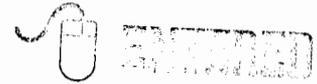


WIPP Library



**SANDIA NATIONAL LABORATORIES
WASTE ISOLATION PILOT PLANT
QUALITY ASSURANCE PROCEDURE (QAP)
QAP 19-1**

WIPP COMPUTER SOFTWARE REQUIREMENTS

Revision E

Effective Date: May 1, 1993



SANDIA NATIONAL LABORATORIES
WIPP COMPUTER SOFTWARE REQUIREMENTS
QAP 19-1
REVISION E

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1.0 PURPOSE

This Quality Assurance Procedure (QAP) establishes a software quality assurance methodology for documenting developed, acquired, and modified computer software intended to support those scientific investigations, studies, and activities to be conducted by SNL as part of the WIPP Project. The intent of this methodology is to assure, within a reasonable degree, that software accomplishes its stated capabilities. This procedure also describes the administrative framework to provide software configuration management. Personnel working on this project may use their own software QA procedure if the procedure has been approved in writing by the QA Department.

2.0 SCOPE

This QAP applies to software whose results will be published in an official document or used to represent a Sandia position on a topic for the WIPP Waste Repository Program (e.g. SAND reports, DOE documents, journals, presentations to National Academy of Sciences (NAS), or parameter input to Performance Assessment (PA) calculations). This includes:

- scientific and engineering software (SES),
- non-SES software (e.g., data-acquisition, data-manipulation, mesh generators, data selectors, and statistical analysis software.)

Exempted from this procedure are:

- commercial, off-the-shelf computer software as received, and
- computer software in development (pre-released version).

The graded approach allows for the scope of this procedure to be governed by the specific software application and governs the implementation of that software. The Principal Investigator at her/his discretion can increase grade and/or requirements for the specific software.

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3.0 APPLICABILITY

This QAP applies to department managers, who have WIPP Program responsibilities, and their personnel whose software is within the scope of this procedure. An equivalent SNL QA approved SNL WIPP procedure may supersede this QAP. When directed by the customer requirements, internal Sandia software requirements shall be superseded by the two types of previously stated procedures.

4.0 REFERENCES

- ANSI/IEEE Std 729-1983, IEEE Standard Glossary of Software Engineering Terminology.
- DOE-AL Order 5700.6C
- NQA-1, latest revision and applicable addenda, Supplement 11S-2 Computer Program Testing
- WPO Management Directive 4.7.1 Computer QA Program
- WPO Management Directive 4.5.1 Records and Information Management
- WIPP Quality Assurance Program Description

5.0 DEFINITIONS

5.1 Benchmarking.

The comparison of predictions of a particular problem or test case made with one applied model with predictions made with other numerical or analytical computational models, where all models were designed to solve comparable mathematical problems.

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5.2 Computer.

(1) A functional unit that can perform substantial computation, including numerous arithmetic operations or logic operations, without intervention by a human operator during a run (International Organization for Standardization, ISO). (2) A functional programmable unit that consists of one or more associated processing units and peripheral equipment, that is controlled by internally stored programs, and that can perform substantial computation, including numerous arithmetic operations or logic operations, without human intervention.

5.3 Computer Program.

A sequence of instructions suitable for processing by a computer. Processing may include the use of an assembler, a compiler, an interpreter, or a translator to prepare the program for execution as well as to execute it. The term computer program can be used interchangeably with computer code and with software.

5.4 Existing Software.

Software that has a Computer Program Abstract (Form 222 or equivalent) in the Sandia WIPP Central File (SWCF) at the effective date of this version of QAP 19-1.

5.5 Graded Approach.

An approach based on the importance of the software application which determines the amount of documentation needed. For example some factors that would determine the importance are the following:

- nature of the software, or
- consequences of failure of the software.

5.6 Model.

The postulated set of hypotheses and assumptions that describe the behavior of a physical process. The implementation may be analytical, numerical, or empirical (the latter being where an implementation uses observed data directly by means of lookup tables and/or interpolation on statistical relationships).

5.7 Peer.

A person whose technical experience is comparable to that of the author of the software and who is independent of the work being reviewed but need not be independent of the SNL WIPP Program.

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- 5.8 Released Software.**
Software that has the required documentation completed and submitted to the SWCF prior to the software being used to generate results to be published in an official document or used to represent a Sandia position on a topic (e.g. SAND reports, DOE documents, journals, presentations to NAS, or parameter input to PA calculations).
- 5.9 Retrievability.**
The ability to obtain the computer code from an archival file (i.e. physical or electronic media).
- 5.10 Scientific and Engineering Software.**
Software that implements the model of a physical process, often by numerical solution of mathematical equations.
- 5.11 Software Configuration Management.**
A system that (1) tracks the software by unique identification, (2) enables the retrieval of software, and (3) tracks and controls changes to software.
- 5.12 Traceability.**
The ability to track software by uniquely identifying it with a name and a version identifier.
- 5.13 Verification.**
Assurance that a computer program performs its numerical and logical operations correctly within the permitted application.
- 6.0 RESPONSIBILITY**
- 6.1 SNL WIPP Project Manager.**
The SNL WIPP Project Manager has overall responsibility for ensuring project compliance with the customer requirements.
- 6.2 Department Manager who has WIPP Program responsibilities.**
Each department manager has the primary responsibility for ensuring that this procedure is fully implemented by department personnel. For each computer program that meets the criteria of Section 2.0 above and used within her/his department, the department manager or designee shall appoint a cognizant contact.

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This includes software developed within the department as well as those acquired from other Sandia organizations and from contractors. The department manager or designee will determine the reviewer(s) to perform a software review for a Class A code.

6.3 Principal Investigator.

The principal investigator can be the designee for the department manager for the above responsibilities. Also, the principal investigator can increase grade and/or requirements for the specific software. This includes software developed within the department as well as those acquired from other Sandia organizations and from contractors.

6.4 SNL WIPP QA Chief.

The SNL WIPP QA Chief or designee shall, by means of periodic audits and overviews, ensure that the requirements of this QAP are implemented by project personnel, Sandia support organizations, and contractors.

6.5 Cognizant Contact.

An individual providing technical expertise in the theoretical basis and application of a computer program and the idealizations contained in the program. The cognizant contact determines when their assigned software is ready for release (See Released Software, Section 5.8). Part of that determination is how and when a program has been adequately verified. Adequate verification is determined by the cognizant contact because the type of verification is dependent on the nature of the code. The cognizant contact is responsible for the software in the following areas:

- ensuring that an Computer Program Abstract (Form 222) is completed and submitted to the SWCF;
- coordinating program development or acquisition;
- ensuring verification of software;
- ensuring completion and submittal of software documentation to the SWCF;
- evaluation of existing documentation in the SWCF for existing software (See Section 7.5);
- maintaining software configuration management

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7.0 PROCEDURE

7.1 Software Grade.

Following the graded approach, the computer software QA documentation requirements are dependent on the specific software's application. The application is graded as one of the following:

- Class A. Adjudicated.

Software whose results are used directly in final performance assessment calculations.

- Class C. Candidate.

Software whose results will be published in an official document or used to represent a Sandia position on a topic for the WIPP Waste Repository Program (e.g. SAND reports, DOE documents, journals, presentations to NAS, or parameter input to PA calculations). This includes all software used in the process of obtaining the results (e.g., data-acquisition and data-manipulation).

- Class D. Dormant.

Software that is no longer in use and was previously graded as Class A or Class C software.

7.2 Software Release.

The cognizant contact determines when the software is ready for release. The software is released for use after the required documentation is submitted to the SWCF. Software can then be run to obtain results for publication in an official document or used to represent a Sandia position on a topic for the WIPP Waste Repository Program.

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7.3 Documentation Requirements.

Table 1 has a summary of the documentation requirements for software.

Class A

Prior to its release as Class A software, the following documentation or equivalent shall be completed and submitted to the SWCF:

- Computer Program Abstract (Form 222),
- user documentation,
- software code listing in physical or electronic media, or executable if the latter is unavailable,
- verification documentation, and
- software review.

Class C

Prior to software release as Class C, the following documentation or equivalent shall be completed and submitted to the SWCF:

- Computer Program Abstract (Form 222),
- software code listing in physical or electronic media, or executable if the latter is unavailable, and
- verification documentation.

7.3.1 Computer Program Abstract.

(see Appendix A for an example). The Computer Program Abstract (Form 222, most recent revision) contains pertinent information concerning the computer program. Signature approval of the Abstract is to be completed by either the cognizant contact, PI, PI designee, or department manager whichever person is independent of the following:

- making changes to the software, and
- completing the Abstract.

Form 222 also includes the instructions for the preparation of the Abstract (see Appendix A for an example).

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7.3.2 User Documentation.

User documentation will aid a user with proper technical background to set up and run the program and to help the user resolve possible difficulties. The user documentation shall contain the software name and major version with the following:

- instructions for using the software,
- input (variables, units, format, default values, ...),
- output (meaning of headers, appropriate units, ...),
- hardware/software environments, and
- example(s).

The user documentation will also contain the following as applicable:

- error definitions, and
- assumptions and limitations.

7.3.3 Verification Documentation.

Verification provides an illustration that the software satisfactorily performs its capabilities as stated in the verification plan section of the verification documentation. (Responsibility is defined in Section 6.5)

Possible methods of verification are the following:

- hand calculation,
- comparison with empirical data,
- benchmarking,
- in-use test, and
- parametric sensitivity analysis.

The verification documentation shall contain the following:

- name and version of software,
- person performing the verification,
- operating environment,
- verification plan, including description, performance criteria and input data set, and
- evaluation of results and output.

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7.3.4 Software Review.

The software review shall be comprised of two sections:

- Section 1. The review of the software to determine if it performs correctly. This would also include the identification of assumptions and limitations as applicable.
- Section 2. The review of associated QA documentation to see that these meet the requirements of retrievability and traceability.

The software review will be conducted by one or more peer reviewers. The department manager or designee will assign the reviewer(s) needed for each review based on the nature and complexity of the software.

The documentation of the review will include the conclusions of the reviewer(s) concerning the correctness of the code and the review of associated QA documents as stated above. The software review documentation will also state the person(s) performing the review with their signature and the date of completion.

7.3.5 Internal Documentation.

The following information shall be contained within the software program, as applicable:

- software name/version,
- brief description of software, and
- name of author(s) and original source of software.

The following is suggested information to be contained within the software program:

- history of modifications including name of modifier(s), version identifier, date, and descriptions of modification,
- government legal disclaimer for Sandia software or proprietary information, if applicable,
- language and language extensions used, and
- machine, operating system, and necessary supporting software, if applicable.

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Table 1
SOFTWARE REQUIREMENTS

	SOFTWARE GRADE	A	C	D
Documentation				
Computer Program Abstract		yes	yes	b
Verification Documentation		yes	yes	b
Source Code Listing (a)		yes	yes	b
User Documentation		yes	no	b
Software Review		yes	no	b
Internal Documentation		yes	yes	b
Traceability		yes	yes	b
Retrievability		yes	yes	b
Change Control		yes	yes	b

(a) If available, otherwise the executable
(b) QA requirements of last A or C gradation

7.4 Software Configuration Management.

All software that is covered and released under this procedure comes under software configuration management. Software configuration management ensures the unique identification of computer programs at the initial release and as the software changes after release. Once software is released, the cognizant contact is responsible for the traceability, retrievability, change control, and grade change of assigned software.

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7.4.1 Traceability.

The ability to track software by uniquely identifying it with a name and a version identifier.

7.4.2 Retrievability.

To ensure retrievability, computer software covered by this QAP shall be placed into an archive file in a format that is compatible with operational computer equipment at the time of submittal to the SWCF. The label on the archival file shall contain the following:

- computer software's name and version,
- computer manufacturer and model of machine, and
- operating system and version number.

7.4.3 Change Control.

Change control is tracked for released software. There are two types of changes that can be made to software: minor or major changes. Table 2 has a summary of the change control requirements.

7.4.3.1 Minor Changes.

Minor changes include: the correction of minor bugs, the addition of minor features, cosmetic, or I/O specific modifications. Minor changes do not require updates to the documentation except for the updating of the source code submitted to the SWCF prior to release of the software version. The version identifier shall reflect that the minor change(s) have been made and this shall be maintained by the cognizant contact. The internal documentation shall be updated for these changes, as applicable.

7.4.3.2 Major Changes.

Major changes are the rest of the changes made to software that do not fall under minor changes, such as changing variables or adding subroutines. For major changes to software, the cognizant contact maintains the software name and new version identifier. Also, documentation impacted by the change shall be revised by the cognizant contact, which always includes the following:

- computer program abstract,
- internal documentation, as applicable,
- source code listing, and
- verification documentation.

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Once the updated documentation has been completed and submitted to the SWCF, the new software version is released. The grade of the new software version is based on the requirements stated in Section 7.1.

The original released software version can be used while the new version is incorporating the major change(s). The cognizant contact may choose to use the old version or change the grade to Class D.

Table 2

CHANGE CONTROL TO RELEASED SOFTWARE

	MINOR CHANGES	MAJOR CHANGES
Computer Program Abstract	no	yes
Verification Documentation	no	yes
Source Code Listing*	yes	yes
Internal Documentation	yes	yes
Affected other QA Documentation (i.e. user documentation, and software review)	no	yes

* Prior to release of new software version.

7.4.4 Grade Change of Software.

The grade change of software may be one of the following:

- from Class C to Class A, or
- from Class A or C to Class D or
- from Class D to Class A or C.

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The cognizant contact shall supply a Computer Software Abstract to the SWCF to change the grade of released software. If the change of grade is from Class C to Class A, the following shall be completed and submitted to the SWCF:

- user documentation,
- software review, and
- updates to previous documentation, as appropriate.

The documentation needed in changing the grade of Class D to Class A or C is the same as stated in Section 7.3 for those grades. If the documentation in the SWCF satisfies those requirements and the version has not changed, then only a new Computer Program Abstract shall be completed and submitted. If the change of grade is from Class C to Class A, see above.

Table 3 has a summary of the above requirements.

Table 3

GRADE CHANGE OF SOFTWARE

	From Class		
	C to Class A	A or C to Class D	D to Class A or C
Computer Program Abstract	yes	yes	yes
User Documentation	yes	no	b
Software Review	yes	no	b
Updates to previous documentation	yes	no	b

b The requirements for the class needs to be met, either by existing documentation in the SWCF for that version or new documentation completed and submitted to the SWCF.

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7.5 Existing Software.

The following shall be done for existing software:

- Computer Program Abstract (Form 222 or equivalent) shall be completed to assign the grade of the software, and
- evaluation by the cognizant contact of existing documentation in the SWCF to support the assigned grade of the software.

8.0 QA Records.

The records generated by this procedure, as applicable, are submitted to, and maintained by the SWCF:

- Computer Program Abstract (Form 222, most recent revision)
- User Documentation
- Software Code Listing or Executable, in physical or electronic media
- Verification Documentation
- Software Review
- Electronic media archival file of the software

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APPENDIX A

**COMPUTER PROGRAM ABSTRACT EXAMPLE AND
INSTRUCTIONS**

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EXAMPLE FORM 222

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WIPP Waste Isolation Pilot Plant	Title COMPUTER PROGRAM ABSTRACT <small>Effective Date: _____</small>	Sandia National Laboratories Procedure QAP 19-1 Revision _____ Form No. 222-A Page 1 of 2
1. Program Name and Version:	2. Version Date:	3. Computer and Operating Systems:
4. Program Title:		
5. Program Description:		
6. Limitations:		
7. Keywords/Phrases (including representative WBS number(s)):		
8. Origin/Source:		
9. Authors:		
10. Parent Program:		
11. Computer Languages:		
12. Grade: <div style="text-align: center;"> Production <input type="checkbox"/> Class A or <input type="checkbox"/> Class C <input type="checkbox"/> Dormant (Class D) </div>		
13. Classification: <div style="text-align: center;"> <input type="checkbox"/> Proprietary <input type="checkbox"/> Other, Specify <input type="checkbox"/> Government Owned, Limited Distribution <input type="checkbox"/> Commercial </div>		
14. Cognizant Contact: <div style="display: flex; justify-content: space-between; margin-top: 10px;"> _____ _____ </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> Printed name Signature </div>		

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**COMPUTER PROGRAM ABSTRACT
Instructions for Preparation**

1. **Program Name and Version** - acronym or mnemonic by which the computer program is known or may be identified. Also, the version mnemonic representing the relationship with other versions and providing a mechanism for documenting the chronological history of the computer program's development.
2. **Version Date** - the date that the required QA documentation is submitted to the SWCF signifying the release of the software.
3. **Computer and Operating System** - computer manufacturer, model of machine, and operating system and version number on which the program is to be executed.
4. **Program Title** - expansion of the program name, acronym or other such concise description of the purpose.
5. **Program Description** - a program synopsis giving a set of concise yet general specifications to relate the function of the program, the basic methods utilized, and any other useful information needed to determine what the program does.
6. **Limitations** - state any major limitations and assumptions inherent in the theoretical basis or implementation approximations of the program.
7. **Keywords/Phrases** - a series of words or phrases that pertain to the program type, theoretical basis, computations performed, etc. The representative WBS (Work Breakdown Structure) number(s) will be entered here to aid in searches based on specific activities.
8. **Origin/Source** - company or institution where the original computer code was written together with contractual information where appropriate. For proprietary programs, identify the organization responsible for program maintenance.

Provide a statement of applicability if a computer program is procured from a commercial source.
9. **Authors** - all persons who had significant input to the development of the code in either engineering/scientific theory or software design, physical programming, and debugging.
10. **Parent Program** - name and version of the antecedent program from which the program being abstracted was derived through substantial revisions or modifications.
11. **Computer Languages** - symbolic languages used in the program source coding together with the compiler/interpreter/assemblies versions if non-standard language extensions were utilized.
12. **Grade** - state the grade of the software.
13. **Classification** - sensitivity of the program with respect to information disclosure and program distribution.

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14. **Cognizant Contact** - individual assigned responsibility for ensuring the preparation and submittal of this abstract.
15. **Verification** - indication of the type(s) of verification performed for this program.
16. **Documentation/References** - indication of the types of references maintained by the user organization and primary references for the program.
17. **Approval** - dated signature indicates approval of the abstract content and program version by the cognizant contact, or PI, or PI designee whichever person is independent of making changes to the software and completing the abstract.