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**Information technology — Portable
Operating System Interface (POSIX®)
Base Specifications, Issue 7**

*Technologies de l'information — Spécifications de base de l'interface
pour la portabilité des systèmes (POSIX®), Issue 7*



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Fax + 41 22 749 09 47
E-mail copyright@iso.org
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Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York • NY 10016-5997, USA
E-mail stds.ipr@ieee.org
Web www.ieee.org

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This first edition of ISO/IEC/IEEE 9945 cancels and replaces ISO/IEC 9945-1:2003, ISO/IEC 9945-2:2003, ISO/IEC 9945-3:2003 and ISO/IEC 9945-4:2003, which have been technically revised. It also incorporates the Technical Corrigenda ISO/IEC 9945-1:2003/Cor.1:2004, ISO/IEC 9945-2:2003/Cor.1:2004, ISO/IEC 9945-3:2003/Cor.1:2004 and ISO/IEC 9945-4:2003/Cor.1:2004.



Standard for Information Technology– Portable Operating System Interface (POSIX[®])

Base Specifications, Issue 7

IEEE Computer Society

Sponsored by the
Portable Applications Standards Committee
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1003.1

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The Open Group Technical Standard
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Standard for Information Technology— Portable Operating System Interface (POSIX®) Base Specifications, Issue 7

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Abstract

POSIX.1-2008 is simultaneously IEEE Std 1003.1™-2008 and The Open Group Technical Standard Base Specifications, Issue 7.

POSIX.1-2008 defines a standard operating system interface and environment, including a command interpreter (or “shell”), and common utility programs to support applications portability at the source code level. POSIX.1-2008 is intended to be used by both application developers and system implementors and comprises four major components (each in an associated volume):

- General terms, concepts, and interfaces common to all volumes of this standard, including utility conventions and C-language header definitions, are included in the Base Definitions volume.
- Definitions for system service functions and subroutines, language-specific system services for the C programming language, function issues, including portability, error handling, and error recovery, are included in the System Interfaces volume.
- Definitions for a standard source code-level interface to command interpretation services (a “shell”) and common utility programs for application programs are included in the Shell and Utilities volume.
- Extended rationale that did not fit well into the rest of the document structure, which contains historical information concerning the contents of POSIX.1-2008 and why features were included or discarded by the standard developers, is included in the Rationale (Informative) volume.

The following areas are outside the scope of POSIX.1-2008:

- Graphics interfaces
- Database management system interfaces
- Record I/O considerations
- Object or binary code portability
- System configuration and resource availability

POSIX.1-2008 describes the external characteristics and facilities that are of importance to application developers, rather than the internal construction techniques employed to achieve these capabilities. Special emphasis is placed on those functions and facilities that are needed in a wide variety of commercial applications.

Keywords

application program interface (API), argument, asynchronous, basic regular expression (BRE), batch job, batch system, built-in utility, byte, child, command language interpreter, CPU, extended regular expression (ERE), FIFO, file access control mechanism, input/output (I/O), job control, network, portable operating system interface (POSIX®), parent, shell, stream, string, synchronous, system, thread, X/Open System Interface (XSI)

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

The Open Group
Thames Tower, Station Road, Reading, Berkshire, RG1 1LX, U.K.

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^A For this standard please send comments via the Austin Group, as indicated on page ii.

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As with all *live* documents, Technical Standards and Specifications require revision to align with new developments and associated international standards. To distinguish between revised specifications which are fully backwards compatible and those which are not:

- A new *Version* indicates there is no change to the definitive information contained in the previous publication of that title, but additions/extensions are included. As such, it *replaces* the previous publication.
- A new *Issue* indicates there is substantive change to the definitive information contained in the previous publication of that title, and there may also be additions/extensions. As such, both previous and new documents are maintained as current publications.

Readers should note that Corrigenda may apply to any publication. Corrigenda information is published at www.opengroup.org/corrigenda.

Introduction

This introduction is not part of POSIX.1-2008, Standard for Information Technology – Portable Operating System Interface (POSIX).

This standard was developed, and is maintained, by a joint working group of members of the IEEE Portable Applications Standards Committee, members of The Open Group, and members of ISO/IEC Joint Technical Committee 1. This joint working group is known as the Austin Group.^B

The Austin Group arose out of discussions amongst the parties which started in early 1998, leading to an initial meeting and formation of the group in September 1998. The purpose of the Austin Group is to develop and maintain the core open systems interfaces that are the POSIX[®] 1003.1 (and former 1003.2) standards, ISO/IEC 9945, and the core of the Single UNIX Specification.

The approach to specification development has been one of “write once, adopt everywhere”, with the deliverables being a set of specifications that carry the IEEE POSIX designation, The Open Group's Technical Standard designation, and an ISO/IEC designation.

This unique development has combined both the industry-led efforts and the formal standardization activities into a single initiative, and included a wide spectrum of participants. The Austin Group continues as the maintenance body for this document.

Anyone wishing to participate in the Austin Group should contact the chair with their request. There are no fees for participation or membership. You may participate as an observer or as a contributor. You do not have to attend face-to-face meetings to participate; electronic participation is most welcome. For more information on the Austin Group and how to participate, see www.opengroup.org/austin.

Background

The developers of POSIX.1-2008 represent a cross-section of hardware manufacturers, vendors of operating systems and other software development tools, software designers, consultants, academics, authors, applications programmers, and others.

Conceptually, POSIX.1-2008 describes a set of fundamental services needed for the efficient construction of application programs. Access to these services has been provided by defining an interface, using the C programming language, a command interpreter, and common utility programs that establish standard semantics and syntax. Since this interface enables application developers to write portable applications – it was developed with that goal in mind – it has been designated POSIX^C, an acronym for Portable Operating System Interface.

Although originated to refer to the original IEEE Std 1003.1-1988, the name POSIX more correctly refers to a *family* of related standards: IEEE Std 1003.*n* and the parts of ISO/IEC 9945. In earlier editions of the IEEE standard, the term POSIX was used as a synonym for IEEE Std 1003.1-1988. A preferred term, POSIX.1, emerged. This maintained the advantages of readability of the symbol “POSIX” without being ambiguous with the POSIX family of standards.

Audience

The intended audience for POSIX.1-2008 is all persons concerned with an industry-wide standard operating system based on the UNIX system. This includes at least four groups of people:

- Persons buying hardware and software systems
- Persons managing companies that are deciding on future corporate computing directions
- Persons implementing operating systems, and especially
- Persons developing applications where portability is an objective

^B The Austin Group is named after the location of the inaugural meeting held at the IBM facility in Austin, Texas in September 1998.

^C The Name POSIX was suggested by Richard Stallman. It is expected to be pronounced *pahz-icks*, as in *positive*, not *poh-six*, or other variations. The pronunciation has been published in an attempt to promulgate a standardized way of referring to a standard operating system interface.

Purpose

Several principles guided the development of POSIX.1-2008:

- Application-Oriented – The basic goal was to promote portability of application programs across UNIX system environments by developing a clear, consistent, and unambiguous standard for the interface specification of a portable operating system based on the UNIX system documentation. POSIX.1-2008 codifies the common, existing definition of the UNIX system.
- Interface, Not Implementation – POSIX.1-2008 defines an interface, not an implementation. No distinction is made between library functions and system calls; both are referred to as functions. No details of the implementation of any function are given (although historical practice is sometimes indicated in the RATIONALE section). Symbolic names are given for constants (such as signals and error numbers) rather than numbers.
- Source, Not Object, Portability – POSIX.1-2008 has been written so that a program written and translated for execution on one conforming implementation may also be translated for execution on another conforming implementation. POSIX.1-2008 does not guarantee that executable (object or binary) code will execute under a different conforming implementation than that for which it was translated, even if the underlying hardware is identical.
- The C Language – The system interfaces and header definitions are written in terms of the standard C language as specified in the ISO C standard.
- No Superuser, No System Administration – There was no intention to specify all aspects of an operating system. System administration facilities and functions are excluded from this standard, and functions usable only by the superuser have not been included. Still, an implementation of the standard interface may also implement features not in POSIX.1-2008. POSIX.1-2008 is also not concerned with hardware constraints or system maintenance.
- Minimal Interface, Minimally Defined – In keeping with the historical design principles of the UNIX system, the mandatory core facilities of POSIX.1-2008 have been kept as minimal as possible. Additional capabilities have been added as optional extensions.
- Broadly Implementable – The developers of POSIX.1-2008 endeavored to make all specified functions implementable across a wide range of existing and potential systems, including:
 - All of the current major systems that are ultimately derived from the original UNIX system code (Version 7 or later)
 - Compatible systems that are not derived from the original UNIX system code
 - Emulations hosted on entirely different operating systems
 - Networked systems
 - Distributed systems
 - Systems running on a broad range of hardware

No direct references to this goal appear in POSIX.1-2008, but some results of it are mentioned in the Rationale (Informative) volume.

- Minimal Changes to Historical Implementations – When the original version – IEEE Std 1003.1-1988 – was published, there were no known historical implementations that did not have to change. However, there was a broad consensus on a set of functions, types, definitions, and concepts that formed an interface that was common to most historical implementations.

The adoption of the 1988 and 1990 IEEE system interface standards, the 1992 IEEE shell and utilities standard, the various Open Group (formerly X/Open) specifications, and IEEE Std 1003.1-2001 and its technical corrigenda have consolidated this consensus, and this version reflects the significantly increased level of consensus arrived at since the original versions. The authors of the original versions tried, as much as possible, to follow the principles below when creating new specifications:

- By standardizing an interface like one in an historical implementation; for example, directories
- By specifying an interface that is readily implementable in terms of, and backwards-compatible with, historical implementations, such as the extended *tar* format defined in the *pax* utility
- By specifying an interface that, when added to an historical implementation, will not conflict with it; for example, the *sigaction()* function

POSIX.1-2008 is specifically not a codification of a particular vendor's product.

It should be noted that implementations will have different kinds of extensions. Some will reflect “historical usage” and will be preserved for execution of pre-existing applications. These functions should be considered “obsolescent” and the standard functions used for new applications. Some extensions will represent functions beyond the scope of POSIX.1-2008. These need to be used with careful management to be able to adapt to future extensions of POSIX.1-2008 and/or port to implementations that provide these services in a different manner.

- Minimal Changes to Existing Application Code – A goal of POSIX.1-2008 was to minimize additional work for application developers. However, because every known historical implementation will have to change at least slightly to conform, some applications will have to change.

POSIX.1-2008

POSIX.1-2008 defines the Portable Operating System Interface (POSIX) requirements and consists of the following topics arranged as a series of volumes within the standard:

- Base Definitions
- System Interfaces
- Shell and Utilities
- Rationale (Informative)

Base Definitions

The Base Definitions volume provides common definitions for this standard, therefore readers should be familiar with it before using the other volumes.

This volume is structured as follows:

- Chapter 1 is an introduction.
- Chapter 2 defines the conformance requirements.
- Chapter 3 defines general terms used.
- Chapter 4 describes general concepts used.
- Chapter 5 describes the notation used to specify file input and output formats in this volume and the Shell and Utilities volume.
- Chapter 6 describes the portable character set and the process of character set definition.
- Chapter 7 describes the syntax for defining internationalization locales as well as the POSIX locale provided on all systems.
- Chapter 8 describes the use of environment variables for internationalization and other purposes.
- Chapter 9 describes the syntax of pattern matching using regular expressions employed by many utilities and matched by the *regcomp()* and *regexexec()* functions.
- Chapter 10 describes files and devices found on all systems.
- Chapter 11 describes the asynchronous terminal interface for many of the functions in the System Interfaces volume and the *stty* utility in the Shell and Utilities volume.
- Chapter 12 describes the policies for command line argument construction and parsing.
- Chapter 13 defines the contents of headers which declare the functions and global variables, and define types, constants, macros, and data structures that are needed by programs using the services provided by the System Interfaces volume.

Comprehensive references are available in the index.

System Interfaces

The System Interfaces volume describes the interfaces offered to application programs by POSIX-conformant systems. Readers are expected to be experienced C language programmers, and to be familiar with the Base Definitions volume.

This volume is structured as follows:

- Chapter 1 explains the status of this volume and its relationship to other formal standards.
- Chapter 2 contains important concepts, terms, and caveats relating to the rest of this volume.
- Chapter 3 defines the functional interfaces to the POSIX-conformant system.

Comprehensive references are available in the index.

Shell and Utilities

The Shell and Utilities volume describes the commands and utilities offered to application programs on POSIX-conformant systems. Readers are expected to be familiar with the Base Definitions volume.

This volume is structured as follows:

- Chapter 1 explains the status of this volume and its relationship to other formal standards. It also describes the defaults used by the utility descriptions.
- Chapter 2 describes the command language used in POSIX-conformant systems, and special built-in utilities.
- Chapter 3 describes a set of services and utilities that are implemented on systems supporting the Batch Environment Services and Utilities option.
- Chapter 4 consists of reference pages for all utilities, other than the special built-in utilities described in Chapter 2, available on POSIX-conformant systems.

Comprehensive references are available in the index.

Rationale (Informative)

The Rationale volume is published to assist in the process of review. It contains historical information concerning the contents of this standard and why features were included or discarded by the standard developers. It also contains notes of interest to application programmers on recommended programming practices, emphasizing the consequences of some aspects of POSIX.1-2008 that may not be immediately apparent.

This volume is organized in parallel to the normative volumes of this standard, with a separate part for each of the three normative volumes.

Within this volume, the following terms are used:

- Base standard – The portions of POSIX.1-2008 that are not optional, equivalent to the definitions of *classic* POSIX.1 and POSIX.2.
- POSIX.0 – Although this term is not used in the normative text of POSIX.1-2008, it is used in this volume to refer to IEEE Std 1003.0™-1995.
- POSIX.1b – Although this term is not used in the normative text of POSIX.1-2008, it is used in this volume to refer to the elements of the POSIX Realtime Extension amendment. (This was earlier referred to as POSIX.4 during the standard development process.)
- POSIX.1c – Although this term is not used in the normative text of POSIX.1-2008, it is used in this volume to refer to the POSIX Threads Extension amendment. (This was earlier referred to as POSIX.4a during the standard development process.)
- Standard developers – The individuals and companies in the development organizations responsible for POSIX.1-2008: the IEEE P1003.1 working groups, The Open Group Base working group, advised by the hundreds of individual technical experts who balloted the draft standards within the Austin Group, and the member bodies and technical experts of ISO/IEC JTC 1/SC 22.
- XSI option – The portions of POSIX.1-2008 addressing the extension added for support of the Single UNIX Specification.

Typographical Conventions

The following typographical conventions are used throughout this standard. In the text, this standard is referred to as POSIX.1-2008, which is technically identical to The Open Group Base Specifications, Issue 7.

The typographical conventions listed here are for ease of reading only. Editorial inconsistencies in the use of typography are unintentional and have no normative meaning in POSIX.1-2008.

| Reference | Example | Notes |
|--|-----------------------|-------|
| C-Language Data Structure | aiocb | |
| C-Language Data Structure Member | <i>aio_lio_opcode</i> | |
| C-Language Data Type | long | |
| C-Language External Variable | <i>errno</i> | |
| C-Language Function | <i>system()</i> | |
| C-Language Function Argument | <i>arg</i> | |
| C-Language Function Family | <i>exec</i> | |
| C-Language Header | < sys/stat.h > | |
| C-Language Keyword | return | |
| C-Language Macro with Argument | <i>assert()</i> | |
| C-Language Macro with No Argument | NET_ADDRSTRLEN | |
| C-Language Preprocessing Directive | #define | |
| Commands within a Utility | a, c | |
| Conversion Specifier, Specifier/Modifier Character | %A, g, E | 1 |
| Environment Variable | <i>PATH</i> | |
| Error Number | [EINTR] | |
| Example Output | Hello, World | |
| Filename | /tmp | |
| Literal Character | 'c', '\r' | 2 |
| Literal String | "abcde" | 2 |
| Optional Items in Utility Syntax | [] | |
| Parameter | <directory pathname> | |
| Special Character | <newline> | 3 |
| Symbolic Constant | _POSIX_VDISABLE | |
| Symbolic Limit, Configuration Value | {LINE_MAX} | 4 |
| Syntax | #include <sys/stat.h> | |
| User Input and Example Code | echo Hello, World | 5 |
| Utility Name | <i>awk</i> | |
| Utility Operand | <i>file_name</i> | |
| Utility Option | -c | |
| Utility Option with Option-Argument | -w width | |

Note that:

1. Conversion specifications, specifier characters, and modifier characters are used primarily in date-related functions and utilities and the *fprintf()* and *fscanf()* formatting functions.
2. Unless otherwise noted, the quotes shall not be used as input or output. When used in a list item, the quotes are omitted. The literal characters <apostrophe> (also known as single-quote) and <backslash> are either shown as the C constants '\ ' and '\\ ', respectively, or as the special characters <apostrophe>, single-quote, and <backslash> depending on context.
3. The style selected for some of the special characters, such as <newline>, matches the form of the input given to the *localedef* utility. Generally, the characters selected for this special treatment are those that are not visually distinct, such as the control characters <tab> or <newline>.
4. Names surrounded by braces represent symbolic limits or configuration values which may be declared in appropriate headers by means of the C **#define** construct.

5. Brackets shown in this font, "`[]`", are part of the syntax and do not indicate optional items. In syntax the '`|`' symbol is used to separate alternatives, and ellipses ("`. . .`") are used to show that additional arguments are optional.

Shading is used to identify extensions and options.

Footnotes and notes within the body of the normative text are for information only (informative).

Informative sections (such as Rationale, Change History, Application Usage, and so on) are denoted by continuous shading bars in the margins.

Ranges of values are indicated with parentheses or brackets as follows:

1. (a,b) means the range of all values from a to b , including neither a nor b .
2. $[a,b]$ means the range of all values from a to b , including a and b .
3. $[a,b)$ means the range of all values from a to b , including a , but not b .
4. $(a,b]$ means the range of all values from a to b , including b , but not a .

Note: A symbolic limit beginning with POSIX is treated differently, depending on context. In a C-language header, the symbol `POSIXstring` (where *string* may contain underscores) is represented by the C identifier `_POSIXstring`, with a leading underscore required to prevent ISO C standard name space pollution. However, in other contexts, such as languages other than C, the leading underscore is not used because this requirement does not exist.

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Contents

| | | | |
|----------------|----------|--|-----------|
| Volume | 1 | Base Definitions, Issue 7 | 1 |
| Chapter | 1 | Introduction | 3 |
| | 1.1 | Scope | 3 |
| | 1.2 | Conformance..... | 4 |
| | 1.3 | Normative References | 4 |
| | 1.4 | Change History | 5 |
| | 1.5 | Terminology | 5 |
| | 1.6 | Definitions and Concepts..... | 6 |
| | 1.7 | Portability | 6 |
| | 1.7.1 | Codes | 7 |
| | 1.7.2 | Margin Code Notation | 13 |
| Chapter | 2 | Conformance | 15 |
| | 2.1 | Implementation Conformance | 15 |
| | 2.1.1 | Requirements | 15 |
| | 2.1.2 | Documentation | 16 |
| | 2.1.3 | POSIX Conformance..... | 16 |
| | 2.1.4 | XSI Conformance | 19 |
| | 2.1.5 | Option Groups..... | 20 |
| | 2.1.6 | Options | 26 |
| | 2.2 | Application Conformance..... | 29 |
| | 2.2.1 | Strictly Conforming POSIX Application..... | 29 |
| | 2.2.2 | Conforming POSIX Application | 30 |
| | 2.2.3 | Conforming POSIX Application Using Extensions..... | 30 |
| | 2.2.4 | Strictly Conforming XSI Application | 30 |
| | 2.2.5 | Conforming XSI Application Using Extensions | 31 |
| | 2.3 | Language-Dependent Services for the C Programming Language | 31 |
| | 2.4 | Other Language-Related Specifications..... | 31 |
| Chapter | 3 | Definitions | 33 |
| | 3.1 | Abortive Release..... | 33 |
| | 3.2 | Absolute Pathname..... | 33 |
| | 3.3 | Access Mode | 33 |
| | 3.4 | Additional File Access Control Mechanism..... | 33 |
| | 3.5 | Address Space..... | 33 |
| | 3.6 | Advisory Information..... | 34 |
| | 3.7 | Affirmative Response | 34 |
| | 3.8 | Alert | 34 |
| | 3.9 | Alert Character (<alert>)..... | 34 |
| | 3.10 | Alias Name..... | 34 |
| | 3.11 | Alignment | 35 |
| | 3.12 | Alternate File Access Control Mechanism | 35 |

Contents

| | | |
|------|---|----|
| 3.13 | Alternate Signal Stack..... | 35 |
| 3.14 | Ancillary Data..... | 35 |
| 3.15 | Angle Brackets..... | 35 |
| 3.16 | Apostrophe Character (<apostrophe>)..... | 35 |
| 3.17 | Application..... | 35 |
| 3.18 | Application Address..... | 36 |
| 3.19 | Application Program Interface (API)..... | 36 |
| 3.20 | Appropriate Privileges..... | 36 |
| 3.21 | Argument..... | 36 |
| 3.22 | Arm (a Timer)..... | 36 |
| 3.23 | Asterisk Character (<asterisk>)..... | 36 |
| 3.24 | Async-Cancel-Safe Function..... | 36 |
| 3.25 | Asynchronous Events..... | 37 |
| 3.26 | Asynchronous Input and Output..... | 37 |
| 3.27 | Async-Signal-Safe Function..... | 37 |
| 3.28 | Asynchronously-Generated Signal..... | 37 |
| 3.29 | Asynchronous I/O Completion..... | 37 |
| 3.30 | Asynchronous I/O Operation..... | 37 |
| 3.31 | Authentication..... | 37 |
| 3.32 | Authorization..... | 38 |
| 3.33 | Background Job..... | 38 |
| 3.34 | Background Process..... | 38 |
| 3.35 | Background Process Group (or Background Job)..... | 38 |
| 3.36 | Backquote Character..... | 38 |
| 3.37 | Backslash Character (<backslash>)..... | 38 |
| 3.38 | Backspace Character (<backspace>)..... | 38 |
| 3.39 | Barrier..... | 39 |
| 3.40 | Basename..... | 39 |
| 3.41 | Basic Regular Expression (BRE)..... | 39 |
| 3.42 | Batch Access List..... | 39 |
| 3.43 | Batch Administrator..... | 39 |
| 3.44 | Batch Client..... | 39 |
| 3.45 | Batch Destination..... | 40 |
| 3.46 | Batch Destination Identifier..... | 40 |
| 3.47 | Batch Directive..... | 40 |
| 3.48 | Batch Job..... | 40 |
| 3.49 | Batch Job Attribute..... | 40 |
| 3.50 | Batch Job Identifier..... | 40 |
| 3.51 | Batch Job Name..... | 41 |
| 3.52 | Batch Job Owner..... | 41 |
| 3.53 | Batch Job Priority..... | 41 |
| 3.54 | Batch Job State..... | 41 |
| 3.55 | Batch Name Service..... | 41 |
| 3.56 | Batch Name Space..... | 41 |
| 3.57 | Batch Node..... | 42 |
| 3.58 | Batch Operator..... | 42 |
| 3.59 | Batch Queue..... | 42 |
| 3.60 | Batch Queue Attribute..... | 42 |
| 3.61 | Batch Queue Position..... | 42 |
| 3.62 | Batch Queue Priority..... | 42 |
| 3.63 | Batch Rerunability..... | 43 |
| 3.64 | Batch Restart..... | 43 |

Contents

| | | |
|-------|---|----|
| 3.65 | Batch Server | 43 |
| 3.66 | Batch Server Name..... | 43 |
| 3.67 | Batch Service | 43 |
| 3.68 | Batch Service Request..... | 43 |
| 3.69 | Batch Submission | 43 |
| 3.70 | Batch System | 44 |
| 3.71 | Batch Target User | 44 |
| 3.72 | Batch User | 44 |
| 3.73 | Bind | 44 |
| 3.74 | Blank Character (<blank>)..... | 44 |
| 3.75 | Blank Line..... | 44 |
| 3.76 | Blocked Process (or Thread) | 44 |
| 3.77 | Blocking | 44 |
| 3.78 | Block-Mode Terminal | 45 |
| 3.79 | Block Special File..... | 45 |
| 3.80 | Braces | 45 |
| 3.81 | Brackets..... | 45 |
| 3.82 | Broadcast | 45 |
| 3.83 | Built-In Utility (or Built-In)..... | 46 |
| 3.84 | Byte..... | 46 |
| 3.85 | Byte Input/Output Functions | 46 |
| 3.86 | Carriage-Return Character (<carriage-return>) | 46 |
| 3.87 | Character | 47 |
| 3.88 | Character Array | 47 |
| 3.89 | Character Class..... | 47 |
| 3.90 | Character Set..... | 47 |
| 3.91 | Character Special File | 47 |
| 3.92 | Character String..... | 47 |
| 3.93 | Child Process | 48 |
| 3.94 | Circumflex Character (<circumflex>)..... | 48 |
| 3.95 | Clock | 48 |
| 3.96 | Clock Jump..... | 48 |
| 3.97 | Clock Tick..... | 48 |
| 3.98 | Coded Character Set | 48 |
| 3.99 | Codeset | 49 |
| 3.100 | Collating Element..... | 49 |
| 3.101 | Collation | 49 |
| 3.102 | Collation Sequence..... | 49 |
| 3.103 | Column Position..... | 50 |
| 3.104 | Command..... | 50 |
| 3.105 | Command Language Interpreter | 50 |
| 3.106 | Composite Graphic Symbol..... | 50 |
| 3.107 | Condition Variable | 50 |
| 3.108 | Connected Socket..... | 51 |
| 3.109 | Connection | 51 |
| 3.110 | Connection Mode..... | 51 |
| 3.111 | Connectionless Mode | 51 |
| 3.112 | Control Character..... | 51 |
| 3.113 | Control Operator..... | 51 |
| 3.114 | Controlling Process | 51 |
| 3.115 | Controlling Terminal | 52 |
| 3.116 | Conversion Descriptor | 52 |

Contents

| | | |
|-------|---|----|
| 3.117 | Core File..... | 52 |
| 3.118 | CPU Time (Execution Time) | 52 |
| 3.119 | CPU-Time Clock..... | 52 |
| 3.120 | CPU-Time Timer..... | 52 |
| 3.121 | Current Job..... | 52 |
| 3.122 | Current Working Directory..... | 53 |
| 3.123 | Cursor Position..... | 53 |
| 3.124 | Datagram..... | 53 |
| 3.125 | Data Segment..... | 53 |
| 3.126 | Deferred Batch Service | 53 |
| 3.127 | Device | 53 |
| 3.128 | Device ID..... | 53 |
| 3.129 | Directory..... | 53 |
| 3.130 | Directory Entry (or Link) | 53 |
| 3.131 | Directory Stream | 54 |
| 3.132 | Disarm (a Timer) | 54 |
| 3.133 | Display..... | 54 |
| 3.134 | Display Line..... | 54 |
| 3.135 | Dollar-Sign Character (<dollar-sign>) | 54 |
| 3.136 | Dot..... | 54 |
| 3.137 | Dot-Dot..... | 55 |
| 3.138 | Double-Quote Character..... | 55 |
| 3.139 | Downshifting..... | 55 |
| 3.140 | Driver..... | 55 |
| 3.141 | Effective Group ID | 55 |
| 3.142 | Effective User ID | 55 |
| 3.143 | Eight-Bit Transparency | 55 |
| 3.144 | Empty Directory..... | 56 |
| 3.145 | Empty Line..... | 56 |
| 3.146 | Empty String (or Null String)..... | 56 |
| 3.147 | Empty Wide-Character String..... | 56 |
| 3.148 | Encoding Rule | 56 |
| 3.149 | Entire Regular Expression..... | 56 |
| 3.150 | Epoch | 57 |
| 3.151 | Equivalence Class..... | 57 |
| 3.152 | Era..... | 57 |
| 3.153 | Event Management..... | 57 |
| 3.154 | Executable File..... | 57 |
| 3.155 | Execute..... | 58 |
| 3.156 | Execution Time | 58 |
| 3.157 | Execution Time Monitoring..... | 58 |
| 3.158 | Expand..... | 58 |
| 3.159 | Extended Regular Expression (ERE)..... | 58 |
| 3.160 | Extended Security Controls..... | 58 |
| 3.161 | Feature Test Macro | 59 |
| 3.162 | Field..... | 59 |
| 3.163 | FIFO Special File (or FIFO) | 59 |
| 3.164 | File | 59 |
| 3.165 | File Description | 59 |
| 3.166 | File Descriptor | 60 |
| 3.167 | File Group Class | 60 |
| 3.168 | File Mode..... | 60 |

Contents

| | | |
|-------|--|----|
| 3.169 | File Mode Bits | 60 |
| 3.170 | Filename | 60 |
| 3.171 | File Offset | 60 |
| 3.172 | File Other Class | 61 |
| 3.173 | File Owner Class | 61 |
| 3.174 | File Permission Bits | 61 |
| 3.175 | File Serial Number | 61 |
| 3.176 | File System | 61 |
| 3.177 | File Type | 61 |
| 3.178 | Filter | 62 |
| 3.179 | First Open (of a File) | 62 |
| 3.180 | Flow Control | 62 |
| 3.181 | Foreground Job | 62 |
| 3.182 | Foreground Process | 62 |
| 3.183 | Foreground Process Group (or Foreground Job) | 62 |
| 3.184 | Foreground Process Group ID | 62 |
| 3.185 | Form-Feed Character (<form-feed>) | 63 |
| 3.186 | Graphic Character | 63 |
| 3.187 | Group Database | 63 |
| 3.188 | Group ID | 63 |
| 3.189 | Group Name | 63 |
| 3.190 | Hard Limit | 63 |
| 3.191 | Hard Link | 64 |
| 3.192 | Home Directory | 64 |
| 3.193 | Host Byte Order | 64 |
| 3.194 | Incomplete Line | 64 |
| 3.195 | Inf | 64 |
| 3.196 | Instrumented Application | 64 |
| 3.197 | Interactive Shell | 64 |
| 3.198 | Internationalization | 65 |
| 3.199 | Interprocess Communication | 65 |
| 3.200 | Invoke | 65 |
| 3.201 | Job | 65 |
| 3.202 | Job Control | 65 |
| 3.203 | Job Control Job ID | 65 |
| 3.204 | Last Close (of a File) | 66 |
| 3.205 | Line | 66 |
| 3.206 | Linger | 66 |
| 3.207 | Link | 66 |
| 3.208 | Link Count | 66 |
| 3.209 | Local Customs | 66 |
| 3.210 | Local Interprocess Communication (Local IPC) | 66 |
| 3.211 | Locale | 67 |
| 3.212 | Localization | 67 |
| 3.213 | Login | 67 |
| 3.214 | Login Name | 67 |
| 3.215 | Map | 67 |
| 3.216 | Marked Message | 67 |
| 3.217 | Matched | 68 |
| 3.218 | Memory Mapped Files | 68 |
| 3.219 | Memory Object | 68 |
| 3.220 | Memory-Resident | 68 |

Contents

| | | |
|-------|---|----|
| 3.221 | Message | 68 |
| 3.222 | Message Catalog..... | 68 |
| 3.223 | Message Catalog Descriptor | 69 |
| 3.224 | Message Queue..... | 69 |
| 3.225 | Mode | 69 |
| 3.226 | Monotonic Clock | 69 |
| 3.227 | Mount Point | 69 |
| 3.228 | Multi-Character Collating Element | 69 |
| 3.229 | Mutex | 69 |
| 3.230 | Name..... | 70 |
| 3.231 | Named STREAM..... | 70 |
| 3.232 | NaN (Not a Number) | 70 |
| 3.233 | Native Language | 70 |
| 3.234 | Negative Response..... | 70 |
| 3.235 | Network..... | 70 |
| 3.236 | Network Address..... | 70 |
| 3.237 | Network Byte Order | 71 |
| 3.238 | Newline Character (<newline>) | 71 |
| 3.239 | Nice Value | 71 |
| 3.240 | Non-Blocking..... | 71 |
| 3.241 | Non-Spacing Characters | 71 |
| 3.242 | NUL..... | 72 |
| 3.243 | Null Byte..... | 72 |
| 3.244 | Null Pointer..... | 72 |
| 3.245 | Null String..... | 72 |
| 3.246 | Null Wide-Character Code | 72 |
| 3.247 | Number-Sign Character (<number-sign>) | 72 |
| 3.248 | Object File..... | 72 |
| 3.249 | Octet | 72 |
| 3.250 | Offset Maximum | 73 |
| 3.251 | Opaque Address..... | 73 |
| 3.252 | Open File | 73 |
| 3.253 | Open File Description..... | 73 |
| 3.254 | Operand..... | 73 |
| 3.255 | Operator | 73 |
| 3.256 | Option | 74 |
| 3.257 | Option-Argument | 74 |
| 3.258 | Orientation | 74 |
| 3.259 | Orphaned Process Group..... | 74 |
| 3.260 | Page | 74 |
| 3.261 | Page Size | 74 |
| 3.262 | Parameter | 75 |
| 3.263 | Parent Directory | 75 |
| 3.264 | Parent Process..... | 75 |
| 3.265 | Parent Process ID | 75 |
| 3.266 | Pathname..... | 75 |
| 3.267 | Pathname Component..... | 76 |
| 3.268 | Path Prefix | 76 |
| 3.269 | Pattern..... | 76 |
| 3.270 | Period Character (<period>) | 76 |
| 3.271 | Permissions | 76 |
| 3.272 | Persistence..... | 76 |

Contents

| | | |
|-------|--|----|
| 3.273 | Pipe..... | 77 |
| 3.274 | Polling..... | 77 |
| 3.275 | Portable Character Set..... | 77 |
| 3.276 | Portable Filename Character Set..... | 77 |
| 3.277 | Positional Parameter..... | 78 |
| 3.278 | Preallocation | 78 |
| 3.279 | Preempted Process (or Thread)..... | 78 |
| 3.280 | Previous Job | 78 |
| 3.281 | Printable Character | 78 |
| 3.282 | Printable File | 78 |
| 3.283 | Priority | 79 |
| 3.284 | Priority Band..... | 79 |
| 3.285 | Priority Inversion | 79 |
| 3.286 | Priority Scheduling..... | 79 |
| 3.287 | Priority-Based Scheduling..... | 79 |
| 3.288 | Privilege..... | 79 |
| 3.289 | Process | 80 |
| 3.290 | Process Group..... | 80 |
| 3.291 | Process Group ID | 80 |
| 3.292 | Process Group Leader..... | 80 |
| 3.293 | Process Group Lifetime | 80 |
| 3.294 | Process ID..... | 81 |
| 3.295 | Process Lifetime..... | 81 |
| 3.296 | Process Memory Locking..... | 81 |
| 3.297 | Process Termination..... | 81 |
| 3.298 | Process-To-Process Communication | 81 |
| 3.299 | Process Virtual Time | 82 |
| 3.300 | Program | 82 |
| 3.301 | Protocol..... | 82 |
| 3.302 | Pseudo-Terminal | 82 |
| 3.303 | Radix Character | 82 |
| 3.304 | Read-Only File System | 82 |
| 3.305 | Read-Write Lock..... | 82 |
| 3.306 | Real Group ID..... | 83 |
| 3.307 | Real Time | 83 |
| 3.308 | Realtime Signal Extension | 83 |
| 3.309 | Real User ID..... | 83 |
| 3.310 | Record | 83 |
| 3.311 | Redirection | 83 |
| 3.312 | Redirection Operator..... | 84 |
| 3.313 | Referenced Shared Memory Object..... | 84 |
| 3.314 | Refresh | 84 |
| 3.315 | Regular Expression | 84 |
| 3.316 | Region | 84 |
| 3.317 | Regular File | 84 |
| 3.318 | Relative Pathname | 85 |
| 3.319 | Relocatable File..... | 85 |
| 3.320 | Relocation..... | 85 |
| 3.321 | Requested Batch Service | 85 |
| 3.322 | (Time) Resolution | 85 |
| 3.323 | Robust Mutex..... | 85 |
| 3.324 | Root Directory | 85 |

Contents

| | | |
|-------|---|----|
| 3.325 | Runnable Process (or Thread) | 85 |
| 3.326 | Running Process (or Thread)..... | 86 |
| 3.327 | Saved Resource Limits | 86 |
| 3.328 | Saved Set-Group-ID | 86 |
| 3.329 | Saved Set-User-ID | 86 |
| 3.330 | Scheduling..... | 86 |
| 3.331 | Scheduling Allocation Domain | 86 |
| 3.332 | Scheduling Contention Scope | 86 |
| 3.333 | Scheduling Policy..... | 87 |
| 3.334 | Screen | 87 |
| 3.335 | Scroll..... | 87 |
| 3.336 | Semaphore..... | 87 |
| 3.337 | Session | 88 |
| 3.338 | Session Leader | 88 |
| 3.339 | Session Lifetime..... | 88 |
| 3.340 | Shared Memory Object..... | 88 |
| 3.341 | Shell | 88 |
| 3.342 | Shell, the | 88 |
| 3.343 | Shell Script..... | 89 |
| 3.344 | Signal..... | 89 |
| 3.345 | Signal Stack | 89 |
| 3.346 | Single-Quote Character | 89 |
| 3.347 | Slash Character (<slash>)..... | 89 |
| 3.348 | Socket | 89 |
| 3.349 | Socket Address | 89 |
| 3.350 | Soft Limit | 90 |
| 3.351 | Source Code | 90 |
| 3.352 | Space Character (<space>)..... | 90 |
| 3.353 | Spawn | 90 |
| 3.354 | Special Built-In..... | 90 |
| 3.355 | Special Parameter..... | 91 |
| 3.356 | Spin Lock..... | 91 |
| 3.357 | Sporadic Server..... | 91 |
| 3.358 | Standard Error | 91 |
| 3.359 | Standard Input..... | 91 |
| 3.360 | Standard Output | 91 |
| 3.361 | Standard Utilities | 91 |
| 3.362 | Stream | 92 |
| 3.363 | STREAM | 92 |
| 3.364 | STREAM End | 92 |
| 3.365 | STREAM Head | 92 |
| 3.366 | STREAMS Multiplexor | 92 |
| 3.367 | String..... | 92 |
| 3.368 | Subshell..... | 93 |
| 3.369 | Successfully Transferred | 93 |
| 3.370 | Supplementary Group ID | 93 |
| 3.371 | Suspended Job | 93 |
| 3.372 | Symbolic Constant | 93 |
| 3.373 | Symbolic Link | 94 |
| 3.374 | Synchronized Input and Output..... | 94 |
| 3.375 | Synchronized I/O Completion | 94 |
| 3.376 | Synchronized I/O Data Integrity Completion..... | 94 |

Contents

| | | |
|-------|--|-----|
| 3.377 | Synchronized I/O File Integrity Completion | 94 |
| 3.378 | Synchronized I/O Operation | 94 |
| 3.379 | Synchronous I/O Operation..... | 95 |
| 3.380 | Synchronously-Generated Signal | 95 |
| 3.381 | System..... | 95 |
| 3.382 | System Boot..... | 95 |
| 3.383 | System Clock..... | 95 |
| 3.384 | System Console | 95 |
| 3.385 | System Crash | 95 |
| 3.386 | System Databases..... | 96 |
| 3.387 | System Documentation | 96 |
| 3.388 | System Process..... | 96 |
| 3.389 | System Reboot | 96 |
| 3.390 | System Trace Event | 96 |
| 3.391 | System-Wide | 96 |
| 3.392 | Tab Character (<tab>)..... | 97 |
| 3.393 | Terminal (or Terminal Device) | 97 |
| 3.394 | Text Column..... | 97 |
| 3.395 | Text File..... | 97 |
| 3.396 | Thread | 97 |
| 3.397 | Thread ID | 97 |
| 3.398 | Thread List | 98 |
| 3.399 | Thread-Safe | 98 |
| 3.400 | Thread-Specific Data Key..... | 98 |
| 3.401 | Tilde Character (<tilde>)..... | 98 |
| 3.402 | Timeouts | 98 |
| 3.403 | Timer | 98 |
| 3.404 | Timer Overrun | 98 |
| 3.405 | Token..... | 99 |
| 3.406 | Trace Analyzer Process..... | 99 |
| 3.407 | Trace Controller Process | 99 |
| 3.408 | Trace Event..... | 99 |
| 3.409 | Trace Event Type | 99 |
| 3.410 | Trace Event Type Mapping | 99 |
| 3.411 | Trace Filter | 99 |
| 3.412 | Trace Generation Version | 99 |
| 3.413 | Trace Log | 100 |
| 3.414 | Trace Point..... | 100 |
| 3.415 | Trace Stream | 100 |
| 3.416 | Trace Stream Identifier | 100 |
| 3.417 | Trace System | 100 |
| 3.418 | Traced Process..... | 100 |
| 3.419 | Tracing Status of a Trace Stream | 100 |
| 3.420 | Typed Memory Name Space | 100 |
| 3.421 | Typed Memory Object..... | 101 |
| 3.422 | Typed Memory Pool | 101 |
| 3.423 | Typed Memory Port..... | 101 |
| 3.424 | Unbind | 101 |
| 3.425 | Unit Data | 101 |
| 3.426 | Upshifting | 101 |
| 3.427 | User Database | 101 |
| 3.428 | User ID..... | 102 |

| | | |
|------------------|--|------------|
| 3.429 | User Name | 102 |
| 3.430 | User Trace Event..... | 102 |
| 3.431 | Utility | 102 |
| 3.432 | Variable | 103 |
| 3.433 | Vertical-Tab Character (<vertical-tab>)..... | 103 |
| 3.434 | White Space..... | 103 |
| 3.435 | Wide-Character Code (C Language) | 103 |
| 3.436 | Wide-Character Input/Output Functions | 103 |
| 3.437 | Wide-Character String..... | 103 |
| 3.438 | Word..... | 104 |
| 3.439 | Working Directory (or Current Working Directory) | 104 |
| 3.440 | Worldwide Portability Interface | 104 |
| 3.441 | Write | 104 |
| 3.442 | XSI | 104 |
| 3.443 | XSI-Conformant | 105 |
| 3.444 | Zombie Process..... | 105 |
| 3.445 | ±0 | 105 |
| Chapter 4 | General Concepts | 107 |
| 4.1 | Concurrent Execution..... | 107 |
| 4.2 | Directory Protection..... | 107 |
| 4.3 | Extended Security Controls | 107 |
| 4.4 | File Access Permissions..... | 108 |
| 4.5 | File Hierarchy | 108 |
| 4.6 | Filenames..... | 109 |
| 4.7 | Filename Portability..... | 109 |
| 4.8 | File Times Update | 109 |
| 4.9 | Host and Network Byte Orders | 110 |
| 4.10 | Measurement of Execution Time | 110 |
| 4.11 | Memory Synchronization | 110 |
| 4.12 | Pathname Resolution..... | 111 |
| 4.13 | Process ID Reuse | 112 |
| 4.14 | Scheduling Policy..... | 112 |
| 4.15 | Seconds Since the Epoch | 113 |
| 4.16 | Semaphore..... | 113 |
| 4.17 | Thread-Safety..... | 114 |
| 4.18 | Tracing | 114 |
| 4.19 | Treatment of Error Conditions for Mathematical Functions | 116 |
| 4.19.1 | Domain Error | 116 |
| 4.19.2 | Pole Error..... | 117 |
| 4.19.3 | Range Error | 117 |
| 4.20 | Treatment of NaN Arguments for the Mathematical Functions | 118 |
| 4.21 | Utility | 118 |
| 4.22 | Variable Assignment..... | 118 |
| Chapter 5 | File Format Notation..... | 121 |
| Chapter 6 | Character Set | 125 |
| 6.1 | Portable Character Set | 125 |
| 6.2 | Character Encoding | 128 |

Contents

| | | | |
|----------------|----------|--|------------|
| | 6.3 | C Language Wide-Character Codes | 129 |
| | 6.4 | Character Set Description File..... | 129 |
| | 6.4.1 | State-Dependent Character Encodings..... | 132 |
| Chapter | 7 | Locale | 135 |
| | 7.1 | General..... | 135 |
| | 7.2 | POSIX Locale | 136 |
| | 7.3 | Locale Definition | 136 |
| | 7.3.1 | LC_CTYPE | 139 |
| | 7.3.2 | LC_COLLATE..... | 146 |
| | 7.3.3 | LC_MONETARY | 154 |
| | 7.3.4 | LC_NUMERIC..... | 157 |
| | 7.3.5 | LC_TIME | 158 |
| | 7.3.6 | LC_MESSAGES..... | 164 |
| | 7.4 | Locale Definition Grammar..... | 165 |
| | 7.4.1 | Locale Lexical Conventions..... | 165 |
| | 7.4.2 | Locale Grammar..... | 166 |
| Chapter | 8 | Environment Variables | 173 |
| | 8.1 | Environment Variable Definition..... | 173 |
| | 8.2 | Internationalization Variables | 174 |
| | 8.3 | Other Environment Variables..... | 177 |
| Chapter | 9 | Regular Expressions..... | 181 |
| | 9.1 | Regular Expression Definitions..... | 181 |
| | 9.2 | Regular Expression General Requirements..... | 182 |
| | 9.3 | Basic Regular Expressions | 183 |
| | 9.3.1 | BREs Matching a Single Character or Collating Element | 183 |
| | 9.3.2 | BRE Ordinary Characters..... | 183 |
| | 9.3.3 | BRE Special Characters | 183 |
| | 9.3.4 | Periods in BREs | 184 |
| | 9.3.5 | RE Bracket Expression..... | 184 |
| | 9.3.6 | BREs Matching Multiple Characters | 186 |
| | 9.3.7 | BRE Precedence..... | 187 |
| | 9.3.8 | BRE Expression Anchoring..... | 187 |
| | 9.4 | Extended Regular Expressions..... | 188 |
| | 9.4.1 | EREs Matching a Single Character or Collating Element | 188 |
| | 9.4.2 | ERE Ordinary Characters..... | 188 |
| | 9.4.3 | ERE Special Characters | 188 |
| | 9.4.4 | Periods in EREs | 189 |
| | 9.4.5 | ERE Bracket Expression | 189 |
| | 9.4.6 | EREs Matching Multiple Characters | 189 |
| | 9.4.7 | ERE Alternation..... | 190 |
| | 9.4.8 | ERE Precedence..... | 190 |
| | 9.4.9 | ERE Expression Anchoring..... | 190 |
| | 9.5 | Regular Expression Grammar | 191 |
| | 9.5.1 | BRE/ERE Grammar Lexical Conventions..... | 191 |
| | 9.5.2 | RE and Bracket Expression Grammar..... | 192 |
| | 9.5.3 | ERE Grammar..... | 194 |

| | | | |
|----------------|-----------|---|------------|
| Chapter | 10 | Directory Structure and Devices | 197 |
| | 10.1 | Directory Structure and Files..... | 197 |
| | 10.2 | Output Devices and Terminal Types..... | 198 |
| Chapter | 11 | General Terminal Interface | 199 |
| | 11.1 | Interface Characteristics | 199 |
| | 11.1.1 | Opening a Terminal Device File..... | 199 |
| | 11.1.2 | Process Groups | 200 |
| | 11.1.3 | The Controlling Terminal..... | 200 |
| | 11.1.4 | Terminal Access Control | 201 |
| | 11.1.5 | Input Processing and Reading Data | 201 |
| | 11.1.6 | Canonical Mode Input Processing..... | 202 |
| | 11.1.7 | Non-Canonical Mode Input Processing..... | 202 |
| | 11.1.8 | Writing Data and Output Processing | 203 |
| | 11.1.9 | Special Characters | 203 |
| | 11.1.10 | Modem Disconnect | 205 |
| | 11.1.11 | Closing a Terminal Device File..... | 205 |
| | 11.2 | Parameters that Can be Set | 205 |
| | 11.2.1 | The termios Structure | 205 |
| | 11.2.2 | Input Modes..... | 206 |
| | 11.2.3 | Output Modes..... | 207 |
| | 11.2.4 | Control Modes | 209 |
| | 11.2.5 | Local Modes | 210 |
| | 11.2.6 | Special Control Characters..... | 212 |
| Chapter | 12 | Utility Conventions | 213 |
| | 12.1 | Utility Argument Syntax..... | 213 |
| | 12.2 | Utility Syntax Guidelines..... | 215 |
| Chapter | 13 | Headers | 219 |
| Volume | 2 | System Interfaces, Issue 7..... | 463 |
| Chapter | 1 | Introduction..... | 465 |
| | 1.1 | Relationship to Other Formal Standards | 465 |
| | 1.2 | Format of Entries | 465 |
| Chapter | 2 | General Information | 467 |
| | 2.1 | Use and Implementation of Interfaces | 467 |
| | 2.1.1 | Use and Implementation of Functions..... | 467 |
| | 2.1.2 | Use and Implementation of Macros | 468 |
| | 2.2 | The Compilation Environment | 468 |
| | 2.2.1 | POSIX.1 Symbols..... | 468 |
| | 2.2.2 | The Name Space..... | 469 |
| | 2.3 | Error Numbers..... | 477 |
| | 2.3.1 | Additional Error Numbers | 484 |
| | 2.4 | Signal Concepts | 484 |
| | 2.4.1 | Signal Generation and Delivery..... | 484 |
| | 2.4.2 | Realtime Signal Generation and Delivery | 485 |
| | 2.4.3 | Signal Actions | 486 |
| | 2.4.4 | Signal Effects on Other Functions..... | 490 |

Contents

| | | |
|---------|--|-----|
| 2.5 | Standard I/O Streams | 490 |
| 2.5.1 | Interaction of File Descriptors and Standard I/O Streams | 491 |
| 2.5.2 | Stream Orientation and Encoding Rules | 493 |
| 2.6 | STREAMS | 494 |
| 2.6.1 | Accessing STREAMS | 495 |
| 2.7 | XSI Interprocess Communication | 496 |
| 2.7.1 | IPC General Description | 496 |
| 2.8 | Realtime | 497 |
| 2.8.1 | Realtime Signals | 497 |
| 2.8.2 | Asynchronous I/O | 497 |
| 2.8.3 | Memory Management | 499 |
| 2.8.4 | Process Scheduling | 501 |
| 2.8.5 | Clocks and Timers | 505 |
| 2.9 | Threads | 507 |
| 2.9.1 | Thread-Safety | 507 |
| 2.9.2 | Thread IDs | 508 |
| 2.9.3 | Thread Mutexes | 508 |
| 2.9.4 | Thread Scheduling | 509 |
| 2.9.5 | Thread Cancellation | 511 |
| 2.9.6 | Thread Read-Write Locks | 515 |
| 2.9.7 | Thread Interactions with Regular File Operations | 516 |
| 2.9.8 | Use of Application-Managed Thread Stacks | 516 |
| 2.10 | Sockets | 517 |
| 2.10.1 | Address Families | 517 |
| 2.10.2 | Addressing | 517 |
| 2.10.3 | Protocols | 517 |
| 2.10.4 | Routing | 518 |
| 2.10.5 | Interfaces | 518 |
| 2.10.6 | Socket Types | 518 |
| 2.10.7 | Socket I/O Mode | 519 |
| 2.10.8 | Socket Owner | 519 |
| 2.10.9 | Socket Queue Limits | 519 |
| 2.10.10 | Pending Error | 519 |
| 2.10.11 | Socket Receive Queue | 520 |
| 2.10.12 | Socket Out-of-Band Data State | 520 |
| 2.10.13 | Connection Indication Queue | 521 |
| 2.10.14 | Signals | 521 |
| 2.10.15 | Asynchronous Errors | 521 |
| 2.10.16 | Use of Options | 522 |
| 2.10.17 | Use of Sockets for Local UNIX Connections | 525 |
| 2.10.18 | Use of Sockets over Internet Protocols | 525 |
| 2.10.19 | Use of Sockets over Internet Protocols Based on IPv4 | 526 |
| 2.10.20 | Use of Sockets over Internet Protocols Based on IPv6 | 526 |
| 2.11 | Tracing | 529 |
| 2.11.1 | Tracing Data Definitions | 531 |
| 2.11.2 | Trace Event Type Definitions | 535 |
| 2.11.3 | Trace Functions | 539 |
| 2.12 | Data Types | 540 |
| 2.12.1 | Defined Types | 540 |

| | | | |
|----------------|----------|--|-------------|
| | 2.12.2 | The char Type..... | 541 |
| | 2.12.3 | Pointer Types | 541 |
| Chapter | 3 | System Interfaces..... | 543 |
| Volume | 3 | Shell and Utilities, Issue 7 | 2277 |
| Chapter | 1 | Introduction..... | 2279 |
| | 1.1 | Relationship to Other Documents | 2279 |
| | 1.1.1 | System Interfaces..... | 2279 |
| | 1.1.2 | Concepts Derived from the ISO C Standard | 2283 |
| | 1.2 | Utility Limits..... | 2285 |
| | 1.3 | Grammar Conventions..... | 2287 |
| | 1.4 | Utility Description Defaults..... | 2288 |
| | 1.5 | Considerations for Utilities in Support of Files of Arbitrary Size..... | 2295 |
| | 1.6 | Built-In Utilities | 2296 |
| Chapter | 2 | Shell Command Language | 2297 |
| | 2.1 | Shell Introduction..... | 2297 |
| | 2.2 | Quoting..... | 2298 |
| | 2.2.1 | Escape Character (Backslash) | 2298 |
| | 2.2.2 | Single-Quotes..... | 2298 |
| | 2.2.3 | Double-Quotes..... | 2298 |
| | 2.3 | Token Recognition..... | 2299 |
| | 2.3.1 | Alias Substitution | 2300 |
| | 2.4 | Reserved Words..... | 2301 |
| | 2.5 | Parameters and Variables..... | 2301 |
| | 2.5.1 | Positional Parameters | 2301 |
| | 2.5.2 | Special Parameters | 2302 |
| | 2.5.3 | Shell Variables..... | 2302 |
| | 2.6 | Word Expansions | 2305 |
| | 2.6.1 | Tilde Expansion | 2305 |
| | 2.6.2 | Parameter Expansion..... | 2306 |
| | 2.6.3 | Command Substitution | 2309 |
| | 2.6.4 | Arithmetic Expansion..... | 2310 |
| | 2.6.5 | Field Splitting | 2311 |
| | 2.6.6 | Pathname Expansion | 2311 |
| | 2.6.7 | Quote Removal..... | 2311 |
| | 2.7 | Redirection | 2312 |
| | 2.7.1 | Redirecting Input | 2312 |
| | 2.7.2 | Redirecting Output | 2313 |
| | 2.7.3 | Appending Redirected Output | 2313 |
| | 2.7.4 | Here-Document..... | 2313 |
| | 2.7.5 | Duplicating an Input File Descriptor | 2314 |
| | 2.7.6 | Duplicating an Output File Descriptor | 2314 |
| | 2.7.7 | Open File Descriptors for Reading and Writing..... | 2315 |
| | 2.8 | Exit Status and Errors | 2315 |
| | 2.8.1 | Consequences of Shell Errors | 2315 |
| | 2.8.2 | Exit Status for Commands | 2315 |
| | 2.9 | Shell Commands | 2316 |

Contents

| | | |
|-------------------|--|-------------|
| 2.9.1 | Simple Commands..... | 2316 |
| 2.9.2 | Pipelines | 2318 |
| 2.9.3 | Lists | 2319 |
| 2.9.4 | Compound Commands..... | 2321 |
| 2.9.5 | Function Definition Command | 2324 |
| 2.10 | Shell Grammar..... | 2325 |
| 2.10.1 | Shell Grammar Lexical Conventions..... | 2325 |
| 2.10.2 | Shell Grammar Rules..... | 2325 |
| 2.11 | Signals and Error Handling..... | 2330 |
| 2.12 | Shell Execution Environment..... | 2331 |
| 2.13 | Pattern Matching Notation | 2332 |
| 2.13.1 | Patterns Matching a Single Character..... | 2332 |
| 2.13.2 | Patterns Matching Multiple Characters..... | 2332 |
| 2.13.3 | Patterns Used for Filename Expansion..... | 2333 |
| 2.14 | Special Built-In Utilities..... | 2334 |
| Chapter 3 | Batch Environment Services..... | 2375 |
| 3.1 | General Concepts | 2375 |
| 3.1.1 | Batch Client-Server Interaction | 2375 |
| 3.1.2 | Batch Queues | 2376 |
| 3.1.3 | Batch Job Creation..... | 2376 |
| 3.1.4 | Batch Job Tracking..... | 2376 |
| 3.1.5 | Batch Job Routing..... | 2377 |
| 3.1.6 | Batch Job Execution | 2377 |
| 3.1.7 | Batch Job Exit..... | 2378 |
| 3.1.8 | Batch Job Abort..... | 2378 |
| 3.1.9 | Batch Authorization..... | 2378 |
| 3.1.10 | Batch Administration | 2378 |
| 3.1.11 | Batch Notification..... | 2379 |
| 3.2 | Batch Services | 2379 |
| 3.2.1 | Batch Job States..... | 2380 |
| 3.2.2 | Deferred Batch Services..... | 2381 |
| 3.2.3 | Requested Batch Services..... | 2390 |
| 3.3 | Common Behavior for Batch Environment Utilities..... | 2397 |
| 3.3.1 | Batch Job Identifier..... | 2397 |
| 3.3.2 | Destination | 2398 |
| 3.3.3 | Multiple Keyword-Value Pairs..... | 2399 |
| Chapter 4 | Utilities..... | 2401 |
| Volume 4 | Rationale (Informative), Issue 7..... | 3407 |
| Part A | Base Definitions | 3409 |
| Appendix A | Rationale for Base Definitions..... | 3411 |
| A.1 | Introduction | 3411 |
| A.1.1 | Scope | 3411 |
| A.1.2 | Conformance..... | 3414 |
| A.1.3 | Normative References | 3414 |
| A.1.4 | Change History | 3414 |
| A.1.5 | Terminology | 3414 |

Contents

| | | |
|--------|--|------|
| A.1.6 | Definitions and Concepts..... | 3416 |
| A.1.7 | Portability..... | 3416 |
| A.2 | Conformance..... | 3417 |
| A.2.1 | Implementation Conformance..... | 3417 |
| A.2.2 | Application Conformance..... | 3421 |
| A.2.3 | Language-Dependent Services for the C Programming Language..... | 3421 |
| A.2.4 | Other Language-Related Specifications..... | 3422 |
| A.3 | Definitions..... | 3422 |
| A.4 | General Concepts..... | 3443 |
| A.4.1 | Concurrent Execution..... | 3443 |
| A.4.2 | Directory Protection..... | 3444 |
| A.4.3 | Extended Security Controls..... | 3444 |
| A.4.4 | File Access Permissions..... | 3444 |
| A.4.5 | File Hierarchy..... | 3444 |
| A.4.6 | Filenames..... | 3445 |
| A.4.7 | Filename Portability..... | 3446 |
| A.4.8 | File Times Update..... | 3446 |
| A.4.9 | Host and Network Byte Order..... | 3447 |
| A.4.10 | Measurement of Execution Time..... | 3447 |
| A.4.11 | Memory Synchronization..... | 3447 |
| A.4.12 | Pathname Resolution..... | 3449 |
| A.4.13 | Process ID Reuse..... | 3450 |
| A.4.14 | Scheduling Policy..... | 3450 |
| A.4.15 | Seconds Since the Epoch..... | 3450 |
| A.4.16 | Semaphore..... | 3452 |
| A.4.17 | Thread-Safety..... | 3452 |
| A.4.18 | Tracing..... | 3452 |
| A.4.19 | Treatment of Error Conditions for Mathematical Functions..... | 3452 |
| A.4.20 | Treatment of NaN Arguments for Mathematical Functions..... | 3452 |
| A.4.21 | Utility..... | 3452 |
| A.4.22 | Variable Assignment..... | 3452 |
| A.5 | File Format Notation..... | 3452 |
| A.6 | Character Set..... | 3453 |
| A.6.1 | Portable Character Set..... | 3453 |
| A.6.2 | Character Encoding..... | 3454 |
| A.6.3 | C Language Wide-Character Codes..... | 3454 |
| A.6.4 | Character Set Description File..... | 3454 |
| A.7 | Locale..... | 3456 |
| A.7.1 | General..... | 3456 |
| A.7.2 | POSIX Locale..... | 3457 |
| A.7.3 | Locale Definition..... | 3457 |
| A.7.4 | Locale Definition Grammar..... | 3464 |
| A.7.5 | Locale Definition Example..... | 3464 |
| A.8 | Environment Variables..... | 3467 |
| A.8.1 | Environment Variable Definition..... | 3467 |
| A.8.2 | Internationalization Variables..... | 3468 |
| A.8.3 | Other Environment Variables..... | 3469 |
| A.9 | Regular Expressions..... | 3470 |
| A.9.1 | Regular Expression Definitions..... | 3471 |

Contents

| | | |
|-------------------|--|-------------|
| A.9.2 | Regular Expression General Requirements..... | 3471 |
| A.9.3 | Basic Regular Expressions | 3472 |
| A.9.4 | Extended Regular Expressions..... | 3475 |
| A.9.5 | Regular Expression Grammar..... | 3477 |
| A.10 | Directory Structure and Devices..... | 3478 |
| A.10.1 | Directory Structure and Files..... | 3478 |
| A.10.2 | Output Devices and Terminal Types..... | 3478 |
| A.11 | General Terminal Interface | 3478 |
| A.11.1 | Interface Characteristics..... | 3479 |
| A.11.2 | Parameters that Can be Set..... | 3483 |
| A.12 | Utility Conventions..... | 3485 |
| A.12.1 | Utility Argument Syntax..... | 3485 |
| A.12.2 | Utility Syntax Guidelines..... | 3486 |
| A.13 | Headers..... | 3488 |
| A.13.1 | Format of Entries..... | 3488 |
| A.13.2 | Removed Headers in Issue 7..... | 3489 |
| Part B | System Interfaces..... | 3491 |
| Appendix B | Rationale for System Interfaces..... | 3493 |
| B.1 | Introduction | 3493 |
| B.1.1 | Change History | 3493 |
| B.1.2 | Relationship to Other Formal Standards..... | 3496 |
| B.1.3 | Format of Entries..... | 3496 |
| B.2 | General Information | 3497 |
| B.2.1 | Use and Implementation of Interfaces..... | 3497 |
| B.2.2 | The Compilation Environment | 3498 |
| B.2.3 | Error Numbers..... | 3503 |
| B.2.4 | Signal Concepts | 3507 |
| B.2.5 | Standard I/O Streams | 3517 |
| B.2.6 | STREAMS..... | 3517 |
| B.2.7 | XSI Interprocess Communication | 3518 |
| B.2.8 | Realtime..... | 3519 |
| B.2.9 | Threads | 3564 |
| B.2.10 | Sockets | 3592 |
| B.2.11 | Tracing | 3594 |
| B.2.12 | Data Types..... | 3620 |
| B.3 | System Interfaces..... | 3622 |
| B.3.1 | System Interfaces Removed in this Version | 3622 |
| B.3.2 | System Interfaces Removed in the Previous Version..... | 3625 |
| B.3.3 | Examples for Spawn..... | 3625 |
| Part C | Shell and Utilities | 3635 |
| Appendix C | Rationale for Shell and Utilities..... | 3637 |
| C.1 | Introduction | 3637 |
| C.1.1 | Change History | 3637 |
| C.1.2 | Relationship to Other Documents | 3638 |
| C.1.3 | Utility Limits..... | 3639 |
| C.1.4 | Grammar Conventions..... | 3642 |
| C.1.5 | Utility Description Defaults..... | 3642 |

| | | |
|-----------------|---|-------------|
| C.1.6 | Considerations for Utilities in Support of Files of Arbitrary Size | 3645 |
| C.1.7 | Built-In Utilities | 3646 |
| C.2 | Shell Command Language | 3648 |
| C.2.1 | Shell Introduction..... | 3648 |
| C.2.2 | Quoting..... | 3648 |
| C.2.3 | Token Recognition..... | 3650 |
| C.2.4 | Reserved Words..... | 3651 |
| C.2.5 | Parameters and Variables..... | 3651 |
| C.2.6 | Word Expansions | 3654 |
| C.2.7 | Redirection | 3660 |
| C.2.8 | Exit Status and Errors | 3662 |
| C.2.9 | Shell Commands | 3662 |
| C.2.10 | Shell Grammar..... | 3669 |
| C.2.11 | Signals and Error Handling..... | 3671 |
| C.2.12 | Shell Execution Environment..... | 3671 |
| C.2.13 | Pattern Matching Notation..... | 3671 |
| C.2.14 | Special Built-In Utilities..... | 3673 |
| C.3 | Batch Environment Services and Utilities | 3673 |
| C.3.1 | Batch General Concepts | 3676 |
| C.3.2 | Batch Services | 3678 |
| C.3.3 | Common Behavior for Batch Environment Utilities..... | 3679 |
| C.4 | Utilities..... | 3679 |
| C.4.1 | Utilities Removed in this Version | 3679 |
| C.4.2 | Utilities Removed in the Previous Version..... | 3679 |
| C.4.3 | Exclusion of Utilities..... | 3679 |
| Part | D Portability Considerations..... | 3683 |
| Appendix | D Portability Considerations (Informative)..... | 3685 |
| D.1 | User Requirements..... | 3685 |
| D.1.1 | Configuration Interrogation | 3686 |
| D.1.2 | Process Management | 3686 |
| D.1.3 | Access to Data..... | 3686 |
| D.1.4 | Access to the Environment | 3686 |
| D.1.5 | Access to Determinism and Performance Enhancements..... | 3686 |
| D.1.6 | Operating System-Dependent Profile | 3687 |
| D.1.7 | I/O Interaction | 3687 |
| D.1.8 | Internationalization Interaction | 3687 |
| D.1.9 | C-Language Extensions..... | 3687 |
| D.1.10 | Command Language | 3687 |
| D.1.11 | Interactive Facilities | 3687 |
| D.1.12 | Accomplish Multiple Tasks Simultaneously..... | 3687 |
| D.1.13 | Complex Data Manipulation..... | 3688 |
| D.1.14 | File Hierarchy Manipulation | 3688 |
| D.1.15 | Locale Configuration | 3688 |
| D.1.16 | Inter-User Communication..... | 3688 |
| D.1.17 | System Environment | 3688 |
| D.1.18 | Printing | 3688 |
| D.1.19 | Software Development..... | 3688 |

Contents

| | | |
|------------------------|---|-------------|
| D.2 | Portability Capabilities..... | 3689 |
| D.2.1 | Configuration Interrogation | 3689 |
| D.2.2 | Process Management | 3690 |
| D.2.3 | Access to Data..... | 3690 |
| D.2.4 | Access to the Environment | 3691 |
| D.2.5 | Bounded (Realtime) Response | 3692 |
| D.2.6 | Operating System-Dependent Profile | 3692 |
| D.2.7 | I/O Interaction | 3692 |
| D.2.8 | Internationalization Interaction | 3693 |
| D.2.9 | C-Language Extensions..... | 3693 |
| D.2.10 | Command Language | 3693 |
| D.2.11 | Interactive Facilities | 3694 |
| D.2.12 | Accomplish Multiple Tasks Simultaneously | 3694 |
| D.2.13 | Complex Data Manipulation | 3694 |
| D.2.14 | File Hierarchy Manipulation | 3695 |
| D.2.15 | Locale Configuration | 3695 |
| D.2.16 | Inter-User Communication..... | 3695 |
| D.2.17 | System Environment | 3696 |
| D.2.18 | Printing..... | 3696 |
| D.2.19 | Software Development..... | 3696 |
| D.2.20 | Future Growth | 3696 |
| D.3 | Profiling Considerations | 3697 |
| D.3.1 | Configuration Options | 3697 |
| D.3.2 | Configuration Options (Shell and Utilities) | 3697 |
| D.3.3 | Configurable Limits | 3699 |
| D.3.4 | Configuration Options (System Interfaces)..... | 3699 |
| D.3.5 | Configurable Limits | 3704 |
| D.3.6 | Optional Behavior | 3707 |
| Part E | Subprofiling Considerations..... | 3709 |
| Appendix E | Subprofiling Considerations (Informative) | 3711 |
| E.1 | Subprofiling Option Groups..... | 3711 |
| | Index | 3717 |
| List of Figures | | |
| B-1 | Example of a System with Typed Memory | 3537 |
| B-2 | Trace System Overview: for Offline Analysis | 3600 |
| B-3 | Trace System Overview: for Online Analysis | 3601 |
| B-4 | Trace System Overview: States of a Trace Stream | 3603 |
| B-5 | Trace Another Process | 3613 |
| B-6 | Trace Name Space Overview: With Third-Party Library | 3614 |
| List of Tables | | |
| 3-1 | Job Control Job ID Formats..... | 66 |
| 5-1 | Escape Sequences and Associated Actions | 121 |
| 6-1 | Portable Character Set | 125 |
| 6-2 | Control Character Set | 130 |

Contents

| | | |
|------|--|------|
| 7-1 | Valid Character Class Combinations..... | 142 |
| 10-1 | Control Character Names | 198 |
| 2-1 | Value of Level for Socket Options..... | 522 |
| 2-2 | Socket-Level Options | 523 |
| 2-3 | Trace Option: System Trace Events..... | 537 |
| 2-4 | Trace and Trace Event Filter Options: System Trace Events..... | 537 |
| 2-5 | Trace and Trace Log Options: System Trace Events | 538 |
| 2-6 | Trace, Trace Log, and Trace Event Filter Options: System Trace Events | 538 |
| 2-7 | Trace Option: User Trace Event..... | 539 |
| 1-1 | Actions when Creating a File that Already Exists..... | 2281 |
| 1-2 | Selected ISO C Standard Operators and Control Flow Keywords | 2284 |
| 1-3 | Utility Limit Minimum Values..... | 2285 |
| 1-4 | Symbolic Utility Limits | 2286 |
| 1-5 | Regular Built-In Utilities | 2296 |
| 3-1 | Batch Utilities..... | 2375 |
| 3-2 | Environment Variable Summary | 2379 |
| 3-3 | Next State Table | 2381 |
| 3-4 | Results/Output Table | 2383 |
| 3-5 | Batch Services Summary | 2390 |
| A-1 | Historical Practice for Symbolic Links | 3440 |

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Referenced Documents

Normative References

Normative references for POSIX.1-2008 are defined in [Section 1.3](#) (on page 4).

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ANSI C

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Part 3: Latin Alphabet No. 3
Part 4: Latin Alphabet No. 4
Part 5: Latin/Cyrillic Alphabet
Part 6: Latin/Arabic Alphabet
Part 7: Latin/Greek Alphabet
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Part 10: Latin Alphabet No. 6
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OSF/1

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**Standard for Information Technology—
Portable Operating System Interface (POSIX®)**

Technical Standard: Base Specifications, Issue 7

Prepared by the Austin Group (www.opengroup.org/austin).

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 *Technical Standard*

1 **Vol. 1:**
2 **Base Definitions, Issue 7**

3 *The Open Group*
4 *The Institute of Electrical and Electronics Engineers, Inc.*

1.1 Scope

POSIX.1-2008 defines a standard operating system interface and environment, including a command interpreter (or “shell”), and common utility programs to support applications portability at the source code level. It is intended to be used by both application developers and system implementors.

POSIX.1-2008 comprises four major components (each in an associated volume):

1. General terms, concepts, and interfaces common to all volumes of POSIX.1-2008, including utility conventions and C-language header definitions, are included in the Base Definitions volume of POSIX.1-2008.
2. Definitions for system service functions and subroutines, language-specific system services for the C programming language, function issues, including portability, error handling, and error recovery, are included in the System Interfaces volume of POSIX.1-2008.
3. Definitions for a standard source code-level interface to command interpretation services (a “shell”) and common utility programs for application programs are included in the Shell and Utilities volume of POSIX.1-2008.
4. Extended rationale that did not fit well into the rest of the document structure, containing historical information concerning the contents of POSIX.1-2008 and why features were included or discarded by the standard developers, is included in the Rationale (Informative) volume of POSIX.1-2008.

The following areas are outside of the scope of POSIX.1-2008:

- Graphics interfaces
- Database management system interfaces
- Record I/O considerations
- Object or binary code portability
- System configuration and resource availability

POSIX.1-2008 describes the external characteristics and facilities that are of importance to application developers, rather than the internal construction techniques employed to achieve these capabilities. Special emphasis is placed on those functions and facilities that are needed in a wide variety of commercial applications.

The facilities provided in POSIX.1-2008 are drawn from the following base documents:

- IEEE Std 1003.1, 2004 Edition (POSIX-1) (incorporating IEEE Std 1003.1-2001, IEEE Std 1003.1-2001/Cor 1-2002, and IEEE Std 1003.1-2001/Cor 2-2004)

- 40 • The Open Group Technical Standard, 2006, Extended API Set Part 1
 - 41 • The Open Group Technical Standard, 2006, Extended API Set Part 2
 - 42 • The Open Group Technical Standard, 2006, Extended API Set Part 3
 - 43 • The Open Group Technical Standard, 2006, Extended API Set Part 4
 - 44 • ISO/IEC 9899:1999, Programming Languages — C, including ISO/IEC
 - 45 9899:1999/Cor.1:2001(E), ISO/IEC 9899:1999/Cor.2:2004(E), and ISO/IEC
 - 46 9899:1999/Cor.3
- 47 Emphasis has been placed on standardizing existing practice for existing users, with changes
48 and additions limited to correcting deficiencies in the following areas:
- 49 • Issues raised by Austin Group defect reports, IEEE Interpretations against IEEE Std 1003.1,
50 and ISO/IEC defect reports against ISO/IEC 9945
 - 51 • Issues raised in corrigenda for The Open Group Technical Standards and working group
52 resolutions from The Open Group
 - 53 • Issues arising from ISO TR 24715:2006, Conflicts between POSIX and the LSB
 - 54 • Changes to make the text self-consistent with the additional material merged
 - 55 • Features, marked Legacy or obsolescent in the base documents, have been considered for
56 removal in this version
 - 57 • A review and reorganization of the options within the standard
 - 58 • Alignment with the ISO/IEC 9899:1999 standard, including ISO/IEC
59 9899:1999/Cor.2:2004(E)

60 1.2 Conformance

61 Conformance requirements for POSIX.1-2008 are defined in [Chapter 2](#) (on page 15).

62 1.3 Normative References

63 The following standards contain provisions which, through references in POSIX.1-2008,
64 constitute provisions of POSIX.1-2008. At the time of publication, the editions indicated were
65 valid. All standards are subject to revision, and parties to agreements based on POSIX.1-2008 are
66 encouraged to investigate the possibility of applying the most recent editions of the standards
67 listed below. Members of IEC and ISO maintain registers of currently valid International
68 Standards.

69 ANS X3.9-1978

70 (Reaffirmed 1989) American National Standard for Information Systems: Standard
71 X3.9-1978, Programming Language FORTRAN.¹

72 ISO/IEC 646:1991

73 ISO/IEC 646:1991, Information Processing — ISO 7-Bit Coded Character Set for
74 Information Interchange.²

75 1. ANSI documents can be obtained from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY
76 10018, USA.

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78 ISO 4217:2001, Codes for the Representation of Currencies and Funds.
- 79 ISO 8601:2004
80 ISO 8601:2004, Data Elements and Interchange Formats — Information Interchange —
81 Representation of Dates and Times.
- 82 ISO C (1999)
83 ISO/IEC 9899:1999, Programming Languages — C, including ISO/IEC
84 9899:1999/Cor.1:2001(E), ISO/IEC 9899:1999/Cor.2:2004(E), and ISO/IEC
85 9899:1999/Cor.3.
- 86 ISO/IEC 10646-1:2000
87 ISO/IEC 10646-1:2000, Information Technology — Universal Multiple-Octet Coded
88 Character Set (UCS) — Part 1: Architecture and Basic Multilingual Plane.