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Information technology — Programming languages — Ada

AMENDMENT 1

Technologies de l'information — Langages de programmation — Ada
AMENDEMENT 1

Reference number

ISO/IEC 8652:1995/Amd.1:2007(E)



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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Amendment 1 to ISO/IEC 8652:1995 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 22, *Programming languages, their environments and system/software interfaces*.

Amendment 1 cancels and replaces those portions of ISO/IEC 8652:1995 as corrected by Technical Corrigendum 1 ISO/IEC 8652:1995/Cor.1:2001 as specified by the body of this amendment. Those portions of the International Standard as corrected by Technical Corrigendum 1 not modified by this amendment remain in force.

The main emphasis of Amendment 1 is to improve the object-oriented programming and the real-time features of ISO/IEC 8652:1995 while also strengthening reliability.

As in ISO/IEC 8652:1995, Annexes A to J form an integral part of the International Standard as amended. Annexes K to Q are for information only.

Introduction

International Standard ISO/IEC 8652:1995 defines the Ada programming language.

This amendment modifies Ada by making changes and additions that improve:

- The safety of applications written in Ada;
- The portability of applications written in Ada;
- Interoperability with other languages and systems; and
- Accessibility and ease of transition from idioms in other programming and modeling languages.

This amendment incorporates the following major additions to the International Standard:

- Support for the entire ISO/IEC 10646:2003 character repertoire, both in program text and executing programs (see subclauses 2.1, 3.5.2, 3.6.3, A.1, A.3, and A.4);
- Interfaces, to provide a limited form of multiple inheritance of operations (see 3.9.4);
- Improvements for access types, such as null excluding subtypes (see 3.10), additional uses for anonymous access types (see 3.6 and 8.5.1), and anonymous access-to-subprogram subtypes to support “downward closures” (see 3.10 and 3.10.2);
- Additional context clause capabilities: limited views to allow mutually dependent types (see 3.10.1 and 10.1.2) and private with clauses that apply only in the private part of a package (see 10.1.2);
- Aggregates, constructor functions and constants for limited types (see 4.3.1, 6.5, and 7.5);
- Control of overriding to eliminate errors (see 8.3);
- Additional standard packages, including time management (see 9.6), file directory and name management (see A.16), containers (see A.18), execution-time clocks (see D.14), timing events (see D.15), and vector and matrix operations (see G.3);
- A mechanism for writing C unions to make interfaces with C systems easier (see B.3.3);
- New task dispatching policies, including non-preemptive (see D.2.4) and earliest deadline first (see D.2.6); and
- The Ravenscar profile to provide a simplified tasking system for high-integrity systems (see D.13).

This amendment is organized by sections corresponding to those in the International Standard. These sections include wording changes and additions to the International Standard. Clause and subclause headings are given for each clause that contains a wording change. Clauses and subclauses that do not contain any change or addition are omitted.

For each change, an *anchor* paragraph from the International Standard (as corrected by Technical Corrigendum 1) is given. New or revised text and instructions are given with each change. The anchor paragraph can be replaced or deleted, or text can be inserted before or after it. When a heading immediately precedes the anchor paragraph, any text inserted before the paragraph is intended to appear under the heading.

Typographical conventions:

Instructions about the text changes are in this font. The actual text changes are in the same fonts as the International Standard – this font for text, this font for syntax, and this font for Ada source code.

Information technology — Programming languages — Ada

AMENDMENT 1

Introduction

Of International Standard ISO/IEC 8652:1995. Modifications of this section of that International Standard are found here.

Replace paragraph 3:

- Rationale for the Ada Programming Language -- 1995 edition, which gives an introduction to the new features of Ada, and explains the rationale behind them. Programmers should read this first.

by:

- Ada 95 Rationale. This gives an introduction to the new features of Ada incorporated in the 1995 edition of this Standard, and explains the rationale behind them. Programmers unfamiliar with Ada 95 should read this first.
- Ada 2005 Rationale. This gives an introduction to the changes and new features in Ada 2005 (compared with the 1995 edition), and explains the rationale behind them. Programmers should read this rationale before reading this Standard in depth.

Replace paragraph 5:

- The Annotated Ada Reference Manual (AARM). The AARM contains all of the text in the RM95, plus various annotations. It is intended primarily for compiler writers, validation test writers, and others who wish to study the fine details. The annotations include detailed rationale for individual rules and explanations of some of the more arcane interactions among the rules.

by:

- The Annotated Ada Reference Manual (AARM). The AARM contains all of the text in the consolidated Ada Reference Manual, plus various annotations. It is intended primarily for compiler writers, validation test writers, and others who wish to study the fine details. The annotations include detailed rationale for individual rules and explanations of some of the more arcane interactions among the rules.

Replace paragraph 6:

Ada was originally designed with three overriding concerns: program reliability and maintenance, programming as a human activity, and efficiency. This revision to the language was designed to provide greater flexibility and extensibility, additional control over storage management and synchronization, and standardized packages oriented toward supporting important application areas, while at the same time retaining the original emphasis on reliability, maintainability, and efficiency.

by:

Ada was originally designed with three overriding concerns: program reliability and maintenance, programming as a human activity, and efficiency. The 1995 revision to the language was designed to provide greater flexibility and extensibility, additional control over storage management and synchronization, and standardized packages oriented toward supporting important application areas, while at the same time retaining the original emphasis on reliability, maintainability, and efficiency. This amended version provides further flexibility and adds more standardized packages within the framework provided by the 1995 revision.

Replace paragraph 32:

An enumeration type defines an ordered set of distinct enumeration literals, for example a list of states or an alphabet of characters. The enumeration types Boolean, Character, and Wide_Character are predefined.

by:

An enumeration type defines an ordered set of distinct enumeration literals, for example a list of states or an alphabet of characters. The enumeration types Boolean, Character, Wide_Character, and Wide_Wide_Character are predefined.

Replace paragraph 34:

Composite types allow definitions of structured objects with related components. The composite types in the language include arrays and records. An array is an object with indexed components of the same type. A record is an object with named components of possibly different types. Task and protected types are also forms of composite types. The array types String and Wide_String are predefined.

by:

Composite types allow definitions of structured objects with related components. The composite types in the language include arrays and records. An array is an object with indexed components of the same type. A record is an object with named components of possibly different types. Task and protected types are also forms of composite types. The array types String, Wide_String, and Wide_Wide_String are predefined.

Insert after paragraph 38:

From any type a new type may be defined by derivation. A type, together with its derivatives (both direct and indirect) form a derivation class. Class-wide operations may be defined that accept as a parameter an operand of any type in a derivation class. For record and private types, the derivatives may be extensions of the parent type. Types that support these object-oriented capabilities of class-wide operations and type extension must be tagged, so that the specific type of an operand within a derivation class can be identified at run time. When an operation of a tagged type is applied to an operand whose specific type is not known until run time, implicit dispatching is performed based on the tag of the operand.

the new paragraph:

Interface types provide abstract models from which other interfaces and types may be composed and derived. This provides a reliable form of multiple inheritance. Interface types may also be implemented by task types and protected types thereby enabling concurrent programming and inheritance to be merged.

Replace paragraph 41:

Representation clauses can be used to specify the mapping between types and features of an underlying machine. For example, the user can specify that objects of a given type must be represented with a given number of bits, or that the components of a record are to be represented using a given storage layout. Other features allow the controlled use of low level, nonportable, or implementation-dependent aspects, including the direct insertion of machine code.

by:

Aspect clauses can be used to specify the mapping between types and features of an underlying machine. For example, the user can specify that objects of a given type must be represented with a given number of bits, or that the components of a record are to be represented using a given storage layout. Other features allow the controlled use of low level, nonportable, or implementation-dependent aspects, including the direct insertion of machine code.

Replace paragraph 42:

The predefined environment of the language provides for input-output and other capabilities (such as string manipulation and random number generation) by means of standard library packages. Input-output is supported for values of user-defined as well as of predefined types. Standard means of representing values in display form are also provided. Other standard library packages are defined in annexes of the standard to support systems with specialized requirements.

by:

The predefined environment of the language provides for input-output and other capabilities by means of standard library packages. Input-output is supported for values of user-defined as well as of predefined types. Standard means of representing values in display form are also provided.

The predefined standard library packages provide facilities such as string manipulation, containers of various kinds (vectors, lists, maps, etc.), mathematical functions, random number generation, and access to the execution environment.

The specialized annexes define further predefined library packages and facilities with emphasis on areas such as real-time scheduling, interrupt handling, distributed systems, numerical computation, and high-integrity systems.

Replace paragraph 44:

This International Standard replaces the first edition of 1987. In this edition, the following major language changes have been incorporated:

by:

This amended International Standard updates the edition of 1995 which replaced the first edition of 1987. In the 1995 edition, the following major language changes were incorporated.

Replace paragraph 45:

- Support for standard 8-bit and 16-bit character sets. See Section 2, 3.5.2, 3.6.3, A.1, A.3, and A.4.

by:

- Support for standard 8-bit and 16-bit characters was added. See clauses 2.1, 3.5.2, 3.6.3, A.1, A.3, and A.4.

Replace paragraph 46:

- Object-oriented programming with run-time polymorphism. See the discussions of classes, derived types, tagged types, record extensions, and private extensions in clauses 3.4, 3.9, and 7.3. See also the new forms of generic formal parameters that are allowed by 12.5.1, "Formal Private and Derived Types" and 12.7, "Formal Packages".

by:

- The type model was extended to include facilities for object-oriented programming with dynamic polymorphism. See the discussions of classes, derived types, tagged types, record extensions, and private extensions in clauses 3.4, 3.9, and 7.3. Additional forms of generic formal parameters were allowed as described in clauses 12.5.1 and 12.7.

Replace paragraph 47:

- Access types have been extended to allow an access value to designate a subprogram or an object declared by an object declaration (as opposed to just a heap-allocated object). See 3.10.

by:

- Access types were extended to allow an access value to designate a subprogram or an object declared by an object declaration as opposed to just an object allocated on a heap. See clause 3.10.

Replace paragraph 48:

- Efficient data-oriented synchronization is provided via protected types. See Section 9.

by:

- Efficient data-oriented synchronization was provided by the introduction of protected types. See clause 9.4.

Replace paragraph 49:

- The library units of a library may be organized into a hierarchy of parent and child units. See Section 10.

by:

- The library structure was extended to allow library units to be organized into a hierarchy of parent and child units. See clause 10.1.

Replace paragraph 50:

- Additional support has been added for interfacing to other languages. See Annex B.

by:

- Additional support was added for interfacing to other languages. See Annex B.

Replace paragraph 51:

- The Specialized Needs Annexes have been added to provide specific support for certain application areas:

by:

- The Specialized Needs Annexes were added to provide specific support for certain application areas:

Replace paragraph 57:

- Annex H, "Safety and Security"

by:

- Annex H, "High Integrity Systems"

Amendment 1 modifies the 1995 International Standard by making changes and additions that improve the capability of the language and the reliability of programs written in the language. In particular, the changes were designed to improve the portability of programs, interfacing to other languages, and both the object-oriented and real-time capabilities.

The following significant changes with respect to the 1995 edition are incorporated:

- Support for program text is extended to cover the entire ISO/IEC 10646:2003 repertoire. Execution support now includes the 32-bit character set. See clauses 2.1, 3.5.2, 3.6.3, A.1, A.3, and A.4.
- The object-oriented model has been improved by the addition of an interface facility which provides multiple inheritance and additional flexibility for type extensions. See clauses 3.4, 3.9, and 7.3. An alternative notation for calling operations more akin to that used in other languages has also been added. See clause 4.1.3.
- Access types have been further extended to unify properties such as the ability to access constants and to exclude null values. See clause 3.10. Anonymous access types are now permitted more freely and anonymous access-to-subprogram types are introduced. See clauses 3.3, 3.6, 3.10, and 8.5.1.
- The control of structure and visibility has been enhanced to permit mutually dependent references between units and finer control over access from the private part of a package. See clauses 3.10.1 and 10.1.2. In addition, limited types have been made more useful by the provision of aggregates, constants, and constructor functions. See clauses 4.3, 6.5, and 7.5.
- The predefined environment has been extended to include additional time and calendar operations, improved string handling, a comprehensive container library, file and directory management, and access to environment variables. See clauses 9.6.1, A.4, A.16, A.17, and A.18.
- Two of the Specialized Needs Annexes have been considerably enhanced:
 - The Real-Time Systems Annex now includes the Ravenscar profile for high-integrity systems, further dispatching policies such as Round Robin and Earliest Deadline First, support for timing events, and support for control of CPU time utilization. See clauses D.2, D.13, D.14, and D.15.
 - The Numerics Annex now includes support for real and complex vectors and matrices as previously defined in ISO/IEC 13813:1998 plus further basic operations for linear algebra. See clause G.3.
- The overall reliability of the language has been enhanced by a number of improvements. These include new syntax which detects accidental overloading, as well as pragmas for making assertions and giving better control over the suppression of checks. See clauses 6.1, 11.4.2, and 11.5.

Section 1: General

1.1.2 Structure

Replace paragraph 13:

- Annex H, "Safety and Security"

by:

- Annex H, "High Integrity Systems"

1.1.4 Method of Description and Syntax Notation

Replace paragraph 9:

`return_statement ::= return [expression];`

`return_statement ::= return; | return expression;`

by:

`simple_return_statement ::= return [expression];`

`simple_return_statement ::= return; | return expression;`

Insert after paragraph 14:

- If the name of any syntactic category starts with an italicized part, it is equivalent to the category name without the italicized part. The italicized part is intended to convey some semantic information. For example *subtype_name* and *task_name* are both equivalent to *name* alone.

the new paragraph:

The delimiters, compound delimiters, reserved words, and `numeric_literals` are exclusively made of the characters whose code position is between 16#20# and 16#7E#, inclusively. The special characters for which names are defined in this International Standard (see 2.1) belong to the same range. For example, the character E in the definition of exponent is the character whose name is "LATIN CAPITAL LETTER E", not "GREEK CAPITAL LETTER EPSILON".

Insert before paragraph 15:

A *syntactic category* is a nonterminal in the grammar defined in BNF under "Syntax." Names of syntactic categories are set in a different font, like *this*.

the new paragraph:

When this International Standard mentions the conversion of some character or sequence of characters to upper case, it means the character or sequence of characters obtained by using locale-independent full case folding, as defined by documents referenced in the note in section 1 of ISO/IEC 10646:2003.

1.2 Normative References

Replace paragraph 3:

ISO/IEC 1539:1991, *Information technology — Programming languages — FORTRAN*.

by:

ISO/IEC 1539-1:2004, *Information technology — Programming languages — Fortran — Part 1: Base language*.

Replace paragraph 4:

ISO 1989:1985, *Programming languages — COBOL*.

by:

ISO/IEC 1989:2002, *Information technology — Programming languages — COBOL*.

Insert after paragraph 5:

ISO/IEC 6429:1992, *Information technology — Control functions for coded graphic character sets*.

the new paragraph:

ISO 8601:2004, *Data elements and interchange formats — Information interchange — Representation of dates and times*.

Replace paragraph 7:

ISO/IEC 9899:1990, *Programming languages — C*.

by:

ISO/IEC 9899:1999, *Programming languages — C*, supplemented by Technical Corrigendum 1:2001 and Technical Corrigendum 2:2004.

Replace paragraph 8:

ISO/IEC 10646-1:1993, *Information technology — Universal Multiple-Octet Coded Character Set (UCS) — Part 1: Architecture and Basic Multilingual Plane*, supplemented by Technical Corrigendum 1:1996.

by:

ISO/IEC 10646:2003, *Information technology — Universal Multiple-Octet Coded Character Set (UCS)*.

ISO/IEC 14882:2003, *Programming languages — C++*.

ISO/IEC TR 19769:2004, *Information technology — Programming languages, their environments and system software interfaces — Extensions for the programming language C to support new character data types*.

1.3 Definitions

Replace paragraph 1:

Terms are defined throughout this International Standard, indicated by *italic* type. Terms explicitly defined in this International Standard are not to be presumed to refer implicitly to similar terms defined elsewhere. Terms not defined in this International Standard are to be interpreted according to the *Webster's Third New International Dictionary of the English Language*. Informal descriptions of some terms are also given in Annex N, "Glossary".

by:

Terms are defined throughout this International Standard, indicated by *italic* type. Terms explicitly defined in this International Standard are not to be presumed to refer implicitly to similar terms defined elsewhere. Mathematical terms not defined in this International Standard are to be interpreted according to the *CRC Concise Encyclopedia of Mathematics, Second Edition*. Other terms not defined in this International Standard are to be interpreted according to the *Webster's Third New International Dictionary of the English Language*. Informal descriptions of some terms are also given in Annex N, "Glossary".

Section 2: Lexical Elements

2.1 Character Set

Replace paragraph 1:

The only characters allowed outside of comments are the `graphic_characters` and `format_effectors`.

by:

The character repertoire for the text of an Ada program consists of the entire coding space described by the ISO/IEC 10646:2003 Universal Multiple-Octet Coded Character Set. This coding space is organized in *planes*, each plane comprising 65536 characters.

Delete paragraph 2:

`character ::= graphic_character | format_effector | other_control_function`

Replace paragraph 3:

`graphic_character ::= identifier_letter | digit | space_character | special_character`

by:

A `character` is defined by this International Standard for each cell in the coding space described by ISO/IEC 10646:2003, regardless of whether or not ISO/IEC 10646:2003 allocates a character to that cell.

Replace paragraph 4:

The character repertoire for the text of an Ada program consists of the collection of characters called the Basic Multilingual Plane (BMP) of the ISO 10646 Universal Multiple-Octet Coded Character Set, plus a set of `format_effectors` and, in comments only, a set of `other_control_functions`; the coded representation for these characters is implementation defined (it need not be a representation defined within ISO-10646-1).

by:

The coded representation for characters is implementation defined (it need not be a representation defined within ISO/IEC 10646:2003). A character whose relative code position in its plane is 16#FFFE# or 16#FFFF# is not allowed anywhere in the text of a program.

The semantics of an Ada program whose text is not in Normalization Form KC (as defined by section 24 of ISO/IEC 10646:2003) is implementation defined.

Replace paragraph 5:

The description of the language definition in this International Standard uses the graphic symbols defined for Row 00: Basic Latin and Row 00: Latin-1 Supplement of the ISO 10646 BMP; these correspond to the graphic symbols of ISO 8859-1 (Latin-1); no graphic symbols are used in this International Standard for characters outside of Row 00 of the BMP. The actual set of graphic symbols used by an implementation for the visual representation of the text of an Ada program is not specified.

by:

The description of the language definition in this International Standard uses the character properties General Category, Simple Uppercase Mapping, Uppercase Mapping, and Special Case Condition of the documents referenced by the note in section 1 of ISO/IEC 10646:2003. The actual set of graphic symbols used by an implementation for the visual representation of the text of an Ada program is not specified.

Replace paragraph 6:

The categories of characters are defined as follows:

by:

Characters are categorized as follows:

Delete paragraph 7:

`identifier_letter`
`upper_case_identifier_letter | lower_case_identifier_letter`

Replace paragraph 8:

upper_case_identifier_letter

Any character of Row 00 of ISO 10646 BMP whose name begins "Latin Capital Letter".

by:

letter_uppercase

Any character whose General Category is defined to be "Letter, Uppercase".

Replace paragraph 9:

lower_case_identifier_letter

Any character of Row 00 of ISO 10646 BMP whose name begins "Latin Small Letter".

by:

letter_lowercase

Any character whose General Category is defined to be "Letter, Lowercase".

letter_titlecase

Any character whose General Category is defined to be "Letter, Titlecase".

letter_modifier

Any character whose General Category is defined to be "Letter, Modifier".

letter_other

Any character whose General Category is defined to be "Letter, Other".

mark_non_spacing

Any character whose General Category is defined to be "Mark, Non-Spacing".

mark_spacing_combining

Any character whose General Category is defined to be "Mark, Spacing Combining".

Replace paragraph 10:

digit

One of the characters 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9.

by:

number_decimal

Any character whose General Category is defined to be "Number, Decimal".

number_letter

Any character whose General Category is defined to be "Number, Letter".

punctuation_connector

Any character whose General Category is defined to be "Punctuation, Connector".

other_format

Any character whose General Category is defined to be "Other, Format".

Replace paragraph 11:

space_character

The character of ISO 10646 BMP named "Space".

by:

separator_space

Any character whose General Category is defined to be "Separator, Space".

Replace paragraph 12:

special_character

Any character of the ISO 10646 BMP that is not reserved for a control function, and is not the space_character, an identifier_letter, or a digit.

by:

separator_line

Any character whose General Category is defined to be "Separator, Line".

separator_paragraph

Any character whose General Category is defined to be "Separator, Paragraph".

Replace paragraph 13:

format_effector

The control functions of ISO 6429 called character tabulation (HT), line tabulation (VT), carriage return (CR), line feed (LF), and form feed (FF).

by:

format_effector

The characters whose code positions are 16#09# (CHARACTER TABULATION), 16#0A# (LINE FEED), 16#0B# (LINE TABULATION), 16#0C# (FORM FEED), 16#0D# (CARRIAGE RETURN), 16#85# (NEXT LINE), and the characters in categories separator_line and separator_paragraph.

other_control

Any character whose General Category is defined to be "Other, Control", and which is not defined to be a format_effector.

other_private_use

Any character whose General Category is defined to be "Other, Private Use".

other_surrogate

Any character whose General Category is defined to be "Other, Surrogate".

Replace paragraph 14:

other_control_function

Any control function, other than a format_effector, that is allowed in a comment; the set of other_control_functions allowed in comments is implementation defined.

by:

graphic_character

Any character that is not in the categories other_control, other_private_use, other_surrogate, format_effector, and whose relative code position in its plane is neither 16#FFFE# nor 16#FFFF#.

Replace paragraph 15:

The following names are used when referring to certain special_characters:

by:

The following names are used when referring to certain characters (the first name is that given in ISO/IEC 10646:2003):

Delete paragraph 16:

In a nonstandard mode, the implementation may support a different character repertoire; in particular, the set of characters that are considered identifier_letters can be extended or changed to conform to local conventions.

Replace paragraph 17:

1 Every code position of ISO 10646 BMP that is not reserved for a control function is defined to be a graphic_character by this International Standard. This includes all code positions other than 0000 - 001F, 007F - 009F, and FFFE - FFFF.

by:

1 The characters in categories other_control, other_private_use, and other_surrogate are only allowed in comments.

2.2 Lexical Elements, Separators, and Delimiters

Replace paragraph 2:

The text of a compilation is divided into *lines*. In general, the representation for an end of line is implementation defined. However, a sequence of one or more `format_effectors` other than character tabulation (HT) signifies at least one end of line.

by:

The text of a compilation is divided into *lines*. In general, the representation for an end of line is implementation defined. However, a sequence of one or more `format_effectors` other than the character whose code position is 16#09# (CHARACTER TABULATION) signifies at least one end of line.

Replace paragraph 3:

In some cases an explicit *separator* is required to separate adjacent lexical elements. A separator is any of a space character, a format effector, or the end of a line, as follows:

by:

In some cases an explicit *separator* is required to separate adjacent lexical elements. A separator is any of a `separator_space`, a `format_effector`, or the end of a line, as follows:

Replace paragraph 4:

- A space character is a separator except within a `comment`, a `string_literal`, or a `character_literal`.

by:

- A `separator_space` is a separator except within a `comment`, a `string_literal`, or a `character_literal`.

Replace paragraph 5:

- Character tabulation (HT) is a separator except within a `comment`.

by:

- The character whose code position is 16#09# (CHARACTER TABULATION) is a separator except within a `comment`.

Replace paragraph 8:

A *delimiter* is either one of the following special characters

by:

A *delimiter* is either one of the following characters:

2.3 Identifiers

Replace paragraph 2:

```
identifier ::=  
  identifier_letter {[underline] letter_or_digit}
```

by:

```
identifier ::=  
  identifier_start {identifier_start | identifier_extend}
```

Replace paragraph 3:

```
letter_or_digit ::= identifier_letter | digit
```

by:

```

identifier_start ::=
    letter_uppercase
  | letter_lowercase
  | letter_titlecase
  | letter_modifier
  | letter_other
  | number_letter

identifier_extend ::=
    mark_non_spacing
  | mark_spacing_combining
  | number_decimal
  | punctuation_connector
  | other_format

```

Replace paragraph 4:

An identifier shall not be a reserved word.

by:

After eliminating the characters in category `other_format`, an identifier shall not contain two consecutive characters in category `punctuation_connector`, or end with a character in that category.

Replace paragraph 5:

All characters of an identifier are significant, including any underline character. Identifiers differing only in the use of corresponding upper and lower case letters are considered the same.

by:

Two identifiers are considered the same if they consist of the same sequence of characters after applying the following transformations (in this order):

- The characters in category `other_format` are eliminated.
- The remaining sequence of characters is converted to upper case.

Replace paragraph 6:

In a nonstandard mode, an implementation may support other upper/lower case equivalence rules for identifiers, to accommodate local conventions.

by:

After applying these transformations, an identifier shall not be identical to a reserved word (in upper case).

In a nonstandard mode, an implementation may support other upper/lower case equivalence rules for identifiers, to accommodate local conventions.

NOTES

- 3 Identifiers differing only in the use of corresponding upper and lower case letters are considered the same.

Replace paragraph 8:

Count	X	Get_Symbol	Ethelyn	Marion
Snobol_4	X1	Page_Count	Store_Next_Item	

by:

Count	X	Get_Symbol	Ethelyn	Marion
Snobol_4	X1	Page_Count	Store_Next_Item	
Πλάτων	--	<i>Plato</i>		
Чайковский	--	<i>Tchaikovsky</i>		
θ φ	--	<i>Angles</i>		

2.9 Reserved Words

In paragraph 2 replace:

The following are the *reserved words* (ignoring upper/lower case distinctions):

by:

The following are the *reserved words*. Within a program, some or all of the letters of a reserved word may be in upper case, and one or more characters in category `other_format` may be inserted within or at the end of the reserved word.

In the list in paragraph 2, add:

interface

overriding

synchronized

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Section 3: Declarations and Types

3.1 Declarations

Replace paragraph 3:

```
basic_declaration ::=
  type_declaration | subtype_declaration
  | object_declaration | number_declaration
  | subprogram_declaration | abstract_subprogram_declaration
  | package_declaration | renaming_declaration
  | exception_declaration | generic_declaration
  | generic_instantiation
```

by:

```
basic_declaration ::=
  type_declaration | subtype_declaration
  | object_declaration | number_declaration
  | subprogram_declaration | abstract_subprogram_declaration
  | null_procedure_declaration | package_declaration
  | renaming_declaration | exception_declaration
  | generic_declaration | generic_instantiation
```

Replace paragraph 6:

Each of the following is defined to be a declaration: any `basic_declaration`; an `enumeration_literal_specification`; a `discriminant_specification`; a `component_declaration`; a `loop_parameter_specification`; a `parameter_specification`; a `subprogram_body`; an `entry_declaration`; an `entry_index_specification`; a `choice_parameter_specification`; a `generic_formal_parameter_declaration`.

by:

Each of the following is defined to be a declaration: any `basic_declaration`; an `enumeration_literal_specification`; a `discriminant_specification`; a `component_declaration`; a `loop_parameter_specification`; a `parameter_specification`; a `subprogram_body`; an `entry_declaration`; an `entry_index_specification`; a `choice_parameter_specification`; a `generic_formal_parameter_declaration`. In addition, an `extended_return_statement` is a declaration of its `defining_identifier`.

3.2 Types and Subtypes

Replace paragraph 2:

Types are grouped into *classes* of types, reflecting the similarity of their values and primitive operations. There exist several *language-defined classes* of types (see NOTES below). *Elementary* types are those whose values are logically indivisible; *composite* types are those whose values are composed of *component* values.

by:

Types are grouped into *categories* of types. There exist several *language-defined categories* of types (see NOTES below), reflecting the similarity of their values and primitive operations. Most categories of types form *classes* of types. *Elementary* types are those whose values are logically indivisible; *composite* types are those whose values are composed of *component* values.

Replace paragraph 4:

The composite types are the *record* types, *record extensions*, *array* types, *task* types, and *protected* types. A *private* type or *private extension* represents a partial view (see 7.3) of a type, providing support for data abstraction. A partial view is a composite type.

by:

The composite types are the *record* types, *record extensions*, *array* types, *interface* types, *task* types, and *protected* types.

There can be multiple views of a type with varying sets of operations. An *incomplete* type represents an incomplete view (see 3.10.1) of a type with a very restricted usage, providing support for recursive data structures. A *private* type or *private extension* represents a partial view (see 7.3) of a type, providing support for data abstraction. The full view (see 3.2.1) of a type represents its complete definition. An incomplete or partial view is considered a composite type, even if the full view is not.

Replace paragraph 5:

Certain composite types (and partial views thereof) have special components called *discriminants* whose values affect the presence, constraints, or initialization of other components. Discriminants can be thought of as parameters of the type.

by:

Certain composite types (and views thereof) have special components called *discriminants* whose values affect the presence, constraints, or initialization of other components. Discriminants can be thought of as parameters of the type.

Replace paragraph 6:

The term *subcomponent* is used in this International Standard in place of the term component to indicate either a component, or a component of another subcomponent. Where other subcomponents are excluded, the term component is used instead. Similarly, a *part* of an object or value is used to mean the whole object or value, or any set of its subcomponents.

by:

The term *subcomponent* is used in this International Standard in place of the term component to indicate either a component, or a component of another subcomponent. Where other subcomponents are excluded, the term component is used instead. Similarly, a *part* of an object or value is used to mean the whole object or value, or any set of its subcomponents. The terms component, subcomponent, and part are also applied to a type meaning the component, subcomponent, or part of objects and values of the type.

Replace paragraph 7:

The set of possible values for an object of a given type can be subjected to a condition that is called a *constraint* (the case of a *null constraint* that specifies no restriction is also included); the rules for which values satisfy a given kind of constraint are given in 3.5 for *range_constraints*, 3.6.1 for *index_constraints*, and 3.7.1 for *discriminant_constraints*.

by:

The set of possible values for an object of a given type can be subjected to a condition that is called a *constraint* (the case of a *null constraint* that specifies no restriction is also included); the rules for which values satisfy a given kind of constraint are given in 3.5 for *range_constraints*, 3.6.1 for *index_constraints*, and 3.7.1 for *discriminant_constraints*. The set of possible values for an object of an access type can also be subjected to a condition that excludes the null value (see 3.10).

Replace paragraph 8:

A *subtype* of a given type is a combination of the type, a constraint on values of the type, and certain attributes specific to the subtype. The given type is called the *type of the subtype*. Similarly, the associated constraint is called the *constraint of the subtype*. The set of values of a subtype consists of the values of its type that satisfy its constraint. Such values *belong* to the subtype.

by:

A *subtype* of a given type is a combination of the type, a constraint on values of the type, and certain attributes specific to the subtype. The given type is called the *type of the subtype*. Similarly, the associated constraint is called the *constraint of the subtype*. The set of values of a subtype consists of the values of its type that satisfy its constraint and any exclusion of the null value. Such values *belong* to the subtype.

Replace paragraph 10:

2 Any set of types that is closed under derivation (see 3.4) can be called a "class" of types. However, only certain classes are used in the description of the rules of the language —generally those that have their own particular set of primitive operations (see 3.2.3), or that correspond to a set of types that are matched by a given kind of generic formal

type (see 12.5). The following are examples of "interesting" *language-defined classes*: elementary, scalar, discrete, enumeration, character, boolean, integer, signed integer, modular, real, floating point, fixed point, ordinary fixed point, decimal fixed point, numeric, access, access-to-object, access-to-subprogram, composite, array, string, (untagged) record, tagged, task, protected, nonlimited. Special syntax is provided to define types in each of these classes.

by:

2 Any set of types can be called a "category" of types, and any set of types that is closed under derivation (see 3.4) can be called a "class" of types. However, only certain categories and classes are used in the description of the rules of the language —generally those that have their own particular set of primitive operations (see 3.2.3), or that correspond to a set of types that are matched by a given kind of generic formal type (see 12.5). The following are examples of "interesting" *language-defined classes*: elementary, scalar, discrete, enumeration, character, boolean, integer, signed integer, modular, real, floating point, fixed point, ordinary fixed point, decimal fixed point, numeric, access, access-to-object, access-to-subprogram, composite, array, string, (untagged) record, tagged, task, protected, nonlimited. Special syntax is provided to define types in each of these classes. In addition to these classes, the following are examples of "interesting" *language-defined categories*: abstract, incomplete, interface, limited, private, record.

Replace paragraph 11:

These language-defined classes are organized like this:

by:

These language-defined categories are organized like this:

Replace paragraph 12:

- all types
- elementary
- scalar
- discrete
- enumeration
 - character
 - boolean
 - other enumeration
- integer
 - signed integer
 - modular integer
- real
 - floating point
 - fixed point
 - ordinary fixed point
 - decimal fixed point
- access
 - access-to-object
 - access-to-subprogram
- composite
- array
 - string
 - other array
- untagged record
- tagged
- task
- protected

by:

all types
 elementary
 scalar
 discrete
 enumeration
 character
 boolean
 other enumeration
 integer
 signed integer
 modular integer
 real
 floating point
 fixed point
 ordinary fixed point
 decimal fixed point
 access
 access-to-object
 access-to-subprogram
 composite
 untagged
 array
 string
 other array
 record
 task
 protected
 tagged (including interfaces)
 nonlimited tagged record
 limited tagged
 limited tagged record
 synchronized tagged
 tagged task
 tagged protected

Replace paragraph 13:

The classes "numeric" and "nonlimited" represent other classification dimensions and do not fit into the above strictly hierarchical picture.

by:

There are other categories, such as "numeric" and "discriminated", which represent other categorization dimensions, but do not fit into the above strictly hierarchical picture.

3.2.1 Type Declarations

Replace paragraph 4:

```
type_definition ::=
  enumeration_type_definition | integer_type_definition
  | real_type_definition | array_type_definition
  | record_type_definition | access_type_definition
  | derived_type_definition
```

by:

```
type_definition ::=
  enumeration_type_definition | integer_type_definition
  | real_type_definition | array_type_definition
  | record_type_definition | access_type_definition
  | derived_type_definition | interface_type_definition
```

Replace paragraph 7:

A type defined by a **type_declaration** is a *named type*; such a type has one or more nameable subtypes. Certain other forms of declaration also include type definitions as part of the declaration for an object (including a parameter or a discriminant). The type defined by such a declaration is *anonymous* — it has no nameable subtypes. For explanatory purposes, this International Standard sometimes refers to an anonymous type by a pseudo-name, written in italics, and uses such pseudo-names at places where the syntax normally requires an **identifier**. For a named type whose first subtype is T, this International Standard sometimes refers to the type of T as simply "the type T."

by:

A type defined by a **type_declaration** is a *named type*; such a type has one or more nameable subtypes. Certain other forms of declaration also include type definitions as part of the declaration for an object. The type defined by such a declaration is *anonymous* — it has no nameable subtypes. For explanatory purposes, this International Standard sometimes refers to an anonymous type by a pseudo-name, written in italics, and uses such pseudo-names at places where the syntax normally requires an **identifier**. For a named type whose first subtype is T, this International Standard sometimes refers to the type of T as simply "the type T".

Replace paragraph 8:

A named type that is declared by a **full_type_declaration**, or an anonymous type that is defined as part of declaring an object of the type, is called a *full type*. The **type_definition**, **task_definition**, **protected_definition**, or **access_definition** that defines a full type is called a *full type definition*. Types declared by other forms of **type_declaration** are not separate types; they are partial or incomplete views of some full type.

by:

A named type that is declared by a **full_type_declaration**, or an anonymous type that is defined by an **access_definition** or as part of declaring an object of the type, is called a *full type*. The declaration of a full type also declares the *full view* of the type. The **type_definition**, **task_definition**, **protected_definition**, or **access_definition** that defines a full type is called a *full type definition*. Types declared by other forms of **type_declaration** are not separate types; they are partial or incomplete views of some full type.

3.2.2 Subtype Declarations

Replace paragraph 3:

```
subtype_indication ::= subtype_mark [constraint]
```

by:

```
subtype_indication ::= [null_exclusion] subtype_mark [constraint]
```

Replace paragraph 15:

```

subtype Rainbow    is Color range Red .. Blue;           -- see 3.2.1
subtype Red_Blue   is Rainbow;
subtype Int         is Integer;
subtype Small_Int  is Integer range -10 .. 10;
subtype Up_To_K     is Column range 1 .. K;                 -- see 3.2.1
subtype Square     is Matrix(1 .. 10, 1 .. 10);             -- see 3.6
subtype Male       is Person(Sex => M);                     -- see 3.10.1

```

by:

```

subtype Rainbow    is Color range Red .. Blue;           -- see 3.2.1
subtype Red_Blue   is Rainbow;
subtype Int         is Integer;
subtype Small_Int  is Integer range -10 .. 10;
subtype Up_To_K     is Column range 1 .. K;                 -- see 3.2.1
subtype Square     is Matrix(1 .. 10, 1 .. 10);             -- see 3.6
subtype Male       is Person(Sex => M);                     -- see 3.10.1
subtype Binop_Ref  is not null Binop_Ptr;                   -- see 3.10.

```

3.2.3 Classification of Operations**Replace paragraph 1:**

An operation *operates on a type T* if it yields a value of type *T*, if it has an operand whose expected type (see 8.6) is *T*, or if it has an access parameter (see 6.1) designating *T*. A predefined operator, or other language-defined operation such as assignment or a membership test, that operates on a type, is called a *predefined operation* of the type. The *primitive operations* of a type are the predefined operations of the type, plus any user-defined primitive subprograms.

by:

An operation *operates on a type T* if it yields a value of type *T*, if it has an operand whose expected type (see 8.6) is *T*, or if it has an access parameter or access result type (see 6.1) designating *T*. A predefined operator, or other language-defined operation such as assignment or a membership test, that operates on a type, is called a *predefined operation* of the type. The *primitive operations* of a type are the predefined operations of the type, plus any user-defined primitive subprograms.

Replace paragraph 7:

- Any subprograms not covered above that are explicitly declared immediately within the same declarative region as the type and that override (see 8.3) other implicitly declared primitive subprograms of the type.

by:

- For a nonformal type, any subprograms not covered above that are explicitly declared immediately within the same declarative region as the type and that override (see 8.3) other implicitly declared primitive subprograms of the type.

3.3 Objects and Named Numbers**Replace paragraph 10:**

- the result of evaluating a `function_call` (or the equivalent operator invocation — see 6.6);

by:

- the return object created as the result of evaluating a `function_call` (or the equivalent operator invocation — see 6.6);

3.3.1 Object Declarations**Replace paragraph 2:**

```
object_declaration ::=
```

```

defining_identifier_list : [aliased] [constant] subtype_indication [= expression]
| defining_identifier_list : [aliased] [constant] array_type_definition [= expression]
| single_task_declaration
| single_protected_declaration
    
```

by:

```

object_declaration ::=
    defining_identifier_list : [aliased] [constant] subtype_indication [= expression]
| defining_identifier_list : [aliased] [constant] access_definition [= expression]
| defining_identifier_list : [aliased] [constant] array_type_definition [= expression]
| single_task_declaration
| single_protected_declaration
    
```

Replace paragraph 5:

An `object_declaration` without the reserved word **constant** declares a variable object. If it has a `subtype_indication` or an `array_type_definition` that defines an indefinite subtype, then there shall be an initialization expression. An initialization expression shall not be given if the object is of a limited type.

by:

An `object_declaration` without the reserved word **constant** declares a variable object. If it has a `subtype_indication` or an `array_type_definition` that defines an indefinite subtype, then there shall be an initialization expression.

Replace paragraph 8:

The `subtype_indication` or full type definition of an `object_declaration` defines the nominal subtype of the object. The `object_declaration` declares an object of the type of the nominal subtype.

by:

The `subtype_indication`, `access_definition`, or full type definition of an `object_declaration` defines the nominal subtype of the object. The `object_declaration` declares an object of the type of the nominal subtype.

A component of an object is said to *require late initialization* if it has an access discriminant value constrained by a per-object expression, or if it has an initialization expression that includes a name denoting the current instance of the type or denoting an access discriminant.

Replace paragraph 9:

If a composite object declared by an `object_declaration` has an unconstrained nominal subtype, then if this subtype is indefinite or the object is constant or aliased (see 3.10) the actual subtype of this object is constrained. The constraint is determined by the bounds or discriminants (if any) of its initial value; the object is said to be *constrained by its initial value*. In the case of an aliased object, this initial value may be either explicit or implicit; in the other cases, an explicit initial value is required. When not constrained by its initial value, the actual and nominal subtypes of the object are the same. If its actual subtype is constrained, the object is called a *constrained object*.

by:

If a composite object declared by an `object_declaration` has an unconstrained nominal subtype, then if this subtype is indefinite or the object is constant the actual subtype of this object is constrained. The constraint is determined by the bounds or discriminants (if any) of its initial value; the object is said to be *constrained by its initial value*. When not constrained by its initial value, the actual and nominal subtypes of the object are the same. If its actual subtype is constrained, the object is called a *constrained object*.

Replace paragraph 16:

1. The `subtype_indication`, `array_type_definition`, `single_task_declaration`, or `single_protected_declaration` is first elaborated. This creates the nominal subtype (and the anonymous type in the latter three cases).

by:

1. The `subtype_indication`, `access_definition`, `array_type_definition`, `single_task_declaration`, or `single_protected_declaration` is first elaborated. This creates the nominal subtype (and the anonymous type in the last four cases).

Replace paragraph 18:

3. The object is created, and, if there is not an initialization expression, any per-object constraints (see 3.8) are elaborated and any implicit initial values for the object or for its subcomponents are obtained as determined by the nominal subtype.

by:

3. The object is created, and, if there is not an initialization expression, the object is *initialized by default*. When an object is initialized by default, any per-object constraints (see 3.8) are elaborated and any implicit initial values for the object or for its subcomponents are obtained as determined by the nominal subtype. Any initial values (whether explicit or implicit) are assigned to the object or to the corresponding subcomponents. As described in 5.2 and 7.6, Initialize and Adjust procedures can be called.

Delete paragraph 19:

4. Any initial values (whether explicit or implicit) are assigned to the object or to the corresponding subcomponents. As described in 5.2 and 7.6, Initialize and Adjust procedures can be called.

Replace paragraph 20:

For the third step above, the object creation and any elaborations and evaluations are performed in an arbitrary order, except that if the `default_expression` for a discriminant is evaluated to obtain its initial value, then this evaluation is performed before that of the `default_expression` for any component that depends on the discriminant, and also before that of any `default_expression` that includes the name of the discriminant. The evaluations of the third step and the assignments of the fourth step are performed in an arbitrary order, except that each evaluation is performed before the resulting value is assigned.

by:

For the third step above, evaluations and assignments are performed in an arbitrary order subject to the following restrictions:

- Assignment to any part of the object is preceded by the evaluation of the value that is to be assigned.
- The evaluation of a `default_expression` that includes the name of a discriminant is preceded by the assignment to that discriminant.
- The evaluation of the `default_expression` for any component that depends on a discriminant is preceded by the assignment to that discriminant.
- The assignments to any components, including implicit components, not requiring late initialization must precede the initial value evaluations for any components requiring late initialization; if two components both require late initialization, then assignments to parts of the component occurring earlier in the order of the component declarations must precede the initial value evaluations of the component occurring later.

Replace paragraph 27:

```
John, Paul : Person_Name := new Person(Sex => M); -- see 3.10.1
```

by:

```
John, Paul : not null Person_Name := new Person(Sex => M); -- see 3.10.1
```

Replace paragraph 29:

```
John : Person_Name := new Person(Sex => M);
Paul : Person_Name := new Person(Sex => M);
```

by:

```
John : not null Person_Name := new Person(Sex => M);
Paul : not null Person_Name := new Person(Sex => M);
```

Replace paragraph 31:

```
Count, Sum : Integer;
Size       : Integer range 0 .. 10_000 := 0;
Sorted    : Boolean := False;
Color_Table : array(1 .. Max) of Color;
```

```
Option      : Bit_Vector(1 .. 10) := (others => True);
Hello      : constant String := "Hi, world.";
```

by:

```
Count, Sum  : Integer;
Size        : Integer range 0 .. 10_000 := 0;
Sorted      : Boolean := False;
Color_Table : array(1 .. Max) of Color;
Option      : Bit_Vector(1 .. 10) := (others => True);
Hello      : aliased String := "Hi, world.";
θ, φ       : Float range -π .. +π;
```

Replace paragraph 33:

```
Limit       : constant Integer := 10_000;
Low_Limit   : constant Integer := Limit/10;
Tolerance   : constant Real := Dispersion(1.15);
```

by:

```
Limit       : constant Integer := 10_000;
Low_Limit   : constant Integer := Limit/10;
Tolerance   : constant Real := Dispersion(1.15);
Hello_Msg   : constant access String := Hello'Access; -- see 3.10.2
```

3.3.2 Number Declarations

Replace paragraph 10:

```
Max          : constant := 500;           -- an integer number
Max_Line_Size : constant := Max/6        -- the integer 83
Power_16     : constant := 2**16;       -- the integer 65_536
One, Un, Eins : constant := 1;          -- three different names for 1
```

by:

```
Max          : constant := 500;           -- an integer number
Max_Line_Size : constant := Max/6;       -- the integer 83
Power_16     : constant := 2**16;       -- the integer 65_536
One, Un, Eins : constant := 1;          -- three different names for 1
```

3.4 Derived Types and Classes

Replace paragraph 1:

A *derived_type_definition* defines a new type (and its first subtype) whose characteristics are *derived* from those of a *parent type*.

by:

A *derived_type_definition* defines a *derived type* (and its first subtype) whose characteristics are *derived* from those of a *parent type*, and possibly from progenitor types.

A *class of types* is a set of types that is closed under derivation; that is, if the parent or a progenitor type of a derived type belongs to a class, then so does the derived type. By saying that a particular group of types forms a class, we are saying that all derivatives of a type in the set inherit the characteristics that define that set. The more general term *category of types* is used for a set of types whose defining characteristics are not necessarily inherited by derivatives; for example, limited, abstract, and interface are all categories of types, but not classes of types.

Replace paragraph 2:

```
derived_type_definition ::= [abstract] new parent_subtype_indication [record_extension_part]
```

by:

```
derived_type_definition ::=
  [abstract] [limited] new parent_subtype_indication [[and interface_list] record_extension_part]
```

Replace paragraph 3:

The *parent_subtype_indication* defines the *parent subtype*; its type is the parent type.

by:

The *parent_subtype_indication* defines the *parent subtype*; its type is the *parent type*. The *interface_list* defines the progenitor types (see 3.9.4). A derived type has one parent type and zero or more progenitor types.

Replace paragraph 5:

If there is a *record_extension_part*, the derived type is called a *record extension* of the parent type. A *record_extension_part* shall be provided if and only if the parent type is a tagged type.

by:

If there is a *record_extension_part*, the derived type is called a *record extension* of the parent type. A *record_extension_part* shall be provided if and only if the parent type is a tagged type. An *interface_list* shall be provided only if the parent type is a tagged type.

If the reserved word **limited** appears in a *derived_type_definition*, the parent type shall be a limited type.

Insert after paragraph 6:

The first subtype of the derived type is unconstrained if a *known_discriminant_part* is provided in the declaration of the derived type, or if the parent subtype is unconstrained. Otherwise, the constraint of the first subtype *corresponds* to that of the parent subtype in the following sense: it is the same as that of the parent subtype except that for a range constraint (implicit or explicit), the value of each bound of its range is replaced by the corresponding value of the derived type.

the new paragraph:

The first subtype of the derived type excludes null (see 3.10) if and only if the parent subtype excludes null.

Replace paragraph 8:

- Each class of types that includes the parent type also includes the derived type.

by:

- If the parent type or a progenitor type belongs to a class of types, then the derived type also belongs to that class. The following sets of types, as well as any higher-level sets composed from them, are classes in this sense, and hence the characteristics defining these classes are inherited by derived types from their parent or progenitor types: signed integer, modular integer, ordinary fixed, decimal fixed, floating point, enumeration, boolean, character, access-to-constant, general access-to-variable, pool-specific access-to-variable, access-to-subprogram, array, string, non-array composite, nonlimited, untagged record, tagged, task, protected, and synchronized tagged.

Delete paragraph 15:

- The derived type is limited if and only if the parent type is limited.

Replace paragraph 17:

- For each user-defined primitive subprogram (other than a user-defined equality operator — see below) of the parent type that already exists at the place of the *derived_type_definition*, there exists a corresponding *inherited* primitive subprogram of the derived type with the same defining name. Primitive user-defined equality operators of the parent type are also inherited by the derived type, except when the derived type is a nonlimited record extension, and the inherited operator would have a profile that is type conformant with the profile of the corresponding predefined equality operator; in this case, the user-defined equality operator is not inherited, but is rather incorporated into the implementation of the predefined equality operator of the record extension (see 4.5.2).

by:

- For each user-defined primitive subprogram (other than a user-defined equality operator — see below) of the parent type or of a progenitor type that already exists at the place of the `derived_type_definition`, there exists a corresponding *inherited* primitive subprogram of the derived type with the same defining name. Primitive user-defined equality operators of the parent type and any progenitor types are also inherited by the derived type, except when the derived type is a nonlimited record extension, and the inherited operator would have a profile that is type conformant with the profile of the corresponding predefined equality operator; in this case, the user-defined equality operator is not inherited, but is rather incorporated into the implementation of the predefined equality operator of the record extension (see 4.5.2).

Replace paragraph 18:

The profile of an inherited subprogram (including an inherited enumeration literal) is obtained from the profile of the corresponding (user-defined) primitive subprogram of the parent type, after systematic replacement of each subtype of its profile (see 6.1) that is of the parent type with a *corresponding subtype* of the derived type. For a given subtype of the parent type, the corresponding subtype of the derived type is defined as follows:

by:

The profile of an inherited subprogram (including an inherited enumeration literal) is obtained from the profile of the corresponding (user-defined) primitive subprogram of the parent or progenitor type, after systematic replacement of each subtype of its profile (see 6.1) that is of the parent or progenitor type with a *corresponding subtype* of the derived type. For a given subtype of the parent or progenitor type, the corresponding subtype of the derived type is defined as follows:

Replace paragraph 22:

The same formal parameters have `default_expressions` in the profile of the inherited subprogram. Any type mismatch due to the systematic replacement of the parent type by the derived type is handled as part of the normal type conversion associated with parameter passing — see 6.4.1.

by:

The same formal parameters have `default_expressions` in the profile of the inherited subprogram. Any type mismatch due to the systematic replacement of the parent or progenitor type by the derived type is handled as part of the normal type conversion associated with parameter passing — see 6.4.1.

Replace paragraph 23:

If a primitive subprogram of the parent type is visible at the place of the `derived_type_definition`, then the corresponding inherited subprogram is implicitly declared immediately after the `derived_type_definition`. Otherwise, the inherited subprogram is implicitly declared later or not at all, as explained in 7.3.1.

by:

If a primitive subprogram of the parent or progenitor type is visible at the place of the `derived_type_definition`, then the corresponding inherited subprogram is implicitly declared immediately after the `derived_type_definition`. Otherwise, the inherited subprogram is implicitly declared later or not at all, as explained in 7.3.1.

Replace paragraph 27:

For the execution of a call on an inherited subprogram, a call on the corresponding primitive subprogram of the parent type is performed; the normal conversion of each actual parameter to the subtype of the corresponding formal parameter (see 6.4.1) performs any necessary type conversion as well. If the result type of the inherited subprogram is the derived type, the result of calling the parent's subprogram is converted to the derived type.

by:

For the execution of a call on an inherited subprogram, a call on the corresponding primitive subprogram of the parent or progenitor type is performed; the normal conversion of each actual parameter to the subtype of the corresponding formal parameter (see 6.4.1) performs any necessary type conversion as well. If the result type of the inherited subprogram is the derived type, the result of calling the subprogram of the parent or progenitor is converted to the derived type, or in the case of a null extension, extended to the derived type using the equivalent of an `extension_aggregate` with the original result as the `ancestor_part` and **null record** as the `record_component_association_list`.

Insert after paragraph 35:

17 If the reserved word **abstract** is given in the declaration of a type, the type is abstract (see 3.9.3).

the new paragraphs:

18 An interface type that has a progenitor type "is derived from" that type. A `derived_type_definition`, however, never defines an interface type.

19 It is illegal for the parent type of a `derived_type_definition` to be a synchronized tagged type.

3.4.1 Derivation Classes**Replace paragraph 2:**

A derived type is *derived from* its parent type *directly*; it is derived *indirectly* from any type from which its parent type is derived. The derivation class of types for a type *T* (also called the class *rooted* at *T*) is the set consisting of *T* (the *root type* of the class) and all types derived from *T* (directly or indirectly) plus any associated universal or class-wide types (defined below).

by:

A derived type is *derived from* its parent type *directly*; it is derived *indirectly* from any type from which its parent type is derived. A derived type, interface type, type extension, task type, protected type, or formal derived type is also derived from every ancestor of each of its progenitor types, if any. The derivation class of types for a type *T* (also called the class *rooted* at *T*) is the set consisting of *T* (the *root type* of the class) and all types derived from *T* (directly or indirectly) plus any associated universal or class-wide types (defined below).

Replace paragraph 3:

Every type is either a *specific* type, a *class-wide* type, or a *universal* type. A specific type is one defined by a `type_declaration`, a `formal_type_declaration`, or a full type definition embedded in a declaration for an object. Class-wide and universal types are implicitly defined, to act as representatives for an entire class of types, as follows:

by:

Every type is either a *specific* type, a *class-wide* type, or a *universal* type. A specific type is one defined by a `type_declaration`, a `formal_type_declaration`, or a full type definition embedded in another construct. Class-wide and universal types are implicitly defined, to act as representatives for an entire class of types, as follows:

Replace paragraph 6:

Universal types

Universal types are defined for (and belong to) the integer, real, and fixed point classes, and are referred to in this standard as respectively, *universal_integer*, *universal_real*, and *universal_fixed*. These are analogous to class-wide types for these language-defined numeric classes. As with class-wide types, if a formal parameter is of a universal type, then an actual parameter of any type in the corresponding class is acceptable. In addition, a value of a universal type (including an integer or real `numeric_literal`) is "universal" in that it is acceptable where some particular type in the class is expected (see 8.6).

by:

Universal types

Universal types are defined for (and belong to) the integer, real, fixed point, and access classes, and are referred to in this standard as respectively, *universal_integer*, *universal_real*, *universal_fixed*, and *universal_access*. These are analogous to class-wide types for these language-defined elementary classes. As with class-wide types, if a formal parameter is of a universal type, then an actual parameter of any type in the corresponding class is acceptable. In addition, a value of a universal type (including an integer or real `numeric_literal`, or the literal `null`) is "universal" in that it is acceptable where some particular type in the class is expected (see 8.6).

Replace paragraph 10:

A specific type *T2* is defined to be a *descendant* of a type *T1* if *T2* is the same as *T1*, or if *T2* is derived (directly or indirectly) from *T1*. A class-wide type *T2*'Class is defined to be a descendant of type *T1* if *T2* is a descendant of *T1*. Similarly, the universal types are defined to be descendants of the root types of their classes. If a type *T2* is a descendant of a type *T1*, then *T1* is called an *ancestor* of *T2*. The *ultimate ancestor* of a type is the ancestor of the type that is not a descendant of any other type.

by:

A specific type *T2* is defined to be a *descendant* of a type *T1* if *T2* is the same as *T1*, or if *T2* is derived (directly or indirectly) from *T1*. A class-wide type *T2*'Class is defined to be a descendant of type *T1* if *T2* is a descendant of *T1*. Similarly, the numeric universal types are defined to be descendants of the root types of their classes. If a type *T2* is a descendant of a type *T1*, then *T1* is called an *ancestor* of *T2*. An *ultimate ancestor* of a type is an ancestor of that type that is not itself a descendant of any other type. Every untagged type has a unique ultimate ancestor.

3.5 Scalar Types**Insert after paragraph 27:**

For an enumeration type, the function returns the value whose position number is one less than that of the value of *Arg*; *Constraint_Error* is raised if there is no such value of the type. For an integer type, the function returns the result of subtracting one from the value of *Arg*. For a fixed point type, the function returns the result of subtracting *small* from the value of *Arg*. For a floating point type, the function returns the machine number (as defined in 3.5.7) immediately below the value of *Arg*; *Constraint_Error* is raised if there is no such machine number.

the new paragraphs:

S'Wide_Wide_Image

S'Wide_Wide_Image denotes a function with the following specification:

```
function S'Wide_Wide_Image(Arg : S'Base)
return Wide_Wide_String
```

The function returns an *image* of the value of *Arg*, that is, a sequence of characters representing the value in display form. The lower bound of the result is one.

The image of an integer value is the corresponding decimal literal, without underlines, leading zeros, exponent, or trailing spaces, but with a single leading character that is either a minus sign or a space.

The image of an enumeration value is either the corresponding identifier in upper case or the corresponding character literal (including the two apostrophes); neither leading nor trailing spaces are included. For a *nongraphic character* (a value of a character type that has no enumeration literal associated with it), the result is a corresponding language-defined name in upper case (for example, the image of the nongraphic character identified as *nul* is "NUL" — the quotes are not part of the image).

The image of a floating point value is a decimal real literal best approximating the value (rounded away from zero if halfway between) with a single leading character that is either a minus sign or a space, a single digit (that is nonzero unless the value is zero), a decimal point, S'Digits-1 (see 3.5.8) digits after the decimal point (but one if S'Digits is one), an upper case E, the sign of the exponent (either + or -), and two or more digits (with leading zeros if necessary) representing the exponent. If S'Signed_Zeros is True, then the leading character is a minus sign for a negatively signed zero.

The image of a fixed point value is a decimal real literal best approximating the value (rounded away from zero if halfway between) with a single leading character that is either a minus sign or a space, one or more digits before the decimal point (with no redundant leading zeros), a decimal point, and S'Aft (see 3.5.10) digits after the decimal point.

Replace paragraph 30:

The function returns an *image* of the value of *Arg*, that is, a sequence of characters representing the value in display form. The lower bound of the result is one.

by:

The function returns an image of the value of *Arg* as a *Wide_String*. The lower bound of the result is one. The image has the same sequence of character as defined for *S'Wide_Wide_Image* if all the graphic characters are defined in *Wide_Character*; otherwise the sequence of characters is implementation defined (but no shorter than that of *S'Wide_Wide_Image* for the same value of *Arg*).

Delete paragraph 31:

The image of an integer value is the corresponding decimal literal, without underlines, leading zeros, exponent, or trailing spaces, but with a single leading character that is either a minus sign or a space.

Delete paragraph 32:

The image of an enumeration value is either the corresponding identifier in upper case or the corresponding character literal (including the two apostrophes); neither leading nor trailing spaces are included. For a *nongraphic character* (a value of a character type that has no enumeration literal associated with it), the result is a corresponding language-defined or implementation-defined name in upper case (for example, the image of the nongraphic character identified as *nul* is "NUL" — the quotes are not part of the image).

Delete paragraph 33:

The image of a floating point value is a decimal real literal best approximating the value (rounded away from zero if halfway between) with a single leading character that is either a minus sign or a space, a single digit (that is nonzero unless the value is zero), a decimal point, *S'Digits-1* (see 3.5.8) digits after the decimal point (but one if *S'Digits* is one), an upper case *E*, the sign of the exponent (either + or -), and two or more digits (with leading zeros if necessary) representing the exponent. If *S'Signed_Zeros* is True, then the leading character is a minus sign for a negatively signed zero.

Delete paragraph 34:

The image of a fixed point value is a decimal real literal best approximating the value (rounded away from zero if halfway between) with a single leading character that is either a minus sign or a space, one or more digits before the decimal point (with no redundant leading zeros), a decimal point, and *S'Aft* (see 3.5.10) digits after the decimal point.

Replace paragraph 37:

The function returns an image of the value of *Arg* as a *String*. The lower bound of the result is one. The image has the same sequence of graphic characters as that defined for *S'Wide_Image* if all the graphic characters are defined in *Character*; otherwise the sequence of characters is implementation defined (but no shorter than that of *S'Wide_Image* for the same value of *Arg*).

by:

The function returns an image of the value of *Arg* as a *String*. The lower bound of the result is one. The image has the same sequence of graphic characters as that defined for *S'Wide_Wide_Image* if all the graphic characters are defined in *Character*; otherwise the sequence of characters is implementation defined (but no shorter than that of *S'Wide_Wide_Image* for the same value of *Arg*).

S'Wide_Wide_Width

S'Wide_Wide_Width denotes the maximum length of a *Wide_Wide_String* returned by *S'Wide_Wide_Image* over all values of the subtype *S*. It denotes zero for a subtype that has a null range. Its type is *universal_integer*.

Insert after paragraph 39:

S'Width

S'Width denotes the maximum length of a *String* returned by *S'Image* over all values of the subtype *S*. It denotes zero for a subtype that has a null range. Its type is *universal_integer*.

the new paragraphs:

S'Wide_Wide_Value

S'Wide_Wide_Value denotes a function with the following specification:

```
function S'Wide_Wide_Value(Arg : Wide_Wide_String)
return S'Base
```

This function returns a value given an image of the value as a Wide_Wide_String, ignoring any leading or trailing spaces.

For the evaluation of a call on S'Wide_Wide_Value for an enumeration subtype S, if the sequence of characters of the parameter (ignoring leading and trailing spaces) has the syntax of an enumeration literal and if it corresponds to a literal of the type of S (or corresponds to the result of S'Wide_Wide_Image for a nongraphic character of the type), the result is the corresponding enumeration value; otherwise Constraint_Error is raised.

For the evaluation of a call on S'Wide_Wide_Value for an integer subtype S, if the sequence of characters of the parameter (ignoring leading and trailing spaces) has the syntax of an integer literal, with an optional leading sign character (plus or minus for a signed type; only plus for a modular type) and the corresponding numeric value belongs to the base range of the type of S, then that value is the result; otherwise Constraint_Error is raised.

For the evaluation of a call on S'Wide_Wide_Value for a real subtype S, if the sequence of characters of the parameter (ignoring leading and trailing spaces) has the syntax of one of the following:

- numeric_literal
- numeral.[exponent]
- .numeral[exponent]
- base#based_numeral#[exponent]
- base#.based_numeral#[exponent]

with an optional leading sign character (plus or minus), and if the corresponding numeric value belongs to the base range of the type of S, then that value is the result; otherwise Constraint_Error is raised. The sign of a zero value is preserved (positive if none has been specified) if S'Signed_Zeros is True.

Replace paragraph 43:

For the evaluation of a call on S'Wide_Value for an enumeration subtype S, if the sequence of characters of the parameter (ignoring leading and trailing spaces) has the syntax of an enumeration literal and if it corresponds to a literal of the type of S (or corresponds to the result of S'Wide_Image for a nongraphic character of the type), the result is the corresponding enumeration value; otherwise Constraint_Error is raised.

by:

For the evaluation of a call on S'Wide_Value for an enumeration subtype S, if the sequence of characters of the parameter (ignoring leading and trailing spaces) has the syntax of an enumeration literal and if it corresponds to a literal of the type of S (or corresponds to the result of S'Wide_Image for a value of the type), the result is the corresponding enumeration value; otherwise Constraint_Error is raised. For a numeric subtype S, the evaluation of a call on S'Wide_Value with Arg of type Wide_String is equivalent to a call on S'Wide_Wide_Value for a corresponding Arg of type Wide_Wide_String.

Delete paragraph 44:

For the evaluation of a call on S'Wide_Value (or S'Value) for an integer subtype S, if the sequence of characters of the parameter (ignoring leading and trailing spaces) has the syntax of an integer literal, with an optional leading sign character (plus or minus for a signed type; only plus for a modular type), and the corresponding numeric value belongs to the base range of the type of S, then that value is the result; otherwise Constraint_Error is raised.

Delete paragraph 45:

For the evaluation of a call on S'Wide_Value (or S'Value) for a real subtype S, if the sequence of characters of the parameter (ignoring leading and trailing spaces) has the syntax of one of the following:

Delete paragraph 46:

- numeric_literal

Delete paragraph 47:

- numeral.[exponent]

Delete paragraph 48:

- .numeral[exponent]

Delete paragraph 49:

- base#based_numeral.#[exponent]

Delete paragraph 50:

- base#.based_numeral#[exponent]

Delete paragraph 51:

with an optional leading sign character (plus or minus), and if the corresponding numeric value belongs to the base range of the type of S, then that value is the result; otherwise Constraint_Error is raised. The sign of a zero value is preserved (positive if none has been specified) if S'Signed_Zeros is True.

Replace paragraph 55:

For the evaluation of a call on S'Value for an enumeration subtype S, if the sequence of characters of the parameter (ignoring leading and trailing spaces) has the syntax of an enumeration literal and if it corresponds to a literal of the type of S (or corresponds to the result of S'Image for a value of the type), the result is the corresponding enumeration value; otherwise Constraint_Error is raised. For a numeric subtype S, the evaluation of a call on S'Value with *Arg* of type String is equivalent to a call on S'Wide_Value for a corresponding *Arg* of type Wide_String.

by:

For the evaluation of a call on S'Value for an enumeration subtype S, if the sequence of characters of the parameter (ignoring leading and trailing spaces) has the syntax of an enumeration literal and if it corresponds to a literal of the type of S (or corresponds to the result of S'Image for a value of the type), the result is the corresponding enumeration value; otherwise Constraint_Error is raised. For a numeric subtype S, the evaluation of a call on S'Value with *Arg* of type String is equivalent to a call on S'Wide_Wide_Value for a corresponding *Arg* of type Wide_Wide_String.

Replace paragraph 56:

An implementation may extend the Wide_Value, Value, Wide_Image, and Image attributes of a floating point type to support special values such as infinities and NaNs.

by:

An implementation may extend the Wide_Wide_Value, Wide_Value, Value, Wide_Wide_Image, Wide_Image, and Image attributes of a floating point type to support special values such as infinities and NaNs.

Replace paragraph 59:

21 For any value V (including any nongraphic character) of an enumeration subtype S, S'Value(S'Image(V)) equals V, as does S'Wide_Value(S'Wide_Image(V)). Neither expression ever raises Constraint_Error.

by:

21 For any value V (including any nongraphic character) of an enumeration subtype S, S'Value(S'Image(V)) equals V, as do S'Wide_Value(S'Wide_Image(V)) and S'Wide_Wide_Value(S'Wide_Wide_Image(V)). None of these expressions ever raise Constraint_Error.

3.5.2 Character Types

Replace paragraph 2:

The predefined type `Character` is a character type whose values correspond to the 256 code positions of Row 00 (also known as Latin-1) of the ISO 10646 Basic Multilingual Plane (BMP). Each of the graphic characters of Row 00 of the BMP has a corresponding `character_literal` in `Character`. Each of the nongraphic positions of Row 00 (0000-001F and 007F-009F) has a corresponding language-defined name, which is not usable as an enumeration literal, but which is usable with the attributes `(Wide_)Image` and `(Wide_)Value`; these names are given in the definition of type `Character` in A.1, "The Package Standard", but are set in *italics*.

by:

The predefined type `Character` is a character type whose values correspond to the 256 code positions of Row 00 (also known as Latin-1) of the ISO/IEC 10646:2003 Basic Multilingual Plane (BMP). Each of the graphic characters of Row 00 of the BMP has a corresponding `character_literal` in `Character`. Each of the nongraphic positions of Row 00 (0000-001F and 007F-009F) has a corresponding language-defined name, which is not usable as an enumeration literal, but which is usable with the attributes `Image`, `Wide_Image`, `Wide_Wide_Image`, `Value`, `Wide_Value`, and `Wide_Wide_Value`; these names are given in the definition of type `Character` in A.1, "The Package Standard", but are set in *italics*.

Replace paragraph 3:

The predefined type `Wide_Character` is a character type whose values correspond to the 65536 code positions of the ISO 10646 Basic Multilingual Plane (BMP). Each of the graphic characters of the BMP has a corresponding `character_literal` in `Wide_Character`. The first 256 values of `Wide_Character` have the same `character_literal` or language-defined name as defined for `Character`. The last 2 values of `Wide_Character` correspond to the nongraphic positions FFFE and FFFF of the BMP, and are assigned the language-defined names *FFFE* and *FFFF*. As with the other language-defined names for nongraphic characters, the names *FFFE* and *FFFF* are usable only with the attributes `(Wide_)Image` and `(Wide_)Value`; they are not usable as enumeration literals. All other values of `Wide_Character` are considered graphic characters, and have a corresponding `character_literal`.

by:

The predefined type `Wide_Character` is a character type whose values correspond to the 65536 code positions of the ISO/IEC 10646:2003 Basic Multilingual Plane (BMP). Each of the graphic characters of the BMP has a corresponding `character_literal` in `Wide_Character`. The first 256 values of `Wide_Character` have the same `character_literal` or language-defined name as defined for `Character`. Each of the `graphic_characters` has a corresponding `character_literal`.

The predefined type `Wide_Wide_Character` is a character type whose values correspond to the 2147483648 code positions of the ISO/IEC 10646:2003 character set. Each of the `graphic_characters` has a corresponding `character_literal` in `Wide_Wide_Character`. The first 65536 values of `Wide_Wide_Character` have the same `character_literal` or language-defined name as defined for `Wide_Character`.

The characters whose code position is larger than 16#FF# and which are not `graphic_characters` have language-defined names which are formed by appending to the string "Hex_" the representation of their code position in hexadecimal as eight extended digits. As with other language-defined names, these names are usable only with the attributes `(Wide_)Wide_Image` and `(Wide_)Wide_Value`; they are not usable as enumeration literals.

Delete paragraph 4:

In a nonstandard mode, an implementation may provide other interpretations for the predefined types `Character` and `Wide_Character`, to conform to local conventions.

Delete paragraph 5:

If an implementation supports a mode with alternative interpretations for `Character` and `Wide_Character`, the set of graphic characters of `Character` should nevertheless remain a proper subset of the set of graphic characters of `Wide_Character`. Any character set "localizations" should be reflected in the results of the subprograms defined in the language-defined package `Characters.Handling` (see A.3) available in such a mode. In a mode with an alternative interpretation of `Character`, the implementation should also support a corresponding change in what is a legal `identifier_letter`.

3.5.4 Integer Types

Replace paragraph 16:

For every modular subtype S, the following attribute is defined:

by:

For every modular subtype S, the following attributes are defined:

S'Mod

S'Mod denotes a function with the following specification:

```
function S'Mod (Arg : universal_integer)
return S'Base
```

This function returns *Arg mod S'Modulus*, as a value of the type of S.

3.5.9 Fixed Point Types

Replace paragraph 8:

The set of values of a fixed point type comprise the integral multiples of a number called the *small* of the type. For a type defined by an *ordinary_fixed_point_definition* (an *ordinary* fixed point type), the *small* may be specified by an *attribute_definition_clause* (see 13.3); if so specified, it shall be no greater than the *delta* of the type. If not specified, the *small* of an ordinary fixed point type is an implementation-defined power of two less than or equal to the *delta*.

by:

The set of values of a fixed point type comprise the integral multiples of a number called the *small* of the type. The *machine numbers* of a fixed point type are the values of the type that can be represented exactly in every unconstrained variable of the type. For a type defined by an *ordinary_fixed_point_definition* (an *ordinary* fixed point type), the *small* may be specified by an *attribute_definition_clause* (see 13.3); if so specified, it shall be no greater than the *delta* of the type. If not specified, the *small* of an ordinary fixed point type is an implementation-defined power of two less than or equal to the *delta*.

3.6 Array Types

Replace paragraph 7:

component_definition ::= [aliased] subtype_indication

by:

```
component_definition ::=
  [aliased] subtype_indication
  | [aliased] access_definition
```

Delete paragraph 11:

Within the definition of a nonlimited composite type (or a limited composite type that later in its immediate scope becomes nonlimited — see 7.3.1 and 7.5), if a *component_definition* contains the reserved word **aliased** and the type of the component is discriminated, then the nominal subtype of the component shall be constrained.

Replace paragraph 22:

The elaboration of a *discrete_subtype_definition* that does not contain any per-object expressions creates the discrete subtype, and consists of the elaboration of the *subtype_indication* or the evaluation of the *range*. The elaboration of a *discrete_subtype_definition* that contains one or more per-object expressions is defined in 3.8. The elaboration of a *component_definition* in an *array_type_definition* consists of the elaboration of the *subtype_indication*. The elaboration of any *discrete_subtype_definitions* and the elaboration of the *component_definition* are performed in an arbitrary order.

by:

The elaboration of a `discrete_subtype_definition` that does not contain any per-object expressions creates the discrete subtype, and consists of the elaboration of the `subtype_indication` or the evaluation of the `range`. The elaboration of a `discrete_subtype_definition` that contains one or more per-object expressions is defined in 3.8. The elaboration of a `component_definition` in an `array_type_definition` consists of the elaboration of the `subtype_indication` or `access_definition`. The elaboration of any `discrete_subtype_definitions` and the elaboration of the `component_definition` are performed in an arbitrary order.

Replace paragraph 30:

```
Grid : array(1 .. 80, 1 .. 100) of Boolean;
Mix  : array(Color range Red .. Green) of Boolean;
Page : array(Positive range <>) of Line := -- an array of arrays
      (1 | 50 => Line'(1 | Line'Last => '+', others => '-'), -- see 4.3.3
       2 .. 49 => Line'(1 | Line'Last => '|', others => ' '));
      -- Page is constrained by its initial value to (1..50)
```

by:

```
Grid      : array(1 .. 80, 1 .. 100) of Boolean;
Mix       : array(Color range Red .. Green) of Boolean;
Msg_Table : constant array(Error_Code) of access constant String :=
      (Too_Big => new String("Result too big"), Too_Small => ...);
Page      : array(Positive range <>) of Line := -- an array of arrays
      (1 | 50 => Line'(1 | Line'Last => '+', others => '-'), -- see 4.3.3
       2 .. 49 => Line'(1 | Line'Last => '|', others => ' '));
      -- Page is constrained by its initial value to (1..50)
```

3.6.2 Operations of Array Types

Replace paragraph 16:

48 A component of an array can be named with an `indexed_component`. A value of an array type can be specified with an `array_aggregate`, unless the array type is limited. For a one-dimensional array type, a slice of the array can be named; also, string literals are defined if the component type is a character type.

by:

48 A component of an array can be named with an `indexed_component`. A value of an array type can be specified with an `array_aggregate`. For a one-dimensional array type, a slice of the array can be named; also, string literals are defined if the component type is a character type.

3.6.3 String Types

Replace paragraph 2:

There are two predefined string types, `String` and `Wide_String`, each indexed by values of the predefined subtype `Positive`; these are declared in the visible part of package `Standard`:

by:

There are three predefined string types, `String`, `Wide_String`, and `Wide_Wide_String`, each indexed by values of the predefined subtype `Positive`; these are declared in the visible part of package `Standard`:

Replace paragraph 4:

```
type String is array(Positive range <>) of Character;
type Wide_String is array(Positive range <>) of Wide_Character;
```

by:

```
type String is array(Positive range <>) of Character;
type Wide_String is array(Positive range <>) of Wide_Character;
type Wide_Wide_String is array(Positive range <>) of Wide_Wide_Character;
```

3.7 Discriminants

Replace paragraph 1:

A composite type (other than an array type) can have discriminants, which parameterize the type. A `known_discriminant_part` specifies the discriminants of a composite type. A discriminant of an object is a component of the object, and is either of a discrete type or an access type. An `unknown_discriminant_part` in the declaration of a partial view of a type specifies that the discriminants of the type are unknown for the given view; all subtypes of such a partial view are indefinite subtypes.

by:

A composite type (other than an array or interface type) can have discriminants, which parameterize the type. A `known_discriminant_part` specifies the discriminants of a composite type. A discriminant of an object is a component of the object, and is either of a discrete type or an access type. An `unknown_discriminant_part` in the declaration of a view of a type specifies that the discriminants of the type are unknown for the given view; all subtypes of such a view are indefinite subtypes.

Replace paragraph 5:

```
discriminant_specification ::=
  defining_identifier_list : subtype_mark [:= default_expression]
  | defining_identifier_list : access_definition [:= default_expression]
```

by:

```
discriminant_specification ::=
  defining_identifier_list : [null_exclusion] subtype_mark [:= default_expression]
  | defining_identifier_list : access_definition [:= default_expression]
```

Replace paragraph 8:

A `discriminant_part` is only permitted in a declaration for a composite type that is not an array type (this includes generic formal types). A type declared with a `known_discriminant_part` is called a *discriminated* type, as is a type that inherits (known) discriminants.

by:

A `discriminant_part` is only permitted in a declaration for a composite type that is not an array or interface type (this includes generic formal types). A type declared with a `known_discriminant_part` is called a *discriminated* type, as is a type that inherits (known) discriminants.

Replace paragraph 9:

The subtype of a discriminant may be defined by a `subtype_mark`, in which case the `subtype_mark` shall denote a discrete or access subtype, or it may be defined by an `access_definition` (in which case the `subtype_mark` of the `access_definition` may denote any kind of subtype). A discriminant that is defined by an `access_definition` is called an *access discriminant* and is of an anonymous general access-to-variable type whose designated subtype is denoted by the `subtype_mark` of the `access_definition`.

by:

The subtype of a discriminant may be defined by an optional `null_exclusion` and a `subtype_mark`, in which case the `subtype_mark` shall denote a discrete or access subtype, or it may be defined by an `access_definition`. A discriminant that is defined by an `access_definition` is called an *access discriminant* and is of an anonymous access type.

Replace paragraph 10:

A `discriminant_specification` for an access discriminant shall appear only in the declaration for a task or protected type, or for a type with the reserved word **limited** in its (full) definition or in that of one of its ancestors. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit.

by:

Default_expressions shall be provided either for all or for none of the discriminants of a known_discriminant_part. No default_expressions are permitted in a known_discriminant_part in a declaration of a tagged type or a generic formal type.

A discriminant_specification for an access discriminant may have a default_expression only in the declaration for a task or protected type, or for a type that is a descendant of an explicitly limited record type. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit.

Delete paragraph 11:

Default_expressions shall be provided either for all or for none of the discriminants of a known_discriminant_part. No default_expressions are permitted in a known_discriminant_part in a declaration of a tagged type [or a generic formal type].

Replace paragraph 27:

An access_definition is elaborated when the value of a corresponding access discriminant is defined, either by evaluation of its default_expression or by elaboration of a discriminant_constraint. The elaboration of an access_definition creates the anonymous access type. When the expression defining the access discriminant is evaluated, it is converted to this anonymous access type (see 4.6).

by:

For an access discriminant, its access_definition is elaborated when the value of the access discriminant is defined: by evaluation of its default_expression, by elaboration of a discriminant_constraint, or by an assignment that initializes the enclosing object.

Replace paragraph 37:

```
type Item(Number : Positive) is
  record
    Content : Integer;
    -- no component depends on the discriminant
  end record;
```

by:

```
task type Worker(Prio : System_Priority; Buf : access Buffer) is
  -- discriminants used to parameterize the task type (see 9.1)
  pragma Priority(Prio); -- see D.1
  entry Fill;
  entry Drain;
end Worker;
```

3.7.1 Discriminant Constraints

Replace paragraph 7:

A discriminant_constraint is only allowed in a subtype_indication whose subtype_mark denotes either an unconstrained discriminated subtype, or an unconstrained access subtype whose designated subtype is an unconstrained discriminated subtype. However, in the case of a general access subtype, a discriminant_constraint is illegal if there is a place within the immediate scope of the designated subtype where the designated subtype's view is constrained.

by:

A discriminant_constraint is only allowed in a subtype_indication whose subtype_mark denotes either an unconstrained discriminated subtype, or an unconstrained access subtype whose designated subtype is an unconstrained discriminated subtype. However, in the case of an access subtype, a discriminant_constraint is illegal if the designated type has a partial view that is constrained or, for a general access subtype, has default_expressions for its discriminants. In addition to the places where Legality Rules normally apply (see 12.3), these rules apply also in the private part of an instance of a generic unit. In a generic body, this rule is checked presuming all formal access types of the generic might be general access types, and all untagged discriminated formal types of the generic might have default_expressions for their discriminants.

3.8 Record Types

Delete paragraph 8:

A default_expression is not permitted if the component is of a limited type.

Replace paragraph 9:

Each component_declaration declares a component of the record type. Besides components declared by component_declarations, the components of a record type include any components declared by discriminant_specifications of the record type declaration. The identifiers of all components of a record type shall be distinct.

by:

Each component_declaration declares a component of the record type. Besides components declared by component_declarations, the components of a record type include any components declared by discriminant_specifications of the record type declaration. The identifiers of all components of a record type shall be distinct.

Insert before paragraph 14:

The component_definition of a component_declaration defines the (nominal) subtype of the component. If the reserved word **aliased** appears in the component_definition, then the component is aliased (see 3.10).

the new paragraph:

If a record_type_declaration includes the reserved word **limited**, the type is called an *explicitly limited record* type.

Replace paragraph 18:

Within the definition of a composite type, if a component_definition or discrete_subtype_definition (see 9.5.2) includes a name that denotes a discriminant of the type, or that is an attribute_reference whose prefix denotes the current instance of the type, the expression containing the name is called a *per-object expression*, and the constraint or range being defined is called a *per-object constraint*. For the elaboration of a component_definition of a component_declaration or the discrete_subtype_definition of an entry_declaration for an entry family (see 9.5.2), if the constraint or range of the subtype_indication or discrete_subtype_definition is not a per-object constraint, then the subtype_indication or discrete_subtype_definition is elaborated. On the other hand, if the constraint or range is a per-object constraint, then the elaboration consists of the evaluation of any included expression that is not part of a per-object expression. Each such expression is evaluated once unless it is part of a named association in a discriminant constraint, in which case it is evaluated once for each associated discriminant.

by:

Within the definition of a composite type, if a component_definition or discrete_subtype_definition (see 9.5.2) includes a name that denotes a discriminant of the type, or that is an attribute_reference whose prefix denotes the current instance of the type, the expression containing the name is called a *per-object expression*, and the constraint or range being defined is called a *per-object constraint*. For the elaboration of a component_definition of a component_declaration or the discrete_subtype_definition of an entry_declaration for an entry family (see 9.5.2), if the component subtype is defined by an access_definition or if the constraint or range of the subtype_indication or discrete_subtype_definition is not a per-object constraint, then the access_definition, subtype_indication, or discrete_subtype_definition is elaborated. On the other hand, if the constraint or range is a per-object constraint, then the elaboration consists of the evaluation of any included expression that is not part of a per-object expression. Each such expression is evaluated once unless it is part of a named association in a discriminant constraint, in which case it is evaluated once for each associated discriminant.

Replace paragraph 25:

61 A component of a record can be named with a selected_component. A value of a record can be specified with a record_aggregate, unless the record type is limited.

by:

61 A component of a record can be named with a selected_component. A value of a record can be specified with a record_aggregate.

3.9 Tagged Types and Type Extensions

Replace paragraph 2:

A record type or private type that has the reserved word **tagged** in its declaration is called a *tagged* type. When deriving from a tagged type, additional components may be defined. As for any derived type, additional primitive subprograms may be defined, and inherited primitive subprograms may be overridden. The derived type is called an *extension* of the ancestor type, or simply a *type extension*. Every type extension is also a tagged type, and is either a *record extension* or a *private extension* of some other tagged type. A record extension is defined by a `derived_type_definition` with a `record_extension_part`. A private extension, which is a partial view of a record extension, can be declared in the visible part of a package (see 7.3) or in a generic formal part (see 12.5.1).

by:

A record type or private type that has the reserved word **tagged** in its declaration is called a *tagged* type. In addition, an interface type is a tagged type, as is a task or protected type derived from an interface (see 3.9.4). When deriving from a tagged type, as for any derived type, additional primitive subprograms may be defined, and inherited primitive subprograms may be overridden. The derived type is called an *extension* of its ancestor types, or simply a *type extension*.

Every type extension is also a tagged type, and is a *record extension* or a *private extension* of some other tagged type, or a non-interface synchronized tagged type (see 3.9.4). A record extension is defined by a `derived_type_definition` with a `record_extension_part` (see 3.9.1), which may include the definition of additional components. A private extension, which is a partial view of a record extension or of a synchronized tagged type, can be declared in the visible part of a package (see 7.3) or in a generic formal part (see 12.5.1).

Replace paragraph 4:

The tag of a specific tagged type identifies the `full_type_declaration` of the type. If a declaration for a tagged type occurs within a `generic_package_declaration`, then the corresponding type declarations in distinct instances of the generic package are associated with distinct tags. For a tagged type that is local to a generic package body, the language does not specify whether repeated instantiations of the generic body result in distinct tags.

by:

The tag of a specific tagged type identifies the `full_type_declaration` of the type, and for a type extension, is sufficient to uniquely identify the type among all descendants of the same ancestor. If a declaration for a tagged type occurs within a `generic_package_declaration`, then the corresponding type declarations in distinct instances of the generic package are associated with distinct tags. For a tagged type that is local to a generic package body and with all of its ancestors (if any) also local to the generic body, the language does not specify whether repeated instantiations of the generic body result in distinct tags.

Replace paragraph 6:

```
package Ada.Tags is
  type Tag is private;
```

by:

```
package Ada.Tags is
  pragma Preelaborate(Tags);
  type Tag is private;
  No_Tag : constant Tag;
```

Insert after paragraph 7:

```
function Expanded_Name(T : Tag) return String;
function External_Tag(T : Tag) return String;
function Internal_Tag(External : String) return Tag;
```

the new paragraphs:

```
function Descendant_Tag(External : String; Ancestor : Tag) return Tag;
function Is_Descendant_At_Same_Level(Descendant, Ancestor : Tag)
  return Boolean;
function Parent_Tag (T : Tag) return Tag;
type Tag_Array is array (Positive range <>) of Tag;
function Interface_Ancestor_Tags (T : Tag) return Tag_Array;
```

Insert after paragraph 9:

```

private
  ... -- not specified by the language
end Ada.Tags;

```

the new paragraph:

No_Tag is the default initial value of type Tag.

Replace paragraph 10:

The function Expanded_Name returns the full expanded name of the first subtype of the specific type identified by the tag, in upper case, starting with a root library unit. The result is implementation defined if the type is declared within an unnamed block_statement.

by:

The function Wide_Wide_Expanded_Name returns the full expanded name of the first subtype of the specific type identified by the tag, in upper case, starting with a root library unit. The result is implementation defined if the type is declared within an unnamed block_statement.

The function Expanded_Name (respectively, Wide_Expanded_Name) returns the same sequence of graphic characters as that defined for Wide_Wide_Expanded_Name, if all the graphic characters are defined in Character (respectively, Wide_Character); otherwise, the sequence of characters is implementation defined, but no shorter than that returned by Wide_Wide_Expanded_Name for the same value of the argument.

Insert after paragraph 11:

The function External_Tag returns a string to be used in an external representation for the given tag. The call External_Tag(S'Tag) is equivalent to the attribute_reference S'External_Tag (see 13.3).

the new paragraph:

The string returned by the functions Expanded_Name, Wide_Expanded_Name, Wide_Wide_Expanded_Name, and External_Tag has lower bound 1.

Replace paragraph 12:

The function Internal_Tag returns the tag that corresponds to the given external tag, or raises Tag_Error if the given string is not the external tag for any specific type of the partition.

by:

The function Internal_Tag returns a tag that corresponds to the given external tag, or raises Tag_Error if the given string is not the external tag for any specific type of the partition. Tag_Error is also raised if the specific type identified is a library-level type whose tag has not yet been created (see 13.14).

The function Descendant_Tag returns the (internal) tag for the type that corresponds to the given external tag and is both a descendant of the type identified by the Ancestor tag and has the same accessibility level as the identified ancestor. Tag_Error is raised if External is not the external tag for such a type. Tag_Error is also raised if the specific type identified is a library-level type whose tag has not yet been created.

The function Is_Descendant_At_Same_Level returns True if the Descendant tag identifies a type that is both a descendant of the type identified by Ancestor and at the same accessibility level. If not, it returns False.

The function Parent_Tag returns the tag of the parent type of the type whose tag is T. If the type does not have a parent type (that is, it was not declared by a derived_type_declaration), then No_Tag is returned.

The function Interface_Ancursor_Tags returns an array containing the tag of each interface ancestor type of the type whose tag is T, other than T itself. The lower bound of the returned array is 1, and the order of the returned tags is unspecified. Each tag appears in the result exactly once. If the type whose tag is T has no interface ancestors, a null array is returned.

Insert after paragraph 18:

X'Tag

X'Tag denotes the tag of X. The value of this attribute is of type Tag.

the new paragraphs:

The following language-defined generic function exists:

```

generic
  type T (<>) is abstract tagged limited private;
  type Parameters (<>) is limited private;
  with function Constructor (Params : not null access Parameters)
    return T is abstract;
function Ada.Tags.Generic_Dispatching_Constructor
  (The_Tag : Tag;
   Params : not null access Parameters) return T'Class;
pragma Preelaborate(Generic_Dispatching_Constructor);
pragma Convention(Intrinsic, Generic_Dispatching_Constructor);

```

Tags.Generic_Dispatching_Constructor provides a mechanism to create an object of an appropriate type from just a tag value. The function Constructor is expected to create the object given a reference to an object of type Parameters.

Replace paragraph 24:

- The tag of the result returned by a function with a class-wide result type is that of the return expression.

by:

- The tag of the result returned by a function with a class-wide result type is that of the return object.

Insert after paragraph 25:

The tag is preserved by type conversion and by parameter passing. The tag of a value is the tag of the associated object (see 6.2).

the new paragraphs:

Tag_Error is raised by a call of Descendant_Tag, Expanded_Name, External_Tag, Interface_Ancestor_Tag, Is_Descendant_At_Same_Level, or Parent_Tag if any tag passed is No_Tag.

An instance of Tags.Generic_Dispatching_Constructor raises Tag_Error if The_Tag does not represent a concrete descendant of T or if the innermost master (see 7.6.1) of this descendant is not also a master of the instance. Otherwise, it dispatches to the primitive function denoted by the formal Constructor for the type identified by The_Tag, passing Params, and returns the result. Any exception raised by the function is propagated.

Erroneous Execution

If an internal tag provided to an instance of Tags.Generic_Dispatching_Constructor or to any subprogram declared in package Tags identifies either a type that is not library-level and whose tag has not been created (see 13.14), or a type that does not exist in the partition at the time of the call, then execution is erroneous.

Replace paragraph 26:

The implementation of the functions in Ada.Tags may raise Tag_Error if no specific type corresponding to the tag passed as a parameter exists in the partition at the time the function is called.

by:

The implementation of Internal_Tag and Descendant_Tag may raise Tag_Error if no specific type corresponding to the string External passed as a parameter exists in the partition at the time the function is called, or if there is no such type whose innermost master is a master of the point of the function call.

Implementation Advice

Internal_Tag should return the tag of a type whose innermost master is the master of the point of the function call.

Replace paragraph 30:

65 If S denotes an untagged private type whose full type is tagged, then S'Class is also allowed before the full type definition, but only in the private part of the package in which the type is declared (see 7.3.1). Similarly, the Class attribute is defined for incomplete types whose full type is tagged, but only within the library unit in which the incomplete type is declared (see 3.10.1).

by:

65 The capability provided by `Tags.Generic_Dispatching_Constructor` is sometimes known as a *factory*.

3.9.1 Type Extensions

Replace paragraph 1:

Every type extension is a tagged type, and is either a *record extension* or a *private extension* of some other tagged type.

by:

Every type extension is a tagged type, and is a *record extension* or a *private extension* of some other tagged type, or a non-interface synchronized tagged type.

Replace paragraph 3:

The parent type of a record extension shall not be a class-wide type. If the parent type is nonlimited, then each of the components of the `record_extension_part` shall be nonlimited. The accessibility level (see 3.10.2) of a record extension shall not be statically deeper than that of its parent type. In addition to the places where Legality Rules normally apply (see 12.3), these rules apply also in the private part of an instance of a generic unit.

by:

The parent type of a record extension shall not be a class-wide type nor shall it be a synchronized tagged type (see 3.9.4). If the parent type or any progenitor is nonlimited, then each of the components of the `record_extension_part` shall be nonlimited. In addition to the places where Legality Rules normally apply (see 12.3), these rules apply also in the private part of an instance of a generic unit.

Replace paragraph 4:

A type extension shall not be declared in a generic body if the parent type is declared outside that body.

by:

Within the body of a generic unit, or the body of any of its descendant library units, a tagged type shall not be declared as a descendant of a formal type declared within the formal part of the generic unit.

Static Semantics

A record extension is a *null extension* if its declaration has no `known_discriminant_part` and its `record_extension_part` includes no `component_declarations`.

Replace paragraph 7:

The accessibility rules imply that a tagged type declared in a `library_package_specification` can be extended only at library level or as a generic formal. When the extension is declared immediately within a `package_body`, primitive subprograms are inherited and are overridable, but new primitive subprograms cannot be added.

by:

When an extension is declared immediately within a body, primitive subprograms are inherited and are overridable, but new primitive subprograms cannot be added.

3.9.2 Dispatching Operations of Tagged Types

Replace paragraph 1:

The primitive subprograms of a tagged type are called *dispatching operations*. A dispatching operation can be called using a statically determined *controlling tag*, in which case the body to be executed is determined at compile time. Alternatively, the controlling tag can be dynamically determined, in which case the call *dispatches* to a body that is determined at run time; such a call is termed a *dispatching call*. As explained below, the properties of the operands and the context of a particular call on a dispatching operation determine how the controlling tag is determined, and hence whether or not the call is a dispatching call. Run-time polymorphism is achieved when a dispatching operation is called by a dispatching call.

by:

The primitive subprograms of a tagged type, the subprograms declared by `formal_abstract_subprogram_declarations`, and the stream attributes of a specific tagged type that are available (see 13.13.2) at the end of the declaration list where the type is declared are called *dispatching operations*. A dispatching operation can be called using a statically determined *controlling tag*, in which case the body to be executed is determined at compile time. Alternatively, the controlling tag can be dynamically determined, in which case the call *dispatches* to a body that is determined at run time; such a call is termed a *dispatching call*. As explained below, the properties of the operands and the context of a particular call on a dispatching operation determine how the controlling tag is determined, and hence whether or not the call is a dispatching call. Run-time polymorphism is achieved when a dispatching operation is called by a dispatching call.

Replace paragraph 2:

A call on a *dispatching operation* is a call whose **name** or **prefix** denotes the declaration of a primitive subprogram of a tagged type, that is, a dispatching operation. A *controlling operand* in a call on a dispatching operation of a tagged type *T* is one whose corresponding formal parameter is of type *T* or is of an anonymous access type with designated type *T*; the corresponding formal parameter is called a *controlling formal parameter*. If the controlling formal parameter is an access parameter, the controlling operand is the object designated by the actual parameter, rather than the actual parameter itself. If the call is to a (primitive) function with result type *T*, then the call has a *controlling result* — the context of the call can control the dispatching.

by:

A call on a *dispatching operation* is a call whose **name** or **prefix** denotes the declaration of a dispatching operation. A *controlling operand* in a call on a dispatching operation of a tagged type *T* is one whose corresponding formal parameter is of type *T* or is of an anonymous access type with designated type *T*; the corresponding formal parameter is called a *controlling formal parameter*. If the controlling formal parameter is an access parameter, the controlling operand is the object designated by the actual parameter, rather than the actual parameter itself. If the call is to a (primitive) function with result type *T*, then the call has a *controlling result* — the context of the call can control the dispatching. Similarly, if the call is to a function with access result type designating *T*, then the call has a *controlling access result*, and the context can similarly control dispatching.

Replace paragraph 4:

- The **name** or expression is *statically tagged* if it is of a specific tagged type and, if it is a call with a controlling result, it has at least one statically tagged controlling operand;

by:

- The **name** or expression is *statically tagged* if it is of a specific tagged type and, if it is a call with a controlling result or controlling access result, it has at least one statically tagged controlling operand;

Replace paragraph 5:

- The **name** or expression is *dynamically tagged* if it is of a class-wide type, or it is a call with a controlling result and at least one dynamically tagged controlling operand;

by:

- The **name** or expression is *dynamically tagged* if it is of a class-wide type, or it is a call with a controlling result or controlling access result and at least one dynamically tagged controlling operand;

Replace paragraph 6:

- The **name** or expression is *tag indeterminate* if it is a call with a controlling result, all of whose controlling operands (if any) are tag indeterminate.

by:

- The **name** or expression is *tag indeterminate* if it is a call with a controlling result or controlling access result, all of whose controlling operands (if any) are tag indeterminate.

Replace paragraph 10:

In the declaration of a dispatching operation of a tagged type, everywhere a subtype of the tagged type appears as a subtype of the profile (see 6.1), it shall statically match the first subtype of the tagged type. If the dispatching operation overrides an inherited subprogram, it shall be subtype conformant with the inherited subprogram. The convention of an inherited or overriding dispatching operation is the convention of the corresponding primitive operation of the parent type. An explicitly declared dispatching operation shall not be of convention Intrinsic.

by:

In the declaration of a dispatching operation of a tagged type, everywhere a subtype of the tagged type appears as a subtype of the profile (see 6.1), it shall statically match the first subtype of the tagged type. If the dispatching operation overrides an inherited subprogram, it shall be subtype conformant with the inherited subprogram. The convention of an inherited dispatching operation is the convention of the corresponding primitive operation of the parent or progenitor type. The default convention of a dispatching operation that overrides an inherited primitive operation is the convention of the inherited operation; if the operation overrides multiple inherited operations, then they shall all have the same convention. An explicitly declared dispatching operation shall not be of convention Intrinsic.

Replace paragraph 11:

The `default_expression` for a controlling formal parameter of a dispatching operation shall be tag indeterminate. A controlling formal parameter that is an access parameter shall not have a `default_expression`.

by:

The `default_expression` for a controlling formal parameter of a dispatching operation shall be tag indeterminate.

If a dispatching operation is defined by a `subprogram_renaming_declaration` or the instantiation of a generic subprogram, any access parameter of the renamed subprogram or the generic subprogram that corresponds to a controlling access parameter of the dispatching operation, shall have a subtype that excludes null.

Replace paragraph 17:

If all of the controlling operands are tag-indeterminate, then:

by:

If all of the controlling operands (if any) are tag-indeterminate, then:

Replace paragraph 18:

- If the call has a controlling result and is itself a (possibly parenthesized or qualified) controlling operand of an enclosing call on a dispatching operation of type *T*, then its controlling tag value is determined by the controlling tag value of this enclosing call;

by:

- If the call has a controlling result or controlling access result and is itself, or designates, a (possibly parenthesized or qualified) controlling operand of an enclosing call on a dispatching operation of a descendant of type *T*, then its controlling tag value is determined by the controlling tag value of this enclosing call;
- If the call has a controlling result or controlling access result and (possibly parenthesized, qualified, or dereferenced) is the expression of an `assignment_statement` whose target is of a class-wide type, then its controlling tag value is determined by the target;

Replace paragraph 20:

For the execution of a call on a dispatching operation, the body executed is the one for the corresponding primitive subprogram of the specific type identified by the controlling tag value. The body for an explicitly declared dispatching operation is the corresponding explicit body for the subprogram. The body for an implicitly declared dispatching operation that is overridden is the body for the overriding subprogram, even if the overriding occurs in a private part. The body for an inherited dispatching operation that is not overridden is the body of the corresponding subprogram of the parent or ancestor type.

by:

For the execution of a call on a dispatching operation, the action performed is determined by the properties of the corresponding dispatching operation of the specific type identified by the controlling tag value. If the corresponding operation is explicitly declared for this type, even if the declaration occurs in a private part, then the action comprises an invocation of the explicit body for the operation. If the corresponding operation is implicitly declared for this type:

- if the operation is implemented by an entry or protected subprogram (see 9.1 and 9.4), then the action comprises a call on this entry or protected subprogram, with the target object being given by the first actual parameter of the call, and the actual parameters of the entry or protected subprogram being given by the remaining actual parameters of the call, if any;
- otherwise, the action is the same as the action for the corresponding operation of the parent type.

Replace paragraph 22:

73 This subclause covers calls on primitive subprograms of a tagged type. Rules for tagged type membership tests are described in 4.5.2. Controlling tag determination for an `assignment_statement` is described in 5.2.

by:

73 This subclause covers calls on dispatching subprograms of a tagged type. Rules for tagged type membership tests are described in 4.5.2. Controlling tag determination for an `assignment_statement` is described in 5.2.

3.9.3 Abstract Types and Subprograms

Replace paragraph 1:

An *abstract type* is a tagged type intended for use as a parent type for type extensions, but which is not allowed to have objects of its own. An *abstract subprogram* is a subprogram that has no body, but is intended to be overridden at some point when inherited. Because objects of an abstract type cannot be created, a dispatching call to an abstract subprogram always dispatches to some overriding body.

by:

An *abstract type* is a tagged type intended for use as an ancestor of other types, but which is not allowed to have objects of its own. An *abstract subprogram* is a subprogram that has no body, but is intended to be overridden at some point when inherited. Because objects of an abstract type cannot be created, a dispatching call to an abstract subprogram always dispatches to some overriding body.

Syntax

```
abstract_subprogram_declaration ::=
    [overriding_indicator]
    subprogram_specification is abstract;
```

Static Semantics

Interface types (see 3.9.4) are abstract types. In addition, a tagged type that has the reserved word **abstract** in its declaration is an abstract type. The class-wide type (see 3.4.1) rooted at an abstract type is not itself an abstract type.

Replace paragraph 2:

An abstract type is a specific type that has the reserved word **abstract** in its declaration. Only a tagged type is allowed to be declared abstract.

by:

Only a tagged type shall have the reserved word **abstract** in its declaration.

Replace paragraph 3:

A subprogram declared by an `abstract_subprogram_declaration` (see 6.1) is an *abstract subprogram*. If it is a primitive subprogram of a tagged type, then the tagged type shall be abstract.

by:

A subprogram declared by an `abstract_subprogram_declaration` or a `formal_abstract_subprogram_declaration` (see 12.6) is an *abstract subprogram*. If it is a primitive subprogram of a tagged type, then the tagged type shall be abstract.

Replace paragraph 4:

For a derived type, if the parent or ancestor type has an abstract primitive subprogram, or a primitive function with a controlling result, then:

by:

If a type has an implicitly declared primitive subprogram that is inherited or is the predefined equality operator, and the corresponding primitive subprogram of the parent or ancestor type is abstract or is a function with a controlling access result, or if a type other than a null extension inherits a function with a controlling result, then:

Replace paragraph 5:

- If the derived type is abstract or untagged, the inherited subprogram is *abstract*.

by:

- If the type is abstract or untagged, the implicitly declared subprogram is *abstract*.

Replace paragraph 6:

Otherwise, the subprogram shall be overridden with a nonabstract subprogram; for a type declared in the visible part of a package, the overriding may be either in the visible or the private part. However, if the type is a generic formal type, the subprogram need not be overridden for the formal type itself; a nonabstract version will necessarily be provided by the actual type.

by:

Otherwise, the subprogram shall be overridden with a nonabstract subprogram or, in the case of a private extension inheriting a function with a controlling result, have a full type that is a null extension; for a type declared in the visible part of a package, the overriding may be either in the visible or the private part. Such a subprogram is said to *require overriding*. However, if the type is a generic formal type, the subprogram need not be overridden for the formal type itself; a nonabstract version will necessarily be provided by the actual type.

Replace paragraph 11:

A generic actual subprogram shall not be an abstract subprogram. The prefix of an `attribute_reference` for the `Access`, `Unchecked_Access`, or `Address` attributes shall not denote an abstract subprogram.

by:

A generic actual subprogram shall not be an abstract subprogram unless the generic formal subprogram is declared by a `formal_abstract_subprogram_declaration`. The prefix of an `attribute_reference` for the `Access`, `Unchecked_Access`, or `Address` attributes shall not denote an abstract subprogram.

Dynamic Semantics

The elaboration of an `abstract_subprogram_declaration` has no effect.

3.9.4 Interface Types**Insert new clause:**

An interface type is an abstract tagged type that provides a restricted form of multiple inheritance. A tagged type, task type, or protected type may have one or more interface types as ancestors.

Syntax

```
interface_type_definition ::=
  [limited | task | protected | synchronized] interface [and interface_list]
interface_list ::= interface_subtype_mark {and interface_subtype_mark}
```

Static Semantics

An interface type (also called an *interface*) is a specific abstract tagged type that is defined by an `interface_type_definition`.

An interface with the reserved word **limited**, **task**, **protected**, or **synchronized** in its definition is termed, respectively, a *limited interface*, a *task interface*, a *protected interface*, or a *synchronized interface*. In addition, all task and protected interfaces are synchronized interfaces, and all synchronized interfaces are limited interfaces.

A task or protected type derived from an interface is a tagged type. Such a tagged type is called a *synchronized* tagged type, as are synchronized interfaces and private extensions whose declaration includes the reserved word **synchronized**.

A task interface is an abstract task type. A protected interface is an abstract protected type.

An interface type has no components.

An *interface_subtype_mark* in an *interface_list* names a *progenitor subtype*; its type is the *progenitor type*. An interface type inherits user-defined primitive subprograms from each progenitor type in the same way that a derived type inherits user-defined primitive subprograms from its progenitor types (see 3.4).

Legality Rules

All user-defined primitive subprograms of an interface type shall be abstract subprograms or null procedures.

The type of a subtype named in an *interface_list* shall be an interface type.

A type derived from a nonlimited interface shall be nonlimited.

An interface derived from a task interface shall include the reserved word **task** in its definition; any other type derived from a task interface shall be a private extension or a task type declared by a task declaration (see 9.1).

An interface derived from a protected interface shall include the reserved word **protected** in its definition; any other type derived from a protected interface shall be a private extension or a protected type declared by a protected declaration (see 9.4).

An interface derived from a synchronized interface shall include one of the reserved words **task**, **protected**, or **synchronized** in its definition; any other type derived from a synchronized interface shall be a private extension, a task type declared by a task declaration, or a protected type declared by a protected declaration.

No type shall be derived from both a task interface and a protected interface.

In addition to the places where Legality Rules normally apply (see 12.3), these rules apply also in the private part of an instance of a generic unit.

Dynamic Semantics

The elaboration of an *interface_type_definition* has no effect.

NOTES

79 Nonlimited interface types have predefined nonabstract equality operators. These may be overridden with user-defined abstract equality operators. Such operators will then require an explicit overriding for any nonabstract descendant of the interface.

Examples

Example of a limited interface and a synchronized interface extending it:

```

type Queue is limited interface;
procedure Append(Q : in out Queue; Person : in Person_Name) is abstract;
procedure Remove_First(Q : in out Queue;
                        Person : out Person_Name) is abstract;
function Cur_Count(Q : in Queue) return Natural is abstract;
function Max_Count(Q : in Queue) return Natural is abstract;
-- See 3.10.1 for Person_Name.

Queue_Error : exception;
-- Append raises Queue_Error if Count(Q) = Max_Count(Q)
-- Remove_First raises Queue_Error if Count(Q) = 0

type Synchronized_Queue is synchronized interface and Queue; -- see 9.11
procedure Append_Wait(Q : in out Synchronized_Queue;
                      Person : in Person_Name) is abstract;
procedure Remove_First_Wait(Q : in out Synchronized_Queue;
                              Person : out Person_Name) is abstract;

...

procedure Transfer(From : in out Queue'Class;

```

```

        To      : in out Queue'Class;
        Number : in      Natural := 1) is
    Person : Person_Name;
begin
    for I in 1..Number loop
        Remove_First(From, Person);
        Append(To, Person);
    end loop;
end Transfer;
```

This defines a Queue interface defining a queue of people. (A similar design could be created to define any kind of queue simply by replacing Person_Name by an appropriate type.) The Queue interface has four dispatching operations, Append, Remove_First, Cur_Count, and Max_Count. The body of a class-wide operation, Transfer is also shown. Every non-abstract extension of Queue must provide implementations for at least its four dispatching operations, as they are abstract. Any object of a type derived from Queue may be passed to Transfer as either the From or the To operand. The two operands need not be of the same type in any given call.

The Synchronized_Queue interface inherits the four dispatching operations from Queue and adds two additional dispatching operations, which wait if necessary rather than raising the Queue_Error exception. This synchronized interface may only be implemented by a task or protected type, and as such ensures safe concurrent access.

Example use of the interface:

```

type Fast_Food_Queue is new Queue with record ...;
procedure Append(Q : in out Fast_Food_Queue; Person : in Person_Name);
procedure Remove_First(Q : in out Fast_Food_Queue; Person : in Person_Name);
function Cur_Count(Q : in Fast_Food_Queue) return Natural;
function Max_Count(Q : in Fast_Food_Queue) return Natural;

...

Cashier, Counter : Fast_Food_Queue;

...
-- Add George (see 3.10.1) to the cashier's queue:
Append (Cashier, George);
-- After payment, move George to the sandwich counter queue:
Transfer (Cashier, Counter);
...

```

An interface such as Queue can be used directly as the parent of a new type (as shown here), or can be used as a progenitor when a type is derived. In either case, the primitive operations of the interface are inherited. For Queue, the implementation of the four inherited routines must be provided. Inside the call of Transfer, calls will dispatch to the implementations of Append and Remove_First for type Fast_Food_Queue.

Example of a task interface:

```

type Serial_Device is task interface; -- see 9.1
procedure Read (Dev : in Serial_Device; C : out Character) is abstract;
procedure Write(Dev : in Serial_Device; C : in Character) is abstract;
```

The Serial_Device interface has two dispatching operations which are intended to be implemented by task entries (see 9.1).

3.10 Access Types

Replace paragraph 2:

```

access_type_definition ::=
    access_to_object_definition
    | access_to_subprogram_definition
```

by:

```

access_type_definition ::=
    [null_exclusion] access_to_object_definition
    | [null_exclusion] access_to_subprogram_definition
```

Replace paragraph 6:

access_definition ::= access subtype_mark

by:

null_exclusion ::= **not null**

access_definition ::=

[null_exclusion] access [**constant**] subtype_mark
 | [null_exclusion] access [**protected**] **procedure** parameter_profile
 | [null_exclusion] access [**protected**] **function** parameter_and_result_profile

Replace paragraph 9:

A view of an object is defined to be *aliased* if it is defined by an **object_declaration** or **component_definition** with the reserved word **aliased**, or by a renaming of an aliased view. In addition, the dereference of an access-to-object value denotes an aliased view, as does a view conversion (see 4.6) of an aliased view. Finally, the current instance of a limited type, and a formal parameter or generic formal object of a tagged type are defined to be aliased. Aliased views are the ones that can be designated by an access value. If the view defined by an **object_declaration** is aliased, and the type of the object has discriminants, then the object is constrained; if its nominal subtype is unconstrained, then the object is constrained by its initial value. Similarly, if the object created by an **allocator** has discriminants, the object is constrained, either by the designated subtype, or by its initial value.

by:

A view of an object is defined to be *aliased* if it is defined by an **object_declaration** or **component_definition** with the reserved word **aliased**, or by a renaming of an aliased view. In addition, the dereference of an access-to-object value denotes an aliased view, as does a view conversion (see 4.6) of an aliased view. The current instance of a limited tagged type, a protected type, a task type, or a type that has the reserved word **limited** in its full definition is also defined to be aliased. Finally, a formal parameter or generic formal object of a tagged type is defined to be aliased. Aliased views are the ones that can be designated by an access value.

Replace paragraph 12:

An **access_definition** defines an anonymous general access-to-variable type; the **subtype_mark** denotes its *designated subtype*. An **access_definition** is used in the specification of an access discriminant (see 3.7) or an access parameter (see 6.1).

by:

An **access_definition** defines an anonymous general access type or an anonymous access-to-subprogram type. For a general access type, the **subtype_mark** denotes its *designated subtype*; if the **general_access_modifier constant** appears, the type is an access-to-constant type; otherwise it is an access-to-variable type. For an access-to-subprogram type, the **parameter_profile** or **parameter_and_result_profile** denotes its *designated profile*.

Replace paragraph 13:

For each (named) access type, there is a literal **null** which has a null access value designating no entity at all. The null value of a named access type is the default initial value of the type. Other values of an access type are obtained by evaluating an **attribute_reference** for the **Access** or **Unchecked_Access** attribute of an aliased view of an object or non-intrinsic subprogram, or, in the case of a named access-to-object type, an **allocator**, which returns an access value designating a newly created object (see 3.10.2).

by:

For each access type, there is a null access value designating no entity at all, which can be obtained by (implicitly) converting the literal **null** to the access type. The null value of an access type is the default initial value of the type. Non-null values of an access-to-object type are obtained by evaluating an **allocator**, which returns an access value designating a newly created object (see 3.10.2), or in the case of a general access-to-object type, evaluating an **attribute_reference** for the **Access** or **Unchecked_Access** attribute of an aliased view of an object. Non-null values of an access-to-subprogram type are obtained by evaluating an **attribute_reference** for the **Access** attribute of a non-intrinsic subprogram.

A **null_exclusion** in a construct specifies that the null value does not belong to the access subtype defined by the construct, that is, the access subtype *excludes null*. In addition, the anonymous access subtype defined by the **access_definition** for a controlling access parameter (see 3.9.2) excludes null. Finally, for a **subtype_indication**

without a `null_exclusion`, the subtype denoted by the `subtype_indication` excludes null if and only if the subtype denoted by the `subtype_mark` in the `subtype_indication` excludes null.

Insert after paragraph 14:

All subtypes of an access-to-subprogram type are constrained. The first subtype of a type defined by an `access_definition` or an `access_to_object_definition` is unconstrained if the designated subtype is an unconstrained array or discriminated subtype; otherwise it is constrained.

the new paragraph:

Legality Rules

If a `subtype_indication`, `discriminant_specification`, `parameter_specification`, `parameter_and_result_profile`, `object_renaming_declaration`, or `formal_object_declaration` has a `null_exclusion`, the `subtype_mark` in that construct shall denote an access subtype that does not exclude null.

Replace paragraph 15:

A `composite_constraint` is *compatible* with an unconstrained access subtype if it is compatible with the designated subtype. An access value *satisfies* a `composite_constraint` of an access subtype if it equals the null value of its type or if it designates an object whose value satisfies the constraint.

by:

A `composite_constraint` is *compatible* with an unconstrained access subtype if it is compatible with the designated subtype. A `null_exclusion` is compatible with any access subtype that does not exclude null. An access value *satisfies* a `composite_constraint` of an access subtype if it equals the null value of its type or if it designates an object whose value satisfies the constraint. An access value satisfies an exclusion of the null value if it does not equal the null value of its type.

Replace paragraph 17:

The elaboration of an `access_definition` creates an anonymous general access-to-variable type [(this happens as part of the initialization of an access parameter or access discriminant)].

by:

The elaboration of an `access_definition` creates an anonymous access type.

Replace paragraph 22:

```
type Peripheral_Ref is access Peripheral; -- see 3.8.1
type Binop_Ptr is access all Binary_Operation'Class;
-- general access-to-class-wide, see 3.9.1
```

by:

```
type Peripheral_Ref is not null access Peripheral; -- see 3.8.1
type Binop_Ptr is access all Binary_Operation'Class;
-- general access-to-class-wide, see 3.9.1
```

3.10.1 Incomplete Type Declarations

Replace paragraph 2:

`incomplete_type_declaration` ::= `type` `defining_identifier` [`discriminant_part`];

by:

`incomplete_type_declaration` ::= `type` `defining_identifier` [`discriminant_part`] [`is tagged`];

Static Semantics

An `incomplete_type_declaration` declares an *incomplete view* of a type and its first subtype; the first subtype is unconstrained if a `discriminant_part` appears. If the `incomplete_type_declaration` includes the reserved word **tagged**, it declares a *tagged incomplete view*. An incomplete view of a type is a limited view of the type (see 7.5).

Given an access type *A* whose designated type *T* is an incomplete view, a dereference of a value of type *A* also has this incomplete view except when:

- it occurs within the immediate scope of the completion of *T*, or
- it occurs within the scope of a `nonlimited_with_clause` that mentions a library package in whose visible part the completion of *T* is declared.

In these cases, the dereference has the full view of *T*.

Similarly, if a `subtype_mark` denotes a `subtype_declaration` defining a subtype of an incomplete view *T*, the `subtype_mark` denotes an incomplete view except under the same two circumstances given above, in which case it denotes the full view of *T*.

Replace paragraph 4:

If an `incomplete_type_declaration` has a `known_discriminant_part`, then a `full_type_declaration` that completes it shall have a fully conforming (explicit) `known_discriminant_part` (see 6.3.1). If an `incomplete_type_declaration` has no `discriminant_part` (or an `unknown_discriminant_part`), then a corresponding `full_type_declaration` is nevertheless allowed to have discriminants, either explicitly, or inherited via derivation.

by:

If an `incomplete_type_declaration` includes the reserved word `tagged`, then a `full_type_declaration` that completes it shall declare a tagged type. If an `incomplete_type_declaration` has a `known_discriminant_part`, then a `full_type_declaration` that completes it shall have a fully conforming (explicit) `known_discriminant_part` (see 6.3.1). If an `incomplete_type_declaration` has no `discriminant_part` (or an `unknown_discriminant_part`), then a corresponding `full_type_declaration` is nevertheless allowed to have discriminants, either explicitly, or inherited via derivation.

Replace paragraph 5:

The only allowed uses of a name that denotes an `incomplete_type_declaration` are as follows:

by:

A name that denotes an incomplete view of a type may be used as follows:

Replace paragraph 7:

- as the `subtype_mark` defining the subtype of a parameter or result of an `access_to_subprogram_definition`;

by:

- as the `subtype_mark` in the `subtype_indication` of a `subtype_declaration`; the `subtype_indication` shall not have a `null_exclusion` or a `constraint`;

Replace paragraph 8:

- as the `subtype_mark` in an `access_definition`;

by:

- as the `subtype_mark` in an `access_definition`.

If such a name denotes a tagged incomplete view, it may also be used:

- as the `subtype_mark` defining the subtype of a parameter in a `formal_part`;

Replace paragraph 9:

- as the prefix of an `attribute_reference` whose `attribute_designator` is `Class`; such an `attribute_reference` is similarly restricted to the uses allowed here; when used in this way, the corresponding `full_type_declaration` shall declare a tagged type, and the `attribute_reference` shall occur in the same library unit as the `incomplete_type_declaration`.

by:

- as the `prefix` of an `attribute_reference` whose `attribute_designator` is `Class`; such an `attribute_reference` is restricted to the uses allowed here; it denotes a tagged incomplete view.

If such a `name` occurs within the declaration list containing the completion of the incomplete view, it may also be used:

- as the `subtype_mark` defining the subtype of a parameter or result of an `access_to_subprogram_definition`.

If any of the above uses occurs as part of the declaration of a primitive subprogram of the incomplete view, and the declaration occurs immediately within the private part of a package, then the completion of the incomplete view shall also occur immediately within the private part; it shall not be deferred to the package body.

No other uses of a `name` that denotes an incomplete view of a type are allowed.

Replace paragraph 10:

A dereference (whether implicit or explicit — see 4.1) shall not be of an incomplete type.

by:

A `prefix` that denotes an object shall not be of an incomplete view.

Delete paragraph 11:

An `incomplete_type_declaration` declares an incomplete type and its first subtype; the first subtype is unconstrained if a `known_discriminant_part` appears.

Replace paragraph 19:

```
type Person(<>);      -- incomplete type declaration
type Car;           -- incomplete type declaration
```

by:

```
type Person(<>);      -- incomplete type declaration
type Car is tagged;  -- incomplete type declaration
```

Replace paragraph 20:

```
type Person_Name is access Person;
type Car_Name is access all Car;
```

by:

```
type Person_Name is access Person;
type Car_Name is access all Car'Class;
```

Replace paragraph 21:

```
type Car is
  record
    Number : Integer;
    Owner  : Person_Name;
  end record;
```

by:

```
type Car is tagged
  record
    Number : Integer;
    Owner  : Person_Name;
  end record;
```

3.10.2 Operations of Access Types

Replace paragraph 2:

For an `attribute_reference` with `attribute_designator` `Access` (or `Unchecked_Access` — see 13.10), the expected type shall be a single access type; the `prefix` of such an `attribute_reference` is never interpreted as an `implicit_dereference`. If the expected type is an access-to-subprogram type, then the expected profile of the `prefix` is the designated profile of the access type.

by:

For an `attribute_reference` with `attribute_designator` `Access` (or `Unchecked_Access` — see 13.10), the expected type shall be a single access type *A* such that:

- *A* is an access-to-object type with designated type *D* and the type of the `prefix` is *D*'Class or is covered by *D*, or
- *A* is an access-to-subprogram type whose designated profile is type conformant with that of the `prefix`.

The `prefix` of such an `attribute_reference` is never interpreted as an `implicit_dereference` or a parameterless `function_call` (see 4.1.4). The designated type or profile of the expected type of the `attribute_reference` is the expected type or profile for the `prefix`.

Replace paragraph 3:

The accessibility rules, which prevent dangling references, are written in terms of *accessibility levels*, which reflect the run-time nesting of *masters*. As explained in 7.6.1, a master is the execution of a `task_body`, a `block_statement`, a `subprogram_body`, an `entry_body`, or an `accept_statement`. An accessibility level is *deeper than* another if it is more deeply nested at run time. For example, an object declared local to a called subprogram has a deeper accessibility level than an object declared local to the calling subprogram. The accessibility rules for access types require that the accessibility level of an object designated by an access value be no deeper than that of the access type. This ensures that the object will live at least as long as the access type, which in turn ensures that the access value cannot later designate an object that no longer exists. The `Unchecked_Access` attribute may be used to circumvent the accessibility rules.

by:

The accessibility rules, which prevent dangling references, are written in terms of *accessibility levels*, which reflect the run-time nesting of *masters*. As explained in 7.6.1, a master is the execution of a certain construct, such as a `subprogram_body`. An accessibility level is *deeper than* another if it is more deeply nested at run time. For example, an object declared local to a called subprogram has a deeper accessibility level than an object declared local to the calling subprogram. The accessibility rules for access types require that the accessibility level of an object designated by an access value be no deeper than that of the access type. This ensures that the object will live at least as long as the access type, which in turn ensures that the access value cannot later designate an object that no longer exists. The `Unchecked_Access` attribute may be used to circumvent the accessibility rules.

Replace paragraph 7:

- An entity or view created by a declaration has the same accessibility level as the innermost enclosing master, except in the cases of renaming and derived access types described below. A parameter of a master has the same accessibility level as the master.

by:

- An entity or view defined by a declaration and created as part of its elaboration has the same accessibility level as the innermost master of the declaration except in the cases of renaming and derived access types described below. A parameter of a master has the same accessibility level as the master.

Replace paragraph 9:

- The accessibility level of a view conversion is the same as that of the operand.

by:

- The accessibility level of a view conversion, `qualified_expression`, or parenthesized expression, is the same as that of the operand.

Replace paragraph 10:

- For a function whose result type is a return-by-reference type, the accessibility level of the result object is the same as that of the master that elaborated the function body. For any other function, the accessibility level of the result object is that of the execution of the called function.

by:

- The accessibility level of an **aggregate** or the result of a function call (or equivalent use of an operator) that is used (in its entirety) to directly initialize part of an object is that of the object being initialized. In other contexts, the accessibility level of an **aggregate** or the result of a function call is that of the innermost master that evaluates the **aggregate** or function call.
- Within a return statement, the accessibility level of the return object is that of the execution of the return statement. If the return statement completes normally by returning from the function, then prior to leaving the function, the accessibility level of the return object changes to be a level determined by the point of call, as does the level of any coextensions (see below) of the return object.

Replace paragraph 12:

- The accessibility level of the anonymous access type of an access discriminant is the same as that of the containing object or associated constrained subtype.

by:

- The accessibility level of the anonymous access type defined by an **access_definition** of an **object_renaming_declaration** is the same as that of the renamed view.
- The accessibility level of the anonymous access type of an access discriminant in the **subtype_indication** or **qualified_expression** of an **allocator**, or in the **expression** or **return_subtype_indication** of a return statement is determined as follows:
 - If the value of the access discriminant is determined by a **discriminant_association** in a **subtype_indication**, the accessibility level of the object or subprogram designated by the associated value (or library level if the value is null);
 - If the value of the access discriminant is determined by a **component_association** in an **aggregate**, the accessibility level of the object or subprogram designated by the associated value (or library level if the value is null);
 - In other cases, where the value of the access discriminant is determined by an object with an unconstrained nominal subtype, the accessibility level of the object.
- The accessibility level of the anonymous access type of an access discriminant in any other context is that of the enclosing object.

Replace paragraph 13:

- The accessibility level of the anonymous access type of an access parameter is the same as that of the view designated by the actual. If the actual is an **allocator**, this is the accessibility level of the execution of the called subprogram.

by:

- The accessibility level of the anonymous access type of an access parameter specifying an access-to-object type is the same as that of the view designated by the actual.
- The accessibility level of the anonymous access type of an access parameter specifying an access-to-subprogram type is deeper than that of any master; all such anonymous access types have this same level.

Replace paragraph 14:

- The accessibility level of an object created by an **allocator** is the same as that of the access type.

by:

- The accessibility level of an object created by an **allocator** is the same as that of the access type, except for an **allocator** of an anonymous access type that defines the value of an access parameter or an access discriminant. For an **allocator** defining the value of an access parameter, the accessibility level is that of the innermost master of the call. For one defining an access discriminant, the accessibility level is determined as follows:
 - for an **allocator** used to define the constraint in a **subtype_declaration**, the level of the **subtype_declaration**;
 - for an **allocator** used to define the constraint in a **component_definition**, the level of the enclosing type;
 - for an **allocator** used to define the discriminant of an object, the level of the object.

In this last case, the allocated object is said to be a *coextension* of the object whose discriminant designates it, as well as of any object of which the discriminated object is itself a coextension or subcomponent. All coextensions of an object are finalized when the object is finalized (see 7.6.1).

Insert after paragraph 16:

- The accessibility level of a component, protected subprogram, or entry of (a view of) a composite object is the same as that of (the view of) the composite object.

the new paragraph:

In the above rules, the operand of a view conversion, parenthesized expression or **qualified_expression** is considered to be used in a context if the view conversion, parenthesized expression or **qualified_expression** itself is used in that context.

Replace paragraph 19:

- The statically deeper relationship does not apply to the accessibility level of the anonymous type of an access parameter; that is, such an accessibility level is not considered to be statically deeper, nor statically shallower, than any other.

by:

- The accessibility level of the anonymous access type of an access parameter specifying an access-to-subprogram type is statically deeper than that of any master; all such anonymous access types have this same level.
- The statically deeper relationship does not apply to the accessibility level of the anonymous type of an access parameter specifying an access-to-object type; that is, such an accessibility level is not considered to be statically deeper, not statically shallower, than any other.

Replace paragraph 26:

- The view shall not be a subcomponent that depends on discriminants of a variable whose nominal subtype is unconstrained, unless this subtype is indefinite, or the variable is aliased.

by:

- The view shall not be a subcomponent that depends on discriminants of a variable whose nominal subtype is unconstrained, unless this subtype is indefinite, or the variable is constrained by its initial value.

Replace paragraph 27:

- If *A* is a named access type and *D* is a tagged type, then the type of the view shall be covered by *D*; if *A* is anonymous and *D* is tagged, then the type of the view shall be either *D*'Class or a type covered by *D*; if *D* is untagged, then the type of the view shall be *D*, and *A*'s designated subtype shall either statically match the nominal subtype of the view or be discriminated and unconstrained;

by:

- If *A* is a named access type and *D* is a tagged type, then the type of the view shall be covered by *D*; if *A* is anonymous and *D* is tagged, then the type of the view shall be either *D*'Class or a type covered by *D*; if *D* is untagged, then the type of the view shall be *D*, and either:

- the designated subtype of *A* shall statically match the nominal subtype of the view; or
- *D* shall be discriminated in its full view and unconstrained in any partial view, and the designated subtype of *A* shall be unconstrained.

Replace paragraph 32:

P'Access yields an access value that designates the subprogram denoted by P. The type of P'Access is an access-to-subprogram type (*S*), as determined by the expected type. The accessibility level of P shall not be statically deeper than that of *S*. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit. The profile of P shall be subtype-conformant with the designated profile of *S*, and shall not be Intrinsic. If the subprogram denoted by P is declared within a generic body, *S* shall be declared within the generic body.

by:

P'Access yields an access value that designates the subprogram denoted by P. The type of P'Access is an access-to-subprogram type (*S*), as determined by the expected type. The accessibility level of P shall not be statically deeper than that of *S*. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit. The profile of P shall be subtype-conformant with the designated profile of *S*, and shall not be Intrinsic. If the subprogram denoted by P is declared within a generic unit, and the expression P'Access occurs within the body of that generic unit or within the body of a generic unit declared within the declarative region of the generic unit, then the ultimate ancestor of *S* shall be either a non-formal type declared within the generic unit or an anonymous access type of an access parameter.

Replace paragraph 34:

82 The predefined operations of an access type also include the assignment operation, qualification, and membership tests. Explicit conversion is allowed between general access types with matching designated subtypes; explicit conversion is allowed between access-to-subprogram types with subtype conformant profiles (see 4.6). Named access types have predefined equality operators; anonymous access types do not (see 4.5.2).

by:

82 The predefined operations of an access type also include the assignment operation, qualification, and membership tests. Explicit conversion is allowed between general access types with matching designated subtypes; explicit conversion is allowed between access-to-subprogram types with subtype conformant profiles (see 4.6). Named access types have predefined equality operators; anonymous access types do not, but they can use the predefined equality operators for *universal_access* (see 4.5.2).

Replace paragraph 37:

The accessibility rules imply that it is not possible to use the Access attribute to implement "downward closures" — that is, to pass a more-nested subprogram as a parameter to a less-nested subprogram, as might be desired for example for an iterator abstraction. Instead, downward closures can be implemented using generic formal subprograms (see 12.6). Note that Unchecked_Access is not allowed for subprograms.

by:

88 The Access attribute for subprograms and parameters of an anonymous access-to-subprogram type may together be used to implement "downward closures" — that is, to pass a more-nested subprogram as a parameter to a less-nested subprogram, as might be appropriate for an iterator abstraction or numerical integration. Downward closures can also be implemented using generic formal subprograms (see 12.6). Note that Unchecked_Access is not allowed for subprograms.

3.11 Declarative Parts

Insert after paragraph 6:

```
proper_body ::=
  subprogram_body | package_body | task_body | protected_body
```

the new paragraph:

Static Semantics

The list of `declarative_items` of a `declarative_part` is called the *declaration list* of the `declarative_part`.

Section 4: Names and Expressions

4.1 Names

Replace paragraph 11:

The evaluation of a name determines the entity denoted by the name. This evaluation has no other effect for a name that is a `direct_name` or a `character_literal`.

by:

The evaluation of a name determines the entity denoted by the name. This evaluation has no other effect for a name that is a `direct_name` or a `character_literal`.

4.1.3 Selected Components

Insert after paragraph 9:

- The `prefix` shall resolve to denote an object or value of some task or protected type (after any implicit dereference). The `selector_name` shall resolve to denote an `entry_declaration` or `subprogram_declaration` occurring (implicitly or explicitly) within the visible part of that type. The `selected_component` denotes the corresponding entry, entry family, or protected subprogram.

the new paragraph:

- A view of a subprogram whose first formal parameter is of a tagged type or is an access parameter whose designated type is tagged:

The `prefix` (after any implicit dereference) shall resolve to denote an object or value of a specific tagged type *T* or class-wide type *T*Class. The `selector_name` shall resolve to denote a view of a subprogram declared immediately within the declarative region in which an ancestor of the type *T* is declared. The first formal parameter of the subprogram shall be of type *T*, or a class-wide type that covers *T*, or an access parameter designating one of these types. The designator of the subprogram shall not be the same as that of a component of the tagged type visible at the point of the `selected_component`. The `selected_component` denotes a view of this subprogram that omits the first formal parameter. This view is called a *prefixed view* of the subprogram, and the `prefix` of the `selected_component` (after any implicit dereference) is called the *prefix* of the prefixed view.

Insert after paragraph 13:

If the `prefix` does not denote a package, then it shall be a `direct_name` or an expanded name, and it shall resolve to denote a program unit (other than a package), the current instance of a type, a `block_statement`, a `loop_statement`, or an `accept_statement` (in the case of an `accept_statement` or `entry_body`, no family index is allowed); the expanded name shall occur within the declarative region of this construct. Further, if this construct is a callable construct and the `prefix` denotes more than one such enclosing callable construct, then the expanded name is ambiguous, independently of the `selector_name`.

the new paragraph:

Legality Rules

For a subprogram whose first parameter is an access parameter, the prefix of any prefixed view shall denote an aliased view of an object.

For a subprogram whose first parameter is of mode **in out** or **out**, or of an anonymous access-to-variable type, the prefix of any prefixed view shall denote a variable.

In paragraph 17 replace:

`Control.Seize` -- *an entry of a protected object* (see 9.4)

by:

`Cashier.Append` -- *a prefixed view of a procedure* (see 3.9.4)
`Control.Seize` -- *an entry of a protected object* (see 9.4)

4.1.4 Attributes

Replace paragraph 14:

5 In general, the **name** in a **prefix** of an **attribute_reference** (or a **range_attribute_reference**) has to be resolved without using any context. However, in the case of the **Access** attribute, the expected type for the **prefix** has to be a single access type, and if it is an access-to-subprogram type (see 3.10.2) then the resolution of the **name** can use the fact that the profile of the callable entity denoted by the **prefix** has to be type conformant with the designated profile of the access type.

by:

5 In general, the **name** in a **prefix** of an **attribute_reference** (or a **range_attribute_reference**) has to be resolved without using any context. However, in the case of the **Access** attribute, the expected type for the **attribute_reference** has to be a single access type, and the resolution of the **name** can use the fact that the type of the object or the profile of the callable entity denoted by the **prefix** has to match the designated type or be type conformant with the designated profile of the access type.

4.2 Literals

Delete paragraph 2:

The expected type for a literal **null** shall be a single access type.

Delete paragraph 7:

A literal **null** shall not be of an anonymous access type, since such types do not have a **null** value (see 3.10).

Replace paragraph 8:

An integer literal is of type *universal_integer*. A real literal is of type *universal_real*.

by:

An integer literal is of type *universal_integer*. A real literal is of type *universal_real*. The literal **null** is of type *universal_access*.

4.3 Aggregates

Replace paragraph 3:

The expected type for an **aggregate** shall be a single nonlimited array type, record type, or record extension.

by:

The expected type for an **aggregate** shall be a single array type, record type, or record extension.

4.3.1 Record Aggregates

Replace paragraph 4:

```
record_component_association ::=
  [ component_choice_list => ] expression
```

by:

```
record_component_association ::=
  [component_choice_list =>] expression
  | component_choice_list => <>
```

Replace paragraph 8:

The expected type for a **record_aggregate** shall be a single nonlimited record type or record extension.

by:

The expected type for a **record_aggregate** shall be a single record type or record extension.

Replace paragraph 16:

Each `record_component_association` shall have at least one associated component, and each needed component shall be associated with exactly one `record_component_association`. If a `record_component_association` has two or more associated components, all of them shall be of the same type.

by:

Each `record_component_association` other than an **others** choice with a $\langle \rangle$ shall have at least one associated component, and each needed component shall be associated with exactly one `record_component_association`. If a `record_component_association` with an `expression` has two or more associated components, all of them shall be of the same type.

Insert after paragraph 17:

If the components of a `variant_part` are needed, then the value of a discriminant that governs the `variant_part` shall be given by a static expression.

the new paragraph:

A `record_component_association` for a discriminant without a `default_expression` shall have an `expression` rather than $\langle \rangle$.

Insert before paragraph 20:

The expression of a `record_component_association` is evaluated (and converted) once for each associated component.

the new paragraph:

For a `record_component_association` with an `expression`, the `expression` defines the value for the associated component(s). For a `record_component_association` with $\langle \rangle$, if the `component_declaration` has a `default_expression`, that `default_expression` defines the value for the associated component(s); otherwise, the associated component(s) are initialized by default as for a stand-alone object of the component subtype (see 3.3.1).

Replace paragraph 27:

Example of component association with several choices:

by:

Examples of component associations with several choices:

Insert after paragraph 29:

-- *The allocator is evaluated twice: Succ and Pred designate different cells*

the new paragraphs:

(Value => 0, Succ|Pred => $\langle \rangle$)

-- *see 3.10.1*

-- *Succ and Pred will be set to null*

4.3.2 Extension Aggregates

Replace paragraph 4:

The expected type for an `extension_aggregate` shall be a single nonlimited type that is a record extension. If the `ancestor_part` is an `expression`, it is expected to be of any nonlimited tagged type.

by:

The expected type for an `extension_aggregate` shall be a single type that is a record extension. If the `ancestor_part` is an `expression`, it is expected to be of any tagged type.

Replace paragraph 5:

If the `ancestor_part` is a `subtype_mark`, it shall denote a specific tagged subtype. The type of the `extension_aggregate` shall be derived from the type of the `ancestor_part`, through one or more record extensions (and no private extensions).

by:

If the `ancestor_part` is a `subtype_mark`, it shall denote a specific tagged subtype. If the `ancestor_part` is an `expression`, it shall not be dynamically tagged. The type of the `extension_aggregate` shall be derived from the type of the `ancestor_part`, through one or more record extensions (and no private extensions).

4.3.3 Array Aggregates**Replace paragraph 3:**

```
positional_array_aggregate ::=
  (expression, expression {, expression})
  | (expression {, expression}, others => expression)
```

by:

```
positional_array_aggregate ::=
  (expression, expression {, expression})
  | (expression {, expression}, others => expression)
  | (expression {, expression}, others => <>)
```

Replace paragraph 5:

```
array_component_association ::=
  discrete_choice_list => expression
```

by:

```
array_component_association ::=
  discrete_choice_list => expression
  | discrete_choice_list => <>
```

Replace paragraph 7:

The expected type for an `array_aggregate` (that is not a subaggregate) shall be a single nonlimited array type. The component type of this array type is the expected type for each array component expression of the `array_aggregate`.

by:

The expected type for an `array_aggregate` (that is not a subaggregate) shall be a single array type. The component type of this array type is the expected type for each array component expression of the `array_aggregate`.

Replace paragraph 11:

For an `explicit_actual_parameter`, an `explicit_generic_actual_parameter`, the expression of a `return_statement`, the initialization expression in an `object_declaration`, or a `default_expression` (for a parameter or a component), when the nominal subtype of the corresponding formal parameter, generic formal parameter, function result, object, or component is a constrained array subtype, the applicable index constraint is the constraint of the subtype;

by:

For an `explicit_actual_parameter`, an `explicit_generic_actual_parameter`, the expression of a return statement, the initialization expression in an `object_declaration`, or a `default_expression` (for a parameter or a component), when the nominal subtype of the corresponding formal parameter, generic formal parameter, function return object, object, or component is a constrained array subtype, the applicable index constraint is the constraint of the subtype;

Insert before paragraph 24:

The bounds of the index range of an `array_aggregate` (including a subaggregate) are determined as follows:

the new paragraph:

Each expression in an `array_component_association` defines the value for the associated component(s). For an `array_component_association` with `<>`, the associated component(s) are initialized by default as for a stand-alone object of the component subtype (see 3.3.1).

Insert after paragraph 43:

```
D : Bit_Vector(M .. N) := (M .. N => True);           -- see 3.6
E : Bit_Vector(M .. N) := (others => True);
F : String(1 .. 1) := (1 => 'F'); -- a one component aggregate: same as "F"
```

the new paragraphs:

Example of an array aggregate with defaulted others choice and with an applicable index constraint provided by an enclosing record aggregate:

```
Buffer'(Size => 50, Pos => 1, Value => String('x', others => <>)) -- see 3.7
```

4.4 Expressions

Replace paragraph 15:

```
Volume                -- primary
not Destroyed         -- factor
2*Line_Count         -- term
-4.0                  -- simple expression
-4.0 + A              -- simple expression
B**2 - 4.0*A*C        -- simple expression
Password(1 .. 3) = "Bwv" -- relation
Count in Small_Int   -- relation
Count not in Small_Int -- relation
Index = 0 or Item_Hit -- expression
(Cold and Sunny) or Warm -- expression (parentheses are required)
A**(B**C)             -- expression (parentheses are required)
```

by:

```
Volume                -- primary
not Destroyed         -- factor
2*Line_Count         -- term
-4.0                  -- simple expression
-4.0 + A              -- simple expression
B**2 - 4.0*A*C        -- simple expression
R*Sin(θ)*Cos(φ)      -- simple expression
Password(1 .. 3) = "Bwv" -- relation
Count in Small_Int   -- relation
Count not in Small_Int -- relation
Index = 0 or Item_Hit -- expression
(Cold and Sunny) or Warm -- expression (parentheses are required)
A**(B**C)             -- expression (parentheses are required)
```

4.5.2 Relational Operators and Membership Tests

Replace paragraph 3:

The *tested type* of a membership test is the type of the `range` or the type determined by the `subtype_mark`. If the tested type is tagged, then the `simple_expression` shall resolve to be of a type that covers or is covered by the tested type; if untagged, the expected type for the `simple_expression` is the tested type.

by:

The *tested type* of a membership test is the type of the `range` or the type determined by the `subtype_mark`. If the tested type is tagged, then the `simple_expression` shall resolve to be of a type that is convertible (see 4.6) to the tested type; if untagged, the expected type for the `simple_expression` is the tested type.

Insert after paragraph 7:

```
function "=" (Left, Right : T) return Boolean
function "/=" (Left, Right : T) return Boolean
```

the new paragraphs:

The following additional equality operators for the *universal_access* type are declared in package Standard for use with anonymous access types:

```
function "=" (Left, Right : universal_access) return Boolean
function "/=" (Left, Right : universal_access) return Boolean
```

Insert after paragraph 9:

```
function "<" (Left, Right : T) return Boolean
function "<=" (Left, Right : T) return Boolean
function ">" (Left, Right : T) return Boolean
function ">=" (Left, Right : T) return Boolean
```

the new paragraphs:*Name Resolution Rules*

At least one of the operands of an equality operator for *universal_access* shall be of a specific anonymous access type. Unless the predefined equality operator is identified using an expanded name with prefix denoting the package Standard, neither operand shall be of an access-to-object type whose designated type is *D* or *D*'Class, where *D* has a user-defined primitive equality operator such that:

- its result type is Boolean;
- it is declared immediately within the same declaration list as *D*; and
- at least one of its operands is an access parameter with designated type *D*.

Legality Rules

At least one of the operands of the equality operators for *universal_access* shall be of type *universal_access*, or both shall be of access-to-object types, or both shall be of access-to-subprogram types. Further:

- When both are of access-to-object types, the designated types shall be the same or one shall cover the other, and if the designated types are elementary or array types, then the designated subtypes shall statically match;
- When both are of access-to-subprogram types, the designated profiles shall be subtype conformant.

Replace paragraph 30:

- The tested type is not scalar, and the value of the `simple_expression` satisfies any constraints of the named subtype, and, if the type of the `simple_expression` is class-wide, the value has a tag that identifies a type covered by the tested type.

by:

- The tested type is not scalar, and the value of the `simple_expression` satisfies any constraints of the named subtype, and:
 - if the type of the `simple_expression` is class-wide, the value has a tag that identifies a type covered by the tested type;
 - if the tested type is an access type and the named subtype excludes null, the value of the `simple_expression` is not null.

Delete paragraph 33:

13 No exception is ever raised by a membership test, by a predefined ordering operator, or by a predefined equality operator for an elementary type, but an exception can be raised by the evaluation of the operands. A predefined equality operator for a composite type can only raise an exception if the type has a tagged part whose primitive equals operator propagates an exception.

4.5.5 Multiplying Operators

Replace paragraph 20:

Legality Rules

The above two fixed-fixed multiplying operators shall not be used in a context where the expected type for the result is itself *universal_fixed* — the context has to identify some other numeric type to which the result is to be converted, either explicitly or implicitly.

by:

Name Resolution Rules

The above two fixed-fixed multiplying operators shall not be used in a context where the expected type for the result is itself *universal_fixed* — the context has to identify some other numeric type to which the result is to be converted, either explicitly or implicitly. Unless the predefined universal operator is identified using an expanded name with prefix denoting the package Standard, an explicit conversion is required on the result when using the above fixed-fixed multiplication operator if either operand is of a type having a user-defined primitive multiplication operator such that:

- it is declared immediately within the same declaration list as the type; and
- both of its formal parameters are of a fixed-point type.

A corresponding requirement applies to the universal fixed-fixed division operator.

4.6 Type Conversions

Replace paragraph 5:

A *type_conversion* whose operand is the **name** of an object is called a *view conversion* if both its target type and operand type are tagged, or if it appears as an actual parameter of mode **out** or **in out**; other *type_conversions* are called *value conversions*.

by:

A *type_conversion* whose operand is the **name** of an object is called a *view conversion* if both its target type and operand type are tagged, or if it appears in a call as an actual parameter of mode **out** or **in out**; other *type_conversions* are called *value conversions*.

Replace paragraph 8:

If the target type is a numeric type, then the operand type shall be a numeric type.

by:

In a view conversion for an untagged type, the target type shall be convertible (back) to the operand type.

Delete paragraph 9:

If the target type is an array type, then the operand type shall be an array type. Further:

Delete paragraph 10:

- The types shall have the same dimensionality;

Delete paragraph 11:

- Corresponding index types shall be convertible;

Delete paragraph 12:

- The component subtypes shall statically match; and

Delete paragraph 12.1:

- In a view conversion, the target type and the operand type shall both or neither have aliased components.

Delete paragraph 13:

If the target type is a general access type, then the operand type shall be an access-to-object type. Further:

Delete paragraph 14:

- If the target type is an access-to-variable type, then the operand type shall be an access-to-variable type;

Delete paragraph 15:

- If the target designated type is tagged, then the operand designated type shall be convertible to the target designated type;

Delete paragraph 16:

- If the target designated type is not tagged, then the designated types shall be the same, and either the designated subtypes shall statically match or the target designated subtype shall be discriminated and unconstrained; and

Delete paragraph 17:

- The accessibility level of the operand type shall not be statically deeper than that of the target type. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit.

Delete paragraph 18:

If the target type is an access-to-subprogram type, then the operand type shall be an access-to-subprogram type. Further:

Delete paragraph 19:

- The designated profiles shall be subtype-conformant.

Delete paragraph 20:

- The accessibility level of the operand type shall not be statically deeper than that of the target type. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit. If the operand type is declared within a generic body, the target type shall be declared within the generic body.

Replace paragraph 21:

If the target type is not included in any of the above four cases, there shall be a type that is an ancestor of both the target type and the operand type. Further, if the target type is tagged, then either:

by:

If there is a type that is an ancestor of both the target type and the operand type, or both types are class-wide types, then at least one of the following rules shall apply:

- The target type shall be untagged; or

Replace paragraph 23:

- The operand type shall be a class-wide type that covers the target type.

by:

- The operand type shall be a class-wide type that covers the target type; or
- The operand and target types shall both be class-wide types and the specific type associated with at least one of them shall be an interface type.

Replace paragraph 24:

In a view conversion for an untagged type, the target type shall be convertible (back) to the operand type.

by:

If there is no type that is the ancestor of both the target type and the operand type, and they are not both class-wide types, one of the following rules shall apply:

- If the target type is a numeric type, then the operand type shall be a numeric type.
- If the target type is an array type, then the operand type shall be an array type. Further:
 - The types shall have the same dimensionality;
 - Corresponding index types shall be convertible;
 - The component subtypes shall statically match;
 - If the component types are anonymous access types, then the accessibility level of the operand type shall not be statically deeper than that of the target type;
 - Neither the target type nor the operand type shall be limited;
 - If the target type of a view conversion has aliased components, then so shall the operand type; and
 - The operand type of a view conversion shall not have a tagged, private, or volatile subcomponent.
- If the target type is *universal_access*, then the operand type shall be an access type.
- If the target type is a general access-to-object type, then the operand type shall be *universal_access* or an access-to-object type. Further, if the operand type is not *universal_access*:
 - If the target type is an access-to-variable type, then the operand type shall be an access-to-variable type;
 - If the target designated type is tagged, then the operand designated type shall be convertible to the target designated type;
 - If the target designated type is not tagged, then the designated types shall be the same, and either:
 - the designated subtypes shall statically match; or
 - the designated type shall be discriminated in its full view and unconstrained in any partial view, and one of the designated subtypes shall be unconstrained;
 - The accessibility level of the operand type shall not be statically deeper than that of the target type. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit.
- If the target type is a pool-specific access-to-object type, then the operand type shall be *universal_access*.
- If the target type is an access-to-subprogram type, then the operand type shall be *universal_access* or an access-to-subprogram type. Further, if the operand type is not *universal_access*:
 - The designated profiles shall be subtype-conformant.
 - The accessibility level of the operand type shall not be statically deeper than that of the target type. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit. If the operand type is declared within a generic body, the target type shall be declared within the generic body.

Insert after paragraph 39:

- In either array case, the value of each component of the result is that of the matching component of the operand value (see 4.5.2).

the new paragraph:

- If the component types of the array types are anonymous access types, then a check is made that the accessibility level of the operand type is not deeper than that of the target type.

Replace paragraph 49:

- If the target type is an anonymous access type, a check is made that the value of the operand is not null; if the target is not an anonymous access type, then the result is null if the operand value is null.

by:

- If the operand value is null, the result of the conversion is the null value of the target type.

Replace paragraph 51:

After conversion of the value to the target type, if the target subtype is constrained, a check is performed that the value satisfies this constraint.

by:

After conversion of the value to the target type, if the target subtype is constrained, a check is performed that the value satisfies this constraint. If the target subtype excludes null, then a check is made that the value is not null.

Replace paragraph 61:

22 A ramification of the overload resolution rules is that the operand of an (explicit) `type_conversion` cannot be the literal `null`, an `allocator`, an `aggregate`, a `string_literal`, a `character_literal`, or an `attribute_reference` for an `Access` or `Unchecked_Access` attribute. Similarly, such an `expression` enclosed by parentheses is not allowed. A `qualified_expression` (see 4.7) can be used instead of such a `type_conversion`.

by:

22 A ramification of the overload resolution rules is that the operand of an (explicit) `type_conversion` cannot be an `allocator`, an `aggregate`, a `string_literal`, a `character_literal`, or an `attribute_reference` for an `Access` or `Unchecked_Access` attribute. Similarly, such an `expression` enclosed by parentheses is not allowed. A `qualified_expression` (see 4.7) can be used instead of such a `type_conversion`.

4.8 Allocators

Replace paragraph 5:

If the type of the `allocator` is an access-to-constant type, the `allocator` shall be an initialized allocator. If the designated type is limited, the `allocator` shall be an uninitialized allocator.

by:

If the type of the `allocator` is an access-to-constant type, the `allocator` shall be an initialized allocator.

If the designated type of the type of the `allocator` is class-wide, the accessibility level of the type determined by the `subtype_indication` or `qualified_expression` shall not be statically deeper than that of the type of the `allocator`.

If the designated subtype of the type of the `allocator` has one or more unconstrained access discriminants, then the accessibility level of the anonymous access type of each access discriminant, as determined by the `subtype_indication` or `qualified_expression` of the `allocator`, shall not be statically deeper than that of the type of the `allocator` (see 3.10.2).

An `allocator` shall not be of an access type for which the `Storage_Size` has been specified by a static expression with value zero or is defined by the language to be zero. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit. This rule does not apply in the body of a generic unit or within a body declared within the declarative region of a generic unit, if the type of the `allocator` is a descendant of a formal access type declared within the formal part of the generic unit.

Replace paragraph 6:

If the designated type of the type of the `allocator` is elementary, then the subtype of the created object is the designated subtype. If the designated type is composite, then the created object is always constrained; if the designated subtype is constrained, then it provides the constraint of the created object; otherwise, the object is constrained by its initial value (even if the designated subtype is unconstrained with defaults).

by:

If the designated type of the type of the `allocator` is elementary, then the subtype of the created object is the designated subtype. If the designated type is composite, then the subtype of the created object is the designated

subtype when the designated subtype is constrained or there is a partial view of the designated type that is constrained; otherwise, the created object is constrained by its initial value (even if the designated subtype is unconstrained with defaults).

Replace paragraph 7:

For the evaluation of an **allocator**, the elaboration of the **subtype_indication** or the evaluation of the **qualified_expression** is performed first. For the evaluation of an initialized allocator, an object of the designated type is created and the value of the **qualified_expression** is converted to the designated subtype and assigned to the object.

by:

For the evaluation of an initialized allocator, the evaluation of the **qualified_expression** is performed first. An object of the designated type is created and the value of the **qualified_expression** is converted to the designated subtype and assigned to the object.

Replace paragraph 8:

For the evaluation of an uninitialized allocator:

by:

For the evaluation of an uninitialized allocator, the elaboration of the **subtype_indication** is performed first. Then:

Replace paragraph 10:

- If the designated type is composite, an object of the designated type is created with tag, if any, determined by the **subtype_mark** of the **subtype_indication**; any per-object constraints on subcomponents are elaborated (see 3.8) and any implicit initial values for the subcomponents of the object are obtained as determined by the **subtype_indication** and assigned to the corresponding subcomponents. A check is made that the value of the object belongs to the designated subtype. **Constraint_Error** is raised if this check fails. This check and the initialization of the object are performed in an arbitrary order.

by:

- If the designated type is composite, an object of the designated type is created with tag, if any, determined by the **subtype_mark** of the **subtype_indication**. This object is then initialized by default (see 3.3.1) using the **subtype_indication** to determine its nominal subtype. A check is made that the value of the object belongs to the designated subtype. **Constraint_Error** is raised if this check fails. This check and the initialization of the object are performed in an arbitrary order.

For any **allocator**, if the designated type of the type of the **allocator** is class-wide, then a check is made that the accessibility level of the type determined by the **subtype_indication**, or by the tag of the value of the **qualified_expression**, is not deeper than that of the type of the **allocator**. If the designated subtype of the **allocator** has one or more unconstrained access discriminants, then a check is made that the accessibility level of the anonymous access type of each access discriminant is not deeper than that of the type of the **allocator**. **Program_Error** is raised if either such check fails.

Replace paragraph 11:

If the created object contains any tasks, they are activated (see 9.2). Finally, an access value that designates the created object is returned.

by:

If the object to be created by an **allocator** has a controlled or protected part, and the finalization of the collection of the type of the **allocator** (see 7.6.1) has started, **Program_Error** is raised.

If the object to be created by an **allocator** contains any tasks, and the master of the type of the **allocator** is completed, and all of the dependent tasks of the master are terminated (see 9.3), then **Program_Error** is raised.

If the created object contains any tasks, they are activated (see 9.2). Finally, an access value that designates the created object is returned.

Bounded (Run-Time) Errors

It is a bounded error if the finalization of the collection of the type (see 7.6.1) of the **allocator** has started. If the error is detected, **Program_Error** is raised. Otherwise, the allocation proceeds normally.

4.9 Static Expressions and Static Subtypes

Replace paragraph 26:

A *static subtype* is either a *static scalar subtype* or a *static string subtype*. A static scalar subtype is an unconstrained scalar subtype whose type is not a descendant of a formal scalar type, or a constrained scalar subtype formed by imposing a compatible static constraint on a static scalar subtype. A static string subtype is an unconstrained string subtype whose index subtype and component subtype are static (and whose type is not a descendant of a formal array type), or a constrained string subtype formed by imposing a compatible static constraint on a static string subtype. In any case, the subtype of a generic formal object of mode **in out**, and the result subtype of a generic formal function, are not static.

by:

A *static subtype* is either a *static scalar subtype* or a *static string subtype*. A static scalar subtype is an unconstrained scalar subtype whose type is not a descendant of a formal type, or a constrained scalar subtype formed by imposing a compatible static constraint on a static scalar subtype. A static string subtype is an unconstrained string subtype whose index subtype and component subtype are static, or a constrained string subtype formed by imposing a compatible static constraint on a static string subtype. In any case, the subtype of a generic formal object of mode **in out**, and the result subtype of a generic formal function, are not static.

Insert after paragraph 31:

- A discriminant constraint is static if each expression of the constraint is static, and the subtype of each discriminant is static.

the new paragraph:

In any case, the constraint of the first subtype of a scalar formal type is neither static nor null.

Replace paragraph 35:

- If the expression is not part of a larger static expression, then its value shall be within the base range of its expected type. Otherwise, the value may be arbitrarily large or small.

by:

- If the expression is not part of a larger static expression and the expression is expected to be of a single specific type, then its value shall be within the base range of its expected type. Otherwise, the value may be arbitrarily large or small.

Replace paragraph 36

- If the expression is of type *universal_real* and its expected type is a decimal fixed point type, then its value shall be a multiple of the *small* of the decimal type.

by:

- If the expression is of type *universal_real* and its expected type is a decimal fixed point type, then its value shall be a multiple of the *small* of the decimal type. This restriction does not apply if the expected type is a descendant of a formal scalar type (or a corresponding actual type in an instance).

Replace paragraph 37:

The last two restrictions above do not apply if the expected type is a descendant of a formal scalar type (or a corresponding actual type in an instance).

by:

In addition to the places where Legality Rules normally apply (see 12.3), the above restrictions also apply in the private part of an instance of a generic unit.

Replace paragraph 38:

For a real static expression that is not part of a larger static expression, and whose expected type is not a descendant of a formal scalar type, the implementation shall round or truncate the value (according to the `Machine_Rounds` attribute of the expected type) to the nearest machine number of the expected type; if the value is exactly half-way between two machine numbers, any rounding shall be performed away from zero. If the expected type is a descendant of a formal scalar type, no special rounding or truncating is required — normal accuracy rules apply (see Annex G).

by:

For a real static expression that is not part of a larger static expression, and whose expected type is not a descendant of a formal type, the implementation shall round or truncate the value (according to the `Machine_Rounds` attribute of the expected type) to the nearest machine number of the expected type; if the value is exactly half-way between two machine numbers, the rounding performed is implementation-defined. If the expected type is a descendant of a formal type, or if the static expression appears in the body of an instance of a generic unit and the corresponding expression is nonstatic in the corresponding generic body, then no special rounding or truncating is required — normal accuracy rules apply (see Annex G).

Implementation Advice

For a real static expression that is not part of a larger static expression, and whose expected type is not a descendant of a formal type, the rounding should be the same as the default rounding for the target system.

4.9.1 Statically Matching Constraints and Subtypes

Replace paragraph 1:

A constraint *statically matches* another constraint if both are null constraints, both are static and have equal corresponding bounds or discriminant values, or both are nonstatic and result from the same elaboration of a constraint of a `subtype_indication` or the same evaluation of a `range` of a `discrete_subtype_definition`.

by:

A constraint *statically matches* another constraint if:

- both are null constraints;
- both are static and have equal corresponding bounds or discriminant values;
- both are nonstatic and result from the same elaboration of a constraint of a `subtype_indication` or the same evaluation of a `range` of a `discrete_subtype_definition`; or
- both are nonstatic and come from the same `formal_type_declaration`.

Replace paragraph 2:

A subtype *statically matches* another subtype of the same type if they have statically matching constraints. Two anonymous access subtypes statically match if their designated subtypes statically match.

by:

A subtype *statically matches* another subtype of the same type if they have statically matching constraints, and, for access subtypes, either both or neither exclude null. Two anonymous access-to-object subtypes statically match if their designated subtypes statically match, and either both or neither exclude null, and either both or neither are access-to-constant. Two anonymous access-to-subprogram subtypes statically match if their designated profiles are subtype conformant, and either both or neither exclude null.

Section 5: Statements

Replace paragraph 2:

This section describes the general rules applicable to all statements. Some statements are discussed in later sections: Procedure_call_statements and return_statements are described in 6, "Subprograms". Entry_call_statements, requeue_statements, delay_statements, accept_statements, select_statements, and abort_statements are described in 9, "Tasks and Synchronization". Raise_statements are described in 11, "Exceptions", and code_statements in 13. The remaining forms of statements are presented in this section

by:

This section describes the general rules applicable to all statements. Some statements are discussed in later sections: Procedure_call_statements and return statements are described in 6, "Subprograms". Entry_call_statements, requeue_statements, delay_statements, accept_statements, select_statements, and abort_statements are described in 9, "Tasks and Synchronization". Raise_statements are described in 11, "Exceptions", and code_statements in 13. The remaining forms of statements are presented in this section.

5.1 Simple and Compound Statements - Sequences of Statements

Replace paragraph 4:

```
simple_statement ::= null_statement
| assignment_statement | exit_statement
| goto_statement | procedure_call_statement
| return_statement | entry_call_statement
| requeue_statement | delay_statement
| abort_statement | raise_statement
| code_statement
```

by:

```
simple_statement ::= null_statement
| assignment_statement | exit_statement
| goto_statement | procedure_call_statement
| simple_return_statement | entry_call_statement
| requeue_statement | delay_statement
| abort_statement | raise_statement
| code_statement
```

Replace paragraph 5:

```
compound_statement ::=
| if_statement | case_statement
| loop_statement | block_statement
| accept_statement | select_statement
```

by:

```
compound_statement ::=
| if_statement | case_statement
| loop_statement | block_statement
| extended_return_statement
| accept_statement | select_statement
```

Replace paragraph 14:

A *transfer of control* is the run-time action of an exit_statement, return_statement, goto_statement, or requeue_statement, selection of a terminate_alternative, raising of an exception, or an abort, which causes the next action performed to be one other than what would normally be expected from the other rules of the language. As explained in 7.6.1, a transfer of control can cause the execution of constructs to be completed and then left, which may trigger finalization.

by:

A *transfer of control* is the run-time action of an *exit_statement*, return statement, *goto_statement*, or *requeue_statement*, selection of a *terminate_alternative*, raising of an exception, or an abort, which causes the next action performed to be one other than what would normally be expected from the other rules of the language. As explained in 7.6.1, a transfer of control can cause the execution of constructs to be completed and then left, which may trigger finalization.

5.2 Assignment Statements

Replace paragraph 4:

The *variable_name* of an *assignment_statement* is expected to be of any nonlimited type. The expected type for the *expression* is the type of the target.

by:

The *variable_name* of an *assignment_statement* is expected to be of any type. The expected type for the *expression* is the type of the target.

Replace paragraph 5:

The target denoted by the *variable_name* shall be a variable.

by:

The target denoted by the *variable_name* shall be a variable of a nonlimited type.

Delete paragraph 16:

3 The values of the discriminants of an object designated by an access value cannot be changed (not even by assigning a complete value to the object itself) since such objects are always constrained; however, subcomponents of such objects may be unconstrained.

Section 6: Subprograms

6.1 Subprogram Declarations

Replace paragraph 2:

subprogram_declaration ::= subprogram_specification ;

by:

subprogram_declaration ::=
 [overriding_indicator]
 subprogram_specification ;

Delete paragraph 3:

abstract_subprogram_declaration ::= subprogram_specification **is abstract**;

Replace paragraph 4:

subprogram_specification ::=
procedure defining_program_unit_name parameter_profile
 | **function** defining_designator parameter_and_result_profile

by:

subprogram_specification ::=
 procedure_specification
 | function_specification
 procedure_specification ::= **procedure** defining_program_unit_name parameter_profile
 function_specification ::= **function** defining_designator parameter_and_result_profile

Replace paragraph 10:

The sequence of characters in an **operator_symbol** shall correspond to an operator belonging to one of the six classes of operators defined in clause 4.5 (spaces are not allowed and the case of letters is not significant).

by:

The sequence of characters in an **operator_symbol** shall form a reserved word, a delimiter, or compound delimiter that corresponds to an operator belonging to one of the six categories of operators defined in clause 4.5.

Replace paragraph 13:

parameter_and_result_profile ::= [formal_part] **return** subtype_mark

by:

parameter_and_result_profile ::=
 [formal_part] **return** [null_exclusion] subtype_mark
 | [formal_part] **return** access_definition

Replace paragraph 15:

parameter_specification ::=
 defining_identifier_list : mode subtype_mark [:= default_expression]
 | defining_identifier_list : access_definition [:= default_expression]

by:

parameter_specification ::=
 defining_identifier_list : mode [null_exclusion] subtype_mark [:= default_expression]
 | defining_identifier_list : access_definition [:= default_expression]

Replace paragraph 20:

A subprogram_declaration or a generic_subprogram_declaration requires a completion: a body, a renaming_declaration (see 8.5), or a **pragma** Import (see B.1). A completion is not allowed for an abstract_subprogram_declaration.

by:

A `subprogram_declaration` or a `generic_subprogram_declaration` requires a completion: a body, a `renaming_declaration` (see 8.5), or a `pragma Import` (see B.1). A completion is not allowed for an `abstract_subprogram_declaration` (see 3.9.3) or a `null_procedure_declaration` (see 6.7).

Replace paragraph 23:

The nominal subtype of a formal parameter is the subtype denoted by the `subtype_mark`, or defined by the `access_definition`, in the `parameter_specification`.

by:

The nominal subtype of a formal parameter is the subtype determined by the optional `null_exclusion` and the `subtype_mark`, or defined by the `access_definition`, in the `parameter_specification`. The nominal subtype of a function result is the subtype determined by the optional `null_exclusion` and the `subtype_mark`, or defined by the `access_definition`, in the `parameter_and_result_profile`.

Replace paragraph 24:

An *access parameter* is a formal `in` parameter specified by an `access_definition`. An access parameter is of an anonymous general access-to-variable type (see 3.10). Access parameters allow dispatching calls to be controlled by access values.

by:

An *access parameter* is a formal `in` parameter specified by an `access_definition`. An *access result type* is a function result type specified by an `access_definition`. An access parameter or result type is of an anonymous access type (see 3.10). Access parameters of an access-to-object type allow dispatching calls to be controlled by access values. Access parameters of an access-to-subprogram type permit calls to subprograms passed as parameters irrespective of their accessibility level.

Replace paragraph 27:

- For any access parameters, the designated subtype of the parameter type.

by:

- For any access parameters of an access-to-object type, the designated subtype of the parameter type.
- For any access parameters of an access-to-subprogram type, the subtypes of the profile of the parameter type.

Replace paragraph 28:

- For any result, the result subtype.

by:

- For any non-access result, the nominal subtype of the function result.
- For any access result type of an access-to-object type, the designated subtype of the result type.
- For any access result type of an access-to-subprogram type, the subtypes of the profile of the result type.

Replace paragraph 30:

A subprogram declared by an `abstract_subprogram_declaration` is abstract; a subprogram declared by a `subprogram_declaration` is not. See 3.9.3, "Abstract Types and Subprograms".

by:

A subprogram declared by an `abstract_subprogram_declaration` is abstract; a subprogram declared by a `subprogram_declaration` is not. See 3.9.3, "Abstract Types and Subprograms". Similarly, a procedure defined by a `null_procedure_declaration` is a null procedure; a procedure declared by a `subprogram_declaration` is not. See 6.7, "Null Procedures".

An `overriding_indicator` is used to indicate whether overriding is intended. See 8.3.1, "Overriding Indicators".

Replace paragraph 31:

The elaboration of a `subprogram_declaration` or an `abstract_subprogram_declaration` has no effect.

by:

The elaboration of a `subprogram_declaration` has no effect.

6.3 Subprogram Bodies**Replace paragraph 2:**

```
subprogram_body ::=
  subprogram_specification is
    declarative_part
  begin
    handled_sequence_of_statements
  end [designator];
```

by:

```
subprogram_body ::=
  [overriding_indicator]
  subprogram_specification is
    declarative_part
  begin
    handled_sequence_of_statements
  end [designator];
```

6.3.1 Conformance Rules**Replace paragraph 10:**

- a subprogram declared immediately within a `protected_body`.

by:

- a subprogram declared immediately within a `protected_body`;
- any prefixed view of a subprogram (see 4.1.3).

Insert after paragraph 13:

- The default calling convention is *entry* for an entry.

the new paragraph:

- The calling convention for an anonymous access-to-subprogram parameter or anonymous access-to-subprogram result is *protected* if the reserved word **protected** appears in its definition and otherwise is the convention of the subprogram that contains the parameter.

Replace paragraph 15:

Two profiles are *type conformant* if they have the same number of parameters, and both have a result if either does, and corresponding parameter and result types are the same, or, for access parameters, corresponding designated types are the same.

by:

Two profiles are *type conformant* if they have the same number of parameters, and both have a result if either does, and corresponding parameter and result types are the same, or, for access parameters or access results, corresponding designated types are the same, or corresponding designated profiles are type conformant.

Replace paragraph 16:

Two profiles are *mode conformant* if they are type-conformant, and corresponding parameters have identical modes, and, for access parameters, the designated subtypes statically match.

by:

Two profiles are *mode conformant* if they are type-conformant, and corresponding parameters have identical modes, and, for access parameters or access result types, the designated subtypes statically match, or the designated profiles are subtype conformant.

Insert after paragraph 24:

Two `discrete_subtype_definitions` are *fully conformant* if they are both `subtype_indications` or are both `ranges`, the `subtype_marks` (if any) denote the same subtype, and the corresponding `simple_expressions` of the `ranges` (if any) fully conform.

the new paragraph:

The *prefixed view profile* of a subprogram is the profile obtained by omitting the first parameter of that subprogram. There is no prefixed view profile for a parameterless subprogram. For the purposes of defining subtype and mode conformance, the convention of a prefixed view profile is considered to match that of either an entry or a protected operation.

6.3.2 Inline Expansion of Subprograms

Insert after paragraph 6:

For each call, an implementation is free to follow or to ignore the recommendation expressed by the `pragma`.

the new paragraph:

An implementation may allow a `pragma Inline` that has an argument which is a `direct_name` denoting a `subprogram_body` of the same `declarative_part`.

6.4 Subprogram Calls

Replace paragraph 8:

The `name` or `prefix` given in a `procedure_call_statement` shall resolve to denote a callable entity that is a procedure, or an entry renamed as (viewed as) a procedure. The `name` or `prefix` given in a `function_call` shall resolve to denote a callable entity that is a function. When there is an `actual_parameter_part`, the `prefix` can be an `implicit_dereference` of an access-to-subprogram value.

by:

The `name` or `prefix` given in a `procedure_call_statement` shall resolve to denote a callable entity that is a procedure, or an entry renamed as (viewed as) a procedure. The `name` or `prefix` given in a `function_call` shall resolve to denote a callable entity that is a function. The `name` or `prefix` shall not resolve to denote an abstract subprogram unless it is also a dispatching subprogram. When there is an `actual_parameter_part`, the `prefix` can be an `implicit_dereference` of an access-to-subprogram value.

Replace paragraph 10:

For the execution of a subprogram call, the `name` or `prefix` of the call is evaluated, and each `parameter_association` is evaluated (see 6.4.1). If a `default_expression` is used, an `implicit_parameter_association` is assumed for this rule. These evaluations are done in an arbitrary order. The `subprogram_body` is then executed. Finally, if the subprogram completes normally, then after it is left, any necessary assigning back of formal to actual parameters occurs (see 6.4.1).

by:

For the execution of a subprogram call, the `name` or `prefix` of the call is evaluated, and each `parameter_association` is evaluated (see 6.4.1). If a `default_expression` is used, an `implicit_parameter_association` is assumed for this rule. These evaluations are done in an arbitrary order. The `subprogram_body` is then executed, or a call on an entry or protected subprogram is performed (see 3.9.2). Finally, if the subprogram completes normally, then after it is left, any necessary assigning back of formal to actual parameters occurs (see 6.4.1).

If the **name** or **prefix** of a subprogram call denotes a prefixed view (see 4.1.3), the subprogram call is equivalent to a call on the underlying subprogram, with the first actual parameter being provided by the **prefix** of the prefixed view (or the Access attribute of this **prefix** if the first formal parameter is an access parameter), and the remaining actual parameters given by the **actual_parameter_part**, if any.

Replace paragraph 11:

The exception **Program_Error** is raised at the point of a **function_call** if the function completes normally without executing a **return_statement**.

by:

The exception **Program_Error** is raised at the point of a **function_call** if the function completes normally without executing a return statement.

Replace paragraph 12:

A **function_call** denotes a constant, as defined in 6.5; the nominal subtype of the constant is given by the result subtype of the function.

by:

A **function_call** denotes a constant, as defined in 6.5; the nominal subtype of the constant is given by the nominal subtype of the function result.

6.5 Return Statements

Replace paragraph 1:

A **return_statement** is used to complete the execution of the innermost enclosing **subprogram_body**, **entry_body**, or **accept_statement**.

by:

A **simple_return_statement** or **extended_return_statement** (collectively called a *return statement*) is used to complete the execution of the innermost enclosing **subprogram_body**, **entry_body**, or **accept_statement**.

Replace paragraph 2:

```
return_statement ::= return [expression];
```

by:

```
simple_return_statement ::= return [expression];
```

```
extended_return_statement ::=
```

```
  return defining_identifier : [aliased] return_subtype_indication [:= expression] [do
    handled_sequence_of_statements
  end return];
```

```
return_subtype_indication ::= subtype_indication | access_definition
```

Replace paragraph 3:

The expression, if any, of a **return_statement** is called the *return expression*. The *result subtype* of a function is the subtype denoted by the **subtype_mark** after the reserved word **return** in the profile of the function. The expected type for a return expression is the result type of the corresponding function.

by:

The *result subtype* of a function is the subtype denoted by the **subtype_mark**, or defined by the **access_definition**, after the reserved word **return** in the profile of the function. The expected type for the expression, if any, of a **simple_return_statement** is the result type of the corresponding function. The expected type for the expression of an **extended_return_statement** is that of the **return_subtype_indication**.

Replace paragraph 4:

A **return_statement** shall be within a callable construct, and it *applies to* the innermost one. A **return_statement** shall not be within a body that is within the construct to which the **return_statement** applies.

by:

A return statement shall be within a callable construct, and it *applies to* the innermost callable construct or `extended_return_statement` that contains it. A return statement shall not be within a body that is within the construct to which the return statement applies.

Replace paragraph 5:

A function body shall contain at least one `return_statement` that applies to the function body, unless the function contains `code_statements`. A `return_statement` shall include a return expression if and only if it applies to a function body.

by:

A function body shall contain at least one return statement that applies to the function body, unless the function contains `code_statements`. A `simple_return_statement` shall include an `expression` if and only if it applies to a function body. An `extended_return_statement` shall apply to a function body.

For an `extended_return_statement` that applies to a function body:

- If the result subtype of the function is defined by a `subtype_mark`, the `return_subtype_indication` shall be a `subtype_indication`. The type of the `subtype_indication` shall be the result type of the function. If the result subtype of the function is constrained, then the subtype defined by the `subtype_indication` shall also be constrained and shall statically match this result subtype. If the result subtype of the function is unconstrained, then the subtype defined by the `subtype_indication` shall be a definite subtype, or there shall be an `expression`.
- If the result subtype of the function is defined by an `access_definition`, the `return_subtype_indication` shall be an `access_definition`. The subtype defined by the `access_definition` shall statically match the result subtype of the function. The accessibility level of this anonymous access subtype is that of the result subtype.

For any return statement that applies to a function body:

- If the result subtype of the function is limited, then the `expression` of the return statement (if any) shall be an `aggregate`, a function call (or equivalent use of an operator), or a `qualified_expression` or parenthesized expression whose operand is one of these.
- If the result subtype of the function is class-wide, the accessibility level of the type of the `expression` of the return statement shall not be statically deeper than that of the master that elaborated the function body. If the result subtype has one or more unconstrained access discriminants, the accessibility level of the anonymous access type of each access discriminant, as determined by the `expression` of the `simple_return_statement` or the `return_subtype_indication`, shall not be statically deeper than that of the master that elaborated the function body.

Static Semantics

Within an `extended_return_statement`, the *return object* is declared with the given `defining_identifier`, with the nominal subtype defined by the `return_subtype_indication`.

Replace paragraph 6:

For the execution of a `return_statement`, the `expression` (if any) is first evaluated and converted to the result subtype.

by:

For the execution of an `extended_return_statement`, the `subtype_indication` or `access_definition` is elaborated. This creates the nominal subtype of the return object. If there is an `expression`, it is evaluated and converted to the nominal subtype (which might raise `Constraint_Error` — see 4.6); the return object is created and the converted value is assigned to the return object. Otherwise, the return object is created and initialized by default as for a stand-alone object of its nominal subtype (see 3.3.1). If the nominal subtype is indefinite, the return object is constrained by its initial value.

For the execution of a `simple_return_statement`, the `expression` (if any) is first evaluated, converted to the result subtype, and then is assigned to the anonymous *return object*.

If the return object has any parts that are tasks, the activation of those tasks does not occur until after the function returns (see 9.2).

Delete paragraph 7:

If the result type is class-wide, then the tag of the result is the tag of the value of the expression.

Replace paragraph 8:

If the result type is a specific tagged type:

by:

If the result type of a function is a specific tagged type, the tag of the return object is that of the result type. If the result type is class-wide, the tag of the return object is that of the value of the expression.

Delete paragraph 9:

- If it is limited, then a check is made that the tag of the value of the return expression identifies the result type. `Constraint_Error` is raised if this check fails.

Delete paragraph 10:

- If it is nonlimited, then the tag of the result is that of the result type.

Delete paragraph 11:

A type is a *return-by-reference* type if it is a descendant of one of the following:

Delete paragraph 12:

- a tagged limited type;

Delete paragraph 13:

- a task or protected type;

Delete paragraph 14:

- a nonprivate type with the reserved word **limited** in its declaration;

Delete paragraph 15:

- a composite type with a subcomponent of a return-by-reference type;

Delete paragraph 16:

- a private type whose full type is a return-by-reference type.

Delete paragraph 17:

If the result type is a return-by-reference type, then a check is made that the return expression is one of the following:

Delete paragraph 18:

- a `name` that denotes an object view whose accessibility level is not deeper than that of the master that elaborated the function body; or

Delete paragraph 19:

- a parenthesized expression or `qualified_expression` whose operand is one of these kinds of expressions.

Replace paragraph 20:

The exception `Program_Error` is raised if this check fails.

by:

If the result subtype of a function has one or more unconstrained access discriminants, a check is made that the accessibility level of the anonymous access type of each access discriminant, as determined by the `expression` or the `return_subtype_indication` of the function, is not deeper than that of the master that elaborated the function body. If this check fails, `Program_Error` is raised.

Delete paragraph 21:

For a function with a return-by-reference result type the result is returned by reference; that is, the function call denotes a constant view of the object associated with the value of the return expression. For any other function, the result is returned by copy; that is, the converted value is assigned into an anonymous constant created at the point of the `return_statement`, and the function call denotes that object.

Replace paragraph 22:

Finally, a transfer of control is performed which completes the execution of the callable construct to which the `return_statement` applies, and returns to the caller.

by:

For the execution of an `extended_return_statement`, the `handled_sequence_of_statements` is executed. Within this `handled_sequence_of_statements`, the execution of a `simple_return_statement` that applies to the `extended_return_statement` causes a transfer of control that completes the `extended_return_statement`. Upon completion of a return statement that applies to a callable construct, a transfer of control is performed which completes the execution of the callable construct, and returns to the caller.

In the case of a function, the `function_call` denotes a constant view of the return object.

Implementation Permissions

If the result subtype of a function is unconstrained, and a call on the function is used to provide the initial value of an object with a constrained nominal subtype, `Constraint_Error` may be raised at the point of the call (after abandoning the execution of the function body) if, while elaborating the `return_subtype_indication` or evaluating the `expression` of a return statement that applies to the function body, it is determined that the value of the result will violate the constraint of the subtype of this object.

Replace paragraph 24:

```
return; -- in a procedure body, entry_body, or accept_statement
return Key_Value (Last_Index); -- in a function body
```

by:

```
return; -- in a procedure body, entry_body,
-- accept_statement, or extended_return_statement

return Key_Value (Last_Index); -- in a function body

return Node : Cell do -- in a function body, see 3.10.1 for Cell
  Node.Value := Result;
  Node.Succ := Next_Node;
end return;
```

6.5.1 Pragma No_Return

Insert new clause:

A `pragma No_Return` indicates that a procedure cannot return normally; it may propagate an exception or loop forever.

Syntax

The form of a `pragma No_Return`, which is a representation pragma (see 13.1), is as follows:

```
pragma No_Return(procedure_local_name{, procedure_local_name});
```

Legality Rules

Each `procedure_local_name` shall denote one or more procedures or generic procedures; the denoted entities are *non-returning*. The `procedure_local_name` shall not denote a null procedure nor an instance of a generic unit.

A return statement shall not apply to a non-returning procedure or generic procedure.

A procedure shall be non-returning if it overrides a dispatching non-returning procedure. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit.

If a renaming-as-body completes a non-returning procedure declaration, then the renamed procedure shall be non-returning.

Static Semantics

If a generic procedure is non-returning, then so are its instances. If a procedure declared within a generic unit is non-returning, then so are the corresponding copies of that procedure in instances.

Dynamic Semantics

If the body of a non-returning procedure completes normally, Program_Error is raised at the point of the call.

Examples

```

procedure Fail(Msg : String); -- raises Fatal_Error exception
pragma No_Return(Fail);
    -- Inform compiler and reader that procedure never returns normally
  
```

6.7 Null Procedures

Insert new clause:

A `null_procedure_declaration` provides a shorthand to declare a procedure with an empty body.

Syntax

```

null_procedure_declaration ::=
  [overriding_indicator]
  procedure_specification is null;
  
```

Static Semantics

A `null_procedure_declaration` declares a *null procedure*. A completion is not allowed for a `null_procedure_declaration`.

Dynamic Semantics

The execution of a null procedure is invoked by a subprogram call. For the execution of a subprogram call on a null procedure, the execution of the subprogram body has no effect.

The elaboration of a `null_procedure_declaration` has no effect.

Examples

```

procedure Simplify(Expr : in out Expression) is null; -- see 3.9
    -- By default, Simplify does nothing, but it may be overridden in extensions of Expression
  
```

Section 7: Packages

7.1 Package Specifications and Declarations

Replace paragraph 5:

A `package_declaration` or `generic_package_declaration` requires a completion (a body) if it contains any `declarative_item` that requires a completion, but whose completion is not in its `package_specification`.

by:

A `package_declaration` or `generic_package_declaration` requires a completion (a body) if it contains any `basic_declarative_item` that requires a completion, but whose completion is not in its `package_specification`.

Replace paragraph 6:

The first list of `declarative_items` of a `package_specification` of a package other than a generic formal package is called the *visible part* of the package. The optional list of `declarative_items` after the reserved word **private** (of any `package_specification`) is called the *private part* of the package. If the reserved word **private** does not appear, the package has an implicit empty private part.

by:

The first list of `basic_declarative_items` of a `package_specification` of a package other than a generic formal package is called the *visible part* of the package. The optional list of `basic_declarative_items` after the reserved word **private** (of any `package_specification`) is called the *private part* of the package. If the reserved word **private** does not appear, the package has an implicit empty private part. Each list of `basic_declarative_items` of a `package_specification` forms a *declaration list* of the package.

7.3 Private Types and Private Extensions

Replace paragraph 3:

```
private_extension_declaration ::=
  type_defining_identifier [discriminant_part] is
    [abstract] new ancestor_subtype_indication with private;
```

by:

```
private_extension_declaration ::=
  type_defining_identifier [discriminant_part] is
    [abstract] [limited | synchronized] new ancestor_subtype_indication
    [and interface_list] with private;
```

Replace paragraph 6:

A private type is limited if its declaration includes the reserved word **limited**; a private extension is limited if its ancestor type is limited. If the partial view is nonlimited, then the full view shall be nonlimited. If a tagged partial view is limited, then the full view shall be limited. On the other hand, if an untagged partial view is limited, the full view may be limited or nonlimited.

by:

A private type is limited if its declaration includes the reserved word **limited**; a private extension is limited if its ancestor type is a limited type that is not an interface type, or if the reserved word **limited** or **synchronized** appears in its definition. If the partial view is nonlimited, then the full view shall be nonlimited. If a tagged partial view is limited, then the full view shall be limited. On the other hand, if an untagged partial view is limited, the full view may be limited or nonlimited.

Insert after paragraph 7:

If the partial view is tagged, then the full view shall be tagged. On the other hand, if the partial view is untagged, then the full view may be tagged or untagged. In the case where the partial view is untagged and the full view is tagged, no derivatives of the partial view are allowed within the immediate scope of the partial view; derivatives of the full view are allowed.

the new paragraphs:

If a full type has a partial view that is tagged, then:

- the partial view shall be a synchronized tagged type (see 3.9.4) if and only if the full type is a synchronized tagged type;
- the partial view shall be a descendant of an interface type (see 3.9.4) if and only if the full type is a descendant of the interface type.

Insert after paragraph 8:

The *ancestor subtype* of a `private_extension_declaration` is the subtype defined by the `ancestor_subtype_indication`; the ancestor type shall be a specific tagged type. The full view of a private extension shall be derived (directly or indirectly) from the ancestor type. In addition to the places where Legality Rules normally apply (see 12.3), the requirement that the ancestor be specific applies also in the private part of an instance of a generic unit.

the new paragraph:

If the reserved word **limited** appears in a `private_extension_declaration`, the ancestor type shall be a limited type. If the reserved word **synchronized** appears in a `private_extension_declaration`, the ancestor type shall be a limited interface.

Insert after paragraph 10:

If a private extension inherits known discriminants from the ancestor subtype, then the full view shall also inherit its discriminants from the ancestor subtype, and the parent subtype of the full view shall be constrained if and only if the ancestor subtype is constrained.

the new paragraph:

If the `full_type_declaration` for a private extension is a `derived_type_declaration`, then the reserved word **limited** shall appear in the `full_type_declaration` if and only if it also appears in the `private_extension_declaration`.

Replace paragraph 16:

A private extension inherits components (including discriminants unless there is a new `discriminant_part` specified) and user-defined primitive subprograms from its ancestor type, in the same way that a record extension inherits components and user-defined primitive subprograms from its parent type (see 3.4).

by:

A private extension inherits components (including discriminants unless there is a new `discriminant_part` specified) and user-defined primitive subprograms from its ancestor type and its progenitor types (if any), in the same way that a record extension inherits components and user-defined primitive subprograms from its parent type and its progenitor types (see 3.4).

Replace paragraph 19:

Declaring a private type with an `unknown_discriminant_part` is a way of preventing clients from creating uninitialized objects of the type; they are then forced to initialize each object by calling some operation declared in the visible part of the package. If such a type is also limited, then no objects of the type can be declared outside the scope of the `full_type_declaration`, restricting all object creation to the package defining the type. This allows complete control over all storage allocation for the type. Objects of such a type can still be passed as parameters, however.

by:

Declaring a private type with an `unknown_discriminant_part` is a way of preventing clients from creating uninitialized objects of the type; they are then forced to initialize each object by calling some operation declared in the visible part of the package.

Replace paragraph 20:

7 The ancestor type specified in a `private_extension_declaration` and the parent type specified in the corresponding declaration of a record extension given in the private part need not be the same — the parent type of the full view can be any descendant of the ancestor type. In this case, for a primitive subprogram that is inherited from the ancestor type and not overridden, the formal parameter names and default expressions (if any) come from the corresponding primitive subprogram of the specified ancestor type, while the body comes from the corresponding primitive subprogram of the parent type of the full view. See 3.9.2.

by:

7 The ancestor type specified in a `private_extension_declaration` and the parent type specified in the corresponding declaration of a record extension given in the private part need not be the same. If the ancestor type is not an interface type, the parent type of the full view can be any descendant of the ancestor type. In this case, for a primitive subprogram that is inherited from the ancestor type and not overridden, the formal parameter names and default expressions (if any) come from the corresponding primitive subprogram of the specified ancestor type, while the body comes from the corresponding primitive subprogram of the parent type of the full view. See 3.9.2.

8 If the ancestor type specified in a `private_extension_declaration` is an interface type, the parent type can be any type so long as the full view is a descendant of the ancestor type. The progenitor types specified in a `private_extension_declaration` and the progenitor types specified in the corresponding declaration of a record extension given in the private part need not be the same — the only requirement is that the private extension and the record extension be descended from the same set of interfaces.

7.3.1 Private Operations

Replace paragraph 12:

9 Partial views provide assignment (unless the view is limited), membership tests, selected components for the selection of discriminants and inherited components, qualification, and explicit conversion.

by:

9 Partial views provide initialization, membership tests, selected components for the selection of discriminants and inherited components, qualification, and explicit conversion. Nonlimited partial views also allow use of `assignment_statements`.

7.4 Deferred Constants

Replace paragraph 5:

- The deferred and full constants shall have the same type;

by:

- The deferred and full constants shall have the same type, or shall have statically matching anonymous access subtypes;

Replace paragraph 6:

- If the subtype defined by the `subtype_indication` in the deferred declaration is constrained, then the subtype defined by the `subtype_indication` in the full declaration shall match it statically. On the other hand, if the subtype of the deferred constant is unconstrained, then the full declaration is still allowed to impose a constraint. The constant itself will be constrained, like all constants;

by:

- If the deferred constant declaration includes a `subtype_indication` that defines a constrained subtype, then the subtype defined by the `subtype_indication` in the full declaration shall match it statically. On the other hand, if the subtype of the deferred constant is unconstrained, then the full declaration is still allowed to impose a constraint. The constant itself will be constrained, like all constants;

Replace paragraph 7:

- If the deferred constant declaration includes the reserved word **aliased**, then the full declaration shall also.

by:

- If the deferred constant declaration includes the reserved word **aliased**, then the full declaration shall also;
- If the subtype of the deferred constant declaration excludes null, the subtype of the full declaration shall also exclude null.

Replace paragraph 9:

The completion of a deferred constant declaration shall occur before the constant is frozen (see 7.4).

by:

The completion of a deferred constant declaration shall occur before the constant is frozen (see 13.14).

7.5 Limited Types

Replace paragraph 1:

A limited type is (a view of) a type for which the assignment operation is not allowed. A nonlimited type is a (view of) a type for which the assignment operation is allowed.

by:

A limited type is (a view of) a type for which copying (such as for an `assignment_statement`) is not allowed. A nonlimited type is a (view of) a type for which copying is allowed.

Replace paragraph 2:

If a tagged record type has any limited components, then the reserved word **limited** shall appear in its `record_type_definition`.

by:

If a tagged record type has any limited components, then the reserved word **limited** shall appear in its `record_type_definition`. If the reserved word **limited** appears in the definition of a `derived_type_definition`, its parent type and any progenitor interfaces shall be limited.

In the following contexts, an `expression` of a limited type is not permitted unless it is an `aggregate`, a `function_call`, or a parenthesized `expression` or `qualified_expression` whose operand is permitted by this rule:

- the initialization `expression` of an `object_declaration` (see 3.3.1)
- the `default_expression` of a `component_declaration` (see 3.8)
- the `expression` of a `record_component_association` (see 4.3.1)
- the `expression` for an `ancestor_part` of an `extension_aggregate` (see 4.3.2)
- an `expression` of a `positional_array_aggregate` or the `expression` of an `array_component_association` (see 4.3.3)
- the `qualified_expression` of an initialized allocator (see 4.8)
- the `expression` of a return statement (see 6.5)
- the `default_expression` or actual parameter for a formal object of mode **in** (see 12.4)

Replace paragraph 3:

A type is *limited* if it is a descendant of one of the following:

by:

A type is *limited* if it is one of the following:

Replace paragraph 4:

- a type with the reserved word **limited** in its definition;

by:

- a type with the reserved word **limited**, **synchronized**, **task**, or **protected** in its definition;

Delete paragraph 5:

- a task or protected type;

Replace paragraph 6:

- a composite type with a limited component.

the new paragraph:

- a composite type with a limited component;
- a derived type whose parent is limited and is not an interface.

Insert after paragraph 8:

There are no predefined equality operators for a limited type.

the new paragraph:

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For an **aggregate** of a limited type used to initialize an object as allowed above, the implementation shall not create a separate anonymous object for the **aggregate**. For a **function_call** of a type with a part that is of a task, protected, or explicitly limited record type that is used to initialize an object as allowed above, the implementation shall not create a separate return object (see 6.5) for the **function_call**. The **aggregate** or **function_call** shall be constructed directly in the new object.

Replace paragraph 9:

13 The following are consequences of the rules for limited types:

by:

13 While it is allowed to write initializations of limited objects, such initializations never copy a limited object. The source of such an assignment operation must be an **aggregate** or **function_call**, and such **aggregates** and **function_calls** must be built directly in the target object.

Delete paragraph 10:

- An initialization expression is not allowed in an **object_declaration** if the type of the object is limited.

Delete paragraph 11:

- A default expression is not allowed in a **component_declaration** if the type of the record component is limited.

Delete paragraph 12:

- An initialized allocator is not allowed if the designated type is limited.

Delete paragraph 13:

- A generic formal parameter of mode **in** must not be of a limited type.

Delete paragraph 14:

14 **Aggregates** are not available for a limited composite type. Concatenation is not available for a limited array type.

Delete paragraph 15:

15 The rules do not exclude a **default_expression** for a formal parameter of a limited type; they do not exclude a deferred constant of a limited type if the full declaration of the constant is of a nonlimited type.

Replace paragraph 23:

The fact that the full view of `File_Name` is explicitly declared **limited** means that parameter passing and function return will always be by reference (see 6.2 and 6.5).

by:

The fact that the full view of `File_Name` is explicitly declared **limited** means that parameter passing will always be by reference and function results will always be built directly in the result object (see 6.2 and 6.5).

7.6 User-Defined Assignment and Finalization

Replace paragraph 5:

```
type Controlled is abstract tagged private;
```

by:

```
type Controlled is abstract tagged private;
pragma Preelaborable_Initialization(Controlled);
```

Replace paragraph 6:

```
procedure Initialize (Object : in out Controlled);
procedure Adjust   (Object : in out Controlled);
procedure Finalize  (Object : in out Controlled);
```

by:

```
procedure Initialize (Object : in out Controlled) is null;
procedure Adjust    (Object : in out Controlled) is null;
procedure Finalize  (Object : in out Controlled) is null;
```

Replace paragraph 7:

```
type Limited_Controlled is abstract tagged limited private;
```

by:

```
type Limited_Controlled is abstract tagged limited private;
pragma Preelaborable_Initialization(Limited_Controlled);
```

Replace paragraph 8:

```
procedure Initialize (Object : in out Limited_Controlled);
procedure Finalize  (Object : in out Limited_Controlled);
private
... -- not specified by the language
end Ada.Finalization;
```

by:

```
procedure Initialize (Object : in out Limited_Controlled) is null;
procedure Finalize  (Object : in out Limited_Controlled) is null;
private
... -- not specified by the language
end Ada.Finalization;
```

Replace paragraph 9:

A controlled type is a descendant of `Controlled` or `Limited_Controlled`. The (default) implementations of `Initialize`, `Adjust`, and `Finalize` have no effect. The predefined "=" operator of type `Controlled` always returns `True`, since this operator is incorporated into the implementation of the predefined equality operator of types derived from `Controlled`, as explained in 4.5.2. The type `Limited_Controlled` is like `Controlled`, except that it is limited and it lacks the primitive subprogram `Adjust`.

by:

A controlled type is a descendant of `Controlled` or `Limited_Controlled`. The predefined "=" operator of type `Controlled` always returns `True`, since this operator is incorporated into the implementation of the predefined equality operator of types derived from `Controlled`, as explained in 4.5.2. The type `Limited_Controlled` is like `Controlled`, except that it is limited and it lacks the primitive subprogram `Adjust`.

A type is said to *need finalization* if:

- it is a controlled type, a task type or a protected type; or
- it has a component that needs finalization; or
- it is a limited type that has an access discriminant whose designated type needs finalization; or
- it is one of a number of language-defined types that are explicitly defined to need finalization.

Replace paragraph 10:

During the elaboration of an **object_declaration**, for every controlled subcomponent of the object that is not assigned an initial value (as defined in 3.3.1), **Initialize** is called on that subcomponent. Similarly, if the object as a whole is controlled and is not assigned an initial value, **Initialize** is called on the object. The same applies to the evaluation of an **allocator**, as explained in 4.8.

by:

During the elaboration or evaluation of a construct that causes an object to be initialized by default, for every controlled subcomponent of the object that is not assigned an initial value (as defined in 3.3.1), **Initialize** is called on that subcomponent. Similarly, if the object that is initialized by default as a whole is controlled, **Initialize** is called on the object.

Replace paragraph 11:

For an **extension_aggregate** whose **ancestor_part** is a **subtype_mark**, for each controlled subcomponent of the ancestor part, either **Initialize** is called, or its initial value is assigned, as appropriate **Initialize** is called on all controlled subcomponents of the ancestor part; if the type of the ancestor part is itself controlled, the **Initialize** procedure of the ancestor type is called, unless that **Initialize** procedure is abstract.

by:

For an **extension_aggregate** whose **ancestor_part** is a **subtype_mark** denoting a controlled subtype, the **Initialize** procedure of the ancestor type is called, unless that **Initialize** procedure is abstract.

Replace paragraph 17.1:

For an **aggregate** of a controlled type whose value is assigned, other than by an **assignment_statement** or a **return_statement**, the implementation shall not create a separate anonymous object for the **aggregate**. The **aggregate** value shall be constructed directly in the target of the assignment operation and **Adjust** is not called on the target object.

by:

For an **aggregate** of a controlled type whose value is assigned, other than by an **assignment_statement**, the implementation shall not create a separate anonymous object for the **aggregate**. The **aggregate** value shall be constructed directly in the target of the assignment operation and **Adjust** is not called on the target object.

Replace paragraph 21:

- For an **aggregate** or function call whose value is assigned into a target object, the implementation need not create a separate anonymous object if it can safely create the value of the **aggregate** or function call directly in the target object. Similarly, for an **assignment_statement**, the implementation need not create an anonymous object if the value being assigned is the result of evaluating a **name** denoting an object (the source object) whose storage cannot overlap with the target. If the source object might overlap with the target object, then the implementation can avoid the need for an intermediary anonymous object by exercising one of the above permissions and perform the assignment one component at a time (for an overlapping array assignment), or not at all (for an assignment where the target and the source of the assignment are the same object). Even if an anonymous object is created, the implementation may move its value to the target object as part of the assignment without re-adjusting so long as the anonymous object has no aliased subcomponents.

by:

- For an **aggregate** or function call whose value is assigned into a target object, the implementation need not create a separate anonymous object if it can safely create the value of the **aggregate** or function call directly in the target object. Similarly, for an **assignment_statement**, the implementation need not create an anonymous object if the value being assigned is the result of evaluating a **name** denoting an object (the source object) whose storage cannot overlap with the target. If the source object might overlap with the target object, then the implementation can avoid the need for an intermediary anonymous object by exercising one of the above permissions and perform the assignment one component at a time (for an overlapping array assignment), or not at all (for an assignment where the target and the source of the assignment are the same object).

Furthermore, an implementation is permitted to omit implicit **Initialize**, **Adjust**, and **Finalize** calls and associated assignment operations on an object of a nonlimited controlled type provided that:

- any omitted Initialize call is not a call on a user-defined Initialize procedure, and
- any usage of the value of the object after the implicit Initialize or Adjust call and before any subsequent Finalize call on the object does not change the external effect of the program, and
- after the omission of such calls and operations, any execution of the program that executes an Initialize or Adjust call on an object or initializes an object by an **aggregate** will also later execute a Finalize call on the object and will always do so prior to assigning a new value to the object, and
- the assignment operations associated with omitted Adjust calls are also omitted.

This permission applies to Adjust and Finalize calls even if the implicit calls have additional external effects.

7.6.1 Completion and Finalization

Replace paragraph 2:

The execution of a construct or entity is *complete* when the end of that execution has been reached, or when a transfer of control (see 5.1) causes it to be abandoned. Completion due to reaching the end of execution, or due to the transfer of control of an **exit_**, **return_**, **goto_**, or **requeue_statement** or of the selection of a **terminate_alternative** is *normal completion*. Completion is *abnormal* otherwise — when control is transferred out of a construct due to abort or the raising of an exception.

by:

The execution of a construct or entity is *complete* when the end of that execution has been reached, or when a transfer of control (see 5.1) causes it to be abandoned. Completion due to reaching the end of execution, or due to the transfer of control of an **exit_statement**, **return statement**, **goto_statement**, or **requeue_statement** or of the selection of a **terminate_alternative** is *normal completion*. Completion is *abnormal* otherwise — when control is transferred out of a construct due to abort or the raising of an exception.

Replace paragraph 3:

After execution of a construct or entity is *complete*, it is *left*, meaning that execution continues with the next action, as defined for the execution that is taking place. Leaving an execution happens immediately after its completion, except in the case of a *master*: the execution of a **task_body**, a **block_statement**, a **subprogram_body**, an **entry_body**, or an **accept_statement**. A master is finalized after it is complete, and before it is left.

by:

After execution of a construct or entity is *complete*, it is *left*, meaning that execution continues with the next action, as defined for the execution that is taking place. Leaving an execution happens immediately after its completion, except in the case of a *master*: the execution of a body other than a **package_body**; the execution of a **statement**; or the evaluation of an **expression**, **function_call**, or **range** that is not part of an enclosing **expression**, **function_call**, **range**, or **simple_statement** other than a **simple_return_statement**. A master is finalized after it is complete, and before it is left.

Replace paragraph 9:

- If the object is of a composite type, then after performing the above actions, if any, every component of the object is finalized in an arbitrary order, except as follows: if the object has a component with an access discriminant constrained by a per-object expression, this component is finalized before any components that do not have such discriminants; for an object with several components with such a discriminant, they are finalized in the reverse of the order of their **component_declarations**.

by:

- If the object is of a composite type, then after performing the above actions, if any, every component of the object is finalized in an arbitrary order, except as follows: if the object has a component with an access discriminant constrained by a per-object expression, this component is finalized before any components that do not have such discriminants; for an object with several components with such a discriminant, they are finalized in the reverse of the order of their **component_declarations**;
- If the object has coextensions (see 3.10.2), each coextension is finalized after the object whose access discriminant designates it.

Replace paragraph 11:

The order in which the finalization of a master performs finalization of objects is as follows: Objects created by declarations in the master are finalized in the reverse order of their creation. For objects that were created by allocators for an access type whose ultimate ancestor is declared in the master, this rule is applied as though each such object that still exists had been created in an arbitrary order at the first freezing point (see 13.14) of the ultimate ancestor type.

by:

The order in which the finalization of a master performs finalization of objects is as follows: Objects created by declarations in the master are finalized in the reverse order of their creation. For objects that were created by allocators for an access type whose ultimate ancestor is declared in the master, this rule is applied as though each such object that still exists had been created in an arbitrary order at the first freezing point (see 13.14) of the ultimate ancestor type; the finalization of these objects is called the *finalization of the collection*. After the finalization of a master is complete, the objects finalized as part of its finalization cease to *exist*, as do any types and subtypes defined and created within the master.

Replace paragraph 12:

The target of an assignment statement is finalized before copying in the new value, as explained in 7.6.

by:

The target of an `assignment_statement` is finalized before copying in the new value, as explained in 7.6.

Replace paragraph 13:

If the `object_name` in an `object_renaming_declaration`, or the actual parameter for a generic formal **in out** parameter in a `generic_instantiation`, denotes any part of an anonymous object created by a function call, the anonymous object is not finalized until after it is no longer accessible via any name. Otherwise, an anonymous object created by a function call or by an `aggregate` is finalized no later than the end of the innermost enclosing `declarative_item` or `statement`; if that is a `compound_statement`, the object is finalized before starting the execution of any `statement` within the `compound_statement`.

by:

The master of an object is the master enclosing its creation whose accessibility level (see 3.10.2) is equal to that of the object.

Replace paragraph 13.1:

If a transfer of control or raising of an exception occurs prior to performing a finalization of an anonymous object, the anonymous object is finalized as part of the finalizations due to be performed for the object's innermost enclosing master.

by:

In the case of an `expression` that is a master, finalization of any (anonymous) objects occurs as the final part of evaluation of the `expression`.

Replace paragraph 16:

- For an `Adjust` invoked as part of the initialization of a controlled object, other adjustments due to be performed might or might not be performed, and then `Program_Error` is raised. During its propagation, finalization might or might not be applied to objects whose `Adjust` failed. For an `Adjust` invoked as part of an assignment statement, any other adjustments due to be performed are performed, and then `Program_Error` is raised.

by:

- For an `Adjust` invoked as part of assignment operations other than those invoked as part of an `assignment_statement`, other adjustments due to be performed might or might not be performed, and then `Program_Error` is raised. During its propagation, finalization might or might not be applied to objects whose `Adjust` failed. For an `Adjust` invoked as part of an `assignment_statement`, any other adjustments due to be performed are performed, and then `Program_Error` is raised.

Replace paragraph 18:

For a Finalize invoked by the transfer of control of an `exit_`, `return_`, `goto_`, or `requeue_statement`, `Program_Error` is raised no earlier than after the finalization of the master being finalized when the exception occurred, and no later than the point where normal execution would have continued. Any other finalizations due to be performed up to that point are performed before raising `Program_Error`.

by:

For a Finalize invoked by the transfer of control of an `exit_statement`, `return_statement`, `goto_statement`, or `requeue_statement`, `Program_Error` is raised no earlier than after the finalization of the master being finalized when the exception occurred, and no later than the point where normal execution would have continued. Any other finalizations due to be performed up to that point are performed before raising `Program_Error`.

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Section 8: Visibility Rules

8.1 Declarative Region

Insert after paragraph 4:

- a loop_statement;

the new paragraph:

- an extended_return_statement;

8.2 Scope of Declarations

Insert after paragraph 10:

The scope of a declaration always contains the immediate scope of the declaration. In addition, for a given declaration that occurs immediately within the visible part of an outer declaration, or is a public child of an outer declaration, the scope of the given declaration extends to the end of the scope of the outer declaration, except that the scope of a library_item includes only its semantic dependents.

the new paragraph:

The scope of an attribute_definition_clause is identical to the scope of a declaration that would occur at the point of the attribute_definition_clause.

8.3 Visibility

Insert after paragraph 12:

- An implicit declaration of an inherited subprogram overrides a previous implicit declaration of an inherited subprogram.

the new paragraphs:

- If two or more homographs are implicitly declared at the same place:
 - If at least one is a subprogram that is neither a null procedure nor an abstract subprogram, and does not require overriding (see 3.9.3), then they override those that are null procedures, abstract subprograms, or require overriding. If more than one such homograph remains that is not thus overridden, then they are all hidden from all visibility.
 - Otherwise (all are null procedures, abstract subprograms, or require overriding), then any null procedure overrides all abstract subprograms and all subprograms that require overriding; if more than one such homograph remains that is not thus overridden, then if they are all fully conformant with one another, one is chosen arbitrarily; if not, they are all hidden from all visibility.

Replace paragraph 18:

- For a package_declaration, task declaration, protected declaration, generic_package_declaration, or subprogram_body, the declaration is hidden from all visibility only until the reserved word **is** of the declaration.

by:

- For a package_declaration, generic_package_declaration, or subprogram_body, the declaration is hidden from all visibility only until the reserved word **is** of the declaration;
- For a task declaration or protected declaration, the declaration is hidden from all visibility only until the reserved word **with** of the declaration if there is one, or the reserved word **is** of the declaration if there is no **with**.

Replace paragraph 20:

- The declaration of a library unit (including a `library_unit_renaming_declaration`) is hidden from all visibility except at places that are within its declarative region or within the scope of a `with_clause` that mentions it. For each declaration or renaming of a generic unit as a child of some parent generic package, there is a corresponding declaration nested immediately within each instance of the parent. Such a nested declaration is hidden from all visibility except at places that are within the scope of a `with_clause` that mentions the child.

by:

- The declaration of a library unit (including a `library_unit_renaming_declaration`) is hidden from all visibility at places outside its declarative region that are not within the scope of a `nonlimited_with_clause` that mentions it. The limited view of a library package is hidden from all visibility at places that are not within the scope of a `limited_with_clause` that mentions it; in addition, the limited view is hidden from all visibility within the declarative region of the package, as well as within the scope of any `nonlimited_with_clause` that mentions the package. Where the declaration of the limited view of a package is visible, any name that denotes the package denotes the limited view, including those provided by a package renaming.
- For each declaration or renaming of a generic unit as a child of some parent generic package, there is a corresponding declaration nested immediately within each instance of the parent. Such a nested declaration is hidden from all visibility except at places that are within the scope of a `with_clause` that mentions the child.

Insert after paragraph 23:

- A declaration is also hidden from direct visibility where hidden from all visibility.

the new paragraph:

An `attribute_definition_clause` is *visible* everywhere within its scope.

Replace paragraph 26:

A non-overridable declaration is illegal if there is a homograph occurring immediately within the same declarative region that is visible at the place of the declaration, and is not hidden from all visibility by the non-overridable declaration. In addition, a type extension is illegal if somewhere within its immediate scope it has two visible components with the same name. Similarly, the `context_clause` for a subunit is illegal if it mentions (in a `with_clause`) some library unit, and there is a homograph of the library unit that is visible at the place of the corresponding stub, and the homograph and the mentioned library unit are both declared immediately within the same declarative region. These rules also apply to dispatching operations declared in the visible part of an instance of a generic unit. However, they do not apply to other overloadable declarations in an instance; such declarations may have type conformant profiles in the instance, so long as the corresponding declarations in the generic were not type conformant.

by:

A non-overridable declaration is illegal if there is a homograph occurring immediately within the same declarative region that is visible at the place of the declaration, and is not hidden from all visibility by the non-overridable declaration. In addition, a type extension is illegal if somewhere within its immediate scope it has two visible components with the same name. Similarly, the `context_clause` for a compilation unit is illegal if it mentions (in a `with_clause`) some library unit, and there is a homograph of the library unit that is visible at the place of the compilation unit, and the homograph and the mentioned library unit are both declared immediately within the same declarative region. These rules also apply to dispatching operations declared in the visible part of an instance of a generic unit. However, they do not apply to other overloadable declarations in an instance; such declarations may have type conformant profiles in the instance, so long as the corresponding declarations in the generic were not type conformant.

8.3.1 Overriding Indicators

Insert new clause:

An `overriding_indicator` is used to declare that an operation is intended to override (or not override) an inherited operation.

Syntax

`overriding_indicator ::= [not] overriding`

Legality Rules

If an `abstract_subprogram_declaration`, `null_procedure_declaration`, `subprogram_body`, `subprogram_body_stub`, `subprogram_renaming_declaration`, `generic_instantiation` of a subprogram, or `subprogram_declaration` other than a protected subprogram has an `overriding_indicator`, then:

- the operation shall be a primitive operation for some type;
- if the `overriding_indicator` is **overriding**, then the operation shall override a homograph at the place of the declaration or body;
- if the `overriding_indicator` is **not overriding**, then the operation shall not override any homograph (at any place).

In addition to the places where Legality Rules normally apply, these rules also apply in the private part of an instance of a generic unit.

NOTES

8 Rules for `overriding_indicators` of task and protected entries and of protected subprograms are found in 9.5.2 and 9.4, respectively.

Examples

The use of `overriding_indicators` allows the detection of errors at compile-time that otherwise might not be detected at all. For instance, we might declare a security queue derived from the Queue interface of 3.9.4 as:

```

type Security_Queue is new Queue with record ...;

overriding
procedure Append(Q : in out Security_Queue; Person : in Person_Name);

overriding
procedure Remove_First(Q : in out Security_Queue; Person : in Person_Name);

overriding
function Cur_Count(Q : in Security_Queue) return Natural;

overriding
function Max_Count(Q : in Security_Queue) return Natural;

not overriding
procedure Arrest(Q : in out Security_Queue; Person : in Person_Name);

```

The first four subprogram declarations guarantee that these subprograms will override the four subprograms inherited from the Queue interface. A misspelling in one of these subprograms will be detected by the implementation. Conversely, the declaration of Arrest guarantees that this is a new operation.

8.4 Use Clauses

Replace paragraph 5:

A `package_name` of a `use_package_clause` shall denote a package.

by:

A `package_name` of a `use_package_clause` shall denote a nonlimited view of a package.

Insert after paragraph 7:

For a `use_clause` immediately within a declarative region, the scope is the portion of the declarative region starting just after the `use_clause` and extending to the end of the declarative region. However, the scope of a `use_clause` in the private part of a library unit does not include the visible part of any public descendant of that library unit.

the new paragraph:

A package is *named* in a `use_package_clause` if it is denoted by a `package_name` of that clause. A type is *named* in a `use_type_clause` if it is determined by a `subtype_mark` of that clause.

Replace paragraph 8:

For each package denoted by a `package_name` of a `use_package_clause` whose scope encloses a place, each declaration that occurs immediately within the declarative region of the package is *potentially use-visible* at this place if the declaration is visible at this place. For each type T or T Class determined by a `subtype_mark` of a `use_type_clause` whose scope encloses a place, the declaration of each primitive operator of type T is potentially use-visible at this place if its declaration is visible at this place.

by:

For each package named in a `use_package_clause` whose scope encloses a place, each declaration that occurs immediately within the declarative region of the package is *potentially use-visible* at this place if the declaration is visible at this place. For each type T or T Class named in a `use_type_clause` whose scope encloses a place, the declaration of each primitive operator of type T is potentially use-visible at this place if its declaration is visible at this place.

8.5.1 Object Renaming Declarations**Replace paragraph 2:**

```
object_renaming_declaration ::=
    defining_identifier : subtype_mark renames object_name;
```

by:

```
object_renaming_declaration ::=
    defining_identifier : [null_exclusion] subtype_mark renames object_name;
    | defining_identifier : access_definition renames object_name;
```

Replace paragraph 3:

The type of the `object_name` shall resolve to the type determined by the `subtype_mark`.

by:

The type of the `object_name` shall resolve to the type determined by the `subtype_mark`, or in the case where the type is defined by an `access_definition`, to an anonymous access type. If the anonymous access type is an access-to-object type, the type of the `object_name` shall have the same designated type as that of the `access_definition`. If the anonymous access type is an access-to-subprogram type, the type of the `object_name` shall have a designated profile that is type conformant with that of the `access_definition`.

Insert after paragraph 4:

The renamed entity shall be an object.

the new paragraphs:

In the case where the type is defined by an `access_definition`, the type of the renamed object and the type defined by the `access_definition`:

- shall both be access-to-object types with statically matching designated subtypes and with both or neither being access-to-constant types; or
- shall both be access-to-subprogram types with subtype conformant designated profiles.

For an `object_renaming_declaration` with a `null_exclusion` or an `access_definition` that has a `null_exclusion`:

- if the *object_name* denotes a generic formal object of a generic unit *G*, and the *object_renaming_declaration* occurs within the body of *G* or within the body of a generic unit declared within the declarative region of *G*, then the declaration of the formal object of *G* shall have a *null_exclusion*;
- otherwise, the subtype of the *object_name* shall exclude null. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit.

Replace paragraph 5:

The renamed entity shall not be a subcomponent that depends on discriminants of a variable whose nominal subtype is unconstrained, unless this subtype is indefinite, or the variable is aliased. A *slice* of an array shall not be renamed if this restriction disallows renaming of the array. In addition to the places where Legality Rules normally apply, these rules apply also in the private part of an instance of a generic unit. These rules also apply for a renaming that appears in the body of a generic unit, with the additional requirement that even if the nominal subtype of the variable is indefinite, its type shall not be a descendant of an untagged generic formal derived type.

by:

The renamed entity shall not be a subcomponent that depends on discriminants of a variable whose nominal subtype is unconstrained, unless this subtype is indefinite, or the variable is constrained by its initial value. A *slice* of an array shall not be renamed if this restriction disallows renaming of the array. In addition to the places where Legality Rules normally apply, these rules apply also in the private part of an instance of a generic unit. These rules also apply for a renaming that appears in the body of a generic unit, with the additional requirement that even if the nominal subtype of the variable is indefinite, its type shall not be a descendant of an untagged generic formal derived type.

Replace paragraph 6:

An *object_renaming_declaration* declares a new view of the renamed object whose properties are identical to those of the renamed view. Thus, the properties of the renamed object are not affected by the *renaming_declaration*. In particular, its value and whether or not it is a constant are unaffected; similarly, the constraints that apply to an object are not affected by renaming (any constraint implied by the *subtype_mark* of the *object_renaming_declaration* is ignored).

by:

An *object_renaming_declaration* declares a new view of the renamed object whose properties are identical to those of the renamed view. Thus, the properties of the renamed object are not affected by the *renaming_declaration*. In particular, its value and whether or not it is a constant are unaffected; similarly, the null exclusion or constraints that apply to an object are not affected by renaming (any constraint implied by the *subtype_mark* or *access_definition* of the *object_renaming_declaration* is ignored).

8.5.3 Package Renaming Declarations

Insert after paragraph 3:

The renamed entity shall be a package.

the new paragraph:

If the *package_name* of a *package_renaming_declaration* denotes a limited view of a package *P*, then a name that denotes the *package_renaming_declaration* shall occur only within the immediate scope of the renaming or the scope of a *with_clause* that mentions the package *P* or, if *P* is a nested package, the innermost library package enclosing *P*.

Insert after paragraph 4:

A *package_renaming_declaration* declares a new view of the renamed package.

the new paragraph:

At places where the declaration of the limited view of the renamed package is visible, a name that denotes the *package_renaming_declaration* denotes a limited view of the package (see 10.1.1).

8.5.4 Subprogram Renaming Declarations

Replace paragraph 2:

subprogram_renaming_declaration ::= subprogram_specification **renames** callable_entity_name;

by:

subprogram_renaming_declaration ::=
 [overriding_indicator]
 subprogram_specification **renames** callable_entity_name;

Insert after paragraph 4:

The profile of a renaming-as-declaration shall be mode-conformant with that of the renamed callable entity.

the new paragraphs:

For a parameter or result subtype of the subprogram_specification that has an explicit null_exclusion:

- if the callable_entity_name denotes a generic formal subprogram of a generic unit *G*, and the subprogram_renaming_declaration occurs within the body of a generic unit *G* or within the body of a generic unit declared within the declarative region of the generic unit *G*, then the corresponding parameter or result subtype of the formal subprogram of *G* shall have a null_exclusion;
- otherwise, the subtype of the corresponding parameter or result type of the renamed callable entity shall exclude null. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit.

Insert after paragraph 5:

The profile of a renaming-as-body shall be subtype-conformant with that of the renamed callable entity, and shall conform fully to that of the declaration it completes. If the renaming-as-body completes that declaration before the subprogram it declares is frozen, the profile shall be mode-conformant with that of the renamed callable entity and the subprogram it declares takes its convention from the renamed subprogram; otherwise, the profile shall be subtype-conformant with that of the renamed callable entity and the convention of the renamed subprogram shall not be Intrinsic. A renaming-as-body is illegal if the declaration occurs before the subprogram whose declaration it completes is frozen, and the renaming renames the subprogram itself, through one or more subprogram renaming declarations, none of whose subprograms has been frozen.

the new paragraph:

The callable_entity_name of a renaming shall not denote a subprogram that requires overriding (see 3.9.3).

The callable_entity_name of a renaming-as-body shall not denote an abstract subprogram.

8.6 The Context of Overload Resolution

Replace paragraph 17:

If a usage name appears within the declarative region of a type_declaration and denotes that same type_declaration, then it denotes the *current instance* of the type (rather than the type itself). The current instance of a type is the object or value of the type that is associated with the execution that evaluates the usage name.

by

If a usage name appears within the declarative region of a type_declaration and denotes that same type_declaration, then it denotes the *current instance* of the type (rather than the type itself); the current instance of a type is the object or value of the type that is associated with the execution that evaluates the usage name. This rule does not apply if the usage name appears within the subtype_mark of an access_definition for an access-to-object type, or within the subtype of a parameter or result of an access-to-subprogram type.

Replace paragraph 20:

The *expected type* for a given **expression**, **name**, or other construct determines, according to the *type resolution rules* given below, the types considered for the construct during overload resolution. The type resolution rules provide support for class-wide programming, universal numeric literals, dispatching operations, and anonymous access types:

by:

The *expected type* for a given **expression**, **name**, or other construct determines, according to the *type resolution rules* given below, the types considered for the construct during overload resolution. The type resolution rules provide support for class-wide programming, universal literals, dispatching operations, and anonymous access types:

Replace paragraph 25:

- when *T* is an anonymous access type (see 3.10) with designated type *D*, to an access-to-variable type whose designated type is *D*Class or is covered by *D*.

by:

- when *T* is a specific anonymous access-to-object type (see 3.10) with designated type *D*, to an access-to-object type whose designated type is *D*Class or is covered by *D*; or
- when *T* is an anonymous access-to-subprogram type (see 3.10), to an access-to-subprogram type whose designated profile is type-conformant with that of *T*.

Replace paragraph 27:

When the expected type for a construct is required to be a *single* type in a given class, the type expected for the construct shall be determinable solely from the context in which the construct appears, excluding the construct itself, but using the requirement that it be in the given class; the type of the construct is then this single expected type. Furthermore, the context shall not be one that expects any type in some class that contains types of the given class; in particular, the construct shall not be the operand of a `type_conversion`.

by:

When a construct is one that requires that its expected type be a *single* type in a given class, the type of the construct shall be determinable solely from the context in which the construct appears, excluding the construct itself, but using the requirement that it be in the given class. Furthermore, the context shall not be one that expects any type in some class that contains types of the given class; in particular, the construct shall not be the operand of a `type_conversion`.

Section 9: Tasks and Synchronization

9.1 Task Units and Task Objects

Replace paragraph 2:

```
task_type_declaration ::=
  task_type defining_identifier [known_discriminant_part] [is task_definition];
```

by:

```
task_type_declaration ::=
  task_type defining_identifier [known_discriminant_part] [is
  [new interface_list with]
  task_definition];
```

Replace paragraph 3:

```
single_task_declaration ::=
  task defining_identifier [is task_definition];
```

by:

```
single_task_declaration ::=
  task defining_identifier [is
  [new interface_list with]
  task_definition];
```

Delete paragraph 8:

Legality Rules

A task declaration requires a completion, which shall be a **task_body**, and every **task_body** shall be the completion of some task declaration.

Insert after paragraph 9.1:

For a task declaration without a **task_definition**, a **task_definition** without **task_items** is assumed.

the new paragraphs:

For a task declaration with an **interface_list**, the task type inherits user-defined primitive subprograms from each progenitor type (see 3.9.4), in the same way that a derived type inherits user-defined primitive subprograms from its progenitor types (see 3.4). If the first parameter of a primitive inherited subprogram is of the task type or an access parameter designating the task type, and there is an **entry_declaration** for a single entry with the same identifier within the task declaration, whose profile is type conformant with the prefixed view profile of the inherited subprogram, the inherited subprogram is said to be *implemented* by the conforming task entry.

Legality Rules

A task declaration requires a completion, which shall be a **task_body**, and every **task_body** shall be the completion of some task declaration.

Each **interface_subtype_mark** of an **interface_list** appearing within a task declaration shall denote a limited interface type that is not a protected interface.

The prefixed view profile of an explicitly declared primitive subprogram of a tagged task type shall not be type conformant with any entry of the task type, if the first parameter of the subprogram is of the task type or is an access parameter designating the task type.

For each primitive subprogram inherited by the type declared by a task declaration, at most one of the following shall apply:

- the inherited subprogram is overridden with a primitive subprogram of the task type, in which case the overriding subprogram shall be subtype conformant with the inherited subprogram and not abstract; or
- the inherited subprogram is implemented by a single entry of the task type; in which case its prefixed view profile shall be subtype conformant with that of the task entry.

If neither applies, the inherited subprogram shall be a null procedure. In addition to the places where Legality Rules normally apply (see 12.3), these rules also apply in the private part of an instance of a generic unit.

Replace paragraph 19:

2 Within the declaration or body of a task unit, the name of the task unit denotes the current instance of the unit (see 8.6), rather than the first subtype of the corresponding task type (and thus the name cannot be used as a subtype_mark).

by:

2 Other than in an access_definition, the name of a task unit within the declaration or body of the task unit denotes the current instance of the unit (see 8.6), rather than the first subtype of the corresponding task type (and thus the name cannot be used as a subtype_mark).

Replace paragraph 21:

4 A task type is a limited type (see 7.5), and hence has neither an assignment operation nor predefined equality operators. If an application needs to store and exchange task identities, it can do so by defining an access type designating the corresponding task objects and by using access values for identification purposes. Assignment is available for such an access type as for any access type. Alternatively, if the implementation supports the Systems Programming Annex, the Identity attribute can be used for task identification (see C.7).

by:

4 A task type is a limited type (see 7.5), and hence precludes use of assignment_statements and predefined equality operators. If an application needs to store and exchange task identities, it can do so by defining an access type designating the corresponding task objects and by using access values for identification purposes. Assignment is available for such an access type as for any access type. Alternatively, if the implementation supports the Systems Programming Annex, the Identity attribute can be used for task identification (see C.7.1).

Replace paragraph 24:

```
task type Keyboard_Driver(ID : Keyboard_ID := New_ID) is
  entry Read (C : out Character);
  entry Write(C : in Character);
end Keyboard_Driver;
```

by:

```
task type Keyboard_Driver(ID : Keyboard_ID := New_ID) is
  new Serial_Device with -- see 3.9.4
  entry Read (C : out Character);
  entry Write(C : in Character);
end Keyboard_Driver;
```

9.2 Task Execution - Task Activation

Replace paragraph 2:

A task object (which represents one task) can be created either as part of the elaboration of an object_declaration occurring immediately within some declarative region, or as part of the evaluation of an allocator. All tasks created by the elaboration of object_declarations of a single declarative region (including subcomponents of the declared objects) are activated together. Similarly, all tasks created by the evaluation of a single allocator are activated together. The activation of a task is associated with the innermost allocator or object_declaration that is responsible for its creation.

by:

A task object (which represents one task) can be a part of a stand-alone object, of an object created by an allocator, or of an anonymous object of a limited type, or a coextension of one of these. All tasks that are part or coextensions of any of the stand-alone objects created by the elaboration of object_declarations (or generic_associations of formal objects of mode in) of a single declarative region are activated together. All tasks that are part or coextensions of a single object that is not a stand-alone object are activated together.

Replace paragraph 3:

For tasks created by the elaboration of object_declarations of a given declarative region, the activations are initiated within the context of the handled_sequence_of_statements (and its associated exception_handlers if any — see 11.2), just prior to executing the statements of the _sequence. For a package without an explicit body or an explicit handled_sequence_of_statements, an implicit body or an implicit null_statement is assumed, as defined in 7.2.

by:

For the tasks of a given declarative region, the activations are initiated within the context of the `handled_sequence_of_statements` (and its associated `exception_handlers` if any — see 11.2), just prior to executing the statements of the `handled_sequence_of_statements`. For a package without an explicit body or an explicit `handled_sequence_of_statements`, an implicit body or an implicit `null_statement` is assumed, as defined in 7.2.

Replace paragraph 4:

For tasks created by the evaluation of an `allocator`, the activations are initiated as the last step of evaluating the `allocator`, after completing any initialization for the object created by the `allocator`, and prior to returning the new access value.

by:

For tasks that are part or coextensions of a single object that is not a stand-alone object, activations are initiated after completing any initialization of the outermost object enclosing these tasks, prior to performing any other operation on the outermost object. In particular, for tasks that are part or coextensions of the object created by the evaluation of an `allocator`, the activations are initiated as the last step of evaluating the `allocator`, prior to returning the new access value. For tasks that are part or coextensions of an object that is the result of a function call, the activations are not initiated until after the function returns.

9.3 Task Dependence - Termination of Tasks

Insert after paragraph 3:

- If the task is created by the elaboration of an `object_declaration`, it depends on each master that includes this elaboration.

the new paragraph:

- Otherwise, the task depends on the master of the outermost object of which it is a part (as determined by the accessibility level of that object — see 3.4.0.2 and 7.6.1), as well as on any master whose execution includes that of the master of the outermost object.

Replace paragraph 7:

- The task depends on some completed master;

by:

- The task depends on some completed master; and

9.4 Protected Units and Protected Objects

Replace paragraph 2:

```
protected_type_declaration ::=
  protected_type_defining_identifier [known_discriminant_part] [is protected_definition];
```

by:

```
protected_type_declaration ::=
  protected_type_defining_identifier [known_discriminant_part] is
  [new interface_list with]
  protected_definition;
```

Replace paragraph 3:

```
single_protected_declaration ::=
  protected_defining_identifier is protected_definition;
```

by:

```
single_protected_declaration ::=
  protected_defining_identifier is
  [new interface_list with]
  protected_definition;
```

Delete paragraph 10:

Legality Rules

A protected declaration requires a completion, which shall be a `protected_body`, and every `protected_body` shall be the completion of some protected declaration.

Insert after paragraph 11:

A `protected_definition` defines a protected type and its first subtype. The list of `protected_operation_declarations` of a `protected_definition`, together with the `known_discriminant_part`, if any, is called the visible part of the protected unit. The optional list of `protected_element_declarations` after the reserved word **private** is called the private part of the protected unit.

the new paragraphs:

For a protected declaration with an `interface_list`, the protected type inherits user-defined primitive subprograms from each progenitor type (see 3.9.4), in the same way that a derived type inherits user-defined primitive subprograms from its progenitor types (see 3.4). If the first parameter of a primitive inherited subprogram is of the protected type or an access parameter designating the protected type, and there is a `protected_operation_declaration` for a protected subprogram or single entry with the same identifier within the protected declaration, whose profile is type conformant with the prefixed view profile of the inherited subprogram, the inherited subprogram is said to be *implemented* by the conforming protected subprogram or entry.

Legality Rules

A protected declaration requires a completion, which shall be a `protected_body`, and every `protected_body` shall be the completion of some protected declaration.

Each `interface_subtype_mark` of an `interface_list` appearing within a protected declaration shall denote a limited interface type that is not a task interface.

The prefixed view profile of an explicitly declared primitive subprogram of a tagged protected type shall not be type conformant with any protected operation of the protected type, if the first parameter of the subprogram is of the protected type or is an access parameter designating the protected type.

For each primitive subprogram inherited by the type declared by a protected declaration, at most one of the following shall apply:

- the inherited subprogram is overridden with a primitive subprogram of the protected type, in which case the overriding subprogram shall be subtype conformant with the inherited subprogram and not abstract; or
- the inherited subprogram is implemented by a protected subprogram or single entry of the protected type, in which case its prefixed view profile shall be subtype conformant with that of the protected subprogram or entry.

If neither applies, the inherited subprogram shall be a null procedure. In addition to the places where Legality Rules normally apply (see 12.3), these rules also apply in the private part of an instance of a generic unit.

If an inherited subprogram is implemented by a protected procedure or an entry, then the first parameter of the inherited subprogram shall be of mode **out** or **in out**, or an access-to-variable parameter.

If a protected subprogram declaration has an `overriding_indicator`, then at the point of the declaration:

- if the `overriding_indicator` is **overriding**, then the subprogram shall implement an inherited subprogram;
- if the `overriding_indicator` is **not overriding**, then the subprogram shall not implement any inherited subprogram.

Insert after paragraph 20:

As the first step of the *finalization* of a protected object, each call remaining on any entry queue of the object is removed from its queue and `Program_Error` is raised at the place of the corresponding `entry_call_statement`.

the new paragraph:

Bounded (Run-Time) Errors

It is a bounded error to call an entry or subprogram of a protected object after that object is finalized. If the error is detected, `Program_Error` is raised. Otherwise, the call proceeds normally, which may leave a task queued forever.

Replace paragraph 21:

13 Within the declaration or body of a protected unit, the name of the protected unit denotes the current instance of the unit (see 8.6), rather than the first subtype of the corresponding protected type (and thus the name cannot be used as a `subtype_mark`).

by:

13 Within the declaration or body of a protected unit other than in an `access_definition`, the name of the protected unit denotes the current instance of the unit (see 8.6), rather than the first subtype of the corresponding protected type (and thus the name cannot be used as a `subtype_mark`).

Replace paragraph 23:

15 A protected type is a limited type (see 7.5), and hence has neither an assignment operation nor predefined equality operators.

by:

15 A protected type is a limited type (see 7.5), and hence precludes use of `assignment_statements` and predefined equality operators.

9.5 Intertask Communication

Insert after paragraph 7:

A corresponding definition of target object applies to a `requeue_statement` (see 9.5.4), with a corresponding distinction between an *internal requeue* and an *external requeue*.

the new paragraph:

The view of the target protected object associated with a call of a protected procedure or entry shall be a variable.

9.5.1 Protected Subprograms and Protected Actions

Insert after paragraph 22:

21 From within a protected action, an internal call on a protected subprogram, or an external call on a protected subprogram with a different target object is not considered a potentially blocking operation.

the new paragraph:

22 The pragma `Detect_Blocking` may be used to ensure that all executions of potentially blocking operations during a protected action raise `Program_Error`. See H.5.

9.5.2 Entries and Accept Statements

Replace paragraph 2:

```
entry_declaration ::=
  entry defining_identifier [(discrete_subtype_definition)] parameter_profile;
```

by:

```
entry_declaration ::=
  [overriding_indicator]
  entry defining_identifier [(discrete_subtype_definition)] parameter_profile;
```

Insert after paragraph 10:

An `entry_declaration` is allowed only in a protected or task declaration.

the new paragraph:

An `overriding_indicator` is not allowed in an `entry_declaration` that includes a `discrete_subtype_definition`.

Insert after paragraph 13:

An entry_declaration in a task declaration shall not contain a specification for an access parameter (see 3.10).

the new paragraphs:

If an entry_declaration has an overriding_indicator, then at the point of the declaration:

- if the overriding_indicator is **overriding**, then the entry shall implement an inherited subprogram;
- if the overriding_indicator is **not overriding**, then the entry shall not implement any inherited subprogram.

In addition to the places where Legality Rules normally apply (see 12.3), these rules also apply in the private part of an instance of a generic unit.

Replace paragraph 29:

24 A return_statement (see 6.5) or a requeue_statement (see 9.5.4) may be used to complete the execution of an accept_statement or an entry_body.

by:

24 A return statement (see 6.5) or a requeue_statement (see 9.5.4) may be used to complete the execution of an accept_statement or an entry_body.

9.6 Delay Statements, Duration, and Time

Replace paragraph 11:

```
subtype Year_Number is Integer range 1901 .. 2099;
subtype Month_Number is Integer range 1 .. 12;
subtype Day_Number is Integer range 1 .. 31;
subtype Day_Duration is Duration range 0.0 .. 86_400.0;
```

by:

```
subtype Year_Number is Integer range 1901 .. 2399;
subtype Month_Number is Integer range 1 .. 12;
subtype Day_Number is Integer range 1 .. 31;
subtype Day_Duration is Duration range 0.0 .. 86_400.0;
```

Replace paragraph 24:

The functions Year, Month, Day, and Seconds return the corresponding values for a given value of the type Time, as appropriate to an implementation-defined timezone; the procedure Split returns all four corresponding values. Conversely, the function Time_Of combines a year number, a month number, a day number, and a duration, into a value of type Time. The operators "+" and "-" for addition and subtraction of times and durations, and the relational operators for times, have the conventional meaning.

by:

The functions Year, Month, Day, and Seconds return the corresponding values for a given value of the type Time, as appropriate to an implementation-defined time zone; the procedure Split returns all four corresponding values. Conversely, the function Time_Of combines a year number, a month number, a day number, and a duration, into a value of type Time. The operators "+" and "-" for addition and subtraction of times and durations, and the relational operators for times, have the conventional meaning.

9.6.1 Formatting, Time Zones, and other operations for Time

Insert new clause:

Static Semantics

The following language-defined library packages exist:

```

package Ada.Calendar.Time_Zones is

  -- Time zone manipulation:

  type Time_Offset is range -28*60 .. 28*60;

  Unknown_Zone_Error : exception;

  function UTC_Time_Offset (Date : Time := Clock) return Time_Offset;

end Ada.Calendar.Time_Zones;

package Ada.Calendar.Arithmetic is

  -- Arithmetic on days:

  type Day_Count is range
    -366*(1+Year_Number'Last - Year_Number'First)
    ..
    366*(1+Year_Number'Last - Year_Number'First);

  subtype Leap_Seconds_Count is Integer range -2047 .. 2047;

  procedure Difference (Left, Right : in Time;
    Days : out Day_Count;
    Seconds : out Duration;
    Leap_Seconds : out Leap_Seconds_Count);

  function "+" (Left : Time; Right : Day_Count) return Time;
  function "+" (Left : Day_Count; Right : Time) return Time;
  function "-" (Left : Time; Right : Day_Count) return Time;
  function "-" (Left, Right : Time) return Day_Count;

end Ada.Calendar.Arithmetic;

with Ada.Calendar.Time_Zones;
package Ada.Calendar.Formatting is

  -- Day of the week:

  type Day_Name is (Monday, Tuesday, Wednesday, Thursday,
    Friday, Saturday, Sunday);

  function Day_of_Week (Date : Time) return Day_Name;

  -- Hours:Minutes:Seconds access:

  subtype Hour_Number is Natural range 0 .. 23;
  subtype Minute_Number is Natural range 0 .. 59;
  subtype Second_Number is Natural range 0 .. 59;
  subtype Second_Duration is Day_Duration range 0.0 .. 1.0;

  function Year (Date : Time;
    Time_Zone : Time_Zones.Time_Offset := 0)
    return Year_Number;

  function Month (Date : Time;
    Time_Zone : Time_Zones.Time_Offset := 0)
    return Month_Number;

```

```

function Day      (Date : Time;
                   Time_Zone : Time_Zones.Time_Offset := 0)
    return Day_Number;

function Hour     (Date : Time;
                   Time_Zone : Time_Zones.Time_Offset := 0)
    return Hour_Number;

function Minute   (Date : Time;
                   Time_Zone : Time_Zones.Time_Offset := 0)
    return Minute_Number;

function Second   (Date : Time)
    return Second_Number;

function Sub_Second (Date : Time)
    return Second_Duration;

function Seconds_Of (Hour   : Hour_Number;
                    Minute  : Minute_Number;
                    Second   : Second_Number := 0;
                    Sub_Second : Second_Duration := 0.0)
    return Day_Duration;

procedure Split (Seconds : in Day_Duration;
                Hour      : out Hour_Number;
                Minute    : out Minute_Number;
                Second     : out Second_Number;
                Sub_Second : out Second_Duration);

function Time_Of (Year      : Year_Number;
                 Month      : Month_Number;
                 Day        : Day_Number;
                 Hour       : Hour_Number;
                 Minute     : Minute_Number;
                 Second     : Second_Number;
                 Sub_Second : Second_Duration := 0.0;
                 Leap_Second: Boolean := False;
                 Time_Zone  : Time_Zones.Time_Offset := 0)
    return Time;

function Time_Of (Year      : Year_Number;
                 Month      : Month_Number;
                 Day        : Day_Number;
                 Seconds    : Day_Duration := 0.0;
                 Leap_Second: Boolean := False;
                 Time_Zone  : Time_Zones.Time_Offset := 0)
    return Time;

procedure Split (Date      : in Time;
                Year       : out Year_Number;
                Month      : out Month_Number;
                Day        : out Day_Number;
                Hour       : out Hour_Number;
                Minute     : out Minute_Number;
                Second     : out Second_Number;
                Sub_Second : out Second_Duration;
                Time_Zone  : in Time_Zones.Time_Offset := 0);

procedure Split (Date      : in Time;
                Year       : out Year_Number;
                Month      : out Month_Number;
                Day        : out Day_Number;
                Hour       : out Hour_Number;
                Minute     : out Minute_Number;
                Second     : out Second_Number;
                Sub_Second : out Second_Duration;
                Leap_Second: out Boolean;
                Time_Zone  : in Time_Zones.Time_Offset := 0);

```

```

procedure Split (Date      : in Time;
                 Year      : out Year_Number;
                 Month     : out Month_Number;
                 Day       : out Day_Number;
                 Seconds   : out Day_Duration;
                 Leap_Second : out Boolean;
                 Time_Zone : in Time_Zones.Time_Offset := 0);

-- Simple image and value:
function Image (Date : Time;
               Include_Time_Fraction : Boolean := False;
               Time_Zone : Time_Zones.Time_Offset := 0) return String;

function Value (Date : String;
               Time_Zone : Time_Zones.Time_Offset := 0) return Time;

function Image (Elapsed_Time : Duration;
               Include_Time_Fraction : Boolean := False) return String;

function Value (Elapsed_Time : String) return Duration;

end Ada.Calendar.Formatting;

```

Type `Time_Offset` represents the number of minutes difference between the implementation-defined time zone used by `Calendar` and another time zone.

```

function UTC_Time_Offset (Date : Time := Clock) return Time_Offset;

```

Returns, as a number of minutes, the difference between the implementation-defined time zone of `Calendar`, and UTC time, at the time `Date`. If the time zone of the `Calendar` implementation is unknown, then `Unknown_Zone_Error` is raised.

```

procedure Difference (Left, Right : in Time;
                    Days : out Day_Count;
                    Seconds : out Duration;
                    Leap_Seconds : out Leap_Seconds_Count);

```

Returns the difference between `Left` and `Right`. `Days` is the number of days of difference, `Seconds` is the remainder seconds of difference excluding leap seconds, and `Leap_Seconds` is the number of leap seconds. If `Left < Right`, then `Seconds` \leq 0.0, `Days` \leq 0, and `Leap_Seconds` \leq 0. Otherwise, all values are nonnegative. The absolute value of `Seconds` is always less than 86_400.0. For the returned values, if `Days = 0`, then `Seconds + Duration(Leap_Seconds) = Calendar."` (Left, Right).

```

function "+" (Left : Time; Right : Day_Count) return Time;
function "+" (Left : Day_Count; Right : Time) return Time;

```

Adds a number of days to a time value. `Time_Error` is raised if the result is not representable as a value of type `Time`.

```

function "-" (Left : Time; Right : Day_Count) return Time;

```

Subtracts a number of days from a time value. `Time_Error` is raised if the result is not representable as a value of type `Time`.

```

function "-" (Left, Right : Time) return Day_Count;

```

Subtracts two time values, and returns the number of days between them. This is the same value that `Difference` would return in `Days`.

```

function Day_of_Week (Date : Time) return Day_Name;

```

Returns the day of the week for `Time`. This is based on the `Year`, `Month`, and `Day` values of `Time`.

```

function Year (Date : Time;
              Time_Zone : Time_Zones.Time_Offset := 0)
  return Year_Number;

```

Returns the year for Date, as appropriate for the specified time zone offset.

```
function Month      (Date : Time;
                    Time_Zone : Time_Zones.Time_Offset := 0)
    return Month_Number;
```

Returns the month for Date, as appropriate for the specified time zone offset.

```
function Day      (Date : Time;
                  Time_Zone : Time_Zones.Time_Offset := 0)
    return Day_Number;
```

Returns the day number for Date, as appropriate for the specified time zone offset.

```
function Hour      (Date : Time;
                   Time_Zone : Time_Zones.Time_Offset := 0)
    return Hour_Number;
```

Returns the hour for Date, as appropriate for the specified time zone offset.

```
function Minute    (Date : Time;
                   Time_Zone : Time_Zones.Time_Offset := 0)
    return Minute_Number;
```

Returns the minute within the hour for Date, as appropriate for the specified time zone offset.

```
function Second    (Date : Time)
    return Second_Number;
```

Returns the second within the hour and minute for Date.

```
function Sub_Second (Date : Time)
    return Second_Duration;
```

Returns the fraction of second for Date (this has the same accuracy as Day_Duration). The value returned is always less than 1.0.

```
function Seconds_Of (Hour : Hour_Number;
                   Minute : Minute_Number;
                   Second : Second_Number := 0;
                   Sub_Second : Second_Duration := 0.0)
    return Day_Duration;
```

Returns a Day_Duration value for the combination of the given Hour, Minute, Second, and Sub_Second. This value can be used in Calendar.Time_Of as well as the argument to Calendar."+" and Calendar."-". If Seconds_Of is called with a Sub_Second value of 1.0, the value returned is equal to the value of Seconds_Of for the next second with a Sub_Second value of 0.0.

```
procedure Split (Seconds : in Day_Duration;
                Hour : out Hour_Number;
                Minute : out Minute_Number;
                Second : out Second_Number;
                Sub_Second : out Second_Duration);
```

Splits Seconds into Hour, Minute, Second and Sub_Second in such a way that the resulting values all belong to their respective subtypes. The value returned in the Sub_Second parameter is always less than 1.0.

```
function Time_Of (Year : Year_Number;
                 Month : Month_Number;
                 Day : Day_Number;
                 Hour : Hour_Number;
                 Minute : Minute_Number;
                 Second : Second_Number;
                 Sub_Second : Second_Duration := 0.0;
                 Leap_Second : Boolean := False;
                 Time_Zone : Time_Zones.Time_Offset := 0)
    return Time;
```

If Leap_Second is False, returns a Time built from the date and time values, relative to the specified time zone offset. If Leap_Second is True, returns the Time that represents the time within the leap second that is one second later than the time specified by the other parameters. Time_Error is raised if the parameters do not form a proper date or time. If Time_Of is called with a Sub_Second value of 1.0, the value returned is equal to the value of Time_Of for the next second with a Sub_Second value of 0.0.

```

function Time_Of (Year      : Year_Number;
                  Month     : Month_Number;
                  Day       : Day_Number;
                  Seconds    : Day_Duration := 0.0;
                  Leap_Second: Boolean := False;
                  Time_Zone  : Time_Zones.Time_Offset := 0)
return Time;

```

If Leap_Second is False, returns a Time built from the date and time values, relative to the specified time zone offset. If Leap_Second is True, returns the Time that represents the time within the leap second that is one second later than the time specified by the other parameters. Time_Error is raised if the parameters do not form a proper date or time. If Time_Of is called with a Seconds value of 86_400.0, the value returned is equal to the value of Time_Of for the next day with a Seconds value of 0.0.

```

procedure Split (Date      : in Time;
                 Year       : out Year_Number;
                 Month      : out Month_Number;
                 Day        : out Day_Number;
                 Hour       : out Hour_Number;
                 Minute     : out Minute_Number;
                 Second     : out Second_Number;
                 Sub_Second : out Second_Duration;
                 Time_Zone  : in Time_Zones.Time_Offset := 0);

```

Splits Date into its constituent parts (Year, Month, Day, Hour, Minute, Second, Sub_Second), relative to the specified time zone offset. The value returned in the Sub_Second parameter is always less than 1.0.

```

procedure Split (Date      : in Time;
                 Year       : out Year_Number;
                 Month      : out Month_Number;
                 Day        : out Day_Number;
                 Hour       : out Hour_Number;
                 Minute     : out Minute_Number;
                 Second     : out Second_Number;
                 Sub_Second : out Second_Duration;
                 Leap_Second: out Boolean;
                 Time_Zone  : in Time_Zones.Time_Offset := 0);

```

If Date does not represent a time within a leap second, splits Date into its constituent parts (Year, Month, Day, Hour, Minute, Second, Sub_Second), relative to the specified time zone offset, and sets Leap_Second to False. If Date represents a time within a leap second, set the constituent parts to values corresponding to a time one second earlier than that given by Date, relative to the specified time zone offset, and sets Leap_Seconds to True. The value returned in the Sub_Second parameter is always less than 1.0.

```

procedure Split (Date      : in Time;
                 Year       : out Year_Number;
                 Month      : out Month_Number;
                 Day        : out Day_Number;
                 Seconds    : out Day_Duration;
                 Leap_Second: out Boolean;
                 Time_Zone  : in Time_Zones.Time_Offset := 0);

```

If Date does not represent a time within a leap second, splits Date into its constituent parts (Year, Month, Day, Seconds), relative to the specified time zone offset, and sets Leap_Second to False. If Date represents a time within a leap second, set the constituent parts to values corresponding to a time one second earlier than that given by Date, relative to the specified time zone offset, and sets Leap_Seconds to True. The value returned in the Seconds parameter is always less than 86_400.0.

```

function Image (Date : Time;
                Include_Time_Fraction : Boolean := False;
                Time_Zone : Time_Zones.Time_Offset := 0) return String;

```

Returns a string form of the Date relative to the given Time_Zone. The format is "Year-Month-Day Hour:Minute:Second", where the Year is a 4-digit value, and all others are 2-digit values, of the functions defined in Calendar and Calendar.Formatting, including a leading zero, if needed. The separators between the values are a minus, another minus, a colon, and a single space between the Day and Hour. If Include_Time_Fraction is True, the integer part of Sub_Seconds*100 is suffixed to the string as a point followed by a 2-digit value.

```
function Value (Date : String;
                Time_Zone : Time_Zones.Time_Offset := 0) return Time;
```

Returns a Time value for the image given as Date, relative to the given time zone. Constraint_Error is raised if the string is not formatted as described for Image, or the function cannot interpret the given string as a Time value.

```
function Image (Elapsed_Time : Duration;
                Include_Time_Fraction : Boolean := False) return String;
```

Returns a string form of the Elapsed_Time. The format is "Hour:Minute:Second", where all values are 2-digit values, including a leading zero, if needed. The separators between the values are colons. If Include_Time_Fraction is True, the integer part of Sub_Seconds*100 is suffixed to the string as a point, followed by a 2-digit value. If Elapsed_Time < 0.0, the result is Image (**abs** Elapsed_Time, Include_Time_Fraction) prefixed with a minus sign. If **abs** Elapsed_Time represents 100 hours or more, the result is implementation-defined.

```
function Value (Elapsed_Time : String) return Duration;
```

Returns a Duration value for the image given as Elapsed_Time. Constraint_Error is raised if the string is not formatted as described for Image, or the function cannot interpret the given string as a Duration value.

Implementation Advice

An implementation should support leap seconds if the target system supports them. If leap seconds are not supported, Difference should return zero for Leap_Seconds, Split should return False for Leap_Second, and Time_Of should raise Time_Error if Leap_Second is True.

NOTES

36 The implementation-defined time zone of package Calendar may, but need not, be the local time zone. UTC_Time_Offset always returns the difference relative to the implementation-defined time zone of package Calendar. If UTC_Time_Offset does not raise Unknown_Zone_Error, UTC time can be safely calculated (within the accuracy of the underlying time-base).

37 Calling Split on the results of subtracting Duration(UTC_Time_Offset*60) from Clock provides the components (hours, minutes, and so on) of the UTC time. In the United States, for example, UTC_Time_Offset will generally be negative.

9.7.2 Timed Entry Calls

Replace paragraph 1:

A `timed_entry_call` issues an entry call that is cancelled if the call (or a requeue-with-abort of the call) is not selected before the expiration time is reached.

by:

A `timed_entry_call` issues an entry call that is cancelled if the call (or a requeue-with-abort of the call) is not selected before the expiration time is reached. A procedure call may appear rather than an entry call for cases where the procedure might be implemented by an entry.

Replace paragraph 3:

```
entry_call_alternative ::=
    entry_call_statement [sequence_of_statements]
```

by:

```
entry_call_alternative ::=
    procedure_or_entry_call [sequence_of_statements]

procedure_or_entry_call ::=
    procedure_call_statement | entry_call_statement
```

Legality Rules

If a `procedure_call_statement` is used for a `procedure_or_entry_call`, the `procedure_name` or `procedure_prefix` of the `procedure_call_statement` shall statically denote an entry renamed as a procedure or (a view of) a primitive subprogram of a limited interface whose first parameter is a controlling parameter (see 3.9.2).

Static Semantics

If a `procedure_call_statement` is used for a `procedure_or_entry_call`, and the procedure is implemented by an entry, then the `procedure_name`, or `procedure_prefix` and possibly the first parameter of the `procedure_call_statement`, determine the target object of the call and the entry to be called.

Replace paragraph 4:

For the execution of a `timed_entry_call`, the `entry_name` and the actual parameters are evaluated, as for a simple entry call (see 9.5.3). The expiration time (see 9.6) for the call is determined by evaluating the `delay_expression` of the `delay_alternative`; the entry call is then issued.

by:

For the execution of a `timed_entry_call`, the `entry_name`, `procedure_name`, or `procedure_prefix`, and any actual parameters are evaluated, as for a simple entry call (see 9.5.3) or procedure call (see 6.4). The expiration time (see 9.6) for the call is determined by evaluating the `delay_expression` of the `delay_alternative`. If the call is an entry call or a call on a procedure implemented by an entry, the entry call is then issued. Otherwise, the call proceeds as described in 6.4 for a procedure call, followed by the `sequence_of_statements` of the `entry_call_alternative`; the `sequence_of_statements` of the `delay_alternative` is ignored.

9.7.3 Conditional Entry Calls**Replace paragraph 1:**

A `conditional_entry_call` issues an entry call that is then cancelled if it is not selected immediately (or if a requeue-with-abort of the call is not selected immediately).

by:

A `conditional_entry_call` issues an entry call that is then cancelled if it is not selected immediately (or if a requeue-with-abort of the call is not selected immediately). A procedure call may appear rather than an entry call for cases where the procedure might be implemented by an entry.

9.7.4 Asynchronous Transfer of Control**Replace paragraph 4:**

`triggering_statement ::= entry_call_statement | delay_statement`

by:

`triggering_statement ::= procedure_or_entry_call | delay_statement`

Replace paragraph 6:

For the execution of an `asynchronous_select` whose `triggering_statement` is an `entry_call_statement`, the `entry_name` and actual parameters are evaluated as for a simple entry call (see 9.5.3), and the entry call is issued. If the entry call is queued (or requeued-with-abort), then the `abortable_part` is executed. If the entry call is selected immediately, and never requeued-with-abort, then the `abortable_part` is never started.

by:

For the execution of an `asynchronous_select` whose `triggering_statement` is a `procedure_or_entry_call`, the `entry_name`, `procedure_name`, or `procedure_prefix`, and actual parameters are evaluated as for a simple entry call (see 9.5.3) or procedure call (see 6.4). If the call is an entry call or a call on a procedure implemented by an entry, the entry call is issued. If the entry call is queued (or requeued-with-abort), then the `abortable_part` is executed. If the entry call is selected immediately, and never requeued-with-abort, then the `abortable_part` is never started. If the call is on a procedure that is not implemented by an entry, the call proceeds as described in 6.4, followed by the `sequence_of_statements` of the `triggering_alternative`; the `abortable_part` is never started.

9.11 Example of Tasking and Synchronization

Replace paragraph 3:

```

task body Producer is
  Char : Character;
begin
  loop
    ... -- produce the next character Char
    Buffer.Write(Char);
    exit when Char = ASCII.EOT;
  end loop;
end Producer;

```

by:

```

task body Producer is
  Person : Person_Name; -- see 3.10.1
begin
  loop
    ... -- simulate arrival of the next customer
    Buffer.Append_Wait(Person);
    exit when Person = null;
  end loop;
end Producer;

```

Replace paragraph 6:

```

task body Consumer is
  Char : Character;
begin
  loop
    Buffer.Read(Char);
    exit when Char = ASCII.EOT;
    ... -- consume the character Char
  end loop;
end Consumer;

```

by:

```

task body Consumer is
  Person : Person_Name;
begin
  loop
    Buffer.Remove_First_Wait(Person);
    exit when Person = null;
    ... -- simulate serving a customer
  end loop;
end Consumer;

```

Replace paragraph 7:

The buffer object contains an internal pool of characters managed in a round-robin fashion. The pool has two indices, an In_Index denoting the space for the next input character and an Out_Index denoting the space for the next output character.

by:

The buffer object contains an internal array of person names managed in a round-robin fashion. The array has two indices, an In_Index denoting the index for the next input person name and an Out_Index denoting the index for the next output person name.

The Buffer is defined as an extension of the Synchronized_Queue interface (see 3.9.4), and as such promises to implement the abstraction defined by that interface. By doing so, the Buffer can be passed to the Transfer class-wide operation defined for objects of a type covered by Queue'Class.

Replace paragraph 8:

```

protected Buffer is
  entry Read (C : out Character);
  entry Write(C : in Character);
private
  Pool      : String(1 .. 100);
  Count     : Natural := 0;
  In_Index, Out_Index : Positive := 1;
end Buffer;

```

by:

```

protected Buffer is new Synchronized_Queue with -- see 3.9.4
  entry Append_Wait(Person : in Person_Name);
  entry Remove_First_Wait(Person : out Person_Name);
  function Cur_Count return Natural;
  function Max_Count return Natural;
  procedure Append(Person : in Person_Name);
  procedure Remove_First(Person : out Person_Name);
private
  Pool      : Person_Name Array(1 .. 100);
  Count     : Natural := 0;
  In_Index, Out_Index : Positive := 1;
end Buffer;

```

Replace paragraph 9:

```

protected body Buffer is
  entry Write(C : in Character)
    when Count < Pool'Length is
  begin
    Pool(In_Index) := C;
    In_Index := (In_Index mod Pool'Length) + 1;
    Count := Count + 1;
  end Write;

```

by:

```

protected body Buffer is
  entry Append_Wait(Person : in Person_Name)
    when Count < Pool'Length is
  begin
    Append(Person);
  end Append_Wait;

  procedure Append(Person : in Person_Name) is
  begin
    if Count = Pool'Length then
      raise Queue_Error with "Buffer Full"; -- see 11.3
    end if;
    Pool(In_Index) := Person;
    In_Index := (In_Index mod Pool'Length) + 1;
    Count := Count + 1;
  end Append;

```

Replace paragraph 10:

```

  entry Read(C : out Character)
    when Count > 0 is
  begin
    C := Pool(Out_Index);
    Out_Index := (Out_Index mod Pool'Length) + 1;
    Count := Count - 1;
  end Read;
end Buffer;

```

by:

```
entry Remove_First_Wait(Person : out Person_Name)
  when Count > 0 is
begin
  Remove_First(Person);
end Remove_First_Wait;

procedure Remove_First(Person : out Person_Name) is
begin
  if Count = 0 then
    raise Queue_Error with "Buffer Empty"; -- see 11.3
  end if;
  Person := Pool(Out_Index);
  Out_Index := (Out_Index mod Pool'Length) + 1;
  Count := Count - 1;
end Remove_First;

function Cur_Count return Natural is
begin
  return Buffer.Count;
end Cur_Count;

function Max_Count return Natural is
begin
  return Pool'Length;
end Max_Count;
end Buffer;
```

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Section 10: Program Structure and Compilation Issues

10.1.1 Compilation Units - Library Units

Insert after paragraph 8:

parent_unit_name ::= name

the new paragraph:

An overriding_indicator is not allowed in a subprogram_declaration, generic_instantiation, or subprogram_renaming_declaration that declares a library unit.

Insert after paragraph 12:

A library_unit_declaration or a library_unit_renaming_declaration is *private* if the declaration is immediately preceded by the reserved word **private**; it is otherwise *public*. A library unit is private or public according to its declaration. The *public descendants* of a library unit are the library unit itself, and the public descendants of its public children. Its other descendants are *private descendants*.

the new paragraphs:

For each library package_declaration in the environment, there is an implicit declaration of a *limited view* of that library package. The limited view of a package contains:

- For each nested package_declaration, a declaration of the limited view of that package, with the same defining_program_unit_name.
- For each type_declaration in the visible part, an incomplete view of the type; if the type_declaration is tagged, then the view is a tagged incomplete view.

The limited view of a library package_declaration is private if that library package_declaration is immediately preceded by the reserved word **private**.

There is no syntax for declaring limited views of packages, because they are always implicit. The implicit declaration of a limited view of a library package is not the declaration of a library unit (the library package_declaration is); nonetheless, it is a library_item. The implicit declaration of the limited view of a library package forms an (implicit) compilation unit whose context_clause is empty.

A library package_declaration is the completion of the declaration of its limited view.

Replace paragraph 15:

A parent_unit_name (which can be used within a defining_program_unit_name of a library_item and in the separate clause of a subunit), and each of its prefixes, shall not denote a renaming_declaration. On the other hand, a name that denotes a library_unit_renaming_declaration is allowed in a with_clause and other places where the name of a library unit is allowed.

by:

A parent_unit_name (which can be used within a defining_program_unit_name of a library_item and in the separate clause of a subunit), and each of its prefixes, shall not denote a renaming_declaration. On the other hand, a name that denotes a library_unit_renaming_declaration is allowed in a nonlimited_with_clause and other places where the name of a library unit is allowed.

Replace paragraph 19:

For each declaration or renaming of a generic unit as a child of some parent generic package, there is a corresponding declaration nested immediately within each instance of the parent. This declaration is visible only within the scope of a with_clause that mentions the child generic unit.

by:

For each child *C* of some parent generic package *P*, there is a corresponding declaration *C* nested immediately within each instance of *P*. For the purposes of this rule, if a child *C* itself has a child *D*, each corresponding declaration for *C* has a corresponding child *D*. The corresponding declaration for a child within an instance is visible only within the scope of a with_clause that mentions the (original) child generic unit.

Replace paragraph 26:

A `library_item` depends semantically upon its parent declaration. A subunit depends semantically upon its parent body. A `library_unit_body` depends semantically upon the corresponding `library_unit_declaration`, if any. A compilation unit depends semantically upon each `library_item` mentioned in a `with_clause` of the compilation unit. In addition, if a given compilation unit contains an `attribute_reference` of a type defined in another compilation unit, then the given compilation unit depends semantically upon the other compilation unit. The semantic dependence relationship is transitive.

by:

A `library_item` depends semantically upon its parent declaration. A subunit depends semantically upon its parent body. A `library_unit_body` depends semantically upon the corresponding `library_unit_declaration`, if any. The declaration of the limited view of a library package depends semantically upon the declaration of the limited view of its parent. The declaration of a library package depends semantically upon the declaration of its limited view. A compilation unit depends semantically upon each `library_item` mentioned in a `with_clause` of the compilation unit. In addition, if a given compilation unit contains an `attribute_reference` of a type defined in another compilation unit, then the given compilation unit depends semantically upon the other compilation unit. The semantic dependence relationship is transitive.

Dynamic Semantics

The elaboration of the declaration of the limited view of a package has no effect.

10.1.2 Context Clauses - With Clauses**Replace paragraph 4:**

`with_clause ::= with library_unit_name {, library_unit_name};`

by:

`with_clause ::= limited_with_clause | nonlimited_with_clause`
`limited_with_clause ::= limited [private] with library_unit_name {, library_unit_name};`
`nonlimited_with_clause ::= [private] with library_unit_name {, library_unit_name};`

Replace paragraph 6:

A `library_item` is *mentioned* in a `with_clause` if it is denoted by a `library_unit_name` or a prefix in the `with_clause`.

by:

A `library_item` (and the corresponding library unit) is *named* in a `with_clause` if it is denoted by a `library_unit_name` in the `with_clause`. A `library_item` (and the corresponding library unit) is *mentioned* in a `with_clause` if it is named in the `with_clause` or if it is denoted by a prefix in the `with_clause`.

Replace paragraph 8:

If a `with_clause` of a given `compilation_unit` mentions a private child of some library unit, then the given `compilation_unit` shall be either the declaration of a private descendant of that library unit or the body or a subunit of a (public or private) descendant of that library unit.

by:

If a `with_clause` of a given `compilation_unit` mentions a private child of some library unit, then the given `compilation_unit` shall be one of:

- the declaration, body, or subunit of a private descendant of that library unit;
- the body or subunit of a public descendant of that library unit, but not a subprogram body acting as a subprogram declaration (see 10.1.4); or
- the declaration of a public descendant of that library unit, in which case the `with_clause` shall include the reserved word **private**.

A name denoting a library item that is visible only due to being mentioned in one or more `with_clauses` that include the reserved word **private** shall appear only within

- a private part;
- a body, but not within the `subprogram_specification` of a library subprogram body;
- a private descendant of the unit on which one of these `with_clauses` appear; or
- a pragma within a context clause.

A `library_item` mentioned in a `limited_with_clause` shall be the implicit declaration of the limited view of a library package, not the declaration of a subprogram, generic unit, generic instance, or a renaming.

A `limited_with_clause` shall not appear on a `library_unit_body`, subunit, or `library_unit_renaming` declaration.

A `limited_with_clause` that names a library package shall not appear:

- in the `context_clause` for the explicit declaration of the named library package;
- in the same `context_clause` as, or within the scope of, a `nonlimited_with_clause` that mentions the same library package; or
- in the same `context_clause` as, or within the scope of, a `use_clause` that names an entity declared within the declarative region of the library package.

Examples

```

package Office is
end Office;

with Ada.Strings.Unbounded;
package Office.Locations is
  type Location is new Ada.Strings.Unbounded.Unbounded_String;
end Office.Locations;

limited with Office.Departments; -- types are incomplete
private with Office.Locations; -- only visible in private part
package Office.Employees is
  type Employee is private;

  function Dept_Of(Emp : Employee) return access Departments.Department;
  procedure Assign_Dept(Emp : in out Employee;
    Dept : access Departments.Department);

  ...
private
  type Employee is
    record
      Dept : access Departments.Department;
      Loc : Locations.Location;
      ...
    end record;
end Office.Employees;

limited with Office.Employees;
package Office.Departments is
  type Department is private;

  function Manager_Of(Dept : Department) return access Employees.Employee;
  procedure Assign_Manager(Dept : in out Department;
    Mgr : access Employees.Employee);

  ...
end Office.Departments;

```

The `limited_with_clause` may be used to support mutually dependent abstractions that are split across multiple packages. In this case, an employee is assigned to a department, and a department has a manager who is an employee. If a `with_clause` with the reserved word **private** appears on one library unit and mentions a second library unit, it provides visibility to the second library unit, but restricts that visibility to the private part and body of the first unit. The compiler checks that no use is made of the second unit in the visible part of the first unit.

Replace paragraph 9:

A *library_item* mentioned in a *with_clause* of a compilation unit is visible within the compilation unit and hence acts just like an ordinary declaration. Thus, within a compilation unit that mentions its declaration, the name of a library package can be given in *use_clauses* and can be used to form expanded names, a library subprogram can be called, and instances of a generic library unit can be declared. If a child of a parent generic package is mentioned in a *with_clause*, then the corresponding declaration nested within each visible instance is visible within the compilation unit.

by:

A *library_item* mentioned in a *nonlimited_with_clause* of a compilation unit is visible within the compilation unit and hence acts just like an ordinary declaration. Thus, within a compilation unit that mentions its declaration, the name of a library package can be given in *use_clauses* and can be used to form expanded names, a library subprogram can be called, and instances of a generic library unit can be declared. If a child of a parent generic package is mentioned in a *nonlimited_with_clause*, then the corresponding declaration nested within each visible instance is visible within the compilation unit. Similarly, a *library_item* mentioned in a *limited_with_clause* of a compilation unit is visible within the compilation unit and thus can be used to form expanded names.

10.1.3 Subunits of Compilation Units

Replace paragraph 3:

subprogram_body_stub ::= *subprogram_specification is separate*;

by:

subprogram_body_stub ::=
 [*overriding_indicator*]
subprogram_specification is separate;

Replace paragraph 8:

The *parent body* of a subunit is the body of the program unit denoted by its *parent_unit_name*. The term *subunit* is used to refer to a subunit and also to the *proper_body* of a subunit.

by:

The *parent body* of a subunit is the body of the program unit denoted by its *parent_unit_name*. The term *subunit* is used to refer to a subunit and also to the *proper_body* of a subunit. The *subunits of a program unit* include any subunit that names that program unit as its parent, as well as any subunit that names such a subunit as its parent (recursively).

10.1.4 The Compilation Process

Replace paragraph 3:

The mechanisms for creating an environment and for adding and replacing compilation units within an environment are implementation defined.

by:

The mechanisms for creating an environment and for adding and replacing compilation units within an environment are implementation defined. The mechanisms for adding a compilation unit mentioned in a *limited_with_clause* to an environment are implementation defined.

Replace paragraph 6:

The implementation may require that a compilation unit be legal before inserting it into the environment.

by:

The implementation may require that a compilation unit be legal before it can be mentioned in a *limited_with_clause* or it can be inserted into the environment.

Replace paragraph 7:

When a compilation unit that declares or renames a library unit is added to the environment, the implementation may remove from the environment any preexisting `library_item` with the same `defining_program_unit_name`. When a compilation unit that is a subunit or the body of a library unit is added to the environment, the implementation may remove from the environment any preexisting version of the same compilation unit. When a given compilation unit is removed from the environment, the implementation may also remove any compilation unit that depends semantically upon the given one. If the given compilation unit contains the body of a subprogram to which a `pragma Inline` applies, the implementation may also remove any compilation unit containing a call to that subprogram.

by:

When a compilation unit that declares or renames a library unit is added to the environment, the implementation may remove from the environment any preexisting `library_item` or `subunit` with the same full expanded name. When a compilation unit that is a subunit or the body of a library unit is added to the environment, the implementation may remove from the environment any preexisting version of the same compilation unit. When a compilation unit that contains a `body_stub` is added to the environment, the implementation may remove any preexisting `library_item` or `subunit` with the same full expanded name as the `body_stub`. When a given compilation unit is removed from the environment, the implementation may also remove any compilation unit that depends semantically upon the given one. If the given compilation unit contains the body of a subprogram to which a `pragma Inline` applies, the implementation may also remove any compilation unit containing a call to that subprogram.

10.1.5 Pragmas and Program Units**Replace paragraph 9:**

An implementation may place restrictions on configuration pragmas, so long as it allows them when the environment contains no `library_items` other than those of the predefined environment.

by:

An implementation may require that configuration pragmas that select partition-wide or system-wide options be compiled when the environment contains no `library_items` other than those of the predefined environment. In this case, the implementation shall still accept configuration pragmas in individual compilations that confirm the initially selected partition-wide or system-wide options.

10.1.6 Environment-Level Visibility Rules**Replace paragraph 2:**

Within the `parent_unit_name` at the beginning of a `library_item`, and within a `with_clause`, the only declarations that are visible are those that are `library_items` of the environment, and the only declarations that are directly visible are those that are root `library_items` of the environment. Notwithstanding the rules of 4.1.3, an expanded name in a `with_clause` may consist of a `prefix` that denotes a generic package and a `selector_name` that denotes a child of that generic package. (The child is necessarily a generic unit; see 10.1.1.)

by:

Within the `parent_unit_name` at the beginning of an explicit `library_item`, and within a `nonlimited_with_clause`, the only declarations that are visible are those that are explicit `library_items` of the environment, and the only declarations that are directly visible are those that are explicit root `library_items` of the environment. Within a `limited_with_clause`, the only declarations that are visible are those that are the implicit declaration of the limited view of a library package of the environment, and the only declarations that are directly visible are those that are the implicit declaration of the limited view of a root library package.

Insert after paragraph 5:

Within a `pragma` that appears at the place of a compilation unit, the immediately preceding `library_item` and each of its ancestors is visible. The ancestor root `library_item` is directly visible.

the new paragraph:

Notwithstanding the rules of 4.1.3, an expanded name in a `with_clause`, a `pragma` in a `context_clause`, or a `pragma` that appears at the place of a compilation unit may consist of a `prefix` that denotes a generic package and a `selector_name` that denotes a child of that generic package. (The child is necessarily a generic unit; see 10.1.1.)

10.2 Program Execution

Replace paragraph 6:

- If a compilation unit with stubs is needed, then so are any corresponding subunits.

by:

- If a compilation unit with stubs is needed, then so are any corresponding subunits;
- If the (implicit) declaration of the limited view of a library package is needed, then so is the explicit declaration of the library package.

Replace paragraph 9:

The order of elaboration of library units is determined primarily by the *elaboration dependences*. There is an elaboration dependence of a given `library_item` upon another if the given `library_item` or any of its subunits depends semantically on the other `library_item`. In addition, if a given `library_item` or any of its subunits has a `pragma Elaborate` or `Elaborate_All` that mentions another library unit, then there is an elaboration dependence of the given `library_item` upon the body of the other library unit, and, for `Elaborate_All` only, upon each `library_item` needed by the declaration of the other library unit.

by:

The order of elaboration of library units is determined primarily by the *elaboration dependences*. There is an elaboration dependence of a given `library_item` upon another if the given `library_item` or any of its subunits depends semantically on the other `library_item`. In addition, if a given `library_item` or any of its subunits has a `pragma Elaborate` or `Elaborate_All` that names another library unit, then there is an elaboration dependence of the given `library_item` upon the body of the other library unit, and, for `Elaborate_All` only, upon each `library_item` needed by the declaration of the other library unit.

10.2.1 Elaboration Control

Insert after paragraph 4:

A `pragma Preelaborate` is a library unit pragma.

the new paragraphs:

The form of a `pragma Preelaborable_Initialization` is as follows:

```
pragma Preelaborable_Initialization(direct_name);
```

Replace paragraph 9:

- The creation of a default-initialized object (including a component) of a descendant of a private type, private extension, controlled type, task type, or protected type with `entry_declarations`; similarly the evaluation of an `extension_aggregate` with an ancestor `subtype_mark` denoting a subtype of such a type.

by:

- The creation of an object (including a component) of a type that does not have preelaborable initialization. Similarly, the evaluation of an `extension_aggregate` with an ancestor `subtype_mark` denoting a subtype of such a type.

Replace paragraph 10:

A generic body is preelaborable only if elaboration of a corresponding instance body would not perform any such actions, presuming that the actual for each formal private type (or extension) is a private type (or extension), and the actual for each formal subprogram is a user-defined subprogram.

by:

A generic body is preelaborable only if elaboration of a corresponding instance body would not perform any such actions, presuming that:

- the actual for each formal private type (or extension) declared within the formal part of the generic unit is a private type (or extension) that does not have preelaborable initialization;
- the actual for each formal type is nonstatic;
- the actual for each formal object is nonstatic; and
- the actual for each formal subprogram is a user-defined subprogram.

Insert after paragraph 11:

If a **pragma** Preelaborate (or **pragma** Pure — see below) applies to a library unit, then it is *preelaborated*. If a library unit is preelaborated, then its declaration, if any, and body, if any, are elaborated prior to all non-preelaborated **library_items** of the partition. The declaration and body of a preelaborated library unit, and all subunits that are elaborated as part of elaborating the library unit, shall be preelaborable. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit. In addition, all compilation units of a preelaborated library unit shall depend semantically only on compilation units of other preelaborated library units.

the new paragraphs:

The following rules specify which entities have *preelaborable initialization*:

- The partial view of a private type or private extension, a protected type without **entry_declarations**, a generic formal private type, or a generic formal derived type, have preelaborable initialization if and only if the **pragma** Preelaborable_Initialization has been applied to them. A protected type with **entry_declarations** or a task type never has preelaborable initialization.
- A component (including a discriminant) of a record or protected type has preelaborable initialization if its declaration includes a **default_expression** whose execution does not perform any actions prohibited in preelaborable constructs as described above, or if its declaration does not include a default expression and its type has preelaborable initialization.
- A derived type has preelaborable initialization if its parent type has preelaborable initialization and (in the case of a derived record extension) if the non-inherited components all have preelaborable initialization. However, a user-defined controlled type with an overriding Initialize procedure does not have preelaborable initialization.
- A view of a type has preelaborable initialization if it is an elementary type, an array type whose component type has preelaborable initialization, a record type whose components all have preelaborable initialization, or an interface type.

A **pragma** Preelaborable_Initialization specifies that a type has preelaborable initialization. This **pragma** shall appear in the visible part of a package or generic package.

If the **pragma** appears in the first list of **basic_declarative_items** of a **package_specification**, then the **direct_name** shall denote the first subtype of a private type, private extension, or protected type that is not an interface type and is without **entry_declarations**, and the type shall be declared immediately within the same package as the **pragma**. If the **pragma** is applied to a private type or a private extension, the full view of the type shall have preelaborable initialization. If the **pragma** is applied to a protected type, each component of the protected type shall have preelaborable initialization. In addition to the places where Legality Rules normally apply, these rules apply also in the private part of an instance of a generic unit.

If the **pragma** appears in a **generic_formal_part**, then the **direct_name** shall denote a generic formal private type or a generic formal derived type declared in the same **generic_formal_part** as the **pragma**. In a **generic_instantiation** the corresponding actual type shall have preelaborable initialization.

Replace paragraph 16:

Legality Rules

A *pure library_item* is a preelaborable *library_item* that does not contain the declaration of any variable or named access type, except within a subprogram, generic subprogram, task unit, or protected unit.

by:

Static Semantics

A *pure library_item* is a preelaborable *library_item* whose elaboration does not perform any of the following actions:

- the elaboration of a variable declaration;
- the evaluation of an *allocator* of an access-to-variable type; for the purposes of this rule, the partial view of a type is presumed to have non-visible components whose default initialization evaluates such an *allocator*;
- the elaboration of the declaration of a named access-to-variable type unless the *Storage_Size* of the type has been specified by a static expression with value zero or is defined by the language to be zero;
- the elaboration of the declaration of a named access-to-constant type for which the *Storage_Size* has been specified by an expression other than a static expression with value zero.

The *Storage_Size* for an anonymous access-to-variable type declared at library level in a library unit that is declared pure is defined to be zero.

Legality Rules

Replace paragraph 17:

A *pragma Pure* is used to declare that a library unit is pure. If a *pragma Pure* applies to a library unit, then its compilation units shall be pure, and they shall depend semantically only on compilation units of other library units that are declared pure.

by:

A *pragma Pure* is used to declare that a library unit is pure. If a *pragma Pure* applies to a library unit, then its compilation units shall be pure, and they shall depend semantically only on compilation units of other library units that are declared pure. Furthermore, the full view of any partial view declared in the visible part of the library unit that has any available stream attributes shall support external streaming (see 13.13.2).

Replace paragraph 18:

If a library unit is declared pure, then the implementation is permitted to omit a call on a library-level subprogram of the library unit if the results are not needed after the call. Similarly, it may omit such a call and simply reuse the results produced by an earlier call on the same subprogram, provided that none of the parameters are of a limited type, and the addresses and values of all by-reference actual parameters, and the values of all by-copy-in actual parameters, are the same as they were at the earlier call. This permission applies even if the subprogram produces other side effects when called.

by:

If a library unit is declared pure, then the implementation is permitted to omit a call on a library-level subprogram of the library unit if the results are not needed after the call. In addition, the implementation may omit a call on such a subprogram and simply reuse the results produced by an earlier call on the same subprogram, provided that none of the parameters nor any object accessible via access values from the parameters are of a limited type, and the addresses and values of all by-reference actual parameters, the values of all by-copy-in actual parameters, and the values of all objects accessible via access values from the parameters, are the same as they were at the earlier call. This permission applies even if the subprogram produces other side effects when called.

Insert after paragraph 25:

If a *pragma Elaborate_Body* applies to a declaration, then the declaration requires a completion (a body).

the new paragraph:

The *library_unit_name* of a *pragma Elaborate* or *Elaborate_All* shall denote a nonlimited view of a library unit.

Section 11: Exceptions

11.3 Raise Statements

Replace paragraph 2:

```
raise_statement ::= raise [exception_name];
```

by:

```
raise_statement ::= raise; |
raise exception_name [with string_expression];
```

Insert after paragraph 3:

The name, if any, in a `raise_statement` shall denote an exception. A `raise_statement` with no `exception_name` (that is, a *re-raise statement*) shall be within a handler, but not within a body enclosed by that handler.

the new paragraph:

Name Resolution Rules

The expression, if any, in a `raise_statement`, is expected to be of type String.

Replace paragraph 4:

To *raise an exception* is to raise a new occurrence of that exception, as explained in 11.4. For the execution of a `raise_statement` with an `exception_name`, the named exception is raised. For the execution of a re-raise statement, the exception occurrence that caused transfer of control to the innermost enclosing handler is raised again.

by:

To *raise an exception* is to raise a new occurrence of that exception, as explained in 11.4. For the execution of a `raise_statement` with an `exception_name`, the named exception is raised. If a `string_expression` is present, the expression is evaluated and its value is associated with the exception occurrence. For the execution of a re-raise statement, the exception occurrence that caused transfer of control to the innermost enclosing handler is raised again.

Replace paragraph 6:

```
raise Ada.IO_Exceptions.Name_Error; -- see A.13
```

by:

```
raise Ada.IO_Exceptions.Name_Error; -- see A.13
raise Queue_Error with "Buffer Full"; -- see 9.11
```

11.4.1 The Package Exceptions

Replace paragraph 2:

```
package Ada.Exceptions is
  type Exception_Id is private;
  Null_Id : constant Exception_Id;
  function Exception_Name (Id : Exception_Id) return String;
```

by:

```
with Ada.Streams;
package Ada.Exceptions is
  pragma Preelaborate (Exceptions);
  type Exception_Id is private;
  pragma Preelaborable_Initialization (Exception_Id);
  Null_Id : constant Exception_Id;
  function Exception_Name (Id : Exception_Id) return String;
  function Wide_Exception_Name (Id : Exception_Id) return Wide_String;
  function Wide_Wide_Exception_Name (Id : Exception_Id)
    return Wide_Wide_String;
```

Replace paragraph 3:

```

type Exception_Occurrence is limited private;
type Exception_Occurrence_Access is access all Exception_Occurrence;
Null_Occurrence : constant Exception_Occurrence;

```

by:

```

type Exception_Occurrence is limited private;
pragma Preelaborable_Initialization(Exception_Occurrence);
type Exception_Occurrence_Access is access all Exception_Occurrence;
Null_Occurrence : constant Exception_Occurrence;

```

Replace paragraph 4:

```

procedure Raise_Exception(E : in Exception_Id;
                          Message : in String := "");
function Exception_Message(X : Exception_Occurrence) return String;
procedure Reraise_Occurrence(X : in Exception_Occurrence);

```

by:

```

procedure Raise_Exception(E : in Exception_Id;
                          Message : in String := "");
    pragma No_Return(Raise_Exception);
function Exception_Message(X : Exception_Occurrence) return String;
procedure Reraise_Occurrence(X : in Exception_Occurrence);

```

Replace paragraph 5:

```

function Exception_Identity(X : Exception_Occurrence)
    return Exception_Id;
function Exception_Name(X : Exception_Occurrence) return String;
    -- Same as Exception_Name(Exception_Identity(X)).
function Exception_Information(X : Exception_Occurrence) return String;

```

by:

```

function Exception_Identity(X : Exception_Occurrence)
    return Exception_Id;
function Exception_Name(X : Exception_Occurrence) return String;
    -- Same as Exception_Name(Exception_Identity(X)).
function Wide_Exception_Name(X : Exception_Occurrence)
    return Wide_String;
    -- Same as Wide_Exception_Name(Exception_Identity(X)).
function Wide_Wide_Exception_Name(X : Exception_Occurrence)
    return Wide_Wide_String;
    -- Same as Wide_Wide_Exception_Name(Exception_Identity(X)).
function Exception_Information(X : Exception_Occurrence) return String;

```

Replace paragraph 6:

```

procedure Save_Occurrence(Target : out Exception_Occurrence;
                          Source : in Exception_Occurrence);
function Save_Occurrence(Source : Exception_Occurrence)
    return Exception_Occurrence_Access;
private
    . . . -- not specified by the language
end Ada.Exceptions;

```

by:

```

procedure Save_Occurrence(Target : out Exception_Occurrence;
                          Source : in Exception_Occurrence);
function Save_Occurrence(Source : Exception_Occurrence)
    return Exception_Occurrence_Access;

procedure Read_Exception_Occurrence
    (Stream : not null access Ada.Streams.Root_Stream_Type'Class;
     Item   : out Exception_Occurrence);
procedure Write_Exception_Occurrence
    (Stream : not null access Ada.Streams.Root_Stream_Type'Class;
     Item   : in Exception_Occurrence);

```

```

for Exception_Occurrence'Read use Read_Exception_Occurrence;
for Exception_Occurrence'Write use Write_Exception_Occurrence;

private
  ... -- not specified by the language
end Ada.Exceptions;

```

Replace paragraph 10:

Raise_Exception raises a new occurrence of the identified exception. In this case, Exception_Message returns the Message parameter of Raise_Exception. For a **raise_statement** with an *exception_name*, Exception_Message returns implementation-defined information about the exception occurrence. Reraise_Occurrence reraises the specified exception occurrence.

by:

Raise_Exception raises a new occurrence of the identified exception.

Exception_Message returns the message associated with the given Exception_Occurrence. For an occurrence raised by a call to Raise_Exception, the message is the Message parameter passed to Raise_Exception. For the occurrence raised by a **raise_statement** with an *exception_name* and a *string_expression*, the message is the *string_expression*. For the occurrence raised by a **raise_statement** with an *exception_name* but without a *string_expression*, the message is a string giving implementation-defined information about the exception occurrence. In all cases, Exception_Message returns a string with lower bound 1.

Reraise_Occurrence reraises the specified exception occurrence.

Replace paragraph 12:

The Exception_Name functions return the full expanded name of the exception, in upper case, starting with a root library unit. For an exception declared immediately within package Standard, the *defining_identifier* is returned. The result is implementation defined if the exception is declared within an unnamed **block_statement**.

by:

The Wide_Wide_Exception_Name functions return the full expanded name of the exception, in upper case, starting with a root library unit. For an exception declared immediately within package Standard, the *defining_identifier* is returned. The result is implementation defined if the exception is declared within an unnamed **block_statement**.

The Exception_Name functions (respectively, Wide_Exception_Name) return the same sequence of graphic characters as that defined for Wide_Wide_Exception_Name, if all the graphic characters are defined in Character (respectively, Wide_Character); otherwise, the sequence of characters is implementation defined, but no shorter than that returned by Wide_Wide_Exception_Name for the same value of the argument.

The string returned by the Exception_Name, Wide_Exception_Name, and Wide_Wide_Exception_Name functions has lower bound 1.

Replace paragraph 13:

Exception_Information returns implementation-defined information about the exception occurrence.

by:

Exception_Information returns implementation-defined information about the exception occurrence. The returned string has lower bound 1.

Replace paragraph 14:

Raise_Exception and Reraise_Occurrence have no effect in the case of Null_Id or Null_Occurrence.

Exception_Message, Exception_Identity, Exception_Name, and Exception_Information raise Constraint_Error for a Null_Id or Null_Occurrence.

by:

Reraise_Occurrence has no effect in the case of Null_Occurrence. Raise_Exception and Exception_Name raise Constraint_Error for a Null_Id. Exception_Message, Exception_Name, and Exception_Information raise Constraint_Error for a Null_Occurrence. Exception_Identity applied to Null_Occurrence returns Null_Id.

Replace paragraph 16:

Implementation Requirements

The implementation of the Write attribute (see 13.13.2) of Exception_Occurrence shall support writing a representation of an exception occurrence to a stream; the implementation of the Read attribute of Exception_Occurrence shall support reconstructing an exception occurrence from a stream (including one written in a different partition).

by:

Write_Exception_Occurrence writes a representation of an exception occurrence to a stream;
 Read_Exception_Occurrence reconstructs an exception occurrence from a stream (including one written in a different partition).

11.4.2 Pragmas Assert and Assertion_Policy

Insert new clause:

Pragma Assert is used to assert the truth of a Boolean expression at any point within a sequence of declarations or statements. Pragma Assertion_Policy is used to control whether such assertions are to be ignored by the implementation, checked at run-time, or handled in some implementation-defined manner.

Syntax

The form of a pragma Assert is as follows:

```
pragma Assert([Check =>] boolean_expression [, [Message =>] string_expression]);
```

A pragma Assert is allowed at the place where a declarative_item or a statement is allowed.

The form of a pragma Assertion_Policy is as follows:

```
pragma Assertion_Policy(policy_identifier);
```

A pragma Assertion_Policy is a configuration pragma.

Name Resolution Rules

The expected type for the *boolean_expression* of a pragma Assert is any boolean type. The expected type for the *string_expression* of a pragma Assert is type String.

Legality Rules

The *policy_identifier* of a pragma Assertion_Policy shall be either Check, Ignore, or an implementation-defined identifier.

Static Semantics

A pragma Assertion_Policy is a configuration pragma that specifies the assertion policy in effect for the compilation units to which it applies. Different policies may apply to different compilation units within the same partition. The default assertion policy is implementation-defined.

The following language-defined library package exists:

```
package Ada.Assertions is
  pragma Pure (Assertions);
  Assertion_Error : exception;

  procedure Assert (Check : in Boolean);
  procedure Assert (Check : in Boolean; Message : in String);

end Ada.Assertions;
```

A compilation unit containing a pragma Assert has a semantic dependence on the Assertions library unit.

The assertion policy that applies to a generic unit also applies to all its instances.

Dynamic Semantics

An assertion policy specifies how a **pragma Assert** is interpreted by the implementation. If the assertion policy is Ignore at the point of a **pragma Assert**, the **pragma** is ignored. If the assertion policy is Check at the point of a **pragma Assert**, the elaboration of the **pragma** consists of evaluating the boolean expression, and if the result is False, evaluating the Message argument, if any, and raising the exception `Assertions.Assertion_Error`, with a message if the Message argument is provided.

Calling the procedure `Assertions.Assert` without a Message parameter is equivalent to:

```
if Check = False then
  raise Ada.Assertions.Assertion_Error;
end if;
```

Calling the procedure `Assertions.Assert` with a Message parameter is equivalent to:

```
if Check = False then
  raise Ada.Assertions.Assertion_Error with Message;
end if;
```

The procedures `Assertions.Assert` have these effects independently of the assertion policy in effect.

Implementation Permissions

`Assertion_Error` may be declared by renaming an implementation-defined exception from another package.

Implementations may define their own assertion policies.

NOTES

- 2 Normally, the boolean expression in a **pragma Assert** should not call functions that have significant side-effects when the result of the expression is True, so that the particular assertion policy in effect will not affect normal operation of the program.

11.4.3 Example of Exception Handling

Replace paragraph 2:

```
with Ada.Exceptions;
use Ada;
package File_System is
  type File_Handle is limited private;
```

by:

```
package File_System is
  type File_Handle is limited private;
```

Replace paragraph 6:

```
package body File_System is
  procedure Open(F : in out File_Handle; Name : String) is
  begin
    if File_Exists(Name) then
      ...
    else
      Exceptions.Raise_Exception(File_Not_Found'Identity,
        "File not found: " & Name & ".");
    end if;
  end Open;
```

by:

```
package body File_System is
  procedure Open(F : in out File_Handle; Name : String) is
  begin
    if File_Exists(Name) then
      ...
    else
      raise File_Not_Found with "File not found: " & Name & ".";
    end if;
  end Open;
```

11.5 Suppressing Checks

Replace paragraph 1:

A `pragma Suppress` gives permission to an implementation to omit certain language-defined checks.

by:

Checking pragmas give instructions to an implementation on handling language-defined checks. A `pragma Suppress` gives permission to an implementation to omit certain language-defined checks, while a `pragma Unsuppress` revokes the permission to omit checks.

Replace paragraph 3:

The form of a `pragma Suppress` is as follows:

by:

The forms of checking pragmas are as follows:

Replace paragraph 4:

`pragma Suppress(identifier [, [On =>] name]);`

by:

`pragma Suppress(identifier);`
`pragma Unsuppress(identifier);`

Replace paragraph 5:

A `pragma Suppress` is allowed only immediately within a `declarative_part`, immediately within a `package_specification`, or as a configuration pragma.

by:

A checking pragma is allowed only immediately within a `declarative_part`, immediately within a `package_specification`, or as a configuration pragma.

Replace paragraph 6:

The identifier shall be the name of a check. The `name` (if present) shall statically denote some entity.

by:

The identifier shall be the name of a check.

Delete paragraph 7:

For a `pragma Suppress` that is immediately within a `package_specification` and includes a `name`, the `name` shall denote an entity (or several overloaded subprograms) declared immediately within the `package_specification`.

Replace paragraph 8:

A `pragma Suppress` gives permission to an implementation to omit the named check from the place of the `pragma` to the end of the innermost enclosing declarative region, or, if the `pragma` is given in a `package_specification` and includes a `name`, to the end of the scope of the named entity. If the `pragma` includes a `name`, the permission applies only to checks performed on the named entity, or, for a subtype, on objects and values of its type. Otherwise, the permission applies to all entities. If permission has been given to suppress a given check, the check is said to be *suppressed*.

by:

A checking pragma applies to the named check in a specific region, and applies to all entities in that region. A checking pragma given in a `declarative_part` or immediately within a `package_specification` applies from the place of the `pragma` to the end of the innermost enclosing declarative region. The region for a checking pragma given as a configuration pragma is the declarative region for the entire compilation unit (or units) to which it applies.

If a checking pragma applies to a generic instantiation, then the checking pragma also applies to the instance. If a checking pragma applies to a call to a subprogram that has a `pragma Inline` applied to it, then the checking pragma also applies to the inlined subprogram body.

A `pragma Suppress` gives permission to an implementation to omit the named check (or every check in the case of `All_Checks`) for any entities to which it applies. If permission has been given to suppress a given check, the check is said to be *suppressed*.

A `pragma Unsuppress` revokes the permission to omit the named check (or every check in the case of `All_Checks`) given by any `pragma Suppress` that applies at the point of the `pragma Unsuppress`. The permission is revoked for the region to which the `pragma Unsuppress` applies. If there is no such permission at the point of a `pragma Unsuppress`, then the `pragma` has no effect. A later `pragma Suppress` can renew the permission.

Replace paragraph 11:

When evaluating a dereference (explicit or implicit), check that the value of the `name` is not `null`. When passing an actual parameter to a formal access parameter, check that the value of the actual parameter is not `null`. When evaluating a `discriminant_association` for an access discriminant, check that the value of the discriminant is not `null`.

by:

When evaluating a dereference (explicit or implicit), check that the value of the `name` is not `null`. When converting to a subtype that excludes null, check that the converted value is not `null`.

Replace paragraph 13:

`Division_Check`

Check that the second operand is not zero for the operations `/`, `rem` and `mod`.

by:

`Division_Check`

Check that the second operand is not zero for the operations `/`, `rem` and `mod`.

Insert before paragraph 20:

`Elaboration_Check`

When a subprogram or protected entry is called, a task activation is accomplished, or a generic instantiation is elaborated, check that the body of the corresponding unit has already been elaborated.

the new paragraphs:

`Accessibility_Check`

Check the accessibility level of an entity or view.

`Allocation_Check`

For an `allocator`, check that the master of any tasks to be created by the `allocator` is not yet completed or some dependents have not yet terminated, and that the finalization of the collection has not started.

Delete paragraph 21:

`Accessibility_Check`

Check the accessibility level of an entity or view.

Replace paragraph 27:

An implementation is allowed to place restrictions on `Suppress pragmas`. An implementation is allowed to add additional check names, with implementation-defined semantics. When `Overflow_Check` has been suppressed, an implementation may also suppress an unspecified subset of the `Range_Checks`.

by:

An implementation is allowed to place restrictions on checking pragmas, subject only to the requirement that `pragma Unsuppress` shall allow any check names supported by `pragma Suppress`. An implementation is allowed to add additional check names, with implementation-defined semantics. When `Overflow_Check` has been suppressed, an implementation may also suppress an unspecified subset of the `Range_Checks`.

An implementation may support an additional parameter on `pragma Unsuppress` similar to the one allowed for `pragma Suppress` (see J.10). The meaning of such a parameter is implementation-defined.

Insert after paragraph 29:

2 There is no guarantee that a suppressed check is actually removed; hence a `pragma Suppress` should be used only for efficiency reasons.

the new paragraph:

3 It is possible to give both a `pragma Suppress` and `Unsuppress` for the same check immediately within the same `declarative_part`. In that case, the last `pragma` given determines whether or not the check is suppressed. Similarly, it is possible to resuppress a check which has been unsuppressed by giving a `pragma Suppress` in an inner declarative region.

Replace paragraph 30:

Examples of suppressing checks:

by:

Examples of suppressing and unsuppressing checks:

Replace paragraph 32:

```
pragma Suppress (Range_Check);  
pragma Suppress (Index_Check, On => Table);
```

by:

```
pragma Suppress (Index_Check);  
pragma Unsuppress (Overflow_Check);
```

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Section 12: Generic Units

12.1 Generic Declarations

Replace paragraph 8:

A `generic_declaration` declares a generic unit — a generic package, generic procedure or generic function, as appropriate.

by:

A `generic_declaration` declares a generic unit — a generic package, generic procedure, or generic function, as appropriate.

12.3 Generic Instantiation

Replace paragraph 2:

```
generic_instantiation ::=
  package defining_program_unit_name is
    new generic_package_name [generic_actual_part];
  | procedure defining_program_unit_name is
    new generic_procedure_name [generic_actual_part];
  | function defining_designator is
    new generic_function_name [generic_actual_part];
```

by:

```
generic_instantiation ::=
  package defining_program_unit_name is
    new generic_package_name [generic_actual_part];
  | [overriding_indicator]
  procedure defining_program_unit_name is
    new generic_procedure_name [generic_actual_part];
  | [overriding_indicator]
  function defining_designator is
    new generic_function_name [generic_actual_part];
```

12.4 Formal Objects

Replace paragraph 2:

```
formal_object_declaration ::=
  defining_identifier_list : mode subtype_mark [:= default_expression]
```

by:

```
formal_object_declaration ::=
  defining_identifier_list : mode [null_exclusion] subtype_mark [:= default_expression]
  | defining_identifier_list : mode access_definition [:= default_expression];
```

Replace paragraph 5:

For a generic formal object of mode **in out**, the type of the actual shall resolve to the type of the formal.

by:

For a generic formal object of mode **in out**, the type of the actual shall resolve to the type determined by the `subtype_mark`, or for a `formal_object_declaration` with an `access_definition`, to a specific anonymous access type. If the anonymous access type is an access-to-object type, the type of the actual shall have the same designated type as that of the `access_definition`. If the anonymous access type is an access-to-subprogram type, the type of the actual shall have a designated profile which is type conformant with that of the `access_definition`.

Insert after paragraph 7:

For a generic formal object of mode **in**, the actual shall be an **expression**. For a generic formal object of mode **in out**, the actual shall be a name that denotes a variable for which renaming is allowed (see 8.5.1).

the new paragraphs:

In the case where the type of the formal is defined by an **access_definition**, the type of the actual and the type of the formal:

- shall both be access-to-object types with statically matching designated subtypes and with both or neither being access-to-constant types; or
- shall both be access-to-subprogram types with subtype conformant designated profiles.

For a **formal_object_declaration** with a **null_exclusion** or an **access_definition** that has a **null_exclusion**:

- if the actual matching the **formal_object_declaration** denotes the generic formal object of another generic unit *G*, and the instantiation containing the actual occurs within the body of *G* or within the body of a generic unit declared within the declarative region of *G*, then the declaration of the formal object of *G* shall have a **null_exclusion**;
- otherwise, the subtype of the actual matching the **formal_object_declaration** shall exclude null. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit.

Delete paragraph 8:

The type of a generic formal object of mode **in** shall be nonlimited.

Replace paragraph 9:

A **formal_object_declaration** declares a generic formal object. The default mode is **in**. For a formal object of mode **in**, the nominal subtype is the one denoted by the **subtype_mark** in the declaration of the formal. For a formal object of mode **in out**, its type is determined by the **subtype_mark** in the declaration; its nominal subtype is nonstatic, even if the **subtype_mark** denotes a static subtype.

by:

A **formal_object_declaration** declares a generic formal object. The default mode is **in**. For a formal object of mode **in**, the nominal subtype is the one denoted by the **subtype_mark** or **access_definition** in the declaration of the formal. For a formal object of mode **in out**, its type is determined by the **subtype_mark** or **access_definition** in the declaration; its nominal subtype is nonstatic, even if the **subtype_mark** denotes a static subtype; for a composite type, its nominal subtype is unconstrained if the first subtype of the type is unconstrained, even if the **subtype_mark** denotes a constrained subtype.

Replace paragraph 10:

In an instance, a **formal_object_declaration** of mode **in** declares a new stand-alone constant object whose initialization expression is the actual, whereas a **formal_object_declaration** of mode **in out** declares a view whose properties are identical to those of the actual.

by:

In an instance, a **formal_object_declaration** of mode **in** is a *full constant declaration* and declares a new stand-alone constant object whose initialization expression is the actual, whereas a **formal_object_declaration** of mode **in out** declares a view whose properties are identical to those of the actual.

12.5 Formal Types

Replace paragraph 1:

A generic formal subtype can be used to pass to a generic unit a subtype whose type is in a certain class of types.

by:

A generic formal subtype can be used to pass to a generic unit a subtype whose type is in a certain category of types.

Replace paragraph 3:

```
formal_type_definition ::=
    formal_private_type_definition
  | formal_derived_type_definition
  | formal_discrete_type_definition
  | formal_signed_integer_type_definition
  | formal_modular_type_definition
  | formal_floating_point_definition
  | formal_ordinary_fixed_point_definition
  | formal_decimal_fixed_point_definition
  | formal_array_type_definition
  | formal_access_type_definition
```

by:

```
formal_type_definition ::=
    formal_private_type_definition
  | formal_derived_type_definition
  | formal_discrete_type_definition
  | formal_signed_integer_type_definition
  | formal_modular_type_definition
  | formal_floating_point_definition
  | formal_ordinary_fixed_point_definition
  | formal_decimal_fixed_point_definition
  | formal_array_type_definition
  | formal_access_type_definition
  | formal_interface_type_definition
```

Replace paragraph 6:

The form of a `formal_type_definition` determines a class to which the formal type belongs. For a `formal_private_type_definition` the reserved words **tagged** and **limited** indicate the class (see 12.5.1). For a `formal_derived_type_definition` the class is the derivation class rooted at the ancestor type. For other formal types, the name of the syntactic category indicates the class; a `formal_discrete_type_definition` defines a discrete type, and so on.

by:

The form of a `formal_type_definition` determines a category (of types) to which the formal type belongs. For a `formal_private_type_definition` the reserved words **tagged** and **limited** indicate the category of types (see 12.5.1). For a `formal_derived_type_definition` the category of types is the derivation class rooted at the ancestor type. For other formal types, the name of the syntactic category indicates the category of types; a `formal_discrete_type_definition` defines a discrete type, and so on.

Replace paragraph 7:

The actual type shall be in the class determined for the formal.

by:

The actual type shall be in the category determined for the formal.

Replace paragraph 8:

The formal type also belongs to each class that contains the determined class. The primitive subprograms of the type are as for any type in the determined class. For a formal type other than a formal derived type, these are the predefined operators of the type. For an elementary formal type, the predefined operators are implicitly declared immediately after the declaration of the formal type. For a composite formal type, the predefined operators are implicitly declared either immediately after the declaration of the formal type, or later in its immediate scope according to the rules of 7.3.1. In an instance, the copy of such an implicit declaration declares a view of the predefined operator of the actual type, even if this operator has been overridden for the actual type. The rules specific to formal derived types are given in 12.5.1.

by:

The formal type also belongs to each category that contains the determined category. The primitive subprograms of the type are as for any type in the determined category. For a formal type other than a formal derived type, these are the predefined operators of the type. For an elementary formal type, the predefined operators are implicitly declared immediately after the declaration of the formal type. For a composite formal type, the predefined operators are implicitly declared either immediately after the declaration of the formal type, or later immediately within the declarative region in which the type is declared according to the rules of 7.3.1. In an instance, the copy of such an implicit declaration declares a view of the predefined operator of the actual type, even if this operator has been overridden for the actual type. The rules specific to formal derived types are given in 12.5.1.

12.5.1 Formal Private and Derived Types

Replace paragraph 1:

The class determined for a formal private type can be either limited or nonlimited, and either tagged or untagged; no more specific class is known for such a type. The class determined for a formal derived type is the derivation class rooted at the ancestor type.

by:

In its most general form, the category determined for a formal private type is all types, but it can be restricted to only nonlimited types or to only tagged types. The category determined for a formal derived type is the derivation class rooted at the ancestor type.

Replace paragraph 3:

formal_derived_type_definition ::= [abstract] new subtype_mark [with private]

by:

formal_derived_type_definition ::=
[abstract] [limited | synchronized] new subtype_mark [[and interface_list] with private]

Replace paragraph 5:

The *ancestor subtype* of a formal derived type is the subtype denoted by the `subtype_mark` of the `formal_derived_type_definition`. For a formal derived type declaration, the reserved words **with private** shall appear if and only if the ancestor type is a tagged type; in this case the formal derived type is a private extension of the ancestor type and the ancestor shall not be a class-wide type. Similarly, the optional reserved word **abstract** shall appear only if the ancestor type is a tagged type.

by:

The *ancestor subtype* of a formal derived type is the subtype denoted by the `subtype_mark` of the `formal_derived_type_definition`. For a formal derived type declaration, the reserved words **with private** shall appear if and only if the ancestor type is a tagged type; in this case the formal derived type is a private extension of the ancestor type and the ancestor shall not be a class-wide type. Similarly, an `interface_list` or the optional reserved words **abstract** or **synchronized** shall appear only if the ancestor type is a tagged type. The reserved word **limited** or **synchronized** shall appear only if the ancestor type and any progenitor types are limited types. The reserved word **synchronized** shall appear (rather than **limited**) if the ancestor type or any of the progenitor types are synchronized interfaces.

The actual type for a formal derived type shall be a descendant of the ancestor type and every progenitor of the formal type. If the reserved word **synchronized** appears in the declaration of the formal derived type, the actual type shall be a synchronized tagged type.

Insert after paragraph 10:

- If the ancestor subtype is an unconstrained discriminated subtype, then the actual shall have the same number of discriminants, and each discriminant of the actual shall correspond to a discriminant of the ancestor, in the sense of 3.7.

the new paragraph:

- If the ancestor subtype is an access subtype, the actual subtype shall exclude null if and only if the ancestor subtype excludes null.

Replace paragraph 16:

The class determined for a formal private type is as follows:

by:

The category determined for a formal private type is as follows:

Replace paragraph 17:

Type Definition *Determined Class*

limited private the class of all types

private the class of all nonlimited types

tagged limited private the class of tagged types

tagged private the class of all nonlimited tagged types

by:

Type Definition *Determined Category*

limited private the category of all types

private the category of all nonlimited types

tagged limited private the category of all tagged types

tagged private the category of all nonlimited tagged types

Replace paragraph 20:

If the ancestor type is a composite type that is not an array type, the formal type inherits components from the ancestor type (including discriminants if a new **discriminant_part** is not specified), as for a derived type defined by a **derived_type_definition** (see 3.4).

by:

If the ancestor type is a composite type that is not an array type, the formal type inherits components from the ancestor type (including discriminants if a new **discriminant_part** is not specified), as for a derived type defined by a **derived_type_definition** (see 3.4 and 7.3.1).

Replace paragraph 21:

For a formal derived type, the predefined operators and inherited user-defined subprograms are determined by the ancestor type, and are implicitly declared at the earliest place, if any, within the immediate scope of the formal type, where the corresponding primitive subprogram of the ancestor is visible (see 7.3.1). In an instance, the copy of such an implicit declaration declares a view of the corresponding primitive subprogram of the ancestor of the formal derived type, even if this primitive has been overridden for the actual type. When the ancestor of the formal derived type is itself a formal type, the copy of the implicit declaration declares a view of the corresponding copied operation of the ancestor. In the case of a formal private extension, however, the tag of the formal type is that of the actual type, so if the tag in a call is statically determined to be that of the formal type, the body executed will be that corresponding to the actual type.

by:

For a formal derived type, the predefined operators and inherited user-defined subprograms are determined by the ancestor type and any progenitor types, and are implicitly declared at the earliest place, if any, immediately within the declarative region in which the formal type is declared, where the corresponding primitive subprogram of the ancestor or progenitor is visible (see 7.3.1). In an instance, the copy of such an implicit declaration declares a view of

the corresponding primitive subprogram of the ancestor or progenitor of the formal derived type, even if this primitive has been overridden for the actual type. When the ancestor or progenitor of the formal derived type is itself a formal type, the copy of the implicit declaration declares a view of the corresponding copied operation of the ancestor or progenitor. In the case of a formal private extension, however, the tag of the formal type is that of the actual type, so if the tag in a call is statically determined to be that of the formal type, the body executed will be that corresponding to the actual type.

Insert after paragraph 23:

S'Definite

S'Definite yields True if the actual subtype corresponding to S is definite; otherwise it yields False. The value of this attribute is of the predefined type Boolean.

the new paragraphs:

Dynamic Semantics

In the case where a formal type is tagged with unknown discriminants, and the actual type is a class-wide type *T*Class:

- For the purposes of defining the primitive operations of the formal type, each of the primitive operations of the actual type is considered to be a subprogram (with an intrinsic calling convention — see 6.3.1) whose body consists of a dispatching call upon the corresponding operation of *T*, with its formal parameters as the actual parameters. If it is a function, the result of the dispatching call is returned.
- If the corresponding operation of *T* has no controlling formal parameters, then the controlling tag value is determined by the context of the call, according to the rules for tag-indeterminate calls (see 3.9.2 and 5.2). In the case where the tag would be statically determined to be that of the formal type, the call raises Program_Error. If such a function is renamed, any call on the renaming raises Program_Error.

Replace paragraph 24:

9 In accordance with the general rule that the actual type shall belong to the class determined for the formal (see 12.5, "Formal Types"):

by:

9 In accordance with the general rule that the actual type shall belong to the category determined for the formal (see 12.5, "Formal Types"):

12.5.2 Formal Scalar Types

Replace paragraph 1:

A *formal scalar type* is one defined by any of the *formal_type_definitions* in this subclause. The class determined for a formal scalar type is discrete, signed integer, modular, floating point, ordinary fixed point, or decimal.

by:

A *formal scalar type* is one defined by any of the *formal_type_definitions* in this subclause. The category determined for a formal scalar type is the category of all discrete, signed integer, modular, floating point, ordinary fixed point, or decimal types.

12.5.3 Formal Array Types

Replace paragraph 1:

The class determined for a formal array type is the class of all array types.

by:

The category determined for a formal array type is the category of all array types.

12.5.4 Formal Access Types

Replace paragraph 1:

The class determined for a formal access type is the class of all access types.

by:

The category determined for a formal access type is the category of all access types.

Replace paragraph 4:

If and only if the **general_access_modifier constant** applies to the formal, the actual shall be an access-to-constant type. If the **general_access_modifier all** applies to the formal, then the actual shall be a general access-to-variable type (see 3.10).

by:

If and only if the **general_access_modifier constant** applies to the formal, the actual shall be an access-to-constant type. If the **general_access_modifier all** applies to the formal, then the actual shall be a general access-to-variable type (see 3.10). If and only if the formal subtype excludes null, the actual subtype shall exclude null.

12.5.5 Formal Interface Types

Insert new clause:

The category determined for a formal interface type is the category of all interface types.

Syntax

```
formal_interface_type_definition ::= interface_type_definition
```

Legality Rules

The actual type shall be a descendant of every progenitor of the formal type.

The actual type shall be a limited, task, protected, or synchronized interface if and only if the formal type is also, respectively, a limited, task, protected, or synchronized interface.

Examples

```
type Root_Work_Item is tagged private;

generic
  type Managed_Task is task interface;
  type Work_Item(<>) is new Root_Work_Item with private;
package Server_Manager is
  task type Server is new Managed_Task with
    entry Start(Data : in out Work_Item);
  end Server;
end Server_Manager;
```

This generic allows an application to establish a standard interface that all tasks need to implement so they can be managed appropriately by an application-specific scheduler.

12.6 Formal Subprograms

Replace paragraph 2:

```
formal_subprogram_declaration ::= with subprogram_specification [is subprogram_default];
```

by:

```
formal_subprogram_declaration ::= formal_concrete_subprogram_declaration
| formal_abstract_subprogram_declaration
formal_concrete_subprogram_declaration ::=
  with subprogram_specification [is subprogram_default];
formal_abstract_subprogram_declaration ::=
  with subprogram_specification is abstract [subprogram_default];
```

Replace paragraph 3:

subprogram_default ::= default_name | <>

by:

subprogram_default ::= default_name | <> | **null**

Insert after paragraph 4:

default_name ::= name

the new paragraph:

A subprogram_default of **null** shall not be specified for a formal function or for a formal_abstract_subprogram_declaration.

Insert after paragraph 8:

The profiles of the formal and actual shall be mode-conformant.

the new paragraphs:

For a parameter or result subtype of a formal_subprogram_declaration that has an explicit null_exclusion:

- if the actual matching the formal_subprogram_declaration denotes a generic formal object of another generic unit *G*, and the instantiation containing the actual that occurs within the body of a generic unit *G* or within the body of a generic unit declared within the declarative region of the generic unit *G*, then the corresponding parameter or result type of the formal subprogram of *G* shall have a null_exclusion;
- otherwise, the subtype of the corresponding parameter or result type of the actual matching the formal_subprogram_declaration shall exclude null. In addition to the places where Legality Rules normally apply (see 12.3), this rule applies also in the private part of an instance of a generic unit.

If a formal parameter of a formal_abstract_subprogram_declaration is of a specific tagged type *T* or of an anonymous access type designating a specific tagged type *T*, *T* is called a *controlling type* of the formal_abstract_subprogram_declaration. Similarly, if the result of a formal_abstract_subprogram_declaration for a function is of a specific tagged type *T* or of an anonymous access type designating a specific tagged type *T*, *T* is called a *controlling type* of the formal_abstract_subprogram_declaration. A formal_abstract_subprogram_declaration shall have exactly one controlling type.

The actual subprogram for a formal_abstract_subprogram_declaration shall be a dispatching operation of the controlling type or of the actual type corresponding to the controlling type.

Insert after paragraph 10:

If a generic unit has a subprogram_default specified by a box, and the corresponding actual parameter is omitted, then it is equivalent to an explicit actual parameter that is a usage name identical to the defining name of the formal.

the new paragraphs:

If a generic unit has a subprogram_default specified by the reserved word **null**, and the corresponding actual parameter is omitted, then it is equivalent to an explicit actual parameter that is a null procedure having the profile given in the formal_subprogram_declaration.

The subprogram declared by a formal_abstract_subprogram_declaration with a controlling type *T* is a dispatching operation of type *T*.

Replace paragraph 16:

18 The actual subprogram cannot be abstract (see 3.9.3).

by:

18 The actual subprogram cannot be abstract unless the formal subprogram is a formal_abstract_subprogram_declaration (see 3.9.3).

19 The subprogram declared by a formal_abstract_subprogram_declaration is an abstract subprogram. All calls on a subprogram declared by a formal_abstract_subprogram_declaration must be dispatching calls. See 3.9.3.

20 A null procedure as a subprogram default has convention Intrinsic (see 6.3.1).

Replace paragraph 18:

```
with function "+"(X, Y : Item) return Item is <>;
with function Image(X : Enum) return String is Enum'Image;
with procedure Update is Default_Update;
```

by:

```
with function "+"(X, Y : Item) return Item is <>;
with function Image(X : Enum) return String is Enum'Image;
with procedure Update is Default_Update;
with procedure Pre_Action(X : in Item) is null; -- defaults to no action
with procedure Write(S      : not null access Root_Stream_Type'Class;
                    Desc : Descriptor)
                    is abstract Descriptor'Write; -- see 13.13.2
-- Dispatching operation on Descriptor with default
```

12.7 Formal Packages**Replace paragraph 3:**

```
formal_package_actual_part ::=
  (<>) | [generic_actual_part]
```

by:

```
formal_package_actual_part ::=
  ([others =>] <>)
  | [generic_actual_part]
  | (formal_package_association {, formal_package_association}, others => <>)

formal_package_association ::=
  generic_association
  | generic_formal_parameter_selector_name => <>
```

Any positional `formal_package_associations` shall precede any named `formal_package_associations`.

Insert after paragraph 4:

The *generic_package_name* shall denote a generic package (the *template* for the formal package); the formal package is an instance of the template.

the new paragraph:

A `formal_package_actual_part` shall contain at most one `formal_package_association` for each formal parameter. If the `formal_package_actual_part` does not include "`others => <>`", each formal parameter without an association shall have a `default_expression` or `subprogram_default`.

Replace paragraph 5:

The actual shall be an instance of the template. If the `formal_package_actual_part` is (<>), then the actual may be any instance of the template; otherwise, each actual parameter of the actual instance shall match the corresponding actual parameter of the formal package (whether the actual parameter is given explicitly or by default), as follows:

by:

The actual shall be an instance of the template. If the `formal_package_actual_part` is (<>) or (`others => <>`), then the actual may be any instance of the template; otherwise, certain of the actual parameters of the actual instance shall match the corresponding actual parameters of the formal package, determined as follows:

- If the `formal_package_actual_part` includes `generic_associations` as well as associations with <>, then only the actual parameters specified explicitly with `generic_associations` are required to match;
- Otherwise, all actual parameters shall match, whether any actual parameter is given explicitly or by default.

The rules for matching of actual parameters between the actual instance and the formal package are as follows:

Replace paragraph 6:

- For a formal object of mode **in** the actuals match if they are static expressions with the same value, or if they statically denote the same constant, or if they are both the literal **null**.

by:

- For a formal object of mode **in**, the actuals match if they are static expressions with the same value, or if they statically denote the same constant, or if they are both the literal **null**.

Replace paragraph 10:

The visible part of a formal package includes the first list of **basic_declarative_items** of the **package_specification**. In addition, if the **formal_package_actual_part** is ($\langle \rangle$), it also includes the **generic_formal_part** of the template for the formal package.

by:

The visible part of a formal package includes the first list of **basic_declarative_items** of the **package_specification**. In addition, for each actual parameter that is not required to match, a copy of the declaration of the corresponding formal parameter of the template is included in the visible part of the formal package. If the copied declaration is for a formal type, copies of the implicit declarations of the primitive subprograms of the formal type are also included in the visible part of the formal package.

For the purposes of matching, if the actual instance *A* is itself a formal package, then the actual parameters of *A* are those specified explicitly or implicitly in the **formal_package_actual_part** for *A*, plus, for those not specified, the copies of the formal parameters of the template included in the visible part of *A*.

Insert after paragraph 11:

For the purposes of matching, if the actual instance *A* is itself a formal package, then the actual parameters of *A* are those specified explicitly or implicitly in the **formal_package_actual_part** for *A*, plus, for those not specified, the copies of the formal parameters of the template included in the visible part of *A*.

the new paragraphs:

Examples

Example of a generic package with formal package parameters:

```
with Ada.Containers.Ordered_Maps; -- see A.18.6
generic
  with package Mapping_1 is new Ada.Containers.Ordered_Maps (<>);
  with package Mapping_2 is new Ada.Containers.Ordered_Maps
    (Key_Type => Mapping_1.Element_Type,
     others => <>);
package Ordered_Join is
  -- Provide a "join" between two mappings

  subtype Key_Type is Mapping_1.Key_Type;
  subtype Element_Type is Mapping_2.Element_Type;

  function Lookup(Key : Key_Type) return Element_Type;

end Ordered_Join;
```

Example of an instantiation of a package with formal packages:

```
with Ada.Containers.Ordered_Maps;
package Symbol_Package is

  type String_Id is ...

  type Symbol_Info is ...

package String_Table is new Ada.Containers.Ordered_Maps
  (Key_Type => String,
   Element_Type => String_Id);
```

```
package Symbol_Table is new Ada.Containers.Ordered_Maps
  (Key_Type => String_Id,
   Element_Type => Symbol_Info);

package String_Info is new Ordered_Join(Mapping_1 => String_Table,
                                         Mapping_2 => Symbol_Table);

Apple_Info : constant Symbol_Info := String_Info.Lookup("Apple");
end Symbol_Package;
```

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Section 13: Representation Issues

13.1 Representation Items

Replace paragraph 7:

The *representation* of an object consists of a certain number of bits (the *size* of the object). These are the bits that are normally read or updated by the machine code when loading, storing, or operating-on the value of the object. This includes some padding bits, when the size of the object is greater than the size of its subtype. Such padding bits are considered to be part of the representation of the object, rather than being gaps between objects, if these bits are normally read and updated.

by:

The *representation* of an object consists of a certain number of bits (the *size* of the object). For an object of an elementary type, these are the bits that are normally read or updated by the machine code when loading, storing, or operating-on the value of the object. For an object of a composite type, these are the bits reserved for this object, and include bits occupied by subcomponents of the object. If the size of an object is greater than that of its subtype, the additional bits are padding bits. For an elementary object, these padding bits are normally read and updated along with the others. For a composite object, padding bits might not be read or updated in any given composite operation, depending on the implementation.

Replace paragraph 11:

Operational and representation aspects of a generic formal parameter are the same as those of the actual. Operational and representation aspects of a partial view are the same as those of the full view. A type-related representation item is not allowed for a descendant of a generic formal untagged type.

by:

Operational and representation aspects of a generic formal parameter are the same as those of the actual. Operational and representation aspects are the same for all views of a type. A type-related representation item is not allowed for a descendant of a generic formal untagged type.

Insert after paragraph 13:

A representation or operational item that is not supported by the implementation is illegal, or raises an exception at run time.

the new paragraph:

A `type_declaration` is illegal if it has one or more progenitors, and a representation item applies to an ancestor, and this representation item conflicts with the representation of some other ancestor. The cases that cause conflicts are implementation defined.

Replace paragraph 15.1:

In contrast, whether operational aspects are inherited by a derived type depends on each specific aspect. When operational aspects are inherited by a derived type, aspects that were directly specified before the declaration of the derived type, or (in the case where the parent is derived) that were inherited by the parent type from the grandparent type are inherited. An inherited operational aspect is overridden by a subsequent operational item that specifies the same aspect of the type.

by:

In contrast, whether operational aspects are inherited by an untagged derived type depends on each specific aspect. Operational aspects are never inherited for a tagged type. When operational aspects are inherited by an untagged derived type, aspects that were directly specified by operational items that are visible at the point of the derived type declaration, or (in the case where the parent is derived) that were inherited by the parent type from the grandparent type are inherited. An inherited operational aspect is overridden by a subsequent operational item that specifies the same aspect of the type.

When an aspect that is a subprogram is inherited, the derived type inherits the aspect in the same way that a derived type inherits a user-defined primitive subprogram from its parent (see 3.4).

Insert after paragraph 18.1:

If an operational aspect is *specified* for an entity (meaning that it is either directly specified or inherited), then that aspect of the entity is as specified. Otherwise, the aspect of the entity has the default value for that aspect.

the new paragraph:

A representation item that specifies an aspect of representation that would have been chosen in the absence of the representation item is said to be *confirming*.

Insert after paragraph 21:

The recommended level of support for all representation items is qualified as follows:

the new paragraph:

- A confirming representation item should be supported.

Replace paragraph 24:

- An aliased component, or a component whose type is by-reference, should always be allocated at an addressable location.

by:

- An implementation need not support a nonconfirming representation item if it could cause an aliased object or an object of a by-reference type to be allocated at a nonaddressable location or, when the alignment attribute of the subtype of such an object is nonzero, at an address that is not an integral multiple of that alignment.
- An implementation need not support a nonconfirming representation item if it could cause an aliased object of an elementary type to have a size other than that which would have been chosen by default.
- An implementation need not support a nonconfirming representation item if it could cause an aliased object of a composite type, or an object whose type is by-reference, to have a size smaller than that which would have been chosen by default.
- An implementation need not support a nonconfirming subtype-specific representation item specifying an aspect of representation of an indefinite or abstract subtype.

For purposes of these rules, the determination of whether a representation item applied to a type *could cause* an object to have some property is based solely on the properties of the type itself, not on any available information about how the type is used. In particular, it presumes that minimally aligned objects of this type might be declared at some point.

13.2 Pragma Pack**Insert after paragraph 6:**

If a type is packed, then the implementation should try to minimize storage allocated to objects of the type, possibly at the expense of speed of accessing components, subject to reasonable complexity in addressing calculations.

the new paragraph:

If a packed type has a component that is not of a by-reference type and has no aliased part, then such a component need not be aligned according to the Alignment of its subtype; in particular it need not be allocated on a storage element boundary.

13.3 Representation Attributes**Insert after paragraph 8:**

A *storage element* is an addressable element of storage in the machine. A *word* is the largest amount of storage that can be conveniently and efficiently manipulated by the hardware, given the implementation's run-time model. A word consists of an integral number of storage elements.

the new paragraph:

A *machine scalar* is an amount of storage that can be conveniently and efficiently loaded, stored, or operated upon by the hardware. Machine scalars consist of an integral number of storage elements. The set of machine scalars is implementation defined, but must include at least the storage element and the word. Machine scalars are used to interpret component_clauses when the nondefault bit ordering applies.

Delete paragraph 18:

- Objects (including subcomponents) that are aliased or of a by-reference type should be allocated on storage element boundaries.

Replace paragraph 22:

For a prefix *X* that denotes a subtype or object:

by:

For a prefix *X* that denotes an object:

Replace paragraph 23:

X'Alignment

The Address of an object that is allocated under control of the implementation is an integral multiple of the Alignment of the object (that is, the Address modulo the Alignment is zero). The offset of a record component is a multiple of the Alignment of the component. For an object that is not allocated under control of the implementation (that is, one that is imported, that is allocated by a user-defined allocator, whose Address has been specified, or is designated by an access value returned by an instance of Unchecked_Conversion), the implementation may assume that the Address is an integral multiple of its Alignment. The implementation shall not assume a stricter alignment.

by:

X'Alignment

The value of this attribute is of type *universal integer*, and nonnegative; zero means that the object is not necessarily aligned on a storage element boundary. If *X*'Alignment is not zero, then *X* is aligned on a storage unit boundary and *X*'Address is an integral multiple of *X*'Alignment (that is, the Address modulo the Alignment is zero).

Delete paragraph 24:

The value of this attribute is of type *universal integer*, and nonnegative; zero means that the object is not necessarily aligned on a storage element boundary.

Replace paragraph 25:

Alignment may be specified for first subtypes and stand-alone objects via an *attribute_definition_clause*; the expression of such a clause shall be static, and its value nonnegative. If the Alignment of a subtype is specified, then the Alignment of an object of the subtype is at least as strict, unless the object's Alignment is also specified. The Alignment of an object created by an allocator is that of the designated subtype.

by:

Alignment may be specified for stand-alone objects via an *attribute_definition_clause*; the expression of such a clause shall be static, and its value nonnegative.

For every subtype *S*:

S'Alignment

The value of this attribute is of type *universal integer*, and nonnegative.

For an object *X* of subtype *S*, if *S*'Alignment is not zero, then *X*'Alignment is a nonzero integral multiple of *S*'Alignment unless specified otherwise by a representation item.

Alignment may be specified for first subtypes via an *attribute_definition_clause*; the expression of such a clause shall be static, and its value nonnegative.

Delete paragraph 26:

If an Alignment is specified for a composite subtype or object, this Alignment shall be equal to the least common multiple of any specified Alignments of the subcomponent subtypes, or an integer multiple thereof.

Replace paragraph 28:

If the Alignment is specified for an object that is not allocated under control of the implementation, execution is erroneous if the object is not aligned according to the Alignment.

by:

For an object that is not allocated under control of the implementation, execution is erroneous if the object is not aligned according to its Alignment.

Replace paragraph 30:

- An implementation should support specified Alignments that are factors and multiples of the number of storage elements per word, subject to the following:

by:

- An implementation should support an Alignment clause for a discrete type, fixed point type, record type, or array type, specifying an Alignment value that is zero or a power of two, subject to the following:

Replace paragraph 31:

- An implementation need not support specified Alignments for combinations of Sizes and Alignments that cannot be easily loaded and stored by available machine instructions.

by:

- An implementation need not support an Alignment clause for a signed integer type specifying an Alignment greater than the largest Alignment value that is ever chosen by default by the implementation for any signed integer type. A corresponding limitation may be imposed for modular integer types, fixed point types, enumeration types, record types, and array types.

Replace paragraph 32:

- An implementation need not support specified Alignments that are greater than the maximum Alignment the implementation ever returns by default.

by:

- An implementation need not support a nonconfirming Alignment clause which could enable the creation of an object of an elementary type which cannot be easily loaded and stored by available machine instructions.
- An implementation need not support an Alignment specified for a derived tagged type which is not a multiple of the Alignment of the parent type. An implementation need not support a nonconfirming Alignment specified for a derived untagged by-reference type.

Delete paragraph 34:

- Same as above, for subtypes, but in addition:

Insert after paragraph 35:

- For stand-alone library-level objects of statically constrained subtypes, the implementation should support all Alignments supported by the target linker. For example, page alignment is likely to be supported for such objects, but not for subtypes.

the new paragraph:

- For other objects, an implementation should at least support the alignments supported for their subtype, subject to the following:
- An implementation need not support Alignments specified for objects of a by-reference type or for objects of types containing aliased subcomponents if the specified Alignment is not a multiple of the Alignment of the subtype of the object.

Delete paragraph 37:

4 The Alignment of a composite object is always equal to the least common multiple of the Alignments of its components, or a multiple thereof.

Replace paragraph 42:

The recommended level of support for the Size attribute of objects is:

by:

The size of an array object should not include its bounds.

The recommended level of support for the Size attribute of objects is the same as for subtypes (see below), except that only a confirming Size clause need be supported for an aliased elementary object.

Delete paragraph 43:

- A Size clause should be supported for an object if the specified Size is at least as large as its subtype's Size, and corresponds to a size in storage elements that is a multiple of the object's Alignment (if the Alignment is nonzero).

Replace paragraph 50:

If the Size of a subtype is specified, and allows for efficient independent addressability (see 9.10) on the target architecture, then the Size of the following objects of the subtype should equal the Size of the subtype:

by:

If the Size of a subtype allows for efficient independent addressability (see 9.10) on the target architecture, then the Size of the following objects of the subtype should equal the Size of the subtype:

Insert after paragraph 56:

- For a subtype implemented with levels of indirection, the Size should include the size of the pointers, but not the size of what they point at.

the new paragraph:

- An implementation should support a Size clause for a discrete type, fixed point type, record type, or array type, subject to the following:
 - An implementation need not support a Size clause for a signed integer type specifying a Size greater than that of the largest signed integer type supported by the implementation in the absence of a size clause (that is, when the Size is chosen by default). A corresponding limitation may be imposed for modular integer types, fixed point types, enumeration types, record types, and array types.
 - A nonconfirming size clause for the first subtype of a derived untagged by-reference type need not be supported.

Replace paragraph 77:

8 The following language-defined attributes are specifiable, at least for some of the kinds of entities to which they apply: Address, Size, Component_Size, Alignment, External_Tag, Small, Bit_Order, Storage_Pool, Storage_Size, Write, Output, Read, Input, and Machine_Radix.

by:

8 The following language-defined attributes are specifiable, at least for some of the kinds of entities to which they apply: Address, Alignment, Bit_Order, Component_Size, External_Tag, Input, Machine_Radix, Output, Read, Size, Small, Storage_Pool, Storage_Size, Stream_Size, and Write.

Replace paragraph 85:

```
function My_Read(Stream : access Ada.Streams.Root_Stream_Type'Class)
  return T;
for T'Read use My_Read; -- see 13.13.2
```

by:

```
function My_Input(Stream : not null access Ada.Streams.Root_Stream_Type'Class)
  return T;
for T'Input use My_Input; -- see 13.13.2
```

13.4 Enumeration Representation Clauses

Replace paragraph 6:

The expressions given in the `array_aggregate` shall be static, and shall specify distinct integer codes for each value of the enumeration type; the associated integer codes shall satisfy the predefined ordering relation of the type.

by:

Each component of the `array_aggregate` shall be given by an `expression` rather than a `<>`. The expressions given in the `array_aggregate` shall be static, and shall specify distinct integer codes for each value of the enumeration type; the associated integer codes shall satisfy the predefined ordering relation of the type.

13.5.1 Record Representation Clauses

Replace paragraph 8:

The `first_subtype_local_name` of a `record_representation_clause` shall denote a specific nonlimited record or record extension subtype.

by:

The `first_subtype_local_name` of a `record_representation_clause` shall denote a specific record or record extension subtype.

Insert after paragraph 10:

The `position`, `first_bit`, and `last_bit` shall be static expressions. The value of `position` and `first_bit` shall be nonnegative. The value of `last_bit` shall be no less than `first_bit - 1`.

the new paragraphs:

If the nondefault bit ordering applies to the type, then either:

- the value of `last_bit` shall be less than the size of the largest machine scalar; or
- the value of `first_bit` shall be zero and the value of `last_bit + 1` shall be a multiple of `System.Storage_Unit`.

Replace paragraph 13:

A `record_representation_clause` (without the `mod_clause`) specifies the layout. The storage place attributes (see 13.5.2) are taken from the values of the `position`, `first_bit`, and `last_bit` expressions after normalizing those values so that `first_bit` is less than `Storage_Unit`.

by:

A `record_representation_clause` (without the `mod_clause`) specifies the layout.

If the default bit ordering applies to the type, the `position`, `first_bit`, and `last_bit` of each `component_clause` directly specify the position and size of the corresponding component.

If the nondefault bit ordering applies to the type then the layout is determined as follows:

- the `component_clauses` for which the value of `last_bit` is greater than or equal to the size of the largest machine scalar directly specify the position and size of the corresponding component;
- for other `component_clauses`, all of the components having the same value of `position` are considered to be part of a single machine scalar, located at that `position`; this machine scalar has a size which is the smallest machine scalar size larger than the largest `last_bit` for all `component_clauses` at that `position`; the `first_bit` and `last_bit` of each `component_clause` are then interpreted as bit offsets in this machine scalar.

Insert after paragraph 17:

The recommended level of support for `record_representation_clauses` is:

the new paragraph:

- An implementation should support machine scalars that correspond to all of the integer, floating point, and address formats supported by the machine.

Replace paragraph 20:

- If the default bit ordering applies to the declaration of a given type, then for a component whose subtype's Size is less than the word size, any storage place that does not cross an aligned word boundary should be supported.

by:

- For a component with a subtype whose Size is less than the word size, any storage place that does not cross an aligned word boundary should be supported.

13.5.2 Storage Place Attributes

Replace paragraph 2:

R.C'Position

Denotes the same value as R.C'Address – R'Address. The value of this attribute is of the type *universal_integer*.

by:

R.C'Position

If the nondefault bit ordering applies to the composite type, and if a *component_clause* specifies the placement of C, denotes the value given for the *position* of the *component_clause*; otherwise, denotes the same value as R.C'Address – R'Address. The value of this attribute is of the type *universal_integer*.

Replace paragraph 3:

R.C'First_Bit

Denotes the offset, from the start of the first of the storage elements occupied by C, of the first bit occupied by C. This offset is measured in bits. The first bit of a storage element is numbered zero. The value of this attribute is of the type *universal_integer*.

by:

R.C'First_Bit

If the nondefault bit ordering applies to the composite type, and if a *component_clause* specifies the placement of C, denotes the value given for the *first_bit* of the *component_clause*; otherwise, denotes the offset, from the start of the first of the storage elements occupied by C, of the first bit occupied by C. This offset is measured in bits. The first bit of a storage element is numbered zero. The value of this attribute is of the type *universal_integer*.

Replace paragraph 4:

R.C'Last_Bit

Denotes the offset, from the start of the first of the storage elements occupied by C, of the last bit occupied by C. This offset is measured in bits. The value of this attribute is of the type *universal_integer*.

by:

R.C'Last_Bit

If the nondefault bit ordering applies to the composite type, and if a *component_clause* specifies the placement of C, denotes the value given for the *last_bit* of the *component_clause*; otherwise, denotes the offset, from the start of the first of the storage elements occupied by C, of the last bit occupied by C. This offset is measured in bits. The value of this attribute is of the type *universal_integer*.

13.5.3 Bit Ordering

Replace paragraph 8:

- If *Word_Size* = *Storage_Unit*, then the implementation should support the nondefault bit ordering in addition to the default bit ordering.

by:

- The implementation should support the nondefault bit ordering in addition to the default bit ordering.

NOTES

13 Bit_Order clauses make it possible to write record_representation_clauses that can be ported between machines having different bit ordering. They do not guarantee transparent exchange of data between such machines.

13.7 The Package System

Replace paragraph 3:

```
package System is
  pragma Preelaborate(System);
```

by:

```
package System is
  pragma Pure(System);
```

In paragraph 15 replace:

```
Default_Bit_Order : constant Bit_Order;
```

by:

```
Default_Bit_Order : constant Bit_Order := implementation-defined;
```

Replace paragraph 34:

Address is of a definite, nonlimited type. Address represents machine addresses capable of addressing individual storage elements. Null_Address is an address that is distinct from the address of any object or program unit.

by:

Address is a definite, nonlimited type with preelaborable initialization (see 10.2.1). Address represents machine addresses capable of addressing individual storage elements. Null_Address is an address that is distinct from the address of any object or program unit.

Replace paragraph 35:

See 13.5.3 for an explanation of Bit_Order and Default_Bit_Order.

by:

Default_Bit_Order shall be a static constant. See 13.5.3 for an explanation of Bit_Order and Default_Bit_Order.

Replace paragraph 36:

An implementation may add additional implementation-defined declarations to package System and its children. However, it is usually better for the implementation to provide additional functionality via implementation-defined children of System. Package System may be declared pure.

by:

An implementation may add additional implementation-defined declarations to package System and its children. However, it is usually better for the implementation to provide additional functionality via implementation-defined children of System.

13.7.1 The Package System.Storage_Elements

Replace paragraph 2:

```
package System.Storage_Elements is
  pragma Preelaborate(System.Storage_Elements);
```

by:

```
package System.Storage_Elements is
  pragma Pure(Storage_Elements);
```

Delete paragraph 15:

Package System.Storage_Elements may be declared pure.

13.7.2 The Package System.Address_To_Access_Conversions

Replace paragraph 5:

The To_Pointer and To_Address subprograms convert back and forth between values of types Object_Pointer and Address. To_Pointer(X'Address) is equal to X'Unchecked_Access for any X that allows Unchecked_Access. To_Pointer(Null_Address) returns **null**. For other addresses, the behavior is unspecified. To_Address(**null**) returns Null_Address (for **null** of the appropriate type). To_Address(Y), where Y /= **null**, returns Y.all'Address.

by:

The To_Pointer and To_Address subprograms convert back and forth between values of types Object_Pointer and Address. To_Pointer(X'Address) is equal to X'Unchecked_Access for any X that allows Unchecked_Access. To_Pointer(Null_Address) returns **null**. For other addresses, the behavior is unspecified. To_Address(**null**) returns Null_Address. To_Address(Y), where Y /= **null**, returns Y.all'Address.

13.8 Machine Code Insertions

Replace paragraph 10:

16 Machine code functions are exempt from the rule that a return_statement is required. In fact, return_statements are forbidden, since only code_statements are allowed.

by:

16 Machine code functions are exempt from the rule that a return statement is required. In fact, return statements are forbidden, since only code_statements are allowed.

13.9 Unchecked Type Conversions

Replace paragraph 11:

Otherwise, the effect is implementation defined; in particular, the result can be abnormal (see 13.9.1).

by:

Otherwise, if the result type is scalar, the result of the function is implementation defined, and can have an invalid representation (see 13.9.1). If the result type is nonscalar, the effect is implementation defined; in particular, the result can be abnormal (see 13.9.1).

Replace paragraph 14:

The Size of an array object should not include its bounds; hence, the bounds should not be part of the converted data.

by:

Since the Size of an array object generally does not include its bounds, the bounds should not be part of the converted data.

13.9.1 Data Validity

Replace paragraph 6:

- The object is not scalar, and is passed to an **in out** or **out** parameter of an imported procedure or language-defined input procedure, if after return from the procedure the representation of the parameter does not represent a value of the parameter's subtype.

by:

- The object is not scalar, and is passed to an **in out** or **out** parameter of an imported procedure, the Read procedure of an instance of Sequential_IO, Direct_IO, or Storage_IO, or the stream attribute T'Read, if after return from the procedure the representation of the parameter does not represent a value of the parameter's subtype.
- The object is the return object of a function call of a nonscalar type, and the function is an imported function, an instance of Unchecked_Conversion, or the stream attribute T'Input, if after return from the function the representation of the return object does not represent a value of the function's subtype.

For an imported object, it is the programmer's responsibility to ensure that the object remains in a normal state.

Replace paragraph 12:

A call to an imported function or an instance of Unchecked_Conversion is erroneous if the result is scalar, and the result object has an invalid representation.

by:

A call to an imported function or an instance of Unchecked_Conversion is erroneous if the result is scalar, the result object has an invalid representation, and the result is used other than as the **expression** of an **assignment_statement** or an **object_declaration**, or as the **prefix** of a Valid attribute. If such a result object is used as the source of an assignment, and the assigned value is an invalid representation for the target of the assignment, then any use of the target object prior to a further assignment to the target object, other than as the **prefix** of a Valid attribute reference, is erroneous.

13.9.2 The Valid Attribute

Insert after paragraph 12:

20 X'Valid is not considered to be a read of X; hence, it is not an error to check the validity of invalid data.

the new paragraph:

22 The Valid attribute may be used to check the result of calling an instance of Unchecked_Conversion (or any other operation that can return invalid values). However, an exception handler should also be provided because implementations are permitted to raise Constraint_Error or Program_Error if they detect the use of an invalid representation (see 13.9.1).

13.11 Storage Management

Replace paragraph 2:

A storage pool is a variable of a type in the class rooted at Root_Storage_Pool, which is an abstract limited controlled type. By default, the implementation chooses a *standard storage pool* for each access type. The user may define new pool types, and may override the choice of pool for an access type by specifying Storage_Pool for the type.

by:

A storage pool is a variable of a type in the class rooted at Root_Storage_Pool, which is an abstract limited controlled type. By default, the implementation chooses a *standard storage pool* for each access-to-object type. The user may define new pool types, and may override the choice of pool for an access-to-object type by specifying Storage_Pool for the type.

Replace paragraph 6:

```
type Root_Storage_Pool is
  abstract new Ada.Finalization.Limited_Controlled with private;
```

by:

```
type Root_Storage_Pool is
  abstract new Ada.Finalization.Limited_Controlled with private;
pragma Preelaborable_Initialization(Root_Storage_Pool);
```

Replace paragraph 12:

For every access subtype S, the following representation attributes are defined:

by:

For every access-to-object subtype S, the following representation attributes are defined:

Replace paragraph 25:

A storage pool for an anonymous access type should be created at the point of an allocator for the type, and be reclaimed when the designated object becomes inaccessible.

by:

The storage pool used for an allocator of an anonymous access type should be determined as follows:

- If the allocator is defining a coextension (see 3.10.2) of an object being created by an outer allocator, then the storage pool used for the outer allocator should also be used for the coextension;
- For other access discriminants and access parameters, the storage pool should be created at the point of the allocator, and be reclaimed when the allocated object becomes inaccessible;
- Otherwise, a default storage pool should be created at the point where the anonymous access type is elaborated; such a storage pool need not support deallocation of individual objects.

13.11.1 The Max_Size_In_Storage_Elements Attribute

Replace paragraph 3:

Denotes the maximum value for Size_In_Storage_Elements that will be requested via Allocate for an access type whose designated subtype is S. The value of this attribute is of type *universal_integer*.

by:

Denotes the maximum value for Size_In_Storage_Elements that could be requested by the implementation via Allocate for an access type whose designated subtype is S. For a type with access discriminants, if the implementation allocates space for a coextension in the same pool as that of the object having the access discriminant, then this accounts for any calls on Allocate that could be performed to provide space for such coextensions. The value of this attribute is of type *universal_integer*.

13.11.2 Unchecked Storage Deallocation

Replace paragraph 9:

3. Free(X), when X is not equal to **null** first performs finalization, as described in 7.6. It then deallocates the storage occupied by the object designated by X. If the storage pool is a user-defined object, then the storage is deallocated by calling Deallocate, passing *access_to_variable_subtype_name*'Storage_Pool as the Pool parameter. Storage_Address is the value returned in the Storage_Address parameter of the corresponding Allocate call. Size_In_Storage_Elements and Alignment are the same values passed to the corresponding Allocate call. There is one exception: if the object being freed contains tasks, the object might not be deallocated.

by:

3. Free(X), when X is not equal to **null** first performs finalization of the object designated by X (and any coextensions of the object — see 3.10.2), as described in 7.6.1. It then deallocates the storage occupied by the object designated by X (and any coextensions). If the storage pool is a user-defined object, then the storage is deallocated by calling Deallocate, passing *access_to_variable_subtype_name*'Storage_Pool as the Pool parameter. Storage_Address is the value returned in the Storage_Address parameter of the corresponding Allocate call. Size_In_Storage_Elements and Alignment are the same values passed to the corresponding Allocate call. There is one exception: if the object being freed contains tasks, the object might not be deallocated.

Replace paragraph 10:

After Free(X), the object designated by X, and any subcomponents thereof, no longer exist; their storage can be reused for other purposes.

by:

After Free(X), the object designated by X, and any subcomponents (and coextensions) thereof, no longer exist; their storage can be reused for other purposes.

13.12 Pragma Restrictions**Replace paragraph 4:**

```
restriction ::= restriction_identifier
             | restriction_parameter_identifier => expression
```

by:

```
restriction ::= restriction_identifier
             | restriction_parameter_identifier => restriction_parameter_argument
restriction_parameter_argument ::= name | expression
```

Replace paragraph 7:

The set of restrictions is implementation defined.

by:

The set of restrictions is implementation defined.

Replace paragraph 10:

30 Restrictions intended to facilitate the construction of efficient tasking run-time systems are defined in D.7. Safety- and security-related restrictions are defined in H.4.

by:

30 Restrictions intended to facilitate the construction of efficient tasking run-time systems are defined in D.7. Restrictions intended for use when constructing high integrity systems are defined in H.4.

13.12.1 Language-Defined Restrictions**Insert new clause:***Static Semantics*

The following *restriction_identifiers* are language-defined (additional restrictions are defined in the Specialized Needs Annexes):

No_Implementation_Attributes

There are no implementation-defined attributes. This restriction applies only to the current compilation or environment, not the entire partition.

No_Implementation_Pragmas

There are no implementation-defined pragmas or pragma arguments. This restriction applies only to the current compilation or environment, not the entire partition.

No_Obsolescent_Features

There is no use of language features defined in Annex J. It is implementation-defined if uses of the renamings of J.1 are detected by this restriction. This restriction applies only to the current compilation or environment, not the entire partition.

The following *restriction_parameter_identifier* is language defined:

No_Dependence

Specifies a library unit on which there are no semantic dependences.

Legality Rules

The restriction_parameter_argument of a No_Dependence restriction shall be a name; the name shall have the form of a full expanded name of a library unit, but need not denote a unit present in the environment.

Post-Compilation Rules

No compilation unit included in the partition shall depend semantically on the library unit identified by the name.

13.13.1 The Package Streams

Replace paragraph 3:

```
type Root_Stream_Type is abstract tagged limited private;
```

by:

```
type Root_Stream_Type is abstract tagged limited private;
pragma Preelaborable_Initialization(Root_Stream_Type);
```

Replace paragraph 8:

The Read operation transfers Item'Length stream elements from the specified stream to fill the array Item. The index of the last stream element transferred is returned in Last. Last is less than Item'Last only if the end of the stream is reached.

by:

The Read operation transfers stream elements from the specified stream to fill the array Item. Elements are transferred until Item'Length elements have been transferred, or until the end of the stream is reached. If any elements are transferred, the index of the last stream element transferred is returned in Last. Otherwise, Item'First - 1 is returned in Last. Last is less than Item'Last only if the end of the stream is reached.

Insert after paragraph 10:

See A.12.1, "The Package Streams.Stream_IO" for an example of extending type Root_Stream_Type.

the new paragraph:

If the end of stream has been reached, and Item'First is Stream_Element_Offset'First, Read will raise Constraint_Error.

13.13.2 Stream-Oriented Attributes

Insert before paragraph 2:

For every subtype S of a specific type T, the following attributes are defined.

the new paragraphs:

For every subtype S of an elementary type T, the following representation attribute is defined:

S'Stream_Size

Denotes the number of bits occupied in a stream by items of subtype S. Hence, the number of stream elements required per item of elementary type T is:

$$T'Stream_Size / Ada.Streams.Stream_Element'Size$$

The value of this attribute is of type *universal_integer* and is a multiple of Stream_Element'Size.

Stream_Size may be specified for first subtypes via an attribute_definition_clause; the expression of such a clause shall be static, nonnegative, and a multiple of Stream_Element'Size.

Implementation Advice

If not specified, the value of Stream_Size for an elementary type should be the number of bits that corresponds to the minimum number of stream elements required by the first subtype of the type, rounded up to the nearest factor or multiple of the word size that is also a multiple of the stream element size.

The recommended level of support for the Stream_Size attribute is:

- A `Stream_Size` clause should be supported for a discrete or fixed point type T if the specified `Stream_Size` is a multiple of `Stream_Element'Size` and is no less than the size of the first subtype of T , and no greater than the size of the largest type of the same elementary class (signed integer, modular integer, enumeration, ordinary fixed point, or decimal fixed point).

Replace paragraph 4:

```

procedure S'Write(
  Stream : access Ada.Streams.Root_Stream_Type'Class;
  Item : in T)

```

by:

```

procedure S'Write(
  Stream : not null access Ada.Streams.Root_Stream_Type'Class;
  Item : in T)

```

Replace paragraph 7:

```

procedure S'Read(
  Stream : access Ada.Streams.Root_Stream_Type'Class;
  Item : out T)

```

by:

```

procedure S'Read(
  Stream : not null access Ada.Streams.Root_Stream_Type'Class;
  Item : out T)

```

Replace paragraph 8.1:

For untagged derived types, the `Write` and `Read` attributes of the parent type are inherited as specified in 13.1; otherwise, the default implementations of these attributes are used. The default implementations of `Write` and `Read` attributes execute as follows:

by:

For an untagged derived type, the `Write` (resp. `Read`) attribute is inherited according to the rules given in 13.1 if the attribute is available for the parent type at the point where T is declared. For a tagged derived type, these attributes are not inherited, but rather the default implementations are used.

The default implementations of the `Write` and `Read` attributes, where available, execute as follows:

Replace paragraph 9:

For elementary types, the representation in terms of stream elements is implementation defined. For composite types, the `Write` or `Read` attribute for each component is called in canonical order, which is last dimension varying fastest for an array, and positional aggregate order for a record. Bounds are not included in the stream if T is an array type. If T is a discriminated type, discriminants are included only if they have defaults. If T is a tagged type, the tag is not included. For type extensions, the `Write` or `Read` attribute for the parent type is called, followed by the `Write` or `Read` attribute of each component of the extension part, in canonical order. For a limited type extension, if the attribute of any ancestor type of T has been directly specified and the attribute of any ancestor type of the type of any of the extension components which are of a limited type has not been specified, the attribute of T shall be directly specified.

by:

For elementary types, `Read` reads (and `Write` writes) the number of stream elements implied by the `Stream_Size` for the type T ; the representation of those stream elements is implementation defined. For composite types, the `Write` or `Read` attribute for each component is called in canonical order, which is last dimension varying fastest for an array, and positional aggregate order for a record. Bounds are not included in the stream if T is an array type. If T is a discriminated type, discriminants are included only if they have defaults. If T is a tagged type, the tag is not included. For type extensions, the `Write` or `Read` attribute for the parent type is called, followed by the `Write` or `Read` attribute of each component of the extension part, in canonical order. For a limited type extension, if the attribute of the parent type or any progenitor type of T is available anywhere within the immediate scope of T , and the attribute of the parent type or the type of any of the extension components is not available at the freezing point of T , then the attribute of T shall be directly specified.

Constraint_Error is raised by the predefined Write attribute if the value of the elementary item is outside the range of values representable using Stream_Size bits. For a signed integer type, an enumeration type, or a fixed point type, the range is unsigned only if the integer code for the lower bound of the first subtype is nonnegative, and a (symmetric) signed range that covers all values of the first subtype would require more than Stream_Size bits; otherwise the range is signed.

Replace paragraph 12:

```
procedure S'Class'Write(
  Stream : access Ada.Streams.Root_Stream_Type'Class;
  Item : in T'Class)
```

by:

```
procedure S'Class'Write(
  Stream : not null access Ada.Streams.Root_Stream_Type'Class;
  Item : in T'Class)
```

Replace paragraph 15:

```
procedure S'Class'Read(
  Stream : access Ada.Streams.Root_Stream_Type'Class;
  Item : out T'Class)
```

by:

```
procedure S'Class'Read(
  Stream : not null access Ada.Streams.Root_Stream_Type'Class;
  Item : out T'Class)
```

Delete paragraph 17:

If a stream element is the same size as a storage element, then the normal in-memory representation should be used by Read and Write for scalar objects. Otherwise, Read and Write should use the smallest number of stream elements needed to represent all values in the base range of the scalar type.

Replace paragraph 20:

```
procedure S'Output(
  Stream : access Ada.Streams.Root_Stream_Type'Class;
  Item : in T)
```

by:

```
procedure S'Output(
  Stream : not null access Ada.Streams.Root_Stream_Type'Class;
  Item : in T)
```

Replace paragraph 23:

```
function S'Input(
  Stream : access Ada.Streams.Root_Stream_Type'Class)
return T
```

by:

```
function S'Input(
  Stream : not null access Ada.Streams.Root_Stream_Type'Class)
return T
```

Replace paragraph 25:

For untagged derived types, the Output and Input attributes of the parent type are inherited as specified in 13.1; otherwise, the default implementations of these attributes are used. The default implementations of Output and Input attributes execute as follows:

by:

For an untagged derived type, the Output (resp. Input) attribute is inherited according to the rules given in 13.1 if the attribute is available for the parent type at the point where *T* is declared. For a tagged derived type, these attributes are not inherited, but rather the default implementations are used.

The default implementations of the Output and Input attributes, where available, execute as follows:

Replace paragraph 27:

S'Output then calls S'Write to write the value of *Item* to the stream. S'Input then creates an object (with the bounds or discriminants, if any, taken from the stream), initializes it with S'Read, and returns the value of the object.

by:

S'Output then calls S'Write to write the value of *Item* to the stream. S'Input then creates an object (with the bounds or discriminants, if any, taken from the stream), passes it to S'Read, and returns the value of the object. Normal default initialization and finalization take place for this object (see 3.3.1, 7.6, and 7.6.1).

If *T* is an abstract type, then S'Input is an abstract function.

Replace paragraph 30:

```
procedure S'Class'Output (
  Stream : access Ada.Streams.Root_Stream_Type'Class;
  Item : in T'Class)
```

by:

```
procedure S'Class'Output (
  Stream : not null access Ada.Streams.Root_Stream_Type'Class;
  Item : in T'Class)
```

Replace paragraph 31:

First writes the external tag of *Item* to *Stream* (by calling `String'Output(Tags.External_Tag(Item'Tag))` — see 3.9) and then dispatches to the subprogram denoted by the `Output` attribute of the specific type identified by the tag.

by:

First writes the external tag of *Item* to *Stream* (by calling `String'Output(Stream, Tags.External_Tag(Item'Tag))` — see 3.9) and then dispatches to the subprogram denoted by the `Output` attribute of the specific type identified by the tag. `Tag_Error` is raised if the tag of *Item* identifies a type declared at an accessibility level deeper than that of *S*.

Replace paragraph 33:

```
function S'Class'Input (
  Stream : access Ada.Streams.Root_Stream_Type'Class)
return T'Class
```

by:

```
function S'Class'Input (
  Stream : not null access Ada.Streams.Root_Stream_Type'Class)
return T'Class
```

Replace paragraph 34:

First reads the external tag from *Stream* and determines the corresponding internal tag (by calling `Tags.Internal_Tag(String'Input(Stream))` — see 3.9) and then dispatches to the subprogram denoted by the `Input` attribute of the specific type identified by the internal tag; returns that result.

by:

First reads the external tag from *Stream* and determines the corresponding internal tag (by calling `Tags.Descendant_Tag(String'Input(Stream), S'Tag)` which might raise `Tag_Error` — see 3.9) and then dispatches to the subprogram denoted by the `Input` attribute of the specific type identified by the internal tag; returns that result. If the specific type identified by the internal tag is not covered by *T'Class* or is abstract, `Constraint_Error` is raised.

Replace paragraph 35:

In the default implementation of Read and Input for a composite type, for each scalar component that is a discriminant or whose `component_declaration` includes a `default_expression`, a check is made that the value returned by Read for the component belongs to its subtype. `Constraint_Error` is raised if this check fails. For other scalar components, no check is made. For each component that is of an access type, if the implementation can detect that the value returned by Read for the component is not a value of its subtype, `Constraint_Error` is raised. If the value is not a value of its subtype and this error is not detected, the component has an abnormal value, and erroneous execution can result (see 13.9.1).

by:

In the default implementation of Read and Input for a composite type, for each scalar component that is a discriminant or whose `component_declaration` includes a `default_expression`, a check is made that the value returned by Read for the component belongs to its subtype. `Constraint_Error` is raised if this check fails. For other scalar components, no check is made. For each component that is of an access type, if the implementation can detect that the value returned by Read for the component is not a value of its subtype, `Constraint_Error` is raised. If the value is not a value of its subtype and this error is not detected, the component has an abnormal value, and erroneous execution can result (see 13.9.1). In the default implementation of Read for a composite type with defaulted discriminants, if the actual parameter of Read is constrained, a check is made that the discriminants read from the stream are equal to those of the actual parameter. `Constraint_Error` is raised if this check fails.

It is unspecified at which point and in which order these checks are performed. In particular, if `Constraint_Error` is raised due to the failure of one of these checks, it is unspecified how many stream elements have been read from the stream.

Replace paragraph 36:

The stream-oriented attributes may be specified for any type via an `attribute_definition_clause`. All nonlimited types have default implementations for these operations. An `attribute_reference` for one of these attributes is illegal if the type is limited, unless the attribute has been specified by an `attribute_definition_clause` or (for a type extension) the attribute has been specified for an ancestor type. For an `attribute_definition_clause` specifying one of these attributes, the subtype of the Item parameter shall be the base subtype if scalar, and the first subtype otherwise. The same rule applies to the result of the Input function.

by:

The stream-oriented attributes may be specified for any type via an `attribute_definition_clause`. The subprogram name given in such a clause shall not denote an abstract subprogram. Furthermore, if a stream-oriented attribute is specified for an interface type by an `attribute_definition_clause`, the subprogram name given in the clause shall statically denote a null procedure.

A stream-oriented attribute for a subtype of a specific type *T* is *available* at places where one of the following conditions is true:

- *T* is nonlimited.
- The `attribute_designator` is Read (resp. Write) and *T* is a limited record extension, and the attribute Read (resp. Write) is available for the parent type of *T* and for the types of all of the extension components.
- *T* is a limited untagged derived type, and the attribute was inherited for the type.
- The `attribute_designator` is Input (resp. Output), and *T* is a limited type, and the attribute Read (resp. Write) is available for *T*.
- The attribute has been specified via an `attribute_definition_clause`, and the `attribute_definition_clause` is visible.

A stream-oriented attribute for a subtype of a class-wide type *TClass* is available at places where one of the following conditions is true:

- *T* is nonlimited;
- the attribute has been specified via an `attribute_definition_clause`, and the `attribute_definition_clause` is visible; or
- the corresponding attribute of *T* is available, provided that if *T* has a partial view, the corresponding attribute is available at the end of the visible part where *T* is declared.

An `attribute_reference` for one of the stream-oriented attributes is illegal unless the attribute is available at the place of the `attribute_reference`. Furthermore, an `attribute_reference` for `T'Input` is illegal if `T` is an abstract type.

In the `parameter_and_result_profiles` for the stream-oriented attributes, the subtype of the `Item` parameter is the base subtype of `T` if `T` is a scalar type, and the first subtype otherwise. The same rule applies to the result of the `Input` attribute.

For an `attribute_definition_clause` specifying one of these attributes, the subtype of the `Item` parameter shall be the base subtype if scalar, and the first subtype otherwise. The same rule applies to the result of the `Input` function.

A type is said to *support external streaming* if `Read` and `Write` attributes are provided for sending values of such a type between active partitions, with `Write` marshalling the representation, and `Read` unmarshalling the representation. A limited type supports external streaming only if it has available `Read` and `Write` attributes. A type with a part that is of an access type supports external streaming only if that access type or the type of some part that includes the access type component, has `Read` and `Write` attributes that have been specified via an `attribute_definition_clause`, and that `attribute_definition_clause` is visible. An anonymous access type does not support external streaming. All other types support external streaming.

Erroneous Execution

If the internal tag returned by `Descendant_Tag` to `T'Class'Input` identifies a type that is not library-level and whose tag has not been created, or does not exist in the partition at the time of the call, execution is erroneous.

Insert after paragraph 36.1:

For every subtype `S` of a language-defined nonlimited specific type `T`, the output generated by `S'Output` or `S'Write` shall be readable by `S'Input` or `S'Read`, respectively. This rule applies across partitions if the implementation conforms to the Distributed Systems Annex.

the new paragraphs:

If `Constraint_Error` is raised during a call to `Read` because of failure of one the above checks, the implementation must ensure that the discriminants of the actual parameter of `Read` are not modified.

Implementation Permissions

The number of calls performed by the predefined implementation of the stream-oriented attributes on the `Read` and `Write` operations of the stream type is unspecified. An implementation may take advantage of this permission to perform internal buffering. However, all the calls on the `Read` and `Write` operations of the stream type needed to implement an explicit invocation of a stream-oriented attribute must take place before this invocation returns. An explicit invocation is one appearing explicitly in the program text, possibly through a generic instantiation (see 12.3).

Replace paragraph 60:

```
procedure My_Write(
  Stream : access Ada.Streams.Root_Stream_Type'Class; Item : My_Integer'Base);
```

by:

```
procedure My_Write(
  Stream : not null access Ada.Streams.Root_Stream_Type'Class;
  Item   : My_Integer'Base);
```

13.14 Freezing Rules

Insert after paragraph 7:

- The declaration of a record extension causes freezing of the parent subtype.

the new paragraph:

- The declaration of a record extension, interface type, task unit, or protected unit causes freezing of any progenitor types specified in the declaration.

Insert after paragraph 15:

- At the place where a subtype is frozen, its type is frozen. At the place where a type is frozen, any expressions or **names** within the full type definition cause freezing; the first subtype, and any component subtypes, index subtypes, and parent subtype of the type are frozen as well. For a specific tagged type, the corresponding class-wide type is frozen as well. For a class-wide type, the corresponding specific type is frozen as well.

the new paragraph:

- At the place where a specific tagged type is frozen, the primitive subprograms of the type are frozen.

Insert after paragraph 19:

An operational or representation item that directly specifies an aspect of an entity shall appear before the entity is frozen (see 13.1).

the new paragraph:

Dynamic Semantics

The tag (see 3.9) of a tagged type T is created at the point where T is frozen.

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Annex A: Predefined Language Environment

Replace paragraph 2:

Standard — A.1
 Ada — A.2
 Asynchronous_Task_Control — D.11
 Calendar — 9.6
 Characters — A.3.1
 Handling — A.3.2
 Latin_1 — A.3.3
 Command_Line — A.15
 Decimal — F.2
 Direct_IO — A.8.4
 Dynamic_Priorities — D.5
 Exceptions — 11.4.1
 Finalization — 7.6
 Float_Text_IO — A.10.9
 Float_Wide_Text_IO — A.11
 Integer_Text_IO — A.10.8
 Integer_Wide_Text_IO — A.11
 Interrupts — C.3.2
 Names — C.3.2
 IO_Exceptions — A.13
 Numerics — A.5
 Complex_Elementary_Functions — G.1.2
 Complex_Types — G.1.1
 Discrete_Random — A.5.2
 Elementary_Functions — A.5.1
 Float_Random — A.5.2
 Generic_Complex_Elementary_Functions — G.1.2
 Generic_Complex_Types — G.1.1
 Generic_Elementary_Functions — A.5.1
 Real_Time — D.8
 Sequential_IO — A.8.1
 Storage_IO — A.9
 Streams — 13.13.1
 Stream_IO — A.12.1

Standard (...continued)
 Ada (...continued)
 Strings — A.4.1
 Bounded — A.4.4
 Fixed — A.4.3
 Maps — A.4.2
 Constants — A.4.6
 Unbounded — A.4.5
 Wide_Bounded — A.4.7
 Wide_Fixed — A.4.7
 Wide_Maps — A.4.7
 Wide_Constants — A.4.7
 Wide_Unbounded — A.4.7
 Synchronous_Task_Control — D.10
 Tags — 3.9
 Task_Attributes — C.7.2
 Task_Identification — C.7.1
 Text_IO — A.10.1
 Complex_IO — G.1.3
 Editing — F.3.3
 Text_Streams — A.12.2
 Unchecked_Conversion — 13.9
 Unchecked_Deallocation — 13.11.2
 Wide_Text_IO — A.11
 Complex_IO — G.1.3

Editing — F.3.4
Text_Streams — A.12.3

Interfaces — B.2
C — B.3
 Pointers — B.3.2
 Strings — B.3.1
COBOL — B.4
Fortran — B.5

System — 13.7
 Address_To_Access_Conversions — 13.7.2
 Machine_Code — 13.8
 RPC — E.5
 Storage_Elements — 13.7.1
 Storage_Pools — 13.11

by:

Standard — A.1
Ada — A.2
 Assertions — 11.4.2
 Asynchronous_Task_Control — D.11
 Calendar — 9.6
 Arithmetic — 9.6.1
 Formatting — 9.6.1
 Time_Zones — 9.6.1
 Characters — A.3.1
 Conversions — A.3.4
 Handling — A.3.2
 Latin_1 — A.3.3
 Command_Line — A.15
 Complex_Text_IO — G.1.3
 Containers — A.18.1
 Doubly_Linked_Lists — A.18.3
 Generic_Array_Sort — A.18.16
 Generic_Constrained_Array_Sort — A.18.16
 Hashed_Maps — A.18.5
 Hashed_Sets — A.18.8
 Indefinite_Doubly_Linked_Lists — A.18.11
 Indefinite_Hashed_Maps — A.18.12
 Indefinite_Hashed_Sets — A.18.14
 Indefinite_Ordered_Maps — A.18.13
 Indefinite_Ordered_Sets — A.18.15
 Indefinite_Vectors — A.18.10
 Ordered_Maps — A.18.6
 Ordered_Sets — A.18.9
 Vectors — A.18.2
 Decimal — F.2
 Direct_IO — A.8.4
 Directories — A.16
 Information — A.16
 Dispatching — D.2.1
 EDF — D.2.6
 Round_Robin — D.2.5
 Dynamic_Priorities — D.5

Standard (...continued)

Ada (...continued)
 Environment_Variables — A.17
 Exceptions — 11.4.1
 Execution_Time — D.14
 Group_Budgets — D.14.2
 Timers — D.14.1
Finalization — 7.6
Float_Text_IO — A.10.9

Float_Wide_Text_IO — A.11
 Float_Wide_Wide_Text_IO — A.11
 Integer_Text_IO — A.10.8
 Integer_Wide_Text_IO — A.11
 Integer_Wide_Wide_Text_IO — A.11
 Interrupts — C.3.2
 Names — C.3.2
 IO_Exceptions — A.13
 Numerics — A.5
 Complex_Elementary_Functions — G.1.2
 Complex_Types — G.1.1
 Discrete_Random — A.5.2
 Elementary_Functions — A.5.1
 Float_Random — A.5.2
 Generic_Complex_Arrays — G.3.2
 Generic_Complex_Elementary_Functions — G.1.2
 Generic_Complex_Types — G.1.1
 Generic_Elementary_Functions — A.5.1
 Generic_Real_Arrays — G.3.1
 Real_Time — D.8
 Timing_Events — D.15
 Sequential_IO — A.8.1
 Storage_IO — A.9
 Streams — 13.13.1
 Stream_IO — A.12.1

Standard (...continued)

Ada (...continued)

Strings — A.4.1
 Bounded — A.4.4
 Hash — A.4.9
 Fixed — A.4.3
 Hash — A.4.9
 Hash — A.4.9
 Maps — A.4.2
 Constants — A.4.6
 Unbounded — A.4.5
 Hash — A.4.9
 Wide_Bounded — A.4.7
 Wide_Hash — A.4.7
 Wide_Fixed — A.4.7
 Wide_Hash — A.4.7
 Wide_Hash — A.4.7
 Wide_Maps — A.4.7
 Wide_Constants — A.4.7
 Wide_Unbounded — A.4.7
 Wide_Hash — A.4.7
 Wide_Wide_Bounded — A.4.8
 Wide_Wide_Hash — A.4.8
 Wide_Wide_Fixed — A.4.8
 Wide_Wide_Hash — A.4.8
 Wide_Wide_Hash — A.4.8
 Wide_Wide_Maps — A.4.8
 Wide_Wide_Constants — A.4.8
 Wide_Wide_Unbounded — A.4.8
 Wide_Wide_Hash — A.4.8
 Synchronous_Task_Control — D.10
 Tags — 3.9
 Generic_Dispatching_Constructor — 3.9
 Task_Attributes — C.7.2
 Task_Identification — C.7.1
 Task_Termination — C.7.3

Standard (...continued)

Ada (...continued)

- Text_IO — A.10.1
- Bounded_IO — A.10.11
- Complex_IO — G.1.3
- Editing — F.3.3
- Text_Streams — A.12.2
- Unbounded_IO — A.10.12
- Unchecked_Conversion — 13.9
- Unchecked_Deallocation — 13.11.2
- Wide_Characters — A.3.1
- Wide_Text_IO — A.11
- Complex_IO — G.1.4
- Editing — F.3.4
- Text_Streams — A.12.3
- Wide_Bounded_IO — A.11
- Wide_Unbounded_IO — A.11
- Wide_Wide_Characters — A.3.1
- Wide_Wide_Text_IO — A.11
- Complex_IO — G.1.5
- Editing — F.3.5
- Text_Streams — A.12.4
- Wide_Wide_Bounded_IO — A.11
- Wide_Wide_Unbounded_IO — A.11

Interfaces — B.2

- C — B.3
- Pointers — B.3.2
- Strings — B.3.1
- COBOL — B.4
- Fortran — B.5

System — 13.7

- Address_To_Access_Conversions — 13.7.2
- Machine_Code — 13.8
- RPC — E.5
- Storage_Elements — 13.7.1
- Storage_Pools — 13.11

Replace paragraph 3:

The implementation shall ensure that each language defined subprogram is reentrant in the sense that concurrent calls on the same subprogram perform as specified, so long as all parameters that could be passed by reference denote nonoverlapping objects.

by:

The implementation shall ensure that each language-defined subprogram is reentrant in the sense that concurrent calls on the same subprogram perform as specified, so long as all parameters that could be passed by reference denote nonoverlapping objects.

A.1 The Package Standard

Replace paragraph 11:

- *The integer type `root_integer` is predefined.*
- *The corresponding universal type is `universal_integer`.*

by:

- *The integer type `root_integer` and the*
- *corresponding universal type `universal_integer` are predefined.*

Replace paragraph 20:

-- *The floating point type root_real is predefined.*
 -- *The corresponding universal type is universal_real.*

by:

-- *The floating point type root_real and the*
 -- *corresponding universal type universal_real are predefined.*

Insert after paragraph 34:

```
function "/" (Left : universal_fixed; Right : universal_fixed;)
  return universal_fixed;
```

the new paragraphs:

-- *The type universal_access is predefined.*
 -- *The following equality operators are predefined:*

```
function "=" (Left, Right: universal_access) return Boolean;
function "/=" (Left, Right: universal_access) return Boolean;
```

In paragraph 35 replace:

'ø', 'ù', 'ú', 'û', 'ü', 'ý', 'þ', 'ÿ', --248 (16#F8#) .. 255 (16#FF#)

by:

'ø', 'ù', 'ú', 'û', 'ü', 'ý', 'þ', 'ÿ'); --248 (16#F8#) .. 255 (16#FF#)

Replace paragraph 36:

-- *The predefined operators for the type Character are the same as for*
 -- *any enumeration type.*

-- *The declaration of type Wide_Character is based on the standard ISO 10646 BMP character set.*
 -- *The first 256 positions have the same contents as type Character. See 3.5.2.*

```
type Wide_Character is (nul, soh ... FFFE, FFFF);
```

```
package ASCII is ... end ASCII; --Obsolescent; see J.5
```

by:

-- *The predefined operators for the type Character are the same as for*
 -- *any enumeration type.*

-- *The declaration of type Wide_Character is based on the standard ISO/IEC 10646:2003 BMP character*
 -- *set. The first 256 positions have the same contents as type Character. See 3.5.2.*

```
type Wide_Character is (nul, soh ... Hex_0000FFFE, Hex_0000FFFF);
```

-- *The declaration of type Wide_Wide_Character is based on the full*
 -- *ISO/IEC 10646:2003 character set. The first 65536 positions have the*
 -- *same contents as type Wide_Character. See 3.5.2.*

```
type Wide_Wide_Character is (nul, soh ... Hex_7FFFFFFE, Hex_7FFFFFFF);
for Wide_Wide_Character'Size use 32;
```

```
package ASCII is ... end ASCII; --Obsolescent; see J.5
```

Replace paragraph 42:

-- *The predefined operators for this type correspond to those for String*

by:

-- *The predefined operators for this type correspond to those for String.*

```
type Wide_Wide_String is array (Positive range <>)
  of Wide_Wide_Character;
```

```
pragma Pack (Wide_Wide_String);
```

-- The predefined operators for this type correspond to those for String.

Replace paragraph 49:

In each of the types Character and Wide_Character, the character literals for the space character (position 32) and the non-breaking space character (position 160) correspond to different values. Unless indicated otherwise, each occurrence of the character literal ' ' in this International Standard refers to the space character. Similarly, the character literals for hyphen (position 45) and soft hyphen (position 173) correspond to different values. Unless indicated otherwise, each occurrence of the character literal '-' in this International Standard refers to the hyphen character.

by:

In each of the types Character, Wide_Character, and Wide_Wide_Character, the character literals for the space character (position 32) and the non-breaking space character (position 160) correspond to different values. Unless indicated otherwise, each occurrence of the character literal ' ' in this International Standard refers to the space character. Similarly, the character literals for hyphen (position 45) and soft hyphen (position 173) correspond to different values. Unless indicated otherwise, each occurrence of the character literal '-' in this International Standard refers to the hyphen character.

A.3 Character Handling

Replace paragraph 1:

This clause presents the packages related to character processing: an empty pure package Characters and child packages Characters.Handling and Characters.Latin_1. The package Characters.Handling provides classification and conversion functions for Character data, and some simple functions for dealing with Wide_Character data. The child package Characters.Latin_1 declares a set of constants initialized to values of type Character.

by:

This clause presents the packages related to character processing: an empty pure package Characters and child packages Characters.Handling and Characters.Latin_1. The package Characters.Handling provides classification and conversion functions for Character data, and some simple functions for dealing with Wide_Character and Wide_Wide_Character data. The child package Characters.Latin_1 declares a set of constants initialized to values of type Character.

A.3.1 Packages Characters, Wide_Characters, and Wide_Wide_Characters

Replace the title:

The Package Characters

by:

The Packages Characters, Wide_Characters, and Wide_Wide_Characters

Insert after paragraph 2:

```
package Ada.Characters is
  pragma Pure (Characters);
end Ada.Characters;
```

the new paragraphs:

The library package Wide_Characters has the following declaration:

```
package Ada.Wide_Characters is
  pragma Pure (Wide_Characters);
end Ada.Wide_Characters;
```

The library package `Wide_Wide_Characters` has the following declaration:

```
package Ada.Wide_Wide_Characters is
  pragma Pure(Wide_Wide_Characters);
end Ada.Wide_Wide_Characters;
```

Implementation Advice

If an implementation chooses to provide implementation-defined operations on `Wide_Character` or `Wide_String` (such as case mapping, classification, collating and sorting, etc.) it should do so by providing child units of `Wide_Characters`. Similarly if it chooses to provide implementation-defined operations on `Wide_Wide_Character` or `Wide_Wide_String` it should do so by providing child units of `Wide_Wide_Characters`.

A.3.2 The Package `Characters.Handling`

Replace paragraph 2:

```
package Ada.Characters.Handling is
  pragma Preelaborate(Handling);
```

by:

```
with Ada.Characters.Conversions;
package Ada.Characters.Handling is
  pragma Pure(Handling);
```

Replace paragraph 13:

-- *Classifications of and conversions between `Wide_Character` and `Character`.*

by:

-- *The functions `Is_Character`, `Is_String`, `To_Character`, `To_String`, `To_Wide_Character`,
-- and `To_Wide_String` are obsolescent; see J.14.*

Delete paragraph 14:

```
function Is_Character (Item : in Wide_Character) return Boolean;
function Is_String   (Item : in Wide_String)   return Boolean;
```

Delete paragraph 15:

```
function To_Character (Item          : in Wide_Character;
                      Substitute    : in Character := ' ')
  return Character;
```

Delete paragraph 16:

```
function To_String   (Item          : in Wide_String;
                      Substitute    : in Character := ' ')
  return String;
```

Delete paragraph 17:

```
function To_Wide_Character (Item : in Character) return Wide_Character;
```

Delete paragraph 18:

```
function To_Wide_String   (Item : in String) return Wide_String;
```

Delete paragraph 42:

The following set of functions test `Wide_Character` values for membership in `Character`, or convert between corresponding characters of `Wide_Character` and `Character`.

Delete paragraph 43:

```
Is_Character
  Returns True if Wide_Character'Pos(Item) <= Character'Pos(Character'Last).
```

Delete paragraph 44:

Is_String
Returns True if Is_Character(Item(I)) is True for each I in Item'Range.

Delete paragraph 45:

To_Character
Returns the Character corresponding to Item if Is_Character(Item), and returns the Substitute Character otherwise.

Delete paragraph 46:

To_String
Returns the String whose range is 1..Item'Length and each of whose elements is given by To_Character of the corresponding element in Item.

Delete paragraph 47:

To_Wide_Character
Returns the Wide_Character X such that Character'Pos(Item) = Wide_Character'Pos(X).

Delete paragraph 48:

To_Wide_String
Returns the Wide_String whose range is 1..Item'Length and each of whose elements is given by To_Wide_Character of the corresponding element in Item.

Delete paragraph 49:

If an implementation provides a localized definition of Character or Wide_Character, then the effects of the subprograms in Characters.Handling should reflect the localizations. See also 3.5.2.

A.3.4 The Package Characters.Conversions

Insert new clause:

The library package Characters.Conversions has the following declaration:

```

package Ada.Characters.Conversions is
  pragma Pure(Conversions);

  function Is_Character (Item : in Wide_Character)      return Boolean;
  function Is_String    (Item : in Wide_String)        return Boolean;
  function Is_Character (Item : in Wide_Wide_Character) return Boolean;
  function Is_String    (Item : in Wide_Wide_String)   return Boolean;
  function Is_Wide_Character (Item : in Wide_Wide_Character)
    return Boolean;
  function Is_Wide_String   (Item : in Wide_Wide_String)
    return Boolean;

  function To_Wide_Character (Item : in Character) return Wide_Character;
  function To_Wide_String   (Item : in String)   return Wide_String;
  function To_Wide_Wide_Character (Item : in Character)
    return Wide_Wide_Character;
  function To_Wide_Wide_String   (Item : in String)
    return Wide_Wide_String;
  function To_Wide_Wide_Character (Item : in Wide_Character)
    return Wide_Wide_Character;
  function To_Wide_Wide_String   (Item : in Wide_String)
    return Wide_Wide_String;

  function To_Character (Item           : in Wide_Character;
                        Substitute : in Character := ' ')
    return Character;
  function To_String   (Item           : in Wide_String;
                        Substitute : in Character := ' ')
    return String;
  
```

```

function To_Character (Item :      in Wide_Wide_Character;
                       Substitute : in Character := ' ')
    return Character;
function To_String (Item :      in Wide_Wide_String;
                    Substitute : in Character := ' ')
    return String;
function To_Wide_Character (Item :      in Wide_Wide_Character;
                            Substitute : in Wide_Character := ' ')
    return Wide_Character;
function To_Wide_String (Item :      in Wide_Wide_String;
                         Substitute : in Wide_Character := ' ')
    return Wide_String;

end Ada.Characters.Conversions;

```

The functions in package Characters.Conversions test Wide_Wide_Character or Wide_Character values for membership in Wide_Character or Character, or convert between corresponding characters of Wide_Wide_Character, Wide_Character, and Character.

```

function Is_Character (Item : in Wide_Character) return Boolean;
    Returns True if Wide_Character'Pos(Item) <= Character'Pos(Character'Last).
function Is_Character (Item : in Wide_Wide_Character) return Boolean;
    Returns True if Wide_Wide_Character'Pos(Item) <= Character'Pos(Character'Last).
function Is_Wide_Character (Item : in Wide_Wide_Character) return Boolean;
    Returns True if Wide_Wide_Character'Pos(Item) <= Wide_Character'Pos(Wide_Character'Last).
function Is_String (Item : in Wide_String) return Boolean;
function Is_String (Item : in Wide_Wide_String) return Boolean;
    Returns True if Is_Character(Item(I)) is True for each I in Item'Range.
function Is_Wide_String (Item : in Wide_Wide_String) return Boolean;
    Returns True if Is_Wide_Character(Item(I)) is True for each I in Item'Range.
function To_Character (Item :      in Wide_Character;
                       Substitute : in Character := ' ') return Character;
function To_Character (Item :      in Wide_Wide_Character;
                       Substitute : in Character := ' ') return Character;
    Returns the Character corresponding to Item if Is_Character(Item), and returns the Substitute Character otherwise.
function To_Wide_Character (Item : in Character) return Wide_Character;
    Returns the Wide_Character X such that Character'Pos(Item) = Wide_Character'Pos (X).
function To_Wide_Character (Item :      in Wide_Wide_Character;
                            Substitute : in Wide_Character := ' ')
    return Wide_Character;
    Returns the Wide_Character corresponding to Item if Is_Wide_Character(Item), and returns the Substitute Wide_Character otherwise.
function To_Wide_Wide_Character (Item : in Character)
    return Wide_Wide_Character;
    Returns the Wide_Wide_Character X such that Character'Pos(Item) = Wide_Wide_Character'Pos (X).
function To_Wide_Wide_Character (Item : in Wide_Character)
    return Wide_Wide_Character;
    Returns the Wide_Wide_Character X such that Wide_Character'Pos(Item) = Wide_Wide_Character'Pos (X).
function To_String (Item :      in Wide_String;
                    Substitute : in Character := ' ') return String;
function To_String (Item :      in Wide_Wide_String;
                    Substitute : in Character := ' ') return String;

```

Returns the String whose range is 1..Item'Length and each of whose elements is given by To_Character of the corresponding element in Item.

```
function To_Wide_String (Item : in String) return Wide_String;
```

Returns the Wide_String whose range is 1..Item'Length and each of whose elements is given by To_Wide_Character of the corresponding element in Item.

```
function To_Wide_String (Item : in Wide_Wide_String;
                        Substitute : in Wide_Character := ' ')
return Wide_String;
```

Returns the Wide_String whose range is 1..Item'Length and each of whose elements is given by To_Wide_Character of the corresponding element in Item with the given Substitute Wide_Character.

```
function To_Wide_Wide_String (Item : in String) return Wide_Wide_String;
function To_Wide_Wide_String (Item : in Wide_String)
return Wide_Wide_String;
```

Returns the Wide_Wide_String whose range is 1..Item'Length and each of whose elements is given by To_Wide_Wide_Character of the corresponding element in Item.

A.4 String Handling

Replace paragraph 1:

This clause presents the specifications of the package Strings and several child packages, which provide facilities for dealing with string data. Fixed-length, bounded-length, and unbounded-length strings are supported, for both String and Wide_String. The string-handling subprograms include searches for pattern strings and for characters in program-specified sets, translation (via a character-to-character mapping), and transformation (replacing, inserting, overwriting, and deleting of substrings).

by:

This clause presents the specifications of the package Strings and several child packages, which provide facilities for dealing with string data. Fixed-length, bounded-length, and unbounded-length strings are supported, for String, Wide_String, and Wide_Wide_String. The string-handling subprograms include searches for pattern strings and for characters in program-specified sets, translation (via a character-to-character mapping), and transformation (replacing, inserting, overwriting, and deleting of substrings).

A.4.1 The Package Strings

Replace paragraph 4:

```
Space      : constant Character      := ' ';
Wide_Space : constant Wide_Character := ' ';
```

by:

```
Space      : constant Character      := ' ';
Wide_Space : constant Wide_Character := ' ';
Wide_Wide_Space : constant Wide_Wide_Character := ' ';
```

A.4.2 The Package Strings.Maps

Replace paragraph 3:

```
package Ada.Strings.Maps is
  pragma Preelaborate (Maps);
```

by:

```
package Ada.Strings.Maps is
  pragma Pure (Maps);
```

Replace paragraph 4:

```
-- Representation for a set of character values:
type Character_Set is private;
```

by:

```
-- Representation for a set of character values:
type Character_Set is private;
pragma Preelaborable_Initialization(Character_Set);
```

Replace paragraph 20:

```
-- Representation for a character to character mapping:
type Character_Mapping is private;
```

by:

```
-- Representation for a character to character mapping:
type Character_Mapping is private;
pragma Preelaborable_Initialization(Character_Mapping);
```

A.4.3 Fixed-Length String Handling**Insert after paragraph 8:**

```
-- Search subprograms
```

the new paragraphs:

```
function Index (Source : in String;
                Pattern : in String;
                From    : in Positive;
                Going   : in Direction := Forward;
                Mapping : in Maps.Character_Mapping := Maps.Identity)
return Natural;

function Index (Source : in String;
                Pattern : in String;
                From    : in Positive;
                Going   : in Direction := Forward;
                Mapping : in Maps.Character_Mapping_Function)
return Natural;
```

Insert after paragraph 10:

```
function Index (Source : in String;
                Pattern : in String;
                Going   : in Direction := Forward;
                Mapping : in Maps.Character_Mapping_Function)
return Natural;
```

the new paragraph:

```
function Index (Source : in String;
                Set     : in Maps.Character_Set;
                From    : in Positive;
                Test     : in Membership := Inside;
                Going   : in Direction := Forward)
return Natural;
```

Insert after paragraph 11:

```
function Index (Source : in String;
                Set     : in Maps.Character_Set;
                Test     : in Membership := Inside;
                Going   : in Direction := Forward)
return Natural;
```

the new paragraph:

```
function Index_Non_Blank (Source : in String;
                        From    : in Positive;
                        Going   : in Direction := Forward)
    return Natural;
```

Insert after paragraph 56:

- Otherwise, Length_Error is propagated.

the new paragraphs:

```
function Index (Source : in String;
               Pattern : in String;
               From    : in Positive;
               Going   : in Direction := Forward;
               Mapping : in Maps.Character_Mapping := Maps.Identity)
    return Natural;
```

```
function Index (Source : in String;
               Pattern : in String;
               From    : in Positive;
               Going   : in Direction := Forward;
               Mapping : in Maps.Character_Mapping_Function)
    return Natural;
```

Each Index function searches, starting from From, for a slice of Source, with length Pattern'Length, that matches Pattern with respect to Mapping; the parameter Going indicates the direction of the lookup. If From is not in Source'Range, then Index_Error is propagated. If Going = Forward, then Index returns the smallest index I which is greater than or equal to From such that the slice of Source starting at I matches Pattern. If Going = Backward, then Index returns the largest index I such that the slice of Source starting at I matches Pattern and has an upper bound less than or equal to From. If there is no such slice, then 0 is returned. If Pattern is the null string, then Pattern_Error is propagated.

Replace paragraph 58:

Each Index function searches for a slice of Source, with length Pattern'Length, that matches Pattern with respect to Mapping; the parameter Going indicates the direction of the lookup. If Going = Forward, then Index returns the smallest index I such that the slice of Source starting at I matches Pattern. If Going = Backward, then Index returns the largest index I such that the slice of Source starting at I matches Pattern. If there is no such slice, then 0 is returned. If Pattern is the null string then Pattern_Error is propagated.

by:

If Going = Forward, returns

```
Index (Source, Pattern, Source'First, Forward, Mapping);
```

otherwise returns

```
Index (Source, Pattern, Source'Last, Backward, Mapping);
```

```
function Index (Source : in String;
               Set      : in Maps.Character_Set;
               From    : in Positive;
               Test     : in Membership := Inside;
               Going   : in Direction := Forward)
    return Natural;
```

Index searches for the first or last occurrence of any of a set of characters (when Test=Inside), or any of the complement of a set of characters (when Test=Outside). If From is not in Source'Range, then Index_Error is propagated. Otherwise, it returns the smallest index I >= From (if Going=Forward) or the largest index I <= From (if Going=Backward) such that Source(I) satisfies the Test condition with respect to Set; it returns 0 if there is no such Character in Source.

Replace paragraph 60:

Index searches for the first or last occurrence of any of a set of characters (when Test=Inside), or any of the complement of a set of characters (when Test=Outside). It returns the smallest index I (if Going=Forward) or the largest index I (if Going=Backward) such that Source(I) satisfies the Test condition with respect to Set; it returns 0 if there is no such Character in Source.

by:

If Going = Forward, returns

```
Index (Source, Set, Source'First, Test, Forward);
```

otherwise returns

```
Index (Source, Set, Source'Last, Test, Backward);
```

```
function Index_Non_Blank (Source : in String;
                          From   : in Positive;
                          Going  : in Direction := Forward)
return Natural;
```

Returns Index (Source, Maps.To_Set(Space), From, Outside, Going);

A.4.4 Bounded-Length String Handling**Insert after paragraph 12:**

```
function To_String (Source : in Bounded_String) return String;
```

the new paragraphs:

```
procedure Set_Bounded_String
  (Target : out Bounded_String;
   Source : in String;
   Drop   : in Truncation := Error);
```

Insert after paragraph 28:

```
function Slice (Source : in Bounded_String;
                Low    : in Positive;
                High   : in Natural)
return String;
```

the new paragraphs:

```
function Bounded_Slice
  (Source : in Bounded_String;
   Low    : in Positive;
   High   : in Natural)
return Bounded_String;

procedure Bounded_Slice
  (Source : in Bounded_String;
   Target : out Bounded_String;
   Low    : in Positive;
   High   : in Natural);
```

Replace paragraph 43:

-- Search functions

by:

-- Search subprograms

```
function Index (Source : in Bounded_String;
                Pattern : in String;
                From    : in Positive;
                Going   : in Direction := Forward;
                Mapping  : in Maps.Character_Mapping := Maps.Identity)
return Natural;
```

```

function Index (Source : in Bounded_String;
                Pattern : in String;
                From    : in Positive;
                Going   : in Direction := Forward;
                Mapping  : in Maps.Character_Mapping_Function)
    return Natural;

```

Insert after paragraph 45:

```

function Index (Source : in Bounded_String;
                Pattern : in String;
                Going   : in Direction := Forward;
                Mapping  : in Maps.Character_Mapping_Function)
    return Natural;

```

the new paragraph:

```

function Index (Source : in Bounded_String;
                Set     : in Maps.Character_Set;
                From    : in Positive;
                Test    : in Membership := Inside;
                Going   : in Direction := Forward)
    return Natural;

```

Insert after paragraph 46:

```

function Index (Source : in Bounded_String;
                Set     : in Maps.Character_Set;
                Test    : in Membership := Inside;
                Going   : in Direction := Forward)
    return Natural;

```

the new paragraph:

```

function Index_Non_Blank (Source : in Bounded_String;
                        From    : in Positive;
                        Going   : in Direction := Forward)
    return Natural;

```

Insert after paragraph 92:

To_String returns the String value with lower bound 1 represented by Source. If B is a Bounded_String, then B = To_Bounded_String(To_String(B)).

the new paragraphs:

```

procedure Set_Bounded_String
    (Target : out Bounded_String;
     Source : in String;
     Drop   : in Truncation := Error);

```

Equivalent to Target := To_Bounded_String (Source, Drop);

Replace paragraph 101:

Returns the slice at positions Low through High in the string represented by Source; propagates Index_Error if Low > Length(Source)+1 or High > Length(Source).

by: Returns the slice at positions Low through High in the string represented by Source; propagates Index_Error if Low > Length(Source)+1 or High > Length(Source). The bounds of the returned string are Low and High.

```

function Bounded_Slice
    (Source : in Bounded_String;
     Low    : in Positive;
     High   : in Natural)
    return Bounded_String;

```

Returns the slice at positions Low through High in the string represented by Source as a bounded string; propagates Index_Error if Low > Length(Source)+1 or High > Length(Source).

```

procedure Bounded_Slice
  (Source : in    Bounded_String;
   Target  : out Bounded_String;
   Low     : in    Positive;
   High    : in    Natural);

```

Equivalent to Target := Bounded_Slice (Source, Low, High);

A.4.5 Unbounded-Length String Handling

Replace paragraph 4:

```

type Unbounded_String is private;

```

by:

```

type Unbounded_String is private;
pragma Preelaborable_Initialization(Unbounded_String);

```

Insert after paragraph 11:

```

function To_String (Source : in Unbounded_String) return String;

```

the new paragraphs:

```

procedure Set_Unbounded_String
  (Target : out Unbounded_String;
   Source : in    String);

```

Insert after paragraph 22:

```

function Slice (Source : in Unbounded_String;
                Low     : in Positive;
                High    : in Natural)
  return String;

```

the new paragraphs:

```

function Unbounded_Slice
  (Source : in Unbounded_String;
   Low     : in Positive;
   High    : in Natural)
  return Unbounded_String;

```

```

procedure Unbounded_Slice
  (Source : in    Unbounded_String;
   Target  : out Unbounded_String;
   Low     : in    Positive;
   High    : in    Natural);

```

Insert after paragraph 38:

```

-- Search subprograms

```

the new paragraphs:

```

function Index (Source : in Unbounded_String;
                Pattern : in String;
                From     : in Positive;
                Going    : in Direction := Forward;
                Mapping  : in Maps.Character_Mapping := Maps.Identity)
  return Natural;

```

```

function Index (Source : in Unbounded_String;
                Pattern : in String;
                From     : in Positive;
                Going    : in Direction := Forward;
                Mapping  : in Maps.Character_Mapping_Function)
  return Natural;

```

Insert after paragraph 40:

```
function Index (Source : in Unbounded_String;
               Pattern : in String;
               Going   : in Direction := Forward;
               Mapping  : in Maps.Character_Mapping_Function)
return Natural;
```

the new paragraph:

```
function Index (Source : in Unbounded_String;
               Set      : in Maps.Character_Set;
               From     : in Positive;
               Test     : in Membership := Inside;
               Going    : in Direction := Forward)
return Natural;
```

Insert after paragraph 41:

```
function Index (Source : in Unbounded_String;
               Set      : in Maps.Character_Set;
               Test     : in Membership := Inside;
               Going    : in Direction := Forward)
return Natural;
```

the new paragraph:

```
function Index_Non_Blank (Source : in Unbounded_String;
                         From     : in Positive;
                         Going    : in Direction := Forward)
return Natural;
```

Insert after paragraph 72:

```
private
... -- not specified by the language
end Ada.Strings.Unbounded;
```

the new paragraph:

The type Unbounded_String needs finalization (see 7.6).

Insert after paragraph 79:

- If U is an Unbounded_String, then To_Unbounded_String(To_String(U)) = U.

the new paragraph:

The procedure Set_Unbounded_String sets Target to an Unbounded_String that represents Source.

Insert after paragraph 82:

The Element, Replace_Element, and Slice subprograms have the same effect as the corresponding bounded-length string subprograms.

the new paragraph:

The function Unbounded_Slice returns the slice at positions Low through High in the string represented by Source as an Unbounded_String. The procedure Unbounded_Slice sets Target to the Unbounded_String representing the slice at positions Low through High in the string represented by Source. Both routines propagate Index_Error if Low > Length(Source)+1 or High > Length(Source).

A.4.6 String-Handling Sets and Mappings

Replace paragraph 3:

```
package Ada.Strings.Maps.Constants is
pragma Preelaborate(Constants);
```

by:

```
package Ada.Strings.Maps.Constants is
pragma Pure(Constants);
```

A.4.7 Wide_String Handling

Replace paragraph 1:

Facilities for handling strings of Wide_Character elements are found in the packages Strings.Wide_Maps, Strings.Wide_Fixed, Strings.Wide_Bounded, Strings.Wide_Unbounded, and Strings.Wide_Maps.Wide_Constants. They provide the same string-handling operations as the corresponding packages for strings of Character elements.

by:

Facilities for handling strings of Wide_Character elements are found in the packages Strings.Wide_Maps, Strings.Wide_Fixed, Strings.Wide_Bounded, Strings.Wide_Unbounded, and Strings.Wide_Maps.Wide_Constants, and in the functions Strings.Wide_Hash, Strings.Wide_Fixed.Wide_Hash, Strings.Wide_Bounded.Wide_Hash, and Strings.Wide_Unbounded.Wide_Hash. They provide the same string-handling operations as the corresponding packages and functions for strings of Character elements.

Replace paragraph 4:

```
-- Representation for a set of Wide_Character values:
type Wide_Character_Set is private;
```

by:

```
-- Representation for a set of Wide_Character values:
type Wide_Character_Set is private;
pragma Preelaborable_Initialization(Wide_Character_Set);
```

Replace paragraph 20:

```
-- Representation for a Wide_Character to Wide_Character mapping:
type Wide_Character_Mapping is private;
```

by:

```
-- Representation for a Wide_Character to Wide_Character mapping:
type Wide_Character_Mapping is private;
pragma Preelaborable_Initialization(Wide_Character_Mapping);
```

Replace paragraph 29:

For each of the packages Strings.Fixed, Strings.Bounded, Strings.Unbounded, and Strings.Maps.Constants the corresponding wide string package has the same contents except that

by:

For each of the packages Strings.Fixed, Strings.Bounded, Strings.Unbounded, and Strings.Maps.Constants, and for functions Strings.Hash, Strings.Fixed.Hash, Strings.Bounded.Hash, and Strings.Unbounded.Hash, the corresponding wide string package has the same contents except that

Insert after paragraph 40:

- To_Wide_String replaces To_String

the new paragraphs:

- Set_Bounded_Wide_String replaces Set_Bounded_String

Insert after paragraph 44:

- To_Unbounded_Wide_String replaces To_Unbounded_String

the new paragraphs:

- Set_Unbounded_Wide_String replaces Set_Unbounded_String

Replace paragraph 46:

```
Character_Set : constant Wide_Maps.Wide_Character_Set;
--Contains each Wide_Character value WC such that Characters.Is_Character(WC) is True
```

by:

```
Character_Set : constant Wide_Maps.Wide_Character_Set;
--Contains each Wide_Character value WC such that
--Characters.Conversions.Is_Character(WC) is True
```

Each Wide_Character_Set constant in the package Strings.Wide_Maps.Wide_Constants contains no values outside the Character portion of Wide_Character. Similarly, each Wide_Character_Mapping constant in this package is the identity mapping when applied to any element outside the Character portion of Wide_Character.

Pragma Pure is replaced by pragma Preelaborate in Strings.Wide_Maps.Wide_Constants.

Delete paragraph 48:

13 Each Wide_Character_Set constant in the package Strings.Wide_Maps.Wide_Constants contains no values outside the Character portion of Wide_Character. Similarly, each Wide_Character_Mapping constant in this package is the identity mapping when applied to any element outside the Character portion of Wide_Character.

A.4.8 Wide_Wide_String Handling

Insert new clause:

Facilities for handling strings of Wide_Wide_Character elements are found in the packages Strings.Wide_Wide_Maps, Strings.Wide_Wide_Fixed, Strings.Wide_Wide_Bounded, Strings.Wide_Wide_Unbounded, and Strings.Wide_Wide_Maps.Wide_Wide_Constants, and in the functions Strings.Wide_Wide_Hash, Strings.Wide_Wide_Fixed.Wide_Wide_Hash, Strings.Wide_Wide_Bounded.Wide_Wide_Hash, and Strings.Wide_Wide_Unbounded.Wide_Wide_Hash. They provide the same string-handling operations as the corresponding packages and functions for strings of Character elements.

Static Semantics

The library package Strings.Wide_Wide_Maps has the following declaration.

```
package Ada.Strings.Wide_Wide_Maps is
  pragma Preelaborate(Wide_Wide_Maps);

  -- Representation for a set of Wide_Wide_Character values:
  type Wide_Wide_Character_Set is private;
  pragma Preelaborable_Initialization(Wide_Wide_Character_Set);

  Null_Set : constant Wide_Wide_Character_Set;

  type Wide_Wide_Character_Range is
    record
      Low   : Wide_Wide_Character;
      High  : Wide_Wide_Character;
    end record;
  -- Represents Wide_Wide_Character range Low..High

  type Wide_Wide_Character_Ranges is array (Positive range <>)
    of Wide_Wide_Character_Range;

  function To_Set (Ranges : in Wide_Wide_Character_Ranges)
    return Wide_Wide_Character_Set;

  function To_Set (Span : in Wide_Wide_Character_Range)
    return Wide_Wide_Character_Set;

  function To_Ranges (Set : in Wide_Wide_Character_Set)
    return Wide_Wide_Character_Ranges;

  function "=" (Left, Right : in Wide_Wide_Character_Set) return Boolean;
```

```

function "not" (Right : in Wide_Wide_Character_Set)
  return Wide_Wide_Character_Set;
function "and" (Left, Right : in Wide_Wide_Character_Set)
  return Wide_Wide_Character_Set;
function "or" (Left, Right : in Wide_Wide_Character_Set)
  return Wide_Wide_Character_Set;
function "xor" (Left, Right : in Wide_Wide_Character_Set)
  return Wide_Wide_Character_Set;
function "-" (Left, Right : in Wide_Wide_Character_Set)
  return Wide_Wide_Character_Set;

function Is_In (Element : in Wide_Wide_Character;
  Set : in Wide_Wide_Character_Set)
  return Boolean;

function Is_Subset (Elements : in Wide_Wide_Character_Set;
  Set : in Wide_Wide_Character_Set)
  return Boolean;

function "<=" (Left : in Wide_Wide_Character_Set;
  Right : in Wide_Wide_Character_Set)
  return Boolean renames Is_Subset;

-- Alternative representation for a set of Wide_Wide_Character values:
subtype Wide_Wide_Character_Sequence is Wide_Wide_String;

function To_Set (Sequence : in Wide_Wide_Character_Sequence)
  return Wide_Wide_Character_Set;

function To_Set (Singleton : in Wide_Wide_Character)
  return Wide_Wide_Character_Set;

function To_Sequence (Set : in Wide_Wide_Character_Set)
  return Wide_Wide_Character_Sequence;

-- Representation for a Wide_Wide_Character to Wide_Wide_Character
-- mapping:
type Wide_Wide_Character_Mapping is private;
pragma Preelaborable_Initialization(Wide_Wide_Character_Mapping);

function Value (Map : in Wide_Wide_Character_Mapping;
  Element : in Wide_Wide_Character)
  return Wide_Wide_Character;

Identity : constant Wide_Wide_Character_Mapping;

function To_Mapping (From, To : in Wide_Wide_Character_Sequence)
  return Wide_Wide_Character_Mapping;

function To_Domain (Map : in Wide_Wide_Character_Mapping)
  return Wide_Wide_Character_Sequence;

function To_Range (Map : in Wide_Wide_Character_Mapping)
  return Wide_Wide_Character_Sequence;

type Wide_Wide_Character_Mapping_Function is
  access function (From : in Wide_Wide_Character)
  return Wide_Wide_Character;

private
  ... -- not specified by the language
end Ada.Strings.Wide_Wide_Maps;

```

The context clause for each of the packages Strings.Wide_Wide_Fixed, Strings.Wide_Wide_Bounded, and Strings.Wide_Wide_Unbounded identifies Strings.Wide_Wide_Maps instead of Strings.Maps.

For each of the packages Strings.Fixed, Strings.Bounded, Strings.Unbounded, and Strings.Maps.Constants, and for functions Strings.Hash, Strings.Fixed.Hash, Strings.Bounded.Hash, and Strings.Unbounded.Hash, the corresponding wide wide string package or function has the same contents except that

- Wide_Wide_Space replaces Space
- Wide_Wide_Character replaces Character
- Wide_Wide_String replaces String
- Wide_Wide_Character_Set replaces Character_Set
- Wide_Wide_Character_Mapping replaces Character_Mapping
- Wide_Wide_Character_Mapping_Function replaces Character_Mapping_Function
- Wide_Wide_Maps replaces Maps
- Bounded_Wide_Wide_String replaces Bounded_String
- Null_Bounded_Wide_Wide_String replaces Null_Bounded_String
- To_Bounded_Wide_Wide_String replaces To_Bounded_String
- To_Wide_Wide_String replaces To_String
- Set_Bounded_Wide_Wide_String replaces Set_Bounded_String
- Unbounded_Wide_Wide_String replaces Unbounded_String
- Null_Unbounded_Wide_Wide_String replaces Null_Unbounded_String
- Wide_Wide_String_Access replaces String_Access
- To_Unbounded_Wide_Wide_String replaces To_Unbounded_String
- Set_Unbounded_Wide_Wide_String replaces Set_Unbounded_String

The following additional declarations are present in Strings.Wide_Wide_Maps.Wide_Wide_Constants:

```
Character_Set : constant Wide_Wide_Maps.Wide_Wide_Character_Set;
-- Contains each Wide_Wide_Character value WWC such that
-- Characters.Conversions.Is_Character(WWC) is True
Wide_Character_Set : constant Wide_Wide_Maps.Wide_Wide_Character_Set;
-- Contains each Wide_Wide_Character value WWC such that
-- Characters.Conversions.Is_Wide_Character(WWC) is True
```

Each Wide_Wide_Character_Set constant in the package Strings.Wide_Wide_Maps.Wide_Wide_Constants contains no values outside the Character portion of Wide_Wide_Character. Similarly, each Wide_Wide_Character_Mapping constant in this package is the identity mapping when applied to any element outside the Character portion of Wide_Wide_Character.

Pragma Pure is replaced by pragma Preelaborate in Strings.Wide_Wide_Maps.Wide_Wide_Constants.

NOTES

14 If a null Wide_Wide_Character_Mapping_Function is passed to any of the Wide_Wide_String handling subprograms, Constraint_Error is propagated.

A.4.9 String Hashing

Insert new clause:

Static Semantics

The library function Strings.Hash has the following declaration:

```
with Ada.Containers;
function Ada.Strings.Hash (Key : String) return Containers.Hash_Type;
pragma Pure (Hash);
```

Returns an implementation-defined value which is a function of the value of Key. If *A* and *B* are strings such that *A* equals *B*, Hash(*A*) equals Hash(*B*).

The library function Strings.Fixed.Hash has the following declaration:

```
with Ada.Containers, Ada.Strings.Hash;
function Ada.Strings.Fixed.Hash (Key : String) return Containers.Hash_Type
renames Ada.Strings.Hash;
pragma Pure (Hash);
```

The generic library function Strings.Bounded.Hash has the following declaration:

```
with Ada.Containers;
generic
  with package Bounded is
    new Ada.Strings.Bounded.Generic_Bounded_Length (<>);
function Ada.Strings.Bounded.Hash (Key : Bounded.Bounded_String)
return Containers.Hash_Type;
pragma Preelaborate (Hash);
```

Strings.Bounded.Hash is equivalent to the function call Strings.Hash (Bounded.To_String (Key));

The library function Strings.Unbounded.Hash has the following declaration:

```
with Ada.Containers;
function Ada.Strings.Unbounded.Hash (Key : Unbounded_String)
return Containers.Hash_Type;
pragma Preelaborate (Hash);
```

Strings.Unbounded.Hash is equivalent to the function call Strings.Hash (To_String (Key));

Implementation Advice

The Hash functions should be good hash functions, returning a wide spread of values for different string values. It should be unlikely for similar strings to return the same value.

A.5 The Numerics Packages

Replace paragraph 3:

```
package Ada.Numerics is
  pragma Pure (Numerics);
  Argument_Error : exception;
  Pi : constant :=
    3.14159_26535_89793_23846_26433_83279_50288_41971_69399_37511;
  e : constant :=
    2.71828_18284_59045_23536_02874_71352_66249_77572_47093_69996;
end Ada.Numerics;
```

by:

```
package Ada.Numerics is
  pragma Pure (Numerics);
  Argument_Error : exception;
  Pi : constant :=
    3.14159_26535_89793_23846_26433_83279_50288_41971_69399_37511;
  π : constant := Pi;
  e : constant :=
    2.71828_18284_59045_23536_02874_71352_66249_77572_47093_69996;
end Ada.Numerics;
```

A.5.2 Random Number Generation

Insert after paragraph 15:

```
private
  ... -- not specified by the language
end Ada.Numerics.Float_Random;
```

the new paragraph:

The type Generator needs finalization (see 7.6).

Insert after paragraph 27:

```
private
  ... -- not specified by the language
end Ada.Numerics.Discrete_Random;
```

the new paragraph:

The type Generator needs finalization (see 7.6) in every instantiation of Numerics.Discrete_Random.

Replace paragraph 53:

```
-Log(Random(G) + Float'Model_Small))
```

by:

```
-Log(Random(G) + Float'Model_Small)
```

A.5.3 Attributes of Floating Point Types

Insert after paragraph 41:

The function yields the integral value nearest to X , rounding toward the even integer if X lies exactly halfway between two integers. A zero result has the sign of X when `S'Signed_Zeros` is True.

the new paragraphs:

`S'Machine_Rounding`

`S'Machine_Rounding` denotes a function with the following specification:

```
function S'Machine_Rounding (X : T)
return T
```

The function yields the integral value nearest to X . If X lies exactly halfway between two integers, one of those integers is returned, but which of them is returned is unspecified. A zero result has the sign of X when `S'Signed_Zeros` is True. This function provides access to the rounding behavior which is most efficient on the target processor.

A.6 Input-Output

Replace paragraph 1:

Input-output is provided through language-defined packages, each of which is a child of the root package `Ada`. The generic packages `Sequential_IO` and `Direct_IO` define input-output operations applicable to files containing elements of a given type. The generic package `Storage_IO` supports reading from and writing to an in-memory buffer. Additional operations for text input-output are supplied in the packages `Text_IO` and `Wide_Text_IO`. Heterogeneous input-output is provided through the child packages `Streams.Stream_IO` and `Text_IO.Text_Streams` (see also 13.13). The package `IO_Exceptions` defines the exceptions needed by the predefined input-output packages.

by:

Input-output is provided through language-defined packages, each of which is a child of the root package `Ada`. The generic packages `Sequential_IO` and `Direct_IO` define input-output operations applicable to files containing elements of a given type. The generic package `Storage_IO` supports reading from and writing to an in-memory buffer. Additional operations for text input-output are supplied in the packages `Text_IO`, `Wide_Text_IO`, and `Wide_Wide_Text_IO`. Heterogeneous input-output is provided through the child packages `Streams.Stream_IO` and `Text_IO.Text_Streams` (see also 13.13). The package `IO_Exceptions` defines the exceptions needed by the predefined input-output packages.

A.7 External Files and File Objects

Replace paragraph 4:

Input-output for direct access files is likewise defined by a generic package called `Direct_IO`. Input-output in human-readable form is defined by the (nongeneric) packages `Text_IO` for Character and String data, and `Wide_Text_IO` for `Wide_Character` and `Wide_String` data. Input-output for files containing streams of elements representing values of possibly different types is defined by means of the (nongeneric) package `Streams.Stream_IO`.

by:

Input-output for direct access files is likewise defined by a generic package called `Direct_IO`. Input-output in human-readable form is defined by the (nongeneric) packages `Text_IO` for Character and String data, `Wide_Text_IO` for `Wide_Character` and `Wide_String` data, and `Wide_Wide_Text_IO` for `Wide_Wide_Character` and `Wide_Wide_String` data. Input-output for files containing streams of elements representing values of possibly different types is defined by means of the (nongeneric) package `Streams.Stream_IO`.

Replace paragraph 10:

```
type File_Mode is (In_File, Out_File, Append_File);
-- for Sequential_IO, Text_IO, Wide_Text_IO, and Stream_IO
```

by:

```
type File_Mode is (In_File, Out_File, Append_File);
-- for Sequential_IO, Text_IO, Wide_Text_IO, Wide_Wide_Text_IO, and Stream_IO
```

Replace paragraph 13:

Several file management operations are common to `Sequential_IO`, `Direct_IO`, `Text_IO`, and `Wide_Text_IO`. These operations are described in subclause A.8.2 for sequential and direct files. Any additional effects concerning text input-output are described in subclause A.10.2.

by:

Several file management operations are common to `Sequential_IO`, `Direct_IO`, `Text_IO`, `Wide_Text_IO`, and `Wide_Wide_Text_IO`. These operations are described in subclause A.8.2 for sequential and direct files. Any additional effects concerning text input-output are described in subclause A.10.2.

Replace paragraph 15:

18 Each instantiation of the generic packages `Sequential_IO` and `Direct_IO` declares a different type `File_Type`. In the case of `Text_IO`, `Wide_Text_IO`, and `Streams.Stream_IO`, the corresponding type `File_Type` is unique.

by:

18 Each instantiation of the generic packages `Sequential_IO` and `Direct_IO` declares a different type `File_Type`. In the case of `Text_IO`, `Wide_Text_IO`, `Wide_Wide_Text_IO`, and `Streams.Stream_IO`, the corresponding type `File_Type` is unique.

A.8 Sequential and Direct Files

Replace paragraph 1:

Two kinds of access to external files are defined in this subclause: *sequential access* and *direct access*. The corresponding file types and the associated operations are provided by the generic packages `Sequential_IO` and `Direct_IO`. A file object to be used for sequential access is called a *sequential file*, and one to be used for direct access is called a *direct file*. Access to stream files is described in A.12.1.

by:

Two kinds of access to external files are defined in this subclause: *sequential access* and *direct access*. The corresponding file types and the associated operations are provided by the generic packages `Sequential_IO` and `Direct_IO`. A file object to be used for sequential access is called a *sequential file*, and one to be used for direct access is called a *direct file*. Access to *stream files* is described in A.12.1.

A.8.1 The Generic Package Sequential_IO

Insert after paragraph 16:

```
private
    ... -- not specified by the language
end Ada.Sequential_IO;
```

the new paragraph:

The type File_Type needs finalization (see 7.6) in every instantiation of Sequential_IO.

A.8.2 File Management

Replace paragraph 3:

Establishes a new external file, with the given name and form, and associates this external file with the given file. The given file is left open. The current mode of the given file is set to the given access mode. The default access mode is the mode Out_File for sequential and text input-output; it is the mode Inout_File for direct input-output. For direct access, the size of the created file is implementation defined.

by:

Establishes a new external file, with the given name and form, and associates this external file with the given file. The given file is left open. The current mode of the given file is set to the given access mode. The default access mode is the mode Out_File for sequential, stream, and text input-output; it is the mode Inout_File for direct input-output. For direct access, the size of the created file is implementation defined.

Replace paragraph 16:

Resets the given file so that reading from its elements can be restarted from the beginning of the file (for modes In_File and Inout_File), and so that writing to its elements can be restarted at the beginning of the file (for modes Out_File and Inout_File) or after the last element of the file (for mode Append_File). In particular, for direct access this means that the current index is set to one. If a Mode parameter is supplied, the current mode of the given file is set to the given mode. In addition, for sequential files, if the given file has mode Out_File or Append_File when Reset is called, the last element written since the most recent open or reset is the last element that can be read from the file. If no elements have been written and the file mode is Out_File, the reset file is empty. If no elements have been written and the file mode is Append_File, then the reset file is unchanged.

by:

Resets the given file so that reading from its elements can be restarted from the beginning of the external file (for modes In_File and Inout_File), and so that writing to its elements can be restarted at the beginning of the external file (for modes Out_File and Inout_File) or after the last element of the external file (for mode Append_File). In particular, for direct access this means that the current index is set to one. If a Mode parameter is supplied, the current mode of the given file is set to the given mode. In addition, for sequential files, if the given file has mode Out_File or Append_File when Reset is called, the last element written since the most recent open or reset is the last element that can be read from the external file. If no elements have been written and the file mode is Out_File, the reset file is empty. If no elements have been written and the file mode is Append_File, then the reset file is unchanged.

Replace paragraph 22:

Returns a string which uniquely identifies the external file currently associated with the given file (and may thus be used in an Open operation). If an external environment allows alternative specifications of the name (for example, abbreviations), the string returned by the function should correspond to a full specification of the name.

by:

Returns a string which uniquely identifies the external file currently associated with the given file (and may thus be used in an Open operation).

A.8.4 The Generic Package Direct_IO

Insert after paragraph 19:

```
private
  ... -- not specified by the language
end Ada.Direct_IO;
```

the new paragraph:

The type File_Type needs finalization (see 7.6) in every instantiation of Direct_IO.

A.10.1 The Package Text_IO

Insert after paragraph 48:

```
procedure Put(File : in File_Type; Item : in String);
procedure Put(Item : in String);
```

the new paragraphs:

```
function Get_Line(File : in File_Type) return String;
function Get_Line return String;
```

Insert after paragraph 85:

```
Status_Error : exception renames IO_Exceptions.Status_Error;
Mode_Error   : exception renames IO_Exceptions.Mode_Error;
Name_Error   : exception renames IO_Exceptions.Name_Error;
Use_Error    : exception renames IO_Exceptions.Use_Error;
Device_Error : exception renames IO_Exceptions.Device_Error;
End_Error    : exception renames IO_Exceptions.End_Error;
Data_Error   : exception renames IO_Exceptions.Data_Error;
Layout_Error : exception renames IO_Exceptions.Layout_Error;
private
  ... -- not specified by the language
end Ada.Text_IO;
```

the new paragraph:

The type File_Type needs finalization (see 7.6).

A.10.6 Get and Put Procedures

In paragraph 5 replace:

Input-output of enumeration values uses the syntax of the corresponding lexical elements. Any Get procedure for an enumeration type begins by skipping any leading blanks, or line or page terminators. Get procedures for numeric or enumeration types start by skipping leading blanks, where a *blank* is defined as a space or a horizontal tabulation character. Next, characters are input only so long as the sequence input is an initial sequence of an identifier or of a character literal (in particular, input ceases when a line terminator is encountered). The character or line terminator that causes input to cease remains available for subsequent input.

by:

Input-output of enumeration values uses the syntax of the corresponding lexical elements. Any Get procedure for an enumeration type begins by skipping any leading blanks, or line or page terminators. A *blank* is defined as a space or a horizontal tabulation character. Next, characters are input only so long as the sequence input is an initial sequence of an identifier or of a character literal (in particular, input ceases when a line terminator is encountered). The character or line terminator that causes input to cease remains available for subsequent input.

A.10.7 Input-Output of Characters and Strings

Replace paragraph 13:

For an item of type String the following procedures are provided:

by:

For an item of type String the following subprograms are provided:

Insert after paragraph 17:

Determines the length of the given string and attempts that number of Put operations for successive characters of the string (in particular, no operation is performed if the string is null).

the new paragraphs:

```
function Get_Line(File : in File_Type) return String;
function Get_Line return String;
```

Returns a result string constructed by reading successive characters from the specified input file, and assigning them to successive characters of the result string. The result string has a lower bound of 1 and an upper bound of the number of characters read. Reading stops when the end of the line is met; Skip_Line is then (in effect) called with a spacing of 1.

Constraint_Error is raised if the length of the line exceeds Positive'Last; in this case, the line number and page number are unchanged, and the column number is unspecified but no less than it was before the call. The exception End_Error is propagated if an attempt is made to skip a file terminator.

A.10.11 Input-Output for Bounded Strings

Insert new clause:

The package Text_IO.Bounded_IO provides input-output in human-readable form for Bounded_Strings.

Static Semantics

The generic library package Text_IO.Bounded_IO has the following declaration:

```
with Ada.Strings.Bounded;
generic
  with package Bounded is
    new Ada.Strings.Bounded.Generic_Bounded_Length (<>);
package Ada.Text_IO.Bounded_IO is

  procedure Put
    (File : in File_Type;
     Item : in Bounded.Bounded_String);

  procedure Put
    (Item : in Bounded.Bounded_String);

  procedure Put_Line
    (File : in File_Type;
     Item : in Bounded.Bounded_String);

  procedure Put_Line
    (Item : in Bounded.Bounded_String);

  function Get_Line
    (File : in File_Type)
    return Bounded.Bounded_String;

  function Get_Line
    return Bounded.Bounded_String;

  procedure Get_Line
    (File : in File_Type; Item : out Bounded.Bounded_String);
```

```

procedure Get_Line
  (Item : out Bounded.Bounded_String);

end Ada.Text_IO.Bounded_IO;

```

For an item of type Bounded_String, the following subprograms are provided:

```

procedure Put
  (File : in File_Type;
   Item : in Bounded.Bounded_String);

  Equivalent to Text_IO.Put (File, Bounded.To_String(Item));

procedure Put
  (Item : in Bounded.Bounded_String);

  Equivalent to Text_IO.Put (Bounded.To_String(Item));

procedure Put_Line
  (File : in File_Type;
   Item : in Bounded.Bounded_String);

  Equivalent to Text_IO.Put_Line (File, Bounded.To_String(Item));

procedure Put_Line
  (Item : in Bounded.Bounded_String);

  Equivalent to Text_IO.Put_Line (Bounded.To_String(Item));

function Get_Line
  (File : in File_Type)
  return Bounded.Bounded_String;

  Returns Bounded.To_Bounded_String(Text_IO.Get_Line(File));

function Get_Line
  return Bounded.Bounded_String;

  Returns Bounded.To_Bounded_String(Text_IO.Get_Line);

procedure Get_Line
  (File : in File_Type; Item : out Bounded.Bounded_String);

  Equivalent to Item := Get_Line (File);

procedure Get_Line
  (Item : out Bounded.Bounded_String);

  Equivalent to Item := Get_Line;

```

A.10.12 Input-Output for Unbounded Strings

Insert new clause:

The package Text_IO.Unbounded_IO provides input-output in human-readable form for Unbounded_Strings.

Static Semantics

The library package Text_IO.Unbounded_IO has the following declaration:

```

with Ada.Strings.Unbounded;
package Ada.Text_IO.Unbounded_IO is

  procedure Put
    (File : in File_Type;
     Item : in Strings.Unbounded.Unbounded_String);

  procedure Put
    (Item : in Strings.Unbounded.Unbounded_String);

  procedure Put_Line
    (File : in File_Type;
     Item : in Strings.Unbounded.Unbounded_String);

```

```

procedure Put_Line
  (Item : in Strings.Unbounded.Unbounded_String);

function Get_Line
  (File : in File_Type)
  return Strings.Unbounded.Unbounded_String;

function Get_Line
  return Strings.Unbounded.Unbounded_String;

procedure Get_Line
  (File : in File_Type; Item : out Strings.Unbounded.Unbounded_String);

procedure Get_Line
  (Item : out Strings.Unbounded.Unbounded_String);

end Ada.Text_IO.Unbounded_IO;

```

For an item of type Unbounded_String, the following subprograms are provided:

```

procedure Put
  (File : in File_Type;
  Item : in Strings.Unbounded.Unbounded_String);

  Equivalent to Text_IO.Put (File, Strings.Unbounded.To_String(Item));

procedure Put
  (Item : in Strings.Unbounded.Unbounded_String);

  Equivalent to Text_IO.Put (Strings.Unbounded.To_String(Item));

procedure Put_Line
  (File : in File_Type;
  Item : in Strings.Unbounded.Unbounded_String);

  Equivalent to Text_IO.Put_Line (File, Strings.Unbounded.To_String(Item));

procedure Put_Line
  (Item : in Strings.Unbounded.Unbounded_String);

  Equivalent to Text_IO.Put_Line (Strings.Unbounded.To_String(Item));

function Get_Line
  (File : in File_Type)
  return Strings.Unbounded.Unbounded_String;

  Returns Strings.Unbounded.To_Unbounded_String(Text_IO.Get_Line(File));

function Get_Line
  return Strings.Unbounded.Unbounded_String;

  Returns Strings.Unbounded.To_Unbounded_String(Text_IO.Get_Line);

procedure Get_Line
  (File : in File_Type; Item : out Strings.Unbounded.Unbounded_String);

  Equivalent to Item := Get_Line (File);

procedure Get_Line
  (Item : out Strings.Unbounded.Unbounded_String);

  Equivalent to Item := Get_Line;

```

A.11 Wide Text Input-Output and Wide Wide Text Input-Output

Replace the title:

Wide Text Input-Output

by:

Wide Text Input-Output and Wide Wide Text Input-Output

Replace paragraph 1:

The package `Wide_Text_IO` provides facilities for input and output in human-readable form. Each file is read or written sequentially, as a sequence of wide characters grouped into lines, and as a sequence of lines grouped into pages.

by:

The packages `Wide_Text_IO` and `Wide_Wide_Text_IO` provide facilities for input and output in human-readable form. Each file is read or written sequentially, as a sequence of wide characters (or wide wide characters) grouped into lines, and as a sequence of lines grouped into pages.

Replace paragraph 2:

The specification of package `Wide_Text_IO` is the same as that for `Text_IO`, except that in each `Get`, `Look_Ahead`, `Get_Immediate`, `Get_Line`, `Put`, and `Put_Line` procedure, any occurrence of `Character` is replaced by `Wide_Character`, and any occurrence of `String` is replaced by `Wide_String`.

by:

The specification of package `Wide_Text_IO` is the same as that for `Text_IO`, except that in each `Get`, `Look_Ahead`, `Get_Immediate`, `Get_Line`, `Put`, and `Put_Line` subprogram, any occurrence of `Character` is replaced by `Wide_Character`, and any occurrence of `String` is replaced by `Wide_String`. Nongeneric equivalents of `Wide_Text_IO.Integer_IO` and `Wide_Text_IO.Float_IO` are provided (as for `Text_IO`) for each predefined numeric type, with names such as `Ada.Integer_Wide_Text_IO`, `Ada.Long_Integer_Wide_Text_IO`, `Ada.Float_Wide_Text_IO`, `Ada.Long_Float_Wide_Text_IO`.

Replace paragraph 3:

Nongeneric equivalents of `Wide_Text_IO.Integer_IO` and `Wide_Text_IO.Float_IO` are provided (as for `Text_IO`) for each predefined numeric type, with names such as `Ada.Integer_Wide_Text_IO`, `Ada.Long_Integer_Wide_Text_IO`, `Ada.Float_Wide_Text_IO`, `Ada.Long_Float_Wide_Text_IO`.

by:

The specification of package `Wide_Wide_Text_IO` is the same as that for `Text_IO`, except that in each `Get`, `Look_Ahead`, `Get_Immediate`, `Get_Line`, `Put`, and `Put_Line` subprogram, any occurrence of `Character` is replaced by `Wide_Wide_Character`, and any occurrence of `String` is replaced by `Wide_Wide_String`. Nongeneric equivalents of `Wide_Wide_Text_IO.Integer_IO` and `Wide_Wide_Text_IO.Float_IO` are provided (as for `Text_IO`) for each predefined numeric type, with names such as `Ada.Integer_Wide_Wide_Text_IO`, `Ada.Long_Integer_Wide_Wide_Text_IO`, `Ada.Float_Wide_Wide_Text_IO`, `Ada.Long_Float_Wide_Wide_Text_IO`.

The specification of package `Wide_Text_IO.Wide_Bounded_IO` is the same as that for `Text_IO.Bounded_IO`, except that any occurrence of `Bounded_String` is replaced by `Wide_Bounded_String`, and any occurrence of package `Bounded` is replaced by `Wide_Bounded`. The specification of package `Wide_Wide_Text_IO.Wide_Bounded_IO` is the same as that for `Text_IO.Bounded_IO`, except that any occurrence of `Bounded_String` is replaced by `Wide_Wide_Bounded_String`, and any occurrence of package `Bounded` is replaced by `Wide_Wide_Bounded`.

The specification of package `Wide_Text_IO.Wide_Unbounded_IO` is the same as that for `Text_IO.Unbounded_IO`, except that any occurrence of `Unbounded_String` is replaced by `Wide_Unbounded_String`, and any occurrence of package `Unbounded` is replaced by `Wide_Unbounded`. The specification of package `Wide_Wide_Text_IO.Wide_Wide_Unbounded_IO` is the same as that for `Text_IO.Unbounded_IO`, except that any occurrence of `Unbounded_String` is replaced by `Wide_Wide_Unbounded_String`, and any occurrence of package `Unbounded` is replaced by `Wide_Wide_Unbounded`.

A.12 Stream Input-Output**Replace paragraph 1:**

The packages `Streams.Stream_IO`, `Text_IO.Text_Streams`, and `Wide_Text_IO.Text_Streams` provide stream-oriented operations on files.

by:

The packages `Streams.Stream_IO`, `Text_IO.Text_Streams`, `Wide_Text_IO.Text_Streams`, and `Wide_Wide_Text_IO.Text_Streams` provide stream-oriented operations on files.

A.12.1 The Package Streams.Stream_IO

Insert after paragraph 27:

```
private
    ... -- not specified by the language
end Ada.Streams.Stream_IO;
```

the new paragraph:

The type File_Type needs finalization (see 7.6).

Replace paragraph 28:

The subprograms Create, Open, Close, Delete, Reset, Mode, Name, Form, Is_Open, and End_of_File have the same effect as the corresponding subprograms in Sequential_IO (see A.8.2).

by:

The subprograms given in subclause A.8.2 for the control of external files (Create, Open, Close, Delete, Reset, Mode, Name, Form, and Is_Open) are available for stream files.

The End_Of_File function:

- Propagates Mode_Error if the mode of the file is not In_File;
- If positioning is supported for the given external file, the function returns True if the current index exceeds the size of the external file; otherwise it returns False;
- If positioning is not supported for the given external file, the function returns True if no more elements can be read from the given file; otherwise it returns False.

Replace paragraph 28.1:

The Set_Mode procedure changes the mode of the file. If the new mode is Append_File, the file is positioned to its end; otherwise, the position in the file is unchanged.

by:

The Set_Mode procedure sets the mode of the file. If the new mode is Append_File, the file is positioned to its end; otherwise, the position in the file is unchanged.

Replace paragraph 30:

The procedures Read and Write are equivalent to the corresponding operations in the package Streams. Read propagates Mode_Error if the mode of File is not In_File. Write propagates Mode_Error if the mode of File is not Out_File or Append_File. The Read procedure with a Positive_Count parameter starts reading at the specified index. The Write procedure with a Positive_Count parameter starts writing at the specified index.

by:

The procedures Read and Write are equivalent to the corresponding operations in the package Streams. Read propagates Mode_Error if the mode of File is not In_File. Write propagates Mode_Error if the mode of File is not Out_File or Append_File. The Read procedure with a Positive_Count parameter starts reading at the specified index. The Write procedure with a Positive_Count parameter starts writing at the specified index. For a file that supports positioning, Read without a Positive_Count parameter starts reading at the current index, and Write without a Positive_Count parameter starts writing at the current index.

A.12.4 The Package Wide_Wide_Text_IO.Text_Streams

Insert new clause:

The package Wide_Wide_Text_IO.Text_Streams provides a function for treating a wide wide text file as a stream.

Static Semantics

The library package Wide_Wide_Text_IO.Text_Streams has the following declaration:

```
with Ada.Streams;
package Ada.Wide_Wide_Text_IO.Text_Streams is
```

```

type Stream_Access is access all Streams.Root_Stream_Type'Class;

function Stream (File : in File_Type) return Stream_Access;
end Ada.Wide_Wide_Text_IO.Text_Streams;

```

The Stream function has the same effect as the corresponding function in Streams.Stream_IO.

A.16 The Package Directories

Insert new clause:

The package Directories provides operations for manipulating files and directories, and their names.

Static Semantics

The library package Directories has the following declaration:

```

with Ada.IO_Exceptions;
with Ada.Calendar;
package Ada.Directories is

    -- Directory and file operations:

    function Current_Directory return String;

    procedure Set_Directory (Directory : in String);

    procedure Create_Directory (New_Directory : in String;
                               Form : in String := "");

    procedure Delete_Directory (Directory : in String);

    procedure Create_Path (New_Directory : in String;
                           Form : in String := "");

    procedure Delete_Tree (Directory : in String);

    procedure Delete_File (Name : in String);

    procedure Rename (Old_Name, New_Name : in String);

    procedure Copy_File (Source_Name, Target_Name : in String;
                          Form : in String := "");

    -- File and directory name operations:

    function Full_Name (Name : in String) return String;

    function Simple_Name (Name : in String) return String;

    function Containing_Directory (Name : in String) return String;

    function Extension (Name : in String) return String;

    function Base_Name (Name : in String) return String;

    function Compose (Containing_Directory : in String := "";
                      Name : in String;
                      Extension : in String := "") return String;

    -- File and directory queries:

    type File_Kind is (Directory, Ordinary_File, Special_File);

    type File_Size is range 0 .. implementation-defined;

    function Exists (Name : in String) return Boolean;

    function Kind (Name : in String) return File_Kind;

```

```

function Size (Name : in String) return File_Size;

function Modification_Time (Name : in String) return Ada.Calendar.Time;

-- Directory searching:

type Directory_Entry_Type is limited private;

type Filter_Type is array (File_Kind) of Boolean;

type Search_Type is limited private;

procedure Start_Search (Search      : in out Search_Type;
                        Directory   : in String;
                        Pattern     : in String;
                        Filter      : in Filter_Type := (others => True));

procedure End_Search (Search : in out Search_Type);

function More_Entries (Search : in Search_Type) return Boolean;

procedure Get_Next_Entry (Search : in out Search_Type;
                          Directory_Entry : out Directory_Entry_Type);

procedure Search (
  Directory : in String;
  Pattern   : in String;
  Filter    : in Filter_Type := (others => True);
  Process   : not null access procedure (
    Directory_Entry : in Directory_Entry_Type));

-- Operations on Directory Entries:

function Simple_Name (Directory_Entry : in Directory_Entry_Type)
  return String;

function Full_Name (Directory_Entry : in Directory_Entry_Type)
  return String;

function Kind (Directory_Entry : in Directory_Entry_Type)
  return File_Kind;

function Size (Directory_Entry : in Directory_Entry_Type)
  return File_Size;

function Modification_Time (Directory_Entry : in Directory_Entry_Type)
  return Ada.Calendar.Time;

Status_Error : exception renames Ada.IO_Exceptions.Status_Error;
Name_Error   : exception renames Ada.IO_Exceptions.Name_Error;
Use_Error    : exception renames Ada.IO_Exceptions.Use_Error;
Device_Error : exception renames Ada.IO_Exceptions.Device_Error;

private
-- Not specified by the language.
end Ada.Directories;

```

External files may be classified as directories, special files, or ordinary files. A *directory* is an external file that is a container for files on the target system. A *special file* is an external file that cannot be created or read by a predefined Ada input-output package. External files that are not special files or directories are called *ordinary files*.

A *file name* is a string identifying an external file. Similarly, a *directory name* is a string identifying a directory. The interpretation of file names and directory names is implementation-defined.

The *full name* of an external file is a full specification of the name of the file. If the external environment allows alternative specifications of the name (for example, abbreviations), the full name should not use such alternatives. A full name typically will include the names of all of the directories that contain the item. The *simple name* of an

external file is the name of the item, not including any containing directory names. Unless otherwise specified, a file name or directory name parameter in a call to a predefined Ada input-output subprogram can be a full name, a simple name, or any other form of name supported by the implementation.

The *default directory* is the directory that is used if a directory or file name is not a full name (that is, when the name does not fully identify all of the containing directories).

A *directory entry* is a single item in a directory, identifying a single external file (including directories and special files).

For each function that returns a string, the lower bound of the returned value is 1.

The following file and directory operations are provided:

function Current_Directory **return** String;

Returns the full directory name for the current default directory. The name returned shall be suitable for a future call to Set_Directory. The exception Use_Error is propagated if a default directory is not supported by the external environment.

procedure Set_Directory (Directory : **in** String);

Sets the current default directory. The exception Name_Error is propagated if the string given as Directory does not identify an existing directory. The exception Use_Error is propagated if the external environment does not support making Directory (in the absence of Name_Error) a default directory.

procedure Create_Directory (New_Directory : **in** String;
Form : **in** String := "");

Creates a directory with name New_Directory. The Form parameter can be used to give system-dependent characteristics of the directory; the interpretation of the Form parameter is implementation-defined. A null string for Form specifies the use of the default options of the implementation of the new directory. The exception Name_Error is propagated if the string given as New_Directory does not allow the identification of a directory. The exception Use_Error is propagated if the external environment does not support the creation of a directory with the given name (in the absence of Name_Error) and form.

procedure Delete_Directory (Directory : **in** String);

Deletes an existing empty directory with name Directory. The exception Name_Error is propagated if the string given as Directory does not identify an existing directory. The exception Use_Error is propagated if the external environment does not support the deletion of the directory (or some portion of its contents) with the given name (in the absence of Name_Error).

procedure Create_Path (New_Directory : **in** String;
Form : **in** String := "");

Creates zero or more directories with name New_Directory. Each non-existent directory named by New_Directory is created. For example, on a typical Unix system, Create_Path ("/usr/me/my"); would create directory "me" in directory "usr", then create directory "my" in directory "me". The Form parameter can be used to give system-dependent characteristics of the directory; the interpretation of the Form parameter is implementation-defined. A null string for Form specifies the use of the default options of the implementation of the new directory. The exception Name_Error is propagated if the string given as New_Directory does not allow the identification of any directory. The exception Use_Error is propagated if the external environment does not support the creation of any directories with the given name (in the absence of Name_Error) and form.

procedure Delete_Tree (Directory : **in** String);

Deletes an existing directory with name Directory. The directory and all of its contents (possibly including other directories) are deleted. The exception Name_Error is propagated if the string given as Directory does not identify an existing directory. The exception Use_Error is propagated if the external environment does not support the deletion of the directory or some portion of its contents with the given name (in the absence of Name_Error). If Use_Error is propagated, it is unspecified whether a portion of the contents of the directory is deleted.

procedure Delete_File (Name : **in** String);

Deletes an existing ordinary or special file with name *Name*. The exception *Name_Error* is propagated if the string given as *Name* does not identify an existing ordinary or special external file. The exception *Use_Error* is propagated if the external environment does not support the deletion of the file with the given name (in the absence of *Name_Error*).

```
procedure Rename (Old_Name, New_Name : in String);
```

Renames an existing external file (including directories) with name *Old_Name* to *New_Name*. The exception *Name_Error* is propagated if the string given as *Old_Name* does not identify an existing external file. The exception *Use_Error* is propagated if the external environment does not support the renaming of the file with the given name (in the absence of *Name_Error*). In particular, *Use_Error* is propagated if a file or directory already exists with name *New_Name*.

```
procedure Copy_File (Source_Name, Target_Name : in String;
                    Form : in String);
```

Copies the contents of the existing external file with name *Source_Name* to an external file with name *Target_Name*. The resulting external file is a duplicate of the source external file. The *Form* parameter can be used to give system-dependent characteristics of the resulting external file; the interpretation of the *Form* parameter is implementation-defined. Exception *Name_Error* is propagated if the string given as *Source_Name* does not identify an existing external ordinary or special file, or if the string given as *Target_Name* does not allow the identification of an external file. The exception *Use_Error* is propagated if the external environment does not support creating the file with the name given by *Target_Name* and form given by *Form*, or copying of the file with the name given by *Source_Name* (in the absence of *Name_Error*).

The following file and directory name operations are provided:

```
function Full_Name (Name : in String) return String;
```

Returns the full name corresponding to the file name specified by *Name*. The exception *Name_Error* is propagated if the string given as *Name* does not allow the identification of an external file (including directories and special files).

```
function Simple_Name (Name : in String) return String;
```

Returns the simple name portion of the file name specified by *Name*. The exception *Name_Error* is propagated if the string given as *Name* does not allow the identification of an external file (including directories and special files).

```
function Containing_Directory (Name : in String) return String;
```

Returns the name of the containing directory of the external file (including directories) identified by *Name*. (If more than one directory can contain *Name*, the directory name returned is implementation-defined.) The exception *Name_Error* is propagated if the string given as *Name* does not allow the identification of an external file. The exception *Use_Error* is propagated if the external file does not have a containing directory.

```
function Extension (Name : in String) return String;
```

Returns the extension name corresponding to *Name*. The extension name is a portion of a simple name (not including any separator characters), typically used to identify the file class. If the external environment does not have extension names, then the null string is returned. The exception *Name_Error* is propagated if the string given as *Name* does not allow the identification of an external file.

```
function Base_Name (Name : in String) return String;
```

Returns the base name corresponding to *Name*. The base name is the remainder of a simple name after removing any extension and extension separators. The exception *Name_Error* is propagated if the string given as *Name* does not allow the identification of an external file (including directories and special files).

```
function Compose (Containing_Directory : in String := "";
                 Name : in String;
                 Extension : in String := "") return String;
```

Returns the name of the external file with the specified *Containing_Directory*, *Name*, and *Extension*. If *Extension* is the null string, then *Name* is interpreted as a simple name; otherwise *Name* is interpreted as a base name. The exception *Name_Error* is propagated if the string given as *Containing_Directory* is not null and does not allow the identification of a directory, or if the string given as *Extension* is not null and is not a possible extension, or if the string given as *Name* is not a possible simple name (if *Extension* is null) or base name (if *Extension* is non-null).

The following file and directory queries and types are provided:

```
type File_Kind is (Directory, Ordinary_File, Special_File);
```

The type File_Kind represents the kind of file represented by an external file or directory.

```
type File_Size is range 0 .. implementation-defined;
```

The type File_Size represents the size of an external file.

```
function Exists (Name : in String) return Boolean;
```

Returns True if an external file represented by Name exists, and False otherwise. The exception Name_Error is propagated if the string given as Name does not allow the identification of an external file (including directories and special files).

```
function Kind (Name : in String) return File_Kind;
```

Returns the kind of external file represented by Name. The exception Name_Error is propagated if the string given as Name does not allow the identification of an existing external file.

```
function Size (Name : in String) return File_Size;
```

Returns the size of the external file represented by Name. The size of an external file is the number of stream elements contained in the file. If the external file is not an ordinary file, the result is implementation-defined. The exception Name_Error is propagated if the string given as Name does not allow the identification of an existing external file. The exception Constraint_Error is propagated if the file size is not a value of type File_Size.

```
function Modification_Time (Name : in String) return Ada.Calendar.Time;
```

Returns the time that the external file represented by Name was most recently modified. If the external file is not an ordinary file, the result is implementation-defined. The exception Name_Error is propagated if the string given as Name does not allow the identification of an existing external file. The exception Use_Error is propagated if the external environment does not support reading the modification time of the file with the name given by Name (in the absence of Name_Error).

The following directory searching operations and types are provided:

```
type Directory_Entry_Type is limited private;
```

The type Directory_Entry_Type represents a single item in a directory. These items can only be created by the Get_Next_Entry procedure in this package. Information about the item can be obtained from the functions declared in this package. A default-initialized object of this type is invalid; objects returned from Get_Next_Entry are valid.

```
type Filter_Type is array (File_Kind) of Boolean;
```

The type Filter_Type specifies which directory entries are provided from a search operation. If the Directory component is True, directory entries representing directories are provided. If the Ordinary_File component is True, directory entries representing ordinary files are provided. If the Special_File component is True, directory entries representing special files are provided.

```
type Search_Type is limited private;
```

The type Search_Type contains the state of a directory search. A default-initialized Search_Type object has no entries available (function More_Entries returns False). Type Search_Type needs finalization (see 7.6).

```
procedure Start_Search (Search      : in out Search_Type;  
                       Directory   : in String;  
                       Pattern     : in String;  
                       Filter      : in Filter_Type := (others => True));
```

Starts a search in the directory named by Directory for entries matching Pattern. Pattern represents a pattern for matching file names. If Pattern is null, all items in the directory are matched; otherwise, the interpretation of Pattern is implementation-defined. Only items that match Filter will be returned. After a successful call on Start_Search, the object Search may have entries available, but it may have no entries available if no files or directories match Pattern and Filter. The exception Name_Error is propagated if the string given by Directory does not identify an existing directory, or if Pattern does not allow the identification of any possible external file or directory. The exception Use_Error is propagated if the

external environment does not support the searching of the directory with the given name (in the absence of Name_Error). When Start_Search propagates Name_Error or Use_Error, the object Search will have no entries available.

procedure End_Search (Search : **in out** Search_Type);

Ends the search represented by Search. After a successful call on End_Search, the object Search will have no entries available.

function More_Entries (Search : **in** Search_Type) **return** Boolean;

Returns True if more entries are available to be returned by a call to Get_Next_Entry for the specified search object, and False otherwise.

procedure Get_Next_Entry (Search : **in out** Search_Type;
Directory_Entry : **out** Directory_Entry_Type);

Returns the next Directory_Entry for the search described by Search that matches the pattern and filter. If no further matches are available, Status_Error is raised. It is implementation-defined as to whether the results returned by this routine are altered if the contents of the directory are altered while the Search object is valid (for example, by another program). The exception Use_Error is propagated if the external environment does not support continued searching of the directory represented by Search.

procedure Search (
Directory : **in** String;
Pattern : **in** String;
Filter : **in** Filter_Type := (others => True);
Process : **not null access procedure** (
Directory_Entry : **in** Directory_Entry_Type));

Searches in the directory named by Directory for entries matching Pattern. The subprogram designated by Process is called with each matching entry in turn. Pattern represents a pattern for matching file names. If Pattern is null, all items in the directory are matched; otherwise, the interpretation of Pattern is implementation-defined. Only items that match Filter will be returned. The exception Name_Error is propagated if the string given by Directory does not identify an existing directory, or if Pattern does not allow the identification of any possible external file or directory. The exception Use_Error is propagated if the external environment does not support the searching of the directory with the given name (in the absence of Name_Error).

function Simple_Name (Directory_Entry : **in** Directory_Entry_Type)
return String;

Returns the simple external name of the external file (including directories) represented by Directory_Entry. The format of the name returned is implementation-defined. The exception Status_Error is propagated if Directory_Entry is invalid.

function Full_Name (Directory_Entry : **in** Directory_Entry_Type)
return String;

Returns the full external name of the external file (including directories) represented by Directory_Entry. The format of the name returned is implementation-defined. The exception Status_Error is propagated if Directory_Entry is invalid.

function Kind (Directory_Entry : **in** Directory_Entry_Type)
return File_Kind;

Returns the kind of external file represented by Directory_Entry. The exception Status_Error is propagated if Directory_Entry is invalid.

function Size (Directory_Entry : **in** Directory_Entry_Type)
return File_Size;

Returns the size of the external file represented by Directory_Entry. The size of an external file is the number of stream elements contained in the file. If the external file represented by Directory_Entry is not an ordinary file, the result is implementation-defined. The exception Status_Error is propagated if Directory_Entry is invalid. The exception Constraint_Error is propagated if the file size is not a value of type File_Size.

function Modification_Time (Directory_Entry : **in** Directory_Entry_Type)
return Ada.Calendar.Time;

Returns the time that the external file represented by `Directory_Entry` was most recently modified. If the external file represented by `Directory_Entry` is not an ordinary file, the result is implementation-defined. The exception `Status_Error` is propagated if `Directory_Entry` is invalid. The exception `Use_Error` is propagated if the external environment does not support reading the modification time of the file represented by `Directory_Entry`.

Implementation Requirements

For `Copy_File`, if `Source_Name` identifies an existing external ordinary file created by a predefined Ada input-output package, and `Target_Name` and `Form` can be used in the `Create` operation of that input-output package with mode `Out_File` without raising an exception, then `Copy_File` shall not propagate `Use_Error`.

Implementation Advice

If other information about a file (such as the owner or creation date) is available in a directory entry, the implementation should provide functions in a child package `Directories`. Information to retrieve it.

`Start_Search` and `Search` should raise `Use_Error` if `Pattern` is malformed, but not if it could represent a file in the directory but does not actually do so.

`Rename` should be supported at least when both `New_Name` and `Old_Name` are simple names and `New_Name` does not identify an existing external file.

NOTES

37 The operations `Containing_Directory`, `Full_Name`, `Simple_Name`, `Base_Name`, `Extension`, and `Compose` operate on file names, not external files. The files identified by these operations do not need to exist. `Name_Error` is raised only if the file name is malformed and cannot possibly identify a file. Of these operations, only the result of `Full_Name` depends on the current default directory; the result of the others depends only on their parameters.

38 Using access types, values of `Search_Type` and `Directory_Entry_Type` can be saved and queried later. However, another task or application can modify or delete the file represented by a `Directory_Entry_Type` value or the directory represented by a `Search_Type` value; such a value can only give the information valid at the time it is created. Therefore, long-term storage of these values is not recommended.

39 If the target system does not support directories inside of directories, then `Kind` will never return `Directory` and `Containing_Directory` will always raise `Use_Error`.

40 If the target system does not support creation or deletion of directories, then `Create_Directory`, `Create_Path`, `Delete_Directory`, and `Delete_Tree` will always propagate `Use_Error`.

41 To move a file or directory to a different location, use `Rename`. Most target systems will allow renaming of files from one directory to another. If the target file or directory might already exist, it should be deleted first.

A.17 The Package Environment_Variables

Insert new clause:

The package `Environment_Variables` allows a program to read or modify environment variables. Environment variables are name-value pairs, where both the name and value are strings. The definition of what constitutes an *environment variable*, and the meaning of the name and value, are implementation defined.

Static Semantics

The library package `Environment_Variables` has the following declaration:

```

package Ada.Environment_Variables is
  pragma Preelaborate(Environment_Variables);

  function Value (Name : in String) return String;

  function Exists (Name : in String) return Boolean;

  procedure Set (Name : in String; Value : in String);

  procedure Clear (Name : in String);
  procedure Clear;

  procedure Iterate (
    Process : not null access procedure (Name, Value : in String));

```

end Ada.Environment_Variables;

function Value (Name : **in** String) **return** String;

If the external execution environment supports environment variables, then Value returns the value of the environment variable with the given name. If no environment variable with the given name exists, then Constraint_Error is propagated. If the execution environment does not support environment variables, then Program_Error is propagated.

function Exists (Name : **in** String) **return** Boolean;

If the external execution environment supports environment variables and an environment variable with the given name currently exists, then Exists returns True; otherwise it returns False.

procedure Set (Name : **in** String; Value : **in** String);

If the external execution environment supports environment variables, then Set first clears any existing environment variable with the given name, and then defines a single new environment variable with the given name and value. Otherwise Program_Error is propagated.

If implementation-defined circumstances prohibit the definition of an environment variable with the given name and value, then Constraint_Error is propagated.

It is implementation defined whether there exist values for which the call Set(Name, Value) has the same effect as Clear (Name).

procedure Clear (Name : **in** String);

If the external execution environment supports environment variables, then Clear deletes all existing environment variable with the given name. Otherwise Program_Error is propagated.

procedure Clear;

If the external execution environment supports environment variables, then Clear deletes all existing environment variables. Otherwise Program_Error is propagated.

procedure Iterate (
 Process : **not null access procedure** (Name, Value : **in** String));

If the external execution environment supports environment variables, then Iterate calls the subprogram designated by Process for each existing environment variable, passing the name and value of that environment variable. Otherwise Program_Error is propagated.

If several environment variables exist that have the same name, Process is called once for each such variable.

Bounded (Run-Time) Errors

It is a bounded error to call Value if more than one environment variable exists with the given name; the possible outcomes are that:

- one of the values is returned, and that same value is returned in subsequent calls in the absence of changes to the environment; or
- Program_Error is propagated.

Erroneous Execution

Making calls to the procedures Set or Clear concurrently with calls to any subprogram of package Environment_Variables, or to any instantiation of Iterate, results in erroneous execution.

Making calls to the procedures Set or Clear in the actual subprogram corresponding to the Process parameter of Iterate results in erroneous execution.

Documentation Requirements

An implementation shall document how the operations of this package behave if environment variables are changed by external mechanisms (for instance, calling operating system services).

Implementation Permissions

An implementation running on a system that does not support environment variables is permitted to define the operations of package `Environment_Variables` with the semantics corresponding to the case where the external execution environment does support environment variables. In this case, it shall provide a mechanism to initialize a nonempty set of environment variables prior to the execution of a partition.

Implementation Advice

If the execution environment supports subprocesses, the currently defined environment variables should be used to initialize the environment variables of a subprocess.

Changes to the environment variables made outside the control of this package should be reflected immediately in the effect of the operations of this package. Changes to the environment variables made using this package should be reflected immediately in the external execution environment. This package should not perform any buffering of the environment variables.

A.18 Containers

Insert new clause:

This clause presents the specifications of the package `Containers` and several child packages, which provide facilities for storing collections of elements.

A variety of sequence and associative containers are provided. Each container includes a *cursor* type. A cursor is a reference to an element within a container. Many operations on cursors are common to all of the containers. A cursor referencing an element in a container is considered to be overlapping with the container object itself.

Within this clause we provide Implementation Advice for the desired average or worst case time complexity of certain operations on a container. This advice is expressed using the Landau symbol $O(X)$. Presuming f is some function of a length parameter N and $t(N)$ is the time the operation takes (on average or worst case, as specified) for the length N , a complexity of $O(f(N))$ means that there exists a finite A such that for any N , $t(N)/f(N) < A$.

If the advice suggests that the complexity should be less than $O(f(N))$, then for any arbitrarily small positive real D , there should exist a positive integer M such that for all $N > M$, $t(N)/f(N) < D$.

A.18.1 The Package `Containers`

Insert new clause:

The package `Containers` is the root of the containers subsystem.

Static Semantics

The library package `Containers` has the following declaration:

```
package Ada.Containers is
  pragma Pure (Containers);

  type Hash_Type is mod implementation-defined;

  type Count_Type is range 0 .. implementation-defined;

end Ada.Containers;
```

`Hash_Type` represents the range of the result of a hash function. `Count_Type` represents the (potential or actual) number of elements of a container.

Implementation Advice

`Hash_Type`'Modulus should be at least 2^{32} . `Count_Type`'Last should be at least $2^{31}-1$.

A.18.2 The Package Containers.Vectors

Insert new clause:

The language-defined generic package Containers.Vectors provides private types Vector and Cursor, and a set of operations for each type. A vector container allows insertion and deletion at any position, but it is specifically optimized for insertion and deletion at the high end (the end with the higher index) of the container. A vector container also provides random access to its elements.

A vector container behaves conceptually as an array that expands as necessary as items are inserted. The *length* of a vector is the number of elements that the vector contains. The *capacity* of a vector is the maximum number of elements that can be inserted into the vector prior to it being automatically expanded.

Elements in a vector container can be referred to by an index value of a generic formal type. The first element of a vector always has its index value equal to the lower bound of the formal type.

A vector container may contain *empty elements*. Empty elements do not have a specified value.

Static Semantics

The generic library package Containers.Vectors has the following declaration:

```

generic
  type Index_Type is range <>;
  type Element_Type is private;
  with function "=" (Left, Right : Element_Type)
    return Boolean is <>;
package Ada.Containers.Vectors is
  pragma Preelaborate (Vectors);

  subtype Extended_Index is
    Index_Type'Base range
      Index_Type'First-1 ..
      Index_Type'Min (Index_Type'Base'Last - 1, Index_Type'Last) + 1;
  No_Index : constant Extended_Index := Extended_Index'First;

  type Vector is tagged private;
  pragma Preelaborable_Initialization (Vector);

  type Cursor is private;
  pragma Preelaborable_Initialization (Cursor);

  Empty_Vector : constant Vector;

  No_Element : constant Cursor;

  function "=" (Left, Right : Vector) return Boolean;

  function To_Vector (Length : Count_Type) return Vector;

  function To_Vector
    (New_Item : Element_Type;
     Length   : Count_Type) return Vector;

  function "&" (Left, Right : Vector) return Vector;

  function "&" (Left   : Vector;
               Right  : Element_Type) return Vector;

  function "&" (Left   : Element_Type;
               Right  : Vector) return Vector;

  function "&" (Left, Right : Element_Type) return Vector;

  function Capacity (Container : Vector) return Count_Type;

  procedure Reserve_Capacity (Container : in out Vector;
                             Capacity  : in      Count_Type);

```

```

function Length (Container : Vector) return Count_Type;

procedure Set_Length (Container : in out Vector;
                    Length   : in   Count_Type);

function Is_Empty (Container : Vector) return Boolean;

procedure Clear (Container : in out Vector);

function To_Cursor (Container : Vector;
                  Index      : Extended_Index) return Cursor;

function To_Index (Position : Cursor) return Extended_Index;

function Element (Container : Vector;
                 Index      : Index_Type)
    return Element_Type;

function Element (Position : Cursor) return Element_Type;

procedure Replace_Element (Container : in out Vector;
                          Index      : in   Index_Type;
                          New_Item   : in   Element_Type);

procedure Replace_Element (Container : in out Vector;
                          Position   : in   Cursor;
                          New_Item   : in   Element_Type);

procedure Query_Element
(Container : in Vector;
 Index    : in Index_Type;
 Process  : not null access procedure (Element : in Element_Type));

procedure Query_Element
(Position : in Cursor;
 Process  : not null access procedure (Element : in Element_Type));

procedure Update_Element
(Container : in out Vector;
 Index    : in   Index_Type;
 Process  : not null access procedure
           (Element : in out Element_Type));

procedure Update_Element
(Container : in out Vector;
 Position : in   Cursor;
 Process  : not null access procedure
           (Element : in out Element_Type));

procedure Move (Target : in out Vector;
                Source : in out Vector);

procedure Insert (Container : in out Vector;
                 Before     : in   Extended_Index;
                 New_Item   : in   Vector);

procedure Insert (Container : in out Vector;
                 Before     : in   Cursor;
                 New_Item   : in   Vector);

procedure Insert (Container : in out Vector;
                 Before     : in   Cursor;
                 New_Item   : in   Vector;
                 Position   : out Cursor);

procedure Insert (Container : in out Vector;
                 Before     : in   Extended_Index;
                 New_Item   : in   Element_Type);

```

```

        Count      : in      Count_Type := 1);

procedure Insert (Container : in out Vector;
  Before      : in      Cursor;
  New_Item    : in      Element_Type;
  Count      : in      Count_Type := 1);

procedure Insert (Container : in out Vector;
  Before      : in      Cursor;
  New_Item    : in      Element_Type;
  Position    : out     Cursor;
  Count      : in      Count_Type := 1);

procedure Insert (Container : in out Vector;
  Before      : in      Extended_Index;
  Count      : in      Count_Type := 1);

procedure Insert (Container : in out Vector;
  Before      : in      Cursor;
  Position    : out     Cursor;
  Count      : in      Count_Type := 1);

procedure Prepend (Container : in out Vector;
  New_Item    : in      Vector);

procedure Prepend (Container : in out Vector;
  New_Item    : in      Element_Type;
  Count      : in      Count_Type := 1);

procedure Append (Container : in out Vector;
  New_Item    : in      Vector);

procedure Append (Container : in out Vector;
  New_Item    : in      Element_Type;
  Count      : in      Count_Type := 1);

procedure Insert_Space (Container : in out Vector;
  Before      : in      Extended_Index;
  Count      : in      Count_Type := 1);

procedure Insert_Space (Container : in out Vector;
  Before      : in      Cursor;
  Position    : out     Cursor;
  Count      : in      Count_Type := 1);

procedure Delete (Container : in out Vector;
  Index       : in      Extended_Index;
  Count      : in      Count_Type := 1);

procedure Delete (Container : in out Vector;
  Position    : in out  Cursor;
  Count      : in      Count_Type := 1);

procedure Delete_First (Container : in out Vector;
  Count      : in      Count_Type := 1);

procedure Delete_Last (Container : in out Vector;
  Count      : in      Count_Type := 1);

procedure Reverse_Elements (Container : in out Vector);

procedure Swap (Container : in out Vector;
  I, J       : in      Index_Type);

procedure Swap (Container : in out Vector;
  I, J       : in      Cursor);

function First_Index (Container : Vector) return Index_Type;

```

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```

function First (Container : Vector) return Cursor;

function First_Element (Container : Vector)
    return Element_Type;

function Last_Index (Container : Vector) return Extended_Index;

function Last (Container : Vector) return Cursor;

function Last_Element (Container : Vector)
    return Element_Type;

function Next (Position : Cursor) return Cursor;

procedure Next (Position : in out Cursor);

function Previous (Position : Cursor) return Cursor;

procedure Previous (Position : in out Cursor);

function Find_Index (Container : Vector;
                    Item      : Element_Type;
                    Index     : Index_Type := Index_Type'First)
    return Extended_Index;

function Find (Container : Vector;
               Item      : Element_Type;
               Position  : Cursor := No_Element)
    return Cursor;

function Reverse_Find_Index (Container : Vector;
                             Item      : Element_Type;
                             Index     : Index_Type := Index_Type'Last)
    return Extended_Index;

function Reverse_Find (Container : Vector;
                       Item      : Element_Type;
                       Position  : Cursor := No_Element)
    return Cursor;

function Contains (Container : Vector;
                  Item      : Element_Type) return Boolean;

function Has_Element (Position : Cursor) return Boolean;

procedure Iterate
    (Container : in Vector;
     Process   : not null access procedure (Position : in Cursor));

procedure Reverse_Iterate
    (Container : in Vector;
     Process   : not null access procedure (Position : in Cursor));

generic
    with function "<" (Left, Right : Element_Type)
        return Boolean is <>;
package Generic_Sorting is

    function Is_Sorted (Container : Vector) return Boolean;

    procedure Sort (Container : in out Vector);

    procedure Merge (Target  : in out Vector;
                    Source  : in out Vector);

end Generic_Sorting;

```

private

... -- *not specified by the language*

end Ada.Containers.Vectors;

The actual function for the generic formal function "=" on Element_Type values is expected to define a reflexive and symmetric relationship and return the same result value each time it is called with a particular pair of values. If it behaves in some other manner, the functions defined to use it return an unspecified value. The exact arguments and number of calls of this generic formal function by the functions defined to use it are unspecified.

The type Vector is used to represent vectors. The type Vector needs finalization (see 7.6).

Empty_Vector represents the empty vector object. It has a length of 0. If an object of type Vector is not otherwise initialized, it is initialized to the same value as Empty_Vector.

No_Element represents a cursor that designates no element. If an object of type Cursor is not otherwise initialized, it is initialized to the same value as No_Element.

The predefined "=" operator for type Cursor returns True if both cursors are No_Element, or designate the same element in the same container.

Execution of the default implementation of the Input, Output, Read, or Write attribute of type Cursor raises Program_Error.

No_Index represents a position that does not correspond to any element. The subtype Extended_Index includes the indices covered by Index_Type plus the value No_Index and, if it exists, the successor to the Index_Type'Last.

Some operations of this generic package have access-to-subprogram parameters. To ensure such operations are well-defined, they guard against certain actions by the designated subprogram. In particular, some operations check for "tampering with cursors" of a container because they depend on the set of elements of the container remaining constant, and others check for "tampering with elements" of a container because they depend on elements of the container not being replaced.

A subprogram is said to *tamper with cursors* of a vector object *V* if:

- it inserts or deletes elements of *V*, that is, it calls the Insert, Insert_Space, Clear, Delete, or Set_Length procedures with *V* as a parameter; or
- it finalizes *V*; or
- it calls the Move procedure with *V* as a parameter.

A subprogram is said to *tamper with elements* of a vector object *V* if:

- it tampers with cursors of *V*; or
- it replaces one or more elements of *V*, that is, it calls the Replace_Element, Reverse_Elements, or Swap procedures or the Sort or Merge procedures of an instance of Generic_Sorting with *V* as a parameter.

function "=" (Left, Right : Vector) **return** Boolean;

If Left and Right denote the same vector object, then the function returns True. If Left and Right have different lengths, then the function returns False. Otherwise, it compares each element in Left to the corresponding element in Right using the generic formal equality operator. If any such comparison returns False, the function returns False; otherwise it returns True. Any exception raised during evaluation of element equality is propagated.

function To_Vector (Length : Count_Type) **return** Vector;

Returns a vector with a length of Length, filled with empty elements.

function To_Vector
(New_Item : Element_Type;
Length : Count_Type) **return** Vector;

Returns a vector with a length of Length, filled with elements initialized to the value New_Item.

function "&" (Left, Right : Vector) **return** Vector;

Returns a vector comprising the elements of Left followed by the elements of Right.

```
function "&" (Left : Vector;
              Right : Element_Type) return Vector;
```

Returns a vector comprising the elements of Left followed by the element Right.

```
function "&" (Left : Element_Type;
              Right : Vector) return Vector;
```

Returns a vector comprising the element Left followed by the elements of Right.

```
function "&" (Left, Right : Element_Type) return Vector;
```

Returns a vector comprising the element Left followed by the element Right.

```
function Capacity (Container : Vector) return Count_Type;
```

Returns the capacity of Container.

```
procedure Reserve_Capacity (Container : in out Vector;
                           Capacity  : in      Count_Type);
```

Reserve_Capacity allocates new internal data structures such that the length of the resulting vector can become at least the value Capacity without requiring an additional call to Reserve_Capacity, and is large enough to hold the current length of Container. Reserve_Capacity then copies the elements into the new data structures and deallocates the old data structures. Any exception raised during allocation is propagated and Container is not modified.

```
function Length (Container : Vector) return Count_Type;
```

Returns the number of elements in Container.

```
procedure Set_Length (Container : in out Vector;
                     Length     : in      Count_Type);
```

If Length is larger than the capacity of Container, Set_Length calls Reserve_Capacity (Container, Length), then sets the length of the Container to Length. If Length is greater than the original length of Container, empty elements are added to Container; otherwise elements are removed from Container.

```
function Is_Empty (Container : Vector) return Boolean;
```

Equivalent to Length (Container) = 0.

```
procedure Clear (Container : in out Vector);
```

Removes all the elements from Container. The capacity of Container does not change.

```
function To_Cursor (Container : Vector;
                   Index      : Extended_Index) return Cursor;
```

If Index is not in the range First_Index (Container) .. Last_Index (Container), then No_Element is returned. Otherwise, a cursor designating the element at position Index in Container is returned.

```
function To_Index (Position : Cursor) return Extended_Index;
```

If Position is No_Element, No_Index is returned. Otherwise, the index (within its containing vector) of the element designated by Position is returned.

```
function Element (Container : Vector;
                  Index      : Index_Type)
return Element_Type;
```

If Index is not in the range First_Index (Container) .. Last_Index (Container), then Constraint_Error is propagated. Otherwise, Element returns the element at position Index.

```
function Element (Position : Cursor) return Element_Type;
```

If Position equals No_Element, then Constraint_Error is propagated. Otherwise, Element returns the element designated by Position.

```
procedure Replace_Element (Container : in out Vector;
                           Index     : in      Index_Type;
                           New_Item  : in      Element_Type);
```

If Index is not in the range First_Index (Container) .. Last_Index (Container), then Constraint_Error is propagated. Otherwise Replace_Element assigns the value New_Item to the element at position Index. Any

exception raised during the assignment is propagated. The element at position Index is not an empty element after successful call to Replace_Element.

```
procedure Replace_Element (Container : in out Vector;
                          Position  : in      Cursor;
                          New_Item  : in      Element_Type);
```

If Position equals No_Element, then Constraint_Error is propagated; if Position does not designate an element in Container, then Program_Error is propagated. Otherwise Replace_Element assigns New_Item to the element designated by Position. Any exception raised during the assignment is propagated. The element at Position is not an empty element after successful call to Replace_Element.

```
procedure Query_Element
(Container : in Vector;
 Index    : in Index_Type;
 Process  : not null access procedure (Element : in Element_Type));
```

If Index is not in the range First_Index (Container) .. Last_Index (Container), then Constraint_Error is propagated. Otherwise, Query_Element calls Process.all with the element at position Index as the argument. Program_Error is propagated if Process.all tampers with the elements of Container. Any exception raised by Process.all is propagated.

```
procedure Query_Element
(Position : in Cursor;
 Process  : not null access procedure (Element : in Element_Type));
```

If Position equals No_Element, then Constraint_Error is propagated. Otherwise, Query_Element calls Process.all with the element designated by Position as the argument. Program_Error is propagated if Process.all tampers with the elements of Container. Any exception raised by Process.all is propagated.

```
procedure Update_Element
(Container : in out Vector;
 Index    : in      Index_Type;
 Process  : not null access procedure (Element : in out Element_Type));
```

If Index is not in the range First_Index (Container) .. Last_Index (Container), then Constraint_Error is propagated. Otherwise, Update_Element calls Process.all with the element at position Index as the argument. Program_Error is propagated if Process.all tampers with the elements of Container. Any exception raised by Process.all is propagated.

If Element_Type is unconstrained and definite, then the actual Element parameter of Process.all shall be unconstrained.

The element at position Index is not an empty element after successful completion of this operation.

```
procedure Update_Element
(Container : in out Vector;
 Position  : in      Cursor;
 Process  : not null access procedure (Element : in out Element_Type));
```

If Position equals No_Element, then Constraint_Error is propagated; if Position does not designate an element in Container, then Program_Error is propagated. Otherwise Update_Element calls Process.all with the element designated by Position as the argument. Program_Error is propagated if Process.all tampers with the elements of Container. Any exception raised by Process.all is propagated.

If Element_Type is unconstrained and definite, then the actual Element parameter of Process.all shall be unconstrained.

The element designated by Position is not an empty element after successful completion of this operation.

```
procedure Move (Target : in out Vector;
               Source  : in out Vector);
```

If Target denotes the same object as Source, then Move has no effect. Otherwise, Move first calls Clear (Target); then, each element from Source is removed from Source and inserted into Target in the original order. The length of Source is 0 after a successful call to Move.

```
procedure Insert (Container : in out Vector;
                 Before    : in      Extended_Index;
                 New_Item  : in      Vector);
```

If Before is not in the range First_Index (Container) .. Last_Index (Container) + 1, then Constraint_Error is propagated. If Length(New_Item) is 0, then Insert does nothing. Otherwise, it computes the new length *NL* as the sum of the current length and Length (New_Item); if the value of Last appropriate for length *NL* would be greater than Index_Type'Last then Constraint_Error is propagated.

If the current vector capacity is less than *NL*, Reserve_Capacity (Container, *NL*) is called to increase the vector capacity. Then Insert slides the elements in the range Before .. Last_Index (Container) up by Length(New_Item) positions, and then copies the elements of New_Item to the positions starting at Before. Any exception raised during the copying is propagated.

```
procedure Insert (Container : in out Vector;
                 Before   : in     Cursor;
                 New_Item  : in     Vector);
```

If Before is not No_Element, and does not designate an element in Container, then Program_Error is propagated. Otherwise, if Length(New_Item) is 0, then Insert does nothing. If Before is No_Element, then the call is equivalent to Insert (Container, Last_Index (Container) + 1, New_Item); otherwise the call is equivalent to Insert (Container, To_Index (Before), New_Item);

```
procedure Insert (Container : in out Vector;
                 Before   : in     Cursor;
                 New_Item  : in     Vector;
                 Position  : out    Cursor);
```

If Before is not No_Element, and does not designate an element in Container, then Program_Error is propagated. If Before equals No_Element, then let *T* be Last_Index (Container) + 1; otherwise, let *T* be To_Index (Before). Insert (Container, *T*, New_Item) is called, and then Position is set to To_Cursor (Container, *T*).

```
procedure Insert (Container : in out Vector;
                 Before   : in     Extended_Index;
                 New_Item  : in     Element_Type;
                 Count     : in     Count_Type := 1);
```

Equivalent to Insert (Container, Before, To_Vector (New_Item, Count));

```
procedure Insert (Container : in out Vector;
                 Before   : in     Cursor;
                 New_Item  : in     Element_Type;
                 Count     : in     Count_Type := 1);
```

Equivalent to Insert (Container, Before, To_Vector (New_Item, Count));

```
procedure Insert (Container : in out Vector;
                 Before   : in     Cursor;
                 New_Item  : in     Element_Type;
                 Position  : out    Cursor;
                 Count     : in     Count_Type := 1);
```

Equivalent to Insert (Container, Before, To_Vector (New_Item, Count), Position);

```
procedure Insert (Container : in out Vector;
                 Before   : in     Extended_Index;
                 Count     : in     Count_Type := 1);
```

If Before is not in the range First_Index (Container) .. Last_Index (Container) + 1, then Constraint_Error is propagated. If Count is 0, then Insert does nothing. Otherwise, it computes the new length *NL* as the sum of the current length and Count; if the value of Last appropriate for length *NL* would be greater than Index_Type'Last then Constraint_Error is propagated.

If the current vector capacity is less than *NL*, Reserve_Capacity (Container, *NL*) is called to increase the vector capacity. Then Insert slides the elements in the range Before .. Last_Index (Container) up by Count positions, and then inserts elements that are initialized by default (see 3.3.1) in the positions starting at Before.

```
procedure Insert (Container : in out Vector;
                 Before   : in     Cursor;
                 Position  : out    Cursor;
                 Count     : in     Count_Type := 1);
```

If Before is not No_Element, and does not designate an element in Container, then Program_Error is propagated. If Before equals No_Element, then let T be Last_Index (Container) + 1; otherwise, let T be To_Index (Before). Insert (Container, T , Count) is called, and then Position is set to To_Cursor (Container, T).

```

procedure Prepend (Container : in out Vector;
                   New_Item  : in   Vector;
                   Count      : in   Count_Type := 1);

```

Equivalent to Insert (Container, First_Index (Container), New_Item).

```

procedure Prepend (Container : in out Vector;
                   New_Item  : in   Element_Type;
                   Count      : in   Count_Type := 1);

```

Equivalent to Insert (Container, First_Index (Container), New_Item, Count).

```

procedure Append (Container : in out Vector;
                  New_Item  : in   Vector);

```

Equivalent to Insert (Container, Last_Index (Container) + 1, New_Item).

```

procedure Append (Container : in out Vector;
                  New_Item  : in   Element_Type;
                  Count      : in   Count_Type := 1);

```

Equivalent to Insert (Container, Last_Index (Container) + 1, New_Item, Count).

```

procedure Insert_Space (Container : in out Vector;
                       Before      : in   Extended_Index;
                       Count       : in   Count_Type := 1);

```

If Before is not in the range First_Index (Container) .. Last_Index (Container) + 1, then Constraint_Error is propagated. If Count is 0, then Insert_Space does nothing. Otherwise, it computes the new length NL as the sum of the current length and Count; if the value of Last appropriate for length NL would be greater than Index_Type'Last then Constraint_Error is propagated.

If the current vector capacity is less than NL , Reserve_Capacity (Container, NL) is called to increase the vector capacity. Then Insert_Space slides the elements in the range Before .. Last_Index (Container) up by Count positions, and then inserts empty elements in the positions starting at Before.

```

procedure Insert_Space (Container : in out Vector;
                       Before      : in   Cursor;
                       Position    : out  Cursor;
                       Count       : in   Count_Type := 1);

```

If Before is not No_Element, and does not designate an element in Container, then Program_Error is propagated. If Before equals No_Element, then let T be Last_Index (Container) + 1; otherwise, let T be To_Index (Before). Insert_Space (Container, T , Count) is called, and then Position is set to To_Cursor (Container, T).

```

procedure Delete (Container : in out Vector;
                  Index      : in   Extended_Index;
                  Count      : in   Count_Type := 1);

```

If Index is not in the range First_Index (Container) .. Last_Index (Container) + 1, then Constraint_Error is propagated. If Count is 0, Delete has no effect. Otherwise Delete slides the elements (if any) starting at position Index + Count down to Index. Any exception raised during element assignment is propagated.

```

procedure Delete (Container : in out Vector;
                  Position    : in out Cursor;
                  Count       : in   Count_Type := 1);

```

If Position equals No_Element, then Constraint_Error is propagated. If Position does not designate an element in Container, then Program_Error is propagated. Otherwise, Delete (Container, To_Index (Position), Count) is called, and then Position is set to No_Element.

```

procedure Delete_First (Container : in out Vector;
                       Count      : in   Count_Type := 1);

```

Equivalent to Delete (Container, First_Index (Container), Count).

```
procedure Delete_Last (Container : in out Vector;
                       Count      : in      Count_Type := 1);
```

If Length (Container) <= Count then Delete_Last is equivalent to Clear (Container). Otherwise it is equivalent to Delete (Container, Index_Type'Val(Index_Type'Pos(Last_Index (Container)) – Count + 1), Count).

```
procedure Reverse_Elements (Container : in out Vector);
```

Reorders the elements of Container in reverse order.

```
procedure Swap (Container : in out Vector;
                I, J       : in      Index_Type);
```

If either I or J is not in the range First_Index (Container) .. Last_Index (Container), then Constraint_Error is propagated. Otherwise, Swap exchanges the values of the elements at positions I and J.

```
procedure Swap (Container : in out Vector;
                I, J       : in      Cursor);
```

If either I or J is No_Element, then Constraint_Error is propagated. If either I or J do not designate an element in Container, then Program_Error is propagated. Otherwise, Swap exchanges the values of the elements designated by I and J.

```
function First_Index (Container : Vector) return Index_Type;
```

Returns the value Index_Type'First.

```
function First (Container : Vector) return Cursor;
```

If Container is empty, First returns No_Element. Otherwise, it returns a cursor that designates the first element in Container.

```
function First_Element (Container : Vector) return Element_Type;
```

Equivalent to Element (Container, First_Index (Container)).

```
function Last_Index (Container : Vector) return Extended_Index;
```

If Container is empty, Last_Index returns No_Index. Otherwise, it returns the position of the last element in Container.

```
function Last (Container : Vector) return Cursor;
```

If Container is empty, Last returns No_Element. Otherwise, it returns a cursor that designates the last element in Container.

```
function Last_Element (Container : Vector) return Element_Type;
```

Equivalent to Element (Container, Last_Index (Container)).

```
function Next (Position : Cursor) return Cursor;
```

If Position equals No_Element or designates the last element of the container, then Next returns the value No_Element. Otherwise, it returns a cursor that designates the element with index To_Index (Position) + 1 in the same vector as Position.

```
procedure Next (Position : in out Cursor);
```

Equivalent to Position := Next (Position).

```
function Previous (Position : Cursor) return Cursor;
```

If Position equals No_Element or designates the first element of the container, then Previous returns the value No_Element. Otherwise, it returns a cursor that designates the element with index To_Index (Position) – 1 in the same vector as Position.

```
procedure Previous (Position : in out Cursor);
```

Equivalent to Position := Previous (Position).

```
function Find_Index (Container : Vector;
                    Item       : Element_Type;
                    Index      : Index_Type := Index_Type'First)
return Extended_Index;
```

Searches the elements of Container for an element equal to Item (using the generic formal equality operator). The search starts at position Index and proceeds towards Last_Index (Container). If no equal element is found, then Find_Index returns No_Index. Otherwise, it returns the index of the first equal element encountered.

```
function Find (Container : Vector;
              Item      : Element_Type;
              Position  : Cursor := No_Element)
return Cursor;
```

If Position is not No_Element, and does not designate an element in Container, then Program_Error is propagated. Otherwise Find searches the elements of Container for an element equal to Item (using the generic formal equality operator). The search starts at the first element if Position equals No_Element, and at the element designated by Position otherwise. It proceeds towards the last element of Container. If no equal element is found, then Find returns No_Element. Otherwise, it returns a cursor designating the first equal element encountered.

```
function Reverse_Find_Index (Container : Vector;
                           Item      : Element_Type;
                           Index     : Index_Type := Index_Type'Last)
return Extended_Index;
```

Searches the elements of Container for an element equal to Item (using the generic formal equality operator). The search starts at position Index or, if Index is greater than Last_Index (Container), at position Last_Index (Container). It proceeds towards First_Index (Container). If no equal element is found, then Reverse_Find_Index returns No_Index. Otherwise, it returns the index of the first equal element encountered.

```
function Reverse_Find (Container : Vector;
                      Item      : Element_Type;
                      Position  : Cursor := No_Element)
return Cursor;
```

If Position is not No_Element, and does not designate an element in Container, then Program_Error is propagated. Otherwise Reverse_Find searches the elements of Container for an element equal to Item (using the generic formal equality operator). The search starts at the last element if Position equals No_Element, and at the element designated by Position otherwise. It proceeds towards the first element of Container. If no equal element is found, then Reverse_Find returns No_Element. Otherwise, it returns a cursor designating the first equal element encountered.

```
function Contains (Container : Vector;
                 Item      : Element_Type) return Boolean;
```

Equivalent to Has_Element (Find (Container, Item)).

```
function Has_Element (Position : Cursor) return Boolean;
```

Returns True if Position designates an element, and returns False otherwise.

```
procedure Iterate
(Container : in Vector;
 Process  : not null access procedure (Position : in Cursor));
```

Invokes Process.all with a cursor that designates each element in Container, in index order. Program_Error is propagated if Process.all tampers with the cursors of Container. Any exception raised by Process is propagated.

```
procedure Reverse_Iterate
(Container : in Vector;
 Process   : not null access procedure (Position : in Cursor));
```

Iterates over the elements in Container as per Iterate, except that elements are traversed in reverse index order.

The actual function for the generic formal function "<" of Generic_Sorting is expected to return the same value each time it is called with a particular pair of element values. It should define a strict ordering relationship, that is, be irreflexive, asymmetric, and transitive; it should not modify Container. If the actual for "<" behaves in some other manner, the behavior of the subprograms of Generic_Sorting are unspecified. How many times the subprograms of Generic_Sorting call "<" is unspecified.

function Is_Sorted (Container : Vector) **return** Boolean;

Returns True if the elements are sorted smallest first as determined by the generic formal "<" operator; otherwise, Is_Sorted returns False. Any exception raised during evaluation of "<" is propagated.

procedure Sort (Container : **in out** Vector);

Reorders the elements of Container such that the elements are sorted smallest first as determined by the generic formal "<" operator provided. Any exception raised during evaluation of "<" is propagated.

procedure Merge (Target : **in out** Vector;
Source : **in out** Vector);

Merge removes elements from Source and inserts them into Target; afterwards, Target contains the union of the elements that were initially in Source and Target; Source is left empty. If Target and Source are initially sorted smallest first, then Target is ordered smallest first as determined by the generic formal "<" operator; otherwise, the order of elements in Target is unspecified. Any exception raised during evaluation of "<" is propagated.

Bounded (Run-Time) Errors

Reading the value of an empty element by calling Element, Query_Element, Update_Element, Swap, Is_Sorted, Sort, Merge, "=", Find, or Reverse_Find is a bounded error. The implementation may treat the element as having any normal value (see 13.9.1) of the element type, or raise Constraint_Error or Program_Error before modifying the vector.

Calling Merge in an instance of Generic_Sorting with either Source or Target not ordered smallest first using the provided generic formal "<" operator is a bounded error. Either Program_Error is raised after Target is updated as described for Merge, or the operation works as defined.

A Cursor value is *ambiguous* if any of the following have occurred since it was created:

- Insert, Insert_Space, or Delete has been called on the vector that contains the element the cursor designates with an index value (or a cursor designating an element at such an index value) less than or equal to the index value of the element designated by the cursor; or
- The vector that contains the element it designates has been passed to the Sort or Merge procedures of an instance of Generic_Sorting, or to the Reverse_Elements procedure.

It is a bounded error to call any subprogram other than "=" or Has_Element declared in Containers.Vectors with an ambiguous (but not invalid, see below) cursor parameter. Possible results are:

- The cursor may be treated as if it were No_Element;
- The cursor may designate some element in the vector (but not necessarily the element that it originally designated);
- Constraint_Error may be raised; or
- Program_Error may be raised.

Erroneous Execution

A Cursor value is *invalid* if any of the following have occurred since it was created:

- The vector that contains the element it designates has been finalized;
- The vector that contains the element it designates has been used as the Source or Target of a call to Move; or
- The element it designates has been deleted.

The result of "=" or Has_Element is unspecified if it is called with an invalid cursor parameter. Execution is erroneous if any other subprogram declared in Containers.Vectors is called with an invalid cursor parameter.

Implementation Requirements

No storage associated with a vector object shall be lost upon assignment or scope exit.

The execution of an **assignment_statement** for a vector shall have the effect of copying the elements from the source vector object to the target vector object.

Implementation Advice

Containers.Vectors should be implemented similarly to an array. In particular, if the length of a vector is N , then

- the worst-case time complexity of Element should be $O(\log N)$;
- the worst-case time complexity of Append with Count=1 when N is less than the capacity of the vector should be $O(\log N)$; and
- the worst-case time complexity of Prepend with Count=1 and Delete_First with Count=1 should be $O(N \log N)$.

The worst-case time complexity of a call on procedure Sort of an instance of Containers.Vectors.Generic_Sorting should be $O(N^2)$, and the average time complexity should be better than $O(N^2)$.

Containers.Vectors.Generic_Sorting.Sort and Containers.Vectors.Generic_Sorting.Merge should minimize copying of elements.

Move should not copy elements, and should minimize copying of internal data structures.

If an exception is propagated from a vector operation, no storage should be lost, nor any elements removed from a vector unless specified by the operation.

NOTES

41 All elements of a vector occupy locations in the internal array. If a sparse container is required, a Hashed_Map should be used rather than a vector.

42 If Index_Type'Base'First = Index_Type'First an instance of Ada.Containers.Vectors will raise Constraint_Error. A value below Index_Type'First is required so that an empty vector has a meaningful value of Last_Index.

A.18.3 The Package Containers.Doubly_Linked_Lists**Insert new clause:**

The language-defined generic package Containers.Doubly_Linked_Lists provides private types List and Cursor, and a set of operations for each type. A list container is optimized for insertion and deletion at any position.

A doubly-linked list container object manages a linked list of internal *nodes*, each of which contains an element and pointers to the next (successor) and previous (predecessor) internal nodes. A cursor designates a particular node within a list (and by extension the element contained in that node). A cursor keeps designating the same node (and element) as long as the node is part of the container, even if the node is moved in the container.

The *length* of a list is the number of elements it contains.

Static Semantics

The generic library package Containers.Doubly_Linked_Lists has the following declaration:

```

generic
  type Element_Type is private;
  with function "=" (Left, Right : Element_Type) return Boolean is <>;
package Ada.Containers.Doubly_Linked_Lists is
  pragma Preelaborate(Doubly_Linked_Lists);

  type List is tagged private;
  pragma Preelaborable_Initialization(List);

  type Cursor is private;
  pragma Preelaborable_Initialization(Cursor);

  Empty_List : constant List;

  No_Element : constant Cursor;

  function "=" (Left, Right : List) return Boolean;

  function Length (Container : List) return Count_Type;

  function Is_Empty (Container : List) return Boolean;

```

```

procedure Clear (Container : in out List);

function Element (Position : Cursor)
    return Element_Type;

procedure Replace_Element (Container : in out List;
                           Position  : in      Cursor;
                           New_Item  : in      Element_Type);

procedure Query_Element
    (Position : in Cursor;
     Process  : not null access procedure (Element : in Element_Type));

procedure Update_Element
    (Container : in out List;
     Position  : in      Cursor;
     Process   : not null access procedure
                (Element : in out Element_Type));

procedure Move (Target : in out List;
                Source : in out List);

procedure Insert (Container : in out List;
                  Before    : in      Cursor;
                  New_Item  : in      Element_Type;
                  Count     : in      Count_Type := 1);

procedure Insert (Container : in out List;
                  Before    : in      Cursor;
                  New_Item  : in      Element_Type;
                  Position  : out Cursor;
                  Count     : in      Count_Type := 1);

procedure Insert (Container : in out List;
                  Before    : in      Cursor;
                  Position  : out Cursor;
                  Count     : in      Count_Type := 1);

procedure Prepend (Container : in out List;
                   New_Item  : in      Element_Type;
                   Count     : in      Count_Type := 1);

procedure Append (Container : in out List;
                  New_Item  : in      Element_Type;
                  Count     : in      Count_Type := 1);

procedure Delete (Container : in out List;
                  Position  : in out Cursor;
                  Count     : in      Count_Type := 1);

procedure Delete_First (Container : in out List;
                        Count      : in      Count_Type := 1);

procedure Delete_Last (Container : in out List;
                       Count      : in      Count_Type := 1);

procedure Reverse_Elements (Container : in out List);

procedure Swap (Container : in out List;
                 I, J      : in      Cursor);

procedure Swap_Links (Container : in out List;
                     I, J      : in      Cursor);

procedure Splice (Target   : in out List;
                  Before    : in      Cursor;
                  Source    : in out List);

```

```

procedure Splice (Target   : in out List;
                  Before   : in     Cursor;
                  Source   : in out List;
                  Position : in out Cursor);

procedure Splice (Container: in out List;
                  Before   : in     Cursor;
                  Position : in     Cursor);

function First (Container : List) return Cursor;

function First_Element (Container : List)
  return Element_Type;

function Last (Container : List) return Cursor;

function Last_Element (Container : List)
  return Element_Type;

function Next (Position : Cursor) return Cursor;

procedure Next (Position : in out Cursor);

function Previous (Position : Cursor) return Cursor;

procedure Previous (Position : in out Cursor);

function Find (Container : List;
              Item       : Element_Type;
              Position   : Cursor := No_Element)
  return Cursor;

function Reverse_Find (Container : List;
                      Item       : Element_Type;
                      Position   : Cursor := No_Element)
  return Cursor;

function Contains (Container : List;
                  Item       : Element_Type) return Boolean;

function Has_Element (Position : Cursor) return Boolean;

procedure Iterate
  (Container : in List;
   Process   : not null access procedure (Position : in Cursor));

procedure Reverse_Iterate
  (Container : in List;
   Process   : not null access procedure (Position : in Cursor));

generic
  with function "<" (Left, Right : Element_Type)
  return Boolean is <>;
package Generic_Sorting is

  function Is_Sorted (Container : List) return Boolean;

  procedure Sort (Container : in out List);

  procedure Merge (Target : in out List;
                  Source  : in out List);

end Generic_Sorting;

private

  ... -- not specified by the language

end Ada.Containers.Doubly_Linked_Lists;

```

The actual function for the generic formal function "=" on Element_Type values is expected to define a reflexive and symmetric relationship and return the same result value each time it is called with a particular pair of values. If it behaves in some other manner, the functions Find, Reverse_Find, and "=" on list values return an unspecified value. The exact arguments and number of calls of this generic formal function by the functions Find, Reverse_Find, and "=" on list values are unspecified.

The type List is used to represent lists. The type List needs finalization (see 7.6).

Empty_List represents the empty List object. It has a length of 0. If an object of type List is not otherwise initialized, it is initialized to the same value as Empty_List.

No_Element represents a cursor that designates no element. If an object of type Cursor is not otherwise initialized, it is initialized to the same value as No_Element.

The predefined "=" operator for type Cursor returns True if both cursors are No_Element, or designate the same element in the same container.

Execution of the default implementation of the Input, Output, Read, or Write attribute of type Cursor raises Program_Error.

Some operations of this generic package have access-to-subprogram parameters. To ensure such operations are well-defined, they guard against certain actions by the designated subprogram. In particular, some operations check for "tampering with cursors" of a container because they depend on the set of elements of the container remaining constant, and others check for "tampering with elements" of a container because they depend on elements of the container not being replaced.

A subprogram is said to *tamper with cursors* of a list object *L* if:

- it inserts or deletes elements of *L*, that is, it calls the Insert, Clear, Delete, or Delete_Last procedures with *L* as a parameter; or
- it reorders the elements of *L*, that is, it calls the Splice, Swap_Links, or Reverse_Elements procedures or the Sort or Merge procedures of an instance of Generic_Sorting with *L* as a parameter; or
- it finalizes *L*; or
- it calls the Move procedure with *L* as a parameter.

A subprogram is said to *tamper with elements* of a list object *L* if:

- it tampers with cursors of *L*; or
- it replaces one or more elements of *L*, that is, it calls the Replace_Element or Swap procedures with *L* as a parameter.

function "=" (Left, Right : List) **return** Boolean;

If Left and Right denote the same list object, then the function returns True. If Left and Right have different lengths, then the function returns False. Otherwise, it compares each element in Left to the corresponding element in Right using the generic formal equality operator. If any such comparison returns False, the function returns False; otherwise it returns True. Any exception raised during evaluation of element equality is propagated.

function Length (Container : List) **return** Count_Type;

Returns the number of elements in Container.

function Is_Empty (Container : List) **return** Boolean;

Equivalent to Length (Container) = 0.

procedure Clear (Container : **in out** List);

Removes all the elements from Container.

function Element (Position : Cursor) **return** Element_Type;

If Position equals No_Element, then Constraint_Error is propagated. Otherwise, Element returns the element designated by Position.

```

procedure Replace_Element (Container : in out List;
                           Position : in Cursor;
                           New_Item : in Element_Type);

```

If Position equals No_Element, then Constraint_Error is propagated; if Position does not designate an element in Container, then Program_Error is propagated. Otherwise Replace_Element assigns the value New_Item to the element designated by Position.

```

procedure Query_Element
(Position : in Cursor;
 Process  : not null access procedure (Element : in Element_Type));

```

If Position equals No_Element, then Constraint_Error is propagated. Otherwise, Query_Element calls Process.all with the element designated by Position as the argument. Program_Error is propagated if Process.all tampers with the elements of Container. Any exception raised by Process.all is propagated.

```

procedure Update_Element
(Container : in out List;
 Position  : in Cursor;
 Process   : not null access procedure (Element : in out Element_Type));

```

If Position equals No_Element, then Constraint_Error is propagated; if Position does not designate an element in Container, then Program_Error is propagated. Otherwise Update_Element calls Process.all with the element designated by Position as the argument. Program_Error is propagated if Process.all tampers with the elements of Container. Any exception raised by Process.all is propagated.

If Element_Type is unconstrained and definite, then the actual Element parameter of Process.all shall be unconstrained.

```

procedure Move (Target : in out List;
                Source : in out List);

```

If Target denotes the same object as Source, then Move has no effect. Otherwise, Move first calls Clear (Target). Then, the nodes in Source are moved to Target (in the original order). The length of Target is set to the length of Source, and the length of Source is set to 0.

```

procedure Insert (Container : in out List;
                  Before    : in Cursor;
                  New_Item  : in Element_Type;
                  Count     : in Count_Type := 1);

```

If Before is not No_Element, and does not designate an element in Container, then Program_Error is propagated. Otherwise, Insert inserts Count copies of New_Item prior to the element designated by Before. If Before equals No_Element, the new elements are inserted after the last node (if any). Any exception raised during allocation of internal storage is propagated, and Container is not modified.

```

procedure Insert (Container : in out List;
                  Before    : in Cursor;
                  New_Item  : in Element_Type;
                  Position  : out Cursor;
                  Count     : in Count_Type := 1);

```

If Before is not No_Element, and does not designate an element in Container, then Program_Error is propagated. Otherwise, Insert allocates Count copies of New_Item, and inserts them prior to the element designated by Before. If Before equals No_Element, the new elements are inserted after the last element (if any). Position designates the first newly-inserted element. Any exception raised during allocation of internal storage is propagated, and Container is not modified.

```

procedure Insert (Container : in out List;
                  Before    : in Cursor;
                  Position  : out Cursor;
                  Count     : in Count_Type := 1);

```

If Before is not No_Element, and does not designate an element in Container, then Program_Error is propagated. Otherwise, Insert inserts Count new elements prior to the element designated by Before. If Before equals No_Element, the new elements are inserted after the last node (if any). The new elements are initialized by default (see 3.3.1). Any exception raised during allocation of internal storage is propagated, and Container is not modified.

```

procedure Prepend (Container : in out List;
                   New_Item  : in      Element_Type;
                   Count     : in      Count_Type := 1);

```

Equivalent to Insert (Container, First (Container), New_Item, Count).

```

procedure Append (Container : in out List;
                  New_Item  : in      Element_Type;
                  Count     : in      Count_Type := 1);

```

Equivalent to Insert (Container, No_Element, New_Item, Count).

```

procedure Delete (Container : in out List;
                  Position  : in out Cursor;
                  Count     : in      Count_Type := 1);

```

If Position equals No_Element, then Constraint_Error is propagated. If Position does not designate an element in Container, then Program_Error is propagated. Otherwise Delete removes (from Container) Count elements starting at the element designated by Position (or all of the elements starting at Position if there are fewer than Count elements starting at Position). Finally, Position is set to No_Element.

```

procedure Delete_First (Container : in out List;
                       Count      : in      Count_Type := 1);

```

Equivalent to Delete (Container, First (Container), Count).

```

procedure Delete_Last (Container : in out List;
                      Count      : in      Count_Type := 1);

```

If Length (Container) <= Count then Delete_Last is equivalent to Clear (Container). Otherwise it removes the last Count nodes from Container.

```

procedure Reverse_Elements (Container : in out List);

```

Reorders the elements of Container in reverse order.

```

procedure Swap (Container : in out List;
                I, J       : in      Cursor);

```

If either I or J is No_Element, then Constraint_Error is propagated. If either I or J do not designate an element in Container, then Program_Error is propagated. Otherwise, Swap exchanges the values of the elements designated by I and J.

```

procedure Swap_Links (Container : in out List;
                     I, J       : in      Cursor);

```

If either I or J is No_Element, then Constraint_Error is propagated. If either I or J do not designate an element in Container, then Program_Error is propagated. Otherwise, Swap_Links exchanges the nodes designated by I and J.

```

procedure Splice (Target   : in out List;
                  Before    : in      Cursor;
                  Source     : in out List);

```

If Before is not No_Element, and does not designate an element in Target, then Program_Error is propagated. Otherwise, if Source denotes the same object as Target, the operation has no effect. Otherwise, Splice reorders elements such that they are removed from Source and moved to Target, immediately prior to Before. If Before equals No_Element, the nodes of Source are spliced after the last node of Target. The length of Target is incremented by the number of nodes in Source, and the length of Source is set to 0.

```

procedure Splice (Target   : in out List;
                  Before    : in      Cursor;
                  Source     : in out List;
                  Position  : in out Cursor);

```

If Position is No_Element then Constraint_Error is propagated. If Before does not equal No_Element, and does not designate an element in Target, then Program_Error is propagated. If Position does not equal No_Element, and does not designate a node in Source, then Program_Error is propagated. If Source denotes the same object as Target, then there is no effect if Position equals Before, else the element designated by Position is moved immediately prior to Before, or, if Before equals No_Element, after the last element. In both cases, Position and the length of Target are unchanged. Otherwise the element designated by Position

is removed from Source and moved to Target, immediately prior to Before, or, if Before equals No_Element, after the last element of Target. The length of Target is incremented, the length of Source is decremented, and Position is updated to represent an element in Target.

```
procedure Splice (Container: in out List;
                 Before  : in   Cursor;
                 Position : in   Cursor);
```

If Position is No_Element then Constraint_Error is propagated. If Before does not equal No_Element, and does not designate an element in Container, then Program_Error is propagated. If Position does not equal No_Element, and does not designate a node in Container, then Program_Error is propagated. If Position equals Before there is no effect. Otherwise, the element designated by Position is moved immediately prior to Before, or, if Before equals No_Element, after the last element. The length of Container is unchanged.

```
function First (Container : List) return Cursor;
```

If Container is empty, First returns the value No_Element. Otherwise it returns a cursor that designates the first node in Container.

```
function First_Element (Container : List) return Element_Type;
```

Equivalent to Element (First (Container)).

```
function Last (Container : List) return Cursor;
```

If Container is empty, Last returns the value No_Element. Otherwise it returns a cursor that designates the last node in Container.

```
function Last_Element (Container : List) return Element_Type;
```

Equivalent to Element (Last (Container)).

```
function Next (Position : Cursor) return Cursor;
```

If Position equals No_Element or designates the last element of the container, then Next returns the value No_Element. Otherwise, it returns a cursor that designates the successor of the element designated by Position.

```
procedure Next (Position : in out Cursor);
```

Equivalent to Position := Next (Position).

```
function Previous (Position : Cursor) return Cursor;
```

If Position equals No_Element or designates the first element of the container, then Previous returns the value No_Element. Otherwise, it returns a cursor that designates the predecessor of the element designated by Position.

```
procedure Previous (Position : in out Cursor);
```

Equivalent to Position := Previous (Position).

```
function Find (Container : List;
              Item       : Element_Type;
              Position   : Cursor := No_Element)
return Cursor;
```

If Position is not No_Element, and does not designate an element in Container, then Program_Error is propagated. Find searches the elements of Container for an element equal to Item (using the generic formal equality operator). The search starts at the element designated by Position, or at the first element if Position equals No_Element. It proceeds towards Last (Container). If no equal element is found, then Find returns No_Element. Otherwise, it returns a cursor designating the first equal element encountered.

```
function Reverse_Find (Container : List;
                      Item       : Element_Type;
                      Position   : Cursor := No_Element)
return Cursor;
```

If Position is not No_Element, and does not designate an element in Container, then Program_Error is propagated. Find searches the elements of Container for an element equal to Item (using the generic formal equality operator). The search starts at the element designated by Position, or at the last element if Position

equals No_Element. It proceeds towards First (Container). If no equal element is found, then Reverse_Find returns No_Element. Otherwise, it returns a cursor designating the first equal element encountered.

```
function Contains (Container : List;
                  Item      : Element_Type) return Boolean;
```

Equivalent to Find (Container, Item) /= No_Element.

```
function Has_Element (Position : Cursor) return Boolean;
```

Returns True if Position designates an element, and returns False otherwise.

```
procedure Iterate
(Container : in List;
 Process   : not null access procedure (Position : in Cursor));
```

Iterate calls Process.all with a cursor that designates each node in Container, starting with the first node and moving the cursor as per the Next function. Program_Error is propagated if Process.all tampers with the cursors of Container. Any exception raised by Process.all is propagated.

```
procedure Reverse_Iterate
(Container : in List;
 Process   : not null access procedure (Position : in Cursor));
```

Iterates over the nodes in Container as per Iterate, except that elements are traversed in reverse order, starting with the last node and moving the cursor as per the Previous function.

The actual function for the generic formal function "<" of Generic_Sorting is expected to return the same value each time it is called with a particular pair of element values. It should define a strict ordering relationship, that is, be irreflexive, asymmetric, and transitive; it should not modify Container. If the actual for "<" behaves in some other manner, the behavior of the subprograms of Generic_Sorting are unspecified. How many times the subprograms of Generic_Sorting call "<" is unspecified.

```
function Is_Sorted (Container : List) return Boolean;
```

Returns True if the elements are sorted smallest first as determined by the generic formal "<" operator; otherwise, Is_Sorted returns False. Any exception raised during evaluation of "<" is propagated.

```
procedure Sort (Container : in out List);
```

Reorders the nodes of Container such that the elements are sorted smallest first as determined by the generic formal "<" operator provided. The sort is stable. Any exception raised during evaluation of "<" is propagated.

```
procedure Merge (Target : in out List;
                 Source  : in out List);
```

Merge removes elements from Source and inserts them into Target; afterwards, Target contains the union of the elements that were initially in Source and Target; Source is left empty. If Target and Source are initially sorted smallest first, then Target is ordered smallest first as determined by the generic formal "<" operator; otherwise, the order of elements in Target is unspecified. Any exception raised during evaluation of "<" is propagated.

Bounded (Run-Time) Errors

Calling Merge in an instance of Generic_Sorting with either Source or Target not ordered smallest first using the provided generic formal "<" operator is a bounded error. Either Program_Error is raised after Target is updated as described for Merge, or the operation works as defined.

Erroneous Execution

A Cursor value is *invalid* if any of the following have occurred since it was created:

- The list that contains the element it designates has been finalized;
- The list that contains the element it designates has been used as the Source or Target of a call to Move; or
- The element it designates has been deleted.

The result of "=" or Has_Element is unspecified if it is called with an invalid cursor parameter. Execution is erroneous if any other subprogram declared in Containers.Doubly_Linked_Lists is called with an invalid cursor parameter.

Implementation Requirements

No storage associated with a doubly-linked List object shall be lost upon assignment or scope exit.

The execution of an **assignment_statement** for a list shall have the effect of copying the elements from the source list object to the target list object.

Implementation Advice

Containers.Doubly_Linked_Lists should be implemented similarly to a linked list. In particular, if N is the length of a list, then the worst-case time complexity of Element, Insert with Count=1, and Delete with Count=1 should be $O(\log N)$.

The worst-case time complexity of a call on procedure Sort of an instance of Containers.Doubly_Linked_Lists.Generic_Sorting should be $O(N^{**2})$, and the average time complexity should be better than $O(N^{**2})$.

Move should not copy elements, and should minimize copying of internal data structures.

If an exception is propagated from a list operation, no storage should be lost, nor any elements removed from a list unless specified by the operation.

NOTES

43 Sorting a list never copies elements, and is a stable sort (equal elements remain in the original order). This is different than sorting an array or vector, which may need to copy elements, and is probably not a stable sort.

A.18.4 Maps

Insert new clause:

The language-defined generic packages Containers.Hashtable and Containers.Ordered_Map provide private types Map and Cursor, and a set of operations for each type. A map container allows an arbitrary type to be used as a key to find the element associated with that key. A hashed map uses a hash function to organize the keys, while an ordered map orders the keys per a specified relation.

This section describes the declarations that are common to both kinds of maps. See A.18.5 for a description of the semantics specific to Containers.Hashtable and A.18.6 for a description of the semantics specific to Containers.Ordered_Map.

Static Semantics

The actual function for the generic formal function "=" on Element_Type values is expected to define a reflexive and symmetric relationship and return the same result value each time it is called with a particular pair of values. If it behaves in some other manner, the function "=" on map values returns an unspecified value. The exact arguments and number of calls of this generic formal function by the function "=" on map values are unspecified.

The type Map is used to represent maps. The type Map needs finalization (see 7.6).

A map contains pairs of keys and elements, called *nodes*. Map cursors designate nodes, but also can be thought of as designating an element (the element contained in the node) for consistency with the other containers. There exists an equivalence relation on keys, whose definition is different for hashed maps and ordered maps. A map never contains two or more nodes with equivalent keys. The *length* of a map is the number of nodes it contains.

Each nonempty map has two particular nodes called the *first node* and the *last node* (which may be the same). Each node except for the last node has a *successor node*. If there are no other intervening operations, starting with the first node and repeatedly going to the successor node will visit each node in the map exactly once until the last node is reached. The exact definition of these terms is different for hashed maps and ordered maps.

Some operations of these generic packages have access-to-subprogram parameters. To ensure such operations are well-defined, they guard against certain actions by the designated subprogram. In particular, some operations check for "tampering with cursors" of a container because they depend on the set of elements of the container remaining

constant, and others check for "tampering with elements" of a container because they depend on elements of the container not being replaced.

A subprogram is said to *tamper with cursors* of a map object *M* if:

- it inserts or deletes elements of *M*, that is, it calls the Insert, Include, Clear, Delete, or Exclude procedures with *M* as a parameter; or
- it finalizes *M*; or
- it calls the Move procedure with *M* as a parameter; or
- it calls one of the operations defined to tamper with the cursors of *M*.

A subprogram is said to *tamper with elements* of a map object *M* if:

- it tampers with cursors of *M*; or
- it replaces one or more elements of *M*, that is, it calls the Replace or Replace_Element procedures with *M* as a parameter.

Empty_Map represents the empty Map object. It has a length of 0. If an object of type Map is not otherwise initialized, it is initialized to the same value as Empty_Map.

No_Element represents a cursor that designates no node. If an object of type Cursor is not otherwise initialized, it is initialized to the same value as No_Element.

The predefined "=" operator for type Cursor returns True if both cursors are No_Element, or designate the same element in the same container.

Execution of the default implementation of the Input, Output, Read, or Write attribute of type Cursor raises Program_Error.

```
function "=" (Left, Right : Map) return Boolean;
```

If Left and Right denote the same map object, then the function returns True. If Left and Right have different lengths, then the function returns False. Otherwise, for each key *K* in Left, the function returns False if:

- a key equivalent to *K* is not present in Right; or
- the element associated with *K* in Left is not equal to the element associated with *K* in Right (using the generic formal equality operator for elements).

If the function has not returned a result after checking all of the keys, it returns True. Any exception raised during evaluation of key equivalence or element equality is propagated.

```
function Length (Container : Map) return Count_Type;
```

Returns the number of nodes in Container.

```
function Is_Empty (Container : Map) return Boolean;
```

Equivalent to Length (Container) = 0.

```
procedure Clear (Container : in out Map);
```

Removes all the nodes from Container.

```
function Key (Position : Cursor) return Key_Type;
```

If Position equals No_Element, then Constraint_Error is propagated. Otherwise, Key returns the key component of the node designated by Position.

```
function Element (Position : Cursor) return Element_Type;
```

If Position equals No_Element, then Constraint_Error is propagated. Otherwise, Element returns the element component of the node designated by Position.

```
procedure Replace_Element (Container : in out Map;
                           Position : in Cursor;
                           New_Item : in Element_Type);
```

If Position equals No_Element, then Constraint_Error is propagated; if Position does not designate an element in Container, then Program_Error is propagated. Otherwise Replace_Element assigns New_Item to the element of the node designated by Position.

```
procedure Query_Element
(Position : in Cursor;
 Process  : not null access procedure (Key      : in Key_Type;
                                       Element  : in Element_Type));
```

If Position equals No_Element, then Constraint_Error is propagated. Otherwise, Query_Element calls Process.all with the key and element from the node designated by Position as the arguments. Program_Error is propagated if Process.all tampers with the elements of Container. Any exception raised by Process.all is propagated.

```
procedure Update_Element
(Container : in out Map;
 Position  : in      Cursor;
 Process   : not null access procedure (Key      : in      Key_Type;
                                       Element  : in out Element_Type));
```

If Position equals No_Element, then Constraint_Error is propagated; if Position does not designate an element in Container, then Program_Error is propagated. Otherwise Update_Element calls Process.all with the key and element from the node designated by Position as the arguments. Program_Error is propagated if Process.all tampers with the elements of Container. Any exception raised by Process.all is propagated.

If Element_Type is unconstrained and definite, then the actual Element parameter of Process.all shall be unconstrained.

```
procedure Move (Target : in out Map;
                Source : in out Map);
```

If Target denotes the same object as Source, then Move has no effect. Otherwise, Move first calls Clear (Target). Then, each node from Source is removed from Source and inserted into Target. The length of Source is 0 after a successful call to Move.

```
procedure Insert (Container : in out Map;
                  Key       : in      Key_Type;
                  New_Item  : in      Element_Type;
                  Position  : out     Cursor;
                  Inserted  : out     Boolean);
```

Insert checks if a node with a key equivalent to Key is already present in Container. If a match is found, Inserted is set to False and Position designates the element with the matching key. Otherwise, Insert allocates a new node, initializes it to Key and New_Item, and adds it to Container; Inserted is set to True and Position designates the newly-inserted node. Any exception raised during allocation is propagated and Container is not modified.

```
procedure Insert (Container : in out Map;
                  Key       : in      Key_Type;
                  Position  : out     Cursor;
                  Inserted  : out     Boolean);
```

Insert inserts Key into Container as per the five-parameter Insert, with the difference that an element initialized by default (see 3.3.1) is inserted.

```
procedure Insert (Container : in out Map;
                  Key       : in      Key_Type;
                  New_Item  : in      Element_Type);
```

Insert inserts Key and New_Item into Container as per the five-parameter Insert, with the difference that if a node with a key equivalent to Key is already in the map, then Constraint_Error is propagated.

```
procedure Include (Container : in out Map;
                  Key       : in      Key_Type;
                  New_Item  : in      Element_Type);
```

Include inserts Key and New_Item into Container as per the five-parameter Insert, with the difference that if a node with a key equivalent to Key is already in the map, then this operation assigns Key and New_Item to the matching node. Any exception raised during assignment is propagated.

```

procedure Replace (Container : in out Map;
                   Key       : in     Key_Type;
                   New_Item  : in     Element_Type);

```

Replace checks if a node with a key equivalent to Key is present in Container. If a match is found, Replace assigns Key and New_Item to the matching node; otherwise, Constraint_Error is propagated.

```

procedure Exclude (Container : in out Map;
                   Key       : in     Key_Type);

```

Exclude checks if a node with a key equivalent to Key is present in Container. If a match is found, Exclude removes the node from the map.

```

procedure Delete (Container : in out Map;
                   Key       : in     Key_Type);

```

Delete checks if a node with a key equivalent to Key is present in Container. If a match is found, Delete removes the node from the map; otherwise, Constraint_Error is propagated.

```

procedure Delete (Container : in out Map;
                   Position  : in out Cursor);

```

If Position equals No_Element, then Constraint_Error is propagated. If Position does not designate an element in Container, then Program_Error is propagated. Otherwise, Delete removes the node designated by Position from the map. Position is set to No_Element on return.

```

function First (Container : Map) return Cursor;

```

If Length (Container) = 0, then First returns No_Element. Otherwise, First returns a cursor that designates the first node in Container.

```

function Next (Position  : Cursor) return Cursor;

```

Returns a cursor that designates the successor of the node designated by Position. If Position designates the last node, then No_Element is returned. If Position equals No_Element, then No_Element is returned.

```

procedure Next (Position  : in out Cursor);

```

Equivalent to Position := Next (Position).

```

function Find (Container : Map;
               Key       : Key_Type) return Cursor;

```

If Length (Container) equals 0, then Find returns No_Element. Otherwise, Find checks if a node with a key equivalent to Key is present in Container. If a match is found, a cursor designating the matching node is returned; otherwise, No_Element is returned.

```

function Element (Container : Map;
                  Key       : Key_Type) return Element_Type;

```

Equivalent to Element (Find (Container, Key)).

```

function Contains (Container : Map;
                  Key       : Key_Type) return Boolean;

```

Equivalent to Find (Container, Key) /= No_Element.

```

function Has_Element (Position : Cursor) return Boolean;

```

Returns True if Position designates a node, and returns False otherwise.

```

procedure Iterate
(Container : in Map;
 Process  : not null access procedure (Position : in Cursor));

```

Iterate calls Process.all with a cursor that designates each node in Container, starting with the first node and moving the cursor according to the successor relation. Program_Error is propagated if Process.all tampers with the cursors of Container. Any exception raised by Process.all is propagated.

Erroneous Execution

A Cursor value is *invalid* if any of the following have occurred since it was created:

- The map that contains the node it designates has been finalized;

- The map that contains the node it designates has been used as the Source or Target of a call to Move; or
- The node it designates has been deleted from the map.

The result of "=" or Has_Element is unspecified if these functions are called with an invalid cursor parameter. Execution is erroneous if any other subprogram declared in Containers.Hashing_Maps or Containers.Ordered_Maps is called with an invalid cursor parameter.

Implementation Requirements

No storage associated with a Map object shall be lost upon assignment or scope exit.

The execution of an assignment_statement for a map shall have the effect of copying the elements from the source map object to the target map object.

Implementation Advice

Move should not copy elements, and should minimize copying of internal data structures.

If an exception is propagated from a map operation, no storage should be lost, nor any elements removed from a map unless specified by the operation.

A.18.5 The Package Containers.Hashing_Maps

Insert new clause:

Static Semantics

The generic library package Containers.Hashing_Maps has the following declaration:

```

generic
  type Key_Type is private;
  type Element_Type is private;
  with function Hash (Key : Key_Type) return Hash_Type;
  with function Equivalent_Keys (Left, Right : Key_Type)
    return Boolean;
  with function "=" (Left, Right : Element_Type)
    return Boolean is <>;
package Ada.Containers.Hashing_Maps is
  pragma Preelaborate (Hashing_Maps);

  type Map is tagged private;
  pragma Preelaborable_Initialization (Map);

  type Cursor is private;
  pragma Preelaborable_Initialization (Cursor);

  Empty_Map : constant Map;

  No_Element : constant Cursor;

  function "=" (Left, Right : Map) return Boolean;

  function Capacity (Container : Map) return Count_Type;

  procedure Reserve_Capacity (Container : in out Map;
    Capacity : in Count_Type);

  function Length (Container : Map) return Count_Type;

  function Is_Empty (Container : Map) return Boolean;

  procedure Clear (Container : in out Map);

  function Key (Position : Cursor) return Key_Type;

  function Element (Position : Cursor) return Element_Type;

  procedure Replace_Element (Container : in out Map;
    Position : in Cursor);

```

```

        New_Item : in      Element_Type);

procedure Query_Element
(Position : in Cursor;
 Process  : not null access procedure (Key      : in Key_Type;
                                       Element   : in Element_Type));

procedure Update_Element
(Container : in out Map;
 Position  : in      Cursor;
 Process   : not null access procedure
           (Key      : in      Key_Type;
            Element  : in out Element_Type));

procedure Move (Target : in out Map;
                Source : in out Map);

procedure Insert (Container : in out Map;
                  Key        : in      Key_Type;
                  New_Item   : in      Element_Type;
                  Position   : out     Cursor;
                  Inserted   : out     Boolean);

procedure Insert (Container : in out Map;
                  Key        : in      Key_Type;
                  Position   : out     Cursor;
                  Inserted   : out     Boolean);

procedure Insert (Container : in out Map;
                  Key        : in      Key_Type;
                  New_Item   : in      Element_Type);

procedure Include (Container : in out Map;
                   Key        : in      Key_Type;
                   New_Item   : in      Element_Type);

procedure Replace (Container : in out Map;
                   Key        : in      Key_Type;
                   New_Item   : in      Element_Type);

procedure Exclude (Container : in out Map;
                   Key        : in      Key_Type);

procedure Delete (Container : in out Map;
                  Key        : in      Key_Type);

procedure Delete (Container : in out Map;
                  Position  : in out Cursor);

function First (Container : Map)
return Cursor;

function Next (Position  : Cursor) return Cursor;

procedure Next (Position  : in out Cursor);

function Find (Container : Map;
               Key        : Key_Type)
return Cursor;

function Element (Container : Map;
                  Key        : Key_Type)
return Element_Type;

function Contains (Container : Map;
                  Key        : Key_Type) return Boolean;

function Has_Element (Position : Cursor) return Boolean;

```

```

function Equivalent_Keys (Left, Right : Cursor)
  return Boolean;

function Equivalent_Keys (Left  : Cursor;
                          Right : Key_Type)
  return Boolean;

function Equivalent_Keys (Left  : Key_Type;
                          Right : Cursor)
  return Boolean;

procedure Iterate
  (Container : in Map;
   Process   : not null access procedure (Position : in Cursor));

private

  ... -- not specified by the language

end Ada.Containers.Hashed_Maps;

```

An object of type Map contains an expandable hash table, which is used to provide direct access to nodes. The *capacity* of an object of type Map is the maximum number of nodes that can be inserted into the hash table prior to it being automatically expanded.

Two keys $K1$ and $K2$ are defined to be *equivalent* if Equivalent_Keys ($K1$, $K2$) returns True.

The actual function for the generic formal function Hash is expected to return the same value each time it is called with a particular key value. For any two equivalent key values, the actual for Hash is expected to return the same value. If the actual for Hash behaves in some other manner, the behavior of this package is unspecified. Which subprograms of this package call Hash, and how many times they call it, is unspecified.

The actual function for the generic formal function Equivalent_Keys on Key_Type values is expected to return the same value each time it is called with a particular pair of key values. It should define an equivalence relationship, that is, be reflexive, symmetric, and transitive. If the actual for Equivalent_Keys behaves in some other manner, the behavior of this package is unspecified. Which subprograms of this package call Equivalent_Keys, and how many times they call it, is unspecified.

If the value of a key stored in a node of a map is changed other than by an operation in this package such that at least one of Hash or Equivalent_Keys give different results, the behavior of this package is unspecified.

Which nodes are the first node and the last node of a map, and which node is the successor of a given node, are unspecified, other than the general semantics described in A.18.4.

```

function Capacity (Container : Map) return Count_Type;

```

Returns the capacity of Container.

```

procedure Reserve_Capacity (Container : in out Map;
                           Capacity  : in      Count_Type);

```

Reserve_Capacity allocates a new hash table such that the length of the resulting map can become at least the value Capacity without requiring an additional call to Reserve_Capacity, and is large enough to hold the current length of Container. Reserve_Capacity then rehashes the nodes in Container onto the new hash table. It replaces the old hash table with the new hash table, and then deallocates the old hash table. Any exception raised during allocation is propagated and Container is not modified.

Reserve_Capacity tampers with the cursors of Container.

```

procedure Clear (Container : in out Map);

```

In addition to the semantics described in A.18.4, Clear does not affect the capacity of Container.

```

procedure Insert (Container : in out Map;
                  Key       : in      Key_Type;
                  New_Item  : in      Element_Type;
                  Position  : out     Cursor;
                  Inserted  : out     Boolean);

```

In addition to the semantics described in A.18.4, if Length (Container) equals Capacity (Container), then Insert first calls Reserve_Capacity to increase the capacity of Container to some larger value.

```
function Equivalent_Keys (Left, Right : Cursor)
    return Boolean;
```

Equivalent to Equivalent_Keys (Key (Left), Key (Right)).

```
function Equivalent_Keys (Left  : Cursor;
                        Right : Key_Type) return Boolean;
```

Equivalent to Equivalent_Keys (Key (Left), Right).

```
function Equivalent_Keys (Left  : Key_Type;
                        Right : Cursor) return Boolean;
```

Equivalent to Equivalent_Keys (Left, Key (Right)).

Implementation Advice

If N is the length of a map, the average time complexity of the subprograms Element, Insert, Include, Replace, Delete, Exclude and Find that take a key parameter should be $O(\log N)$. The average time complexity of the subprograms that take a cursor parameter should be $O(1)$. The average time complexity of Reserve_Capacity should be $O(N)$.

A.18.6 The Package Containers.Ordered_Maps

Insert new clause:

Static Semantics

The generic library package Containers.Ordered_Maps has the following declaration:

```
generic
    type Key_Type is private;
    type Element_Type is private;
    with function "<" (Left, Right : Key_Type) return Boolean is <>;
    with function "=" (Left, Right : Element_Type) return Boolean is <>;
package Ada.Containers.Ordered_Maps is
    pragma Preelaborate(Ordered_Maps);

    function Equivalent_Keys (Left, Right : Key_Type) return Boolean;

    type Map is tagged private;
    pragma Preelaborable_Initialization(Map);

    type Cursor is private;
    pragma Preelaborable_Initialization(Cursor);

    Empty_Map : constant Map;

    No_Element : constant Cursor;

    function "=" (Left, Right : Map) return Boolean;

    function Length (Container : Map) return Count_Type;

    function Is_Empty (Container : Map) return Boolean;

    procedure Clear (Container : in out Map);

    function Key (Position : Cursor) return Key_Type;

    function Element (Position : Cursor) return Element_Type;

    procedure Replace_Element (Container : in out Map;
                            Position : in Cursor;
                            New_Item : in Element_Type);

    procedure Query_Element
```

```

(Position : in Cursor;
 Process  : not null access procedure (Key      : in Key_Type;
                                       Element  : in Element_Type));

procedure Update_Element
(Container : in out Map;
 Position  : in      Cursor;
 Process   : not null access procedure
           (Key      : in      Key_Type;
            Element  : in out Element_Type));

procedure Move (Target : in out Map;
                Source : in out Map);

procedure Insert (Container : in out Map;
                  Key       : in      Key_Type;
                  New_Item  : in      Element_Type;
                  Position  : out     Cursor;
                  Inserted  : out     Boolean);

procedure Insert (Container : in out Map;
                  Key       : in      Key_Type;
                  Position  : out     Cursor;
                  Inserted  : out     Boolean);

procedure Insert (Container : in out Map;
                  Key       : in      Key_Type;
                  New_Item  : in      Element_Type);

procedure Include (Container : in out Map;
                   Key       : in      Key_Type;
                   New_Item  : in      Element_Type);

procedure Replace (Container : in out Map;
                   Key       : in      Key_Type;
                   New_Item  : in      Element_Type);

procedure Exclude (Container : in out Map;
                   Key       : in      Key_Type);

procedure Delete (Container : in out Map;
                  Key       : in      Key_Type);

procedure Delete (Container : in out Map;
                  Position  : in out Cursor);

procedure Delete_First (Container : in out Map);

procedure Delete_Last (Container : in out Map);

function First (Container : Map) return Cursor;

function First_Element (Container : Map) return Element_Type;

function First_Key (Container : Map) return Key_Type;

function Last (Container : Map) return Cursor;

function Last_Element (Container : Map) return Element_Type;

function Last_Key (Container : Map) return Key_Type;

function Next (Position : Cursor) return Cursor;

procedure Next (Position : in out Cursor);

function Previous (Position : Cursor) return Cursor;

procedure Previous (Position : in out Cursor);

```

```

function Find (Container : Map;
               Key       : Key_Type) return Cursor;

function Element (Container : Map;
                  Key       : Key_Type) return Element_Type;

function Floor (Container : Map;
                Key       : Key_Type) return Cursor;

function Ceiling (Container : Map;
                  Key       : Key_Type) return Cursor;

function Contains (Container : Map;
                  Key       : Key_Type) return Boolean;

function Has_Element (Position : Cursor) return Boolean;

function "<" (Left, Right : Cursor) return Boolean;

function ">" (Left, Right : Cursor) return Boolean;

function "<" (Left : Cursor; Right : Key_Type) return Boolean;

function ">" (Left : Cursor; Right : Key_Type) return Boolean;

function "<" (Left : Key_Type; Right : Cursor) return Boolean;

function ">" (Left : Key_Type; Right : Cursor) return Boolean;

procedure Iterate
  (Container : in Map;
   Process   : not null access procedure (Position : in Cursor));

procedure Reverse_Iterate
  (Container : in Map;
   Process   : not null access procedure (Position : in Cursor));

private

  ... -- not specified by the language

end Ada.Containers.Ordered_Maps;

```

Two keys $K1$ and $K2$ are *equivalent* if both $K1 < K2$ and $K2 < K1$ return False, using the generic formal "<" operator for keys. Function `Equivalent_Keys` returns True if Left and Right are equivalent, and False otherwise.

The actual function for the generic formal function "<" on Key_Type values is expected to return the same value each time it is called with a particular pair of key values. It should define a strict ordering relationship, that is, be irreflexive, asymmetric, and transitive. If the actual for "<" behaves in some other manner, the behavior of this package is unspecified. Which subprograms of this package call "<" and how many times they call it, is unspecified.

If the value of a key stored in a map is changed other than by an operation in this package such that at least one of "<" or "=" give different results, the behavior of this package is unspecified.

The first node of a nonempty map is the one whose key is less than the key of all the other nodes in the map. The last node of a nonempty map is the one whose key is greater than the key of all the other elements in the map. The successor of a node is the node with the smallest key that is larger than the key of the given node. The predecessor of a node is the node with the largest key that is smaller than the key of the given node. All comparisons are done using the generic formal "<" operator for keys.

```

procedure Delete_First (Container : in out Map);

```

If Container is empty, Delete_First has no effect. Otherwise the node designated by First (Container) is removed from Container. Delete_First tampers with the cursors of Container.

```

procedure Delete_Last (Container : in out Map);

```

If Container is empty, Delete_Last has no effect. Otherwise the node designated by Last (Container) is removed from Container. Delete_Last tampers with the cursors of Container.

function First_Element (Container : Map) **return** Element_Type;

Equivalent to Element (First (Container)).

function First_Key (Container : Map) **return** Key_Type;

Equivalent to Key (First (Container)).

function Last (Container : Map) **return** Cursor;

Returns a cursor that designates the last node in Container. If Container is empty, returns No_Element.

function Last_Element (Container : Map) **return** Element_Type;

Equivalent to Element (Last (Container)).

function Last_Key (Container : Map) **return** Key_Type;

Equivalent to Key (Last (Container)).

function Previous (Position : Cursor) **return** Cursor;

If Position equals No_Element, then Previous returns No_Element. Otherwise Previous returns a cursor designating the node that precedes the one designated by Position. If Position designates the first element, then Previous returns No_Element.

procedure Previous (Position : **in out** Cursor);

Equivalent to Position := Previous (Position).

function Floor (Container : Map;
Key : Key_Type) **return** Cursor;

Floor searches for the last node whose key is not greater than Key, using the generic formal "<" operator for keys. If such a node is found, a cursor that designates it is returned. Otherwise No_Element is returned.

function Ceiling (Container : Map;
Key : Key_Type) **return** Cursor;

Ceiling searches for the first node whose key is not less than Key, using the generic formal "<" operator for keys. If such a node is found, a cursor that designates it is returned. Otherwise No_Element is returned.

function "<" (Left, Right : Cursor) **return** Boolean;

Equivalent to Key (Left) < Key (Right).

function ">" (Left, Right : Cursor) **return** Boolean;

Equivalent to Key (Right) < Key (Left).

function "<" (Left : Cursor; Right : Key_Type) **return** Boolean;

Equivalent to Key (Left) < Right.

function ">" (Left : Cursor; Right : Key_Type) **return** Boolean;

Equivalent to Right < Key (Left).

function "<" (Left : Key_Type; Right : Cursor) **return** Boolean;

Equivalent to Left < Key (Right).

function ">" (Left : Key_Type; Right : Cursor) **return** Boolean;

Equivalent to Key (Right) < Left.

procedure Reverse_Iterate
(Container : **in** Map;
Process : **not null access procedure** (Position : **in** Cursor));

Iterates over the nodes in Container as per Iterate, with the difference that the nodes are traversed in predecessor order, starting with the last node.

Implementation Advice

If N is the length of a map, then the worst-case time complexity of the Element, Insert, Include, Replace, Delete, Exclude and Find operations that take a key parameter should be $O((\log N)^2)$ or better. The worst-case time complexity of the subprograms that take a cursor parameter should be $O(1)$.

A.18.7 Sets**Insert new clause:**

The language-defined generic packages Containers.Hashing_Sets and Containers.Ordered_Sets provide private types Set and Cursor, and a set of operations for each type. A set container allows elements of an arbitrary type to be stored without duplication. A hashed set uses a hash function to organize elements, while an ordered set orders its element per a specified relation.

This section describes the declarations that are common to both kinds of sets. See A.18.8 for a description of the semantics specific to Containers.Hashing_Sets and A.18.9 for a description of the semantics specific to Containers.Ordered_Sets.

Static Semantics

The actual function for the generic formal function "=" on Element_Type values is expected to define a reflexive and symmetric relationship and return the same result value each time it is called with a particular pair of values. If it behaves in some other manner, the function "=" on set values returns an unspecified value. The exact arguments and number of calls of this generic formal function by the function "=" on set values are unspecified.

The type Set is used to represent sets. The type Set needs finalization (see 7.6).

A set contains elements. Set cursors designate elements. There exists an equivalence relation on elements, whose definition is different for hashed sets and ordered sets. A set never contains two or more equivalent elements. The *length* of a set is the number of elements it contains.

Each nonempty set has two particular elements called the *first element* and the *last element* (which may be the same). Each element except for the last element has a *successor element*. If there are no other intervening operations, starting with the first element and repeatedly going to the successor element will visit each element in the set exactly once until the last element is reached. The exact definition of these terms is different for hashed sets and ordered sets.

Some operations of these generic packages have access-to-subprogram parameters. To ensure such operations are well-defined, they guard against certain actions by the designated subprogram. In particular, some operations check for "tampering with cursors" of a container because they depend on the set of elements of the container remaining constant, and others check for "tampering with elements" of a container because they depend on elements of the container not being replaced.

A subprogram is said to *tamper with cursors* of a set object S if:

- it inserts or deletes elements of S , that is, it calls the Insert, Include, Clear, Delete, Exclude, or Replace_Element procedures with S as a parameter; or
- it finalizes S ; or
- it calls the Move procedure with S as a parameter; or
- it calls one of the operations defined to tamper with cursors of S .

A subprogram is said to *tamper with elements* of a set object S if:

- it tampers with cursors of S .

Empty_Set represents the empty Set object. It has a length of 0. If an object of type Set is not otherwise initialized, it is initialized to the same value as Empty_Set.

No_Element represents a cursor that designates no element. If an object of type Cursor is not otherwise initialized, it is initialized to the same value as No_Element.

The predefined "=" operator for type Cursor returns True if both cursors are No_Element, or designate the same element in the same container.

Execution of the default implementation of the Input, Output, Read, or Write attribute of type Cursor raises Program_Error.

function "=" (Left, Right : Set) **return** Boolean;

If Left and Right denote the same set object, then the function returns True. If Left and Right have different lengths, then the function returns False. Otherwise, for each element *E* in Left, the function returns False if an element equal to *E* (using the generic formal equality operator) is not present in Right. If the function has not returned a result after checking all of the elements, it returns True. Any exception raised during evaluation of element equality is propagated.

function Equivalent_Sets (Left, Right : Set) **return** Boolean;

If Left and Right denote the same set object, then the function returns True. If Left and Right have different lengths, then the function returns False. Otherwise, for each element *E* in Left, the function returns False if an element equivalent to *E* is not present in Right. If the function has not returned a result after checking all of the elements, it returns True. Any exception raised during evaluation of element equivalence is propagated.

function To_Set (New_Item : Element_Type) **return** Set;

Returns a set containing the single element New_Item.

function Length (Container : Set) **return** Count_Type;

Returns the number of elements in Container.

function Is_Empty (Container : Set) **return** Boolean;

Equivalent to Length (Container) = 0.

procedure Clear (Container : **in out** Set);

Removes all the elements from Container.

function Element (Position : Cursor) **return** Element_Type;

If Position equals No_Element, then Constraint_Error is propagated. Otherwise, Element returns the element designated by Position.

procedure Replace_Element (Container : **in out** Set;
 Position : **in** Cursor;
 New_Item : **in** Element_Type);

If Position equals No_Element, then Constraint_Error is propagated; if Position does not designate an element in Container, then Program_Error is propagated. If an element equivalent to New_Item is already present in Container at a position other than Position, Program_Error is propagated. Otherwise, Replace_Element assigns New_Item to the element designated by Position. Any exception raised by the assignment is propagated.

procedure Query_Element
 (Position : **in** Cursor;
 Process : **not null access procedure** (Element : **in** Element_Type));

If Position equals No_Element, then Constraint_Error is propagated. Otherwise, Query_Element calls Process.all with the element designated by Position as the argument. Program_Error is propagated if Process.all tampers with the elements of Container. Any exception raised by Process.all is propagated.

procedure Move (Target : **in out** Set;
 Source : **in out** Set);

If Target denotes the same object as Source, then Move has no effect. Otherwise, Move first clears Target. Then, each element from Source is removed from Source and inserted into Target. The length of Source is 0 after a successful call to Move.

procedure Insert (Container : **in out** Set;
 New_Item : **in** Element_Type;
 Position : **out** Cursor;
 Inserted : **out** Boolean);

Insert checks if an element equivalent to New_Item is already present in Container. If a match is found, Inserted is set to False and Position designates the matching element. Otherwise, Insert adds New_Item to

Container; Inserted is set to True and Position designates the newly-inserted element. Any exception raised during allocation is propagated and Container is not modified.

```
procedure Insert (Container : in out Set;
                  New_Item  : in      Element_Type);
```

Insert inserts New_Item into Container as per the four-parameter Insert, with the difference that if an element equivalent to New_Item is already in the set, then Constraint_Error is propagated.

```
procedure Include (Container : in out Set;
                  New_Item  : in      Element_Type);
```

Include inserts New_Item into Container as per the four-parameter Insert, with the difference that if an element equivalent to New_Item is already in the set, then it is replaced. Any exception raised during assignment is propagated.

```
procedure Replace (Container : in out Set;
                  New_Item  : in      Element_Type);
```

Replace checks if an element equivalent to New_Item is already in the set. If a match is found, that element is replaced with New_Item; otherwise, Constraint_Error is propagated.

```
procedure Exclude (Container : in out Set;
                  Item       : in      Element_Type);
```

Exclude checks if an element equivalent to Item is present in Container. If a match is found, Exclude removes the element from the set.

```
procedure Delete (Container : in out Set;
                  Item       : in      Element_Type);
```

Delete checks if an element equivalent to Item is present in Container. If a match is found, Delete removes the element from the set; otherwise, Constraint_Error is propagated.

```
procedure Delete (Container : in out Set;
                  Position  : in out Cursor);
```

If Position equals No_Element, then Constraint_Error is propagated. If Position does not designate an element in Container, then Program_Error is propagated. Otherwise, Delete removes the element designated by Position from the set. Position is set to No_Element on return.

```
procedure Union (Target : in out Set;
                 Source  : in      Set);
```

Union inserts into Target the elements of Source that are not equivalent to some element already in Target.

```
function Union (Left, Right : Set) return Set;
```

Returns a set comprising all of the elements of Left, and the elements of Right that are not equivalent to some element of Left.

```
procedure Intersection (Target : in out Set;
                       Source  : in      Set);
```

Intersection deletes from Target the elements of Target that are not equivalent to some element of Source.

```
function Intersection (Left, Right : Set) return Set;
```

Returns a set comprising all the elements of Left that are equivalent to the some element of Right.

```
procedure Difference (Target : in out Set;
                     Source  : in      Set);
```

If Target denotes the same object as Source, then Difference clears Target. Otherwise, it deletes from Target the elements that are equivalent to some element of Source.

```
function Difference (Left, Right : Set) return Set;
```

Returns a set comprising the elements of Left that are not equivalent to some element of Right.

```
procedure Symmetric_Difference (Target : in out Set;
                               Source  : in      Set);
```

If Target denotes the same object as Source, then Symmetric_Difference clears Target. Otherwise, it deletes from Target the elements that are equivalent to some element of Source, and inserts into Target the elements of Source that are not equivalent to some element of Target.

function Symmetric_Difference (Left, Right : Set) **return** Set;

Returns a set comprising the elements of Left that are not equivalent to some element of Right, and the elements of Right that are not equivalent to some element of Left.

function Overlap (Left, Right : Set) **return** Boolean;

If an element of Left is equivalent to some element of Right, then Overlap returns True. Otherwise it returns False.

function Is_Subset (Subset : Set;
Of_Set : Set) **return** Boolean;

If an element of Subset is not equivalent to some element of Of_Set, then Is_Subset returns False. Otherwise it returns True.

function First (Container : Set) **return** Cursor;

If Length (Container) = 0, then First returns No_Element. Otherwise, First returns a cursor that designates the first element in Container.

function Next (Position : Cursor) **return** Cursor;

Returns a cursor that designates the successor of the element designated by Position. If Position designates the last element, then No_Element is returned. If Position equals No_Element, then No_Element is returned.

procedure Next (Position : **in out** Cursor);

Equivalent to Position := Next (Position).

function Find (Container : Set;
Item : Element_Type) **return** Cursor;

If Length (Container) equals 0, then Find returns No_Element. Otherwise, Find checks if an element equivalent to Item is present in Container. If a match is found, a cursor designating the matching element is returned; otherwise, No_Element is returned.

function Contains (Container : Set;
Item : Element_Type) **return** Boolean;

Equivalent to Find (Container, Item) /= No_Element.

function Has_Element (Position : Cursor) **return** Boolean;

Returns True if Position designates an element, and returns False otherwise.

procedure Iterate
(Container : **in** Set;
Process : **not null access procedure** (Position : **in** Cursor));

Iterate calls Process.all with a cursor that designates each element in Container, starting with the first element and moving the cursor according to the successor relation. Program_Error is propagated if Process.all tampers with the cursors of Container. Any exception raised by Process.all is propagated.

Both Containers.Hashed_Set and Containers.Ordered_Set declare a nested generic package Generic_Keys, which provides operations that allow set manipulation in terms of a key (typically, a portion of an element) instead of a complete element. The formal function Key of Generic_Keys extracts a key value from an element. It is expected to return the same value each time it is called with a particular element. The behavior of Generic_Keys is unspecified if Key behaves in some other manner.

A key is expected to unambiguously determine a single equivalence class for elements. The behavior of Generic_Keys is unspecified if the formal parameters of this package behave in some other manner.

function Key (Position : Cursor) **return** Key_Type;

Equivalent to Key (Element (Position)).

The subprograms in package `Generic_Keys` named `Contains`, `Find`, `Element`, `Delete`, and `Exclude`, are equivalent to the corresponding subprograms in the parent package, with the difference that the `Key` parameter is used to locate an element in the set.

```
procedure Replace (Container : in out Set;
                  Key       : in   Key_Type;
                  New_Item  : in   Element_Type);
```

Equivalent to `Replace_Element (Container, Find (Container, Key), New_Item)`.

```
procedure Update_Element_Preserving_Key
(Container : in out Set;
 Position  : in   Cursor;
 Process   : not null access procedure
            (Element : in out Element_Type));
```

If `Position` equals `No_Element`, then `Constraint_Error` is propagated; if `Position` does not designate an element in `Container`, then `Program_Error` is propagated. Otherwise, `Update_Element_Preserving_Key` uses `Key` to save the key value K of the element designated by `Position`. `Update_Element_Preserving_Key` then calls `Process.all` with that element as the argument. `Program_Error` is propagated if `Process.all` tampers with the elements of `Container`. Any exception raised by `Process.all` is propagated. After `Process.all` returns, `Update_Element_Preserving_Key` checks if K determines the same equivalence class as that for the new element; if not, the element is removed from the set and `Program_Error` is propagated.

If `Element_Type` is unconstrained and definite, then the actual `Element` parameter of `Process.all` shall be unconstrained.

Erroneous Execution

A `Cursor` value is *invalid* if any of the following have occurred since it was created:

- The set that contains the element it designates has been finalized;
- The set that contains the element it designates has been used as the Source or Target of a call to `Move`; or
- The element it designates has been deleted from the set.

The result of `"=`" or `Has_Element` is unspecified if these functions are called with an invalid cursor parameter. Execution is erroneous if any other subprogram declared in `Containers.Hashed_Sets` or `Containers.Ordered_Sets` is called with an invalid cursor parameter.

Implementation Requirements

No storage associated with a `Set` object shall be lost upon assignment or scope exit.

The execution of an `assignment_statement` for a set shall have the effect of copying the elements from the source set object to the target set object.

Implementation Advice

`Move` should not copy elements, and should minimize copying of internal data structures.

If an exception is propagated from a set operation, no storage should be lost, nor any elements removed from a set unless specified by the operation.

A.18.8 The Package `Containers.Hashed_Sets`

Insert new clause:

Static Semantics

The generic library package `Containers.Hashed_Sets` has the following declaration:

```
generic
  type Element_Type is private;
  with function Hash (Element : Element_Type) return Hash_Type;
  with function Equivalent_Elements (Left, Right : Element_Type)
  return Boolean;
  with function "=" (Left, Right : Element_Type) return Boolean is <>;
package Ada.Containers.Hashed_Sets is
```

```

pragma Preelaborate(Hashed_Sets);

type Set is tagged private;
pragma Preelaborable_Initialization(Set);

type Cursor is private;
pragma Preelaborable_Initialization(Cursor);

Empty_Set : constant Set;

No_Element : constant Cursor;

function "=" (Left, Right : Set) return Boolean;

function Equivalent_Sets (Left, Right : Set) return Boolean;

function To_Set (New_Item : Element_Type) return Set;

function Capacity (Container : Set) return Count_Type;

procedure Reserve_Capacity (Container : in out Set;
                           Capacity : in Count_Type);

function Length (Container : Set) return Count_Type;

function Is_Empty (Container : Set) return Boolean;

procedure Clear (Container : in out Set);

function Element (Position : Cursor) return Element_Type;

procedure Replace_Element (Container : in out Set;
                           Position : in Cursor;
                           New_Item : in Element_Type);

procedure Query_Element
  (Position : in Cursor;
   Process : not null access procedure (Element : in Element_Type));

procedure Move (Target : in out Set;
                Source : in out Set);

procedure Insert (Container : in out Set;
                  New_Item : in Element_Type;
                  Position : out Cursor;
                  Inserted : out Boolean);

procedure Insert (Container : in out Set;
                  New_Item : in Element_Type);

procedure Include (Container : in out Set;
                  New_Item : in Element_Type);

procedure Replace (Container : in out Set;
                  New_Item : in Element_Type);

procedure Exclude (Container : in out Set;
                  Item : in Element_Type);

procedure Delete (Container : in out Set;
                  Item : in Element_Type);

procedure Delete (Container : in out Set;
                  Position : in out Cursor);

procedure Union (Target : in out Set;
                  Source : in Set);

function Union (Left, Right : Set) return Set;

```

```

function "or" (Left, Right : Set) return Set renames Union;

procedure Intersection (Target : in out Set;
                       Source : in Set);

function Intersection (Left, Right : Set) return Set;

function "and" (Left, Right : Set) return Set renames Intersection;

procedure Difference (Target : in out Set;
                     Source : in Set);

function Difference (Left, Right : Set) return Set;

function "-" (Left, Right : Set) return Set renames Difference;

procedure Symmetric_Difference (Target : in out Set;
                               Source : in Set);

function Symmetric_Difference (Left, Right : Set) return Set;

function "xor" (Left, Right : Set) return Set
renames Symmetric_Difference;

function Overlap (Left, Right : Set) return Boolean;

function Is_Subset (Subset : Set;
                  Of_Set : Set) return Boolean;

function First (Container : Set) return Cursor;

function Next (Position : Cursor) return Cursor;

procedure Next (Position : in out Cursor);

function Find (Container : Set;
              Item : Element_Type) return Cursor;

function Contains (Container : Set;
                  Item : Element_Type) return Boolean;

function Has_Element (Position : Cursor) return Boolean;

function Equivalent_Elements (Left, Right : Cursor)
return Boolean;

function Equivalent_Elements (Left : Cursor;
                              Right : Element_Type)
return Boolean;

function Equivalent_Elements (Left : Element_Type;
                              Right : Cursor)
return Boolean;

procedure Iterate
(Container : in Set;
 Process : not null access procedure (Position : in Cursor));

generic
type Key_Type (<>) is private;
with function Key (Element : Element_Type) return Key_Type;
with function Hash (Key : Key_Type) return Hash_Type;
with function Equivalent_Keys (Left, Right : Key_Type) return Boolean;
package Generic_Keys is

function Key (Position : Cursor) return Key_Type;

function Element (Container : Set;

```

```

        Key      : Key_Type)
    return Element_Type;

procedure Replace (Container : in out Set;
    Key      : in      Key_Type;
    New_Item : in      Element_Type);

procedure Exclude (Container : in out Set;
    Key      : in      Key_Type);

procedure Delete (Container : in out Set;
    Key      : in      Key_Type);

function Find (Container : Set;
    Key      : Key_Type)
    return Cursor;

function Contains (Container : Set;
    Key      : Key_Type)
    return Boolean;

procedure Update_Element_Preserving_Key
    (Container : in out Set;
    Position  : in      Cursor;
    Process   : not null access procedure
        (Element : in out Element_Type));

end Generic_Keys;

private

    ... -- not specified by the language

end Ada.Containers.Hashed_Sets;

```

An object of type Set contains an expandable hash table, which is used to provide direct access to elements. The *capacity* of an object of type Set is the maximum number of elements that can be inserted into the hash table prior to it being automatically expanded.

Two elements *E1* and *E2* are defined to be *equivalent* if Equivalent_Elements (*E1*, *E2*) returns True.

The actual function for the generic formal function Hash is expected to return the same value each time it is called with a particular element value. For any two equivalent elements, the actual for Hash is expected to return the same value. If the actual for Hash behaves in some other manner, the behavior of this package is unspecified. Which subprograms of this package call Hash, and how many times they call it, is unspecified.

The actual function for the generic formal function Equivalent_Elements is expected to return the same value each time it is called with a particular pair of Element values. It should define an equivalence relationship, that is, be reflexive, symmetric, and transitive. If the actual for Equivalent_Elements behaves in some other manner, the behavior of this package is unspecified. Which subprograms of this package call Equivalent_Elements, and how many times they call it, is unspecified.

If the value of an element stored in a set is changed other than by an operation in this package such that at least one of Hash or Equivalent_Elements give different results, the behavior of this package is unspecified.

Which elements are the first element and the last element of a set, and which element is the successor of a given element, are unspecified, other than the general semantics described in A.18.7.

```
function Capacity (Container : Set) return Count_Type;
```

Returns the capacity of Container.

```
procedure Reserve_Capacity (Container : in out Set;
    Capacity : in      Count_Type);
```

Reserve_Capacity allocates a new hash table such that the length of the resulting set can become at least the value Capacity without requiring an additional call to Reserve_Capacity, and is large enough to hold the current length of Container. Reserve_Capacity then rehashes the elements in Container onto the new hash

table. It replaces the old hash table with the new hash table, and then deallocates the old hash table. Any exception raised during allocation is propagated and Container is not modified.

Reserve_Capacity tampers with the cursors of Container.

```
procedure Clear (Container : in out Set);
```

In addition to the semantics described in A.18.7, Clear does not affect the capacity of Container.

```
procedure Insert (Container : in out Set;
                 New_Item  : in   Element_Type;
                 Position  : out  Cursor;
                 Inserted  : out  Boolean);
```

In addition to the semantics described in A.18.7, if Length (Container) equals Capacity (Container), then Insert first calls Reserve_Capacity to increase the capacity of Container to some larger value.

```
function First (Container : Set) return Cursor;
```

If Length (Container) = 0, then First returns No_Element. Otherwise, First returns a cursor that designates the first hashed element in Container.

```
function Equivalent_Elements (Left, Right : Cursor)
return Boolean;
```

Equivalent to Equivalent_Elements (Element (Left), Element (Right)).

```
function Equivalent_Elements (Left  : Cursor;
                             Right : Element_Type) return Boolean;
```

Equivalent to Equivalent_Elements (Element (Left), Right).

```
function Equivalent_Elements (Left  : Element_Type;
                             Right : Cursor) return Boolean;
```

Equivalent to Equivalent_Elements (Left, Element (Right)).

For any element E , the actual function for the generic formal function Generic_Keys.Hash is expected to be such that Hash (E) = Generic_Keys.Hash (Key (E)). If the actuals for Key or Generic_Keys.Hash behave in some other manner, the behavior of Generic_Keys is unspecified. Which subprograms of Generic_Keys call Generic_Keys.Hash, and how many times they call it, is unspecified.

For any two elements $E1$ and $E2$, the boolean values Equivalent_Elements ($E1$, $E2$) and Equivalent_Keys (Key ($E1$), Key ($E2$)) are expected to be equal. If the actuals for Key or Equivalent_Keys behave in some other manner, the behavior of Generic_Keys is unspecified. Which subprograms of Generic_Keys call Equivalent_Keys, and how many times they call it, is unspecified.

Implementation Advice

If N is the length of a set, the average time complexity of the subprograms Insert, Include, Replace, Delete, Exclude and Find that take an element parameter should be $O(\log N)$. The average time complexity of the subprograms that take a cursor parameter should be $O(1)$. The average time complexity of Reserve_Capacity should be $O(N)$.

A.18.9 The Package Containers.Ordered_Sets

Insert new clause:

Static Semantics

The generic library package Containers.Ordered_Sets has the following declaration:

```
generic
  type Element_Type is private;
  with function "<" (Left, Right : Element_Type) return Boolean is <>;
  with function "=" (Left, Right : Element_Type) return Boolean is <>;
package Ada.Containers.Ordered_Sets is
  pragma Preelaborate (Ordered_Sets);

  function Equivalent_Elements (Left, Right : Element_Type) return Boolean;

  type Set is tagged private;
```

```

pragma Preelaborable_Initialization(Set);

type Cursor is private;
pragma Preelaborable_Initialization(Cursor);

Empty_Set : constant Set;

No_Element : constant Cursor;

function "=" (Left, Right : Set) return Boolean;

function Equivalent_Sets (Left, Right : Set) return Boolean;

function To_Set (New_Item : Element_Type) return Set;

function Length (Container : Set) return Count_Type;

function Is_Empty (Container : Set) return Boolean;

procedure Clear (Container : in out Set);

function Element (Position : Cursor) return Element_Type;

procedure Replace_Element (Container : in out Set;
                          Position : in Cursor;
                          New_Item : in Element_Type);

procedure Query_Element
(Position : in Cursor;
 Process : not null access procedure (Element : in Element_Type));

procedure Move (Target : in out Set;
                Source : in out Set);

procedure Insert (Container : in out Set;
                  New_Item : in Element_Type;
                  Position : out Cursor;
                  Inserted : out Boolean);

procedure Insert (Container : in out Set;
                  New_Item : in Element_Type);

procedure Include (Container : in out Set;
                   New_Item : in Element_Type);

procedure Replace (Container : in out Set;
                   New_Item : in Element_Type);

procedure Exclude (Container : in out Set;
                   Item : in Element_Type);

procedure Delete (Container : in out Set;
                  Item : in Element_Type);

procedure Delete (Container : in out Set;
                  Position : in out Cursor);

procedure Delete_First (Container : in out Set);

procedure Delete_Last (Container : in out Set);

procedure Union (Target : in out Set;
                 Source : in Set);

function Union (Left, Right : Set) return Set;

function "or" (Left, Right : Set) return Set renames Union;

procedure Intersection (Target : in out Set);

```

```

        Source : in      Set);

function Intersection (Left, Right : Set) return Set;

function "and" (Left, Right : Set) return Set renames Intersection;

procedure Difference (Target : in out Set;
                     Source : in      Set);

function Difference (Left, Right : Set) return Set;

function "-" (Left, Right : Set) return Set renames Difference;

procedure Symmetric_Difference (Target : in out Set;
                               Source : in      Set);

function Symmetric_Difference (Left, Right : Set) return Set;

function "xor" (Left, Right : Set) return Set renames
  Symmetric_Difference;

function Overlap (Left, Right : Set) return Boolean;

function Is_Subset (Subset : Set;
                  Of_Set : Set) return Boolean;

function First (Container : Set) return Cursor;

function First_Element (Container : Set) return Element_Type;

function Last (Container : Set) return Cursor;

function Last_Element (Container : Set) return Element_Type;

function Next (Position : Cursor) return Cursor;

procedure Next (Position : in out Cursor);

function Previous (Position : Cursor) return Cursor;

procedure Previous (Position : in out Cursor);

function Find (Container : Set;
              Item      : Element_Type)
  return Cursor;

function Floor (Container : Set;
               Item      : Element_Type)
  return Cursor;

function Ceiling (Container : Set;
                 Item      : Element_Type)
  return Cursor;

function Contains (Container : Set;
                  Item      : Element_Type) return Boolean;

function Has_Element (Position : Cursor) return Boolean;

function "<" (Left, Right : Cursor) return Boolean;

function ">" (Left, Right : Cursor) return Boolean;

function "<" (Left : Cursor; Right : Element_Type)
  return Boolean;

function ">" (Left : Cursor; Right : Element_Type)
  return Boolean;

```

```

function "<" (Left : Element_Type; Right : Cursor)
  return Boolean;

function ">" (Left : Element_Type; Right : Cursor)
  return Boolean;

procedure Iterate
  (Container : in Set;
   Process   : not null access procedure (Position : in Cursor));

procedure Reverse_Iterate
  (Container : in Set;
   Process   : not null access procedure (Position : in Cursor));

generic
  type Key_Type (<>) is private;
  with function Key (Element : Element_Type) return Key_Type;
  with function "<" (Left, Right : Key_Type)
    return Boolean is <>;
package Generic_Keys is

  function Equivalent_Keys (Left, Right : Key_Type)
    return Boolean;

  function Key (Position : Cursor) return Key_Type;

  function Element (Container : Set;
                   Key       : Key_Type)
    return Element_Type;

  procedure Replace (Container : in out Set;
                   Key       : in Key_Type;
                   New_Item  : in Element_Type);

  procedure Exclude (Container : in out Set;
                   Key       : in Key_Type);

  procedure Delete (Container : in out Set;
                   Key       : in Key_Type);

  function Find (Container : Set;
                Key       : Key_Type)
    return Cursor;

  function Floor (Container : Set;
                 Key       : Key_Type)
    return Cursor;

  function Ceiling (Container : Set;
                  Key       : Key_Type)
    return Cursor;

  function Contains (Container : Set;
                   Key       : Key_Type) return Boolean;

  procedure Update_Element_Preserving_Key
  (Container : in out Set;
   Position : in Cursor;
   Process   : not null access procedure
   (Element : in out Element_Type));

end Generic_Keys;

private

  ... -- not specified by the language

end Ada.Containers.Ordered_Sets;

```

Two elements $E1$ and $E2$ are *equivalent* if both $E1 < E2$ and $E2 < E1$ return False, using the generic formal " $<$ " operator for elements. Function `Equivalent_Elements` returns True if Left and Right are equivalent, and False otherwise.

The actual function for the generic formal function " $<$ " on `Element_Type` values is expected to return the same value each time it is called with a particular pair of key values. It should define a strict ordering relationship, that is, be irreflexive, asymmetric, and transitive. If the actual for " $<$ " behaves in some other manner, the behavior of this package is unspecified. Which subprograms of this package call " $<$ " and how many times they call it, is unspecified.

If the value of an element stored in a set is changed other than by an operation in this package such that at least one of " $<$ " or " $=$ " give different results, the behavior of this package is unspecified.

The first element of a nonempty set is the one which is less than all the other elements in the set. The last element of a nonempty set is the one which is greater than all the other elements in the set. The successor of an element is the smallest element that is larger than the given element. The predecessor of an element is the largest element that is smaller than the given element. All comparisons are done using the generic formal " $<$ " operator for elements.

procedure `Delete_First` (`Container` : **in out** `Set`);

If `Container` is empty, `Delete_First` has no effect. Otherwise the element designated by `First` (`Container`) is removed from `Container`. `Delete_First` tampers with the cursors of `Container`.

procedure `Delete_Last` (`Container` : **in out** `Set`);

If `Container` is empty, `Delete_Last` has no effect. Otherwise the element designated by `Last` (`Container`) is removed from `Container`. `Delete_Last` tampers with the cursors of `Container`.

function `First_Element` (`Container` : `Set`) **return** `Element_Type`;

Equivalent to `Element` (`First` (`Container`)).

function `Last` (`Container` : `Set`) **return** `Cursor`;

Returns a cursor that designates the last element in `Container`. If `Container` is empty, returns `No_Element`.

function `Last_Element` (`Container` : `Set`) **return** `Element_Type`;

Equivalent to `Element` (`Last` (`Container`)).

function `Previous` (`Position` : `Cursor`) **return** `Cursor`;

If `Position` equals `No_Element`, then `Previous` returns `No_Element`. Otherwise `Previous` returns a cursor designating the element that precedes the one designated by `Position`. If `Position` designates the first element, then `Previous` returns `No_Element`.

procedure `Previous` (`Position` : **in out** `Cursor`);

Equivalent to `Position := Previous` (`Position`).

function `Floor` (`Container` : `Set`;
 `Item` : `Element_Type`) **return** `Cursor`;

`Floor` searches for the last element which is not greater than `Item`. If such an element is found, a cursor that designates it is returned. Otherwise `No_Element` is returned.

function `Ceiling` (`Container` : `Set`;
 `Item` : `Element_Type`) **return** `Cursor`;

`Ceiling` searches for the first element which is not less than `Item`. If such an element is found, a cursor that designates it is returned. Otherwise `No_Element` is returned.

function " $<$ " (`Left`, `Right` : `Cursor`) **return** `Boolean`;

Equivalent to `Element` (`Left`) $<$ `Element` (`Right`).

function " $>$ " (`Left`, `Right` : `Cursor`) **return** `Boolean`;

Equivalent to `Element` (`Right`) $<$ `Element` (`Left`).

function " $<$ " (`Left` : `Cursor`; `Right` : `Element_Type`) **return** `Boolean`;

Equivalent to `Element` (`Left`) $<$ `Right`.

function ">" (Left : Cursor; Right : Element_Type) **return** Boolean;

Equivalent to Right < Element (Left).

function "<" (Left : Element_Type; Right : Cursor) **return** Boolean;

Equivalent to Left < Element (Right).

function ">" (Left : Element_Type; Right : Cursor) **return** Boolean;

Equivalent to Element (Right) < Left.

procedure Reverse_Iterate

(Container : **in** Set;

Process : **not null access procedure** (Position : **in** Cursor));

Iterates over the elements in Container as per Iterate, with the difference that the elements are traversed in predecessor order, starting with the last element.

For any two elements $E1$ and $E2$, the boolean values ($E1 < E2$) and ($\text{Key}(E1) < \text{Key}(E2)$) are expected to be equal. If the actuals for Key or Generic_Keys."<" behave in some other manner, the behavior of this package is unspecified. Which subprograms of this package call Key and Generic_Keys."<", and how many times the functions are called, is unspecified.

In addition to the semantics described in A.18.7, the subprograms in package Generic_Keys named Floor and Ceiling, are equivalent to the corresponding subprograms in the parent package, with the difference that the Key subprogram parameter is compared to elements in the container using the Key and "<" generic formal functions. The function named Equivalent_Keys in package Generic_Keys returns True if both Left < Right and Right < Left return False using the generic formal "<" operator, and returns True otherwise.

Implementation Advice

If N is the length of a set, then the worst-case time complexity of the Insert, Include, Replace, Delete, Exclude and Find operations that take an element parameter should be $O((\log N)**2)$ or better. The worst-case time complexity of the subprograms that take a cursor parameter should be $O(1)$.

A.18.10 The Package Containers.Indefinite_Vectors

Insert new clause:

The language-defined generic package Containers.Indefinite_Vectors provides a private type Vector and a set of operations. It provides the same operations as the package Containers.Vectors (see A.18.2), with the difference that the generic formal Element_Type is indefinite.

Static Semantics

The declaration of the generic library package Containers.Indefinite_Vectors has the same contents as Containers.Vectors except:

- The generic formal Element_Type is indefinite.
- The procedures with the profiles:

```
procedure Insert (Container : in out Vector;
                 Before   : in   Extended_Index;
                 Count    : in   Count_Type := 1);
```

```
procedure Insert (Container : in out Vector;
                 Before   : in   Cursor;
                 Position  : out  Cursor;
                 Count    : in   Count_Type := 1);
```

are omitted.

- The actual Element parameter of access subprogram Process of Update_Element may be constrained even if Element_Type is unconstrained.

A.18.11 The Package Containers.Indefinite_Doubly_Linked_Lists

Insert new clause:

The language-defined generic package Containers.Indefinite_Doubly_Linked_Lists provides private types List and Cursor, and a set of operations for each type. It provides the same operations as the package Containers.Doubly_Linked_Lists (see A.18.3), with the difference that the generic formal Element_Type is indefinite.

Static Semantics

The declaration of the generic library package Containers.Indefinite_Doubly_Linked_Lists has the same contents as Containers.Doubly_Linked_Lists except:

- The generic formal Element_Type is indefinite.
- The procedure with the profile:

```

procedure Insert (Container : in out List;
                  Before   : in   Cursor;
                  Position  : out  Cursor;
                  Count     : in   Count_Type := 1);

```

is omitted.

- The actual Element parameter of access subprogram Process of Update_Element may be constrained even if Element_Type is unconstrained.

A.18.12 The Package Containers.Indefinite_Hashed_Maps

Insert new clause:

The language-defined generic package Containers.Indefinite_Hashed_Maps provides a map with the same operations as the package Containers.Hashed_Maps (see A.18.5), with the difference that the generic formal types Key_Type and Element_Type are indefinite.

Static Semantics

The declaration of the generic library package Containers.Indefinite_Hashed_Maps has the same contents as Containers.Hashed_Maps except:

- The generic formal Key_Type is indefinite.
- The generic formal Element_Type is indefinite.
- The procedure with the profile:

```

procedure Insert (Container : in out Map;
                  Key       : in   Key_Type;
                  Position  : out  Cursor;
                  Inserted  : out  Boolean);

```

is omitted.

- The actual Element parameter of access subprogram Process of Update_Element may be constrained even if Element_Type is unconstrained.

A.18.13 The Package Containers.Indefinite_Ordered_Maps

Insert new clause:

The language-defined generic package Containers.Indefinite_Ordered_Maps provides a map with the same operations as the package Containers.Ordered_Maps (see A.18.6), with the difference that the generic formal types Key_Type and Element_Type are indefinite.

Static Semantics

The declaration of the generic library package Containers.Indefinite_Ordered_Maps has the same contents as Containers.Ordered_Maps except:

- The generic formal Key_Type is indefinite.
- The generic formal Element_Type is indefinite.
- The procedure with the profile:

```

procedure Insert (Container : in out Map;
                  Key       : in      Key_Type;
                  Position  :         out Cursor;
                  Inserted  :         out Boolean);
    
```

is omitted.

- The actual Element parameter of access subprogram Process of Update_Element may be constrained even if Element_Type is unconstrained.

A.18.14 The Package Containers.Indefinite_Hashed_Sets

Insert new clause:

The language-defined generic package Containers.Indefinite_Hashed_Sets provides a set with the same operations as the package Containers.Hashed_Sets (see A.18.8), with the difference that the generic formal type Element_Type is indefinite.

Static Semantics

The declaration of the generic library package Containers.Indefinite_Hashed_Sets has the same contents as Containers.Hashed_Sets except:

- The generic formal Element_Type is indefinite.
- The actual Element parameter of access subprogram Process of Update_Element_Preserving_Key may be constrained even if Element_Type is unconstrained.

A.18.15 The Package Containers.Indefinite_Ordered_Sets

Insert new clause:

The language-defined generic package Containers.Indefinite_Ordered_Sets provides a set with the same operations as the package Containers.Ordered_Sets (see A.18.9), with the difference that the generic formal type Element_Type is indefinite.

Static Semantics

The declaration of the generic library package Containers.Indefinite_Ordered_Sets has the same contents as Containers.Ordered_Sets except:

- The generic formal Element_Type is indefinite.
- The actual Element parameter of access subprogram Process of Update_Element_Preserving_Key may be constrained even if Element_Type is unconstrained.

A.18.16 Array Sorting

Insert new clause:

The language-defined generic procedures Containers.Generic_Array_Sort and Containers.Generic_Constrained_Array_Sort provide sorting on arbitrary array types.

Static Semantics

The generic library procedure Containers.Generic_Array_Sort has the following declaration:

```

generic
  type Index_Type is (<>);
  type Element_Type is private;
  type Array_Type is array (Index_Type range <>) of Element_Type;
  with function "<" (Left, Right : Element_Type)
    return Boolean is <>;
procedure Ada.Containers.Generic_Array_Sort (Container : in out Array_Type);
pragma Pure(Ada.Containers.Generic_Array_Sort);

```

Reorders the elements of Container such that the elements are sorted smallest first as determined by the generic formal "<" operator provided. Any exception raised during evaluation of "<" is propagated.

The actual function for the generic formal function "<" of Generic_Array_Sort is expected to return the same value each time it is called with a particular pair of element values. It should define a strict ordering relationship, that is, be irreflexive, asymmetric, and transitive; it should not modify Container. If the actual for "<" behaves in some other manner, the behavior of the instance of Generic_Array_Sort is unspecified. How many times Generic_Array_Sort calls "<" is unspecified.

The generic library procedure Containers.Generic_Constrained_Array_Sort has the following declaration:

```

generic
  type Index_Type is (<>);
  type Element_Type is private;
  type Array_Type is array (Index_Type) of Element_Type;
  with function "<" (Left, Right : Element_Type)
    return Boolean is <>;
procedure Ada.Containers.Generic_Constrained_Array_Sort
  (Container : in out Array_Type);
pragma Pure(Ada.Containers.Generic_Constrained_Array_Sort);

```

Reorders the elements of Container such that the elements are sorted smallest first as determined by the generic formal "<" operator provided. Any exception raised during evaluation of "<" is propagated.

The actual function for the generic formal function "<" of Generic_Constrained_Array_Sort is expected to return the same value each time it is called with a particular pair of element values. It should define a strict ordering relationship, that is, be irreflexive, asymmetric, and transitive; it should not modify Container. If the actual for "<" behaves in some other manner, the behavior of the instance of Generic_Constrained_Array_Sort is unspecified. How many times Generic_Constrained_Array_Sort calls "<" is unspecified.

Implementation Advice

The worst-case time complexity of a call on an instance of Containers.Generic_Array_Sort or Containers.Generic_Constrained_Array_Sort should be $O(N^2)$ or better, and the average time complexity should be better than $O(N^2)$, where N is the length of the Container parameter.

Containers.Generic_Array_Sort and Containers.Generic_Constrained_Array_Sort should minimize copying of elements.

Annex B: Interface to Other Languages

B.1 Interfacing Pragmas

Insert after paragraph 38:

Notwithstanding what this International Standard says elsewhere, the elaboration of a declaration denoted by the `local_name` of a `pragma Import` does not create the entity. Such an elaboration has no other effect than to allow the defining name to denote the external entity.

the new paragraph:

Erroneous Execution

It is the programmer's responsibility to ensure that the use of interfacing pragmas does not violate Ada semantics; otherwise, program execution is erroneous.

Delete paragraph 49:

8 An interfacing pragma might result in an effect that violates Ada semantics.

B.2 The Package Interfaces

Insert after paragraph 10:

- Floating point types corresponding to each floating point format fully supported by the hardware.

the new paragraph:

Support for interfacing to any foreign language is optional. However, an implementation shall not provide any attribute, library unit, or pragma having the same name as an attribute, library unit, or pragma (respectively) specified in the following clauses of this Annex unless the provided construct is either as specified in those clauses or is more limited in capability than that required by those clauses. A program that attempts to use an unsupported capability of this Annex shall either be identified by the implementation before run time or shall raise an exception at run time.

Insert after paragraph 11:

An implementation may provide implementation-defined library units that are children of Interfaces, and may add declarations to the visible part of Interfaces in addition to the ones defined above.

the new paragraph:

A child package of package Interfaces with the name of a convention may be provided independently of whether the convention is supported by the pragma Convention and vice versa. Such a child package should contain any declarations that would be useful for interfacing to the language (implementation) represented by the convention. Any declarations useful for interfacing to any language on the given hardware architecture should be provided directly in Interfaces.

Delete paragraph 12

For each implementation-defined convention identifier, there should be a child package of package Interfaces with the corresponding name. This package should contain any declarations that would be useful for interfacing to the language (implementation) represented by the convention. Any declarations useful for interfacing to any language on the given hardware architecture should be provided directly in Interfaces.

B.3 Interfacing with C and C++

Replace the title:

Interfacing with C

by:

Interfacing with C and C++

Replace paragraph 1:

The facilities relevant to interfacing with the C language are the package Interfaces.C and its children; support for the Import, Export, and Convention pragmas with *convention_identifier* C; and support for the Convention pragma with *convention_identifier* C_Pass_By_Copy.

by:

The facilities relevant to interfacing with the C language and the corresponding subset of the C++ language are the package Interfaces.C and its children; support for the Import, Export, and Convention pragmas with *convention_identifier* C; and support for the Convention pragma with *convention_identifier* C_Pass_By_Copy.

Replace paragraph 2:

The package Interfaces.C contains the basic types, constants and subprograms that allow an Ada program to pass scalars and strings to C functions.

by:

The package Interfaces.C contains the basic types, constants and subprograms that allow an Ada program to pass scalars and strings to C and C++ functions. When this clause mentions a C entity, the reference also applies to the corresponding entity in C++.

Insert after paragraph 39:

```

procedure To_Ada (Item      : in wchar_array;
                  Target    : out Wide_String;
                  Count     : out Natural;
                  Trim_Nul  : in Boolean := True);

```

the new paragraphs:

```

-- ISO/IEC 10646:2003 compatible types defined by ISO/IEC TR 19769:2004.

type char16_t is <implementation-defined character type>;

char16_nul : constant char16_t := implementation-defined;

function To_C (Item : in Wide_Character) return char16_t;
function To_Ada (Item : in char16_t) return Wide_Character;

type char16_array is array (size_t range <>) of aliased char16_t;

pragma Pack(char16_array);

function Is_Nul_Terminated (Item : in char16_array) return Boolean;
function To_C (Item      : in Wide_String;
              Append_Nul : in Boolean := True)
  return char16_array;

function To_Ada (Item      : in char16_array;
                Trim_Nul  : in Boolean := True)
  return Wide_String;

procedure To_C (Item      : in Wide_String;
                Target    : out char16_array;
                Count     : out size_t;
                Append_Nul : in Boolean := True);

procedure To_Ada (Item      : in char16_array;
                  Target    : out Wide_String;
                  Count     : out Natural;
                  Trim_Nul  : in Boolean := True);

type char32_t is <implementation-defined character type>;

char32_nul : constant char32_t := implementation-defined;

function To_C (Item : in Wide_Wide_Character) return char32_t;
function To_Ada (Item : in char32_t) return Wide_Wide_Character;

```

```

type char32_array is array (size_t range <>) of aliased char32_t;

pragma Pack(char32_array);

function Is_Nul_Terminated (Item : in char32_array) return Boolean;
function To_C (Item          : in Wide_Wide_String;
               Append_Nul  : in Boolean := True)
  return char32_array;

function To_Ada (Item      : in char32_array;
                 Trim_Nul : in Boolean := True)
  return Wide_Wide_String;

procedure To_C (Item      : in Wide_Wide_String;
                Target    : out char32_array;
                Count     : out size_t;
                Append_Nul : in Boolean := True);

procedure To_Ada (Item      : in char32_array;
                  Target     : out Wide_Wide_String;
                  Count      : out Natural;
                  Trim_Nul   : in Boolean := True);

```

Replace paragraph 43:

The types `int`, `short`, `long`, `unsigned`, `ptrdiff_t`, `size_t`, `double`, `char`, and `wchar_t` correspond respectively to the C types having the same names. The types `signed_char`, `unsigned_short`, `unsigned_long`, `unsigned_char`, `C_float`, and `long_double` correspond respectively to the C types `signed char`, `unsigned short`, `unsigned long`, `unsigned char`, `float`, and `long double`.

by:

The types `int`, `short`, `long`, `unsigned`, `ptrdiff_t`, `size_t`, `double`, `char`, `wchar_t`, `char16_t`, and `char32_t` correspond respectively to the C types having the same names. The types `signed_char`, `unsigned_short`, `unsigned_long`, `unsigned_char`, `C_float`, and `long_double` correspond respectively to the C types `signed char`, `unsigned short`, `unsigned long`, `unsigned char`, `float`, and `long double`.

Replace paragraph 50:

The result of `To_C` is a `char_array` value of length `Item'Length` (if `Append_Nul` is `False`) or `Item'Length+1` (if `Append_Nul` is `True`). The lower bound is 0. For each component `Item(I)`, the corresponding component in the result is `To_C` applied to `Item(I)`. The value `nul` is appended if `Append_Nul` is `True`.

by:

The result of `To_C` is a `char_array` value of length `Item'Length` (if `Append_Nul` is `False`) or `Item'Length+1` (if `Append_Nul` is `True`). The lower bound is 0. For each component `Item(I)`, the corresponding component in the result is `To_C` applied to `Item(I)`. The value `nul` is appended if `Append_Nul` is `True`. If `Append_Nul` is `False` and `Item'Length` is 0, then `To_C` propagates `Constraint_Error`.

Insert after paragraph 60:

The `To_C` and `To_Ada` subprograms that convert between `Wide_String` and `wchar_array` have analogous effects to the `To_C` and `To_Ada` subprograms that convert between `String` and `char_array`, except that `wide_nul` is used instead of `nul`.

the new paragraphs:

```

function Is_Nul_Terminated (Item : in char16_array) return Boolean;

```

The result of `Is_Nul_Terminated` is `True` if `Item` contains `char16_nul`, and is `False` otherwise.

```

function To_C (Item : in Wide_Character) return char16_t;
function To_Ada (Item : in char16_t) return Wide_Character;

```

`To_C` and `To_Ada` provide mappings between the Ada and C 16-bit character types.

```

function To_C (Item      : in Wide_String;
                Append_Nul : in Boolean := True)
  return char16_array;

function To_Ada (Item      : in char16_array;
                 Trim_Nul  : in Boolean := True)
  return Wide_String;

procedure To_C (Item      : in Wide_String;
                 Target    : out char16_array;
                 Count     : out size_t;
                 Append_Nul : in Boolean := True);

procedure To_Ada (Item      : in char16_array;
                  Target    : out Wide_String;
                  Count     : out Natural;
                  Trim_Nul  : in Boolean := True);

```

The To_C and To_Ada subprograms that convert between Wide_String and char16_array have analogous effects to the To_C and To_Ada subprograms that convert between String and char_array, except that char16_nul is used instead of nul.

```

function Is_Nul_Terminated (Item : in char32_array) return Boolean;

```

The result of Is_Nul_Terminated is True if Item contains char16_nul, and is False otherwise.

```

function To_C (Item : in Wide_Wide_Character) return char32_t;
function To_Ada (Item : in char32_t) return Wide_Wide_Character;

```

To_C and To_Ada provide mappings between the Ada and C 32-bit character types.

```

function To_C (Item      : in Wide_Wide_String;
                Append_Nul : in Boolean := True)
  return char32_array;

function To_Ada (Item      : in char32_array;
                 Trim_Nul  : in Boolean := True)
  return Wide_Wide_String;

procedure To_C (Item      : in Wide_Wide_String;
                 Target    : out char32_array;
                 Count     : out size_t;
                 Append_Nul : in Boolean := True);

procedure To_Ada (Item      : in char32_array;
                  Target    : out Wide_Wide_String;
                  Count     : out Natural;
                  Trim_Nul  : in Boolean := True);

```

The To_C and To_Ada subprograms that convert between Wide_Wide_String and char32_array have analogous effects to the To_C and To_Ada subprograms that convert between String and char_array, except that char32_nul is used instead of nul.

Replace paragraph 60.2:

The eligibility rules in B.1 do not apply to convention C_Pass_By_Copy. Instead, a type T is eligible for convention C_Pass_By_Copy if T is a record type that has no discriminants and that only has components with statically constrained subtypes, and each component is C-compatible.

by:

The eligibility rules in B.1 do not apply to convention C_Pass_By_Copy. Instead, a type T is eligible for convention C_Pass_By_Copy if T is an unchecked union type or if T is a record type that has no discriminants and that only has components with statically constrained subtypes, and each component is C-compatible.

Replace paragraph 62.1:

The constants `nul` and `wide_nul` should have a representation of zero.

by:

The constants `nul`, `wide_nul`, `char16_nul`, and `char32_nul` should have a representation of zero.

Replace paragraph 68.1:

- An Ada parameter of a `C_Pass_By_Copy`-compatible (record) type `T`, of mode **in**, is passed as a `t` argument to a `C` function, where `t` is the `C` struct corresponding to the Ada type `T`.

by:

- An Ada parameter of a (record) type `T` of convention `C_Pass_By_Copy`, of mode **in**, is passed as a `t` argument to a `C` function, where `t` is the `C` struct corresponding to the Ada type `T`.

Replace paragraph 69:

- An Ada parameter of a record type `T`, of any mode, other than an **in** parameter of a `C_Pass_By_Copy`-compatible type, is passed as a `t*` argument to a `C` function, where `t` is the `C` struct corresponding to the Ada type `T`.

by:

- An Ada parameter of a record type `T`, of any mode, other than an **in** parameter of a type of convention `C_Pass_By_Copy`, is passed as a `t*` argument to a `C` function, where `t` is the `C` struct corresponding to the Ada type `T`.

Insert after paragraph 71:

- An Ada parameter of an access-to-subprogram type is passed as a pointer to a `C` function whose prototype corresponds to the designated subprogram's specification.

the new paragraph:

An Ada parameter of a private type is passed as specified for the full view of the type.

Delete paragraph 74:

11 There is no explicit support for `C`'s union types. Unchecked conversions can be used to obtain the effect of `C` unions.

B.3.1 The Package Interfaces.C.Strings

Replace paragraph 5:

```
type chars_ptr is private;
```

by:

```
type chars_ptr is private;  
pragma Preelaborable_Initialization(chars_ptr);
```

Replace paragraph 6:

```
type chars_ptr_array is array (size_t range <>) of chars_ptr;
```

by:

```
type chars_ptr_array is array (size_t range <>) of aliased chars_ptr;
```

Replace paragraph 50:

Equivalent to `Update(Item, Offset, To_C(Str), Check)`.

by:

Equivalent to `Update(Item, Offset, To_C(Str, Append_Nul => False), Check)`.

B.3.3 Pragma Unchecked_Union

Insert new clause:

A pragma `Unchecked_Union` specifies an interface correspondence between a given discriminated type and some C union. The pragma specifies that the associated type shall be given a representation that leaves no space for its discriminant(s).

Syntax

The form of a pragma `Unchecked_Union` is as follows:

```
pragma Unchecked_Union (first_subtype_local_name);
```

Legality Rules

`Unchecked_Union` is a representation pragma, specifying the unchecked union aspect of representation.

The *first_subtype_local_name* of a pragma `Unchecked_Union` shall denote an unconstrained discriminated record subtype having a `variant_part`.

A type to which a pragma `Unchecked_Union` applies is called an *unchecked union type*. A subtype of an unchecked union type is defined to be an *unchecked union subtype*. An object of an unchecked union type is defined to be an *unchecked union object*.

All component subtypes of an unchecked union type shall be C-compatible.

If a component subtype of an unchecked union type is subject to a per-object constraint, then the component subtype shall be an unchecked union subtype.

Any name that denotes a discriminant of an object of an unchecked union type shall occur within the declarative region of the type.

A component declared in a `variant_part` of an unchecked union type shall not have a controlled, protected, or task part.

The completion of an incomplete or private type declaration having a `known_discriminant_part` shall not be an unchecked union type.

An unchecked union subtype shall only be passed as a generic actual parameter if the corresponding formal type has no known discriminants or is an unchecked union type.

Static Semantics

An unchecked union type is eligible for convention C.

All objects of an unchecked union type have the same size.

Discriminants of objects of an unchecked union type are of size zero.

Any check which would require reading a discriminant of an unchecked union object is suppressed (see 11.5). These checks include:

- The check performed when addressing a variant component (i.e., a component that was declared in a variant part) of an unchecked union object that the object has this component (see 4.1.3).
- Any checks associated with a type or subtype conversion of a value of an unchecked union type (see 4.6). This includes, for example, the check associated with the implicit subtype conversion of an assignment statement.
- The subtype membership check associated with the evaluation of a qualified expression (see 4.7) or an uninitialized allocator (see 4.8).

Dynamic Semantics

A view of an unchecked union object (including a type conversion or function call) has *inferable discriminants* if it has a constrained nominal subtype, unless the object is a component of an enclosing unchecked union object that is subject to a per-object constraint and the enclosing object lacks inferable discriminants.

An expression of an unchecked union type has inferable discriminants if it is either a name of an object with inferable discriminants or a qualified expression whose `subtype_mark` denotes a constrained subtype.

Program_Error is raised in the following cases:

- Evaluation of the predefined equality operator for an unchecked union type if either of the operands lacks inferable discriminants.
- Evaluation of the predefined equality operator for a type which has a subcomponent of an unchecked union type whose nominal subtype is unconstrained.
- Evaluation of a membership test if the `subtype_mark` denotes a constrained unchecked union subtype and the expression lacks inferable discriminants.
- Conversion from a derived unchecked union type to an unconstrained non-unchecked-union type if the operand of the conversion lacks inferable discriminants.
- Execution of the default implementation of the Write or Read attribute of an unchecked union type.
- Execution of the default implementation of the Output or Input attribute of an unchecked union type if the type lacks default discriminant values.

Implementation Permissions

An implementation may require that `pragma Controlled` be specified for the type of an access subcomponent of an unchecked union type.

NOTES

15 The use of an unchecked union to obtain the effect of an unchecked conversion results in erroneous execution (see 11.5). Execution of the following example is erroneous even if `Float'Size = Integer'Size`:

```

type T (Flag : Boolean := False) is
  record
    case Flag is
      when False =>
        F1 : Float := 0.0;
      when True =>
        F2 : Integer := 0;
    end case;
  end record;
pragma Unchecked_Union (T);

X : T;
Y : Integer := X.F2; -- Erroneous

```

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Annex C: Systems Programming

C.2 Required Representation Support

Replace paragraph 1:

This clause specifies minimal requirements on the implementation's support for representation items and related features.

by:

This clause specifies minimal requirements on the support for representation items and related features.

C.3 Interrupt Support

Replace paragraph 23:

If the underlying system or hardware does not allow interrupts to be blocked, then no blocking is required as part of the execution of subprograms of a protected object whose one of its subprograms is an interrupt handler.

by:

If the underlying system or hardware does not allow interrupts to be blocked, then no blocking is required as part of the execution of subprograms of a protected object for which one of its subprograms is an interrupt handler.

Replace paragraph 26:

Other forms of handlers are allowed to be supported, in which case, the rules of this subclause should be adhered to.

by:

Other forms of handlers are allowed to be supported, in which case the rules of this clause should be adhered to.

Replace paragraph 28:

If the Ceiling_Locking policy is not in effect, the implementation should provide means for the application to specify which interrupts are to be blocked during protected actions, if the underlying system allows for a finer-grain control of interrupt blocking.

by:

If the Ceiling_Locking policy is not in effect, the implementation should provide means for the application to specify which interrupts are to be blocked during protected actions, if the underlying system allows for finer-grained control of interrupt blocking.

C.3.1 Protected Procedure Handlers

Replace paragraph 7:

The Attach_Handler pragma is only allowed immediately within the protected_definition where the corresponding subprogram is declared. The corresponding protected_type_declaration or single_protected_declaration shall be a library level declaration.

by:

The Attach_Handler pragma is only allowed immediately within the protected_definition where the corresponding subprogram is declared. The corresponding protected_type_declaration or single_protected_declaration shall be a library-level declaration.

Replace paragraph 8:

The Interrupt_Handler pragma is only allowed immediately within a protected_definition. The corresponding protected_type_declaration shall be a library level declaration. In addition, any object_declaration of such a type shall be a library level declaration.

by:

The Interrupt_Handler pragma is only allowed immediately within the protected_definition where the corresponding subprogram is declared. The corresponding protected_type_declaration or single_protected_declaration shall be a library-level declaration.

Replace paragraph 11:

If the Ceiling_Locking policy (see D.3) is in effect then upon the initialization of a protected object that either an Attach_Handler or Interrupt_Handler pragma applies to one of its procedures, a check is made that the ceiling priority defined in the protected_definition is in the range of System.Interrupt_Priority. If the check fails, Program_Error is raised.

by:

If the Ceiling_Locking policy (see D.3) is in effect, then upon the initialization of a protected object for which either an Attach_Handler or Interrupt_Handler pragma applies to one of its procedures, a check is made that the ceiling priority defined in the protected_definition is in the range of System.Interrupt_Priority. If the check fails, Program_Error is raised.

Replace paragraph 16:

1. The worst case overhead for an interrupt handler that is a parameterless protected procedure, in clock cycles. This is the execution time not directly attributable to the handler procedure or the interrupted execution. It is estimated as $C - (A+B)$, where A is how long it takes to complete a given sequence of instructions without any interrupt, B is how long it takes to complete a normal call to a given protected procedure, and C is how long it takes to complete the same sequence of instructions when it is interrupted by one execution of the same procedure called via an interrupt.

by:

- The worst-case overhead for an interrupt handler that is a parameterless protected procedure, in clock cycles. This is the execution time not directly attributable to the handler procedure or the interrupted execution. It is estimated as $C - (A+B)$, where A is how long it takes to complete a given sequence of instructions without any interrupt, B is how long it takes to complete a normal call to a given protected procedure, and C is how long it takes to complete the same sequence of instructions when it is interrupted by one execution of the same procedure called via an interrupt.

Replace paragraph 23:

5 The ceiling priority of a protected object that one of its procedures is attached to an interrupt should be at least as high as the highest processor priority at which that interrupt will ever be delivered.

by:

5 A protected object that has a (protected) procedure attached to an interrupt should have a ceiling priority at least as high as the highest processor priority at which that interrupt will ever be delivered.

C.3.2 The Package Interrupts

Replace paragraph 22:

The Reference function returns a value of type System.Address that can be used to attach a task entry, via an address clause (see J.7.1) to the interrupt specified by Interrupt. This function raises Program_Error if attaching task entries to interrupts (or to this particular interrupt) is not supported.

by:

The Reference function returns a value of type System.Address that can be used to attach a task entry via an address clause (see J.7.1) to the interrupt specified by Interrupt. This function raises Program_Error if attaching task entries to interrupts (or to this particular interrupt) is not supported.

Replace paragraph 24:

If the Ceiling_Locking policy (see D.3) is in effect the implementation shall document the default ceiling priority assigned to a protected object that contains either the Attach_Handler or Interrupt_Handler pragmas, but not the Interrupt_Priority pragma. This default need not be the same for all interrupts.

by:

If the Ceiling_Locking policy (see D.3) is in effect, the implementation shall document the default ceiling priority assigned to a protected object that contains either the Attach_Handler or Interrupt_Handler pragmas, but not the Interrupt_Priority pragma. This default need not be the same for all interrupts.

C.4 Prelaboration Requirements

Insert after paragraph 4:

- Any subtype_mark denotes a statically constrained subtype, with statically constrained subcomponents, if any;

the new paragraph:

- no subtype_mark denotes a controlled type, a private type, a private extension, a generic formal private type, a generic formal derived type, or a descendant of such a type;

C.5 Pragma Discard_Names

Replace paragraph 7:

If the pragma applies to an enumeration type, then the semantics of the Wide_Image and Wide_Value attributes are implementation defined for that type; the semantics of Image and Value are still defined in terms of Wide_Image and Wide_Value. In addition, the semantics of Text_IO.Enumeration_IO are implementation defined. If the pragma applies to a tagged type, then the semantics of the Tags.Expanded_Name function are implementation defined for that type. If the pragma applies to an exception, then the semantics of the Exceptions.Exception_Name function are implementation defined for that exception.

by:

If the pragma applies to an enumeration type, then the semantics of the Wide_Wide_Image and Wide_Wide_Value attributes are implementation defined for that type; the semantics of Image, Wide_Image, Value, and Wide_Value are still defined in terms of Wide_Wide_Image and Wide_Wide_Value. In addition, the semantics of Text_IO.Enumeration_IO are implementation defined. If the pragma applies to a tagged type, then the semantics of the Tags.Wide_Wide_Expanded_Name function are implementation defined for that type; the semantics of Tags.Expanded_Name and Tags.Wide_Expanded_Name are still defined in terms of Tags.Wide_Wide_Expanded_Name. If the pragma applies to an exception, then the semantics of the Exceptions.Wide_Wide_Exception_Name function are implementation defined for that exception; the semantics of Exceptions.Exception_Name and Exceptions.Wide_Exception_Name are still defined in terms of Exceptions.Wide_Wide_Exception_Name.

C.6 Shared Variable Control

Replace paragraph 7:

An *atomic* type is one to which a pragma Atomic applies. An *atomic* object (including a component) is one to which a pragma Atomic applies, or a component of an array to which a pragma Atomic_Components applies, or any object of an atomic type.

by:

An *atomic* type is one to which a pragma Atomic applies. An *atomic* object (including a component) is one to which a pragma Atomic applies, or a component of an array to which a pragma Atomic_Components applies, or any object of an atomic type, other than objects obtained by evaluating a slice.