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SYSTEM DOCUMENTATION FOR COMPUTER-AIDED ENVIRONMENTAL LEGISLATI--ETC(U)
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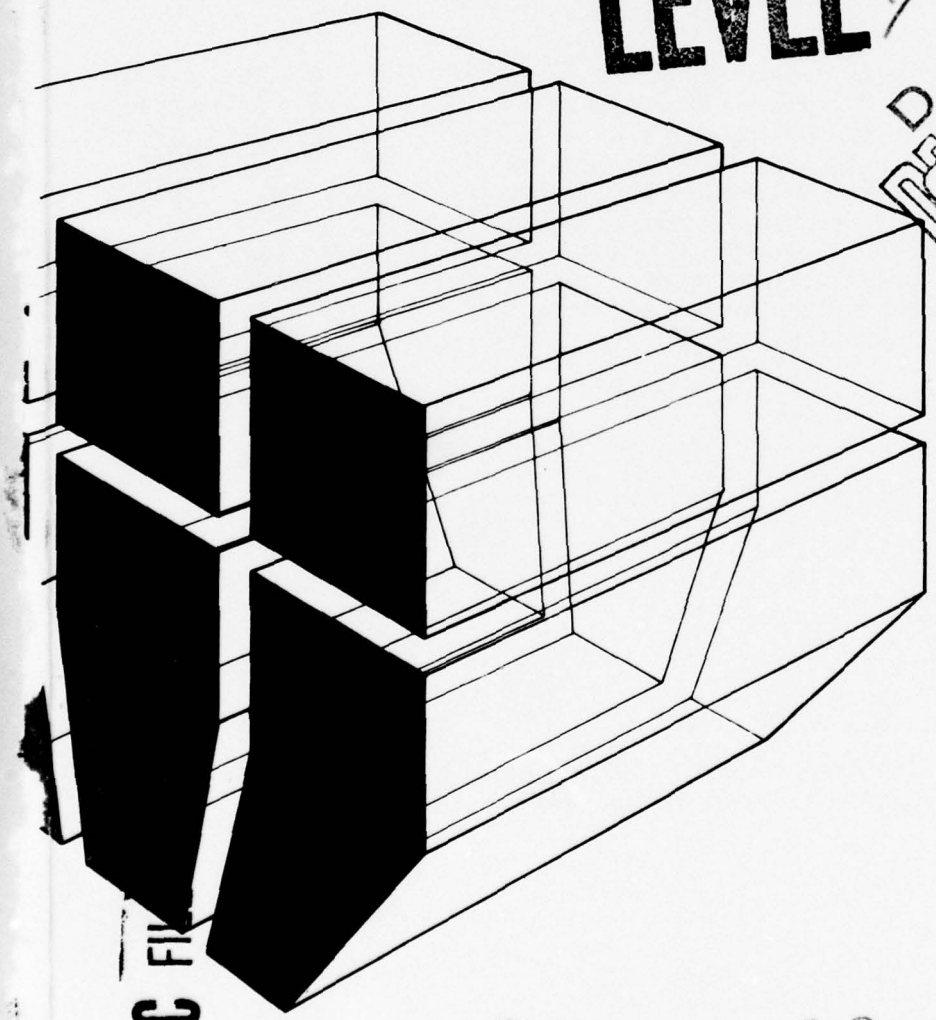
September 1978

SYSTEM DOCUMENTATION FOR COMPUTER-AIDED ENVIRONMENTAL LEGISLATIVE DATA SYSTEM



by
R. L. Welsh

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This report presents the total system documentation for the Computer-Aided Environmental Legislative Data System (CELDS). All information necessary for the maintenance, update, and modification of the CELDS software is presented. See also AD-A061 126. ☆

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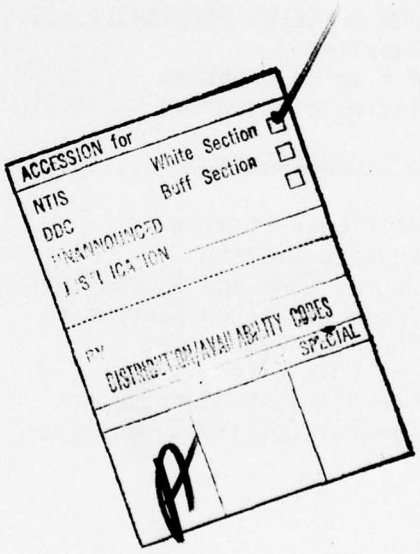
FOREWORD

This project was performed for the Directorate of Military Construction, Office of the Chief of Engineers (OCE), under Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities," Task 01, "Environmental Quality Management for Military Facilities," Work Unit 002, "Development of Environmental Technical Information System." Mr. V. Gottschalk was the OCE Technical Monitor.

This research was made possible through the efforts of Mr. James A. Gast to whom most of the software development is attributed, the Library Research Center of the University of Illinois, and the scientists and engineers of the U.S. Army Construction Engineering Research Laboratory (CERL).

Administrative support and counsel were provided by Dr. R. K. Jain, Chief of the CERL Environmental Division. COL J. E. Hays is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.



CONTENTS

SYSTEM DOCUMENTATION FOR COMPUTER-AIDED
ENVIRONMENTAL LEGISLATIVE DATA SYSTEM

1 INTRODUCTION

Background

The Computer-Aided Environmental Legislative Data System (CELDS) was developed to respond to the Army's need for rapid, easy access to environmental legislation relevant to a specific project or activity. In 1972, CERL developed a pilot system which contained legislation from six states and the Federal government.[1] Based on results of the pilot, the system's content and operation were modified, and a prototype CELDS containing data for 32 states was implemented in 1975. A user manual[2] was published in November 1975.

While data were being collected for the remaining 18 states, CERL studied the feasibility of implementing CELDS on a low-cost minicomputer. Results of this study considerably enhanced CELDS, simplified its updating, and significantly reduced its cost.

Purpose

The purpose of this report is to document the current version of CELDS.

Outline of Report

The CELDS documentation will include procedures for selecting and updating legislation to be included in the system (Chapter 2), a description of the data records (Chapter 3), the formatting of legislation into CELDS data records (including abstracting and indexing) (Chapter 4), and complete documentation of the software (Chapter 5).

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1 R. D. Webster, R. L. Welsh, and R. K. Jain, *Development of an Environmental Technical Information System,* Interim Report E-52/ADA009668 (Construction Engineering Research Laboratory [CERL], March 1975).

2 R. L. Welsh, *User Manual for the Computer-Aided Environmental Legislative Data System,* Technical Report E-78/ADA019018 (CERL, November 1975). Superseded by AD-A061 126.

Description of CELDS Hardware and Software

CELDS uses a PDP11/50 minicomputer, stores data on one 88-megabyte disk, and uses the UNIX operating system. All of the CELDS software is written in "C", a high-level language supported by UNIX. The system administrator should have access to and be familiar with the UNIX reference manual[3] and the UNIX utilities manual.[4]

Mode of Technology Transfer

The technology transfer will be accomplished in accordance with techniques for computer-assisted systems as defined in appropriate Army regulations.

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[3] K. Thompson and D. M. Ritchie, *UNIX Programmer's Manual*, 6th ed. (Bell Telephone Laboratories, Inc., May 1975).

[4] *Documents for Use with the UNIX Time-Sharing System* (Western Electric Company, 1975).

2 DATA COLLECTION PROCEDURES

Identification

Legislation included in CELDS must contain objective criteria pertaining to the environment. The following guidelines should be applied to help identify relevant standards:

1. Laws and regulations containing quantifiable or objective standards should be entered (for example, those which numerically define the maximum permissible amount of a substance which can be released to air or water, or those which name protected species or list specific requirements for the location of a landfill site). "Enabling legislation," which creates or authorizes a specific agency to promulgate and administer regulations, is helpful for understanding the purpose of those regulations, but merits few entries because it does not express concrete, measurable standards. An exception is enabling legislation which also establishes interim standards.

2. Legislation requiring permits or reports for an activity should be entered.

3. Laws and regulations must be orginated and administered by a nationwide or statewide agency, i.e., city and county ordinances, are not included.

4. Only *enacted* laws or regulations are included.

5. Laws dealing only with violations of regulations and the penalties for noncompliance are excluded.

Collection

Collection of legislative data is begun by searching administrative codes and/or statutes available in a law library. Administrative codes with complete up-to-date coverage will provide regulations from all agencies and are the preferred source materials for CELDS data records. When a code is available, the index should be searched for regulations pertaining to the following areas:

Air pollution

1. Incineration
2. Industrial plants
3. Refineries
4. Ambient air quality standards
5. Air pollution standards

Drinking water quality standards	
Endangered species	1. Endangered and protected species 2. Pests
Erosion	1. Sedimentation/erosion control
Land Use	1. Management of coastal wetlands 2. Fencing 3. Forest cutting 4. Dredging 5. Landfills
Noise	1. Motor vehicles 2. Aircraft 3. Exclude regulations designed to protect employees at work.
Pesticides and economic poisons	1. Restricted use materials 2. Disposal of wastes 3. Storage/disposal of containers 4. Control of pests
Radiation	1. Emission limitations 2. Exposure standards 3. Waste disposal procedures
Solid waste	1. Disposal of solid and hazardous wastes 2. Landfills 3. Recycling
Transportation of explosives	1. Storage and transportation of explosive and hazardous materials
Water pollution	1. Liquid industrial waste disposal 2. Protection of coastal waters 3. Oil spill cleanup 4. Standards for lakes and streams

Not all states have comprehensive administrative codes, nor do they update them frequently. In these cases, the state statutes are searched in the areas listed above. The statutes occasionally include some laws which meet the CELDS criteria; however, they are primarily useful for providing the "enabling legislation" which gives the names of specific agencies and the activities that each is empowered to regulate. The appropriate agencies should then be contacted for copies of the regulations they administer.

Agency addresses can be obtained from a variety of sources: state blue books, telephone books, and the *Directory of Governmental Agencies Safeguarding Consumer and Environment.*[5] Agency correspondence is filed, since it often provides corrected or more specific addresses, names of persons to contact, and information about relevant or upcoming regulations. If an agency indicates that certain types of regulations are nonexistent, this fact should be noted and filed.

An alternate source of air quality, water quality, and solid waste disposal agency addresses and regulations is the *Environmental Reporter.*[6] However, direct correspondence with agencies often produces more current materials and more comprehensive coverage.

Update

Federal

Updating Federal data records that are already in CELDS involves locating changes in, additions to, or deletions from the abstracted legislation. Both substantive and insignificant changes to the scope of CELDS should be considered. Because the effective date on a data record indicates the last noted revision in the legislative contents, this date must be changed to match that of the most recent revision, whether the revision is significant to the data record contents or not. This is done to avoid additional rechecking of a revision that has already been noted. In addition, transfers of administrative agencies, revisions in text, and changes in tables must be noted. Such changes may affect both the bibliographic and legislative reference and the attribute and keyword indexing.

To locate pertinent revisions, additions, or deletions in Federal regulations, the following sources may be used:

1. An up-to-date master list of *Code of Federal Regulations* (CFR) sections included in the Federal data records should be maintained. This list will direct the abstracter to CFR sections that are already abstracted and to the accession number of the data record in which the regulation appears.

2. The *Federal Register* (issued Monday through Friday) contains material affecting existing Federal regulations and also contains newly adopted regulations. Changes in regulations which are already included in the data base may be found by comparing the master list (mentioned

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[5] *Directory of Governmental Agencies Safeguarding Consumer and Environment* (1974).

[6] *Environment Reporter* (Bureau of National Affairs).

above) with the "Cumulative List of CFR Parts Affected" which appears in each issue. An "affected part" is a section which has been revised, deleted, or added. New regulations, which must also be examined for inclusions in CELDS, may be discovered (1) by checking the cumulative list for section numbers that do not appear on the CELDS master list but are successive to numbers which do appear, and (2) by consulting the contents listing of each issue.

3. Changes cited in the *Federal Register* occasionally refer to a sentence or paragraph in a previously published regulation. The full text of the regulation must then be found to determine what changes have been made. This may involve searching through previous issues of the *Federal Register* or finding the regulation in the *Code of Federal Regulations*.

Since the *Federal Register* is a daily publication, updating CELDS coverage of Federal regulations can be a continuous process, thus insuring optimum currentness. However, updating Federal statutes is a less continuous task because of the nature of the sources used. The primary source is the *United States Code Annotated* (USCA). These volumes are kept current through distribution of cumulative annual pocket parts and monthly pamphlets that contain new laws and judicial constructions. Each volume, pocket part, and pamphlet contains laws, executive orders, proclamations, and an index to the publication's contents. Amendments to statutes already in CELDS can be located in the cited sections of current pocket parts or pamphlets. New laws may be found by using the indexes. The *United States Code* (USC) is the official publication of enacted laws, but is updated less frequently than the USCA and therefore is not useful to this project.

States

Updating of state records follows the general procedures established for Federal regulations. The original sources, such as administrative codes or state statutes, are compared to the existing abstracts for changes in effective date, content, and administrative agency and address.

The individual agencies are requested by letter to provide copies of current regulations and asked to routinely send future changes and additions. Included with the request is a self-addressed prepaid card on which the agency can indicate whether or not regulations are being sent and whether a mailing list is maintained. Agencies which do not have mailing lists are contacted about new or revised regulations at 6-month intervals by postcard. Agencies which do not respond to the initial letter within 3 months are contacted again. As regulations are received from the agencies, the existing abstracts are revised, new laws are abstracted, and all the information is entered into the data base. Legislation pertaining to new CELDS subject areas is found in statutes

and code books; names of possible relevant agencies to be contacted are provided in state blue books or *The National Directory of State Agencies.*[7]

Checking code books and statute supplements against the legislative reference lists reveals any amendments to the legislation. The table of contents of weekly *Environment Reporter* supplements is checked for applicable regulations. Additions, changes, and deletions are checked continuously by examining supplements as they become available, by checking supplements to the *Environment Reporter,* and by contacting state agencies periodically.

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[7] *The National Directory of State Agencies* (Information Resources Press, 1974).

3 DATA ENTRY PROCEDURES

Scope of Data Records

A single agency regulation generally covers many subdivisions of a particular interest area. For example, the Alabama Air Pollution Control Commission's Rules and Regulations booklet contains general sections on provisions for permits, variances, compliance schedules, sampling, records, and reporting. In addition, it contains specific sections on air pollution emergencies, open burning and incineration, and control of various emissions from many emission sources, such as kraft pulp mills, general process industries, nitric acid manufacturing plants, and motor vehicles.

The CELDS abstracter must rewrite this material in concise legal or environmental standards statements for entry into the data base on individual CELDS data records. Each data record should provide information on a specific subdivision of required or prohibited actions, and should be retrievable by a CELDS user.

Description of Data

Each CELDS record consists of 12 data fields:

1. Accession number
2. Title
3. Effective date
4. Legislative reference
5. Major environmental category
6. Geographical/political scope
7. Administrative agency
8. Bibliographic reference
9. Abstract
10. Table of standards
11. Environmental attributes
12. Keywords

Accession Number

An accession number assigned to each data record indicates the order in which it has been collected and entered into the system. The accession number is useful for referring to specific laws in the CELDS retrieval program. If a data record is removed from the system because it has been repealed or amended, its permanent accession number is not reassigned to a new entry, but instead is added to a master list of deleted accession numbers. Accession numbers are entered as digits without any punctuation.

Title

Each data record receives a brief but comprehensive title that indicates the abstract's content. This title helps the user determine the relevance of the entry to his/her specific search. Therefore, it should reflect the scope and emphasis of the abstract, and need not correspond to the heading of the source material. For example, titles for regulations on emission standards from a manufacturing process should include the name of the process and the type of emission, e.g., SULFUR OXIDE EMISSIONS FROM KRAFT PULP MILLS. Each title is followed by a period.

Effective Date

Most laws and regulations are printed with a date or series of dates that indicate when the document or section was enacted, when its contents became law, and when any subsequent revisions or amendments were made. Similarly, the date assigned to a CELDS data record reflects the currentness of the laws from which the abstract is taken, and is generally the most recent date found in the source material. For example, the Water Pollution Control Act of 1972 which was amended December 28, 1973 and January 2, 1974, receives the date 1-2-74. However, there is one exception. When a law which has already been enacted becomes effective significantly later than the enactment date, the enactment date is used in the date field and the effective date is cited in the abstract field. "Significantly later" is more than 6 months. For example, a regulation enacted on November 12, 1974 which will become effective on July 1, 1975 should have the date 11-12-74 assigned to field 3; in the abstract (field 9), the following should be noted: EFFECTIVE 7-1-75, THE FOLLOWING STANDARDS MUST BE MET...).

Accuracy is important when assigning a date to each data record; the CELDS user must know when a regulation or amendment took effect and how current the legislation on a particular subject is. Moreover, this information helps the abstracter keep the data base current, since the legal sources can later be scanned for updating in terms of a predefined cutoff date. When no date appears in the source material, the appropriate government branch should be contacted. Dates are entered numerically, without terminal punctuation, specifically in the order of month-day-year. When a day is not given in the original, the entry is numerical for month-year.

Legislative Reference

The legislative reference is the official source of a law or regulation which tells the user where to locate the full text of an abstract for legal citation purposes. Data record references do not follow strict legal citation format; instead, they use the publication title

followed by a breakdown of as many subdivision numbers and titles as are necessary to enable the user to locate the specific abstracted sections.

Uniformity of citation format is virtually impossible to maintain throughout the records of a given state, or among several states, because different government publishers and agencies tend to develop their own systems of subdivision breakdown. However, for all references to a single publication or to the publications of a single agency, citation format and punctuation should be consistent, conforming to the following general pattern: publication title; chapter number and title; part number and title; subpart number and title; and complete section number (or numbers). Titles are preceded by a colon and followed by a semicolon; the final section number is preceded by a comma and followed by a period. A typical example is:

> California Administrative Code; Title 17: Public Health; Part III: Air Resources; Subchapter I: Air Basins and Air Quality Standards, Section 70101.

It is often necessary to scan the text of a regulation to determine how it is set up and what terms it uses to refer to various subdivisions. Use of the regulation's own terminology in the legislative reference will prevent confusion to the user who consults the original text.

Major Environmental Category

Assigning major environmental categories is the first step in indexing a data record. There are ten major environmental categories in the CELDS system:

Air Quality	Noise
Earth Science	Sociology
Ecology	Solid Waste
Health Science	Transportation
Land Use	Water Quality

Most data records are assigned to the one category that represents the aspect of the environment most directly affected by the law or regulation; however, regulations may be assigned to as many environmental categories as are applicable. For example, regulations on the use of pesticides and radioactive materials often get assigned to HEALTH SCIENCE, AIR QUALITY, and WATER QUALITY.

Geographical/Political Scope

This field indicates a regulation's political origin and is always a state name, the Federal government, or the District of Columbia. The states are entered by their two-character postal abbreviations. The Federal government is "US," the District of Columbia is "DC," and Puerto Rico is "PR."

Administrative Agency

This field contains the official name and address of the agency responsible for administering a specific law or regulation. If the source of the data record is U.S. or state legislation rather than an agency regulation, the information recorded in this field should be the name and address of the department or agency designated in that particular law to oversee enforcement of its provisions.

Bibliographic Reference

The bibliographic reference indicates the printed source in which a law or regulation was located by the abstracter, and from which photocopies were taken for the CELDS manual files. It is preferable to take data from the original legislative source, because it is more reliable than unofficial reprints. In these cases, field 8 should read "SAME AS LEGISLATIVE REFERENCE." If an agency has sent regulations that are not available in statutes or codes, the bibliographic reference should read: "AGENCY (or DEPARTMENT) PUBLIC INFORMATION PAMPHLET."

For the areas of air and water quality, solid waste, land use, and noise, regulations received from an agency should be checked for accuracy and currentness against the contents of the *Environment Reporter*. If rules and regulations in the *Environment Reporter* are identical and up to date, they should be cited as the bibliographic reference instead of the agency copies.

Use of the *Environment Reporter* is an exception to the rule stated in the previous paragraph, because it is available commercially and through libraries; it is therefore a more convenient source for checking a text than agency reprints which are not readily available. Where the *Environment Reporter* is cited, use the title, volume name, and section number; the parts of the reference should be separated by commas; for example, ENVIRONMENT REPORTER, STATE AIR LAWS, 361. Page numbers should not be included because service is continuously updated and the pagination is therefore temporary. All bibliographic references end with a period.

Abstract

The abstract is a concise, informative presentation of pertinent details in a law or regulation. Its opening sentence should repeat or rephrase the title (field 2). Abstracts must be written in a straightforward narrative style, eliminating verbiage and legal jargon; however, coverage of technical specifications should be thorough and precise. Most source documents include a section of terminology definitions. Since it is assumed that CELDS users are familiar with standard scientific terms and technical terms, these are not generally included in the data base. If a regulation uses a term in an uncommon or specialized

context and a definition is required for clarification, it should be incorporated into the abstract text. When a chart or table is used to present data, the abstract should describe its contents briefly (subject and scope) without detailing the specifics; these will appear in tabular format in field 10.

Individual states regulate different areas of the environment in varying depths and organize their coverage in different ways. The abstracter must determine which sections of a document are relevant to CELDS, and how to present those sections in an organized, concise, and retrievable form. Each data record should be a self-contained unit concerning one or more related aspects of a subject. If the source document is well organized, CELDS coverage may simply follow the subdivision levels in the regulation, with one data record for each division or group of subdivisions. For a more complex or poorly organized document, however, it may be necessary to reorganize the grouping of sections for entry into data records. An air quality regulation may present rules 1a-e for air contaminant emissions from *existing* sources of type A to E, followed by rules 2a-e for emissions from *new* sources of type A to E. If the limits specified for new and existing sources of type A are identical or vary in only some specifics, rules 1a and 2a should be combined in a single data record. Similarly, radiation standards often list exposure limits for "individuals" in one section and for "minors" several sections later. It is not only logical to abstract these rules together in a single data record, but also potentially misleading not to. A CELDS user searching index terms for radiation regulations will find terms differentiating between maximum permissible dose and concentration levels, radioactive wastes, and radiation hazards, but no terms relating to age limits. A user who retrieves a data record on exposure limits for "individuals" may not be aware that he should search further for similar rules on "minors"; therefore, the two rules should be in the same data record. This is also true for regulations concerning "old" and "new" sources of air pollution and for many other sub-topics.

A section may sometimes need to be repeated in more than one data record (for example, a statement of applicability or a definition of exceptions which applies to several data records). In all cases, combinations and repetitions of sections will be reflected in the legislative reference (field 4). When reviewing a source document to determine the breakdown for data records, the abstracter should remember that sections may be combined only if the resulting data records can be indexed distinctively for retrieval and will not require the user to read through lengths of material to find a specific section of interest.

Basic requirements for permits, reports, and tests should be included in the abstract, but without administrative details or test procedures. Abstracts may also include parenthetical or explanatory notes by the abstracter when a source document contains an obvious error or is confusing. References to other documents contained in the CELDS data

base should be avoided; however, when such references are necessary, a citation is given to the appropriate CELDS accession number.

Table of Standards

This field is used when the best way to present the content of a regulation or portion of a regulation is in tabular format (for example, rules on maximum permissible levels of chemical substances in the air or water). A table must use no more than 60 spaces across the page, and must have a table number, descriptive title, and column headings which include the relevant units of measure. Tables are numbered consecutively with each data record. If no table is necessary for a particular accession number, the word "NONE" is entered in this field.

Environmental Attributes

Environmental attributes (EA's) are index terms developed by CERL which are arranged by areas under corresponding major environmental categories. (Appendix A provides the list of acceptable attributes.) The list is arranged hierarchically in three levels: (1) parametric terms form the broadest level; (2) subparametric names list subdivisions of parametric terms; and (3) at the most specific level, detailed attributes list individual chemical compounds, types of plants and animals, and other environmental aspects. Terms from any level of the hierarchy may be assigned to a data record, depending on the level of specificity of the document being indexed. As many terms as necessary should be used to describe the content of the data record adequately; however, no EA term may be assigned unless the corresponding Major Environmental Category (MEC) was entered in field 5. It should be noted that an attribute may be expressed by several terms within one MEC. For example, RADIOACTIVE and RADIOACTIVE EMISSIONS both appear in the EA list under the MEC AIR QUALITY. Similarly, different MEC's may use different terms for related subjects. The EA's RADIATIONS and OTHER RADIATIONS appear under the MEC HEALTH SCIENCE; the EA's RADIOACTIVE and RADIOACTIVITY appear under MEC WATER QUALITY. For a data record on emissions of radioactive wastes to air and water, all of these terms should be listed in field 11. Particular attention should be paid to attributes listed beneath the parametric name CONTROVERSIAL ATTRIBUTES, which appears at the end of each major environmental category section of the EA list. These are frequently variations of general terms and are of particular interest to users.

When EA's are assigned, regulations that are similar from state to state should be indexed consistently so that users searching the system can easily make a transition between states or from the Federal government to a state. EA's should be entered one to a line, without punctuation, and should be uniform. If no EA pertains to a data record, the word NONE is entered in this field.

Keywords

Because an appropriate attribute does not always exist for a particular data record, a thesaurus of keywords has been developed as a supplementary index (Appendix B provides a listing of acceptable keywords). It differs significantly from the list of environmental attributes because of the inclusion of process names (e.g., MANUFACTURING) and procedural terms (e.g., PERMITS) in addition to names of the chemical compounds and environmental variables affected by the processes; this allows an added degree of document separation and content identification. This list is arranged hierarchically by major environmental category.

To assign keywords to a CELDS document, the major environmental categories under which the document belongs must be determined and the keyword list consulted for these specific categories. It should be noted that the keyword thesaurus is dynamic, i.e., it may grow or be revised. It is conceivable that new legislation regulating sectors of the environment that were not considered previously may not fit into the existing structure of keywords (or major environmental categories); thus, they cannot be accurately indexed with the existing terms, and creation of new keywords may be necessary. When this happens, it is also necessary to determine whether any of the past laws already in the data base should have this keyword added to their indexing terms.

4 COMPUTER OPERATIONS

Data Input

When legislation has been collected and the data records established according to the outlined procedures, the data is input by using the text editor "ed." This program is part of the UNIX operating system on the computer rather than the CELDS software. (For questions regarding the use of "ed," the *UNIX Programmer's Manual* should be consulted.) A file should be created and laws typed into this file in sequential order by accession number. Each data field in the file should begin with a "#," followed by a five-digit accession number and a three-digit field number. See the Detailed File Description section in Chapter 5 for a more in-depth discussion of this.

The accession number, field number, and stop code should each be right-justified and zero-filled in the columns indicated. The stop code is 00 if it is not the last line of a field, 01 if it is the last line of a field (but not the last line of the accession number), and 02 if it is the last line of the accession number. For example, the last line of field 7 for accession number 135 begins with a 10-digit code of "0013500701."

When the size of the file approaches 65,000 characters, no more data should be input into it; however, the last line of the file should end with an accession number, i.e., data fields for a single accession number should not be split across file boundaries. At this point, a re-indexing program should be executed for this file by typing "repair <filename>". "Repair" will check field numbers and print out errors; flagged errors should be corrected with "ed." When a file checks out, it should be moved to the/cerl/celds directory and its name changed to "laws.xxxx," where "xxxx" is the accession number of the first law in the file. Data input can now be continued by creating another new file and following the same procedures.

Data Base Creation

The "laws" files that are created as described above comprise the CELDS data files and are read to create the inverted search files which make rapid retrievals possible. The program which creates the search files is "push". Thus, to create a new data base, it is necessary to change the working directory to "/cerl/celds" and execute "push". However, since this is a relatively lengthy process, it is usually run in the background mode, and the output is diverted to a file called "push.out". This is accomplished by typing "push>push.out&". Note that "push" does not modify any of the "laws" files but does read them to create the search files. "Push" must be run to include new laws in the data base or to change the search terms for any laws that have had

searchable fields modified. Merely editing the contents of a "laws" file will change the output that is produced when a particular law is printed; however, changing a "laws" file does not change the search files until "push" is executed.

5 DOCUMENTATION OF CELDS PROGRAM

CELDS Algorithm

CELDS is set up with an inverted index. A group of search files in the inverted index indicates each valid search term and a list of accession numbers which represent "hits" for those terms. Since the length of this list of accession numbers varies, two files are involved; one contains the search term and an address in the second file, and the other contains the list of accession numbers, beginning at the address specified for that search term in the first file. These two files are all that are needed to perform searches; when a search is requested, these files are consulted and the appropriate list of accession numbers is returned to the calling program.

The only remaining important file is a table of contents file, which contains an entry for every accession number in the system. The entry indicates the proper file and the starting address for every field. This file is consulted only when it is necessary to get actual text from a "laws" file.

Thus, the procedure is to use only the inverted search files until the desired law set is established. The table of contents file is then used for each of the accession numbers in the list to locate the desired data fields.

For a rapid identification of search terms, a "hashing" scheme is used to convert textual search terms to a number. Search terms may contain as many as 62 characters (although this is an arbitrary limit). A term is hashed by breaking it into pairs and adding the pairs as integer numbers. For example, "nitrogen dioxide" would be hashed as "ni/tr/og/en d/io/xi/de"; the bit representations for each of the pairs would be treated as if they were integers and added. This would give a large number for the value of "nitrogen dioxide." To fit these values into a table of fixed size, the value is divided by 4001 (this is currently being used as max_hash_num), and the remainder is used to designate the "slot" or "hash value" of this term. Since the remainder may be any number from 1 to 4000, there are 4000 available slots in the hash table. (Remainder "0" is not used.) However, max_has_num should be picked so that the hash table is never more than approximately two-thirds full; this will insure efficient operations. If a "collision" occurs--that is, two different terms happen to hash to the same value--the next empty slot is used for the second one. This is why the search term itself is also a part of the "val" files (see pp 24,25). The hash number is checked; then terms are compared character by character to guarantee that the term sought and the term found are the same.

Detailed File Description

The files used in CELDS consist of "laws.toc" file, "isol" files, "alpha" files, "val" files, and "list" files.

Law Files

Laws files contain the data used in CELDS and are selected to be less than 65,536 characters (i.e., 2^{15}) length. The file name is "laws." concatenated with the accession number of the first law in the file; e.g., "laws.131" would be a file beginning with accession number 131. The current laws files are:

laws.1	laws.905	laws.1547	laws.2172	laws 2612
laws.97	laws.931	laws.1573	laws.2185	laws.2616
laws.131	laws.960	laws.1596	laws.2199	laws.2632
laws.165	laws.986	laws.1616	laws.2222	laws.2645
laws.195	laws.1020	laws.1632	laws.2238	laws.2650
laws.224	laws.1043	laws.1650	laws.2259	laws.2663
laws.242	laws.1074	laws.1666	laws.2275	laws.2666
laws.257	laws.1095	laws.1680	laws.2295	laws.2677
laws.282	laws.1120	laws.1700	laws.2306	laws.2692
laws.309	laws.1142	laws.1720	laws.2320	laws.2708
laws.341	laws.1165	laws.1743	laws.2332	laws.2716
laws.373	laws.1193	laws.1772	laws.2352	laws.2731
laws.410	laws.1220	laws.1792	laws.2370	laws.2738
laws.443	laws.1245	laws.1809	laws.2381	laws.2747
laws.481	laws.1268	laws.1825	laws.2393	laws.2760
laws.516	laws.1294	laws.1843	laws.2413	laws.2770
laws.545	laws.1314	laws.1861	laws.2424	laws.2779
laws.579	laws.1327	laws.1884	laws.2445	laws.2793
laws.612	laws.1339	laws.1896	laws.2452	laws.2799
laws.643	laws.1360	laws.1916	laws.2469	laws.2819
laws.679	laws.1376	laws.1937	laws.2482	laws.2831
laws.701	laws.1398	laws.1938	laws.2495	laws.2845
laws.716	laws.1422	laws.1954	laws.2520	laws.2860
laws.737	laws.1440	laws.1967	laws.2536	laws.2883
laws.766	laws.1462	laws.1986	laws.2553	laws.2904
laws.792	laws.1479	laws.2109	laws.2560	laws.2926
laws.823	laws.1499	laws.2122	laws.2573	
laws.856	laws.1521	laws.2141	laws.2587	
laws.883		laws.2158	laws.2595	

The laws are ordered sequentially within the files; therefore, to find any particular accession number (1040, for example), check the list of laws files. In the laws files listed above, there is a file named "laws.1020" and the next one is "laws.1043." The file "laws.1020" will contain accession numbers 1020 to 1042. Therefore, number 1040 must be

in "laws.1020." This information is only necessary for editing, since the CELDS retrieval program will automatically find the appropriate file when CELDS is being used.

Within an accession number, the data fields are in sequential order. Each field must be present and must be preceded by a line beginning with "#," a five-digit accession number, and a three-digit field number. For example, the beginning of field 2 in accession number 5 would be preceded by: #00005002

The following is a sample from the file "laws.2793":

```
#02793001
#02793002   2793
#02793003   transportation of radioactive material.
#02793004   2-10-75
            rules and regulations for protection against radiation; part c:
#02793005   licensing of radioactive material; section c.100.
#02793006   transportation
#02793007
            dept. of public health
#02793008   535 w. jefferson st., springfield il   62761
#02793009   same as legislative reference
            radioactive material shall not be transported outside of the
            authorized location of use unless the regulations found in the
            following are complied with:
            1) 49 cfr, parts 170-189
            2) 14 cfr, part 103
            3) 46 cfr, part 146
            4) 19 cfr, parts 14 and 15
            5) illinois vehicle code, chap. 95 1/2, section 12-704.1
               these regulations relate to the packaging, marking, storing,
            loading, and monitoring of radioactive material, and to the
            reporting of accidents.
               procedures for opening and closing packages of radioactive
            material shall be established and made available to those receiving
            the packages
#0273010
#02793011   none
#02793012   damage to vehicles-injuries to humans
            radioactive substances
            packaging
            transportation
```

Laws.toc File

The index to the laws and fields in the "laws" files is kept in a table of contents (toc) file known as the "laws.toc" file. The CELDS retriever uses this file to determine the file that contains a given law

and what character numbers in the file the fields of that law include. The "laws.toc" file contains 13 entries for each accession number. The first entry is the number of the file containing the accession number. For example, a particular law may be in the laws.31 file. For this law, the first entry in "laws.toc" would contain the number 31. The remaining 12 entries are the character numbers within that file which represent the start of each of the 12 additional data fields. Therefore, to locate any law, multiply the accession by 13 and locate that record number in the "laws.toc" file. The first word will indicate which "laws" file to search for the accession number and the next 12 words will indicate the start of each field within that file. The "laws.toc" file is created by the "push" program and is updated or modified by the "repair" program.

Isol Files

The "Isol" files, created by the "push" program, are: agy.isol, mec.isol, gps.isol, att.isol, and top.isol. Each searchable field has an "isol" file created which consists of the searchable fields from the "laws" files--that is, the first line of the agency field, the gps field, the mec field, the attribute field, and the keyword field. A sample from "mec.isol" would look like:

```
00005:  air quality
00006:  air quality
00039:  air quality
00047:  air quality
00047:  health science
00047:  solid waste
00048:  air quality
00050:  air quality
00051:  air quality
00052:  air quality
00054:  water quality
```

Alpha Files

The "alpha" files are sorted versions of the "isol" files. They are in alphabetical order by search term, and for the same search terms they are in sequential order by accession number. For example, under the key.isol file, "dredging" would be before "estuaries," and under "dredging," the laws would be sequenced by accession number.

Val Files

The "val" file for a field contains all of its search terms and a "hash" table for quick access to those terms. The first part of the file is the hash table. It contains max_hash_number + 10 "slots" or words. "Max_hash_number" is currently defined to be 4001. The 10

additional slots is merely to allow for the possibility of several different terms hashing to 4000. This number must be greater than the number of searchable terms, since each term must occupy one slot. Each slot contains either a zero, which indicates that no terms hashed to this number, or the record number of the term that hashed to this value. Following the hash table are the records, each of which (one for every term) is 64 characters long. The first 62 characters are the search term itself; the remaining two characters (one word) are an integer number that gives the position in the "list" file of the beginning of the list of accession numbers associated with this term. Therefore, to locate the list of laws associated with a search term, determine the hash number and look in that "slot" in the hash table. This will give the record number in the val file. Calculate the character number with which the record begins by multiplying the record number by 64 (the number of characters per record) and adding the size in characters of the hash tables (since this precedes the records in the val file).

The "val" files are created by the "make_search" program and are used in the CELDS retriever to do searches.

List Files

The "list" files are lists of law numbers terminated by 19999 and are of variable length. The law numbers are stored as integers, i.e., one word (two characters) per number. The entry contained in the "val" file is the position of the start of a law list, i.e., its number in the "list" file. To convert this to the starting character number of a law list, multiply by two, since there are two characters per integer number.

Documentation of Programs

Repair

"Repair" is the program which reads a "laws" file and prepares the "laws.toc" file. A variable keeps the current character number as the file is read. When a new field is encountered, the appropriate address is entered into the "laws.toc" file.

Some data validation is also performed by "repair." Accession numbers and field numbers are checked for sequential order. Lines containing errors are printed. If "repair" is executed without a "_" argument, validation is the only task performed.

If "repair" is executed with a "_" argument (e.g., "repair - laws.1"), "isol" files are produced (see Detailed File Description section). As searchable fields are encountered in the input stream, they are copied to an appropriate "isol" file (e.g., "key.isol" for key-

words). In standard operation "repair" is executed with a "_" argument only by the "push" program. Appendix C provides a documented copy of the source code.

Make_Search

"Make_search" is the program which reads a sorted version of the "isol" files produced by "repair" and creates "val" and "list" files for each searchable field. It requires an argument indicating which searchable field is being prepared. For example, "make_search mec" will use "mec.alpha" to produce the files "mec.list" and "mec.val." Appendix D provides a documented copy of this source code.

Hier

"Hier" reads a static thesaurus file ("key.hier") and creates hierarchical search files ("list" and "val"). Currently, this applies only to the keyword field. Searches in the keyword field are presumed to be hierarchical, i.e., a search for a broad term will also include all narrower terms under it. The nonhierarchical file is referred to as "top" (for topic), while the hierarchical file is "key" (e.g., "top.val," "key.val," etc.).

"Top.val" and "top.list" files are produced by "make_search top." These two files are then used by "hier" to construct lists of laws for the terms in the thesaurus file. Appendix E provides the documented source.

Push

"Push" is the shell program (command file) which is executed to create a new data base. It systematically executes "repair" for every "laws" file, and then sorts the "isol" files produced into the "alpha" files required by the "make_search" program. Next, it executes "make_search" for each of the CELDS searchable fields. Finally, "hier" is executed to produce the hierarchical keyword file.

"Push" is a shell file. The procedures it uses include "repair" and "make_search." Appendix F provides a documented copy of this file.

CELDS

The "CELDS" program, sometimes referred to as the retriever, is the main part of the CELDS system. It provides the user interface and performs the requested searching and listing of information. A few conventions involving global variables are used throughout the CELDS routines. An input line is read into a buffer called "request." Two pointers into this buffer are maintained: (1) "old_request_location" points to the previous position in the line, and (2) request_location

points to the current position in the request line. The word that is currently being processed in the request line is stored in the array "word" and is null-terminated. Every routine that uses a word gets the next word and places it into the "word" array in preparation for the next routine to be called. Thus, every routine expects that "word" is already prepared for it; in turn, it fixes "word" for the next routine. If the line terminates, then a null is placed into word [0]. In all cases, "get_next_word" is called to provide the next word from a line. Appendix G provides the documented source code for the retriever routines.

Library Routines

Besides the routines appearing in the appendices, several routines of general utility to the CELDS programs are kept in a library. These include routines of the type to do hashing, input/output, concatenation of strings, etc. Appendix H provides these routines. One other file also included in Appendix H is "search.i." This is an "include" file (see *C Reference Manual*[8]). It contains constants used by most of the CELDS programs, such as hash table size, maximum number of laws, etc. Each program that depends on these has an "include" statement which has the effect of incorporating the "search.i" file into the source code. Changing a parameter in the "search.i" file will therefore cause it to be changed in all of the CELDS programs, thus eliminating errors due to oversight.

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[8] Dennis M. Ritchie, *C Reference Manual* (Bell Telephone Laboratories).

6 SUMMARY AND RECOMMENDATION

CELDS contains abstracts of environmental legislation for the Federal government and for all 50 states and Puerto Rico. This report has provided complete documentation of CELDS, including background information, description of data records, how the information is abstracted, indexed, and updated, and listings of the software. The documentation described in this report should be used for any future modification, update, and maintenance of CELDS.

CELDS should be brought up in an operational environment and made available to all elements of the Army to aid with environmental questions.

Appendix A - Attribute Listing

ENV INFLUENCE FAC
- AIR MASS
  - STABILITY
  - TEMPERATURE
  - MIXING DEPTH
  - WIND SPEED
  - WIND DIRECTION
  - HUMIDITY
  - PRECIPITATION
- LAND MASS
  - ALBEDO
  - INSOLATION
  - TOPOGRAPHY

PARTICULATES
- AGGREGATE
  - DUST AND FUMES
  - FLY ASH
  - SMOKE AND SOOT
- INORG SOLIDS, MISTS
  - ALUMINUM AND COMPOUNDS
  - ARSENIC AND COMPOUNDS
  - ASBESTOS
  - BARIUM AND COMPOUNDS
  - BERYLLIUM AND COMPOUNDS
  - BORON AND COMPOUNDS
  - CADMIUM AND COMPOUNDS
  - CALCIUM AND COMPOUNDS
  - CHROMIUM AND COMPOUNDS
  - COPPER AND COMPOUNDS
  - IRON AND COMPOUNDS
  - LEAD AND COMPOUNDS
  - MANGANESE AND COMPOUNDS
  - MOLYBDENUM AND COMPOUNDS
  - NICKEL AND COMPOUNDS
  - SELENIUM AND COMPOUNDS
  - SILICON AND COMPOUNDS
  - SILVER AND COMPOUNDS
  - SODIUM AND COMPOUNDS
  - THALLIUM AND COMPOUNDS
  - TIN AND COMPOUNDS
  - TITANIUM AND COMPOUNDS
  - TUNGSTEN AND COMPOUNDS
  - VANADIUM AND COMPOUNDS
  - ZINC AND COMPOUNDS
  - ZIRCONIUM AND COMPOUNDS
  - RADIOACTIVE SUBSTANCES
  - FLUORINE AND COMPOUNDS
  - SULFUR AND COMPOUNDS

- CHLORINE AND COMPOUNDS
- BROMINE AND COMPOUNDS
- IODINE AND COMPOUNDS
- PHOSPHOROUS AND COMPOUNDS
- MERCURY AND COMPOUNDS
- NITROGEN AND COMPOUNDS
- MAGNESIUM AND COMPOUNDS
- POTASSIUM AND COMPOUNDS
- ANTIMONY AND COMPOUNDS

ORGANIC COMPOUNDS

- SATURATED HYDROCARBONS
- CYCLIC SATURATED HYDROCARBONS
- UNSATURATED HYDROCARBONS
- AROMATIC HYDROCARBONS
- ALCOHOLS
- PHENOLS
- ETHERS
- AMINES
- ALDEHYDES
- KETONES
- ORGANIC ACIDS AND DERIVATIVES
- ORGANIC SULFUR
- ORGANIC HALIDES

BIOLOGICAL

- AEROALLERGENS
- ALLERGENS (EXCLUDING AEROALLERGENS)
- FUNGI
- BACTERIA
- VIRUSES

PARTICULATE BIOCIDES

- INSECTICIDES
- MITICIDES AND NEMATOCIDES
- RODENTICIDES AND FUNGICIDES
- HERBICIDES

GASES AND VAPORS

INORGANIC

- SULFUR AND COMPOUNDS
- NITROGEN AND COMPOUNDS
- BROMINE AND COMPOUNDS
- OZONE
- CHLORINE AND COMPOUNDS
- FLUORINE AND COMPOUNDS
- RADIOACTIVE

ORGANIC

- SATURATED HYDROCARBONS
- CYCLIC SATURATED HYDROCARBONS
- UNSATURATED HYDROCARBONS
- AROMATIC HYDROCARBONS
- ALCOHOLS

PHENOLS
ETHERS
AMINES
ALDEHYDES
KETONES
ORGANIC ACIDS AND DERIVATIVES
SULFUR
HALIDES
RADIOACTIVE
CARBON AND COMPOUNDS
GASEOUS BIOCIDES
INSECTICIDES
MITICIDES AND NEMATOCIDES
RODENTICIDES AND FUNGICIDES
HERBICIDES

CNTRVSL

PARTICULATE MATTER
SULFUR OXIDES
HYDROCARBONS
PHOTOCHEMICAL OXIDANTS
CARBON MONOXIDE
OXIDES OF NITROGEN
ODORS
RADIOACTIVE EMISSIONS
AESTHETIC CONSIDERATIONS

EARTH SCIENCE

SITE ATT
- TOPOGRAPHY
  - SLOPE
- SUBSTRATUM
  - HYDROLOGIC REGIME
- PRECIPITATION
  - BEDROCK

PROCESS AT
- SUBSTRATUM
  - SOIL COMPACTION
  - SOIL HORIZON MIXING
  - SUBSURFACE VIBRATION
- EROSION + TRANSPORT
  - WATER EROSION
  - ICE EROSION
  - WIND EROSION
  - GRAVITY, MASS WASTING

CNTRVSL
- WATER EROSION
- HYDROLOGIC REGIME
- SUBSURFACE VIBRATION
- WIND EROSION
- GRAVITY, MASS WASTING
- LANDSCAPE AESTHETICS

ECOLOGY

ECOSYSTEM
- KINDS OF ANIMALS
  - LARGE MAMMALS
  - SMALL MAMMALS
  - BIRDS
  - FISH
  - AMPHIBIANS
  - INSECTS
  - OTHER ANIMALS
  - ENDANGERED ANIMAL SPECIES
- KINDS OF PLANTS
  - TREES
  - SHRUBS
  - HERBS
  - ALGAE
  - FUNGI
  - LICHENS
  - OTHER PLANT SPECIES
  - ENDANGERED PLANT SPECIES
- SYSTEM STABILITY
  - FOOD WEBS
  - PRODUCTIVITY
  - SEASONAL ASPECT
  - STRATIFICATION
  - SUCCESSIONAL STAGE

WILDLIFE MANAGEMENT
- HUNTING
  - SMALL GAME HUNTING
  - WATERFOWL HUNTING
  - BIG GAME HUNTING
- FISHING
  - BOTTOM LIFE
  - WARM WATER FISHING
  - COLD WATER FISHING
  - LARGE LAKE FISHING
  - COASTAL WATER FISHING
  - SHELLFISH
  - DEEP SEA FISHING
- PESTS
  - DISEASE VECTORS
  - NOXIOUS WEEDS
  - OTHER UNDESIRABLE SPECIES

CNTRVSL
- IMPACTS ON GAME ANIMALS
- ENCROACHMENT ON NATURAL HABITATS
- THREATENED SPECIES

HEALTH SCIENCE

BIOLOGICAL
- POLLEN
- VIRUS
- RICKETTSIA
- PROTOZOA
- BACTERIA
- FUNGI
- WORMS
- ARTHROPODS
- RODENTS

CHEMICAL
- CARBON MONOXIDE
- SULFUR DIOXIDE
- NITROGEN AND NITROGEN OXIDES
- PARTICULATE MATTER
- LEAD
- MERCURY
- ACIDS
- CADMIUM
- ARSENIC
- SELENIUM
- PESTICIDES AND RESIDUES
- BARIUM
- CHROMIUM
- COPPER
- NICKEL
- ZINC
- DETERGENTS
- HALOGENS
- SULFUR
- PHENOLS
- CYANIDE
- METHANE
- CARCINOGENIC SUBSTANCES
- ALUMINUM
- BERYLLIUM
- SILICON
- THALLIUM
- ASBESTOS
- ALCOHOLS
- ALDEHYDES
- KETONES
- ETHERS

PSYCHOLOGICAL
- MIL + CIV ARMY PERSONNEL
  - WORK OVEREXPOSURE
  - INADEQUATE TRAINING

DISLOCATION ADJUSTMENTS
ARMY DISCIPLINE
PERSONNEL POLICIES
PHYSICAL OVEREXPOSURE
ECONOMIC HARDSHIPS
INDIV IN COMMUNITY NEAR INST
MILITARY SECRECY
VISUAL ENVIRONMENTAL CHANGES
COMMUNICATIONS NETWORK INTERFERENCE
BOTH ARMY PERSONNEL + PRIVATE INDIV
TRAFFIC OVEREXPOSURE
TRAUMATIC EXPERIENCES
POLLUTANT OVEREXPOSURE
HOUSING CONDITIONS
POPULATION CHANGE

SAFETY
TRANSPORTATION SAFETY
AIR
GROUND
WATER
RESIDENTIAL OR HOME AREA
COMMUNITY/MARKETING
WORK
RECREATION
RADIATIONS
RADIATION-IONIZING
RADIATION-MICROWAVE
RADIATION-LASER
OTHER RADIATION

CNTRVSL
EXPOSURE TO CARCINOGENS/MUTAGENS
HARMFUL FOODS/WATER ADDITIVES
PSYCHOLOGICAL STRESSORS
DRUG + NARCOTICS ABUSE
ENDANGERING COMMUNITY HEALTH
ENDANGERING COMMUNITY SAFETY

LAND USE

CONSUMPTION
    CONSUMPTION OF LAND
CONFLICT
    ACCESS TO MINERALS
    INTERFERENCE OFF OF POST
    INCOMPATIBILITY ON POST
CHANGE
    INDUCED LAND-USE CHANGES
CNTRVSL
    CONSUMPTION OF LAND
    ACCESS TO MINERALS
    INTERFERENCE OFF OF POST
    INDUCED LAND-USE CHANGES

NOISE

PHYSIOLOGICAL MAINTENANCE
SLEEP PERFORMANCE
TASK PERFORMANCE
AURAL COMMUNICATION
TELEVISION/RADIO COMMUNICATION
LAND USE INCOMPATIBILITY AND INTEGRITY
CNTRVSL
    COMMUNITY ANNOYANCE
    PROPERTY VALUE DEPRECIATION

SOCIOLOGY

HUMAN ECOLG
- POPULATION
  - SIZE
  - COMPOSITION
  - NET CHANGE
- HUMAN ECOLG
  - RURAL AREAS
  - URBAN AREAS
  - SUBURBS
  - URBAN FRINGE

SOC STRUCT
- SOCIAL CATEGORIES
  - AGE CATEGORIES
  - SEX CATEGORIES
  - FAMILY STATUS CATEGORIES
- SOCIAL CLASSES
  - UPPER CLASS
  - MIDDLE CLASS
  - LOWER CLASS
- ASSOCIATIONS
  - VOLUNTARY ASSOCIATION
  - ORGANIZATIONS
- INSTITUTIONS
  - FAMILIES
  - EDUCATIONAL ORGANIZATIONS
  - RELIGIOUS ORGANIZATIONS
- SOCIAL CONTROL
  - LAW ENFORCEMENT

SOCL PROC
- SOCIAL CONTROL
  - COURTS
  - POLITICAL PROCESS
  - WELFARE AND DEPENDENCY
- PUBLIC OPINION
  - PUBLICS
  - OPINION LEADERS
  - OPINION PROCESS
- MASS COMMUNICATIONS
  - PRINTED MEDIA
  - BROADCAST MEDIA

CNTRVSL
- POPULATION
- ECOLOGY
- EDUCATIONAL ORGANIZATIONS
- SOCIAL CONTROL
- PUBLIC OPINION
- MASS COMMUNICATION

AESTHETIC CHARACTER OF COMMUNITY

SOLID WASTE

COLLECTION
DISPOSAL
MANAGEMENT

TRANSPORTATION

ROAD TRANS
- DISRUPTIONS IN HIGHWAY TRAFFIC FLOW
- INDUCED MODIFICATION TO HIGHWAYS
- POLLUTION FROM HIGHWAYS
- DAMAGE TO HIGHWAYS
- DAMAGE TO VEHICLES -INJURIES TO HUMANS

RAIL TRANS
- DISRUPTION TO RAILWAY TRAFFIC
- INDUCED MODIFICATION TO RAILWAYS
- POLLUTION FROM RAILWAYS
- DAMAGE TO RAILWAYS

AIR TRANS
- DISRUPTION TO AIRFIELD TRAFFIC
- INDUCED MODIFICATION TO AIRFIELDS
- POLLUTION FROM AIRFIELDS
- DAMAGE TO AIRFIELDS

WATER TRAN
- DISRUPTION TO WATERWAY TRAFFIC
- INDUCED MODIFICATION TO WATERWAYS
- POLLUTION FROM WATERWAYS
- DAMAGE TO WATERWAYS

CNTRVSL
- DISRUPTIONS IN HIGHWAY TRAFFIC FLOWS
- DAMAGE TO VEHICLES-INJURIES TO HUMANS
- INDUCED MODIFICATION TO HIGHWAYS
- INDUCED MODIFICATION TO AIRFIELDS

WATER QUALITY

- PHYS ENVMT
  - AQUIFER CHAR
    - AVAILABILITY OF GROUND WATER
  - WATER QUALITY PARAMS
    - TURBIDITY
    - TEMPERATURE
    - COLOR
    - SUSPENDED SOLIDS
    - GROSS SOLIDS
    - SETTLEABLE SOLIDS
    - FLOATING SOLIDS
    - VOLATILE SUSPENDED SOLIDS
    - TASTE AND ODOR
    - OILS
    - DISSOLVED GASES
  - STREAM OR WATER BODY
    - DEPTH
    - VELOCITY
    - SOLAR RADIATION INTENSITY
    - WIND VELOCITY AND DIRECTION
    - DYNAMIC PRESSURE
    - ATMOSPHERIC REAERATION
    - MORPHOMETRY AND FLOW PATTERN
    - SUBSTRATUM
    - DEPENDABLE YIELD
    - MAXIMUM DISCHARGE
    - MINIMUM DISCHARGE
    - RATE OF CHANGE OF DISCHARGE
- CHEM ENVMT
  - INORGANIC
    - IRON
    - MANGANESE
    - SODIUM
    - CALCIUM
    - MAGNESIUM
    - NITROGEN
    - PHOSPHORUS
    - ARSENIC
    - BARIUM
    - BORON
    - CADMIUM
    - CHROMIUM
    - COPPER
    - FLUORIDE
    - LEAD
    - MERCURY
    - NICKEL

```
                SELENIUM
                SILVER
                ZINC
                ALKALINITY AND ACIDITY
                HYDROGEN ION CONCENTRATION (PH)
                OXIDATION REDUCTION POTENTIAL (EH)
                DISSOLVED CARBON DIOXIDE
                TOTAL DISSOLVED SOLIDS
                CHLORIDE
                SULFUR
                DISSOLVED OXYGEN
                SALINITY
                OTHER INORGANCIC CHEMICALS
        ORGANIC
                BOD
                COD
                PHENOLS
                DETERGENTS
                CARCINOGENIC SUBSTANCES
                CARBON CHLOROFORM EXTRACT (CCE)
                CYANIDE
                METHANE
                OTHER ORGANIC COMPOUNDS
        BIOCIDES
                PESTICIDES
        RADIOACTIVE
                RADIOACTIVITY
BIOLOGICAL
        PATHOGENIC
                PATHOGENIC VIRUSES
                PATHOGENIC BACTERIA
                PATHOGENIC PROTOZOA
                OTHER PATHOGENIC ORGANISMS
        AQUATIC LIFE
                PLANKTON
                BENTHOS
                NEKTON
                OTHER ORGANISMS
                COMMUNITY MAINTENANCE
CNTRVSL
        SYNTHETIC DETERGENTS
        FLUORIDATION
        WATER QUANTITY
        MERCURY
        OIL
        THERMAL POLLUTION
        OTHER POTENTIALLY CONTROVERSIAL ASPECTS
        AQUIFER YIELD
```

Appendix B - Keyword Listing

ACCIDENTS
SN UNINTENTIONAL RELEASES OF CONTAMINANTS INTO THE AIR OR WATER.
NT OIL SPILLS

ACIDS
BT INORGANIC COMPOUNDS
NT NITRIC ACID
SULFURIC ACID
RT HAZARDOUS MATERIALS
*

AGRICULTURAL POLLUTION
NT FEEDLOTS
GRAIN HANDLING
RT COTTON GINS
EROSION
FERTILIZERS
HERBICIDES
PESTICIDES
RENDERING

AIR POLLUTION CONTROL
SN DEVICE OR PROCEDURE USED TO LIMIT THE RELEASE OF CONTAMINANTS INTO THE AIR.

AIR POLLUTION EPISODES
SN STATUS DECLARED BY STATE OFFICIALS WHEN AIR CONTAMINANTS REACH HIGH LEVELS; EMISSION REDUCTION PLANS MUST THEN BE ADHERED TO.

AIR POLLUTION SOURCES
NT ASPHALT PLANTS
BOILERS
CEMENT PLANTS
COATINGS
COKE OVENS
COTTON GINS
FERROALLOYS
STEEL
FOUNDRIES
FURNACES
BLAST FURNACES
CUPOLAS
GRAIN HANDLING
HEAT EXCHANGERS
INCINERATORS
CONICAL BURNERS
INDIRECT SOURCES
AIRPORTS
ROADS

INDUSTRIAL COOLING
LANDFILLS
SANITARY LANDFILL
MANUFACTURING
CHEMICAL MANUFACTURING
NONFERROUS METALS
ARSENIC
BARIUM
BERYLLIUM
CADMIUM
CHROMIUM
COPPER
LEAD
MANGANESE
MERCURY
NICKEL
SILVER
SODIUM
ZINC
OPEN BURNING
POWER SOURCES
INTERNAL COMBUSTION ENGINES
DIESEL ENGINES
GASOLINE ENGINES
NUCLEAR ENERGY
STEAM GENERATING PLANTS
TURBINES
PULP MILLS
SEPARATION PROCESSES
SINTERING
SMELTERS
SPRAYING
STOCKPILES
VEHICLES

AIR QUALITY CLASSIFICATION
BT CLASSIFICATION
RT LAND CLASSIFICATION
WATER CLASSIFICATION

AIR QUALITY CONTROL REGIONS
USE AQCR, SPECIFIC

AIR QUALITY STANDARDS
RT EMISSION STANDARDS

AIRBORNE PARTICULATES
UF PARTICULATES
NT ASH
DUST

FUMES
MISTS
SMOKE
RT OPACITY

AIRCRAFT
RT VEHICLES
WATERCRAFT

AIRPORTS
BT AIR POLLUTION SOURCES
INDIRECT SOURCES
RT ROADS

ALCOHOLS
BT ORGANIC COMPOUNDS
RT *

ALDEHYDES
BT ORGANIC COMPOUNDS
RT *

ALKYL BENZENE SULFONATES
BT INORGANIC COMPOUNDS
SULFUR
RT SULFUR OXIDES
SULFURIC ACID

AMMONIA
BT INORGANIC COMPOUNDS
NT AMMONIA NITROGEN
RT HAZARDOUS MATERIALS
*

AMMONIA NITROGEN
BT INORGANIC COMPOUNDS
AMMONIA

AMMUNITION
BT EXPLOSIVES
RT *

AQCR, SPECIFIC
SN A COLLECTIVE KEYWORD FOR SPECIFIC AQCR'S WHICH HAVE BEEN TREATED INDIVIDUALLY IN THE REGULATIONS AND DATA BASE; NAMES OF AQCR'S ARE NOT LISTED IN THE THESAURUS.
UF AIR QUALITY CONTROL REGIONS

AQUATIC ANIMALS
BT AQUATIC LIFE
RT AQUATIC PLANTS
FISH

AQUATIC LIFE
NT AQUATIC ANIMALS
AQUATIC PLANTS
FISH
RT FLORA
PROTECTED SPECIES
WILDLIFE

AQUATIC PLANTS
BT AQUATIC LIFE
RT AQUATIC ANIMALS
FISH

ARSENIC
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS
RT *

ASBESTOS
BT INORGANIC COMPOUNDS
SILICATES
POINT SOURCES
RT FELDSPARS
HAZARDOUS MATERIALS
*

ASH
BT AIRBORNE PARTICULATES
RT DUST
FUMES
MISTS
SMOKE

ASPHALT PLANTS
BT AIR POLLUTION SOURCES
RT *

ATLANTIC OCEAN
RT COASTS
SALINE WATER

WATERWAYS
WETLANDS

BACTERIA
NT FECAL COLIFORMS
RT HAZARDOUS MATERIALS

BARIUM
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS
RT *

BASINS
USE BAYS, SPECIFIC

BAYS, SPECIFIC
SN A COLLECTIVE KEYWORD FOR SPECIFIC BAYS WHICH HAVE BEEN TREATED INDIVIDUALLY IN THE REGULATIONS AND DATA BASE; NAMES OF BAYS ARE NOT LISTED IN THE THESAURUS.
UF BASINS
HARBORS
RT SEAPORTS

BERYLLIUM
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS
RT *

BIOCHEMICAL OXYGEN DEMAND
USE BOD

BIOLOGICAL WARFARE AGENTS
RT CHEMICAL WARFARE AGENTS
HAZARDOUS MATERIALS

BLACK POWDER
BT EXPLOSIVES
RT *

BLAST FURNACES
BT AIR POLLUTION SOURCES

FURNACES
POINT SOURCES
FURNACES
RT CUPOLAS

BLASTING CAPS
BT EXPLOSIVES
RT *

BOD
UF BIOCHEMICAL OXYGEN DEMAND
RT COD
DISSOLVED OXYGEN

BOILERS
BT AIR POLLUTION SOURCES
POINT SOURCES
RT *

BORON
BT INORGANIC COMPOUNDS
RT *

CADMIUM
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS
RT *

CANNON AMMUNITION
BT EXPLOSIVES
RT *

CARBON
BT ORGANIC COMPOUNDS
NT CARBON MONOXIDE
ORGANIC CARBON
RT CCE
HYDROCARBONS
*

CARBON CHLOROFORM EXTRACT
USE CCE

CARBON MONOXIDE
BT ORGANIC COMPOUNDS

CARBON
RT ORGANIC CARBON
OXIDANTS

CCE
UF CARBON CHLOROFORM EXTRACT
BT ORGANIC COMPOUNDS
RT CARBON
*

CEMENT PLANTS
BT AIR POLLUTION SOURCES
POINT SOURCES
RT *

CHANNELIZATION
SN ANY ACT WHICH AFFECTS THE BED OR ROUTE OF A BODY OF WATER.
NT DREDGING

CHANNELS
RT WATERWAYS

CHEMICAL AMMUNITION
BT EXPLOSIVES
RT *

CHEMICAL MANUFACTURING
SN TERM TO DENOTE POINT SOURCES WHICH MANUFACTURE INORGANIC OR ORGANIC CHEMICALS
BT AIR POLLUTION SOURCES
MANUFACTURING
POINT SOURCES
RT INORGANIC COMPOUNDS
ORGANIC COMPOUNDS
*

CHEMICAL OXYGEN DEMAND
USE COD

CHEMICAL WARFARE AGENTS
RT BIOLOGICAL WARFARE AGENTS
HAZARDOUS MATERIALS

CHLORIDES
NT VINYL CHLORIDES
RT HAZARDOUS MATERIALS

CHLORINE
BT INORGANIC COMPOUNDS
RT *

CHROMIUM
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS
RT *

CITIES
USE URBAN AREAS
URBAN AREAS, SPECIFIC

CLASSIFICATION
SN QUALITY AND/OR USE CLASSIFICATION FOR LAND OR WATER; ADMINISTRATIVE REGIONS FOR AIR QUALITY.
NT AIR QUALITY CLASSIFICATION
LAND CLASSIFICATION
WATER QUALITY CLASSIFICATION

COAL
BT FUELS
RT COKE
LIQUID FUELS
PETROLEUM
WOOD

COASTS
RT ATLANTIC OCEAN
PACIFIC OCEAN
SALINE WATER
SEAPORTS
TIDAL WATER
WETLANDS

COATINGS
SN SUBSTANCES APPLIED TO SURFACES BY ELECTROPLATING OR SPRAYING IN A MANNER PERMITTING RELEASE OF POLLUTANTS; E.G., PAINTS OR METALS.
UF ELECTROPLATING
BT AIR POLLUTION SOURCES
POINT SOURCES
RT HAZARDOUS MATERIALS
SPRAYING
*

COD
UF CHEMICAL OXYGEN DEMAND
RT BOD
DISSOLVED OXYGEN

COKE
BT FUELS
RT COAL
LIQUID FUELS
PETROLEUM
WOOD

COKE OVENS
BT AIR POLLUTION SOURCES
POINT SOURCES
RT *

COLIFORM BACTERIA
USE FECAL COLIFORMS

COLOR

CONDUCTIVITY

CONICAL BURNERS
BT AIR POLLUTION SOURCES
INCINERATORS
WASTE DISPOSAL
INCINERATORS

CONTAINERS
RT PACKAGING
STORAGE TANKS

COPPER
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS

RT *

COTTON GINS
BT AIR POLLUTION SOURCES
RT AGRICULTURAL POLLUTION
*

COUNTIES, SPECIFIC
SN A COLLECTIVE KEYWORD FOR SPECIFIC COUNTIES WHICH HAVE BEEN TREATED INDIVIDUALLY IN THE REGULATIONS AND DATA BASE; NAMES OF COUNTIES ARE NOT LISTED IN THE THESAURUS.

CRUDE OIL
USE PETROLEUM

CUPOLAS
BT AIR POLLUTION SOURCES
FURNACES
POINT SOURCES
FURNACES
RT BLAST FURNACES

CYANIDES
BT INORGANIC COMPOUNDS
RT HAZARDOUS MATERIALS
*

DEPOSITION
RT EROSION
SEDIMENTATION
SETTLEABLE SOLIDS

DESIGN CRITERIA

DETONATING DEVICES
BT EXPLOSIVES
RT *

DIESEL ENGINES
BT AIR POLLUTION SOURCES
POWER SOURCES
INTERNAL COMBUSTION ENGINES
POINT SOURCES
POWER SOURCES
INTERNAL COMBUSTION ENGINES
RT GASOLINE ENGINES

DISPERSANTS
UF EMULSIFIERS
RT OIL SPILLS
SOLVENTS

DISSOLVED OXYGEN
RT BOD
COD

DISSOLVED SOLIDS
RT SETTLEABLE SOLIDS
SUSPENDED SOLIDS

DREDGING
BT CHANNELIZATION

DRINKING WATER

USE POTABLE WATER

DUMPING GROUNDS
SN SOLID WASTE DISPOSAL AREAS IN A BODY OF WATER.
BT WASTE DISPOSAL
RT GARBAGE COLLECTION
INCINERATORS
JUNKYARDS
LANDFILLS
OPEN BURNING
OPEN DUMPING
TRANSFER STATIONS
WASTE PROCESSING

DUST
BT AIRBORNE PARTICULATES
RT ASH
FUMES
MISTS
SMOKE

ECONOMIC POISONS
USE HERBICIDES
PESTICIDES

EFFLUENT STANDARDS
RT WATER QUALITY STANDARDS

EFFLUENTS
NT INDUSTRIAL WASTES
PROCESS WASTE WATER
SEWAGE
RT MIXING ZONE
POINT SOURCES
THERMAL POLLUTION

ELECTROPLATING
USE COATINGS

EMISSION STANDARDS

RT AIR QUALITY STANDARD

EMISSIONS
NT EXHAUST EMISSIONS

EMULSIFIERS
USE DISPERSANTS

ENDANGERED SPECIES
BT PROTECTED SPECIES
RT THREATENED SPECIES

EROSION
RT AGRICULTURAL POLLUTION
DEPOSITION
SEDIMENTATION
SETTLEABLE SOLIDS

ESTUARIES
BT TIDAL WATER

ETHYLENE
BT ORGANIC COMPOUNDS
RT *

EXHAUST EMISSIONS
BT EMISSIONS

EXHAUST SYSTEMS
SN TERM INCLUDES EXHAUST AND VENTILATING SYSTEMS.

EXPLOSIVE BOMBS
BT EXPLOSIVES
RT *

EXPLOSIVE GRENADES
BT EXPLOSIVES
RT *

EXPLOSIVE MINES
BT EXPLOSIVES
RT *

EXPLOSIVE POWER DEVICES
BT EXPLOSIVES
RT *

EXPLOSIVE PROJECTILES
BT EXPLOSIVES

RT *

EXPLOSIVE TORPEDOES
BT EXPLOSIVES
RT *

EXPLOSIVES
NT AMMUNITION
BLACK POWDER
BLASTING CAPS
CANNON AMMUNITION
CHEMICAL AMMUNITION
DETONATING DEVICES
EXPLOSIVE BOMBS
EXPLOSIVE GRENADES
EXPLOSIVE MINES
EXPLOSIVE POWER DEVICES
EXPLOSIVE PROJECTILES
EXPLOSIVE TORPEDOES
GAS MINES
GAS PROJECTILES
HIGH EXPLOSIVES
IGNITERS
INCENDIARY PROJECTILES
INITIATING EXPLOSIVES
JET THRUST UNITS
LOW EXPLOSIVES
NONEXPLOSIVE AMMUNITION
PROPELLANT EXPLOSIVES
ROCKET AMMUNITION
ROCKET MOTORS
STARTER CARTRIDGES
RT HAZARDOUS MATERIALS
PACKAGING
STORAGE
TRANSPORTATION

FECAL COLIFORMS
UF COLIFORM BACTERIA
BT BACTERIA

FEEDLOTS
BT ARGICULTURAL POLLUTION
POINT SOURCES
RT GRAIN HANDLING
*

FELDSPARS
BT INORGANIC COMPOUNDS

SILICATES
RT ASBESTOS

FERROALLOYS
BT AIR POLLUTION SOURCES
POINT SOURCES
NT STEEL
RT IRON
SMELTERS
*

FERTILIZERS
BT POINT SOURCES
RT AGRICULTURAL POLLUTION
*

FIRES
RT OPEN BURNING

FISH
SN TERM INCLUDES SHELLFISH; DISTINGUISHED FROM OTHER AQUATIC ANIMALS MAINLY BY ECONOMIC IMPORTANCE.
UF SHELLFISH
BT AQUATIC LIFE
RT AQUATIC ANIMALS
AQUATIC PLANTS

FLOATING DEBRIS

FLOOD CONTROL

FLORA
UF PLANT LIFE
RT AQUATIC LIFE
PROTECTED SPECIES
WILDLIFE

FLUORIDES
BT INORGANIC COMPOUNDS
RT *

FOREST PRESERVATION
RT LAND PRESERVATION

FOUNDRIES
BT AIR POLLUTION SOURCES
RT *

FUEL OIL

BT FUELS
LIQUID FUELS
RT GASOLINE

FUELS
NT COAL
COKE
LIQUID FUELS
FUEL OIL
GASOLINE
WOOD

FUMES
BT AIRBORNE PARTICULATES
RT ASH
DUST
MISTS
SMOKE

FURNACES
BT AIR POLLUTION SOURCES
POINT SOURCES
NT BLAST FURNACES
CUPOLAS
RT *

GARBAGE COLLECTION
BT WASTE DISPOSAL
RT DUMPING GROUNDS
INCINERATORS
JUNKYARDS
LANDFILLS
OPEN BURNING
OPEN DUMPING
TRANSFER STATIONS
WASTE PROCESSING

GAS MINES
BT EXPLOSIVES
RT *

GAS PROJECTILES
BT EXPLOSIVES
RT *

GASOLINE
BT FUELS
LIQUID FUELS
RT FUEL OIL

GASOLINE ENGINES
BT AIR POLLUTION SOURCES
POWER SOURCES
INTERNAL COMBUSTION ENGINES
SOURCES
POINT SOURCES
POWER SOURCES
INTERNAL COMBUSTION ENGINES
RT DIESEL ENGINES

GRAIN HANDLING
BT AGRICULTURAL POLLUTION
AIR POLLUTION SOURCES
POINT SOURCES
RT FEEDLOTS
*

HARBORS

USE BAYS, SPECIFIC

HAZARDOUS MATERIALS
RT ACIDS
AMMONIA
ASBESTOS
BACTERIA
BIOLOGICAL WARFARE AGENTS
CHEMICAL WARFARE AGENTS
CHLORIDES
COATINGS
CYANIDES
EXPLOSIVES
HERBICIDES
INDUSTRIAL WASTES
NONFERROUS METALS
OILS
PESTICIDES
RADIOACTIVE SUBSTANCES
SEWAGE
SLUDGE
SOLVENTS
TOXIC SUBSTANCES
VOLATILE SUBSTANCES

HEAT EXCHANGERS
UF INDIRECT HEAT EXCHANGERS
BT AIR POLLUTION SOURCES
RT *
HERBICIDES

UF ECONOMIC POISONS
BT PESTS
RT AGRICULTURAL POLLUTION
HAZARDOUS MATERIALS
PEST CONTROL
PESTICIDES

HIGH EXPLOSIVES
BT EXPLOSIVES
RT *

HYDROCARBONS
BT ORGANIC COMPOUNDS
RT CARBON
HYDROGEN
*

HYDROGEN
BT INORGANIC COMPOUNDS
NT HYDROGEN FLUORIDE
HYDROGEN SULFIDE
RT HYDROCARBONS
PH
*

HYDROGEN FLUORIDE
BT INORGANIC COMPOUNDS
HYDROGEN
RT HYDROGEN SULFIDE

HYDROGEN ION CONCENTRATION
USE PH

HYDROGEN SULFIDE
BT INORGANIC COMPOUNDS
HYDROGEN
RT HYDROGEN FLUORIDE

IGNITERS
BT EXPLOSIVES
RT *

IMPOUNDMENTS OF WATER
UF RESERVOIRS

INCENDIARY PROJECTILES
BT EXPLOSIVES
RT *

INCINERATORS
BT AIR POLLUTION SOURCES
WASTE DISPOSAL
NT CONICAL BURNERS
RT DUMPING GROUNDS
GARBAGE COLLECTION
JUNKYARDS
LANDFILLS
OPEN BURNING
OPEN DUMPING
TRANSFER STATIONS
WASTE PROCESSING
*

INDIRECT HEAT EXCHANGERS
USE HEAT EXCHANGERS

INDIRCT SOURCES
SN A COLLECTIVE TERM FOR BUILDINGS, FACILITIES, AND INSTALLATIONS, THE EXISTENCE OR USE OF WHICH LEADS TO AIR POLLUTANT EMISSIONS; E.G., SHOPPING CENTERS, AMUSEMENT AND RECREATION AREAS, PARKING LOTS, OFFICES.
BT AIR POLLUTION SOURCES
NT AIRPORTS
ROADS
RT *

INDUSTRIAL COOLING
BT AIR POLLUTION SOURCES
RT *

INDUSTRIAL WASTES
BT EFFLUENTS
NT PROCESS WASTE WATER
RT HAZARDOUS MATERIALS
SEWAGE

INITIATING EXPLOSIVES
BT EXPLOSIVES
RT *

INORGANIC COMPOUNDS
NT ACIDS
NITRIC ACID
SULFURIC ACID
AMMONIA
AMMONIA NITROGEN
BORON
CHLORINE

CYANIDES
FLUORIDES
HYDROGEN
HYDROGEN FLUORIDE
HYDROGEN SULFIDE
IRON
KAOLINITE
MICA
NITROGEN
NITRIC ACID
NITROGEN OXIDES
NITROGEN DIOXIDE
NONFERROUS METALS
ARSENIC
BARIUM
BERYLLIUM
CADMIUM
CHROMIUM
COPPER
LEAD
MANGANESE
MERCURY
NICKEL
SILVER
SODIUM
ZINC
PHOSPHORUS
SELENIUM
SILICATES
ASBESTOS
FELDSPARS
SULFUR
ALKYL BENZENE SULFONATES
SULFUR OXIDES
SULFUR DIOXIDE
SULFURIC ACID
RT CHEMICAL MANUFACTURING

INSECTICIDES
USE PESTICIDES

INTERNAL COMBUSTION ENGINES
BT AIR POLLUTION SOURCES
POWER SOURCES
POINT SOURCES
POWER SOURCES
NT DIESEL ENGINES
GASOLINE ENGINES
RT NUCLEAR ENERGY

STEAM GENERATING PLANTS
TURBINES
VEHICLES

IRON
BT INORGANIC COMPOUNDS
POINT SOURCES
RT FERROALLOYS
*

JET THRUST UNITS
BT EXPLOSIVES
RT *

JUNKYARDS
BT WASTE DISPOSAL
RT DUMPING GROUNDS
GARBAGE COLLECTION
INCINERATORS
LANDFILLS
OPEN BURNING
OPEN DUMPING
TRANSFER STATIONS
WASTE PROCESSING

KAOLINITE
BT INORGANIC COMPOUNDS
RT *

KEY LARGO CORAL REEF PRESERVE, FL

KWAJELEIN ATOLL

LAKES
NT LAKES, SPECIFIC
RT WATERWAYS

LAKES, SPECIFIC
SN A COLLECTIVE TERM FOR SPECIFIC LAKES WHICH HAVE BEEN TREATED INDIVIDUALLY IN THE REGULATIONS AND DATA BASE; NAMES OF LAKES ARE NOT LISTED IN THE THESAURUS.
BT LAKES

LAND ACQUISITION

LAND CLASSIFICATION
BT CLASSIFICATION
RT AIR QUALITY CLASSIFICATION

WATER QUALITY CLASSIFICATION

LAND PRESERVATION
RT FOREST PRESERVATION

LANDFILLS
SN SITES FOR DISPOSAL OF SOLID WASTES ON LAND BY COVERING; SITES OR DISPOSAL PROCEDURES USED ARE INADEQUATE FOR SANITARY DISPOSAL OF HAZARDOUS OR PUTRESCIBLE WASTES.
BT AIR POLLUTION SOURCES
WASTE DISPOSAL
NT SANITARY LANDFILL
RT DUMPING GROUNDS
GARBAGE COLLECTION
INCINERATORS
JUNKYARDS
OPEN BURNING
OPEN DUMPING
TRANSFER STATIONS
WASTE PROCESSING
*

LEAD
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS
RT *

LIQUID FUELS
BT FUELS
NT FUEL OIL
GASOLINE
RT COAL
COKE
OILS
WOOD

LONG ISLAND, NY

LOW EXPLOSIVES
BT EXPLOSIVES
RT *

LUMBER
SN WOOD USED AS A SOURCE OF BUILDING MATERIAL.

BT POINT SOURCES
RT PULP MILLS
WOOD
*

MANGANESE
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS
RT *

MANUFACTURING
BT AIR POLLUTION SOURCES
NT CHEMICAL MANUFACTURING
RT POINT SOURCES
*

MAXIMUM PERMISSIBLE CONCENTRATION
SN TERM USED ONLY FOR RADIATION STANDARDS.
BT RADIATION STANDARDS.
RT MAXIMUM PERMISSIBLE DOSE

MAXIMUM PERMISSIBLE DOSE
SN TERM USED ONLY FOR RADIATION STANDARDS.
BT RADIATION STANDARDS
RT MAXIMUM PERMISSIBLE CONCENTRATION

MEASUREMENTS
SN TERM FOR MEASUREMENTS OR MEASUREMENT METHODS
REQUIRED FOR A PARTICULAR POLLUTANT, EMISSION,
OR EFFLUENT.

MERCURY
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS
RT *

METHYLENE BLUE
BT ORGANIC COMPOUNDS
RT *

MICA

BT INORGANIC COMPOUNDS
RT *

MIDWAY ISLANDS

MISTS
BT AIRBORNE PARTICULATES
RT ASH
DUST
FUMES
SMOKE

MIXING ZONE
SN AN AREA OF WATER TO WHICH EFFLUENTS, INCLUDING HEAT, MAY BE DISCHARGED FOR DISPERSAL.
RT EFFLUENTS

MONITORING
NT STACK MONITORING

NICKEL
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS
RT *

NITRATES
RT NITRITES
NITROGEN

NITRIC ACID
BT INORGANIC COMPOUNDS
ACIDS
NITROGEN
RT NITROGEN OXIDES
SULFURIC ACID

NITRITES
RT NITRATES
NITROGEN

NITROGEN
BT INORGANIC COMPOUNDS
NT NITRIC ACID
NITROGEN OXIDES
NITROGEN DIOXIDE

RT NITRATES
NITRITES
*

NITROGEN DIOXIDE
BT INORGANIC COMPOUNDS
NITROGEN
NITROGEN OXIDES

NITROGEN OXIDES
BT INORGANIC COMPOUNDS
NITROGEN
NT NITROGEN DIOXIDE
RT NITRIC ACID
OXIDANTS

NOISE
NT NOISE CONTROL
NOISE LEVELS

NOISE CONTROL
BT NOISE
RT NOISE LEVELS

NOISE LEVELS
BT NOISE
RT NOISE CONTROL

NONEXPLOSIVE AMMUNITION
BT EXPLOSIVES
RT *

NONFERROUS METALS
BT AIR POLLUTION SOURCES
INORGANIC COMPOUNDS
POINT SOURCES
NT ARSENIC
BARIUM
BERYLLIUM
CADMIUM
CHROMIUM
COPPER
LEAD
MANGANESE
MERCURY
NICKEL
SILVER
SODIUM
ZINC

RT HAZARDOUS MATERIALS
SMELTERS
*

NUCLEAR ENERGY
BT AIR POLLUTION SOURCES
POWER SOURCES
POINT SOURCES
POWER SOURCES
RT INTERNAL COMBUSTION ENGINES
STEAM GENERATING PLANTS
TURBINES

ODORS

OIL SPILLS
BT ACCIDENTS
ORGANIC COMPOUNDS
OILS
RT DISPERSANTS
OIL STORAGE
OIL TRANSFER
SOLVENTS

OIL STORAGE
BT ORGANIC COMPOUNDS
OILS
STORAGE
RT OIL SPILLS
OIL TRANSFER

OIL TRANSFER
BT ORGANIC COMPOUNDS
OILS
RT OIL SPILLS
OIL STORAGE

OILS
BT ORGANIC COMPOUNDS
NT OIL SPILLS
OIL STORAGE
OIL TRANSFER
RT HAZARDOUS MATERIALS
LIQUID FUELS
PETROLEUM
REFINERIES
SALVAGE
*

OPACITY
RT AIRBORNE PARTICULATES

OPEN BURNING
BT AIR POLLUTION SOURCES
WASTE DISPOSAL
RT DUMPING GROUNDS
FIRES
GARBAGE COLLECTION
INCINERATORS
JUNKYARDS
LANDFILLS
OPEN DUMPING
TRANSFER STATIONS
WASTE PROCESSING
*

OPEN DUMPING
BT WASTE DISPOSAL
RT DUMPING GROUNDS
GARBAGE COLLECTION
INCINERATORS
JUNKYARDS
LANDFILLS
OPEN BURNING
TRANSFER STATIONS
WASTE PROCESSING

ORGANIC CARBON
UF TOC
TOTAL ORGANIC CARBON
BT ORGANIC COMPOUNDS
CARBON
RT CARBON MONOXIDE

ORGANIC COMPOUNDS
NT ALCOHOLS
ALDEHYDES
CARBON
CARBON MONOXIDE
ORGANIC CARBON
CCE
ETHYLENE
HYDROCARBONS
METHYLENE BLUE
OILS
OIL SPILLS
OIL STORAGE
OIL TRANSFER

PHENOLS
RT CHEMICAL MANUFACTURING

OXIDANTS
RT CARBON MONOXIDE
NITROGEN OXIDES
PHOTOCHEMICAL REACTIONS
SULFUR OXIDES

PACIFIC OCEAN
RT COASTS
SALINE WATER
WATERWAYS
WETLANDS

PACKAGING
RT CONTAINERS
EXPLOSIVES
RADIOACTIVE SUBSTANCES
STORAGE TANKS

PARTICULATES
USE AIRBORNE PARTICULATES

PERMITS
SN LICENSES REQUIRED FOR THE CONSTRUCTION OR OERATION OF A FACILITY OR THE PERFORMANCE OF SOME ACT.

PEST CONTROL
BT PESTS
RT HERBICIDES
PESTICIDES

PESTICIDES
UF ECONOMIC POISONS
INSECTICIDES
BT PESTS
RT AGRICULTURAL POLLUTION
HAZARDOUS MATERIALS
HERBICIDES
PEST CONTROL

PESTS
NT HERBICIDES
PEST CONTROL
PESTICIDES
RT WILDLIFE

PETROLEUM

UF CRUDE OIL
BT POINT SOURCES
RT COAL
COKE
OILS
REFINERIES
SALVAGE
*

PH
UF HYDROGEN ION CONCENTRATION
RT HYDROGEN

PHENOLS
BT ORGANIC COMPOUNDS
RT *

PHOSPHORUS
BT INORGANIC COMPOUNDS
RT *

PHOTOCHEMICAL REACTIONS
RT OXIDANTS

PLANT LIFE
USE FLORA

PLASTICS AND SYNTHETICS
UF SYNTHETICS
BT POINT SOURCES
NT VINYL CHLORIDES
RT *

POINT SOURCES
SN MANUFACTURING POINT SOURCE CATEGORY; PROCESSES AND SUBSTANCES CAUSING WATER POLLUTION, FOR WHICH THE FEDERAL GOVERNMENT HAS ESTABLISHED EFFLUENT STANDARDS.
NT ASBESTOS
BOILERS
CEMENT PLANTS
CHEMICAL MANUFACTURING
COATINGS
COKE OVENS
FEEDLOTS
FERROALLOYS
STEEL
FERTILIZERS
FURNACES

BLAST FURNACES
CUPOLAS
GRAIN HANDLING
IRON
LUMBER
NONFERROUS METALS
ARSENIC
BARIUM
BERYLLIUM
CADMIUM
CHROMIUM
COPPER
LEAD
MANGANESE
MERCURY
NICKEL
SILVER
SODIUM
ZINC
PETROLEUM
PLASTICS AND SYNTHETICS
VINYL CHLORIDES
POWER SOURCES
INTERNAL COMBUSTION ENGINES
DIESEL ENGINES
GASOLINE ENGINES
NUCLEAR ENERGY
STEAM GENERATING PLANTS
TURBINES
PULP MILLS
REFINERIES
RUBBER
SINTERING
RT EFFLUENTS
MANUFACTURING

POTABLE WATER
UF DRINKING WATER

POWER SOURCES
BT AIR POLLUTION SOURCES
POINT SOURCES
NT INTERNAL COMBUSTION ENGINES
DIESEL ENGINES
GASOLINE ENGINES
NUCLEAR ENERGY
STEAM GENERATING PLANTS
TURBINES
RT *

PROCESS WASTE WATER
BT EFFLUENTS
INDUSTRIAL WASTES

PROPELLANT EXPLOSIVES
BT EXPLOSIVES
RT *

PROTECTED SPECIES
NT ENDANGERED SPECIES
THREATENED SPECIES
RT AQUATIC LIFE
FLORA
WILDLIFE

PULP MILLS
BT AIR POLLUTION SOURCES
POINT SOURCES
RT LUMBER
WOOD
*

RADIATION SOURCES

RADIATION STANDARDS
NT MAXIMUM PERMISSIBLE CONCENTRATION
MAXIMUM PERMISSIBLE DOSE

RADIOACTIVE SUBSTANCES
RT HAZARDOUS MATERIALS
PACKAGING
STORAGE
TRANSPORTATION
WASTE DISPOSAL

RECORD KEEPING
SN REQUIRED RECORDING AND FILING OF DATA FOR POSSIBLE INSPECTION BY A SUPERVISING AGENCY.
RT REPORTING REQUIREMENTS

REFINERIES
BT POINT SOURCES
RT OILS
PETROLEUM
*

REFUSE
UF SOLID WASTE
RT WASTE DISPOSAL

RENDERING
RT AGRICULTURAL POLLUTION

REPORTING REQUIREMENTS
SN REQUIREMENTS THAT REPORTS BE FILED WITH A SUPERVISORY AGENCY, EITHER AS A PART OF NORMAL OPERATIONS OR AFTER AN ACCIDENT.
RT RECORD KEEPING

RESERVOIRS
USE IMPOUNDMENTS OF WATER

RIVERS
UF STREAMS
NT RIVERS, SPECIFIC
RT WATERWAYS

RIVERS, SPECIFIC
SN A COLLECTIVE KEYWORD FOR SPECIFIC RIVERS WHICH HAVE BEEN TREATED INDIVIDUALLY IN THE REGULATIONS AND DATA BASE; NAMES OF RIVERS ARE NOT LISTED IN THE THESAURUS.
BT RIVERS

ROADS
BT AIR POLLUTION SOURCES
INDIRECT SOURCES
RT AIRPORTS

ROCKET AMMUNITION
BT EXPLOSIVES
RT *

ROCKET MOTORS
BT EXPLOSIVES
RT *

RUBBER
BT POINT SOURCES
RT *

SALINE WATER
RT ATLANTIC OCEAN
COASTS
PACIFIC OCEAN
TIDAL WATER
WETLANDS

SALTS

SALVAGE
RT OILS
PETROLEUM

SANITARY LANDFILL
SN SITES FOR NONPOLLUTING DISPOSAL OF SOLID WASTES ON THE LAND, BY SPREADING WASTES IN LAYERS, COMPACTING THEM TO THE SMALLEST PRACTICAL VOLUME, AND COVERING THEM WITH SOIL DAILY.
BT AIR POLLUTION SOURCES
LANDFILLS
WASTE DISPOSAL
LANDFILLS

SCUM

SEAPORTS
RT BAYS
COASTS

SEDIMENTATION
RT DEPOSITION
EROSION
SETTLEABLE SOLIDS

SEDIMENTS
USE SETTLEABLE SOLIDS

SELENIUM
BT INORGANIC COMPOUNDS
RT *

SEPARATION PROCESSES
BT AIR POLLUTION SOURCES
RT *

SETTLEABLE SOLIDS
UF SEDIMENTS
RT DEPOSITION
DISSOLVED SOLIDS
EROSION
SEDIMENTATION
SUSPENDED SOLIDS

SEWAGE
BT EFFLUENTS
RT HAZARDOUS MATERIALS
INDUSTRIAL WASTES
SLUDGE

SEWAGE DISPOSAL
NT SEWER SYSTEMS
WATER TREATMENT WORKS

SEWER SYSTEMS
SN NETWORKS OF SEWER PIPES.
BT SEWAGE DISPOSAL
ER WATER TREATMENT WORKS

SHELLFISH
USE FISH

SILICATES
BT INORGANIC COMPOUNDS
NT ASBESTOS
FELDSPARS
RT *

SILVER
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS
RT *

SINTERING
BT AIR POLLUTION SOURCES
POINT SOURCES
RT *

SLUDGE
RT HAZARDOUS MATERIALS
SEWAGE

SMELTERS
BT AIR POLLUTION SOURCES
RT FERROALLOYS
NONFERROUS METALS
*

SMOKE
BT AIRBORNE PARTICULATES
RT ASH
DUST
FUMES
MISTS

SODIUM
BT AIR POLLUTION SOURCES
NONFERROUS METALS
INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS

SOLID WASTE
USE REFUSE
SOLVENTS
RT DISPERSANTS
HAZARDOUS MATERIALS
OIL SPILLS

SPRAYING
BT AIR POLLUTION SOURCES
RT COATINGS
*

STACK MONITORING
SN CONTINUOUS MEASUREMENT OF STACK EMISSIONS.
BT MONITORING
RT STACK TESTS

STACK TESTS
SN OCCASIONAL MEASUREMENTS OF STACK EMISSIONS.
BT TESTS
RT STACK MONITORING

STARTER CARTRIDGES
BT EXPLOSIVES
RT *

STEAM GENERATING PLANTS
BT AIR POLLUTION SOURCES
POWER SOURCES
POINT SOURCES
POWER SOURCES
RT INTERNAL COMBUSTION ENGINES
NUCLEAR ENERGY
TURBINES

STEEL
BT AIR POLLUTION SOURCES
FERROALLOYS
POINT SOURCES
FERROALLOYS

STOCKPILES
SN SUPPLIES OF MATERIALS STORED IN THE OPEN, WHICH COULD CAUSE FUGITIVE DUST.
BT AIR POLLUTION SOURCES
RT *

STORAGE
NT OIL STORAGE
RT EXPLOSIVES
RADIOACTIVE SUBSTANCES

STORAGE TANKS
RT CONTAINERS
PACKAGING

STREAMS
USE RIVERS

SULFATES
RT SULFUR

SULFITES
RT SULFUR

SULFUR
BT INORGANIC COMPOUNDS
NT ALKYL BENZENE SULFONATES
SULFUR OXIDES
SULFUR DIOXIDE
SULFURIC ACID
RT SULFATES
SULFITES
.
*

SULFUR DIOXIDE
BT INORGANIC COMPOUNDS
SULFUR
SULFUR OXIDES

SULFUR OXIDES
BT INORGANIC COMPOUNDS
SULFUR
NT SULFUR DIOXIDE
RT ALKYL BENZENE SULFONATES
OXIDANTS
SULFURIC ACID

SULFURIC ACID

BT INORGANIC COMPOUNDS
ACIDS
SULFUR
RT ALKYL BENZENE SULFONATES
NITRIC ACID
SULFUR OXIDES

SUSPENDED SOLIDS
RT DISSOLVED SOLIDS
SETTLEABLE SOLIDS

SYNTHETICS
USE PLASTICS AND SYNTHETICS

TASTE

TEMPERATURE
RT THERMAL POLLUTION

TESTS
NT STACK TESTS

THERMAL POLLUTION
RT EFFLUENTS
TEMPERATURE

THREATENED SPECIES
BT PROTECTED SPECIES
RT ENDANGERED SPECIES

TIDAL WATER
SN WATER AFFECTED BY THE TIDES; WATERS ARE OF VARYING SALINITY.
NT ESTUARIES
RT COASTS
SALINE WATER
WETLANDS

TOC
USE ORGANIC CARBON

TOTAL ORGANIC CARBON
USE ORGANIC CARBON

TOXIC SUBSTANCES
SN TERM USED IF A SPECIFIC TOXIC SUBSTANCE IS NOT LISTED IN THE ABSTRACT AND/OR THESAURUS.
RT HAZARDOUS MATERIALS

TRANSFER STATIONS
SN SUPPLEMENTAL TRANSPORTATION FACILITIES USED TO TRANSFER SOLID WASTES FROM SMALL VEHICLES TO LARGER ONES.
BT WASTE DISPOSAL
RT DUMPING GROUNDS
GARBAGE COLLECTION
INCINERATORS
JUNKYARDS
LANDFILLS
OPEN BURNING
OPEN DUMPING
WASTE PROCESSING

TRANSPORTATION
RT EXPLOSIVES
RADIOACTIVE SUBSTANCES

TURBIDITY

TURBINES
BT AIR POLLUTION SOURCES
POWER SOURCES
POINT SOURCES
POWER SOURCES
RT INTERNAL COMBUSTION ENGINES
NUCLEAR ENERGY
STEAM GENERATING PLANTS

URBAN AREAS
UF CITIES
NT URBAN AREAS, SPECIFIC

URBAN AREAS, SPECIFIC
SN A COLLECTIVE KEYWORD FOR SPECIFIC URBAN AREAS WHICH HAVE BEEN TREATED INDIVIDUALLY IN THE REGULATIONS AND DATA BASE; NAMES OF CITIES ARE NOT LISTED IN THE THESAURUS.
UF CITIES
BT URBAN AREAS

VARIANCE
SN LICENSE TO ENGAGE IN AN ACT CONTRARY TO THE RULE.

VEHICLES
BT AIR POLLUTION SOURCES
RT AIRCRAFT
INTERNAL COMBUSTION ENGINES
WATERCRAFT

*

VINYL CHLORIDES
BT CHLORIDES
POINT SOURCES
PLASTICS AND SYNTHETICS

VOLATILE SUBSTANCES
RT HAZARDOUS SUBSTANCES

WAKE ISLAND

WASTE DISPOSAL
NT DUMPING GROUNDS
GARBAGE COLLECTION
INCINERATORS
CONICAL BURNERS
JUNKYARDS
LANDFILLS
SANITARY LANDFILL
OPEN BURNING
OPEN DUMPING
TRANSFER STATIONS
WASTE PROCESSING
RT RADIOACTIVE SUBSTANCES
REFUSE

WASTE PROCESSING
SN REFUSE TREATMENT METHODS, INCLUDING SHREDDING, BALING, RECYCLING, AND COMPOSTING.
BT WASTE DISPOSAL
RT DUMPING GROUNDS
GARBAGE COLLECTION
INCINERATORS
JUNKYARDS
LANDFILLS
OPEN BURNING
OPEN DUMPING
TRANSFER STATIONS

WATER POLLUTION CONTROL
SN DEVICE OR PROCEDURE USED TO LIMIT THE RELEASE OF EFFLUENTS INTO THE WATER.

WATER QUALITY CLASSIFICATION
BT CLASSIFICATION
RT AIR QUALITY CLASSIFICATION
LAND CLASSIFICATION

WATER QUALITY STANDARDS
RT EFFLUENT STANDARDS

WATER RIGHTS
SN THE RIGHT TO DRAW WATER FROM A SOURCE, INCLUDING GROUNDWATER SOURCES.

WATER TREATMENT WORKS
SN SEWAGE TREATMENT FACILITIES.
BT SEWAGE DISPOSAL
RT SEWER SYSTEMS

WATERCRAFT
RT AIRCRAFT
VEHICLES

WATERWAYS
SN BODIES OF WATER USED FOR WATERCRAFT NAVIGATION.
RT ATLANTIC OCEAN
CHANNELS
LAKES
PACIFIC OCEAN
RIVERS

WETLANDS
RT ATLANTIC OCEAN
COASTS
PACIFIC OCEAN
SALINE WATER
TIDAL WATER

WILDLIFE
RT AQUATIC LIFE
FLORA
PESTS
PROTECTED SPECIES

WOOD
BT FUELS
RT COAL
COKE
FOREST PRESERVATION
LIQUID FUELS
LUMBER
PULP MILLS

ZINC
BT AIR POLLUTION SOURCES
NONFERROUS METALS

INORGANIC COMPOUNDS
NONFERROUS METALS
POINT SOURCES
NONFERROUS METALS
RT *

* CHECK THE BROADER TERMS FOR A LIST OF POTENTIALLY RELATED TERMS

Appendix C - Source Code and Subroutines

```
/*                      R E P A I R

        Repair updates the laws.toc file for CELDS, creates and/or  adds
to  the  isol  files, and performs minor error checking functions on the
laws files.

Arguments:      -               if isol files are to be created
                <fnames>        for laws files to be repaired
                                (any number of laws files may be named)

Main variables:
        acc:            current accession number
        agy:            file descriptor of agy.isol file
        argc:           number of arguments with procedure was called
        argnum:         argument number of file undergoing repair
        argstart:       argument number of first file to undergo repair
        argv            array of pointers to arguments
        att             file descriptor of att.isol file
        bf              buffer for reading from laws file
        card            copy of line read from laws file
        ch_this_fil:    running total of characters read from laws file
        chars:          number of chars read by current read
        data:           file descriptor of file undergoing repair
        gps:            file descriptor of gps.isol file
        installing:     a flag set to 1 if toc file is to be modified,
                        otherwise set to 0.
        iobuf:          buffer used to read records from the laws files
        isols:          a flag set to 1 if isol files are to be
                        produced, otherwise set to 0.
        top:            file descriptor of top.isol file
        mec:            file descriptor of mec.isol file
        p:              pointer into read buffer (bf)
        prev_acc:               previous accession number
        prev_stop:              previous stop code
        prev_type:              previous field number
        q:              pointer into copy of line read (card)
        stop:           current stop code
        toc:            file descriptor of laws.toc file
        type:           current field number
        type_start:             record to be written into laws.toc file
*/

main(argc,argv) int argc; char *argv[];
{
/* Declaration of variables */
        char bf[82], card[82], *ch_this_fil, iobuf[530];
        int acc, agy, argnum, argstart, att, chars, data, gps,
            installing, isols, top, mec, prev_acc, prev_stop,
            prev_type, stop, toc, type, type_start[13];
        register char *p, *q;
```

```
/* Check for proper calling of repair */
        if (argc < 2) { printf("USAGE: repair <lawsfile>\n"); return; }


toc = open("laws.toc",1);
/* If toc file doesn't exist, then turn installing off.  This
        means that repair is being used only for error-checking. */
        if (toc < 0) installing = 0;
        else installing = 1;

/* Set isols flag */
        isols = (*argv[1] == '-' ? 1:0);

if (isols)
        {
        mec = open("mec.isol",1);
        if (mec < 0)
                /* create all of the isol files */
                {
                mec = creat("mec.isol",0666);
                if (mec < 0) {perror("creating isol files"); return;}
                gps = creat("gps.isol",0666);
                agy = creat("agy.isol",0666);
                att = creat("att.isol",0666);
                top = creat("top.isol",0666);
                }
        else
        /* Files already exist, append to end */
                {
                seek(mec,0,2);
                gps = open("gps.isol",1);
                seek(gps,0,2);
                agy = open("agy.isol",1);
                seek(agy,0,2);
                att = open("att.isol",1);
                seek(att,0,2);
                top = open("top.isol",1);
                seek(top,0,2);
                }
        }

/* Set argstart to argument number of first file */
        argstart = (isols ? 2:1);

/* Now, loop for each file to be repaired (up to argc) */
for (argnum = argstart; argnum < argc; argnum++)
    {
        /* Open laws file to be repaired */
                data = gopen(argv[argnum],&iobuf);
                if (data < 0) {perror("repair"); return;}
                printf("repairing %s\n",argv[argnum]);
```

```
/* Initialize parameters */
p = argv[argnum] + 5;
type_start[0] = atoi(p);
prev_stop = 2;
prev_type = 12;
prev_acc = type_start[0];
ch_this_fil = 0;

/* Now, read and check data until entire file has been read */
do
{
/* Read 1 line from file into bf */
        chars = ggets(bf,&iobuf);

/* Set pointers, p and q */
        p = &bf[0];
        q = &card[0];

/* Copy bf into card */
        while (*q++ = *p++);

/* Convert stop code, field number, and acc number to integer */
        bf[10] = 0;
        stop = atoi(&bf[8]);
        bf[8] = 0;
        type = atoi(&bf[5]);
        bf[5] = 0;
        acc = atoi(&bf[0]);

if (acc != prev_acc || chars <= 0)
/* Then this is either a new law or an error */
        {
        if (acc < prev_acc && chars > 0) printf("bad acc :%s\n",card);
        if (installing)
                {
                lseek(toc, (prev_acc * 26.0));
                write(toc,type_start,26);
                }
        }

/* Check for end of file */
        if (chars <= 0) break;

if (type != prev_type)
/* Then this is a new field (and maybe a new law) */
        {
        if (type != (prev_type + 1) && type != 1)
                printf("bad type:%s\n",card);
        if (type == 1 && (prev_stop != 2 || prev_type != 12))
                printf("bad fld1:%s\n",card);
        if (stop == 2 && type != 12)
```

```
                printf("bad stop:%s\n",card);
            if (prev_stop < 1) printf("bad stop:%s\n",card);
            if (type >= 1 && type <= 12) type_start[type] = ch_this_fil;
                else printf("bad type:%s\n",card);
            }

        if (isols)
        /* Then add to isol files */
            {
            /* Replace nul at end of card with a newline */
                card[chars - 1] = 012;

            switch(type)
                {
                case 5:  write(mec,card,chars); break;
                case 6:  write(gps,card,chars); break;
                case 7:  if (type != prev_type)
                  .          write(agy,card,chars); break;..
                case 11: write(att,card,chars); break;
                case 12: write(top,card,chars); break;
                default: break;
                }
            }

        /* Change this card to previous card */
            prev_stop = stop;
            prev_type = type;
            prev_acc = acc;

        /* Add characters read to running total */
            ch_this_fil =+ chars;

        } while (chars > 0);

    /* Close laws file */
        close(data);
    }

/* Close all open files */
        if (installing) close(toc);
        if (isols)
            {
            close(mec);
            close(gps);
            close(agy);
            close(att);
            close(top);
            }
}
```

Appendix D - The Make_Search Subroutine

```
#
/*                      M A K E _ S E A R C H

        Make_search takes an "alpha" file for a given field and  creates
the search file for that field.

Arguments:      mec, gps, agy, key, or att

Main variables:
        alpha:          file descriptor for alpha file
        bf:             buffer used for reading from alpha file
        collisions:     total number of hash collisions
        eof:            end-of-file indicator
        first_hash:     actual hash number for value
        hash_num:       hash number incremented to avoid collision
        hash_table:     array, 4011 long
        i:              counter
        iobuf:          structure used for reading from alpha file.
                        it is of the shape required by ggets.
                        the ggets routines are the only ones that
                        touch these variables.
        laws:           count of laws with the current value
        list_file:      file descriptor for list file
        loc_in_laws_list:       start of current law list in list file
        old_value:      copy of last value read
        p:              pointer into bf
        q:              pointer into old_value
        v:              structure of shape val_record
        val_file:       file descriptor for val file
        value_num:
*/

#include "search.i"

main(argc,argv) int argc; char *argv[];
{
/* Declaration of variables */
        char bf[122], old_value[64], *p, *q;
        int alpha, collisions, eof, first_hash, hash_num,
                hash_table[hash_size], i, law[2000], laws, list_file,
                loc_in_laws_list, val_file, value_num;
        struct iostru   {
                int gfildes;
                char *gnextp;
                char *gstop;
                int geof;
                char gdbuf[513];
                } iobuf;
        struct val_record v;

/* Check for proper calling of make_search */
```

```
        if (argc != 2)
                {
                printf("USAGE: make_search <field_name>\n");
                return;
                }

printf("making search file for field %s\n",argv[1]);

concat(argv[1],".alpha",bf);
/* Open appropriate alpha file */
        alpha = gopen(bf,&iobuf);
        if (alpha < 0) {perror("mksrch(oal)"); return;}

concat(argv[1],".val",bf);
/* Create appropriate val file */
        val_file = creat(bf,0666);
        if (val_file < 0) {perror("mksrch(cva)"); return;}

concat(argv[1],".list",bf);
/* Open appropriate list file */
        list_file = creat(bf,0666);
        if (list_file < 0) {perror("mksrch(cli)"); return;}

/* Zero out hash table and save room in val file */
        for (i = 0; i < hash_size; i++) hash_table[i] = 0;
        write(val_file,hash_table, hash_size * 2);

/* Initialize counters */
        value_num = 0;
        collisions = 0;
        loc_in_laws_list = 0;

/* Read first line from alpha into bf */
        eof = ggets(bf,&iobuf);
        if (eof <= 0) {perror("mksrch(ral)"); return;}

/* Now, repeat until end-of-file is reached */
while (eof > 0)
        {
        /* copy the value into old_value */
                p = &bf[10];
                q = old_value;
                while(*q++ = *p++);

        /* Zero out the unused part of val_record */
                while (q < &old_value[63]) *q++ = 0;

        /* Initialize laws counter */
        laws = 0;

        /* Repeat as long as value remains the same */
```

```
while (eof > 0 && compar(&bf[10],old_value) == 0)
        {
        /* Convert accession number to integer and put in laws */
                bf[5] = 0;
                law[laws++] = atoi(&bf[0]);

        /* Read the next record */
                eof = ggets(bf,&iobuf);
        }

/* Mark end of law list with 19999 */
        law[laws++] = 19999;

/* Write list of laws into list file */
        write(list_file,law, laws << 1);

/* Compute hash number */
        hash_num = hash(old_value) % max_hash_num;
        first_hash = hash_num;

/* Add 1 as long as this hash_num already exists */
        while(hash_table[hash_num] != 0)
                {
                collisions++;
                hash_num++;
                }

/* Print message for collisions */
 if (first_hash != hash_num)
        printf("slide %d to %d\n",first_hash,hash_num);.

/* Put value_num into slot in the hash table */
        hash_table[hash_num] = ++value_num;

/* Print insertion message */
        printf("%5d at %5d:%s\n",laws,hash_num,old_value);

/* Copy this value into val_record array */
        p = old_value;
        q = v.value;
        while (p < &old_value[63]) *q++ = *p++;

/* Set first_law to beginning of law list */
        v.first_law = loc_in_laws_list;

/* Write val_record into val file */
        write(val_file,&v,64);

/* Adjust loc_in_laws_list */
        loc_in_laws_list =+ laws;
```

AD-A061 158 CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAI--ETC F/G 5/2
SYSTEM DOCUMENTATION FOR COMPUTER-AIDED ENVIRONMENTAL LEGISLATI--ETC(U)
SEP 78 R L WELSH

UNCLASSIFIED CERL-SR-N-31 NL

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```
        }

/* Go to beginning of file and write hash table */
        seek(val_file, 0, 0);
        write(val_file,hash_table,hash_size * 2);

/* Close all open files */
        close(alpha);
        close(list_file);
        close(val_file);

/* Print out total statistics */
        printf(" total collisions = %d\n",collisions);
        printf(" unique values = %d\n",value_num);
        printf(" last list word = %d\n",loc_in_laws_list);
}
```

Appendix E - The Hier Subroutine

```
#
/*                      H I E R

        Hier put in the hierarchy of terms for CELDS.  It reads the file
"key.hier" and constructs the hierarchical terms.
*/
#include "search.i"
/* Global variables */
        int loc_in_law_list, val_num;
        int hash_table[hash_size];
        int data, list, nlist, nval, val;
        char iobuf[600];
        struct val_record v;

main()
{
/* Declaration of variables */
        int i, first, flag, new[max_laws], old[max_laws];
        int *o, *n;
        char *p, *r, rvalue[63];
        char *q;

        debugging = 0;
/* Open files */
        data = gopen("/cerl/celds/key.hier",iobuf);
        if(data<0){perror("open(key.hier)");return;}
        list = open("/cerl/celds/top.list",0);
        if(list<0){perror("open(top.list");return;};
        val = open("/cerl/celds/top.val",0);
        if(val<=0){perror("open(top.val)");return;}
if (debugging) printf("Files are open\n");

/* Create new files */
        nval = creat("/cerl/celds/key.val",0644);
        if(nval <= 0){perror("creat(key.val)");return;}
        nlist = creat("/cerl/celds/key.list",0644);
        if(nlist <= 0){perror("creat(key.list)");return;}
if(debugging)printf("Files are created\n");

/* Zero out hash table and write it */
        for (i=0; i<hash_size; i++) hash_table[i] = 0;
        write(nval,hash_table,hash_size*2);
        val_num = 0;
        loc_in_law_list = 0;
        old[0] = 0;

/* Now we're all set to begin */

first = 1;
while(ggets(rvalue,&iobuf))
        {
```

```
        r = rvalue;
        if (*r == '^')
                {
                terminate(old);
                /* Zero out v.value */
                        for (i=0; i<62; i++) v.value[i] = 0;

                /* Fill "old" array */
                        fill(old,&rvalue[1]);

                /* Fill v.value with this term */
                        p = &v.value;
                        r = &rvalue[1];
                        while(*p++ = *r++);
                        first = 0;
                }
        else
                {
                flag = fill(new,&rvalue[0]);
                if (flag > 0) or(old,new);
                }
        }
terminate(&old);
/* Put final write here */
close(val); close(list); close(nval); close(nlist);
nval = open("/cerl/celds/key.val",0644);
write(nval,hash_table,hash_size*2);
close(nval);
}
/**/
terminate(old)  int old[];
{
/* Declaration of variables */
        int hash_num, i, *p;

/* Check for nul list */
        if(old[0] == 0 || old[0] == 19999) return;

/* Find slot in val_file */
        hash_num = hash(v.value) % max_hash_num;
if(debugging)printf("   %s hashes to %d\n",v.value,hash_num);
        while (hash_table[hash_num] != 0) hash_num++;

/* Put val_location into hash table */
        hash_table[hash_num] = ++val_num;

/* Write val_record onto file */
        v.first_law = loc_in_law_list;
        write(nval,&v,64);

/* Now do the list file */
```

```
        p = old;
        i = 0;
        while (*p++ < 19999) i++;
        i++;
        write(nlist,old,i*2);
        loc_in_law_list =+ i;
        printf("%5d inserted at %d for %s\n",i-1,hash_num,v.value);
        return;
}
/**/
int fill(laws,rvalue)   int laws[]; char *rvalue;
{
int number;
/* Declaration of variables */
        int bf[100], hash_num, *r, seek_location, wrong;
        struct val_record x;

/* Calculate hash number */
        hash_num = hash(rvalue) % max_hash_num;
/* Seek to proper slot in hash table -- each hash_num takes 2 bytes */
        seek_location = hash_num * 2;
        seek(val,seek_location,0);

/* Read from val file */
        read(val,bf,200);

/* Point r to beginning of record read */
        r = &bf[0];

/* Initialize wrong to be true */
        wrong = 1;

while (*r)
/* If *r is zero, then this hash number contains a zero in the table */
        {
        /* Locate record with this hash number */
                seek_location = ((*r * 64) + val_table_start);
                seek(val,seek_location,0);
                read(val,&x,64);

        /* Compare fvalue with the value in the val file */
                wrong = compar(x.value,rvalue);
        if(debugging)printf("compar %s to %s\n",x.value,rvalue);

        /* If wrong is zero, we found fvalue */
                if (wrong == 0) break;

        r++;
        }
if (wrong != 0)
        {
```

```
        printf("WARNING:  %s -- no laws found\n",rvalue);
        return(-1);
        }
/* Calculate location */
        seek_location = x.first_law * 2;
        seek (list,seek_location,0);
        read(list,laws,max_laws);
        return;
}
/**/
int or(old,new) int old[], new[];
{
int result[2*max_laws];
int chars;
register int *r, *s, *t;

r = old;
s = new;
t = &result[0] - 1;
do
        {
        if (*r < *s) *++t = *r++; else
                {if (*r == *s) r++;
                 *++t = *s++;}
        } while (*t < 19999);

chars = (t - &result[0]) << 1;
if (chars > lawset_size)
        {
        printf("lawset size exceeds %d laws\n",(max_laws -1));
        printf("only the first %d laws will be used\n",(max_laws -1));
        t = &result[max_laws];
        *t = 19999;
        }
t = &result[0];
r = old;
while (*t < 19999) *r++ = *t++;
*r = *t;
return;
}
```

Appendix F - The Push File

```
:                                   P U S H
:
: Enter start date and time
date
: Remove all old isol files
rm *.isol
: Repair all files -- being careful not to have arg list too long
/cerl/programs/celds/push_progs/obj/repair - laws.? laws.?? laws.[123456789]??
/cerl/programs/celds/push_progs/obj/repair - laws.1???
/cerl/programs/celds/push_progs/obj/repair - laws.2[01234]??
/cerl/programs/celds/push_progs/obj/repair - laws.2[56789]??
: Sort isol files into alpha files and execute make_search
sort +0.10 +0.0 -0.5 mec.isol -o mec.alpha
/cerl/programs/celds/push_progs/obj/make_search mec
sort +0.10 +0.0 -0.5 gps.isol -o gps.alpha

/cerl/programs/celds/push_progs/obj/make_search gps
sort +0.10 +0.0 -0.5 agy.isol -o agy.alpha

/cerl/programs/celds/push_progs/obj/make_search agy
sort +0.10 +0.0 -0.5 att.isol -o att.alpha

/cerl/programs/celds/push_progs/obj/make_search att
sort +0.10 +0.0 -0.5 top.isol -o top.alpha

/cerl/programs/celds/push_programs/obj/make_search top
: Get rid of all alpha files
rm *.alpha
/cerl/programs/celds/push_progs/hier
: Include finish date and time
date
```

Appendix G - The Retriever Subroutines

```
#
/*                      C E L D S

        Celds is the retrieval program for the celds system.

Arguments:      -       if celds is executed with a "-" argument,
                        then on termination, "etis -" is executed.
                        This is the case when celds is entered
                        from etis.

Global variables:
        client:                 user id for the person using celds
        debugging:              flag set to 1 for debugging program.
                                this causes parameters to be printed.
        field_is_searchable:    array indicating which of fields 1 to 13
                                are searchable
        fld_name:               alphabetic identifier for field
        old_req_location:       pointer to previous position in
                                request array
        punctuation:            array indicating which ASCII are
                                recognized punctuation
        reading_commands:       1 until user asks to leave celds, then 0
        req_location:           pointer to current position in request
        request:                the array containing the current line of
                                user input
        requests:               total number of celds commands
        temp_file_name:         array of scratch file names
        word:                   the array containing the current word, null term

Main variables:
        i:      counter
        p:      pointer into punctuation array
*/

#include "search.i"

main(argc,argv) int argc; char *argv[];
{
/* Declaration of variables */
        char *p;
        int i;

/* Set a trap for break */
        signal(2,1);
/* Print hail message */
        write(2,"\nWelcome to CELDS\n\n\n",20);
        message();

/* Zero out punctuation array */
        p = &punctuation[0];
        for (i = 0; i < 128; i++) *p++ = 0;
```

```
/* Fill in only recognized punctuation */
        punctuation[0] = 1;
        punctuation['&' & 0177] = 1;
        punctuation['|' & 0177] = 1;
        punctuation[',' & 0177] = 1;
        punctuation['"' & 0177] = 1;
        punctuation['(' & 0177] = 1;
        punctuation[')' & 0177] = 1;
        punctuation[' ' & 0177] = 1;

/* Fill in field name abbreviations */
        fld_name[1] = "acc";
        fld_name[2] = "ttl";
        fld_name[3] = "dat";
        fld_name[4] = "ref";
        fld_name[5] = "mec";
        fld_name[6] = "gps";
        fld_name[7] = "agy";
        fld_name[8] = "bib";
        fld_name[9] = "abs";
        fld_name[10] = "tbl";
        fld_name[11] = "att";
        fld_name[12] = "top";
        fld_name[13] = "key";

/* Set flags for searchable fields */
        field_is_searchable[0] = 0;
        field_is_searchable[1] = 1;
        field_is_searchable[2] = 0;
        field_is_searchable[3] = 0;
        field_is_searchable[4] = 0;
        field_is_searchable[5] = 1;
        field_is_searchable[6] = 1;
        field_is_searchable[7] = 1;
        field_is_searchable[8] = 0;
        field_is_searchable[9] = 0;
        field_is_searchable[10] = 0;
        field_is_searchable[11] = 1;
        field_is_searchable[12] = 1;
        field_is_searchable[13] = 1;

/* Initialize everything */
        old_req_location = request;
        req_location = request;
        request[0] = 0;
        word[0] = 0;
        requests = 0;

/* Turn debugging off */
        debugging = 0;
```

```
/* Get user id and put it into client */
        client = getuid() & 0377;


/* Execute this loop until user ends celds session */
do
        {
        /* Initialize temp_file name to "celds_tempa" */
                concat("celds_temp","a",temp_file_name);

        /* Set trap for quit */
                signal(2,1);

        /* Set reading_commands to true */
                reading_commands = 1;

        /* Get the next command */
                command();

        /* Increment number of requests */
                requests++;
        }       while (reading_commands);

/* Remove all of the temp files */
        concat("celds_temp","a",temp_file_name);
        while (temp_file_name[10] < 'k')
                {
                unlink(temp_file_name);
                temp_file_name[10] =+ 1;
                }
        unlink("current_laws");
        unlink("previous_laws");

/* Print out summary statistics */
/* Print farewell */
        printf("Good bye from CELDS\n");

/* Check whether to execute etis */
        if (compar(argv[1],"-") == 0) execl("/cerl/etis","etis","-",0);
}
```

```
#
#include "search.i"
/*                      A B O R T E R

        Aborter is the interrupt procedure that gets called when the
rubout, del, or break key is pressed. This procedure is only active
during list, print, and show verbs. At all other times, those keys are
ignored.

Global variables:       (see list for expr.c)
        reading_commands:       aborter modifies "reading_commands"
*/

int *aborter(){
reading_commands = 2;
signal(2,aborter);
return;

}
```

```
#
#include "search.i"
/*                              A N D

        And takes two lists of law numbers and logically "ands"
the two into a third list, i.e. it saves law numbers that occur
in both lists.

Arguments       first           file descriptor of file containing
                                first list of law numbers
                second          file descriptor of file containing
                                second list of law numbers

Returns         fil             file descriptor of file containing
                                the "anded" list

And variables:
        bf1:            buffer for first list
        bf2:            buffer for second list
        chars:          number characters written into result
        chars1:         number characters read into bf1
        chars2:         number characters read into bf2
        fil:            file descriptor of resultant list
        r:              pointer to result
        result:         buffer for resultant list
        s:              pointer to bf1
        t:              pointer to bf2
*/

int and(first,second) int first,second;
{
/* Declaration of variables */
        int bf1[max_laws], bf2[max_laws], chars, chars1, chars2, fil,
                result[max_laws];
        register int *r,*s,*t;

/* Fill bf1 and bf2 with law sets */
        chars1 = read(first,bf1,lawset_size);
        chars2 = read(second,bf2,lawset_size);

/* Guarantee that there is a 19999 at end (paranoia) */
        bf1[chars1 / 2] = 19999;
        bf2[chars2 / 2] = 19999;

/* Set up pointers */
        r = bf1;
        s = bf2;
        t = &result[0];

/* Since t gets pre-incremented the first one will be skipped */
        *t = 0;
```

```
do      {
        if (*r < *s) r++;
        else
                {
                if (*r == *s) *++t = *r++;
                s++;
                }
        } while (*t < 19999);

/* Calculate number of characters in result */
        chars = (t - &result[0]) << 1;

/* Create file to write result into */
        fil = creat(temp_file_name,0666);
        if (fil < 0) {perror("bool(c)"); return(fil);}

/* Write result beginning with result[1] since [0] is skipped */
        write(fil,&result[1],chars);

/* Position fil at beginning of file (by closing, then opening) */
        close(fil);
        fil = open(temp_file_name,0);

/* Increment temp_file_name[10] since we just made a file */
        temp_file_name[10] =+ 1;

/* Close first and second files */
        close(first);
        close(second);

return(fil);
}
```

```
#
#include "search.i"
/*                      C O M M A N D

        Command parses the command line to find the verb. Any word that
is not a verb is taken to be a request to create a new file
by that name.

Arguments       none

Command variables:
        eof:            end of file indicator
        laws:           number of laws in list
        new:            file descriptor of new file
        old:            file descriptor of old file
        time_vector:    random number used for insuring uniqueness
                        of job numbers for batch print requests
*/

command()
{
/* Declaration of variables */
        char set_name[62];
        int eof, laws, new, old, time_vector[2];

if (word[0] == 0)
/* Then no words are waiting */
        {
        eof = get_next_word("What next?:");
        if (eof == 0)
        /* Then cntrl-d was typed */
                {
                reading_commands = 0;
                return;
                }
        }

/* Echo command line if debugging is turned on */
        if (debugging) printf("Command: '%s'\n",word);

/* Now, begin compares to find out what command this is */
if (compar(word,"find") == 0 || compar(word,"for") == 0 ||
    compar(word,"get") == 0)
        {
/* Then this is a new search command */
        get_next_word("Search criterion?:");
        old = expression();
        if (old < 0) return;
        laws = copy_list(old,"current_laws",1);
        close(old);
        printf("%5d laws found\n",laws);
```

```
        return;
        }
/* ---- "and" command ---- */
if (compar(word,"and") == 0)
        {
        new = open("current_laws",0);
        if (new < 0)
                {
                reject_this_word("no laws selected");
                return;
                }
        get_next_word("And what?:");
        old = expression();
        if (old < 0) {close(new); return;}
        old = and(old,new);
        laws = copy_list(old,"current_laws",1);
        close(old);
        printf("%5d laws remain\n",laws);
        return;
        }

/* ---- "or" command ---- */
if (compar(word,"or") == 0)
        {
        new = open("current_laws",0);
        if (new < 0) {reject_this_word("no laws selected"); return;}
        get_next_word("Or what?:");
        old = expression();
        if (old < 0) {close(new); return;}
        old = or(old,new);
        laws = copy_list(old,"current_laws",1);
        close(old);
        printf("%5d laws now selected\n",laws);
        return;
        }

/* ---- "except" command ---- */
if (compar(word,"except") == 0)
        {
        new = open("current_laws",0);
        if (new < 0) {reject_this_word("no laws selected"); return;}
        get_next_word("Except what?:");
        old = expression();
        if (old < 0) {close(new); return;}
        old = except(new,old);
        laws = copy_list(old,"current_laws",1);
        close(old);
        printf("%5d laws remain\n",laws);
        return;
        }
```

```
/* ---- "show" command ---- */
if (compar(word,"show") == 0) {show(); return;}

/* ---- "suggest" command ---- */
if (compar(word,"suggest") == 0)
        {
        printf("\nType comment (end with cntrl-d):\n\n");
        execute("mail welsh");
        printf("\n");
        get_next_word("");
        return;
        }

/* ---- "remove" command ---- */
if (compar(word,"remove") == 0 || compar(word,"delete") == 0)
        {
        get_next_word("Set names to delete?:");
        while(word[0])
                {
                /* open it only to see if it exists */
                concat("_",word,set_name);
                old = open(set_name,0);
                if (old < 0)
                        {
                        printf("%s: no such set, unable to delete\n",word);
                        }
                        else
                        {
                        close(old);
                        unlink(set_name);
                        printf("%s: deleted\n",word);
                        }
                get_next_word("");
                if (compar(word,",") == 0) get_next_word("More set names?:");
                if (compar(word,"and") == 0) get_next_word("More set names?:");
                }
        return;
        }

/* ---- "save" command ---- */
if (compar(word,"save") == 0)
        {
        old = open("current_laws",0);
        if (old < 0)
                {
                reject_this_word("no laws selected");
                return;
                }
        get_next_word("New lawset name?:");
        if (compar(word,"abort") == 0)
                {
```

```
                reject_this_word("lawset not saved");
                return;
                }
        concat("_",word,set_name);
        laws = copy_list(old,set_name,0);
        close(old);
        printf("%5d laws saved\n",laws);
        get_next_word("");
        return;
        }

/* ---- "make" command ---- */
if (compar(word,"make") == 0 || compar(word,"set") == 0)
        {
        get_next_word("New lawset name?:");
        if (compar(word,"abort") == 0)
                {
                reject_this_word("well if you insist");
                return;
                }
        concat("_",word,set_name);
        get_next_word("Search criterion?:");
        if (compar(word,"is") == 0) get_next_word("Search criterion?:");
        if (compar(word,"from") == 0) get_next_word("Search criterion?:");
        old = expression();
        if (old < 0) return;
        laws = copy_list(old,set_name,0);
        close(old);
        printf("%5d laws saved\n",laws);
        old = open(set_name,0);
        copy_list(old,"current_laws",1);
        close(old);
        return;
        }

/* ---- "list" command ---- */
if (compar(word,"list") == 0)
        {
        lister(1,"");
        return;
        }

/* ---- "print" command ---- */
if (compar(word,"print") == 0)
        {
        /* Create the listing in the line printer daemon's directory,
                and give it a pseudo-random name (to avoid conflicts) */

        time(time_vector);
        concat("/usr/lpd/celds",locv(0,time_vector[1]),set_name);
        old = creat(set_name,0666);
```

```
        if (old < 0) {perror("print"); return;}
        laws = lister(old,set_name);
        close(old);
        return;
        }

/* ---- "debug" command ---- */
if (compar(word,"debug") == 0)
        {
        debugging = 1 - debugging;
        get_next_word("");
        return;
        }

/* ---- "what" command ---- */
if (compar(word,"what") == 0)
        {
        get_next_word("Sets, does or is?:");
        if (compar(word,"are") == 0) get_next_word("Say 'the sets':");
        if (compar(word,"the") == 0) get_next_word("Say 'sets':");
        if (compar(word,"sets") != 0)
                {
                reject_this_word("Only 'sets' is available, sorry");
                return;
                }
        execute("ls _*");
        get_next_word("");
        return;
        }

/* ---- "help" command ---- */
if (compar(word,"help") == 0)
        {
        printf("verbs are:\n");
        printf("FIND,AND,OR,EXCEPT,SAVE,MAKE,OOPS,\n");
        printf("DELETE,SHOW,LIST,PRINT,WHAT,SUGGEST,HELP,END\n");
        get_next_word("More detail?:");
        if (word[0] != 'y') { get_next_word(""); return; }
        printf("FIND    begins a new search\n");
        printf("AND     further limits the previous search\n");
        printf("OR      extends a search\n");
        printf("EXCEPT  excludes selected laws\n");
        printf("SAVE    stores the result of a search\n");
        printf("MAKE    finds and saves\n");
        printf("OOPS    reinstates previous lawset\n");
        printf("\n");
        printf("DELETE  removes a saved lawset\n");
        printf("SHOW    shows the accession numbers of laws found\n");
        printf("LIST    summarizes laws on the terminal\n");
        printf("PRINT   summarizes laws on high-speed printer\n");
        printf("WHAT    shows lawset names\n");
```

```
        printf("SUGGEST to send a comment to the authors of CELDS\n");
        printf("HELP    shows this list\n");
        printf("END     signs the user off the system\n");
        get_next_word("");
        return;
        }

/* ---- "end" command ---- */
if (compar(word,"end") == 0 || compar(word,"bye") == 0)
        {
        reading_commands = 0;
        return;
        }

/* ---- "abort" command ---- */
if (compar(word,"abort") == 0)
        {
        reject_this_word("nothing to abort. all is cool.");
        return;
        }

/* ---- "oops" command ---- */
if (compar(word,"oops") == 0)
        {
        old = open("previous_laws",0);
        if (old < 0) {reject_this_word("Recovery not possible"); return;}
        laws = copy_list(old,"current_laws",0);
        printf("%5d laws recovered\n",laws);
        close(old);
        get_next_word("");
        return;
        }
reject_this_word("Oh worthy master, I fear I have\nfailed to
}       understand your intention
```

```
#
#include "search.i"
/*                      C O P Y _ L I S T

        Copy_list copies a list of laws from one file into another.
All new lawsets are created with a temporary name and are not copied
until the whole command has been read and checked for syntactic
correctness.  Then copy_list is called to transfer the law list
into a permanent file.

Argument:       mode    if mode is 1, a copy of what is in the "new"
                        file (if existent) is put into "previous_laws"
                        before old is copied to new.
                new     name of new file (copied to)
                old     file descriptor of old file (copied from)

Returns:        -1      for error conditions
                the number of laws copied, for successful calls

Copy_list variables:
        bf:     buffer for reading files
        chars:  number of characters read from a file
        nw:     file descriptor of the new file
        r:      pointer into bf
        tmp:    file descriptor of a temporary file
*/

int copy_list(old,new,mode) int old,mode; char *new;
{
/* Declaration of variables */
        int bf[max_laws], chars, nw, *r, tmp;

if (mode == 1)
/* Then copy "new" to "previous_laws" */
        {
        tmp = open(new,0);
        if (tmp >= 0)
                {
                /* Create "previous_laws" */
                        nw = creat("previous_laws", 0666);
                        if (nw < 0) {perror("prev_laws"); return(-1);}

                /* Read from new and write to previous */
                        chars = read(tmp,bf,lawset_size);
                        if (chars < 0 ) {perror("copy"); return(-1);}
                        write(nw,bf,chars);
                        close(tmp);
                        close(nw);
                }
        }
/* Create new file */
```

```
        nw = creat(new,0666);
        if (nw < 0) {perror("copy"); return(-1);}

/* Read old file */
        chars = read(old,bf,lawset_size);
        if (chars < 0) {perror("copy"); return(-1);}

/* Count number of laws */......
        bf[chars / 2] = 19999;
        r = bf;
        while (*r++ < 19999);

chars = (r - &bf[0]) * 2;
write(nw,bf,chars);
close(nw);
return(r - &bf[1]);
}
```

```
#
#include "search.i"
/*                      E X C E P T

        Except takes two lists of law numbers and constructs a
list containing laws that are in the first list and not in the
second list.

Arguments       first           file descriptor of file containing
                                first list of law numbers
                second          file descriptor of file containing
                                second list of law numbers

Returns         fil             file descriptor of file containing
                                the "ored" list

Or variables:
        bf1:            buffer for first list
        bf2:            buffer for second list
        chars:          number characters written into result
        chars1:         number characters read into bf1
        chars2:         number characters read into bf2
        fil:            file descriptor of resultant list
        r:              pointer to result
        result:         buffer for resultant list
        s:              pointer to bf1
        t:              pointer to bf2
*/

int except(first,second) int first,second;
/* Declaration of variables */
        {
        int bf1[max_laws], bf2[max_laws], chars, chars1, chars2, fil,
                result[2 * max_laws];
        register int *r,*s,*t;

/* Fill bf1 and bf2 with lawsets */
        chars1 = read(first,bf1,lawset_size);
        chars2 = read(second,bf2,lawset_size);

/* Guarantee that there is a 19999 at end (paranoia) */
        bf1[chars1 / 2] = 19999;
        bf2[chars2 / 2] = 19999;

/* Set up pointers */
        r = bf1;
        s = bf2;
        t = &result[0];

/* Since t gets pre-incremented the first one will be skipped */
        *t = 0;
```

```
while (*r < 19999)
        {
        if (*r < *s) *++t = *r++;
        else
                {
                if (*r == *s) r++;
                s++;
                }
        }
*++t = 19999;

/* Calculate number of characters in result */
        chars = (t - &result[0]) << 1;

/* Create file to write result into */
        fil = creat(temp_file_name,0666);
        if (fil < 0) {perror("bool(c)"); return(-1);}

/* Write result beginning with result[1] since [0] is skipped */
        write(fil,&result[1],chars);

/* Position fil at beginning of file (by closing and opening) */
        close(fil);
        fil = open(temp_file_name,0);

/* Increment temp_fil_name[10] since we just made a file */
        temp_file_name[10] =+ 1;

/* Close first and second files */
        close(first);
        close(second);

return(fil);
}
```

```
#
#include "search.i"
/*                      E X P R E S S I O N

        Expression is the routine for evaluating "ors".
It is evaluated last, after "ands" and "excepts" are done.

Returns         fil             a file descriptor

Expression variables:
        fil:            file descriptor
        second:         file descriptor
*/

int expression()
{
/* Declaration of variables */
        int fil, second;

/* Call term to check for ?? */
fil = term();
if (fil < 0) return(fil);

while (compar(word,"or") == 0 || compar(word,"union") == 0 ||
    compar(word,"|") == 0)
        {
        get_next_word("Or what?:");
        second = term();
        if (second < 0) return(second);
        fil = or(fil,second);
        }
return(fil);
}
```

```
#
#include "search.i"
/*                      F A C T O R

        Factor is the routine used for doing "ands".  It is the
highest order in the hierarcy, i.e. it gets done before "ors" or
"excepts" regardless of which is on the line first.

Returns         fil             file descriptor to an open file
                                containing the result

Factor variables:
        fil:            file descriptor
        second:         file descriptor
*/

int factor()
{
/* Declaration of variables */
        int fil, second;

/* Call primary to get lawset */
        fil = primary();
        if (fil < 0) return(fil);

while (compar(word,"and") == 0 || compar(word,"intersect") == 0 ||
         compar(word,"&") == 0)
        {
        get_next_word("And what?:");
        second = primary();
        if (second < 0) return(second);
        fil = and(fil,second);
        }
return(fil);
}
```

```
#
#include "search.i"
/*                      G E T _ S E T

        Get_set takes a fieldname and value for that field, and looks to
see if it is a legal value.  Get_set returns -1 for illegal value,
or a file descriptor to an open file if the value is included in
that field.
        The "list" file is positioned at the start of the lawlist
for that field value.

Arguments       fieldname       three character name of a field
                fvalue          a value to be looked up in that
                                field

Returns         -1              for illegal values
                fid             to an open "list" file

Get_set variables:
        bf:             buffer used for reading
        filename:       name of file to be opened
        hash_num:       hash number for fvalue
        list:           file identifier for list file
        p:              pointer used to build filenames
        r:              pointer to record read from hash table
        seek_location:  location to seek to
        v:              pointer to val_record structure
        val:            file descriptor for "val" file for fieldname
        wrong:          flag = 1 if value is illegal (i.e., wrong)
*/

int get_set(field_name, fvalue) char *field_name, *fvalue;
{
/* Declaration of variables */
        char filename[50], *p;
        int bf[100], hash_num, list, *r, seek_location, val, wrong;
        struct val_record v;

/* Open the ".val" file for this field */
        p = concat("/cerl/celds/",field_name,filename);
        concat(".val","",p);
        val = open(filename,0);
        if (val < 0) {perror("getst"); return(val);}

/* Calculate hash number for this value */
        hash_num = hash(fvalue) % max_hash_num;

if (debugging) printf("hashes to %d\n",hash_num);
/* Seek to proper slot in hash table -- each hash_num takes 2 bytes */
        seek_location = hash_num * 2;
        seek(val,seek_location,0);
```

```
#
#include "search.i"
/*                      F A C T O R

        Factor is the routine used for doing "ands".  It is the
highest order in the hierarcy, i.e. it gets done before "ors" or
"excepts" regardless of which is on the line first.

Returns         fil             file descriptor to an open file
                                containing the result

Factor variables:
        fil:            file descriptor
        second:         file descriptor
*/

int factor()
{
/* Declaration of variables */
        int fil, second;

/* Call primary to get lawset */
        fil = primary();
        if (fil < 0) return(fil);

while (compar(word,"and") == 0 || compar(word,"intersect") == 0 ||
         compar(word,"&") == 0)
        {
        get_next_word("And what?:");
        second = primary();
        if (second < 0) return(second);
        fil = and(fil,second);
        }
return(fil);
}
```

```
#
#include "search.i"
/*                      G E T _ S E T

        Get_set takes a fieldname and value for that field, and looks to
see if it is a legal value.  Get_set returns -1 for illegal value,
or a file descriptor to an open file if the value is included in
that field.
        The "list" file is positioned at the start of the lawlist
for that field value.

Arguments       fieldname       three character name of a field
                fvalue          a value to be looked up in that
                                field

Returns         -1              for illegal values
                fid             to an open "list" file

Get_set variables:
        bf:             buffer used for reading
        filename:       name of file to be opened
        hash_num:       hash number for fvalue
        list:           file identifier for list file
        p:              pointer used to build filenames
        r:              pointer to record read from hash table
        seek_location:  location to seek to
        v:              pointer to val_record structure
        val:            file descriptor for "val" file for fieldname
        wrong:          flag = 1 if value is illegal (i.e., wrong)
*/

int get_set(field_name, fvalue) char *field_name, *fvalue;
{
/* Declaration of variables */
        char filename[50], *p;
        int bf[100], hash_num, list, *r, seek_location, val, wrong;
        struct val_record v;

/* Open the ".val" file for this field */
        p = concat("/cerl/celds/",field_name,filename);
        concat(".val","",p);
        val = open(filename,0);
        if (val < 0) {perror("getst"); return(val);}

/* Calculate hash number for this value */
        hash_num = hash(fvalue) % max_hash_num;

if (debugging) printf("hashes to %d\n",hash_num);
/* Seek to proper slot in hash table -- each hash_num takes 2 bytes */
        seek_location = hash_num * 2;
        seek(val,seek_location,0);
```

```
/* Read from val file */
        read(val,bf,200);

/* Point r to beginning of record read */
        r = &bf[0];

/* Initialize wrong to be true */
        wrong = 1;

while (*r)
/* If *r is zero, then this hash number contains a zero in the table */
        {
        /* Locate record with this hash number */
                seek_location = ((*r * 64) + val_table_start);
                seek(val,seek_location,0);
                read(val,&v,64);
                if (debugging) printf("try %d:%s\n",*r,v.value);

        /* Compare fvalue with the value in the val file */
                wrong = compar(v.value,fvalue);

        /* If wrong is zero, we found fvalue */
                if (wrong == 0) break;

        r++;
        }

/* Close the "val" file */
        close(val);

if (wrong != 0)
/* Then fvalue was not found in the val file */
        {
        printf("searching field %s for %s\n",field_name,fvalue);
        reject_this_word("not a legal value");
        return(-1);
        }

/* Calculate location in "list" file */
        seek_location = v.first_law * 2;

/* Open ".list" file for this field */
        concat(".list","",p);
        list = open(filename,0);
        if (list < 0) {perror("getst(oli)"); return(list);}

/* Position list file at start of laws list */
        seek(list,seek_location,0);
        if (debugging) printf("get_set opens %d\n",list);

return(list);
}
```

```
#
#include "search.i"
/*                      G E T _ N E X T _ W O R D

        Get_next_word is the scanner for CELDS.  The argument is
a prompt to give in case the client has not yet supplied this word.
A special case is the nul prompt, which means the caller only wants
the next word if it has already been supplied.
Global variables that may be changed are:
        word:           array containing current word (nul terminated)
        request:        array containing current line of user input
        req_location:   a pointer into current position in request
        old_req_location:       previous req_location

Get_next_word recognizes punctuation and returns punctuation
marks as a word.

Arguments       prompt          pointer to a prompt

Returns:        0
                1
                2               if word is a punctuation mark

Get_next_word variables:
        eof:            flag indicating if user has typed an end-of-file
        w:              pointer to the "word" array
*/

int get_next_word(prompt) char *prompt;
{
/* Declaration of variables */
        char *w;
        int eof;

/* Skip over any leading blanks */
        while (*req_location++ == ' ');
        --req_location;

if (*req_location == 0)
/* Then this is the end of the line */
        {
        do      {
                if (*prompt == 0)
                /* This is the special case of a nul prompt */
                        {
                        word[0] = 0;
                        return(0);
                        }

                /* Write out prompt */
                        printf("%s",prompt);
```

```
#
#include "search.i"
/*                      L I S T E R

        Lister is the procedure called by the list and print verbs to
list the contents of selected laws; it only lists chosen fields.

Arguments:      output_file     file descriptor of output file
                out_name        name of output_file
                                if name is non-zero, listing will
                                be sent to the line printer

Returns:        -1              for error conditions
                +1              otherwise

Lister variables:
        bf:             buffer for reading and writing
        chars:          number of characters read
        chosen:         array indicating which fields to list
        flag:           used to indicate when all of a field has
                        been listed.  This is set to the last digit
                        of the field being listed.
        iobuf:          buffer used only by the ggets routines
        field:          field number
        laws:           file descriptor of the laws file from which
                        reading is taking place
        list:           file descriptor of current_laws file,
                        the file containing the list of law numbers
        margin:         pointer to "marg_string"
        marg_string:    string which is printed as the margin for
                        each output line.  Blanks for most lines but
                        field names for first lines of fields.
        oldlawsfile:    contains numerical portion of previous "laws."
                        file name (which is still open).  This is
                        -1 if there is no open "laws." file.
        p:              pointer to bf
        sel:            pointer to selected
        selected:       array containing law numbers of laws to be printed
        toc:            file descriptor of "laws.toc" file
        type_start:     array containing the "laws.toc" record for the
                        current law number
*/

int lister(output_file,out_name) int output_file; char *out_name;
{
int *aborter();
/* Declaration of variables */
        int chars, chosen[14], field, laws, list, oldlawsfile, *sel,
                selected[max_laws], toc, type_start[13];
        char bf[122], flag, iobuf[550], *margin, marg_string[10], *p;
```

```
                /* Read response from the terminal */
                        eof = gets(request);

                if (eof == 0)
                /* Then user typed a cntrl-d */
                        {
                        word[0] = 0;
                        reading_commands = 0;
                        return(0);
                        }

                /* Reset req_location */
                        req_location = &request[0];

                /* Get rid of leading blanks */
                        while (*req_location++ == ' ');
                        --req_location;

                if (*req_location == '!')
                /* Then this is a UNIX command */
                        {
                        req_location++;
                        execute(req_location);
                        /* Set to zero so we loop again */
                                *req_location = 0;

                        }
                } while (*req_location == 0);
        }

/* Reset old_req_location */
        old_req_location = req_location;

/* Check for punctuation in word */
w = &word[0];
if (punctuation[*req_location & 0177])
/* Then there is recognized punctuation */
        {
        *w++ = *req_location++;
        *w = 0;
        return(2);
        }

/* Word must be alphabetic, so copy to next blank or punctuation */
        while (punctuation[*req_location & 0177] == 0)
                *w++ = *req_location++;

/* Set word[0] to zero */
        *w = 0;

return(1);
}
```

```
/* Initialization */
        oldlawsfile = -1;
        for (field = 1; field < 14; field++) chosen[field] = 0;

/* Open current laws file */
        list = open("current_laws",0);
        if (list < 0) {reject_this_word("no laws selected"); return(-1);}

/* Fill in selected array */
        chars = read(list,selected,lawset_size);
        close(list);
        selected[chars / 2] = 19999;
        if (selected[0] >= 19999)
                {
                reject_this_word("no laws selected");
                return(-1);
                }

/* Call get_next_word to find out which fields to list */
        get_next_word("What field(s)?:");

while (word[0] != 0)
/* We still have more fields requested on this line of input */
        {
        if (compar(word,"all") == 0)
                {
                for (field = 2; field < 11; field++) chosen[field] = 1;
                get_next_word("");
                break;
                }
        if (compar(word,"abort") == 0)
                {
                reject_this_word("listing aborted");
                return(-1);
                }
        field = xlate_field(word);
        if (field < 0) {reject_this_word("not a field name"); return(-1);}
        /* Fill in the chosen array for requested fields, except
                if keywords are requested, show topics */
                if (field != 13) chosen[field] = 1;
                else chosen[12] = 1;

        get_next_word("");
        /* Check for optional syntax */
                if (compar(word,",") == 0) get_next_word("Next field?:");
                if (compar(word,"and") == 0) get_next_word("Next field?:");
        }

/* If this is a print batch it off */
if (*out_name)
/* Out_name will have a value of zero for the terminal */
```

```
        {
        if (fork() != 0) return(1);
        }

else
/* Set a trap for interrupt */
signal(2,aborter);

/* Open table of contents (toc) file */
        toc = open("/cerl/celds/laws.toc",0);
        if (toc < 0)
                {
                perror("lister(otoc)");
                if (*out_name) exit();
                else return(-1);
                }

sel = &selected[0];
while (*sel < 19999)
/* While there are still law numbers left */
        {
        /* Put two newlines at beginning of bf */
                p = &bf[0];
                *p++ = 012;
                *p++ = 012;

        /* Put "law" number, and another newline into bf */
                p = concat("law ",locv(0,*sel),p);
                *p++ = 012;

        write(output_file,bf,(p - &bf[0]));

        /* Locate appropriate record in toc file */
                lseek(toc,(*sel * 26.0));
                chars = read(toc,type_start,26);
                if (chars < 0)
                        {
                        perror("lister(rlw)");
                        close(toc);
                        if (oldlawsfile != -1) close(laws);
                        break;
                        }
        if (type_start[0] != oldlawsfile)
        /* Then we need to open a new "laws." file */
                {
                if (oldlawsfile != -1) close(laws);
                concat("/cerl/celds/laws.",locv(0,type_start[0]),bf);
                laws = gopen(bf,&iobuf);
                if (laws < 0) {perror("lister"); close(toc); break;}
                oldlawsfile = type_start[0];
                }
```

```
        for (field = 1; field < 13; field++)
                {
                if (chosen[field])
                /* Then field has been requested */
                        {
                        /* Construct margin */
                                margin = &marg_string[0];
                                concat(fld_name[field],":",margin);

                        gseek(&iobuf,type_start[field]);
                        chars = ggets(bf,&iobuf);
                        flag = bf[7];
                        while (flag == bf[7] && chars > 0)
                                {
                                p = concat(margin,&bf[10],bf);
                                margin = "    ";
                                *p++ = 012;
                                write(output_file,bf,(p - &bf[0]));
                                if (reading_commands != 1)
                                /* Then aborter was called */
                                        {
                                        close(toc);
                                        close(laws);
                                        printf("\n\n\nlisting aborted\n");
                                        return(-1);
                                        }
                                chars = ggets(bf,&iobuf);
                                }
                        }
                }
        sel++;
        }

/* Write four newlines between laws */
        p = &bf[0];
        *p++ = 012;
        *p++ = 012;
        *p++ = 012;
        *p++ = 012;
        write(output_file,bf,4);

/* Close files */
        close(toc);
        close(laws);

/* This code is only for the child process (print).  Give the
listing to the lineprinter (lpr) and exit.  */
if (*out_name)
/* Then this is the child */
        {
        close(output_file);
```

```
        concat("lpr -r ",out_name,bf);
        execute(bf);
        exit();
        }

return(1);

}
```

```
#
#include "search.i"
/*                      O R

        Or takes two lists of law numbers and logically "ors"
the two into a third list, i.e. it make a composite list of laws
occurring in either list.

Arguments       first           file descriptor of file containing
                                first list of law numbers
                second          file descriptor of file containing
                                second list of law numbers

Returns         fil             file descriptor of file containing
                                the "ored" list

Or variables:
        bf1:            buffer for first list
        bf2:            buffer for second list
        chars:          number characters written into result
        chars1:         number characters read into bf1
        chars2:         number characters read into bf2
        fil:            file descriptor of resultant list
        r:              pointer to result
        result:         buffer for resultant list
        s:              pointer to bf1
        t:              pointer to bf2
*/

int or(first,second) int first,second;
/* Declaration of variables */
        {
        int bf1[max_laws], bf2[max_laws], chars, chars1, chars2,  fil,
                result[2 * max_laws];
        register int *r,*s,*t;

/* Fill bf1 and bf2 with lawsets */
        chars1 = read(first,bf1,lawset_size);
        chars2 = read(second,bf2,lawset_size);

/* Guarantee that there is a 19999 at end (paranoia) */
        bf1[chars1 / 2] = 19999;
        bf2[chars2 / 2] = 19999;

/* Set up pointers */
        r = bf1;
        s = bf2;
        t = &result[0];

/* Since t gets pre-incremented the first one will be skipped */
        *t = 0;
```

```
do      {
        if (*r < *s) *++t = *r++;
        else
                {
                if (*r == *s) r++;
                *++t = *s++;
                }
        } while (*t < 19999);

/* Calculate the number of characters in result */
        chars = (t - &result[0]) << 1;

if (chars > lawset_size)
/* Then our lawset is too big for the buffers in CELDS */
        {
        printf("lawset exceeds %d laws\n",(max_laws - 1));
        printf("only the first %d laws will be used\n",(max_laws - 1));
        t = &result[max_laws];
        *t = 19999;
        chars = lawset_size;
        }

/* Create fil to write result into */
        fil = creat(temp_file_name,0666);
        if (debugging) printf("or creating %s\n",temp_file_name);
        if (fil < 0) {perror("bool(c)"); return(-1);}

/* Write result beginning with result[1] since [0] is skipped */
        write(fil,&result[1],chars);

/* Position fil at beginning of file (by closing and opening) */
        close(fil);
        fil = open(temp_file_name,0);
        if (debugging) printf("or %d with %d giving %d (%d laws)\n",
                        first,second,fil,(t - &result[1]));

/* Increment temp_file_name since we just made a file */
        temp_file_name[10] =+ 1;

/* Close first and second files */
        close(first);
        close(second);

return(fil);
}
```

```
#
#include "search.i"
/*                      P R I M A R Y

        Primary finds the lowest order terms in expressions for
commands.  This is the "value" of the field requested.  Primary
returns -1 on various error conditions.  Otherwise it creates a file
containing the set of laws with the specified value.

Returns         fil             file descriptor of an open file
                                containing the set of laws with the
                                current value
                -1              on error conditions

Primary variables:
        content:        array used to put an accession number in to
                        write to a file
        delim:          delimiter for values, either a nul or a
                        double quote mark depending on whether a
                        quote has been encountered
        fil:            fil descriptor of current lawset
        fld:            flag indicating whether a field is being searched
        fld_num:        field number
        p:              pointer
        q:              pointer
        st:             indicates if a set name is being searched
        value:          array containing the current value
*/

int primary()
{
/*Declaration of variables */
        int content[2], fil, fld, fld_num, st;
        char delim, *p, *q, value[62];

/* Check for ordering by parenthesis */
        if (compar(word,"(") == 0)
                {
                get_next_word("Search criterion:");
                fil = expression();
                if (compar(word,")") == 0)
                        {
                        get_next_word("");
                        return(fil);
                        }
                reject_this_word("right paren expected");
                return(-1);
                }

fld = 0;
/* Remove optional text in command structure */
```

```
        if (compar(word,"all") == 0)
                {
                get_next_word("Field name?:");
                fld = 1;
                }.......
        if (compar(word,"laws") == 0)
                {
                get_next_word("Field name?:");
                fld = 1;
                }
        if (compar(word,"with") == 0)
                {
                get_next_word("Field name?:");
                fld = 1;
                }
        if (compar(word,"where") ==0)
                {
                get_next_word("Field name?:");
                fld = 1;
                }

/* Translate field name to a number */
        fld_num = xlate_field(word);

if (field_is_searchable[fld_num])
/* Then this is a searchable field */
        {
        get_next_word("What value?:");
        if (compar(word,"is") == 0) get_next_word("What value?:");
        if (*word == '"')
        /* Then there is a term in quotes */
                {
                /* Skip past quote mark */
                        old_req_location++;

                /* Set delimiter to look for other quote */
                        delim = '"';

                request[121] = '"';
                }
        else delim = 0;

        /* Copy word into value until delim */
                p = &value[0];
                q = old_req_location;
                while (*q != delim) *p++ = *q++;

        if (q > &request[120])
        /* Then we never found the delimiter */
                {
                reject_this_word("closing quote mark missing");
```

```
                return(-1);
                }

        *p = 0;
        if (*q != 0) q++;
        req_location = q;
        old_req_location = q;
        get_next_word("");
        if (fld_num == 1)
        /* Then search was for accession number */
                {
                /* Convert accession number to integer */
                        content[0] = atoi(value);

                /* put in a test here to see if acc num is legal */
                /* Create temp_file */
                        fil = creat(temp_file_name,0666);
                        if (fil < 0) {perror("getacc"); return(fil);}

                content[1] = 19999;
                write(fil,content,4);
                /* Position fil at beginning of file */
                        close(fil);
                        fil = open(temp_file_name,0);

                /* Increment temp_file_name */
                        temp_file_name[10]++;

                return(fil);
                }

        if (compar(value,"abort") == 0)
                {
                reject_this_word("search aborted");
                return(-1);
                }

        /* Get the set of laws for this field and value */
                fil = get_set(fld_name[fld_num],value);

        return(fil);
        }

if (fld_num > 0)
        {
        reject_this_word("field is not a searchable field");
        return(-1);
        }

if (compar(word,"abort") == 0)
        {
```

```
        reject_this_word("search aborted");
        return(-1);
        }
if (fld)
        {
        reject_this_word("field name expected");
        return(-1);
        }

/* If we have reached this point, then it must be a setname */

st = 0;
/* Remove optional text */
        if (compar(word,"my" == 0))
                {
                get_next_word("Lawset name?:");
                st = 1;
                }
        if (compar(word,"set" == 0))
                {
                get_next_word("Lawset name:");
                st = 1;
                }
if (compar(word,"set") == 0) {get_next_word("Lawset name?:"); st = 1;}

if (compar(word,"abort") == 0)
        {
        reject_this_word("search aborted");
        return(-1);
        }

/* File will have an arbitray "_" preceding the name */

concat("_",word,value);
fil = open(value,0);

if (fil < 0)
/* Then this file does not exist */
        if (st == 0)
             reject_this_word("Neither a lawset name nor a field name");
     else reject_this_word("no set by that name");

get_next_word("");

return(fil);
}
```

```
#
#include "search.i"
/*                      R E J E C T _ T H I S _ W O R D

        Reject_this_word is the CELDS error processing routine.

Arguments       error_message   pointer to message to be printed

Globals:
        req_location:   pointer to current position in request
        word:           array containing the current word

Reject_this_word variables:
        error_message:  pointer to message to be printed
*/

int reject_this_word(error_message) char *error_message;
{
printf("ERROR: %s - %s\n",word,error_message);
/* Reset global indicators */
        *req_location = 0;
        word[0] = 0;
}
```

```
#
#include "search.i"
/*                      S H O W

        Show writes the accession numbers of "current_laws" on
the terminal, ten to a line.

Returns:        -1      for error conditions (no laws selected).
                 0      otherwise

Show variables:
        bf:     buffer used for reading
        chars:  number of characters read
        fil:    file descriptor of current_laws
        i:      counter
        *r:     pointer to bf
*/

int show()
{
int *aborter ();
/* Declaration of variables */
        int bf[max_laws], chars, fil, i, *r;

/* Open current_laws file */
        fil = open("current_laws",0);
        if (fil < 0)
                {
                reject_this_word("no laws selected");
                return(-1);
                }

/* Read file into bf */
        chars = read(fil,bf,lawset_size);

close(fil);
/* Every two bytes is an integer number.  Put a 19999 at end. */
        bf[chars / 2] = 19999;
        if (bf[0] >= 19999)
                {
                reject_this_word("no laws selected");
                return(-1);
                }

r = &bf[0];
/* Set trap for interrupt signal */
        signal(2,aborter);

while (*r < 19999)
/* Write out list, ten to a line */
        {
```

```
        for (i = 0; i < 9; i++)
                {
                if (*r >= 19999) break;
                printf("%5d ",*r++);
                }
        printf("\n");
        /* Check to see if aborter was called (reading_commands = 2) */
                if (reading_commands != 1) return(-1);
        }
/* Prepare next "word" for celds */
        get_next_word("");
/* Throw away optional words on "show" command */
        if (compar(word,"the") == 0) get_next_word("");
        if (compar(word,"laws") == 0) get_next_word("");
return(0);
}
```

```
#
#include "search.i"
/*                      T E R M

        Term is the routine for evaluating "excepts".  It comes
second in the hierarchy.  "Ands" are evaluated first, "excepts"
second, and "ors" last.

Returns         fil             file descriptor of result file

Term variables:
        fil:            file descriptor
        second:         file descriptor
*/

int term()
{
/* Declaration of variables */
        int fil, second;

fil = factor();
if (fil < 0) return(fil);

while (compar(word,"except") == 0)
        {
        get_next_word("Except what?:");
        second = factor();
        if (second < 0) return(second);
        fil = except(fil,second);
        }
return(fil);
}
```

```
#
#include "search.i"
/*                      X L A T E _ F I E L D

        Xlate_field translates a field_name to a fld_num, and returns
the fld_num. If the field_name is not the name of a legal field,
then -1 is returned.
        For matching a field to a number, only the first three
characters of field_name are used.

Arguments:      field_name      name of field

Returns:        -1              if not a legal field
                fieldnum        for recognized fields

Globals:        (see globals for "expr.c")

Xlate_field variables:
        fld_num:                field number
        p:
        short_fname[4]:         first 3 characters of field_name
*/

int xlate_field(field_name) char *field_name;
{
/* Declaration of variables */
        char *p, short_fname[4];
        int fld_num;

/* Put first 3 characters of field_name into short_fname */
        p = &short_fname[0];
        *p++ = *field_name++;
        *p++ = *field_name++;
        *p++ = *field_name;
        *p = 0;

for (fld_num = 1; fld_num < 14; fld_num++)
        if (compar(fld_name[fld_num],short_fname) == 0) return(fld_num);

return(-1);
}
```

Appendix H - General Utility Subroutines

```
/*                      C O M P A R

        Compar compares two strings and determines if they are the same.

Arguments:      s1      pointer to string one
                s2      pointer to string two

Returns:        0       if strings are the same
                -       if string one is "bigger"
                +       if string two is "bigger"

Compar variables:
        greater:        algebraic difference of chars in s1 - s2
        p:              pointer to s1
        q:              pointer to s2
*/

int compar(s1,s2) char *s1,*s2;
{
/* Declaration of variables */
        register char *p,*q;
        register int greater;

        p = s1;
        q = s2;
        while ((greater = *p - *q++) == 0 && *p++ != 0);
        return (greater);
}
```

```
/*                              C O N C A T

        Concat  concatenates  two  strings  and  returns  the  composite
string.

Arguments:      first           pointer to first string
                second          pointer to second string
                result          pointer to end of resulting string

Returns:        pointer to end of result string
*/

char *concat(first, second, result) char *first, *second, *result;
{
/* Put first string into result string */
        while (*result++ = *first++);

/* Back up over nul */
        --result;

/* Put second string into result */
        while (*result++ = *second++);

/* Back up over nul */
        --result;

return(result);
}
```

```
        char *gnextp;
        char *gstop;
        int geof;
        char gdbuf[513];
        };

int ggets(bf,stru) char *bf; struct gstru *stru;
{

/* Declaration of variables */
        int ch, chars, more_to_read;
        register char *p, *q;

/* Point q to the start of bf */
        q = bf;

/* Continue this as long as no new-line has been found, other
   than the artificial one at gdbuf[512] */
do      {
        /* Reset new-line flag */
                more_to_read = 0;

        /* point p to next character to be read */
                p = stru->gnextp;

        /* copy next line into the callers buffer, bf */
                while (*p != 012) *q++ = *p++;

        /* Now, adjust gnextp to point at next character to be read */
                stru->gnextp = p + 1;

        if (p >= stru->gstop)
        /* Then we need to read into the next block */
                {
                /* Turn on no new-line indicator */
                        more_to_read = 1;

                /* Check for end-of-file */
                        if (stru->geof) {bf[0] = 0; return(0);}

                /* Point gnextp to beginning of gdbuf */
                        stru->gnextp = &stru->gdbuf[0];

                /* Read next block from file to gdbuf */
                        ch = read(stru->gfildes,stru->gdbuf,512);

                if (ch < 0)
                /* Then we can't read a block and haven't yet
                   encountered a new-line */
                        {
                        perror("ggets(read)");
```

```
/*                      G G E T S

        The gopen, ggets, and gseek routines are an alternative way to
read ASCII files.  They are designed primarily for sequential line-
oriented reading, with some seeks.  The only seeks allowed are absolute
character number (ptrname = 0).
        A core buffer (gdbuf) is filled by the gopen routine with one
block of data from a file.  When ggets is called, data is transferred
from gdbuf to the caller's buffer (bf) until a new-line is encountered.
If no new-line is encountered by the end of the block, the next block
of data is read from the file into gdbuf and the transfer continues.
        To use ggets with a file, the file must be opened with gopen
and seeks should be performed using gseek.

Globals:        (for ggets, gopen, and gseek)
        gstru:  This is a structure which is used for reading lines
                from a file.  Its components are:
                        gdbuf   --      a buffer holding one block of
                                        data.
                        geof    --      0 until last block is read,
                                        1 when gdbuf contains last block
                        gfildes --      file descriptor
                        gnextp  --      a pointer to the next character
                                        to be read from gdbuf
                        gstop   --      a pointer to the next critical
                                        character, signaling when to
                                        read a new block.  After eof,
                                        this points to the last
                                        character of data.

Arguments:      bf:     a pointer to the caller's buffer into which
                        the next line of data should be read
                stru:   a pointer to the structure (array) of shape
                        gstru which contains file descriptor, etc.

Returns:        the number of characters read into bf

Ggets variables:
        ch:     number of characters read from file to gdbuf
        chars:  number of characters read into bf
        more_to_read:   flag indicating if read continues into the
                        next block
        p:      a pointer into the core buffer, gdbuf
        q:      a pointer into the caller's buffer, bf

Returns:
*/

struct gstru
        {
        int gfildes;
```

```
/*                          G O P E N

        Gopen opens a file and reads the first block of data into a
core buffer, and sets up geof, gnextp, and gstop.  The file is opened
for reading only.

Globals:        see list for ggets
                (gopen should only be used when using ggets.)

Arguments:      fname   name of the file to be opened
                stru    pointer to a structure of shape gstru
                        which will contain the core buffer and
                        parameters for this file

Returns:        the file descriptor of the file opened

Gopen variables:
        ch:     number of characters read from file to gdbuf
*/

int gopen(fname,stru) char *fname; struct gstru *stru;
{
/* Declaration of variables */
        int ch;

/* Open file, mode 0 */
        stru->gfildes = open(fname,0);
        if (stru->gfildes < 0)
                {
                perror("gopen");........
                return(stru->gfildes);..
                }

/* Read first block from file into gdbuf */
        ch = read(stru->gfildes,&stru->gdbuf[0],512);
        if (ch < 0) {perror("gopen(read)"); return(ch);}

/* Set up stop, nextp, and eof */
        stru->gstop = &stru->gdbuf[512];
        stru->gnextp = &stru->gdbuf[0];
        stru->geof = 0;

if (ch < 512)
/* Then this is the last (and only) block */
        {
        stru->geof = 1;
        stru->gstop = &stru->gdbuf[ch];
        *stru->gstop = 012;
        }

/* Put in the terminating new-line */
```

```
                        stru->geof = 1;
                        *stru->gnextp = 012;
                        stru->gstop = stru->gnextp;
                        bf[0] = 0;
                        return(0);
                        }

                if (ch < 512)
                /* Then this must be the last block */
                        {
                        stru->geof = 1;
                        stru->gstop = &stru->gdbuf[ch];
                        *stru->gstop = 012;
                        }

                /* make absolutely sure there is a newline to find */
                        stru->gdbuf[512] = 012;

                }
        } while(more_to_read);

/* Put nul at end of bf */
        *q++ = 0;

/* Calculate characters transferred to bf */
        chars = q - bf;

return(chars);
}
```

```
        stru->gdbuf[512] = 012;

return(stru->gfildes);
}
```

```
/*                      G S E E K

        Gseek seeks an absolute character number in a file opened
by gopen, fills gdbuf , and adjusts nextp, stop, and eof accordingly.

Globals:        see list for ggets
                (gseek should only be used when using ggets.)

Arguments:      offset  character number desired
                stru    pointer to a structure of shape gstru
                        which will contain the core buffer and
                        parameters for this file

Returns:        1 if seek was successful
                error code, otherwise

Gopen variables:
        ch:     number of characters read from file to gdbuf
*/
a
int gseek(stru,offset) struct gstru *stru; int offset;
{
/* Declaration of variables */
        int ch;

/* Seek to offset */
        ch = seek(stru->gfildes,offset,0);
        if (ch < 0) {perror("gseek(seek)"); return(ch);}

/* Read block of data into gdbuf */
        ch = read(stru->gfildes,&stru->gdbuf[0],512);
        if (ch < 0) {perror("gseek(read)"); return(ch);}

/* Set up stop, nextp, and eof */
        stru->gstop = &stru->gdbuf[512];
        stru->gnextp = &stru->gdbuf[0];
        stru->geof = 0;

if (ch < 512)
/* Then this is the last block */
        {
        stru->geof = 1;
        stru->gstop = &stru->gdbuf[ch];
        *stru->gstop = 012;
        }

/* Put in the terminating new-line */
        stru->gdbuf[512] = 012;

return(1);
}
```

```
        Hash encrypts a string into a single integer number.

Arguments:      str     pointer to string to be encrypted

Returns:        encrypted integer number

Hash variables:
        total:  running total for additions in encryption
*/

int hash(str) char *str;
{
/* Declaration of variables */
        register int total;

/* Initialize total */
        total = 0;
/* Add up words as integer numbers */
        while (*str) total =+ *str++;

return(total);
}
```

```
/*                      L S E E K

        Lseek seeks an absolute character number in a file.  The number
may be greater than 65535.

Arguments:      fil     --      integer file descriptor
                dcharnum--      double, character number sought

Returns:        1               if no block seek performed
                2               if block seek performed

Lseek variables:
        block:  block number of desired character number
        dcharnum:       desired character number (double)
        fil:    file descriptor
        plus:   position of desired character number in its block
        seeker: desired character number (long)
*/

int lseek(fil,dcharnum) int fil; double dcharnum; {
/* Declaration of variables */
        int block, plus;
        long seeker;

/* convert dcharnum to long */
        seeker = dcharnum;

if (dcharnum < 65535.0)
/* Then we don't need a block seek */
        {
        plus = seeker;
        seek(fil,plus,0);
        return(1);
        }

else
/* A block is sought first */
        {
        block = seeker / 512;
        plus = seeker % 512;
        seek(fil,block,3);
        seek(fil,plus,1);
        return(2);
        }
}
```

```
/*                          M O V E

        Move moves a specified number of characters from one location
to another.

Arguments:      count   number of characters to be moved
                from    pointer to string to be moved
                to      pointer to receiving location

Variables:
        i:      counter
*/

int move(from,to,count) char *from, *to; int count;
{
/* Declaration of variables */
        int i;

for (i = 0; i < count; i++) *to++ = *from++;
return;
}
```

/* S E A R C H . I

Search.i is the include file of structures and defines used to access the search file x.val.

The value file contains the names of all of the values for a given field and a hash table for quick access to those names. The numbers of the laws that belong in a given set are found in a separate file named x.list (where x is the field name).

The value file starts with the hash table for max_hash_num + 10 words. The hash table contains 1 word per hash number, either 0 or the value_number of a value that hashes here. If a slot is full, and the value is different from the value to be inserted, the hash_number is simply incremented by one. This kind of hash table, while exceedingly simple to build, tends to get cluttered when it is over 60% full. For this reason, max_hash_num is chosen to be a large number.

Each set has a value number greater than 0. The next N records (one per set) are 64 characters long. Each record contains 62 characters for the set name, and an integer telling where in the list file the laws list for that set starts.

The list file is simply lists of law numbers terminated by 19999.
*/

```
#define hash_size     4011
#define lawset_size 3000
#define max_hash_num 4001
#define max_laws 1501
#define val_table_start 7958

struct val_record
        {
        char value[62];
        int first_law;
        };

/* Declaration of global variables for the retriever */
        char *fld_name[14], *old_req_location, *req_location;
        char field_is_searchable[14];
        char punctuation[128], request[122], temp_file_name[12], word[62];
        int client, debugging, reading_commands, requests;
```

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