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Ada Compiler Validation Summary Report:

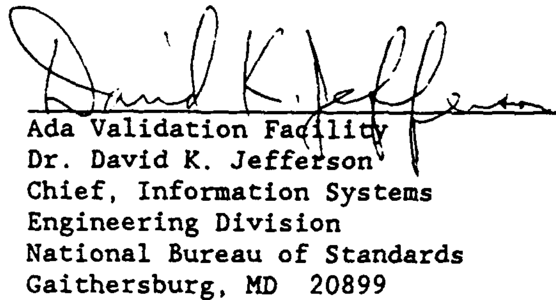
Compiler Name: DACS-386/UNIX, Version 4.2

Certificate Number: 880728S1.09141

Host:	Target:
ICL DRS 300	ICL DRS 300
under DRS/NX Ver 3 Level 0 Increment 50	under DRS/NX Ver 3 Level 0 Increment 50
which is run over UNIX SYSTEM V/386 Rel. 3.1	which is run over UNIX SYSTEM V/386 Rel. 3.1

Testing Completed 28 July 1988 Using ACVC 1.9

This report has been reviewed and is approved.



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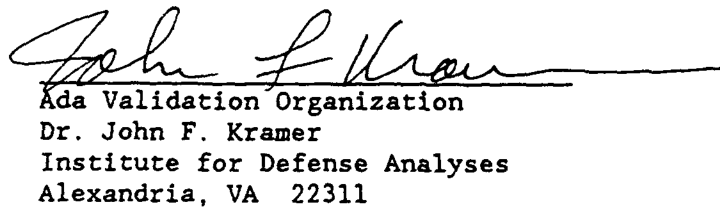

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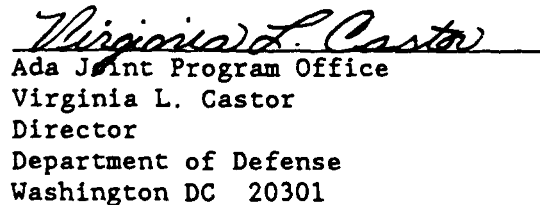

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Ada Compiler
VALIDATION SUMMARY REPORT:
Certificate Number: 880728S1.09141
DDC-I, Inc.
DACS-386/UNIX, Version 4.2
ICL DRS 300

Completion of On-Site Testing:
28 July 1988

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Ada Joint Program Office
United States Department of Defense
Washington, D.C. 20301-3081

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CHAPTER 1

INTRODUCTION

This Validation Summary Report (VSR) describes the extent to which a specific Ada compiler conforms to the Ada Standard, ANSI/MIL-STD-1815A. This report explains all technical terms used within it and thoroughly reports the results of testing this compiler using the Ada Compiler Validation Capability (ACVC). An Ada compiler must be implemented according to the Ada Standard, and any implementation-dependent features must conform to the requirements of the Ada Standard. The Ada Standard must be implemented in its entirety, and nothing can be implemented that is not in the Standard.

Even though all validated Ada compilers conform to the Ada Standard, it must be understood that some differences do exist between implementations. The Ada Standard permits some implementation dependencies--for example, the maximum length of identifiers or the maximum values of integer types. Other differences between compilers result from the characteristics of particular operating systems, hardware, or implementation strategies. All the dependencies observed during the process of testing this compiler are given in this report.

This information in this report is derived from the test results produced during validation testing. The validation process includes submitting a suite of standardized tests, the ACVC, as inputs to an Ada compiler and evaluating the results. The purpose of validating is to ensure conformity of the compiler to the Ada Standard by testing that the compiler properly implements legal language constructs and that it identifies and rejects illegal language constructs. The testing also identifies behavior that is implementation dependent but permitted by the Ada Standard. Six classes of test are used. These tests are designed to perform checks at compile time, at link time, and during execution.

1.1 PURPOSE OF THIS VALIDATION SUMMARY REPORT

This VSR documents the results of the validation testing performed on an Ada compiler. Testing was carried out for the following purposes:

> To attempt to identify any language constructs supported by the compiler that do not conform to the Ada Standard
>
> To attempt to identify any unsupported language constructs required by the Ada Standard
>
> To determine that the implementation-dependent behavior is allowed by the Ada Standard

On-site testing was completed 28 July 1988 at Copenhagen, Denmark.

1.2 USE OF THIS VALIDATION SUMMARY REPORT

Consistent with the national laws of the originating country, the AVO may make full and free public disclosure of this report. In the United States, this is provided in accordance with the "Freedom of Information Act" (5 U.S.C. #552). The results of this validation apply only to the computers, operating systems, and compiler versions identified in this report.

The organizations represented on the signature page of this report do not represent or warrant that all statements set forth in this report are accurate and complete, or that the subject compiler has no nonconformities to the Ada Standard other than those presented. Copies of this report are available to the public from:

> Ada Information Clearinghouse
> Ada Joint Program Office
> OUSDRE
> The Pentagon, Rm 3D-139 (Fern Street)
> Washington DC 20301-3081

or from:

> Software Standards Validation Group
> Institute for Computer Sciences and Technology
> National Bureau of Standards
> Building 225, Room A266
> Gaithersburg, Maryland 20899

Questions regarding this report or the validation test results should be directed to the AVF listed above or to:

Ada Validation Organization
Institute for Defense Analyses
1801 North Beauregard Street
Alexandria VA 22311

1.3 REFERENCES

1. Reference Manual for the Ada Programming Language, ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.

2. Ada Compiler Validation Procedures and Guidelines. Ada Joint Program Office, 1 January 1987.

3. Ada Compiler Validation Capability Implementers' Guide., December 1986.

1.4 DEFINITION OF TERMS

ACVC — The Ada Compiler Validation Capability. The set of Ada programs that tests the conformity of an Ada compiler to the Ada programming language.

Ada Commentary — An Ada Commentary contains all information relevant to the point addressed by a comment on the Ada Standard. These comments are given a unique identification number having the form AI-ddddd.

Ada Standard — ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.

Applicant — The agency requesting validation.

AVF — The Ada Validation Facility. The AVF is responsible for conducting compiler validations according to procedures contained in the Ada Compiler Validation Procedures and Guidelines.

AVO — The Ada Validation Organization. The AVO has oversight authority over all AVF practices for the purpose of maintaining a uniform process for validation of Ada compilers. The AVO provides administrative and technical support for Ada validations to ensure consistent practices.

Compiler — A processor for the Ada language. In the context of this report, a compiler is any language processor, including cross-compilers, translators, and

interpreters.

Term	Definition
Failed test	An ACVC test for which the compiler generates a result that demonstrates nonconformity to the Ada Standard.
Host	The computer on which the compiler resides.
Inapplicable test	An ACVC test that uses features of the language that a compiler is not required to support or may legitimately support in a way other than the one expected by the test.
Language Maintenance	The Language Maintenance Panel (LMP) is a committee established by the Ada Board to recommend interpretations and Panel possible changes to the ANSI/MIL-STD for Ada.
Passed test	An ACVC test for which a compiler generates the expected result.
Target	The computer for which a compiler generates code.
Test	An Ada program that checks a compiler's conformity regarding a particular feature or a combination of features to the Ada Standard. In the context of this report, the term is used to designate a single test, which may comprise one or more files.
Withdrawn test	An ACVC test found to be incorrect and not used to check conformity to the Ada Standard. A test may be incorrect because it has an invalid test objective, fails to meet its test objective, or contains illegal or erroneous use of the language.

1.5 ACVC TEST CLASSES

Conformity to the Ada Standard is measured using the ACVC. The ACVC contains both legal and illegal Ada programs structured into six test classes: A, B, C, D, E, and L. The first letter of a test name identifies the class to which it belongs. Class A, C, D, and E tests are executable, and special program units are used to report their results during execution. Class B tests are expected to produce compilation errors. Class L tests are expected to produce compilation or link errors.

Class A tests check that legal Ada programs can be successfully compiled and executed. There are no explicit program components in a Class A test to check semantics. For example, a Class A test checks that reserved words of another language (other than those already reserved in the Ada language) are not treated as reserved words by an Ada compiler.

A Class A test is passed if no errors are detected at compile time and the program executes to produce a PASSED message.

Class B tests check that a compiler detects illegal language usage. Class B tests are not executable. Each test in this class is compiled and the resulting compilation listing is examined to verify that every syntax or semantic error in the test is detected. A Class B test is passed if every illegal construct that it contains is detected by the compiler.

Class C tests check that legal Ada programs can be correctly compiled and executed. Each Class C test is self-checking and produces a PASSED, FAILED, or NOT APPLICABLE message indicating the result when it is executed.

Class D tests check the compilation and execution capacities of a compiler. Since there are no capacity requirements placed on a compiler by the Ada Standard for some parameters--for example, the number of identifiers permitted in a compilation or the number of units in a library--a compiler may refuse to compile a Class D test and still be a conforming compiler. Therefore, if a Class D test fails to compile because the capacity of the compiler is exceeded, the test is classified as inapplicable. If a Class D test compiles successfully, it is self-checking and produces a PASSED or FAILED message during execution.

Each Class E test is self-checking and produces a NOT APPLICABLE, PASSED, or FAILED message when it is compiled and executed. However, the Ada Standard permits an implementation to reject programs containing some features addressed by Class E tests during compilation. Therefore, a Class E test is passed by a compiler if it is compiled successfully and executes to produce a PASSED message, or if it is rejected by the compiler for an allowable reason.

Class L tests check that incomplete or illegal Ada programs involving multiple, separately compiled units are detected and not allowed to execute. Class L tests are compiled separately and execution is attempted. A Class L test passes if it is rejected at link time--that is, an attempt to execute the main program must generate an error message before any declarations in the main program or any units referenced by the main program are elaborated.

Two library units, the package REPORT and the procedure CHECK FILE, support the self-checking features of the executable tests. The package REPORT provides the mechanism by which executable tests report PASSED, FAILED, or NOT APPLICABLE results. It also provides a set of identity functions used to defeat some compiler optimizations allowed by the Ada Standard that would circumvent a test objective. The procedure CHECK FILE is used to check the contents of text files written by some of the Class C tests for chapter 14 of the Ada Standard. The operation of REPORT and CHECK_FILE is checked by a set of executable tests. These tests produce messages that are examined to verify that the units are operating correctly. If these units are not operating correctly, then

the validation is not attempted.

The text of the tests in the ACVC follow conventions that are intended to ensure that the tests are reasonably portable without modification. For example, the tests make use of only the basic set of 55 characters, contain lines with a maximum length of 72 characters, use small numeric values, and place features that may not be supported by all implementations in separate tests. However, some tests contain values that require the test to be customized according to implementation-specific values--for example, an illegal file name. A list of the values used for this validation is provided in Appendix C.

A compiler must correctly process each of the tests in the suite and demonstrate conformity to the Ada Standard by either meeting the pass criteria given for the test or by showing that the test is inapplicable to the implementation. The applicability of a test to an implementation is considered each time the implementation is validated. A test that is inapplicable for one validation is not necessarily inapplicable for a subsequent validation. Any test that was determined to contain an illegal language construct or an erroneous language construct is withdrawn from the ACVC and, therefore, is not used in testing a compiler. The tests withdrawn at the time of validation are given in Appendix D.

CHAPTER 2

CONFIGURATION INFORMATION

2.1 CONFIGURATION TESTED

The candidate compilation system for this validation was tested under the following configuration:

Compiler: DACS-386/UNIX, Version 4.2

ACVC Version: 1.9

Certificate Number: 880728S1.09141

Host Computer:

Machine: ICL DRS 300

Operating System: DRS/NX Ver 3 Level 0 Increment 50 which is run over: UNIX SYSTEM V/386 Rel. 3.1

Memory Size: 8 Mbyte RAM

Target Computer:

Machine: ICL DRS 300

Operating System: DRS/NX Ver 3 Level 0 Increment 50 which is run over: UNIX SYSTEM V/386 Rel. 3.1

Memory Size: 8 Mbyte RAM

Communications Network: VAX-11/8530 via Ethernet LAN via SUN-3 Workstation via streamer tape to the RC900 (386/UNIX V Workstation) via floppy disks to the ICL DRS 300.

2.2 IMPLEMENTATION CHARACTERISTICS

One of the purposes of validating compilers is to determine the behavior of a compiler in those areas of the Ada Standard that permit implementations to differ. Class D and E tests specifically check for such implementation differences. However, tests in other classes also characterize an implementation. The tests demonstrate the following characteristics:

- Capacities.

  The compiler correctly processes tests containing loop statements nested to 65 levels and recursive procedures separately compiled as subunits nested to 17 levels. It does not process 65 levels of block nesting. It correctly processes a compilation containing 723 variables in the same declarative part. (See test D55A03A..H (8 tests), D56001B, D64005E..G (3 tests), and D29002K.)

- Universal integer calculations.

  An implementation is allowed to reject universal integer calculations having values that exceed SYSTEM.MAX_INT. This implementation processes 64 bit integer calculations. (See tests D4A002A, D4A002B, D4A004A, and D4A004B.)

- Predefined types.

  This implementation supports the additional predefined types SHORT_INTEGER, LONG_INTEGER, and LONG_FLOAT in the package STANDARD. (See tests B86001BC and B86001D.)

- Based literals.

  An implementation is allowed to reject a based literal with a value exceeding SYSTEM.MAX_INT during compilation, or it may raise NUMERIC_ERROR or CONSTRAINT_ERROR during execution. This implementation raises NUMERIC_ERROR during execution. (See test E24101A.)

- Expression evaluation.

  Apparently all default initialization expressions for record components are evaluated before any value is checked to belong to a component's subtype. (See test C32117A.)

Assignments for subtypes are performed with the same precision as the base type. (See test C35712B.)

This implementation uses no extra bits for extra precision. This implementation uses all extra bits for extra range. (See test C35903A.)

Apparently NUMERIC_ERROR is raised when an integer literal operand in a comparison or membership test is outside the range of the base type. (See test C45232A.)

Apparently NUMERIC_ERROR is raised when a literal operand in a fixed point comparison or membership test is outside the range of the base type. (See test C45252A.)

Apparently underflow is gradual. (See tests C45524A..Z.)

- Rounding.

The method used for rounding to integer is apparently round to even. (See tests C46012A..Z.)

The method used for rounding to longest integer is apparently round to even. (See tests C46012A..Z.)

The method used for rounding to integer in static universal real expressions is apparently round away from zero. (See test C4A014A.)

- Array types.

An implementation is allowed to raise NUMERIC_ERROR or CONSTRAINT_ERROR for an array having a 'LENGTH that exceeds STANDARD.INTEGER'LAST and/or SYSTEM.MAX_INT. For this implementation:

Declaration of an array type or subtype declaration with more than SYSTEM.MAX_INT components raises NUMERIC_ERROR. (See test C36003A.)

NUMERIC_ERROR is raised when an array type with INTEGER'LAST + 2 components is declared. (See test C36202A.)

NUMERIC_ERROR is raised when an array type with SYSTEM.MAX_INT + 2 components is declared. (See test C36202B.)

A packed BOOLEAN array having a 'LENGTH exceeding INTEGER'LAST raises NUMERIC_ERROR when the array objects are declared. (See test C52103X.)

A packed two-dimensional BOOLEAN array with more than INTEGER'LAST components raises NUMERIC_ERROR when the array type is declared. (See test C52104Y.)

A null array with one dimension of length greater than INTEGER'LAST may raise NUMERIC_ERROR or CONSTRAINT_ERROR either when declared or assigned. Alternatively, an implementation may accept the declaration. However, lengths must match in array slice assignments. This implementation raises NUMERIC_ERROR when the array type is declared. (See test E52103Y.)

In assigning one-dimensional array types, the expression appears to be evaluated in its entirety before CONSTRAINT_ERROR is raised when checking whether the expression's subtype is compatible with the target's subtype. In assigning two-dimensional array types, the expression appears to be evaluated in its entirety before CONSTRAINT_ERROR is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)

- Discriminated types.

During compilation, an implementation is allowed to either accept or reject an incomplete type with discriminants that is used in an access type definition with a compatible discriminant constraint. This implementation accepts such subtype indications. (See test E38104A.)

In assigning record types with discriminants, the expression appears to be evaluated in its entirety before CONSTRAINT_ERROR is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)

- Aggregates.

In the evaluation of a multi-dimensional aggregate, all choices appear to be evaluated before checking against the index subtype. (See tests C43207A and C43207B.)

In the evaluation of an aggregate containing subaggregates, not all choices are evaluated before being checked for identical bounds. (See test E43212B.)

All choices are evaluated before CONSTRAINT_ERROR is raised if a bound in a nonnull range of a nonnull aggregate does not belong to an index subtype. (See test E43211B.)

- Representation clauses.

An implementation might legitimately place restrictions on representation clauses used by some of the tests. If a representation clause is not supported, then the implementation must reject it.

Enumeration representation clauses containing noncontiguous values for enumeration types other than character and boolean types are supported. (See tests C35502I..J, C35502M..N, and A39005F.)

Enumeration representation clauses containing noncontiguous values for character types are supported. (See tests C35507I..J, C35507M..N, and C55B16A.)

Enumeration representation clauses for boolean types containing representational values other than (FALSE => 0, TRUE => 1) are not supported. (See tests C35508I..J and C35508M..N.)

Length clauses with SIZE specifications for enumeration types are supported. (See test A39005B.)

Length clauses with STORAGE_SIZE specifications for access types are supported. (See test A39005C.)

Length clauses with STORAGE_SIZE specifications for task types are supported. (See tests A39005D and C87B62D.)

Length clauses with SMALL specifications are not supported. (See tests A39005E and C87B62C.)

Record representation clauses are not supported. (See test A39005G.)

Length clauses with SIZE specifications for derived integer types are supported. (See test C87B62A.)

- Pragmas.

The pragma INLINE is supported for procedures. The pragma INLINE is supported for functions. (See tests LA3004A, LA3004B, EA3004C, EA3004D, CA3004E, and CA3004F.)

- Input/output.

The package SEQUENTIAL_IO can be instantiated with unconstrained array types and record types with discriminants without defaults. (See tests AE2101C, EE2201D, and EE2201E.)

The package DIRECT_IO can be instantiated with record types with discriminants without defaults. (See tests AE2101H and

EE2401G.)

There are no strings which are illegal external file names for SEQUENTIAL_IO and DIRECT_IO. (See tests CE2102C and CE2102H.)

Modes IN_FILE and OUT_FILE are supported for SEQUENTIAL_IO. (See tests CE2102D and CE2102E.)

Modes IN_FILE, OUT_FILE, and INOUT_FILE are supported for DIRECT_IO. (See tests CE2102F, CE2102I, and CE2102J.)

RESET and DELETE are supported for SEQUENTIAL_IO and DIRECT_IO. (See tests CE2102G and CE2102K.)

Dynamic creation and deletion of files are supported for SEQUENTIAL_IO and DIRECT_IO. (See tests CE2106A and CE2106B.)

Overwriting to a sequential file truncates the file to last element written. (See test CE2208B.)

An existing text file can be opened in OUT_FILE mode, cannot be created in OUT_FILE mode, and cannot be created in IN_FILE mode. (See test EE3102C.)

Only one internal file may be associated with the same external file if only one file is opened for writing. (See test CE3111B.)

More than one internal file can be associated with each external file for text I/O for reading only or for writing only. (See tests CE3111A, CE3111C..E (3 tests), CE3114B, CE3115A, CE2110B, and CE2111D.)

More than one internal file can be associated with each external file for sequential I/O for both reading and writing. (See tests CE2107A..D (4 tests), CE2110B, and CE2111D.)

More than one internal file can be associated with each external file for direct and sequential I/O for writing only. (See test CE2107E.)

More than one internal file can be associated with each external file for direct I/O for both reading and writing. (See tests CE2107F..I (4 tests), and CE2110B.)

More than one internal file cannot be associated with each external file for direct I/O for both reading and writing. (See test CE2111H.)

An external file associated with more than one internal file can be deleted for SEQUENTIAL_IO, DIRECT_IO, and TEXT_IO. (See test CE2110B.)

Temporary sequential files are given names. Temporary direct files are given names. Temporary files given names are not deleted when they are closed. (See tests CE2108A and CE2108C.)

- Generics.

Generic subprogram declarations and bodies can compiled in separate compilations. (See test CA1012A.)

Generic package declarations and bodies can be compiled in separate compilations so long as no instantiations of those units precede the bodies. This compiler requires that a generic unit's body be compiled prior to instantiation, and so the unit containing the instantiations is rejected. (See tests CA2009C, BC3204C, and BC3205D.)

Generic unit bodies and their subunits can be compiled in separate compilations. (See test CA3011A.)

CHAPTER 3

TEST INFORMATION

3.1 TEST RESULTS

Version 1.9 of the ACVC comprises 3122 tests. When this compiler was tests, 28 tests had been withdrawn because of test errors. The AVF determined that 236 tests were inapplicable to this implementation. All inapplicable tests were processed during validation testing. Modifications to the code, processing, or grading for 69 tests were required to successfully demonstrate the test objective. (See section 3.6.)

The AVF concludes that the testing results demonstrate acceptable conformity to the Ada Standard.

3.2 SUMMARY OF TEST RESULTS BY CLASS

RESULT	TEST CLASS						TOTAL
	A	B	C	D	E	L	
Passed	108	1048	1624	16	16	46	2858
Inapplicable	2	3	229	1	1	0	236
Withdrawn	3	2	21	0	2	0	28
TOTAL	113	1053	1874	17	19	46	3122

3.3 SUMMARY OF TEST RESULTS BY CHAPTER

RESULT	CHAPTER													TOTAL
	2	3	4	5	6	7	8	9	10	11	12	13	14	
Passed	187	494	548	247	165	98	140	326	135	36	232	3	247	2858
Inapplicable	17	78	126	1	0	0	3	1	2	0	2	0	6	236
Withdrawn	2	14	3	0	1	1	2	0	0	0	2	1	2	28
TOTAL	206	586	677	248	166	99	145	327	137	36	236	4	255	3122

3.4 WITHDRAWN TESTS

The following 28 tests were withdrawn from ACVC Version 1.9 at the time of this validation:

B28003A	E28005C	C34004A	C35502P	A35902C	C35904A
C35904B	C35A03E	C35A03R	C37213H	C37213J	C37215C
C37215E	C37215G	C37215H	C38102C	C41402A	C45332A
C45614C	E66001D	A74106C	C85018B	C87B04B	CC1311B
BC3105A	AD1A01A	CE2401H	CE3208A		

See Appendix D for the reason that each of these tests was withdrawn.

3.5 INAPPLICABLE TESTS

Some tests do not apply to all compilers because they make use of features that a compiler is not required by the Ada Standard to support. Others may depend on the result of another test that is either inapplicable or withdrawn. The applicability of a test to an implementation is considered each time a validation is attempted. A test that is inapplicable for one validation attempt is not necessarily inapplicable for a subsequent attempt. For this validation attempt, 236 test were inapplicable for the reasons indicated:

C24113I..K (3 tests) were rejected because they contain declarations that exceed MAX_IN_LEN (126 characters)

C35508I..J (2 tests) and C35508M..N (2 tests) use enumeration representation clauses for boolean types containing representational values other than (FALSE => 0, TRUE => 1). These clauses are not supported by this compiler.

C35702A uses SHORT_FLOAT which is not supported by this implementation.

A39005E and C87B62C use length clauses with SMALL specifications which are not supported by this implementation.

A39005G uses a record representation clause which is not supported by this compiler.

C45231D requires a macro substitution for any predefined numeric types other than INTEGER, SHORT_INTEGER, LONG_INTEGER, FLOAT, SHORT_FLOAT, and LONG_FLOAT. This implementation supports only INTEGER, LONG_INTEGER, FLOAT, and LONG_FLOAT.

C45531M, C45531N, C45532M, and C45532N use fine 48 bit fixed point base types which are not supported by this compiler.

C45531O, C45531P, C45532O, and C45532P use coarse 48 bit fixed point base types which are not supported by this compiler.

C4A013B uses a static value that is outside the range of the most accurate floating point base type. The declaration was rejected at compile time.

D56001B uses 65 levels of block nesting which exceeds the capacity of the compiler.

B86001D requires a predefined numeric type other than those defined by the Ada language in package STANDARD. There is no such type for this implementation.

C87B62B this test contains the application of the attribute STORAGE_SIZE to access types for which no corresponding STORAGE_SIZE length clause has been provided; this compiler rejects such an application. The AVO accepted this behavior because the Ada standard is not clear on how such a situation should be treated; the matter will be discussed by the language maintenance body.

C96005B requires the range of type DURATION to be different from those of its base type; in this implementation they are the same.

CA2009C, BC3204C, BC3205D, and CA2009F compiles generic subprogram declarations and bodies in separate compilations; the compilation occurs following a compilation that contains instantiations of those units. This compiler requires that a generic unit's body be compiled prior to instantiation, and so the unit containing the instantiations is rejected.

CE2105A checks that CREATE is permitted for an IN_FILE for SEQUENTIAL_IO. An implementation can raise USE_ERROR or NAME_ERROR (see AI-00332). This implementation raises USE_ERROR.

CE2105B checks that CREATE is permitted for an IN_FILE for DIRECT_IO. An implementation can raise USE_ERROR or NAME_ERROR (see AI-00332). This implementation raises USE_ERROR.

CE2111H checks whether resetting an internal file has any effect upon other internal files accessing the same external file for DIRECT_IO. An implementation can raise USE_ERROR or NAME_ERROR (see AI-00332). This implementation raises USE_ERROR.

CE3109A checks that CREATE is permitted for an IN_FILE. An implementation can raise USE_ERROR or NAME_ERROR (see AI-00332). This implementation raises USE_ERROR.

CE3111B checks whether more than one internal file may be associated with the same external file if only one file is opened for writing. An implementation can raise USE_ERROR or NAME_ERROR (see AI-00332). This implementation allows an external file to be simultaneously opened for reading and writing. However, the exception END_ERROR is raised. The reason for END_ERROR being raised is that this implementation allows more than one internal file to be associated with the same external file while one is OPENed in IN_FILE mode and the other is OPENed in OUT_FILE mode with the output being directed to a buffer. When the file is read, the END_ERROR exception is raised because the output has not been flushed to the external file; if the buffer were small enough or the output large enough then the output would be flushed to the external file, but this is problematic. Ada does not define the physical status of a file until that file has been closed.

EE2401D uses instantiations of package DIRECT_IO with unconstrained array types. These instantiations are rejected by this compiler.

The following 201 tests require a floating-point accuracy that exceeds the maximum of 15 digits supported by this implementation:

C24113L..Y (14 tests)	C35705L..Y (14 tests)
C35706L..Y (14 tests)	C35707L..Y (14 tests)
C35708L..Y (14 tests)	C35802L..Z (15 tests)
C45241L..Y (14 tests)	C45321L..Y (14 tests)
C45421L..Y (14 tests)	C45521L..Z (15 tests)
C45524L..Z (15 tests)	C45621L..Z (15 tests)
C45641L..Y (14 tests)	C46012L..Z (15 tests)

3.6 TEST, PROCESSING, AND EVALUATION MODIFICATIONS

It is expected that some tests will require modifications of code, processing, or evaluation in order to compensate for legitimate implementation behavior. Modifications are made by the AVF in cases where legitimate implementation behavior prevents the successful completion of an (otherwise) applicable test. Examples of such

modifications include: adding a length clause to alter the default size of a collection; splitting a Class B test into sub-tests so that all errors are detected; and confirming that messages produced by an executable test demonstrate conforming behavior that wasn't anticipated by the test (such as raising one exception instead of another).

Modifications were required for 69 Class B tests.

The following Class B test files were split because syntax errors at one point resulted in the compiler not detecting other errors in the test:

B22003A	B26001A	B26002A	B26005A
B28001D	B29001A	B2A003A	B2A003B
B2A003C	B33301A	B35101A	B37106A
B37301B	B37302A	B38003A	B38003B
B38009A	B38009B	B51001A	B53009A
B54A01C	B55A01A	B61001C	B61001D
B61001F	B61001H	B61001I	B61001M
B61001R	B61001S	B61001W	B67001A
B67001C	B67001D	B91001A	B91002A
B91002B	B91002C	B91002D	B91002E
B91002F	B91002G	B91002H	B91002I
B91002J	B91002K	B91002L	B95030A
B95061A	B95061F	B95061G	B95077A
B97101A	B97101E	B97102A	B97103E
B97104G	BA1101B0M	BA1101B1	BA1101B2
BA1101B3	BA1101B4	BC10AEB	BC1109A
BC1109C	BC1109D	BC1202A	BC1202B
BC1202E	BC1202F	BC1202G	BC2001D
BC2001E			

C34007A, C34007D, C34007G, C34007M, C34007P, C34007S these tests contain the application of the attribute STORAGE_SIZE to access types for which no corresponding STORAGE_SIZE length clause has been provided; this compiler rejects such an application. The AVO accepted this behavior because the Ada standard is not clear on how such a situation should be treated; the matter will be discussed by the language maintenance body. For this implementation, the lines within each of these tests which have the STORAGE_SIZE length clause were changed to comment lines under the direction of the AVF Manager. These modified tests ran to a successful completion and produced a PASSED message.

3.7 ADDITIONAL TESTING INFORMATION

3.7.1 Prevalidation

Prior to validation, a set of test results for ACVC Version 1.9 produced by the DACS-386/UNIX was submitted to the AVF by the applicant for review. Analysis of these results demonstrated that the compiler successfully passed all applicable tests, and the compiler exhibited the expected behavior on all inapplicable tests.

3.7.2 Test Method

Testing of the DACS-386/UNIX using ACVC Version 1.9 was conducted on-site by a validation team from the AVF. The configuration consisted of a VAX-11/8530 computer (20 Mbytes RAM; 4 456 Mbytes disk drives; 24 terminal ports; 1 1600/6250 bpi tape-drive) operating under VMX Version 4.5 onto which was loaded the magnetic tape, a SUN-3/50 Workstation operating under UNIX V Rel. 1.0.4 which served to transfer the test files onto a streamer tape, a RC900 (386/UNIX V Workstation) and a ICL DRS 300 which served as the host/target computer. The VAX-11/8530 was linked via an Ethernet LAN to the SUN-3/50 Workstation; the SUN-3/50 Workstation was linked via streamer tape to the RC900 (386/UNIX V Workstation) which was in turn linked via floppy disks to the ICL DRS 300.

A magnetic tape containing all tests except for withdrawn tests was taken on-site by the validation team for processing. Tests that make use of implementation-specific values were customized before being written to the magnetic tape. The contents of the magnetic tape were loaded directly onto the VAX-11/8530, then downloaded via an Ethernet LAN to the SUN UNIX Workstation and then downloaded via a streamer tape to the RC900 (386/UNIX V Workstation) and then downloaded via floppy disks to the ICL DRS 300. The contents of these floppy tapes were loaded onto the ICL DRS 300.

After the test files were loaded to disk on the ICL DRS 300, the full set of tests was compiled, and all executable tests were linked and executed on the ICL DRS 300. Results were copied onto floppy disks and loaded onto the RC900 (386/UNIX Workstation); the RC900 (386/UNIX Workstation) wrote a streamer tape which was then transferred to the SUN-3/50 Workstation. The results were then transfered from the SUN-3/50 Workstation via the Ethernet LAN to the VAX-11/8530. The results were then printed from the VAX-11/8530 computer.

The compiler was tested using command scripts provided by DDC-I, Inc. and reviewed by the validation team. The compiler was tested using all default option | switch settings except for the following:

Option | Switch	Effect.
-L	List option
-l	Name of the program library; both the default values and explicitly specified program libraries were used.

Tests were compiled, linked, and executed using the same Host/Target computer. Test output, compilation listings, and job logs were captured on magnetic tape and archived at the AVF.

3.7.3 Test Site

Testing was conducted at Copenhagen, Denmark and was completed on 28 July 1988.

APPENDIX A

CONFORMANCE STATEMENT

APPENDIX A

CONFORMANCE STATEMENT

DDC International A/S has submitted the following Declaration of Conformance statement concerning the DACS-386/UNIX.

DECLARATION OF CONFORMANCE

Compiler Implementor: DDC International A/S
Ada Validation Facility:

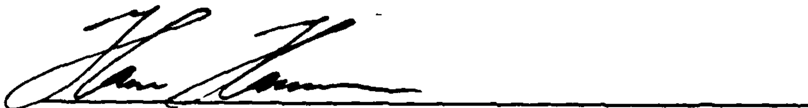
Software Standards Validation Group
Institute for Computer Sciences and Technology
National Bureau of Standards
Building 225, Room A266
Gaithersburg, Maryland 20899

Base Configuration

Base Compiler Name: DACS-386/UNIX, Version: 4.2
Host Architecture ISA:
ICL/DRS 300 OS&VER #: DRS/NX Ver 3 Level 0 Increment 50
Target Architecture ISA:
ICL/DRS 300 OS&VER #: DRS/NX Ver 3 Level 0 Increment 50

Implementor's Declaration

I, the undersigned, representing DDC International A/S, have implemented no deliberate extensions to the Ada Language Standard ANSI/MIL-STD-1815A in the compiler(s) listed in this declaration. I declare that DDC International A/S is the owner of record of the Ada language compiler(s) listed above and, as such, is responsible for maintaining said compiler(s) in conformance to ANSI/MIL-STD-1815A. All certificates and registrations for Ada language compiler(s) listed in this declaration shall be made only in the owner's name.



Date: 26 July 1988

DDC International A/S
Hasse Hanssor. Department Manager, Product Development

Owner's Declaration

I, the undersigned, representing DDC International A/S, take full responsibility for implementation and maintenance of the Ada compiler(s) listed above, and agree to the public disclosure of the final Validation Summary Report. I further agree to continue to comply with the Ada trademark policy, as defined by the Ada Joint Program Office. I declare that all of the Ada language compilers listed, and their host/target performance are in compliance with the Ada Language Standard ANSI/MIL-STD-1815A.

Date: 26 July 1988

DDC International A/S
Hasse Hansson, Department Manager, Product Development

APPENDIX B

APPENDIX F OF THE Ada STANDARD

The only allowed implementation dependencies correspond to implementation-dependent pragmas, to certain machine-dependent conventions as mentioned in chapter 13 of MIL-STD-1815A, and to certain allowed restrictions on representation clauses. The implementation-dependent characteristics of the DACS-80x86, Version 4.2, are described in the following sections which discuss topics in Appendix F of the Ada Language Reference Manual (ANSI/MIL-STD-1815A).. Implementation-specific portions of the package STANDARD are also included in this appendix.

```
package STANDARD is

  type INTEGER is range -2_147_483_648 .. 2_147_483_647;
  type SHORT_INTEGER is range -32_768 .. 32_767;
  type LONG_INTEGER is range
         -16#8000_0000_0000# .. 16#7FFF_FFFF_FFFF_FFFF#;

  type FLOAT is digits 6 range
                    -3.40282366920938E38 .. 3.40282366920938E38;
  type LONG_FLOAT is digits  15 range
              -1.79769313486231 57E308 .. 1.79769313486231 57E308;
  type DURATION is delta 2#1.0#E-14 range -131_072.0 .. 131_071.0;
```

DDC-I Ada Compiler System™

User's Guide

for DACS-386/UNIX™

™DDC-I Ada Compiler System is a trademark of DDC-I, Inc.

November 15, 1988 Document no.: DDC-I 5801/RPT/74, issue 3

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APPENDIX F
IMPLEMENTATION-DEPENDENT CHARACTERISTICS

This appendix describes the implementation-dependent characteristics of DACS-386/UNIX™ as required in Appendix F of the Ada Reference Manual (ANSI/MIL-STD-1815A).

F.1 Implementation-Dependent Pragmas

This section describes all implementation defined pragmas.

F.1.1 Pragma INTERFACE_SPELLING

This pragma allows an Ada program to call a non-Ada program whose name contains characters that would be an invalid Ada subprogram identifier. This pragma must be used in conjunction with pragma INTERFACE, i.e., pragma INTERFACE must be specified for the non- Ada subprogram name prior to using pragma INTERFACE_SPELLING.

The pragma has the format:

```
pragma INTERFACE_SPELLING (subprogram name, string literal);
```

where the subprogram name is that of one previously given in pragma INTERFACE and the string literal is the exact spelling of the interfaced subprogram in its native language. This pragma is only required when the subprogram name contains invalid characters for Ada identifiers.

F.1.2 Pragma INTERRUPT_HANDLER

The DACS-386/UNIX™ allows the use of pragma INTERRUPT_HANDLER for compatibility with other DACS compiler systems. In this implementation this pragma does not have any affect in the Ada program. The following information is reference only. It has the format:

```
pragma INTERRUPT_HANDLER;
```

The pragma must appear as the first thing in the specification of the task object. The task must be specified in a package and not a procedure.

F.1.3 Pragma LT_STACK_SPACE

This pragma sets the size of a library task stack segment. The pragma has the format:

```
pragma LT_STACK_SPACE (T, N);
```

where T denotes either a task object or task type and N designates the size of the library task stack segment in words.

The size of the library task stack is normally specified via the representation clause:

for T'STORAGE_SIZE use N;

The size of the library task stack segment determines how many tasks can be created which are nested within the library task. All tasks created within a library task will have their stacks allocated from the same segment as the library task stack. Thus, pragma LT_STACK_SPACE must be specified to reserve space within the library task stack segment so that nested tasks' stacks may be allocated.

The following restrictions are places on the use of LT_STACK_SPACE:

1) It must be used only for library tasks.

2) It must be placed immediately after the task object or type name declaration.

3) The library task stack segment size (N) must be greater than or equal to the library task stack size.

F.2 Implementation-Dependent Attributes

No implementation-dependent attributes are defined.

F.3 Package System

The package System for DACS-386/UNIX™ is:

```
package System is

    type   Word                    is new Short_Integer;
    type   DWord                   is new Integer;
    type   QWord                   is new Long_Integer
    type   UnsignedWord            is range 0..65535;
    for    UnsignedWord'SIZE       use 16;
    type   UnsignedDword           is range 0..16#7FFF_FFFF#;
    for    UnsignedDWord'SIZE      use 32;

    type   Address is record
             offset            : UnsignedDWord;
    end record;

    subtype Priority           is Word range 0..31;
    type   Name                is (386UNIX);

    System_Name     :  constant Name :=                    386UNIX;
    Storage_Unit    :  constant      :=                         16;
    Memory_Size     :  constant      :=                      2**32;
    Min_Int         :  constant      :=  -16#8000_0000_0000_0000#;
    Max_Int         :  constant      :=  16#7FFF_FFFF_FFFF_FFFF#;
    Max_Digits      :  constant      :=                         15;
    Max_Mantissa    :  constant      :=                         31;
    Fine_Delta      :  constant      :=                 2#1.0#E-31;
    Tick            :  constant      :=            0.000_000_062_5;
                                                --machine dedpendant

    type   Interface_Language is (ASM86, C86, C86_REVERSE);
    type   ExceptionId is record
             unit_number     : UnsignedDWord;
             unique_number   : UnsignedDWord;
    end record;

    type   TaskValue       is new Integer;
    type   AccTaskValue    is access TaskValue;

    type   Semaphore       is record
             counter       : UnsignedWord;
             first         : TaskValue;
             last          : TaskValue;
    end record;

    InitSemaphore          : constant Semaphore'(1, 0, 0);

end SYSTEM;
```

F.4 Representation Clauses

The DACS-386/UNIX™ fully supports the 'SIZE representation for derived types. The representation clauses that are accepted for non-derived types are described in the following subsections.

F.4.1 Length Clause

Some remarks on implementation dependent behavior of length clauses are necessary:

- When using the SIZE attribute for discrete types, the maximum value that can be specified is 16 bits.
- SIZE is only obeyed for discrete types when the type is a part of a composite object, e.g. arrays or records, for example:

```
type byte is range 0..255;
for byte'size use 8;

sixteen_bits_allocated : byte;                  -- one word allocated

eight_bit_per_element : array(0..7) of byte;    -- four words allocated

type rec is record
  c1,c2 : byte;                                 -- eight bits per component
end record;
```

- Using the STORAGE_SIZE attribute for a collection will set an upper limit on the total size of objects allocated in this collection. If further allocation is attempted, the exception STORAGE_ERROR is raised.
- When STORAGE_SIZE is specified in a length clause for a task, the process stack area will be of the specified size. The process stack area will be allocated inside the "standard" stack segment.

F.4.2 Enumeration Representation Clause

Enumeration representation clauses may specify representations in the range of INTEGER'FIRST + 1..INTEGER'LAST - 1.

F.4.3 Record Representation Clauses

When representation clauses are applied to records the following restrictions are imposed:

- the component type is a discrete type different from LONG_INTEGER

- the component type is an array with a discrete element type different from LONG_INTEGER
- the storage unit is 16 bits
- a record occupies an integral number of storage units
- a record may take up a maximum of 32K storage units
- a component must be specified with its proper size (in bits), regardless of whether the component is an array or not.
- if a non-array component has a size which equals or exceeds one storage unit (16 bits) the component must start on a storage unit boundary, i.e. the component must be specified as:

  component at N range 0..16 * M - 1;

  where N specifies the relative storage unit number (0,1,...) from the beginning of the record, and M the required number of storage units (1,2,...)
- the elements in an array component should always be wholly contained in one storage unit
- if a component has a size which is less than one storage unit, it must be wholly contained within a single storage unit:

  component at N range X .. Y;

  where N is as in previous paragraph, and O <= X <= Y <= 15

When dealing with PACKED ARRAY the following should be noted:

- the elements of the array are packed into 1,2,4 or 8 bits

If the record type contains components which are not covered by a component clause, they are allocated consecutively after the component with the value. Allocation of a record component without a component clause is always aligned on a storage unit boundary. Holes created because of component clauses are not otherwise utilized by the compiler.

F.4.3.1 Alignment Clauses

The DACS-386/UNIX™ allows the use of alignment clauses for compatibility with other DACS Ada Compiler Systems. In this implementation, however, these representation clauses do not actually modify the internal data representation of objects. The following information is provided to show the allowed syntax for the representation clauses.

F.5 Implementation-Dependent Names for Implementation -Dependent Components

None defined by the compiler.

F.6 Address Clauses

This section describes the implementation of address clauses and what types of entities may have their address specified by the user. In the DACS 386/UNIX™ implementation, addresses clauses are allowed to provide compatibility with other DACS Ada Compiler Systems, although they do not actually affect the data representation.

F.6.1 Task Entries

The implementation supports two methods to equate a task entry to a hardware interrupt through an address clause:

1) Direct transfer of control to a task accept statement when an interrupt occurs (requires use of the pragma INTERRUPT_HANDLER).

2) Mapping of an interrupt onto a normal conditional entry call, i.e., the entry can be called from other tasks without special actions, as well as being called when an interrupt occurs.

F.7 Unchecked Conversions

Unchecked conversion is only allowed between objects of the same "size".

F.8 Input/Output Packages

The implementation supports all requirements of the Ada language. It is an effective interface to the UNIX file system, and in the case of the text I/O also an effective interface to the UNIX standard input, standard output and standard error streams.

This section describes the functional aspects of the interface to the UNIX file system, including the methods of using the interface to take advantage of the file control facilities provided.

The Ada input-output concept as defined in Chapter 14 of the ARM does not constitute a complete functional specification of the input-output packages. Some aspects of the I/O system are not described at all, with others intentionally left open for implementation. This section describes those sections not covered in the ARM.

The UNIX operating system considers all files to be raw sequences of characters. Files can either be accessed sequentially or randomly. Files are not structured into records, but an access routine can treat a file as a sequence of records if it arranges the record level input-output. Two restrictions that apply are:

- If a direct access (using lseek(2)) to standard input, standard output, or standard error will cause a USE_ERROR to occur.
- Attempting to direct access (using lseek(2), open(2), mknod(2), or pipe(2)) a UNIX pipe or FIFO will cause a USE_ERROR to occur.

Note that for sequential or text files (Ada files not UNIX external files) RESET on a file in mode OUT_FILE will empty the file. Also, a sequential or text file opened as an OUT_FILE will be emptied.

F.8.1 External Files

An external file is either a UNIX disk file, a UNIX FIFO, a UNIX pipe, or any device defined in the UNIX directory. The use of devices such as a tape drive or communication line may require special access permissions or have restrictions. If an inappropriate operation is attempted on a device, the USE_ERROR exception is raised.

External files created within the UNIX file system shall exist after the termination of the program that created it, and will be accessible from other Ada programs. A form created with the FORM parameter will also exist after program termination. However, pipes and temporary files will not exist after program termination.

Creation of a file with the same name as an existing external file will cause the exception USE_ERROR to be raised. Also, creation of files with mode IN_FILE will raise USE_ERROR.

The name parameter to the input/output routines must be a valid UNIX file name. If the name parameter is empty then a temporary file is created in the /tmp directory. This file is automatically deleted when the program that created it terminates.

F.8.2 File Management

This section provides useful information for performing file management functions within an Ada program.

The only restrictions in performing Sequential and Direct I/O are:

- The maximum size of an object of ELEMENT_TYPE is 32k bytes.
- If the size of an object of ELEMENT_TYPE is variable, the maximum size must be determinable at the point of instantiation from the value of the SIZE attribute.

The NAME parameter

The NAME parameter must be a valid UNIX pathname (unless null). If any directory in the pathname is inaccessible, a USE_ERROR is raised.

The UNIX names "stdin", "stdout", and "stderr" can be used with TEXT_IO.OPEN/ No physical opening of the external file is performed and the Ada file will be associated with already open external file. These names have no significance for other packages.

Temporary files (NAME = null string) are created using tmpname(3) and are deleted when CLOSED. Abnormal program termination may leave temporary files in existence.

The FORM parameter

The FORM parameter has the following facilities:

- A FIFO special file can be opened using the open(2) system call. This is achieved with the "FIFO" string. Note that this cannot be used with CREATE.

  The default value for this facility is "ORDINARY", which designates the creation of an ordinary file.

  An additional flag associated with FIFO specials is provided to allow waiting or immediate return. This flag, and its status, is specified with the additional strings, "O_NDELAY=ON" for ON and "O_NDELAY=OFF" for OFF. Default is "O_NDELAY=OFF".

- The "APPEND" string can be used to open text files without emptying the file. This parameter cannot be used with CREATE. The default condition is "NOAPPEND".

- Access rights to a file can be controlled by using a "MODE=<mode>" string in the CREATE procedure. <mode> is an octal, decimal, or hexadecimal integer in the standard UNIX format. Default mode is 0644. This facility can also be used by OPEN to change access permissions on existing files by means of the chmod(2) system call.

If more than one of the three options (FIFO, APPEND, and MODE) is included, the rightmost option is selected. Blanks are not significant within any part of the string. The syntax of the FORM parameter provides all default options as required in the Ada Reference Manual:

<form_parameter> := [<option> ,...]

where <option> := <access rights> | <fifo> | <append>

<access_rights> is MODE=<mode #>. The mode number can be in decimal, octal (0###), or hexadecimal (0##).

<fifo> is either "FIFO [O_NDELAY= ON|OFF]" or "ORDINARY"

<append> is either "APPEND" or "NOAPPEND"

File Access

The following guidelines should be observed when performing file I/O operations:

- At a given instant, any number of files in an Ada program can be associated with corresponding external files.
- When sharing files between programs, it is the responsibility of the programmer to determine the effects of sharing files.
- The RESET and OPEN operations to files of mode OUT_FILE will empty the contents of the file in SEQUENTIAL_IO and TEXT_IO.
- Files can be interchanged between SEQUENTIAL_IO and DIRECT_IO without any special operations, if the files are the same object type.

F.8.3 Package TEXT_IO

The specification of package TEXT_IO:

```
with BASIC_IO_TYPES;

with IO_EXCEPTIONS;
package TEXT_IO is

  type FILE_TYPE is limited private;

  type FILE_MODE is (IN_FILE, OUT_FILE);

  type    COUNT is range 0 .. LONG_INTEGER'LAST;
  subtype POSITIVE_COUNT is COUNT range 1 .. COUNT'LAST;
  UNBOUNDED: constant COUNT:= 0; -- line and page length

 -- max. size of an integer output field 2#....#
  subtype FIELD        is INTEGER range 0 .. 35;

  subtype NUMBER_BASE   is INTEGER range 2 .. 16;

  type TYPE_SET is (LOWER_CASE, UPPER_CASE);

  -- File Management

  procedure CREATE (FILE        : in out FILE_TYPE;
                    MODE        : in     FILE_MODE :=OUT_FILE;
                    NAME        : in     STRING     :="";
                    FORM        : in     STRING     :=""
                    );

  procedure OPEN  ( FILE        : in out FILE_TYPE;
                    MODE        : in     FILE_MODE;
                    NAME        : in     STRING;
                    FORM        : in     STRING   :=""
                    );

  procedure CLOSE    (FILE  : in out FILE_TYPE;)
  procedure DELETE   (FILE  : in out FILE_TYPE);
  procedure RESET    (FILE  : in out FILE_TYPE; MODE  : in FILE_MODE);
  procedure RESET    (FILE  : in out FILE_TYPE);

  function MODE      (FILE  : in FILE_TYPE) return FILE_MODE;
  function NAME      (FILE  : in FILE_TYPE) return STRING;
  function FORM      (FILE  : in FILE_TYPE) return STRING;

  function IS_OPEN   (FILE  : in FILE_TYPE return BOOLEAN;

  -- control of default input and output files

  procedure SET_INPUT  (FILE : in FILE_TYPE);
  procedure SET_OUTPUT (FILE : in FILE_TYPE);
```

```
function STANDARD_INPUT     return FILE_TYPE;
function STANDARD_OUTPUT return FILE_TYPE;

function CURRENT_INPUT   return FILE_TYPE;
function CURRENT_OUTPUT  return FILE_TYPE;

-- specification of line and page lengths

procedure SET_LINE_LENGTH (FILE : in FILE_TYPE; TO : in COUNT);
procedure SET_LINE_LENGTH (TO : in COUNT);

procedure SET_PAGE_LENGTH (FILE : in FILE_TYPE; TO : in COUNT);
procedure SET_PAGE_LENGTH (TO : in COUNT);

function LINE_LENGTH (FILE : in FILE_TYPE) return COUNT;
function LINE_LENGTH  return COUNT;

function PAGE_LENGTH  (FILE : in FILE_TYPE) return COUNT;
function PAGE_LENGTH  return COUNT;

-- Column, Line, and Page Control

procedure NEW_LINE (FILE : in FILE_TYPE;
                    SPACING : in POSITIVE_COUNT := 1);
procedure NEW_LINE (SPACING : in POSITIVE_COUNT := 1);

procedure SKIP_LINE (FILE : in FILE_TYPE;
          SPACING : in POSITIVE_COUNT := 1);
procedure SKIP_LINE (SPACING : in POSITIVE_COUNT := 1);

function END_OF_LINE (FILE : in FILE_TYPE) return BOOLEAN;
function END_OF_LINE                       return BOOLEAN;

procedure NEW_PAGE   (FILE : in FILE_TYPE);
procedure NEW_PAGE;

procedure SKIP_PAGE  (FILE : in FILE_TYPE);
procedure SKIP_PAGE;

function END_OF_PAGE (FILE : in FILE_TYPE) return BOOLEAN;
function END_OF_PAGE                       return BOOLEAN;

function END_OF_FILE (FILE : in FILE_TYPE) return BOOLEAN;
function END_OF_FILE                       return BOOLEAN;

procedure SET_COL    (FILE : in FILE_TYPE;  TO   : in POSITIVE_COUNT);
procedure SET_COL    (TO : in POSITIVE_COUNT);

procedure SET_LINE   (FILE : in FILE_TYPE; TO : in POSITIVE_COUNT);
procedure SET_LINE   (TO : in POSITIVE_COUNT);

function COL     (FILE : in FILE_TYPE) return POSITIVE_COUNT;
function COL                           return POSITIVE_COUNT;
```

```
function  LINE    (FILE : in FILE_TYPE) return POSITIVE_COUNT;
function  LINE                          return POSITIVE_COUNT;

function  PAGE    (FILE : in FILE_TYPE) return POSITIVE_COUNT;
function  PAGE                          return POSITIVE_COUNT;

-- Character Input-Output

procedure GET  (FILE   : in FILE_TYPE; ITEM : out CHARACTER);
procedure GET  ( ITEM  : out CHARACTER);
procedure PUT  (FILE   : in FILE_TYPE; ITEM :  in CHARACTER);
procedure PUT  (ITEM   :  in CHARACTER);

-- String Input-Output

procedure GET  (FILE   : in FILE_TYPE; ITEM : out CHARACTER);
procedure GET  (ITEM   : out CHARACTER);
procedure PUT  (FILE   : in FILE_TYPE; ITEM :  in CHARACTER);
procedure PUT  (ITEM   :  in CHARACTER);

procedure GET_LINE  (FILE    : in FILE_TYPE;
                     ITEM    : out STRING;
                     LAST    : out NATURAL);

procedure GET_LINE  (ITEM    : out STRING; LAST : out NATURAL);
procedure PUT_LINE  (FILE    : in FILE_TYPE;  ITEM :  in STRING);
procedure PUT_LINE  (ITEM    :  in STRING);
```

```
-- Generic Package for Input-Output of Integer Types

generic
  type NUM is range <> is

  DEFAULT_WIDTH : FIELD          := NUM'WIDTH;
  DEFAULT_BASE  : NUMBER_BASE    :=     10;

  procedure GET (  FILE     : in FILE_TYPE;
                   ITEM     : out NUM;
                   WIDTH    : in FIELD := 0);
  procedure GET (  ITEM     : out NUM;
                   WIDTH    : in FIELD := 0);

  procedure PUT (  FILE     : in FILE_TYPE;
                   ITEM     :  in NUM;
                   WIDTH    :  in FIELD := DEFAULT_WIDTH;
                   BASE     :  in NUMBER_BASE := DEFAULT_BASE);
  procedure PUT (  ITEM     :  in NUM;
                   WIDTH    :  in FIELD := DEFAULT_WIDTH;
                   BASE     :  in NUMBER_BASE := DEFAULT_BASE);

  procedure GET (  FROM     : in STRING;
                   ITEM     : out NUM;
                   LAST     : out POSITIVE);

  procedure PUT (  TO       : out STRING;
                   ITEM     :  in NUM;
                   BASE     :  in NUMBER_BASE := DEFAULT_BASE);

end INTEGER_IO;
```

```
-- Generic Packages for Input-Output of Real Types

generic
  type NUM is digits <>;
package FLOAT_IO is

  DEFAULT_FORE : FIELD :=          2;
  DEFAULT_AFT  : FIELD := NUM'DIGITS - 1;
  DEFAULT_EXP  : FIELD :=          3;

  procedure GET (  FILE   : in FILE_TYPE;
                   ITEM   : out NUM;
                   WIDTH  : in FIELD := 0);
  procedure GET (  ITEM   : out NUM;
                   WIDTH  : in FIELD := 0);

  procedure PUT (  FILE   : in FILE_TYPE;
                   ITEM   : in NUM;
                   FORE   : in FIELD := DEFAULT_FORE;
                   AFT    : in FIELD := DEFAULT_AFT;
                   EXP    : in FIELD := DEFAULT_EXP);
  procedure PUT (  ITEM   : in NUM;
                   FORE   : in FIELD := DEFAULT_FORE;
                   AFT    : in FIELD := DEFAULT_AFT;
                   EXP    : in FIELD := DEFAULT_EXP);

  procedure GET (  FROM   : in STRING;
                   ITEM   : out NUM;
                   LAST   : out POSITIVE);
  procedure PUT (  TO     : out STRING;
                   ITEM   :  in NUM;
                   AFT    :  in FIELD        := DEFAULT_AFT;
                   EXP    :  in FIELD        := DEFAULT_EXP);

end FLOAT_IO;
```

```
generic
  type NUM is delta <>;
package FIXED_IO is

  DEFAULT_FORE   : FIELD := NUM'FORE;
  DEFAULT_AFT    : FIELD := NUM'AFT;
  DEFAULT_EXP    : FIELD := 0;

  procedure GET (  FILE      : in     FILE_TYPE;
                   ITEM      :    out NUM;
                   WIDTH     : in     FIELD        := 0);
  procedure GET (  TEM       : out NUM;
                   WIDTH     : in FIELD            := 0);

  procedure PUT (  FILE      : in FILE_TYPE;
                   ITEM      : in NUM;
                   FORE      : in FIELD := DEFAULT_FORE;
                   AFT       : in FIELD := DEFAULT_AFT;
                   EXP       : in FIELD := DEFAULT_EXP);
  procedure PUT (  ITEM      : in NUM;
                   FORE      : in FIELD := DEFAULT_FORE;
                   AFT       : in FIELD := DEFAULT_AFT;
                   EXP       : in FIELD := DEFAULT_EXP);

  procedure GET (  FROM      : in STRING;
                   ITEM      : out NUM;
                   LAST      : out POSITIVE);

  procedure PUT (  TO        : out STRING;
                   ITEM      :  in NUM;
                   AFT       :  in FIELD := DEFAULT_AFT;
                   EXP       :  in FIELD := DEFAULT_EXP);

end FIXED_IO;
```

```
   -- Generic Package for Input-Output of Enumeration Types

 generic
   type ENUM is (<>);
 package ENUMERATION_IO is

   DEFAULT_WIDTH         : FIELD      := 0;
   DEFAULT_SETTING       : TYPE_SET   := UPPER_CASE;

   procedure GET (   FILE : in FILE_TYPE; ITEM : out ENUM);
   procedure GET (   ITEM: out ENUM);

   procedure PUT (   FILE         : FILE_TYPE;
                     ITEM         : in ENUM;
                     WIDTH        : in FIELD          := DEFAULT_WIDTH;
                     SET          : in TYPE_SET       := DEFAULT_SETTING);
   procedure PUT (   ITEM         : in ENUM;
                     WIDTH        : in FIELD          := DEFAULT_WIDTH;
                     SET          : in TYPE_SET       := DEFAULT_SETTING);

   procedure GET (   FROM         : in  STRING;
                     ITEM         : out ENUM;
                     LAST         : out POSITIVE);

   procedure PUT (   TO           : out STRING;
                     ITEM         : in  ENUM;
                     SET          : in  TYPE_SET      := DEFAULT_SETTING);

 end ENUMERATION_IO;

   -- Exceptions

   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

   type FILE_TYPE is new BASIC_IO_TYPES.FILE_TYPE;

 end TEXT_IO;
```

F.8.4 Package LOW_LEVEL_IO

The specification of LOW_LEVEL_IO is:

```
with SYSTEM;

package LOW_LEVEL_IO is

    subtype port_address is System.Word;

    type byte is new integer;

    procedure send_control     (device  : in port_address;  data  : in System.Word);

    procedure send_control     (device  : in port_address;  data  : in byte);

    procedure receive_control  (device  : in port_address;  data  : out byte);

    procedure receive_control  (device  : in port_address;  data  : out System.Word);

    private

        pragma inline          (send_control, receive_control);

end LOW_LEVEL_IO;
```

F.8.5 Package SEQUENTIAL_IO

In SEQUENTIAL_IO, type checking for DATA_ERROR has been excluded for elements are an unconstrained type.

```
-- Source code for SEQUENTIAL_IO

with IO_EXCEPTIONS;

generic

  type ELEMENT_TYPE is private;

package SEQUENTIAL_IO is

  type FILE_TYPE is limited private;

  type FILE_MODE is (IN_FILE, OUT_FILE);

-- File management

  procedure CREATE(FILE  : in out FILE_TYPE;
                   MODE  : in     FILE_MODE := OUT_FILE;
                   NAME  : in     STRING    := "";
                   FORM  : in     STRING    := "");

  procedure OPEN ( FILE  : in out FILE_TYPE;
                   MODE  : in     FILE_MODE;
                   NAME  : in     STRING;
                   FORM  : in     STRING    := "");

  procedure CLOSE (FILE  : in out FILE_TYPE);

  procedure DELETE(FILE  : in out FILE_TYPE);

  procedure RESET (FILE  : in out FILE_TYPE; MODE : in   FILE_MODE);

  procedure RESET (FILE  : in out FILE_TYPE);

  function MODE   (FILE  : in FILE_TYPE) return FILE_MODE;

  function NAME   (FILE  : in FILE_TYPE) return STRING;

  function FORM   (FILE  : in FILE_TYPE) return STRING;

  function IS_OPEN(FILE  : in FILE_TYPE) return BOOLEAN;

-- input and output operations

  procedure READ ( FILE  : in     FILE_TYPE;
                   ITEM  :    out ELEMENT_TYPE);
```

```
  procedure WRITE ( FILE    : in FILE_TYPE;
                    ITEM    : in ELEMENT_TYPE);

  function END_OF_FILE(FILE : in FILE_TYPE) return BOOLEAN;

-- exceptions

  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;

private

  type FILE_TYPE is new BASIC_IO_TYPES.FILE_TYPE;

end SEQUENTIAL_IO;
```

F.8.6 Package Direct_IO

In DIRECT_IO, type checking for DATA_ERROR has been excluded for elements of an unconstrained type.

```
with BASIC_IO_TYPES;
with IO_EXCEPTIONS;

generic

    type ELEMENT_TYPE is private;

package DIRECT_IO is

    type FILE_TYPE is limited private;

    type FILE_MODE is (IN_FILE, INOUT_FILE, OUT_FILE);

    type COUNT is range 0..LONG_INTEGER'LAST;

    subtype POSITIVE_COUNT is COUNT range 1..COUNT'LAST;

  -- File management

  procedure CREATE(FILE   : in out FILE_TYPE;
                   MODE   : in     FILE_MODE := INOUT_FILE;
                   NAME   : in     STRING    := "";
                   FORM   : in     STRING    := "");

  procedure OPEN ( FILE   : in out FILE_TYPE;
                   MODE   : in     FILE_MODE;
                   NAME   : in     STRING;
                   FORM   : in     STRING    := "");

  procedure CLOSE (FILE   : in out FILE_TYPE);

  procedure DELETE(FILE   : in out FILE_TYPE);

  procedure RESET (FILE   : in out FILE_TYPE;
                   MODE   : in     FILE_MODE);

  procedure RESET (FILE   : in out FILE_TYPE);

  function MODE   (FILE   : in     FILE_TYPE) return FILE_MODE;

  function NAME   (FILE   : in     FILE_TYPE) return STRING;

  function FORM   (FILE   : in     FILE_TYPE) return STRING;

  function IS_OPEN(FILE   : in     FILE_TYPE) return BOOLEAN;
```

```
-- input and output operations

  procedure READ ( FILE   : in       FILE_TYPE;
                   ITEM   :    out   ELEMENT_TYPE;
                   FROM   : in       POSITIVE_COUNT);
  procedure READ ( FILE   : in       FILE_TYPE;
                   ITEM   :    out   ELEMENT_TYPE);

  procedure WRITE ( FILE  : in       FILE_TYPE;
                    ITEM  : in       ELEMENT_TYPE;
                    TO    : in       POSITIVE_COUNT);
  procedure WRITE ( FILE  : in       FILE_TYPE;
                    ITEM  : in       ELEMENT_TYPE);

  procedure SET_INDEX(FILE : in FILE_TYPE;
                      TO   : in POSITIVE_COUNT);

  function INDEX(FILE : in FILE_TYPE) return POSITIVE_COUNT;

  function SIZE (FILE : in FILE_TYPE) return COUNT;

  function END_OF_FILE(FILE : in FILE_TYPE) return BOOLEAN;

-- exceptions

  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;

private

  type FILE_TYPE is new BASIC_IO_TYPES.FILE_TYPE;

end DIRECT_IO;
```

F.9 Machine Code Insertions

The reader should be familiar with the code generation strategy and the 80386 instruction set to fully benefit from this section.

As described in chapter 13.8 of the ARM [83] it is possible to write procedures containing only code statements using the predefined package MACHINE_CODE. The package MACHINE_CODE defines the type MACHINE_INSTRUCTION which, used as a record aggregate, defines a machine code insertion. The following sections list the type MACHINE_INSTRUCTION and types on which it depends, give the restrictions, and show an example of how to use the package MACHINE_CODE.

F.9.1 Predefined Types for Machine Code Insertions

The following types are defined for use when making machine code insertions (their type declarations are given in the following pages):

```
type opcode_type
type operand_type
type register_type
type segment_register
type machine_instruction
```

The type REGISTER_TYPE defines registers and register combinations. The double register combinations (e.g. BX_SI) can be used only as address operands (BX_SI describing [BX+SI]). The registers STi describe registers on the floating stack. (ST is the top of the floating stack).

The type SEGMENT_REGISTER defines the four segment registers that can be used to overwrite default segments in an address operand.

The type MACHINE_INSTRUCTION is a discriminant record type with which every kind of instruction can be described. Symbolic names may be used in the form

```
name'ADDRESS
```

```
type opcode_type is (
        -- 8086 instructions:
            m_AAA,      m_AAD,      m_AAM,      m_AAS,
            m_ADC,      m_ADD,      m_AND,
            m_CALL,     m_CALLn,
            m_CBW,      m_CLC,      m_CLD       m_CLI,
            m_CMC,      m_CMP,      m_CMPS,     m_CWD,
            m_DAA,      m_DAS,
            m_DEC,      m_DIV,      m_HLT,
            m_IDIV,     m_IMUL,     m_IN,       m_INC,
            m_INT,      m_INTO,     m_IRET,
            m_JA,       m_JAE,      m_JB,       m_JBE,
            m_JC,       m_JCXZ,     m_JE,       m_JG,
            m_JGE,      m_JL,       m_JLE,      m_JNA,
```

```
          m_JNAE,     m_JNB,      m_JNBE,     m_JNC
          m_JNE,      m_JNG,      m_JNGE,     m_JNL,
          m_JNLE,     m_JNO,      m_JNP,      m_JNS,
          m_JNZ,      m_JO,       m_JP,       m_JPE,
          m_JPO,      m_JS,       m_JZ,       m_JMP,
          m_LAHF,     m_LDS,      m_LES,      m_LEA,
          m_LOCK,     m_LODS,
          m_LOOP,     m_LOOPE,    m_LOOPNE,   m_LOOPNZ,
          m_LOOPZ,    m_MOV,      m_MOVS,     m_MUL,
          m_NEG,      m_NOP,      m_NOT,      m_OR,
          m_OUT,      m_POP,      m_POPF,     m_PUSH,
          m_PUSHF,
          m_RCL,      m_RCR,      m_ROL,      m_ROR,
          m_REP,      m_REPE,     m_REPNE,
          m_RET,      m_RETP,     m_RETN,     m_RETNP,
          m_SAHF,
          m_SAL,      m_SAR,      m_SHL,      m_SHR,
          m_SBB,      m_SCAS,
          m_STC,      m_STD,      m_STI,      m_STOS,
          m_SUB,      m_TEST,     m_WAIT,     m_XCHG,
          m_XLAT,     m_XOR,

-- 8087/80187/80287 Floating Point Processor instructions
          m_FABS,     m_FADD,     m_FADDD,    m_FADDP,
          m_FBLD,     m_FBSTP,    m_FCHS,     m_FNCLEX,
          m_FCOM,     m_FCOMD,    m_FCOMP,    m_FCOMPD,
          m_FCOMPP,   m_FDECSTP,  m_FDIV,     m_FDIVD,
          m_FDIVP,    m_FDIVR,    m_FDIVRD,   m_FDIVRP,
          m_FFREE,    m_FIADD,    m_FIADDD,   m_FICOM,
          m_FICOMD,   m_FICOMP,   m_FICOMPD,  m_FIDIV,
          m_FIDIVD,   m_FIDIVR,   m_FIDIVRD,
          m_FILD,     m_FILDD,    m_FILDL,    m_FIMUL,
          m_FIMULD,   m_FINCSTP,  m_FNINIT,   m_FIST,
          m_FISTD,    m_FISTP,    m_FISTPD,   m_FISTPL,
          m_FISUB,
          m_FISUBD,   m_FISUBR,   m_FISUBRD,  m_FLD,
          m_FLDD,     m_FLDCW,    m_FLDENV,   m_FLDLG2,
          m_FLDLN2,   m_FLDL2E,   m_FLDL2T,   m_FLDPI,
          m_FLDZ,     m_FLD1,     m_FMUL,     m_FMULD,
          m_FMULP,    m_FNOP,     m_FPATAN,   m_FPREM,
          m_FPTAN,    m_FRNDINT,  m_FRSTOR,   m_FSAVE,
          m_FSCALE,   m_FSETPM,   m_FSQRT,
          m_FST,      m_FSTD,     m_FSTCW,
          m_FSTENV,   m_FSTP,     m_FSTPD,    m_FSTSW,
          m_FSTSWAX,  m_FSUB,     m_FSUBD,    m_FSUBP,
          m_FSUBR,    m_FSUBRD,   m_FSUBRP,   m_FTST,
          m_FWAIT,    m_FXAM,     m_FXCH,     m_FXTRACT,
          m_FYL2X,    m_FYL2XP1,  m_F2XM1,
```

```
-- 80186/80286/80386 instructions:
-- Notice that some immediate versions ot the 8086 instructions
-- only exist on these targets (shifts, rotates, push, imul, ...)

        m_BOUND,    m_CLTS,      m_ENTER,     m_INS,
        m_LAR,      m_LEAVE,     m_LGDT,      m_LIDT
        m_LSL       m_OUTS       m_POPA,      m_PUSHA
        m_SGDT,     m_SIDT,
        m_ARPL,     m_LLDT,      m_LMSW,      m_LTR,
        m_SLDT,     m_SMSW,      m_STR,       m_VERR,
        m_VERW,
-- the 80386 specific instructions:

        m_SETA,     m_SETAE,     m_SETB,      m_SETBE,
        m_SETC,     m_SETE,      m_SETG,      m_SETGE,
        m_SETL,     m_SETLE,     m_SETNA,     m_SETNAE,
        m_SETNB,    m_SETNBE,    m_SETNC,     m_SETNE,
        m_SETNG,    m_SETNGE,    m_SETNL,     m_SETNLE
        m_SETNO,    m_SETNP,     m_SETNS,     m_SETNZ,
        m_SETO,     m_SETP,      m_SETPE,     m_SETPO,
        m_SETS,     m_SETZ,

        m_BSF,      m_BSR,
        m_BT,       m_BTC,       m_BTR,       m_BTS,
        m_LFS,      m_LGS,       m_LSS,
        m_MOVZX     m_MOVSX,
        m_MOVCR,    m_MOVDB,     m_MOVTR,
        m_SHLD,     M_SHRD,

    -- the 80387 specific instructions
        m_FUCOM,    m_FUCOMP,    m_FUCOMPP
        m_FPREM1,   m_FSIN,      m_FCOS,      m_FSINCOS
```

```
-- byte/word/dword variants (to be used, when not deductible from
-- context)
                m_ADDCB,    m_ADCW,     m_ADCD,
                m_ADDB,     m_ADDW,     m_ADDD,
                m_ANDB,     m_ANDW,     m_ANDD,
                m_BTW,      m_BTD,
                m_BTCW,     m_BTCD,
                m_BTRW,     m_BTRD,
                m_BTSW,     m_BTSD,
                m_CBWW,     m_CWDE,
                m_CWDW      m_CDQ,
                m_CMPB,     m_CMPW,     m_CMPD,
                m_CMPSB,    m_CMPSW,    m_CMPSD,
                m_DECB,     m_DECW,     m_DECD,
                m_DIVB,     m_DIVW,     m_DIVD,
                m_IDIVB,    m_IDIVW,    m_IDIVD,
                m_IMULB,    m_IMULW,    m_IMULD,
                m_INCB,     m_INCW,     m_INCD,
                m_INSB,     m_INSW,     m_INSD,
                m_LODSB,    m_LODSW,    m_LODSD,
                m_MOVB,     m_MOVW,     m_MOVD,
                m_MOVSB,    m_MOVSW,    m_MOVSD,
                m_MOVSXB,   m_MOVSXW,
                m_MOVZXB,   m_MOVZXW,
                m_MULB,     m_MULW,     m_MULD,
                m_NEGB,     m_NEGW,     m_NEGD,
                m_NOTB,     m_NOTW,     m_NOTD,
                m_ORB,      m_ORW,      m_ORD,
                m_OUTSB,    m_OUTSW,    m_OUTSD,
                m_POPW,     m_POPD,
                m_PUSHW,    m_PUSHD,
                m_RCLB,     m_RCLW,     m_RCLD,
                m_RCRB,     m_RCRW,     m_RCRD,
                m_ROLB,     m_ROLW,     m_ROLD,
                m_RORB,     m_RORW,     m_RORD,
                m_SALB,     m_SALW,     m_SALD,
                m_SARB,     m_SARW,     m_SARD,
                m_SHLB,     m_SHLW,     m_SHLDW,
                m_SHRB,     m_SHRW,     m_SHRDW,
                m_SBBB,     m_SBBW,     m_SBBD,
                m_SCASB,    m_SCASW,    m_SCASD,
                m_STOSB,    m_STOSW,    m_STOSD,
                m_SUBB,     m_SUBW,     m_SUBD,
                m_TESTB,    m_TESTW,    m_TESTD,
                m_XORB,     m_XORW,     m_XORD,
                m_DATAB,    m_DATAW,    m_DATAD

    -- Special 'instructions'

                m_label,    m_reset);
```

```
type operand_type is ( none,                         -- no operands

                immediate,                           -- 1 immediate operand
                register,                            -- 1 register operand
                address,                             -- 1 address operand
                system_address,                      -- 1 'address operand
                name,                                -- CALL name
                register_immediate,                  -- 2 operands: dest is
                                                     -- register, source is
                                                     -- immediate
                register_register,                   -- 2 register operands
                register_address,                    -- 2 operands: dest is register,
                                                     -- source is address
                address_register,                    -- 2 operands: dest is address,
                                                     -- source is register
                register_system_address,             -- 2 operands: dest is register,
                                                     -- source is 'address
                system_address_register,             -- 2 operands: dest is 'address,
                                                     -- source is register
                address_immediate,                   -- 2 operands: dest is 'address,
                                                     -- source is immediate
                system_address_immediate,            -- 2 operands: dest is 'address,
                                                     -- source is immediate
                immediate_register,                  -- only allowed for OUT port is
                                                     -- immediate source is register
                immediate_immediate,                 -- only allowed for ENTER
                register_register_immediate,         -- allowed for IMULimm,SHRDimm,
                                                     -- and SHLDimm
                register_address_immediate           -- allowed for IMULimm
                register_system_address_immediate    -- allowed for IMULimm
                address_register_immediate           -- allowed for SHRDimm,
                                                     -- SHLDimm
                system_address_register_immediate    -- allowed for SHRDimm,
                                                     -- SHLDimm
                );

type register_type is ( AX, CX, DX, BX,              -- word registers
                SP, BP, SI, DI,                      --

                AL, CL, DL, BL,                      -- byte registers
                AH, CH, DH, BH,                      --

                EAX, ECX, EDX, EBX                   -- dword registers
                ESP, EBP, ESI, EDI

                ES, CS, SS, DS,                      -- selector registers
                FS, GS

                BX_SI, BX_DI,                        -- 8086/80186/80286
                BP_SI, BP_DI,                        -- combinations

                ST, ST1, ST2, ST3,                   -- floating stack registers
                ST4, ST5, ST6, ST7,
                nil );
```

```
type segment_register is ( ES, CS, SS, DS, FS, GS, nil );

subtype machine_string is string (1..100);

pragma page;
type machine_instruction (operand_kind : operand_type is record
   opcode              : opcode_type;

   case operand_kind is
     when immediate =>
       immediate           : integer;

     when register =>
       r_register          : register_type;

     when address =>
       a_segment           : register_type;
       a_address_reg       : register_type;
       a_offset            : integer;

     when system_address =>
       sa_address          : system.address;

     when name =>
       n_string            : machine_string;

     when register_immediate =>
       r_i_register        : register_type;
       r_i_immediate       : integer;

     when register_register =>
       r_r_register_to     : register_type;
       r_r_register_from :  register_type;

     when register_address =>
       r_a_register_to     : register_type;
       r_a_segment         : segment_register;
       r_a_address_reg     : register_type;
       r_a_offset          : integer;

     when address_register =>
       a_r_segment         : segment_register;
       a_r_address_reg     : register_type;
       a_r_offset          : integer;
       a_r_register_from   : register_type;

     when register_system_address =>
       r_sa_register_to    : register_type;
       r_sa_address        : system.address

     when system_address_register =>
       sa_r_address        : system.address;
       sa_r_reg_from       : register_type;
```

```
        when address_immediate =>
          a_i_segment            : segment_register;
          a_i_address_reg        : register_type;
          a_i_offset             : integer;
          a_i_immediate          : integer;

        when system_address_immediate =>
          sa_i_address           : system.address;
          sa_i_immediate         : integer;

        when immediate_register =>
          i_r_register           : integer;
          i_r_register           : register_type;

        when immediate_immediate =>
          i_i_immediate1         : integer;
          i_i_immediate2         : integer;

        when register_register_immediate =>
          r_r_i_register1        : register_type;
          r_r_i_register2        : register_type;
          r_r_i_immediate2       : integer;

        when register_address_immediate =>
          r_a_i_register         : register_type;
          r_a_i_segment          : register_type;
          r_a_i_address_reg      : register_type;
          r_a_i_offset           : integer;
          r_a_i_immediate        : integer;

        when register_system_address_immediate =>
          r_sa_i_register        : register_type;
          addr10                 : system.address;
          r_sa_i_immediate       : integer;

        when address_register_immediate =>
          a_r_i_register         : register_type;
          a_r_i_segment          : register_type;
          a_r_i_address_reg      : register_type;
          a_r_i_offset           : integer;
          a_r_i_immediate        : integer;

        when system_address_register_immediate =>
          sa_r_i_address         : system.address;
          sa_r_i_register        : register_type;
          sa_r_i_immediate       : integer;

        when others =>
          null;
      end case;
    end record;
```

F.9.2 Restrictions

Only procedures, and not functions, may contain machine code insertions. Also procedures that use machine code insertions specified with PRAGMA inline.

Symbolic names in the form x'ADDRESS can only be used in the following cases:

1) x is an object of scalar type or access type declared as an object, a formal parameter, or by static renaming.

2) x is an array with static constraints declared as an object (not as a formal parameter or by renaming).

3) x is a record declared as an object (not a formal parameter or by renaming).

All opcodes defined by the type OPCODE_type except the m_CALL can be used.

Two opcodes to handle labels have been defined:

m_label: defines a label. The label number must be in therange 1 <= x <= 25 and is put in the offset field in the first operand of the MACHINE_INSTRUCTION.

m_reset: used to enable use of more than 25 labels. The label number after a m_RESET must be in the range 1 <= x <=25. To avoid errors you must make sure that all used labels have been defined before a reset, since the reset operation clears all used labels.

All floating instructions have at most one operand which can be any of the following:

- a memory address
- a register or an immediate value
- an entry in the floating stack

F.9.3 Examples

The following section contains examples of how to use the machine code insertions and lists the generated code.

F.9.3.2 Example Using Labels

The following assembler code can be described by machine code insertions as shown:

```
   MOV    AX,7
   MOV    CX,4
   CMP    AX,CX
   JG     1
   JE     2
   MOV    CX,AX
1: ADD    AX,CX
2: MOV    SS: [BP+DI], AX
```

```
with MACHINE_CODE; use MACHINE_CODE;
package example_MC is

   procedure test_labels;
   pragma inline (test_labels);

end example_MC;

package body example_MC is


procedure test_labels is

begin

 MACHINE_INSTRUCTION'(register_immediate, m_MOV, AX, 7);
 MACHINE_INSTRUCTION'(register_immediate, m_MOV, CX, 4);
 MACHINE_INSTRUCTION'(register_register, m_CMP, AX, CX);
 MACHINE_INSTRUCTION'(immediate, m_JG, 1);
 MACHINE_INSTRUCTION'(immediate, m_JE, 2);
 MACHINE_INSTRUCTION'(register_register, m_MOV, CX, AX);
 MACHINE_INSTRUCTION'(immediate, m_label, 1);
 MACHINE_INSTRUCTION'(register_register, m_ADD, AX, CX);
 MACHINE_INSTRUCTION'(immediate, m_label, 2);
 MACHINE_INSTRUCTION'(address_register,m_MOV,SS,BP_DI,O,AX);

end test_labels;

end example_MC;
```

F.10 Package Tasktypes

The TaskTypes packages defines the TaskControlBlock type. This data structure could be useful in debugging a tasking program.

```
with System;
package TaskTypes is

  subtype Offset       is System.UnsignedDWord;
  subtype BlockId      is System.UnsignedDWord;

  type   TaskEntry     is new System.UnsignedDWord;
  type   EntryIndex    is new System.UnsignedDWord;
  type   AlternativeId is new System.UnsignedDWord;
  type   Ticks         is new System.UnsignedDWord;
  type   Bool          is new Boolean;
  for    Bool'size     use 8;
  type   UIntg         is new System.UnsignedDWord;

  type   TaskState    is (Initial,
                          Engaged,
                          Running,
                          Delayed,
                          EntryCallingTimed,
                          EntryCallingUnconditional,
                          SelectingTimed,
                          SelectingTerminable,
                          Accepting,
                          Synchronizing,
                          Completed,
                          Terminated);

  type TaskTypeDescriptor is
    record
      priority              : System.Priority;
      entry_count           : UIntg;
      block_id              : BlockId;
      first_own_address     : System.Address;
      module_number         : UIntg;
      entry_number          : UIntg;
      code_address          : System.Address;
      stack_size            : System.QWord;
      stack_segment_size    : UIntg;
    end record;

  type NPXSaveArea is array(1..48) of System.Word;

pragma page;
  type TaskControlBlock is
    record
      sem           : System.Semaphore;
```

```
-- Delay queue handling

dnext            : System.TaskValue ;
dprev            : System.TaskValue ;
ddelay           : Ticks ;

-- Saved registers

SS               : System.Word ;
SP               : Offset ;

-- Ready queue handling

next             : System.TaskValue ;

-- Semaphore handling

semnext          : System.TaskValue ;

-- Priority fields

priority         : System.Priority;
saved_priority   : System.Priority;

time_slice       : Ticks;

stack_start      : Offset;
stack_end        : Offset;

-- State fields

state            : TaskState;
is_abnormal      : Bool;
is_activated     : Bool;
failure          : Bool;

-- Activation handling fields

activator        : System.TaskValue;
act_chain        : System.TaskValue;
next_chain       : System.TaskValue;
no_not_act       : System.Word;
act_block        : BlockId;

-- Accept queue fields

partner          : System.TaskValue;
next_partner     : System.TaskValue;

-- Entry queue fields

next_caller      : System.TaskValue;
```

```
  -- Rendezvous fields

     called_task      : System.TaskValue;
     task_entry       : TaskEntry;
     entry_index      : EntryIndex;
     entry_assoc      : System.Address;
     call_params      : System.Address;
     alt_id           : AlternativeId;
     excp_id          : System.ExceptionId;

  -- Dependency fields

     parent_task      : System.TaskValue;
     parent_block     : BlockId;
     child_task       : System.TaskValue;
     next_child       : System.TaskValue;
     first_child      : System.TaskValue;
     prev_child       : System.TaskValue;
     child_act        : System.Word;
     block_act        : System.Word;
     terminated_task  : System.TaskValue;

  -- Abortion handling fields

     busy             : System.Word;

  -- Auxiliary fields

     ttd              : TaskTypeDescriptor;
     segment_size     : System.Word;

  -- Run-Time System fields

     ACF              : Offset;
     collection       : System.Address;

  -- NPX save area
     NPXSave          : NPXSaveArea;
  end record;

end TaskTypes;
```

APPENDIX C

TEST PARAMETERS

Certain tests in the ACVC make use of implementation-dependent values, such as the maximum length of an input line and invalid file names. A test that makes use of such values is identified by the extension .TST in its file name. Actual values to be substituted are represented by names that begin with a dollar sign. A value must be substituted for each of these names before the test is run. The values used for this validation are given below.

Name and Meaning	Value
$BIG_ID1 Identifier the size of the maximum input line length with varying last character.	<125 X "A">1
$BIG_ID2 Identifier the size of the maximum input line length with varying last character.	<125 X "A">2
$BIG_ID3 Identifier the size of the maximum input line length with varying middle character.	<63 X "A">3<62 X "A">
$BIG_ID4 Identifier the size of the maximum input line length with varying middle character.	<63 X "A">4<62 X "A">
$BIG_INT_LIT An integer literal of value 298 with enough leading zeroes so that it is the size of the maximum line length.	<123 X "0">298
$BIG_REAL_LIT A universal real literal of value 690.0 with enough leading zeroes to be the size of the maximum line length.	<120 X "0">69.0E1

$BIG_STRING1 <63 X "A">

A string literal which when catenated with BIG_STRING2 yields the image of BIG_ID1.

$BIG_STRING2 <62 X "A">1

A string literal which when catenated to the end of BIG_STRING1 yields the image of BIG_ID1.

$BLANKS <106 X " ">

A sequence of blanks twenty characters less than the size of the maximum line length.

$COUNT_LAST 2147483647

A universal integer literal whose value is TEXT_IO.COUNT'LAST.

$FIELD_LAST 35

A universal integer literal whose value is TEXT_IO.FIELD'LAST.

$FILE_NAME_WITH_BAD_CHARS "abc^%.!@#longname"

An external file name that either contains invalid characters or is too long.

$FILE_NAME_WITH_WILD_CARD_CHAR "abv%.*longname2"

An external file name that either contains a wild card character or is too long.

$GREATER_THAN_DURATION 100_000.0

A universal real literal that lies between DURATION'BASE'LAST and DURATION'LAST or any value in the range of DURATION.

$GREATER_THAN_DURATION_BASE_LAST 200_000.0

A universal real literal that is greater than DURATION'BASE'LAST.

$ILLEGAL_EXTERNAL_FILE_NAME1 "BAD-CHARACTER*^"

An external file name which contains invalid characters.

$ILLEGAL_EXTERNAL_FILE_NAME2 An external file name which is too long.	"BAD-CHARACTER*^"
$INTEGER_FIRST A universal integer literal whose value is INTEGER'FIRST.	-2147483648
$INTEGER_LAST A universal integer literal whose value is INTEGER'LAST.	2147483647
$INTEGER_LAST_PLUS_1 A universal integer literal whose value is INTEGER'LAST + 1.	2147483648
$LESS_THAN_DURATION A universal real literal that lies between DURATION'BASE'FIRST and DURATION'FIRST or any value in the range of DURATION.	-100_000.0
$LESS_THAN_DURATION_BASE_FIRST A universal real literal that is less than DURATION'BASE'FIRST.	-200_000.0
$MAX_DIGITS Maximum digits supported for floating-point types.	15
$MAX_IN_LEN Maximum input line length permitted by the implementation.	126
$MAX_INT A universal integer literal whose value is SYSTEM.MAX_INT.	9223372036854775807
$MAX_INT_PLUS_1 A universal integer literal whose value is SYSTEM.MAX_INT+1.	9223372036854775808
$MAX_LEN_INT_BASED_LITERAL A universal integer based literal whose value is 2#11# with enough leading zeroes in the mantissa to be MAX_IN_LEN long.	<121 X "0"> 2:11:

Parameter	Value
$MAX_LEN_REAL_BASED_LITERAL A universal real based literal whose value is 16:F.E: with enough leading zeroes in the mantissa to be MAX_IN_LEN long.	16:<119 X "0">F.E
$MAX_STRING_LITERAL A string literal of size MAX_IN_LEN, including the quote characters.	"<12 X "1234567890" + "1234">
$MIN_INT A universal integer literal whose value is SYSTEM.MIN_ INT.	-9223372036854775808
$NAME A name of a predefined numeric type other than FLOAT, INTEGER, SHORT_FLOAT, SHORT_INTEGER, LONG_FLOAT, or LONG_INTEGER.	SHORT_SHORT_INTEGER
$NEG_BASED_INT A based integer literal whose highest order nonzero bit falls in the sign bit position of the representation for SYSTEM.MAX_INT.	16#fffffff#

APPENDIX D

WITHDRAWN TESTS

Some tests are withdrawn from the ACVC because they do not conform to the Ada Standard. The following 28 tests had been withdrawn at the time of validation testing for the reasons indicated. A reference of the form "AI-ddddd" is to an Ada Commentary.

B28003A: A basic declaration (line 36) wrongly follows a later declaration.

E28005C: This test requires that 'PRAGMA LIST (ON);' not appear in a listing that has been suspended by a previous "pragma LIST (OFF);"; the Ada Standard is not clear on this point, and the matter will be reviewed by the ARG.

C34004A: The expression in line 168 wrongly yields a value outside of the range of the target type T, raising CONSTRAINT_ERROR.

C35502P: Equality operators in lines 62 & 69 should be inequality operators.

A35902C: Line 17's assignment of the nomimal upper bound of a fixed-point type to an object of that type raises CONSTRAINT_ERROR, for that value lies outside of the actual range of the type.

C35904A: The elaboration of the fixed-point subtype on line 28 wrongly raises CONSTRAINT_ERROR, because its upper bound exceeds that of the type.

C35904B: The subtype declaration that is expected to raise CONSTRAINT_ERROR when its compatibility is checked against that of various types passed as actual generic parameters, may in fact raise NUMERIC_ERROR or CONSTRAINT_ERROR for reasons not anticipated by the test.

C35A03E, & R: These tests assume that attribute 'MANTISSA returns 0 when applied to a fixed-point type with a null range, but the Ada Standard doesn't support this assumption.

C37213H: The subtype declaration of SCONS in line 100 is wrongly expected to raise an exception when elaborated.

C37213J: The aggregate in line 451 wrongly raises CONSTRAINT_ERROR.

C37215C, E, G, H: Various discriminant constraints are wrongly expected to be incompatible with type CONS.

C38102C: The fixed-point conversion on line 23 wrongly raises CONSTRAINT_ERROR.

C41402A: 'STORAGE_SIZE is wrongly applied to an object of an access type.

C45332A: The test expects that either an expression in line 52 will raise an exception or else MACHINE_OVERFLOWS is FALSE. However, an implementation may evaluate the expression correctly using a type with a wider range than the base type of the operands, and MACHINE_OVERFLOWS may still be TRUE.

C45614C: REPORT.IDENT_INT has an argument of the wrong type (LONG_INTEGER).

E66001D: AI-330 states this test is to be changed from an "E" test to a "B" test during the next version of the ACVC. AI-330 was approved in July 1986, 6 months before the initial version of ACVC Version 1.9 was released and a nearly a full year before the final version of ACVC Version 1.9 was released. This test is withdrawn pending further comment from AJPO regarding issue of the test being a B Test rather than an E Test.

A74106C, C85018B, C87B04B, CC1311B: A bound specified in a fixed-point subtype declaration lies outside of that calculated for the base type, raising CONSTRAINT_ERROR. Errors of this sort occur re lines 37 & 59, 142 & 143, 16 & 48, and 252 & 253 of the four tests, respectively (and possibly elsewhere).

BC3105A: Lines 159..168 are wrongly expected to be illegal; they are legal.

AD1A01A: The declaration of subtype INT3 raises CONSTRAINT_ERROR for implementations that select INT'SIZE to be 16 or greater.

CE2401H: The record aggregates in lines 105 & 117 contain the wrong values.

CE3208A: This test expects that an attempt to open the default output file (after it was closed) with mode IN_FILE raises NAME_ERROR or USE_ERROR; by Commentary AI-00048, MODE_ERROR should be raised.