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USAARL REPORT NO. 70-9

THE DESIGN OF A LITERATURE FILE IN AIRCRAFT-RELATED ENVIRONMENTAL MEDICINE

By

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410 S. Cedros
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U. S. ARMY AEROMEDICAL RESEARCH LABORATORY
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The U. S. Army Aeromedical Research Laboratory is often required to make specialized measurements and perform applied research in aircraft-related areas of environmental medicine. Rapid access to the periodical literature is essential for the completion of many of these projects. A growing file of reprints from the periodical literature is available at USAARL. A method for the orderly storage of the reprints in printed form and a separate scheme for rapid retrieval of abstracts was developed for the file. Both methods were based upon the natural organization of the data. Storage of papers within the file will be based on the major topic of each reprint while retrieval will be accomplished by the use of key words. The combined system is expandable and can be easily adapted to a variety of mechanical, electro-optical and computer storage and retrieval methods.

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U. S. Army Medical Research and Development Command

FOREWORD

This study is a continuation of work initiated by LTC W. Schane and CPT G. Hody at the U. S. Army Aeromedical Research Unit. The report was written at Geoscience Ltd., 410 South Cedros Avenue, Solana Beach, California 92075, under U. S. Army Contract No. DABCOI-69-C-0247.

ABSTRACT

The U. S. Army Aeromedical Research Laboratory is often required to make specialized measurements and perform applied research in aircraft-related areas of environmental medicine. Rapid access to the periodical literature is essential for the completion of many of these projects. A growing file of reprints from the periodical literature is available at USAARL. A method for the orderly storage of the reprints in printed form and a separate scheme for rapid retrieval of abstracts was developed for the file. Both methods were based upon the natural organization of the data. Storage of papers within the file will be based on the major topic of each reprint while retrieval will be accomplished by the use of key words. The combined system is expandable and can be easily adapted to a variety of mechanical, electro-optical and computer storage and retrieval methods.

APPROVED: Robert W. Bailey

ROBERT W. BAILEY, COL, MSC
Commanding

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INTRODUCTION

The U. S. Army Aeromedical Research Laboratory (USAARL) is often involved in the examination of the hazards which arise when toxic materials are present in the aircraft environment. However, neither a full toxicology laboratory nor a highly specialized staff is yet available at USAARL proper. Instead, a physiologist, biochemist, or aviation medicine specialist with training in instrumentation is usually assigned to the toxicology problems. This is a satisfactory solution because the largest proportion of the work is measurement, a task which is easily learned by anyone with a good scientific background. The USAARL staff's familiarity with aviation and the peculiar requirements of the flying task is a great advantage which more than balances their incomplete knowledge of highly specific areas of toxicology. Often, some applied research as well as critical evaluation of measurement results are also required. In those cases, expert consultants are asked to assist the USAARL staff, particularly in the planning and final evaluation phases of the project.

In all cases, the responsibility for recommendations related to aircraft safety lies with USAARL and, in many projects, a fast response is essential. For these reasons, current, authoritative information must be rapidly available and easily accessible to the investigators. In addition to the excellent textbook collection available at the USAARL library, a file of reprints from the current environmental medicine literature was begun in 1965. The size of the collection grew as the result of contributions from consultants, scanning of current periodicals by investigators, and computer-assisted searches by the Defense Documentation Center (DDC) and the National Library of Medicine. Additional papers were added by Geoscience Ltd. under U. S. Army contract DABCOI-69-C-0247 (June 1969).

A portion of the work performed under Army contract at Geoscience was a careful examination and organization of the literature file. While it is necessary to accommodate the present collection in printed form, the use of automated storage and retrieval methods is planned for the near future. Therefore, any system selected for the immediate requirement must be easily convertible to an automatic mode of operation.

A combination of filing by subject and retrieval by key words was chosen and initial subject headings and key words were selected. The specific examples given will probably prove to be naive or restrictive as new studies are initiated

and new data storage methods are developed. The general scheme, however, should prove to be an efficient and economic one, particularly with the present literature collection and its foreseeable extensions. It should also provide a sound model for the later design of more complex systems.

First, the traditional methods of organizing library collections will be briefly described and contrasted to more modern techniques. Then, the organization of the proposed file will be discussed. Coding suggestions will be included in an appendix. The catalog subject headings with their associated accession numbers and an initial key word list will be listed. The present catalog of reprints and abstracts will be documented in a subsequent publication.

BACKGROUND

Classical Library Methods

The traditional way to index a library collection is to provide a catalog entry under the title, author and major subject of each document. The process of finding information on a specific topic is often very inefficient with such a traditional index:

> ". . .a knowledge of how and where to find the record of a fact is often of more practical use than a knowledge of the fact itself. . ."
>
> "When a physician has observed a fact . . . which he wishes to examine by the light of medical literature, he is often very much at a loss to know how to begin . . . . The information he desires may be . . . next his hand, but how is he to know that? And even when the usual subject category is placed before him, he finds it very difficult to use it, especially when . . . he has by no means a well defined idea as to what it is he wishes to look for. . . . To find accounts of cases similar to your own rare case, you must know what your own case is. . . the subject catalogue . . . will often seem . . . a very blind guide to one who is not familiar with the classification and nomenclature adopted by the compiler. . . . very often the title of a book gives little information as to its contents . . ."
>
> ---John Shaw Billings (1881)[1]

Doctor Billings' exasperation with subject catalogs would only increase were he faced with the malignant growth rate of the modern periodical literature.

Many of the difficulties in the retrieval of the information contained in written articles are much the same today as they were in 1881. Some of the principal problems are:

1. Even a simple paper usually contains several important concepts, methods, or measurements, not all of which can be referred to in the title.

2. An interested investigator may call a certain phenomenon by a particular name while the author of another article about the same phenomenon may use an entirely different synonym.

3. A researcher may be able to state his problem intelligently but if that statement is not couched in the conventional language of the specialty field concerned, he will not find many articles whose titles would suggest that they are relevant to his problem.

4. The volume of the literature, and its specificity, are so extreme that an individual can only be intimately familiar with a small, specialized segment.

The old subject catalog still is useful, however, in providing a framework for orderly sequencing of documents within a file. It is also useful in the event that other data retrieval aids are unavailable due to distance or mechanical failure. In such cases, a logical file organization is certainly better than a random numbering system. A detailed subject catalog is also useful for browsing and to establish the scope of a collection.

Additional aids to data retrieval are essential, however, for rapid and efficient use of a literature collection. In the classification developed in this study, a catalog is used and it serves as the basis for giving a unique accession number to each document within the file.

Key Word Systems

A group of key words (a "key word" may actually consist of a short phrase), a key word list, can represent the contents of an article more comprehensively than a title. The concept of the key word could be used with a catalog system, but it would require a catalog entry for each reprint under each of its key words. In addition to the size of such a catalog, access to a particular card would be a tedious process. The retrieval of reprints on the basis of key word lists is practical only because modern devices can be used to store and search large lists and source information efficiently. The same automatic devices also add great power to the technique because they can be instructed to search for specified key word combinations as well as single key words. Reprints whose associated key word lists omit certain key words can also be selectively recovered.

The use of large digital computers has revolutionized the storage and retrieval of information in general, but the methods of data processing are just beginning to be applied extensively to library sciences. The primary reason for the time which elapsed between their use in science and business and their application to library systems is their high cost. Fortunately, this cost is

rapidly decreasing. Also, a number of far less expensive but highly useful automatic retrieval aids are available. A few of these will be described.

Key Word Retrieval Aids

The cost spectrum for retrieval aids ranges from two dollars for a deck of special cards to a multi-million dollar outlay for a computer system. Naturally, the convenience and capacity of the systems is to some degree proportional to their cost. The most popular methods fall into the categories of: punch card/mechanical retrieval; punch card plus microfilm/electronic retrieval; microfilm/electro-optical retrieval; and fully computer controlled systems.

The punch cards for mechanical retrieval are circumferentially lined with numbered holes which can be converted to slots with a simple hand tool. When a sorting rod is pushed through a particular peripheral hole, only the cards slotted at that position drop out of the deck. A sample card from a representative system is shown in Figure 1. To use these, a separate card is prepared for each reprint. The face of the card contains in printed form accession information for recovery of the reprint from the file and it may also contain a written abstract. The key word list is encoded into the peripheral holes by slotting a

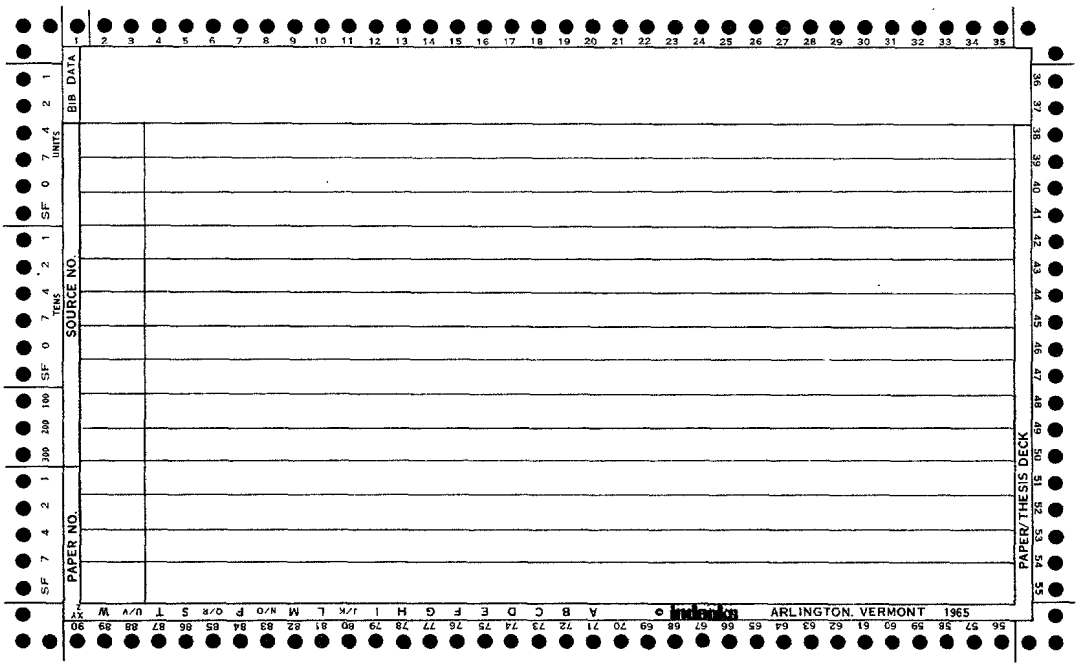

Figure 1. Typical edge-punched data storage card for mechanical retrieval.

specific edge hole for each key word desired (each key word in the system is assigned a hole number). The capacity of the system is limited with respect to possible key words by the total number of edge holes (116). As many reprints as desired can be accommodated by increasing the number of cards. Access time increases slightly as more cards are added.

Another punched card system has a larger key word capacity but is a little more expensive and difficult to use. In this system each card represents a key word rather than a reprint. Each card can be drilled with a precision machine in one of ten thousand spots. Each hole location can be uniquely identified by its coordinate position on a 100 x 100 position grid-ruled pattern. To enter a document into the system, it is first assigned an arbitrary number from one to ten thousand for accession, and the printed material is then stored under that number in a simple sequential file system. To encode key words, the cards corresponding to the desired key words are removed from the system and drilled in the spot whose coordinates represent the accession number of the document being entered. To recover the specific reprints associated with a single key word the card representing that key word is placed on a special reader, which is mainly a back-lighted ground glass screen with a finely ruled 100 x 100 division grid. By simply looking at the back-lighted screen through the card, the location of the drilled holes and the associated document accession numbers can be read. Key word cards can be used in combination by superimposing them when they are placed on the reader. If this is done only the accession numbers corresponding to hole locations drilled through on both key word cards will be read. The system can accommodate 10,000 reprints per card deck and there is no limit to the number of key words used. Each new key word card slightly increases the recovery time for a typical application of the system. A ten-year accumulation of reprints in Nephrology has been successfully indexed by this method[2].

The next most complex method is the use of an automatic card sorter such as the type made by International Business Machines. With this system, each card carries either written accession information for a single reprint, or it may carry the entire reprint (or an abstract) on microfilm incorporated into the card construction. The key words associated with the reprint are encoded in the form of punched holes in specified locations on the card[3] (figure 2). The maximum number of columns of holes is eighty for a standard card. Each column can represent either a number from 0 to 9 or any letter of the alphabet. Usually the key words are not punched on the card in alphabetic form. Rather, for efficiency, a number is assigned to the key words and the number is punched

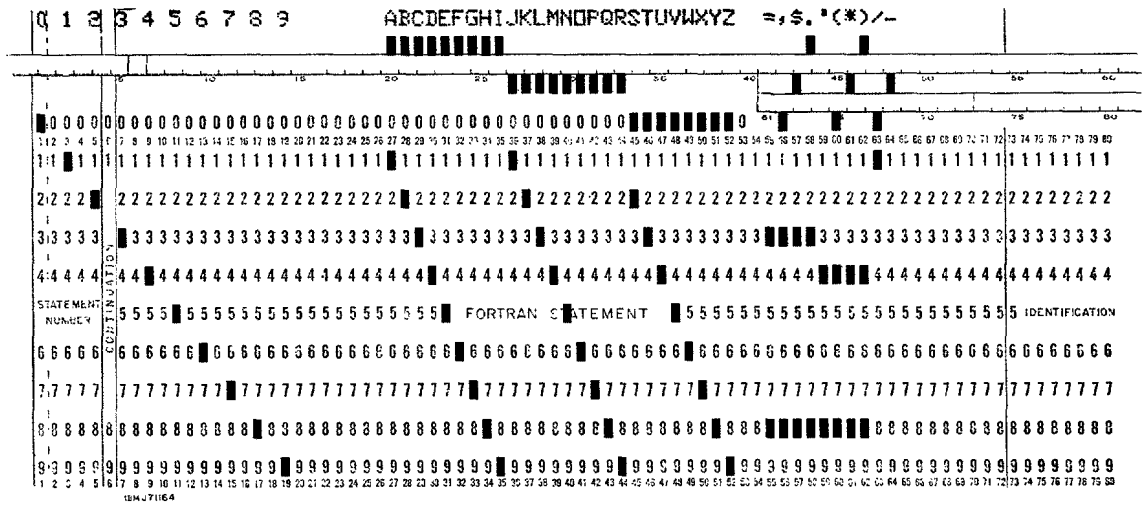

Figure 2. Typical punched card for automatic sorting.

on the card.

The capacity of such a system can easily be demonstrated. For example, if it is assumed that 9,999 key words are sufficient, each key word can be represented by a four-digit number. When it is punched into a card, such a four-digit group is called a field. Since each card can hold eighty columns of information and each field is composed of four digits, each card will hold twenty fields. Should more than twenty key words be required for any reprint, the key word list can be "continued" on a subsequent card. Thus, the system has no absolute limit, either with reference to the number of reprints which can be accommodated, or with respect to the number of key words per reprint.

Punched card/electronic retrieval systems are relatively fast and the equipment required, while fairly costly, can be leased at reasonable rates. The principal practical problems are those of handling large numbers of cards and manually introducing them into the sorting device. In addition, the systems which include microfilmed copies of the filed publications on the punched card often yield reproductions of rather inferior quality.

Microfilm systems have undergone important recent improvements. For example, one of the most modern, the Kodak Miracode*, carries information entirely on sixteen millimeter microfilm encased in easily-handled cassettes. The entire text of the stored documents is usually contained in the films though selected portions or abstracts can, of course, be stored instead. A key word list associated with each reprint is carried on the film in the form of an optical code. A "retrieval station" is able to scan the films at extremely high speeds, stopping automatically at the desired document which can then be viewed on a screen or reproduced in printed form.

The capacity of this system can be illustrated in the same way as that of a punched card deck. Each film "frame" unit can hold one page of a document or, alternatively, three columns of coded data for retrieval purposes, plus certain other information such as automatic verification and a "utility bit." Finally, each one hundred-foot cassette of film holds 3000 frame units. It is easy to show that if each reprint is assumed to occupy ten pages, each key word is allowed four digits for identification and twenty key words are allowed per reprint, about eighty reprints with their associated key word lists can be accommodated per cassette of microfilm. Since the number of cassettes can be increased without limit, the system is indefinitely expandable.

The most rapid and versatile methods are based entirely upon computer storage of data and fully automatic retrieval. One major advantage of the computer systems is that they do not restrict the choice of key words to a predetermined numbered list as do the methods described above. Instead, any "non-trivial" word may be a key word (articles, conjunctions and such are trivial). Very large capacity systems may store only selected data such as: accession information, title, author, journal data, and perhaps author affiliation. An unusual service, ASCE III**, also includes the references listed in the filed article's bibliography. Thus, a paper can be found on the basis of

*Eastman Kodak & Company, Rochester, New York.

**Institute for Scientific Information, 325 Chestnut Street, Philadelphia, Pennsylvania 19106.

earlier work which it cites. An extremely convenient service is provided by Data Central*, whose system files the full text of desired articles or abstracts and makes each non-trivial word within the text into a key word. Not only may combinations and omissions of key words be included in recovery instructions, but the spacing of the words within the text can also be specified. The operation of the system is carried on by continuous dialogue with the computer so that the user can narrow the search as necessary. An internal synonym dictionary is included in the system and the search automatically encompasses synonyms to the key words requested.

In summary, it is possible to use a number of mechanical and electronic devices to help in the recovery of information on the basis of a list of key words. The ultimate generalization of the principle is illustrated by the computer system which includes every word in the file as a key word. There are clear tradeoffs, which must be made between cost, capacity and convenience. The simplest systems become unwieldy if their capacity is stretched too far. The other chief disadvantage of all but the most advanced computer systems is that the user is limited to a specified dictionary of key words. While the access time for the computer systems is very short and almost independent of the system's size, their usefulness is still limited, primarily, by their high initial and operating costs.

*Data Corporation, 7500 Old Xenia Pike, Dayton, Ohio 45432.

CATALOG ORGANIZATION

The Catalog

The catalog is simply a list of all documents in the literature file, arranged in accord with the principal subject of their contents. In this way, the catalog provides an alternative to a key word search when recovery of information of a relatively general nature is required. Each catalog entry contains the author and the title of the document, its original source and a key word list. An abstract may be added at a later date.

If a catalog of this type is restricted to a relatively specific subject area, such as "environmental medicine related to aviation," the arrangement of the contents can be tailored to fit the topics important to the speciality field covered. For example, in this literature file, most papers will fall into just four large groupings: basic sciences (chemistry and physics, mainly), sampling methods, analytical methods, and toxicology (biological effects of toxic materials). Within each of these groups, further classification can be made on the basis of the approach to the subject. For example, a specific chemical agent, an analytical or experimental method, or a particular biological effect may be the parameter of major concern to the author. The process of refinement of the classifications is continued until the most specific groups contain manageable numbers of entries from the point of view of convenient scanning by a reader.

Accession Numbers

The accession number is simply an identifier for each document in the file. Each item in the collection is filed logically by accession number for fast recovery. The present and projected size of the literature collection dictates the configuration of the accession numbers. For this group of documents, they were made to allow three groups of classification plus an individual reprint number within the most specific group. The way in which a typical accession number is written is seen below (Figure 3).

Major Group	Minor Group	Subgroup	Individual Number
1 2	3 4	5 6	0 7

Figure 3. Arrangement of Accession Numbers

Individual numbers within the subgroup are assigned in chronological order in which the documents are received and have no specific meaning. Obviously, as long as a space is used to separate the groups when they are written, the number of entries in each group can be indefinitely enlarged. However, if direct use of these accession numbers in a computer is desired, it would probably be desirable to specify a maximum size of "field," say three or four digits, that each group would be allowed to occupy.

A few simple conventions ensure a uniformly-consistent system:

1. Each major group contains two or more minor groups. The first minor group is always a "miscellaneous" group.

2. Miscellaneous entries are those which do not fit into any other classification. When sufficient miscellaneous entries of the same type have been accumulated, they are used to start a new group.

3. In the catalog listings, major groups will be printed in capital letters, minor groups in lower case and subgroups will be indented.

The full catalog subject headings as of the date of this publication appear as Appendix I.

THE KEY WORD DICTIONARY

The initial word list selected for this literature file was based upon the capacity of an edge-punched card system. As the study progressed, the USAARL announced tentative plans to purchase either an electro-optical or a computer storage and retrieval system. The key word selection program was, consequently, modified.

Key words can be arranged logically under topical headings in the same way as catalog entries can. The key words are, however, usually much more specific than catalog headings because there can be far more of the key words and they can be used in logical combinations. The major subject headings chosen for the key word dictionary are:

BASIC SCIENCES (CHEMISTRY AND PHYSICS)	06
LISTING OF AGENTS (GASES AND VAPORS)	11
LISTING OF AGENTS (PARTICLES AND AEROSOLS)	19
LISTING OF STUDIES (GROUPED BY ENVIRONMENTS)	25
SAMPLING METHODS	31
ANALYTICAL METHODS	39
BIOLOGICAL EFFECTS	51

Two special key word categories were added. One identified REVIEW ARTICLES (01). A review article, as here defined, is one in which a subject is covered broadly or a number of research papers are discussed. Such an article may report new data as well, if its discussion of antecedent works is sufficiently comprehensive. Reviewers who select key words will be called upon to use judgment in assigning this category since almost all research papers include brief comments intended to provide background information. The designation of REVIEW ARTICLE should be reserved for those which are clearly of value in obtaining a broad summary of the desired subject.

The second special category relates to the relevance of the paper to interests of the USAARL. Since this is obviously a subjective decision which will vary with time as the projects change at USAARL, it would be desirable to review it regularly. Articles of no unusual interest to the Army are not keyed at all in these categories. Articles of moderate interest are keyed MODERATELY RELEVANT (03) and those of special value are keyed HIGHLY RELEVANT (02). Investigators interested in recovery of articles of moderate relevance would key both 02 and 03, since obviously articles of "more than

moderate or high relevance" would interest them also.

The key word dictionary appears as Appendix II. In this appendix, the key words are grouped by subject. The most general key words are printed in capital letters and underlined. The next most general are printed in capitals and assigned numbers corresponding to the initial edge-punched card key word selections. The most specific key words are printed in lower case and will not be assigned numbers until a definite data storage system is acquired by USAARL.

SUMMARY

A method for orderly storage and rapid retrieval of reprints in environmental medicine was developed. The documents are stored by accession numbers which are based upon the principal subject covered. A list of key words is appended to each entry in the accession number catalog. Thus, conversion to automated recovery should be easy. This report includes a list of current catalog subject headings and key words.

References

1. Billings, J. S., "Our Medical Literature," Transac. Int. Med. Congress, London, 1881 (cited in MD, July 1969, pp 48 and 52).

2. Kaye, M. and R. Nyeky, "A Reprint Retrieval System for Nephrology Using Termatrex Cards," Canad. Med. Assn, J. 98:781-784, 1968.

3. McCracken, D. D., "A Guide to COBOL Programming," pg. 28-29, John Wiley, 1963.

APPENDIX I

ENVIRONMENTAL MEDICINE REPRINTS:

SUBJECT HEADINGS AND ACCESSION NUMBERS

BASIC SCIENCES
(01 00 00)

01 01 00	miscellaneous
01 02 00	meteorology and atmospheric diffusion
01 03 00	chemical kinetics, equilibria, interactions
01 04 00	model studies, exhaust composition predictions, computer simulation of reactions, microrockets

SAMPLING METHODS (LISTED BY TYPE OF AGENT)
(02 00 00)

02 01 00	miscellaneous
02 02 00	gases and vapors
02 03 00	particles and aerosols

ANALYTICAL METHODS (LISTED BY TYPE OF AGENT)
(03 00 00)

03 01 00	miscellaneous
03 02 00	aldehydes
03 03 00	alkylating agents
03 04 00	ammonia
03 05 00	carbon monoxide
03 05 01	miscellaneous
03 05 02	in air by low cost tube methods

03 05 03	in air, instrumental methods
03 05 04	in blood by direct blood gas analysis
03 05 05	in blood by estimation from alveolar air
03 05 06	in blood and tissues at postmortem examination
03 06 00	carbon dioxide
03 07 00	oxides of nitrogen
03 07 01	miscellaneous
03 07 02	nitrogen dioxide
03 08 00	hydrocarbons
03 08 01	miscellaneous
03 08 02	halogenated
03 09 00	lead
03 10 00	particles
03 11 00	weapons exhaust
03 12 00	vehicular exhaust
03 13 00	sulfur dioxide

ANALYTICAL METHODS (LISTED BY TYPE OF METHOD) (04 00 00)

04 01 00	miscellaneous and multiple methods
04 02 00	colorimetry
04 03 00	gas chromatography
04 04 00	mass spectrometry
04 05 00	infrared spectrometry
04 06 00	thin film sensors
04 07 00	microdiffusion analysis

04 08 00 inflammable or explosive vapor detectors

04 09 00 NBS type detector tubes and low cost kits

04 10 00 particle counting and sizing

04 11 00 blood gas extraction

ANALYTICAL METHODS (MISCELLANEOUS GROUPINGS) (05 00 00)

05 01 00 miscellaneous

05 02 00 calibration technique
05 02 01 miscellaneous
05 02 02 gas mixtures
05 02 03 gas flow rates

TOXICOLOGY AND BIOLOGICAL EFFECTS (BY AGENT) (06 00 00)

06 01 00 miscellaneous

06 02 00 acetaldehyde

06 03 00 acrolein

06 04 00 ammonia

06 05 00 anoxia or hypoxia

06 06 00 beryllium

06 07 00 carbon monoxide
06 07 01 miscellaneous
06 07 02 rate of uptake and metabolism, pulmonary diffusion, ratio of blood to alveolar levels
06 07 03 psychomotor changes, visual, sensory threshold shifts
06 07 04 cardiovascular effects
06 07 05 hematological effects
06 08 06 specific effects related to aviation
06 08 07 chronic effects

06 09 00	cigarettes
06 10 00	hydrocarbons
06 11 00	hydrogen sulfide
06 12 00	iron and its compounds
06 13 00	lead and its compounds
06 14 00	ozone
06 15 00	peroxyacetyl nitrate (PAN)
06 16 00	propellants and explosives excluding gasoline (for gasoline and jet fuel, see hydrocarbons)
06 17 00	sulfur dioxide
06 18 00	pesticides and defoliants
06 19 00	chemical warfare agents
06 20 00	thermal decomposition products of plastics
06 21 00	triaryl phosphate (as used in hydraulic fluids)
06 22 00	dimethyl hydrazine
06 23 00	vehicular exhaust
06 24 00	oxides of nitrogen including nitrogen dioxide
06 24 01	miscellaneous
06 24 02	uptake and metabolism
06 24 03	cardiovascular effects
06 24 04	hematological effects
06 25 00	tetrachloroethylene
06 26 00	tricresyl phosphate (TCP)
06 27 00	mineral particulates

06 27 01 miscellaneous
06 27 02 pulmonary retention
06 27 03 synergistic effects

TOXICOLOGY (BY ENVIRONMENT) (07 00 00)

07 01 00 miscellaneous

07 02 00 aircraft, not including spacecrafts and armed helicopters

07 03 00 space capsules and spacecrafts including simulators

07 04 00 armed helicopters

07 05 00 naval problems including submarines and ship-launched missiles

07 06 00 tanks and self-propelled guns

07 07 00 rockets used as vehicles

07 08 00 rockets used as weapons

07 09 00 highway tunnels

07 10 00 cities

07 11 00 industrial including garages

TOXICOLOGY BY EFFECT AND SYSTEM (08 00 00)

08 01 00 miscellaneous

08 02 00 synergism and inhibition

08 03 00 pulmonary

08 04 00 psychomotor
08 04 01 miscellaneous
08 04 02 visual
08 04 03 auditory

08 05 00	carcinogenic
08 06 00	irritant
08 06 01	miscellaneous
08 06 02	eye
08 06 03	lung

TOXICOLOGY (MISCELLANEOUS GROUPINGS) (09 00 00)

09 01 00	miscellaneous
09 02 00	treatment of toxic exposure
09 03 00	prevention of toxic exposure including equipment
09 04 00	facilities and devices for toxicology experiments
09 05 00	exposure limits
09 05 01	miscellaneous
09 05 02	specific data for multiple agents (for single agents see "Toxicology by agents," 06 00 00)
09 05 03	criteria and methods

APPENDIX II

ENVIRONMENTAL MEDICINE REPRINTS:

KEY WORDS TO 1 NOVEMBER 1969

01	REVIEW ARTICLE
02	RELEVANCE HIGH
03	RELEVANCE MODERATE
04	SPARE
05	SPARE
06	BASIC SCIENCES - CHEMISTRY AND PHYSICS
07	METEOROLOGY atmospheric diffusion
08	REACTION STUDIES computer assisted calculations of exhaust composition reaction rates and kinetics interactions of reactive components
09	SPARE
10	SPARE
11	LISTING OF AGENT - GASES AND VAPORS
12	AMMONIA
13	CARBON MONOXIDE
14	CARBON DIOXIDE
15	OXIDES OF NITROGEN nitrogen dioxide

16	SULFUR DIOXIDE
17	OXIDANTS (other than NO_2) ozone peroxyacetyl nitrate (PAN) free radicals
18	SPARE
19	LISTING OF AGENT - PARTICULATES AND AEROSOLS
20	LEAD
21	COPPER iron
22	MISCELLANEOUS MINERALS silicates fibers metals not previously listed
23	MICROBIOLOGICAL AEROSOLS bacterial viral
24	SPARE
25	LISTING OF STUDIES - GROUPED BY ENVIRONMENT
	(closed space contamination analysis results on multicomponent mixtures)
26	VEHICULAR EXHAUSTS turbines (gas) diesel internal combustion rocket (transportation)
27	WEAPON EXHAUSTS machine guns rockets (as weapons) cannon tanks naval missiles armed helicopters

28 CIVILIAN ENVIRONMENTS
urban air quality
garages
industrial health
tunnels

29 AIRCRAFT ENVIRONMENT
fuels
hydraulic fluids
degradation products of structural materials in fire
paint vapors
space craft interiors

30 SPARE

31 SAMPLING METHODS

32 TRAPPING TECHNIQUES
cryogenic condensation
plastic bags
evacuated cylinders
sequencing devices
air pumps
sampling accessories
sample interaction (see also REACTIONS 08)

33 IMPINGERS
liquid adsorption

34 ELECTRO-OPTICAL SAMPLERS (PARTICULATE)

35 PRECIPITATION
cyclones
electroprecipitation
Andersen sampler
cascade impactor

36 FILTRATION
millipore filters
high volume samplers

37 SPARE

38 SPARE

39	ANALYTICAL METHODS
40	SPECTROSCOPIC METHODS light ultraviolet infrared
41	SPECTROSCOPIC METHODS mass nuclear magnetic resonance microwave others (specify)
42	GAS CHROMATOGRAPHY
43	INDICATOR TUBES NBS types miscellaneous types comparative studies of indicator tubes
44	WET CHEMICAL METHODS
45	BLOOD CASES extraction methods analytical methods
46	PARTICLE SIZE ANALYSIS size distribution by count size distribution by weight or volume
47	ADSORBED GASES ON PARTICLES
48	CALIBRATION gas mixture preparation gas flow calibration preparation of reagent standards instrument calibration
49	SPARE
50	SPARE
51	BIOLOGICAL EFFECTS
52	ACUTE EFFECTS brief exposures

short term effects
high dose-rate experiments

53 CHRONIC EFFECTS
long term exposures

54 METABOLIC HANDLING AND UPTAKE - GASES AND VAPORS
rate of absorption or uptake
metabolism and internal detoxification
excretion
relationship of blood and alveolar levels

55 PARTICLE RETENTION
measurement methods
retention as a function of size

56 IRRITATION
eye
lung

57 STRUCTURAL INJURY
biochemical changes
histological changes
enzymatic tests
urinary test results

58 PSYCHOLOGICAL EFFECTS
psychomotor effects
visual threshold
temporal discrimination
reaction time

59 SYNERGISM
inhibition

60 EXPOSURE LIMITS
methods
philosophy
data LD50
data EV50
data MAC
data threshold limit values (TLV)
data short term values

61 RESEARCH FACILITIES
toxic hazard evaluation laboratories
toxic hazard evaluation devices
exposure chambers
human experimentation

62 PREVENTION AND TREATMENT
hazard control devices
gas masks and respirators
shields
special suits

63 PHYSIOLOGICAL EFFECTS (BY SYSTEM)
cardiovascular
respiratory
neurological
renal
hepatic