the Buttress Pits, Tendon Tunnels, Circulating Water Intake Pipe and Circulating Water Discharge Piping

Table 11 Operational DCGLs for Embedded Pipe ($OpDCGL_{EP}$) (pCi/m^2)

Radionuclide	Auxiliary Bldg. Basement Embedded Floor Drains(1)	Turbine Bldg. Basement Embedded Floor Drains	Unit 1 Containment In-Core Sump Embedded Drain Pipe	Unit 2 Containment In-Core Sump Embedded Drain Pipe	Unit 1 & Unit 2 Steam Tunnel Embedded Floor Drains	Unit 1 Tendon Tunnel Embedded Floor Drains	Unit 2 Tendon Tunnel Embedded Floor Drains
H-3	N/A	N/A	6.62E+08	6.62E+08	N/A	3.22E+08	3.22E+08
Co-60	7.33E+09	2.52E+08	4.38E+08	4.38E+08	1.63E+09	2.12E+08	2.12E+08
Ni-63	2.78E+11	7.84E+09	1.12E+10	1.12E+10	5.04E+10	5.44E+09	5.44E+09
Sr-90	2.41E+08	2.78E+06	3.98E+06	3.98E+06	1.79E+07	1.94E+06	1.94E+06
Cs-134	5.10E+09	5.72E+07	8.40E+07	8.40E+07	3.69E+08	4.08E+07	4.08E+07
Cs-137	2.68E+09	7.56E+07	1.10E+08	1.10E+08	4.88E+08	5.34E+07	5.34E+07
Eu-152	N/A	N/A	1.02E+09	1.02E+09	N/A	4.96E+08	4.96E+08
Eu-154	N/A	N/A	8.88E+08	8.88E+08	N/A	4.32E+08	4.32E+08

(1) The FSS of the Auxiliary Building 542 ft. embedded floor drain has been completed. The DCGLs listed are the $DCGL_{AD}$ values used to demonstrate compliance from Table 2 of the Release Record

Table 12 Operational DCGLs for Penetrations ($OpDCGL_{PN}$) (pCi/m^2)

Radionuclide	Auxiliary Bldg.	Unit 1 Containment	Unit 2 Containment	SFP/ Transfer Canal	Turbine Bldg.	Crib House/ Forebay	WWTF
H-3	3.14E+08	2.33E+08	2.33E+08	1.13E+16	2.58E+08	N/A	N/A
Co-60	6.95E+06	1.54E+08	1.54E+08	1.04E+08	1.41E+08	N/A	N/A
Ni-63	5.35E+09	3.93E+09	3.93E+09	4.33E+13	4.38E+09	N/A	N/A
Sr-90	1.90E+06	1.40E+06	1.40E+06	2.16E+10	1.55E+06	N/A	N/A
Cs-134	2.58E+07	2.94E+07	2.94E+07	1.74E+08	3.20E+07	N/A	N/A
Cs-137	4.86E+07	3.85E+07	3.85E+07	3.40E+08	4.23E+07	N/A	N/A
Eu-152	2.59E+07	3.58E+08	3.58E+08	2.20E+08	3.25E+08	N/A	N/A
Eu-154	1.84E+07	3.11E+08	3.11E+08	1.99E+08	2.86E+08	N/A	N/A

Table 13 Operational *a priori* DCGLs for Surface Soils ($OpDCGL_{SS}$) (pCi/g)

Radionuclide	Surface Soil DCGL
Co-60	1.091
Cs-134	1.733
Cs-137	3.630
Ni-63	914.458
Sr-90	3.095

Table 14 Operational *a priori* DCGLs for Subsurface Soils ($OpDCGL_{SB}$) (pCi/g)

Radionuclide	Subsurface Soil DCGL
Co-60	0.881
Cs-134	1.137
Cs-137	1.984
Ni-63	195.333
Sr-90	0.425

Table 15 Operational *a priori* DCGLs for Buried Pipe ($OpDCGL_{BP}$) ($dpm/100cm^2$)

Radionuclide	Buried Piping DCGL
Co-60	6.76E+03
Cs-134	1.16E+04
Cs-137	2.59E+04
Ni-63	1.25E+07
Sr-90	1.15E+04

7. REFERENCES

1. ZSRP License Termination Plan (LTP)