RASCAL TRAINING

This training covers all the concepts of RASCAL, primarily focusing on the Source Term to Dose tool. It requires no previous RASCAL experience, but a general knowledge of emergency response, reactor operations, and health physics will be beneficial.

Day 1	Introduction Source Term to Dose Walkthrough Long Term Station Black Out Lunch break Multi-Unit Assessment Monitored Mixtures Comparing with Field Measurements
Day 2	Spent Fuel Pool Containment Rad Monitor Steam Generator Tube Rupture <u>Optional Demos (time permitting):</u> Download Meteorology from Internet Transportation/Materials Accident Fuel Cycle

Note: This RASCAL tutorial was developed by the U.S. Nuclear Regulatory Commission to support training for its Incident Response Program and the Radiation Protection Computer Code Analysis and Maintenance Program (RAMP). The situations presented may not be realistic or likely and are for training purposes only.

SOURCE TERM TO DOSE WALKTHROUGH (LOCA)

Scenario

Arkansas Nuclear One, Unit 1 had been operating at full power. At 10:00am local time the reactor tripped due to an earthquake, causing a major rupture in the primary coolant system (loss-of-coolant accident [LOCA])

The licensee believes the core may become uncovered at 13:00 and are unable to activate the containment spray system. They expect the containment to remain intact and any release to the atmosphere will be at the design leak rate.

At 17:00, operators were able to recover the core. Containment remained at high pressure and wasn't reduced until 21:00.

Weather Data:

Type	Date	Time	Wind Dir (deg)	Wind Spd (mph)	Stability Class	Precip	Air Temp (°F)
Obs	Today	12:00	210	6	B	None	53

Your Task

Do an assessment of the Unit 1 LOCA and record the TEDE and Thyroid CDE at 0.2 and 4 miles from the release.

	Dose at 0.2 miles	Dose at 4 miles
TEDE (rem)		
Adult Thyroid CDE (rem)		

LONG-TERM STATION BLACK OUT

Scenario

Arkansas Nuclear One (ANO), Unit 2, was shutdown at the same time as ANO Unit 1, 10:00, due to the earthquake which caused the Unit 1 LOCA. All offsite and onsite AC power was lost. Diesels initially provided power and cooling was maintained. However, a strong aftershock 5 hours after the original quake incapacitated the diesels. The batteries lasted six hours. Fission products leak through a slightly damaged containment at 2.0 percent/d with no sprays available. Finally, power is restored and the core is recovered at 10:00 on the next day. Containment pressure was reduced to atmosphere at noon. Use the following weather data for the ARKA station:

Type	Date	Time	Wind Dir (deg)	Wind spd (mph)	Stability Class	Precip	Air Temp (Deg F)
Obs	Today	12:00	210	6	B	None	53
Fcst	Today+1	00:00	210	6	B	None	53
Fcst	Today+1	04:00	340	4	D	None	48
Fcst	Today+1	08:00	350	6	C	None	50
Fcst	Today+1	12:00	0	7	B	None	66

Your Task

Do an assessment of the Unit 2 LTSBO and record the TEDE and Thyroid CDE at 1 and 5 miles from the release.

	Dose at 1 mile	Dose at 5 miles
TEDE (rem)		
Adult Thyroid CDE (rem)		

MULTI-UNIT ASSESSMENT

Scenario

Combine the Arkansas Nuclear LOCA and LTSBO cases using the Source Term Merge/Export tool.

Your Task

Record the doses below and compare to the individual LOCA and LTSBO cases.

	Dose at 1 mile	Dose at 5 miles
TEDE (rem)		
Adult Thyroid CDE (rem)		

MONITORED MIXTURES

Scenario

Wolf Creek Generating Station had been operating at 80% percent power for about a week, and during a ramp-up back to 100%, a malfunction occurred causing the plant to shutdown at 15:50. Approximately 10 minutes later (16:00), an effluent release through a monitored pathway (stack height 211 ft) was detected by plant operators.

The effluent release rate was reported to be 950 Ci/s for noble gases, 12 Ci/s for iodine radioisotopes, and 0.3 Ci/s for particulates. The plant's Technical Specification (TS) requires that the release duration must be limited to no more than 30 minutes and use predefined Standard Meteorology.

Your Task

Determine the projected TEDE and Adult Thyroid CDE at 1 mile and 5 miles.

	Dose at 1 mile	Dose at 5 miles
TEDE (rem)		
Adult Thyroid CDE (rem)		

COMPARING WITH FIELD MEASUREMENTS

Scenario

Wolf Creek Generating Station had been operating at 80% percent power for about a week, and during a ramp-up back to 100%, a malfunction occurred causing the plant to shutdown at 15:50. Approximately 10 minutes later (16:00), an effluent release through a monitored pathway (stack height 211 ft) was detected by plant operators.

The effluent release rate was reported to be 950 Ci/s for noble gases, 12 Ci/s for iodine radioisotopes, and 0.3 Ci/s for particulates. The plant's Technical Specification (TS) requires that the release duration must be limited to no more than 30 minutes and use predefined Standard Meteorology.

Field teams have been dispatched and reported measurements at 18:00 local time. Do these readings confirm that the RASCAL TEDE and Adult Thyroid CDE projections are representative of the impact?

Your Task

Do these field team readings confirm that the RASCAL TEDE and Adult Thyroid CDE projections are representative of the impact (assuming that the release continues for 4 hours)?

Field Team & Location	Measurement	Field Team Reading	RASCAL Results
Team 1 3 miles downwind on the centerline	Gamma	4 mR/h	
	I-131	1.9E-10 µCi/cm^3	
Team 2 8 miles downwind on the centerline	Gamma	32 mR/h	
	I-131	1.5E-07 µCi/cm^3	

SPENT FUEL POOL

Scenario

The Diablo Canyon, Unit 2, power plant has experienced a loss of water level in the spent fuel pool due to an earthquake. The licensee reports it is the result of a large crack in the pool and postulates that the water is possibly flowing into a sink hole.

Due to a malfunctioning pump, the operators have not been able to make up for the loss of water in the spent fuel pool. The water level in the pool dropped to the top of the fuel at 08:50, and will likely to continue to drop. Estimates are that the fuel will be fully uncovered by 11:00 and the licensee is attempting to recover the fuel or provide alternate cooling methods. In technical consultation with the licensee and based upon the age of the fuel in the SFP it is estimated that the hottest assemblies experience a gap release (a precursor to a potential zirconium fire) in approximately 22 hours.

The licensee also reports that the pool currently contains three batches of fuel (a batch is defined as one-third of a core): one of which was from the most recent refueling 360 days ago, and 2 from previous refuelings. The licensee anticipates being able to be able to recover the fuel or provide alternate spray flow cooling within 24 hours. The building has been severely damaged and is in many places directly open to the atmosphere. Assume the release point to be unfiltered, 10 meters above ground and Standard Meteorology.

Your Task

Do an assessment and record the source term and dose information in the tables.

	Activity (Ci)	% of Total
Noble gas		
Iodines		
Other		
Total		

	Dose at 1 mile	Dose at 5 miles	Dose at 10 miles
TEDE (rem)			
Adult Thyroid CDE (rem)			

To what distances are the EPA PAGs exceeded for TEDE and Adult Thyroid CDE?

If the date of the last refueling changed to 30 days vice the 360 days entered above, how does that change the distances that the change the distance at which the EPA PAGs are exceeded for TEDE and Adult Thyroid CDE? If so why?

CONTAINMENT RADIATION MONITOR

Scenario

A malfunction occurred at the Fort Calhoun, Nuclear Power Plant causing the plant to shutdown (reactor scram) at 12:00. Approximately 45 minutes later it was determined by the operators that the core was uncovered.

During the course of the event, the operators in the control room receive periodic readings from the containment dome radiation monitor.

Time	Containment Radiation Monitor Reading (R/h)
12:45	14
13:30	50,000
15:00	100,000
+1 day, 15:00	100,000

The release from the core passed into the containment building and the containment sprays are not operating. The operators determined that the containment remained intact and the release from the containment was via design leakage rate.

Use the RASCAL Predefined Data (Non Site-specific) option with Standard Meteorology.

Your Task

Perform an assessment and consult the case summary report to see how much core damage RASCAL estimated for each reading

Time	Containment Radiation Monitor Reading (R/h)	RASCAL Calculated Core Damage (%)
12:45	14	
13:30	50,000	
15:00	100,000	
+1 day, 15:00	100,000	

STEAM GENERATOR TUBE RUPTURE

Scenario

The St. Lucie, Unit 1, Nuclear Power Plant experienced a sudden drop in primary system pressure and a sudden rise in secondary pressure at 00:36. The resulting drop in primary system pressure caused the reactor to automatically shutdown at the same time.

The control room operators assume that a steam generator tube rupture (SGTR) had occurred and estimate that the makeup flow (including safety injection) to be about 500 gpm.

The increase in steam generator pressure caused the high-pressure safety relief valves to open briefly, but subsequently the increased steam generator pressure is released through the condenser off-gas exhaust.

The control room operators have indications to assume that the SGTR break is above the water line (worst case) and that the steaming rate is at the default value.

The release point is 30 meters above ground. Use the Predefined Data (Non Site-specific) option with Standard Meteorology

Your Task

Do an assessment and determine the projected TEDE and Adult Thyroid CDE at 0.5 miles.

	Dose at 0.2 miles
TEDE (rem)	
Adult Thyroid CDE (rem)	

TRANSPORTATION ACCIDENT

Scenario

At 02:00 a tractor trailer truck crashed in central Pennsylvania near the intersection of I-80 and I-180 when the driver lost control on the icy road.

The truck manifest says it was carrying 150,000 Ci of tritium gas and was bound for the Safety Light facility in Bloomsburg, PA. State highway patrol reports that the trailer slid at high speed into a bridge support and split open.

Reports from the scene are that the weather is cold, but the precipitation had stopped and the winds are very light.

	Nearby Population
City	Milton
County	Northumberland
State	Pennsylvania
Country	United States

	Accident Location Info
Time Zone	Eastern
Latitude	41.0495° (+ is north)
Longitude	-76.8400° (- is west)
Elevation	153 meters

The licensee estimates that 10 percent of the containers may have ruptured and that most of their contents are likely to leak out within 10-20 minutes and would quickly volatilize and become airborne.

Your Task

What are the doses (TEDE) to persons and the first responders in the immediate vicinity of the crash (0.1 and 0.2 miles)?

What are the doses (TEDE) to nearby residents in the vicinity of the crash (0.5 and 1.0 miles)?

	0.1 miles	0.2 miles	0.5 miles	1 mile
TEDE (rem)				