



NUCLEAR POWER PLANT

CONTAINMENT RADIATION MONITOR

Prerequisites

Basic working familiarity with the RASCAL STDose model, from either the online RASCAL Fundamentals course or from previous practical RASCAL experience.

Disclaimer

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.

Introduction

RASCAL can use measurements from a containment radiation monitor to estimate the amount of core damage, which is then used to calculate the amount of material available for release.

ADDITIONAL INFORMATION

- The model used to convert containment radiation monitor readings has a number of cautions. These can be reviewed in NUREG-1940.
- This method should be used as a secondary assessment of core damage. Given the cautions and limitations it should be used for confirmatory calculations only.

Walkthrough

SCENARIO

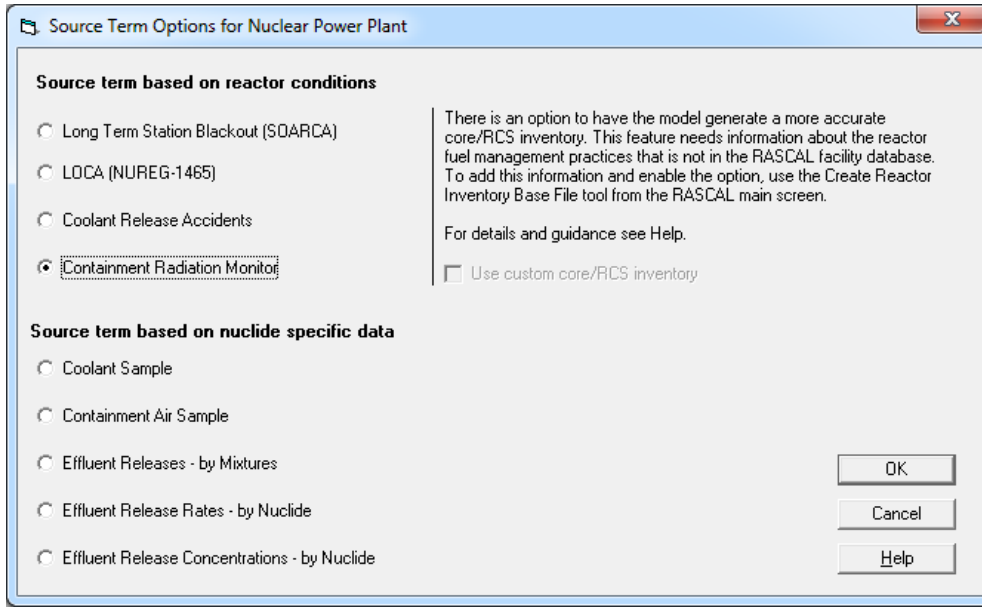
An accident is underway at the Palo Verde Unit 1 nuclear power plant. The reactor scrammed at 12:00 P.M. By 12:45 P.M. some of the core was uncovered. The release from the core passed into the containment building. Release from the containment was at design leak rate. The containment sprays are off.

During the course of the event, you receive periodic readings from the containment dome radiation monitor. For each reading, determine what amount of core damage is estimated by RASCAL. For this exercise, assume Standard Meteorology.

Time	PWR containment monitor reading, R/h
12:45 P.M.	14
1:30 P.M.	10,000
3:00 P.M.	50,000
3:00 P.M. NEXT DAY	50,000

STEP BY STEP

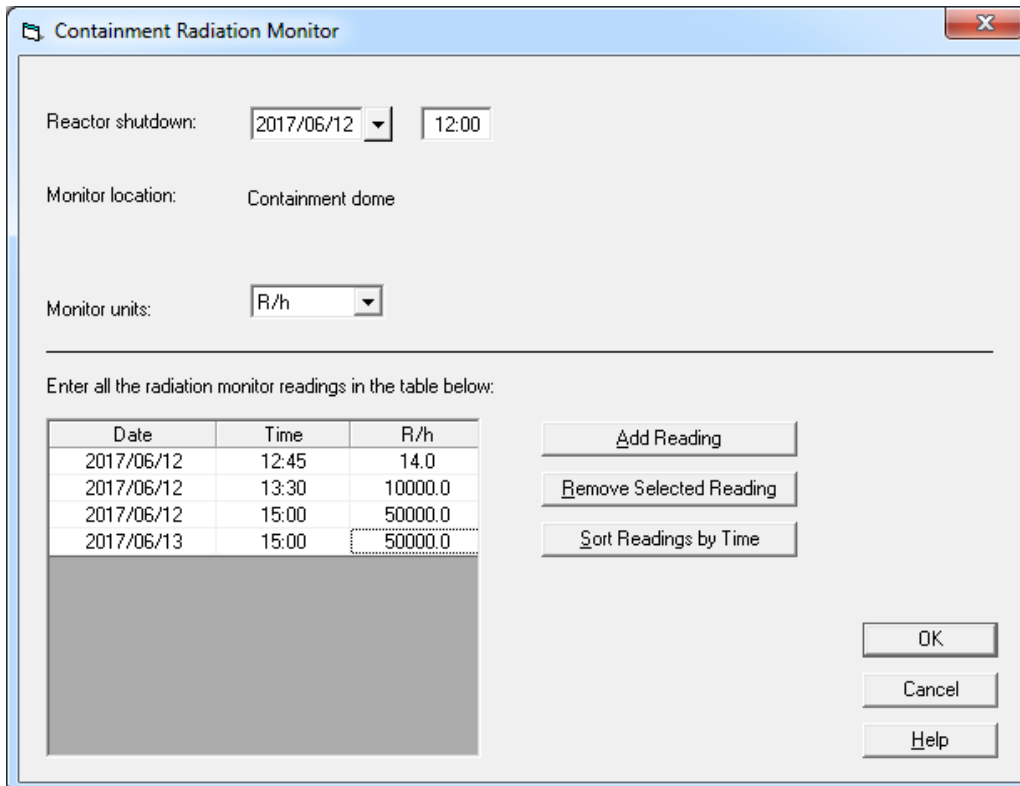
Start the STDose tool; set Event Type as Nuclear Power Plant and Event Location as Palo Verde Unit 1.



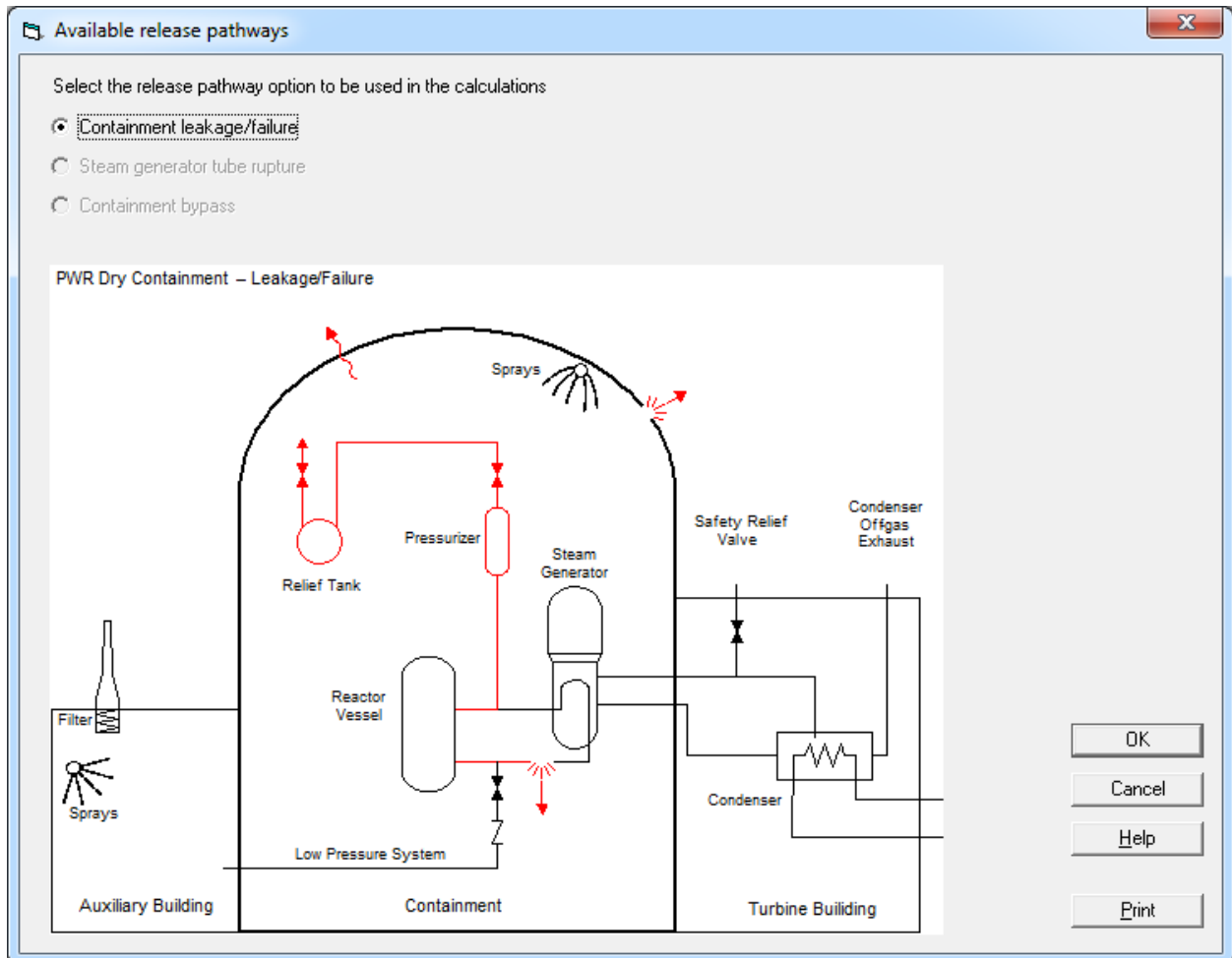
Click Source Term. Then, select the Containment Radiation Monitor option. Click OK.

Enter the reactor shutdown time of 12:00. Then add the four containment radiation monitor readings:

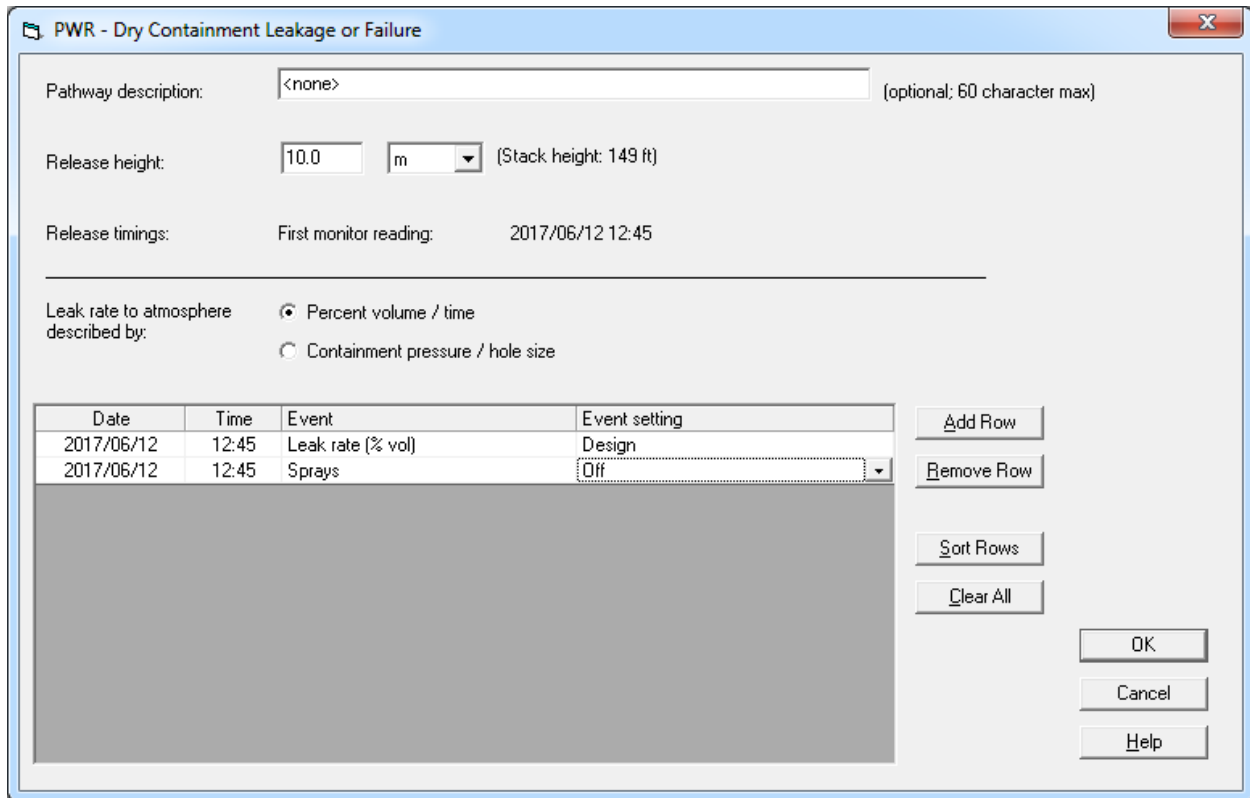
- Click the Add Reading button thrice to add the needed rows to the table
- For each reading, edit the time and the R/h values (make sure and set the last entry date ahead one day)
- Click OK



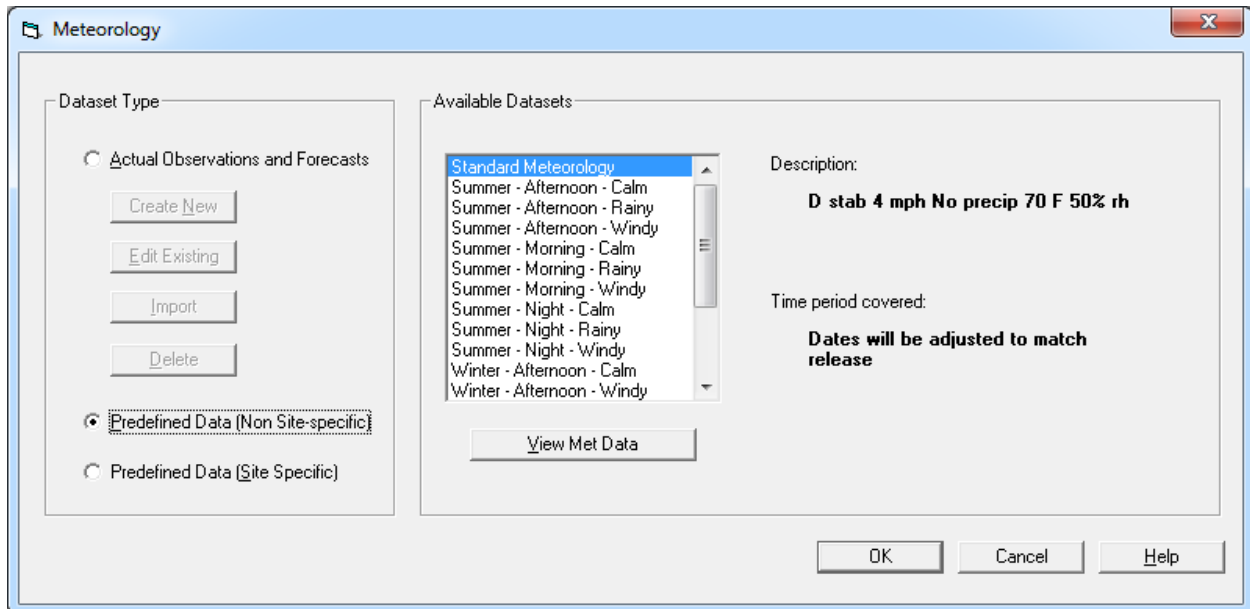
Click Release Pathway. The only option available for the selected source term type is Containment leakage/failure. Click OK.

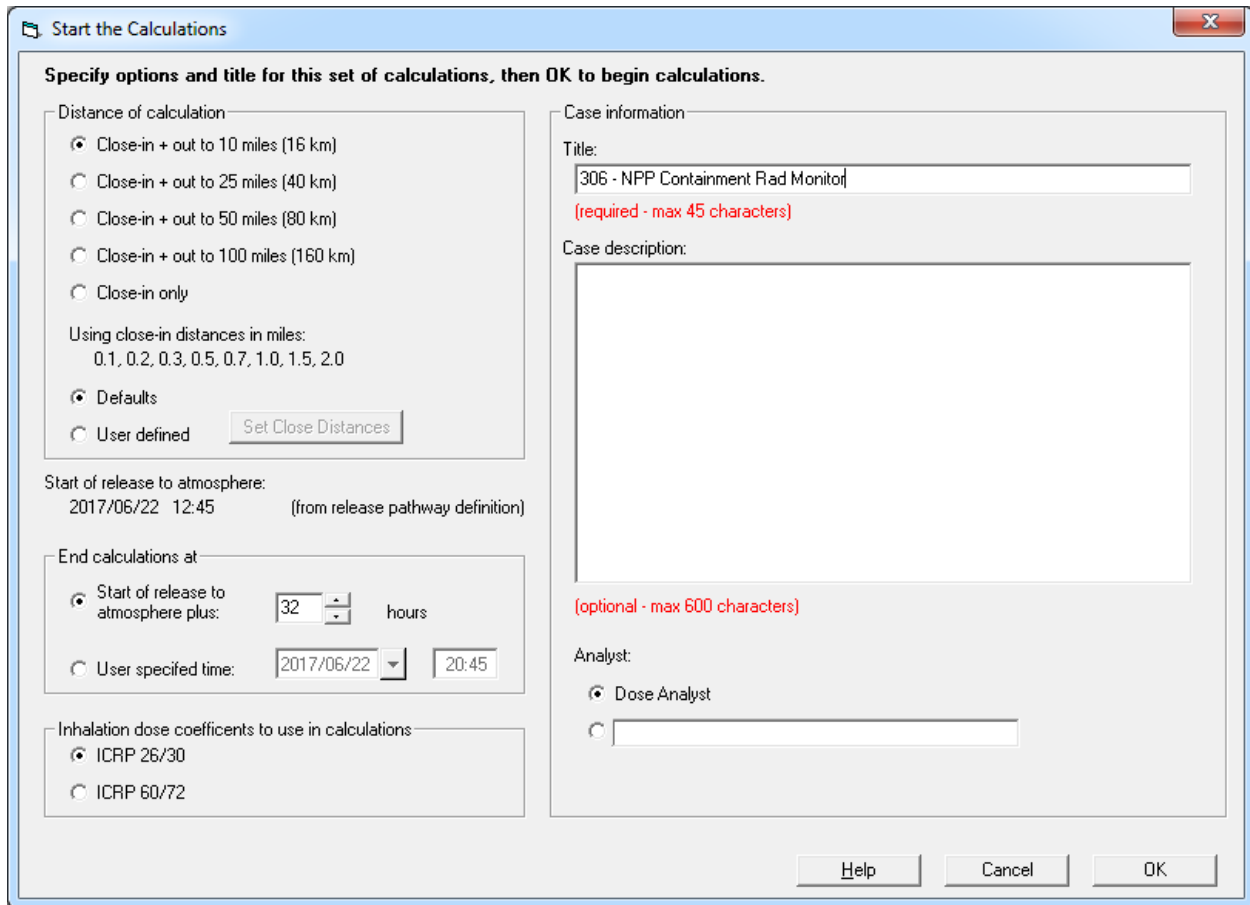


Since no release height was provided in the scenario we can leave the value at the default of 10 meters. The scenario also states that the sprays were off and the containment was leaking at the design rate. Thus, default events and event settings in the table are good. Click OK.



Click Meteorology. Select the Predefined Data (Non Site-specific) option and make sure Standard Meteorology is highlighted in the list of available datasets. Click OK.



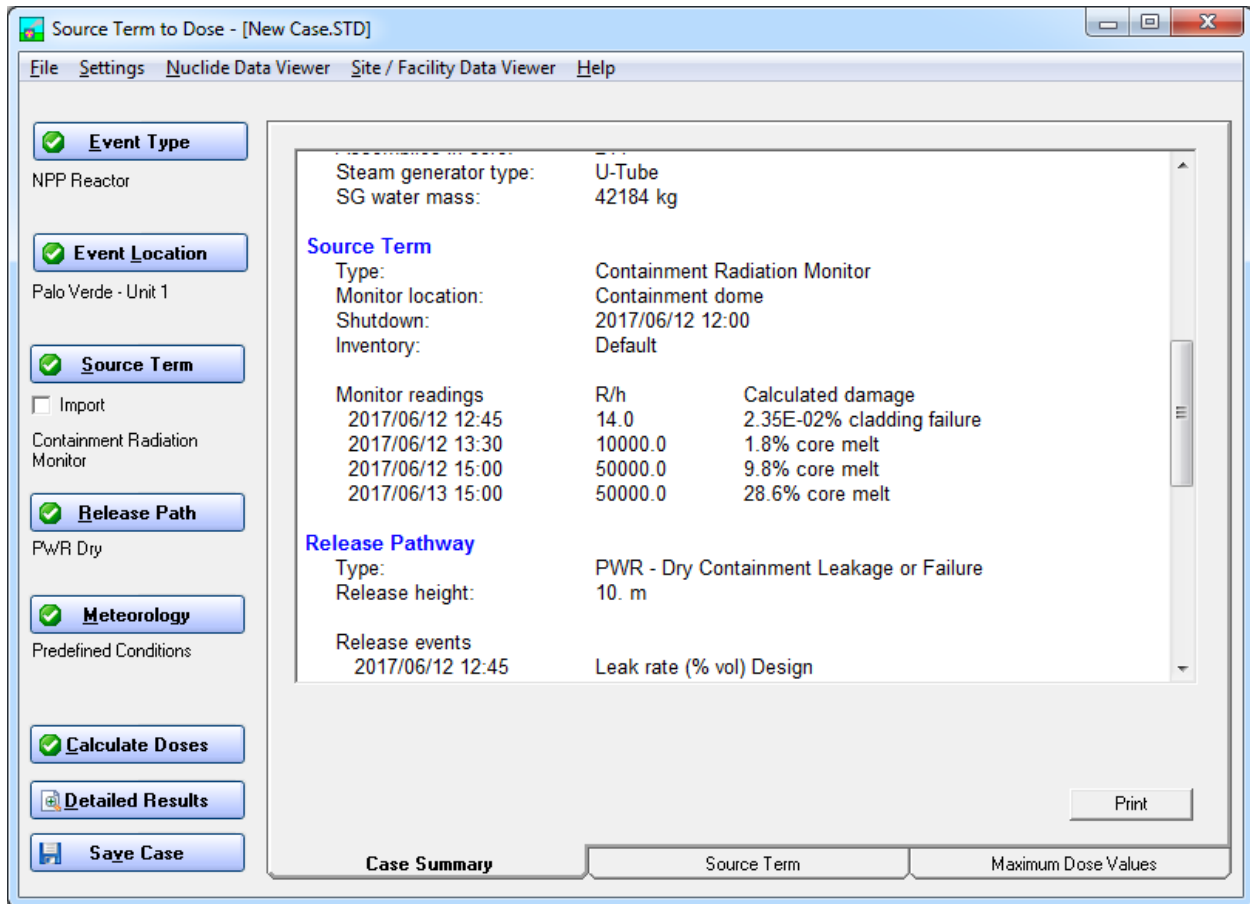


Click Calculate Doses. The Distance of calculation can be left at the default of Close-in + out to 10 miles as that is the best resolution and we don't yet know how large the doses will be. For setting the calculation duration, we have the following information. The release starts at 12:45 with our first rad monitor reading. The last reading is at 15:00 on the second day. We have no additional information on how the accident may progress. The monitor readings may continue to increase and the release rate may change.

- a. 12:45 to 3pm (next day) = 26.25 h
- b. Calc dist = 10 miles; wind speed in std is 4 mph. Thus, $10/4 = 2.5$ h
- c. $(26.25 + 2.5) \times 1.1 = 31.625$ which rounds up to 32 hours. Enter 32 hours in the field.

Enter a case title and then click OK to start the calculations.

For this problem, we were asked to provide an estimate of core damage first, not offsite doses. Click the Case Summary tab at the bottom of the main screen. Scroll down to view the source term section. Next to the monitor readings are the calculated damage values.



Conclusion

Let's review the data shown in the case summary screenshot above (rad monitor readings and % core damage).

Why is the core damage estimate for the second 50,000 R/h (4th entry) higher than the 3rd entry?

It may be useful to go to NUREG-1940 and examine Figure 1-1 (copied on next page).

This is the containment monitor response for a PWR. Look at the line for 50,000 R/h and follow across to the bars in the Core Melt section of the chart. The bars represent the damage amount associated with a monitor reading. Notice in the chart that the 24-hr bars on the right are all shifted lower than the 1-h bars on the left. With time, decay and natural processes will reduce the amount of activity in the containment atmosphere. Thus, to have any reading of "X" R/h there would have to be more damage to the core.

A similar behavior exists with sprays. Turning sprays on using this model actually increases the amount of core damage (but then washes some of it out with the sprays themselves). Let's look at the table again. The light grey is with sprays off and the dark grey is with sprays on. You can see that throughout the whole chart the sprays on always has more damage than with sprays off (the grey bar is always shifted lower on the chart). If sprays are on in the containment, then material is being removed from the containment atmosphere. Thus, to get enough material to have any reading of "X" R/h there would have to be more damage to the core.

