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USA Standard FORTRAN

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USA Standard

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Foreword

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This USA Standard presents the form for and the interpretation of programs written in the FORTRAN common programming language for use on computers and information processing systems.

This standard is one of two related standards dealing with the group of closely related languages which have been historically known as FORTRAN.

Suggestions for improvement gained in the use of this standard will be welcome. They should be sent to the United States of America Standards Institute.

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USA Standard FORTRAN

1. Purpose and Scope

1.1 Purpose. This standard establishes the form for and the interpretation of programs expressed in the FORTRAN language for the purpose of promoting a high degree of interchangeability of such programs for use on a variety of automatic data processing systems. A processor shall conform to this standard provided it accepts, and interprets as specified, at least those forms and relationships described herein.

Insofar as the interpretation of the FORTRAN form and relationships described are not affected, any statement of requirement could be replaced by a statement expressing that the standard does not provide an interpretation unless the requirement is met. Further, any statement of prohibition could be replaced by a statement expressing that the standard does not provide an interpretation when the prohibition is violated.

1.2 Scope. This standard establishes:

(1) The form of a program written in the FORTRAN language.

(2) The form of writing input data to be processed by such a program operating on automatic data processing systems.

(3) Rules for interpreting the meaning of such a program.

(4) The form of the output data resulting from the use of such a program on automatic data processing systems, provided that the rules of interpretation establish an interpretation.

1.2.1 This standard does not prescribe:

(1) The mechanism by which programs are transformed for use on a data processing system (the combination of this mechanism and data processing system is called a processor).

(2) The method of transcription of such programs or their input or output data to or from a data processing medium.

(3) The manual operations required for set-up and control of the use of such programs on data processing equipment.

(4) The results when the rules for interpretation fail to establish an interpretation of such a program.

(5) The size or complexity of a program that will exceed the capacity of any specific data processing system or the capability of a particular processor.

(6) The range or precision of numerical quantities.

2. Basic Terminology

This section introduces some basic terminology and some concepts. A rigorous treatment of these is given in later sections. Certain conventions concerning the meaning of grammatical forms and particular words are presented.

A program that can be used as a self-contained computing procedure is called an *executable program* (9.1.6).

An executable program consists of precisely one main program and possibly one or more subprograms (9.1.6).

A *main program* is a set of statements and comments not containing a FUNCTION, SUBROUTINE, or BLOCK DATA statement (9.1.5).

A *subprogram* is similar to a main program but is headed by a BLOCK DATA, FUNCTION, or SUBROUTINE statement. A subprogram headed by a BLOCK DATA statement is called a specification subprogram. A subprogram headed by a FUNCTION or SUBROUTINE statement is called a procedure subprogram (9.1.3, 9.1.4).

The term *program unit* will refer to either a main program or subprogram (9.1.7).

Any program unit except a specification subprogram may reference an *external procedure* (Section 9).

An external procedure that is defined by FORTRAN statements is called a *procedure subprogram*. External procedures also may be defined by other means. An external procedure may be an external function or an external subroutine. An external function defined by FORTRAN statements headed by a FUNCTION statement is called a *function subprogram*. An external subroutine defined by FORTRAN statements headed by a SUBROUTINE statement is called a *subroutine subprogram* (Sections 8 and 9).

Any program unit consists of *statements* and *comments*. A statement is divided into physical sections called *lines*, the first of which is called an *initial line* and the rest of which are called *continuation lines* (3.2).

There is a type of line called a comment that is not a statement and merely provides information for documentary purposes (3.2).

The statements in FORTRAN fall into two broad classes—executable and nonexecutable. The executable statements specify the action of the program while the nonexecutable statements describe the use of the program, the characteristics of the operands, editing information, statement functions, or data arrangement (7.1, 7.2).

The syntactic elements of a statement are *names* and *operators*. Names are used to reference objects such as data or procedures. Operators, including the imperative verbs, specify action upon named objects.

One class of name, the *array name*, deserves special mention. An array name must have the size of the identified array defined in an array declarator (7.2.1.1). An array name qualified only by a subscript is used to identify a particular element of the array (5.1.3).

Data names and the arithmetic (or logical) operations may be connected into expressions. Evaluation of such an expression develops a value. This value is derived by performing the specified operations on the named data.

The identifiers used in FORTRAN are names and numbers. Data are named. Procedures are named. Statements are labeled with numbers. Input/output units are numbered (Sections 3, 6, 7).

At various places in this standard there are statements with associated lists of entries. In all such cases the list is assumed to contain at least one entry unless an explicit exception is stated. As an example, in the statement

SUBROUTINE $s(a_1, a_2, \ldots a_n)$

it is assumed that at least one symbolic name is included in the list within parentheses. A *list* is a set of identifiable elements each of which is separated from its successor by a comma. Further, in a sentence a plural form of a noun will be assumed to specify also the singular form of that noun as a special case when the context of the sentence does not prohibit this interpretation.

The term *reference* is used as a verb with special meaning as defined in Section 5.

3. Program Form

Every program unit is constructed of characters grouped into lines and statements.

3.1 The FORTRAN Character Set. A program unit is written using the following characters: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and:

Character	Name of Character
	Blank
=	Equals
+	Plus
−	Minus
*	Asterisk
/	Slash
(	Left Parenthesis
)	Right Parenthesis
,	Comma
.	Decimal Point
$	Currency Symbol

The order in which the characters are listed does not imply a collating sequence.

3.1.1 ***Digits.*** A digit is one of the ten characters: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. Unless specified otherwise, a string of digits will be interpreted in the decimal base number system when a number system base interpretation is appropriate.

An octal digit is one of the eight characters: 0, 1, 2, 3, 4, 5, 6, 7. These are only used in the STOP (7.1.2.7.1) and PAUSE (7.1.2.7.2) statements.

3.1.2 ***Letters.*** A letter is one of the twenty-six characters: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z.

3.1.3 ***Alphanumeric Characters.*** An alphanumeric character is a letter or a digit.

3.1.4 ***Special Characters.*** A special character is one of the eleven characters: blank, equals, plus, minus, asterisk, slash, left parenthesis, right parenthesis, comma, decimal point, and currency symbol.

3.1.4.1 *Blank Character.* With the exception of the uses specified (3.2.2, 3.2.3, 3.2.4, 4.2.6, 5.1.1.6, 7.2.3.6, and 7.2.3.8), a blank character has no meaning and may be used freely to improve the appearance of the program subject to the restriction on continuation lines in 3.3.

3.2 Lines. A line is a string of 72 characters. All characters must be from the FORTRAN character set except as described in 5.1.1.6 and 7.2.3.8.

The character positions in a line are called columns and are consecutively numbered 1, 2, 3, ..., 72. The number indicates the sequential position of a character in the line starting at the left and proceeding to the right.

3.2.1 ***Comment Line.*** The letter C in column 1 of a line designates that line as a comment line. A comment line must be immediately followed by an initial line, another comment line, or an end line.

A comment line does not affect the program in any way and is available as a convenience for the user.

3.2.2 ***End Line.*** An end line is a line with the character blank in columns 1 through 6, the characters E, N, and D, once each and in that order, in columns 7 through 72, preceded by, interspersed with, or followed by the character blank. The end line indicates to the processor the end of the written description of a program unit (9.1.7). Every program unit must physically terminate with an end line.

3.2.3 ***Initial Line.*** An initial line is a line that is neither a comment line nor an end line and that contains the digit 0 or the character blank in column 6. Columns 1 through 5 contain the statement label or each contains the character blank.

3.2.4 ***Continuation Line.*** A continuation line is a line that contains any character other than the digit 0 or the character blank in column 6, and does not contain the character C in column 1.

A continuation line may only follow an initial line or another continuation line.

3.3 Statements. A statement consists of an initial line optionally followed by up to nineteen ordered continuation lines. The statement is written in columns 7 through 72 of the lines. The order of the characters in the statement is columns 7 through 72 of the initial line followed, as applicable, by columns 7 through 72 of the first continuation line, columns 7 through 72 of the next continuation line, etc.

3.4 Statement Label. Optionally, a statement may be labeled so that it may be referred to in other statements. A statement label consists of from one to five digits. The value of the integer represented is not significant but must be greater than zero. The statement label may be placed anywhere in columns 1 through 5 of the initial line of the statement. The same statement label may not be given to more than one statement in a program unit. Leading zeros are not significant in differentiating statement labels.

3.5 Symbolic Names. A symbolic name consists of from one to six alphanumeric characters, the first of which must be alphabetic. See 10.1 through 10.1.10 for a discussion of classification of symbolic names and restrictions on their use.

3.6 Ordering of Characters. An ordering of characters is assumed within a program unit. Thus, any meaningful collection of characters that constitutes names, lines, and statements exists as a totally ordered set. This ordering is imposed by the character position rule of 3.2 (which orders characters within a line) and the order in which lines are presented for processing.

4. Data Types

Six different types of data are defined. These are integer, real, double precision, complex, logical, and Hollerith. Each type has a different mathematical significance and may have different internal representation. Thus the data type has a significance in the interpretation of the associated operations with which a datum is involved. The data type of a function defines the type of the datum it supplies to the expression in which it appears.

4.1 Data Type Association. The name employed to identify a datum or function carries the data type association. The form of the string representing a constant defines both the value and the data type.

A symbolic name representing a function, variable, or array must have only a single data type association for each program unit. Once associated with a particular data type, a specific name implies that type for any differing usage of that symbolic name that requires a data type association throughout the program unit in which it is defined.

Data type may be established for a symbolic name by declaration in a type-statement (7.2.1.6) for the integer, real, double precision, complex, and logical types. This specific declaration overrides the implied association available for integer and real (5.3).

There exists no mechanism to associate a symbolic name with the Hollerith data type. Thus data of this type, other than constants, are identified under the guise of a name of one of the other types.

4.2 Data Type Properties. The mathematical and the representation properties for each of the data types are defined in the following sections. For real, double precision, and integer data, the value zero is considered neither positive nor negative.

4.2.1 ***Integer Type.*** An integer datum is always an exact representation of an integer value. It may assume positive, negative, and zero values. It may only assume integral values.

4.2.2 ***Real Type.*** A real datum is a processor approximation to the value of a real number. It may assume positive, negative, and zero values.

4.2.3 ***Double Precision Type.*** A double precision datum is a processor approximation to the value of a real number. It may assume positive, negative, and zero values. The degree of approximation, though undefined, must be greater than that of type real.

4.2.4 ***Complex Type.*** A complex datum is a processor approximation to the value of a complex number. The representation of the approximation is in the form of an ordered pair of real data. The first of the pair represents the real part and the second, the imaginary part. Each part has, accordingly, the same degree of approximation as for a real datum.

4.2.5 ***Logical Type.*** A logical datum may assume only the truth values of true or false.

4.2.6 ***Hollerith Type.*** A Hollerith datum is a string of characters. This string may consist of any characters capable of representation in the processor. The blank character is a valid and significant character in a Hollerith datum.

5. Data and Procedure Identification

Names are employed to reference or otherwise identify data and procedures.

The term *reference* is used to indicate an identification of a datum implying that the current value of the datum will be made available during the execution of the statement containing the reference. If the datum is identified but not necessarily made available, the datum is said to be *named.* One case of special interest in which the datum is named is that of assigning a value to a datum, thus defining or redefining the datum.

The term *reference* is used to indicate an identification of a procedure implying that the actions specified by the procedure will be made available.

A complete and rigorous discussion of reference and definition, including redefinition, is contained in Section 10.

5.1 Data and Procedure Names. A data name identifies a constant, a variable, an array or array element, or a block (7.2.1.3). A procedure name identifies a function or a subroutine.

5.1.1 ***Constants.*** A constant is a datum that is always defined during execution and may not be redefined. Rules for writing constants are given for each data type.

An integer, real, or double precision constant is said to be signed when it is written immediately following a plus or minus. Also, for these types, an optionally signed constant is either a constant or a signed constant.

5.1.1.1 *Integer Constant.* An integer constant is written as a nonempty string of digits. The constant is the digit string interpreted as a decimal numeral.

5.1.1.2 *Real Constant.* A basic real constant is written as an integer part, a decimal point, and a decimal fraction part in that order. Both the integer part and the decimal part are strings of digits; either one of these strings may be empty but not both. The constant is an approximation to the digit string interpreted as a decimal numeral.

A decimal exponent is written as the letter, E, followed by an optionally signed integer constant. A decimal exponent is a multiplier (applied to the constant written immediately preceding it) that is an approximation to the exponential form ten raised to the power indicated by the integer written following the E.

A real constant is indicated by writing a basic real constant, a basic real constant followed by a decimal exponent, or an integer constant followed by a decimal exponent.

5.1.1.3 *Double Precision Constant.* A double precision exponent is written and interpreted identically to a decimal exponent except that the letter, D, is used instead of the letter, E.

A double precision constant is indicated by writing a basic real constant followed by a double precision exponent or an integer constant followed by a double precision exponent.

5.1.1.4 *Complex Constant.* A complex constant is written as an ordered pair of optionally signed real constants, separated by a comma, and enclosed within parentheses. The datum is an approximation to the complex number represented by the pair.

5.1.1.5 *Logical Constant.* The logical constants, true and false, are written .TRUE. and .FALSE. respectively.

5.1.1.6 *Hollerith Constant.* A Hollerith constant is written as an integer constant (whose value n is greater than zero) followed by the letter H, followed by exactly n characters which comprise the Hollerith datum proper. Any n characters capable of representation by the processor may follow the H. The character blank is significant in the Hollerith datum string. This type of constant may be written only in the argument list of a CALL statement and in the data initialization statement.

5.1.2 ***Variable.*** A variable is a datum that is identified by a symbolic name (3.5). Such a datum may be referenced and defined.

5.1.3 ***Array.*** An array is an ordered set of data of one, two, or three dimensions. An array is identified by a symbolic name. Identification of the entire ordered set is achieved via use of the array name.

5.1.3.1 *Array Element.* An array element is one of the members of the set of data of an array. An array element is identified by immediately following the array name with a qualifier, called a subscript, which points to the particular element of the array.

An array element may be referenced and defined.

5.1.3.2 *Subscript.* A subscript is written as a parenthesized list of subscript expressions. Each subscript expression is separated by a comma from its successor, if there is a successor. The number of subscript expressions must correspond to the declared dimensionality (7.2.1.1), except in an EQUIVALENCE statement (7.2.1.4). Following evaluation of all of the subscript expressions, the array element successor function (7.2.1.1.1) determines the identified array element.

5.1.3.3 *Subscript Expressions.* A subscript expression is written as one of the following constructs:

$$c*v+k$$
$$c*v-k$$
$$c*v$$
$$v+k$$
$$v-k$$
$$v$$
$$k$$

where c and k are integer constants and v is an integer variable reference. See Section 6 for a discussion of evaluation of expressions and 10.2.8 and 10.3 for requirements that apply to the use of a variable in a subscript.

5.1.4 ***Procedures.*** A procedure (Section 8) is identified by a symbolic name. A procedure is a statement function, an intrinsic function, a basic external function, an external function, or an external subroutine. Statement functions, intrinsic functions, basic external functions, and external functions are referred to as functions or function procedures; external subroutines as subroutines or subroutine procedures.

A function supplies a result to be used at the point of reference; a subroutine does not. Functions are referenced in a manner different from subroutines.

5.2 Function Reference. A function reference consists of the function name followed by an actual argument list enclosed in parentheses. If the list contains more than one argument, the arguments are separated by commas. The allowable forms of function arguments are given in Section 8.

See 10.2.1 for a discussion of requirements that apply to function references.

5.3 Type Rules for Data and Procedure Identifiers. The type of a constant is implicit in its name.

There is no type associated with a symbolic name that identifies a subroutine or a block.

A symbolic name that identifies a variable, an array, or a statement function may have its type specified in a type-statement. In the absence of an explicit declaration, the type is implied by the first character of the name: I, J, K, L, M, and N imply type integer; any other letter implies type real.

A symbolic name that identifies an intrinsic function or a basic external function when it is used to identify this designated procedure, has a type associated with it as specified in Tables 3 and 4.

In the program unit in which an external function is referenced, its type definition is defined in the same manner as for a variable and an array. For a function subprogram, type is specified either implicitly by its name or explicitly in the FUNCTION statement.

The same type is associated with an array element as is associated with the array name.

5.4 Dummy Arguments. A dummy argument of an external procedure identifies a variable, array, subroutine, or external function.

When the use of an external function name is specified, the use of a dummy argument is permissible if an external function name will be associated with that dummy argument. (Section 8.)

When the use of an external subroutine name is specified, the use of a dummy argument is permissible if an external subroutine name will be associated with that dummy argument.

When the use of a variable or array element reference is specified, the use of a dummy argument is permissible if a value of the same type will be made available through argument association.

Unless specified otherwise, when the use of a variable, array, or array element name is specified, the use of a dummy argument is permissible provided that a proper association with an actual argument is made.

The process of argument association is discussed in Sections 8 and 10.

6. Expressions

This section gives the formation and evaluation rules for arithmetic, relational, and logical expressions. A relational expression appears only within the context of logical expressions. An expression is formed from elements and operators. See 10.3 for a discussion of requirements that apply to the use of certain entities in expressions.

6.1 Arithmetic Expressions. An arithmetic expression is formed with arithmetic operators and arithmetic elements. Both the expression and its constituent elements identify values of one of the types integer, real, double precision, or complex. The arithmetic operators are:

Operator	Representing
+	Addition, positive value (zero + element)
−	Subtraction, negative value (zero − element)
*	Multiplication
/	Division
**	Exponentiation

The arithmetic elements are primary, factor, term, signed term, simple arithmetic expression, and arithmetic expression.

A primary is an arithmetic expression enclosed in parentheses, a constant, a variable reference, an array element reference, or a function reference.

A factor is a primary or a construct of the form:

*primary**primary*

A term is a factor or a construct of one of the forms:

term/factor

or:

*term*term*

A signed term is a term immediately preceded by + or −.

A simple arithmetic expression is a term or two simple arithmetic expressions separated by a + or −.

An arithmetic expression is a simple arithmetic expression or a signed term or either of the preceding forms immediately followed by a + or − immediately followed by a simple arithmetic expression.

A primary of any type may be exponentiated by an integer primary, and the resultant factor is of the same type as that of the element being exponentiated. A real or double precision primary may be exponentiated by a real or double precision primary, and the resultant factor is of type real if both primaries are of type real and otherwise of type double precision. These are the only cases for which use of the exponentiation operator is defined.

By use of the arithmetic operators other than exponentiation, any admissible element may be combined with another admissible element of the same type, and the resultant element is of the same type. Further, an admissible real element may be combined with an admissible double precision or complex element; the resultant element is of type double precision or complex, respectively.

6.2 Relational Expressions. A relational expression consists of two arithmetic expressions separated by a relational operator and will have the value true or false as the relation is true or false, respectively. One arithmetic expression may be of type real or double precision and the other of type real or double precision, or both arithmetic expressions may be of type integer. If a real expression and a double precision expression appear in a relational expression, the effect is the same as a similar relational expression. This similar expression contains a double precision zero as the right hand arithmetic expression and the difference of the two original expressions (in their original order) as the left. The relational operator is unchanged. The relational operators are:

Operator	Representing
.LT.	Less than
.LE.	Less than or equal to
.EQ.	Equal to
.NE.	Not equal to
.GT.	Greater than
.GE.	Greater than or equal to

6.3 Logical Expressions. A logical expression is formed with logical operators and logical elements and has the value true or false. The logical operators are:

Operator	Representing
.OR.	Logical disjunction
.AND.	Logical conjunction
.NOT.	Logical negation

The logical elements are logical primary, logical factor, logical term, and logical expression.

A logical primary is a logical expression enclosed in parentheses, a relational expression, a logical constant, a logical variable reference, a logical array element reference, or a logical function reference.

A logical factor is a logical primary or .NOT. followed by a logical primary.

A logical term is a logical factor or a construct of the form:

logical term .AND. logical term

A logical expression is a logical term or a construct of the form:

logical expression .OR. logical expression

6.4 Evaluation of Expressions. A part of an expression need be evaluated only if such action is necessary to establish the value of the expression. The rules for formation of expressions imply the binding strength of operators. It should be noted that the range of the subtraction operator is the term that immediately succeeds it. The evaluation may proceed according to any valid formation sequence (except as modified in the following paragraph).

When two elements are combined by an operator, the order of evaluation of the elements is optional. If mathematical use of operators is associative, commutative, or both, full use of these facts may be made to revise orders of combination, provided only that integrity of parenthesized expressions is not violated. The value of an integer factor or term is the nearest integer whose magnitude does not exceed the magnitude of the mathematical value represented by that factor or term. The associative and commutative laws do not apply in the evaluation of integer terms containing division, hence the evaluation of such terms must effectively proceed from left to right.

Any use of an array element name requires the evaluation of its subscript. The evaluation of functions appearing in an expression may not validly alter the value of any other element within the expressions, assignment statement, or CALL statement in which the function reference appears. The type of the expression in which a function reference or subscript appears does not affect, nor is it affected by, the evaluation of the actual arguments or subscript.

No factor may be evaluated that requires a negative valued primary to be raised to a real or double precision exponent. No factor may be evaluated that requires raising a zero valued primary to a zero valued exponent.

No element may be evaluated whose value is not mathematically defined.

7. Statements

A statement may be classified as executable or non-executable. Executable statements specify actions; non-executable statements describe the characteristics and arrangement of data, editing information, statement functions, and classification of program units.

7.1 Executable Statements. There are three types of executable statements:

(1) Assignment statements
(2) Control statements
(3) Input/output statements

7.1.1 ***Assignment Statements.*** There are three types of assignment statements:

(1) Arithmetic assignment statement
(2) Logical assignment statement
(3) GO TO assignment statement

7.1.1.1 *Arithmetic Assignment Statement.* An arithmetic assignment statement is of the form:

$$v = e$$

where v is a variable name or array element name of type other than logical and e is an arithmetic expression. Execution of this statement causes the evaluation of the expression e and the altering of v according to Table 1.

7.1.1.2 *Logical Assignment Statement.* A logical assignment statement is of the form

$$v = e$$

where v is a logical variable name or a logical array element name and e is a logical expression. Execution of this statement causes the logical expression to be evaluated and its value to be assigned to the logical entity.

7.1.1.3 GO TO *Assignment Statement.* A GO TO assignment statement is of the form:

ASSIGN k TO i

where k is a statement label and i is an integer variable name. After execution of such a statement, subsequent execution of any assigned GO TO statement (7.1.2.1.2) using that integer variable will cause the statement identified by the assigned statement label to be executed next (9.2), provided there has been no intervening redefinition of the variable. The statement label must refer to an executable statement in the same program unit in which the ASSIGN statement appears.

Once having been mentioned in an ASSIGN statement, an integer variable may not be referenced in any statement other than an assigned GO TO statement until it has been redefined (10.2.3).

Table 1
Rules for Assignment of *e* to *v*

If *v* Type Is	And *e* Type Is	The Assignment Rule Is*
Integer	Integer	Assign
Integer	Real	Fix & Assign
Integer	Double Precision	Fix & Assign
Integer	Complex	P
Real	Integer	Float & Assign
Real	Real	Assign
Real	Double Precision	DP Evaluate & Real Assign
Real	Complex	P
Double Precision	Integer	DP Float & Assign
Double Precision	Real	DP Evaluate & Assign
Double Precision	Double Precision	Assign
Double Precision	Complex	P
Complex	Integer	P
Complex	Real	P
Complex	Double Precision	P
Complex	Complex	Assign

*NOTES:

(1) P means prohibited combination.

(2) Assign means transmit the resulting value, without change, to the entity.

(3) Real Assign means transmit to the entity as much precision of the most significant part of the resulting value as a real datum can contain.

(4) DP Evaluate means evaluate the expression according to the rules of 6.1 (or any more precise rules) then DP Float.

(5) Fix means truncate any fractional part of the result and transform that value to the form of an integer datum.

(6) Float means transform the value to the form of a real datum.

(7) DP Float means transform the value to the form of a double precision datum, retaining in the process as much of the precision of the value as a double precision datum can contain.

7.1.2 *Control Statements.* There are eight types of control statements:

(1) GO TO statements
(2) Arithmetic IF statement
(3) Logical IF statement
(4) CALL statement
(5) RETURN statement
(6) CONTINUE statement
(7) Program control statements
(8) DO statement

The statement labels used in a control statement must be associated with executable statements within the same program unit in which the control statement appears.

7.1.2.1 GO TO *Statements.* There are three types of GO TO statements:

(1) Unconditional GO TO statement
(2) Assigned GO TO statement
(3) Computed GO TO statement

7.1.2.1.1 *Unconditional* GO TO *Statement.* An unconditional GO TO statement is of the form:

GO TO k

where k is a statement label.

Execution of this statement causes the statement identified by the statement label to be executed next.

7.1.2.1.2 *Assigned* GO TO *Statement.* An assigned GO TO statement is of the form:

GO TO $i, (k_1, k_2, \ldots, k_n)$

where i is an integer variable reference, and the k's are statement labels.

At the time of execution of an assigned GO TO statement, the current value of i must have been assigned by the previous execution of an ASSIGN statement to be one of the statement labels in the parenthesized list, and such an execution causes the statement identified by that statement label to be executed next.

7.1.2.1.3 *Computed* GO TO *Statement.* A computed GO TO statement is of the form:

GO TO $(k_1, k_2, \ldots, k_n), i$

where the k's are statement labels and i is an integer variable reference. See 10.2.8 and 10.3 for a discussion of requirements that apply to the use of a variable in a computed GO TO statement.

Execution of this statement causes the statement identified by the statement label k_j to be executed next, where j is the value of i at the time of the execution. This statement is defined only for values such that $1 \leq j \leq n$.

7.1.2.2 *Arithmetic* IF *Statement.* An arithmetic IF statement is of the form:

IF $(e)\ k_1, k_2, k_3$

where e is any arithmetic expression of type integer, real, or double precision, and the k's are statement labels.

The arithmetic IF is a three-way branch. Execution of this statement causes evaluation of the expression e following which the statement identified by the statement label k_1, k_2, or k_3 is executed next as the value of e is less than zero, zero, or greater than zero, respectively.

7.1.2.3 *Logical* IF *Statement.* A logical IF statement is of the form:

IF $(e)\ S$

where e is a logical expression and S is any executable statement except a DO statement or another logical IF statement. Upon execution of this statement, the logical expression e is evaluated. If the value of e is false, statement S is executed as though it were a CONTINUE statement. If the value of e is true, statement S is executed.

7.1.2.4 CALL *Statement.* A CALL statement is of one of the forms:

CALL $s(a_1, a_2, \ldots, a_n)$

or

CALL s

where s is the name of a subroutine and the a's are actual arguments (8.4.2).

The inception of execution of a CALL statement references the designated subroutine. Return of control from the designated subroutine completes execution of the CALL statement.

7.1.2.5 RETURN *Statement.* A RETURN statement is of the form:

RETURN

A RETURN statement marks the logical end of a procedure subprogram and, thus, may only appear in a procedure subprogram.

Execution of this statement when it appears in a subroutine subprogram causes return of control to the current calling program unit.

Execution of this statement when it appears in a function subprogram causes return of control to the current calling program unit. At this time the value of the function (8.3.1) is made available.

7.1.2.6 CONTINUE *Statement.* A CONTINUE statement is of the form:

CONTINUE

Execution of this statement causes continuation of the normal execution sequence.

7.1.2.7 *Program Control Statements.* There are two types of program control statements:

(1) STOP statement
(2) PAUSE statement

7.1.2.7.1 STOP *Statement.* A STOP statement is of one of the forms:

STOP n

or

STOP

where n is an octal digit string of length from one to five.

Execution of this statement causes termination of execution of the executable program.

7.1.2.7.2 PAUSE *Statement.* A PAUSE statement is of one of the forms:

PAUSE n

or

PAUSE

where n is an octal digit string of length from one to five.

The inception of execution of this statement causes a cessation of execution of the executable program. Execution must be resumable. At the time of cessation of execution the octal digit string is accessible. The decision to resume execution is not under control of the program. If execution is resumed without otherwise changing the state of the processor, then, after the completion of the PAUSE statement, the normal execution sequence is continued.

7.1.2.8 DO *Statement.* A DO statement is of one of the forms:

DO n $i = m_1, m_2, m_3$

or

DO n $i = m_1, m_2$

where:

(1) n is the statement label of an executable statement. This statement, called the terminal statement of the associated DO, must physically follow and be in the same program unit as that DO statement. The terminal statement may not be a GO TO of any form, arithmetic IF, RETURN, STOP, PAUSE, or DO statement, nor a logical IF containing any of these forms.

(2) i is an integer variable name; this variable is called the control variable.

(3) m_1, called the initial parameter; m_2, called the terminal parameter; and m_3, called the incremantation parameter, are each either an integer constant or integer variable reference. If the second form of the DO statement is used so that m_3 is not explicitly stated, a value of one is implied for the incrementation parameter. At time of execution of the DO statement, m_1, m_2, and m_3 must be greater than zero.

Associated with each DO statement is a range that is defined to be those executable statements from and including the first executable statement following the DO, to and including the terminal statement associated with the DO. A special situation occurs when the range of a DO contains another DO statement. In this case, the range of the contained DO must be a subset of the range of the containing DO.

A completely nested nest is a set of DO statements and their ranges, and any DO statements contained within their ranges, such that the first occurring terminal statement of any of those DO statements physically follows the last occurring DO statement and the first occurring DO statement of the set is not in the range of any DO statement.

7.1.2.8.1 A DO statement is used to define a loop. The action succeeding execution of a DO statement is described by the following six steps:

(1) The control variable is assigned the value represented by the initial parameter. This value must be less than or equal to the value represented by the terminal parameter.

(2) The range of the DO is executed.

(3) If control reaches the terminal statement, then after execution of the terminal statement, the control variable of the most recently executed DO statement associated with the terminal statement is incremented by the value represented by the associated incrementation parameter.

(4) If the value of the control variable after incrementation is less than or equal to the value represented by the associated terminal paramenter, then the action described starting at step 2 is repeated, with the understanding that the range in question is that of the DO,

whose control variable has been most recently incremented. If the value of the control variable is greater than the value represented by its associated terminal parameter, then the DO is said to have been satisfied and the control variable becomes undefined.

(5) At this point, if there were one or more other DO statements referring to the terminal statement in question, the control variable of the next most recently executed DO statement is incremented by the value represented by its associated incrementation parameter and the action described in step 4 is repeated until all DO statements referring to the particular termination statement are satisfied, at which time the first executable statement following the terminal statement is executed.

In the remainder of this section (7.1.2.8) a logical IF statement containing a GO TO or an arithmetic IF statement form is regarded as a GO TO or an arithmetic IF statement, respectively.

(6) Upon exiting from the range of a DO by the execution of a GO TO statement or an arithmetic IF statement, that is, other than by satisfying the DO, the control variable of the DO is defined and is equal to the most recent value attained as defined in the preceding paragraphs.

7.1.2.8.2 A DO is said to have an EXTENDED RANGE if both of the following conditions apply:

(1) There exists a GO TO statement or arithmetic IF statement within the range of the innermost DO of a completely nested nest that can cause control to pass out of that nest.

(2) There exists a GO TO statement or arithmetic IF statement not within the nest that, in the collection of all possible sequences of execution in the particular program unit, could be executed after a statement of the type described in (1), and the execution of which could cause control to return into the range of the innermost DO of the completely nested nest.

If both of these conditions apply, the extended range is defined to be the set of all executable statements that may be executed between all pairs of control statements, the first of which satisfies the condition of (1) and the second of (2). The first of the pair is not included in the extended range; the second is. A GO TO statement or an arithmetic IF statement may not cause control to pass into the range of a DO unless it is being executed as part of the extended range of that particular DO. Further, the extended range of a DO may not contain a DO of the same program unit that has an extended range. When a procedure reference occurs in the range of a DO the actions of that procedure are considered to be temporarily within that range, i.e., during the execution of that reference.

The control variable, initial parameter, terminal parameter, and incrementation parameter of a DO may not be redefined during the execution of the range or extended range of that DO.

If a statement is the terminal statement of more than one DO statement, the statement label of that terminal statement may not be used in any GO TO or arithmetic IF statement that occurs anywhere but in the range of the most deeply contained DO with that terminal statement.

7.1.3 ***Input/Output Statements.*** There are two types of input/output statements:

(1) READ and WRITE statements.

(2) Auxiliary Input/Output statements.

The first type consists of the statements that cause transfer of records of sequential files to and from internal storage, respectively. The second type consists of the BACKSPACE and REWIND statements that provide for positioning of such an external file, and ENDFILE, which provides for demarcation of such an external file.

In the following descriptions, *u* and *f* identify input/output units and format specifications, respectively. An input/output unit is identified by an integer value and *u* may be either an integer constant or an integer variable reference whose value then identifies the unit. The format specification is described in 7.2.3. Either the statement label of a FORMAT statement or an array name may be represented by *f*. If a statement label, the identified statement must appear in the same program unit as the input/output statement. If an array name, it must conform to the specifications in 7.2.3.10.

7.1.3.1 A particular unit has a single sequential file associated with it. The most general case of such a unit has the following properties:

(1) If the unit contains one or more records, those records exist as a totally ordered set.

(2) There exists a unique position of the unit called its initial point. If a unit contains no records, that unit is positioned at its initial point. If the unit is at its initial point and contains records, the first record of the unit is defined as the next record.

(3) If a unit is not positioned at its initial point, there exists a unique preceding record associated with that position. The least of any records in the ordering described by (1) following this preceding record is defined as the next record of that position.

(4) Upon completion of execution of a WRITE or ENDFILE statement, there exist no records following the records created by that statement.

(5) When the next record is transmitted, the position of the unit is changed so that this next record becomes the preceding record.

If a unit does not provide for some of the properties given in the preceding paragraphs, certain statements that will be defined may not refer to that unit. The use of such a statement is not defined for that unit.

7.1.3.2 READ *and* WRITE *Statements.* The READ and WRITE statements specify transfer of information. Each such statement may include a list of the names of variables, arrays, and array elements. The named elements are assigned values on input and have their values transferred on output.

Records may be formatted or unformatted. A formatted record consists of a string of the characters that are permissible in Hollerith constants (5.1.1.6). The transfer of such a record requires that a format specification be referenced to supply the necessary positioning and conversion specifications (7.2.3). The number of records transferred by the execution of a formatted READ or WRITE is dependent upon the list and referenced format specification (7.2.3.4). An unformatted record consists of a string of values. When an unformatted or formatted READ statement is executed, the required records on the identified unit must be, respectively, unformatted or formatted records.

7.1.3.2.1 *Input/Output Lists.* The input list specifies the names of the variables and array elements to which values are assigned on input. The output list specifies the references to variables and array elements whose values are transmitted. The input and output lists are of the same form.

A list is a simple list, a simple list enclosed in parentheses, a DO-implied list, or two lists separated by a comma.

Lists are formed in the following manner. A simple list is a variable name, an array element name, or an array name, or two simple lists separated by a comma.

A DO-implied list is a list followed by a comma and a DO-implied specification, all enclosed in parentheses.

A DO-implied specification is of one of the forms:

$$i = m_1, m_2, m_3$$

or

$$i = m_1, m_2$$

The elements i, m_1, m_2, and m_3 are as defined for the DO statement (7.1.2.8). The range of DO-implied specification is the list of the DO-implied list and, for input lists, i, m_1, m_2, and m_3 may appear, within that range, only in subscripts.

A variable name or array element name specifies itself. An array name specifies all of the array element names defined by the array declarator, and they are specified in the order given by the array element successor function (7.2.1.1.1).

The elements of a list are specified in the order of their occurrence from left to right. The elements of a list in a DO-implied list are specified for each cycle of the implied DO.

7.1.3.2.2 *Formatted* READ. A formatted READ statement is of one of the forms:

READ (u, f) k

or

READ (u, f)

where k is a list.

Execution of this statement causes the input of the next records from the unit identified by u. The information is scanned and converted as specified by the format specification identified by f. The resulting values are assigned to the elements specified by the list. See however 7.2.3.4.

7.1.3.2.3 *Formatted* WRITE. A formatted WRITE statement is of one of the forms:

WRITE (u, f) k

or

WRITE (u, f)

where k is a list.

Execution of this statement creates the next records on the unit identified by u. The list specifies a sequence of values. These are converted and positioned as specified by the format specification identified by f. See however 7.2.3.4.

7.1.3.2.4 *Unformatted* READ. An unformatted READ statement is of one of the forms:

READ (u) k

or

READ (u)

where k is a list.

Execution of this statement causes the input of the next record from the unit identified by u, and, if there is a list, these values are assigned to the sequence of elements specified by the list. The sequence of values required by the list may not exceed the sequence of values from the unformatted record.

7.1.3.2.5 *Unformatted* WRITE. An unformatted WRITE statement is of the form:

WRITE (u) k

where k is a list.

Execution of this statement creates the next record on the unit identified by u of the sequence of values specified by the list.

7.1.3.3 *Auxiliary Input/Output Statements.* There are three types of auxiliary input/output statements:

(1) REWIND statement
(2) BACKSPACE statement
(3) ENDFILE statement

7.1.3.3.1 REWIND *Statement.* A REWIND statement is of the form:

REWIND u

Execution of this statement causes the unit identified by u to be positioned at its initial point.

7.1.3.3.2 BACKSPACE *Statement.* A BACKSPACE statement is of the form:

BACKSPACE u

If the unit identified by u is positioned at its initial point, execution of this statement has no effect. Otherwise, the execution of this statement results in the positioning of the unit identified by u so that what had been the preceding record prior to that execution becomes the next record.

7.1.3.3.3 ENDFILE *Statement.* An ENDFILE statement is of the form:

ENDFILE u

Execution of this statement causes the recording of an endfile record on the unit identified by u. The endfile record is an unique record signifying a demarcation of a sequential file. Action is undefined when an endfile record is encountered during execution of a READ statement.

7.1.3.4 *Printing of Formatted Records.* When formatted records are prepared for printing, the first character of the record is not printed.

The first character of such a record determines vertical spacing as follows:

Character	**Vertical Spacing Before Printing**
Blank	One line
0	Two lines
1	To first line of next page
+	No advance

7.2 Nonexecutable Statements. There are five types of nonexecutable statements:

(1) Specification statements
(2) Data initialization statement
(3) FORMAT statement
(4) Function defining statements
(5) Subprogram statements

See 10.1.2 for a discussion of restrictions on appearances of symbolic names in such statements.

The function defining statements and subprogram statements are discussed in Section 8.

7.2.1 ***Specification Statements.*** There are five types of specification statements:

(1) DIMENSION statement
(2) COMMON statement
(3) EQUIVALENCE statement
(4) EXTERNAL statement
(5) Type-statements

7.2.1.1 *Array-Declarator.* An array declarator specifies an array used in a program unit.

The array declarator indicates the symbolic name, the number of dimensions (one, two, or three), and the size of each of the dimensions. The array declarator form may be in a type-statement, DIMENSION, or COMMON statement.

An array declarator has the form:

$$v\ (i)$$

where:

(1) v, called the declarator name, is a symbolic name.

(2) (i), called the declarator subscript, is composed of 1, 2, or 3 expressions, each of which may be an integer constant or an integer variable name. Each expression is separated by a comma from its successor if there are more than one of them. In the case where i contains no integer variable, i is called the constant declarator subscript.

The appearance of a declarator subscript in a declarator statement serves to inform the processor that the declarator name is an array name. The number of subscript expressions specified for the array indicates its dimensionality. The magnitude of the values given for the subscript expressions indicates the maximum value that the subscript may attain in any array element name.

No array element name may contain a subscript that, during execution of the executable program, assumes a value less than one or larger than the maximum length specified in the array declarator.

7.2.1.1.1 *Array Element Successor Function and Value of a Subscript.* For a given dimensionality, subscript declarator, and subscript, the value of a subscript pointing to an array element and the maximum value a subscript may attain are indicated in Table 2. A subscript expression must be greater than zero.

The value of the array element successor function is obtained by adding one to the entry in the subscript value column. Any array element whose subscript has this value is the successor to the original element. The last element of the array is the one whose subscript value is the maximum subscript value and has no successor element.

Table 2
Value of a Subscript

Dimensionality	Subscript Declarator	Subscript	Subscript Value	Maximum Subscript Value
1	(A)	(a)	a	A
2	(A, B)	(a, b)	$a + A \cdot (b-1)$	$A \cdot B$
3	(A, B, C)	(a, b, c)	$a + A\ (b-1) + A \cdot B \cdot (c-1)$	$A \cdot B \cdot C$

NOTES:
(1) a, b, and c are subscript expressions.
(2) A, B, and C are dimensions.

7.2.1.1.2 *Adjustable Dimension.* If any of the entries in a declarator subscript is an integer variable name, the array is called an adjustable array, and the variable names are called adjustable dimensions. Such an array may only appear in a procedure subprogram. The dummy argument list of the subprograms must contain the array name and the integer variable names that represent the adjustable dimensions. The values of the actual arguments that represent array dimensions in the argument list of the reference must be defined (10.2) prior to calling the subprogram and may not be redefined or undefined during execution of the subprogram. The maximum size of the actual array may not be exceeded. For every array appearing in an executable program (9.1.6), there must be at least one constant array declarator associated through subprogram references.

In a subprogram, a symbolic name that appears in a COMMON statement may not identify an adjustable array.

7.2.1.2 DIMENSION *Statement.* A DIMENSION statement is of the form:

$$\text{DIMENSION } v_1(i_1),\ v_2(i_2),\ \ldots\ ,\ v_n(i_n)$$

where each $v(i)$ is an array declarator.

7.2.1.3 COMMON *Statement.* A COMMON statement is of the form:

$$\text{COMMON } / x_1 / a_1 / \ldots / x_n / a_n$$

where each a is a nonempty list of variable names, array names, or array declarators (no dummy arguments are permitted) and each x is a symbolic name or is empty.

If x_1 is empty, the first two slashes are optional. Each x is a block name, a name that bears no relationship to any variable or array having the same name. This holds true for any such variable or array in the same or any other program unit. See 10.1.1 for a discussion of restrictions on uses of block names.

In any given COMMON statement, the entities occurring between block name x and the next block name (or the end of the statement if no block name follows) are declared to be in common block x. All entities from the beginning of the statement until the appearance of a block name, or all entities in the statement if no block name appears, are declared to be in blank or unlabeled common. Alternatively, the appearance of two slashes with no block name between them declares the entities that follow to be in blank common.

A given common block name may occur more than once in a COMMON statement or in a program unit. The processor will string together in a given common block all entities so assigned in the order of their appearance (10.1.2). The first element of an array will follow the immediately preceding entity, if one exists, and the last element of an array will immediately precede the next entity, if one exists.

The size of a common block in a program unit is the sum of the storage required for the elements introduced through COMMON and EQUIVALENCE statements. The sizes of labeled common blocks with the same label in the program units that comprise an executable program must be the same. The sizes of blank common in the various program units that are to be executed together need not be the same. Size is measured in terms of storage units (7.2.1.3.1).

7.2.1.3.1 *Correspondence of Common Blocks.* If all of the program units of an executable program that contain any definition of a common block of a particular name define that block such that:

(1) There is identity in type for all entities defined in the corresponding position from the beginning of that block.

(2) If the block is labeled and the same number of entities is defined for the block

then the values in the corresponding positions (counted by the number of preceding storage units) are the same quantity in the executable program

7.2.1.3.1.1 A double precision or a complex entity is counted as two logically consecutive storage units; a logical, real, or integer entity, as one storage unit.

Then for common blocks with the same number of storage units or blank common:

(1) In all program units which have defined the identical type to a given position (counted by the number of preceding storage units) references to that position refer to the same quantity.

(2) A correct reference is made to a particular position assuming a given type if the most recent value assignment to that position was of the same type.

7.2.1.4 EQUIVALENCE *Statement.* An EQUIVALENCE statement is of the form:

$$\text{EQUIVALENCE } (k_1), (k_2), \ldots, (k_n)$$

in which each k is a list of the form:

$$a_1, a_2, \ldots, a_m.$$

Each a is either a variable name or an array element name (not a dummy argument), the subscript of which contains only constants, and m is greater than or equal to two. The number of subscript expressions of an array element name must correspond in number to the dimensionality of the array declarator or must be one (the array element successor function defines a relation by which an array can be made equivalent to a one dimensional array of the same length).

The EQUIVALENCE statement is used to permit the sharing of storage by two or more entities. Each element in a given list is assigned the same storage (or part of the same storage) by the processor. The EQUIVALENCE statement should not be used to equate mathematically two or more entities. If a two storage unit entity is equivalenced to a one storage unit entity, the latter will share space with the first storage unit of the former.

The assignment of storage to variables and arrays declared directly in a COMMON statement is determined solely by consideration of their type and the COMMON and array declarator statements. Entities so declared are always assigned unique storage, contiguous in the order declared in the COMMON statement.

The effect of an EQUIVALENCE statement upon common assignment may be the lengthening of a common block; the only such lengthening permitted is that which extends a common block beyond the last assignment for that block made directly by a COMMON statement.

When two variables or array elements share storage because of the effects of EQUIVALENCE statements, the symbolic names of the variables or arrays in question may not both appear in COMMON statements in the same program unit.

Information contained in 7.2.1.1.1, 7.2.1.3.1, and the present section suffices to describe the possibilities of additional cases of sharing of storage between array elements and entities of common blocks. It is incorrect to cause either directly or indirectly a single storage unit to contain more than one element of the same array.

7.2.1.5 EXTERNAL *Statement.* An EXTERNAL statement is of the form:

$$\text{EXTERNAL } v_1, v_2, \ldots, v_n$$

where each v is an external procedure name.

Appearance of a name in an EXTERNAL statement declares that name to be an external procedure name. If an external procedure name is used as an argument to another external procedure, it must appear in an EXTERNAL statement in the program unit in which it is so used.

7.2.1.6 *Type-Statements.* A type-statement is of the form:

$$t\ v_1, v_2, \ldots, v_n$$

where t is INTEGER, REAL, DOUBLE PRECISION, COMPLEX, or LOGICAL, and each v is a variable name, an array name, a function name, or an array declarator.

A type-statement is used to override or confirm the implicit typing, to declare entities to be of type double precision, complex, or logical, and may supply dimension information.

The appearance of a symbolic name in a type-statement serves to inform the processor that it is of the specified data type for all appearances in the program unit. See, however, the restriction in 8.3.1, second paragraph.

7.2.2 *Data Initialization Statement*. A data initialization statement is of the form:

$$\text{DATA } k_1 / d_1 / , k_2 / d_2 / , \ldots , k_n / d_n /$$

where:

(1) Each k is a list containing names of variables and array elements

(2) Each d is a list of constants and optionally signed constants, any of which may be preceded by j*

(3) j is an integer constant

If a list contains more than one entry, the entires are separated by commas.

Dummy arguments may not appear in the list k. Any subscript expression must be an integer constant.

When the form j* appears before a constant it indicates that the constant is to be specified j times. A Hollerith constant may appear in the list d.

A data initialization statement is used to define initial values of variables or array elements. There must be a one-to-one correspondence between the list-specified items and the constants. By this correspondence, the initial value is established.

An initially defined variable or array element may not be in blank common. A variable or array element in a labeled common block may be initially defined only in a block data subprogram.

7.2.3 FORMAT *Statement*. FORMAT statements are used in conjunction with the input/output of formatted records to provide conversion and editing information between the internal representation and the external character strings.

A FORMAT statement is of the form:

$$\text{FORMAT } (q_1 t_1 z_1 t_2 z_2 \ldots t_n z_n q_2)$$

where:

(1) $(q_1 t_1 z_1 t_2 z_2 \ldots t_n z_n q_2)$ is the format specification

(2) Each q is a series of slashes or is empty

(3) Each t is a field descriptor or group of field descriptors

(4) Each z is a field separator

(5) n may be zero

A FORMAT statement must be labeled.

7.2.3.1 *Field Descriptors*. The format field descriptors are of the forms:

$sr\mathrm{F}w.d$
$sr\mathrm{E}w.d$
$sr\mathrm{G}w.d$
$sr\mathrm{D}w.d$
$r\mathrm{I}w$
$r\mathrm{L}w$
$r\mathrm{A}w$
$n\mathrm{H}h_1h_2 \ldots h_n$
$n\mathrm{X}$

where:

(1) The letters F, E, G, D, I, L, A, H, and X indicate the manner of conversion and editing between the internal and external representations and are called the conversion codes.

(2) w and n are nonzero integer constants representing the width of the field in the external character string.

(3) d is an integer constant representing the number of digits in the fractional part of the external character string (except for G conversion code).

(4) r, the repeat count, is an optional nonzero integer constant indicating the number of times to repeat the succeeding basic field descriptor.

(5) s is optional and represents a scale factor designator.

(6) Each h is one of the characters capable of representation by the processor.

For all descriptors, the field width must be specified. For descriptors of the form $w.d$, the d must be specified, even if it is zero. Further, w must be greater than or equal to d.

The phrase *basic field descriptor* is used to signify the field descriptor unmodified by s or r.

The internal representation of external fields corresponds to the internal representation of the corresponding type constants (4.2 and 5.1.1).

7.2.3.2 *Field Separators*. The format field separators are the slash and the comma. A series of slashes is also a field separator. The field descriptors or groups of field descriptors are separated by a field separator.

The slash is used not only to separate field descriptors, but to specify demarcation of formatted records. A formatted record is a string of characters. The lengths of the strings for a given external medium are dependent upon both the processor and the external medium.

The processing of the number of characters that can be contained in a record by an external medium does not of itself cause the introduction or inception of processing of the next record.

7.2.3.3 *Repeat Specifications*. Repetition of the field descriptors (except nH and nX) is accomplished by using the repeat count. If the input/output list warrants, the specified conversion will be interpreted repetitively up to the specified number of times.

Repetition of a group of field descriptors or field separators is accomplished by enclosing them within parentheses and optionally preceding the left parenthesis with an integer constant called the group repeat count indicating the number of times to interpret the enclosed grouping. If no group repeat count is specified, a group repeat count of one is assumed. This form of grouping is called a basic group.

A further grouping may be formed by enclosing field descriptors, field separators, or basic groups within parentheses. Again, a group repeat count may be specified. The parentheses enclosing the format specification are not considered as group delineating parentheses.

7.2.3.4 *Format Control Interaction with an Input/Output List.* The inception of execution of a formatted READ or formatted WRITE statement initiates format control. Each action of format control depends on information jointly provided respectively by the next element of the input/output list, if one exists, and the next field descriptor obtained from the format specification. If there is an input/output list, at least one field descriptor other than nH or nX must exist.

When a READ statement is executed under format control, one record is read when the format control is initiated, and thereafter additional records are read only as the format specification demands. Such action may not require more characters of a record than it contains.

When a WRITE statement is executed under format control, writing of a record occurs each time the format specification demands that a new record be started. Termination of format control causes writing of the current record.

Except for the effects of repeat counts, the format specification is interpreted from left to right.

To each I, F, E, G, D, A, or L basic descriptor interpreted in a format specification, there corresponds one element specified by the input/output list, except that a complex element requires the interpretation of two F, E, or G basic descriptors. To each H or X basic descriptor there is no corresponding element specified by the input/output list, and the format control communicates information directly with the record. Whenever a slash is encountered, the format specification demands that a new record start or the preceding record terminate. During a READ operation, any unprocessed characters of the current record will be skipped at the time of termination of format control or when a slash is encountered.

Whenever the format control encounters an I, F, E, G, D, A, or L basic descriptor in a format specification, it determines if there is a corresponding element specified by the input/output list. If there is such an element, it transmits appropriately converted information between the element and the record and proceeds. If there is no corresponding element, the format control terminates.

If, however, the format control proceeds to the last outer right parenthesis of the format specification, a test is made to determine if another list element is specified. If not, control terminates. However, if another list element is specified, the format control demands a new record start and control reverts to that group repeat specification terminated by the last preceding right parenthesis, or if none exists, then to the first left parenthesis of the format specification. Note, this action of itself has no effect on the scale factor.

7.2.3.5 *Scale Factor.* A scale factor designator is defined for use with the F, E, G, and D conversions and is of the form:

nP

where n, the scale factor, is an integer constant or minus followed by an integer constant.

When the format control is initiated, a scale factor of zero is established. Once a scale factor has been established, it applies to all subsequently interpreted F, E, G, and D field descriptors, until another scale factor is encountered, and then that scale factor is established.

7.2.3.5.1 *Scale Factor Effects.* The scale factor n affects the appropriate conversions in the following manner:

(1) For F, E, G, and D input conversions (provided no exponent exists in the external field) and F output conversions, the scale factor effect is as follows:

externally represented number equals internally represented number times the quantity ten raised to the nth power.

(2) For F, E, G, and D input, the scale factor has no effect if there is an exponent in the external field.

(3) For E and D output, the basic real constant part of the output quantity is multiplied by 10^n and the exponent is reduced by n.

(4) For G output, the effect of the scale factor is suspended unless the magnitude of the datum to be converted is outside the range that permits the effective use of F conversion. If the effective use of E conversion is required, the scale factor has the same effect as with E output.

7.2.3.6 *Numeric Conversions.* The numeric field descriptors I, F, E, G, and D are used to specify input/output of integer, real, double precision, and complex data.

(1) With all numeric input conversions, leading blanks are not significant and other blanks are zero. Plus signs may be omitted. A field of all blanks is considered to be zero.

(2) With the F, E, G, and D input conversions, a decimal point appearing in the input field overrides the decimal point specification supplied by the field descriptor.

(3) With all output conversions, the output field is right justified. If the number of characters produced by the conversion is smaller than the field width, leading blanks will be inserted in the output field.

(4) With all output conversions, the external representation of a negative value must be signed; a positive value may be signed.

(5) The number of characters produced by an output conversion must not exceed the field width.

7.2.3.6.1 *Integer Conversion.* The numeric field descriptor Iw indicates that the external field occupies w positions as an integer. The value of the list item appears, or is to appear, internally as an integer datum.

In the external input field, the character string must be in the form of an integer constant or signed integer constant (5.1.1.1), except for the interpretation of blanks (7.2.3.6).

The external output field consists of blanks, if necessary, followed by a minus if the value of the internal datum is negative, or an optional plus otherwise, followed by the magnitude of the internal value converted to an integer constant.

7.2.3.6.2 *Real Conversions.* There are three conversions available for use with real data: F, E, and G.

The numeric field descriptor F$w.d$ indicates that the external field occupies w positions, the fractional part of which consists of d digits. The value of the list item appears, or is to appear, internally as a real datum.

The basic form of the external input field consists of an optional sign, followed by a string of digits optionally containing a decimal point. The basic form may be followed by an exponent of one of the following forms:

(1) Signed integer constant
(2) E followed by an integer constant
(3) E followed by a signed integer constant
(4) D followed by an integer constant
(5) D followed by a signed integer constant

An exponent containing D is equivalent to an exponent containing E.

The external output field consists of blanks, if necessary, followed by a minus if the internal value is negative, or an optional plus otherwise, followed by a string of digits containing a decimal point representing the magnitude of the internal value, as modified by the established scale factor, rounded to d fractional digits.

The numeric field descriptor E$w.d$ indicates that the external field occupies w positions, the fractional part of which consists of d digits. The value of the list item appears, or is to appear, internally as a real datum.

The form of the external input field is the same as for the F conversion.

7.2.3.6.2.1 The standard form of the external output field for a scale factor of zero is[1]

$$\xi 0.x_1 \ldots x_d Y$$

where:

(1) $x_1 \ldots x_d$ are the d most significant rounded digits of the value of the data to be output.

(2) Y is of one of the forms:

$$\mathrm{E} \pm y_1 y_2$$

or

$$\pm y_1 y_2 y_3$$

and has the significance of a decimal exponent (an alternative for the plus in the first of these forms is the character blank).

(3) The digit 0 in the aforementioned standard form may optionally be replaced by no character position.

(4) Each y is a digit.

7.2.3.6.2.2 The scale factor n controls the decimal normalization between the number part and the exponent part such that:

(1) If $n \leqq 0$, there will be exactly $-n$ leading zeros and $d+n$ significant digits after the decimal point.

(2) If $n > 0$, there will be exactly n significant digits to the left of the decimal point and $d-n+1$ to the right of the decimal point.

The numeric field descriptor G$w.d$ indicates that the external field occupies w positions with d significant digits. The value of the list item appears, or is to appear, internally as a real datum.

Input processing is the same as for the F conversion.

The method of representation in the external output string is a function of the magnitude of the real datum being converted. Let N be the magnitude of the internal datum. The following tabulation exhibits a correspondence between N and the equivalent method of conversion that will be effected:

Magnitude of Datum	Equivalent Conversion Effected
$0.1 \leqq N < 1$	F$(w-4).d$, 4X
$1 \leqq N < 10$	F$(w-4).(d-1)$, 4X
⋮	⋮
$10^{d-2} \leqq N < 10^{d-1}$	F$(w-4)$.1, 4X
$10^{d-1} \leqq N < 10^{d}$	F$(w-4)$.0, 4X
Otherwise	sE$w.d$

Note that the effect of the scale factor is suspended unless the magnitude of the datum to be converted is outside of the range that permits effective use of F conversion.

7.2.3.6.3 *Double Precision Conversion.* The numeric field descriptor D$w.d$ indicates that the external field occupies w positions, the fractional part of which consists of d digits. The value of the list item appears, or is to appear, internally as a double precision datum.

The basic form of the external input field is the same as for real conversions.

The external output field is the same as for the E conversion, except that the character D may replace the character E in the exponent.

7.2.3.6.4 *Complex Conversion.* Since a complex datum consists of a pair of separate real data, the conversion is specified by two successively interpreted real field descriptors. The first of these supplies the real part. The second supplies the imaginary part.

7.2.3.7 *Logical Conversion.* The logical field descriptor Lw indicates that the external field occupies w positions as a string of information as defined below.

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[1] ξ signifies no character position or minus in that position.

The list item appears, or is to appear, internally as a logical datum.

The external input field must consist of optional blanks followed by a T or F followed by optional characters, for true and false, respectively.

The external output field consists of $w-1$ blanks followed by a T or F as the value of the internal datum is true or false, respectively.

7.2.3.8 *Hollerith Field Descriptor.* Hollerith information may be transmitted by means of two field descriptors, nH and Aw.

(1) The nH descriptor causes Hollerith information to be read into, or written from, the n characters (including blanks) following the nH descriptor in the format specification itself.

(2) The Aw descriptor causes w Hollerith characters to be read into, or written from, a specified list element.

Let g be the number of characters representable in a single storage unit (7.2.1.3.1). If the field width specified for A input is greater than or equal to g, the rightmost g characters will be taken from the external input field. If the field width is less than g, the w characters will appear left justified with $w-g$ trailing blanks in the internal representation.

If the field width specified for A output is greater than g, the external output field will consist of $w-g$ blanks, followed by the g characters from the internal representation. If the field width is less than or equal to g, the external output field will consist of the leftmost w characters from the internal representation.

7.2.3.9 *Blank Field Descriptor.* The field descriptor for blanks is nX . On input, n characters of the external input record are skipped. On output, n blanks are inserted in the external output record.

7.2.3.10 *Format Specification in Arrays.* Any of the formatted input/output statements may contain an array name in place of the reference to a FORMAT statement label. At the time an array is referenced in such a manner, the first part of the information contained in the array, taken in the natural order, must constitute a valid format specification. There is no requirement on the information contained in the array following the right parenthesis that ends the format specification.

The format specification which is to be inserted in the array has the same form as that defined for a FORMAT statement; that is, begins with a left parenthesis and ends with a right parenthesis. An nH field descriptor may not be part of a format specification within an array.

The format specification may be inserted in the array by use of a data initialization statement, or by use of a READ statement together with an A format.

8. Procedures and Subprograms

There are four categories of procedures: statement functions, intrinsic functions, external functions, and external subroutines. The first three categories are referred to collectively as functions or function procedures; the last as subroutines or subroutine procedures. There are two categories of subprograms: procedure subprograms and specification subprograms. Function subprograms and subroutine subprograms are classified as procedure subprograms. Block data subprograms are classified as specification subprograms. Type rules for function procedures are given in 5.3.

8.1 Statement Functions. A statement function is defined internally to the program unit in which it is referenced. It is defined by a single statement similar in form to an arithmetic or logical assignment statement.

In a given program unit, all statement function definitions must precede the first executable statement of the program unit and must follow the specification statements, if any. The name of a statement function must not appear in an EXTERNAL statement, nor as a variable name or an array name in the same program unit.

8.1.1 ***Defining Statement Functions.*** A statement function is defined by a statement of the form:

$$f(a_1, a_2, \dots, a_n) = e$$

where f is the function name, e is an expression, and the relationship between f and e must conform to the assignment rules in 7.1.1.1 and 7.1.1.2. The a's are distinct variable names, called the *dummy arguments* of the function. Since these are dummy arguments, their names, which serve only to indicate type, number, and order of arguments, may be the same as variable names of the same type appearing elsewhere in the program unit.

Aside from the dummy arguments, the expression e may only contain:

(1) Non-Hollerith constants

(2) Variable references

(3) Intrinsic function references

(4) References to previously defined statement functions

(5) External function references

8.1.2 ***Referencing Statement Functions.*** A statement function is referenced by using its reference (5.2) as a primary in an arithmetic or logical expression. The actual arguments, which constitute the argument list, must agree in order, number, and type with the corresponding dummy arguments. An actual argument in a statement function reference may be any expression of the same type as the corresponding dummy argument.

Execution of a statement function reference results in an association (10.2.2) of actual argument values with the corresponding dummy arguments in the expression of the function definition, and an evaluation of the expression. Following this, the resultant value is made available to the expression that contained the function reference.

8.2 Intrinsic Functions and Their Reference. The symbolic names of the intrinsic functions (see Table 3)

Table 3
Intrinsic Functions

Intrinsic Function	Definition	Number of Arguments	Symbolic Name	Type of: Argument	Function
Absolute Value	$\|a\|$	1	ABS	Real	Real
			IABS	Integer	Integer
			DABS	Double	Double
Truncation	Sign of a times largest integer $\leqq \|a\|$	1	AINT	Real	Real
			INT	Real	Integer
			IDINT	Double	Integer
Remaindering*	$a_1 \pmod{a_2}$	2	AMOD	Real	Real
			MOD	Integer	Integer
Choosing Largest Value	Max $(a_1, a_2, \ldots)$	$\geqq 2$	AMAX0	Integer	Real
			AMAX1	Real	Real
			MAX0	Integer	Integer
			MAX1	Real	Integer
			DMAX1	Double	Double
Choosing Smallest Value	Min $(a_1, a_2, \ldots)$	$\geqq 2$	AMIN0	Integer	Real
			AMIN1	Real	Real
			MIN0	Integer	Integer
			MIN1	Real	Integer
			DMIN1	Double	Double
Float	Conversion from integer to real	1	FLOAT	Integer	Real
Fix	Conversion from real to integer	1	IFIX	Real	Integer
Transfer of Sign	Sign of a_2 times $\|a_1\|$	2	SIGN	Real	Real
			ISIGN	Integer	Integer
			DSIGN	Double	Double
Positive Difference	a_1 − Min (a_1, a_2)	2	DIM	Real	Real
			IDIM	Integer	Integer
Obtain Most Significant Part of Double Precision Argument		1	SNGL	Double	Real
Obtain Real Part of Complex Argument		1	REAL	Complex	Real
Obtain Imaginary Part of Complex Argument		1	AIMAG	Complex	Real
Express Single Precision Argument in Double Precision Form		1	DBLE	Real	Double
Express Two Real Arguments in Complex Form	$a_1 + a_2\sqrt{-1}$	2	CMPLX	Real	Complex
Obtain Conjugate of a Complex Argument		1	CONJG	Complex	Complex

*The function MOD or AMOD (a_1, a_2) is defined as $a_1 - [a_1/a_2]a_2$, where $[x]$ is the integer whose magnitude does not exceed the magnitude of x and whose sign is the same as x.

are predefined to the processor and have a special meaning and type if the name satisfies the conditions of 10.1.7.

An intrinsic function is referenced by using its reference as a primary in an arithmetic or logical expression. The actual arguments, which constitute the argument list, must agree in type, number, and order with the specification in Table 3 and may be any expression of the specified type. The intrinsic functions AMOD, MOD, SIGN, ISIGN, and DSIGN are not defined when the value of the second argument is zero.

Execution of an intrinsic function reference results in the actions specified in Table 3 based on the values of the actual arguments. Following this, the resultant value is made available to the expression that contained the function reference.

8.3 External Functions. An external function is defined externally to the program unit that references it. An external function defined by FORTRAN statements headed by a FUNCTION statement is called a function subprogram.

8.3.1 ***Defining Function Subprograms.*** A FUNCTION statement is of the form:

$$t \text{ FUNCTION } f(a_1, a_2 \ldots, a_n)$$

where:

(1) t is either INTEGER, REAL, DOUBLE PRECISION, COMPLEX, or LOGICAL, or is empty.

(2) f is the symbolic name of the function to be defined.

(3) The a's, called the dummy arguments, are each either a variable name, an array name, or an external procedure name.

8.3.1.1 Function subprograms are constructed as specified in 9.1.3 with the following restrictions:

(1) The symbolic name of the function must also appear as a variable name in the defining subprogram. During every execution of the subprogram, this variable must be defined and, once defined, may be referenced or redefined. The value of the variable at the time of execution of any RETURN statement in this subprogram is called the value of the function.

(2) The symbolic name of the function must not appear in any nonexecutable statement in this program unit, except as the symbolic name of the function in the FUNCTION statement.

(3) The symbolic names of the dummy arguments may not appear in an EQUIVALENCE, COMMON, or DATA statement in the function subprogram.

(4) The function subprogram may define or redefine one or more of its arguments so as to effectively return results in addition to the value of the function.

(5) The function subprogram may contain any statements except BLOCK DATA, SUBROUTINE, another FUNCTION statement, or any statement that directly or indirectly references the function being defined.

(6) The function subprogram must contain at least one RETURN statement.

8.3.2 ***Referencing External Functions.*** An external function is referenced by using its reference (5.2) as a primary in an arithmetic or logical expression. The actual arguments, which constitute the argument list, must agree in order, number, and type with the corresponding dummy arguments in the defining program unit. An actual argument in an external function reference may be one of the following:

(1) A variable name

(2) An array element name

(3) An array name

(4) Any other expression

(5) The name of an external procedure

If an actual argument is an external function name or a subroutine name, then the corresponding dummy argument must be used as an external function name or a subroutine name, respectively.

If an actual argument corresponds to a dummy argument that is defined or redefined in the referenced subprogram, the actual argument must be a variable name, an array element name, or an array name. Execution of an external function reference results in an association (10.2.2) of actual arguments with all appearances of dummy arguments in executable statements, function definition statements, and as adjustable dimensions in the defining subprogram. If the actual argument is an expression, then this association is by value rather than by name. Following these associations, execution of the first executable statement of the defining subprogram is undertaken. An actual argument which is an array element name containing variables in the subscript could in every case be replaced by the same argument with a constant subscript containing the same values as would be derived by computing the variable subscript just before the association of arguments takes place.

If a dummy argument of an external function is an array name, the corresponding actual argument must be an array name or array element name (10.1.3).

If a function reference causes a dummy argument in the referenced function to become associated with another dummy argument in the same function or with an entity in common, a definition of either within the function is prohibited.

Unless it is a dummy argument, an external function is also referenced (in that it must be defined) by the appearance of its symbolic name in an EXTERNAL statement.

8.3.3 ***Basic External Functions.*** FORTRAN processors must supply the external functions listed in Table 4. Referencing of these functions is accomplished as described in 8.3.2. Arguments for which the result of these functions is not mathematically defined or is of type other than that specified are improper.

Table 4
Basic External Functions

Basic External Function	Definition	Number of Arguments	Symbolic Name	Type of: Argument	Function
Exponential	e^a	1	EXP	Real	Real
		1	DEXP	Double	Double
		1	CEXP	Complex	Complex
Natural Logarithm	$\log_e(a)$	1	ALOG	Real	Real
		1	DLOG	Double	Double
		1	CLOG	Complex	Complex
Common Logarithm	$\log_{10}(a)$	1	ALOG10	Real	Real
			DLOG10	Double	Double
Trigonometric Sine	$\sin(a)$	1	SIN	Real	Real
		1	DSIN	Double	Double
		1	CSIN	Complex	Complex
Trigonometric Cosine	$\cos(a)$	1	COS	Real	Real
		1	DCOS	Double	Double
		1	CCOS	Complex	Complex
Hyperbolic Tangent	$\tanh(a)$	1	TANH	Real	Real
Square Root	$(a)^{1/2}$	1	SQRT	Real	Real
		1	DSQRT	Double	Double
		1	CSQRT	Complex	Complex
Arctangent	$\arctan(a)$	1	ATAN	Real	Real
		1	DATAN	Double	Double
	$\arctan(a_1/a_2)$	2	ATAN2	Real	Real
		2	DATAN2	Double	Double
Remaindering*	$a_1 \pmod{a_2}$	2	DMOD	Double	Double
Modulus		1	CABS	Complex	Real

*The function DMOD (a_1, a_2) is defined as $a_1 - [a_1/a_2]a_2$, where $[x]$ is the integer whose magnitude does not exceed the magnitude of x and whose sign is the same as the sign of x.

8.4 Subroutine. An external subroutine is defined externally to the program unit that references it. An external subroutine defined by FORTRAN statements headed by a SUBROUTINE statement is called a subroutine subprogram.

8.4.1 ***Defining Subroutine Subprograms.*** A SUBROUTINE statement is of one of the forms:

SUBROUTINE $s\ (a_1, a_2, \ldots, a_n)$

or

SUBROUTINE s

where:

(1) s is the symbolic name of the subroutine to be defined.

(2) The a's, called the dummy arguments, are each either a variable name, an array name, or an external procedure name.

8.4.1.1 Subroutine subprograms are constructed as specified in 9.1.3 with the following restrictions:

(1) The symbolic name of the subroutine must not appear in any statement in this subprogram except as the symbolic name of the subroutine in the SUBROUTINE statement itself.

(2) The symbolic names of the dummy arguments may not appear in an EQUIVALENCE, COMMON, or DATA statement in the subprogram.

(3) The subroutine subprogram may define or redefine one or more of its arguments so as to effectively return results.

(4) The subroutine subprogram may contain any statements except BLOCK DATA, FUNCTION, another SUBROUTINE statement, or any statement that directly or indirectly references the subroutine being defined.

(5) The subroutine subprogram must contain at least one RETURN statement.

8.4.2 ***Referencing Subroutines.*** A subroutine is referenced by a CALL statement (7.1.2.4). The actual arguments, which constitute the argument list, must agree in order, number, and type with the corresponding dummy arguments in the defining program. The use of a Hollerith constant as an actual argument is an exception to the role requiring agreement of type. An actual argument in a subroutine reference may be one of the following:

(1) A Hollerith constant
(2) A variable name
(3) An array element name
(4) An array name
(5) Any other expression
(6) The name of an external procedure

If an actual argument is an external function name or a subroutine name, the corresponding dummy argument must be used as an external function name or a subroutine name, respectively.

If an actual argument corresponds to a dummy argument that is defined or redefined in the referenced subprogram, the actual argument must be a variable name, an array element name, or an array name.

Execution of a subroutine reference, as described in the preceding paragraphs, results in an association of actual arguments with all appearances of dummy arguments in executable statements, function definition statements, and as adjustable dimensions in the defining subprogram. If the actual argument is as specified in item (5), this association is by value rather than by name. Following these associations, execution of the first executable statement of the defining subprogram is undertaken.

An actual argument which is an array element name containing variables in the subscript could in every case be replaced by the same argument with a constant subscript containing the same values as would be derived by computing the variable subscript just before the association of arguments takes place.

If a dummy argument of an external function is an array name, the corresponding actual argument must be an array name or array element name (10.1.3).

If a subroutine reference causes a dummy argument in the referenced subroutine to become associated with another dummy argument in the same subroutine or with an entity in common, a definition of either entity within the subroutine is prohibited.

Unless it is a dummy argument, a subroutine is also referenced (in that it must be defined) by the appearance of its symbolic name in an EXTERNAL statement.

8.5 Block Data Subprogram. A BLOCK DATA statement is of the form:

BLOCK DATA

This statement may only appear as the first statement of specification subprograms that are called block data subprograms, and that are used to enter initial values into elements of labeled common blocks. This special subprogram contains only type-statements, EQUIVALENCE, DATA, DIMENSION, and COMMON statements.

If any entity of a given common block is being given an initial value in such a subprogram, a complete set of specification statements for the entire block must be included, even though some of the elements of the block do not appear in DATA statements. Initial values may be entered into more than one block in a single subprogram.

9. Programs

An executable program is a collection of statements, comment lines, and end lines that completely (except for input data values and their effects) describe a computing procedure.

9.1 Program Components. Programs consist of program parts, program bodies, and subprogram statements.

9.1.1 ***Program Part.*** A program part must contain at least one executable statement and may contain FORMAT statements, and data initialization statements. It need not contain any statements from either of the latter two classes of statement. This collection of statements may optionally be preceded by statement function definitions, data initialization statements, and FORMAT statements. As before only some or none of these need be present.

9.1.2 ***Program Body.*** A program body is a collection of specification statements, FORMAT statements or both, or neither, followed by a program part, followed by an end line.

9.1.3 ***Subprogram.*** A subprogram consists of a SUBROUTINE or FUNCTION statement followed by a program body, or is a block data subprogram.

9.1.4 ***Block Data Subprogram.*** A block data subprogram consists of a BLOCK DATA statement, followed by the appropriate (8.5) specification statements, followed by data initialization statements, followed by an end line.

9.1.5 ***Main Program.*** A main program consists of a program body.

9.1.6 ***Executable Program.*** An executable program consists of a main program plus any number of subprograms, external procedures, or both.

9.1.7 ***Program Unit.*** A program unit is a main program or a subprogram.

9.2 Normal Execution Sequence. When an executable program begins operation, execution commences with the execution of the first executable statement of the main program. A subprogram, when referenced, starts execution with execution of the first executable statement of that subprogram. Unless a statement is a GO TO, arithmetic IF, RETURN, or STOP statement or the terminal statement of a DO, completion of execution of that statement causes execution of the next following executable statement. The sequence of execution following execution of any of these statements is described in Section 7. A program part may not (in the sense of 1.1) contain an executable statement that can never be executed.

A program part must contain a first executable statement.

10. Intra- and Inter-Program Relationships

10.1 Symbolic Names. A symbolic name has been defined to consist of from one to six alphanumeric characters, the first of which must be alphabetic. Sequences of characters that are format field descriptors or uniquely identify certain statement types, e.g., GO TO, READ, FORMAT, etc, are not symbolic names in such occurrences nor do they form the first characters of symbolic names in these cases. In a program unit, a symbolic name (perhaps qualified by a subscript) must identify an element of one (and usually only one) of the following classes:

Class I	An array and the elements of that array
Class II	A variable
Class III	A statement function
Class IV	An intrinsic function
Class V	An external function
Class VI	A subroutine
Class VII	An external procedure which cannot be classified as either a subroutine or an external function in the program unit in question
Class VIII	A block name

10.1.1 ***Restrictions on Class.*** A symbolic name in Class VIII in a program unit may also be in any one of the Classes I, II, or III in that program unit.

In the program unit in which a symbolic name in Class V appears immediately following the word FUNCTION in a FUNCTION statement, that name must also be in Class II.

Once a symbolic name is used in Class V, VI, VII, or VIII in any unit of an executable program, no other program unit of that executable program may use that name to identify an entity of these classes other than the one originally identified. In the totality of the program units that make up an executable program, a Class VII name must be associated with a Class V or VI name. Class VII can only exist locally in program units.

In a program unit, no symbolic name can be in more than one class except as noted in the preceding paragraphs. There are no restrictions on uses of symbolic names in different program units of an executable program other than those noted in the preceding paragraphs.

10.1.2 ***Implications of Mentions in Specification and DATA Statements.*** A symbolic name is in Class I if and only if it appears as a declarator name. Only one such appearance for a symbolic name in a program unit is permitted.

A symbolic name that appears in a COMMON statement (other than as a block name) is either in Class I, or in Class II but not Class V (8.3.1). Only one such appearance for a symbolic name in a program unit is permitted.

A symbolic name that appears in an EQUIVALENCE statement is either in Class I, or in Class II but not Class V (8.3.1).

A symbolic name that appears in a type-statement cannot be in Class VI or Class VII. Only one such appearance for a symbolic name in a program unit is permitted.

A symbolic name that appears in an EXTERNAL statement is in either Class V, Class VI, or Class VII. Only one such appearance for a symbolic name in a program unit is permitted.

A symbolic name that appears in a DATA statement is in either Class I, or in Class II but not Class V (8.3.1). In an executable program, a storage unit (7.2.1.3.1) may have its value initialized one time at the most.

10.1.3 ***Array and Array Element.*** In a program unit, any appearance of a symbolic name that identifies an array must be immediately followed by a subscript, except in the following cases:

(1) In the list of an input/output statement

(2) In a list of dummy arguments

(3) In the list of actual arguments in a reference to an external procedure

(4) In a COMMON statement

(5) In a type-statement

Only when an actual argument of an external procedure reference is an array name or an array element name may the corresponding dummy argument be an array name. If the actual argument is an array name, the length of the dummy argument array must be no greater than the length of the actual argument array. If the actual argument is an array element name, the length of the dummy argument array must be less than or equal to the length of the actual argument array plus one minus the value of the subscript of the array element.

10.1.4 ***External Procedures.*** The only case when a symbolic name is in Class VII occurs when that name appears only in an EXTERNAL statement and as an actual argument to an external procedure in a program unit.

Only when an actual argument of an external procedure reference is an external procedure name may the corresponding dummy argument be an external procedure name.

In the execution of an executable program, a procedure subprogram may not be referenced twice without the execution of a RETURN statement in that procedure having intervened.

10.1.5 ***Subroutine.*** A symbolic name is in Class VI if it appears:

(1) Immediately following the word SUBROUTINE in a SUBROUTINE statement.

(2) Immediately following the word CALL in a CALL statement.

10.1.6 ***Statement Function.*** A symbolic name is in Class III in a program unit if and only if it meets all three of the following conditions:

(1) It does not appear in an EXTERNAL statement nor is it in Class I.

(2) Every appearance of the name, except in a type-statement, is immediately followed by a left parenthesis.

(3) A function defining statement (8.1.1) is present for that symbolic name.

10.1.7 *Intrinsic Function.* A symbolic name is in Class IV in a program unit if and only if it meets all four of the following conditions:

(1) It does not appear in an EXTERNAL statement nor is it in Class I or Class III.

(2) The symbolic name appears in the name column of the table in 8.2.

(3) The symbolic name does not appear in a type-statement of type different from the intrinsic type specified in the table.

(4) Every appearance of the symbolic name (except in a type-statement as described previously is immediately followed by an actual argument list enclosed in parentheses.

The use of an intrinsic function in a program unit of an executable program does not preclude the use of the same symbolic name to identify some other entity in a different program unit of that executable program.

10.1.8 *External Function.* A symbolic name is in Class V if it:

(1) Appears immediately following the word FUNCTION in a FUNCTION statement.

(2) Is not in Class I, Class III, Class IV, or Class VI and appears immediately followed by a left parenthesis on every occurrence except in a type-statement, in an EXTERNAL statement, or as an actual argument. There must be at least one such appearance in the program unit in which it is so used.

10.1.9 *Variable.* In a program unit, a symbolic name is in Class II if it meets all three of the following conditions:

(1) It is not in Class VI or Class VII.

(2) It is never immediately followed by a left parenthesis unless it is immediately preceded by the word FUNCTION in a FUNCTION statement.

(3) It occurs other than in a Class VIII appearance.

10.1.10 *Block Name.* A symbolic name is in Class VIII if and only if it is used as a block name in a COMMON statement.

10.2 Definition. There are two levels of definition of numeric values, first level definition and second level definition. The concept of definition on the first level applies to array elements and variables; that of second level definition to integer variables only. These concepts are defined in terms of progression of execution; and thus, an executable program, complete and in execution, is assumed in what follows.

There are two other varieties of definition that should be noted. The first. effected by GO TO assignment and referring to an integer variable being defined with other than an integer value, is discussed in 7.1.1.3 and 7.1.2.1.2; the second, which refers to when an external procedure may be referenced, will be discussed in the next section.

In what follows, otherwise unqualified use of the terms definition and undefinition (or their alternate forms), as applied to variables and array elements, will imply modification by the phrase on the first level.

10.2.1 *Definition of Procedures.* If an executable program contains information describing an external procedure, such an external procedure, with the applicable symbolic name, is defined for use in that executable program. An external function reference or subroutine reference (as the case may be) to that symbolic name may then appear in the executable program, provided that number of arguments agrees between definition and reference. In addition, for an external function, the type of function must agree between definition and reference. Other restrictions on agreements are contained in 8.3.1, 8.3.2, 8.4.1, 8.4.2, 10.1.3, and 10.1.4.

The basic external functions listed in 8.3.3 are always defined and may be referenced subject to the restrictions alluded to in the preceding paragraphs.

A symbolic name in Class III or Class IV is defined for such use.

10.2.2 *Associations That Effect Definition.* Entities may become associated by:

(1) COMMON association

(2) EQUIVALENCE association

(3) Argument substitution

Multiple association to one or more entities can be the result of the foregoing combinations. Any definition or undefinition of one of a set of associated entities effects the definition or undefinition of each entity of the entire set.

For purposes of definition, in a program unit there is no association between any two entities both of which appear in COMMON statements. Further, there is no other association for common and equivalenced entities other than those stated in 7.2.1.3.1 and 7.2.1.4.

If an actual argument of an external procedure reference is an array name, an array element name, or a variable name, then the discussions in 10.1.3 and 10.2.1 allow an association of dummy arguments with the actual arguments only between the time of execution of the first executable statement of the procedure and the inception of execution of the next encountered RETURN statement of that procedure. Note specifically that this association can be carried through more than one level of external procedure reference.

In what follows, variables or array elements associated by the information in 7.2.1.3.1 and 7.2.1.4 will be equivalent if and only if they are of the same type.

If an entity of a given type becomes defined, then all associated entities of different type become undefined at the same time, while all associated entities of the same type become defined unless otherwise noted.

Association by argument substitution is only valid in the case of identity of type, so the rule in this case is that an entity created by argument substitution is defined at time of entry if and only if the actual argument was defined. If an entity created by argument substitution becomes defined or undefined (while the association exists) during execution of a subprogram, then the corresponding actual entities in all calling program units becomes defined or undefined accordingly.

10.2.3 ***Events That Effect Definition.*** Variables and array elements become initially defined if and only if their names are associated in a data initialization statement with a constant of the same type as the variable or array in question. Any entity not initially defined is undefined at the time of the first execution of the first executable statement of the main program. Redefinition of a defined entity is always permissible except for certain integer variables (7.1.2.8, 7.1.3.2.1, and 7.2.1.1.2) or certain entities in subprograms (6.4, 8.3.2, and 8.4.2).

Variables and array elements become defined or redefined as follows:

(1) Completion of execution of an arithmetic or logical assignment statement causes definition of the entity that precedes the equals.

(2) As execution of an input statement proceeds, each entity, which is assigned a value of its corresponding type from the input medium, is defined at the time of such association. Only at the completion of execution of the statement do associated entities of the same type become defined.

(3) Completion of execution of a DO statement causes definition of the control variable.

(4) Inception of execution of action specified by a DO-implied list causes definition of the control variable.

10.2.3.1 Variables and array elements become undefined as follows:

(1) At the time a DO is satisfied, the control variable becomes undefined.

(2) Completion of execution of an ASSIGN statement causes undefinition of the integer variable in the statement.

(3) Certain entities in function subprograms (10.2.9) become undefined.

(4) Completion of execution of action specified by a DO-implied list causes undefinition of the control variable.

(5) When an associated entity of different type becomes defined.

(6) When an associated entity of the same type becomes undefined.

10.2.4 ***Entities in Blank Common.*** Entities in blank common and those entities associated with them may not be initially defined.

Such entities, once defined by any of the rules previously mentioned, remain defined until they become undefined.

10.2.5 ***Entities in Labeled Common.*** Entities in labeled common or any associates of those entities may be initially defined.

A program unit contains a labeled common block name if the name appears as a block name in the program unit. If a main program or referenced subprogram contains a labeled common block name, any entity in the block (and its associates) once defined remain defined until they become undefined.

It should be noted that redefinition of an initially defined entity will allow later undefinition of that entity. Specifically, if a subprogram contains a labeled common block name that is not contained in any program unit currently referencing the subprogram directly or indirectly, the execution of a RETURN statement in the subprogram causes undefinition of all entities in the block (and their associates) except for initially defined entities that have maintained their initial definitions.

10.2.6 ***Entities Not in Common.*** An entity not in common except for a dummy argument or the value of a function may be initially defined.

Such entities once defined by any of the rules previously mentioned, remain defined until they become undefined.

If such an entity is in a subprogram, the completion of execution of a RETURN statement in that subprogram causes all such entities and their associates at that time (except for initially defined entities that have not been redefined or become undefined) to become undefined. In this respect, it should be noted that the association between dummy arguments and actual arguments is terminated at the inception of execution of the RETURN statement.

Again, it should be emphasized, the redefinition of an initially defined entity can result in a subsequent undefinition of that entity.

10.2.7 ***Basic Block.*** In a program unit, a basic block is a group of one or more executable statements defined as follows.

The following statements are block terminal statements:

(1) DO statement

(2) CALL statement

(3) GO TO statement of all types

(4) Arithmetic IF statement

(5) STOP statement

(6) RETURN statement

(7) The first executable statement, if it exists, preceding a statement whose label is mentioned in a GO TO or arithmetic IF statement

(8) An arithmetic statement in which an integer variable precedes the equals

(9) A READ statement with an integer variable in the list

(10) A logical IF containing any of the admissible forms given above.

10.2.7.1 The following statements are block initial statements:

(1) The first executable statement of a program unit

(2) The first executable statement, if it exists, following a block terminal statement

Every block initial statement defines a basic block. If that initial statement is also a block terminal statement, the basic block consists of that one statement. Otherwise, the basic block consists of the initial statement and all executable statements that follow until a block terminal statement is encountered. The terminal statement is included in the basic block.

10.2.7.1 *Last Executable Statement.* In a program unit the last executable statement (which cannot be part of a logical IF) must be one of the following statements: GO TO statement, arithmetic IF statement, STOP statement, or RETURN statement.

10.2.8 ***Second Level Definition.*** Integer variables must be defined on the second level when used in subscripts and computed GO TO statements.

Redefinition of an integer entity causes all associated variables to be undefined for use on the second level during this execution of this program unit until the associated integer variable is explicitly redefined.

Except as just noted, an integer variable is defined on the second level upon execution of the initial statement of a basic block only if both of the following conditions apply:

(1) The variable is used in a subscript or in a computed GO TO in the basic block in question.

(2) The variable is defined on the first level at the time of execution of the initial statement in question.

10.2.8.1 This definition persists until one of the following happens:

(1) Completion of execution of the terminal statement of the basic block in question.

(2) The variable in question becomes undefined or receives a new definition on the first level.

10.2.8.2 At this time, the variable becomes undefined on the second level.

In addition, the occurrence of an integer variable in the list of an input statement in which that integer variable appears following in a subscript causes that variable to be defined on the second level. This definition persists until one of the following happens:

(1) Completion of execution of the terminal statement of the basic block containing the input statement.

(2) The variable becomes undefined or receives a new definition on the first level.

An integer variable defined as the control variable of a DO-implied list is defined on the second level over the range of that DO-implied list and only over that range.

10.2.9 ***Certain Entities in Function Subprograms.*** If a function subprogram is referenced more than once with an identical argument list in a single statement, the execution of that subprogram must yield identical results for those cases mentioned, no matter what the order of evaluation of the statement.

If a statement contains a factor that may not be evaluated (6.4), and if this factor contains a function reference, then all entities that might be defined in that reference become undefined at the completion of evaluation of the expression containing the factor.

10.3 Definition Requirements for Use of Entities. Any variable referenced in a subscript or a computed GO TO must be defined on the second level at the time of this use.

Any variable, array element, or function referenced as a primary in an expression and any subroutine referenced by a CALL statement must be defined at the time of this use. In the case where an actual argument in the argument list of an external procedure reference is a variable name or an array element name, this in itself is not a requirement that the entity be defined at the time of the procedure reference; however, when such an argument is an external procedure name, it must be defined.

Any variable used as an initial value, terminal value, or incrementation value of a DO statement or a DO-implied list must be defined at the time of this use.

Any variable used to identify an input/output unit must be defined at the time of this use.

At the time of execution of a RETURN statement in a function subprogram, the value (8.3.1) of that function must be defined.

At the time of execution of an output statement, every entity whose value is to be transferred to the output medium must be defined unless the output is under control of a format specification and the corresponding conversion code is A. If the output is under control of a format specification, a correct association of conversion code with type of entity is required unless the conversion code is A. The following are the correct associations: I with integer; D with double precision; E, F, and G with real and complex; and L with logical.

Appendixes

(These Appendixes are not a part of USA Standard FORTRAN, X3.9-1966, but are included to facilitate its use.)

Appendix A

Considerations Relating to Purpose of FORTRAN Standardization

A1. Introduction

Processors for a group of closely related programming languages using the name "FORTRAN" have been constructed for most of the types of computing systems in wide use today. These FORTRAN processors are so widely used that FORTRAN is the most commonly used of all of the common programming languages for computers and information processing systems.

A2. FORTRAN Historical Development and Current Status

The original objective in the first FORTRAN programming language was:

"The FORTRAN language is intended to be capable of expressing any problem of numerical computation. In particular, it deals easily with problems containing large sets of formulae and many variables, and it permits any variable to have up to three independent subscripts. However, for problems in which machine words have a logical rather than a numerical meaning it is less satisfactory, and it may fail entirely to express some such problems. Nevertheless, many logical operations not directly expressable in the FORTRAN language can be obtained by making use of provisions for incorporating library routines."

This quotation is taken from "The FORTRAN Automatic Coding System for the IBM 704 EDPM," dated October 15, 1956.

The first FORTRAN processor was modified in 1958 to accept programs written in an augmented FORTRAN language, commonly known as "FORTRAN II." The usage of FORTRAN II grew rapidly and processors became available for a wide variety of computers of quite varied structure and power.

Beginning in 1962, processors for "FORTRAN IV" began to appear and have come into increasing use although FORTRAN II processors remain in quite substantial use. FORTRAN IV not only added to the FORTRAN language but made certain changes such that FORTRAN II programs could not be run directly on FORTRAN IV processors. Computer programs that accept most FORTRAN II programs and produce correct equivalent FORTRAN IV programs have been used for conversion. A brief discussion of the FORTRAN II-FORTRAN IV interrelation is given in A5.

In addition to the partial dichotomy introduced into the FORTRAN language family by the advent of FORTRAN IV, other language differences have arisen in the course of time through differences in particular processors, and these differences restrict the interchangeability of FORTRAN programs between processors. These differences generally exist for one or more of the following reasons: (1) to expand the application area of the language, (2) to simplify the language for the user, (3) to exploit a particular computing system more effectively, (4) to simplify or speed up the operation of a processor, and (5) misunderstanding or disagreement as to what FORTRAN is for lack of definitive standards.

A3. General Purpose

The purpose of FORTRAN standards is to *facilitate* the interchange of programs for use on a number of processors. The criteria given in Section A4 resulted in FORTRAN standards that define and qualify the level of interchangeability. This is reflected in the scope and in certain specifics of the language (discussed in Appendix B).

A4. Criteria Used in Developing FORTRAN Standards

The principal criteria used in developing FORTRAN standards were (in approximate priority):

(1) Interchangeability of FORTRAN programs between processors.

(2) Compatibility with existing practice.

(3) Consistency and simplicity to the user preparing FORTRAN programs.

(4) Suitability for efficient processor operation for a wide range of computing equipment of varying structure and power.

(5) Allowance for future growth in the language.

The FORTRAN standards were developed without adding any new language content not presently in use on some processor. Development of the standards has been exclusively concerned with codification and regularization of "FORTRAN" practice.

In view of the extensive past and current usage of FORTRAN, the standards development was devoted entirely to language definition rather than language design (1) so that the content of the standards might reflect only that which had proven itself of value in actual usage, and (2) to facilitate and encourage acceptance of the standards.

A5. FORTRAN II and FORTRAN IV

The principal language features of FORTRAN IV having no counterpart in FORTRAN II are (1) DATA statement, (2) logical type and its use in expressions, (3) labeled COMMON, and (4) logical IF statement. The principal differences between FORTRAN II and FORTRAN IV which inhibit interchangeability are:

(1) EQUIVALENCE-COMMON ordering and association differ basically. The FORTRAN II rules are relatively complex by comparison to FORTRAN IV rules and reflect a historical peculiarity of the original processor.

(2) A special class of "library" functions exists in FORTRAN II which is a vestigial remain from the original FORTRAN processor. This class of functions has special implicit type and naming rules in conflict with the more general and inclusive FUNCTION capability retained in FORTRAN IV.

(3) Statement functions in FORTRAN II have special implicit type and naming rules in contrast to the single uniform implicit type and naming rules of FORTRAN IV.

(4) FORTRAN II complex and double precision capabilities are expressed differently and are more limited than the FORTRAN IV counterparts.

(5) FORTRAN IV input/output statements are uniform for all device types whereas the FORTRAN II statements are specific in some cases to the device type. In addition certain machine trigger references of the original processor were retained in FORTRAN II but omitted in FORTRAN IV.

(6) The EXTERNAL statement of FORTRAN IV expresses a feature handled differently in FORTRAN II.

The differences listed in the preceding paragraphs are so widely used that very few FORTRAN II and FORTRAN IV programs are directly interchangeable. Accordingly, the application of the criteria in Section A4 indicated that standards should be based on FORTRAN IV solely.

A6. FORTRAN for a Wide Range of Equipment

The criteria of interchangeability and suitability for a wide range of equipment are conflicting. To obtain efficient operation on small computing systems, it is desirable to omit certain less commonly used parts of the FORTRAN language. To restrict the standards for small systems would, however, deny the advantages of standardization to processors readily able to handle a much larger language efficiently.

The compromise adopted therefore provides two related standards: USA Standard FORTRAN, X3.9-1966, and USA Standard Basic FORTRAN, X3.10-1966. Thus processors can be constructed for the standard judged most effective in exploiting a particular computing system. All programs written in USA Standard X3.10-1966 are valid USA Standard FORTRAN programs.

The existence of *two* standards, however, restricts interchangeability in that programs written to run on a processor that accepts USA Standard FORTRAN will not, in general, be acceptable to Basic FORTRAN processors. A summary of the differences between these standards is given in Appendix C.

Appendix B

Notes by Section

B1. Section 1 Notes

The standard is a permissive standard in that it does not prescribe how a processor will respond to a program for which no interpretation is provided. This allows for language growth in that a processor may accept a superset language and perform some useful operation without thereby deviating from the standard. A program written, however, in such an augmented language deviates from the standard and will therefore not, in general, give the same response on other processors.

A second consequence of excluding a prescription of processor response where no interpretation is provided, is that unintentional deviation from a FORTRAN standard is not covered. This area of "diagnostics" can greatly affect the usefulness of a processor. This important area is omitted, however, as it was felt premature to standardize here, since so many considerations affecting internal processor construction are involved.

Interchangeability is standardized at the coding form level. While actual interchange is frequently convenient in the form of data processing media, this standard does not cover such interchange.

The term "processor" is here defined to include a combination of program and data processing system, so as to allow processor constructors to employ combinations of hardware and software techniques including compiling, interpreting, and combinations of these to accomplish interpretation and execution of a FORTRAN program to conform to the standard.

Manual operation of equipment, operating system functions, libraries, processor description manuals are not standardized herein.

B1.1 Processor Limitations. This standard partially describes a "FORTRAN machine" which is embodied in an actual FORTRAN processor. The standard, however, is deliberately incomplete in describing the "FORTRAN machine" in some specific areas—storage capacity, number system, range, precision, internal representation, nature and number of input/output units. While these differences between processors restrict interchangeability, the standard is written to allow great variability in processor capacity.

B2. Section 2 Notes

External procedures may be written in languages other than that of the standard. Such procedures or other procedures that depend on them may not be interchangeable.

B3. Section 3 Notes

The FORTRAN character set is contained in the character set of the USA Standard Code for Information Interchange, X3.4-1965.[2] Characters not in the FORTRAN set may be used in Hollerith data if a processor accepts them. Differing character sets may, however, limit program interchangeability.

Specific mention should be made of the character, "$." Although this character may only appear in Hollerith data, most processors have accepted it, and the inability of a processor to handle "$" will definitely restrict interchangeability of current programs.

B4. Section 4 Notes

An alternative and equivalent formulation to that given in the standard would have defined a seventh data type, "statement label type" for a datum assuming a statement label as its value.

Any variable referred to in any ASSIGN or assigned GO TO statement would also have an implied "statement label type." In 10.2.2 there would be a fourth class of association for such variables, i.e., association of statement label variables and integer variables of the same name. In 10.2.3, the ASSIGN statement would define or redefine the value of a statement label variable. It would be unnecessary to state explicitly that the ASSIGN causes undefinition of an integer variable since this would be covered by the rule that undefinition occurs when an associated variable of different type is defined or redefined. In this alternative formulation the assigned GO TO (7.1.2.1.2) and ASSIGN (7.1.1.3) statement definitions would use "statement label" in place of "integer."

B5. Section 6 Notes

The construction and evaluation rules of common algebra are defined in this section. The maximum latitude consistent with the normal rules of arithmetic is allowed in the evaluation sequence with a single significant exception. The purpose of allowing this latitude is to permit processors to most efficiently exploit equipment capabilities of a particular computer. In order to ensure that this latitude does not result in ambiguity it is necessary to prohibit intra-statement "side-effects" (i.e., function references may not define or redefine other elements in the same statement).

To allow a user to control the evaluation sequence where this might affect the approximation error in com-

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*A revised USA Standard Code for Information Interchange was approved in 1967.

putation (e.g., arithmetic of real number approximants), a processor may not use mathematical identities which involve parentheses (e.g., factoring or distributive laws).

B6. Section 7 Notes

The restrictions on redefining the control variable of a DO and its parameters when control is within the DO is for the purpose of permitting efficient processor operation.

The extended DO is retained in USA Standard FORTRAN for the purpose of conforming to current practice, despite the somewhat *ad hoc* character of this aspect of FORTRAN.

The input/output description is given in great detail owing to its great practical importance. It is important to note that the definition of "record" covers its usage in the language only and does not necessarily correspond to its physical embodiment in a processor or medium. The language provides for any "length" records including zero length records, "length" being measured in characters for formatted records and "list element values" for unformatted records. Processor restrictions arising from specific input/output devices are not discussed in the standard. The type of restriction may best be illustrated by an example: A line printer might be expected to accept formatted WRITE statements only, and then only if the length of each record does not exceed the width of the carriage. Unformatted I/O, backspace, endfile, rewind, and read operations might be prohibited on such a device. The standard does not prescribe which input/output operations are meaningful on a given processor and computer configuration even though interchangeability of programs is compromised.

Although the word "REWIND" might imply tape-like devices, the definition given does not require tape, and drums and disks can and have been used in processors with "REWIND" as well as "BACKSPACE."

The ENDFILE performs no intrinsic function in FORTRAN in that there is no interpretation for reading such a record. It is included for historical purposes where one of its uses has been to identify to the machine operator separation points for off-line printing.

The PAUSE statement has customarily been used to allow intervention manually, but has been defined to allow for unspecified external intervention.

B6.1 Common-Equivalence (7.2.1.3.1). The value correspondence of variables in COMMON that are mentioned in different program units is expressed by corresponding position of mention in COMMON where "corresponding" is counted in "storage units."

In processors, this is customarily implemented by allocating equal storage for "storage units." This is not always the most efficient usage of physical storage, however alternatives which require type correspondence in corresponding positions and the prohibition on EQUIVALENCE of variables of different type were deemed unduly restrictive.

The "storage unit" chosen fixes the number of characters of Hollerith data that corresponds and this variation between processors limits interchangeability.

FORMAT control as described in the standard differs very slightly from one common practice. A ")" on writing can cause a zero length record to be written. This makes FORMAT operation with a given list completely symmetrical, i.e., always the same number of records on writing as on reading.

B7. Section 8 Notes

Subscripted variables may not be mentioned in intrinsic functions. This corresponds to a restriction in many current processors.

B8. Section 10 Notes

B8.1 Second Level Definition. For processor efficiency, it has been customary often to treat variables in subscripts and variables in a computed GO TO in a special way. In particular they are computed at the beginning of a basic block and assumed to be fixed in value throughout the block unless they "appear" to vary. Side effects through COMMON via function references not mentioning the variable explicitly in the argument list and similar redefinitions through EQUIVALENCE association are restricted when they affect subscripts and the computed GO TO. That is the purpose of the restrictions in 10.2.8.

Appendix C

Principal Differences between USA Standard FORTRAN and USA Standard Basic FORTRAN

The two FORTRAN standards documents use identical section numbering and discuss the same topics in the identically numbered sections. Where USA Standard Basic FORTRAN has no language content counterpart to that defined in a particular section of USA Standard FORTRAN, only the section number and section title are retained.

The following list summarizes the principal differences between the two standards. This list is provided for convenience only and for an exhaustive comparison the two documents should be studied section by section.

USA Standard Basic FORTRAN (as compared to USA Standard FORTRAN) has:

(1) A maximum of five continuation cards (instead of 19 continuation cards).

(2) A maximum of five characters in a symbolic name (rather than six).

(3) Neither logical type, logical nor relational expressions, logical IF statement, nor "L" format descriptor.

(4) No "$" in its character set.

(5) Neither complex type, double precision type, type-statement, double precision and complex constants and expressions, nor "D" and "G" format descriptors.

(6) No EXTERNAL statement.

(7) No 3-dimensional arrays, subscripts.

(8) A prohibition on FUNCTION subprograms, in that they may not define nor redefine any of their arguments nor any entity in common.

(9) No array declarator permitted in a COMMON statement.

(10) No labeled common blocks.

(11) No ASSIGN nor assigned GO TO statements.

(12) No DATA statement nor BLOCK DATA programs.

(13) A maximum of four (rather than five) octal digits in the PAUSE statement.

(14) No print carriage control for formatted output records.

(15) No Hollerith datum nor the "A" format descriptor and therefore no FORMAT can be read in during execution.

(16) No provisions in a FORMAT statement for (a) scale factor, (b) data exponent on input for "F" descriptor, (c) second level of parentheses.

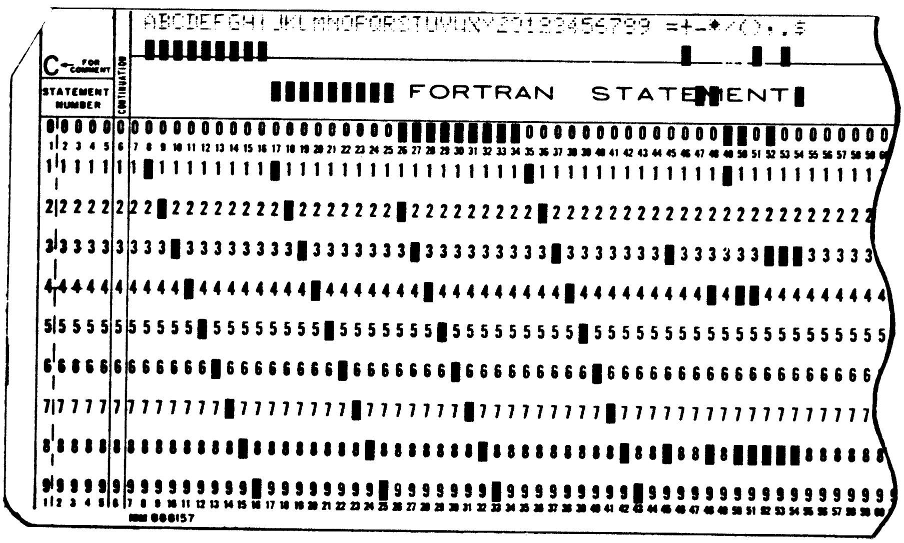
(17) A restriction on external functions that they may not alter variables in common or variables associated with common via an EQUIVALENCE statement.

(18) A requirement that all DIMENSION statements must precede all COMMON statements, which must in turn precede all EQUIVALENCE statements.

(19) A statement label may contain only 4 digits rather than 5.

Appendix D
A Current Media Representation for the Graphics of the FORTRAN Character Set

At the time of drafting USA Standard FORTRAN, no USA or International existing or proposed standard defined media representations for the graphics of the FORTRAN character set defined in 3.1. However, a current representation in 80-column punched cards, widely used in the USA, is given below in columns 1 through 47 in the same sequence as in 3.1.



American National Standards on Computers and Information Processing

X3.1-1969	Synchronous Signaling Rates for Data Transmission
X3.2-1970	Print Specifications for Magnetic Ink Character Recognition
X3.3-1970	Bank Check Specifications for Magnetic Ink Character Recognition
X3.4-1968	Code for Information Interchange
X3.5-1970	Flowchart Symbols and Their Usage in Information Processing
X3.6-1965	Perforated Tape Code for Information Interchange
X3.9-1966	FORTRAN
X3.10-1966	Basic FORTRAN
X3.11-1969	Specifications for General Purpose Paper Cards for Information Processing
X3.12-1970	Vocabulary for Information Processing
X3.15-1966	Code for Information Interchange in Serial-by-Bit Data Transmission
X3.16-1966	Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange
X3.17-1966	Character Set for Optical Character Recognition
X3.18-1967	One-Inch Perforated Paper Tape for Information Interchange
X3.19-1967	Eleven-Sixteenths Inch Perforated Paper Tape for Information Interchange
X3.20-1967	Take-Up Reels for One-Inch Perforated Tape for Information Interchange
X3.21-1967	Rectangular Holes in Twelve-Row Punched Cards
X3.22-1967	Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI)
X3.23-1968	COBOL
X3.24-1968	Signal Quality at Interface Between Data Processing Terminal Equipment and Synchronous Data Communication Equipment for Serial Data Transmission
X3.25-1968	Character Structure and Character Parity Sense for Parallel-by-Bit Communication in the American National Standard Code for Information Interchange
X3.26-1970	Hollerith Punched Card Code
X3.27-1969	Magnetic Tape Labels for Information Interchange
X3.28-1971	Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links
X3.29-1971	Specifications for Properties of Unpunched Oiled Paper Perforator Tape
X3.30-1971	Representation for Calendar Date and Ordinal Date for Information Interchange
X3.34-1972	Interchange Rolls of Perforated Tape for Information Interchange