README for SCALE 5.1 on Unix, Linux, and Mac
RSICC code package C00732/MNYCP/00
November 2006

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1. Introduction

This document is the README file for the Unix/Linux version of SCALE 5.1, which is RSICC code package CCC-732. You can find additional information and technical support at the following websites.

http://www.ornl.gov/sci/scale (SCALE Web site)
http://rsicc.ornl.gov (RSICC Web site)
http://rsicc.ornl.gov/rsiccnew/CFDOCS/scale5enotebook.cfm (SCALE 5 Notebook)

2. Computer Hardware Requirements

The UNIX version of SCALE runs on IBM RS/6000, HP/Compaq Alpha, HP, SunOS, and Linux workstations and requires approximately 5 GB of disk space to create executables and data libraries and run sample problems. This distribution includes Fortran 95 and C source codes, data libraries, test cases, and Makefiles necessary to build and test the entire system. Fortran 95 and C compilers are required. Executable files for Linux, built on a Fedora Core 5 system, are also distributed. SCALE 5.1 runs in serial mode; there is no parallel version.

SCALE 5.1 was benchmarked on DEC Alpha workstations (Tru64 4.0F, 5.0, 5.1) using the HP and Compaq Fortran 95 compilers. A Makefile to build the system on IBM, DEC, SUN, HP, Linux, and Mac/OSX is provided to facilitate installation of the code system, which is distributed on a DVD in several gnu compressed tar files. Approximately 4 GB of disk space is required to build the system on one operating system (OS) and execute the sample cases. Each additional OS needs about 0.5 GB, of which half is the output of the sample cases. A minimum of 1 GB RAM is required, and more may be needed for TSUNAMI. Note that very complex problems may require large amounts of memory (2 GB RAM or more) and scratch disk space (up to 2 GB). SCALE 5.1 was tested only under the systems listed below and may require modification for other systems. Windows users should install the Windows version which is distributed by RSICC on a separate DVD. Complete instructions for Windows users are given in the Getting Started file on the SCALE 5.1 install disk for Windows.

The GNU software is available free of charge from http://www.gnu.org/directory/gnu/

SCALE 5.1 was tested on the following systems.

- DEC6600 running Tru64 UNIX V5.0A, Tru64 UNIX V5.1A with HP Fortran V5.5A and C compiler V6.1 and V6.4
- DEC6600, DEC4100, and other DEC's running Digital UNIX V4.0D, V4.0F, V4.0D with Compaq Fortran V5.5 and DEC C V5.9
- IBM RS/6000 590 running AIX 5.1 with XL Fortran 08.01.0000.0003 and C 5.0.0.0
- HP workstation running HP-UX B.11.11, Fortran HP F90 2.9, C/HP-UX Version B.11.11.12
- Sun SPARCstation-20 running Solaris 5.9 with Fortran 95 8.2 and CC 5.9
- Intel Dual Xeon running Fedora Core 5 with Intel Fortran 95 9.1 and GNU gcc 4.1.1

- AMD Opteron running RedHat Enterprise Linux 4 with Intel Fortran compiler 9.1.0.39 and GNU 3.4.6
- Intel Mac OS X with Intel 9.1.030

Note that the HP, Sun, and AIX systems on which we tested are older systems with compilers that do not fully support some newer Fortran standards that are included in SCALE 5.1. As a result, some errors were encountered on these systems. If you encounter problems compiling on these systems, please check the SCALE 5 Notebook for guidance and possible updates:
Unix/Linux, page 130 http://rsicc.ornl.gov/rsic-cgi-bin/enote.pl?nb=c725&action=view&page=130
Linux specific, page 131 http://rsicc.ornl.gov/rsic-cgi-bin/enote.pl?nb=c725&action=view&page=131
IBM/AIX, page 132 http://rsicc.ornl.gov/rsic-cgi-bin/enote.pl?nb=c725&action=view&page=132
Sun, page 133 http://rsicc.ornl.gov/rsic-cgi-bin/enote.pl?nb=c725&action=view&page=133
HP, page 134 http://rsicc.ornl.gov/rsic-cgi-bin/enote.pl?nb=c725&action=view&page=134
Intel Mac, page 135 http://rsicc.ornl.gov/rsic-cgi-bin/enote.pl?nb=c725&action=view&page=135
PowerPC Mac, page 136 http://rsicc.ornl.gov/rsic-cgi-bin/enote.pl?nb=c725&action=view&page=136

The latest news and software updates are posted on the SCALE website. From the SCALE home page, click on "Newsletter" for current and back issues of the *SCALE Newsletter*; click on "Download" for software updates, new utilities, verification & validation input files, and other files. The SCALE 5 electronic notebook on the website contains a great deal of helpful information including answers to many FAQs.

If you encounter problems, please read all this information and determine where the first problem occurred before contacting ORNL for help. Inquiries for technical assistance may be directed to the SCALE staff at scalehelp@ornl.gov. To aid in identifying the problem, try to include as much detail as possible, including log files, input/output files and error messages. Be sure to specify your computer, operating system and compiler versions.

3. Installation of SCALE

The following commands (shown in `Courier font`) create the SCALE 5.1 system under the current working directory, install the system, build libraries, and run sample problems. **Note that your current working directory '.' must be included in the user's path for the Make commands to work correctly.** One may choose any name for this directory, but changing names of any other files/directories will require changes to Makefiles and is **NOT** recommended. If you rename the directory, it should be done **before** Make is invoked to build the system.

WARNING: If space is limited on /usr/tmp, after extracting the system, modify installscale.patn and cmds/batch5.patn to define **TMPDIR** on a disk with more free space (100 MB minimum, 0.5 to 1.0 GB recommended).

To install on Unix or Linux systems:

Note that ***/dvdrom*** represents the directory where the DVD is loaded. Unix commands are written in `Courier font`.

Create the head directory for the SCALE 5.1 system and `cd` into it.

Load the DVD and uncompress and extract files under the present working directory:

```
gunzip -c /dvdrom/Scale5.1.base.tar.gz | tar xf  -
gunzip -c /dvdrom/Scale5.1.src.tar.gz | tar xf  -
gunzip -c /dvdrom/Scale5.1.xsecs.tar.gz | tar xf  -
gunzip -c /dvdrom/Scale5.1.cen5.tar.gz | tar xf  -
gunzip -c /dvdrom/Scale5.1.cen6.tar.gz | tar xf  -
gunzip -c /dvdrom/Scale5.1.manual.tar.gz | tar xf  -
```

The environmental variable $SCALE must be set to the head directory where SCALE 5.1 is to be installed. For example,

```
export SCALE=SCALE5.1
```

where **SCALE5.1** is the head directory.

Each of the following steps creates a log file in **sysname**, the system-dependent directory. Examine the logs to determine the success of the installation. All compilations, library creations, and sample problems are performed from the head SCALE 5.1 directory. If the head directory is accessible on different systems using the same directory pathname, then SCALE 5.1 can be built and maintained on each system, as all the system dependent files are kept under the system dependent directory. The data libraries only need to be created once, as they are shared between the systems. All the data libraries are kept in "big endian" order. On "little endian" machines (Tru64, x86 Linux, Mac OS X), the HP compiler for Tru64 and the Intel compiler for Linux and Mac are able to read "big endian" ordered files using options specified in the **cmds/scale5** script that set the necessary environmental variables for this to happen.

Installing Linux or Intel Mac Executables

The Unix DVD includes Linux executables compiled with Intel ifort version 9.1.039 on an AMD Opteron running RedHat Enterprise Linux 4. If the user is running on a fairly recent Linux machine and wishes to try using the ORNL supplied precompiled executables, extract distribution files as directed above, then execute the following commands.

```
gunzip –c /dvdrom/Scale5.1.linux_2.tar.gz | tar xf  -
make SUBDIRS= configure          [Note: one blank character must follow the =]
nohup runsmpls &
```

Likewise for Intel Mac computers, executables created by the developers on Intel Mac OS X with Intel ifort compiler 9.1.030 are included in the distribution. Use the following commands instead.

```
gunzip –c /dvdrom/Scale5.1.intel_mac.tar.gz | tar xf  -
make SUBDIRS= configure          [Note: one blank character must follow the =]
nohup runsmpls &
```

See **"Running and Verifying SCALE Sample Problems"** later in this document for detailed instructions on checking the sample problem results. Note that the Linux executables in the distribution are 32-bit binaries and may not be capable of handling very large TSUNAMI problems, which could require 64-bit executables.

If these steps fail, then the user should (from the head SCALE5.1 directory) do a

```
make realclean
```

and perform a full installation as described next.

Full Installation

The next command begins the Make process by creating a configuration file for your system.

```
make configure
```

This command queries the operating system for machine type. It creates a directory with a system-dependent name set by the script **cmds/sysname** and generates a **config.data** file in this directory. For example, if you are running under **AIX 5** in a head directory called **SCALE5.1,** the configuration file will be **SCALE5.1/AIX_5/config.data.** Check that a valid **sysname/config.data** file was created for this system. If not, look at the files in the **config** directory, and create a **config.data** file in the system-dependent directory by hand. Verify that the "**SCALE=**" definition in **config.data** is the directory path of the directory into which the tar files were extracted. Numerous subdirectories are created during the `make configure`. If "SCALE=" or "TMPDIR=" is redefined, then redo the `make configure` before invoking `installscale`, as this will fix the scripts.

At this point, if only a partial installation is desired, edit the files **LDIRS, BDIRS, FDIRS, CDIRS, ADIRS,** and **UDIRS** in the head SCALE 5.1 directory to remove the undesired programs. **LDIRS** is the list of the subroutine libraries in SCALE 5.1. **scalelib** is required for all parts of scale, and **miplib** is required if any control program is desired. **marslib** is needed for **morse**, **sas3**, and **sas4**. **senlib** is needed by the **tsunami** sensitivity sequences, while the last 3 libraries (gd-1.8.1, libpng-1.2.0, and zlib-1.1.4) are used in making 2-D slices through **keno** and **morse** geometries. **BDIRS** defines the **shell** command, the scale **driver**, and the **compoz** program. The utility **compoz** creates and edits the **standard composition library**. Also here are **mal** and **wgt,** which make the **keno** albedo and weight files. **FDIRS** is the list of SCALE functional modules, and **CDIRS** is the list of SCALE control modules. Check the documentation for descriptions of what these programs do. **ADIRS** contains the list of **AMPX** programs included with SCALE 5.1, and **UDIRS** is a list of utility programs. These are documented in sections **M15** and **M17**. If any programs are removed, remove the program names from the file **SMPL** in the head directory to make sure the sample problems for those programs will not be run.

In the head directory, the **installscale** script invokes Make to process source files and build executables. Enter the next command:

```
installscale &
```

The **installscale** script invokes Make to compile sources and build executables. If installation is aborted or must be restarted, you may use **updatescale** to continue. Make compiles the *.f90 and *.c files in each source directory. The UNIX command **ar** is used to build relocatable object libraries from *.o files; these object libraries are created in the ***sysname*/lib** directory. For each program source directory, sources are compiled, **ar** is executed, and the compiler is run to build executables. The object files, relocatable object libraries, and executables are not deleted from the ***sysname*** subdirectories in which they were created because Make checks these original files for dependencies if it is invoked again.

After all executables are built in their respective ***SCALE5.1/sysname*** directories, **installscale** copies executable programs to the ***SCALE5.1/sysname*/bin** directory and updates the file **qatable** in the **data** directory to reflect the correct code version and date on which the executables were created. There is more information about the **qatable** file later in this document. The **installscale** step creates 2 separate log files (one for creating executables and one for copying executables to the bin directory). Be sure to examine both logs. Verify that all data libraries were created. Contents of the **bin** and **data** directories appear under "**Contents of This Distribution**."

Run sample problems defined in **SMPL** in the background, because this can take many hours. See Section 7 later in this file for more information on running and checking sample problems.

```
nohup runsmpls &
```

See **"Running and Verifying SCALE Sample Problems"** later in this document for detailed instructions on checking the sample problem results.

4. User Registration

Registration of the software is highly encouraged. To that end, each user will need to access the SCALE 5.1 registration site https://public.ornl.gov/scale/index.cfm using a browser.

Log in using your RSICC pass number and password. On the second screen in the field labeled "Computer name", enter the user ID that will be used when executing SCALE 5.1. Enter your RSICC pass number in the second field. A registration key will be returned.

Next the user executes the "register" script in the **cmds** directory. The user will be asked to enter their RSICC pass number and the registration key. A file, **.scalerc**, will be generated in their home directory. The **.scalerc** file will be created with the user's default privileges, which can be changed by running the "chmod" command.

5. How to Run SCALE

Users must add the *SCALE5.1*/cmds directory to their path. The command **#!/bin/ksh** which is specified at the beginning of most scripts forces them to run in the korn shell (k shell). A few

scripts run in the c shell (csh). The **batch5** script in the **cmds** directory runs SCALE in batch mode and sets environmental variables necessary to run the **scale5** script and calls the **scale5** script. It also removes the temporary directory after execution. The **scale5** script copies or links the executables and data files from their respective subdirectories to a temporary directory for execution then invokes the driver to read the **sysin** input file and executes the problem. On the local system a directory **/usr/tmp** has been allocated so that all users have write access.

It is important to note that the link (**ln –s** command) will not overwrite files that exist or are already linked, so it may be necessary to remove files before executing again a problem that failed using the **scale5** command (this is not an issue if the **batch5** script is used because it starts with a clean temporary directory). Extra data files that are needed to execute any problem must be present (or linked) in the temporary directory where the problems will be run.

To run SCALE, use one of the following commands

batch5 [-m -p -r -t -x -n N] ***inputfile*** **[*outputfile*]**

where
-m = print messages from KENO, XSDRN, MORSE, NEWT to the screen (optional flag)
-p = print block letter banner pages in output (optional flag)
-r = don't remove temporary working directory at end of job (optional flag)
-t = use existing temporary working directory $TMPDIR (optional flag)
-x = return XSDRN output files (optional flag)
-n N = nice value to be used during execution (default N = 2)
inputfile = input file name (required) (can include input path)
outputfile = output file name (optional) (This can include path - all output files will go to the same directory as the output file. If not specified, the output file will be derived from the input file, and output will be returned to the input file directory)

or

scale5 ***inputfile*** **[*outputfile*]**

where ***inputfile*** is the SCALE input file without the extension. This script works with input file names with no extension (e.g., case1), or extensions of .inp, or .input (e.g., case1.inp, case1.input). The output file will automatically be written with the .out or .output extension (e.g., case1.out or case1.output), respectively. The batch5 script also automatically saves system messages in a .msg or .msgs file (e.g., case1.msg or case1.msgs), respectively. The **batch5** script automatically sets the environmental variables needed by the **scale5** script, allocates a temporary directory for the calculation, calls the **scale5** script, and deletes the temporary directory after **scale5** completes execution. If you use the **scale5** script instead, you must set the required environmental variables and allocate the temporary directory. The directory will not be deleted when execution is completed. The environmental variables that must be set are:

SCALE - the full directory path where SCALE is installed
TMPDIR - the full path for the temporary directory

If a message about “unknown locale” appears when running SCALE, try adding the following line near the beginning of the **cmds/scale5** script:

```
export LANG=C
```

6. Running and Verifying the SCALE Sample Problems

The **runsmpls** command runs all sample problems using the **batch5** command, which returns output to the ***SCALE5.1/sysname/*smplprbs** directory. This command creates *.done files in ***SCALE5.1/sysname/smplprbs*** for each module. If the sample jobs abort and need to be rerun, the user must remove the ***.done** targets for any sample problems that need to be rerun before executing **runsmpls** again. If **runsmpls** terminates without error, it will delete the ***.done** files. Runtimes for sample problems vary from approximately 8 hours to 24 hours depending on the speed of the machine. Please check the *.**msgs** files to confirm that no execution errors occurred.

Some of the TSUNAMI problems require a large amount of memory and may not run on computers with less than 1 GB of available memory. To increase physical memory or the size of the data area for the current shell environment, the user can issue one or both of the following commands. The syntax varies on different computers. System administrators can reset default limits.

```
ulimit -m unlimited

ulimit -d unlimited

ulimit –a   [queries the system for user’s limits]
```

Once the sample problems are completed, compare the results to those provided in the **output** directory by running the **check_results** script while sitting in the ***SCALE5.1/sysname*/smplprbs** directory. The **check_results** script calls the **make_results_table** script that extracts key data from sample problem output files and writes them into tables. The tables are then compared to similar tables from ORNL that are distributed in the ***SCALE5.1/*tables/*sysname*** directory**.** The differences are written to **compare_output.txt in *SCALE5.1/sysname*/smplprbs**. This procedure significantly reduces the amount of data compared, and consequently, the time required for the installer to verify that the sample problem results are acceptable. Note that the ***SCALE5.1/*tables** directory contains the tables from ORNL output on several different operating systems, as labeled. If tables for your operating system are available, the script will compare with those tables. If tables do not exist for your operating system, you may want to try comparing your results to those of a different system to find which set compares most closely.

The differences for most of the non-Monte Carlo functional module sample problems should be fairly small, i.e., numerical round-off in the last one or two digits. For Monte Carlo results from KENO V.a, KENO-VI, and MORSE (this includes CSAS, CSAS6, TSUNAMI-3D, KMART, KMART6, SAS3, and SAS4), it is common for results to vary within 1 to 3 standard deviations.

The MORSE sample problems require an F90 compiler to build special executables with problem-specific Fortran routines. These sample problems will not run with the distributed Linux

executables unless an F90 compiler is installed on the computer. However, the MORSE module is adequately tested in the SAS3 and SAS4 sample problems.

Because the TSUNAMI-1D and -3D output files are very large, a special TSUNAMI-IP sample problem named **tsunami-3d_summary.input** is executed after the standard TSUNAMI-1D and -3D sample problems to generate a summary output file for comparison. This problem compares the sensitivity profiles generated by the standard TSUNAMI-1D and -3D sample problems on the test machine to the sensitivity profiles generated at ORNL by calculating the c_k index, which assesses the similarity of two systems based on normalized differences in the energy-dependent sensitivity data for fission capture and scatter. The resulting c_k values should be near 1.0 (typically 1% or less). For comparisons of TSUNAMI-3D results for cases run on machines with the same operating system and compiler, the c_k indices may (but not necessarily) be 1.0, indicating an exact match.

NOTE: The **compare_output.txt** file should be examined very carefully. There must be corresponding lines from each output file that is being compared. In other words, if one or more sample problems fail to run, the extracted lines from the ORNL output files will be listed as differences in **compare_output.txt**.

7. How SCALE Works

When SCALE is executed, the user's input file is copied to a file named **sysin**. The driver calls each module requested and passes the input for each module as it is called via the file **input**. The output from the driver is written to file **print**. The functional modules write to **_out0000**, **_out0001**, **_out0002**, etc. The control modules write output files called **_prt0000**, **_prt0001**, **_prt0002**, etc. After each control module is finished, the driver collects the **_prt*** and **_out*** files into a unique **_tot000n** file, and removes the **_prt*** and **_out*** files.

After executing the problem, output files are collected and returned to the user's directory. If there is a problem with execution, sometimes the files are not returned. The user can manually go to the temporary directory and examine the files, **print**, **_out000n** and **_prt000n**, etc., to find the problem. The files beginning with "_" are numbered with an integer that increments each time another file is written.

All files written by the SCALE modules (e.g., working format cross sections, restart files, scratch files) are written to the temporary working directory. You may copy any of the files in the temporary working directory to another directory for later use (e.g., a KENO-V.a restart file.) You can insert UNIX commands in your SCALE input file to copy or delete files or perform other operations. Specify "**=shell**" before or after the input for another SCALE module. The UNIX commands written on the lines following "**=shell**" and before the "**end**" terminator will be executed from the temporary working directory. The original input file directory (aka the return directory) can be specified by the environmental variable **$RTNDIR** and the temporary working directory by **$TMPDIR**. For an example, view the sample problem input file **lava.inp** in ***SCALE5.1/*smplprbs**. Once the SCALE job is completed and any desired files are copied, you may delete all files in the temporary working directory to free disk space, if needed. Otherwise, the files may be used, overwritten, or deleted by the next SCALE job. Using the **batch5**

command automatically allocates and removes a temporary working directory at the beginning and end of each job.

8. SCALE Manual

The SCALE 5 manual is distributed in PDF format in a compressed tar file named **Scale5.1.manual.tar.gz** on the **Unix** DVD. Note that PDF files can be viewed on Unix, Linux or Windows platforms. The manual is compatible with Acrobat Reader 7.0. Version 7 for Windows is included on the Windows DVD. Unix users must download the Reader from www.adobe.com. Be sure to check the box "Download the full version of Adobe Reader," if it is displayed.

Open the Table of Contents for the manual, **contents.pdf**. You may click on one of the titles in the table of contents to open that section of the manual. Each section has bookmarks and thumbnails for ease in navigation of the document. If the bookmarks and thumbnails are not displayed when a section of the manual is opened, click on the tabs on the left side of the document.

The manual contains a searchable index. To activate the searchable index, open the SCALE manual. In Acrobat, click on the "Search" icon and click on "Use Advanced Search Options." Then click on "Select Index…" The SCALE 5.1 index is **manual/index/scale5.1-index.pdx**. You can search the entire SCALE Manual for words or phrases. Search returns a list of all sections of the SCALE Manual that contain the specified word(s). You may then select one of these files to view. Each occurrence of the word or phrase is listed.

9. SCALE Graphical Interfaces and Visualization Tools for Windows

The Windows DVD of SCALE includes several graphical user interfaces (GUIs) as well as 2-D plotting and 3-D visualization tools that Unix/Linux users may want to install on a Windows PC to set up input files and/or plot and review results. These components are briefly described below. Shortcuts for these are installed on the Start Menu in the **scale5.1** folder.

GeeWiz User Interface

GeeWiz (Graphically Enhanced Editor Wizard for SCALE) is the graphical user interface (GUI) that serves as a "command center" for SCALE users. It assists users in setting up, running, and viewing results for CSAS/KENO V.a, CSAS6/KENO-VI, TSUNAMI-1D and -3D, TRITON/KENO V.a, TRITON6/KENO-VI, STARBUCS, and SMORES cases from an integrated user-friendly environment. It is integrated with KENO3D, Javapeño, and the KENO V.a HTML output.

Keno3D

Keno3D is the 3-D visualization software designed for interactively viewing KENO V.a and KENO-VI geometry models on Windows computers. It is built on the ACIS 3-D Toolkit from Spatial Technologies and a royalty fee is required. A limited capability (100 maximum bodies) 30-day evaluation version is distributed on the Windows DVD and may be installed at no charge.

To obtain the full version, go to the SCALE website and click on "Order and Download KENO3D Full Version" to purchase by credit card for $100 and download. If you have already purchased the full version of KENO3D Version 5.0, you may request a free upgrade on the SCALE Download web page.

KENO V.a Primer with GeeWiz and KENO3D

The KENO V.a Primer is designed to teach new users how to use KENO V.a with the GeeWiz user interface in SCALE 5.1. It includes a section on the use of the KENO3D visualization tool to plot models and overlay them with calculated results. The primer gives an overview of the basic requirements for KENO V.a input and allows the user to quickly run a simple criticality problem with KENO V.a. Each subsequent section provides a list of basic objectives that identifies the goal of the section and the individual SCALE/KENO V.a features that are covered in detail in the sample problems in that section. The document contains over 100 color figures illustrating the GeeWiz input screens, the KENO V.a geometry, and the sample KENO V.a models. The primer is written as a "getting started" manual for new KENO V.a users and complements the training provided in the SCALE workshops at ORNL.

OrigenArp/PlotOPUS

ORIGEN-ARP is a sequence in SCALE that serves as a fast and easy-to-use system to perform nuclear irradiation and decay calculations with the ORIGEN-S code using problem-dependent cross sections. ARP (Automatic Rapid Processing) uses an algorithm that allows the generation of cross-section libraries for the ORIGEN-S code by interpolation over pre-generated SAS2H cross-section libraries. The interpolations are carried out on the following variables: burnup, enrichment, and moderator density (optional). The OrigenArp GUI provides an easy-to-use Windows interface with menus, toolbars, and forms that allow the user to set up, run, and view results of ORIGEN-ARP calculations in an integrated user-friendly environment.

PlotOPUS is a Windows GUI designed to plot ORIGEN-S results that have been post-processed with the OPUS utility. Input for OPUS and viewing plots with PlotOPUS are handled automatically by the integrated OrigenArp GUI.

The ORIGEN-ARP libraries in SCALE 5.1 have been significantly expanded. All light water reactor (LWR) libraries and VVER libraries are based on TRITON/NEWT 2-D depletion models. All BWR libraries contain moderator density dependent cross sections. The available libraries include:

- BWR:
  - GE 7x7, 8x8 , 9x9, 10x10
  - ABB 8x8
  - ATRIUM-9 and ATRIUM-10
  - SVEA-64 and SVEA-100
- PWR
  - Siemens 14x14
  - Westinghouse CE 14x14 and 16x16
  - Westinghouse 14x14, 15x15, 17x17, 17x17 OFA
- CANDU reactor fuel (28- and 37-element bundle designs)
- MAGNOX graphite reactor fuel

- Advanced Gas Cooled (AGR) fuel
- VVER-440 flat enrichment (1.6% - 3.6%) and profiled enrichment (average 3.82%, 4.25%, 4.38%)
- VVER-1000
- MOX BWR 8×8-2, 9×9-1, 9×9-9, 10×10-9
- MOX PWR 14×14, 15×15, 16×16, 17×17, 18×18

Programmer's File Editor (PFE) 1.01

PFE is a powerful freeware text editor that can handle very large files and is useful for editing and printing SCALE input and output files. This is the same version that was distributed with SCALE 4.4a.

SAS4 ESPN GUI

ESPN (Easy Shielding Processor iNput) is the graphical user interface (GUI) that assists users in setting up, running, and viewing results from SAS4/MORSE 3-D Monte Carlo shielding cases.

10. Javapeño

Javapeño (**Java P**lots, **E**specially **N**ice **O**utput) is an interactive 2-D and 3-D plotting package that is written in Java and operates on numerous computing platforms. Javapeño enables the plotting of data from TSUNAMI-A and TSUNAMI-B sensitivity data files, KENO V.a and KENO-VI data files generated with KMART and KMART6, XSDRNPM data files, and SMORES data files. New for SCALE 5.1, Javapeño includes a 3-D plotting engine and can plot data directly from binary AMPX master and working formatted cross-section data libraries and from binary COVERX formatted cross-section-covariance data libraries. Javapeño executes on any system with a Java Virtual Machine (JVM) version 1.5 or newer installed. Java3D components are required for 3-D plotting and Java Advanced Imaging components are required for image exporting. Current versions of the JVM for many operating are available from Sun Microsystems at http://java.com/en/download/manual.jsp. Implementations of JVM for other platforms may be available from the manufacturer.

Supported data file formats are:

- TSUNAMI Sensitivity Data (default extension .sdf)
  - TSUNAMI-1D data in TSUNAMI-A format
  - TSUNAMI-3D data in TSUNAMI-B format
- KENO V.a and KENO-VI Data (default extension .kmt)
  - KMART data files from KMART and KMART6
- XSDRNPM Data (default extension .idf)
  - Data generated in Input Dump File, Balance Table File, and Activity Data File
- SMORES Data (default extensions .plotd and .plote)
  - Effectiveness functions and density functions
- ICSBEP Sensitivity Data (no default extension)
  - International Handbook of Evaluated Criticality Safety Benchmark Evaluations sensitivity data

- General 2-D Plot Data (default extension .plt)
  - General 2-D data format
- Cross-Section-Covariance Data (no default extension)
  - Multigroup cross-section covariance data
- Cross-Section Data (no default extension)
  - Multigroup cross-section data
- General 3-D Plot Data (default extension .j3d)
  - General 3-D data format

Many new features have been added to Javapeño since its version 1.0 release. Below is a list highlighting the major (and some minor) new features:

1. 3-D plotting capability
2. Support for multigroup cross-section data
3. Support for multigroup cross-section-covariance data
4. Modern, floating window layout for Javapeño's application mode
5. Advanced 3-D plotting customization such as zooming, panning, rotating
6. Auto-rotate capability on 3-D plots
7. Simple mathematical operation capability for 2-D plots
8. Addition of a general 3-D plot data type
9. Printer Page Layout customization
10. Improved applet mode capabilities and layout

Javapeño 5.1 has the following system requirements:

1. Java supported operating system (OS) and processor. Please see Java's list of supported architectures. If your architecture is not listed, check your hardware manufacturer's website. For an example, Apple and HP are known to release their own port of Java.
2. Java 1.5.x+ must be installed. Only the runtime environment (JRE) is required.
3. Java 3D 1.31+ must be installed.
4. Java Advanced Imaging (JAI) 1.12+ must be installed.
5. 30MB of RAM free to run Javapeño.
6. Java 3D supported video card (to plot 3-D data).

For a more enjoyable Javapeño experience, the following system specifications are **Error! Reference source not found.** if plotting 3-D data.

1. 512MB+ of free RAM
2. 1.4GHz+ processor
3. Java 3D 1.4+

11. Color 2-D Plot PNG and PS Files

KENO-V.a, KENO-VI, CSAS, CSAS6, and PICTURE can generate color PNG 2-D plot files. The files will be named "*inputfile*.plot*xxxx*.png", where "*inputfile*" is the input file name and "*xxxx*" is the plot number from 0000 to 9999 generated by *inputfile*. For more information about how to generate these plot files, please read the SCALE manual section for the appropriate SCALE module. The PNG files can be viewed by many different graphics viewers and web browsers.

NEWT generates 2-D color PostScript (PS) files. These files also can be viewed by many different graphics viewers.

12. KENO V.a HTML Output

A new feature in SCALE 5.1 is HTML output generated by KENO V.a. Javapeño 5.1 includes a full featured applet mode, which is used for interactive plots in the HTML output. All features included in the application mode can now be used in the applet mode. To accomplish this, the Javapeño applet had to be signed with a security certificate. Before running Javapeño in applet mode, the certificate must be accepted. The first time that you open the applet within the HTML output, you may see a message such as

The application's digital signature is invalid. Do you want to run the application?

Click the button to accept the certificate. This should only happen once. For more information, please refer to the help files in Javapeño.

If the Javapeño plotting applet does not work when viewing the HTML output, try adjusting the settings in your web browser. The following settings are from Internet Explorer. Other browsers should have similar options.

In the Internet Explorer menu bar, click on Tools, then Internet Options. On the Advanced tab, scroll down to the Security heading. Check the box labeled "Allow active content to run in files on My Computer."

13. Uninstalling SCALE

If you want to clean up and restore the directory to its initial structure, typing

make realclean

from the SCALE 5.1 head directory deletes all data libraries, object, sample output, and executable files created in this system.

14. Contents of This Distribution

Command Files to Execute SCALE

The ***SCALE5.1/*cmds** directory contains scripts to execute SCALE and to compile and link executables. The following is a list of commonly used scripts installed in the **cmds** directory to run SCALE.

Commands	**Function**
scale5	Executes SCALE
batch5	Executes SCALE in batch mode (sets environmental variables and makes new temporary directory); calls scale5
check_results	Checks SCALE 5.1 sample problem results by comparing to ORNL results
collect_output	Collects individual module output files in proper order to produce complete SCALE output file
compare_scale_output	Called by check_results to compare two files for differences
copy_file	Copies a file. This allows use of the same command in =shell input on both Windows and Unix platforms.
copy_graphic	Copies graphics files from \scale5.1\data\html_resources for HTML output.
cpexec	Used by SCALE driver to call executable programs.
make_*module*_tables	One for each SCALE *module*. Called by check_results to make summary tables of results from sample problem output for comparison.
makedirectory	Called by SCALE HTML routine to make HTML output directory
scale5_populate_tmp	Called by scale5 to populate the temporary working directory by copying or linking files
scale5_return_calc	Called by scale5 to copy output files to return directory after SCALE execution is completed

SCALE Fortran Source Files

This distribution includes the source code for each module in separate subdirectories under ***SCALE5.1*/src**. Compilations are done under ***SCALE5.1/sysname*/src**. An executable is created for each module and stored in the ***SCALE5.1/sysname*/bin** directory.

Other **src** subdirectories include source code for routines common to multiple modules, such as **scalelib** (SCALE general purpose subroutine library), **miplib** (Material Information Processor library), **klib** (KENO library), **sgmlib** (SCALE Generalized Geometry library), and **smclib** (SCALE Monte Carlo cross section mixing library) subdirectories. Files in each of these are

used to create an archive program library of objects which are saved in the ***SCALE5.1/sysname/*lib** directory to be accessed by the loader when building executables.

SCALE Modules and Executable Files

This distribution contains all the SCALE criticality, source term, reactor physics, shielding, and utility modules. The table below lists the executable name(s) corresponding to each module and the section of the SCALE manual where it is documented.

Module	Executable	Documentation
AIM	aim	M15
AJAX	ajax	M15
ALPO	alpo	M15
ARP	arp	D1
ARPLIB	arplib	D1
AWL	awl	M15
BONAMI	bonami	F1
BONAMIST	bonamist	M18
C5TOC6	c5toc6	M17
CADILLAC	cadillac	M15
CAJUN	cajun	M17
CENTRM	centrm	F18
CENTRMST	centrmst	M18
CHOPS	chops	M7
COGNAC	cognac	M15
COMPOZ	compoz	M14
COUPLE	couple	F6
CSAS	csas	C4
CSAS6	csas6	C6
CUTLET	cutlet	M17
GENWGTS	genwgts	M17
GWAS	gwas	M17
ICE	ice	F8
K5TOK6	k5tok6	M17
KENO V.a	kenova	F11
KENO-VI	kenovi	F17
KMART	kmart	M17
KMART6	kmart6	M17
LAVA	lava	M15
LEGEND	legend	M13
LSULIB	lsulib	M17
MAL	mal	M15
MALOCS	malocs	M15
MODIFY	modify	C4
MORSE	morse, o0o006, o0o106	F9
NEWSIE	newsie	M17

NEWT	newt	F21
NITAWL	nitawl	F2
NITAWLST	nitawlst	M18
OPUS	opus	F15
ORIGEN	origen	F7
PALEALE	paleale	M15
PERFUME	perfume	M15
PICTURE	picture, o0o016	M13
PMC	pmc	F19
PMCST	pmcst	M18
PRISM	prism	D1
QAD-CGGP	qadcggp	S5
QADS	qads	S5
RADE	rade	M15
REORG	reorg	M6
SAMS	sams	F22
SAS1	sas1	S1
SAS2	sas2	S2
SAS3	sas3	S3
SAS4	sas4	S4
SCALE driver	scale	M1
SHELL	shell	M17
SMORES	smores	C7
STARBUCS	starbucs	C10
SWIF	swif	C7
TOC	toc	M17
TRITON	triton	T1
TRITON6	triton6	T1
TSUNAMI-1D	tsunami-1d	C8
TSUNAMI-3D	tsunami-3d	C9
TSUNAMI-IP	tsunami-ip	M18
WAX	wax	M15
WGT	wgt	M17
WORKER	worker	F20
XSDOSE	xsdose	F4
XSDRN	xsdrn	F3
XSECLIST	xseclist	D1

SCALE Data Libraries

After installing the system, the ***SCALE5.1/*data** directory contains the SCALE Standard Composition Library, the AMPX master cross-section libraries, KENO biasing weights and albedos, ORIGEN-S binary libraries, the **aliases** file (contains aliases for module/sequence names), and the ASCII data libraries for QAD-CGGP. The **arplibs** directory contains the ORIGEN-ARP libraries. The **origen_data** directory contains the ORIGEN-S ASCII libraries. The **endf_b** directory contains the ENDF/B-V and ENDF/B-VI continuous energy cross-section

libraries for CENTRM. There will also be a **data** directory under the ***sysname*** directory that includes the file **qatable** used to contain software quality assurance information.

The table below lists the data libraries included in this distribution. The ORIGEN-S libraries are described in Section M6 and may be converted from binary to ASCII and back using the REORG utility. The AMPX master format libraries are described in Section M4 and are distributed in binary format only. You may use the AIM module to convert these cross-section libraries to ASCII format and back to binary. The PERFUME module processes a cross-section library after it has been reconverted to binary format. You may use COMPOZ to convert the Standard Composition Library to ASCII format and back to binary. Examples of these conversions may be found in the ***SCALE5.1/*work** folder.

Data Library Description	**File or subdirectory name (in *SCALE5.1/*data)**	**SCALE Manual**
18GROUPGAMMA	scale.rev06.xg18	M4
22N-18COUPLE	scale.rev04.xn22g18	M4
238GROUPNDF5	scale.rev14.xn238	M4
V6-238	scale.rev02.xn238v6	M4
27N-18COUPLE	scale.rev06.xn27g18	M4
44GROUPNDF5	scale.rev16.xn44	M4
HANSEN-ROACH	scale.rev04.xn16	M4
CENTRM ENDF/B-V point cross-section data	endf_b/vers5	M4
CENTRM ENDF/B-VI point cross-section data	endf_b/vers6	M4
44-Group ENDF/B-V covariance data	scale.rev01.44groupv5cov	M18
Recommended 44-Group ENDF/B-V covariance data	scale.rev00.44groupv5rec	M18
44-Group ENDF/B-VI covariance data	scale.rev01.44groupv6cov	M18
Recommended 44-Group ENDF/B-VI covariance data	scale.rev01.44groupv6rec	M18
ARP library index	arpdata.txt	D1
KENO Albedos	albedos	F11
KENO Weights	weights	F11
ORIGEN-S alpha cross-section data	origen_data\origen.rev00.alphaxs.data	M6
ORIGEN-S alpha decay data	origen_data\origen.rev00.alphdec.data	M6
ORIGEN-S alpha yield data	origen_data\origen.rev00.alphyld.data	M6
ORIGEN-S alpha stopping coefficients	origen_data\origen.rev00.stcoeff.data	M6

ORIGEN-S card-image ENDF/B-VI decay data	origen_data\origen.rev04.end6dec.data	M6
ORIGEN-S card-image thermal LWR cross-section data	origen_data\origen.rev02.pwrlib.data	M6
ORIGEN-S master photon data for bremsstrahlung from negatrons slowing down in water	origen_data\origen.rev00.mpbrh2om.data	M6
ORIGEN-S master photon data for bremsstrahlung from positrons slowing down in water	origen_data/origen.rev00.mpbrh2op.data	M6
ORIGEN-S master photon data for bremsstrahlung from negatrons slowing down in UO2	origen_data/origen.rev00.mpbruo2m.data	M6
ORIGEN-S master photon data for bremsstrahlung from positrons slowing down in UO2	origen_data/origen.rev00.mpbruo2p.data	M6
ORIGEN-S master photon gamma ray spectra from spontaneous fission and (alpha,n) reactions	origen_data/origen.rev00.mpsfangm.data	M6
ORIGEN-S master photon decay X- and gamma-ray line data	origen_data/origen.rev02.mpdkxgam.data	M6
ORIGEN-S binary master photon lib w/ H2O bremsstrahlung	origen.rev02.maphh2ob	M6
ORIGEN-S binary master photon lib w/ no bremsstrahlung	origen.rev02.maphnobr	M6
ORIGEN-S binary master photon lib w/ UO2 bremsstrahlung	origen.rev02.maphuo2b	M6
ORIGEN-S PWR 33 GWD/MTU binary library	origen.rev02.pwr33gwd	M6
Filenames for ORIGEN libraries	origen_filenames	F7
QAD-CGGP attenuation factors	attenuat	S5
QAD-CGGP buildup factors	buildup	S5
QADS dummy xsec library	scale.rev01.qadxslib	S5
Parametric data for fissile solutions	scale.rev00.soln_parameters	M7
Standard Composition Library	scale.rev27.sclib	M8

The ASCII file **qatable** is required for execution on all computers. It is located in the ***sysname***/**data** directory and is used by the control and functional modules to check the latest revision date and version for the modules. This is to help implement software quality assurance. In order to validate the **qatable** for use in a SQA procedure, the dates and versions are changed by Make to agree with the dates on which the executables were created. The changes are made by **make install** which you can invoke by running either the **installscale** or the **updatescale** script. A portion of this file, illustrating the format, is listed below.

```
  scale   5.1
aim             aim             5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
ajax            ajax            5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
alpo            alpo            5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
arp             arp             5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
arplib          arplib          5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
awl             awl             5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
bonami          bonami          5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
bonamist        bonamist        5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
c5toc6          c5toc6          5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
cadillac        cadillac        5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
cajun           cajun           5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
centrm          centrm          5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
centrmst        centrmst        5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
chops           chops           5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
compoz          compoz          5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
cognac          cognac          5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
couple          couple          5.1.0  p14_sep_2006/scale/scale5.1/OSF1_V5/bin
```

The name of the executable files begins in column 1, followed by the module name and version number. The "p" indicates that the particular module has production status. Other valid flags are "t" for test and "m" for migration. The revision date follows in dd_mmm_yyyy format. The last field is the pathname.

ORIGEN-ARP Libraries

The ARP libraries for ORIGEN-ARP are stored in the ***SCALE5.1*/data/arplibs** folder and are listed in Sect. D1 of the SCALE Manual. Like other ORIGEN-S binary libraries, they may also be converted to and from ASCII using REORG as documented in Section M6 of the SCALE Manual.

15. Reserved Unit Numbers in SCALE

While data can be read on logical units 1-99, some units are reserved as defaults for certain programs. When defining input, avoid using units 1-19, 21-28, and 79-99. SCALE expects to read SCALE libraries on units 21-28 and 79-88; it reads the Standard Composition Library on 89 and uses other units for temporary files. A list of unit numbers and their default assignments are included in Table 1. All distributed data libraries are kept in "big endian" order on all computers. On "little endian" machines (Tru64, x86 Linux, Mac OS X), some unit numbers are set to "big endian" are listed in Table 2.

Table 1. SCALE 5.1 Logical Unit Master List

Unit Number	Module	Type of File
1	BONAMI	Master library
	NITAWL	Master library
	SAMS	Master library
	WORKER	Master library

2	ICE	Macroscopic working library
	TRITON	Single mixture weighted 3-group library used by COUPLE
3	XSDRNPM	Cell-weighted working library
	ICE	Cell-weighted working library
	KENO V.a	Cell-weighted working library
	KENO VI	Cell-weighted working library
	NEWT	Cell-weighted working library
	SAMS	Cell-weighted working library
	SWIF	Binary interface data file
	TRITON	Spectrum-weighted three-group working library
4	NITAWL	Working library
	CENTRM	Working library
	ICE	Working library
	KENO V.a	Working library
	KENO VI	Working library
	XSDRNPM	Working library
	NEWT	Working library
	TRITON	Working library
	SWIF	Working library
	NITAWLST	Working Library
	WORKER	Working Library
	SAMS	Working Library
7	NEWT	Preprocessed (alias-expanded) input file
8	BONAMI	Random-access scratch file
	ICE	Random-access scratch file
	KENO V.a	Random-access scratch file
	KENO VI	Random-access scratch file
	XSDRNPM	Random-access scratch file
	TRITON	Random-access scratch file
	SWIF	Auxiliary output file
9	BONAMI	Random-access scratch file
	CENTRM	Random-access scratch file
	NITAWL	Random-access scratch file
	ICE	Random-access scratch file
	KENO V.a	Random-access scratch file
	KENO VI	Random-access scratch file
	XSDRNPM	Random-access scratch file
	CSAS	Random-access scratch file
	WORKER	Random-access scratch file
	TRITON	Random-access scratch file

10	ICE	Random-access scratch file
	KENO V.a	Random-access scratch file
	KENO VI	Random-access scratch file
	XSDRNPM	Random-access scratch file
	CSAS	Random-access scratch file
	TRITON	Random-access scratch file
	SENLIB	Implicit-sensitivity-data file
	SAMS	Implicit-sensitivity-data file
11	BONAMI	Master library
	CSAS	Master library
	SAS3	Master library
	SAS4	Master library
	NEWT	Master library
	ORIGENS	Scratch file
	NITAWLST	Implicit-sensitivity-data file
	SAMS	Implicit-sensitivity-data file
12	SAS4	XSDRN adjoint flux file
	SAS3	
	SAS2	Scratch file
	QADCGGP	
	SWIF	Plot data file
	BONAMIST	Implicit-sensitivity-data file
	SAMS	Implicit-sensitivity-data file
13	ORIGENS	FIDO edit of input
	SWIF	Collection of auxiliary output files
	MIPLIB	Working CENTRM point cross-section library
	CENTRM	Working CENTRM point cross-section library
	PMC	Working CENTRM point cross-section library
14	ICE	Monte Carlo library
	KENO V.a	Monte Carlo library
	KENO VI	Monte Carlo library
	TRITON	Direct-access scratch file
	SAS2	Scratch file
	SWIF	Plot data file
15	SAS2	Scratch file
	CENTRM	Pointwise flux file
	PMC	Pointwise flux file
	TRITON	ORIGENS library
	SWIF	Plot data file
16	KENO V.a	Scratch file
	KENO VI	Scratch file

	XSDRNPM	Angular flux file
	SAS3	Scratch file
	SAS4	Scratch file
	MORSE	Scratch file
	SMORES	Scratch file
	TRITON	Depletion/branch homogenized cross section library
17	XSDRNPM	Scalar flux file
	CENTRM	Scratch file
	PMC	Scratch file
	COUPLE	Scratch file
	MORSE	Scratch file
	SAS3	Scratch file
	SAS4	Scratch file
18	BONAMI	Scratch file
	CENTRM	Scratch file
	PMC	Scratch file
	NITAWL	Scratch file
	XSDRNPM	Scratch file
	COUPLE	Scratch file
	WORKER	Scratch file
19	BONAMI	Scratch file
	CENTRM	Scratch file
	PMC	Scratch file
	NITAWL	Scratch file
	COUPLE	Scratch file
	XSDRNPM	Scratch file
	WORKER	Scratch file
20	NITAWLST	Master sensitivity cross section file
	SAMS	Master sensitivity cross section file
	QADS	Scratch file
	QAD-CGGP	Scratch file
21	ORIGENS	33 GWD PWR library
23	ORIGENS	Master Photon Data - No Bremstrahlung
24	ORIGENS	Master Photon Data - H2O Bremstrahlung
26	ORIGENS	Master Photon Data - UO2 Bremstrahlung
27	ORIGENS	BCD library - decay data
	COUPLE	BCD library - decay data

28	ORIGENS	BCD library – cross-section data
	COUPLE	BCD library – cross-section data
29	COUPLE	Input binary library
30	ORIGENS	Input binary library
	NEWT	Spectrum-weighted working library
31	NEWT	Forward flux file
	XSDRNPM	Binary interface data file (forward soln – TSUNAMI-1D)
	SAMS	Binary interface data file (forward soln – TSUNAMI-1D)
32	COUPLE	Output binary library
	NEWT	Adjoint flux file
	XSDRNPM	Binary interface data file (adjoint soln – TSUNAMI-1D)
	SAMS	Binary interface data file (XSDRNPM adjoint soln – TSUNAMI-1D)
33	SAS2	Output ORIGENS Multiburnup library
	TRITON	Output ORIGENS Multiburnup library
34	XSDRNPM	Flux Guess File
35	KENO V.a	Binary interface data file (forward soln – TSUNAMI-3D)
	SAMS	Binary interface data file (forward soln – TSUNAMI-3D)
36	KENO V.a	Binary interface data file (adjoint soln – TSUNAMI-3D)
	SAMS	Binary interface data file (adjoint soln – TSUNAMI-3D)
42	PMC	Master cross-section library
53	SAS2	Scratch file
55	SAS2	Halt file for restart
60	SAS2	Scratch file
70	SCALE/MIPLIB	User-specified master cross-section library

71	SAS2	Binary output concentrations
	ORIGEN-S	Binary output concentrations
72	SAS2	BCD output concentrations
73	XSDRNPM	Input and derived data file
74	SAS2	Scratch file
75	XSDRNPM	Activity output file
76	XSDRNPM	Balance table output file
77	MIPLIB	Master point cross-section data file
	SAMS	Cross-section covariance data library
	TSUNAMI-IP	Cross-section covariance data library
79	KENO V.a	KENO V.a albedo file
	KENO VI	KENO VI albedo file
80	KENO V.a	KENO V.a weight file
	KENO VI	KENO VI weight file
81	CENTRM	Pointwise cross-section library
	PMC	Pointwise cross-section library
88	SCALE	Master Cross Section library
89	SCALE	Standard Composition library
90	CSAS	Random-access scratch file
	SAS3	Random-access scratch file
	SAS4	Random-access scratch file
	SAS2	Scratch file
91	SAS2	Scratch file
	NEWT	Alternate binary input file
	SAS4	Scratch file
	SMORES	Plot data file
92	SAS4	Scratch file
	SMORES	Collection of input files for restart
93	SMORES	Direct-access data file
	SAS4	PICTURE input file
94	SAS4	Scratch file

95	MORSE	Input file
	SAS4	MORSE input file
	KENOV.a	Binary restart file
	KENOVI	Binary restart file
96	MORSE	Input file (SAS4)
97	CENTRM	Pointwise thermal kernels
98	SAS4	Adjoint XSDRN input file
99	SCALE	Scratch

Table 2. SCALE Big Endian Logical Unit Numbers for Unix/Linux

Unit Number	Modules	Description
21	SAS2, TRITON, ORIGEN-S	PWR library
22		
23	SAS2, TRITON, ORIGEN-S	ORIGEN-S master photon library (No bremsstrahlung)
24	SAS2, TRITON, ORIGEN-S	ORIGEN-S master photon library (H_2O bremsstrahlung)
25		
26	SAS2, TRITON, ORIGEN-S	ORIGEN-S master photon library (UO_2 bremsstrahlung)
33	SAS2, TRITON, ORIGEN-S, ARP, XSECLIST	ORIGEN-S multiburnup library
77	ARP, ARPLIB TSUNAMI-IP, SAMS	ORIGEN-S multiburnup library Cross-section covariance data
78		
79	KENO V.a, KENO-VI	KENO albedo library
80	KENO V.a, KENO-VI	KENO weighting library
88	MIPLIB	Master cross section library
89	MIPLIB	Standard composition library

16. Reference Citation

The official citation for the SCALE 5.1 Manual as a reference in publications is:

SCALE: A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluations, ORNL/TM-2005/39, Version 5.1, Vols. I–III, November 2006. Available from Radiation Safety Information Computational Center at Oak Ridge National Laboratory as CCC-732.