EMERGENCY DOSE CALCULATION MANUAL (EDCM) INSTRUCTION MEMO
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TMI Emergency Dose Calculation Manual (EDCM)		Revision No. **12**

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1.0 PURPOSE

The purpose of this manual is to provide a summary of the mathematics and assumptions used to perform offsite dose projections during emergency situations. This includes calculating projected on-site and off-site doses from releases of radioactive material to the environment in accident conditions upon implementation of the Emergency Plan. As such, this document describes methods of projecting off-site doses during emergencies or for training purposes. Indications of releases may result from Radiation Monitoring System (RMS) readings, on-site or off-site sample results, or contingency calculations, if RMS and sample results are not available.

2.0 APPLICABILITY/SCOPE

The EDCM is applicable to all qualified TMI Radiological Assessment Coordinator (RAC) personnel involved in the projection of on-site and off-site doses during an emergency. This manual provides the calculational methodologies used in performance of dose projections during emergency situations where radioactive material has been or is predicted to be released to the environment. The contents of the EDCM shall be used as the basis for the computations performed in the Emergency Plan RAC computer program.

3.0 DEFINITIONS

3.1 BUILDING WAKE EFFECTS - When an atmospheric release occurs at, near, or below the top of a building (or any structure) the dispersion of the release is affected by the wake effect of the building. Air flow over and around the structure from the prevailing wind tends to drive the release down to the ground on the downwind side of the structure. This has two effects: it increases on-site concentrations dramatically, while slightly reducing concentrations downwind for a short distance. Far downwind concentrations are affected very little by building wake. Building wake effects are most noticeable for ground level or low flow stack releases such as the condenser off-gas exhaust. Normal plant ventilation usually has a high enough flow that building wake does not affect the plume significantly. Building wake is accounted for as part of the split wake release modeling.

3.2 "CHI over Q" (X/Q) - is the dispersion of a gaseous release in the environment calculated by the split wake dispersion model. Normal units of X/Q are sec/cubic meter. X/Q is used to determine environmental atmospheric concentrations by multiplying the source term represented by Q. Thus dispersion, X/Q (sec/cubic meter) times source term, Q (μCi/sec) yields environmental concentration X (μCi/cubic meter). X/Q is a function of many parameters including wind speed, delta T (change in temperature with height), release point height, building size, and release velocity, among others. The release model takes all these into account when calculating atmospheric dispersion.

3.3 CONTAINMENT ATMOSPHERIC POST-ACCIDENT SAMPLING SYSTEM (CATPASS) - Post accident sampling system capable of providing sample(s) following an accident condition, coincident with a blackout, with limited personnel exposure. The sampling system, located in a post-accident accessible area, provides the capability for obtaining samples of the Reactor Building atmosphere, within one hour after the decision has been made to acquire the sample(s). The samples(s) are then used for radiological and hydrogen analysis. These results will provide an indication of the extent of core damage and provide good data for the Reactor Building source term if a Reactor Building release is possible.

3.4 CONTINGENCY CALCULATION - A source term calculation performed in the absence of sufficient effluent radiation monitoring system readings or post accident sample data. It is a mathematical calculation based upon the most representative physical model of actual accident plant conditions.

3.5 CORE DAMAGE - (Note: This definition to be used in lieu of defective/failed fuel.) A set of core classifications used to address the requirements of the NRC NUREG 0737 Criterion 2(a) upon implementation of the Emergency Plan. Based upon RCS pressure and incore thermocouple readings, an assessment is made of the degree of cladding failure, fuel overheat, and fuel melt.

3.6 DEFECTIVE FUEL/FAILED FUEL - See definition of core damage.

3.7 DOSE RATE CONVERSION FACTOR (DRCF) - A parameter calculated by the methods and models of internal dosimetry, which indicates the Committed Dose Equivalent (CDE) to an organ or Total Effective Dose Equivalent (TEDE) to the whole body per unit activity inhaled or ingested. This parameter is specific to the radionuclide and the dose pathway. Dose conversion factors are commonly tabulated in units of mrem/hr per curie/m^3 inhaled or ingested.

3.8 ELEVATED RELEASE - An airborne effluent plume which is well above any building wake effects so as to be essentially unentrained is termed an elevated release. The source of the plume may be elevated either by virtue of the physical height of the source above the ground elevation and buildings or by a combination of the physical height and the jet plume rise. Semi infinite modeling of elevated releases generally will not produce any significant ground level concentrations within the first few hundred yards of the source. Semi infinite modeling of elevated releases generally have less dose consequence to the public due to the greater downwind distance to the ground concentration maximum compared to ground releases. Elevated releases as used in the EDCM actually means "not at ground" in the split wake plume model. Other definitions of "elevated" with respect to plumes abound in literature.

3.9 EMERGENCY ACTION LEVEL (EAL) - Predetermined conditions or values, including radiation dose rates; specific levels of airborne; waterborne; or surface-deposited contamination; events such as natural disasters or fires; or specific instrument indicators which, when reached or exceeded, require implementation of the Emergency Plan.

3.10 EMERGENCY DIRECTOR (ED) - Designated on-site individual having the responsibility and authority to implement the Emergency Plan, and who will coordinate efforts to limit consequences of, and bring under control, the emergency.

3.11 EMERGENCY DOSE CALCULATION MANUAL (EDCM) - This controlled dose calculation manual is the documentation describing the content and calculational methods of the TMI Radiological Assessment Coordinator (RAC) model.

3.12 EMERGENCY OPERATIONS FACILITY (EOF) - The Emergency Operations Facilities serve as the primary locations for management of the Corporation's overall emergency response. These facilities are equipped for and staffed by the Emergency Support Organization to coordinate emergency response with off-site support agencies and to assess the environmental impact of the emergency. The EOF participates in accident assessment and transmits appropriate data and recommended protective actions to Federal, State and Local agencies.

3.13 EMERGENCY PLANNING ZONE (EPZ) - There are two Emergency Planning Zones. The first is an area, approximately 10 miles in radius around the site, for which emergency planning consideration of the plume exposure pathway has been given in order to assure that prompt and effective actions can be taken to protect the public and property in the event of an accident. This is called the Plume Exposure Pathway EPZ. The second is an area approximately 50 miles in radius around the site, for which emergency planning consideration of the ingestion exposure pathway has been given. This is called the Ingestion Exposure Pathway EPZ.

3.14 ENTRAINMENT - When a release is treated as a wake split release an entrainment factor is applied to specify how much of the release is to be considered elevated and how much is to be considered a ground release. Entrainment factor is related to the building wake effect. The entrainment factor is computed on a case by case basis and is dependent on both the stack exit velocity and the wind speed. At low wind speeds and high exit velocities, building effects are lowest and the entrainment factor selects for elevated release. At high wind speeds and/or low exit velocities the building effect is highest and the entrainment factor results in a ground level release. Intermediate conditions cause entrainment factors which will split the release between ground and elevated. The general form for the application of the entrainment factor (Ef) is:

X/Q(splitwake)=X/Q(ground)*Ef + X/Q(elevated)*(1-Ef).

As can be seen from the formula, when the entrainment factor is one, the release is entirely ground and when the entrainment factor is zero, the release is entirely elevated. When $0 < Ef < 1$ then the release is split.

3.15 EPICOR II - Radioactive Liquid Waste Processing Facility located on the east side of TMI-2. This facility is used to process radioactive liquid waste. A Victoreen radiation monitor is located on the ventilation system of this facility. The ventilation system average flow rate is 9000 CFM.

3.16 EXCLUSION AREA (EA) - As defined in 10CFR100.3; "that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area". At TMI this is an area with a 2000 ft. radius from the point equidistant between the centers of the TMI-1 and TMI-2 reactor buildings.

3.17 EXIT VELOCITY AND PLUME RISE - Atmospheric dispersion and ground concentrations are in part dependent on release height. Higher release heights will cause lower maximum concentrations at ground and will cause that maximum to occur further downwind than would a lower release height. The effective height of a stack is not only dependent on its physical height, but also on whether the plume rises or not. At high linear flow rates (exit velocity), the release plume behaves much like a geyser and rises in a jet flow above the stack. The height to which the jet flow rises becomes the effective stack height.

3.18 FINITE PLUME MODEL - Atmospheric dispersion and dose assessment model which is based on the assumption that the horizontal and vertical dimensions of an effluent plume are not necessarily large compared to the distance that gamma rays can travel in air. It is more realistic than the semi-infinite plume model because it considers the finite dimensions of the plume, the radiation build-up factor, and the air attenuation of the gamma rays coming from the cloud. This model can estimate the dose to a receptor who is not submerged in the radioactive cloud. It is particularly useful in evaluating doses from an elevated plume or when the receptor is near the effluent source. This model is used by the MIDAS computer program.

3.19 FUEL HANDLING BUILDING ENGINEERED SAFETY FEATURE VENTILATION SYSTEM - The Fuel Handling Building ESF Ventilation System is installed to contain, confine, control, mitigate, monitor and record radiation release resulting from a TMI-1 postulated spent fuel accident in the Fuel Handling Building as described in FSAR, Section 14.2.2.1. Normal operation of the Fuel Handling Building ESF Ventilation System is during TMI-1 spent fuel movements in the Fuel Handling Building. The system design includes adequate air filtration and exhaust capacity to ensure that no uncontrolled radioactive release to atmosphere occurs. The System includes effluent radiation monitoring capability.

3.20 GAUSSIAN PLUME EQUATION - An equation which takes input parameters of plume height, sigma-Y, sigma-Z, and wind speed, which explicitly calculates the straight line Gaussian Plume Dispersion. The Gaussian Plume equation actually averages short term variations to produce a mean effective plume, so short term measurements of the plume may not be duplicated by the Gaussian Plume Model.

3.21 GROUND RELEASE - An airborne effluent plume which contacts the ground essentially at the point of release either from a source actually located at the ground elevation or from a source well above the ground elevation which has significant building wake effects to cause the plume to be entrained in the wake and driven to the ground elevation is termed a ground level release. Ground level releases are treated differently than elevated releases in that the X/Q calculation results in significantly higher concentrations at the ground elevation near the release point. Ground releases also have generally lower X/Qs all the way downwind.

3.22 HYDROGEN PURGE SYSTEM - Post-accident containment purge system is designed to maintain the hydrogen concentration of the post-accident containment atmosphere below the lower flammability limit. The system does this by introducing outside air into the Reactor Building, which allows the displaced containment atmosphere to be discharged in a controlled manner into the normal Reactor Building exhaust duct. In the flow path three release rates exist which can be additive to give flow from 5 to 1250 CFM.

3.23 INTERIM SOLID WASTE STAGING FACILITY (ISWSF) - This facility has no ventilation system or radiation monitor, but has the potential to release radioactive material to the environment. Releases would be assessed using field team data and/or MIDAS.

3.24 LOW POPULATION ZONE (LPZ) - As defined in 10CFR100.3 "the area immediately surrounding the exclusion area which contains residents, the total number and density of which are such that there is a reasonable probability that appropriate protective measures could be taken in their behalf in the event of a serious accident.

3.25 METEOROLOGICAL INFORMATION AND DOSE ASSESSMENT SYSTEM (MIDAS) - This is the acronym for the computer program that can be used by the Environmental Assessment Command Center (EACC) to project off-site doses for routine effluents and releases during emergencies. Some features of MIDAS that are not in the RAC program are ingestion pathway doses, liquid and gas population doses, dose projections at any desired point of interest, and sector dose integration.

3.26 FUEL DAMAGE CLASS - A method of estimating the extent of core damage per NUREG-0737 Criterion 2 (a) under accident conditions requiring implementation of the Emergency Plan. The initial estimate of the degree of reactor core damage is derived from the average of the five highest incore thermocouples and RCS pressure. The assessment is performed utilizing a matrix that consists of ten (10) possible damage categories ranging from "no damage" to "major clad damage plus fuel melting".

3.27 PARTITION FACTOR - (Condenser), see NUREG-0017

3.28 RCS POST-ACCIDENT SAMPLING SYSTEM (PASS) - System used for acquiring a pressurized liquid sample of the RCS during emergency conditions. The post-accident reactor coolant sampling system provides a means of obtaining and analyzing a representative sample of reactor coolant, including dissolved gases, reactor coolant bleed tank contents and reactor containment sump contents, within three hours after the decision to acquire the sample, without excessive operator exposure or compromise of interfacing safety-related systems.

3.29 PLANT SHUTDOWN RADIOIODINE SPIKING -

Radioiodine spiking occurs when the reactor is shutdown, and is caused when the fuel gap activity is washed out of fuel rods with cladding defects.

3.30 PROTECTIVE ACTION GUIDE (PAG) - Projected radiological dose or dose commitment values to individuals of the general population and to emergency workers that warrant protective action before or after a release of radioactive material. Protective actions would be warranted provided the reduction in individual dose expected to be achieved by carrying out the protective action is not offset by excessive risks to individual safety in taking the protective action. The protective action guide does not include the dose that has unavoidably occurred prior to the assessment.

3.31 PROTECTIVE ACTION RECOMMENDATION (PAR) - Those actions taken during or after an emergency situation that are intended to minimize or eliminate the hazard to the health and safety of the general public and/or on-site personnel.

3.32 RADIATION MONITORING SYSTEM (RMS) - The RMS detects, indicates, annunciates, and records the radiation level at selected locations inside and outside the plant to verify compliance with applicable Code of Federal Regulations (CFR) limits. The RMS consists of the following subsystems: area monitoring, atmospheric monitoring, and liquid monitoring.

3.33 RADIOIODINE PLATEOUT - Iodines are very chemically reactive, being members of the halogen family. As such, iodines have a very high probability of reacting with almost any other material they come in contact with. Radioiodine plateout is a generic term for the mechanisms by which radioactive iodines are removed from a waste stream by contact with materials not specifically designed or engineered for radioiodine removal. Examples of potential radioiodine plateout reactions are the removal of iodine from gaseous wastes by adsorption onto interior surfaces of ductwork and piping and on any exposed surfaces of the room or building originating the release.

3.34 RADIOIODINE PROCESSOR STATIONS (MAP-5) - System used for acquiring particulate and iodine samples from the Reactor Building Exhaust, Auxiliary and Fuel Handling Building Exhaust or the Condenser Off-gas Exhaust during emergency conditions. The stations are controlled by solenoid valves which activate on high alarm indications on the low gas channels of the effluent stream. Flow is actuated through (3) parallel filter cartridges per station. The sampling times are adjustable on each local control panel. The filter cartridges must be removed manually for analysis.

3.35 RADIOLOGICAL ASSESSMENT COORDINATOR (RAC) - The RAC is responsible for all on-site radiological assessment activities. Initially, the RAC is responsible for directing the on-site and off-site survey teams. The RAC is relieved of off-site radiological monitoring responsibilities by the Environmental Assessment Coordinator. The RAC performs dose projections, based upon source term estimates and provides information to the EAC. Initially the Group Radiological Control Supervisor assumes the role of the RAC until relieved by the Initial Response Emergency Organization RAC, and RASE.

3.36 RADIOLOGICAL ASSESSMENT SUPPORT ENGINEER (RASE) - Individuals assigned to assist the RAC in performing dose calculations, source term calculations, and overall assessment and control of radiological hazards. Normally one RAC and one RASE are on duty at all times.

3.37 REACTOR COOLANT SYSTEM (RCS) - This system contains the necessary piping and components to provide sufficient water flow to cool the reactor. This system provides for the transfer of thermal energy from the reactor core to the once through steam generators (OTSG) to make steam, acts as a moderator for thermal fission, and provides a boundary to separate fission products from the atmosphere.

3.38 RELEASE DURATION - Release duration refers to the time interval during which radionuclides are released from the nuclear facility. Releases may be monitored, unmonitored, actual, or projected. The time interval used to estimate a release of unknown duration should reflect best estimates of the plant technical staff. In the absence of other information, use eight hours as the expected release duration. For purposes of determining whether to take a protective action on the basis of projected dose from an airborne plume, the projected dose should not include the dose that has already been received prior to the time the dose projection is done.

3.39 RELEASE RATE - This term refers to the rate at which radionuclides are released to the environment. Normally, it will be expressed in curies per second (Ci/sec) or microcuries per second (µCi/sec).

3.40 RESPIRATOR AND LAUNDRY MAINTENANCE FACILITY (RLM) - This facility is used to process clean and maintain laundry and respirators for TMI. This facility's 900 CFM ventilation system is monitored using an AMS-3 radiation monitor. The RLM has HEPA filters installed in the ventilation system. Releases would be assessed using field team data and/or MIDAS.

3.41 RMS RESPONSE FACTOR - Parameter which is used to convert RMS monitor count rates to total microcurie per cubic centimeter of the assumed or measured radionuclide spectrum passing by the monitor. This is different from a meter calibration factor which does the same thing for a single calibration nuclide. These factors are adjusted for changes in mixture decay.

3.42 SEMI-INFINITE PLUME MODEL - Dose assessment model which is based on the assumption that the dimensions of an effluent plume are large compared to the distance that gamma rays can travel in air. If the plume dimensions are larger than the gamma ray range, then the radius of the plume might just as well be infinite since radiation emitted from beyond a certain distance will not reach the receptor. The ground is considered to be an infinitely large flat plate and the receptor is assumed to be standing at the center of a hemispherical cloud of infinite radius. The radioactive cloud is limited to the space above the ground plane. This is the origin of the name SEMI-INFINITE PLUME. The noble gas DAC's were developed on the basis of the semi-infinite plume model.

3.43 SIGMA-Y AND SIGMA-Z - Parameters of the Gaussian diffusion equation which determine horizontal and vertical diffusion. Sigma-Y and Sigma-Z varies by stability class and distance from release point.

3.44 SOURCE TERM - A source term is the activity of an actual release or the activity available for release. The common units for the source term are curies, curies/Sec, or multiples thereof (e.g., microcuries). The term "Source Term" derives from the equations involved in doing dose calculations, since the equations contain many terms (a term being mathematical nomenclature for a portion of an equation), the "Source Term" is that portion of the equation which addresses the activity released. Although the term "Source Term" is used loosely to mean almost any activity for airborne, liquids, and even dose rate calculations in plant, strictly speaking "Source Term" applies only to radioactive material actually released.

3.45 SPLIT WAKE RELEASE - Airborne releases, for purposes of assessing off-site dispersion, must address the elevation of the release since wind speed changes with height, buildings affect dispersion for low releases and even wind direction can be different. Many release points are actually at a height where, given different conditions of release flow rate and meteorology, could either be most accurately described as ground or elevated releases, or some mixture between the two. The purpose of treating a release as a split wake release is to address this problem. When a release point is set up to be treated as a split wake release, the atmospheric dispersion is calculated based on a mixture of elevated and ground releases. Thus at high release flow rates the release may appear to be entirely an elevated release and at very low flow rates it may appear to be entirely a ground level release. In intermediate conditions, the model will "split" the release between ground and elevated as appropriate, so that a release might be 25% ground and 75% elevated from the same release point.

3.46 STABILITY CLASS - Dispersion of an effluent plume in the atmosphere is a function of the amount of mixing occurring between the plume and the atmosphere around the plume. The amount of mixing is related to what is referred to as the stability of the atmosphere. Conditions which create good mixing are unstable and conditions which create poorer mixing are stable. Pasquill stability class is a breakdown of the relative atmospheric stability into seven groups, denoted as A through G, from most unstable to most stable. In the pasquill stability class system, stability is related to the relative change in temperature with height, delta T. The more negative the change in temperature with increasing height, the more unstable the atmosphere. The RAC program uses sensors on the Meteorological tower at 33 feet and 150 feet to determine the delta T. Once the delta T is determined, a stability class is selected based on the delta T and the atmospheric dispersion (X/Q) is calculated based on the selected stability class.

3.47 TERRAIN FACTOR - The terrain factor is the terrain height in meters above plant grade. Terrain factor varies with sector and distance from the release point.

3.48 TWO PHASE RELEASE - Liquid and steam release from the main steam safety relief valves. Following discharge to the environment the steam fraction is calculated assuming there is no change in system entropy and that the OTSG wide range level instrument is indicating that the valve inlet fluid condition is either pure liquid or steam (greater than 600 inches as indicated on the Wide Range Level Indicators on PCL Panel, and the pressure indicators PI-950A and PI-952A).

3.49 WASTE HANDLING AND PACKAGING FACILITY (WHPF) - This facility is used to handle and package radioactive waste. This facility's ventilation is monitored by an AMS-3 radiation monitor, and runs at 7100 CFM. Releases would be assessed using field team data and/or MIDAS.

3.50 WIND SPEED ADJUSTMENTS - Since wind speed varies with height and the wind speed sensors are not at the release height, an adjustment is made to extrapolate the measured wind speed to the wind speed at the release height. The adjustment amount is dependent on the stability class.

4.0 PREREQUISITES

4.1 The following are the prerequisites for performance of TMI projected doses using the methods in the EDCM, and the current TMI RAC model.

4.1.1 The Emergency Plan is being implemented.

4.1.2 The RAC station is manned and functional.

5.0 **PROCEDURE**

This section of the EDCM is divided into the processes that are contained in the RAC model. Listed below is a table of contents for the procedure section of the EDCM:

Each part of this section explains what each process does and how it does it.

5.1 Source Term Calculations - The source term portion of the TMI dose assessment model is used to generate the quantity and radionuclide make up of the radioactive material released (or available for release) to the environment. Once the source term is measured or estimated, meteorological and dosimetry models are applied to the assessment.

5.2 Release Pathways and Characteristics

5.2.1 The following are the Release Pathways:

1. OTSG Tube Rupture Release
   - Includes: via the condenser off-gas or directly to atmosphere.
2. Reactor Building Release
3. Station Vent Release
   - Includes: Auxiliary Building, Fuel Handling Building (FHB) and ESF FHB.

5.2.2 The following are the Release Characteristics

1. OTSG Tube Rupture via condenser off-gas
2. OTSG Tube Rupture directly to atmosphere via the Main Steam Reliefs or Atmospheric Dump Valves
3. LOCA in the Reactor Building
4. Fuel Handling Accident in the Reactor Building
5. Fuel Handling Accident in the Fuel Handling Building, including ESF Fuel Handling Building Releases
6. LOCA in the Auxiliary Building
7. Waste Gas Tank Release

5.2.3 The following methods are used for source term generation:

1. Use Post Accident Sample Result
2. Use RMS
3. Use Contingency Calculation

NOTE

The least accurate to the most accurate source term generation methodology is contingency calculations, RMS calculations, and post accident sample result calculations.

5.2.4 Airborne releases from the following pathways are evaluated (See Figure 5.9-4):

A. The OTSG Tube Rupture:

1. RM-A-5 Condenser Off-gas
2. RM-A-5 High-Condenser Off-gas
3. RM-G-25 Condenser Off-gas
4. RM-G-26 Main Steam Reliefs and Atmospheric Dump Valves
5. RM-G-27 Main Steam Reliefs and Atmospheric Dump Valves
6. RM-A-5 MAP-5 Samples
7. Main Steam Release directly to the atmosphere
8. Contingency Calculations without RMS or Post Accident Samples

B. The Reactor Building:

1. RM-A-9 Reactor Building Purge
2. RM-A-9 High-Reactor Building Purge
3. RM-G-24 High High-Reactor Building Purge
4. RM-A-2 Reactor Building Atmosphere
5. CATPASS Samples
6. RM-A-9 MAP-5 Samples
7. Contingency Calculations without RMS or Post Accident Samples

C. The Station Vent:

1. RM-A-4 Fuel Handling Building Exhaust
2. RM-A-6 Auxiliary Building Exhaust
3. RM-A-8 Station Vent (Auxiliary and Fuel Handling Buildings)
4. RM-A-8 High-Auxiliary Building Exhaust
5. RM-A-14 ESF Fuel Handling Building Exhaust
6. RM-A-8 MAP-5 Samples

5.3 Calculation of Fuel Damage Class and Isotopic Percentages - This calculation will determine the mix or percentages of the following fifteen radionuclides.

5.3.1 Ten Noble Gases / Five Radioiodines

Ten Noble Gases	Five Radioiodines
1. Kr-85m	1. I-131
2. Kr-85	2. I-132
3. Kr-87	3. I-133
4. Kr-88	4. I-134
5. Xe-131m	5. I-135
6. Xe-133m	
7. Xe-133	
8. Xe-135m	
9. Xe-135	
10. Xe-138	

5.3.2 The Fuel Damage Class Determination

The determination of the Fuel Damage Class is performed using various core temperature regions from Operations Procedure 1210-8, see Figure 5.3-1. The core temperatures used in the model are the average of the five highest incore thermocouples. The curves relating to saturation, and cladding failures are approximated by straight line equations. Fuel damage classes 1 - 10 are based on the different pressure and temperature regions of Figure 5.3-1.

5.3.2.1 Core Temperature Regions - Figure 5.3-1

The region to the left of curve C represents normal RCS activity, Fuel Damage Class-1. The region between curves C and D represents RCS plus a percentage of gap activity, Fuel Damage Class 2 - 4. The region between Curve D and Curve E represents RCS plus all gap activity plus a percentage of noble and volatile fission product release from fuel grain boundaries, (CS, I, Rb), Fuel Damage Class 5 - 7. The region between Curve E and 2550°F incore temperature represents RCS activity plus 100% of the gap activity and 100% of the in vessel melt release assuming NUREG-1228 release fractions, Fuel Damage Class 8 - 10.

5.3.2.2 The curves represented in Figure 5.3-1 have the following equations:

- Curve C: 1400F Tclad Curve

Temperature = 406.1 + (0.34027 * PRESS)-(0.0000538 * PRESS^2)

- Curve D: 1800F Tclad Curve

Temperature = 690.92 + (0.37178 * PRESS)-(0.0000554 * PRESS^2)

- Curve E: 2200F Tclad Curve

Temperature = 1135.3 + (0.40018 * PRESS)-(0.0000567 * PRESS^2)

Where: Temperature = Incore Thermocouple Temperature (F°);

PRESS = RCS Indicated Pressure (Psig)

5.3.2.3 The matrix below shows the theory of fuel damage based on TDR-431.

Degree of Degradation	Fuel Damage Class Minor < 10%	Intermediate 10 - 50%	Major > 50%
No Fuel Damage (RCS)	-No Damage :	Class 1 or Class 1A	
Cladding Failure (GAP)	2	3	4
Fuel Overheat (Fuel Matrix)	5	6	7
Fuel Melt (Fuel Matrix)	8	9	10

5.3.3 Calculation of Radionuclide Mix Percentages Based on Fuel Damage Classification. Once the determination of Fuel Damage Class 1 - 10 has been determined from the Core Temperature Regions the various radionuclide mix percentages can be calculated based on the distribution of the RCS Activity, GAP Activity, and/or Fuel Matrix Activity. Various combinations of activities for each Fuel Damage Class are modeled as follows:

Fuel Damage Class	RCS Activity Fraction	GAP Activity Fraction	Fuel Matrix Fraction
1	1	0.0	0.0
2	1	0.1	0.0
3	1	0.5	0.0
4	1	1	0.0
5	1	1	0.1
6	1	1	0.5
7	1	1	1
8	1	1	1
9	1	1	1
10	1	1	1

5.3.3.1 Therefore, as an example: Fuel Damage Class-6 would consist of 100% RCS Activity, plus 100% of the GAP Activity, plus 50% of the Fuel Matrix Activity.

5.3.3.2 TMI-1 Normal RCS Activity - TMI-1 normal RCS Activity is monitored regularly during operation and is readily available to emergency dose assessment personnel.

5.3.3.2.1 Plant Shutdown Radioiodine Spiking represents the "spiking" of the radioiodines and noble gases. Plant Shutdown Radioiodine Spiking occurs when the reactor is shutdown, and is caused when the fuel gap activity is washed out of fuel rods with cladding defects.

Default spiking factors for current fuel conditions are monitored by Radiological Engineering and Nuclear Engineering, and made available to emergency dose assessment personnel.

The TSC should be requested to provide the actual "spiking" factors for the particular plant shutdown situation. The default factors are to be used if information is not available from the TSC.

This "spiking" of radioiodine and noble gas activities represent an increase in RCS radioactivity due to a plant evolution and do not represent an indication of fuel damage; i.e., Fuel Damage Classes 2-10. Spiking only occurs when fuel defects are present.

5.3.3.3 Gap Activity and Fuel Matrix Activity - Gap activity and Fuel Matrix activity used in the model are determined from TDR-431.

TMI Unit 1

Isotope	GAP Act. Curies	GAP %	Fuel Matrix Act. Curies	Fuel Matrix %
Kr-85m	4.84E+04	0.45	2.13E+07	2.36
Kr-85	7.48E+04	0.70	8.59E+04	0.01
Kr-87	2.63E+04	0.25	3.90E+07	4.33
Kr-88	6.67E+04	0.63	5.91E+07	6.56
Xe-131m	7.96E+04	0.75	5.40E+05	0.06
Xe-133m	9.30E+04	0.87	3.09E+06	0.34
Xe-133	8.34E+06	78.31	1.28E+08	14.20
Xe-135m	2.72E+04	0.26	3.37E+07	3.74
Xe-135	3.45E+04	0.32	1.59E+07	1.76
Xe-138	0.00E+00	0.00	0.00E+00	0.00
I-131	1.29E+06	12.11	6.37E+07	7.07
I-132	1.85E+05	1.74	9.70E+07	10.76
I-133	2.79E+05	2.62	1.43E+08	15.86
I-134	1.74E+04	0.16	1.67E+08	18.53
I-135	8.83E+04	0.83	1.30E+08	14.42
Sum	1.13E+07	100.0	Sum 9.02E+08	100.0

5.3.3.4 The following tables represent the Fuel Damage Class 2 - 10 mixes, percentages, curies, and concentrations used in the RAC model.

	Damage Class 2			Damage Class 3		
	μCi/cc**	Percent	Curies	μCi/cc**	Percent	Curies
I-131	6.03E+02	12.09	1.29E+05	3.01E+03	12.11	6.45E+05
I-132	8.66E+01	1.74	1.85E+04	4.32E+02	1.74	9.25E+04
I-133	1.31E+02	2.62	2.79E+04	6.52E+02	2.62	1.40E+05
I-134	8.43E+00	0.17	1.80E+03	4.10E+01	0.16	8.76E+03
I-135	4.15E+01	0.83	8.88E+03	2.07E+02	0.83	4.42E+04
Subtotal	8.70E+02	17.45	1.86E+05	4.35E+03	17.46	9.30E+05
KR-85M	2.28E+01	0.46	4.87E+03	1.13E+02	0.45	2.42E+04
KR-85	3.50E+01	0.70	7.48E+03	1.75E+02	0.70	3.74E+04
KR-87	1.25E+01	0.25	2.67E+03	6.16E+01	0.25	1.32E+04
KR-88	3.15E+01	0.63	6.73E+03	1.56E+02	0.63	3.34E+04
XE-131M	3.72E+01	0.75	7.96E+03	1.86E+02	0.75	3.98E+04
XE-133M	4.36E+01	0.87	9.32E+03	2.17E+02	0.87	4.65E+04
XE-133	3.90E+03	78.29	8.35E+05	1.95E+04	78.30	4.17E+06
XE-135M	1.28E+01	0.26	2.74E+03	6.37E+01	0.26	1.36E+04
XE-135	1.72E+01	0.34	3.68E+03	8.17E+01	0.33	1.75E+04
XE-138	1.70E-01	0.00	3.64E+01	1.70E-01	0.00	3.64E+01
Subtotal	4.12E+03	82.55	8.81E+05	2.05E+04	82.54	4.40E+06
Total	4.99E+03	100.00	1.07E+06	2.49E+04	100.00	5.33E+06
Noble Gas To Iodine Ratio	4.73	4.73	4.73	4.73	4.73	4.73

** THESE μCi/cc VALUES ARE BASED ON NORMAL RCS VOLUME OF 66,595 GALLONS

	Damage Class 4			Damage Class 5		
	μCi/cc**	Percent	Curies	μCi/cc**	Percent	Curies
I-131	6.03E+03	12.11	1.29E+06	3.58E+04	7.60	7.66E+06
I-132	8.65E+02	1.74	1.85E+05	4.62E+04	9.81	9.89E+06
I-133	1.30E+03	2.62	2.79E+05	6.81E+04	14.46	1.46E+07
I-134	8.16E+01	0.16	1.75E+04	7.81E+04	16.59	1.67E+07
I-135	4.13E+02	0.83	8.83E+04	6.12E+04	12.99	1.31E+07
Subtotal	8.69E+03	17.46	1.86E+06	2.89E+05	61.44	6.19E+07
KR-85M	2.26E+02	0.45	4.84E+04	1.02E+04	2.16	2.18E+06
KR-85	3.50E+02	0.70	7.48E+04	3.90E+02	0.08	8.34E+04
KR-87	1.23E+02	0.25	2.63E+04	1.83E+04	3.90	3.93E+06
KR-88	3.12E+02	0.63	6.68E+04	2.79E+04	5.93	5.98E+06
XE-131M	3.72E+02	0.75	7.96E+04	6.24E+02	0.13	1.34E+05
XE-133M	4.35E+02	0.87	9.30E+04	1.88E+03	0.40	4.02E+05
XE-133	3.90E+04	78.31	8.34E+06	9.88E+04	20.97	2.11E+07
XE-135M	1.27E+02	0.26	2.72E+04	1.59E+04	3.37	3.40E+06
XE-135	1.62E+02	0.33	3.47E+04	7.59E+03	1.61	1.62E+06
XE-138	1.70E-01	0.00	3.64E+01	1.70E-01	0.00	3.64E+01
Subtotal	4.11E+04	82.54	8.79E+06	1.82E+05	38.56	3.89E+07
Total	4.98E+04	100.00	1.07E+07	4.71E+05	100.00	1.01E+08
Noble Gas To Iodine Ratio	4.73	4.73	4.73	0.63	0.63	0.63

**THESE μCi/cc VALUES ARE BASED ON NORMAL RCS VOLUME OF 66,595 GALLONS

	Damage Class 6			Damage Class 7		
	µCi/cc**	Percent	Curies	µCi/cc**	Percent	Curies
I-131	1.55E+05	7.18	3.31E+07	3.04E+05	7.13	6.50E+07
I-132	2.28E+05	10.55	4.87E+07	4.54E+05	10.66	9.72E+07
I-133	3.35E+05	15.56	7.18E+07	6.70E+05	15.71	1.43E+08
I-134	3.90E+05	18.10	8.35E+07	7.80E+05	18.31	1.67E+08
I-135	3.04E+05	14.11	6.51E+07	6.08E+05	14.26	1.30E+08
Subtotal	1.41E+06	65.50	3.02E+08	2.82E+06	66.07	6.03E+08
KR-85M	5.00E+04	2.32	1.07E+07	9.98E+04	2.34	2.13E+07
KR-85	5.50E+02	0.03	1.18E+05	7.51E+02	0.02	1.61E+05
KR-87	9.12E+04	4.23	1.95E+07	1.82E+05	4.28	3.90E+07
KR-88	1.38E+05	6.42	2.96E+07	2.76E+05	6.49	5.92E+07
XE-131M	1.63E+03	0.08	3.50E+05	2.90E+03	0.07	6.20E+05
XE-133M	7.65E+03	0.36	1.64E+06	1.49E+04	0.35	3.18E+06
XE-133	3.38E+05	15.68	7.23E+07	6.37E+05	14.95	1.36E+08
XE-135M	7.89E+04	3.66	1.69E+07	1.58E+05	3.70	3.37E+07
XE-135	3.73E+04	1.73	7.98E+06	7.45E+04	1.75	1.59E+07
XE-138	1.70E-01	0.00	3.64E+01	1.70E-01	0.00	3.64E+01
Subtotal	7.44E+05	34.50	1.59E+08	1.45E+06	33.93	3.10E+08
Total	2.16E+06	100.00	4.61E+08	4.26E+06	100.00	9.12E+08
Noble Gas To Iodine Ratio	0.53	0.53	0.53	0.51	0.51	0.51

**THESE µCi/cc VALUES ARE BASED ON NORMAL RCS VOLUME OF 66,595 GALLONS

	Damage Class 8			Damage Class 9		
	μCi/cc**	Percent	Curies	μCi/cc**	Percent	Curies
I-131	3.04E+05	7.13	6.50E+07	3.04E+05	7.13	6.50E+07
I-132	4.54E+05	10.66	9.72E+07	4.54E+05	10.66	9.72E+07
I-133	6.70E+05	15.71	1.43E+08	6.70E+05	15.71	1.43E+08
I-134	7.80E+05	18.31	1.67E+08	7.80E+05	18.31	1.67E+08
I-135	6.08E+05	14.26	1.30E+08	6.08E+05	14.26	1.30E+08
Subtotal	2.82E+06	66.07	6.03E+08	2.82E+06	66.07	6.03E+08
KR-85M	9.98E+04	2.34	2.13E+07	9.98E+04	2.34	2.13E+07
KR-85	7.51E+02	0.02	1.61E+05	7.51E+02	0.02	1.61E+05
KR-87	1.82E+05	4.28	3.90E+07	1.82E+05	4.28	3.90E+07
KR-88	2.76E+05	6.49	5.92E+07	2.76E+05	6.49	5.92E+07
XE-131M	2.90E+03	0.07	6.20E+05	2.90E+03	0.07	6.20E+05
XE-133M	1.49E+04	0.35	3.18E+06	1.49E+04	0.35	3.18E+06
XE-133	6.37E+05	14.95	1.36E+08	6.37E+05	14.95	1.36E+08
XE-135M	1.58E+05	3.70	3.37E+07	1.58E+05	3.70	3.37E+07
XE-135	7.45E+04	1.75	1.59E+07	7.45E+04	1.75	1.59E+07
XE-138	1.70E-01	0.00	3.64E+01	1.70E-01	0.00	3.64E+01
Subtotal	1.45E+06	33.93	3.10E+08	1.45E+06	33.93	3.10E+08
Total	4.26E+06	100.00	9.12E+08	4.26E+06	100.00	9.12E+08
Noble Gas To Iodine Ratio	0.51	0.51	0.51	0.51	0.51	0.51

**THESE μCi/cc VALUES ARE BASED ON NORMAL RCS VOLUME OF 66,595 GALLONS

Damage Class 10			
	µCi/cc**	Percent	Curies
I-131	3.04E+05	7.13	6.50E+07
I-132	4.54E+05	10.66	9.72E+07
I-133	6.70E+05	15.71	1.43E+08
I-134	7.80E+05	18.31	1.67E+08
I-135	6.08E+05	14.26	1.30E+08
Subtotal	2.82E+06	66.07	6.03E+08
KR-85M	9.98E+04	2.34	2.13E+07
KR-85	7.51E+02	0.02	1.61E+05
KR-87	1.82E+05	4.28	3.90E+07
KR-88	2.76E+05	6.49	5.92E+07
XE-131M	2.90E+03	0.07	6.20E+05
XE-133M	1.49E+04	0.35	3.18E+06
XE-133	6.37E+05	14.95	1.36E+08
XE-135M	1.58E+05	3.70	3.37E+07
XE-135	7.45E+04	1.75	1.59E+07
XE-138	1.70E-01	0.00	3.64E+01
Subtotal	1.45E+06	33.93	3.10E+08
Total	4.26E+06	100.00	9.12E+08
Noble Gas To Iodine Ratio	0.51	0.51	0.51

**THESE µCi/cc VALUES ARE BASED ON NORMAL RCS VOLUME OF 66,595 GALLONS

5.3.3.5 Calculation of Radionuclide Mix Percentages - Once the total amount of combined activities or curies for a certain Fuel Damage Class has been determined, these curies are then normalized to 100%, i.e., the percentage of each radionuclide in the total mix is calculated.

Exceptions - The above percentages are replaced in cases where an assumed mix is more appropriate. These cases are:

1. Contingency calculations for:

   a. Spent Fuel Accident in the Fuel Handling Building - FSAR mix is assumed.

   b. Fuel Cask Accident in the Fuel Handling Building - FSAR mix is assumed.

   c. Spent Fuel Accident in the Reactor Building - FSAR mix is assumed.

   d. Waste Gas Decay Tank - FSAR mix is assumed.

2. The RCS inputs for these cases are as follows:

RCS ACTIVITY INPUTS (1)

ISOTOPE	(2) WGDT RUPTURE	(3) RB FUEL HANDLING ACCIDENT	(4) FHB FUEL HANDLING ACCIDENT	(5) FUEL CASK ACCIDENT
KR85M	5.56E-03	2.88E-06	9.54E-08	0.00E+00
KR85	3.23E-02	2.10E-02	1.19E-01	1.00E+00
KR87	3.03E-03	0.00E+00	0.00E+00	0.00E+00
KR88	9.79E-03	1.13E-08	0.00E+00	0.00E+00
XE131M	8.68E-03	4.12E-03	8.45E-03	1.07E-04
XE133M	1.01E-02	1.36E-02	5.77E-03	0.00E+00
XE133	9.05E-01	9.53E-01	8.65E-01	2.14E-06
XE135M	3.43E-03	0.00E+00	0.00E+00	0.00E+00
XE135	2.16E-02	1.03E-03	2.62E-04	0.00E+00
XE138	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I131	1.11E-04	6.37E-03	1.72E-03	6.76E-05
I132	1.72E-04	0.00E+00	0.00E+00	0.00E+00
I133	1.32E-04	1.22E-03	4.03E-05	0.00E+00
I134	2.02E-05	0.00E+00	0.00E+00	0.00E+00
I135	7.07E-05	8.06E-06	7.46E-08	0.00E+00
TOTAL	1.00E+00	1.00E+00	1.00E+00	1.00E+00

(1) Normalized isotopic activities released from FSAR analysis to be input into model as RCS activity to get proper monitor response.

(2) From FSAR Table 14.2-21

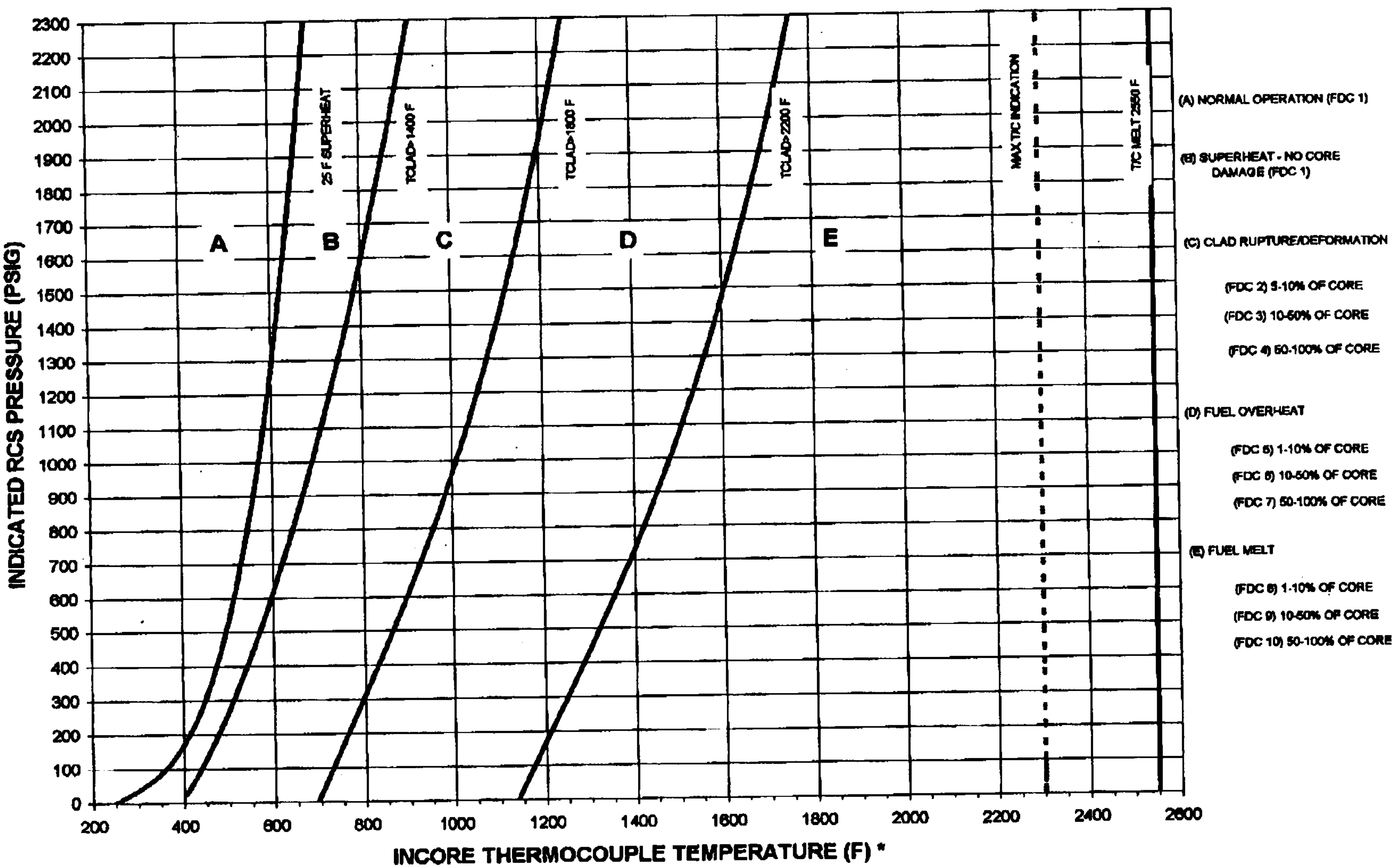
(3) From FSAR Table 14.2-5, Decayed to 72 hours

(4) From FSAR Table 14.2-2

(5) From FSAR Table 14.2-25

FIGURE 5.3-1

CORE DAMAGE REGIONS



* A T/C READING MUST BE IN THE LAST 2/3 OF A GIVEN REGION, OR, IF IN 1ST 1/3, IT MUST REMAIN IN THE REGION FOR AT LEAST 5-10 MINUTES

5.4 Radiation Monitoring System (RMS) Source Term Calculation - This portion of the model allows the user to determine an effluent source term from readings on the TMI-1 Radiation Monitoring System.

5.4.1 Source Term Calculations Using Effluent Monitors

5.4.1.1 To calculate a source term from a RMS reading the following parameters are used:

1. RMS READING: CPM, mR/HR, OR CPM/MIN
2. RMS CHANNEL EFFICIENCY RELATING TO THE CALIBRATION NUCLIDE: CPM/μCI/CC
3. THE METER RESPONSE FACTOR
4. THE FUEL DAMAGE CLASS MIXTURE
5. THE RELEASE FLOW RATE

5.4.1.2 The RMS reading, the particular radiation monitor's efficiency, the monitor response factor, the nuclide fraction from the isotopic percentage section of the program relating to fuel damage class determination, radionuclide mix percentages, and the associated flow rate to the environment are used to calculate a source term. Source terms are identified for the noble gas source term and for the radioiodines.

5.4.1.3 The calculations are performed in the following fashion:

1. First the total monitor response factor is calculated by multiplying the individual nuclide percentages from the fuel damage class determination by the individual nuclide monitor response factors.

$$M = \sum_{1}^{15} P * In$$

Where: M = total monitor response factor

P = individual nuclide percentages from fuel damage class

I_n = individual nuclide monitor response factors

The I_n's for the various RMS detectors are listed as follows:

Individual Mixture Response Factors (I_n)

Nuclide	Scintillation Detectors RM-G26 & RM-G27 (1)	Ion Chamber RM-G24(2)	GM Tubes RM-A5Hi, RM-A8Hi (3), RM-A9Hi, RM-G25	Beta Scint. Detectors RM-A2Lo, RM-A4Lo, RM-A6Lo, RM-A5Lo, RM-A8Lo, RM-A9Lo (4) RM-A15Lo RM-A14Lo
Kr-85m	70.7	212.2	2.35	1.92
Kr-85	1.0	1	0.011	1.98
Kr-87	356	324.39	3.59	9.12
Kr-88	1160	334.15	3.70	2.78
Xe-131m	9.01	4.88	0.054	0.0
Xe-133m	18.6	35.15	0.378	0.0
Xe-133	0.0 (<80keV)	90.24	1	1.0
Xe-135m	193	195.12	2.16	0.0
Xe-135	111	221.95	2.54	2.59
Xe-138	1560	939.02	10.41	4.62
I-131	172	240	2.66	*
I-132	1030	747.8	8.286	*
I-133	274	219.51	2.432	*
I-134	1180	542.44	6.011	*
I-135m	706	341.46	3.784	*

(1) $\frac{\Sigma \text{ MeV*Dis: Nuclide}}{\Sigma \text{ MeV*Dis cal Nuclide}}$ (calibration isotope is Kr-85, threshold set to exclude Xe-133 at 80 keV.)

(2) $\frac{\Sigma\% \text{ Probability Nuclide}}{\Sigma\% \text{ Probability Cal. Nuclide}}$ (calibration nuclide is Kr-85)

(3) $\frac{\Sigma\% \text{ Probability Nuclide}}{\Sigma\% \text{ Probability Cal. Nuclide}}$ (calibration isotope is Xe-133; values for RM-A5Hi, except Xe-133, will be multiplied by 4)

(4) $\frac{\Sigma \text{ Beta decay probability * Beta end-pt. energy nuclide}}{\Sigma \text{ Beta decay probability * Beta end-pt. energy cal. nuclide}}$ (cal. isotope is Xe-133)

* Radioiodines filtered out prior to noble gas channel

2. The noble gas source term in µCi/sec is now calculated using the following equation and input data:

$$Ngst = \left(\frac{1}{M} * ACT * \frac{1}{Me} * Ng/100\right) * (Flow) * 472$$

Where: Ngst = Noble Gas source term in µCi/sec.

M = Total monitor response factor, unitless.

Act = cpm, mR/hr, cpm/min reading from the monitor.

Me = Monitor sensitivity in cpm/µCi/cc, mR/hr/µCi/cc, or cpm/min/µCi/cc.

Flow = Flow rate in CFM

472 = cc/sec/CFM.

Ng = Sum of Noble gas percentages from the selected Fuel Damage classification.

3. The radioiodine source term in µi/sec is then calculated using the noble gas source term and the noble gas to iodine ratio, as discussed in Section 5.8.

$$Rist = Ngst * \frac{Ri}{Ng} * \underline{RDF}$$

Where: Rist = Radioiodine source term in µCi/sec.

$\frac{Ri}{Ng}$ = The radioiodine to noble gas ratio.

RDF = Iodine reduction factor for the release pathway as discussed in Section 5.11.

4. The noble gas and the radioiodine source terms are then multiplied by the individual isotopic percentages of the fuel damage class mixture to determine the µCi/sec of each of the 15 nuclides, 10 noble gas and 5 radioiodines.

5.4.2 Source Term Calculations Using RM-G-22 and RM-G-23

5.4.2.1 During a Loss of Coolant Accident in the Reactor Building, the high range radiation monitors in the Reactor Building, RM-G-22 and RM-G-23, may be used to estimate the airborne activity in containment. Use of these monitors to estimate the activity released to the containment atmosphere is based on the following assumptions:

1. The response of RM-G-22 and 23 to airborne activity in containment during a LOCA is assumed to be conservatively approximated as a semi-infinite cloud surrounding the detector.

2. It is assumed that the detectors are responding to noble gases only. While some response from airborne iodines would be expected, it is difficult to predict the fraction of iodines released from the RCS that would remain airborne for all LOCA situations. As a result, it is conservatively assumed that all response of the monitors is from noble gases.

3. The isotopic mix of the noble gas activity in containment is assumed to be the same as the distribution in the RCS for a Fuel Damage Class 2. Since the isotopic distribution in the RCS does not dramatically change between Fuel Damage Classes 1-4, this assumption covers a wide range of the most probable core damage conditions. In addition, this mix produces higher μCi/cc/R/hr values than mixes above Damage Class 4, so it is conservative for those conditions.

5.4.2.2 The noble gas source term in μCi/sec is now calculated using the following equation and input data:

Ngst = (ACT)(1/65.6)(Flow)(472)

Where:

Ngst = Noble Gas source term in μCi/sec

ACT = R/hr reading from the monitor

65.6 = Monitor sensitivity in R/hr/μCi/cc per Reference 7.43

Flow = Flow rate in CFM

472 = cc/sec/CFM

5.4.2.3 The radioiodine source term in μCi/sec is then calculated using the noble gas source term and the noble gas to iodine ratio, as discussed in Section 5.8.

Rist = (Ngst)(Ri/Ng)(RDF)

Where:

Rist = Radioiodine source term in μCi/sec.
Ngst = Noble gas source term in μCi/sec
Ri/Ng = The radioiodine to noble gas ratio

RDF = Iodine Reduction Factor for the pathway as discussed in Section 5.11.

5.4.2.4 The noble gas and the radioiodine source terms are then multiplied by the individual isotopic percentages of the Fuel damage class mixture to determine the μCi/sec of each of the 15 nuclides, 10 noble gas and 5 radioiodines.

5.5 Post Accident Samples Source Term Calculation - Actual plant effluent sample results may be used to develop the release source terms. This is in fact the preferable method for estimating release quantities if the sample results are available since the method eliminates some of the built in conservatisms of using monitor readings, or contingency calculations. Using sample results also eliminates errors in the source term when the actual release mixture is different from the assumed mix. The use of post accident samples in the RAC model is dependent on the type of post accident sample.

5.5.1 One criteria is the sample station/method to be used. For the Reactor Building three options are presented: 1) CATPASS (Containment Atmosphere Post Accident Sample System), 2) Marinelli/prefilter (marinelli with a particulate and iodine filter upstream), or 3) MAP-5, Radioiodine Processor Station. For the condenser off-gas or the Aux/FHB release pathways, only the Marinelli/prefilter and MAP-5 samples are available.

5.5.2 For MAP-5 sample results each of the identified radioiodine species in the silver zeolite or charcoal cartridge sample from the MAP-5 Processor Station are used for source term generation. The mixture can be decayed from time of shutdown and from time of the sample. NORMALLY THE DECAY CORRECTION WOULD NOT BE APPLIED FROM TIME OF SHUTDOWN SINCE THE ANALYSIS ITSELF ACCOUNTS FOR THAT. Since the MAP-5 only provides information on the radioiodines, the expected ratio between the iodines and noble gases is used to approximate the noble gas activity. The MAP-5 measures radioiodines after they have been acted on by the iodine reduction factors for the release pathway under consideration. These reduction factors are described in Section 5.11. As a result, the noble gas activity will be increased by a factor that is the inverse of the reduction factors described in Section 5.11 to account for reduction of the iodines that is not applicable to the noble gases. Based on the release rate in CFM the isotopic concentrations in µCi/cc are converted to a release rate in µCi/sec for the final source term.

5.5.3 For CATPASS sample results the 10 noble gas and the five radioiodine nuclides identified from air sampling are used for source term generation. The mix can be decayed from the sample to dose projection time. Since the CATPASS only applies to the containment, whether the containment is isolated or not and if the release is proposed or in progress must be considered. Calculations are made using the input activities to develop new isotopic percentages and the activities are changed from µCi/cc to µCi/sec based on the release rate defined to arrive at the final source term.

5.5.4 The marinelli sample results are used if a marinelli/prefilter sample has been collected. This option is available for all three release pathways. Since the production of the source term is based on the measured isotopics, as did the CATPASS program, the marinelli program proceeds in an identical manner.

5.6 Contingency Calculations Source Term Generation - The contingency calculations determine a source term based upon a prioritized set of plant conditions. In this way, credible conservative assumptions, as defined in the FSAR default parameters, are replaced with real-time accident conditions as indicated by plant instrumentation. This will make the calculated source terms more realistic.

5.6.1 In the contingency calculations the previously determined release pathway is utilized to select:

1. Secondary Side Release
2. Reactor Building Release
3. Station Ventilation Releases

The "Secondary Side Release" includes accidents that result in release via: The condenser off-gas, the atmospheric dump valves, the main steam reliefs, and a main steam line rupture.

The "Reactor Building Release" includes accidents that result in a release from the Reactor Building via: the purge duct, when the purge valves are open, or design basis leakage, when the purge valves are closed.

The "Station Ventilation Releases" include accidents that result in a release from the Auxiliary Building, Fuel Handling Building, or ESF Fuel Handling Building.

5.6.2 A "Secondary Side Release" contingency calculation is calculated by identifying four parameters:

1. RCS Activity [D1] μCi/cc
2. Primary to Secondary Leakage [D2] gpm
3. Iodine Reduction Factor (RDF) [D3]
4. Two Phase Release [Tfcf]

5.6.2.1 The "RCS Activity" is determined utilizing:

1. RM-L1 High [A1] cpm, D1 = A1/22.2 μCi/cc
2. RM-L1 Lo [A1] cpm, D1 = A1/1330 μCi/cc
3. Most recent RCS sample, in μCi/cc, or
4. Default to a RCS concentration dependent on the Fuel Damage Class:

Fuel Damage Class	RCS Default μCi/cc
1	*
1A	*
2	4.99E+03
3	2.49E+04
4	4.98E+04
5	4.71E+05
6	2.16E+06
7	4.26E+06
8	4.26E+06
9	4.26E+06
10	4.26E+06

* Damage classes 1 and 1A are variable, based on RCS activity entered from sample data and radioiodine spiking factors used.

5.6.2.2 The "Primary to Secondary Leakage" is determined utilizing:

1. RCS identified leakage [D2] gpm
2. Default to 400 gpm for a double-ended tube shear [D2]

5.6.2.3 The "RDF" [D3] is a function of the release pathway. They are discussed in Section 5.11. The resultant source terms in μCi/sec are calculated by:

Ngst = D1 * D2 * Ng/100 * 63.09

Rist = D1 * D2 * D3 * RI/100 * 63.09 * 1/Tfcf.

Tfcf is described in Section 5.10.

5.6.3 A "Reactor Building Release" contingency calculation is calculated by one of two methods. If the accident type is a LOCA then four parameters are identified:

1. RCS Activity [A2] μCi/cc

2. RCS Leakage to RB [A3] gallons

3. RDF, E4 as discussed in Section 5.11.

4. Release Flow Rate CFM; E3 = flow * 472 to convert CFM to cc/sec

5.6.3.1 The RCS Activity is determined utilizing:

1. RM-L1 High Channel [A1] cpm; [A2] = [A1]/22.2 μCi/cc
2. RM-L1 Low Channel [A1] cpm; [A2] = [A1]/1270 μCi/cc
3. Representative RCS sample results [A2] in μCi/cc
4. Default to a RCS concentration dependent on the Fuel Damage Class:

Fuel Damage Class	RCS Default μCi/cc
1	*
1A	*
2	4.99E+03
3	2.49E+04
4	4.98E+04
5	4.71E+05
6	2.16E+06
7	4.26E+06
8	4.26E+06
9	4.26E+06
10	4.26E+06

* Damage classes 1 and 1A are variable, based on RCS activity entered from sample data and radioiodine spiking factors used.

5. Default mix according to core condition as previously identified. The noble gas and radioiodine released to the Reactor Building is calculated as follows:

   E1 = A2 * A3 * Ng/100 * 3785/5.6E10 μCi

   E2 = A2 * A3 * Ri/100 * 3785/5.6E10 μCi

6. If the accident type is a Fuel Handling Accident in the Reactor Building, then the number of damaged fuel rods is identified by the "user" or an FSAR default condition is used.

   E1 = 1.7 * Num rod/208

   E2 = 0.05 * Num rod/208

5.6.3.2 <u>RCS LEAKAGE</u> - The RCS leakage to the Reactor Building is the "total gallons of RCS leakage into the RB".

5.6.3.3 <u>RDF</u> - This fraction is used to reduce the radioiodines available for release in the Reactor Building, as discussed in Section 5.11.

5.6.3.4 RELEASE FLOW RATE - The release flow rate is determined via flow rate recorder FR-148 if the purge valves are open. If the purge valves are closed the release flow rate is determined via the design basis RB leakrate adjusted for actual RB internal pressure as indicated on PT-291.

5.6.4 A "Station Ventilation Release" contingency calculation is calculated by utilizing the FSAR fuel assembly mix or WGDT mix.

1. Waste Gas Release
2. Fuel Handling Accident in the Fuel Handling Building
3. ESF Fuel Handling Release

5.6.4.1 The extent of the accident is modeled by:

1. Determining the number of damaged fuel rods for a fuel handling accident in the Fuel Handling Building, or for the ESF FHB.

   Ngst = 4.2E6 * Num rods/56 μCi/Second

   Rist = 750 * Num rods/56 μCi/Second

2. Using the worst case FSAR source term for WGDT's of 10,000 curies of noble gas and 5 curies of radioiodine, or using the typical WGDT FSAR mix of 1000 curies of noble gas and 5 curies of radioiodine.

3. Determining the curies released for a Waste Gas Accident. Typical source term based on a typical inventory of:

   Ngst = 1.0E9/Dr μCi/second

   Rist = 1.0E5/Dr μCi/second

   or

   FSAR worst case:

   Ngst = 1.0E10/Dr μCi/second

   Rist = 5E6/Dr μCi/second

   Where: Dr = duration of release.

5.7 Decay Scheme Calculation - The model provides the capability to (1) decay the postulated mixture from the time of reactor shutdown to time of the dose projection or (2) decay sample data from the time the sample is obtained to the time of dose projection. The calculation only decays forward in time. This calculation adjusts the individual nuclide percentages according to the conventional exponential decay equation:

$$A = A_o \exp(-\lambda t)$$

5.7.1 Fifteen isotopes are decayed according to the equation

N(w) = I(w) * EXP (-decay time * f [w])

where:

I(w) = postulated isotopic percentage

decay time = user input time

f(w) = isotopic decay constants

5.7.1.1 The adjusted isotopic percentages N(w) are corrected for Xenon buildup due to iodine decay. For Xe-131m the equations are:

S1 = I(11) - N(11)

N(5) = 0.88 * S1 + N(5)

where:

S1 = amount of I-131 decayed

0.88 * S1 = amount of Xe-131M buildup

5.7.1.2 For Xe-133M the equations are:

S1 = I(13) - N(13)

N(6) = 0.02 * S1 + N(6)

where:

S1 = amount of I-133 decayed

0.02 * S1 = amount of Xe-133m buildup

N(7) = 0.98 * S1 + N(7) calculates the amount of Xe-133 buildup from I-133

5.7.1.3 For Xe-135m and Xe-135 the equations are:

S1 = I(15) - N(15)

N(8) = 0.3 * S1 + N(8)

N(9) = 0.7 * S1 + N(9)

where:

S1 = amount of I-135 decayed

0.3 * S1 = amount of Xe-135m buildup

0.7 * S1 = amount of Xe-135 buildup

5.7.1.4 The isotopic percentages are recalculated as:

I(w) = N(w)/Sum (N) * 100

where:

N(w) = adjusted/corrected postulated isotopic percentages

Sum (N) = sum of the fifteen isotopic percentages

I(w) = final isotopic percentages based upon 100.

5.8 Noble Gas to Iodine Ratio Calculations

5.8.1 Whether performing dose projections based upon RMS readings, post accident samples or contingency calculations, it may be necessary to compute the NOBLE GAS TO IODINE RATIO. The uses of this ratio are discussed below.

An airborne release from a nuclear power plant will primarily consist of noble gases and radioiodines. Except in the most severe and improbable accident scenarios, radioactive particulates are not expected to be important dose contributors. The RAC model was designed to incorporate ten noble gases and five radioiodines.

The 15 isotopes are considered to be the most radiologically significant gaseous isotopes available for release from an operating nuclear power plant. Pertinent radioactive decay parameters such as half life, average gamma energy per disintegration and average beta energy per disintegration for each isotope, and individual isotope source term information are used to determine dose rate conversion factors and dose rates that are specific to the isotopic mixture being released. These calculated quantities can be adjusted to account for radioactive decay during the accident sequence.

5.8.2 The TMI RAC model always projects both thyroid (CDE) and whole body (TEDE) dose rates at specified downwind distances. Consequently an estimate of the isotopic release rate is necessary for both iodines and noble gases. Under normal circumstances the model starts with a core inventory of all fifteen isotopes and traces the progress of each one through various systems or processes until it is released. Depending upon the type and severity of the accident and the engineered safety systems that have been activated, the isotopic ratios can vary widely. There are some circumstances where the release rates of specific isotopes may be zero or negligibly small. But, in general, the model accounts for the fifteen isotopes listed above.

In certain circumstances it is not possible to obtain release rates for all fifteen isotopes individually. For example, some plant effluent monitors have only noble gas channels while others have particulate, iodine and gas channels. The MAP-5 sampling system yields only iodine information, where the CATPASS and the Marinelli gas sampling systems yield information on all fifteen isotopes. For release pathways where information on both noble gases and iodines is not available, the RAC model uses the noble gas to iodine ratio to fill in the missing information. The following example illustrates the use of this ratio:

A certain type of reactor accident has occurred. Based on an assessment of the degree of core damage and the accident type, the model uses a default mixture of 15 nuclides and calculates the fraction of the mix that each isotope represents. The noble gas to iodine ratio is also calculated. Assume that the ratio was equal to 5/1 in this case. Also assume that an iodine sample was taken which indicated a total radioiodine release rate of 5000 μCi/sec. Using the noble gas to iodine ratio in the absence of specific noble gas measurements, the model would calculate a gross noble gas release rate of 25,000 μCi/sec. It would also calculate individual noble gas release rates by using the isotopic fractions from the default mix.

5.8.3 To summarize, the highest quality information available is a quantitative measurement of each nuclide. This type of information is available from RCS, gas Marinelli and prefilter, and CATPASS samples. So there is no need to invoke the noble gas to iodine ratio in these cases. The second best measurement would be one that yielded gross noble gas and gross iodine readings. This situation occurs in the low range radiation monitors which have individual noble gas and iodine channels. Based upon the default mixture fractions, the release is apportioned among the fifteen nuclides to arrive at isotopic release rates. Again, there is no need to use the noble gas to iodine ratio. It is used only in circumstances where either noble gas or iodine measurements are not available, for example, when only noble gas or only iodine information is available.

5.8.4 There are some refinements and subtleties that the model user should be aware of. The noble gas to iodine ratio changes with time because of radioactive decay. The RAC model has the ability to account for radioactive decay and to compute a decay corrected noble gas to iodine ratio. As explained elsewhere in this manual, the model also corrects the Dose Rate Conversion Factor (DRCF) for decay of the isotopes in the mix. When performing dose projections several hours or more after the reactor has tripped, these two decay corrections can significantly alter the resultant projections. The model provides the capability to account for decay between reactor trip and dose projection.

5.8.5 For dose projections based upon RMS readings, the decay correction to the noble gas to iodine ratio is straightforward. A default mixture of the fifteen noble gases and iodines is selected based upon an assessment of core damage. If the mix, is to be decayed, all fifteen isotopes are decayed by the standard exponential decay law using the decay time between reactor trip and dose projection. The noble gases and iodines are totaled separately so that their ratio at dose projection time can be calculated. (Ingrowth of xenon isotopes from decay of iodine is accounted for.) The decay adjusted ratio is then used to fill in the missing noble gas or iodine information, as explained above.

5.8.6 When iodine samples are taken at the MAP-5 stations a two step decay process is used. As above, a default mixture is chosen, based upon the fuel damage classification. For a dose calculation based upon a radioiodine processor sample, if decay correction is desired, the model uses two decay time intervals:

1. The time between sampling and dose projection
2. The time between reactor trip and dose projection

Sample results from the radiochemistry lab are reported as of the sample collection time. When significant time has elapsed between sampling and dose projection, the results should be decayed from sampling time to dose projection time. In order to compute the noble gas portion of the source term, the default mix is first decayed from reactor trip time to dose projection time. The noble gas to iodine ratio is computed for the decayed default mix, and any iodine reduction factors present in the specific release pathway. This ratio, along with the gross radioiodine sample result, is used to compute a gross noble gas source term. Isotopic source terms are calculated from the decayed mixture noble gas fractions. Note that the final source term is a combination of noble gases from a default mix and radioiodines from a sample. Each has been decayed to the dose projection time.

A word of caution should be added at this point. The iodine released in certain types of accidents may be reduced by various chemical and physical processes such as iodine plateout or formation of water soluble iodide salts. The noble gas to iodine ratio, as calculated above, may not completely account for this iodine reduction. As a consequence, the ratio, based upon the default mix, may be too low. This creates the potential for underestimating the noble gas portion of the source term. RAC personnel should be aware of this possibility. A comparison of field team data and the source term dose projections would reveal agreement for thyroid (CDE) doses, but not for whole body (TEDE) doses.

5.9 Effluent Release Flow Rates - Flow rates for effluent releases to the environment are divided into four categories:

1. Normal ventilation flow rates.

2. Reactor Building leakage flow rates.

3. Adjacent momentum plume rise (station vent and reactor purge concurrently releasing).

4. Flow rates for OTSG tube rupture release directly to atmosphere.
   - Buoyant plume rise
   - Source term calculation using RMG-26 or RMG-27
   - Source term calculation using a contingency calculation

These flow rates for accident source terms to the environment are calculated as follows:

5.9.1 TMI-1 Normal Ventilation Flow Rates

The RAC Model provides the option to use the actual ventilation flow rates as read from the flow recorders or to use default flow rate(s). Each normal plant flow path has predetermined flow rate ranges, and assigned flow recorders as follows:

1. Reactor Building Purge
   - FR909 0-20,000 CFM; Low Range
   - FR148B 0-50,000 CFM; High Range
2. Reactor Building Purge and Make-up Exhaust
   - FR148A 0-50,000 CFM
3. Reactor Building Hydrogen Purge System
   - FI282 5-50 CFM
   - FI283 20-200 CFM
   - FI284 100-1000 CFM
   - Total 5-1250 CFM
4. Kidney Filter System
   - AHE-101, AH-F-12 P/I filters 20,200 SCFM
5. Auxiliary Building Exhaust
   - FR150 0-100,000 CFM
6. Fuel Handling Building Exhaust
   - FR149 0-50,000 CFM

7. Auxiliary and Fuel Handling Building Exhausts

   - FR-151 0-150,000 CFM

8. Condenser Off-Gas Exhaust

   - RMR15 Recorder FT-1113 Ch. A0-200 CFM

9. ESF Fuel Handling Building Exhaust

   - No Flow Recorder at this time 0-8000 CFM

Default values are used in the RAC Model when a small value or an unknown value is required as input to a dose projection. The default values are:

5000 CFM - Reactor Building Purge

- Reactor Building Purge and Make-up Exhaust
- Auxiliary Building Exhaust
- Fuel Handling Exhaust
- Auxiliary and Fuel Handling Building Exhausts.

40 CFM - Condenser Off-Gas

7000 CFM - ESF FHB Exhaust

These default values allow the user to continue with dose projections even though a value is small or unknown. Therefore, once the dose projection is complete, the results may be ratioed up or down depending on the situation. For example, if the default value of 5000 CFM was used for a Reactor Building Purge and subsequently an engineering calculation was performed indicating 1000 CFM flow. The dose projection could be ratioed down by one fifth (1/5). Therefore, a dose projection of 10 mrem would then be approximately 2 mrem based on the reduced flow calculation, realizing that the X/Q will also be affected by reducing flow.

5.9.2 Reactor Building Leakage Flow Rate

Another section of the model calculates a leakage flow rate out of the Reactor Building based on Reactor Building pressure. The Reactor Building pressure indicator is PT-291, 0-100 psig, located on control room panel CR. The leakage out of the Reactor Building is based on the amount of pressure in the Reactor Building with all penetrations closed. The following equation is used to calculate the Reactor Building Leak Rate:

L_T = L_A*SQRT(P_T/P_A)

Where:

L_T = Reactor Building Leak Rate in CFM

L_A = Maximum allowable integrated leakage rate at P_A L_A = 6.14 CFM

P_A = Peak Reactor Building internal pressure at design basis accident,

P_A = 50.6 psig

P_T = Actual Reactor Building internal pressure in psig

Therefore, the maximum leakage allowed at a design basis accident pressure of 50.6 psig is 6.14 CFM. Leak rates at 0-60 psig can be calculated from the above formula. The default value in the model is 50.6 psig. A graphic representation follows in Figure 5.9-1.

5.9.3 Adjacent Momentum Plume Rise (Station Vent and Reactor Purge)

For an isolated stack, either the station vent or the Reactor Purge, the stack gas exit velocity can be calculated from the flow rate according to the following formula:

$$w = \frac{V}{\pi r_2} \quad (1)$$

Where w = stack gas exit velocity
V = flow rate or volume flux
r = radius of stack

The Station Vent and the Reactor Purge stack are situated close enough together that their plumes will mix as the plumes rise. For two or more adjacent stacks that have different exit velocities, the effect of mixing on the exit velocities of non-buoyant plumes can be given by the following formula:

$$\overline{w} = \frac{\Sigma wV}{\Sigma V} \quad (2)$$

Where $\overline{w}$ = exit velocity due to mixing

If these adjacent stacks were modeled as a single stack, the radius of the stack would be given by:

$$\bar{r} = \sqrt{\frac{\sum V}{\pi \ \bar{w}}} \qquad (3)$$

At TMI-1, the reactor building stack and station vent are adjacent stacks. For computing plume rise, the stack gas exit velocity and stack radius were calculated according to Eq. (2) and (3) above. A comparison of the adjacent plume rise with the plume rise from the individual stacks is shown in Table 5.9-1.

5.9.4 Flow Rate Calculations for OTSG Tube Rupture Release Directly to the Atmosphere (see Figure 5.9-2 and Figure 5.9-3).

TMI-1 has 22 main steam relief and 2 atmospheric dump valves. Data on the valves are presented in Table 2, which lists the valve identification number, function, manufacturer, pressure set point and flow rate. The set point pressures vary from 200 psig to 1092.5 psig, and the steam flow rate from 70,211 lbs/hr to 824,269 lbs/hr. Note that valves 4A&B are manually operated and do not have a set point pressure. These valves, MS-V-4A/B, can be operated from 0 to 100% open. The valve position openings along with the secondary system pressure relate to a release flow and plume height. The percent open for these two (2) valves can be read at the center control panel under the turbine bypass dump controller for MS-V-4A/B from 0 - 100%.

Each of the 22 valves at TMI-1 has a stack or vent where the steam is ejected into the atmosphere. The location of these stacks is shown in Figure 5.9-2. If a steam generator tube ruptures, each of the 22 valves and stacks acts as a throttle to limit the flow from the steam line to the atmosphere. When a valve opens, the flow through it will be approximately equal to the rated flow, and the flow can be assumed to be approximately constant until the pressure in the steam line drops to the point where the valve reseats. For a stuck open valve, the pressure decreases rapidly with time, and the flow through the valve is only a small fraction of the rated flow. For either a normally operating valve or stuck open valve, if the pressure and temperature in the steam line are known, the conditions just beyond the stack exit can be estimated by assuming expansion of the steam to atmospheric pressure and temperature.

5.9.4.1 Buoyant Plume Rise

When the steam is released into the atmosphere, the rise of the steam plume is initially controlled by its velocity, temperature and cross-sectional area. Depending on these variables and atmospheric conditions, the plume rise can vary from hundreds to thousands of feet. Plume rise is a very important factor in determining maximum ground level doses. For a PWR, plume rise can increase the effective stack height by a factor of 5 to 50. Since maximum ground level dose is roughly proportional to the inverse square of the effective stack height, a plume rise of 200 feet, for example, gives a ground level concentration 100 times higher than that from a plume rise of 2000 feet.

Modeling of plume rise begins with modeling the steam condition at the valve inlet. Table 5.9-3 outlines the calculational steps required to compute buoyant plume rise, beginning with the valve inlet. The far left side of the table identifies the area for which the calculation applies: valve inlet, top of stack, jet origin, and plume rise. For each area, several quantities must be computed from various inputs, and these are also identified in the table. Buoyant plume rise was calculated according to Briggs (1984). The details of all the calculations are discussed in the Environmental Controls document Potentially Buoyant Releases at TMI-1.

CAUTION

In highly stable atmospheric conditions, the presence of layers of different temperature air can cause thermal boundaries resistant to plume vertical travel. In some conditions, a buoyant plume may penetrate these layers and not come down to the surface as predicted. In other cases the plume may be unable to penetrate the layer and the effective stack height will be reduced to the height of the layer. This may cause ground concentrations to be higher and closer to the plant than predicted. In these conditions (i.e., highly stable meteorology with a buoyant plume) off-site monitoring will provide an indication of the magnitude of the effect. It may also be possible to estimate the effect through visual observation of the plume.

5.9.4.2 Source Term Calculation Using RM-G-26 or RM-G-27 (see Figure 5.9-3)

RMG-26 and RMG-27 are effective in calculating a primary to secondary release source term direct to the atmosphere when:

1. Atmospheric Dump Values (ADV) MS-V-4A or MS-V-4B are open from 0-100%, as indicated on Control Room Panel "CC", and releasing radioactive steam to the environment, and/or,

2. Emergency Feed Pump (EFP) relief valves, MS-V-22A or MS-V-22B are open and releasing radioactive steam to the environment, and/or,

3. EFP is in operation and releasing radioactive steam from the EFP exhaust to the environment.

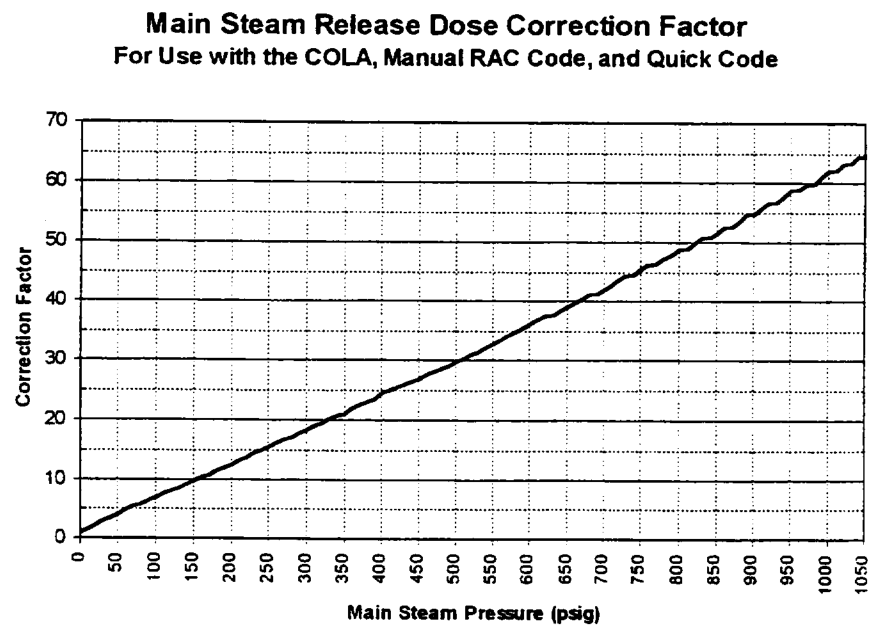
4. Steam bypass dump to the condenser through MS-V-8A/B.

When the model calculates a release from an OTSG tube rupture directly to the atmosphere and uses RM-G-26 or RM-G-27 readings, the calculation Steam Flow Computation is used to determine a release flow rate, depending on which of the valves are open (Table 5.9-2 and Reference 7.44). The mass flow rate from each open valve is added up to give a total flow rate to the environment. A source term is calculated using the mass flow rates and the RM-G-26/27 readings converted to mass concentration using the monitor efficiencies to give μCi/second.

A correction factor must be applied to results provided by the following dose assessment codes when RM-G-26 and RM-G-27 are used to quantify direct-to-atmosphere steam release (Atmospheric Dump Valve, Main Steam Relief Valve, or Steam Driven Emergency Feed Pump Discharge) source terms and offsite doses:

- COLA Code
- Manual RAC Code
- Quick Code

These codes do not account for main steam pressure when using these monitors to calculate source terms. As a result, they are overly conservative. The following graph provides a correction factor to compensate for this conservatism (Reference RAF 3640-00-011).



To use the graph:

1. On the x-axis of the graph, find the main steam pressure when the dose projection was performed.
2. Determine the appropriate correction factor from the y-axis of the graph.
3. **Divide** the source terms, dose rates and doses produced by the code by this correction factor to provide a more realistic assessment of the release.

NOTE
This correction factor is not to be used for results provided by RAC Spreadsheet.

> **NOTE**
>
> Calculation of a source term using RMS (RM-G-26/27) is dependent on the Atmospheric Dump Valves (ADV) status. If the ADV is open, the calculation is appropriate. If the ADV is closed but plant conditions (OTSG leakrate and core damage) have not changed significantly, or there is other flow past the monitors as noted above, then the use of a RM-G-26/27 peak reading will be appropriate. If the ADV is closed and plant conditions have changed significantly, and there is no other source of flow downstream of MS-V-2A/B, then the contingency calculation applies.

5.9.4.3 Source Term Calculation Using a Contingency Calculation

When the user performs a Contingency Calculation due to the lack of sample results or RM-G-26/27 readings, the flow rate corresponding to the set point pressure is used, if the valve operates normally. This flow rate is given in Table 5.9-2. If, however, the valve sticks open, and the steam generator pressure is less than the set point pressure, then the flow rate is based on the tables supplied by the valve manufacturer. These tables have been incorporated into the RAC model. The flow from all the valves is totaled and modeled as a release to the atmosphere.

TABLE 5.9-1

Adjacent Plume Rise at TMI

Reactor Bldg. Stack and Station Vent Stack

Stability	Actual Flow Characteristics				RAC Model			MIDAS		
	Reac Bld Stack	Stack Diameter	Station Vent	Stack Diameter	Flow Rate	Stack Diameter	Plume Rise	Flow Rate	Stack Diameter	Plume Rise
	(cfm)	(m)	(cfm)	(m)	(cfm)	(m)	(ft)	(cfm)	(m)	(ft)
Unstable	10,000	1.1	10,000	1.7	20,000	1.847	**30.3**	10,000	1.1	**25.4**
Neutral								10,000	1.7	**16.4**
(Class A)										
	10,000	1.1	120,000	1.7	130,000	1.827	**199.2**	65,000	1.1	**165.4**
								65,000	1.7	**107.0**
Stable	10,000	1.1	10,000	1.7	20,000	1.847	**24.8**	10,000	1.1	**22.1**
								10,000	1.7	**16.5**
(Class F)										
	10,000	1.1	120,000	1.7	130,000	1.827	**85.8**	65,000	1.1	**75.9**
								65,000	1.7	**57.0**

TABLE 5.9-2

TMI STEAM GENERATOR RELIEF VALVES						
Valve Number	Function	Valve Manufacturer	Valve			Stack Diameter
			Discharge Area	Set Point		
				Pressure	Flow Rate	
(MS-V)			(sq.in.)	(psig)	(lbs/hr)	(inches)
17A-D	Relief Valves, Bank 1	Dresser/ Consolidated	16	1050	792,617	10.02
18A-D	Relief Valves, Bank 2	Dresser/ Consolidated	16	1060	800,065	10.02
19A-D	Relief Valves, Bank 3	Dresser/ Consolidated	16	1080	814,960	10.02
20A&D	Relief Valves, Bank 1	Dresser/ Consolidated	16	1050	792,617	10.02
20B&C	Relief Valves, Bank 4	Dresser/ Consolidated	16	1092.5	824,269	10.02
21A&B	Relief Valves, Small Safety	Dresser/ Consolidated	3.97	1040	194,820	10.02
22A	Safety Relief, Emergency Feed Pump	Lonergan	6.38	200	70,211	13.13
22B	Safety Valve, Emerg. (F.W.P.T. Steam Inlet)	Lonergan	6.38	220	76,795	13.13
4A&B	Relief Valves (manual) to Atmosphere	Fisher	Variable	1010	402,792	13.13

TABLE 5.9-3

	Calculation Steps For Computing Plume Rise			
	Step	Quantity Computed	Input Values Needed	Source of Input
Valve Inlet	1	Steam flow rate thru valve	pressure of steam	Plant Instrumentation
Top of Stack, Below Chamfer	2	Pressure of steam at top of stack, below chamfer (if choked flow)	a. steam flow rate b. internal radius of stack c. enthalphy	Step 1 constant <constant>
	3	Specific volume of steam at to of stack, below chamfer	pressure at top of stack	Step 2
Below Chamfer	4	Temperature of steam at top of stack, below chamfer	pressure at top of stack	Step 2
Also Jet Origin	5	Velocity of steam at top of stack, below chamfer	a. specific volume of steam b. flow rate of steam c. internal radius of stack	Step 3 Step 1 constant
Jet Origin	6	Density of steam at jet origin (ambient pressure)	a. temperature of steam b. pressure of ambient air	Step 4 <constant>
	7	Jet radius at origin (Needed for MIDAS only; used in RAC but not really needed)	a. density of steam b. velocity of steam c. flow rate of steam	Step 6 Step 5 Step 1
Plume Rise	8	Plume rise	a. jet radius at origin b. density of steam at origin c. velocity of steam at origin d. density of ambient air e. wind speed at origin f. 150'-33' delta T	Step 7 Step 6 Step 5 <constant> Plant Instrumentation Plant Instrumentation

FIGURE 5.9-1

TMI–1 RB LEAK RATE VS RB PRESSURE

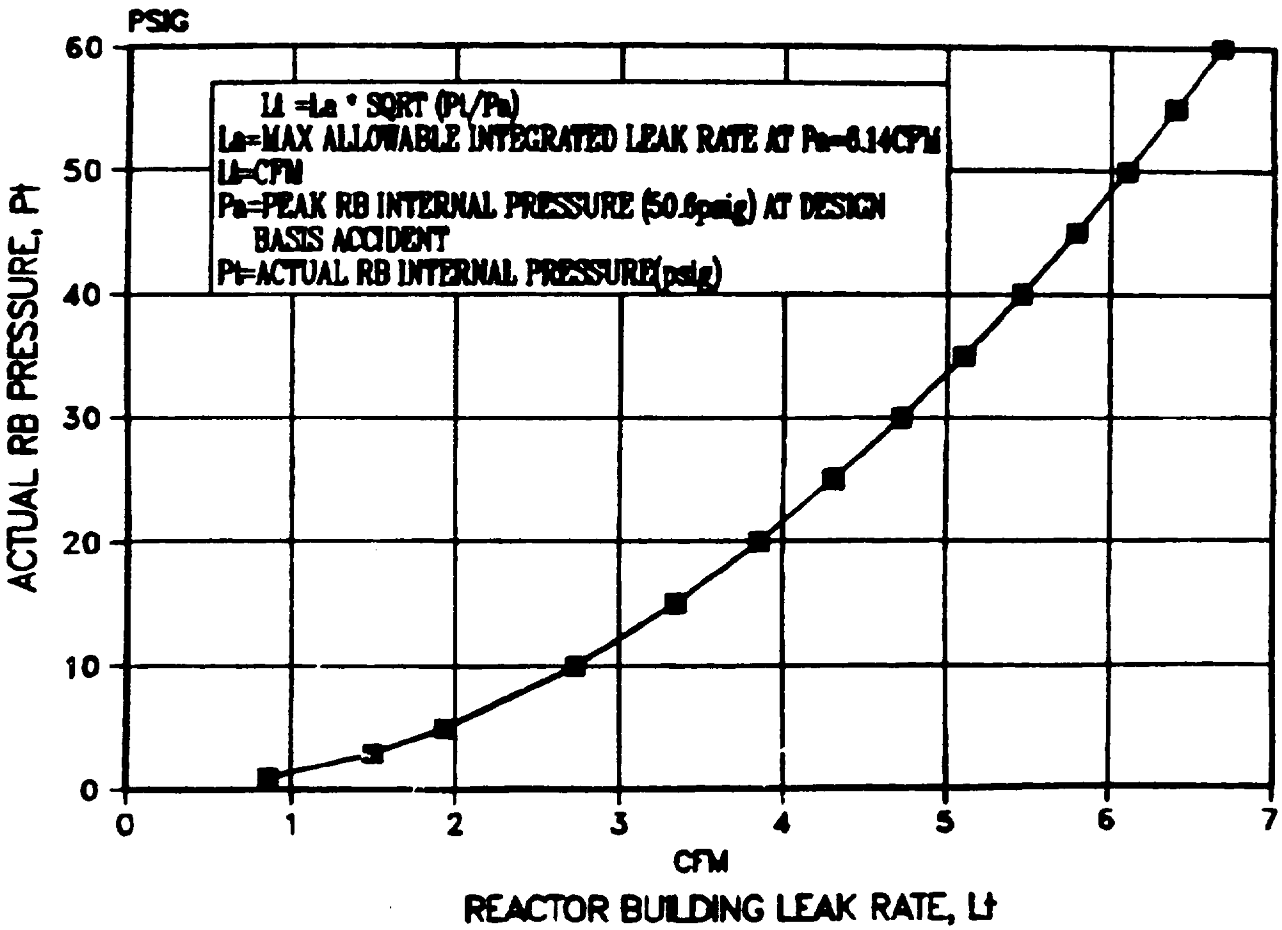


FIGURE 5.9-2

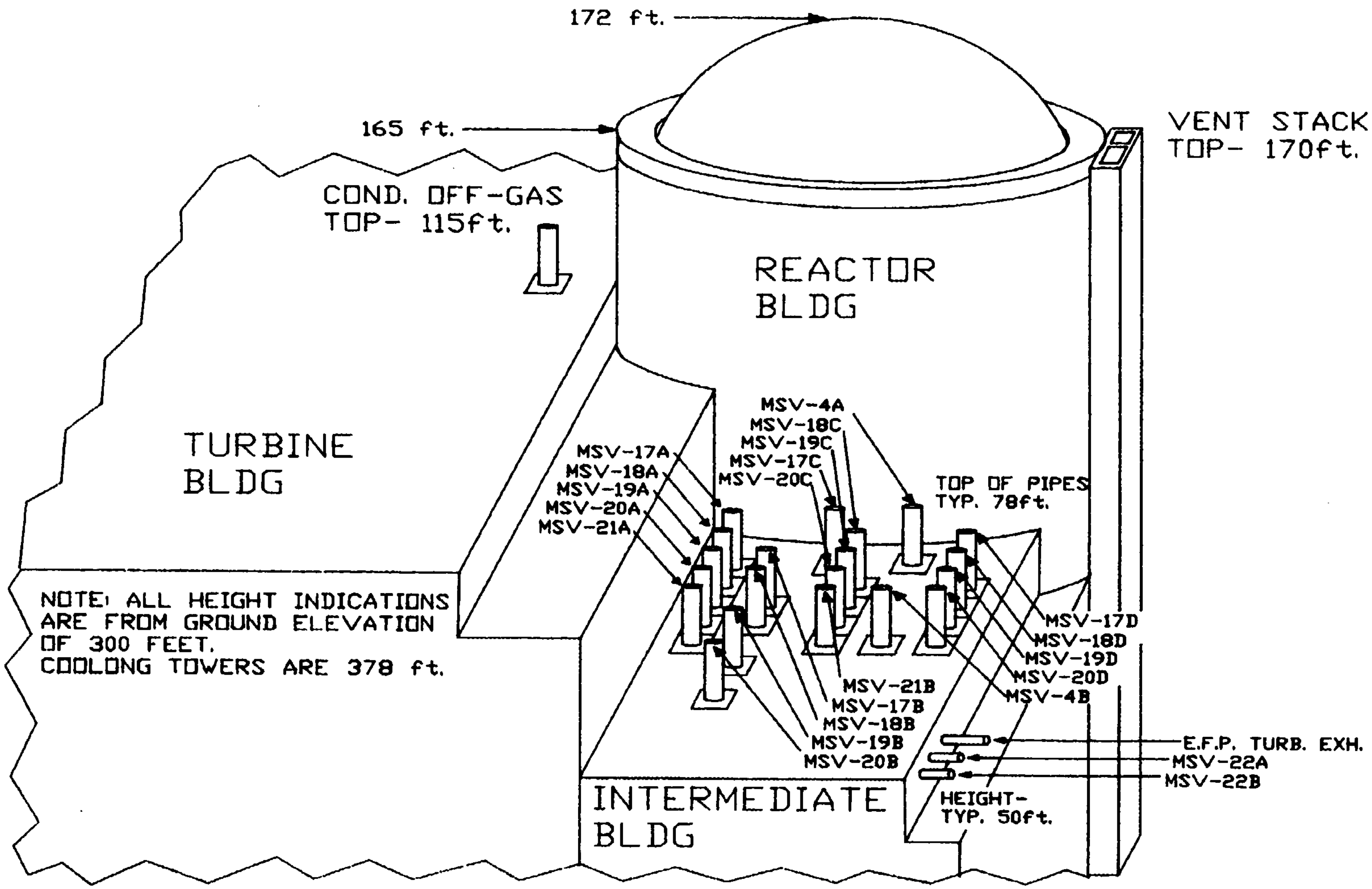
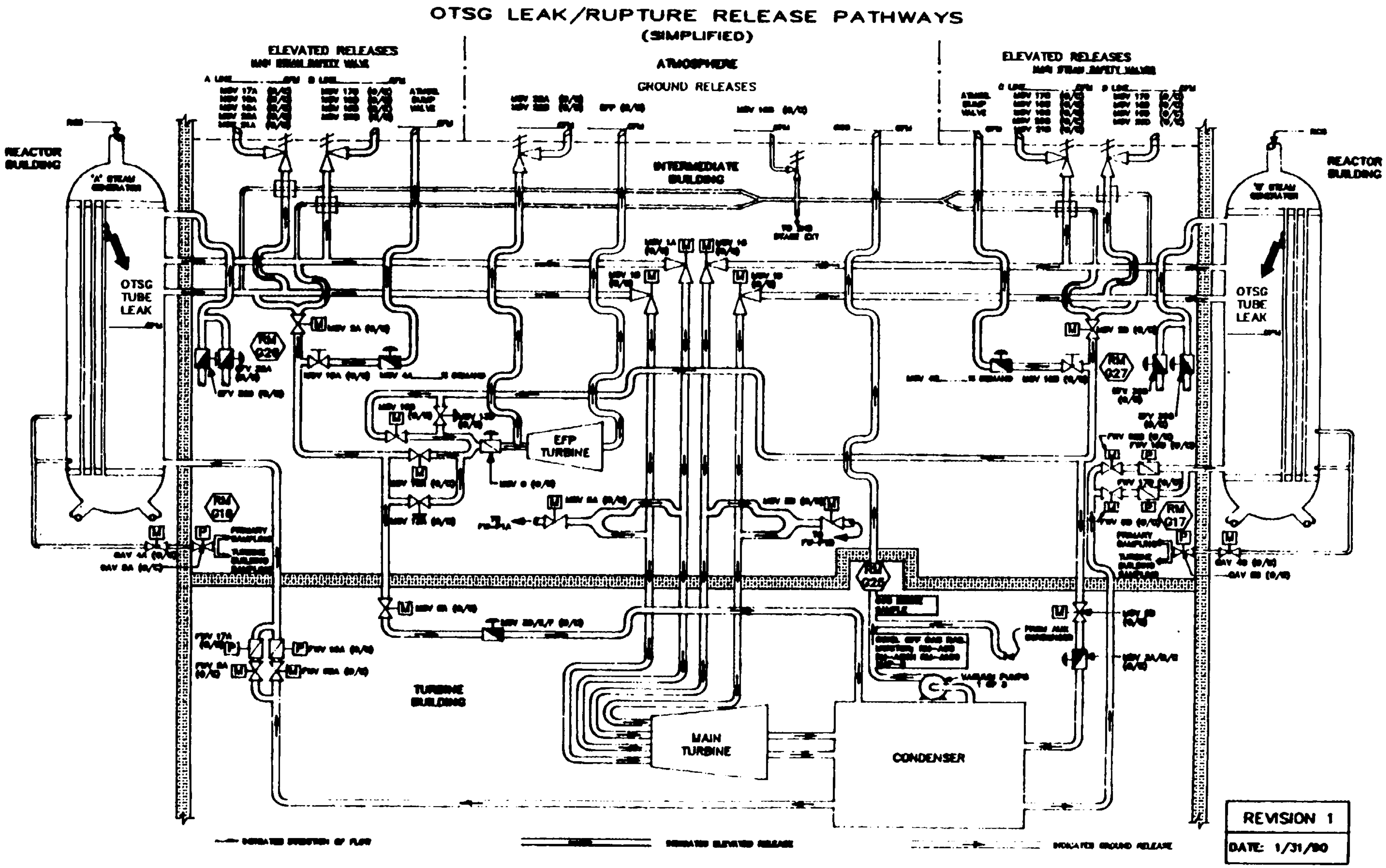
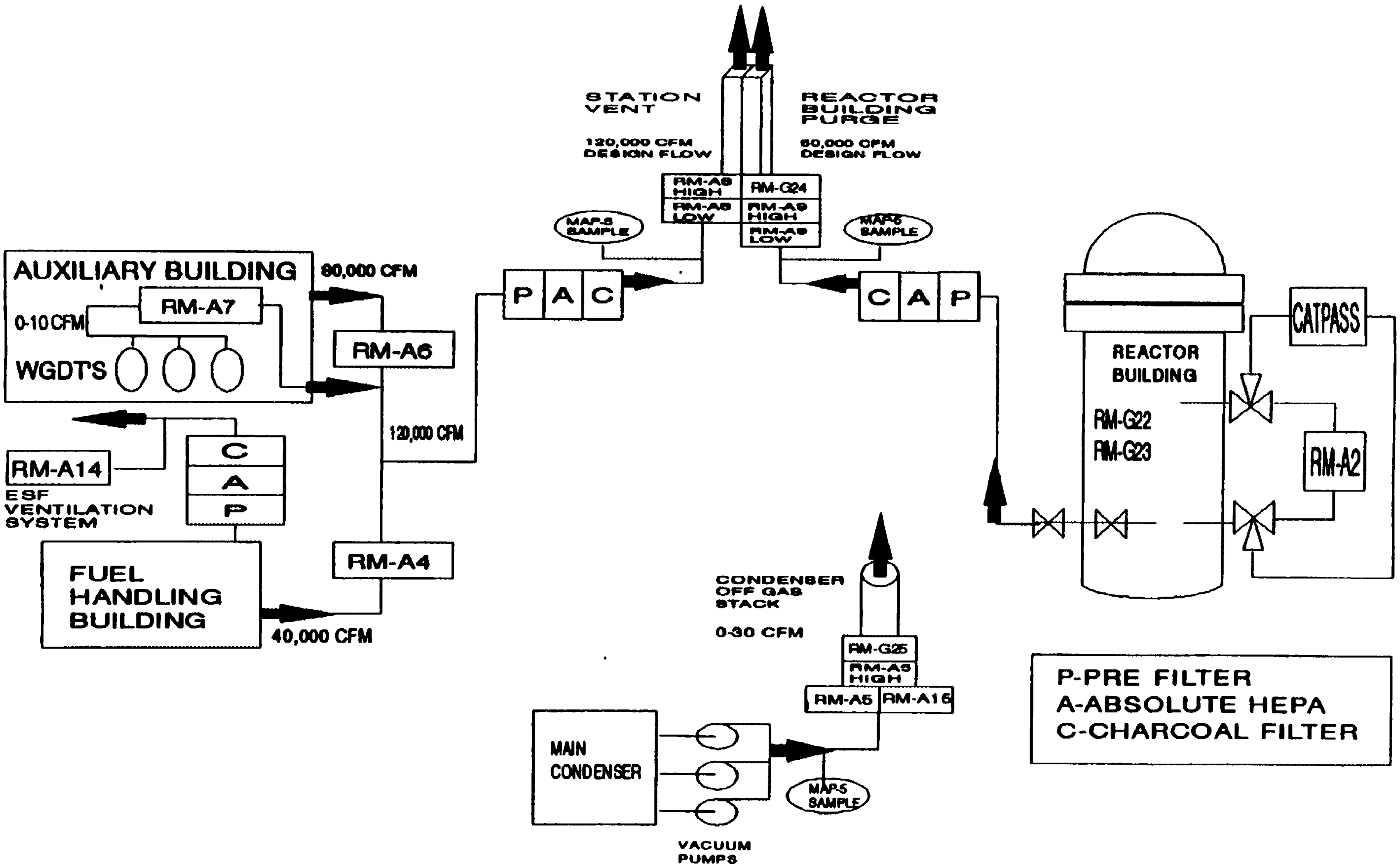

172 ft.
165 ft.
VENT STACK
TOP- 170ft.
COND. OFF-GAS
TOP- 115ft.
REACTOR
BLDG
TURBINE
BLDG
MSV-4A
MSV-18C
MSV-19C
MSV-17C
MSV-20C
MSV-17A
MSV-18A
MSV-19A
MSV-20A
MSV-21A
TOP OF PIPES
TYP. 78ft.
NOTE: ALL HEIGHT INDICATIONS
ARE FROM GROUND ELEVATION
OF 300 FEET.
COOLONG TOWERS ARE 378 ft.
MSV-17D
MSV-18D
MSV-19D
MSV-20D
MSV-4B
MSV-21B
MSV-17B
MSV-18B
MSV-19B
MSV-20B
E.F.P. TURB. EXH.
MSV-22A
MSV-22B
HEIGHT-
TYP. 50ft.
INTERMEDIATE
BLDG

FIGURE 5.9-3


OTSG LEAK/RUPTURE RELEASE PATHWAYS
(SIMPLIFIED)
ELEVATED RELEASES
ATMOSPHERE
GROUND RELEASES
ELEVATED RELEASES
REACTOR BUILDING
INTERMEDIATE BUILDING
REACTOR BUILDING
OTSG TUBE LEAK
OTSG TUBE LEAK
RM G26
RM G27
EFP TURBINE
RM G16
RM G17
RM G25
TURBINE BUILDING
MAIN TURBINE
CONDENSER
REVISION 1
DATE: 1/31/90


STATION VENT
120,000 CFM DESIGN FLOW
REACTOR BUILDING PURGE
60,000 CFM DESIGN FLOW
RM-A8 HIGH
RM-A8 LOW
RM-G24
RM-A9 HIGH
RM-A9 LOW
MAP-5 SAMPLE
MAP-5 SAMPLE
P A C
C A P
AUXILIARY BUILDING
90,000 CFM
RM-A7
0-10 CFM
WGDT'S
RM-A6
120,000 CFM
RM-A14
ESF VENTILATION SYSTEM
C
A
P
FUEL HANDLING BUILDING
RM-A4
40,000 CFM
REACTOR BUILDING
RM-G22
RM-G23
CATPASS
RM-A2
CONDENSER OFF GAS STACK
0-30 CFM
RM-G25
RM-A5 HIGH
RM-A5
RM-A15
MAIN CONDENSER
MAP-5 SAMPLE
VACUUM PUMPS
P-PRE FILTER
A-ABSOLUTE HEPA
C-CHARCOAL FILTER

5.10 Two-Phase Steam Flow Determination -A two-phase (liquid and gas) release calculation was included for an OTSG tube rupture accident in response to INPO SOER 83-2 (Recommendation #12). INPO SOER 83-2 "Steam Generator Tube Ruptures" was developed based upon the steam generator tube rupture events at R. E. Ginna, Oconee and Rancho Seco. Recommendation #12 states "Emergency Plan Implementation Procedures should . . . ensure that estimates of doses can be made for two-phase or liquid releases through the steam generator safety relief valves." GPUN Corporation is required to respond to all SOER recommendations. The calculational method used to implement this recommendation is based upon the assumptions that the valve inlet fluid condition is either pure liquid or steam (as indicated by the OTSG wide range level instrumentation) and following discharge, the steam fraction is described by assuming that there is no change in total energy content. If the OTSG wide range level instrument is indicating that the valve inlet fluid condition is pure liquid, greater than 600 inches, and the fluid is near saturation for the pressure and temperature, then the fraction of gas vapor present in the release is a function of the OTSG pressure as indicated on the PCL panel, PI950A and 951A, or the console center, SPGA PT1 and 2 or SPGB PT 1 and 2.

5.10.1 The model determines a two-phase correction factor [Tfcf] which is a function of OTSG pressure in psia. This factor is only calculated if the OTSG water level is indicating a liquid release (greater than 600 inches on the wide range level instrument reading). The correction factors are used to account for the radioiodine that would remain in the liquid portion of the resultant two-phase release to the environment.

Using the OTSG pressure in Psia, the model selects a correction factor which is subsequently used with other iodine reduction factors applicable to the release pathway to correct the radioiodine source term. These other iodine reduction factors are described in Section 5.11. The algorithm used by the RAC model to determine Tfcf is as follows:

OTSG pressure ≥ 1200	Tfcf = 2.43
1000 ≤ OTSG pressure < 1200	Tfcf = 2.61
800 ≤ OTSG pressure < 1000	Tfcf = 2.83
600 ≤ OTSG pressure < 800	Tfcf = 3.18
400 ≤ OTSG pressure < 600	Tfcf = 3.77
200 ≤ OTSG pressure < 400	Tfcf = 5.09
OTSG pressure < 200	Tfcf = 7.27

NOTE

Increasing OTSG A/B water level will possibly help cut down the release of radioiodine due to the partitioning effect of the iodine in water. Increasing OTSG level should be discussed with the Emergency Director as a means of reducing off-site doses.

5.11 Iodine Reduction Factors

Radioiodine normally exists in chemical forms which are highly reactive. They readily adsorb onto surfaces and can be scrubbed chemically from the atmosphere. The radioiodine removal methods available are specific to each release pathway and are described in Reference 7.21. The TMI RAC Model provides the capability to include or disregard radioiodine reduction during the movement of these isotopes from the core to the atmosphere. The reduction factors (RDF) used by the TMI RAC Model are those described in Reference 7.21.

5.11.1 Releases from Condenser Offgas During an OTSG Tube Rupture

For a release through the condenser off-gas the, radioiodine RDF is 0.0075. The radioiodine RDF is a product of: The fraction of radioiodine entering the OTSG from the RCS that is a volatile iodine species (.05) and the partition factors for volatile iodine species in the main condenser (.15). Non-volatile iodine species have a partition factor of zero in the condenser off-gas. This is discussed in Reference 7.17.

5.11.2 Releases from Reactor Building Design Basis Leakage

Radioiodines released into the containment building are subject to airborne iodine reduction from either natural processes (e.g., gravitational settling and plateout) or from Reactor Building sprays. The effectiveness of these reduction processes are dependent on the holdup time of the activity in the building prior to the beginning of the release.

For Reactor Building design basis leakage where Reactor Building spray is not on, iodine reduction factors are as follows (Reference 7.21):

$H \geq 24$ hours	RDF = 0.01
2 hours $\leq H < 24$ hours	RDF = 0.04
$H < 2$ hours	RDF = 0.4

For Reactor Building design basis leakage where Reactor Building spray is on, iodine reduction factors are as follows (Reference 7.21):

$H \geq 24$ hours	RDF = 0.002
2 hours $\leq H < 24$ hours	RDF = 0.02
$H < 2$ hours	RDF = 0.03

5.11.3 Direct to Atmosphere Releases During an OTSG Tube Rupture

Iodine reduction factor for direct to atmosphere steam releases during leakage of reactor coolant into the secondary side is 0.5. The RDF is the result of partioning in the steam generator per Reference 7.21.

As described in Section 5.10, if OTSG level is > 600 inches, a two phase correction factor also applies. In these conditions the RDF becomes:

$$RDF=(0.5)(1/Tfcf)$$

Where

0.5 = Steam generator partition factor for B&W type OTSG (Reference 7.21)

Tfcf = Two phase steam flow correction factor described in Section 5.10.

5.11.4 Releases from Auxiliary and Fuel Handling Buildings via Station Vent

Releases from Auxiliary and Fuel Handling Buildings via Station Vent are considered as bypass accidents per Reference 7.21. The reduction factors for this pathway are a function of primary system retention and filtration by the building ventilation system. The RDF for this type of release is as follows:

$$RDF=(0.4)(.01)=0.004$$

Where

0.4 = Primary system retention and plateout reduction (Reference 7.21)

0.01 = Normal reduction for effective ventilation filters (Reference 7.21)

5.11.5 Releases from Reactor Building via Reactor Building Purge

Releases from the Reactor Buildings may occur through the purge ventilation system if the main or hydrogen purge valves are not shut. Radioiodines released into the containment building are subject to airborne iodine reduction from either natural processes (e.g., gravitational settling and plateout) or from Reactor Building sprays. They are also subject to reduction by filtration through the building ventilation system if the release is through the purge exhaust valves. The RDF for this type of release, with no Reactor Building Spray, is as follows:

$$RDF=(0.4)(0.01)=0.004$$

Where

0.4 = reduction by natural processes for minimal hold up time of 0.5 hours (Reference 7.21)

0.01 = Normal reduction for effective ventilation filters (Reference 7.21)

The RDF for this type of release, with Reactor Building Spray on, is as follows:

$$RDF=(0.01)(.03)=0.0003$$

Where

0.01 = Normal reduction for effective ventilation filters (Reference 7.21)

0.03 = Reduction by Reactor Building Spray for minimal hold up time of 0.5 hours (Reference 7.21)

The reduction factor for filtration of 0.01 applies to normal filter conditions. If the filters are known to be degraded (for example, due to moisture) but still partially functioning, this is accounted for in the RAC Model. The filters are either functioning at the full capacity, 99%, or from 0 - 99% due to degradation. If the leakage is not through the purge system filters, the reduction factor component for filtration is 1.

5.11.6 Releases from Fuel Handling ESF Vent System

During a fuel handling accident in the fuel handling building, noble gases and iodines may be released into the fuel pool and subsequently into the atmosphere of the fuel handling building. The ESF ventilation system would then exhaust the atmosphere in the building, through filter banks, to the environment. The RDF for this type of release is as follows:

$$RDF=(0.01)(0.01)=0.0001$$

Where

0.01 = Normal reduction for effective ventilation filters (Reference 7.21)

0.01 = Retention of iodines in the fuel pool water (References 7.21 and Reg. Guide 1.25)

5.12 Dispersion Model

5.12.1 <u>Semi-Infinite Dose Model</u>

The TMI-1 RAC model computes both whole body dose (TEDE) and thyroid dose (CDE) using a semi-infinite model. In the semi-infinite model, the ground is considered to be an infinitely large flat plate and the receptor is assumed to be standing at the center of a hemispherical cloud of infinite radius. The radioactive cloud is limited to the space above the ground plane.

In computing whole body dose, the semi-infinite plume model is based on the assumption that the dimensions of an effluent plume are large compared to the distance that gamma rays can travel in air. If the plume dimensions are larger than the gamma ray range, then the radius of the plume might just as well be infinite since radiation emitted from beyond a certain distance will not reach the receptor. This assumption forms the basis for the Dose Conversion Factors (DCFs) provided in Reference 7.42 which are used by the RAC Model to calculate whole body dose. These DCFs combine doses from external exposure, inhalation from the plume, and exposure for an individual immersed in a plume. The whole body (TEDE) DCFs used in the TMI RAC Model are as follows:

Isotope	DCF (mrem/hr)(µCi/cc)
Kr 85m	9.30E+04
Kr 85	1.30E+03
Kr 87	5.10E+05
Kr 88	1.30E+06
Xe 131m	4.90E+03
Xe 133m	1.70E+04
Xe 133	2.00E+04
Xe 135m	2.50E+05
Xe 135	1.40E+05
Xe 138	7.10E+05
I 131	5.30E+07
I 132	4.90E+06
I 133	1.50E+07
I 134	3.10E+06
I 135	8.10E+06

The TMI-1 RAC model calculates the thyroid dose rate due to inhalation of I-131, I-132, I-133, I-134, and I-135 in the hemispherical cloud. The thyroid dose rate is proportional to X/Q. The thyroid dose conversion factors are calculated using the child breathing rate of 0.42 m^3/hr from Table E-5 of Reference 7.35 and the child inhalation dose factors from Table E-9 of Reference 7.35. The dose is computed by multiplying the dose rate by the expected duration of release. The thyroid DCFs used in the TMI RAC Model are as follows:

Isotope	DCF (mrem/hr)(μCi/cc)
I 131	1.84E+09
I 132	2.21E+07
I 133	4.38E+08
I 134	5.76E+06
I 135	9.00E+07

The radioiodines are decayed during plume travel time. The decay constants for I-131 through I-135 are from the Radiological Health Handbook. They are as follows:

Isotope	Decay Constant (min^{-1})
Kr 85m	2.58E-03
Kr 85	1.23E-07
Kr 87	9.12E-03
Kr 88	4.04E-03
Xe 131m	4.09E-05
Xe 133m	2.20E-04
Xe 133	9.18E-05
Xe 135m	4.43E-02
Xe 135	1.27E-03
Xe 138	4.89E-02
I 131	5.99E-05
I 132	5.06E-03
I 133	5.53E-04
I 134	1.32E-02
I 135	1.75E-03

5.12.2 Calculations Used in the Model

5.12.2.1 X/Q Calculation:

The basis for the X/Q calculation is the Gaussian diffusion equation and a 10 x 7 array of sigma y's and sigma z's. The array of values correspond to sigma y's and sigma z's for 7 stability classes and at 10 fixed downwind distances. For distances other than the fixed downwind distances, the sigma y's and sigma Z's are linearly interpolated before X/Q is computed for that distance. The ten fixed distances are: 200, 500, 1000, 2000, 3000, 6000, 10000, 30000, 50000, and 80000 meters.

5.12.2.2 Compute Building Effect

Returns one of seven pre-computed virtual source distances, depending on stability class. The virtual source distances for each of the seven stability categories are 209,209,209,308,465,770 and 1254 meters, respectively. These values were computed based on the cross-sectional area of the nearest large building. Building wake effects are simulated by adding the virtual source distance, for a particular stability class, to the actual downwind distance for the purpose of computing X/Q. For example, suppose we wanted to know X/Q without building wake effects at 800 meters downwind with stability class D. X/Q would then be computed at 800 meters downwind. With building wake effects, X/Q would be computed at 1108 meters downwind (800 + 308) Thus building wake effect is simulated by computing X/Q at a distance greater than the actual downwind distance and is called only for ground level portion of release.

5.12.3 Other Calculations

5.12.3.1 Compute TMI-1 Emergency Action Level. Declares the emergency action level from highest dose whether whole body (TEDE) or thyroid (CDE).

5.12.3.2 Compute Site Boundary

The whole body and thyroid doses are computed at the site boundary. The distance to the site boundary varies with the compass sector that the wind is blowing to. This distance is in meters.

5.12.3.3 Compute Terrain Factor

Computes terrain height in meters for a given downwind distance. At downwind distances other than the given distances, terrain height is computed by linear interpolation, except at distances closer than 610 meters. Between the plant and 610 meters downwind, the terrain height is set equal to the terrain height at 610 meters. Terrain further from the plant is never lower than terrain closer to the plant due to mathematical approximations.

5.12.3.4 Compute Stability Class

As measured by the TMI Meteorological Tower from the 150 ft minus 33 ft temperature difference. Table 5.13-1 relates the temperature difference to the stability class. The equivalent temperature difference per 100 ft is shown in the last column of the table. Stability class is determined by the measured temperature lapse rate per Reg. Guide 1.21.

5.12.3.5 Adjust Wind Speed

Adjusts wind speed from the anemometer height to the release height. The wind speed is adjusted according to the following equation:

$$u = u_0(h/h_0)^p$$

where the subscript "0" denotes the anemometer height and "u" and "h" are the wind speed and height above ground, respectively. The exponent p is a function of stability: 0.25, 0.33 and 0.50 for unstable, neutral and stable cases, respectively. If the adjusted wind speed is less than 0.5 mph, the adjusted wind speed is set equal to 0.5 mph.

5.12.3.6 Compute Exit Velocity

Computes exit velocity of the released material in feet per second by dividing cubic feet per minute by the stack cross-sectional area.

5.12.3.7 Compute Plume Rise

Computes the plume rise in meters for the elevated portion of a spilt wake release. Two formulas are used to calculate the plume rise; for unstable and neutral conditions jet plume rise, momentum dominated, is calculated from Briggs' Plume Rise, Eq. 4.33; for stable stability, it is calculated using Eq. 4.28 from Briggs' Plume Rise.

5.12.3.8 Compute Entrainment Factor

Computes entrainment factor for wake split flows. A mixed mode release is assumed when: (1) the release point is at the level of or above adjacent solid structures but lower than elevated release points, (2) the ratio of plume exit velocity to horizontal wind speed is between one and five. Specifically, the entrainment factor, E_t, is computed according to the following formulas:

E_t = 1.0 for w_o/u le 1

E_t = 2.58 - 1.58(w_0/u) for 1 gt w_0/u le 1.5

E_t = 0.30 - 0.06(w_0/u) for 1.5 gt w_0/u le 5.0

E_t = 0 for w_0/u gt 5.0

where w_0 is the stack gas exit velocity and u is the wind speed at stack height in miles per hour.

Note that the entrainment factor does not address the case of two adjacent plumes mixing with each other, as would be the case in TMI-1, where it is possible for a clean plume and a contaminated plume to be emitted from adjacent but separate stacks. These plumes are examples of co-located adjacent jets; little is known about the modeling of co-located adjacent jets such as the ones at TMI-1.

5.12.3.9 Release Duration

The release duration is the best estimate of the time that it will take for the plant to be put in a condition that significantly reduces the current release rate of radioactivity from the plant. Significant is generally considered to be one to two orders of magnitude.

The release duration is a key parameter in the dose projection and decision making process, however, it is also somewhat subjective. The most conservative interpretation of release duration would be that point in the future when no further radioactivity will be released from the plant. This definition, however, is not appropriate for the dose projection process. Following a plant event that involves a radiological release, some abnormal level of radioactivity may continue to be released from the plant for days or even weeks following the event. However, there will be a point at which these release rates are insignificant compared to the release rates that were seen in the early stages of the event. The best estimate of the time to reach this point should be considered as the release duration for dose projection purposes.

If a significant radiological release to the environment is occurring, there is a leak (or series of leaks) from a plant component or system that is allowing it to get out. Such leakage could include RCS leakage, main steam releases to direct the environment, containment leakage due to high pressure in the reactor building, or combinations thereof. The release rate of radioactivity from the plant, and resulting offsite dose rates, are proportional to the rate of leakage from the plant component or system. Following the onset of the event, plant operators will take actions to stop the leak or reduce the driving forces that perpetuate the leak. When the leak rate has been reduced by one or two orders of magnitude compared to the leak rate present during the initial stages of the event, offsite dose rates are proportionally reduced. The time it is expected to reach this point should be considered the release duration. To assume that the release duration will be the time it takes to completely isolate the leak makes the assumption that offsite dose rates will remain at their initial levels even though the release rate from the plant will have been dramatically reduced. This can grossly overestimate potential offsite doses and may lead to event over classification and unnecessary protective action recommendations. As a result, the release duration should be the best estimate of the time that it will take for the plant to be put in a condition that significantly reduces the current release rate of radioactivity from the plant. Significant is generally considered to be one of two orders of magnitude.

TABLE 5.12-1

Classification of Atmospheric Stability

Stability Classification	Pasquill Categories	Delta T (150' - 33') (°F)	Delta T (°F/100') (°F)
Extremely Unstable	A	< -1.22	< -1.04
Moderately Unstable	B	≥ -1.22to< -1.09	≥ -1.04to< -0.93
Slightly Unstable	C	≥ -1.09to< -0.96	≥ -0.93to< -0.82
Neutral	D	≥ -0.96to< -0.32	≥ -0.82to -0.27
Slightly Stable	E	≥ -0.32to< +0.96	≥ -0.27to< +0.82
Moderately Stable	F	≥ +0.96to< +2.56	≥ +0.82to< +2.19
Extremely Stable	G	> +2.56	> +2.19

5.13 Liquid Release Calculation - In this section of the model calculations are performed for liquid source term determination, (see Figure 5.13-1 and Tables 5.13-1, 5.13-2) concentrations in the river, travel time to downstream users, and ingestion dose commitment calculations. The methods used to perform the calculations are as follows:

1. The concentrations of the liquid effluents are determined by sampling and analysis of the effluent stream. If sample results are not immediately available, previous Chemistry data may be used to provide a best estimate of the effluent concentrations. Only the four usual iodine isotopes (I-131, I-132, I-133, I-135), H-3, Cs-134, Cs-137, Co-58 and Co-60 are considered in the calculation.

2. The dilution in the river is calculated by first obtaining the river flow rate and inputting the value in the model. The flow rate may be obtained by the following methods:

   Calling the York Haven Dam at 266-3654 or,

   Calling the River Forecast Center at 1-814-234-9861

   The river flow rate is then used along with the discharge flow rate to calculate the concentration in the river. Complete mixing is assumed by the time it reaches the first drinking water station. The concentration in the river is then divided by the effluent concentrations in 10 CFR 20 Appendix B, Table 2, Column 2, to determine the fraction of these concentrations in the river to downstream users.

3. The river concentration is used along with the total discharge time, to calculate the dose commitment to an individual from drinking the river water from one of the downstream intakes. The river concentration is multiplied by the duration of the release, the usage factor, the ingestion dose commitment factor for infants (Reg. Guide 1.109), and the infant usage factor (330 liters/yr) to obtain an estimated dose commitment for the downstream drinker. The infant dose is used because the product of the usage factor and DCF shows that the infant is the maximum age group for the predominant isotopes.

4. A flume arrival time is estimated for each known downstream user. The river volume flow is used in an algorithm based on a model derived from river dye dilution and flow studies conducted from the TMI discharge. The algorithm uses the following equation:

$$\text{Time (hrs)} = \frac{\text{Distance to Downstream User (Miles)}}{[\text{River flow (cfs)} \times .0283\ (m^3/ft^3)]^{0.628} \times 0.019667}$$

5. If the concentration of any nuclides in the river exceeds the concentrations specified in 10 CFR 20 Appendix B, Table 2, Column 2, downstream users must be informed and recommended to curtail usage. Refer to Procedure 1203-44 for downstream users and telephone numbers.

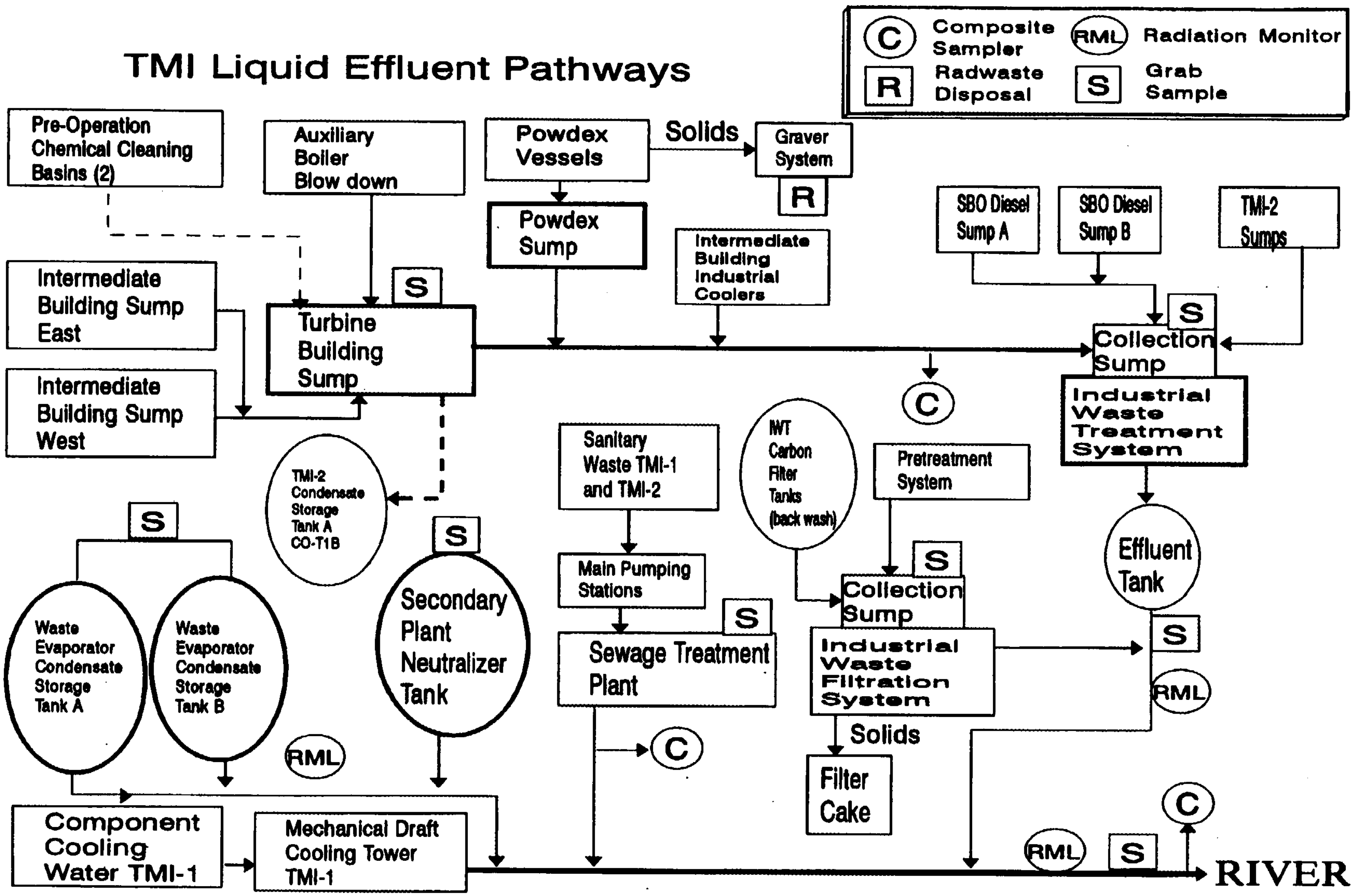

TMI Liquid Effluent Pathways
C Composite Sampler
RML Radiation Monitor
R Radwaste Disposal
S Grab Sample
Pre-Operation Chemical Cleaning Basins (2)
Auxiliary Boiler Blow down
Powdex Vessels
Solids
Graver System
R
Powdex Sump
Intermediate Building Industrial Coolers
SBO Diesel Sump A
SBO Diesel Sump B
TMI-2 Sumps
Intermediate Building Sump East
Intermediate Building Sump West
S
Turbine Building Sump
S
Collection Sump
C
Industrial Waste Treatment System
TMI-2 Condensate Storage Tank A CO-T1B
Sanitary Waste TMI-1 and TMI-2
IWT Carbon Filter Tanks (back wash)
Pretreatment System
Effluent Tank
S
Waste Evaporator Condensate Storage Tank A
Waste Evaporator Condensate Storage Tank B
S
Secondary Plant Neutralizer Tank
Main Pumping Stations
S
Sewage Treatment Plant
S
Collection Sump
Industrial Waste Filtration System
S
RML
RML
C
Solids
Filter Cake
Component Cooling Water TMI-1
Mechanical Draft Cooling Tower TMI-1
C
RML
S
RIVER

TABLE 5.13-1

TMI-2 Sump Capacity

Sump	Total Capacity	Gallons/Inch
Turbine Building Sump	1346 gals	22.43
Circulating Water Pump House Sump	572 gals	10.59
Control Building Area Sump	718 gals	9.96
Tendon Access Gallery Sump	538 gals	9.96
Control to Service Building Sump	1346 gals	22.43
Emergency Diesel Generator		
Sump A/B wet	837 gals	9.96
A/B dry	1200 gals	14.29
Chlorinator House Sump	-----	-----
Water Treatment Sump	1615 gals	22.43
Air Intake Tunnel		
Normal Sump	700 gals	-----
Emergency Sump	100,000 gals	766.00
Condensate Polisher Sump	2617 gals	62.31
Sludge Collection Sump	1006 gals	26.33
Heater Drain Sump	-----	-----
Solid Waste Staging Facility Sump	1476 gals	24.
Auxiliary Building Sump	10,102 gals	~202
Decay Heat Vault Sump	478.5 gals or 957 gals (total)	~ 10
Building Spray Vault Sump	478.5 gals or 957 gals (total)	~ 10

TABLE 5.13-2

TMI-1 Sump/Tank Capacities

Sump	Capacity (Gallons)
Turbine Building Sump (TBS)	10,000
Auxiliary Building Sump (ABS)	10,000
Reactor Building Sump (RBS)	10,000
Intermediate Building Sump West	1,000
Tendon Access Gallery Sump	1,000
Intermediate Building Sump East	1,000
Auxiliary Boiler Sump	2,000
Powdex Sump	40,000
Industrial Waste Treatment System Sump (IWTS)	300,000
Industrial Waste Treatment System Sump (IWFS)	80,000
Tanks	
TMI-2 Condensate B Tank	250,000
TMI-1 OTSG A or B (secondary)	25,000
TMI-1 WECST A or B	8,000
Neutralizer Tank	100,000
BWST	350,000
Condensate Tank A/B	265,000

5.14 Off-site Air Sample Analysis

5.14.1 Introduction

The results provided from field teams can be used to assess thyroid dose commitment.

The method involves collection of an air sample using a low flow (about 50 LPM) sampler with both a particulate filter and an iodine adsorber cartridge. The flow rate of the sampler, the duration of sample collection, the background of the frisker used to count the sample, the gross counts on the particulate filter, and the gross counts on the iodine cartridge are called into the RAC or EACC from the field teams. The RAC or EACC staff then can estimate the off-site dose commitment based on the sample.

5.14.2 Assumptions

A calibrated face loaded iodine cartridge was obtained and was used to determine the actual efficiency of a Eberline E140N with a HP-210/260 type probe to be used for counting in the field. The results of several tests on combinations of different probes and ratemeters showed a consistent 0.0039 (0.39%) counting efficiency. (Reference 7.7, 7.10, 7.11). Since I-131 has a fairly strong beta (0.6 MeV max.), the usual particulate filter counting efficiency of 0.1 (10%) is used. The collection efficiency for both filters for these calculations are assumed to be 1.0.

5.14.3 Calculation

The method first calculates the net counts per minute for the particulate and iodine cartridge. Then, using the given efficiencies separately, it calculates the air concentration of gaseous and particulate iodines. These are then combined for a total air concentration. A child breathing rate and dose conversion factor is then applied along with the estimated duration of exposure to obtain the off-site dose commitment.

Since the plant RAC model normally accounts for five different iodine isotopes, the dose conversion factor (DCF) used is a weighted average of the child DCFs based on the relative abundances of the five isotopes at damage classes of one and five with 100 minutes decay. This accounts for counts on the samples which will be caused by isotopes other than I-131.

5.14.4 Example:

Given an off-site air sample was taken with the following results:

Background = 100 cpm
gross cartridge countrate = 200 cpm
gross particulate countrate = 200 cpm
flow rate through sampler = 50 LPM
sample duration = 10 min.
exposure duration = 1 hour
DRCF = 4.0E8 $\frac{\text{mrem/hr}}{\mu\text{Ci/cc}}$

The RAC model follows the logic below to calculate an off-site thyroid dose commitment for this sample.

a. net particulate countrate = 200 - 100 = 100 cpm

b. net particulate activity = 100/.1 = 1000 dpm

c. net cartridge count rate = 200 - 100 = 100 cpm

d. net cartridge activity = 100/0.0039 = 25600 dpm

e. total activity in sample = 1000 + 25600 = 26600 dpm

f. total microcuries = 26600/2.22E6 = 0.012 μCi

g. sample volume = 50 * 1000 * 10 = 5E5 cc

h. air concentration = 0.012/5E6 = 2.4E-8 μCi/cc

i. dose commitment = 2.4E-8μCi/cc*1 hour*4E8 $\frac{\text{mrem/hr}}{\mu\text{Ci/cc}}$ = 9.6 mrem

5.15 Protective Action Recommendation Logic - The Logic Diagram is designed to enable the user to develop protective actions based primarily upon declaration of a General Emergency and also taking into account plant conditions, release duration and dose assessments. The logic is diagramed in Procedure EPIP-TMI-27, and EPIP-TMI-.02.

6.0 RESPONSIBILITIES

6.1 The RAC is responsible to ensure that dose assessments using the methodology in the EDCM are performed upon implementation of the Emergency Plan.

6.2 The RASE has the responsibility to support the RAC in performance of radiological controls and dose assessment using the methodology in the EDCM.

6.3 The Chemistry Coordinator has the responsibility to support the RAC in the procurement and analysis of in-plant samples required to quantify the accident.

6.4 Radiological Controls has the responsibility of proper review, and evaluation of the EDCM and to assist with the user interface of the RAC program software. Emergency Preparedness is responsible for ensuring that the EDCM and the RAC computer models are current and compatible.

6.5 The Technical Support Center (TSC) has the responsibility to provide the RAC with appropriate fuel damage data and other infomation pertinent to performing dose calculations.

6.6 The Emergency Preparedness Department and Radiological Engineering have the responsibility to ensure any changes to the RAC program are performed and documented IAW Procedure 1000-ADM-1230.10.

6.7 The Radiological Controls and Emergency Planning Departments have the responsibility to make any changes to the RAC Code, and to compile and distribute new versions of the program.

7.0 REFERENCES

7.1 American National Standard (ANS), ANSI/ANS-18.1 - 1984, Radioactive Source Term for Normal Operations of Light Water Reactors

7.2 APS Source Term Report - Report to the American Physical Society of the Study Group on Radionuclide Releases From Severe Accidents at Nuclear Power Plants, February 1985

7.3 Dose Assessment Manual for Emergency Preparedness Coordinators, February 1986, INPO 86-008

7.4 Efficiency Check using an Air I-131 Source Cartridge and a Ba-133 Source Cartridge, Memorandum 9502-88-0139, September 28, 1988

7.5 EPA 520/1-75-001 - Manual of Protective Action Guides and Protective Actions for Nuclear Incidents

7.6 EPIP-TMI-.07 - Off-site/On-site Dose Projections

7.7 Evaluation of a Front Loaded Iodine Cartridge using Various Survey Equipment, Memorandum 9100-88-0194, May 12, 1988

7.8 Field Measurements of Airborne Releases of Radioactive Material, Memorandum 9502-88-0098, May 25, 1988

7.9 FSAR, TMI-1 Chapter 11, Radioactive Waste and Radiation Protection

7.10 FSAR, TMI-1 Chapter 14 - Safety Analysis

7.11 TMI-2 PDMS Safety Analysis Report

7.12 TMI Emergency Plan, 1000-PLN-1300.01

7.13 ICRP-23 - Report of the Task Group on Reference Man, 1981

7.14 INPO SOER 83-2 - "Steam Generator Tube Ruptures"

7.15 Introduction to Health Physics, Herman Cember, 2nd Edition, 1985

7.16 NRC-BNL Source Term Report

7.17 NUREG-0017 PB-251 718 - PWR - GALE Code; Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from PWR, Revision 1, 1985

7.18 NUREG-0133 - Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, October 1978.

7.19 NUREG-0654 - Revision I - Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants

7.20 NUREG-0737 - Clarification of TMI Action Plant Requirements, U.S. Nuclear Regulatory Commission, November 1980, Generic Letter 82-33, Supplement 1 to NUREG-0737 - Requirements for Emergency Response Capability, U.S. Nuclear Regulatory Commission, Washington, D.C., December 1982

7.21 NUREG-1228 - Source Term Estimation during Incident Response to Severe Nuclear Power Plant Accidents, October 1988

7.22 NUREG/CR-3011 - Dose Projection Considerations for Emergency Conditions at Nuclear Power Plants

7.23 N1830 - Post Accident Reactor Coolant Sampling

7.24 N1831 - Post Accident Atmospheric Sampling

7.25 N1832 - Post Accident Sample Analysis

7.26 Deleted

7.27 1210-10 - Abnormal Transients Rules, Guides and Graphs

7.28 1210-8 - RCS Super Heated

7.29 1202-12 - Excessive Radiation Levels

7.30 Operational Quality Assurance Plan, 1000-PLN-7200.01

7.31 Proprietary Midas User Documentation, Pickard, Lowe, and Garrick

7.32 Radioactive Decay Data Tables, David C. Kocher, ORNL, DOE/TIC-11026, 1981

7.33 Radiological Health Handbook, Revised Edition Jan. 1970, US Dept. HEW

7.34 Reg. Guide 1.21 Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants, Rev. 1, June 1974.

7.35 Reg. Guide 1.109 - Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I, October 1977, Rev. 1

7.36 SER-419628-003, Rev. 7, Instrument Calibration Facility, Feb. 12, 1988

7.37 TDR-390 - TMI-1; Primary-to-Secondary OTSG Leakage and its On-site/Off-site Radiological Impact, April 1983

7.38 TDR-405 - TMI-1; Evaluation of Plant Radiation Release and its 10CFR50, Appendix I Conformance for Different Operating Conditions

7.39 TDR-431 - Method for Estimating Extent of Core Damage Under Severe Accident Conditions

7.40 WASH-1400 - 1975 Nuclear Safety Study WASH-1400 (also known as Rasmussen Report)

7.41 Sutron Report No. SCR-358-82-063, Study of Travel Time and Mixing Characteristics for the Susquehanna River Below Three Mile Island

7.42 EPA 400-R-92-001, Manual of Protective Action Guides and Protective Actions for Nuclear Incidents

7.43 RAF 6612-97-019, "Source Term Algorith for RMG-22/23

7.44 RAF 3640-98-19, "Documentation of Calculation of Direct-to-Atmosphere Mass Flow Rates"

8.0 **EXHIBITS**

Exhibit 1 - Emergency Dose Assessment User's Manual

INDEX

Overview of the Emergency Information Network

The Emergency Information Network (EIN) at TMI is a LAN based system that allows emergency organization personnel to view information on plant conditions and offsite dose projections during a plant emergency. Because it is a LAN based system, the same information can be viewed from any of the major emergency facilities. The ability of the different facilities to share common data during an emergency enhances communications within the emergency team, and minimizes the potential for conflicting information.

The heart of the EIN is the Continuous Online Assessment System or **COLA**. The COLA produces a new dose projection every 4 to 6 minutes and displays it on the EIN. This is accomplished by a central "Host Computer" retrieving Met Data, RMS readings, RCS Activity, Iodine Spiking Factors, and plant information such as pressures, temperatures, flowrates etc from the plant's computer system. This information is used to produce a separate dose calculation for each of TMI's release pathways that are then added together for a complete dose projection from TMI. The dose projection is then sent to the Local Area Network (LAN) and is available for review by Emergency Management Personnel. Since the host computer automatically runs dose projections every 4 to 6 minutes, the RAC cannot produce a dose projection any time he/she wishes using the COLA.

In addition to the COLA, the EIN also provides the capability to run manual versions of the code. The Manual Codes are located on the hard drives of the dose projection computers in the emergency response facilities and are independent of the LAN system. As a result, they can be used if the LAN system is not operational for some reason. Because the manual codes are independent of the LAN system, the results are NOT displayed on the network. Therefore, information that is important to other personnel such as the Group Leader R&EC must be faxed to them. The two versions of the manual code available on the EIN menu are:

1. Manual Code – used to perform dose projections out to 30 miles. IREO personnel performing manual dose projections would use this code.

2. Quick Code – a simplified manual code that would be used by the GRCS during the first hour if the COLA is not functional. Only an RMS reading and met data are required for entry.

The Manual Codes can be used for some of the following reasons:

1. To perform a dose projection if the COLA is out of service

2. To perform dose projections between COLA dose projections

3. To perform a "What If" dose projection.

4. To perform a dose projection if the data being retrieved by the COLA is considered inaccurate (i.e., a bad RMG-25 reading).

5. To perform a dose projection if the release is not properly monitored by an RMS monitor.

6. To compare or validate the COLA dose projection for any other reason.

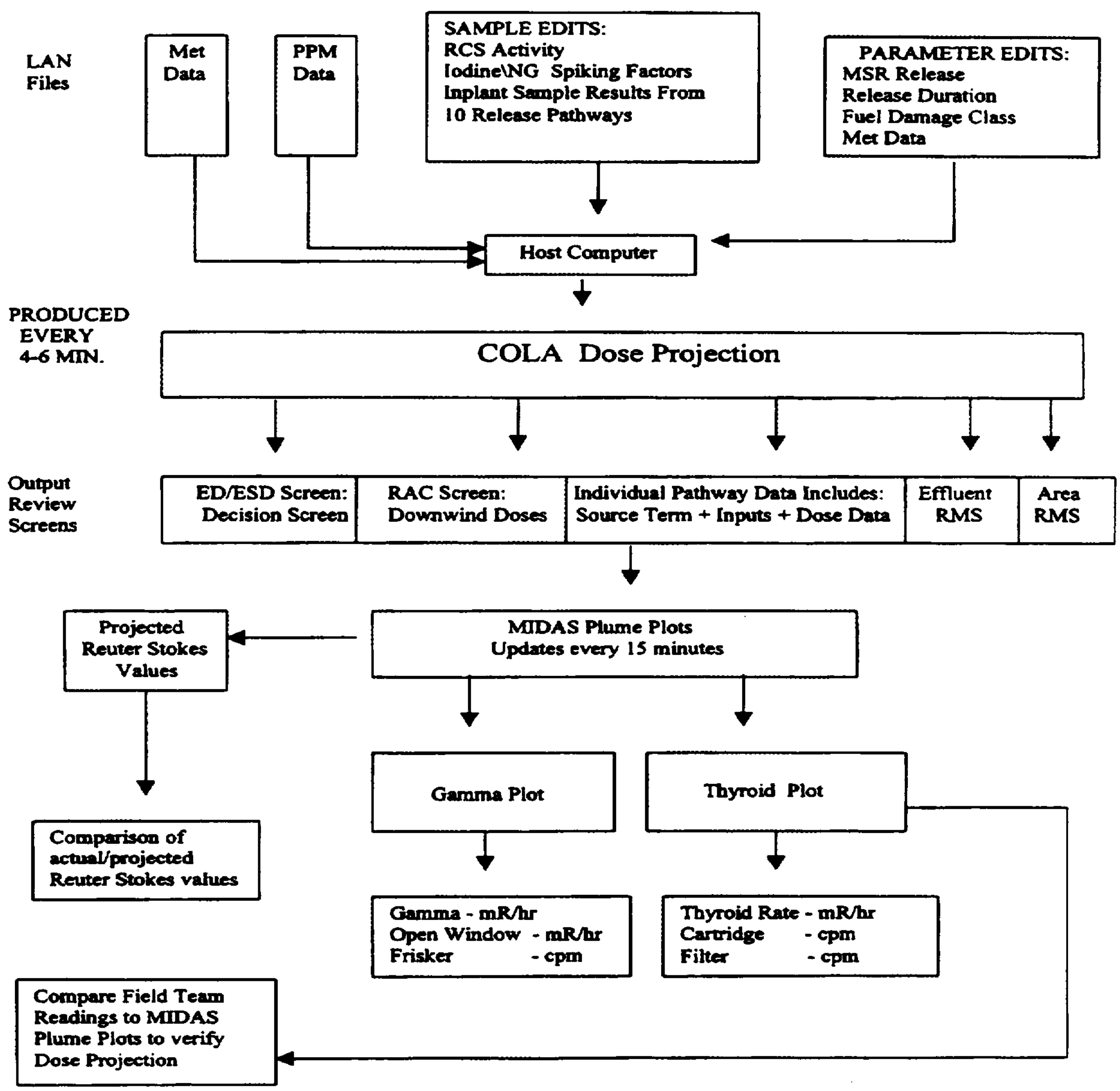
A much more detailed description of Manual Code calculations is discussed later in this manual

The third dose projection component of the EIN is the MIDAS Plume Plot System. The COLA calculated source term leaving the plant is automatically imported into the MIDAS program, which produces plume plots. MIDAS calculates dose projections differently than the RAC codes. The RAC code is a straight-line gaussian model. That means it takes the source term leaving the plant at that moment and calculates the dose based on the most current met conditions. It ignores releases of radioactivity that occurred prior to the most current dose projection. It projects the doses that will be seen offsite if things do not change. The MIDAS code is a particle in cell model. That means it models the offsite doses by tracking the activity released every 15 minutes and coupling that activity with the met data for that 15 minutes. As a result, it more closely approximates dose rates that should currently be seen offsite. As a result, the MIDAS Plume Plots are used for comparison with field team and Reuter Stokes data. The EAC compares field team data it receives with the MIDAS Plume Plots. In addition, the EIN provides an option which displays a comparison of MIDAS projected doses with actual Reuter Stokes monitor readings. This comparison is used to check that the source term produced by the COLA is reasonable based on what we are seeing in the field. The MIDAS Program can be run off the "C" drive by EACC personnel with manual input of source terms when the COLA is out of service.

Finally, the EIN also displays effluent RMS and plant area monitor readings. It also provides a listing of the parameter values that were used in calculating the dose projection for each pathway. A schematic illustration of the EIN appears on the next page.

EXHIBIT 1

Emergency Information Network Block Diagram



Emergency Information Network Block Diagram Description

The Host Computer, located on the 1st floor of the OSF, produces the COLA dose projection screens by retrieving a lot of different information that resides on the LAN. This information includes:

1. Plant Performance Monitor (PPM) Data – Includes all of the data residing on the PPM such as RMS data, Condenser flow rates, Condenser vacuum, RCS temperature/pressure, OTSG pressures, OTSG levels etc.

2. Met Data – Retrieves wind speed, wind direction, delta temperature directly from the Met Tower. Updated every 15 minutes.

Sample Edit Screen

1. RCS Activity – Retrieves the default RCS Activity entered into the Sample Edit screen by Rad Engineering or the edited RCS Activity entered by RAC/Rad. Eng. Support personnel into the Sample Edit screen.

2. Iodine/NG Spiking Factors – Retrieves the default Spiking Factors entered into the Sample Edit screen by Rad Engineering or the edited Spiking Factors entered by RAC/Rad. Eng. Support personnel into the Sample Edit screen. The Nuclear Engineering Group determines the default spiking factors.

3. In-plant Sample Results – The sample results from TMI 1's 10 release pathways may be entered into this screen by RAC/Rad. Eng. Support personnel. Examples are MAP – 5/sample panel results for RMA-5, 8, 9, effluent pathways and CATPASS samples for the Design Basis Leakage pathway.

Parameter Edit Screen

1. MSR Release – The default MSR position is closed but should a release occur through this pathway an open MSR position can be indicated by using this screen.

2. Release Duration – 8 hours is the default release duration but can be edited by RAC/Rad. Eng. Support personnel.

3. Fuel Damage Class – The COLA automatically determines the Damage Class from the RCS Temperature (average of the 5 highest incores). If plant conditions warrant it, RAC/Rad. Eng. Support personnel can edit the Damage Class.

4. Met Data – If the COLA is retrieving inaccurate Met Data from the Met Tower, this screen can be used to input the correct information.

The COLA, after retrieving all of this information, calculates a new dose projection every 4 to 6 minutes and displays the associated screens on the LAN. The only information that is not updated within the 4 to 6 minute run is the Met Date, which is updated every 15 minutes. All of the information on the Emergency Information Network is retrieved by the Host Computer and displayed on the LAN. The COLA dose projection includes the following screens:

1. ED/ESD Screen
2. RAC Screen
3. Individual pathway Data

4. Parameter Edit Screen
5. Sample Edit Screen

The Host Computer then uses the source term from the dose projection to produce a new MIDAS Plume Plot every 15 minutes. The MIDAS program produces a Beta/Gamma plot and a Thyroid Plot. These plots are produced in three different map sizes, island view, 2.5 mile view, and 6 mile view. The primary purpose of MIDAS is to verify the dose projection.

The MIDAS program then produces the projected Reuter Stokes values again every 15 minutes. These projected Reuter Stokes values can be compared to the actual Reuter Stokes values as another confirmation of the dose projection. This is possible since MIDAS uses the same source term as the COLA dose projection and then produces the Reuter Stokes projected values.

EXHIBIT 1

Emergency Information System Main Menu
(Typical)

EMERGENCY INFORMATION NETWORK

1A. ED/ESD SCREEN 1B. RAC SCREEN 1C. PARAMETER EDITS 1D. SAMPLE EDITS

2A. MIDAS PLUME PLOTS 2B. FIELD TEAM DATA

2C. AIR SAMPLE CALC 2D MIDAS Plume Plot Edit (EACC Only)

3. REUTER STOKES FIELD DATA AND MIDAS CALCULATION COMPARISON

4. INDIVIDUAL PATHWAY DATA * SOURCE TERM * INPUT DATA * DOSE DATA

5. EFFLUENT RMS

6. AREA GAMMA AND LIQUID RMS

7. DELETED

8. QUICK CODE

9. MANUAL CODE

10. EXIT TO DOS

ENTER THE APPLICATION NUMBER:

This is the main menu for the Emergency Information Network. Each selection will be discussed in detail in the subsequent pages.

ED/ESD Screen (1A)
(Typical)

ACTIONS TO BE TAKEN BASED UPON THIS DOSE CALCULATION:
Declare an ALERT per A1.1 (5.40E+01) mRem/Hr CDE)

Do NOT Issue A Protective Action Recommendation

Most Limiting Dose (Rate)	Dose Type	Location	Presently at Percent of Next Limit
1.71E+01 mRem	TEDE	1 Mile	17%
4.32E+02 mRem	CDE	1 Mile	86%

RELEASE PATHWAY CONTRIBUTION TO MOST LIMITING DOSE using CDE Dose

CONDENSER OFFGAS	0.0%	B OTSG ADV	100.0%
RX BLDG DESIGN BASIS LEAKAGE	0.0%	B OTSG MSR	0.0%
EMERGENCY FEED PUMP EXHAUST	0.0%	STATION VENTILATION	0.0%
A OTSG ADV	0.0%	RX BLDG PURGE EXHAUST	0.0%
A OTSG MSR	0.0%	ESF EXHAUST	0.0%

WIND SPEED (MPH): 5.0 WIND DIRECTION (DEG FROM): 90 DELTA TEMP (DEG): -1.00
STABILITY CLASS (A TO G): C RELEASE DURATION (HRS): 8 NRC CLASS (1-10): 1

CURSOR LEFT (BACKWARD) CURSOR RIGHT (FORWARD) ALT-H (HARDCOPY) HOME (EXIT)

1. The ED/ESD Screen provides the **Radiological Emergency Action Level (EAL)** for the event straight out of the Emergency Classification and Basis procedure. It also provides the most limiting dose or dose rate that required entry into the EAL.

2. Prompts a **Protective Action Recommendation (PAR)** if a General Emergency is declared. If a Site Area Emergency is declared, the message will prompt RAC personnel to review the PAR Logic Diagram.

3. **Most Limiting Dose (Rate)** provides the highest integrated Total Whole Body Dose/Dose Rate (TEDE) or Child Thyroid Dose/Dose Rate (CDE) based on the latest dose projection. The Most Limiting Dose (Rate) is the summation of all 10 of TMI's release pathways and shows the downwind location of the highest dose or dose rate. Dose rates are shown for dose projections requiring less than an Alert classification. Integrated dose is displayed for dose projections requiring an Alert classification or above (i.e., approaching a Site Area or General Emergency).

4. **Presently at PerCent of Next Limit** provides the user with an indication of how close the dose projection is to approaching the next emergency classification level that would require escalation of the event. The most limiting type of dose is highlighted.

5. Displays TMI's 10 release pathways in % of dose contribution. The pathway with the highest % doses will be highlighted on the screen. The screen also displays which type of dose (TEDE or CDE) is being used to calculate the percentages.

6. Provides **Met Date:** Wind Speed, Wind Direction (degrees from), Delta T, and Stability Class (A to G). This information is updated every 15 minutes from the Met Tower. The Met Data is also the average of all of the readings taken over 15 minutes from the Met Tower. If the Met Tower stops transmitting to the LAN, inaccurate Met Data will display on this screen and will be used by the COLA. Editing of the Met Data is then required and will be discussed in the "Parameter Edits" screen section.

7. Provides **Release Duration** default (8 hours). This parameter can be edited and will also be discussed in the "Parameter Edits " screen section. Protective Action Guidelines (PAGs) are based on the integrated dose at the site boundary therefore a conservative release duration would cause a conservative dose projection.

8. **Fuel Damage Class** is calculated automatically by the COLA using PPM data that uses the average of the 5 highest incore detectors. If the calculated Fuel Damage Class is not accurate based on plant conditions (i.e. mechanical fuel damage would not affect the incore detectors) editing can be performed . This will also be discussed in the "Parameter Edits" section.

RAC Screen (1B)
(Typical)

TOTAL DOSE FROM ALL PATHWAYS IN MREM

TIME: 07:23:18 DATE: 01-13-1998 CALCULATION #: 1

DISTANCE	COMMITTED DOSE EQ (MREM)	TOTAL EFFECTIVE DOSE EQ (MREM)
Site Boun.	**1.5E-01**	**1.0E-02**
Ex. Area	1.0E-01	6.5E-03
1 MILE	3.5E-02	2.6E-03
2 MILE	1.4E-02	1.2E-03
5 MILE	3.4E-03	2.6E-04
10 MILE	1.4E-03	1.0E-04

HIGHLIGHTED DOSES ARE MAXIMUM VALUES

CURSOR LEFT (BACKWARD) CURSOR RIGHT (FORWARD) ALT-H (HARDCOPY) HOME (EXIT)

The **RAC Screen** lists the "Total Dose from All 10 Pathways. This screen displays the Committed Dose Equivalent CDE (Child Thyroid) and Total Effective Dose Equivalent TEDE in ranges from the Site Boundary out to 10 miles. If RAC personnel suspect that significant doses are present outside of 10 miles, then the Manual RAC Code must be used since it can calculate doses beyond 10 miles. The downwind location with the most limiting dose is highlighted on the screen.

Parameter Edits Screen (1C)

	SELECT PARAMETER EDITS	
Minimum: 0	Default: 0	Maximum: 1
	PARAMETER EDITS	
PARAMETER NAME	PARAMETER VALUE	ACTIVE EDIT
MSR RELEASE	0 (1 IS OPEN)	0 (1 IS ACTIVE)
RELEASE DURATION	8 (0-99 HOURS)	0 (1 IS ACTIVE)
DAMAGE CLASS	1 (CLASS 1-10)	0 (1 IS ACTIVE)
WIND SPEED	4 (2-99 MPH)	0 (1 IS ACTIVE)
WIND DIRECTION	210 (0-360 DEG)	0 (1 IS ACTIVE)
DELTA TEMP	-1.1 (-10 TO +10 DEG)	0 (1 IS ACTIVE)
F1: Next F2: Prev	Alt F10: Abort	F10: Done

1. **MSR Release** – This option allows RAC personnel to indicate to the COLA whether a Main Steam Relief Valve is open. A "1" entered in the parameter value indicates that a valve is open and a "0" indicates a closed position. The COLA will then calculate the flow rate based on the main steam pressure obtained from the PPM. This option is only accurate if ONE MSRV is open. In the unlikely event that more than one valve is stuck open the Manual RAC Code must then be used. The Manual Code allows inputs for the position of all of the MSRVs and ADVs. Also the COLA always uses RMG-26 or RMG -27. If this RMS monitor is isolated, which occurs when MSV 2A or 2B are closed, then the Manual Code (Contingency Calculation) must be used. An operator must be sent up to the Intermediate Building roof to visually check the valve to verify whether a MSRV is really open. This requirement is incorporated into plant procedures.

2. **Release Duration** – This edit option is probably the one most often changed by the RAC. Eight hours is the default release duration used by the COLA. Anytime you want to enter another release duration other than 8 hours simply select a number from 1-99 and enter it in the Parameter Value. Since this option has a direct effect on the integrated dose released from TMI, the number used must always come only from the Emergency Director. If you suspect the ED is giving you a conservative value for release duration question him on it.

3. **Fuel Damage Class** – This very important parameter is calculated by the COLA, using the average temperature of the 5 highest incore detectors. However if you don't think this calculation is accurate, the parameter can be edited by selecting 1 through 10 and entering it as the Parameter Value. One example of the need to edit would occur if the core suffered mechanical damage unrelated to temperature and pressure. A Damage Class of 2, 3, or 4 would then be entered as the Parameter Value.

   Keep in mind that once core damage occurs it can never be repaired. The COLA calculated damage class may decrease based on the cooling of the core but the previously higher Damage Class must continue to be used by using the editing option.

The purpose of the Fuel Damage Class is to determine what percentage each of the 10 noble gas and 5 iodine isotopes contribute to the total RCS activity. The total RCS activity is not important since the activity leaving the plant is being directly measured by an RMS monitor for all COLA calculations. If the COLA uses damage class 1, then the current RCS activity that was entered on the LAN or the edited RCS Activity will be used. If Damage Class 2 though 10 is either calculated by COLA or manually edited, then the RCS activities listed in the EDCM for each Damage Class will be used in the calculation of the source term. Also the noble gas and iodine Spiking factors are only used when the Damage Class is 1. Damage Class 1 with a spike is considered to be Damage Class 1A.

Also the Damage Class can determine how much offsite CDE Child Thyroid Dose will occur as compared to the offsite TEDE Whole Body Dose, i.e., if the Damage Class is 1 though 4 the NG to iodine ratio is approximately 5 to 1. When the Damage Class increases to 5 though 10 the NG to iodine ratio changes drastically to 0.63. Therefore a increase to Damage Class 5 or above will cause a significant increase in the Child Thyroid Dose as compared to the TEDE Whole Body Dose

4. **Wind Speed –** Enter 1 – 99 as the Parameter Value
Wind Direction – Enter 0 – 360 as the parameter value
Delta Temp – Enter – 10 - + 10 as the parameter value

Bear in mind that the COLA will retrieve Met Data from the Met Tower whether the data is accurate or not. This could occur if the Met Tower goes out of service (0's would be displayed by the COLA). This also would render the weather charts in the Control Room inaccurate. If this occur contact the EACC for the correct Met Data to input in the Parameter Edits.

Another problem might be that the met tower is operational, but has stopped communicating with the host computer. In this case the host computer will continue to use the last met data it received from the tower. The user should be alert to the fact that met data that does not change at all over the course of 30 to 45 minutes may indicate that the communication has broken down. Control room instrumentation should be checked to verify that the met data is accurate.

Active or inactive Parameter Edits - Placing a "1" in the Parameter Edit box will cause the entered Parameter Value to be used by the COLA or to be active. Therefore a "0" would cause the value to be inactive. **Remember that once a value is made active, it stays that way until the inactive option is chosen.**

After all of the editing of the Parameter Edits screen is completed and the selections made active, hit the F10 key to close out the screen.

Sample Types (1D)

	SELECT TYPE OF SAMPLE DATA	
Minimum: 1	Default: None	Maximum: 12
ACTIVE	SAMPLE TYPE	
NO 1.	CONDENSER OFFGAS PATHWAY	
NO 2.	REACTOR BUILDING DESIGN BASIS LEAKAGE PATHWAY	
NO 3.	EMERGENCY FEEDPUMP EXHAUST PATHWAY	
NO 4.	ALPHA OTSG ADV PATHWAY	
NO 5.	BRAVO OTSG ADV PATHWAY	
NO 6.	ALPHA OTSG MSR PATHWAY	
NO 7.	BRAVO OTSG MSR PATHWAY	
NO 8.	STATION VENTILATION PATHWAY	
NO 9.	REACTOR BUILDING PURGE PATHWAY	
NO 10.	ESF VENTILATION PATHWAY	
NO 11.	REACTOR COOLANT BASELINE ACTIVITY	
NO 12.	REACTOR COOLANT SPIKING FACTORS	
	ENTER CHOICE (1 THRU 12)	
F1: Next F2: Prev	Alt F10: Abort	F10: Done

The first 10 selections are TMI's 10 release pathways. Isotopic results from in-plant samples such as CATPASS, or RMA-5, RMA-8, RMA-9 sample panels can also be entered into these screens. MAP-5 samples cannot be input into the COLA, as there are no noble gas results. MAP-5 sample calculations must be performed using the manual codes. These samples provide a more refined dose projection than ones calculated from RMS data since they provide a GELI analysis of each isotope. The concentration obtained from these samples is combined with the release rate to calculate the source term leaving the plant. It is recommended that in-plant samples be obtained as practicable and entered into the sample edit screen.

1. **Condenser Offgas Pathway** – accepts RMA-5 sample panel marinelli beaker/iodine pre-filter sample results.

2. **Reactor Building Design Basis Leakage Pathway** – Accepts CATPASS sample results.

3. **Emergency Feed Pump Exhaust Pathway** – Sample Edit Screen inactive at this time.

4. **Alpha OTSG ADV Pathway** - Sample Edit Screen inactive at this time.

5. **Bravo OTSG ADV Pathway** - Sample Edit Screen inactive at this time.

6. **Alpha OTSG MSR Pathway** - Sample Edit Screen inactive at this time.

7. **Bravo OTSG MSR Pathway** - Sample Edit Screen inactive at this time.

8. **Station Ventilation Pathway** - accepts RMA-8 sample panel marinelli beaker/iodine pre-filter sample results.

9. **Reactor Building Purge Pathway** - accepts RMA-9 sample panel marinelli beaker/iodine pre-filter sample results.

10. **ESF Ventilation Pathway** – Accepts iodine and noble gas sample results.

    The 10 pathway sample edit screens, once sample results are entered, must be made active in order to be used by the COLA.

11. **Reactor Coolant Baseline Activity** – This is where RCS sample results are entered for use by the COLA. Rad Engineering updates the default RCS activities on this screen as RCS changes during the core life. RCS sample results are only used in the COLA dose projection if the Fuel Damage Class is 1. If the core damage is Damage Class 2 through 10, the COLA will use the RCS activities listed in the EDCM. Since the RCS activities listed in the EDCM are conservative it would be justified to request a Post Accident RCS Sample and input the results in the Sample Edit screen. You would then have to edit the Damage Class to 1 in order for the results to be used by the COLA. One major difference between this screen and the 10 pathway screens are the results are always active.

12. **Reactor Coolant Spiking Factors** – Normally the spiking factors, which are determined by the Nuclear Engineering Group, are entered onto the LAN by Rad Engineering. If these values are considered inaccurate, then the spiking factors may be edited using this screen. Remember that spiking factors are only used when the Damage Class is 1 AND the plant is at 0% power. One major difference between this screen and the 10 pathway screens is the results are always active.

    To use this screen, select the release pathway and hit the F10 key to reach the actual isotopic input screen. Also you can select either the RCS activity or spiking Factors screen and then hit the F10 key for these inputs. Remember that the RCS activity and spiking factors screens are always active and used by the COLA, therefore the results in these two screens must always be accurate and up to date. If Post Accident RCS results are being used, ensure the spiking factors on this screen are set to 1, or the code will erroneously spike the sample results.

EXHIBIT 1

Effluent Sample Screen

Entry MUST be Y or N

RADIONUCLIDE CONCENTRATIONS IN UCI/CC

NOBLE GAS ISOTOPES		RADIOIODINE ISOTOPES	
KR_85M	0.00E+00	I_131	0.00E+00
KR_85	0.00E+00	I_132	0.00E+00
KR_87	0.00E+00	I_133	0.00E+00
KR_88	0.00E+00	I_134	0.00E+00
XE_131M	0.00E+00	I_135	0.00E+00
XE_133M	0.00E+00		
XE_133	0.00E+00		
XE_135M	0.00E+00		
XE_135	0.00E+00		
XE_138	0.00E+00	Make Active(Y/N)	N

Enter values for only those nuclides designed to be collected by the analysis.

If these values are <MDA then enter the MDA value, not a zero.

Enter a zero value for nuclides not designed to be collected by the analysis

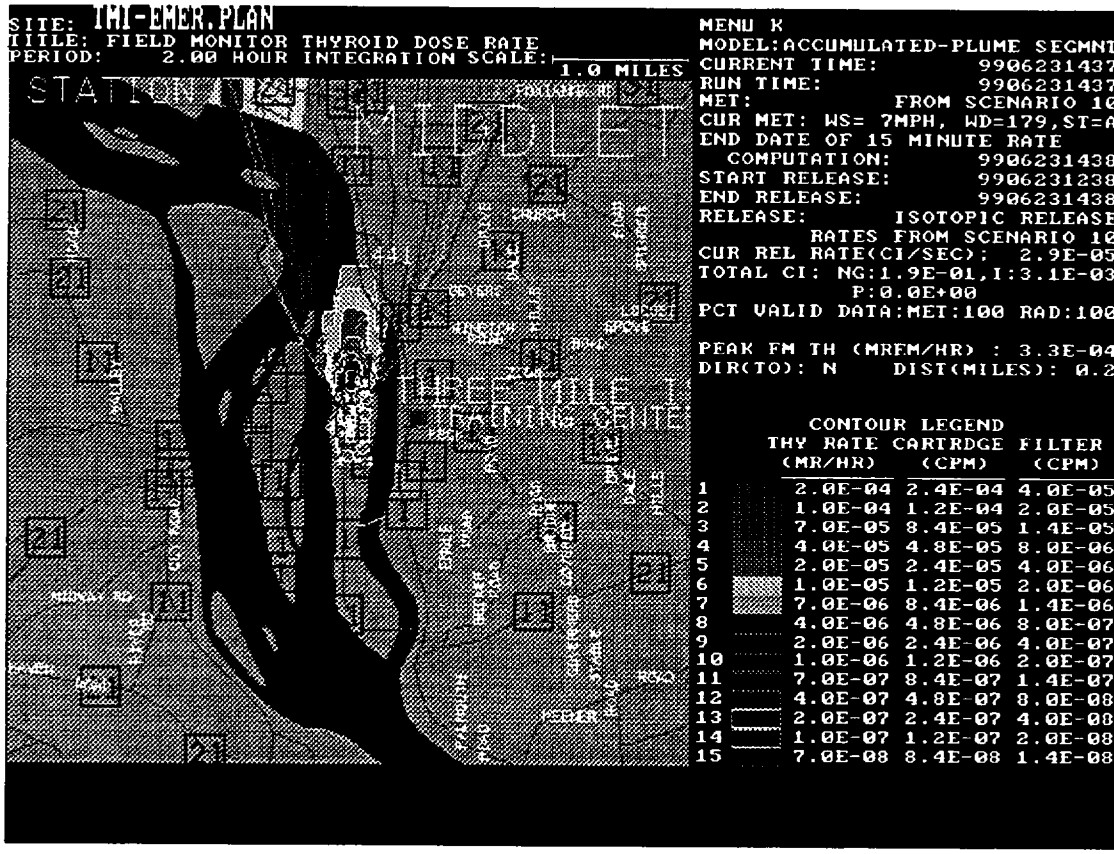
F1: Next F2: Prev Alt F10: Abort F10: Done

The bottom statement on this screen may need some clarification. i.e. MAP-5 sample results only include the 5 iodine isotopes but not the 10 noble gas isotopes. As a result, the COLA will not calculate a noble gas source term from a MAP-5 sample. The COLA can only use pre-filter marinelli sample results or CATPASS results, where both noble gases and iodines are analyzed, to calculate the TEDE dose properly. If the MAP-5 sample is input into the COLA, the COLA will calculate the correct thyroid dose.

To enter sample results first select the release pathway and hit the F10 key. Enter the isotopic sample results for each isotope. When all 15 isotopic results are entered hit the F10 key and select "Y" to make the screen active. Hit the F10 key again to close out the screen.

EXHIBIT 1

MIDAS Plume Plots (2A)



MIDAS Screen - The primary purpose of the MIDAS Screen is to compare field team readings and to indicate the plume location in order to send out field monitoring teams. If the field monitoring team results match up with this screen, then the accuracy of the dose projection is confirmed. The Group Leader R&EC is in charge of the dose assessment process and will determine which dose projection/field team ratio is acceptable to confirm the dose projection and possible PAR.

Both the dose projection model and the MIDAS Program use the same source term and should be in reasonable agreement if the COLA calculations are correct. The COLA dose projection source term is automatically used by MIDAS, however if the Manual Code is used by RAC personnel, the source term results must be provided to the EACC in order to be added to MIDAS.

The MIDAS Program provides a snapshot that takes into account residual airborne radiation for a 2 hour block of time. It uses 8, 15 minute sets of Met Data and is updated with a new set of data every 15 minutes. A new MIDAS Plume Plot snapshot is also updated every 15 minutes with the oldest Met Data set being eliminated and the new set of data added. As you can see MIDAS uses a different dispersion model than the RAC dose projection program, which projects the highest dose for the current time. This is why the COLA or Manual dose projection and not MIDAS is used for comparison to the PAGs and possible PAR. A PAR only looks at what the predicted integrated dose is for the future time of the release duration, not what has been released in the past. MIDAS includes past radioactivity in the atmosphere in its plume plots.

Because the dose projection model and MIDAS use the same source term but different dispersion models (15 minutes vs. 2 hours), their results will most likely not match up. Since both programs use the same source term, if the field monitoring team results match up with MIDAS the dose projection is confirmed. If the results are unacceptable an investigation among dose assessment personnel is prudent. Here are some potential problems:

1. Did the Field Team really find plume centerline
2. Is there an unusual release pathway that is not indicated on the COLA
3. Is the COLA using inaccurate information such as Met Data, RMS, flow rates
4. Are RMG 26 or RMG 27 results being incorrectly used by the COLA.
5. Is the Manual Code in use with more than one release pathway occurring from TMI.

Another difference between the dose projection and MIDAS is that MIDAS uses precipitation (wet deposition) in its calculation unlike the RAC Code models.

Midas normally uses the same source term and met data as the COLA dose projection program. MIDAS automatically retrieves these parameters when the COLA is valid. However if the Manual Dose Projection model is used the source term and met data are not automatically added to MIDAS by the Host Computer. EACC personnel must then use the "Stand Alone MIDAS" program to add met data and source term data. RAC personnel must then provide the source term results from the manual dose projection to the EACC. EACC personnel can get the met data inputs from the LAN that need to be added to MIDAS. If LAN is down, a Meteorologist or the National Weather Service can be contacted. Also if the manual dose projection program is being used and the release is a Buoyant Plume Rise the release height found on the downwind dose results must be faxed to the EACC. This is only for releases via a MSRV or ADV.

MIDAS produces the following plots:

1.	Gamma Plot - Readings =	Gamma	-	mR/hr
		Open Window	-	mR/hr
		Frisker	-	cpm
2.	Child Thyroid Plot - Readings =	Thyroid Rate	-	mR/hr
		Cartridge	-	cpm
		Filter	-	cpm

Note that the cartridge and filter count rates are based on a standard 300 liter air sample.

EXHIBIT 1

Air Sample Calculation (2C)

Offsite Iodine Air Sample Analysis

Inputs

Location	------------------>	ENE11
Date	------------------>	2/3/98
Time	------------------>	1100

Inputs

Background (cpm)	------------->	50
Flow Rate (LPM)	-------------->	29
Sample Run (min)	--------------->	11
Gross Cartridge (cpm)	---------->	300
Gross Particulate (cpm)	--------->	50

Outputs ENTER TO QUIT

Concentration (uCi/cc)

Thyroid Dose Rate (mrem/hr)

The **Air Sample Calculation Screen** is used to convert iodine and particulate results in net cpm to thyroid dose rate. The results displayed in the fields in the above screen are transmitted from the onsite/offsite field monitoring teams. The thyroid dose rate is multiplied by the release duration in hours to provide the integrated thyroid dose. The thyroid dose is then compared to the MIDAS Plume Plots to confirm the dose projection.

To use this screen:

1. Select the 2C option from the EIN
2. Enter the results in each field and hit the "Enter" key.
3. Once the screen inputs are complete hit the "enter" key again
4. This will put you back on the EIN, print a copy of the results and clear the Air Sample Calculation Screen for future use.

Offsite Field Monitoring Team Data (2B)

Date:

				Measurements		
Time	Field Team	Distance Miles	Monitoring Location	Whole Body mR/hr	Thyroid mRem/hr	Dose Projection Agreement?
______	______	______	______	______	______	______

Offsite Field Monitoring Team Data – This screen is used to add the results from the Field monitoring Team to the Emergency Information Network. EACC personnel for the offsite team results usually add this data to this screen. RAC personnel can also use the screen when the RAC computer is available. The information on this screen must be manually added. It is not automatically retrieved. To add information from the Emergency Information Network Main Menu perform the following:

1. Exit to DOS
2. At the Y: prompt type in **fielddat.bat** and press enter.
3. After entering the DOS screen, use the arrow keys to maneuver around to add the information required for this screen: Time, Field Team Designation, Downwind Distances in miles ,REMP Map Monitoring Location, Whole Body Dose mR/hr, Thyroid Dose mR/hr, and Dose Projection Agreement

After entering the appropriate information select File, select Save, and select Exit to leave the screen.

Reuter Stokes Data and MIDAS Calculation Comparison (3)

COMPARISON OF RS MONITOR ACTUAL VICE MIDAS CALCULATED VALUES

MONITOR	ACTUAL 01/08 08:09	MIDAL 01/08 10:56	CONFIRMATION?
MIDDLETOWN	0.0083	0.0000	NOT AFFECTED
NORTH GATE TMI	0.0058	0.0000	NOT AFFECTED
MIDDLETOWN SUB	0.0062	0.0000	NOT AFFECTED
ALWINE FARM	0.0087	0.0000	NOT AFFECTED
VISITORS CTR	0.0077	0.0000	NOT AFFECTED
500 KVA SUB	0.0077	0.0000	NOT AFFECTED
BECKER FARM	0.0077	0.0000	NOT AFFECTED
FLAMOUTH SUB	0.0069	0.0000	NOT AFFECTED
CLY SUBSTATION	0.0061	0.0000	NOT AFFECTED
TMI WAREHOUSE	0.0068	0.0000	NOT AFFECTED
TMI MDCT	0.0079	0.0000	NOT AFFECTED
GOLDSBORO	0.0064	0.0000	NOT AFFECTED
TMI INTAKES	0.0070	0.0000	NOT AFFECTED
FAIRVIEW TWP	0.0071	0.0000	NOT AFFECTED
HPG AIRPORT	0.0080	0.0000	NOT AFFECTED
CRAWFORD STATION	0.0091	0.0000	NOT AFFECTED

CURSOR LEFT (BACKWARD) CURSOR RIGHT (FORWARD) ALT-H (HARDCOPY) HOME (EXIT)

Reuter Stokes Field Data and MIDAS Calculation Comparison - The Reuter Stokes screen provides actual readings from 16 ion chamber monitors located in each of the 16 sectors surrounding TMI. These readings are updated every 4 hours until any monitor exceeds 0.08 mR/hr (80 μR/hr) which increases the updates to every 15 minutes.

The primary purpose of this screen is to quickly obtain onsite/offsite doses in order to verify the dose projection. The system is set up to compare the actual monitor readings to the MIDAS projected monitor readings when any monitor exceeds 0.020 mR/hr (20 μR/hr). The third column on this screen, "CONFIRMATION" is not operational and should be ignored.

Individual Pathway Data - Source Term/Input Data/Dose Data (4)

RELEASE PATHWAY INFORMATION		
CONDENSER OFFGAS		D1 DOSE I1 INPUTS S1 SOURCE TERM
RX BUILDING DESIGN BASIS LEAKAGE		D2 DOSE I22 INPUTS S2 SOURCE TERM
EMERGENCY FEED PUMP EXHAUST		D3 DOSE I3 INPUTS S3 SOURCE TERM
A OTSG ADV DIRECT		D4 DOSE I4 INPUTS S4 SOURCE TERM
A OTSG MSR DIRECT		D5 DOSE I5 INPUTS S5 SOURCE TERM
B OTSG ADV DIRECT		D6 DOSE I6 INPUTS S6 SOURCE TERM
B OTSG MSR DIRECT		D7 DOSE I7 INPUTS S7 SOURCE TERM
STATION VENTILATION		D8 DOSE I8 INPUTS S8 SOURCE TERM
RX BUILDING PURGE EXHAUST		D9 DOSE I9 INPUTS S9 SOURCE TERM
ESF EXHAUST		D10 DOSE I10 INPUTS S10 SOURCE TERM
RETURN TO MAIN MENU	P1	
ENTER THE APPLICATION NUMBER:		

To retrieve individual pathway information, select the pathway, such as the Reactor Building Design Basis Leakage. Select D2 for dose, I2 for inputs, and S2 for source term. P1 returns to the Emergency Information Menu. Listed are the 10 release pathways from TMI-1.

EXHIBIT 1

Individual Release Pathway Dose Screen (D[1-10])
(Typical)

CONDENSER OFFGAS DOSE IN MREM (PATH #1)

TIME: 05:33:46 DATE: 01-15-1998 CALCULATION #: 1

DISTANCE	COMMITTED DOSE EQ (MREM)	TOTAL EFFECTIVE DOSE EQ (MREM)
Site Boun.	6.2E-06	1.7E-06
Ex. Area	4.0E-06	1.1E-06
1 MILE	1.3E-06	3.4E-07
2 MILE	5.0E-07	1.3E-07
5 MILE	1.2E-07	2.8E-08
10 MILE	5.2E-08	1.1E-08

HIGHLIGHTED DOSES ARE MAXIMUM VALUES

CURSOR LEFT (BACKWARD) CURSOR RIGHT (FORWARD) ALT-H (HARDCOPY) HOME (EXIT)

Individual Release Pathway Dose Screen - Lists the downwind doses from the Site Boundary out to 10 miles for the individual pathway selected. Whole Body (TEDE) and Child Thyroid (CDE) integrated doses are listed with the highest downwind dose location highlighted.

Pathway Specific PPM Data (I[1-10])

RX BLDG DESIGN BASIS LEAKAGE (PATH #2) INPUT DATA

TIME: 05:33:46 DATE: 01-15-1998 CALCULATION #: 1

PATHWAY SPECIFIC PPM DATA

RB SPRAY L2825 (0 ON, 1 OFF)	1.0E+00
RB SPRAY L2827 (0 ON, 1 OFF)	1.0E+00
RB PRESS (PSIG)	1.1E-01
RMA2 GAS (CPM)	6.1E+02
RMA2 IOD (CPM)	1.3E+02
RMG22 (R/HR)	9.8E-01
RMG23 (R/HR)	9.7E-01

CURSOR LEFT (BACKWARD) CURSOR RIGHT (FORWARD) ALT-H (HARDCOPY) HOME (EXIT)

Pathway Specific PPM Data – The screen displayed for the Designed Basis Leakage shows the inputs or PPM Data that was used by the COLA to calculate this individual pathway source term. Remember the COLA calculates each of the 10 pathways individually and adds them up for the most limiting dose. In this example RMG 22/23, along with the RB Pressure, are used as PPM inputs to calculate the source term. It also displays the closed position of the RB Spray system that can be used by operations, when conditions warrant it, to reduce the airborne atmospheric concentration of iodines in the Reactor Building after a LOCA.

Isotopic Release Rates (S[1-10])

RELEASE PATH #2 RX BLDG DESIGN BASIS LEAKAGE

TIME: 05:33:46DATE: 01-15-1998 CALCULATION #: 1

ISOTOPIC RELEASE CONCENTRATIONS IN UCI/SEC

NOBLE GAS NUCLIDES		RADIOIODINE NUCLIDES	
KR85M	9.1E-02	I131	1.4E-02
KR85	5.8 E-08	I132	1.2E-01
KR87	2.9E-01	I133	2.01E-01
KR88	3.2E-01	I134	6.5E-01
XE131M	5.8E-08	I135	3.8E-01
XE133M	5.8E-08		
XE133	1.2E-01	TOTAL RI = 1.4E=01	
XE135M	2.1E-01		
XE135	9.9E-01		
XE138	5.8E-08		
TOTAL NG = 2.0E+00			

CURSOR LEFT (BACKWARD)CURSOR RIGHT (FORWARD) ALT-H (HARDCOPY) HOME (EXIT)

Isotopic Release Rates - This screen shows the individual source term for the Design Basis Leakage release pathway. The results are listed for the 10 noble gas and 5 iodine isotopes used in the dose projection process. Also listed are the totals for the noble gas and iodine isotopes. This information is frequently requested by the State BRP so they can verify our dose projections using their own dose projection model.

EXHIBIT 1

Effluent RMS (5)

EFFLUENT RMS READINGS

TIME: 07:55:39 DATE: 01-16-1998 CALCULATION #: 1

RADIATION MONITORING SYSTEM

RELEASE PATHWAY	MONITOR NAME	VALUE	STATUS	UNITS
CONDENSER OFFGAS	RM-A5(G) LOW	3.4E+01	NORMAL	CPM
	RM-A15(G) LOW	3.7E+01	NORMAL	CPM
	RM-A5(G) HIGH	1.9E+01	NORMAL	CPM
	RM-G25	-.2 E-01	NORMAL	MR/HR
STA VENTILATION	RM-A8(G) LOW	4.6E+01	NORMAL	CPM
	RM-A8(I) LOW	1.6E+01	NORMAL	CPM\MIN
	RM-A8(G) HIGH	1.8E+01	NORMAL	CPM
RB PURGE	RM-A9(G) LOW	3.9E+01	NORMAL	CPM
	RM-A9(I) LOW	4.6E+01	NORMAL	CPM\MIN
	RM-A9(G) HIGH	2.4E+01	NORMAL	CPM
	RM-G24	-.2E+00	NORMAL	MR/HR
DIRECT OTSG	RM-G26	2.8E+01	NORMAL	CPM
	RM-G27	3.6E+01	NORMAL	CPM

CURSOR LEFT (BACKWARD)CURSOR RIGHT (FORWARD) ALT-H (HARDCOPY) HOME (EXIT)

The **Effluent RMS Screen** is updated from the Plant Performance Monitor (PPM) every 4 – 6 minutes. The screen displays the associated RMS effluent monitors by release pathway. This screen can be very useful to help validate the release pathway during evaluation of the COLA dose projection. It also can be helpful to trend RMS data since these screens are saved once any Radiological EAL is reached. This screen provides a "quick look" to see if any other release pathway RMS are increasing which could possibly affect the dose projection.

1. Normal RMS reading = gray background
2. Alert RMS reading = green background
3. High alarm reading = red background
4. Off scale reading = black background

EXHIBIT 1

Area Gamma and Liquid RMS Screen (6)

AREA GAMMA AND LIQUID RMS

TIME: 10:55:50 DATE: 01-16-1998 CALCULATION #: 1

AREA MONITORS=MR/HR : RMG22/23=R/HR : LIQUID RMS=(CPM)

RX BUILDING	RM-G22 9.8 E-01 NORMAL	RMG-23 9.7E-01 NORMAL
	RM-G6 2.8E+02 NORMAL	RM-G7 5.2E+01 NORMAL
	RM-G5 5.5E-01 NORMAL	
AUX BUILDING	RMG-10 6.0E-02 NORMAL	RMG-11 2.6E-01 NORMAL
	RMG-12 8.0E-02 NORMAL	RMG-13 9.0E-02 NORMAL
	RMG-14 8.0E-02 NORMAL	RMG-15 9.0E-02 NORMAL
FH BUILDING	RMG-9 1.3E+00 NORMAL	
CONTROL TOWER	RMG-1 8.0E-02 NORMAL	RMG-2 5.0E-02 NORMAL
	RMG-3 1.6E-01 NORMAL	RMG-4 6.0E-02 NORMAL
SELECT LIQUID	RML1L 4.2E+03 NORMAL	RML1H 3.6E+01 NORMAL

CURSOR LEFT (BACKWARD)CURSOR RIGHT (FORWARD) ALT-H (HARDCOPY) HOME (EXIT)

The **Area Gamma and Liquid RMS Screen** displays the associated area gamma monitors by building along with selected liquid monitors. This screen is also very useful for evaluating in plant dose rates prior to sending personnel reentry teams into the plant. Area gamma monitor readings are useful to verify improving or degrading plant conditions.

EXHIBIT 1

Screen (7)

This screen is reserved for future use.

Quick Code (8)

Minimum: 1	Default: None Input Data	Maximum: 9
Release via Condenser Offgas		
1. RMA5 LOW OR RMA15	2. RMA5 HIGH	3. RMG25
Release via ADV or MSR		
4. RMG26 OR RMG27		
Release via Reactor Building Purge		
5. RMA9 LOW	6. RMA9 HIGH	7. RMG24
Release via Station Ventilation		
8. RMA8 LOW	9. RMA8 HIGH	
Enter Radiation Monitor Selection (1 thru 9)______		
Enter the Monitor Reading (1 thru 10 million)______		
Enter the Wind Speed in MPH (1 thru 100) ______		
Enter the Wind Direction in Degrees From (1 thru 360)______		
Enter the Delta Temperature in Degrees F (-9 to 10) ______		
F1: Next F2: Prev	Alt F10: Abort	F10: Done

The **Quick Code** was designed with the on shift GRCS in mind. In the first hour of an event if the COLA goes out of service the GRCS has two options to produce a dose projection, the Manual RAC Code or the Quick Code. It takes time to gather all of the inputs for the Manual RAC Code and the luxury of time may not be available. As you can see above, the Quick Code inputs are all on one screen and consist of the RMS monitor and reading associated with the release pathway and met data. Default flow rates for each pathway are used in the Quick Code .As with the Manual RAC Code the Quick Code can only handle one release pathway. **Also this code produces very conservative results during core damage situations as it uses a 1-1 iodine to noble gas ratio.**

An alternative to use of the Quick Code is to use the Excel spreadsheet RAC Spreadsheet. It is described in the following section. With only a few additional inputs, it produces a less conservative but more realistic, dose projection than the Quick Code.

Manual RAC Code (9)

The **Manual RAC Code** is an option on the Emergency Information Network that will produce a dose projection based on user input, rather than data from the plant computer. The Manual RAC Code can be used for some of the following reasons:

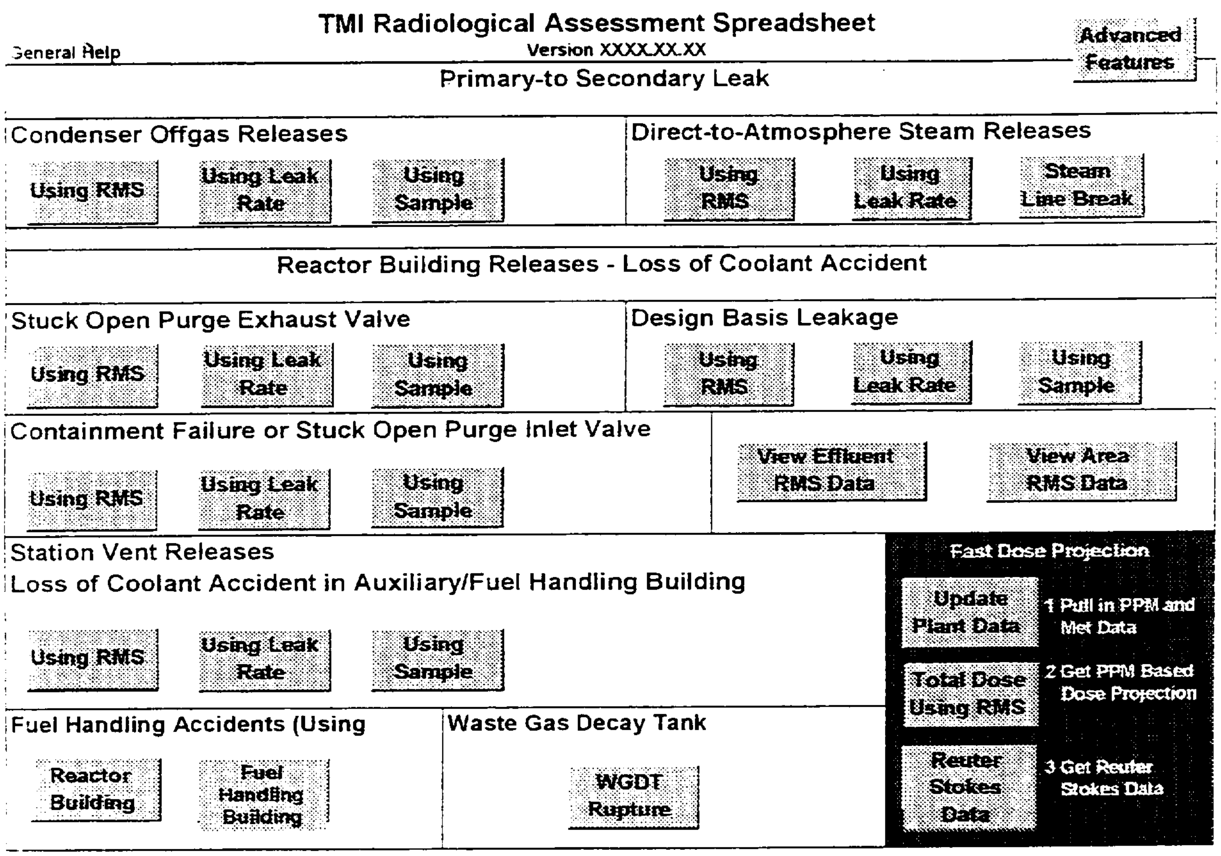
1. To produce a dose projection if data being retrieved by the COLA is considered inaccurate (i.e. a bad RMG-25 reading or met data).
2. To perform a "What If" dose projection
3. Having a release through the MSRV's with MSV 2A/2B in the closed position since the COLA automatically uses RMG-26/27.
4. Multiple MSRV's are stuck open at the same time.
5. RB Design Basis Leakage release with RMG 22/23 out of service.
6. To compare or validate the dose projection for any other reason.
7. To estimate offsite doses beyond 10 miles.

Results from the Manual Code are not displayed on the LAN therefore they must be faxed to the EACC. Also if the Manual RAC Code is used, the source term results must be faxed to the EACC so they can be entered into the MIDAS program. If the COLA is inaccurate then the MIDAS results produced from the COLA source term is inaccurate. The Manual Code source term results must be entered into MIDAS in this situation. In addition, if the COLA is inaccurate then the Group Leader RE&C, the EAC, and the state BRP representative must be notified that the COLA displays are not accurate.

One disadvantage of the Manual Code is that it can handle only one release pathway at a time. If two release pathways are significant, each one must be run separate and the results added together.

RAC Spreadsheet

An alternative method for performing dose projections is to use the Excel spreadsheet RAC Spreadsheet. The spreadsheet is available via a shortcut from the desktop of the RAC computer. It is loaded into the RAC Computer as a "Read Only" file from the computer's hard drive. As a result, it is available for use even if the LAN is down. During the process of loading, the spreadsheet imports plant parameter data, meteorological data, and Reuter Stokes data from the LAN drives. If the LAN is down, an error message will appear informing the user that the data is not available and must be input manually. The main menu of the spreadsheet is shown below:



To utilize the spreadsheet, the user selects the pathway/calculation type by clicking the computer's mouse on the button for that pathway. In addition to calculation pathways, other options include:

- The "Update Plant Data" button retrieves the latest plant parameter, meteorological and Reuter Stokes data stored on the LAN drives. **Prior to performing a new dose projection, the user should select this option to ensure the most recent data is used.**

- The "Total Dose Using RMS" button is used to find the total offsite dose for pathways monitored by the RMS system. This total dose projection will only be accurate if RMS data is valid and RMS monitors the release pathway.

RAC Spreadsheet (Cont'd)

- The "Reuter Stokes Data" button provides a display and/or printout of the most recent Reuter Stokes data available on the LAN.
- The "View Effluent RMS Data" button provides a display and/or printout of the most recent RMS effluent monitor data and meteorological data available on the LAN.
- The "View Area RMS Data" button provides a display and/or printout of the most recent RMS area monitor data available on the LAN.
- The "Advanced Features" button allows the user to enter RCS Post Accident Sample results and to edit the default RCS spike factors. It also allows printout of these parameters.

When the pathway/calculation type is selected, the user is then taken to the input screen for that calculation. An example is shown below:

Data Entry Panel for Condenser Offgas Release Using RMS Data

If the PPM is down, or the data is suspect, data can be obtained by asking the Control Room Supervisor for a printout of PPC Data from Area 38, Group 35

If you believe fuel damage has occurred form previous thermal or mechanical damage enter the damage class here		1	1 - 10
Enter the following Information about the RCS to ensure that the damage class is not worse than you think:	PPM	User Defined	
RCS Pressure (A0505)	2146		psig
Average of 5 Highest Incores (C4006)	620		Deg F
Is the Reactor Shutdown? (Y or N)	N		(Y or N)
Date Shut Down		08/15/2000	
Time Shut Down (Use XX:XX Format)		11:13	
Enter Condenser Offgas Rad Monitor(s) readings you wish to use for the calculation below:			
RM-A-5Lo (C4028)	45		cpm
RM-A-15 (A1020)	26		cpm
RM-A-5HI (A1008)	48		cpm
RM-G-25 (C4035)	0		mR/hr
Enter the Condenser Offgas Flow Rate (A0436)	34		cfm
Enter the release duration		8	hours
Enter the wind speed	3.5		mph
Enter the wind direction (from)	293		degrees
Enter the Delta T	-1.9		degrees F

Add Comments | Display Projection | Print Projection | Main Menu | Print all EACC | Send to LAN | Send to MIDAS

PPM Data Updated	08/15/2000	'11:08'
Met Data Updated	"08-15-2000"	"11:00:33"

RAC Spreadsheet (Cont'd)

The input columns on the left (green cells on the screen listed under "PPM") contain the plant data and meteorological data that were imported from the LAN if such data is available for that parameter. The user should review this data to see if it makes sense given current plant conditions. The input column on the right (blue cells on the screen listed under "User Defined") permits the user to override the plant computer data and to make entries for parameters not monitored by the plant computer. For parameters that have both a green and blue cell, the spreadsheet will use the data in the green cell as long as the blue cell is left blank. If the user makes an entry in the blue cell, the spreadsheet will ignore the data in the green cell and use the user-specified data in the blue cell. If the plant data is not available from the LAN drives (as indicated by the previously described warning message), all data will need to be manually entered in the blue cells by the user.

At the bottom of each screen, the time/date stamp for the plant and meteorological data allow the user to ensure the data being used is current.

The buttons at the bottom of each screen perform the following functions:

- The "Add Comments" button takes the user to a screen that permits him/her to annotate any additional information that should be associated with the dose projection.
- The "Display Projection" button allows the user to view a summary of the dose projection.
- The "Print Projection" screen allows the user to print the complete dose projection.
- The "Main Menu" button returns the user to the main menu screen.
- The "Print at EACC" button sends a copy of the dose projection at the EOF for the EACC and Group Leader R&EC.
- The "Send to LAN" button takes a snapshot of the dose projection and sends it to a LAN file where it can be viewed from other emergency facilities
- The "Send to Midas" button can be used to create a source term file that can be imported into the MIDAS code. Use of this button should be limited to validated dose projections. "What IF" dose projections should not be fed to MIDAS.

Selection of the "Display Projection" option for individual pathways provides the following dose projection summary:

DOSE PROJECTION FOR CONDENSER OFFGAS RELEASE PATHWAY
RECOMMENDED ACTIONS TO BE TAKEN BASED ON THIS DOSE PROJECTION

Do Not Declare an Emergency Action Level

Do Not Issue a Protective Action Recommendation

Maximum Dose Rate (mrem/hr)

Location	TEDE	Location	CDE	Location	DDE
Site Boundary	0.0	Site Boundary	0.0	Site Boundary	0.0

Maximum Dose (mrem)

Location	TEDE	Location	CDE	Location	DDE
Site Boundary	0.0	Site Boundary	0.0	Site Boundary	0.0

Return to Input   Print Projection

RAC Spreadsheet (Cont'd)

Selection of the "Display Projection" option for "Total Dose Using RMS" provides the following dose projection summary:

06/29/00 13:53

DOSE PROJECTION FOR ALL PATHWAYS WITH RMS DATA AVAILABLE

RECOMMENDED ACTIONS TO BE TAKEN BASED ON THIS DOSE PROJECTION

Do Not Declare an Emergency Action Level

Do Not Issue a Protective Action Recommendation

Maximum Dose Rate (mrem/hr)

Location	TEDE	Location	CDE	Location	DDE
Exclusion Area	0.0	Exclusion Area	0.0	Exclusion Area	0.0

Maximum Dose (mrem)

Location	TEDE	Location	CDE	Location	DDE
Exclusion Area	0.0	Exclusion Area	0.0	Exclusion Area	0.0

Pathways Contributing to Maximum Dose Location

	TEDE	CDE
Condenser Offgas Releases	0%	0%
Direct-to-Atmosphere Steam Releases	0%	0%
Reactor Building Design Basis Leakage	0%	4%
Reactor Building Purge Releases	0%	0%
Station Ventilation Releases	100%	96%

Return to Input

Print Projection

In addition to showing the maximum dose rates and doses, this screen also shows the contribution of each pathway. Having identified the major pathway, the user should then go to the individual pathway and validate the dose projection by reviewing the data inputs.

If at any time the user gets "lost in the spreadsheet" (i.e., can't get back to the input screen), pressing ALT and H simultaneously will return the user to the pathway input screen. Using the mouse and buttons to navigate through the spreadsheet will prevent getting lost in the spreadsheet. Avoid using the Page Up and Page Down keys on the keyboard.

To reset the spreadsheet to its normal default data, the user can simply exit the spreadsheet then re-enter it. To exit the spreadsheet, use the mouse to go to the File command on the upper toolbar. Then choose the Exit subcommand. A message box will ask if you wish to save the spreadsheet. Since the spreadsheet is only accessed as a "Read Only" file, it is impossible to save it. Just click on No and the exit will be complete.

If the **LAN GOES OUT OF SERVICE** the RAC computer will automatically boot up to the following menu:

EMERGENCY INFORMATION NETWORK
LAN BACKUP CALCULATIONS

IF THIS MENU APPEARS
THE LAN CONNECTION WAS NOT MADE

CONTACT I.S. AT X8393 WHEN TIME PERMITS

USE ONE OF THE FOLLOWING MANUAL CODES TO PERFORM DOSE PROJECTIONS UNTIL THE LAN PROBLEM IS CORRECTED

1. QUICK CALC CODE (RECOMMENDED FOR ON-SHIFT GRCS/RAC)
2. MANUAL RAC
3. AIR SAMPLE CALC
4. EXIT TO DOS

ENTER THE APPLICATION NUMBER:

As previously described, if the LAN is out of service, RAC Spreadsheet can be accessed for use from the Desktop of the RAC Computer. This spreadsheet can be used as an alternative to the Quick Code and the Manual RAC Code.

Instructions for Rebooting the COLA

There are times when transients in the LAN system occur that cause the host computer performing the dose projections to lock up. As a result, the host computer quits performing dose projections and the last dose projection on the EIN will be more than 10 – 15 minutes old. When the COLA is locked up, it needs to be rebooted. A remote COLA reboot device has been installed to do this. The following steps can be used to reboot the COLA from any site phone. Reboot can also be accomplished from an off-site phone simply by dialing "948" before the extension.

If the automated dose projection system host computer (COLA host) is "locked up", reboot it as follows:

Dial the COLA computer's reboot device at extension 8297.

The call will connect and an electronic voice will state "please enter your access code,". Wait until the message is complete then enter "1979".

The reboot electronic voice will then state "power is on" or "power is off" (normally "power is on")"

To reboot the COLA:

Press "2" (the electronic voice will state "power is off").

Press "1" (the electronic voice will state "power is on").

Hang up the phone. The host computer will begin rebooting immediately.

Go to the Y:\EPRAC directory and type reset, then press enter.

The process may take up to 15 minutes before new dose projections appear.

EXHIBIT 1

Basic RAC Checkoff

1. Determine Release Pathways with Emergency Director.

2. Print Decision Support Screen (1A), RAC Screen (1B), and Input Screen on Predominate Pathway. (4 then I1-10)

3. Print Source Term Screen of Predominate Pathway (4 then S1-10) and review noble gas to iodine ratio. *(Normally a 50:1 or greater ratio.)*

4. Validate inputs into the RAC Code *Check that RMS is functional and operational.*

5. Review Field Team Data. *(Reuter Stokes monitors are like field teams.) Remember, Reuter Stokes uses 15 minute averages and compares against MIDAS. Field team data should be checked against MIDAS. MIDAS does not take into consideration environmental iodine plateout or precipitation. MIDAS can estimate precipitation depletion of the plume upon request. The RAC Code is considered validated if field team data is within a tenth **but not greater than** MIDAS.*

6. Use the TSC to verify inputs. *(i.e., condition of charcoal filtration, damage class determination, leak rates in plant systems, etc.)*

7. If the COLA is not providing accurate dose projections, for whatever reason, ensure that the Group Leader RE&C, the EAC, and the state BRP representative understand that the COLA screens are not displaying accurate dose projections.

EXHIBIT 1

Indications of Mechanical Fuel Damage

For Thermal Hydraulic damage use RAC Code. For Mechanical Damage and as a gross backup to the RAC code here are 2 tables for consideration:

LOCA with Leakrate and Isotopic Concentrations in Equilibrium

Fuel Damage Class	RCS Activity (uCi/ml)	RMG 22/23 (R/hr)
2-4	4500 - 45,000	6000 - 45,000
5-7	5.6E5 - 5.2E6	>45,000

LOCA Has NOT Occurred

Fuel Damage Class	RCS Activity (uCi/ml)	RMG 22/23 (R/hr)
2-4	4500 - 45,000	1.5 - 20
5-7	5.6E5 - 5.2E6	>20

Reference RAF 6612-89-002

RM-G-6/7 Indications of Mechanical Fuel Damage During Non-LOCA Situations

If 5% of the core has experienced cladding damage and released its gap activity, RM-G-6 would be expected to read between 30,000 to 40,000 mR/hr. Due to its normal location, RM-G-7 would be expected to read about 10% of what RM-G-6 reads. Reference RAF 3640-98-034.

EDCM Calculation Guides

Condenser Offgas Releases

Calculation Type	When to Use	Page
COLA Using RMS	COG RMS and flowrate instrumentation available on PPM	113
COLA Using Samples	Representative RM-A-5 pre-filter/marinelli results available with flow rate available on PPM	116
Manual Code Using RMS	COLA RMS calculation not available due to PPM or LAN problems	118
Manual Code Using Samples	Representative COG pre-filter/marinelli results available with flow rate unavailable on PPM. Use this calc for MAP-5 samples.	121
Manual Code Contingency Calculation	Use when RMS is not available. Should be used for performing "What If" calculations	123
Quick Code	Used by on-shift RAC in first hour if COLA is not available	126

Reactor Building Design Basis Leakage

Calculation Type	When to Use	Page
COLA Using RMS	RMG-22/23 and RB pressure available on PPM	128
COLA Using Samples	Representative CATPASS results available with RB pressure available on PPM	131
Manual Code Using RMS	COLA RMS calculation not available due to PPM or LAN problems or if using RMA-2 monitor results	133
Manual Code Using Samples	Representative CATPASS results available with RB pressure unavailable on PPM	136
Manual Code Contingency Calculation	Use when RMS is not available. Should be used for performing "What If" calculations	138
Quick Code	Not available for this pathway	141

Emergency Feed Pump Exhaust (Also used for Main Steam Line Breaks)

Calculation Type	When to Use	Page
COLA Using RMS	RMG-26/27 and emergency feedwater flow rate available on PPM	142
COLA Using Samples	Not available for this pathway	145
Manual Code Using RMS	RMG-26/27 or emergency feedwater flow not available due to PPM or LAN problems	146
Manual Code Using Samples	Not available for this pathway	149
Manual Code Contingency Calculation	Use when RMS or feedwater flow is not available. Use to perform "What If" calculations. **This calculation should be used for a main steam line break.**	150
Quick Code	Not available for this pathway	153

Atmospheric Dump Valve Release (MS-V-4A or MS-V-4B)

Calculation Type	When to Use	Page
COLA Using RMS	RMG-26/27 and main steam pressure available on PPM	154
COLA Using Samples	Not available for this pathway	157
Manual Code Using RMS	RMG-26/27 or main steam pressure not available due to PPM or LAN problems	158
Manual Code Using Samples	Not available for this pathway	161
Manual Code Contingency Calculation	Use when RMS or main steam pressure is not available. Use to perform "What If" calcs	162
Quick Code	Used by on-shift RAC in first hour if COLA is not available	165

Main Steam Relief Valves ('A' or 'B' side)

Calculation Type	When to Use	Page
COLA Using RMS	RMG-26/27 and main steam pressure available on PPM and MS-V-2 is open	167
COLA Using Samples	Not available for this pathway	170
Manual Code Using RMS	RMG-26/27 or main steam pressure not available due to PPM or LAN problems and MS-V-2 is open	171
Manual Code Using Samples	Not available for this pathway	174
Manual Code Contingency Calculation	Use when RMS or main steam pressure is not available, or if MS-V-2 is closed. Should be used for performing "What If" calculations	175
Quick Code	Used by on-shift RAC in first hour if COLA is not available	178

Station Ventilation

Calculation Type	When to Use	Page
COLA Using RMS	Station Vent RMS and ventilation flow rate are available on PPM	180
COLA Using Samples	Representative RM-A-8 pre-filter/marinelli results available with flow rate available on PPM	183
Manual Code Using RMS	Station Vent RMS or ventilation flow rate not available due to PPM or LAN problems	185
Manual Code Using Samples	Representative RM-A-8 pre-filter/marinelli results available with flow rate not available on PPM. Use this for MAP-5 samples	188
Manual Code Contingency Calculation	Use when RMS or Station Vent flow rate is not available. Should be used for performing "What If" calculations	190
Quick Code	Used by on-shift RAC in first hour if COLA is not available	191

Reactor Building Purge Exhaust

Calculation Type	When to Use	Page
COLA Using RMS	RB Purge RMS and ventilation flow rate are available on PPM	193
COLA Using Samples	Representative RM-A-9 pre-filter/marinelli results available with flow rate available on PPM	196
Manual Code Using RMS	RB Purge RMS or ventilation flow rate not available due to PPM or LAN problems	198
Manual Code Using Samples	Representative RM-A-9 pre-filter/marinelli results available with flow rate not available on PPM. Use this for MAP-5 samples	201
Manual Code Contingency Calculation	Use when RMS or RB Purge flow rate is not available. Should be used for performing "What If" calculations	203
Quick Code	Used by on-shift RAC in first hour if COLA is not available	206

ESF Fuel Handling Building

Other Manual Calculations Available

Condenser Offgas
COLA Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is 0.0075 (1/133) based on partitioning of iodine in the condenser
- The RMS monitor (RM-A-5, RM-A-15, RM-A-5 Hi, or RM-G-25) determines the activity leaving via this pathway. These monitors will respond to both increases in RCS activity and primary-to-secondary leakrate.
- The logic the COLA uses in picking which monitor to perform the calculation is as follows:
  1. If RM-G-25 and RM-A-5 Hi both read ≤ 100, the COLA is using the highest reading on RM-A-5 or RM-A-15.
  2. If RM-A-5 Hi reads > 100 cpm, but RM-G-25 is < 100 mR/hr, the COLA is using RM-A-5 Hi.
  3. If RM-G-25 reads > 100 mR/hr, the COLA is using RM-G-25
- Once the COLA determines the isotopic concentrations leaving via COG, it uses the COG flow rate from the plant computer to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

- Release duration using the Parameter Edit screen if other than 8 hours.
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad
- Fuel Damage Class using the Parameter Edit screen if the damage class is believed to be other than that indicated by the COLA using current RCS temperature and pressure.

Condenser Offgas
COLA Calculation
Using RMS

Problems to Watch For

- Condenser offgas monitor increases can result from increased RCS activity or increased primary-to-secondary leakage, or a combination of the two. If a sudden increase occurs:

  1. Check for signs of increased RCS activity. Coincident increases on RM-L-1, RM-G-22, RM-G-23, RM-G-6, or RM-G-7 may indicate increased RCS activity from fuel damage. Also check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.

  2. Check for signs of increased primary-to-secondary leakage. Check with STA or TSC to determine if leak rate changes have been observed.

- Remember that if fuel damage has occurred, it cannot get better.

  1. If damage has occurred, but RCS temperature and pressure improve, the COLA will reduce the Fuel Damage Class.

  2. If this occurs, the user must edit the damage class using the Parameter Edit Screen to lock in the higher damage class.

  3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

- If post accident RCS results are to be input into the Reactor Coolant Baseline Activity Edit Screen, ensure the Fuel damage class is set to 1 on the Parameter Edit Screen and the spiking factors in the Sample Edit Screen are set to 1. If the COLA is using a damage class greater than 1, the COLA will use the default isotopic activities for that damage class instead of the post accident samples that were input. If the spiking factors are not set to 1, the COLA will erroneously apply the spiking factors to the input sample results.

- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If COLA dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.
- Consider performing manual "What If" dose projections for losing condenser vacuum or increases in damage class.
- Consider getting an effluent sample from this pathway (MAP-5 or pre-filter marinelli) when conditions appear to have stabilized.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Condenser Offgas
COLA Calculation
Using Samples

How it works:

- Effluents leaving via COG are sampled using a pre-filter marinelli sample
- The user enters the positive noble gas and iodine isotope concentrations from the analysis into the Condenser Offgas Sample Edit Screen.
- If a MAP-5 sample is used, the manual code must be used to perform the calculation, since the COLA will not produce a noble gas source term.
- Once the COLA determines the isotopic concentrations leaving via COG, it uses the COG flow rate from the plant computer to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

- Sample results need to be entered on the Condenser Offgas Sample Edit Screen
- Release duration using the Parameter Edit screen if other than 8 hours
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad

Condenser Offgas
COLA Calculation
Using Samples

Problems to Watch For

- The user must ensure that the sample results are representative of current plant conditions. If plant conditions change significantly after the sample was obtained, the user should make the Condenser Offgas Sample Edit Screen inactive and resume COLA RMS calculations.
- MAP-5 samples cannot be used solely with the COLA code since noble gases are not measured. The COLA code will not produce a noble gas source term from a MAP-5 sample. MAP-5 samples must be calculated using the manual codes to get the correct TEDE dose. The MAP-5 sample should still be input into the COLA code since the thyroid doses produced by the COLA will still be accurate.
- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If COLA dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles
- Periodically verify the release duration and pathway with the ED.
- Consider performing manual "What If" dose projections for losing condenser vacuum or increase in damage class using a manual code contingency calculation.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Condenser Offgas
Manual Code Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is 0.0075 (1/133) based on partitioning of iodine in the condenser. It is accounted for in the manual code.
- The RMS monitor (RM-A-5, RM-A-15, RM-A-5 Hi, or RM-G-25) determines the activity leaving via this pathway. These monitors will respond to both increases in RCS activity and primary-to-secondary leakrate. The user selects which monitor will be used for the calculation. Generally, the highest range monitor reading > 100 should be used.
- Once the code determines the isotopic concentrations leaving via COG, it uses the COG flow rate input by the user to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway is always considered a ground level release

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- The monitor to be used and the monitor reading
- The time in minutes since reactor shutdown
- Condenser offgas flowrate
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Condenser Offgas
Manual Code Calculation
Using RMS

<u>Problems to Watch For</u>

- Condenser offgas monitor increases can result from increased RCS activity or increased primary-to-secondary leakage, or a combination of the two. If a sudden increase occurs:

  1. Check for signs of increased RCS activity. Coincident increases on RM-L-1, RM-G-22, RM-G-23, RM-G-6, or RM-G-7 may indicate increased RCS activity from fuel damage. Also check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.

  2. Check for signs of increased primary-to-secondary leakage. Check with STA or TSC to determine if leak rate changes have been observed.

- Remember that if fuel damage has occurred, it cannot get better.

  1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.

  2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.

  3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Consider performing manual "What If" dose projections for losing condenser vacuum or increase in damage class using a manual code contingency calculation.

- Consider getting an effluent sample from this pathway (MAP-5 or pre-filter marinelli) when conditions appear to have stabilized.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Condenser Offgas
Manual Code Calculation
Using Samples

How it works:

- Effluents leaving via COG are sampled using a MAP-5 sample or a pre-filter marinelli sample
- If a pre-filter marinelli sample is used, the user enters the positive noble gas and iodine isotope concentrations from the analysis when prompted by the code.
- If a MAP-5 sample is used, the user enters the positive iodine isotope concentrations from the analysis when prompted by the code. Since MAP-5 samples do not provide noble gas results, manual code will scale in the noble gases. It assumes that the noble gas to iodine ratio leaving COG is the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway.
- The iodine reduction factor for this pathway used to scale in noble gases from MAP-5 samples is 0.0075 (1/133) based on partitioning of iodine in the condenser
- Once the code determines the isotopic concentrations leaving via COG, it uses the COG flow rate input by the user to determine the μCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.

THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- The code will prompt the user to input values for RCS temperature and pressure or Fuel Damage Class values. These must be input but will have no bearing on the calculation since effluent concentrations leaving the plant are being determined by isotopic sample analysis.
- Sample results and sample time from condenser offgas
- Time since reactor shutdown
- Condenser offgas flowrate
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Condenser Offgas
Manual Code Calculation
Using Samples

Problems to Watch For

- The MAP-5 sample panel may present a dose rate hazard to personnel if the release rate is high or if it has been running for a long time with the same cartridges.

- The user must ensure that the sample results are representative of current plant conditions. If plant conditions change significantly after the sample was obtained, the user should begin using COLA or manual code RMS calculations.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Consider performing manual "What If" dose projection for losing condenser vacuum or increases in damage class.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Condenser Offgas
Manual Code Calculation
Contingency Calculation

How it works:

- This calculation is very useful for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.
- This calculation uses no RMS data. The isotopic distribution and total activity being released via this pathway is equal to the product of the primary-to-secondary leak rate and the activity concentration in the RCS, after adjusting for iodine losses (reduction factors) applicable to this pathway. It is independent of condenser offgas flow rate.
- The iodine reduction factor for this pathway is 0.0075 (1/133) based on partitioning of iodine in the condenser. It is accounted for in the manual code.
- Unlike RMS calculations, this calculation is very dependent on RCS total activity. As a result, the code has the ability to use RM-L-1 high or low readings to estimate total RCS activity. The user may also specify a total RCS activity.
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- RM-L-1 high or low readings if letdown is not isolated.
- An estimate of total RCS activity, if known.
- The primary-to-secondary leak rate, in gpm, provided by the STA or TSC.
- The time in minutes since reactor shutdown
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Condenser Offgas
Manual Code Calculation
Contingency Calculation

Problems to Watch For

- Of all calculations available, contingency calculations are the least accurate. They should only be used when RMS data or effluent samples are not available. Contingency calculations are ideal for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.
- This type of calculation is very dependent on total RCS activity. The code will adjust RCS total activity if an RM-L-1 reading is input. Prior to inputting an RM-L-1 reading, verify that RCS letdown is not secured. If it has been secured (and it typically is during this type of accident), RM-L-1 readings should not be used unless the user is sure that the last reading is representative of current RCS conditions. Note that due to travel time in the sample lines, RM-L-1 may take up to 30 minutes before responding to a change in RCS activity.
- If RM-L-1 readings are not available, the code will permit the user to enter a total RCS activity (uCi/cc) if this is known. It generally is not. An example of when this could be used is if an RCS sample has just been pulled but has not been analyzed. If the dose rate on the sample is a factor of 10 higher than a normal RCS sample, it can be inferred that the RCS activity is 10 times higher than it was prior to the incident. Be aware, entering a total RCS activity will replace damage class default RCS activities and spiking factors.
- Remember that if fuel damage has occurred, it cannot get better.
    1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.
    2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.
    3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.
- Consider getting an effluent sample from this pathway (MAP-5 or pre-filter/marinelli) to increase the accuracy of the dose projection.
- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- When performing "What If" dose projections, clearly label them as "What If" calculations.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? Depending on the inputs, this type of calculation could go either way. The key will be the accuracy of the RCS total activity and primary-to-secondary leak rate estimates.

Condenser Offgas
Quick Code Calculation

How it works:

- This code provides a quick, but crude, estimate of offsite dose. As such it should only be used by the on-shift RAC, during the first hour of an emergency, if the COLA Code is not available.
- This code requires an RMS reading for its calculation. If an RMS reading is not available, a manual code contingency calculation must be performed.
- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The RCS mixture is assumed to have the same isotopic distribution as a Fuel Damage Class 2.
- The iodine reduction factor for this pathway is 0.0075 (1/133) based on partitioning of iodine in the condenser. It is accounted for in the code.
- The RMS monitor (RM-A-5, RM-A-15, RM-A-5 Hi, or RM-G-25) determines the activity leaving via this pathway. These monitors will respond to both increases in RCS activity and primary-to-secondary leakrate. The user selects which monitor will be used for the calculation. Generally, the highest range monitor reading > 100 should be used.
- The code assumes a COG flow of 40 cfm. Dose results may be ratioed by the actual cfm (i.e. if the actual flow is only 20 cfm, the dose projection is reduced by ½).
- The code assumes an 8 hour release duration.
- Once the code determines the isotopic concentrations leaving via COG, it uses the flow rate to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- The monitor to be used and the monitor reading.
- Met Data (wind speed, wind direction, and delta t)
- Since the COLA is not available, all readings must come from control room instrumentation.

Condenser Offgas
Quick Code Calculation

Problems to Watch For

- The IREO RAC should not use this code. The full manual code should be used when the IREO organization is activated.
- This calculation assumes an RCS isotopic distribution that is the same as a Fuel Damage Class 2. This may be somewhat non-conservative where fuel damage is not present, but significant iodine spiking has occurred. As soon as time is available, a manual code RMS calculation should be performed so a dose estimate using more representative plant parameters can be obtained.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Label all Quickcode calculations as "Quickcode"

Reactor Building Design Basis Leakage
COLA Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant via reactor building leakage is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is 0.4 with RB spray off, or 0.03 with RB spray on, based on minimal hold-up time in the building.
- The RMS monitor (RM-G-22 or RM-G-23) determines the airborne activity in the reactor building. The COLA uses the higher of the readings on RM-G-22 or RM-G-23. If RM-G-22 or 23 read less than 1 R/hr, the COLA assumes they are seeing only background and assumes they read 0 for dose calculations. It does not use RMA-2 in the calculation.
- Once the COLA determines the isotopic concentrations in the reactor building, it uses the leakage flow rate from the building, based on building pressure, to determine the uCi/sec leaving the plant (source term). Reduction of RB pressure to atmospheric pressure stops releases from this pathway.
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.

THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

- Release duration using the Parameter Edit screen if other than 8 hours
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad
- Fuel Damage Class using the Parameter Edit screen the damage class is believed to be other than that indicated by current RCS temperature and pressure.

Reactor Building Design Basis Leakage
COLA Calculation
Using RMS

Problems to Watch For

- This calculation should only be used when the purge valves are closed. If they are open, some form of reactor building purge calculation should be performed.
- Remember that if fuel damage has occurred, it cannot get better.
  1. If damage has occurred, but RCS temperature and pressure improve, the COLA will reduce the Fuel Damage Class.
  2. If this occurs, the user must edit the damage class using the Parameter Edit Screen to lock in the higher damage class.
  3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.
- If post accident RCS results are to be input into the Reactor Coolant Baseline Activity Edit Screen, ensure the Fuel Damage Class is set to 1 on the Parameter Edit Screen and the spiking factors in the Sample Edit Screen are set to 1. If the COLA is using a damage class greater than 1, the COLA will use the default isotopic activities for that damage class instead of the post accident samples that were input. If the spiking factors are not set to 1, the COLA will erroneously apply the spiking factors to the input sample results.
- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Consider performing manual "What If" dose projections for losing containment integrity or increase in damage class.
- Consider getting an effluent sample from this pathway (pre-filter marinelli or CATPASS as applicable) when conditions appear to have stabilized.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Reactor Building Design Basis Leakage
COLA Calculation
Using Samples

How it works:

- A sample of the reactor building atmosphere can be obtained using the CATPASS system.
- The user enters the positive noble gas and iodine isotope concentrations from the analysis into the Reactor Building Design Basis Leakage Sample Edit Screen.
- Once the isotopic concentrations in the reactor building are input, the COLA uses the leakage flow rate from the building, based on building pressure, to determine the uCi/sec leaving the plant (source term). Reduction of RB pressure to atmospheric pressure stops releases from this pathway.
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

- CATPASS sample results need to be entered on the Reactor Building Design Basis Leakage Sample Edit Screen
- Release duration using the Parameter Edit screen if other than 8 hours
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad

Reactor Building Design Basis Leakage
COLA Calculation
Using Samples

Problems to Watch For

- At very high levels of airborne activity in the reactor building, a CATPASS sample can involve personnel exposure to high dose rates when obtaining the sample.
- The CATPASS system takes 45 minutes to warm up so direct the OSC to start the warm up as soon as you think you may want this type of sample.
- The sample will typically be collected from the cooler discharge rather than the isokinetic nozzle to reduce moisture in the sample.
- The user must ensure that the sample results are representative of current plant conditions. If plant conditions change significantly after the sample was obtained, the user should make the Reactor Building Design Basis Leakage Sample Edit Screen inactive and resume COLA RMS calculations.
- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Consider performing manual "What If" dose projections for losing containment integrity using a manual code sample calculation, or increases in damage class using a manual code contingency calculation.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

EXHIBIT 1

Reactor Building Design Basis Leakage
Manual Code Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant via reactor building leakage is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is 0.4 with RB spray off, or 0.03 with RB spray on, based on minimal hold-up time in the building.
- The RMS monitor (RM-A-2) determines the airborne activity in the reactor building. The manual code does not use RM-G-22 or RM-G-23. If RM-A-2 is isolated (>4 psi in RB), this calculation cannot be used. Use COLA RMS calculation or manual contingency calculation.
- Once the code determines the isotopic concentrations in the reactor building, it uses the leakage flow rate from the building, based on a user input building pressure, to determine the uCi/sec leaving the plant (source term). Reduction of RB pressure to atmospheric pressure stops releases from this pathway.
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 37 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- Status of the purge valves (closed if this calculation is being used)
- The RM-A-2 readings:
  1. Current RM-A-2 noble gas reading
  2. Current RM-A-2 iodine reading
  3. Previous RM-A-2 iodine reading
  4. Time since previous RM-A-2 iodine reading
- The time in minutes since reactor shutdown
- Reactor building pressure

Reactor Building Design Basis Leakage
Manual Code Calculation
Using RMS

- Met Data (wind speed, wind direction, and delta t)
- Release duration

Problems to Watch For

- This calculation should only be used when the purge valves are closed. If they are open, some form of reactor building purge exhaust calculation should be performed.
- This calculation option is only good when reactor building pressure is below 4 psi. If RM-A-2 is isolated (>4 psi in RB), this calculation cannot be used. Use COLA RMS calculation or manual contingency calculation if building pressure is above 4 psi.
- Remember that if fuel damage has occurred, it cannot get better.
  1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.
  2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.
  3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.
- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Consider performing manual "What If" dose projections for losing containment integrity or increases in damage class using a manual code contingency calculation.

Reactor Building Design Basis Leakage
Manual Code Calculation
Using RMS

- Consider getting an effluent sample from this pathway (pre-filter marinelli or CATPASS as applicable) when conditions appear to have stabilized.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Reactor Building Design Basis Leakage
Manual Code Calculation
Using Samples

How it works:

- A sample of the reactor building atmosphere can be obtained using the CATPASS system.
- The user enters the positive noble gas and iodine isotope concentrations from the analysis when prompted by the code.
- Once the isotopic concentrations in the reactor building are input, the code uses the leakage flow rate from the building, based on a user input building pressure, to determine the uCi/sec leaking from the reactor building (source term). Reduction of RB pressure to atmospheric pressure stops releases from this pathway.
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 37 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- The code will prompt the user to input values for RCS temperature and pressure or Fuel Damage Class values. These must be input but will have no bearing on the calculation since effluent concentrations leaving the plant are being determined by isotopic sample analysis.
- CATPASS sample results and time of sample results.
- Purge valve position (normally closed but open if doing a "what if containment is lost" calculation)
- Reactor building pressure
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Reactor Building Design Basis Leakage
Manual Code Calculation
Using Samples

Problems to Watch For

- This is a good calculation to perform a "What If" calculations for loss of containment integrity when a CATPASS sample has been obtained.
- The CATPASS system takes 45 minutes to warm up so direct the OSC to start the warm up as soon as you think you may want this type of sample.
- The sample will typically be collected from the cooler discharge rather than the isokinetic nozzle to reduce moisture in the sample.
- The user must ensure that the sample results are representative of current plant conditions. If plant conditions change significantly after the sample was obtained, the user should begin using COLA or manual code RMS calculations.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles
- Periodically verify the release duration and pathway with the ED.
- Consider performing manual "What If" dose projections for losing containment integrity or increase in damage class using a manual code contingency calculation.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Reactor Building Design Basis Leakage
Manual Code Calculation
Contingency Calculation

How it works:

- This calculation is very useful for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.
- This calculation uses no RMS data. The isotopic distribution and total activity being released via this pathway is equal to the product of the total RCS leakage into the reactor building and the activity concentration in the RCS, after adjusting for iodine losses (reduction factors) applicable to this pathway.
- The iodine reduction factor for this pathway is 0.4 with RB spray off, or 0.03 with RB spray on, based on minimal hold-up time in the building..
- Unlike RMS calculations, this calculation is very dependent on RCS total activity. As a result, the code has the ability to use RM-L-1 high or low readings to estimate total RCS activity. The user may also specify a total RCS activity.
- Once the code determines the isotopic concentrations in the reactor building, it uses building leak rate, based on a user input building pressure, to determine the uCi/sec leaking from the building (source term). Reduction of RB pressure to atmospheric pressure stops releases from this pathway.
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 37 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- RM-L-1 high or low readings if letdown is not isolated.
- An estimate of total RCS activity, if known.
- The total RCS leakage into the RB, if known. The STA or TSC should provide RCS leak rates.
- The time in minutes since reactor shutdown
- The status of reactor building spray (on or off)

Reactor Building Design Basis Leakage
Manual Code Calculation
Contingency Calculation

- The status of the purge valves (closed if performing this calculation)
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Problems to Watch For

- Of all calculations available, contingency calculations are the least accurate. They should only be used when RMS data or effluent samples are not available. Contingency calculations are ideal for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.
- This type of calculation is very dependent on total RCS activity. The code will adjust RCS total activity if an RM-L-1 reading is input. Prior to inputting an RM-L-1 reading, verify that RCS letdown is not secured. If it has been secured (and it typically is during this type of accident), RM-L-1 readings should not be used unless the user is sure that the last reading is representative of current RCS conditions. Note that due to travel time in the sample lines, RM-L-1 may take up to 30 minutes before responding to a change in RCS activity.
- If RM-L-1 readings are not available, the code will permit the user to enter a total RCS activity (uCi/cc) if this is known. It generally is not. An example of when this could be used is if an RCS sample has just been pulled but has not been analyzed. If the dose rate on the sample is a factor of 10 higher than a normal RCS sample, it can be inferred that the RCS activity is 10 times higher than it was prior to the incident. Be aware, entering a total RCS activity will replace damage class default RCS activities and spiking factors.
- The code will prompt the user for the total RCS leakage into the reactor building. If the leakage is less than 63,000 gallons (one RCS volume), the actual leakage should be input. If the leakage is more than 63,000 gallons, a maximum of 63,000 gallons should be used. Inputting more than 63,000 gallons will overestimate the source term because it will put more activity in the building than is available for release from the RCS.
- If the total RCS leakage is not known, the code will assume the entire RCS volume (63,000 gallons) has been released to the building using a damage class 4. If total RCS leakage is not known and the damage class is other than 4, the user should respond that the leakage is known and specify the leakage as 63,000 gallons.
- Remember that if fuel damage has occurred, it cannot get better.
    1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.
    2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.
    3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

Reactor Building Design Basis Leakage
Manual Code Calculation
Contingency Calculation

- Consider getting a CATPASS sample to increase the accuracy of the dose projection. The CATPASS system takes 45 minutes to warm up so direct the OSC to start the warm up as soon as you think you may want this type of sample.

- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- When performing "What If" dose projections, clearly label them as "What If" calculations.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? Depending on the inputs, this type of calculation could go either way.

Reactor Building Design Basis Leakage
Quick Code Calculation

How it works:

This calculation is not performed by the Quick Code.

Emergency Feed Pump Exhaust
COLA Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is 0.5 based on partitioning of iodine in the steam generators. Additional iodine reduction can occur if the OTSG level is raised above 600 inches.
- The RMS monitor (RM-G-26 or RM-G27) determines the activity in the main steam. These monitors will respond to both increases in RCS activity and primary-to-secondary leakrate.
- The COLA uses the higher reading of RM-G-26 or RM-G-27
- Once the COLA determines the isotopic concentrations in the main steam line, it uses the mass flow rate through the EFP turbine (based on emergency feedwater being supplied) to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.

THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

- Release duration using the Parameter Edit screen if other than 8 hours
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad
- Fuel Damage Class using the Parameter Edit screen the damage class is believed to be other than that indicated by current RCS temperature and pressure.

Emergency Feed Pump Exhaust
COLA Calculation
Using RMS

Problems to Watch For

- Main steam line and condenser offgas monitor increases can result from increased RCS activity or increased primary-to-secondary leakage, or a combination of the two. If a sudden increase occurs:

  1. Check for signs of increased RCS activity. Coincident increases on RM-L-1, RM-G-22, RM-G-23, RM-G-6, or RM-G-7 may indicate increased RCS activity from fuel damage. Also check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.

  2. Check for signs of increased primary-to-secondary leakage. Check with STA or TSC to determine if leak rate changes have been observed.

- If the steam driven EFP (EFP-1) is on, request that the ED switch over to the electrically driven pumps to terminate this release pathway. If this is not possible, request that the ED use the auxiliary boilers via AS-V-4 to drive the pump. Ask to switch to the unaffected OTSG until the boilers can be used.

- Raising the OTSG level to 600 inches will provide additional iodine reduction. Request that the ED consider increasing OTSG level for this purpose.

- If the steam driven EFP is on and being fed by steam from the OTSG's, the steam must travel past RM-G-26 or RM-G-27. There is no concern about the monitors being isolated by a closed MS-V-2.

- The methodology this code uses to quantify releases using RM-G-26 and 27 is overly conservative. To get a more realistic estimate of the release, utilize the correction factor described in Section 5.9.4.2 of the EDCM to correct the offsite doses and release rates produced by this calculation.

- Remember that if fuel damage has occurred, it cannot get better.

  1. If damage has occurred, but RCS temperature and pressure improve, the COLA will reduce the Fuel Damage Class.

  2. If this occurs, the user must edit the damage class using the Parameter Edit Screen to lock in the higher damage class.

  3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

- Effluent samples are not available for this pathway. If fuel damage is suspected, consider asking for an RCS post accident sample to refine the dose projection.

Emergency Feed Pump Exhaust
COLA Calculation
Using RMS

- If post accident RCS results are to be input into the Reactor Coolant Baseline Activity Edit Screen, ensure the Fuel Damage Class is set to 1 on the Parameter Edit Screen and the spiking factors in the Sample Edit Screen are set to 1. If the COLA is using a damage class greater than 1, the COLA will use the default isotopic activities for that damage class instead of the post accident samples that were input. If the spiking factors are not set to 1, the COLA will erroneously apply the spiking factors to the input sample results.

- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Consider performing manual "What If" dose projections for an increase in damage class.

- Consider performing a manual contingency calculation based on primary-to-secondary leak rate as verification of this type of dose projection if RM-G-26 and RM-G-27 are reading close to background.

- If a Site Protection Officer is stationed at the reactor building equipment hatch, consider moving the individual from that area.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? If RM-G-26 and RM-G-27 readings are less than 100 cpm, this will probably be a bounding type calculation. If they are above 100 cpm, this type of calculation should be a pretty good approximation of what the doses could be.

Emergency Feed Pump Exhaust
COLA Calculation
Using Samples

How it works:

This option cannot be used on the COLA at this time

Emergency Feed Pump Exhaust
Manual Code Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is 0.5 based on partitioning of iodine in the steam generators. Additional iodine reduction can occur if the OTSG level is raised above 600 inches
- The RMS monitor (RM-G-26 or RM-G27) determines the activity in the main steam. These monitors will respond to both increases in RCS activity and primary-to-secondary leakrate.
- The choice of which monitor should be based on which generator is supplying the pump.RM-G-26 for the 'A' side or RM-G-27 for the 'B' side.
- Once the code determines the isotopic concentrations in the main steam line, it uses the mass flow rate through the EFP turbine. The user must specify this mass flow rate (obtain from TSC). Use default of 30,000 lb/hr until the TSC can provide a better value.
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.

THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- The monitor to be used and the monitor reading.
- The time in minutes since reactor shutdown
- The mass flow rate of steam exiting the EFP turbine must be specified by the user in the "Sum of other Direct to Atmosphere Releases" space on the screen used to specify which MSR's or ADV's are open. The mass flow rate can be obtained from the TSC. Use default of 30,000 lb/hr until the TSC can provide a better value.
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Emergency Feed Pump Exhaust
Manual Code Calculation
Using RMS

Problems to Watch For

- Main steam line and Condenser offgas monitor increases can result from increased RCS activity or increased primary-to-secondary leakage, or a combination of the two. If a sudden increase occurs:

  1. Check for signs of increased RCS activity. Coincident increases on RM-L-1, RM-G-22, RM-G-23, RM-G-6, or RM-G-7 may indicate increased RCS activity from fuel damage. Also check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.

  2. Check for signs of increased primary-to-secondary leakage. Check with STA or TSC to determine if leak rate changes have been observed.

- If the steam driven EFP (EFP-1) is on, request that the ED switch over to the electrically driven pumps to terminate this release pathway. If this is not possible, request that the ED use the auxiliary boilers via AS-V-4 to drive the pump. Ask to switch to the unaffected OTSG until the boilers can be used.

- Raising the OTSG level to 600 inches will provide additional iodine reduction. Request that the ED consider increasing OTSG level for this purpose.

- If the steam driven EFP is on and being fed by steam from the OTSG's, the steam must travel past RM-G-26 or RM-G-27. There is no concern about the monitors being isolated by a closed MS-V-2.

- The methodology this code uses to quantify releases using RM-G-26 and 27 is overly conservative. To get a more realistic estimate of the release, utilize the correction factor described in Section 5.9.4.2 of the EDCM to correct the offsite doses and release rates produced by this calculation.

- If the mass flow rate through the pump cannot immediately be determined, use the manual code contingency calculation for this pathway.

- This pathway is always considered a ground level release. However, if this calculation is run with an ADV or MSR also open, the code may inappropriately classify it as an elevated release. If the EFP is running with an ADV or MSR open, both cases must be run separately and the doses added together.

- Remember that if fuel damage has occurred, it cannot get better.

  1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.

  2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.

  3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

Emergency Feed Pump Exhaust
Manual Code Calculation
Using RMS

- Effluent samples are not available for this pathway. If fuel damage is suspected, consider asking for an RCS post accident sample to refine the dose projection.

- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Consider performing manual "What If" dose projections for losing condenser vacuum or increases in damage class using a manual code contingency calculation.

- Consider performing a manual contingency calculation based on primary-to-secondary leak rate as verification of this type of dose projection if RM-G-26 and RM-G-27 are reading close to background.

- If a Site Protection Officer is stationed at the reactor building equipment hatch, consider moving the individual from that area.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? If RM-G-26 and RM-G-27 readings are less than 100 cpm, this will probably be a very bounding type calculation. If they are above 100 cpm, this type of calculation should be a pretty good approximation of what the doses could be.

Emergency Feed Pump Exhaust
Manual Code Calculation
Using Samples

How it works:

This option cannot be used on the manual code at this time

Emergency Feed Pump Exhaust/Main Steam Line Break
Manual Code Calculation
Contingency Calculation

How it works:

- This calculation is very useful for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted. It is also good to use if the mass flow through the EFP cannot immediately be obtained and the 30,000 lb/hr default is not believed to be representative, or if RM-G-26 and RM-G-27 are at background levels.
- This is the calculation that should also be used in the case of a main steam line break.
- This calculation uses no RMS data. The isotopic distribution and total activity being released via this pathway is equal to the product of the primary-to-secondary leak rate and the activity concentration in the RCS. The source term rate is independent of mass flow through the steam driven EFP or the main steam line break.
- The iodine reduction factor for this pathway is 0.5 based on partitioning of iodine in the steam generators. Additional iodine reduction can occur if the OTSG level is raised above 600 inches.
- Unlike RMS calculations, this calculation is very dependent on RCS total activity. As a result, the code has the ability to use RM-L-1 high or low readings to estimate total RCS activity. The user may also specify a total RCS activity.
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.

THIS PATHWAY IS ALWAYS CONSIDERED A GROUND LEVEL RELEASE

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- RM-L-1 high or low readings if letdown is not isolated.
- An estimate of total RCS activity, if known.
- The primary-to-secondary leak rate, in gpm, provided by the STA or TSC.
- The time in minutes since reactor shutdown
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Emergency Feed Pump Exhaust/Main Steam Line Break
Manual Code Calculation
Contingency Calculation

Problems to Watch For

- Of all calculations available, contingency calculations are the least accurate. They should only be used when RMS data or effluent samples are not available. Contingency calculations are ideal for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.

- If the steam driven EFP (EFP-1) is on, request that the ED switch over to the electrically driven pumps to terminate this release pathway. If this is not possible, request that the ED use the auxiliary boilers to drive the pump. Ask to switch to the unaffected OTSG until the boilers can be used.

- Raising the OTSG level to 600 inches will provide additional iodine reduction. Request that the ED consider increasing OTSG level for this purpose.

- If the mass flow rate of steam through the pump turbine cannot immediately be determined, this is a good calculation to use. If all ADV's and MSR's are kept closed, all primary activity entering the secondary side will be assumed to be released via this pathway.

- If RM-G-26 and RM-G-27 are at background levels, this is a good calculation to perform to verify dose projections made using RMS data.

- This type of calculation is very dependent on total RCS activity. The code will adjust RCS total activity if an RM-L-1 reading is input. Prior to inputting an RM-L-1 reading, verify that RCS letdown is not secured. If it has been secured (and it typically is during this type of accident), RM-L-1 readings should not be used unless the user is sure that the last reading is representative of current RCS conditions. Note that due to travel time in the sample lines, RM-L-1 may take up to 30 minutes before responding to a change in RCS activity.

- If RM-L-1 readings are not available, the code will permit the user to enter a total RCS activity (uCi/cc) if this is known. It generally is not. An example of when this could be used is if an RCS sample has just been pulled but has not been analyzed. If the dose rate on the sample is a factor of 10 higher than a normal RCS sample, it can be inferred that the RCS activity is 10 times higher than it was prior to the incident. Be aware, entering a total RCS activity will replace damage class default RCS activities and spiking factors.

- Remember that if fuel damage has occurred, it cannot get better.

    1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.

    2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.

    3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

Emergency Feed Pump Exhaust/Main Steam Line Break
Manual Code Calculation
Contingency Calculation

- Effluent samples are not available for this pathway. Consider requesting an RCS sample (normal or post accident) to increase the accuracy of the dose projection.
- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.
- This pathway is always considered a ground level release. However, if this calculation is run with an ADV or MSR also open, the code may inappropriately classify it as an elevated release. If the EFP is running with an ADV or MSR open, both cases must be run separately and the doses added together.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- When performing "What If" dose projections, clearly label them as "What If" calculations.
- If a Site Protection Officer is stationed at the reactor building equipment hatch, consider moving the individual from that area.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? Depending on the inputs, this type of calculation could go either way.

Emergency Feed Pump Exhaust
Quick Code Calculation

How it works:

This calculation is not performed by the Quick Code.

Atmospheric Dump Valve Release (A or B Side)
COLA Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is 0.5 based on partitioning of iodine in the steam generators. Additional iodine reduction can occur if the OTSG level is raised above 600 inches.
- The RMS monitor (RM-G-26 or RM-G27) determines the activity in the main steam. These monitors will respond to both increases in RCS activity and primary-to-secondary leakrate.
- The COLA uses the reading on RM-G-26 if MS-V-4A is open and the reading on RM-G-27 if MS-V-4B is open.
- Once the COLA determines the isotopic concentrations in the main steam line, it uses the mass flow rate out the ADV. The mass flow rate is a function of the main steam pressure and the percent demand on the MS-V-4 valve. Both of these parameters are picked up off the plant computer.
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.

AS A RESULT OF BUOYANT PLUME RISE, THIS PATHWAY IS ALMOST ALWAYS AN ELEVATED RELEASE.

User Inputs Needed to Perform the Calculation

- Release duration using the Parameter Edit screen if other than 8 hours
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad
- Fuel Damage Class using the Parameter Edit screen the damage class is believed to be other than that indicated by current RCS temperature and pressure.

Atmospheric Dump Valve Release (A or B Side)
COLA Calculation
Using RMS

Problems to Watch For

- Main steam line and condenser offgas monitor increases can result from increased RCS activity or increased primary-to-secondary leakage, or a combination of the two. If a sudden increase occurs:

  1. Check for signs of increased RCS activity. Coincident increases on RM-L-1, RM-G-22, RM-G-23, RM-G-6, or RM-G-7 may indicate increased RCS activity from fuel damage. Also check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.

  2. Check for signs of increased primary-to-secondary leakage. Check with STA or TSC to determine if leak rate changes have been observed.

- Be aware that the COLA measures the degree of the ADV opening by the percent demand (how much it should be open for plant conditions). If an ADV were to stick open, but did not need to be open, the percent demand will be 0 and the COLA will not recognize the ADV is open. As a result, it will compute a source term of 0. If this occurs, a manual code RMS calculation should be performed specifying the valve as 100% open. An alternative would be to edit the COLA Parameter Edit Screen to say an MSR is stuck open. The latter will provide a more conservative dose estimate (factor of 2), but will keep the EIN and MIDAS plume plots reasonably accurate.

- If the steam driven EFP (EFP-1) is on, request that the ED switch over to the electrically driven pumps to terminate this release pathway. If this is not possible, request that the ED use the auxiliary boilers via AS-V-4 to drive the pump. Ask to switch to the unaffected OTSG until the boilers can be used.

- Raising the OTSG level to 600 inches will provide additional iodine reduction. Request that the ED consider increasing OTSG level for this purpose

- If the release is through an ADV, the steam must travel past RM-G-26 or RM-G-27. There is no concern about the monitors being isolated by a closed MS-V-2.

- The methodology this code uses to quantify releases using RM-G-26 and 27 is overly conservative. To get a more realistic estimate of the release, utilize the correction factor described in Section 5.9.4.2 of the EDCM to correct the offsite doses and release rates produced by this calculation.

- Remember that if fuel damage has occurred, it cannot get better.

  1. If damage has occurred, but RCS temperature and pressure improve, the COLA will reduce the Fuel Damage Class.

Atmospheric Dump Valve Release (A or B Side)
COLA Calculation
Using RMS

2. If this occurs, the user must edit the damage class using the Parameter Edit Screen to lock in the higher damage class.

3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

- Effluent samples are not available for this pathway. If fuel damage is suspected, consider asking for a RCS post accident sample to refine the dose projection.
- If post accident RCS results are to be input into the Reactor Coolant Baseline Activity Edit Screen, ensure the Fuel Damage Class is set to 1 on the Parameter Edit Screen and the spiking factors in the Sample Edit Screen are set to 1. If the COLA is using a damage class greater than 1, the COLA will use the default isotopic activities for that damage class instead of the post accident samples that were input. If the spiking factors are not set to 1, the COLA will erroneously apply the spiking factors to the input sample results.
- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Consider performing manual "What If" dose projections for an increase in damage class using the manual code contingency calculation
- Consider performing a manual contingency calculation based on primary-to-secondary leak rate as verification of this type of dose projection if RM-G-26 and RM-G-27 are reading close to background.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? If RM-G-26 and RM-G-27 readings are less than 100 cpm, this will probably be a bounding type calculation. If they are above 100 cpm, this type of calculation should be a pretty good approximation of what the doses could be.

Atmospheric Dump Valve Release (A or B Side)
COLA Calculation
Using Samples

How it works:

This option cannot be used on the COLA at this time

Atmospheric Dump Valve Release (A or B Side)
Manual Code Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is 0.5 based on partitioning of iodine in the steam generators. Additional iodine reduction can occur if the OTSG level is raised above 600 inches. These reduction factors are accounted for in the manual code.
- The RMS monitor (RM-G-26 or RM-G27) determines the activity in the main steam. These monitors will respond to both increases in RCS activity and primary-to-secondary leakrate.
- The choice of which monitor should be based on which ADV is open. RM-G-26 for MS-V-4A or RM-G-27 for MS-V-4B. If both valves are open, use the higher of the two monitors.
- Once the code determines the isotopic concentrations in the main steam line, it uses the mass flow rate out the ADV. The mass flow rate is a function of the main steam pressure and the percent open of the MS-V-4 valve. The user specifies both of these parameters.
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- As a result of buoyant plume rise, this pathway is almost always an elevated release.

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- The monitor to be used and the monitor reading.
- The time in minutes since reactor shutdown
- The main steam pressure
- The percent the ADV is open.
- Whether generator level is above 600 inches or not
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Atmospheric Dump Valve Release (A or B Side)
Manual Code Calculation
Using RMS

Problems to Watch For

- Main steam line and condenser offgas monitor increases can result from increased RCS activity or increased primary-to-secondary leakage, or a combination of the two. If a sudden increase occurs:

  1. Check for signs of increased RCS activity. Coincident increases on RM-L-1, RM-G-22, RM-G-23, RM-G-6, or RM-G-7 may indicate increased RCS activity from fuel damage. Also check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.

  2. Check for signs of increased primary-to-secondary leakage. Check with STA or TSC to determine if leak rate changes have been observed.

- If the steam driven EFP (EFP-1) is on, request that the ED switch over to the electrically driven pumps to terminate this release pathway. If this is not possible, request that the ED use the auxiliary boilers to drive the pump. Ask to switch to the unaffected OTSG until the boilers can be used.

- Raising the OTSG level to 600 inches will provide additional iodine reduction. Request that the ED consider increasing OTSG level for this purpose

- If the release is through an ADV, the steam must travel past RM-G-26 or RM-G-27. There is no concern about the monitors being isolated by a closed MS-V-2.

- The methodology this code uses to quantify releases using RM-G-26 and 27 is overly conservative. To get a more realistic estimate of the release, utilize the correction factor described in Section 5.9.4.2 of the EDCM to correct the offsite doses and release rates produced by this calculation.

- Remember that if fuel damage has occurred, it cannot get better.

  1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.

  2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.

  3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

- Effluent samples are not available for this pathway. If fuel damage is suspected, consider asking for an RCS post accident sample to refine the dose projection.

- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.

**Atmospheric Dump Valve Release (A or B Side)
Manual Code Calculation
Using RMS**

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Consider performing manual "What If" dose projections for an increase in damage class using the manual code contingency calculation.

- Consider performing a manual contingency calculation based on primary-to-secondary leak rate as verification of this type of dose projection if RM-G-26 and RM-G-27 are reading close to background.

- This pathway is always considered an elevated release. However, if this calculation is run with the EFP running, the code will erroneously classify the EFP release as an elevated release. With the EFP running both cases must be run separately and the doses added together.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? If RM-G-26 and RM-G-27 readings are less than 100 cpm, this will probably be a very bounding type calculation. If they are above 100 cpm, this type of calculation should be a pretty good approximation of what the doses could be.

EXHIBIT 1

Atmospheric Dump Valve Release (A or B Side)
Manual Code Calculation
Using Samples

How it works:

This option cannot be used on the manual code at this time

Atmospheric Dump Valve Release (A or B Side)
Manual Code Calculation
Contingency Calculation

How it works:

- This calculation is very useful for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted, or if RM-G-26 and RM-G-27 are at background levels.
- This calculation uses no RMS data. The isotopic distribution and total activity being released via this pathway is equal to the product of the primary-to-secondary leak rate and the activity concentration in the RCS. The source term rate is independent of mass flow through the ADV.
- The iodine reduction factor for this pathway is 0.5 based on partitioning of iodine in the steam generators. Additional iodine reduction can occur if the OTSG level is raised above 600 inches.
- Unlike RMS calculations, this calculation is very dependent on RCS total activity. As a result, the code has the ability to use RM-L-1 high or low readings to estimate total RCS activity. The user may also specify a total RCS activity.
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- As a result of buoyant plume rise, this pathway is almost always an elevated release.

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- RM-L-1 high or low readings if letdown is not isolated.
- An estimate of total RCS activity, if known.
- The primary-to-secondary leak rate, in gpm, provided by the STA or TSC.
- The main steam pressure
- The percent the ADV is open
- Whether generator level is above 600 inches or not
- The time in minutes since reactor shutdown
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Atmospheric Dump Valve Release (A or B Side)
Manual Code Calculation
Contingency Calculation

Problems to Watch For

- Of all calculations available, contingency calculations are the least accurate. They should only be used when RMS data or effluent samples are not available. Contingency calculations are ideal for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.

- If RM-G-26 and RM-G-27 are at background levels, this is a good calculation to perform to verify dose projections made using RMS data.

- If the steam driven EFP (EFP-1) is on, request that the ED switch over to the electrically driven pumps to terminate this release pathway. If this is not possible, request that the ED use the auxiliary boilers to drive the pump. Ask to switch to the unaffected OTSG until the boilers can be used.

- Raising the OTSG level to 600 inches will provide additional iodine reduction. Request that the ED consider increasing OTSG level for this purpose.

- This type of calculation is very dependent on total RCS activity. The code will adjust RCS total activity if an RM-L-1 reading is input. Prior to inputting an RM-L-1 reading, verify that RCS letdown is not secured. If it has been secured (and it typically is during this type of accident), RM-L-1 readings should not be used unless the user is sure that the last reading is representative of current RCS conditions. Note that due to travel time in the sample lines, RM-L-1 may take up to 30 minutes before responding to a change in RCS activity.

- If RM-L-1 readings are not available, the code will permit the user to enter a total RCS activity (uCi/cc) if this is known. It generally is not. An example of when this could be used is if an RCS sample has just been pulled but has not been analyzed. If the dose rate on the sample is a factor of 10 higher than a normal RCS sample, it can be inferred that the RCS activity is 10 times higher than it was prior to the incident. Be aware, entering a total RCS activity will replace damage class default RCS activities and spiking factors.

- Remember that if fuel damage has occurred, it cannot get better.

    1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.

    2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.

    3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.

Atmospheric Dump Valve Release (A or B Side)
Manual Code Calculation
Contingency Calculation

- Effluent samples are not available for this pathway. Consider requesting an RCS Sample (normal or post accident) to increase the accuracy of the dose projection.
- This pathway is always considered an elevated release. However, if this calculation is run with the EFP running, the code will erroneously classify the EFP release as an elevated release. With the EFP running both cases must be run separately and the doses added together.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- When performing "What If" dose projections, clearly label them as "What If" calculations.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? Depending on the inputs, this type of calculation could go either way.

Atmospheric Dump Valve Release (A or B Side)
Quick Code Calculation

How it works:

- This code provides a quick, but crude, estimate of offsite dose. As such it should only be used by the on-shift RAC, during the first hour of an emergency, if the COLA Code is not available.
- This code requires an RMS reading for its calculation. If an RMS reading is not available, a manual code contingency calculation must be performed.
- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The RCS mixture is assumed to have the same isotopic distribution as a Fuel Damage Class 2.
- The iodine reduction factor for this pathway is 0.5 based on partitioning of iodine in the steam generators. It is accounted for in the code.
- The RMS monitor (RM-G-26 or RM-G27) determines the activity in the main steam. These monitors will respond to both increases in RCS activity and primary-to-secondary leakrate. The user selects which monitor will be used for the calculation.
- The code assumes the mass flow rate to approximate an ADV 100% open at a main steam pressure of 1040 psi.
- The code assumes an 8 hour release duration.
- Once the code determines the isotopic concentrations in the main steam line, it uses the flow rate out of the ADV to determine the μCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway is always considered a ground level release

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- The monitor to be used and the monitor reading.
- Met Data (wind speed, wind direction, and delta t)
- Since the COLA is not available, all readings must come from control room instrumentation.

Atmospheric Dump Valve Release (A or B Side)
Quick Code Calculation

Problems to Watch For

- The IREO RAC should not use this code. The full manual code should be used when the IREO organization is activated.

- This calculation assumes an RCS isotopic distribution that is the same as a Fuel Damage Class 2. This provides a reasonable estimate of offsite dose for both fuel damage and iodine spiking situations. As soon as time is available, however, a manual code RMS calculation should be performed so a dose estimate using more representative plant parameters can be obtained.

- The methodology this code uses to quantify releases using RM-G-26 and 27 is overly conservative. To get a more realistic estimate of the release, utilize the correction factor described in Section 5.9.4.2 of the EDCM to correct the offsite doses and release rates produced by this calculation.

  If the MS-V-2 valves are closed, RM-G-26 and RM-G-27 are isolated from steam flow and may not be representative of current main steam conditions. Determine MS-V-2 position from the ED. With the MS-V-2 valves closed, manual code contingency calculations should be used to calculate offsite doses unless the last know reading on these monitors is know to e representative of current main steam conditions.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Label all Quickcode calculations as "Quickcode"

Main Steam Safety Release (A or B Side)
COLA Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is 0.5 based on partitioning of iodine in the steam generators. Additional iodine reduction can occur if the OTSG level is raised above 600 inches.
- The RMS monitor (RM-G-26 or RM-G27) determines the activity in the main steam. These monitors will respond to both increases in RCS activity and primary-to-secondary leakrate.
- The COLA uses the highest reading on RM-G-26 or RM-G-27.
- There is no plant computer point that provides indication that an MSR is open. The user must tell the COLA that an MSR is open by editing the Parameter Edit Screen. Opening an MSR on the COLA does not specify whether it is on the A or B side.
- Once the COLA determines the isotopic concentrations in the main steam line, it uses the mass flow rate out the highest rated MSR. The mass flow rate is a function of the main steam pressure. This parameter is picked up off the plant computer.
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- As a result of buoyant plume rise, this pathway is almost always an elevated release.

User Inputs Needed to Perform the Calculation

- MSR open using the Parameter Edit screen
- Release duration using the Parameter Edit screen if other than 8 hours
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad
- Fuel Damage Class using the Parameter Edit screen the damage class is believed to be other than that indicated by current RCS temperature and pressure.

Main Steam Safety Release (A or B Side)
COLA Calculation
Using RMS

Problems to Watch For

- Main steam line and condenser offgas monitor increases can result from increased RCS activity or increased primary-to-secondary leakage, or a combination of the two. If a sudden increase occurs:
  - ❶ Check for signs of increased RCS activity. Coincident increases on RM-L-1, RM-G-22, RM-G-23, RM-G-6, or RM-G-7 may indicate increased RCS activity from fuel damage. Also check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.
  - ❷ Check for signs of increased primary-to-secondary leakage. Check with STA or TSC to determine if leak rate changes have been observed.
- If the steam driven EFP (EFP-1) is on, request that the ED switch over to the electrically driven pumps to terminate this release pathway. If this is not possible, request that the ED use the auxiliary boilers to drive the pump. Ask to switch to the unaffected OTSG until the boilers can be used.
- Raising the OTSG level to 600 inches will provide additional iodine reduction. Request that the ED consider increasing OTSG level for this purpose
- If the MS-V-2 valves are closed, RM-G-26 and RM-G-27 are isolated from steam flow and may not be representative of current main steam conditions. Determine MS-V-2 position from the ED. With the MS-V-2 valves closed, manual code contingency calculations should be used to calculate offsite doses unless the last known reading on these monitors is known to be representative of current main steam conditions.
- Since the COLA does not know whether the open MSR is on the A or B side, and because it uses the highest of the main steam monitor readings, it can be a conservative calculation. For example, if the open MSR is on the B side (RM-G-27) but it is the OTSG-A that is leaking (RM-G-26), the COLA is assuming that an A side MSR is open, resulting in what could be a very conservative calculation. Should this type of situation occur, the manual code RMS calculation should be used to see how conservative the COLA is.
- The methodology this code uses to quantify releases using RM-G-26 and 27 is overly conservation. To get a more realistic estimate of the release, utilize the correction factor described in Section 5.9.4.2 of the EDCM to correct the offsite doses and release rates produced by this calculation.
- Remember that if fuel damage has occurred, it cannot get better.
  - ❶ If damage has occurred, but RCS temperature and pressure improve, the COLA will reduce the Fuel Damage Class.
  - ❷ If this occurs, the user must edit the damage class using the Parameter Edit Screen to lock in the higher damage class.

Main Steam Safety Release (A or B Side)
COLA Calculation
Using RMS

3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

- Effluent samples are not available to this pathway. If fuel damage is suspected, consider asking for an RCS post accident sample to refine the dose projection.

- If post accident RCS results are to be input into the Reactor Coolant Baseline Activity Edit Screen, ensure the Fuel Damage Class is set to 1 on the Parameter Edit Screen and the spiking factors in the Sample Edit Screen are set to 1. If the COLA is using a damage class greater than 1, the COLA will use the default isotopic activities for that damage class instead of the post accident samples that were input. If the spiking factors are not set to 1, the COLA will erroneously apply the spiking factors to the input sample results.

- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Consider performing manual "What If" dose projections for an increase in damage class using the manual code contingency calculation.

- Consider performing a manual contingency calculation based on primary-to-secondary leak rate as verification of this type of dose projection if RM-G-26 and RM-G-27 are reading close to background.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? If RM-G-26 and RM-G-27 readings are less than 100 cpm, this will probably be a bounding type calculation. If they are above 100 cpm, this type of calculation should be a pretty good approximation of what the doses could be.

Main Steam Safety Release (A or B Side)
COLA Calculation
Using Samples

<u>How it works:</u>

This option cannot be used on the COLA at this time

EXHIBIT 1

Main Steam Safety Release (A or B Side)
Manual Code Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is 0.5 based on partitioning of iodine in the steam generators. Additional iodine reduction can occur if the OTSG level is raised above 600 inches. These reduction factors are accounted for in the manual code.
- The RMS monitor (RM-G-26 or RM-G27) determines the activity in the main steam. These monitors will respond to both increases in RCS activity and primary-to-secondary leakrate.
- The user inputs the reading on RM-G-26 if an 'A' side MSR is open or the reading on RM-G-27 if a 'B' side MSR open. If MSR's are open on both the A and B side, the highest of the two readings should be used.
- Once the code determines the isotopic concentrations in the main steam line, it uses the mass flow rate out the MSR. The mass flow rate is a function of the main steam pressure. The main steam pressure is input by the user.
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- As a result of buoyant plume rise, this pathway is almost always an elevated release.

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- The monitor to be used and the monitor reading.
- The time in minutes since reactor shutdown
- The main steam pressure
- The specific MSR that is open.
- Whether generator level is above 600 inches or not
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Main Steam Safety Release (A or B Side)
Manual Code Calculation
Using RMS

Problems to Watch For

- Main steam line and condenser offgas monitor increases can result from increased RCS activity or increased primary-to-secondary leakage, or a combination of the two. If a sudden increase occurs:

  1. Check for signs of increased RCS activity. Coincident increases on RM-L-1, RM-G-22, RM-G-23, RM-G-6, or RM-G-7 may indicate increased RCS activity from fuel damage. Also check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.

  2. Check for signs of increased primary-to-secondary leakage. Check with STA or TSC to determine if leak rate changes have been observed.

- If the steam driven EFP (EFP-1) is on, request that the ED switch over to the electrically driven pumps to terminate this release pathway. If this is not possible, request that the ED use the auxiliary boilers to drive the pump. Ask to switch to the unaffected OTSG until the boilers can be used.

- Raising the OTSG level to 600 inches will provide additional iodine reduction. Request that the ED consider increasing OTSG level for this purpose

- If the MS-V-2 valves are closed, RM-G-26 and RM-G-27 are isolated from steam flow and may not be representative of current main steam conditions. Determine MS-V-2 position from the ED. With the MS-V-2 valves closed, manual code contingency calculations should be used to calculate offsite doses unless the last known reading on these monitors is known to be representative of current main steam conditions.

- The methodology this code uses to quantify releases using RM-G-26 and 27 is overly conservation. To get a more realistic estimate of the release, utilize the correction factor described in Section 5.9.4.2 of the EDCM to correct the offsite doses and release rates produced by this calculation.

- Remember that if fuel damage has occurred, it cannot get better.

  1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.

  2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.

  3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.

- Effluent samples are not available for this pathway. If fuel damage is suspected, consider asking for an RCS post accident sample to refine the dose projection.

Main Steam Safety Release (A or B Side)
Manual Code Calculation
Using RMS

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Consider performing manual "What If" dose projections for an increase in damage class using the manual code contingency calculation.
- Consider performing a manual contingency calculation based on primary-to-secondary leak rate as verification of this type of dose projection if RM-G-26 and RM-G-27 are reading close to background.
- This pathway is always considered an elevated release. However, if this calculation is run with the EFP running, the code will erroneously classify the EFP release as an elevated release. With the EFP running both cases must be run separately and the doses added together.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? If RM-G-26 and RM-G-27 readings are less than 100 cpm, this will probably be a very bounding type calculation. If they are above 100 cpm, this type of calculation should be a pretty good approximation of what the doses could be.

Main Steam Safety Release (A or B Side)
Manual Code Calculation
Using Samples

How it works:

This option cannot be used on the manual code at this time

Main Steam Safety Release (A or B Side)
Manual Code Calculation
Contingency Calculation

How it works:

- This calculation is very useful for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.
- If RM-G-26 and RM-G-27 are at background levels, this is a good calculation to perform to verify dose projections made using RMS data.
- This calculation uses no RMS data. The isotopic distribution and total activity being released via this pathway is equal to the product of the primary-to-secondary leak rate and the activity concentration in the RCS. The source term rate is independent of mass flow through the MSR.
- The iodine reduction factor for this pathway is 0.5 based on partitioning of iodine in the steam generators. Additional iodine reduction can occur if the OTSG level is raised above 600 inches.
- Unlike RMS calculations, this calculation is very dependent on RCS total activity. As a result, the code has the ability to use RM-L-1 high or low readings to estimate total RCS activity. The user may also specify a total RCS activity.
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- As a result of buoyant plume rise, this pathway is almost always an elevated release.

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- RM-L-1 high or low readings if letdown is not isolated.
- An estimate of total RCS activity, if known.
- The primary-to-secondary leak rate, in gpm, provided by the STA or TSC.
- The main steam pressure
- The specific MSR that is open
- Whether generator level is above 600 inches or not
- The time in minutes since reactor shutdown

Main Steam Safety Release (A or B Side)
Manual Code Calculation
Contingency Calculation

- Met Data (wind speed, wind direction, and delta t)
- Release duration

Problems to Watch For

- Of all calculations available, contingency calculations are the least accurate. They should only be used when RMS data or effluent samples are not available. Contingency calculations are ideal for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.
- If the steam driven EFP (EFP-1) is on, request that the ED switch over to the electrically driven pumps to terminate this release pathway. If this is not possible, request that the ED use the auxiliary boilers to drive the pump. Ask to switch to the unaffected OTSG until the boilers can be used.
- Raising the OTSG level to 600 inches will provide additional iodine reduction. Request that the ED consider increasing OTSG level for this purpose.
- This type of calculation is very dependent on total RCS activity. The code will adjust RCS total activity if an RM-L-1 reading is input. Prior to inputting an RM-L-1 reading, verify that RCS letdown is not secured. If it has been secured (and it typically is during this type of accident), RM-L-1 readings should not be used unless the user is sure that the last reading is representative of current RCS conditions. Note that due to travel time in the sample lines, RM-L-1 may take up to 30 minutes before responding to a change in RCS activity.
- If RM-L-1 readings are not available, the code will permit the user to enter a total RCS activity (uCi/cc) if this is known. It generally is not. An example of when this could be used is if an RCS sample has just been pulled but has not been analyzed. If the dose rate on the sample is a factor of 10 higher than a normal RCS sample, it can be inferred that the RCS activity is 10 times higher than it was prior to the incident. Be aware, entering a total RCS activity will replace damage class default RCS activities and spiking factors.
- Remember that if fuel damage has occurred, it cannot get better.
    1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.
    2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.
    3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.
- Effluent samples are not available for this pathway. Consider requesting an RCS sample (normal or post accident) to increase the accuracy of the dose projection.

Main Steam Safety Release (A or B Side)
Manual Code Calculation
Contingency Calculation

- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.

- This pathway is always considered an elevated release. However, if this calculation is run with the EFP running, the code will erroneously classify the EFP release as an elevated release. With the EFP running both cases must be run separately and the doses added together.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- When performing "What If" dose projections, clearly label them as "What If" calculations.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? Depending on the inputs, this type of calculation could go either way.

Main Steam Safety Release (A or B Side)
Quick Code Calculation

How it works:

- This code provides a quick, but crude, estimate of offsite dose. As such it should only be used by the on-shift RAC, during the first hour of an emergency, if the COLA Code is not available.
- This code requires an RMS reading for its calculation. If an RMS reading is not available, a manual code contingency calculation must be perfomed.
- The isotopic distribution of activity leaving the plant is assumed to have the same isotopic distribution as a Fuel Damage Class 2.
- The iodine reduction factor for this pathway is 0.5 based on partitioning of iodine in the steam generators. It is accounted for in the code.
- The RMS monitor (RM-G-26 or RM-G27) determines the activity in the main steam. These monitors will respond to both increases in RCS activity and primary-to-secondary leakrate. The user selects which monitor will be used for the calculation.
- The code assumes the mass flow rate out of the MSR to be approximately equivalent to an ADV 100% open at a main steam pressure of 1040 psi.
- The code assumes an 8 hour release duration.
- Once the code determines the isotopic concentrations in the main steam line, it uses the assumed flow rate out of the MSR to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway is always considered an elevated release.

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 35 & 36 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- The monitor to be used and the monitor reading.
- Met Data (wind speed, wind direction, and delta t)
- Since the COLA is not available, all readings must come from control room instrumentation.

Main Steam Safety Release (A or B Side)
Quick Code Calculation

Problems to Watch For

- The IREO RAC should not use this code. The full manual code should be used when the IREO organization is activated.
- This calculation assumes an RCS isotopic distribution that is the same as a Fuel Damage Class 2. This provides a reasonable estimate of offsite dose for both fuel damage and iodine spiking situations. As soon as time is available, however, a manual code RMS calculation should be performed so a dose estimate using more representative plant parameters can be obtained.
- The methodology this code uses to quantify releases using RM-G-26 and 27 is overly conservative. To get a more realistic estimate of the release, utilize the correction factor described in Section 5.9.4.2 of the EDCM to correct the offsite doses and release rates produced by this calculation.
- If the MS-V-2 valves are closed, RM-G-26 and RM-G-27 are isolated from steam flow and may not be representative of current main steam conditions. Determine MS-V-2 position from the ED. With the MS-V-2 valves closed, manual code contingency calculations should be used to calculate offsite doses unless the last known reading on these monitors is known to be representative of current main steam conditions.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Label all Quickcode calculations as "Quickcode".

Station Vent
COLA Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is a combination of primary system iodine retention (0.4) and charcoal filtration (0.01). The total iodine reduction factor is then (0.4)(0.01) = 0.004.
- The RMS monitor (RM-A-8 Gas, RM-A-8 Iodine, or RM-A-8 high) determines the activity leaving via this pathway. These monitors will respond to both increases in RCS activity and increased leakage into the auxiliary/fuel handling building.
- The logic the COLA uses in picking which monitor to perform the calculation is as follows:
    1. If RM-A-8 High reads less than 100, the COLA is using the reading on RM-A-8 Gas to compute the noble gas source term.
    2. If RM-A-8 High reads less than 100, the COLA is using the difference between the current reading on RM-A-8 Iodine and the previous reading on RM-A-8 iodine compute the iodine source term.
    3. If RM-A-8 High reads > 100 cpm, the COLA is using RM-A-8 High to compute the noble gas and iodine source terms.
- Once the COLA determines the isotopic concentrations leaving via station vent, it uses the flow rate to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

User Inputs Needed to Perform the Calculation

- Release duration using the Parameter Edit screen if other than 8 hours
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad
- Fuel Damage Class using the Parameter Edit screen the damage class is believed to be other than that indicated by current RCS temperature and pressure.

Station Vent
COLA Calculation
Using RMS

Problems to Watch For

- Station vent monitor increases can result from increased RCS activity or RCS leakage in the Auxiliary/Fuel Handling Building, or a combination of the two. If a sudden increase occurs:

    1. Check for signs of increased RCS activity. Coincident increases on RM-L-1, RM-G-22, RM-G-23, RM-G-6, or RM-G-7 may indicate increased RCS activity from fuel damage. Also check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.

    2. Check for signs of increased leakage to the Auxiliary/Fuel Handling Building. Check with STA or TSC to determine if leak rate changes have been observed.

- If RM-A-8 High is ≤ 100 cpm, RM-A-8 Iodine is used to calculate the iodine source term. The iodine source term is not ratioed in from the RCS noble gas to iodine ratio. The isotopic distribution of the iodines is the same as in the RCS.

- The RM-A-8 iodine calculation assumes that 4 minutes have elapsed since the current and previous iodine channel readings. Due to differences in the timing of PPM files and COLA calculations, there can be variability in thyroid dose estimate (factor of 2) during each 15 minute period. Use the highest of the three estimates performed each 15 minutes.

- If RM-A-8 High is ≤ 100 cpm, and RM-A-8 Iodine is offscale high, the iodine source term will not be calculated correctly. In this situation, the manual RMS calculation for station vent should be performed.

- If RM-A-8 High is > 100 cpm, the iodine source term is scaled in from the noble gas to iodine ratio after adjusting for iodine losses (reduction factors) applicable to this pathway.

- Remember that if fuel damage has occurred, it cannot get better.

    1. If damage has occurred, but RCS temperature and pressure improve, the COLA will reduce the Fuel Damage Class.

    2. If this occurs, the user must edit the damage class using the Parameter Edit Screen to lock in the higher damage class.

    3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

- If post accident RCS results are to be input into the Reactor Coolant Baseline Activity Edit Screen, ensure the Fuel Damage Class is set to 1 on the Parameter Edit Screen and the spiking factors in the Sample Edit Screen are set to 1. If the COLA is using a damage class greater than 1, the COLA will use the default isotopic activities for that damage class instead of the post accident samples that were input. If the spiking factors are not set to 1, the COLA will erroneously apply the spiking factors to the input sample results.

EXHIBIT 1

Station Vent
COLA Calculation
Using RMS

- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Consider getting an effluent sample from this pathway (MAP-5 or pre-filter marinelli) when conditions appear to have stabilized.

- Consider performing manual "What If" dose projections for increases in damage class.

- If the charcoal filters become degraded and are believed to be operating at less than normal efficiency, the manual code RMS calculation should be used for this pathway. The TSC can provide information on charcoal filter efficiency and degradation.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Station Vent
COLA Calculation
Using Samples

How it works:

- Effluents leaving via Station Vent are sampled using a pre-filter marinelli sample
- The user enters the positive noble gas and iodine isotope concentrations from the analysis into the Station Vent Sample Edit Screen.
- If a MAP-5 sample is used, the manual code must be used to perform the calculation, since the COLA will not produce a noble gas source term.
- Once the COLA determines the isotopic concentrations leaving via Station Vent, it uses the flow rate from the plant computer to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

User Inputs Needed to Perform the Calculation

- Sample results need to be entered on the Station Vent Sample Edit Screen
- Release duration using the Parameter Edit screen if other than 8 hours
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad

Station Vent
COLA Calculation
Using Samples

Problems to Watch For

- The user must ensure that the sample results are representative of current plant conditions. If plant conditions change significantly after the sample was obtained, the user should make the Station Vent Sample Edit Screen inactive and resume COLA RMS calculations.

- MAP-5 samples cannot be used solely with the COLA code since noble gases are not measured. The COLA code will not produce a noble gas source term from a MAP-5 sample. MAP-5 samples must be calculated using the manual codes to get the correct TEDE dose. The MAP-5 sample should still be input into the COLA code since the thyroid doses produced by the COLA will still be accurate.

- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Consider performing manual "What If" dose projections for increases in damage class using a manual code contingency calculation.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Station Vent
Manual Code Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.

- The iodine reduction factor for this pathway is a combination of primary system iodine retention (0.4) and charcoal filtration efficiency specified by the user (E). The total iodine reduction factor is then (0.4)(1-E), normally = 0.004.

- The RMS monitor (RM-A-4, 6, or 8 Gas, RM-A-4, 6, or 8 Iodine, or RM-A-8 high) determines the activity leaving via this pathway. These monitors will respond to both increases in RCS activity and increased leakage into the auxiliary/fuel handling building.

- The user selects whether RM-A-4, RM-A-6, RM-A-8 or RM-A-8 High is used for the calculation:

  1. If RM-A-8 or RM-A-8 High is selected, the code will ask the user if RM-A-8 Iodine is on scale. If the answer is yes, the code will calculate the iodine source term base on the current and previous iodine channel readings specified by the user. If RM-A-8 iodine is offscale, the iodine source term is scaled in from the noble gas to iodine ratio after adjusting for iodine losses (reduction factors) applicable to this pathway.

  2. If RM-A-4 or RM-A-6 are selected. The code assumes the iodine channels are onscale and iodine channels must be input to get an iodine source term.

  3. If RM-A-4 or RM-A-6 are selected, or if RM-A-8 Iodine is offscale, the code will ask the user if the charcoal filters are operational. If they are, the code will prompt the user to input their efficiency. The efficiency should be input as 0.99 unless information from the TSC indicates another value should be used.

- Once the code determines the isotopic concentrations leaving via station vent, it uses the flow rate to determine the uCi/sec leaving the plant (source term).

- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.

- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

Station Vent
Manual Code Calculation
Using RMS

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 38 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- The monitor to be used and the monitor reading.
- The time in minutes since reactor shutdown
- Station Vent flowrate
- The Reactor building purge flowrate (for adjacent plume rise)
- Charcoal filter operability and efficiency
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Problems to Watch For

- Station Vent monitor increases can result from increased RCS activity or increased RCS leakage to the Aux/FHB, or a combination of the two. If a sudden increase occurs:
  1. Check for signs of increased RCS activity. Coincident increases on RM-L-1, RM-G-22, RM-G-23, RM-G-6, or RM-G-7 may indicate increased RCS activity from fuel damage. Also check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.
  2. Check for signs of increased leakage to the Auxiliary/Fuel Handling Building. Check with STA or TSC to determine if leak rate changes have been observed.
- Remember that if fuel damage has occurred, it cannot get better.
  1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.
  2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.
  3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

Station Vent
Manual Code Calculation
Using RMS

- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Consider performing manual "What If" dose projections for increases in damage class using a manual code contingency calculation.
- Consider getting an effluent sample from this pathway (MAP-5 or pre-filter marinelli) when conditions appear to have stabilized.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Station Vent
Manual Code Calculation
Using Samples

How it works:

- Effluents leaving via station vent are sampled using a MAP-5 sample or a pre-filter marinelli sample
- If a pre-filter marinelli sample is used, the user enters the positive noble gas and iodine isotope concentrations from the analysis when prompted by the code.
- If a MAP-5 sample is used, the user enters the positive iodine isotope concentrations from the analysis when prompted by the code. Since MAP-5 samples do not provide noble gas results, manual code will scale in the noble gases. It assumes that the noble gas to iodine ratio leaving Station Vent is the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway.
- The iodine reduction factor for this pathway is a combination of primary system iodine retention (0.4) and charcoal filtration efficiency specified by the user (E). The total iodine reduction factor is then (0.4)(1-E), normally = 0.004.
- Once the code determines the isotopic concentrations leaving via Station Vent, it uses the Station Vent flow rate input by the user to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 38 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- The code will prompt the user to input values for RCS temperature and pressure or Fuel Damage Class values. These must be input but will have no bearing on the calculation since effluent concentrations leaving the plant are being determined by isotopic sample analysis.
- Sample results from Station Vent and the time of the sample
- Station vent flow rate
- The reactor building purge flow rate (for adjacent plume rise)
- Charcoal filter operability and efficiency
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Station Vent
Manual Code Calculation
Using Samples

Problems to Watch For

- The MAP-5 sample panel may present a dose rate hazard to personnel if the release rate is high or if it has been running for a long time with the same cartridges.
- The user must ensure that the sample results are representative of current plant conditions. If plant conditions change significantly after the sample was obtained, the user should begin using COLA or manual code RMS calculations.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- Periodically verify the release duration and pathway with the ED.
- Consider performing manual "What If" dose projection for increases in damage class.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Station Vent
Manual Code Calculation
Contingency Calculation

How it works:

The manual code does not support this calculation at this time.

Station Vent
Quick Code Calculation

How it works:

- This code provides a quick, but crude, estimate of offsite dose. As such it should only be used by the on-shift RAC, during the first hour of an emergency, if the COLA Code is not available.
- This code requires an RMS reading for its calculation. If an RMS reading is not available, a manual code contingency calculation must be performed.
- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The RCS mixture is assumed to have the same isotopic distribution as a Fuel Damage Class 2.
- The iodine reduction factor for this pathway is a combination of primary system iodine retention (0.4) and charcoal filtration (0.1). The total iodine reduction factor should be (0.4)(0.1) = 0.04. This is conservative since the charcoal filtration of iodines should be closer to 99% efficient.
- The RMS monitor (RM-A-8 or RM-A-8 High) determines the activity leaving via this pathway. These monitors will respond to both increases in RCS activity and increased leakrate into the Aux /Fuel Handling Building. The user selects which monitor will be used for the calculation. Generally, the highest range monitor reading > 100 should be used.
- The code assumes a Station Vent flow of 80,000 cfm. Dose results may be ratioed by the actual cfm (i.e. if the actual flow is only 40,000 cfm, the dose projection is reduced by ½).
- The code assumes an 8 hour release duration.
- Once the code determines the isotopic concentrations leaving via Station Vent, it uses the flow rate to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the meteorological conditions present.

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 38 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- The monitor to be used and the monitor reading.
- Met Data (wind speed, wind direction, and delta t)
- Since the COLA is not available, all readings must come from control room instrumentation.

Station Vent
Quick Code Calculation

Problems to Watch For

- The IREO RAC should not use this code. The full manual code should be used when the IREO organization is activated.
- This calculation assumes an RCS isotopic distribution that is the same as a Fuel Damage Class 2. This provides a reasonable estimate of offsite dose for both fuel damage and iodine spiking situations. As soon as time is available, however, a manual code RMS calculation should be performed so a dose estimate using more representative plant parameters can be obtained.
- The user should check the sum of the actual flow at FR-149 and FR-150 to determine if the dose needs to be adjusted based on the 80,000 cfm flow assumed in the calculation.
- As soon as time is available, a manual RMS calculation should be performed so a dose estimate using more representative plant parameters can be obtained.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Label all Quickcode calculations as "Quickcode"

Reactor Building Purge Exhaust
COLA Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.

- The iodine reduction factor for this pathway is a combination of reduction by natural processes (0.4) or reduction by reactor building spray (0.03) and charcoal filtration (0.01). The total iodine reduction factor with no reactor building spray is then (0.4) (0.01) = 0.004. The total iodine reduction factor with reactor building spray is then (0.03)(0.01) = 0.0003.

- The RMS monitor (RM-A-9 Gas, RM-A-9 Iodine, RM-A-9 High, or RM-G-24) determines the activity leaving via this pathway. These monitors will respond to both increases in RCS activity and increased leakage into the reactor building.

- The logic the COLA uses in picking which monitor to perform the calculation is as follows:

    1. If RM-A-9 High and RM-G-24 read ≤100, the COLA is using the reading on RM-A-9 Gas to compute the noble gas source term.

    2. If RM-A-9 High and RM-G-24 read ≤100, the COLA is using the difference between the current reading on RM-A-9 Iodine and the previous reading on RM-A-9 iodine compute the iodine source term

    3. If RM-A-9 High reads > 100 cpm and RM-G-24 reads ≤100 mR/hr, the COLA is using RM-A-9 High to compute the noble gas and iodine source terms.

    4. If RM-G-24 reads > 100 mR/hr, the COLA is using RM-G-24 to compute the noble gas and iodine source terms

- Once the COLA determines the isotopic concentrations leaving via the reactor building purge exhaust, it uses the flow rate to determine the uCi/sec leaving the plant (source term).

- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.

- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

User Inputs Needed to Perform the Calculation

- Release duration using the Parameter Edit screen if other than 8 hours

- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad

Reactor Building Purge Exhaust
COLA Calculation
Using RMS

Problems to Watch For

- Fuel Damage Class using the Parameter Edit screen the damage class is believed to be other than that indicated by current RCS temperature and pressure.
- Reactor Building Purge Exhaust monitor increases can result from increased RCS activity or RCS leakage in the reactor building, or a combination of the two. If a sudden increase occurs:
  1. Check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.
  2. Check for signs of increased leakage to the Reactor Building. Check with STA or TSC to determine if leak rate changes have been observed.
- If RM-A-9 High is ≤ 100 cpm, RM-A-9 Iodine is used to calculate the iodine source term. The iodine source term is not ratioed in from the RCS noble gas to iodine ratio. The isotopic distribution of the iodines is the same as in the RCS.
- The RM-A-9 iodine calculation assumes that 4 minutes have elapsed since the current and previous iodine channel readings. Due to differences in the timing of PPM files and COLA calculations, there can be variability in thyroid dose estimate (factor of 2) during each 15 minute period. Use the highest of the three estimates performed each 15 minutes.
- If RM-A-9 High is ≤ 100 cpm and RM-A-9 Iodine is offscale high, the iodine source term will not be calculated correctly. In this situation, the manual RMS calculation for the reactor building purge exhaust should be performed.
- If RM-A-9 High or RM-G-24 is > 100, the iodine source term is scaled in from the noble gas to iodine ratio after adjusting for iodine losses (reduction factors) applicable to this pathway
- Remember that if fuel damage has occurred, it cannot get better.
  1. If damage has occurred, but RCS temperature and pressure improve, the COLA will reduce the Fuel Damage Class.
  2. If this occurs, the user must edit the damage class using the Parameter Edit Screen to lock in the higher damage class.
  3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.
- If post accident RCS results are to be input into the Reactor Coolant Baseline Activity Edit Screen, ensure the Fuel Damage Class is set to 1 on the Parameter Edit Screen and the spiking factors in the Sample Edit Screen are set to 1. If the COLA is using a damage class greater than 1, the COLA will use the default isotopic activities for that damage class instead of the post accident samples that were input. If the spiking factors are not set to 1, the COLA will erroneously apply the spiking factors to the input sample results.

Reactor Building Purge Exhaust
COLA Calculation
Using RMS

- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Consider performing manual "What If" dose projections for increases in damage class.

- Consider getting an effluent sample from this pathway (MAP-5, pre-filter marinelli, or CATPASS as applicable) when conditions appear to have stabilized.

- If the charcoal filters become degraded and are believed to be operating at less than normal efficiency, the manual code RMS calculation should be used for this pathway. The TSC can provide information on charcoal filter efficiency and degradation.

- If no significant releases are occurring through station vent, consider maximizing station vent flow to increase dispersion from adjacent plume momentum.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Reactor Building Purge Exhaust
COLA Calculation
Using Samples

How it works:

- Effluents leaving via the reactor building purge exhaust are sampled using a pre-filter marinelli sample
- The user enters the positive noble gas and iodine isotope concentrations from the analysis into the Reactor Building Purge Exhaust Sample Edit Screen.
- If a MAP-5 sample is used, the manual code must be used to perform the calculation, since the COLA will not produce a noble gas source term.
- Once the COLA determines the isotopic concentrations leaving via the reactor building purge exhaust, it uses the flow rate from the plant computer to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

User Inputs Needed to Perform the Calculation

- Sample results need to be entered on the Station Vent Sample Edit Screen
- Release duration using the Parameter Edit screen if other than 8 hours
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad

Reactor Building Purge Exhaust
COLA Calculation
Using Samples

Problems to Watch For

- The user must ensure that the sample results are representative of current plant conditions. If plant conditions change significantly after the sample was obtained, the user should make the Reactor Building Purge Exhaust Sample Edit Screen inactive and resume COLA RMS calculations.

- MAP-5 samples cannot be used solely with the COLA code since noble gases are not measured. The COLA code will not produce a noble gas source term from a MAP-5 sample. MAP-5 samples must be calculated using the manual codes to get the correct TEDE dose. The MAP-5 sample should still be input into the COLA code since the thyroid doses produced by the COLA will still be accurate.

- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Consider performing manual "What If" dose projections for increases in damage class using a manual code contingency calculation.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation if what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

- If no significant releases are occurring through station vent, consider maximizing station vent flow to increase dispersion from adjacent plume momentum.

Reactor Building Purge Exhaust
Manual Code Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the RCS is not important to this calculation, just the RCS isotopic distribution.
- The iodine reduction factor for this pathway is a combination of reduction by natural processes (0.4) or reduction by reactor building spray (0.03) and charcoal filtration (E) specified by the user. The total iodine reduction factor with no reactor building spray is then (0.4)(1-E), normally 0.004. The total iodine reduction factor with reactor building spray is then (0.03)(1-E), normally = 0.0003.
- The RMS monitor (RM-A-9 Gas, RM-A-9 Iodine, RM-A-9 High, or RM-G-24) determines the activity leaving via this pathway. These monitors will respond to both increases in RCS activity and increased leakage into the reactor building.
- The user selects whether RM-A-9, RM-A-9 High, or RM-G-24 is used for the calculation. The logic the code uses in picking which monitor to perform the calculation is as follows:

  1. If RM-A-9, RM-A-9 High, or RM-G-24 is selected, the code will ask the user if RM-A-9 Iodine is on scale. If the answer is yes, the code will calculate the iodine source term based on the current and previous iodine channel readings specified by the user. If RM-A-9 iodine is offscale, the iodine source term is scaled in from the noble gas to iodine ratio after adjusting for iodine losses (reduction factors) applicable to this pathway.
  2. If RM-A-9, RM-A-9 High, or RM-G-24 are selected, and RM-A-9 Iodine is offscale, the code will ask the user if the charcoal filters are operational. If they are, the code will prompt the user to input their efficiency. The efficiency (E) should be input as 0.99 unless information from the TSC indicates another value should be used.

- Once the code determines the isotopic concentrations leaving via the reactor building purge exhaust, it uses the flow rate input by the user to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

Reactor Building Purge Exhaust
Manual Code Calculation
Using RMS

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 37 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- Purge valve position (open if performing this calculation)
- The monitor to be used and the monitor reading.
- The time in minutes since reactor shutdown
- Station vent flowrate (for adjacent plume rise)
- The reactor building purge flowrate
- RB spray on or off
- Charcoal filter operability and efficiency
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Problems to Watch For

- Reactor Building Purge Exhaust monitor increases can result from increased RCS activity or RCS leakage in the reactor building, or a combination of the two. If a sudden increase occurs:
  1. Check the ED/ESD Screen for changes in Fuel Damage Class based on thermal hydraulic conditions in the core.
  2. Check for signs of increased leakage to the Reactor Building. Check with STA or TSC to determine if leak rate changes have been observed.
- Remember that if fuel damage has occurred, it cannot get better.
  1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.
  2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.

Reactor Building Purge Exhaust
Manual Code Calculation
Using RMS

3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Consider performing manual "What If" dose projections for increases in damage class using a manual code contingency calculation

- Consider getting an effluent sample from this pathway (MAP-5, pre-filter marinelli, or CATPASS as applicable) when conditions appear to have stabilized.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Reactor Building Purge Exhaust
Manual Code Calculation
Using Samples

How it works:

- The MAP-5 sample panel may present a dose rate hazard to personnel if the release rate is high or if it has been running for a long time with the same cartridges.
- Effluents leaving via the reactor building purge exhaust are sampled using a MAP-5 sample or a pre-filter marinelli sample.
- If a pre-filter marinelli sample is used, the user enters the positive noble gas and iodine isotope concentrations from the analysis when prompted by the code.
- If a MAP-5 sample is used, the user enters the positive iodine isotope concentrations from the analysis when prompted by the code. Since MAP-5 samples do not provide noble gas results, manual code will scale in the noble gases. It assumes that the noble gas to iodine ratio leaving the reactor building purge exhaust is the same as the isotopic distribution of activity in the RCS after adjusting for iodine losses (reduction factors) applicable to this pathway.
- The iodine reduction factor for this pathway is a combination of reduction by natural processes (0.4) or reduction by reactor building spray (0.03) and charcoal filtration (E) specified by the user. The total iodine reduction factor with no reactor building spray is then (0.4)(1-E), normally 0.004. The total iodine reduction factor with reactor building spray is then (0.03)(1-E), normally = 0.0003
- Once the code determines the isotopic concentrations leaving via the reactor building purge exhaust, it uses the reactor building purge exhaust flow rate input by the user to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

Reactor Building Purge Exhaust
Manual Code Calculation
Using Samples

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 37 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- The code will prompt the user to input values for RCS temperature and pressure or Fuel Damage Class values. These must be input but will have no bearing on the calculation since effluent concentrations leaving the plant are being determined by isotopic sample analysis.
- Sample results from the reactor building purge exhaust and the time of the sample
- Station Vent flowrate (for adjacent plume rise)
- The Reactor Building purge flowrate
- Charcoal filter operability and efficiency (normally 0.99)
- Reactor building spray status
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Problems to Watch For

- The user must ensure that the sample results are representative of current plant conditions. If plant conditions change significantly after the sample was obtained, the user should begin using COLA or manual code RMS calculations.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles
- Periodically verify the release duration and pathway with the ED.
- Consider performing manual "What If" dose projection for increases in damage class.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

Reactor Building Purge Exhaust
Manual Code Calculation
Contingency Calculation

How it works:

- This calculation is very useful for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.
- This calculation uses no RMS data. The isotopic distribution and total activity being released via this pathway is equal to the product of the total leakage into the reactor building and the activity concentration in the RCS, after adjusting for iodine losses (reduction factors) applicable to this pathway.
- The iodine reduction factor for this pathway is a combination of reduction by natural processes (0.4) or reduction by reactor building spray (0.03) and charcoal filtration (E) specified by the user. The total iodine reduction factor with no reactor building spray is then (0.4)(1-E), normally 0.004. The total iodine reduction factor with reactor building spray is then (0.03)(1-E), normally = 0.0003.
- Unlike RMS calculations, this calculation is very dependent on RCS total activity. As a result, the code has the ability to use RM-L-1 high or low readings to estimate total RCS activity. The user may also specify a total RCS activity.
- Once the code determines the isotopic concentrations in the reactor building, it uses the reactor building purge exhaust flow rate to determine the uCi/sec leaking from the building (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 37 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- RCS temperature and pressure or the user specified Fuel Damage Class
- RM-L-1 high or low readings if letdown is not isolated.
- An estimate of total RCS activity, if known.
- The total RCS leakage into the reactor building, if known. The STA or TSC should provide.
- The time in minutes since reactor shutdown
- Charcoal filter efficiency (normally 0.99)
- The status of reactor building spray (on or off)

Reactor Building Purge Exhaust
Manual Code Calculation
Contingency Calculation

- The status of the purge valves (open if doing this calculation)
- Met Data (wind speed, wind direction, and delta t) and release duration

Problems to Watch For

- Of all calculations available, contingency calculations are the least accurate. They should only be used when RMS data or effluent samples are not available. Contingency calculations are ideal for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.
- This type of calculation is very dependent on total RCS activity. The code will adjust RCS total activity if an RM-L-1 reading is input. Prior to inputting an RM-L-1 reading, verify that RCS letdown is not secured. If it has been secured (and it typically is during this type of accident), RM-L-1 readings should not be used unless the user is sure that the last reading is representative of current RCS conditions. Note that due to travel time in the sample lines, RM-L-1 may take up to 30 minutes before responding to a change in RCS activity.
- If RM-L-1 readings are not available, the code will permit the user to enter a total RCS activity (uCi/cc) if this is known. It generally is not. An example of when this could be used is if an RCS sample has just been pulled but has not been analyzed. If the dose rate on the sample is a factor of 10 higher than a normal RCS sample, it can be inferred that the RCS activity is 10 times higher than it was prior to the incident. Be aware, entering a total RCS activity will replace damage class default RCS activities and spiking factors.
- The code will prompt the user for the total RCS leakage into the reactor building. If the leakage is less than 63,000 gallons (one RCS volume), the actual leakage should be input. If the leakage is more than 63,000 gallons, a maximum of 63,000 gallons should be used. Inputting more than 63,000 gallons will overestimate the source term because it will put more activity in the building than is available for release from the core.
- If the total RCS leakage is not known, the code will assume the entire RCS volume (63,000 gallons) has been released to the building using a damage class 4. If total RCS leakage is not known and the damage class is other than 4, the user should respond that the total leakage is known and specify the leakage as 63,000 gallons.
- Remember that if fuel damage has occurred, it cannot get better.

  1. If damage has occurred but RCS temperature and pressure improve, and the new values are input into the code, the code will reduce the Fuel Damage Class.
  2. If this occurs, the user must specify the damage class instead of entering pressure and temperature.
  3. After doing this, the user must watch RCS temperature and pressure to ensure that damage class does not increase beyond the damage class assumed.

Reactor Building Purge Exhaust
Manual Code Calculation
Contingency Calculation

- If post accident RCS results are to be input into code, specify that the Fuel Damage Class as 1 and there has been no power transient when the code asks. If the code is using a damage class greater than 1, the code will use the default isotopic activities for that damage class instead of the post accident samples that were input.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- When performing "What If" dose projections, clearly label them as "What If" calculations

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? Depending on the inputs, this type of calculation could go either way

- Consider getting a MAP-5, pre-filter/marinelli, or CATPASS sample from this pathway to increase the accuracy of the dose projection. The CATPASS system takes 45 minutes to warm up so direct the OSC to start the warm up as soon as you think you may want this type of sample.

Reactor Building Purge Exhaust
Quick Code Calculation

How it works:

- This code provides a quick, but crude, estimate of offsite dose. As such it should only be used by the on-shift RAC, during the first hour of an emergency, if the COLA Code is not available.
- This code requires an RMS reading for its calculation. If an RMS reading is not available, a manual code contingency calculation must be performed.
- The isotopic distribution of activity leaving the plant is assumed to have the same isotopic distribution as a Fuel Damage Class 2.
- The iodine reduction factor for this pathway is a combination of reduction by natural processes (0.4) and charcoal filtration (0.1). The total iodine reduction factor is then (0.4) (0.1) = 0.04. Reactor building spray is assumed to be off. This is conservative since the charcoal filtration of iodines should be closer to 99% efficient.
- The RMS monitor (RM-A-9, RM-A-9 High, or RM-G-24) determines the activity leaving via this pathway. These monitors will respond to both increases in RCS activity and increased leakrate into the reactor building. The user selects which monitor will be used for the calculation. Generally, the highest range monitor reading > 100 should be used.
- The code assumes a reactor building purge exhaust flow of 10,000 cfm. Dose results may be ratioed by the actual cfm (i.e. if the actual flow is only 5,000 cfm, the dose projection is reduced by ½).
- The code assumes an 8 hour release duration.
- Once the code determines the isotopic concentrations leaving via the reactor building purge exhaust, it uses the flow rate to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the meteorological conditions present.

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 37 of the PPC (See STA)
Met Data is available on Area 19, Group 2 of the PPC (See STA)

- The monitor to be used and the monitor reading.
- Met Data (wind speed, wind direction, and delta t)
- Since the COLA is not available, all readings must come from control room instrumentation.

Reactor Building Purge Exhaust
Quick Code Calculation

Problems to Watch For

- The IREO RAC should not use this code. The full manual code should be used when the IREO organization is activated.
- This calculation assumes an RCS isotopic distribution that is the same as a Fuel Damage Class 2. This provides a reasonable estimate of offsite dose for both fuel damage and iodine spiking situations. As soon as time is available, however, a manual code RMS calculation should be performed so a dose estimate using more representative plant.parameters can be obtained.
- The user should check the actual flow at FR-909 or FR-148A to determine if the dose needs to be adjusted based on the 10,000 cfm flow assumed in the calculation.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Label all Quickcode calculations as "Quickcode"

ESF Fuel Handling Building
COLA Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same isotopic distribution of activity as a fuel assembly 72 hours after shutdown from full power, after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the fuel assembly is not important to this calculation, just the isotopic distribution.
- The iodine reduction factor for this pathway is a combination of reduction by decontamination in the spent fuel pool (0.01) and charcoal filtration (0.01). The total iodine reduction factor is then (0.01)(0.01) = 0.0001.
- The RMS monitor (RM-A-14) determines the activity leaving via this pathway.
- If the COLA sees that the normal fuel handling building ventilation system is < 3000 cfm, it assumes that the shutdown of the ventilation system was caused by a fuel handling accident (interlock with RM-G-9 or RM-A-14). It then assumes the ESF Ventilation is operating at a constant flow rate of 7000 cfm.
- Once the COLA determines the isotopic concentrations leaving via the ESF Ventilation, it uses the 7000 cfm flow rate to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway is always a ground level release.

User Inputs Needed to Perform the Calculation

- Release duration using the Parameter Edit screen if other than 8 hours
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad

ESF Fuel Handling Building
COLA Calculation
Using RMS

Problems to Watch For

- The assumed isotopic mix is the same as a spent fuel assembly 72 hours after shutdown from full power. It is likely to be conservative for CDE if the actual fuel assembly is significantly older than that. Air samples from this pathway should be obtained as soon as possible to run a COLA or manual calculation using samples.
- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Consider getting an effluent sample from this pathway (radioiodine or pre-filter marinelli) as soon as possible.
- If the charcoal filters become degraded and are believed to be operating at less than normal efficiency, the manual code RMS calculation should be used for this pathway. The TSC can provide information on charcoal filter efficiency and degradation.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation will produce conservative thyroid doses if the fuel assembly is significantly greater than 72 hours old.

ESF Fuel Handling Building
COLA Calculation
Using Samples

How it works:

- Effluents leaving via the ESF ventilation system are sampled using a pre-filter marinelli sample
- The user enters the positive noble gas and iodine isotope concentrations from the analysis into the ESF Ventilation Sample Edit Screen.
- If just the RM-A-14 iodine sample is used, the manual code must be used to perform the calculation, since the COLA will not produce a noble gas source term.
- If the COLA sees that the normal fuel handling building ventilation system is < 3000 cfm, it assumes that the shutdown of the ventilation system was caused by a fuel handling accident (interlock with RM-G-9 or RM-A-14). It then assumes the ESF Ventilation is operating at a constant flow rate of 7000 cfm.
- Once the COLA determines the isotopic concentrations leaving via the ESF Ventilation, it uses the 7000 cfm flow rate to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the COLA uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway is always a ground level release.

User Inputs Needed to Perform the Calculation

- Sample results need to be entered on the ESF Vent Sample Edit Screen
- Release duration using the Parameter Edit screen if other than 8 hours
- Met Data using the Parameter Edit screen if the data being picked up from the Met Tower is bad

ESF Fuel Handling Building
COLA Calculation
Using Samples

Problems to Watch For

- RM-A-14 iodine samples cannot be used solely with the COLA code since noble gases are not measured. The COLA code will not produce a noble gas source term from a RM-A-14 iodine sample. RM-A-14 iodine samples must be calculated using the manual codes to get the correct TEDE dose. The RM-A-14 iodine sample should still be input into the COLA code since the thyroid doses produced by the COLA will still be accurate.

- Monitor met data. If met data shows absolutely no changes for a 30 – 45 minute period, there may be a problem with the data. Verify met data with EACC and/or Control Room indications.

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.

- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.

- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.

- Periodically verify the release duration and pathway with the ED.

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

ESF Fuel Handling Building
Manual Code Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same isotopic distribution of activity as a fuel assembly 72 hours after shutdown from full power, after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the fuel assembly is not important to this calculation, just the isotopic distribution.
- The iodine reduction factor for this pathway is a combination of reduction by decontamination in the spent fuel pool (0.01) and charcoal filtration (E). The total iodine reduction factor is then (0.01)(1-E), normally = 0.0001.
- The RMS monitor (RM-A-14) determines the activity leaving via this pathway.
- The code defaults to a ventilation flow rate of 7000 cfm.
- Once the code determines the isotopic concentrations leaving via the ESF Ventilation, it uses the flow rate to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway is always a ground level release.

User Inputs Needed to Perform the Calculation

- The monitor to be used and the monitor reading.
- The time in minutes since the accident
- Charcoal filter operability and efficiency (normally 0.99)
- Met Data (wind speed, wind direction, and delta t)
- Release duration

ESF Fuel Handling Building
Manual Code Calculation
Using RMS

Problems to Watch For

- The assumed isotopic mix is the same as a spent fuel assembly 72 hours after shutdown from full power. It is likely to be conservative for CDE if the actual fuel assembly is significantly older than that. Air samples from this pathway should be obtained as soon as possible to run a COLA or manual calculation using samples.
- The code prompts the user for the time since reactor shutdown to perform decay corrections. The time since the fuel handling accident occurred should be entered in this field.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Consider getting an effluent sample from this pathway radioiodine or pre-filter marinelli as soon as possible.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be. This type of calculation will produce conservative thyroid doses if the fuel assembly is significantly greater than 72 hours old.

ESF Fuel Handling Building
Manual Code Calculation
Using Samples

How it works:

- Effluents leaving via the reactor building purge exhaust are sampled using an RM-A-14 iodine sample or a pre-filter marinelli sample.
- If a pre-filter marinelli sample is used, the user enters the positive noble gas and iodine isotope concentrations from the analysis when prompted by the code.
- If a radioiodine sample is used, the user enters the positive iodine isotope concentrations from the analysis when prompted by the code. Since radioiodine samples do not provide noble gas results, manual code will scale in the noble gases. It assumes that the noble gas to iodine ratio leaving the ESF ventilation is the same as the isotopic distribution of activity in the damaged fuel assembly after adjusting for iodine losses (reduction factors) applicable to this pathway.
- The iodine reduction factor for this pathway is a combination of reduction by decontamination in the spent fuel pool (0.01) and charcoal filtration (E). The total iodine reduction factor is then (0.01)(1-E), normally = 0.0001
- The code assumes a ventilation flow rate of 7000 cfm.
- Once the isotopic concentrations leaving via the ESF Vent are entered, the code uses the ESF Vent flow rate to determine the uCi/sec leaving the plant (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway is always a ground level release.

User Inputs Needed to Perform the Calculation

- Sample results from ESF Ventilation System and the time of the sample
- Met Data (wind speed, wind direction, and delta t)
- Release duration

ESF Fuel Handling Building
Manual Code Calculation
Using Samples

Problems to Watch For

- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- Periodically verify the release duration and pathway with the ED.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation should be a pretty good approximation of what the doses could be.

ESF Fuel Handling Building
Manual Code Calculation
Contingency Calculation

How it works:

- This calculation is very useful for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted. It should be used when RMS data is not available.
- This calculation uses no RMS data. The isotopic distribution and total activity being released via this pathway is assumed to be equal to the gap activity in 56 fuel pins, 72 hours after reactor shutdown.
- The iodine reduction factor for this pathway is a combination of reduction by decontamination in the spent fuel pool (0.01) and charcoal filtration (E). The total iodine reduction factor is then (0.01)(1-E), normally = 0.0001.
- Once the code determines the isotopic concentrations in the fuel handling building, it uses ESF Vent flow rate input by the user to determine the uCi/sec leaking from the building (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway is always a ground level release.

User Inputs Needed to Perform the Calculation

- Charcoal filter operability and efficiency (normally 0.99)
- Flow rate out the ESF Ventilation System (normally assumed to be 7000 cfm)
- Met Data (wind speed, wind direction, and delta t)
- Release duration

ESF Fuel Handling Building
Manual Code Calculation
Contingency Calculation

Problems to Watch For

- Of all calculations available, contingency calculations are the least accurate. They should only be used when RMS data or effluent samples are not available. Contingency calculations are ideal for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.
- This type of calculation is very dependent on the activity in the damaged fuel assembly and the extent of damage to the fuel assembly. The calculation assumes 56 of 208 pins are broken during the accident. It assumes the assembly involved was shutdown from full power 72 hours ago. Conditions that vary from these assumptions will decrease the accuracy of the dose projection.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- When performing "What If" dose projections, clearly label them as "What If" calculations.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? Depending on how closely actual conditions match the stated assumptions, this type of calculation could go either way. However, it will typically be a bounding type calculation.
- Consider getting an effluent sample from this pathway (radioiodine or pre-filter/marinelli) as soon as possible.

ESF Fuel Handling Building
Quick Code Calculation

How it works:

This calculation is not performed by the Quick Code.

Reactor Building Fuel Handling Accident
Manual Code Calculation
Using RMS

How it works:

- The isotopic distribution of activity leaving the plant is assumed to be the same as the isotopic distribution of activity fuel assembly 72 hours after shutdown from full power, after adjusting for iodine losses (reduction factors) applicable to this pathway. The total activity in the fuel assembly is not important to this calculation, just the isotopic distribution.

- The iodine reduction factor for this pathway is a combination of reduction by decontamination in the fuel transfer canal (0.01) and charcoal filtration (E). The total iodine reduction factor is then (0.01)(1-E), normally = 0.0001.

- **If the purge valves are open**, the RMS monitor (RM-A-9 Gas, RM-A-9 Iodine, RM-A-9 High, or RM-G-24) determines the activity leaving via this pathway.

    - The user selects whether RM-A-9, RM-A-9 High, or RM-G-24 is used for the calculation. The logic the code uses in picking which monitor to perform the calculation is as follows:

        1. If RM-A-9, RM-A-9 High, or RM-G-24 is selected, the code will ask the user if RM-A-9 Iodine is on scale. If the answer is yes, the code will calculate the iodine source term based on the current and previous iodine channel readings specified by the user. If RM-A-9 iodine is offscale, the iodine source term is scaled in from the noble gas to iodine ratio after adjusting for iodine losses (reduction factors) applicable to this pathway.

        2. If RM-A-9, RM-A-9 High, or RM-G-24 are selected, and RM-A-9 Iodine is offscale, the code will ask the user if the charcoal filters are operational. If they are, the code will prompt the user to input their efficiency. The efficiency (E) should be input as 0.99 unless information from the TSC indicates another value should be used.

    - Once the code determines the isotopic concentrations leaving via the reactor building purge exhaust, it uses the flow rate to determine the uCi/sec leaving the plant (source term).

- **If the purge valves are closed**, the RMS monitor (RM-A-2) determines the airborne activity in the reactor building. The manual code does not use RM-G-22 or RM-G-23. If RM-A-2 is isolated (>4 psi in RB), this calculation cannot be used. Use manual contingency calculation.

    - Once the code determines the isotopic concentrations in the reactor building, it uses the leakage flow rate from the building, based on building pressure input by the user, to determine the uCi/sec leaving the plant (source term).

- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.

- If the purge valves are closed, this pathway is always a ground level release. If the purge valves are open, this pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

Reactor Building Fuel Handling Accident
Manual Code Calculation
Using RMS

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 37 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- The monitor to be used and the monitor reading.
- The time in minutes since the accident
- Purge valves open or closed
- Charcoal filter operability and efficiency (normally 0.99)
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Problems to Watch For

- The assumed isotopic mix is the same as a spent fuel assembly that was shutdown from full power 72 hours ago. It is likely to be conservative for CDE if the actual fuel assembly is significantly older than that. For this type of accident in the reactor building, an age of 72 hours is probably a pretty good assumption. Air samples from this pathway should be obtained as soon as possible to run a COLA or manual calculation using samples.
- The code prompts the user for the time since reactor shutdown to perform decay corrections. The time since the fuel handling accident occurred should be entered in this field.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Consider getting an effluent sample from this pathway (MAP-5, pre-filter marinelli, or CATPASS as applicable) as soon as possible.

Reactor Building Fuel Handling Accident
Manual Code Calculation
Using RMS

- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation will produce conservative thyroid doses if the fuel assembly is significantly greater than 72 hours old.

Reactor Building Fuel Handling Accident
Manual Code Calculation
Using Samples

How it works:

- If the purge valves are open, this calculation is identical to a reactor building purge exhaust manual code calculation using samples.
- If the purge valves are closed, this calculation is identical to a reactor building design basis leakage exhaust manual code calculation using samples.

Reactor Building Fuel Handling Accident
Manual Code Calculation
Contingency Calculation

How it works:

- This calculation is very useful for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted. It should be used when RMS data is not available.
- This calculation uses no RMS data. The isotopic distribution and total activity being released via this pathway is assumed to be equal to the gap activity in an entire fuel assembly (208 fuel pins), 72 hours after reactor shutdown. The user may modify the number of pins that were believed to be damaged.
- The iodine reduction factor for this pathway is a combination of reduction by decontamination in the fuel transfer canal (0.01) and charcoal filtration (E). The total iodine reduction factor is then (0.01)(1-E), normally = 0.0001.
- **If the purge valves are open**, the code uses reactor building purge exhaust flow rate input by the user to determine the uCi/sec leaking from the building (source term).
- **If the purge valves are closed**, the code uses reactor building leak rate based on the building pressure input by the user to determine the uCi/sec leaking from the building (source term).
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- If the purge valves are closed, this pathway is always a ground level release. If the purge valves are open, this pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 37 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- Charcoal filter operability and efficiency (normally 0.99)
- Estimated number of fuel pins damaged
- Flow rate out the reactor building purge exhaust and the station vent if the purge valves are open
- Reactor building pressure if the purge valves are closed.
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Reactor Building Fuel Handling Accident
Manual Code Calculation
Contingency Calculation

Problems to Watch For

- Of all calculations available, contingency calculations are the least accurate. They should only be used when RMS data or effluent samples are not available. Contingency calculations are ideal for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.
- This type of calculation is very dependent on the activity in the damaged fuel assembly and the extent of damage to the fuel assembly. The calculation assumes as a default that 208 pins are broken during the accident. It assumes the assembly involved was shutdown from full power 72 hours ago. Conditions that vary from these assumptions will decrease the accuracy of the dose projection.
- Consider getting an effluent sample from this pathway (MAP-5 pre-filter/marinelli, or CATPASS as applicable) as soon as possible.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- When performing "What If" dose projections, clearly label them as "What If" calculations.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? Depending on how closely actual conditions match the stated assumptions, this type of calculation could go either way. However, it will typically be a bounding type calculation.

Waste Gas Decay Tank Rupture Accident
Manual Code Calculation
Using RMS

How it works:

- The isotopic distribution of activity in the tank is assumed to be the same as the isotopic distribution of activity In TMI-1 FSAR Table 14.2-21 for the design basis waste gas decay tank rupture. The total activity in the tank is not important to this calculation, just the isotopic distribution.

- The iodine reduction factor for this pathway is solely charcoal filtration (E). The total iodine reduction factor is normally (1-E) = 0.01.

- The RMS monitor (RM-A-4, 6, or 8 Gas, RM-A-4, 6, or 8 Iodine, or RM-A-8 high) determines the activity leaving via this pathway. These monitors will respond to a waste gas decay tank rupture as well as increases in RCS activity and increased leakage into the auxiliary/fuel handling building.

- The user selects whether RM-A-4, RM-A-6, RM-A-8 or RM-A-8 High is used for the calculation: logic the COLA uses in picking which monitor to perform the calculation is as follows:

    1. If RM-A-8 or RM-A-8 High is selected, the code will ask the user if RM-A-8 Iodine is on scale. If the answer is yes, the code will calculate the iodine source term base on the current and previous iodine channel readings specified by the user. If RM-A-8 iodine is offscale, the iodine source term is scaled in from the noble gas to iodine ratio after adjusting for iodine losses (reduction factors) applicable to this pathway.

    2. If RM-A-4 or RM-A-6 are selected. The code assumes the iodine channels are onscale and iodine channels must be input to get an iodine source term.

    3. If RM-A-4 or RM-A-6 are selected, or if RM-A-8 Iodine is offscale, the code will ask the user if the charcoal filters are operational. If they are, the code will prompt the user to input their efficiency. The efficiency (E) should be input as 0.99 unless information from the TSC indicates another value should be used.

- Once the code determines the isotopic concentrations leaving via station vent, it uses the flow rate input by the user to determine the uCi/sec leaving the plant (source term).

- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.

- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

Waste Gas Decay Tank Rupture Accident
Manual Code Calculation
Using RMS

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 38 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- The monitor to be used and the monitor reading.
- The station vent and reactor building purge exhaust flow rates
- The time in minutes since the accident
- Charcoal filter operability and efficiency
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Problems to Watch For

- The assumed isotopic mix is the same as the design basis accident in the FSAR. It is likely to be very conservative for CDE since historically, there is much less iodine in the tank than was assumed in the FSAR accident. Air samples from this pathway should be obtained as soon as possible to run a COLA or manual calculation using samples.
- The code prompts the user for the time since reactor shutdown to perform decay corrections. The time since the waste gas decay tank rupture occurred should be entered in this field.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- Consider getting an effluent sample from this pathway (MAP-5 or pre-filter marinelli) as soon as possible.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? This type of calculation will produce conservative thyroid doses.

Waste Gas Decay Tank Rupture Accident
Manual Code Calculation
Using Samples

How it works:

- This calculation is identical to a station vent manual code calculation using samples.

Waste Gas Decay Tank Rupture Accident
Manual Code Calculation
Contingency Calculation

How it works:

- This calculation is very useful for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted. It should be used when RMS data is not available.
- This calculation uses no RMS data. The user inputs the isotopic distribution and total activity being released via this pathway. Two selections are available; a "typical" tank inventory or a "worst case" inventory. Both of these inventories are very conservative based on operational history.
- The iodine reduction factor for this pathway is solely charcoal filtration (E). The total iodine reduction factor is normally (1-E) = 0.01.
- The code uses duration of the accident input by the user to determine the uCi/sec leaking from the building (source term).
- The code uses station vent flow rate input by the user to determine the effective release height.
- Having developed the source term, the code uses the meteorological dispersion model to calculate the concentrations and doses at distances from the plant.
- This pathway can be a ground level release, an elevated release, or a mixture of the two depending on the flow rate from station vent and the reactor building purge exhaust and the meteorological conditions present.

User Inputs Needed to Perform the Calculation

Plant data inputs are available on Area 38, Group 38 of the PPC (See STA)
Met Data is available on Area 19, Group2 of the PPC (See STA)

- Charcoal filter operability and efficiency (normally 0.99)
- "Typical" or "worst case" tank
- Flow rate out the reactor building purge exhaust and the station vent
- Met Data (wind speed, wind direction, and delta t)
- Release duration

Waste Gas Decay Tank Rupture Accident
Manual Code Calculation
Contingency Calculation

Problems to Watch For

- Of all calculations available, contingency calculations are the least accurate. They should only be used when RMS data or effluent samples are not available. Contingency calculations are ideal for performing "What If" calculations, where the precise response of an RMS monitor to a change in plant conditions cannot be predicted.
- This type of calculation is very dependent on the activity in the damaged waste gas decay tank. The assumptions for the activity in the tank are very conservative.
- Remember that the CDE contributes to the TEDE. Do not expect field team dose rate readings to match up with TEDE projections. Roughly 3% of the CDE dose is included in the TEDE dose. Ensure field teams get iodine samples even if E-520 dose rates are low.
- Depending on the physical form of iodine in the field, the "LLD" for thyroid dose rates measured by field teams could be as high as 5 mrem/hr based on a 10 minute air sample. Consider longer sampling times if additional sensitivity is desired.
- If dose projections show PAG's are exceeded at 10 miles, validation of the dose projection from field reading should be performed prior to issuing a PAR beyond 10 miles.
- Periodically verify the release duration and pathway with the ED.
- When performing "What If" dose projections, clearly label them as "What If" calculations.
- Always communicate the uncertainty of the dose projection. Is it a bounding calculation such that I know doses can't be any higher than this? Or, is this the best approximation of what I believe offsite doses actually could be? Depending on how closely actual conditions match the stated assumptions, this type of calculation could go either way. However, it will typically be a bounding type calculation.
- Consider getting an effluent sample from this pathway (MAP-5 or pre-filter/marinelli) as soon as possible.

PSLR vs COG RMS Reading Graphs

Graphs are presented in this section which can be used to provide a rough estimate of PSLR based on condenser off gas monitor readings and estimated RCS activities. The graphs are referenced in RAF 6612-97-011. The following assumptions were used in the graphs:

- The condenser off gas flow rate was fixed at 50 cfm to simplify the correction of the PSLR for the actual COG flow during use. The correction is made by taking the Factor value from the graph and multiplying it by the actual flow divided by 50 cfm.
- Total RCS activity for the purposes of these graphs are the total iodine and noble gas activity. Tritium is not to be included in the total RCS activity.
- For RCS activities 10 uCi/cc and below, the isotopic mix is assumed to be the same as TMI Cycle 9, which represents a core with fuel pin defects that are present prior to the PSLR.
- Do not adjust total RCS activity for iodine spiking. The RCS total activities listed on the graphs are not intended to be used with iodine spiking factors since most of the iodine transferred to the secondary side does not leave via the condenser off gas. For example, if the RCS activity prior to shutdown was 10 uCi/cc and an iodine spike of 50 would be expected upon shutdown (Damage Class 1A), the iodine spiking would not be used to adjust the RCS activity for the graph. The 10 uCi/cc line would still be used to determine the leak rate.
- For RCS activities above 10 uCi/cc up to Damage Class 2 the isotopic mix is assumed to be the same as a Damage Class 2. The total RCS activity specified for each diagonal line was multiplied by the normalized Damage Class 2 isotopic distribution to develop an isotopic distribution for that activity. This is meant to represent the RCS isotopic mix that could occur as gap activity enters the RCS during the accident.
- The lines for Damage Classes 2 - 5 are the default RCS activities found in the TMI EDCM.
- Graphs were generated for each range monitor for times of 0, 4, and 8 hours post shutdown to account for isotopic distribution changes resulting from radiological decay.

- The graphs assume there are no direct to atmosphere releases (main steam relief valve, atmospheric dump valve, or EF-P-1) occurring. If such a release is occurring, the estimation of PSLR using condenser off gas monitor is more complex since all of the activity released into the secondary side does not reach the condenser. To correct for this loss of activity, the following equation can used:

$$PSLR_t = (PSLR_{cog})/(1 - F_m - F_e - F_a)$$

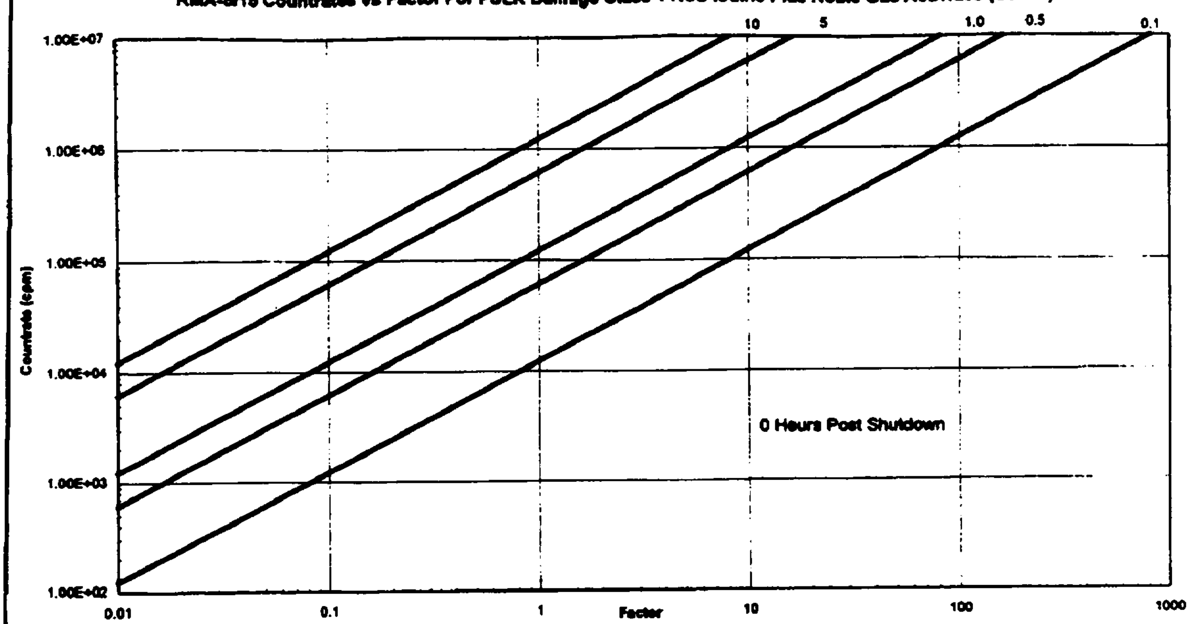
Where:

$PSLR_t$	=	Total primary-to-secondary leakage (gpm)
$PSLR_{cog}$	=	Primary-to-secondary leakage estimated from the graph (gpm)
F_m	=	Estimated fraction of main steam flow estimated to be leaving through a main steam safety (dimensionless)
Fe	=	Estimated fraction of main steam flow estimated to be leaving through EF-P-1A (dimensionless)
Fe	=	Estimated fraction of main steam flow estimated to be leaving through the atmospheric dump valves (dimensionless)

The user of these graphs must be aware that the PSLR results they produce are only as accurate as the estimate of RCS activities. The uncertainty in the PSLR derived should be essentially the same as the uncertainty of the RCS activity estimate. The graphs for 0, 4, and 8 hours post shutdown are attached in the following pages.

Figure 1

RMA-5/15 Countrates vs Factor For PSLR Damage Class 1 RCS Iodine Plus Noble Gas Activities (uCi/cc)

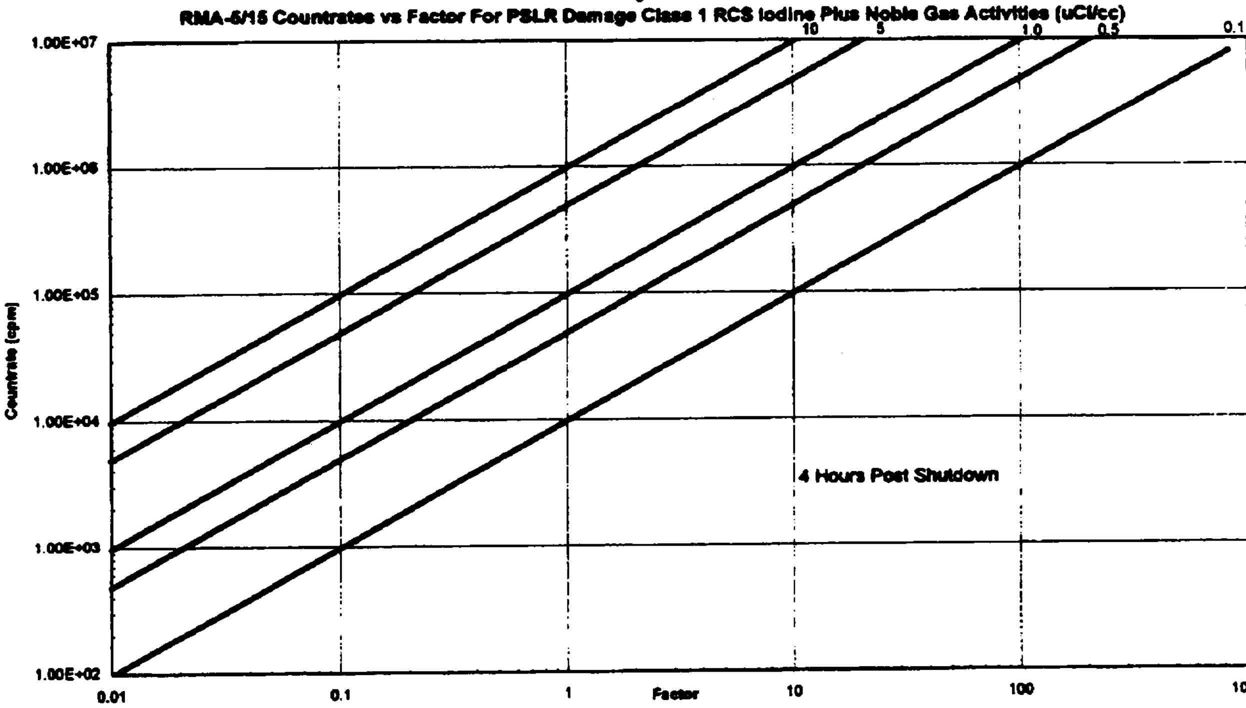


$$\text{PSLR (gpm)} = \frac{\text{Condenser Offgas Flow (cfm)}}{50} \times \text{Factor}$$

The PSLR results produced by this graph are only as accurate as the estimate of RCS activity. The uncertainty in the PSLR derived should be essentially the same as the uncertainty of the RCS activity estimate.

Figure 2

RMA-5/15 Countrates vs Factor For PSLR Damage Class 1 RCS Iodine Plus Noble Gas Activities (uCi/cc)

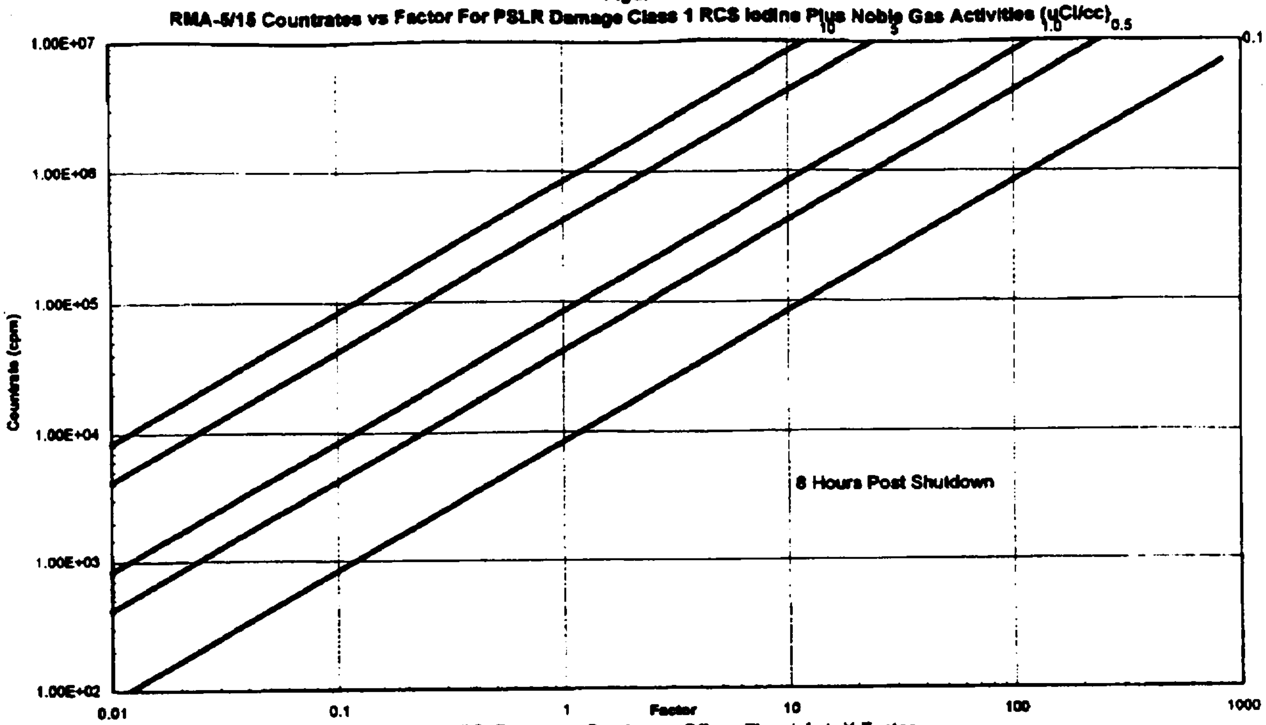


$$PSLR\ (gpm) = \frac{\text{Condenser Offgas Flow (cfm)}}{50} \times \text{Factor}$$

The PSLR results produced by this graph are only as accurate as the estimate of RCS activity. The uncertainty in the PSLR derived should be essentially the same as the uncertainty of the RCS activity estimate.

Figure 3

RMA-5/15 Countrates vs Factor For PSLR Damage Class 1 RCS Iodine Plus Noble Gas Activities (uCi/cc)

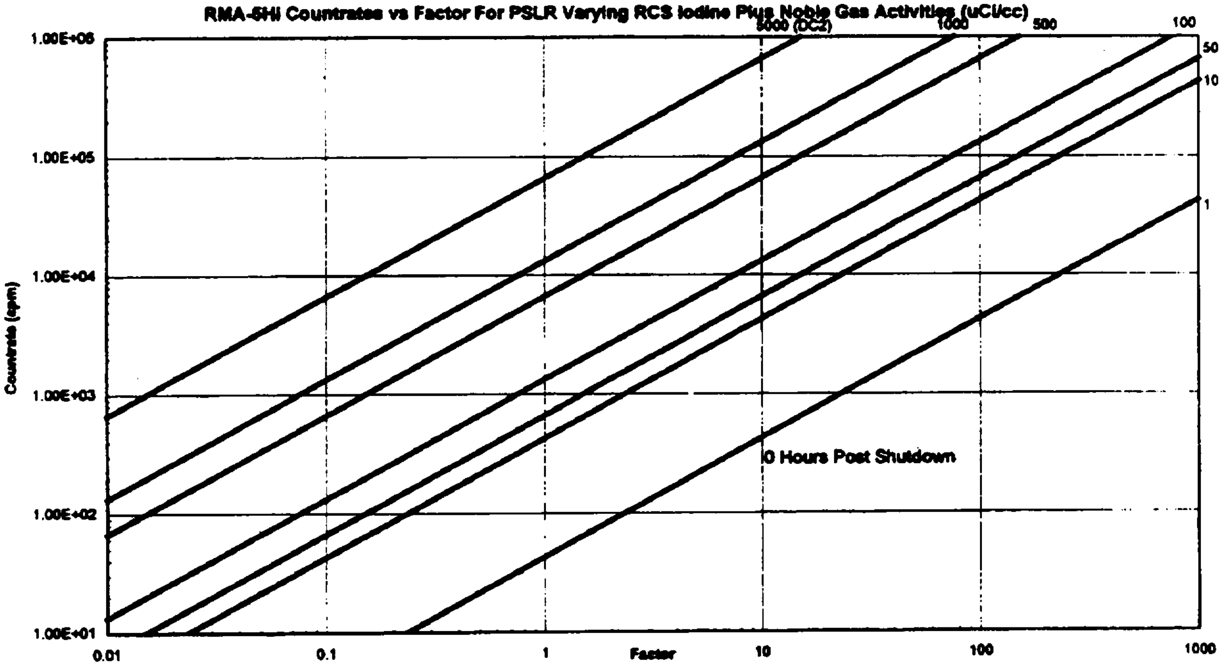


PSLR (gpm) = <u>Condenser Offgas Flow (cfm)</u> X Factor
50

The PSLR results produced by this graph are only as accurate as the estimate of RCS activity. The uncertainty in the PSLR derived should be essentially the same as the uncertainty of the RCS activity estimate.

Figure 4

RMA-5HI Countrates vs Factor For PSLR Varying RCS Iodine Plus Noble Gas Activities (uCi/cc)

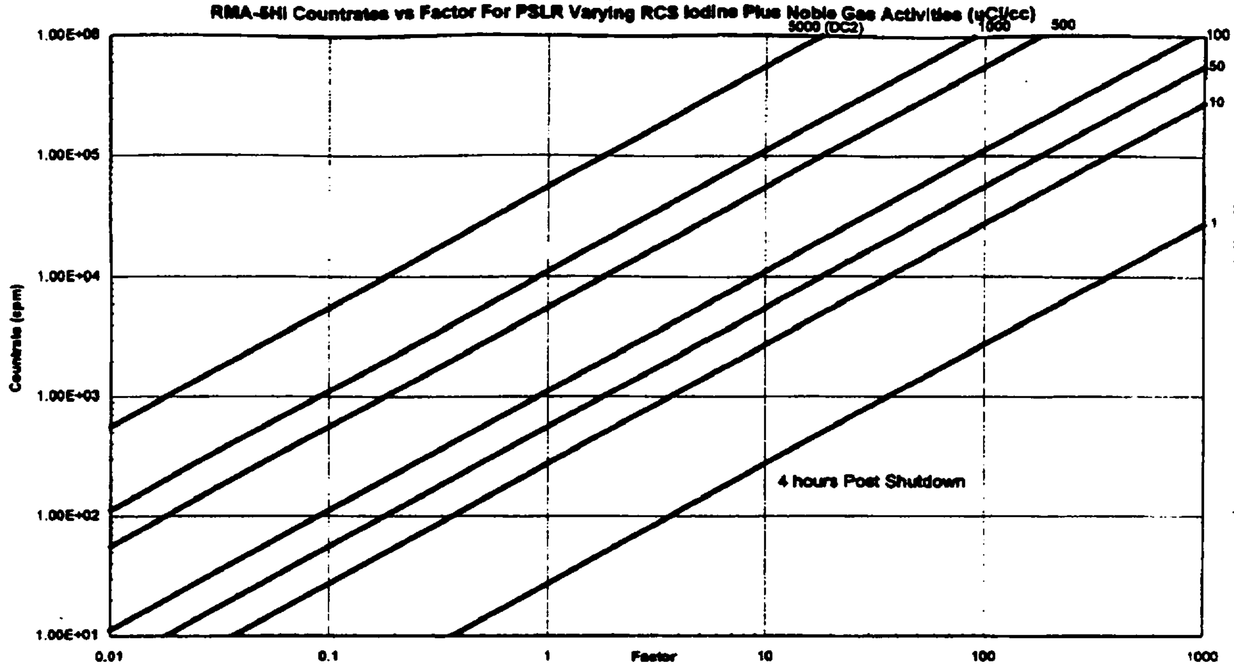


PSLR (gpm) = $\frac{\text{Condenser Offgas Flow (cfm)}}{50}$ X Factor

The PSLR results produced by this graph are only as accurate as the estimate of RCS activity. The uncertainty in the PSLR derived should be essentially the same as the uncertainty of the RCS activity estimate.

Figure 5

RMA-5HI Countrates vs Factor For PSLR Varying RCS Iodine Plus Noble Gas Activities (uCi/cc)

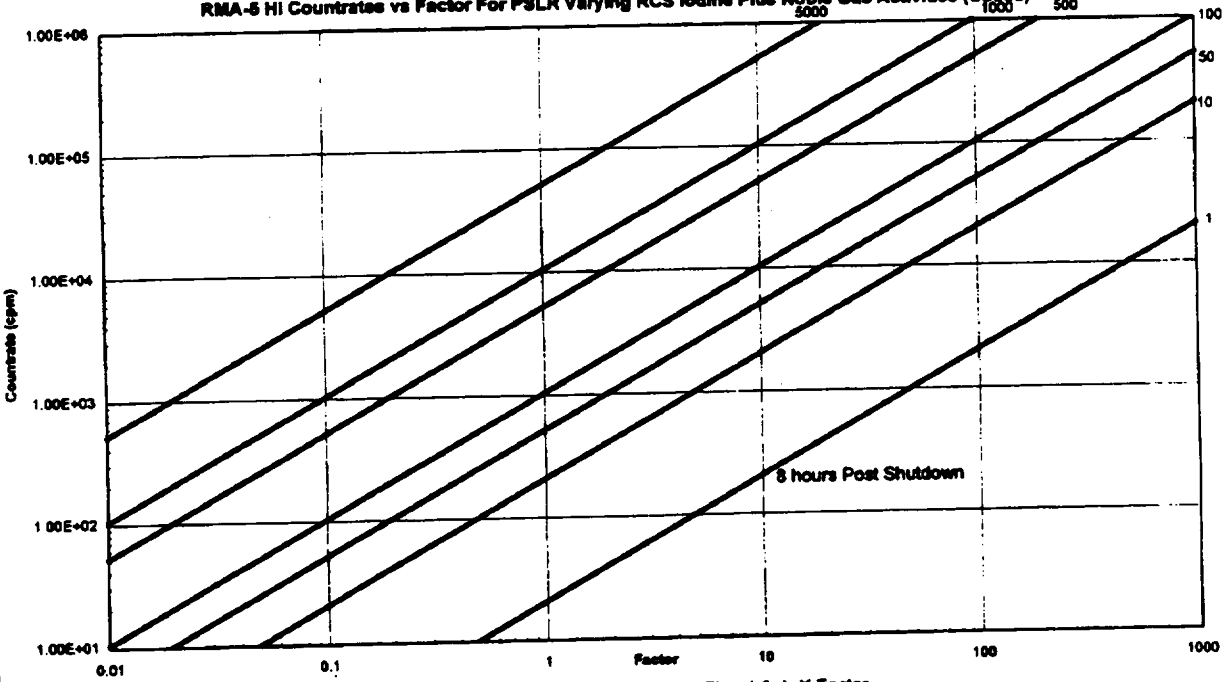


PSLR (gpm) = Condenser Offgas Flow (cfm) / 50 X Factor

The PSLR results produced by this graph are only as accurate as the estimate of RCS activity. The uncertainty in the PSLR derived should be essentially the same as the uncertainty of the RCS activity estimate.

Figure 6

RMA-5 HI Countrates vs Factor For PSLR Varying RCS Iodine Plus Noble Gas Activities (uCi/cc)

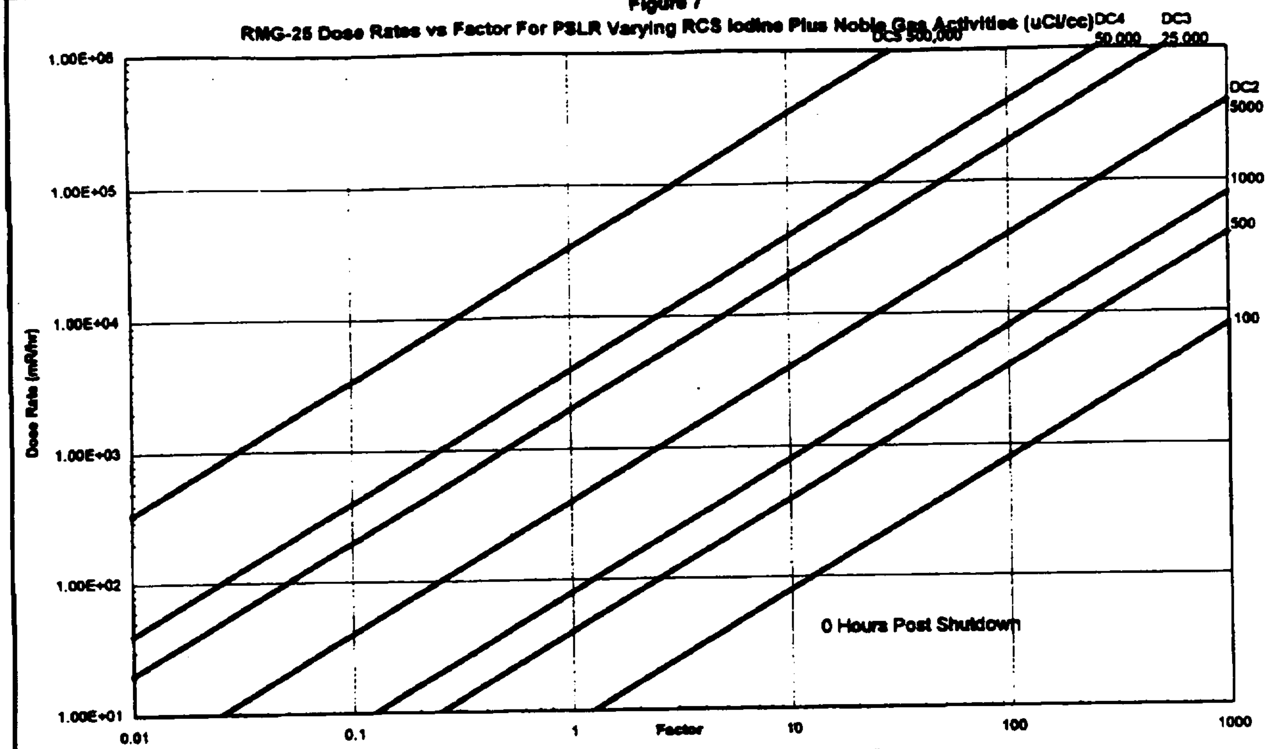


PSLR (gpm) = $\frac{\text{Condenser Offgas Flow (cfm)}}{50}$ X Factor

The PSLR results produced by this graph are only as accurate as the estimate of RCS activity. The uncertainty in the PSLR derived should be essentially the same as the uncertainty of the RCS activity estimate.

Figure 7

RMG-25 Dose Rates vs Factor For PSLR Varying RCS Iodine Plus Noble Gas Activities (uCi/cc)

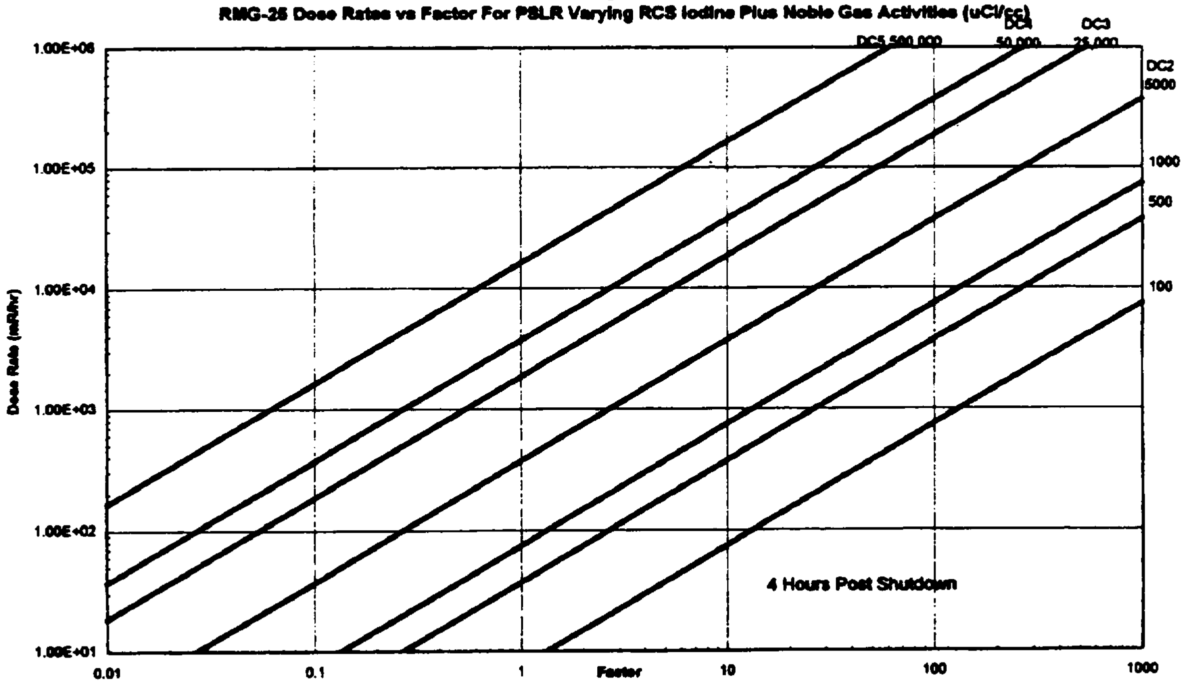


$$PSLR\ (gpm) = \frac{\text{Condenser Offgas Flow (cfm)}}{50} \times \text{Factor}$$

The PSLR results produced by this graph are only as accurate as the estimate of RCS activity. The uncertainty in the PSLR derived should be essentially the same as the uncertainty of the RCS activity estimate.

Figure 8

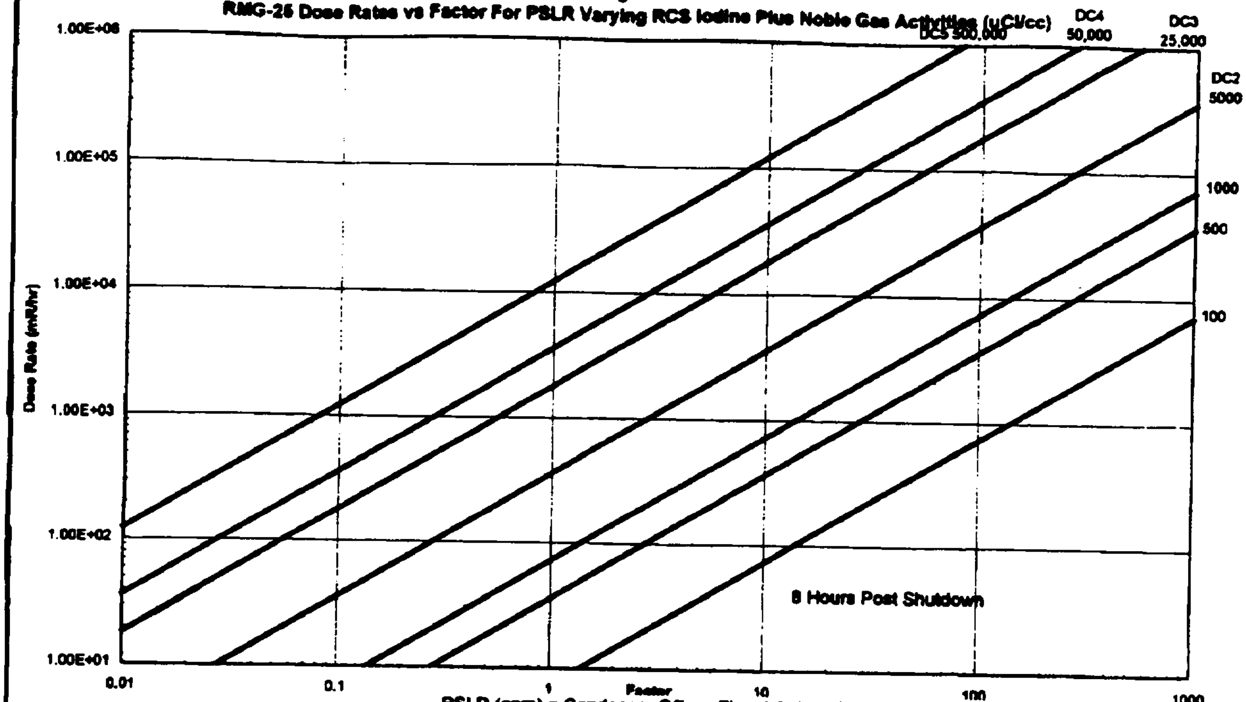
RMG-25 Dose Rates vs Factor For PSLR Varying RCS Iodine Plus Noble Gas Activities (uCi/cc)



PSLR (gpm) = $\frac{\text{Condenser Offgas Flow (cfm)}}{50}$ X Factor

The PSLR results produced by this graph are only as accurate as the estimate of RCS activity. The uncertainty in the PSLR derived should be essentially the same as the uncertainty of the RCS activity estimate.

Figure 9
RMG-25 Dose Rates vs Factor For PSLR Varying RCS Iodine Plus Noble Gas Activities (uCi/cc)



PSLR (gpm) = $\frac{\text{Condenser Offgas Flow (cfm)}}{50}$ X Factor

The PSLR results produced by this graph are only as accurate as the estimate of RCS activity. The uncertainty in the PSLR derived should be essentially the same as the uncertainty of the RCS activity estimate.