A. Overview

A.1. This draft is a revision of (C)LI Datatypes CD 11404.1, as balloted in SC22 (SC22 N970) in July 1991. All changes reflect committee decisions of WGII at editing meetings in Vienna (September, 1991), Baltimore (April, 1992), and Tampere (August 1992), and an alignment meeting with the RPC Rapporteur's Group (from JTC1/SC21/WG8) in Paris (October, 1992).

This draft contains all changes required by resolution of the SC22 ballot comments (SC22 N1069). All national body comments are resolved in this draft. Document SC22/WGII N346 describes the resolution of the individual comments.

All formerly Outstanding Issues are now resolved, but there are a few unresolved alignment issues with RPC (ISO CD 11578) remaining.

Section B below, Annotations to Changes, identifies individual changes clause-by-clause and the source of those changes.

A.2. The major changes from the First Committee Draft are:

1. The compliance rules have been significantly revised.
2. Value specification has been significantly revised and "dependent values" (dynamic datatype parameters) have been added.
3. Attributes have been replaced by freely occurring "annotations," and the "representation attributes" Annex significantly reworked.
4. The generated datatypes have been reorganized, the notion "aggregate datatype" has been added, and the semantics of primitive and generated has changed.
5. Defined datatypes are now "equal" in status to the types defined ab initio.
6. Type-declaration syntax and semantics significantly revised.
7. Character-type now permits a list of repertoire and is aligned with ISO 10646.
8. The Real and Complex datatypes have new descriptions.
9. Datatypes Null and Undefined have been replaced by Void.
10. Procedure-type syntax changed and termination-declarations added.
11. The Choice generator has been completely rewritten.
12. List datatypes renamed Sequence datatypes.
13. The Array generator has been completely rewritten.
14. The Table generator has been significantly revised.
15. Private has been redefined to be a defined-datatype.
16. Generator Tree (LISP list) added to Defined-generators.
17. Physical appearance of the document changed in several ways.

A.3. Resolution of Outstanding Issues in CD 11404.1:

Issue 1. How to classify datatypes. Resolved Issues 31 and 32. Extensive taxonomic changes have been made to resolve this issue with respect to "aggregate" datatypes. See 6.4 and 6.8.


Issue 4. Description of the Table type. Revision and Notes to 8.4.6. (But see Issue 1.)

Issue 5. User-defined datatypes and generators. Note to clause 9. Whether the generator capability will be used by RPC or LIFC is a matter for those standards.

Issue 6. Null and Undefined. Value is changed to "Void". Void has a "nominal" value and Equal is defined to be "true" (vacuously satisfied). Undefined has been removed. Resolved Issues 10 and 11 revised.

Issue 7. Is Direct compliance meaningful? Provide examples of direct and indirect compliance. Notes to 5.1 and 5.2.

Issue 8. Use of outward mappings. Revision of 5.2 and 12.1 Notes 4 and 5.

Issue 9. Radices of Scaled datatypes. Resolved Issue 28. A 3-element representation, in which each value is a decimal integer is now used for values of arbitrary radix.

Issue 10. Model of Real and Complex. Resolved Issue 29 and 8.1.11 Notes 1 and 2. LI Datatype Real is a conceptual type. LIA-1 is a specification for language implementations of real.

Issue 11. Model of Pointer. Resolved Issue 13 revised and 6.3.3 Notes 3 and 5. The WG decided that these are LIFC issues, not LID issues.

A draft mapping to Pascal is included in Annex E.

A.4. Outstanding Alignment Issues between CD 11404.2 and CD 11578-2.2:

1. Choice-type discriminant. RPC replaces "tag-type" with "value-reference," requiring the discriminant source to be specified and limiting it to "dependent-values." In LID, the source of the discriminant is NOT a parameter of the datatype.

2. Value-expression syntax. RPC value-expressions are much more limited, and the RPC syntax is organized to allow what little is permitted, not for supporting the LID semantics.
A.5. Outstanding editorial changes
These were agreed to, but the timely distribution of the CD made it necessary to forgo them in this draft.

1. Align wording of definitions with ISO 2382.

2. Reorganize Annex F (Resolved Issues) to follow the format of the normative text, like L1A Annex A. Many notes from the text could also be moved into this Annex, but the Editor requires direction.

B. Annotations to Changes
Because significant textual changes occurred throughout, even though the technical changes were limited, the committee felt that "change bars" would not be informative.

B.1. Abbreviated references
All comment documents are referenced by both WG11 and X372 document number wherever they are applied. Abbreviated references are used for the following documents, which recommend many individual changes:

[US n] refers to SC22 N1069, comments on the CD ballot from USA.
The n is the number of the U.S. comment.

[FR n] refers to SC22/WG11 N077, comments on the CD from the French national body, not formally accepted as a ballot comment (but treated as such by WG11).
The n is the number of the French comment.

[Arles] refers to the joint agreements reached at the Arles meeting (5/91) with SC22/WG6 RPC Rapporteurs Group.

[BPC] refers to changes made in agreement with ISO CD 11578-2, as resolved in the joint meeting in Paris (10/92).

[Tampere n] refers to agreements reached at the Tampere meeting to resolve issues that were not addressed by national body comments. n is the issue number from the minutes, k identifies an issue from WO5.

[Paris n] refers to agreements reached at the Paris meeting to resolve issues that were not addressed by national body comments. n is the issue number from the minutes which matches WO5 issue numbers.

[N309] refers to comments from Roger Scowsen, convener WG17 (Prolog), in document SC22/WG11 N309 and responses by BSI 157/5 in SC22/WG11 N324.

[Directives] refers to editorial changes made to satisfy requirements of the ISO Directives.

B.2. Global changes
1. The term "discrete" has been replaced by "exact", and the term "dense" by "approximate". In two cases, other changes were required. (FR 8.9, 8.10)

2. The notion "attribute" has been changed to "annotation". and attributes have been eliminated from all syntactic productions. (RPC)

3. All text references to syntactic objects italicized, and all definitions changed to boldface. (Paris, RPC)

4. All references to Common Language-Independent changed to Language-Independent and all occurrences of CLI changed to LI, (Title change agreed to by WG11 in Paris)

5. All references to "this (International) Standard" replaced by "this draft International Standard", [N309]

6. Value-syntax is now a separate item in each type description and type-generator description, and is accompanied by identification of the value denoted, [N309]

7. The syntactic objects "datatype-designator", "datatype" and "CLI-datatype" have been uniformly replaced by "typedef", [RPC]

8. The delimiters for the definition of a characterizing operation changed to either "=" or "eq"; "d". [N309]

9. All uses of the term "mapping" which did not refer to datatype mappings have been changed to "function" or "association" as needed. [Tampere 2 - 14 a].

B.3 Changes by Clause

1. Scope
Discussion of primitive and non-primitive datatypes moved to Clause 6. [US 1]

4.1 Formal Syntax
The rationale for the formal syntax was moved to new Clause 7.

4.3 Text Conventions
The lexical objects clauses of 4.2 were moved to a separate clause 8 and reorganized. (Directives)

5.1 Direct compliance
Revised to remove references to Annex A. [US 1]
Revised to remove total direct compliance and remove requirement (II) requiring use of the declaration mechanisms for additional types removed, [US 1]

5.2 Indirect compliance
Revised to remove references to Annex A. [US 1]
Revised to remove notion of total/partial compliance. [US 1]
Note added to indicate what may comply indirectly. [SC2/ N306 FR 14]
5.1 Compliance of a mapping.
   Note 2. Syntax of example changed to conform to current IDN.  [Ed.]

6.1 Datatype.
   Note added.  [US 7]

6.3 Properties
   All specifications for support moved to a new clause 10.  [US 8]

6.3.4 Cardinality
   Statements about discrete and dense corrected to approximate/exact.  [FR 8.9, 8.10]

6.3.5 Exact/Approximate replaces former 6.3.5 Dense/Discrete.
   Most requirements for the discrete property unintentionally excluded rational. The former notions have been replaced by the proper notions.  [FR 8.9, 8.10]

6.3.6 Numeric, Redescribed.  [Resolution of FR 2.3]

6.4 Primitive and Non-primitive datatypes, new.
   Revision of 3 paragraphs of scope clause which were moved to Clause 6.  [US 1, FR 8.2]
   Text modified with respect to aggregate types.  [Paris 1]

6.5 Datatype generator former 6.4
   Reworded to avoid ambiguity.  [Ed.]

6.7 Datatype families former 6.6
   Parameter notion explained.  [Arle]

6.8 Aggregate Types new.
   Made from Meek's treatise on Aggregates, Incorporating notes from Schaffert and Greguss.  [Paris 1]

7. Fundamental Objects of the DSL (IDN) new.
   Made from the non-convention parts of the former clause 4.
   [Directives]
   Rationale for syntax moved here  [Ed.]
   Relationship to IDN added.  [RFC]

7.1 Character-set (formerly part of 4.2 Lexical Objects)
   Quote and escape characters added to the character set to support character string literals.  [US 13]
   By-symbol bindings to ISO 10646 added to explain string semantics.  [SC2]

7.3 formerly part of 4.2 Lexical Objects.

7.3.2 Digit-string
   The lexical object "number" was renamed "digit-string" to avoid the semantic connotations of "number" which do not necessarily apply to the lexical object, as in time-literals.  [Ed.]

7.4 Annotations, new.
   Replaces former "attribute" notion and syntax.  [Tampere 15]

7.5 Values, new, added to provide a home for the following.  [Ed.]

7.5.1 Independent values.
   New clause added.  [US 3, US 13],
   Note explaining relationship of denotations to values added.

7.5.2 Dependent values. New clause added.  [US 3, Arle, Paris]
   Text and syntax aligned with RFC to the extent possible.

   Syntactic objects datatype, CLI-datatype and datatype-designator replaced by type-specifier and corresponding text revisions.  [RFC]
   Type-attributes removed.  [Tampere 15, resolution of US 9]
   Heading reformatted.  [Ed.]

8.1 Primitive types former 7.1
   Notation "datatype.operation" defined.  [N309]

8.1.1 Boolean former 7.1.1
   Syntax corrected.  [Ed.]

8.1.2 State former 7.1.2
   State values can no longer be parametric, because of changes to type-declaration.  [RFC]

8.1.3 Enumerated.former 7.1.3
   Enumerated values can no longer be parametric, because of changes to type-declaration.  [RFC]
   Specification of successor corrected.  [Ed.]

8.1.4 Character.former 7.1.4
   Character syntax and text to allow a repertoire list.  [RFC]
   Changed to allow a default to be otherwise specified.  [RFC]
   Many editorial changes to align wording with S22 work.  [SC2]
   Positional value removed and character-name extension added to agree with resolution of US 13.
   Type changed to "unordered".  [Canada, N1069]
   Example rewritten with new syntax.  [Ed.]

8.1.5 Ordinal former 7.1.5
   Specification of values corrected.  [FR 8.5]
   Specification of successor corrected.  [Ed.]

8.1.6 Date-and-Time former 7.1.6
   "unit-type" uniformly replaced by "time-unit" and related editorial changes, to avoid the word "type" which is otherwise used only for datatypes.  [Ed.]
   Reference to ISO 8601 corrected.  [Ed.]

8.1.9 Rational former 7.1.9
   Definition of rational-literal corrected.  [FR 8.7]
   Rational is "exact" [dense, but not approximate].  [FR 8.9]
   Note 3 modified to avoid implication that CLID describes arithmetic.

8.1.10 Scaled (former 7.1.10)
   Syntax of values changed to accommodate radices other than 10.  [Paris 9]
   Note 3 modified to avoid implication that CLID describes arithmetic.  [Paris 10]

8.1.11 Real (former 7.1.11)
   Syntax of values changed to accommodate radices other than 10.  [Paris 9]
   Real changed to "a computational approximation to the mathematical reals. This change required numerous changes to the definitions of the value space and the operations.  [FR 5]
Editor's Notes to LI Datatypes 2cd 11404 - WG11 N347
2cd.enotes

Description reworded to parallel others. [Ed.]

Null-value is not required to be available. [X3J3 comment]
Note 1. Extraneous mathematical wording deleted. [Ed.]

Note 2. Following Baltimore decision on similar French comments. [Paris]

Note 5 added to explain RFC attributes. [Paris]

8.3.3 formerly 7.1.16 Procedure.

Syntactic and text changes in the non-terminals: "exception" to
termination and procedure-name to procedure-identifier. [RFC]

Principal result added, permitting an optional argument-name in
the return clause, with corresponding changes to the text. [US 25,]

RFC

Attributes removed. [RFC]

Model of a value of procedure-type defined mathematically, note
3 revised to match. Note 7 modified to explain the reason for
the difference between the syntax and the mathematical model. Note 8
added to relate the mathematical model of the input and result
spaces to the computational model. [resolution of US 20]

Definition of subtypes repaired to support the return clause
[Ed.]

Apply changed to Invoke. [RFC]

8.4 Aggregate types, new.

Result of the committee compromise on the handling of Pointer,
Procedure, choice versus the types which are not atomic. [Tampere
2]

All type descriptions modified to use the Mook property list.
[Paris 1]

All type descriptions modified to use the wording suggested by 7
[Ed.]

8.4.1 former 7.3.2 Record

"field-attributies" corrected to "component-attributies". [Ed.]

Characterizing operation Aggregate replaced by FieldReplace
to match the Mook properties. Notes modified to match. [Paris 1]

Note 4 added per Greengrass and Turba. [Tampere 2]

8.4.2 formerly 7.3.4 Set

Set-value syntax changed to support empty value. [Aries]

Syntax changed to avoid ambiguity for subtypes. [US 9, Aries]

Description reworded, type defined with a mathematical model.
[FR 1]

8.4.3 formerly 7.3.6 Bag

Bag-value syntax changed to support empty value. [Aries]

Syntax changed to avoid ambiguity for subtypes. [US 9, Aries]

Type defined with a mathematical model. [FR 1.3]

8.4.4 Sequence, former 7.3.5 List

Renamed to avoid confusion with LISP List datatype. [Paris 1]

Value syntax changed to support empty value. [Aries]

Syntax changed to avoid ambiguity for subtypes. [US 9, Aries]

8.4.5 formerly 7.3.7 Array

Datatype redefined as mappings, and the sequencing of the
product space redefined to interpreting array-values. This
required revision of much of the text including several Notes. [FR
6]

Asterisk removed from upperbound, lowerbound syntax, replaced
by data-dependent-value in value-expression. [US 3]

Syntax changed to avoid ambiguity for subtypes. [US 9, Aries]

Index-types must be finite and exact (the only case in which
"discrete" was r). [FR 8, 10]

"Array-Index" changed (back) to index-type and corresponding
text changes, to match Heek model. [Paris] 1
Note 1 incorporates text from Heek.
Note 4 and 5 change List to Sequence.

8.4.6 formerly 7.3.8 Table
Syntax changed to avoid ambiguity for subtypes. [US 9, Aries]
Table-definition syntax changed to support empty value. [Aries]
Table-redefined to permit multiple keys and be analogous to
Array. [Tampere 4 – 4]
Revised definition of Equal and Empty. [Ed.]
Notes 1, 2, 3 reorganised per Heek and Greengrass. [Paris] 1

8.5 Defined Types (former 7.4)
Revised and combined with former 7.3.9 Declared Generators
to match the changes to type declarations. [RFC, Ed.]


9.1 Type Declarations
Rewritten from 8.1 and 8.5 to require the formal parameters to
specify the datatype of the actual value. The syntax departs from
that of the RFC IDN to avoid ambiguous references in the text.

9.2 Value declarations, former 8.3
value-expression changed to independent-value, and associated
new syntax. [US 3]

9.3 Termination Declarations, new.
Added to accommodate RFC changes to procedure declarations.

former 9. Attributes, deleted.
Notion is now supported by "annotations" (7.4) and
recommendations in Annex B. [Tampere 15, Paris]

10. Derived types and generators, former Annexes B and C,
Moved into main text, editorial changes made to clause headings.

10.1 Defined datatypes, former Annex B.
Value specification for defined-datatypes added. [US 13]

10.1.1 Switch (former 8.11)
Note cannot be modified to comply with new type-declaration
syntax. [Ed.]

10.1.3 Bit String, former B.3.
Value syntax added, editor's invention. [US 13]
Derived from Sequence instead of List. [Ed.]

10.1.4 Character String, former B.4.
Value syntax added, similar to previous RFC draft, with the
character-name extension. [Resolution of US 13]
Minor changes to notes to agree with SC2 comments. [SC2]
Derived from Sequence instead of List. [Ed.]
Note 3 (Concatenation) moved to 8.4.4 Sequence Note 2. [Ed.]

10.1.5 Modulo, former B.5 Integer-Modulo
Renamed and syntax slightly revised. [US 14.4, Tampere 12]

Quotient and Remainder moved to Integer. [Ed.]

10.1.9 Private, former 7.1.15.
Moved from 7.1 and redescoped. [US 11]

10.1.10 Object-Identifier, former B.9
Renamed and redescoped. Note added to explain why it is not
primitive. [Resolution of US 19]
Reference to ISO 9836 was wrong. Changed to ISO 8824. [Ed.]
Value syntax corrected. [Ed.]
List changed to sequence.

10.1.11 Distinguished-name, new. [Resolution of US 18]

10.2 Defined Generators, formerly Annex C.

10.2.1 Stack, former C.1
Derived from Sequence instead of List. [Ed.]

10.2.2 Tree, new.
Added to resolve the "recursive" attribute of List. [Paris]

10.2.3 Cyclic, replaces former C.2 Modulo.
The generic Modulo operation was reduced to redefining Successor
on Enumerated types. [US 14.4, Tampere 12]

11. Support of Datatypes, new
Made from excerpts of support requirements from US 8.

11.4 Approximate/Exact.

11.5 Numeric.
New. Replaces excerpts from US 8. [FR 14.3.6]

12.1 Outward Mappings, formerly 10.1.
Notes 4 and 5 added. [Tampere 7 = 8]

12.2 Inward Mappings, formerly 10.2
Note 4 added, to explain relation to "marshalling". [Tampere 7=8]

12.3 Reverse Inward Mappings
Replaces former 10.3 Consistency of Mappings. This concept is
the one wanted by IETF/RFC. [Tampere 7=8]

former Annex A. Datatypes required. Deleted. [US 1]

Annex A, formerly Annex E. Character Set standards
Reworded per SC2 recommendations. [SC2]
ISO 2375 added. [US 16]
Reason for inclusion of ISO 6931 added. [Aries]
ISO 8824 added, to define VisibleString, etc. [Aries]
Notes to ISO 10664 added to explain references to the
repertoires thereby defined. [RFC, Paris]

Annex B. Recommended Placement of Attributes, former Clause 9.
Informative salvage from former clause 9 Attributes. It is not
clear whether there is still consensus on this material. [Ed.]

Annex C. Recommended Representation Attributes, formerly Annex D.
Reduced to a list of representation concerns. This is the
attempt to resolve the U.S. concern requesting deletion of the
"representation" annex outright. [US 15]

It is not clear whether there is still consensus on this
material. Any national body is welcome to propose suggested syntax, but much of the former syntax is no longer appropriate.

Annex D. IDN. formerly Annex F.
Reconstructed from the text. [Ed.]

Annex E. Pascal Mapping, now.
Added to exemplify mappings. [FR registration comment 59]

Annex F. Resolved Issues, former Annex G.
All references to “the committee” replaced by “there was consensus”. [H309]