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U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, Secretary
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Director

Foreword

The Federal Information Processing Standards Publication Series of the National Bureau of Standards is the official publication relating to standards, guidelines, and documents adopted and promulgated under the provisions of Public Law 89-306 (Brooks Act) and under Part 6 of Title 15, Code of Federal Regulations. These legislative and executive mandates have given the Secretary of Commerce important responsibilities for improving the utilization and management of computers and automatic data processing in the Federal Government. To carry out the Secretary's responsibilities, the NBS, through its Institute for Computer Sciences and Technology, provides leadership, technical guidance, and coordination of Government efforts in the development of standards, guidelines and documents in these areas.

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Abstract

This publication announces adoption of American National Standard Database Language SQL, ANSI X3.135-1986, as a Federal Information Processing Standard (FIPS). ANSI X3.135-1986 specifies two languages that make up a relational model database management system. They are:

- a. A schema definition language, for declaring the structures and integrity constraints of a database.
- b. A module language, including SQL statements, for declaring the database procedures and executable statements of a specific database application.

The purpose of this standard is to promote portability of database definitions and database application programs between different installations. The standard is used by implementors as the reference authority in developing a relational model database management system and standard language interfaces to that database management system; and by other computer professionals who need to know the precise syntactic and semantic rules of the standard.

Key words: ANSI standard; data manipulation language; database language standard; Federal Information Processing Standard (FIPS); ISO standard; schema definition language; software; Structured Query Language (SQL).

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**Federal Information
Processing Standards Publication 127**

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**Announcing the Standard for
DATABASE LANGUAGE SQL**

Federal Information Processing Standards Publications (FIPS PUBS) are issued by the National Bureau of Standards pursuant to Section 111 (f) (2) of the Federal Property and Administrative Services Act of 1949, as amended, Public Law 89-306 (79 Stat. 1127), Executive Order 11717 (38 FR 12315, dated May 11, 1973), and Part 6 of Title 15 Code of Federal Regulations (CFR).

- 1. Name of Standard.** Database Language SQL (FIPS PUB 127).
- 2. Category Standard.** Software Standard, Database.
- 3. Explanation.** This publication announces adoption of American National Standard Database Language SQL, ANSI X3.135-1986, as a Federal Information Processing Standard (FIPS). ANSI X3.135-1986 specifies two languages that make up a relational model database management system. They are:
 - a. A schema definition language, for declaring the structures and integrity constraints of a database.
 - b. A module language, including SQL statements, for declaring the database procedures and executable statements of a specific database application.

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- 4. Approving Authority.** Secretary of Commerce.
- 5. Maintenance Agency.** Department of Commerce, National Bureau of Standards (Institute for Computer Sciences and Technology).
- 6. Cross Index.**
 - a. American National Standard Database Language SQL, ANSI X3.135-1986.
 - b. ISO 9075, Database Language SQL.
- 7. Related Documents.**
 - a. Federal Information Resource Management Regulation 201-8.1, Federal ADP and Telecommunication Standards.
 - b. American National Standard Database Language ND, ANSI X3.133-1986.
 - c. ISO 8907, Database Language ND.
 - d. Federal Information Processing Standards Publication 126, Database Language ND.
 - e. Federal Information Processing Standards Publication 110, Guideline for Choosing a Data Management Approach.
 - f. NBS Special Publication 500-115, Report on Approaches to Database Translation.
 - g. NBS Special Publication 500-108, Guide on Data Models in the Selection and Use of Database Management Systems.

8. Objectives. Federal standards for database management systems permit Federal departments and agencies to exercise more effective control over the production, management, and use of the Government's information resources. The primary objectives of Federal database management system standards are:

- to encourage more effective utilization and management of database application programmers by insuring that skills acquired on one job are transportable to other jobs, thereby reducing the cost of database programmer retraining.
- to reduce the overall software costs by making it easier and less expensive to maintain database definitions and database application programs and to transfer these definitions and programs among different computers and database management systems, including replacement database management systems.
- to reduce the cost of software development by achieving increased database application programmer productivity through the understanding and use of database methods employing standard structures and operations, standard data types, standard constraints, and standard interfaces to programming languages.
- to protect the software assets of the Federal Government by insuring to the maximal feasible extent that Federal database management system standards are technically sound and that subsequent revisions are compatible with the installed base.

Government-wide attainment of the above objectives depends upon the widespread availability and use of comprehensive and precise standard database management system specifications.

9. Applicability.

a. Federal standards for database management systems should be used for computer database applications and programs that are either developed or acquired for government use. The FIPS Database Language SQL (FIPS SQL) is one of the database management system standards provided for use by all Federal departments and agencies. FIPS SQL is suited for use by applications written in one of the FIPS programming languages for which SQL module language is specified in ANSI X3.135-1986; e.g., in COBOL, FORTRAN, or Pascal. The FIPS SQL is suited for use in database applications that employ the relational data model. The relational data model is appropriate for applications requiring flexibility in the data structures and access paths of the database. The relational data model is desirable where there is a substantial need for ad hoc data manipulation by end users who are not computer professionals, in addition to the need for access by applications under production control. Although this standard does not specifically address distributed database applications, it may be used, along with facilities for distributed transaction processing, to access relational structured data at remote nodes in a distributed system.

b. The use of FIPS database languages is strongly recommended for database applications when one or more of the following situations exist:

- It is anticipated that the life of the database application will be longer than the life of the presently utilized equipment or database management system, if any.
- The database application is under constant review for updating of the specifications, and changes may result frequently.
- The database application is being designed and developed centrally for a decentralized system that employs computers of different makes and models or database software acquired from a different vendor.
- The database application will or might be run on equipment other than that for which the database application is initially written.
- The database application is to be understood and maintained by programmers other than the original ones.
- The database application is or is likely to be used by organizations outside the Federal Government (i.e., State and local governments, and others).

c. Nonstandard language features should be used only when the needed operation or function cannot reasonably be implemented with the standard features alone. A needed language feature not provided by the FIPS database languages should, to the extent possible, be acquired as part of an otherwise FIPS conforming database management system. Although nonstandard language features can be very useful, it should be recognized that their use may make the interchange of programs and future conversion to a revised standard or replacement database management system more difficult and costly.

d. It is recognized that programmatic requirements may be more economically and efficiently satisfied through the use of a database management system employing a different data model than those provided by the FIPS database languages or the use of a database management system that functionally conforms to a FIPS database language but does not conform to all other aspects of the FIPS. The use of any facility should be considered in the context of system life, system cost, data integrity, and the potential for data sharing.

e. Programmatic requirements may be also more economically and efficiently satisfied by the use of automatic program generators. However, if the final output of a program generator is SQL database language, then the resulting language should conform to the conditions and specifications of FIPS SQL.

10. Specifications. The specifications for FIPS SQL are the Level 2 language specifications of the schema definition language and the module language (including SQL statements) contained in American National Standard Database Language SQL, ANSI X3.135-1986.

ANSI X3.135-1986 defines the scope of the specification (Clause 1, ANSI X3.135-1986) and the syntax and semantics of SQL language (Clauses 3 through 8, ANSI X3.135-1986). All of these specifications apply to FIPS SQL, with two exceptions. FIPS SQL requires full SQL conformance to Level 2. (Level 1 is the subset of Level 2 defined in Clause 9, ANSI X3.135-1986.) Also, FIPS SQL does not include module language for programming language PL/I.

In addition, a facility must be available in the implementation for the user to optionally specify monitoring of SQL (comprised of schema definition and module language). The monitoring is an analysis of SQL syntax used against the syntax specified by FIPS SQL. The implementation will diagnose and identify to the user, in an implementor-defined manner, the following:

- Any SQL syntax that does not conform to that included in FIPS SQL.
- Any SQL syntax conforming to FIPS SQL that, based on a user option (see Clause 3.4 of ANSI X3.135-1986), may be processed in a non-conforming manner. This monitoring will be based on the analysis of the SQL syntax and the invocation of the user option selecting the non-conforming functions. It is not intended that an analysis be made at processing time.

The standard does not specify the following:

- Concurrent access to the database by multiple users or processes.
- The limits on the number or sizes of database constructs; e.g., columns, rows, tables, views, subqueries, boolean expressions, etc.
- Application pre-processing facilities for producing separate standard database modules and standard language programs.
- A distributed database facility.

11. Implementation. The implementation of this standard involves three areas of consideration: acquisition of SQL implementations, interpretation of FIPS SQL, and validation of SQL implementations.

11.1 Acquisition of SQL Implementations.

a. This publication is effective August 3, 1987. Relational model database management systems acquired for Federal use after this date should implement FIPS SQL (which includes the schema and module languages). Conformance to FIPS SQL should be considered whether SQL implementations are developed internally, acquired as part of an ADP system procurement, acquired by separate procurement, used under an ADP leasing arrangement, or specified for use in contracts for programming services.

A transition period provides time for industry to produce database management systems conforming to this standard. The transition period begins on the effective date and continues for one (1) year thereafter. The provisions of this publication apply to orders placed after the effective date; however, an SQL implementation conforming to FIPS SQL, if available, may be acquired for use prior to the effective date.

ANSI X3.135-1986 specifies two levels of conformance. Level 1 has been defined to facilitate conformance of extant implementations. Although conformance to Level 1 of ANSI X3.135-1986 is not sufficient to claim conformance to FIPS SQL, Level 1 implementations are expected to be available during the transition period. A full SQL Level 1 implementation may be acquired for interim use during the transition period if a FIPS SQL implementation is not available.

b. Database software is normally purchased as a complete package called a database management system (DBMS). A DBMS is an implementation of one or more data models (e.g., the network model or the relational model). In addition, a DBMS usually provides additional facilities and data interfaces independent of the interfaces specified by the standard. These may include access control, loading and unloading, dynamic schema manipulation, data dictionary, application program pre-processing, data storage specification, natural language query, report generator, or graphics display. A DBMS may also provide additional data structures, such as indices, or software, such as query optimizers, to enhance performance. User requirements for performance or for additional data administration facilities should be specified explicitly.

c. For a wide variety of new applications, either a network model or a relational model DBMS would satisfy user requirements for database services. A procurement may specify that the DBMS must provide interfaces conforming to one of the FIPS database language standards, but leave the selection of the specific standard to the vendor. This approach would be appropriate in the procurement of a DBMS-based application or a turnkey system, or in the procurement of a system where the choice of a data model is less significant than other factors.

11.2 Interpretation of FIPS SQL. NBS provides for the resolution of questions regarding FIPS SQL specifications and requirements, and issues official interpretations as needed. All questions about the interpretation of FIPS SQL should be addressed to:

Director
 Institute for Computer Sciences and Technology
 ATTN: Database Language SQL Interpretation
 National Bureau of Standards
 Gaithersburg, MD 20899

11.3 Validation of SQL Implementations. A suite of automated validation tests for SQL implementations is currently under development. The suite will be made available when it is completed. For more information on SQL validation tests, contact:

Director
 Institute for Computer Sciences and Technology
 ATTN: Software Standards Testing Program
 National Bureau of Standards
 Gaithersburg, MD 20899

12. Waivers. Under certain exceptional circumstances, the head of the agency is authorized to waive the application of the provisions of this FIPS PUB. Exceptional circumstances which would warrant a waiver are:

- a. Significant, continuing cost or efficiency disadvantages will be encountered by the use of this standard and,
- b. The interchange of information between the system for which the waiver is sought and other systems is not anticipated.

Agency heads may act only upon written waiver requests containing the information detailed above. Agency heads may approve requests for waivers only by a written decision which explains the basis upon which the agency head made the required finding(s). A copy of each such decision, with procurement sensitive or classified portions clearly identified, shall be sent to the Director, Institute for Computer Sciences and Technology, National Bureau of Standards, Gaithersburg, MD 20899.

When the determination on a waiver request applies to the procurement of equipment and/or services, a notice of the waiver determination must be published in the *Commerce Business Daily* as a part of the notice of solicitation for offers on an acquisition or, if the waiver determination is made after that notice is published, by amendment to such notice.

A copy of the waiver request, any supporting documents, the document approving the waiver request and any supporting and accompanying document(s), with such deletions as the agency is authorized and decides to make under 5 U.S.C. Sec. 552 (b), shall be part of the procurement documentation and retained by the agency.

13. Where to Obtain Copies. Copies of this publication are for sale by the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. (Sale of the included specification document is by arrangement with the American National Standards Institute.) When ordering, refer to Federal Information Processing Standards Publication 127 (FIPSPUB127), and title. Payment may be made by check, money order, or deposit account.

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