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Nuclear Facility Accident (NFAC) Unit Test Report For HPAC Version 6.4

Ronald W. Lee
C. David Sulfredge

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Computational Sciences and Engineering Division

NUCLEAR FACILITY ACCIDENT (NFAC) UNIT TEST REPORT FOR HPAC VERSION 6.4

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CONTENTS

Page

LIST OF FIGURES v
LIST OF TABLES vii
ACRONYMS ix
1. Overview 1
2. NFAC Description 2
   2.1 Source Models 2
   2.2 Material Modes 3
   2.3 PIR Release Modes 5
3. Test Approach 6
   3.1 NFAC Unit Tests 6
   3.2 NFAC-RTH Integration Tests 6
   3.3 NFAC-RTH-SCIPUFF Integration Tests 7
4. Automated Tests 7
   4.1 ExternalFileFinderTest 7
   4.2 ModelDefsTest 8
   4.3 ModelTimesTest 22
   4.4 PIRModelDefsTest 24
   4.5 ParticleGroupsMgrTest 34
   4.6 SourceTermTableTest 35
   4.7 SourceTermTableTest2 42
   4.8 RTHTimesTest 42
   4.9 Spcr6918Test 43
      4.9.1 No Shutdown Full 43
      4.9.2 No Shutdown Partial 44
      4.9.3 Shutdown Full 44
      4.9.4 Shutdown Partial 44
5. Interactive Tests 49
   5.1 Top Level Interactions 49
   5.2 Where Tab 50
   5.3 What Tab 51
   5.4 When Tab 58
   5.5 Notes Tab 62
6. Results 63
   6.1 Automated Test Results 63
   6.2 Automated Test Coverage 66
   6.3 Interactive Test Results 69

LIST OF FIGURES

Figures **Page**

1 NFAC Source Terms. 2

LIST OF TABLES

Tables		Page
1	Multicomponent Material Mode Isotopes	5
2	Sub-Release Time Scales	5
3	Code Coverage by Package	66
4	Code Coverage: CAComp	67
5	Code Coverage: CAComp.data	67
6	Code Coverage: CAComp.data.analyst	67
7	Code Coverage: CAComp.data.analyst.plantcond	68
8	Code Coverage: CAComp.data.times	68
9	Code Coverage: CAComp.exceptions	68
10	Code Coverage: CAComp.impl	68
11	Interactive Test Results: Top Level Interactions	69
12	Interactive Test Results: Where Tab	69
13	Interactive Test Results: What Tab	70
14	Interactive Test Results: When Tab	71
15	Interactive Test Results: Notes Tab	71

ACRONYMS

AGR	Advanced Gas-Cooled Reactor
API	Application Programming Interface
ATR	Advanced Thermal Reactor
BWR	Boiling Water Reactor
DTRA	Defense Threat Reduction Agency
FBR	Fast Breeder Reactor
GCHWR	Gas-Cooled Heavy Water Reactor
GCR	Gas-Cooled Reactor
GUI	Graphical User Interface
HPAC	Hazard Prediction and Assessment Capability
HTGR	High-Temperature Gas Reactor
HWGCR	Heavy Water Gas-Cooled Reactor
HWLWR	Heavy Water Light Water Reactor
LGR	Light-Water Cooled Graphite-Moderated Reactor
LMFBR	Liquid-Metal Fast Breeder Reactor
LWR	Light Water Reactor
MELCOR	Methods for Estimation of Leakages and Consequences of Releases
MWt	Megawatt thermal
NFAC	Nuclear Facility Accident Model
NRC	Nuclear Regulatory Commission
ORIGEN	Oak Ridge Isotope Generator
OSGi	Open Service Gateway Initiative
PHWR	Pressurized Heavy Water Reactor
PIR	Percent Inventory Release
RASCAL	Radiological Assessment Systems for Consequence Analysis
PWR	Pressurized Water Reactor
RBMK	(Russian) Reaktor Bolshoy Moschnosti Kanainy
RTH	Radiological Transport for HPAC
SCIPUFF	Second-order Closure Integrated Puff Model
SGHWR	Steam-Generating Heavy Water Reactor
SOARCA	State-of-the-Art Reactor Consequence Analysis
SPCR	Software Problem/Change Report
VVER	(Russian) Water-Water Energy Reactor

1. OVERVIEW

This document describes the methodology for and results of testing the Nuclear Facility Accident (NFAC) incident source model (ISM) in Version 6.4 of the Hazard Predication and Assessment Capability (HPAC). Tests and results for Version 6.3 have been documented previously.[3] Individual tests from Version 6.3 that are still relevant are repeated for this report, but the descriptions and source listings of NFAC-specific JUnit test driver components are not repeated and can be found in the prior report.

NFAC's responsibility as an HPAC ISM is as follows. First, it must present an interactive graphical user interface (GUI) by which users can view and edit the definition of an NFAC incident. Second, for each incident defined, NFAC must interact with the Radiological Transport for HPAC (RTH) component to create activity table inputs and associate them with radiological materials to be transported via the Second-order Closure Integrated Puff Model (SCIPUFF). Third, NFAC must create SCIPUFF transport releases and materials and associate them with radiological materials for transport and dispersion. The goal of NFAC unit testing is to verify that these three responsibilities are implemented correctly, and the inputs produced are correct for the source term or model definition as specified.

However, in order for NFAC to function correctly, the other components with which it interacts must process the NFAC-generated inputs in the manner in which NFAC expects. Thus, it is necessary to include NFAC-RTH and NFAC-RTH-SCIPUFF integration tests.

WHAT'S NEW IN 6.4

Significant changes in NFAC since Version 6.3 are noted below.

Multicomponent material mode. (SPCR 6918) A new material mode has been added to leverage SCIPUFF's multicomponent processing capability. The primary motivation is to approximate the high fidelity of *groups* mode with orders-of-magnitude improvement in performance. Refer to Section 2.2. Note this new capability coincides with new functionality added to RTH and SCIPUFF for HPAC-6.4.

Improved handling of noble gases in *groups* material mode. In conjunction with adding *multicomponent* mode, accounting for noble gases has been corrected and improved when particle groups are used to represent activity in releases.

Improved source term report. The layout of source term reports has been improved to be more consistent with available material and Percent Inventory release modes.

Default spatial domain changed. The default spatial domain for NFAC incidents has been changed to 10 km.

Update to research reactor data. (SPCR 6787) Research reactors have been updated to remove those that were proposed and never built, assign correct names, and add new reactors that have been planned or built. Also, locations have been updated to higher resolution coordinates.

2. NFAC DESCRIPTION

The critical components and capabilities of NFAC Version 6.4 which must be tested are described below.

2.1 SOURCE MODELS

As shown in Fig. 1, NFAC contains 22 distinct source term models, all of which are tested.

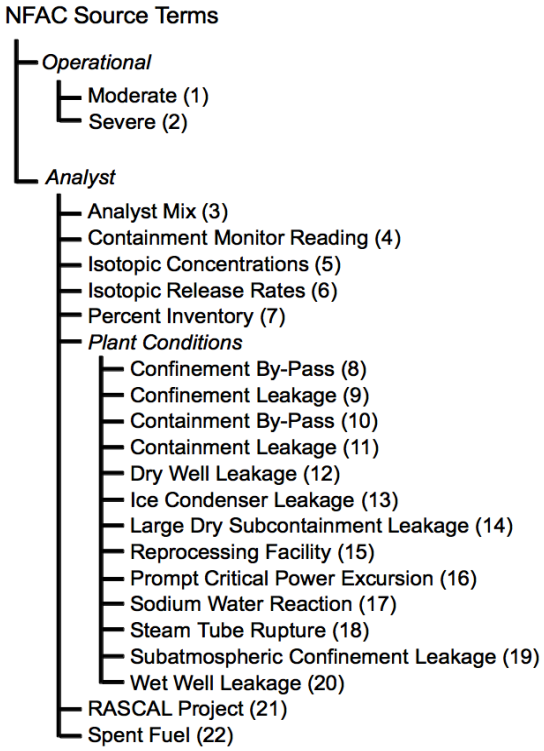

Fig. 1: NFAC Source Terms.

The distinction between *operational* and *analyst* models is largely a vestige from HPAC Version 4. The two operational models require minimal user input to define the scenario and are implemented as Percent Inventory source terms. They are based on phased release scenarios defined by the Nuclear Regulatory Commission (NRC).

Percent Inventory is the most widely used and thus the most important source term. Consequently, it is covered more completely in the range of tests. Whereas most models are based on defined accident scenarios, a few are purely for advanced analysis. Each is summarized below.

Moderate. Moderate scale accident defined by the NRC as a series of phased releases specifying percentages of activity released by isotope groups defined by the Methods Estimation of Leakages and Consequences of Releases (MELCOR) code.

Severe. Like Moderate but defining a more severe accident.

Analyst Mix. Non-scenario mode in which the user specifies the percentage of inventory activity released by MELCOR groups.

Containment Monitor Reading. Scenario defined by readings taken at a containment monitor.

Isotopic Concentrations. Non-scenario mode in which the user specifies what is released as concentrations of specific isotopes.

Isotopic Release Rates. Non-scenario mode in which the user specifies the release as rates for specific isotopes.

Percent Inventory (PIR). Specifies an event as a series of phased releases, which are specifications of percentages by MELCOR group of the inventory released over a specified duration. A shutdown period is represented as an initial duration of no activity released. This is the most used NFAC source term and is used for operational scenarios.

Plant Conditions. A collection of 13 specific accident/event scenarios, the names of which describe the respective scenario. Each requires input of specific parameters to define the event.

RASCAL Project. Imports a project file created with the NRC's Radiological Assessment Systems for Consequence Analysis (RASCAL) application.

Spent Fuel. Specifies a spent fuel pool incident.

NFAC source terms define one or more releases with an activity vector associated with each release. There are variations on how these releases are modeled for transport and dispersion based on nine combinations of three *material modes* and three *PIR release modes*, default values for which are *simple* and *none*, respectively.

2.2 MATERIAL MODES

In terms of radiological materials, NFAC offers three modes for representing the activity associated with each release: *simple*, *groups*, *multicomponent*.

Simple

The default material mode, *simple*, offers the fastest calculation but the least fidelity. Each phased release is represented by at most two radiological materials and associated transport releases, one representing depositor isotopes and another representing non-depositors. Noble gases (one of the MELCOR groups) are non-depositors, and other isotopes are depositors.* If the activity vector associated with a phased released contains only depositors, no non-depositor release is created and vice versa.

The gas deposition velocity for the depositor material is 3.0 mm/s. That is, each depositor isotope is assumed to settle at the same rate.

*The one exception is O-19, a non-depositor that belongs to the chalcogens group.

Particle Size Groups

A single deposition velocity for all isotopes has obvious limitations. Thus, NFAC offers a high-fidelity option in which activity is apportioned across as many as 11 particle size groups, each with a specific gas deposition velocity. This *groups* mode is only available for facilities of the following types:

- Boiling Water Reactor (BWR)
- Light Water Reactor (LWR)
- Pressurized Water Reactor (PWR) (certain variants)
- Water-Water Energy Reactor (VVER)

Apportionment tables are obtained from the State-of-the-Art Reactor Consequence Analysis (SOARCA) studies. BWR tables come from analysis at Peach Bottom,[4] and tables for the other facility types come from analysis at Surry.[5] Further, cesium and iodine isotopes are apportioned into cesium iodide (CsI), which is treated as a MELCOR group and for which apportionment ratios are given in the tables. CsI apportionment is also based on SOARCA studies as well as other sources.[6,1]

In *groups* mode, each activity released is represented by as many transport releases and associated transport and radiological materials as there are particle groups with non-zero activity after apportionment, plus a non-depositor release and materials if needed. This geometric growth in the number of materials and releases has an obvious effect on calculation time. Although this mode offers the highest fidelity available in NFAC, it will require a significant increase, sometimes orders of magnitude, in calculation time as compared to *simple* mode.

Multicomponent

SCIPUFF has been enhanced for HPAC-6.4 to support definition of multicomponent radiological materials. In conjunction with requisite RTH enhancments, NFAC now offers a third (*multicomponent*) material mode that leverages this capability. Instead of representing each particle group as a separate material, particle groups are bins associated with ”components”, which are isotopes. Each transport release associated with an NFAC incident references the same multicomponent radiological material.

NFAC passes a single activity vector to RTH for the latter to use in calculating dose factor tables to write to the radfile that is read by SCIPUFF. In this new scheme, a basis value of 1.0 Ci is set as the activity for each isotope in the vector. In effect, the radfile dose factor tables are basis factors. Also written to the radfile are the particle group sizes and deposition velocities as well as names for each isotope representing a ”component”. The association of the actual activity for each isotope in each particle group or bin is now in the transport release. That is, each transport release created by NFAC for an incident references the same radiological material but includes ”mass” factors to apply for each isotope and group/bin. This representation allows SCIPUFF to calculate the transport and deposition and account for radiological dose with much less computational overhead.

Table 1: Multicomponent Material Mode Isotopes

MELCOR Group	Isotopes				
Noble Gases	Kr-85	Xe-133	Xe-135		
Alkali Metals	Cs-134	Cs-137			
Alkaline Earths	Ba-140	Sr-89	Sr-90		
Halogens	I-131				
Chalcogens	Te-129				
Platinoids	Ru-103	Ru-106			
Early Transition Elements	Mo-99				
Tetravalents	Ce-141	Ce-144	Pu-239	Zr-95	
Trivalents	La-140	Nb-95	Nd-147	Pr-143	Y-91

However, there is a limitation on the number of "components" that SCIPUFF can process efficiently. Consequently, NFAC limits the activity vector to a list of 22 isotopes that represent the lion's share of activity and effects. They are listed in Table 1.

It is important to note that NFAC's *multicomponent* material mode is a close approximation to *groups* mode that requires significantly less calculation time. However, activity is not preserved in in *multicomponent* mode.

2.3 PIR RELEASE MODES

As described above, PIR scenarios are specified as a series of phased releases with an associated duration. The activity vectors (lists of isotopes and associated activity) associated with each phased release are determined by decaying the inventory to the start of the release. For a long duration phase (e.g., 48 h), there are many daughter products which will never be accounted for due to their appearance and decay during the period. Even shorter duration phases early in the series can lose significant effects due to lost daughter products. NFAC offers three release modes, two of which offer an accounting for daughter products in these situations. In order of increasing calculation time and fidelity, the modes are: *none*, *average*, and *explicit*.

For *average* and *explicit* modes, each phased is divided into sub-releases as shown in Table 2.

Table 2: Sub-Release Time Scales

Time in Phase	Sub-Phase Duration	Sub-Release Duration	No. Releases
0.0	3.0	0.5	+6 = 6
3.0	3.0	1.0	+3 = 9
6.0	9.0	3.0	+3 = 12
15.0	36.0	12.0	+3 = 15
51.0	–	24.0	

(Times are in hours)

For the first 3.0 h of a phased release, a subrelease is created every 0.5 h, resulting in a maximum six releases. For the next 3.0 h, a subrelease is created every 1.0 h, for an additional three releases. Thus, a phased release of 6.0 h will have nine subreleases, six with a duration of 0.5 h, and three with a duration of 1.0 h.

Over the next 9.0 h, a subrelease is created every 3.0 h (an additional three), and over the next 36.0 h, a subrelease is created every 12.0 h (another three). After 51.0 h, a subrelease is created for every 24.0 h. For example, a phase with duration 72.0 h will have 15 releases representing the first 51.0 h and an additional release of 21.0 h. A phase of 12.0 h duration will have 11 releases, nine for the first 6.0 h and additional two for the next 6.0 h.

None. This is the default. No subreleases are created, and thus there is no accounting for lost daughter products.

Explicit. A transport release and associated transport and radiological materials are created for each subrelease. Although this mode offers the highest fidelity, it can greatly increase the SCIPUFF calculation time.

Average. This is a reasonable compromise that avoids long calculation times for SCIPUFF. Activities in subreleases are averaged with subrelease durations as weights. The resulting activity vector is applied to the original release.

3. TEST APPROACH

Although NFAC unit tests comprise most of the tests conducted, testing includes NFAC-RTH and NFAC-RTH-SCIPUFF integration tests. The integration tests are are necessary to verify NFAC is functioning as designed.

Testing is divided into two paths: automated tests and interactive tests. Nine automated JUnit4 test suites containing 150 individual tests have been built and are described in detail below. Each individual test includes one or more assertions challenging specific results or consequences designed to exercise a key functional capability. The granularity of the capability being tested varies by test from an individual component method to an aggregate or composite test involving multiple components and methods. Success or failure of automated tests is an output of the test framework. They are run as unattended batch processes.

The GUI is not conducive to automated tests and thus must be tested interactively. All capabilities in the GUI are tested explicitly as described below.

3.1 NFAC UNIT TESTS

Some automated NFAC unit tests rely on aggregate information written by NFAC components to the log file. The log output contains all the data regarding activity table inputs fed to RTH and releases created for SCIPUFF and thus can be compared with baseline logs for equivalence.

3.2 NFAC-RTH INTEGRATION TESTS

For NFAC-RTH integration, two kinds of test artifacts are used in comparisons:

- Source term report HTML files
- Radfiles

Report files are created from information retrieved from RTH by NFAC. That is, NFAC asks RTH to return information previously passed to RTH by NFAC. Radfiles are generated by RTH as requested by SCIPUFF when a calculation is requested.

3.3 NFAC-RTH-SCIPUFF INTEGRATION TESTS

Some tests use artifacts that are created by SCIPUFF after transport and dispersion calculation. These are outputs based on plots requested via an HPAC OutputManager instance.

4. AUTOMATED TESTS

4.1 EXTERNALFILEFINDERTEST

This suite is composed of four individual tests to verify correct function of NFAC's PropertyFinder class used to identify and locate ExternalFile instances to be (re)stored for a project. PropertyFinder instances are used by NfacImpl instances in exportFiles() and importFiles() methods now required for correct HPAC project export and import operations, respectively. Tests in alphabetical order are summarized below.

NFAC components tested:

mil.dtra.hpac.models.nfac.CAcomp.data.FacilityDef
mil.dtra.hpac.models.nfac.CAcomp.data.NfacIncident
mil.dtra.hpac.models.nfac.CAcomp.data.PropertyFinder

mil.dtra.hpac.models.nfac.CAcomp.impl.NfacImpl

Test: testAllIncidents

Loads a project containing multiple NfacImpl instances, assigns a custom inventory with an ExternalFile reference to each instance, and invokes the finder() method of a PropertyFinder instance to locate the ExternalFiles. Verifies all ExternalFiles are found.

Test: testFileReleases

Loads a project containing FileRelease instances and ensures all associated ExternalFiles are found.

Test: testNfacImpl

Tests correct behavior of the NfacImpl.exportFiles() method.

Test: testProject

Loads a project with an NFAC incident with a custom inventory and verifies that the findExternalFiles() method of PropertyFinder behaves correctly.

4.2 MODELDEFSTEST

This suite contains 35 individual tests designed to verify proper function of each of the NFAC source models. For each test there is a corresponding HPAC 6 project (*.hpac6*) file or a project export (*.zip*) file. For most tests a source term report (*.html*) is requested and compared to the baseline fixture, and when appropriate a log file (*.log*) is an additional fixture.

A ProjectManager instance is used to open the project file. The NfacImp instance(s) in the project are retrieved, and the getSourceTermReport() method is called to generated the HTML report. The test and baseline reports are compared for equivalence, allowing for different seed values used in material names. For those tests including a log file fixture, the fixture and log file resulting from the run are read into NfacLog objects and compared with the NfacLog.equals() method. Exact matches determine a successful test. Any difference in report content or NfacLog objects represents a test failure. Tests in alphabetical order are summarized below.

NFAC components tested:

mil.dtra.hpac.models.nfac.CAcomp.data.ActivityHash
mil.dtra.hpac.models.nfac.CAcomp.data.AmbClient
mil.dtra.hpac.models.nfac.CAcomp.data.Element
mil.dtra.hpac.models.nfac.CAcomp.data.Facility
mil.dtra.hpac.models.nfac.CAcomp.data.FacilityDB
mil.dtra.hpac.models.nfac.CAcomp.data.FacilityDBMgr
mil.dtra.hpac.models.nfac.CAcomp.data.FacilityDef
mil.dtra.hpac.models.nfac.CAcomp.data.MaterialMode
mil.dtra.hpac.models.nfac.CAcomp.data.ModelDefUtils
mil.dtra.hpac.models.nfac.CAcomp.data.ModelTimes
mil.dtra.hpac.models.nfac.CAcomp.data.ModerateModel
mil.dtra.hpac.models.nfac.CAcomp.data.NfacIncident
mil.dtra.hpac.models.nfac.CAcomp.data.NfacIncidentMgr
mil.dtra.hpac.models.nfac.CAcomp.data.NfacRelease
mil.dtra.hpac.models.nfac.CAcomp.data.Options
mil.dtra.hpac.models.nfac.CAcomp.data.ParticleGroups
mil.dtra.hpac.models.nfac.CAcomp.data.ParticleGroupsMgr
mil.dtra.hpac.models.nfac.CAcomp.data.ReproInventory
mil.dtra.hpac.models.nfac.CAcomp.data.SevereModel

mil.dtra.hpac.models.nfac.CAcomp.data.analyst.AnalystMix
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.AnalystModelUtils
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.ConcentrationUnits
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.ContainmentMonitorReading
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.IsotopeReleases
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.IsotopeValue
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.IsotopicConcentrations
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.IsotopicReleaseRates
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.PIRSubReleaseMode
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.PercentInventory
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.PercentInventoryConstants
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.PercentInventoryRelease

mil.dtra.hpac.models.nfac.CAcomp.data.analyst.PercentInventoryReleaseTree
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.RascalFileReader
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.RascalProject
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.RascalXmlReader
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.ReleaseRate
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.ReleaseRateUnits
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.SpentFuel

mil.dtra.hpac.models.nfac.CAcomp.data.analyst.plantcond.PCConfinementByPass
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.plantcond.PCConfinementLeakage
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.plantcond.PCContainmentByPass
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.plantcond.PCContainmentLeakage
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.plantcond.PCDryWellLeakage
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.plantcond.PCIceCondenserContainment
...models.nfac.CAcomp.data.analyst.plantcond.PCLargeDrySubContainmentLeakage
...models.nfac.CAcomp.data.analyst.plantcond.PCPromptCriticalPowerExcursion
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.plantcond.PCReproFacility
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.plantcond.PCWaterReaction
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.plantcond.PCSteamTubeRupture
...models.nfac.CAcomp.data.analyst.plantcond.PCSubatmosphericConfinementLeakage
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.plantcond.PCWetWellLeakaage

mil.dtra.hpac.models.nfac.CAcomp.impl.MelcorFraction
mil.dtra.hpac.models.nfac.CAcomp.impl.MelcorFractions
mil.dtra.hpac.models.nfac.CAcomp.impl.MelcorReleaseFractionsFile
mil.dtra.hpac.models.nfac.CAcomp.impl.NfacImpl
mil.dtra.hpac.models.nfac.CAcomp.impl.PercentInventoryFileMgr
mil.dtra.hpac.models.nfac.CAcomp.impl.RepoData
mil.dtra.hpac.models.nfac.CAcomp.impl.ReproMod
mil.dtra.hpac.models.nfac.CAcomp.impl.StcalcClient

Test: test10682GroupsExplicit

Tests the new capabilities added for SPCR 10682. Refer to Section 2.2 for a description of the material modes. This test ensures the activity apportionment across particle groups is correct and the corresponding materials are created with the *groups* material mode and the *explicit* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3414.0 MWt
Material Mode: Groups
PIR Release Mode: Explicit
Source Term: Percent Inventory
Shutdown Duration: 0
Release Duration: 7.0 h
Releases:

#	Duration	Percentages by Group
0	0.5 h	NobleGas=0.01, AlkaMetal=0.6, Chalcogen=0.35
1	2.0 h	NobleGas=0.09, AlkaMetal=1.7, AlkaEarth=0.03, Chalcogen=1.45
2	4.5 h	NobelGas=0.8, AlkaMetal=0.9, Chalcogen=0.45

Test: test10682GroupsNone

Tests proper activity apportionment and material creation for the *groups* material mode and *none* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3414.0 MWt
Material Mode: Groups
PIR Release Mode: None
Source Term: Percent Inventory
Shutdown Duration: 0
Release Duration: 7.0 h
Releases:

#	Duration	Percentages by Group
0	0.5 h	NobleGas=0.01, AlkaMetal=0.6, Chalcogen=0.35
1	2.0 h	NobleGas=0.09, AlkaMetal=1.7, AlkaEarth=0.03, Chalcogen=1.45
2	4.5 h	NobelGas=0.8, AlkaMetal=0.9, Chalcogen=0.45

Test: test10682PwrGroupsNone

Tests proper activity apportionment and material creation for the *groups* material mode and *none* PIR release mode.

Facility: Arkansas One-1 (PWR)
Operating Power: 2550.0 MWt
Material Mode: Groups
PIR Release Mode: None
Source Term: Percent Inventory
Shutdown Duration: 1.0 h
Release Duration: 7.0 h
Releases:

#	Duration	Percentages by Group
0	1.0 h	0
1	5.0 h	NobleGas=3.0, AlkaMetal=0.003, Halogens=0.003, Chalcogen=0.03, Platinoid=1.68e-6, Tetravalent=4.0e-7, Trivalent=6.0e-7
2	2.0 h	NobleGas=17, AlkaMetal=0.07, AlkaEarth=8.95e-5, Halogens=0.089, Chalcogen=0.64,Platinoid=6.2e-6, Tetravalent=7.0e-7, Trivalent=1.6e-6

Test: test10682RascalGroupsNone

Tests proper activity apportionment and material creation for a RASCAL source term and the *groups* material mode.

Facility: Robinson-2 (PWR)
Operating Power: 2295.0 MWt
Material Mode: Groups
Source Term: Rascal Project
Units: Ci
Release Times: 0.0, 2.0, 4.0, 6.0, 8.0 h
Isotopes: Ba-140, Ce-141, Ce-144, Cs-137, I-131, Kr-85, La-140, Mo-99, Nb-95, Nd-147, Pr-143, Pu-239, Ru-103, Ru-106, Sr-89, Sr-90, Te-129, Xe-133, Xe-135, Y-91, Zr-95

Test: test10682RascalSimpleNone

Tests proper activity apportionment and material creation for a RASCAL source term and the *groups* material mode.

Facility: Robinson-2 (PWR)
Operating Power: 2295.0 MWt
Material Mode: Simple
Source Term: Rascal Project
Units: Ci
Release Times: 0.0, 2.0, 4.0, 6.0, 8.0 h
Isotopes: Ba-140, Ce-141, Ce-144, Cs-137, I-131, Kr-85, La-140, Mo-99, Nb-95, Nd-147, Pr-143, Pu-239, Ru-103, Ru-106, Sr-89, Sr-90, Te-129, Xe-133, Xe-135, Y-91, Zr-95

Test: test10682SimpleExplicit

Tests that activity apportionment and per-particle-size material creation do not occur for a scenario using the *explicit* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3414.0 MWt
Material Mode: Simple
PIR Release Mode: Explicit
Source Term: Percent Inventory
Shutdown Duration: 0
Release Duration: 7.0 h
Releases:

#	Duration	Percentages by Group
0	0.5 h	NobleGas=0.01, AlkaMetal=0.6, Chalcogen=0.35,
1	2.0 h	NobleGas=0.09, AlkaMetal=1.7, AlkaEarth=0.03, Chalcogen=1.45,
2	4.5 h	NobleGas=0.8, AlkaMetal=0.9, Chalcogen=0.45

Test: test10682SimpleNone

Tests that activity apportionment and per-particle-size material creation do not occur for a scenario using the *none* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3414.0 MWt
Material Mode: Simple
PIR Release Mode: None
Source Term: Percent Inventory
Shutdown Duration: 0
Release Duration: 7.0 h
Releases:

#	Duration	Percentages by Group
0	0.5 h	NobleGas=0.01, AlkaMetal=0.6, Chalcogen=0.35,
1	2.0 h	NobleGas=0.09, AlkaMetal=1.7, AlkaEarth=0.03, Chalcogen=1.45,
2	4.5 h	NobleGas=0.8, AlkaMetal=0.9, Chalcogen=0.45

Test: test10682UnsupportedGroupsNone

Tests that activity apportionment and per-particle-size material creation do not occur even though requested via the *groups* material mode for an unsupported facility type and the *none* PIR release mode.

Facility:	Hartlepool-1 (AGR)
Operating Power:	1785.0 MWt
Material Mode:	*disabled*
PIR Release Mode:	None
Source Term:	Percent Inventory
Shutdown Duration:	1.0 h
Release Duration:	7.0 h

Releases:

#	Duration	Percentages by Group
0	1.0 h	0
1	2.0 h	NobleGas=3.0, AlkaMetal=0.003, Halogens=0.003, Chalcogen=0.03, Platinoid=1.68e-6, Tetravalent=4.0e-7, Trivalent=6.0e-7
2	5.0 h	NobleGas=17, AlkaMetal=0.07, AlkaEarth=8.95e-5, Chalcogen=0.64, Platinoid=6.2e-6, Tetravalent=7.0e-7, Trivalent=1.6e-6

Test: test10682VverGroupsNone

Tests proper activity apportionment and material creation occurs for a VVER facility based on the model for a PWR using the *groups* material mode and the *none* PIR release mode.

Facility:	Zaporozhe-1 (VVER-1000)
Operating Power:	2850.0 MWt
Material Mode:	Groups
PIR Release Mode:	None
Source Term:	Percent Inventory
Shutdown Duration:	1.0 h
Release Duration:	7.0 h

Releases:

#	Duration	Percentages by Group
0	1.0 h	0
1	2.0 h	NobleGas=3.0, AlkaMetal=0.003, Halogens=0.003, Chalcogen=0.03, Platinoid=1.68e-6, Tetravalent=4.0e-7, Trivalent=6.0e-7
2	5.0 h	NobleGas=17, AlkaMetal=0.07, AlkaEarth=8.95e-5, Chalcogen=0.64, Platinoid=6.2e-6, Tetravalent=7.0e-7, Trivalent=1.6e-6

Test: test11653

Explicitly tests the fix for SPCR 11653 to ensure a custom inventory is accounted for when determining the available plant conditions source terms.

Facility:	Arkansas One-1 (PWR)
Operating Power:	2550.0 MWt
Custom Inventory:	Created from kewaunee.f71 ORIGEN file
Material Mode:	Simple
Source Term:	Mix Specified by Analyst
Gross Release Rate:	1.0 Ci/s
Release Percentages:	
Nobel Gases:	98.0%
Halogens:	2.0%

Test: testAnalystMix

Tests an AnalystMix model instance with the following properties:

Facility:	Brunswick-1 (BWR Mk-1)		
Operating Power:	2949.0 MWt		
Material Mode:	Simple	Nobel Gases:	98.0%
Source Term:	Mix Specified by Analyst	Halogens:	2.0%
Gross Release Rate:	100.0 Ci/s		
Release Percentages:			

Test: testContainmentMonitorReading

Tests a ContainmentMonitorReading model instance with the following properties:

Facility:	Brunswick-1 (BWR Mk-1)
Operating Power:	2949.0 MWt
Material Mode:	Simple
Source Term:	Containment Monitor Reading
Leak Rate:	10%/h
Monitor Location:	Wet Well
Monitor Reading:	25.0 R/h
Release Path:	Unfiltered
Sprays:	Off

Test: testIsotopicConcentrations

Tests a IsotopicConcentrations model instance with the following properties:

Facility:	Brunswick-1 (BWR Mk-1)		
Operating Power:	2949.0 MWt	Cs-130:	130.0
Material Mode:	Simple	Cs-131:	131.0
Source Term:	Isotopic Concentrations	I-130:	130.0
Concentration Units:	kCi/cc	I-132:	132.0
Release Rate:	20.0 cc/s	I-133:	133.0
Isotope Values:			

Test: testIsotopicReleaseRates

Tests a IsotopicReleaseRates model instance with the following properties:

		Cs-130:	130.0
Facility:	Brunswick-1 (BWR Mk-1)	Cs-131:	131.0
Operating Power:	2949.0 MWt	Cs-132:	132.0
Material Mode:	Simple	Cs-134:	134.0
Source Term:	Isotopic Release Rates	I-130:	130.0
Release Units:	kCi/s	I-131:	131.0
Isotope Values:		I-132:	132.0
		I-133:	133.0

Test: testModerate

Tests an operational ModerateModel instance with properties:

Facility:	Brunswick-1 (BWR Mk-1)
Operating Power:	2949.0 MWt

Test: testMultiFive

Tests a project with five NFAC incidents.

Facility:	Calvert Cliffs-1 (PWR)
Operating Power:	2535.0 MWt
Materal Mode:	Simple
Source Term:	Steam Generator Tube Rupture (Coolant)
Partitioned Generator:	false
Release Rate:	1 Tube (35%/h)
Release Source:	Steam Jet Air Ejector

Facility:	Limerick-1 (BWR Mk-2)
Operating Power:	3165.0 MWt
Materal Mode:	Simple
Source Term:	Dry Well Leakage/Failure (BWR Containment)
Core Condition:	Vessel Melt Through
Leak Rate:	50%/h (release duration=2.0 h)
Filtered Release Path:	false
Sprays On:	false

Facility:	Oyster Creek (BWR Mk-1)
Operating Power:	1950.0 MWt
Materal Mode:	Simple
Source Term:	Containment Monitor Reading
Leak Rate:	50%/h (release duration=2.0 h)
Monitor Location:	Wet Well
Monitor Reading:	20.0 R/h
Release Path:	Unfiltered
Sprays:	Off

Facility:	Peach Bottom-2 (BWR Mk-1)
Operating Power:	3414.0 MWt
Materal Mode:	Simple
Source Term:	Spent Fuel/Spent Fuel Pool
Fuel Condition:	Fuel Cladding Failure
Number of Batches:	1
Release Path:	Unfiltered
Sprays:	Off
Time Last Batch in Pool:	*same as ReleaseToContainment*

Facility:	Salem-1 (PWR)
Operating Power:	3507.0 MWt
Materal Mode:	Simple
Source Term:	Large, Dry, or Subatmospheric Containment Leakage/Failure
Core Condition:	Gap Release
Filtered Release Path:	false
Leak Rate:	50%/h (release duration=2.0 h)
Sprays On:	false

Test: testPCConfinementByPass

Tests a PCConfinementByPass plant conditions model instance with properties:

Facility:	Hartlepool-1 (AGR)
Operating Power:	1785.0 MWt
Material Mode:	*disabled*
Source Term:	Plant Conditions: Bypass of Confinement
Core Condition:	Gap Release
Leak Rate:	25%/h (release duration=4.0 h)

Test: testPCConfinementLeakage

Tests a PCConfinementLeakage plant conditions model instance with properties:

Facility:	Novovoronezh-3 (VVER-400/230)
Operating Power:	1155.0 MWt
Material Mode:	Simple
Source Term:	Plant Conditions: Confinement Leakage/Failure
Core Condition:	Gap Release
Leak Rate:	50%/h (release duration=2.0 h)

Test: testPCContainmentByPass

Tests a PCContainmentByPass plant conditions model instance with properties:

Facility:	Hamaoka-3 (BWR Mk-1)
Operating Power:	3168.0 MWt
Material Mode:	Simple
Source Term:	Plant Conditions: Bypass of Containment
Core Condition:	Gap Release
Leak Rate:	100%/h (release duration=1.0 h)
Filtered Release Path:	false

Test: testPCContainmentLeakage

Tests a PCContainmentLeakage plant conditions model instance with properties:

Facility:	Beloyarski-3 (BN-600) (LMFBR)
Operating Power:	1680.0 MWt
Material Mode:	*disabled*
Source Term:	Plant Conditions: Containment Leakage/Failure
Core Condition:	Gap Release
Leak Rate:	50%/h (release duration=2.0 h)
Filtered Release Path:	false

Test: testPCDryWellLeakage

Tests a PCDryWellLeakage plant conditions model instance with properties:

Facility:	Hamaoka-3 (BWR Mk-1)
Operating Power:	3168.0 MWt
Material Mode:	Simple
Source Term:	Plant Conditions: Dry Well Leakage/Failure (BWR Containment)
Core Condition:	Gap Release
Filtered Release Path:	false
Leak Rate:	100%/h (release duration=1.0 h)
Sprays On:	false

Test: testPCIceCondenserContainmentCoreDamage

Tests a PCIceCondenserContainment plant conditions model instance with properties:

Facility:	Watts Bar-1 (PWR)
Operating Power:	3465.0 MWt
Material Mode:	Simple
Source Term:	Plant Conditions: Ice Condenser Containment Leakage/Failure
Core Condition:	In-Vessel Severe Core Damage
Fans On:	true
Filtered Release Path:	true
Ice Bed Exhausted:	true
Leak Rate:	50%/h (release duration=2.0 h)
Sprays On:	true

Test: testPCIceCondenserContainmentGapRelease

Tests a PCIceCondenserContainment plant conditions model instance with properties:

Facility:	Watts Bar-1 (PWR)
Operating Power:	3465.0 MWt
Material Mode:	Simple
Source Term:	Plant Conditions: Ice Condenser Containment Leakage/Failure
Core Condition:	Gap Release
Fans On:	false
Filtered Release Path:	false
Ice Bed Exhausted:	false
Leak Rate:	50%/h (release duration=2.0 h)
Sprays On:	false

Test: testPCIceCondenserContainmentMeltThrough

Tests a PCIceCondenserContainment plant conditions model instance with properties:

Facility:	Watts Bar-1 (PWR)
Operating Power:	3465.0 MWt
Material Mode:	Simple
Source Term:	Plant Conditions: Ice Condenser Containment Leakage/Failure
Core Condition:	Vessel Melt Through
Fans On:	false
Filtered Release Path:	false
Ice Bed Exhausted:	false
Leak Rate:	50%/h (release duration=2.0 h)
Sprays On:	false

Test: testPCLargeDrySubcontainmentLeakage

Tests a PCLargeDrySubcontainmentLeakage plant conditions model instance with properties:

Facility:	Beaver Valley-1 (PWR)
Operating Power:	2733.0 MWt
Material Mode:	Simple
Source Term:	Plant Conditions: Large, Dry, or Subatmospheric Containment Leakage/Failure
Core Condition:	Gap Release
Filtered Release Path:	false
Leak Rate:	100%/h (release duration=1.0 h)
Sprays On:	false

Test: testPCPromptCriticalPowerExcursion

Tests a PCPromptCriticalPowerExcursion plant conditions model instance with properties:

Facility:	Bilibino Unit A (RBMK)
Operating Power:	33.0 MWt
Material Mode:	*disabled*
Source Term:	Plant Conditions: Prompt Critical Power Excursion
Core Involvement:	Total

Test: testPCReproFacility

Tests a PCReproFacility plant conditions model instance with properties:

Facility:	Savannah River (Reprocessing)
Material Mode:	*disabled*
Source Term:	Plant Conditions: Reprocessing Facility
Plant Throughput:	1.0 tonnes/day
Release Rate:	100%/h (release duration=1.0 h)
Release Fraction by Component:	
Aqueous Waste Treatment:	0.5
Dissolution: :	1.0
Feed Adjustment and Accountability: :	1.0
Pu Recovery: :	0.5
Solvent Treatment: :	0.5
U-Pu Co-Decontamination, Partitioning, and U Purification:	1.0

Test: testPCSodiumWaterReaction

Tests a PCSodiumWaterReaction plant conditions model instance with properties:

Facility:	Phenix (LMFBR)
Custom Inventory:	stlauren_1.avc
Operating Power:	699.0 MWt
Material Mode:	*disabled*
Source Term:	Plant Conditions: Sodium-Water Reaction
Core Condition:	Gap Release
Leak Rate:	50%/h (release duration=2.0 h)

Test: testPCSteamTubeRuptureCoreDamage

Tests a PCSteamTubeRupture plant conditions model instance with properties:

Facility:	Dungeness B-1 (AGR)
Operating Power:	1560.0 MWt
Material Mode:	*disabled*
Source Term:	Plant Conditions: Steam Generator Tube Rupture (Coolant)
Coolant Concentration:	In-Vessel Severe Core Damage
Partitioned Generator:	false
Release Rate:	1 Tube (35%/h)
Release Source:	Safety Valve

Test: testPCSteamTubeRuptureGapRelease

Tests a PCSteamTubeRupture plant conditions model instance with properties:

Facility:	Dungeness B-1 (AGR)
Operating Power:	1560.0 MWt
Material Mode:	*disabled*
Source Term:	Plant Conditions: Steam Generator Tube Rupture (Coolant)
Coolant Concentration:	Gap Release
Partitioned Generator:	false
Release Rate:	1 Tube (35%/h)
Release Source:	Safety Valve

Test: testPCSubatmosphericConfinementLeakage

Tests a PCSubatmosphericConfinementLeakage plant conditions model instance with properties:

Facility:	Rovno-1 (VVER-440/213)
Operating Power:	1143.0 MWt
Material Mode:	Simple
Source Term:	Plant Conditions: Subatmospheric Confinement Leakage/Failure
Core Condition:	Gap Release
Leak Rate:	100%/h (release duration=1.0 h)
Pool Suppression System:	true

Test: testPCWetWellLeakage

Tests a PCWetWellLeakage plant conditions model instance with properties:

Facility:	Hamaoka-3 (BWR Mk-1)
Operating Power:	3168.0 MWt
Material Mode:	Simple
Source Term:	Plant Conditions: Wet Well Leakage/Failure (BWR Containment)
Core Condition:	Gap Release
Leak Rate:	100%/h (release duration=1.0 h)
Filtered Release Path:	false
Wet Well:	Saturated

Test: testRascalProject

Tests a RascalProject model instance with properties:

Facility:	Brunswick-1 (BWR Mk-1)
Operating Power:	2949.0 MWt
Material Mode:	Simple
Source Term:	Rascal Project
Units:	Ci
Release Times:	0.0, 0.25, 0.5, 0.75, ..., 8.0 h
Isotopes:	Ba-139, Ba-140, Cs-134, Cs-136, Cs-137, Cs-138, I-131, I-132, I-133, I-134, I-135, Kr-83m, Kr-85, Kr-85m, Kr-87, Kr-88, La-140, Mo-99, Rb-86, Rb-88, Rh-103, Rh-105, Ru-103, Ru-105, Ru-106, Sb-127, Sb-129, Sr-89, Sr-90, Sr-91, Sr-92, Tc-99m, Tc-127, Tc-127m, Tc-129, Tc-129m, Tc-131, Tc-131m, Tc-132, Xc-131m, Xc-133, Xc-133m, Xc-135, Xc-135m, Xc-138, Y-90, Y-91, Y-91m, Y-92

Test: testSevere

Tests an operational SevereModel instance with properties:

Facility:	Brunswick-1 (BWR Mk-1)
Operating Power:	2949.0 MWt

Test: testSpentFuel

Tests an operational SpentFuel instance with properties:

Facility:	Brunswick-1 (BWR Mk-1)
Operating Power:	2949.0 MWt
Source Term:	Spent Fuel/Spent Fuel Pool
Fuel Condition:	Fuel Cladding Failure
Number of Batches:	1
Release Path:	Unfiltered
Sprays:	Off
Time Last Batch in Pool:	*6 months prior to ReleaseToContainment*

4.3 MODELTIMESTEST

One of the most critical aspects of NFAC processing is correct management of event times within a scenario. There are six possible events whose times define or are defined by associated durations:

Event	Associated Duration	From Event
Shutdown / Start of Decay		
Release to Containment	Containment	Start of Decay
Release to Environment	Shutdown	Start of Decay
	Holdup	Release to Containment
End of Release	Release	Release to Environment
End of Dispersion	Dispersion	End of Release
End of Exposure	Exposure	End of Dispersion

For some NFAC source models, individual events have no meaning and thus are ignored and not displayed in the GUI. Some times are computed directly from the model definition and thus are made uneditable (although displayed) in the GUI. Which times are displayed and/or editable are determined based on the model, and uneditable times must be computed based on the model parameters. Finally, uneditable times can be forced to be editable via the Advanced Mode toggle button in the When tab. The purpose of this test suite is to exercise event times management against various models and conditions. The eight tests are described below. Each unique times management class is tested.

NFAC components tested:

mil.dtra.hpac.models.nfac.CAcomp.data.ModelTimes

mil.dtra.hpac.models.nfac.CAcomp.data.times.AnalystMixTimesMgr
mil.dtra.hpac.models.nfac.CAcomp.data.times.IsotopicConcentrationsTimesMgr
mil.dtra.hpac.models.nfac.CAcomp.data.times.IsotopicReleaseRatesTimesMgr
mil.dtra.hpac.models.nfac.CAcomp.data.times.ModelTimesMgr
mil.dtra.hpac.models.nfac.CAcomp.data.times.ModelTimesMgrFactory
mil.dtra.hpac.models.nfac.CAcomp.data.times.OperationalTimesMgr
mil.dtra.hpac.models.nfac.CAcomp.data.times.PCContainmentByPassTimesMgr
mil.dtra.hpac.models.nfac.CAcomp.data.times.PercentInventoryTimesMgr
mil.dtra.hpac.models.nfac.CAcomp.data.times.RascalProjectTimesMgr
mil.dtra.hpac.models.nfac.CAcomp.data.times.SpentFuelTimesMgr

Test: testAnalystMix

This test verifies the following:

- The ModelTimesMgrFactory.getInstance() method correctly returns an AnalystMixTimesMgr instance for an AnalystMix model.
- The default times based on test input times are correctly set by the AnalystMixTimesMgr instance.
- After explicit settings of editable times, the Release to Environment and Release to Containment times are equivalent.

Test: testIsotopicConcentrations

This test verifies the following:

- The ModelTimesMgrFactory.getInstance() method correctly returns an IsotopicConcentrationsTimesMgr instance for an IsotopicConcentrations model.
- The default times based on test input times are correctly set by the IsotopicConcentrationsTimesMgr instance.
- After explicit settings of editable times, the Start of Decay, Release to Containment, and Release to Environment times are equivalent.

Test: testIsotopicReleaseRates

This test verifies the following:

- The ModelTimesMgrFactory.getInstance() method correctly returns an IsotopicReleaseRatesTimesMgr instance for an IsotopicReleaseRates model.
- The default times based on test input times are correctly set by the IsotopicReleaseRatesTimesMgr instance.
- After explicit settings of editable times, the Start of Decay, Release to Containment, and Release to Environment times are equivalent.

Test: testPCContainmentByPass

This test verifies the following:

- The ModelTimesMgrFactory.getInstance() method correctly returns a PCContainmentByPassTimesMgr instance for an PCContainmentByPass model.
- The default times based on test input times are correctly set by the PCContainmentByPassTimesMgr instance.
- After explicit settings of editable times, the Start of Decay and Release to Containment times are equivalent, and the Shutdown, Release, Dispersion, and Exposure durations are all correct.

Test: testPercentInventoryNoShutdown

This test verifies the following:

- The ModelTimesMgrFactory.getInstance() method correctly returns a PercentInventoryTimesMgr instance for a PercentInventory model.
- After explicit setting of editable times, the Release to Containment and Release to Environment times are equivalent, the Shutdown Duration is zero, and the Release, Dispersion, and Exposure durations are correct.
- After explicit setting of editable times in lenient mode, the Release to Containment and Release to Environment times are equivalent, and the Shutdown, Release, Dispersion, and Exposure durations are correct for the input times.

Test: testPercentInventoryShutdown

This test verifies the following:

- The ModelTimesMgrFactory.getInstance() method correctly returns a PercentInventoryTimesMgr instance for a PercentInventory model.
- After explicit setting of editable times, the Release to Containment and Release to Environment times are equivalent, and the Shutdown, Release, Dispersion, and Exposure durations are correct.
- After explicit setting of editable times in lenient mode, the Release to Containment and Release to Environment times are equivalent, and the Shutdown, Release, Dispersion, and Exposure durations are correct for the input times.

Test: testRascalProject

This test verifies the following:

- The ModelTimesMgrFactory.getInstance() method correctly returns a RascalProjectTimesMgr instance for an RascalProject model.
- After explicit setting of editable times, the Start of Decay, Release to Containment and Release to Environment times are equivalent.

Test: testSpentFuel

This test verifies the following:

- The ModelTimesMgrFactory.getInstance() method correctly returns a SpentFuelTimesMgr instance for an SpentFuel model.
- After explicit setting of editable times, the Start of Decay and Release to Containment times are equivalent, and the Holdup, Shutdown, Release, Dispersion, and Exposure durations are correct.

4.4 PIRMODELDEFSTEST

This suite contains 24 individual tests designed to verify proper function of Percent Inventory models and special processing associated with them. For each test there is a corresponding HPAC 6 project (*.hpac6*) file or a project export (*.zip*) file. For most tests a source term report (*.html*) is requested and compared to the baseline fixture, and when appropriate a log file (*.log*) is an additional fixture.

Included in this suite is verification that user overrides of model times and durations (see Section 4.3) result in correctly prorated PIR durations, and proper handling of material modes (refer to Section 2.2) and PIR release modes (refer to Section 2.3).

Test: testPIRGroupsAvgNoShutdown

Tests a PercentInventory model instance with no shutdown time and using *groups* material mode and *average* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3924.0 MWt
Material Mode: Groups
PIR Release Mode: Average
Source Term: Percent Inventory
Shutdown Duration: 0
Release Duration: 6.695 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
1	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRGroupsAvgWithShutdown

Tests a PercentInventory model instance with a shutdown time and using *groups* material mode and *average* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3924.0 MWt
Material Mode: Groups
PIR Release Mode: Average
Source Term: Percent Inventory
Shutdown Duration: 41.7 m
Release Duration: 6.695 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	0
1	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
2	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRGroupsExplWithShutdown

Tests a PercentInventory model instance with a shutdown time and using *groups* material mode and *explicit* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3924.0 MWt
Material Mode: Groups
PIR Release Mode: Explicit
Source Term: Percent Inventory
Shutdown Duration: 41.7 m
Release Duration: 6.695 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	0
1	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
2	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRGroupsNoneNoShutdown

Tests a PercentInventory model instance with no shutdown time and using *groups* material mode and *none* PIR release mode.

Facility:	Peach Bottom-2 (BWR Mk-1)
Operating Power:	3924.0 MWt
Material Mode:	Groups
PIR Release Mode:	None
Source Term:	Percent Inventory
Shutdown Duration:	0
Release Duration:	6.695 h

Releases:

#	Duration	Percentages by Group
0	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
1	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRGroupsNoneWithShutdown

Tests a PercentInventory model instance with a shutdown time and using *groups* material mode and *none* PIR release mode.

Facility:	Peach Bottom-2 (BWR Mk-1)
Operating Power:	3924.0 MWt
Material Mode:	Groups
PIR Release Mode:	None
Source Term:	Percent Inventory
Shutdown Duration:	41.7 m
Release Duration:	6.695 h

Releases:

#	Duration	Percentages by Group
0	41.7 m	0
1	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
2	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRMcAvgNoShutdown

Tests a PercentInventory model instance with no shutdown time and using *multicomponent* material mode and *average* PIR release mode.

Facility:	Peach Bottom-2 (BWR Mk-1)
Operating Power:	3924.0 MWt
Material Mode:	Multicomponent
PIR Release Mode:	Average
Source Term:	Percent Inventory
Shutdown Duration:	0
Release Duration:	6.695 h
Releases:	

#	Duration	Percentages by Group
0	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
1	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRMcAvgWithShutdown

Tests a PercentInventory model instance with a shutdown time and using *multicomponent* material mode and *average* PIR release mode.

Facility:	Peach Bottom-2 (BWR Mk-1)
Operating Power:	3924.0 MWt
Material Mode:	Multicomponent
PIR Release Mode:	Average
Source Term:	Percent Inventory
Shutdown Duration:	41.7 m
Release Duration:	6.695 h
Releases:	

#	Duration	Percentages by Group
0	41.7 m	0
1	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
2	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRMcExplNoShutdown

Tests a PercentInventory model instance with no shutdown time and using *multicomponent* material mode and *explicit* PIR release mode.

Facility:	Peach Bottom-2 (BWR Mk-1)
Operating Power:	3924.0 MWt
Material Mode:	Multicomponent
PIR Release Mode:	Explicit
Source Term:	Percent Inventory
Shutdown Duration:	0
Release Duration:	6.695 h
Releases:	

#	Duration	Percentages by Group
0	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
1	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRMcExplWithShutdown

Tests a PercentInventory model instance with a shutdown time and using *multicomponent* material mode and *explicit* PIR release mode.

Facility:	Peach Bottom-2 (BWR Mk-1)
Operating Power:	3924.0 MWt
Material Mode:	Multicomponent
PIR Release Mode:	Explicit
Source Term:	Percent Inventory
Shutdown Duration:	41.7 m
Release Duration:	6.695 h

Releases:

#	Duration	Percentages by Group
0	41.7 m	0
1	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
2	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRMcNoneNoShutdown

Tests a PercentInventory model instance with no shutdown time and using *multicomponent* material mode and *none* PIR release mode.

Facility:	Peach Bottom-2 (BWR Mk-1)
Operating Power:	3924.0 MWt
Material Mode:	Multicomponent
PIR Release Mode:	None
Source Term:	Percent Inventory
Shutdown Duration:	0
Release Duration:	6.695 h

Releases:

#	Duration	Percentages by Group
0	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
1	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRMcNoneWithShutdown

Tests a PercentInventory model instance with a shutdown time and using *multicomponent* material mode and *none* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3924.0 MWt
Material Mode: Multicomponent
PIR Release Mode: None
Source Term: Percent Inventory
Shutdown Duration: 41.7 m
Release Duration: 6.695 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	0
1	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
2	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRSimpleAvgNoShutdown

Tests a PercentInventory model instance with no shutdown time and using *simple* material mode and *average* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3924.0 MWt
Material Mode: Simple
PIR Release Mode: Average
Source Term: Percent Inventory
Shutdown Duration: 0
Release Duration: 6.695 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
1	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRSimpleAvgWithShutdown

Tests a PercentInventory model instance with a shutdown time and using *simple* material mode and *average* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3924.0 MWt
Material Mode: Simple
PIR Release Mode: Average
Source Term: Percent Inventory
Shutdown Duration: 41.7 m
Release Duration: 6.695 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	0
1	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
2	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRSimpleExplNoShutdown

Tests a PercentInventory model instance with no shutdown time and using *simple* material mode and *explicit* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3924.0 MWt
Material Mode: Simple
PIR Release Mode: Explicit
Source Term: Percent Inventory
Shutdown Duration: 0
Release Duration: 6.695 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
1	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRSimpleExplWithShutdown

Tests a PercentInventory model instance with a shutdown time and using *simple* material mode and *explicit* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3924.0 MWt
Material Mode: Simple
PIR Release Mode: Explicit
Source Term: Percent Inventory
Shutdown Duration: 41.7 m
Release Duration: 6.695 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	0
1	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
2	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRSimpleNoneNoShutdown

Tests a PercentInventory model instance with no shutdown time and using *simple* material mode and *none* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3924.0 MWt
Material Mode: Simple
PIR Release Mode: None
Source Term: Percent Inventory
Shutdown Duration: 0
Release Duration: 6.695 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
1	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRSimpleNoneWithShutdown

Tests a PercentInventory model instance with a shutdown time and using *simple* material mode and *none* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3924.0 MWt
Material Mode: Simple
PIR Release Mode: None
Source Term: Percent Inventory
Shutdown Duration: 41.7 m
Release Duration: 6.695 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	0
1	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=1.45
2	6.0 h	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.67, LessVolatile=0.27

Test: testPIRSubReleasesAverage

Tests a PercentInventory model instance with the *average* PIR release mode.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3414.0 MWt
Material Mode: Simple
PIR Release Mode: Average
Source Term: Percent Inventory
Shutdown Duration: 30.0 m
Release Duration: 48.0 h
Releases:

#	Duration	Percentages by Group
0	48.0 h	NobelGas=100

Test: testPIRSubReleasesExplicit

Tests a PercentInventory model instance with the *explicit* PIR release mode.

Facility:	Peach Bottom-2 (BWR Mk-1)
Operating Power:	3414.0 MWt
Material Mode:	Simple
PIR Release Mode:	Explicit
Source Term:	Percent Inventory
Shutdown Duration:	30.0 m
Release Duration:	48.0 h

Releases:

#	Duration	Percentages by Group
0	48.0 h	NobelGas=100

Test: testPIRSubReleasesNone

Tests a PercentInventory model instance with the *none* PIR release mode.

Facility:	Peach Bottom-2 (BWR Mk-1)
Operating Power:	3414.0 MWt
Material Mode:	Simple
PIR Release Mode:	None
Source Term:	Percent Inventory
Shutdown Duration:	30.0 m
Release Duration:	48.0 h

Releases:

#	Duration	Percentages by Group
0	48.0 h	NobelGas=100

Test: testPercentInventoryNoShutdownAsIs

Tests a PercentInventory model instance with no shutdown duration defined in the releases and no override of the model event times.

Facility:	Watts Bar-1 (PWR)
Operating Power:	3465.0 MWt
Material Mode:	Simple
PIR Release Mode:	Average
Source Term:	Percent Inventory
Shutdown Duration:	0
Release Duration:	44.9 h

Releases:

#	Duration	Percentages by Group
0	1.9 h	NobleGas=3.0, AlkaMetal=0.003, AlkaEarth=1e-5, Halogens=0.003, Chalcogen=0.03, Platinoid=1.2e-7
1	32.0 h	NobleGas=3.0, AlkaMetal=0.003, Halogens=0.003, Chalcogen=0.03, Platinoid=1.68e-6, Tetravalent=4.0e-7, Trivalent=6.0e-7
2	11.0 h	NobleGas=17, AlkaMetal=0.07, AlkaEarth=8.95e-5, Halogens=8.9e-2, Chalcogen=0.64, Platinoid=6.2e-6, Tetravalent=7.0e-7, Trivalent=1.6e-6

Test: testPercentInventoryNoShutdownForced

Tests a PercentInventory model instance with no shutdown duration defined in the releases, but model event times are overridden to force a shutdown time.

Facility:	Watts Bar-1 (PWR)
Operating Power:	3465.0 MWt
Material Mode:	Simple
PIR Release Mode:	Average
Source Term:	Percent Inventory
Shutdown Duration:	10 m
Release Duration:	44.9 h

Releases:

#	Duration	Percentages by Group
0	1.9 h	NobleGas=3.0, AlkaMetal=0.003, AlkaEarth=1e-5, Halogens=0.003, Chalcogen=0.03, Platinoid=1.2e-7
1	32.0 h	NobleGas=3.0, AlkaMetal=0.003, Halogens=0.003, Chalcogen=0.03, Platinoid=1.68e-6, Tetravalent=4.0e-7, Trivalent=6.0e-7
2	11.0 h	NobleGas=17, AlkaMetal=0.07, AlkaEarth=8.95e-5, Halogens=8.9e-2, Chalcogen=0.64, Platinoid=6.2e-6, Tetravalent=7.0e-7, Trivalent=1.6e-6

Test: testPercentInventoryWithShutdownAsIs

Tests a PercentInventory model instance with a shutdown duration defined in the releases and no override of the model event times.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3414.0 MWt
Material Mode: Simple
PIR Release Mode: Average
Source Term: Percent Inventory
Shutdown Duration: 41.7 m
Release Duration: 11.3 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	0
1	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=0.35
2	83.33 m	NobelGas=0.09, AlkaMetal=1.7, AlkaEarth=0.03, Chalcogen=1.45
3	250.0 m	NobelGas=0.8, AlkaMetal=0.9, Chalcogen=0.45
4	303.0 m	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.22, LessVolatile=0.27

Test: testPercentInventoryWithShutdownForced

Tests a PercentInventory model instance with a shutdown duration defined in the releases, but model event times are overridden to force no shutdown time.

Facility: Peach Bottom-2 (BWR Mk-1)
Operating Power: 3414.0 MWt
Material Mode: Simple
PIR Release Mode: Average
Source Term: Percent Inventory
Shutdown Duration: 41.7 m
Release Duration: 11.3 h
Releases:

#	Duration	Percentages by Group
0	41.7 m	0
1	41.7 m	NobelGas=0.01, AlkaMetal=0.6, Chalcogen=0.35
2	83.33 m	NobelGas=0.09, AlkaMetal=1.7, AlkaEarth=0.03, Chalcogen=1.45
3	250.0 m	NobelGas=0.8, AlkaMetal=0.9, Chalcogen=0.45
4	303.0 m	NobelGas=0.3, AlkaMetal=0.1, Chalcogen=0.22, LessVolatile=0.27

4.5 PARTICLEGROUPSMGRTEST

The major enhancement for NFAC version 6.3 was the addition of a new mode for processing materials. Refer to Section 2.2 for a description of the material modes. This test suite is comprised of seven tests that ensure the apportionment tables are properly read and activity apportionment and material creation are correctly processsed.

NFAC components tested:

mil.dtra.hpac.models.nfac.CAcomp.data.ParticleGroups
mil.dtra.hpac.models.nfac.CAcomp.data.ParticleGroupsMgr

Test: testBWRCounts

Checks that the number of particle size groups, MELCOR groups, and table entries for each MELCOR group associated with the BWR facility type, as read from *defaults.properties*, are correct.

Test: testBWRValues

Checks that the BWR table entries giving apportionments for each MELCOR group and particle group, as read from *defaults.properties* are correct.

Test: testPWRCounts

Checks that the number of particle size groups, MELCOR groups, and table entries for each MELCOR group associated with the PWR facility type, as read from *defaults.properties*, are correct.

Test: testPWRValues

Checks that the PWR table entries giving apportionments for each MELCOR group and particle group, as read from *defaults.properties*, are correct.

Test: testReadCounts

Checks that the number of particle group tables and the list of associated facility types, as read from *defaults.properties*, are correct.

Test: testTypeMap

Verifies that the table associated with each reactor type and subtype are correct if the type/subtype should be supported and are not specified otherwise.

Test: testWriteAndRead

Verifies that the java.util.Properties entries as read from *defaults.properties* can be written and read back with the same resulting deserialized objects.

4.6 SOURCETERMTABLETEST

Another critical piece of NFAC functionality is determination of which of the 22 source models are valid or can be applied to a specific facility definition. A facility definition includes the facility selected from NFAC's facility "database" as well as a reference to any custom inventory file. NFAC's SourceTermTable and PlantConditionTables classes encapsulate the capability of determining available source terms. They are "data driven" in that they read the *source_terms.data* and *plntcond.dat* files, respectively, to drive the determination process.

This test suite includes 26 individual tests to verify that the source model availability process functions correctly.

NFAC components tested:

mil.dtra.hpac.models.nfac.CAcomp.data.Facility

mil.dtra.hpac.models.nfac.CAcomp.data.FacilityDB
mil.dtra.hpac.models.nfac.CAcomp.data.FacilityDBMgr
mil.dtra.hpac.models.nfac.CAcomp.data.FacilityDef

mil.dtra.hpac.models.nfac.CAcomp.data.analyst.PlantConditionTables
mil.dtra.hpac.models.nfac.CAcomp.data.analyst.SourceTermTable

Test: testAGRCompatibility

Explicitly tests for individual model compatibility via the SourceTermTable.checkCompatability() method. The Dungeness B-1 and Windscale AGR facilities (without custom inventories) are tested against the following models with expected compatibility:

Dungeness B-1

AnalystMix	yes
ContainmentMonitorReading	no
IsotopicConcentrations	yes
IsotopicReleaseRates	yes
ModerateModel	no
PCLargeDrySubContainment	no
PercentInventory	yes
SevereModel	no
SpentFuel	no

Windscale AGR

PCConfinementByPass	yes
PCConfinementLeakage	yes
PCContainmentByPass	no
PCContainmentLeakage	no
PCDryWellLeakage	no
PCIceCondenserContainment	no
PCLargeDrySubContainmentLeakage	no
PCPromptCriticalPowerExcursion	no
PCReproFacility	no
PCSodiumWaterReaction	no
PCSteamTubeRupture	yes
PCSubatmosphericConfinementLeakage	no
PCWetWellLeakage	no

Test: testAGRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following AGR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Dungeness B-1	Windscale AGR[1]	Hunterston B-1[2]

1 Inventory filename set explicitly
2 Inventory filename cleared explicitly

Test: testBWR0SourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following BWR type-0 facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Leibstadt	Brunsbuettel (kkb)	Leibstadt[2]

2 Inventory filename cleared explicitly

Test: testBWR1SourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following BWR type-1 facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Santa Maria De Garona	Fukushima-Daiichi-1	Santa Maria De Garona[2]

2 Inventory filename cleared explicitly

Test: testBWR2SourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following BWR type-2 facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Fukushima-Daini-1	Fukushima-Daini-1[3]	Fukushima-Daini-1[2]

2 Inventory filename cleared explicitly
3 Explicitly set inactive

Test: testBWR3SourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following BWR type-3 facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Cofrentes	Cofrentes[3]	Cofrentes[2]

2 Inventory filename cleared explicitly
3 Explicitly set inactive

Test: testFBRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following FBR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Monju[1]	KNK II[1]	Monju

1 Inventory filename set explicitly

Test: testGCHWRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following GCHWR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Monts D'Arree[1]	Monts D'Arree	Monts D'Arree[4]

1 Inventory filename set explicitly
4 Explicitly set active

Test: testGCRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following GCR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Oldbury-1	Oldbury-2	Latina

Test: testHTGRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following HTGR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Peach Bottom-1[1,4]	Peach Bottom-1[1]	Peach Bottom-1

1 Inventory filename set explicitly
4 Explicitly set active

Test: testHWGCRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following HWGCR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
A-1 Bohunice[1,4]	A-1 Bohunice[1]	A-1 Bohunice

1 Inventory filename set explicitly
4 Explicitly set active

Test: testHWLWRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following HWLWR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Fugen ATR[1,4]	Fugen ATR[1]	Fugen ATR

1 Inventory filename set explicitly
4 Explicitly set active

Test: testLGRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following LGR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Hanford - N[1,4]	Toitsk E	Troitsk F[4]

1 Inventory filename set explicitly
4 Explicitly set active

Test: testLMFBRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following LMFBR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Beloyarsky-3(BN-600)[1]	Beloyarsky-4(BN-800)[1,3]	Beloyarsky-3(BN-600)

1 Inventory filename set explicitly
3 Explicitly set inactive

Test: testLWRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following LWR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Generic LWR Site	Generic LWR Site[3]	Generic LWR Site[2]

2 Inventory filename cleared explicitly
3 Explicitly set inactive

Test: testPHWRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following PHWR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Bruce-1	Gentilly-1	Agesta

Test: testPWRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following PWR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Doel-1	BR-3	Doel-2[2]

2 Inventory filename cleared explicitly

Test: testRBMKSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following RBMK facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Bilibino Unit A	Beloyarsky-1	Bilibino Unit A[2]

2 Inventory filename cleared explicitly

Test: testReproSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following Repro facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Idaho Falls ICPP	Mol	Idaho Falls ICPP[2]

2 Inventory filename cleared explicitly

Test: testResearchSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following Research facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
AFRRI TRIGA Reactor	BR-3 (Mol)	ATR

Test: testSGHWRSourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following SGHWR facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Winfrith SGHWR[1,4]	Winfrith SGHWR[1]	Winfrith SGHWR[4]

1 Inventory filename set explicitly
4 Explicitly set active

Test: testSPCR6787

This test verifies changes to research reactors in the NFAC facility database resulting from SPCR 6787. It calls FacilityDB.getFacilities() to list all facilities for a country code and then searches the list to the match name and research reactor facility type. Explicit tests by country are as follows.

Country	Facilities
Albania	(no existing research reactors)
China	CARR (Beijing), CEFR (Beijing), CMRR (Mienyang), HTR-10 (Beijing), HWRR-II (Beijing),
North Korea	IRT-DPRK, YONGBYON GCR
Portugal	RPI

Test: testVVER0SourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following VVER type-0 facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Bushehr-1	Bushehr-1[3]	Bushehr-1[2]

2 Inventory filename cleared explicitly
3 Explicitly set inactive

Test: testVVER1SourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following VVER type-1 facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Metzamor-2	Metzamor-1	Kola-1[2]

2 Inventory filename cleared explicitly

Test: testVVER2SourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following VVER type-2 facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Dukovany-1	Nord (Greifswald)-5	Dukovany-2[2]

2 Inventory filename cleared explicitly

Test: testVVER3SourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following VVER type-3 facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	With inventory + Inactive	No inventory
Kozloduy-5	Kozloduy-6[3]	Kalinin-3[2]

2 Inventory filename cleared explicitly
3 Explicitly set inactive

4.7 SOURCETERMTABLETEST2

This test suite is distinguished from SourceTermTableTest for cases in which no plant condition models apply. For now, this is limited to the new HWRESRC research facility type.

Test: testHWRESRC3SourceTerms

Calls SourceTermTable.isOperationalSupported(), SourceTermTable.getFacilityTerms(), and PlantConditionTables.getPlantConditionTerms() with the following HWRESRC facilities and conditions, verifying the correct source term names are returned:

With inventory + Active	No inventory
IR-40	IR-40[2]

2 Inventory filename cleared explicitly

4.8 RTHTIMESTEST

Interacts with RTH to test times returned from decay calculations when various decay times are passed as input.

Test Iteration	Start Time	Offsets
0	3.0h	1.0m, 15.0m, 30.0m, 1.0h, 2.0h
1	6.0h	1.0m, 15.0m, 30.0m, 1.0h, 2.0h
2	12.0h	1.0m, 15.0m, 30.0m, 1.0h, 2.0h
3	24.0h	1.0m, 15.0m, 30.0m, 1.0h, 2.0h
4	48.0h	1.0m, 15.0m, 30.0m, 1.0h, 2.0h
5	96.0h	1.0m, 15.0m, 30.0m, 1.0h, 2.0h
6	192.0h	1.0m, 15.0m, 30.0m, 1.0h, 2.0h
7	384.0h	1.0m, 15.0m, 30.0m, 1.0h, 2.0h
8	768.0h	1.0m, 15.0m, 30.0m, 1.0h, 2.0h
9	1536.0h	1.0m, 15.0m, 30.0m, 1.0h, 2.0h
10	720.0h	20.0m, 1.0h, 12.0h, 36.0h

4.9 SPCR6918TEST

This suite contains 44 individual tests designed to verify proper function of Percent Inventory models with the number *multicomponent* material mode and all the PIR release modes relative to the same scenarios using *simple* and *groups* material modes. Some aspects of these tests are covered in the PIRModelDefsTest suite, (Section 4.4), but this suite focuses on expected results in a typical NRC moderate accident scenario at Watts Bar-1 and an abbreviated version of that scenario. Moreover, this suite includes NFAC-RTH-SCIPUFF integration tests with plot output results as test artifacts. NFAC-RTH-SCIPUFF integration tests request areas of contours for the following fields:

Class	Choice	Kind	Category	Type
Isotope Ground Deposition	Total Activity		Surface Data	Mean Value (M)
RTH Radiation Field	Total Effective Dose	Rate	Surface Data	Mean Value (M)

The four scenarios over which the nine combinations of material and PIR release modes are repeated are defined as follows.

4.9.1 No Shutdown Full

This is the Watts Bar-1 moderate accident scenario with the shutdown period removed.

Facility: Watts Bar-2 (PWR)
Operating Power: 3480.0 MWt
Material Mode: Groups
PIR Release Mode: Average
Source Term: Percent Inventory
Shutdown Duration: 0
Release Duration: 44.9 h
Releases:

#	Duration	NG	AM	AE	Hal	Chal	Plat	Tetraval	Trival
0	1.9 h	3.0	0.003	1.0e-5	0.003	0.03	1.2e-7	0	0
1	32.0 h	3.0	0.003	0	0.003	0.03	1.68e-6	4.0e-7	6.0e-7
2	11.0 h	17.0	0.07	8.95e-5	0.089	0.64	6.2e-6	7.0e-7	1.6e-6

4.9.2 No Shutdown Partial

This is the Watts Bar-1 moderate accident scenario with the shutdown period removed, the second phased release removed, and the final phase reduced to a duration of 3.0 h.

Facility:	Watts Bar-2 (PWR)
Operating Power:	3480.0 MWt
Material Mode:	Groups
PIR Release Mode:	Average
Source Term:	Percent Inventory
Shutdown Duration:	0
Release Duration:	44.9 h

Releases:

#	Duration	NG	AM	AE	Hal	Chal	Plat	Tetraval	Trival
0	1.9 h	3.0	0.003	1.0e-5	0.003	0.03	1.2e-7	0	0
1	3.0 h	17.0	0.07	8.95e-5	0.089	0.64	6.2e-6	7.0e-7	1.6e-6

4.9.3 Shutdown Full

This is the Watts Bar-1 moderate accident scenario as defined by the NRC.

Facility:	Watts Bar-2 (PWR)
Operating Power:	3480.0 MWt
Material Mode:	Groups
PIR Release Mode:	Average
Source Term:	Percent Inventory
Shutdown Duration:	3.1 h
Release Duration:	44.9 h

Releases:

#	Duration	NG	AM	AE	Hal	Chal	Plat	Tetraval	Trival
0	1.9 h	3.0	0.003	1.0e-5	0.003	0.03	1.2e-7	0	0
1	32.0 h	3.0	0.003	0	0.003	0.03	1.68e-6	4.0e-7	6.0e-7
2	11.0 h	17.0	0.07	8.95e-5	0.089	0.64	6.2e-6	7.0e-7	1.6e-6

4.9.4 Shutdown Partial

This is the Watts Bar-1 moderate accident scenario with the second phased release removed, and the final phase reduced to a duration of 3.0 h.

Facility:	Watts Bar-2 (PWR)
Operating Power:	3480.0 MWt
Material Mode:	Groups
PIR Release Mode:	Average
Source Term:	Percent Inventory
Shutdown Duration:	3.1 h
Release Duration:	44.9 h
Releases:	

#	Duration	NG	AM	AE	Hal	Chal	Plat	Tetraval	Trival
0	1.9 h	3.0	0.003	1.0e-5	0.003	0.03	1.2e-7	0	0
1	3.0 h	17.0	0.07	8.95e-5	0.089	0.64	6.2e-6	7.0e-7	1.6e-6

Test:testNoShutdownFullGroupsAverage

An NFAC-RTH integration test, this exercises the ”No Shutdown Full” scenario with *groups* material mode and *average* PIR release mode.

Test:testNoShutdownFullGroupsExplicit

An NFAC-RTH integration test, this exercises the ”No Shutdown Full” scenario with *groups* material mode and *explicit* PIR release mode.

Test:testNoShutdownFullGroupsNone

An NFAC-RTH integration test, this exercises the ”No Shutdown Full” scenario with *groups* material mode and *none* PIR release mode.

Test:testNoShutdownFullMCAverage

An NFAC-RTH integration test, this exercises the ”No Shutdown Full” scenario with *multicomponent* material mode and *average* PIR release mode.

Test:testNoShutdownFullMCExplicit

An NFAC-RTH integration test, this exercises the ”No Shutdown Full” scenario with *multicomponent* material mode and *explicit* PIR release mode.

Test:testNoShutdownFullMCNone

An NFAC-RTH integration test, this exercises the ”No Shutdown Full” scenario with *multicomponent* material mode and *none* PIR release mode.

Test:testNoShutdownFullMCNoneContours

An NFAC-RTH-SCIPUFF integration test, this exercises the ”No Shutdown Full” scenario with *multicomponent* material mode and *none* PIR release mode and compares resulting contour areas.

Test:testNoShutdownFullSimpleAverage

An NFAC-RTH integration test, this exercises the ”No Shutdown Full” scenario with *simple* material mode and *average* PIR release mode.

Test:testNoShutdownFullSimpleExplicit

An NFAC-RTH integration test, this exercises the ”No Shutdown Full” scenario with *simple* material mode and *explicit* PIR release mode.

Test:testNoShutdownFullSimpleNone

An NFAC-RTH integration test, this exercises the ”No Shutdown Full” scenario with *simple* material mode and *none* PIR release mode.

Test:testNoShutdownPartialGroupsAverage

An NFAC-RTH integration test, this exercises the ”No Shutdown Partial” scenario with *groups* material mode and *average* PIR release mode.

Test:testNoShutdownPartialGroupsExplicit

An NFAC-RTH integration test, this exercises the ”No Shutdown Partial” scenario with *groups* material mode and *explicit* PIR release mode.

Test:testNoShutdownPartialGroupsNone

An NFAC-RTH integration test, this exercises the ”No Shutdown Partial” scenario with *groups* material mode and *none* PIR release mode.

Test:testNoShutdownPartialGroupsNoneContours

An NFAC-RTH-SCIPUFF integration test, this exercises the ”No Shutdown Partial” scenario with *groups* material mode and *none* PIR release mode and compares resulting contour areas.

Test:testNoShutdownPartialMCAverage

An NFAC-RTH integration test, this exercises the ”No Shutdown Partial” scenario with *multicomponent* material mode and *average* PIR release mode.

Test:testNoShutdownPartialMCExplicit

An NFAC-RTH integration test, this exercises the ”No Shutdown Partial” scenario with *multicomponent* material mode and *explicit* PIR release mode.

Test:testNoShutdownPartialMCNone

An NFAC-RTH integration test, this exercises the ”No Shutdown Partial” scenario with *multicomponent* material mode and *none* PIR release mode.

Test:testNoShutdownPartialMCNoneContours

An NFAC-RTH-SCIPUFF integration test, this exercises the ”No Shutdown Partial” scenario with *multicomponent* material mode and *none* PIR release mode and compares resulting contour areas.

Test:testNoShutdownPartialSimpleAverage

An NFAC-RTH integration test, this exercises the ”No Shutdown Partial” scenario with *simple* material mode and *average* PIR release mode.

Test:testNoShutdownPartialSimpleExplicit

An NFAC-RTH integration test, this exercises the ”No Shutdown Partial” scenario with *simple* material mode and *explicit* PIR release mode.

Test:testNoShutdownPartialSimpleNone

An NFAC-RTH integration test, this exercises the ”No Shutdown Partial” scenario with *simple* material mode and *none* PIR release mode.

Test:testNoShutdownPartialSimpleNoneContours

An NFAC-RTH-SCIPUFF integration test, this exercises the ”No Shutdown Partial” scenario with *simple* material mode and *none* PIR release mode and compares resulting contour areas.

Test:testShutdownFullGroupsAverage

An NFAC-RTH integration test, this exercises the ”Shutdown Full” scenario with *groups* material mode and *average* PIR release mode.

Test:testShutdownFullGroupsExplicit

An NFAC-RTH integration test, this exercises the ”Shutdown Full” scenario with *groups* material mode and *explicit* PIR release mode.

Test:testShutdownFullGroupsNone

An NFAC-RTH integration test, this exercises the ”Shutdown Full” scenario with *groups* material mode and *none* PIR release mode.

Test:testShutdownFullMCAverage

An NFAC-RTH integration test, this exercises the ”Shutdown Full” scenario with *multicomponent* material mode and *average* PIR release mode.

Test:testShutdownFullMCExplicit

An NFAC-RTH integration test, this exercises the ”Shutdown Full” scenario with *multicomponent* material mode and *explicit* PIR release mode.

Test:testShutdownFullMCNone

An NFAC-RTH integration test, this exercises the ”Shutdown Full” scenario with *multicomponent* material mode and *none* PIR release mode.

Test:testShutdownFullMCNoneContours

An NFAC-RTH-SCIPUFF integration test, this exercises the ”Shutdown Full” scenario with *multicomponent* material mode and *none* PIR release mode and compares resulting contour areas.

Test:testShutdownFullSimpleAverage

An NFAC-RTH integration test, this exercises the ”Shutdown Full” scenario with *simple* material mode and *average* PIR release mode.

Test:testShutdownFullSimpleExplicit

An NFAC-RTH integration test, this exercises the ”Shutdown Full” scenario with *simple* material mode and *explicit* PIR release mode.

Test:testShutdownFullSimpleNone

An NFAC-RTH integration test, this exercises the ”Shutdown Full” scenario with *simple* material mode and *none* PIR release mode.

Test:testShutdownPartialGroupsAverage

An NFAC-RTH integration test, this exercises the ”Shutdown Partial” scenario with *groups* material mode and *average* PIR release mode.

Test:testShutdownPartialGroupsExplicit

An NFAC-RTH integration test, this exercises the ”Shutdown Partial” scenario with *groups* material mode and *explicit* PIR release mode.

Test:testShutdownPartialGroupsNone

An NFAC-RTH integration test, this exercises the ”Shutdown Partial” scenario with *groups* material mode and *none* PIR release mode.

Test:testShutdownPartialGroupsNoneContours

An NFAC-RTH-SCIPUFF integration test, this exercises the ”Shutdown Partial” scenario with *groups* material mode and *none* PIR release mode and compares resulting contour areas.

Test:testShutdownPartialMCAverage

An NFAC-RTH integration test, this exercises the ”Shutdown Partial” scenario with *multicomponent* material mode and *average* PIR release mode.

Test:testShutdownPartialMCExplicit

An NFAC-RTH integration test, this exercises the "Shutdown Partial" scenario with *multicomponent* material mode and *explicit* PIR release mode.

Test:testShutdownPartialMCNone

An NFAC-RTH integration test, this exercises the "Shutdown Partial" scenario with *multicomponent* material mode and *none* PIR release mode.

Test:testShutdownPartialMCNoneContours

An NFAC-RTH-SCIPUFF integration test, this exercises the "Shutdown Partial" scenario with *multicomponent* material mode and *none* PIR release mode and compares resulting contour areas.

Test:testShutdownPartialSimpleAverage

An NFAC-RTH integration test, this exercises the "Shutdown Partial" scenario with *simple* material mode and *average* PIR release mode.

Test:testShutdownPartialSimpleExplicit

An NFAC-RTH integration test, this exercises the "Shutdown Partial" scenario with *simple* material mode and *explicit* PIR release mode.

Test:testShutdownPartialSimpleNone

An NFAC-RTH integration test, this exercises the "Shutdown Partial" scenario with *simple* material mode and *none* PIR release mode.

Test:testShutdownPartialSimpleNoneContours

An NFAC-RTH-SCIPUFF integration test, this exercises the "Shutdown Partial" scenario with *simple* material mode and *none* PIR release mode and compares resulting contour areas.

5. INTERACTIVE TESTS

The purpose of the interactive tests is to exercise each piece of functionality in the Nuclear Facility Incident Edit dialog and its constituent components. Verification of results is by visual inspection of the interface and/or examination of project files after being saved and are recorded in the test descriptions below.

5.1 TOP LEVEL INTERACTIONS

Test: Set Incident Name

Set the incident name via the *Name* edit field.
Verification:

- Incident name correctly (de)serialized from/to the project file.

5.2 WHERE TAB

Test: Select Facility

Select a facility via the *Select* button in the *Facility* group. Examine the facility tree to verify correct representation of the facilities defined in NFAC data files.

Verification:

- The *All Facilities* tree lists all the countries (and generic) represented in the *wcountry.dat* file.
- Each country tree node expands to the proper subtrees (Power Reactor, Reprocessing Facility, and/or Research Reactor) based on facilities available in that country.
- Verify special statuses *decommissioned*, *not yet completed*, and *no inventory* are accurately represented.
- Each leaf node lists the available facilities correctly as per the associated *lwr_??.dat* file.
- The selected facility is correctly represented and (de)serialized from/to the project file.

Test: Select Default Facility Location

Choose the *Facility Location* radio button in the *Location* group for the default facility location.

Verification:

- The coordinate for the facility as stored in the facility database is (de)serialized from/to the project file.

Test: Enter Explicit Facility Location

Selected the *Customized Location* radio button and enter an explicit coordinate for the facility location.

Verification:

- The entered coordinate is (de)serialized from/to the project file as the facility location.

Test: Define Facility Location by Dragging the Incident Icon

With the *Customized Location* radio button selected, drag the incident icon on the map to set the location.

Verification:

- The dragged-to coordinate is (de)serialized from/to the project file as the facility location.

Test: Select the Default Inventory File

Choose the *Default for Facility* radio button in the *Inventory* group.

Verification:

- The inventory file referenced in the facility database entry is (de)serialized from/to the project file.

Test: Select a Custom Inventory File

Choose the *Customized* radio button in the *Inventory* group and specify an inventory (i.e., activity vector or *.avc*) file.

Verification:

- The specified file is (de)serialized from/to the project file as the custom inventory.

Test: Use the ORIGEN File Import Utility to Create a Custom Inventory File

Activate the *Origen Import* button to run the ORIGEN Importer.

Verification:

- After selecting a F71 file, the *ORIGEN File Import* utility appears and displays the cases in the file.
- Activating the *Show File Overview* button brings up an overview windowing showing information about each case in the F71 file.
- After selecting a case and activating the *Show Case Overview* button, a window giving a summary of the selected case appears.
- After selecting a case and activating the *Show Case Details* button, a windowing displaying details of the selected case appears.
- After selecting a case, selecting and entering values in the *Inventory File Units* group, and activating the *Create Inventory File* button, and entering a target filename, an inventory file is created.
- The created inventory file can be specified as the custom inventory for the facility.

5.3 WHAT TAB

Test: Enter an Explicit Operating Power

Change the value of the *Operating Power* field.

Verification:

- The specified operating power is (de)serialized from/to the project file.

Test: Select a Moderate Incident

Choose the *Moderate Incident* radio button.

Verification:

- The Moderate model appropriate for the selected facility is (de)serialized from/to the project file and displayed in the report resulting from activating the *View Source Term* button (compared to the associated *acmxxx.dat* file).

Test: Select a Severe Incident

Choose the *Severe Incident* radio button.

Verification:

- The Severe model appropriate for the selected facility is (de)serialized from/to the project file and displayed in the report resulting from activating the *View Source Term* button (compared to the associated *acs*xxx.dat file).

Test: Define an Isotopic Release Rates Incident

Choose the *Technical Analysis* radio button. Activate the *Define Incident* button and choose *Isotopic Release Rates* from the *Source Terms Available* list. Click the *Next* button. From the *Define Isotopic Release Rates* dialog, choose *Release Units* and enter values under *Isotope Values*.

Verification:

- The defined isotope values and release units are (de)serialized from/to the project file and displayed in the report resulting from activating the *View Source Term* button.

Test: Define an Isotopic Concentrations Incident

Choose the *Technical Analysis* radio button. Activate the *Define Incident* button and choose *Isotopic Concentrations* from the *Source Terms Available* list. Click the *Next* button. From the *Define Isotopic Release Rates* dialog, choose *Release Units* and enter values under *Isotope Values*.

Verification:

- The defined isotope values and release units are (de)serialized from/to the project file and displayed in the report resulting from activating the *View Source Term* button.

Test: Define a Percent Inventory Incident

Choose the *Technical Analysis* radio button. Activate the *Define Incident* button and choose *Percent Inventory* from the *Source Terms Available* list. Click the *Next* button. From the *Define Percent Inventory Releases* dialog, activate the *Load* button and choose *From Moderate Model*. Then, activate the *Load* button and choose *From Severe Model*. Enter explicit values in the release duration and group percentage cells. Activate the *New* button to add a release. Change the duration units via the *Duration Units* combo box. Select a cell in any release column and activate *Delete* to remove that release.

Verification:

- The release definitions for the moderate and severe models are correct for the type of facility *acmxxx.dat* and *acsxxx.dat* files, respectively).
- The (first) totals column is accurately updated after cell edits.
- All duration cell values are converted upon selection of new duration units.
- A new, release column is added when *New* is activated with cell values set to the remainder required to reach 100% release of each group.
- *Delete*d releases are moved.
- The defined releases are (de)serialized from/to the project file and displayed in the report resulting from activating the *View Source Term* button.

Test: Define an Analyst Mix Incident

Choose the *Technical Analysis* radio button. Activate the *Define Incident* button and choose *Mix Specified by Analyst* from the *Source Terms Available* list. Click the *Next* button. From the *Define Mix Specified by Analyst* dialog, enter a *Gross Release Rate* and various values for the percentages by MELCOR group.

Verification:

- The *Gross Release Rate* value is (de)serialized from/to the project file.
- Entering release percentages totaling more than 100% results in a warning dialog.
- Release percentages for each group are (de)serialized from/to the project file.

Test: Define a Containment Monitor Reading Incident

Choose the *Technical Analysis* radio button. Activate the *Define Incident* button and choose *Mix Specified by Analyst* from the *Source Terms Available* list. Click the *Next* button. From the *Define Containment Monitor Reading Incident* dialog, enter various values for: *Representative Operating Power*, *Monitor Reading and Location*, *Sprays*, *Release Path*, and *Leak Rate*.

Verification:

- All entered values are (de)serialized from/to the project file.
- A warning appears if 100% leak rate is selected with a filtered release path.
- The release duration is correctly calculated from the specified leak rate.

Test: Define a Spent Fuel Incident

Choose the *Technical Analysis* radio button. Activate the *Define Incident* button and choose *Spent Fuel* from the *Source Terms Available* list. Click the *Next* button. From the *Define Spent Fuel/Spent Fuel Pool Incident* dialog, enter various values for: *Representative Operating Power*, *Number of Batches*, *Fuel Condition*, *Sprays*, *Release Path*, *Last Batch in Pool* datetime, and *Leak Rate*.

Verification:

- All entered values are (de)serialized from/to the project file.
- A warning appears if 100% leak rate is selected with a filtered release path.
- The *Last Batch in Pool* time is forced to be no later than *Shutdown/Start of Decay* on the *When* tab.
- The release duration is correctly calculated from the specified leak rate.

Test: Define a RASCAL Project Incident

Choose the *Technical Analysis* radio button. Activate the *Define Incident* button and choose *RASCAL Project* from the *Source Terms Available* list. Click the *Next* button. From the *RASCAL Project* dialog, activate the *Read File* button to locate and select a RASCAL project file.

Verification:

- The contained *tadspecs.tmp* file is read correctly to get the case name.
- The contained *NucName.tmp* file is read correctly to get the list of isotopes.
- The contained *STC_Rel.tmp* file is read correctly to get release durations and activity values for each isotope at each release time.
- The isotope activities and durations for each release are correctly (de)serialized from/to the project file.

Test: Define a Confinement Bypass Plant Conditions Incident

In the *Where* tab, choose a facility for which the Confinement Bypass plant condition is available, such as Hartlepool-1 in Great Britain (an AGR). On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Bypass of Confinement* from the *Plant Conditions Available* list. From the *Bypass of Confinement* dialog, enter or select various values for *Representative Operating Power*, *Core Condition*, and *Leak Rate*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.
- The release duration is correctly calculated from the specified leak rate.

Test: Define a Confinement Leakage/Failure Plant Conditions Incident

In the *Where* tab, choose a facility for which the Confinement Bypass plant condition is available, such as Novovoronezh-3 in Russia (a VVER-440/230). On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Confinement Leakage/Failure* from the *Plant Conditions Available* list. From the *Confinement Leakage/Failure* dialog, enter or select various values for *Representative Operating Power*, *Core Condition*, and *Leak Rate*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.
- The release duration is correctly calculated from the specified leak rate.

Test: Define a Containment Bypass Plant Conditions Incident

In the *Where* tab, choose a facility for which the Containment Bypass plant condition is available, such as Hamaoka-3 in Japan (a BWR Mk-1). On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Bypass of Containment* from the *Plant Conditions Available* list. From the *Bypass of Containment* dialog, enter or select various values for *Representative Operating Power*, *Core Condition*, *Release Path*, and *Leak Rate*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.
- The release duration is correctly calculated from the specified leak rate.

Test: Define a Containment Leakage/Failure Plant Conditions Incident

In the *Where* tab, choose a facility for which the Containment Leakage plant condition is available, such as Beloyarsky-3(BN-600) in Russia (an LMFBR, requires a custom inventory file). On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Containment Leakage/Failure* from the *Plant Conditions Available* list. From the *Containment Leakage/Failure* dialog, enter or select various values for *Representative Operating Power*, *Core Condition*, *Release Path*, and *Leak Rate*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.
- The release duration is correctly calculated from the specified leak rate.

Test: Define a Dry Well Leakage/Failure Plant Conditions Incident

In the *Where* tab, choose a facility for which the Dry Well Leakage plant condition is available, such as Hamaoka-3 in Japan (a BWR Mk-1). On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Dry Well Leakage/Failure* from the *Plant Conditions Available* list. From the *Dry Well Leakage/Failure* dialog, enter or select various values for *Representative Operating Power*, *Core Condition*, *Release Path*, *Sprays*, and *Leak Rate*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.
- The release duration is correctly calculated from the specified leak rate.

Test: Define an Ice Condenser Containment Leakage/Failure Plant Conditions Incident

In the *Where* tab, choose a facility for which the Ice Condenser Containment plant condition is available, such as Watts Bar-1 in the United States (a PWR). On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Ice Condenser Containment Leakage/Failure* from the *Plant Conditions Available* list. From the *Ice Condenser Containment Leakage/Failure* dialog, enter or select various values for *Representative Operating Power*, *Core Condition*, *Release Path*, *Sprays*, *Fans*, *Ice Bed Condition Before Core Damage*, and *Leak Rate*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.
- The release duration is correctly calculated from the specified leak rate.

Test: Define a Large Dry Subcontainment Leakage/Failure Plant Conditions Incident

In the *Where* tab, choose a facility for which the Large Dry Subcontainment Leakage plant condition is available, such as Beaver Valley-1 in the United States (a PWR). On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Large, Dry, or Subatmospheric Containment Leakage/Failure* from the *Plant Conditions Available* list. From the *Large, Dry, or Subatmospheric Containment Leakage/Failure* dialog, enter or select various values for *Representative Operating Power*, *Core Condition*, *Release Path*, *Sprays*, and *Leak Rate*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.
- The release duration is correctly calculated from the specified leak rate.

Test: Define a Prompt Critical Power Excursion Plant Conditions Incident

In the *Where* tab, choose a facility for which the Prompt Critical Power Excursion plant condition is available, such as Bilibino Unit A in Russia (an RBMK). On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Prompt Critical Power Excursion* from the *Plant Conditions Available* list. From the *Prompt Critical Power Excursion* dialog, enter or select various values for *Representative Operating Power*, and *Core Involvement*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.

Test: Define a Reprocessing Facility Plant Conditions Incident

In the *Where* tab, choose a facility for which the Reprocessing Facility plant condition is available, such as Savannah River in the United States. On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Reprocessing Facility Plant Conditions* from the *Plant Conditions Available* list. From the *Reprocessing Facility Plant Conditions* dialog, enter or select various values for *Plant Throughput*, *Release Rate*, and the values in the *Release Fraction by Component* group.

Representative Operating Power, and *Core Involvement*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.

Test: Define a Steam Generator Tube Rupture Plant Conditions Incident

In the *Where* tab, choose a facility for which the Steam Tube Rupture plant condition is available, such as Dungeness B-1 in Great Britain (an AGR). On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Steam Generator Tube Rupture (Coolant)* from the *Plant Conditions Available* list. From the *Steam Generator Rube Rupture (Coolant)* dialog, enter or select various values for *Coolant Concentration*, *Steam Generator Conditions*, *Release is From*, and *Release Rate*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.

Test: Define a Subatmospheric Confinement Leakage/Failure Plant Conditions Incident

In the *Where* tab, choose a facility for which the Subatmospheric Confinement Leakage/Failure plant condition is available, such as Rovno-1 in the Ukraine (VVER-440/213). On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Subatmospheric Confinement Leakage/Failure* from the *Plant Conditions Available* list. From the *Subatmospheric Confinement Leakage/Failure* dialog, enter or select various values for *Representative Operating Power*, *Core Condition*, *Pool Suppression System*, and *Leak Rate*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.
- The release duration is correctly calculated from the specified leak rate.

Test: Define a Wet Well Leakage/Failure Plant Conditions Incident

In the *Where* tab, choose a facility for which the Wet Well Leakage plant condition is available, such as Hamaoka-3 in Japan (a BWR Mk-1). On the *What* tab, choose the *Technical Analysis* radio button. Activate the *Define Incident* button, choose *Plant Conditions* from the *Source Terms Available* list, activate the *Next* button, and then choose *Wet Well Leakage/Failure* from the *Plant Conditions Available* list. From the *Wet Well Leakage/Failure* dialog, enter or select various values for *Representative Operating Power*, *Core Condition*, *Release Path*, *Wet Well*, and *Leak Rate*.

Verification:

- Values entered or selected are (de)serialized from/to the project file.
- The release duration is correctly calculated from the specified leak rate.

Test: Select Material Processing Modes

Step 1. From the *Where* tab, select the facility Bruce-1 (Canada → Power Reactor). On the *What* tab activate the *Edit Calculation Options* button to bring up the *Edit Calculation Options* dialog. Check that the *Mode* combo box in the *Material Processing* group is disabled.

Verification:

- The combo box is disabled.

Step 2. From the *Where* tab, select the facility Beaver Valley-1 Bruce-1 (United States → Power Reactor). On the *What* tab activate the *Technical Analysis* radio button. Activate the *Edit Calculation Options* button to bring up the *Edit Calculation Options* dialog. In turn for each option, do the following.

Select the mode. Activate the *OK* button to close dialog. Select File → Export Project to ASCII from the menu bar. After saving the file, examine it with an editor to verify the *materialMode* field has the correct value.

Verification:

- The combo box is enabled.
- Three modes are available: *Simple*, *Groups*, *Multicomponent*.
- The *materialMode* field value is correct in the ASCII project export.

Test: Select Percent Inventory Release Modes

On the *What* tab activate the *Technical Analysis* radio button. Activate the *Edit Calculation Options* button to bring up the *Edit Calculation Options* dialog. Activate the *Mode* combo box in the *Percent Inventory Release* group. In turn for each option, do the following.

Select the mode. Activate the *OK* button to close dialog. Select File → Export Project to ASCII from the menu bar. After saving the file, examine it with an editor to verify the *PIRMode* field has the correct value.

Verification:

- Three modes are available: *Average*, *Explicit*, *None*.
- The *PIRMode* field value is correct in the ASCII project export.

Test: View Source Term

Activate the *View Source Term* button to generate and display an HTML report giving details of the source term as currently defined.

Verification:

- Source term HTML report generated for all source models.

5.4 WHEN TAB

The *When* tab in the NFAC GUI is relatively complex compared to other incident source models. Refer to Section 3.4 ModelTimesTest for a discription of the six event times possible in NFAC incidents. Which of the event times are visible and/or editable for a particular NFAC source model depends on that model and which of the event times are defined or computed based on the model definition. Further, the new *Advanced Mode* toggle button allows the user to override these settings and enter explicit times for all events, possibly redefining the model in the process. The interactive tests examine each NFAC source model to verify the proper times are visible and editable and are correctly computed if appropriate. The *Reset Times* button is activated to ensure the default times are applied.

Test: Moderate Model Times Edit

Verification:

Shutdown/Start of Decay:	visible, editable
Release to Containment:	invisible
Release to Environment:	visible, uneditable, calculated correctly
End of Release:	visible, uneditable, calculated correctly
End of Dispersion:	visible, editable
End of Exposure:	visible, editable

After reset, times set correctly

Test: Severe Model Times Edit

Verification:

Shutdown/Start of Decay:	visible, editable
Release to Containment:	invisible
Release to Environment:	visible, uneditable, calculated correctly
End of Release:	visible, uneditable, calculated correctly
End of Dispersion:	visible, editable
End of Exposure:	visible, editable

After reset, times set correctly

Test: Analyst Mix Model Times Edit

Verification:

Shutdown/Start of Decay: visible, editable
Release to Containment: invisible
Release to Environment: visible, editable
End of Release: visible, editable
End of Dispersion: visible, editable
End of Exposure: visible, editable
After reset, times set correctly

Test: Containment Monitor Reading Model Times Edit

Verification:

Shutdown/Start of Decay: invisible
Release to Containment: visible, editable
Release to Environment: visible, editable
End of Release: visible, editable[1]
End of Dispersion: visible, editable
End of Exposure: visible, editable
After reset, times set correctly

1 Time can be manually set less than computed end time based on leak rate

Test: Isotopic Concentrations Model Times Edit

Verification:

Shutdown/Start of Decay: invisible
Release to Containment: invisible
Release to Environment: visible, editable
End of Release: visible, editable
End of Dispersion: visible, editable
End of Exposure: visible, editable
After reset, times set correctly

Test: Isotopic Release Rates Model Times Edit

Verification:

Shutdown/Start of Decay: invisible
Release to Containment: invisible
Release to Environment: visible, editable
End of Release: visible, editable
End of Dispersion: visible, editable
End of Exposure: visible, editable
After reset, times set correctly

Test: Percent Inventory Model Times Edit

Verification:

Shutdown/Start of Decay: visible, editable
Release to Containment: invisible
Release to Environment: visible, uneditable, calculated correctly
End of Release: visible, uneditable, calculated correctly
End of Dispersion: visible, editable
End of Exposure: visible, editable
After reset, times set correctly

Test: Containment Bypass Plant Conditions Model Times Edit

Verification:

Shutdown/Start of Decay: visible, editable
Release to Containment: invisible
Release to Environment: visible, editable
End of Release: visible, editable[1]
End of Dispersion: visible, editable
End of Exposure: visible, editable
After reset, times set correctly

1 Time can be manually set less than computed end time based on leak rate

Test: Prompt Critical Power Excursion Plant Conditions Model Times Edit

Verification:

Shutdown/Start of Decay: invisible
Release to Containment: invisible
Release to Environment: visible, editable
End of Release: visible, editable
End of Dispersion: visible, editable
End of Exposure: visible, editable
After reset, times set correctly

Test: Reprocessing Facility Plant Conditions Model Times Edit

Verification:

Shutdown/Start of Decay: invisible
Release to Containment: invisible
Release to Environment: visible, editable
End of Release: visible, editable
End of Dispersion: visible, editable
End of Exposure: visible, editable
After reset, times set correctly

Test: Confinement Bypass Plant Conditions Model Times Edit

Times management for this source model is shared by all other Plant Conditions models except for the three identified in the preceeding tests.

Verification:

Shutdown/Start of Decay:	visible, editable
Release to Containment:	invisible
Release to Environment:	visible, editable
End of Release:	visible, editable[1]
End of Dispersion:	visible, editable
End of Exposure:	visible, editable

After reset, times set correctly

1 Time can be manually set less than computed end time based on leak rate

Test: Spent Fuel Model Times Edit

Verification:

Shutdown/Start of Decay:	invisible
Release to Containment:	visible, editable
Release to Environment:	visible, editable
End of Release:	visible, editable[1]
End of Dispersion:	visible, editable
End of Exposure:	visible, editable

After reset, times set correctly

1 Time can be manually set less than computed end time based on leak rate

Test: RASCAL Project Model Times Edit

Verification:

Shutdown/Start of Decay:	invisible
Release to Containment:	invisible
Release to Environment:	visible, editable
End of Release:	visible, uneditable, calculated correctly
End of Dispersion:	visible, editable
End of Exposure:	visible, editable

After reset, times set correctly

Test: Detect Event Times Out of Chronological Order

After modification of editable time fields and activation of the *OK* button for the *Nuclear Facility Incident Edit* dialog, if times are not in chronological order, a "Times are not in chronological order" error dialog is displayed, and the model definition remains unchanged.

Verification:

- Out of order times are detected, a warning dialog is displayed, and the model definition is not updated.

Test: Apply Time Field Changes for All Events

Enter a field value and activate the corresponding button in the *Change Field for All Events* group.

Verification:

- Month (*MM*) fields are updated.
- Day (*DD*) fields are updated.
- Year fields are updated.
- Hours (*hh*) fields are updated.
- Minutes (*mm*) fields are updated.
- Seconds (*ss*) fields are updated.
- Calculated fields are updated correctly.

Test: Override Times in Advanced Mode

Activate the *Advanced Mode* toggle button to override editability of fields.

Verification:

- All visible fields are editable.
- Chronological order checks are still applied.

5.5 NOTES TAB

Test: Edit Notes

Verification:

- Notes are (de)serialized from/to the project file.
- Notes can be modified (changed, deleted, augmented).

6. RESULTS

6.1 AUTOMATED TEST RESULTS

NfacJUnit4Adapter consolidates all test results into a single report. The report is listed below.

```
Running tests...
Test project Z:/re7x/src/hpac5-poplib-cmake/build-win
      Start  1: test0001_dc_around_tiles
 1/62 Test  #1: test0001_dc_around_tiles .....................   Passed    0.64 sec
      Start  2: test0002_dc_around_rasters
 2/62 Test  #2: test0002_dc_around_rasters ....................   Passed    0.75 sec
      Start  3: test0003_dc_inner_tiles
 3/62 Test  #3: test0003_dc_inner_tiles .....................   Passed    0.56 sec
      Start  4: test0004_dc_inner_rasters
 4/62 Test  #4: test0004_dc_inner_rasters ....................   Passed    0.53 sec
      Start  5: test0005_dc_diamond_tiles
 5/62 Test  #5: test0005_dc_diamond_tiles ....................   Passed    0.56 sec
      Start  6: test0006_dc_diamond_rasters
 6/62 Test  #6: test0006_dc_diamond_rasters ...................   Passed    0.52 sec
      Start  7: test0007_ny_triangle_tiles
 7/62 Test  #7: test0007_ny_triangle_tiles ....................   Passed    0.58 sec
      Start  8: test0008_ny_triangle_rasters
 8/62 Test  #8: test0008_ny_triangle_rasters ..................   Passed    0.58 sec
      Start  9: test0009_va_exclude_1_tiles
 9/62 Test  #9: test0009_va_exclude_1_tiles ...................   Passed    1.55 sec
      Start 10: test0010_va_exclude_1_tiles_ini
10/62 Test #10: test0010_va_exclude_1_tiles_ini ...............   Passed    1.52 sec
      Start 11: test0011_va_exclude_1_rasters
11/62 Test #11: test0011_va_exclude_1_rasters .................   Passed    1.80 sec
      Start 12: test0012_va_exclude_1_rasters_ini
12/62 Test #12: test0012_va_exclude_1_rasters_ini .............   Passed    1.83 sec
      Start 13: test0013_va_exclude_2_tiles
13/62 Test #13: test0013_va_exclude_2_tiles ...................   Passed    1.55 sec
      Start 14: test0014_va_exclude_2_tiles_ini
14/62 Test #14: test0014_va_exclude_2_tiles_ini ...............   Passed    1.62 sec
      Start 15: test0015_va_exclude_2_rasters
15/62 Test #15: test0015_va_exclude_2_rasters .................   Passed    1.59 sec
      Start 16: test0016_va_exclude_2_rasters_ini
16/62 Test #16: test0016_va_exclude_2_rasters_ini .............   Passed    1.56 sec
      Start 17: test0017_va_exclude_12_tiles
17/62 Test #17: test0017_va_exclude_12_tiles ..................   Passed    1.47 sec
      Start 18: test0018_va_exclude_12_tiles_ini
18/62 Test #18: test0018_va_exclude_12_tiles_ini ..............   Passed    1.86 sec
      Start 19: test0019_va_exclude_12_rasters
19/62 Test #19: test0019_va_exclude_12_rasters ................   Passed    1.66 sec
      Start 20: test0020_va_exclude_12_rasters_ini
20/62 Test #20: test0020_va_exclude_12_rasters_ini ............   Passed    1.77 sec
      Start 21: test0021_va_exclude_1n_tiles
21/62 Test #21: test0021_va_exclude_1n_tiles ..................   Passed    1.64 sec
      Start 22: test0022_va_exclude_1n_tiles_ini
22/62 Test #22: test0022_va_exclude_1n_tiles_ini ..............   Passed    1.91 sec
      Start 23: test0023_va_exclude_1n_rasters
23/62 Test #23: test0023_va_exclude_1n_rasters ................   Passed    1.84 sec
      Start 24: test0024_va_exclude_1n_rasters_ini
24/62 Test #24: test0024_va_exclude_1n_rasters_ini ............   Passed    1.69 sec
      Start 25: test0025_va_exclude_2n_tiles
25/62 Test #25: test0025_va_exclude_2n_tiles ..................   Passed    1.34 sec
      Start 26: test0026_va_exclude_2n_tiles_ini
26/62 Test #26: test0026_va_exclude_2n_tiles_ini ..............   Passed    1.37 sec
      Start 27: test0027_va_exclude_2n_rasters
27/62 Test #27: test0027_va_exclude_2n_rasters ................   Passed    1.52 sec
      Start 28: test0028_va_exclude_2n_rasters_ini
28/62 Test #28: test0028_va_exclude_2n_rasters_ini ............   Passed    1.53 sec
```

```
      Start 29: test0029_va_exclude_12n_tiles
29/62 Test #29: test0029_va_exclude_12n_tiles ..................   Passed    1.41 sec
      Start 30: test0030_va_exclude_12n_tiles_ini
30/62 Test #30: test0030_va_exclude_12n_tiles_ini ..............   Passed    1.41 sec
      Start 31: test0031_va_exclude_12n_rasters
31/62 Test #31: test0031_va_exclude_12n_rasters ................   Passed    1.55 sec
      Start 32: test0032_va_exclude_12n_rasters_ini
32/62 Test #32: test0032_va_exclude_12n_rasters_ini ............   Passed    1.55 sec
      Start 33: test0033_i285_tiles
33/62 Test #33: test0033_i285_tiles ............................   Passed    0.73 sec
      Start 34: test0034_i285_rasters
34/62 Test #34: test0034_i285_rasters ..........................   Passed    0.69 sec
      Start 35: test0035_i285_exclude_tech_tiles
35/62 Test #35: test0035_i285_exclude_tech_tiles ...............   Passed    0.78 sec
      Start 36: test0036_i285_exclude_tech_tiles_ini
36/62 Test #36: test0036_i285_exclude_tech_tiles_ini ...........   Passed    0.81 sec
      Start 37: test0037_i285_exclude_tech_rasters
37/62 Test #37: test0037_i285_exclude_tech_rasters .............   Passed    0.77 sec
      Start 38: test0038_i285_exclude_tech_rasters_ini
38/62 Test #38: test0038_i285_exclude_tech_rasters_ini .........   Passed    0.77 sec
      Start 39: test0039_i285_exclude_tech_fixed_tiles
39/62 Test #39: test0039_i285_exclude_tech_fixed_tiles .........   Passed    0.81 sec
      Start 40: test0040_i285_exclude_tech_fixed_tiles_ini
40/62 Test #40: test0040_i285_exclude_tech_fixed_tiles_ini .....   Passed    0.80 sec
      Start 41: test0041_i285_exclude_tech_fixed_rasters
41/62 Test #41: test0041_i285_exclude_tech_fixed_rasters .......   Passed    0.73 sec
      Start 42: test0042_i285_exclude_tech_fixed_rasters_ini
42/62 Test #42: test0042_i285_exclude_tech_fixed_rasters_ini ...   Passed    0.75 sec
      Start 43: test0043_mgrs
43/62 Test #43: test0043_mgrs ..................................   Passed    0.06 sec
      Start 44: test0044_va_exclude_12_mgrs_12_tiles
44/62 Test #44: test0044_va_exclude_12_mgrs_12_tiles ...........   Passed    1.45 sec
      Start 45: test0045_va_exclude_12_mgrs_12_tiles_ini
45/62 Test #45: test0045_va_exclude_12_mgrs_12_tiles_ini .......   Passed    1.36 sec
      Start 46: test0046_va_exclude_12_mgrs_12_rasters
46/62 Test #46: test0046_va_exclude_12_mgrs_12_rasters .........   Passed    1.50 sec
      Start 47: test0047_va_exclude_12_mgrs_12_rasters_ini
47/62 Test #47: test0047_va_exclude_12_mgrs_12_rasters_ini .....   Passed    1.52 sec
      Start 48: test0048_va_exclude_12_mgrs_1_tiles
48/62 Test #48: test0048_va_exclude_12_mgrs_1_tiles ............   Passed    1.34 sec
      Start 49: test0049_va_exclude_12_mgrs_1_rasters
49/62 Test #49: test0049_va_exclude_12_mgrs_1_rasters ..........   Passed    1.55 sec
      Start 50: test0050_va_exclude_12_mgrs_2_tiles
50/62 Test #50: test0050_va_exclude_12_mgrs_2_tiles ............   Passed    1.41 sec
      Start 51: test0051_va_exclude_12_mgrs_2_rasters
51/62 Test #51: test0051_va_exclude_12_mgrs_2_rasters ..........   Passed    1.84 sec
      Start 52: test0052_mosul_raster_only_inner
52/62 Test #52: test0052_mosul_raster_only_inner ...............   Passed    0.84 sec
      Start 53: test0053_mosul_raster_only_cut
53/62 Test #53: test0053_mosul_raster_only_cut .................   Passed    1.30 sec
      Start 54: test0054_mosul_raster_only_outer
54/62 Test #54: test0054_mosul_raster_only_outer ...............   Passed    1.17 sec
      Start 55: test0055_mosul_raster_levant_raster_inner
55/62 Test #55: test0055_mosul_raster_levant_raster_inner ......   Passed    0.67 sec
      Start 56: test0056_mosul_raster_levant_raster_cut
56/62 Test #56: test0056_mosul_raster_levant_raster_cut ........   Passed    1.50 sec
      Start 57: test0057_mosul_raster_levant_raster_outer
57/62 Test #57: test0057_mosul_raster_levant_raster_outer ......   Passed    1.42 sec
      Start 58: test0058_mosul_raster_levant_tile_inner
58/62 Test #58: test0058_mosul_raster_levant_tile_inner ........   Passed    0.81 sec
      Start 59: test0059_mosul_raster_levant_tile_cut
59/62 Test #59: test0059_mosul_raster_levant_tile_cut ..........   Passed    1.59 sec
      Start 60: test0060_mosul_raster_levant_tile_outer
60/62 Test #60: test0060_mosul_raster_levant_tile_outer ........   Passed    1.23 sec
      Start 61: test0061_mosul_rasters_only
```

```
61/62 Test #61: test0061_mosul_rasters_only ....................   Passed    1.06 sec
      Start 62: test0062_mosul_rasters_and_tiles
62/62 Test #62: test0062_mosul_rasters_and_tiles ...............   Passed    1.12 sec

100% tests passed, 0 tests failed out of 62

Label Time Summary:
exclusion    =  56.70 sec (40 tests)
mgrs         =   0.06 sec (1 test)
rasters      =  45.09 sec (36 tests)
simple       =  18.87 sec (21 tests)
tiles        =  31.61 sec (26 tests)

Total Test time (real) =  76.00 sec
```

6.2 AUTOMATED TEST COVERAGE

Test coverage analysis is produced using version 0.7.9 of JaCoco.[2] Just as not all NFAC components have equal importance in providing functionality, not all branches within any NFAC component have equal importance. Coverage results from the JaCoCo report are presented in the following tables. Table 3 gives a summary by Java package.[†]

Table 3: Code Coverage by Package

Package	Instructions Coverage (%)	Branches Coverage (%)	Complexity Missed	Complexity Total	Lines Missed	Lines Total	Mehods Missed	Methods Total	Classes Missed	Classes Total
CAcomp	92	59	14	41	2	64	2	25	0	1
CAcomp.data	56	35	1,040	1,593	1,494	3,510	373	785	5	39
CAcomp.data.analyst	47	30	796	1,242	1,575	2,978	218	525	4	26
CAcomp.data.analyst.plantcond	42	7	237	389	534	983	130	278	0	14
CAcomp.data.times	91	61	35	104	22	234	5	61	0	13
CAcomp.data.impl	72	47	668	1,045	1,034	3,578	83	227	2	14
CAcomp.exception	0	n/a	3	3	6	6	3	3	1	1

Coverage for each class is presented in Tables 4–10. In terms of significance in NFAC processing, the most important classes are:

- CAcomp.data.AmbClient
- CAcomp.data.Facility
- CAcomp.data.ModelTimes
- CAcomp.data.NfacIncident
- CAcomp.data.NfacIncidentMgr
- CAcomp.data.ParticleGroups
- CAcomp.data.ParticleGroupsMgr
- CAcomp.data.analyst.PercentInventory
- CAcomp.data.analyst.PercentInventoryRelease
- CAcomp.data.analyst.PercentInventoryReleaseTree
- CAcomp.data.analyst.SourceTermTable
- all classes in CAcomp.data.times
- CAcomp.impl.AmbInputsMgr
- CAcomp.impl.NfacImpl
- CAcomp.impl.ReproMod
- CAcomp.impl.St_Monitor
- CAcomp.impl.StcalcClient

[†]Package names assume a mil.dtra.hpac.model.nfac prefix.

Table 4: Code Coverage: CAComp

Class	Instructions Coverage (%)	Branches Coverage (%)	Complexity Missed	Complexity Total	Lines Missed	Lines Total	Methods Missed	Methods Total
NfacServiceRefs	92	59	14	41	2	64	2	25

Table 5: Code Coverage: CAComp.data

Class	Instructions Coverage (%)	Branches Coverage (%)	Complexity Missed	Complexity Total	Lines Missed	Lines Total	Methods Missed	Methods Total
ActivityHash	0	0	28	28	49	49	12	12
ActivityHash.ActivityZComparator	0	0	7	7	6	6	4	4
AmbClient	66	46	133	223	154	533	15	74
AmbClient.ActivityNameSorter	51	0	3	5	2	6	2	4
AmbClient.ActivityTableInputMatIDSorter	46	25	6	8	2	7	2	4
AmbClient.ActivityValueSorter	0	0	5	5	4	4	4	4
AmbClient.IsotopeDepSorter	50	37	9	12	2	11	2	4
AmbClient.IsotopeShortNameSorter	37	25	6	8	2	5	2	4
AmbClient.Refs	100	n/a	0	1	0	6	0	1
AmbClient.ReleaseMCSorter	71	50	10	14	4	19	2	4
CountryCodeMap	54	42	8	16	18	48	3	9
DummyInstanceValue	0	n/a	6	6	7	7	6	6
Element	11	9	37	44	79	100	17	23
Facility	66	28	92	158	97	330	12	68
FacilityDB	80	50	6	13	4	22	3	9
FacilityDBMgr	54	40	9	18	25	69	2	8
FacilityDef	71	47	54	107	57	238	8	44
FastIsotopes	35	31	22	34	35	67	8	15
MaterialMode	92	100	1	7	0	7	1	5
ModelDefUtils	35	23	87	98	133	206	18	27
ModelTimes	78	26	27	68	32	186	4	45
ModerateModel	35	0	8	15	7	16	5	12
NfacConstants	100	n/a	0	1	0	2	0	1
NfacDummyMaterial	0	0	136	136	162	162	131	131
NfacIncident	66	13	22	49	47	133	6	31
NfacIncidentMgr	48	47	35	63	103	196	19	39
NfacIncidentMgr.MCParameters	100	n/a	0	1	0	4	0	1
NfacRelease	89	50	7	20	5	38	3	16
Options	47	10	31	63	67	175	8	39
ParticleGroups	72	48	59	95	74	273	8	24
ParticleGroups.GroupActivityList	81	62	10	22	7	47	3	6
ParticleGroups.GroupInfo	64	50	6	13	5	18	1	8
ParticleGroups.MelcorInfo	41	40	13	19	8	21	3	9
ParticleGroupsMgr	71	47	19	40	21	88	3	16
PropertyFinder	87	73	16	38	15	100	0	8
Range	19	15	40	45	69	86	13	16
Range.Mode	76	n/a	2	4	0	3	2	4
ReproInventory	11	11	70	74	183	206	34	38
SevereModel	29	0	10	15	9	16	7	12

Table 6: Code Coverage: CAComp.data.analyst

Class	Instructions Coverage (%)	Branches Coverage (%)	Complexity Missed	Complexity Total	Lines Missed	Lines Total	Methods Missed	Methods Total
AbstractAnalystModel	63	n/a	1	6	3	8	1	6
AnalystMix	55	25	27	49	60	126	12	31
AnalystModelUtils	62	62	7	9	4	11	4	5
ConcentrationUnits	30	0	21	32	50	76	12	23
ContainmentMonitorReading	48	10	24	44	63	135	9	29
IsotopeReleases	33	20	42	58	81	120	18	31
IsotopeValue	27	12	41	55	87	123	18	30
IsotopicConcentrations	46	10	25	42	65	124	11	27
IsotopicReleaseRates	48	14	22	38	51	104	9	24
PIRSubReleaseMode	92	100	1	7	0	7	1	5
PercentInventory	56	44	46	83	83	215	9	28
PercentInventoryConstants	0	n/a	1	1	2	2	1	1
PercentInventoryRelease	51	31	37	69	76	154	16	42
PercentInventoryReleaseTree	91	62	84	150	32	361	6	37
PlantConditionConstants	55	13	31	35	51	60	8	12
PlantConditionTables	31	38	62	102	156	230	11	24
PlantConditionsModel	100	n/a	0	1	0	1	0	1
RascalFileReader	0	0	89	89	233	233	15	15
RascalProject	40	22	62	90	134	228	14	35
RascalXmlReader	0	0	51	51	117	117	9	9
RascalXmlReader.ReleaseStepRec	0	n/a	1	1	5	5	1	1
ReleaseRate	31	0	22	35	57	90	12	25
ReleaseUnits	44	5	17	32	40	76	8	23
SourceTermTable	73	55	53	109	53	209	3	26
SourceTermTable.OperationalInfo	94	n/a	1	3	2	14	1	3
SpentFuel	48	13	28	51	70	149	9	32

Table 7: Code Coverage: CAComp.data.analyst.plantcond

Class	Instructions Coverage (%)	Branches Coverage (%)	Complexity Missed	Complexity Total	Lines Missed	Lines Total	Methods Missed	Methods Total
PCConfinementByPass	29	0	10	15	13	22	7	12
PCConfinementLeakage	29	0	10	15	13	22	7	12
PCContainmentByPass	37	0	17	26	39	62	11	20
PCContainmentLeakage	55	n/a	5	9	8	18	5	9
PCCoreLeakData	51	33	15	30	39	82	7	18
PCDryWellLeakage	42	0	17	28	40	73	10	21
PCIceCondenserContainment	45	0	19	34	48	100	10	25
PCLargeDrySubContainmentLeakage	42	0	17	28	40	74	10	21
PCPromptCriticalPowerExcursion	42	9	22	34	43	76	11	23
PCReproFacility	42	0	22	44	76	155	10	32
PCSodiumWaterReaction	24	0	14	19	20	29	9	14
PCSteamTubeRupture	42	11	30	47	65	119	12	29
PCSubatmosphericConfinementLeakage	36	0	16	25	40	66	10	19
PCWetWellLeakage	40	8	23	35	50	85	11	23

Table 8: Code Coverage: CAComp.data.times

Class	Instructions Coverage (%)	Branches Coverage (%)	Complexity Missed	Complexity Total	Lines Missed	Lines Total	Methods Missed	Methods Total
AbstractTimesMgr	90	50	6	12	2	19	2	8
AnalystMixTimesMgr	100	n/a	0	4	0	6	0	4
IsotopicConcentrationsTimesMgr	100	n/a	0	4	0	7	0	4
IsotopicReleaseRatesTimesMgr	100	n/a	0	4	0	8	0	4
LeakRateTimesMgr	89	50	4	9	2	27	0	5
ModelTimesMgrFactory	68	70	6	15	4	12	1	3
NoopTimesMgr	83	n/a	2	4	2	8	2	4
OperationalTimesMgr	81	45	10	14	8	42	0	4
PCContainmentByPassTimesMgr	100	n/a	0	4	0	7	0	4
PCLeakRateTimesMgr	100	n/a	0	1	0	2	0	1
PercentInventoryTimesMgr	100	83	3	19	0	59	0	10
RascalProjectTimesMgr	91	50	4	10	4	29	0	6
SpentFuelTimesMgr	100	n/a	0	4	0	8	0	4

Table 9: Code Coverage: CAComp.exceptions

Class	Instructions Coverage (%)	Branches Coverage (%)	Complexity Missed	Complexity Total	Lines Missed	Lines Total	Methods Missed	Methods Total
NfacValidationException	0	n/a	3	3	6	6	3	3

Table 10: Code Coverage: CAComp.impl

Class	Instructions Coverage (%)	Branches Coverage (%)	Complexity Missed	Complexity Total	Lines Missed	Lines Total	Methods Missed	Methods Total
AmbInputsMgr	84	58	77	141	56	430	8	35
AmbInputsMgr.MCReleaseRec	92	62	6	11	2	30	0	3
EfficiencyFile	92	70	4	12	1	32	1	7
EquilibrateActivityVector	0	0	36	36	115	115	12	12
MelcorFraction	38	14	15	20	13	25	8	13
MelcorFractions	83	53	12	19	2	37	1	5
MelcorReleaseFractionsFile	82	83	2	7	2	18	1	4
NfacFieldDescribeHelper	0	0	155	155	405	405	35	35
NfacImpl	69	48	91	145	158	589	9	45
PercentInventoryFileMgr	66	45	8	13	6	25	0	3
RepoData	58	43	14	26	22	58	3	10
ReproMod	100	100	0	58	0	413	0	13
St_Monitor	90	42	8	12	6	23	1	5
StcalcClient	81	55	240	390	246	1,378	4	37

6.3 INTERACTIVE TEST RESULTS

Table 11: Interactive Test Results: Top Level Interactions

Test	Result
Set Incident Name	Success

Table 12: Interactive Test Results: Where Tab

Test	Result
Select facility	Success
Select default facility location	Success
Enter explicit facility location	Success
Define facility location by dragging the incident Icon	Success
Select the default inventory file	Success
Select a custom inventory file	Success
Use the ORIGEN File Import Utility to create a custom inventory file	Success

Table 13: Interactive Test Results: What Tab

Test	Result
Enter an explicit operating power	Success
Select a moderate incident	Success
Select a severe incident	Success
Define an Isotopic Release Rates incident	Success
Define an Isotopic Concentrations incident	Success
Define a Percent Inventory incident	Success
Define an Analyst Mix incident	Success
Define a Containment Monitor Reading incident	Success
Define a Spent Fuel incident	Sucess
Define a RASCAL Project incident	Success
Define a Confinement Bypass Plant Conditions incident	Success
Define a Confinement Leakage/Failure Plant Conditions incident	Success
Define a Containment Bypass Plant Conditions incident	Success
Define a Containment Leakage/Failure Plant Conditions incident	Success
Define a Dry Well Leakage/Failure Plant Conditions incident	Success
Define an Ice Condenser Containment Leakage/Failure Plant Conditions incident	Success
Define a Large Dry Subcontainmet Leakage/Failure Plant Conditions incident	Success
Define a Prompt Critical Power Excursion Plant Condition incident	Success
Define a Reprocessing Facility Plant Condition incident	Success
Define a Steam Generator Tube Rupture Plant Condition incident	Success
Define a Subatmospheric Confinement Leakage/Failure Plant Conditions incident	Success
Define a Wet Well Leakage/Failure Plant Conditions incident	Success
Select Material Processing Modes	Success
Select Percent Inventory Release Modes	Success
View source term	Success

Table 14: Interactive Test Results: When Tab

Test	Result
Moderate model times edit	Success
Severe model times edit	Success
Analyst Mix model times edit	Success
Containment Monitor Reading model times edit	Success
Isotopic Concentrations model times edit	Success
Isotopic Release Rates model times edit	Success
Percent Inventory model times edit	Success
Containment Bypass Plant Conditions model Times edit	Success
Prompt Critical Power Excursion Plant Conditions model times edit	Success
Reprocessing Facility Plant Conditions model times edit	Success
Confinement Bypass Plant Conditions model times edit	Success
Spent Fuel model times edit	Success
RASCAL Project model times edit	Success
Detect event times out of chronological order	Success
Apply time field changes for all events	Success
Override times in advanced mode	Success

Table 15: Interactive Test Results: Notes Tab

Test	Result
Edit notes	Success

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