Conf-740424--3

MATERIALS INFORMATION SERVICES OF THE ENVIRONMENTAL INFORMATION SYSTEM OFFICE AND THE TOXIC MATERIALS INFORMATION CENTER[1]

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The Environmental Information System Office offers to users bibliographic references, factual information, numerical data, and evaluated reviews of data in and for all of the major environmental research areas active at Oak Ridge National Laboratory: energy, trace contaminants, human health, environmental impact, radiation research, land use and planning, ecosystems modeling, and analysis. The Toxic Materials Information Center is a materials-oriented center dealing with trace contaminants in the environment with particular emphasis on metals and organo-metallic compounds.

Funded by several federal agencies, EISO and TMIC services are available to all users, with priority accorded to the funding agency and other governmental agencies in that order. Limitations to outside use are determined by funding and staffing levels of the individual center.

Keywords: Air pollution, analysis, ecology, energy, environmental impact, land pollution, mutagenicity, toxic materials, toxicology, trace contaminants, water pollution

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[1]Work supported by the National Science Foundation RANN Program under NSF Interagency Agreement No. Ag 389 with the U. S. Atomic Energy Commission at Oak Ridge National Laboratory operated by Union Carbide Corporation for the USAEC under Contract No. W-7405-eng-26.

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INTRODUCTION

To complement and augment its research efforts in environmental areas, Oak Ridge National Laboratory (ORNL) maintains a large-scale environmental information network known as the Environmental Information System Office (EISO). Under the direction of Dr. Gerald U. Ulrikson, EISO offers to ORNL and other users entry to the information retrieved in and for all of the major environmental research areas active at ORNL: energy, human health, environmental impact, radiation research, trace contaminants, land use and planning, ecosystems modeling and analysis. The organization is outlined in figure 1. The Toxic Materials Information Center (TMIC) is one of several affiliated information centers within this information network, and it stresses the environmental aspects of trace contaminants; the human health aspects are covered by other information centers such as the Toxicology Information Response Center (TIRC) and Environmental Mutagen Information Center (EMIC).

EISO has component information centers or data collections related to the areas of biomedical sciences, ecological and environmental sciences, physical and chemical sciences, and maintains a central services unit.

The Biomedical Sciences Section includes the Biomedical Studies Group (BMS), the Toxicology Information Response Center (TIRC), and the Environmental Mutagen Information Center (EMIC). Services rendered by the Biomedical Sciences Section include toxicology literature collection and evaluation, data extraction and data base building, state-of-the-art reviews, and consultation. These services can be used to discern real and potential biologic effects and hazards due to human interactions with chemicals. Topical subject areas and disciplines are selected for extensive literature review and reference collection. State-of-the-art reviews are prepared either internally by BMS or contracted externally to topical experts in selected fields of competence. The reviews are submitted for publication in recognized scientific journals. Longer reviews or those containing an extensive bibliographic section (keyworded and annotated references) are printed as BMS-ORNL publications. The toxicology data extraction and resultant data base building involve selection and utilization of basic source references, types and definition of data elements, and correlation with scientific research evidence. The BMS is funded by the Toxicology Information Program, National Library of Medicine; the U. S. Forestry Service, U. S. Department of Agriculture; the U. S. Atomic Energy Commission; and the Environmental Protection Agency.

The Toxicology Information Response Center, sponsored by the National Library of Medicine's Toxicology Information Program, was formed in the fall of 1971 to establish a national and international center of toxicology information. It provides information on a wide variety of chemical classes; pharmaceuticals, industrial chemicals, food additives, pesticides, and environmental pollutants. Requested information may range from a specific toxicologic datum to metabolic, pharmacologic, and other biologic phenomena. The center utilizes various information sources such as MEDLINE, TOXLINE, and ORNL computerized data bases and secondary sources including Biological Abstracts, Chemical Abstracts, Excerpta Medica, Index Medicus, and others. TIRC's resources and services are available to all individuals. There is a charge for services, based on the scope, time coverage, and type of product required - bibliography, annotated bibliography, and others.

The Environmental Mutagen Information Center was organized by the Environmental Mutagen Society (EMS) in 1969. EMIC's mission is to create, maintain, and disseminate a data base of chemical mutagenesis information. Information contained in the EMIC data file is either pertinent to the testing of chemicals in one of the many available mutagenic assay systems or contains data useful for understanding the known or suspected mutagenic activity of environmental chemical agents. The information collected for this data base is processed and disseminated to the scientific community. The Center's citation file currently contains 12,000 entries for articles published primarily since 1961 in about 1,200 publication sources. This information file contains bibliographic details and keywording of chemicals, organisms, and systems studied. To make this information easily available, bibliographies with permuted title and author indices are printed and distributed to individuals active in mutagenesis research. When specific questions arise in the scientific community or among health officials, special literature compilations are selected and printed. To make these data more convenient, EMIC has initiated a tabular abstraction of selected data in its holdings. These data are entered into computer files linked to the citation file. The staff of the Center also prepares literature reviews at periodic intervals on urgent problems involving the widespread occurrence of specific mutagens in the human population. Yearly reviews of the literature reporting mutagenic action of chemicals are also produced by EMIC. EMIC is funded jointly by the National Cancer Institute and the National Institute of Environmental Health Sciences.

Ecological and environmental sciences information groups include the Toxic Materials Information Center (TMIC) and the Environmental Response and Referral Group (ERRG). TMIC collects, stores, and disseminates pertinent information on materials in the environment, with particular emphasis on metals and organometallic compounds. TMIC was established as a project support center for NSF-RANN funded Ecology and Analysis of Trace Contaminants (EATC) program at ORNL. The Center's activities have become quite diversified since its inception and its multiple objectives include the following: to serve as the focal point for all information acquisition, storage, retrieval, and dissemination for the 14 EATC task groups; to serve as an information line between EATC task groups and with external groups with similar interests; to prepare and issue bimonthly the NSF-RANN Trace Contaminants Abstracts and newsletter covering the activities of the nationwide Trace Contaminants Program of NSF; to prepare and publish periodically an indexed directory to all NSF-RANN Trace Contaminants Program participants; to respond to inquiries for information on toxic materials in the environment from researchers, administrators, and laymen; to create data bases from which inquiries can be answered and special bibliographies can be drawn and published once the need for such has been demonstrated; to maintain distribution lists and special directories for the EATC Program; to extract environment data in a tabular format for certain environmental pollutants; to participate in the preparation of state-of-the-art reviews; and to provide information services to the EPA/AEC Testing Protocols for Environmental Transport Study under way at ORNL.

The Environmental Response and Referral Group responds to requests for environmental information from sources all over the world; provides information services to ORNL research teams engaged in preparing environmental impact statements for nuclear power plants; cooperatively exchanges information with USDA Forest Service in establishing a forest thesaurus, in establishing various

environmentally oriented Forest Service data bases, and in preparing input to technical documents for publication; maintains a computerized record of all documents ordered for ORNL's environmental scientists (Document Acquisition and Control, or DAC); maintains a small but selective environmentally oriented resource center with, for example, a complete set of environmental impact statements for all nuclear power plants, the Great Lakes Bibliography, and a complete set of the Nuclear Science Abstracts; maintains a directory of technical environmental specialists and centers by location, telephone numbers, discipline training, and interest; and prepares state-of-the-art or generic documents as required.

EISO information activities in the area of physical and chemical sciences center on the Energy Information Center and the Energy Research and Development Inventory. The current Energy Information Center began as a project support center for the NSF-RANN funded energy work at ORNL and serves as a nucleus for the emerging energy information complex at ORNL. This energy data base now includes 2,800 bibliographic entries, covering energy in general: electric power (generation, transmission, distribution, supply and demand studies, economic studies, forecasts of supply and demand, use); energy sources (coal, petroleum, natural gas, shale oil and tar sands, hydrogen, nuclear, solar, geothermal, and other unconventional sources such as wastes, wood, tidal, and wind); energy (conservation, supply and demand studies, economic studies, forecasts of supply and demand, conservation, policy); environmental effects of energy (waste heat, air and water pollution); and energy uses (residential, commercial, industrial, agricultural, transportation).

The Energy Research and Development Inventory data base and publication were first prepared during late 1971 and early 1972 under sponsorship of the National Science Foundation. It is being updated and expanded under the additional sponsorship of the U. S. Atomic Energy Commission. Government agencies, academic institutions, private industry, and other sponsored research are being covered in the survey. The scope of research projects of interest is broad, including: (1) all types of energy sources - fossil fuels, nuclear, hydroelectric, solar, geothermal, tidal, wind, wood, plant, animal materials, and waste products; (2) electric power - generation, transmission, distribution, and storage; and (3) energy uses - residential, commercial, industrial, transportation, agricultural, and specialized applications. In addition to exploration, mining processing, resources and reserves studies in relation to energy sources, information on any basic or applied research, engineering development, economics, environmental effects, regulations, and legislation studies relevant to the above subjects are also of interest. Current efforts include improving format organization, revising subject categories, and broadening questionnaire and report dissemination. Based upon the results of this survey, the Energy Research and Development data base has been updated and released through the U. S. Government Printing Office.

The information storage and retrieval processes are performed by a centralized data processing and computer production group working in conjunction with ORNL's Computer Sciences Division. The Data Processing Center is responsible for the input of bibliographic, abstract, index, numeric, questionnaire, and other forms of data. Input is done through remote terminals or Magnetic Tape/Selectric Typewriter with upper and lower case capability to direct access computer files. The computer production group has the responsibility for submission,

follow-up, and other activities involved in the computer job aspects of data management, publication and indices production, searches, and other information areas required by EISO and several other ORNL groups.

This brief description of the overall Environmental Information System serves only to acquaint one with the framework of our consolidated information activities. Though each of these centers deals with "materials" in some context, our Toxic Materials Information Center is oriented toward the effects of specific materials being released to the environment. The activities and data holdings of TMIC will be covered in more detail, bearing in mind that the other centers in EISO are engaged to a large extent in similar activities relating to their respective specialities.

For an information system to operate in a relevant and timely manner, it must be conceived and designed for the user and remain service-oriented throughout its existence. Information needs of the users must be simply stated for the information system to meet its objectives. Table 1 lists five major general types of information needs as defined by our users and requested from our information systems.

Table 1. Environmental Information Needs

Bibliographic References
Directory of People, Places, and Projects
Inventory of Current and Proposed Research
Factual Information
Numerical Data
Assessment of Information

BIBLIOGRAPHIC INFORMATION

In recent years the emphasis of environmental research has changed from the small, individual disciplinary research projects, where researchers were aware of the state-of-the-art of a given project. Today many research projects are multi- and interdisciplinary applied research programs. Researchers of many disciplines (engineering, mathematics, chemistry, etc.) are now concerned with biological and ecological information in relation to the applied environmental programs currently being developed.

Many of the bibliographic services available are oriented toward disciplinary objectives, i.e., Chemical Abstracts, [1][3] Biological Abstracts, [2] Engineering Abstracts, [3] Physics Abstracts, [4] Metals Abstracts. [5] In

[3]Figures in brackets indicate the literature references at the end of this paper.

gathering the needed bibliographic information for a given request or building an interdisciplinary applied information base, an information system can use the large computer readable data bases produced by bibliographic services (Table 2). The repackaging of this information rather than building of new data bases is extremely cost effective and expedient. TMIC uses this method of data base creation as well as the time-honored method of manually selecting and abstracting pertinent papers for inclusion in certain data files. The Toxic Materials general data base contains approximately 9,600 abstracted citations in trace contaminants ecology, analysis and mathematical modeling. In addition, several specialized data bases are maintained; they are listed in Table 3.

Table 2. Examples of Computer Searchable Bulk Data Bases Available

Data Base	Frequency of Issue	Approx. No. of Records/Issue
BA (Biological Abstracts)	24/year	5,835
BRI (Bio-Research Index Biological Abstracts	12/year	8,333
CBAC (Chemical-Biological Activities, CAS)*	26/year	1,150
CAE (Chemical Condensates - Even Issues, CAS)*	13/year	7,900
CAIN (Catalog and Indexing System, National Agricultural Library)	12/year	11,000
CAO (Chemical Condensates - Odd Issues, CAS)*	13/year	4,900
NSA (Nuclear Science Abstracts)	24/year	2,700
USG (Government Research Abstracts)	12/year	2,200

*CAS = Chemical Abstracts Service.

The Toxic Materials Information Center compiles these data bases principally to meet its obligations as the focal point for information acquisition, storage, retrieval, and dissemination for the NSF-RANN Environmental Aspects of Trace Contaminants Program in general and as the project support center for the ORNL

Ecology and Analysis of Trace Contaminants Program funded by NSF-RANN. Once these data bases have been created and computerized, they are available to others through response to specific inquiries; also, special bibliographies can be extracted, indexed, and published directly from the computerized data bases without remachining the data. Examples of TMIC special bibliographies include Cadmium in the Environment, [6] Trace Elements in Sewage/Sludge, [7] and Environmental Transport of Chemicals. [8]

Table 3. TMIC Special Data Bases

Subject areas	Citations	Comments
Environmental modeling	8000	B
Trace elements in coals and other fuels	800	B
Trace contaminants in soils and sediments	1500	B
Cadmium	2500	B
Arsenic	900	B
Mercury	1450	B
Chlorine	880	B
Environmental quality indicators	600	A, C
Liquid wastes	250	A, D
Environmental transport	1005	E

A – file with abstracts
B – file partially with abstracts
C – created by W. A. Thomas, G. Goldstein, W. Wilcox, ORNL
D – created by W. J. Boegly and W. D. Griffith, ORNL, HUD funded
E – support data base for EPA/AEC study on environmental transport of chemicals

DIRECTORIES AND INVENTORIES OF CURRENT RESEARCHERS AND RESEARCH PROJECTS

A second important need of researchers is a directory of people, places, and current research projects. We keep this type of information in two degrees of completeness. The EISO computerized directory lists approximately 20,000 persons by name, address, telephone number, and various types of identifying labels and/or keywords. This directory is used to maintain distribution lists and to locate researchers and administrators. More sophisticated subsets can be prepared and used to maintain and publish directories for specific programs such as the NSF-RANN Trace Contaminants Directory. [9] Once these data bases are constructed, they can be used for searching "geographic locations" by "zip code" or area telephone number and/or experts by professional or research interest.

Comprehensive data files listing current research projects in detail are prepared wherever funding is available. This type of information base is important only if it is kept current. Two of our files (computerized and subsequently published) are: Inventory of Current Energy Research and Development, [10] and the NSF-RANN Trace Contaminants Abstracts. [11] The Trace Contaminants Abstracts is a bimonthly abstract journal recording where

results are being reported by the grantees in the NSF-RANN Trace Contaminants Program. The abstracts are accompanied by a more informal newsletter containing brief program notes and meeting notices and reviews. This abstract journal facilitates the exchange of information between the grantees as well as between the grantees and others interested in this area of environmental concern. If a program or agency will keep this information current, the contents can be used to produce annual progress reports by programs or agencies. This operation ultimately can save bench workers time in responding to their administrator needs.

FACTUAL INFORMATION FILES

It is becoming increasingly more important for information centers to answer questions rather than build comprehensive bibliographic files. Factual information about a chemical substance in the environment is necessary to assess the effects of that chemical. Many factual information files exist today; however, many of these have been produced with a single objective. There are desk top reference books such as the Chemical Rubber Publishing Company's Handbook of Chemistry and Physics [12] for chemical and physical data and Biology Data Book [13] for biological data.

The need has become pressing to reduce to a more assimilable form the scientific data contained in the growing volume of literature being generated. Both scientists and information processors are giving thought to developing a method of extracting and summarizing pertinent data from technical papers and reports without destroying the integrity of the data reported.

The necessity for establishing such data files, particularly in the area of toxic chemicals, has been recognized by such groups as the United Nations Advisory Committee on the Application of Science and Technology to Development, the Scientific Committee on Problems of the Environment of the International Council of Scientific Unions, and the United Nations Conference on the Human Environment. To date, Dr. Alexander Hollaender (Consultant) and Dr. F. Schmidt-Bleek of the University of Tennessee have been engaged in a feasibility evaluation of an International Registry of Potentially Toxic Chemicals as requested by the United Nations Advisory Committee on the Application of Science and Technology to Development. [14]

This proposed registry is viewed as a computerized compendium of data by various national and international agencies, designed to coordinate and stimulate activities at the international level to effectively reduce or eliminate the worldwide hazards from potentially toxic chemicals. The Toxicology Information Program, National Library of Medicine, under the direction of Dr. Henry Kissman, is also engaged in feasibility studies of a large-scale toxicology data file of this same general nature.

The Environmental Information System Office of ORNL is interested in proving the viability of the concept of such a large-scale system and is using the efforts of its individual information center units to construct various interlocking data files that show promise of conversion to a large integrated file. For example, the Environmental Mutagen Information Center (EMIC) has extracted and published data concerning the mutagenicity and

teratogenicity of a selected number of food additives. [15] In addition to published data, the EMIC funding agency now requires data from all its contractors to be added to this file. In this manner, EMIC will assimilate and distribute this information to all its users.

The Biomedical Sciences Section of EISO is defining the data field descriptors and beginning to extract toxicologically related information for the Toxicology Information Program of National Library of Medicine (figure 2). They are also engaged in extracting data for an insecticides file for the U. S. Forest Service.

The Toxic Materials Information Center is determining the feasibility of reducing scientific and technical data pertaining to the sources, transport, and fate of trace contaminants in the environment (figure 3). These data, to be machine-stored in their reduced form, could be subsequently ordered on any two subject categories and printed out in tabular form.

When these files are added together, making a comprehensive data file, information will be available to study the impact of chemicals or substances in the environment, and more complete information will be stored in one place for setting standards and criteria to protect environmental quality.

NUMERICAL DATA FILES

The last type of data, needed mainly by researchers but also decision makers, is numerical data bases concerning environmental measurements. With the growing concern for rational land use and planning, environmental impact of industrial and federal construction, and economic growth and development of man-made changes in our environment, there is a need for detailed unanalyzed numerical data that can be merged with other information for final assessment.

Though TMIC is not yet storing numerical data, information system specialists can play a major role in knowing where files are located, the content of the data files, the means of accessing the data, and the shortcomings and strong points of the data in relation to the applicability of data to the needs of the requestor.

ASSESSMENT OF INFORMATION

The information gathered in the files just described is often passed on to the requestor for evaluation. However, information systems can play a significant role in the evaluation of data and the subsequent preparation of reviews and state-of-the-art documents. Senior information specialists with academic specialities in the area under review can serve to unify the efforts of the more generally oriented information center staff with those of the highly specialized research participants or university professors to produce an extremely useful and accurate state-of-the-art document. TMIC participated

in the preparation of the review document Cadmium, The Dissipated Element [16], and has just completed a review on heavy metals in the aquatic environment in conjunction with Dr. Harry Leland of the University of Illinois to be part of the Journal of Water Control Federation yearly review issue.

CONCLUSIONS

Thus, TMIC and all of EISO strives to be flexible enough to handle all types of data needed by their user communities. Whether providing bibliographic references, factual information, numerical data, as evaluated reviews, the user's needs must be the keystone to the development and operation of all information systems.

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Fig. 1. Environmental Information System Office organization

Fig. 2. Toxicology data descriptors.

Fig. 3. Environmental data descriptors.

ORNL-DWG 73-12653

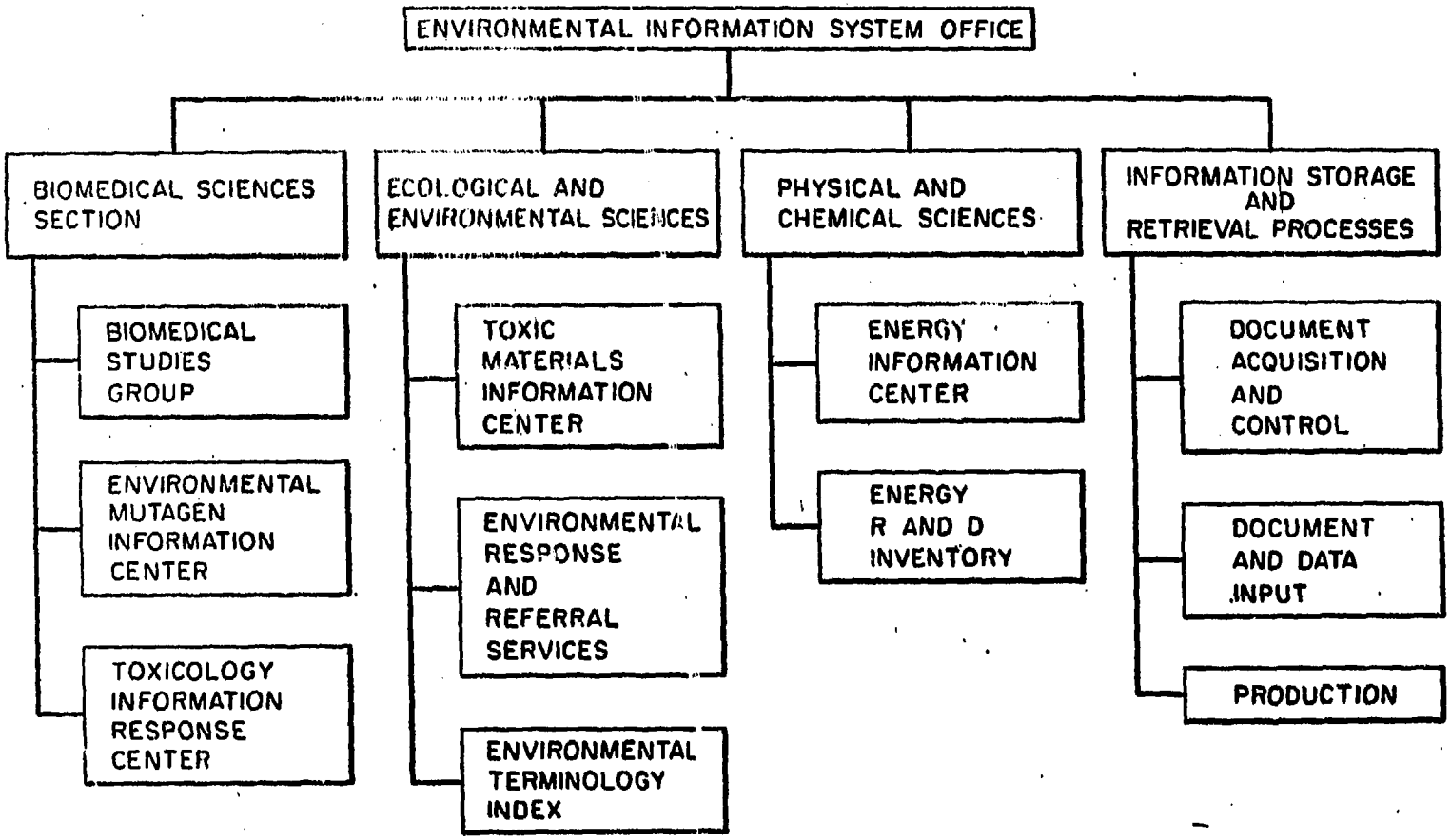

Fig. [illegible].1. Environmental Information System/Office Organization.

ORNL-DWG 73-6171

TOXICOLOGY DATA FILE

SUBSTANCE IDENTIFICATION	CHEMICAL	CAS NO.	MOL. FORM	NOMENCLATURE	SOURCE						
SUBSTANCE CLASSIFICATION	CHEMICAL CLASS	USE CLASS	THERAPEUTIC CLASS	SOURCE	EXPERIMENTAL CLASS						
PRODUCTION DATA	MANUFACTURER	PLACE OF PRODUCTION	DISTRIBUTION	STATUS	CHEMICAL GRADE	FORMULATIONS					
ORGANISM IDENTIFICATION	ORGANISM	ORGANISM NUMBER	LIFE STAGE	COMMON NAME	SOURCE						
ANIMAL TOXICITY	STUDY TYPE	SPECIES	STRAIN	ANIMAL DATA	ROUTE	DOSAGE DATA	SPECIFIC DOSE	SITE AND TEST NAME	BIO-EFFECT	SOURCE	
TERATO-GENESIS	SPECIES	STRAIN	ROUTE	PROTOCOL	EFFECT	ABSTRACT	SOURCE	SEX	GENERATION		
CARCINO-GENESIS	SPECIES	STRAIN	SEX AND NUMBER	RTE	DSGE	DURATION	TUMOR TYPE AND NUMBER	SURVIVAL DATA	SOURCE		
MUTA-GENESIS	ORGANISM	ASSAY SYSTEM	TREATMENT CONDITION	CONCEN-TRATION	TIME	TEMP	BIO-EFFECT	AUTH RMKS	ABSTRACT	EMIC NO.	SOURCE
APPLICATIONS	HOST	INSECT	INSECTICIDE	FORMULATION	DILUTION	METHOD OF APPLICATION	SAFETY	SOURCE			

Substance identification	1 Substance	2 CAS number	3 Molecular formula	4 Synonyms	5	6 Reference source		
Physical properties	7 Substance	8 Atomic/molecular weight	9 Melting point	10 Boiling point	11 Vapor pressure	12 Specific gravity	13 Solubility	14 Reference source
Environmental standards	15 Substance	16 Air ambient	17 Air emission	18 Water general	19 Water effluent	20 Water drinking	21 Comment	22 Reference source
Production/uses	23 Substance	24 Manufacturer	25 Location	26 Production (quantity)	27 Uses	28 Comment	29 Reference	
Disposal abatement	30 Substance	31 Environmental source	32 Disposal	33 Losses	34 Abatement	35 Comment	36 Reference source	

Environmental monitoring	37 Substance	38 Environmental source	39 Range/geography	40 Discharge form/quantity	41 Medium	42 Organism	43 Collection method/time	44 Method of analysis	45 Concentration	46 Other substances measured	47 Comment	48 Reference source
Transport/ persistency	49 Substance	50 Environmental source	51 Medium	52 Half-life	53 Physical changes	54 Chemical changes	55 Biochemical change	56 Organism	57 Comment	58 Reference source		
Biologic uptake/elimination	59 Substance	60 Route of entry	61 Organism	62 Tissue	63 Methods	64 Concentration/concentration factor	65 Half-life	66 Elimination rate	67 Comment	68 Reference source		