

Human health risk assessment: selected internet and world wide web resources[☆]

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Abstract

The world wide web (WWW) has become a valuable source of 24 hour-a-day access to information needed by human health risk assessors. Various web sites and other Internet resources provide information needed for human hazard identification, dose–response evaluation, exposure assessment, risk characterization, and risk management. Information on risk communication is also available. Substantial collections of information on multiple aspects of risk assessment are found in sites sponsored by RiskWorld, the (US) EPA's National Center for Environmental Assessment (NCEA), the (US) National Library of Medicine's TOXNET, the (US) Agency for Toxic Substances and Disease Registry (ATSDR), and the International Programme on Chemical Safety (IPCS). Also valuable are various web sites providing information on the physical and chemical properties of chemicals, the environmental fate and transport of chemicals, government regulations, and guidance and training for performing risk assessments. Several professional societies and other organizations have web sites addressing risk assessment issues and information, and there are Internet mailing lists for online help and for sharing information and perspectives. We classify selected web sites according to user needs and provide the reader with a collection of selected sites that can serve as entry points to risk assessment-related web resources. © 2002 Published by Elsevier Science Ireland Ltd.

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1. Introduction

Human health risk assessment involves the evaluation and quantification of potential health hazards to humans from exposure to substances and agents in their environment. This paper identifies selected world wide web (WWW) and other Internet resources that can assist those conducting or interpreting these assessments. It focuses on human health hazards primarily from exposure to substances in the environment. Government and private web sites from the US and elsewhere are highlighted. Web resources for evaluating ecologi-

[☆] The authors do not necessarily endorse any products or services mentioned in this paper, or provided via the Web resources described. They have no editorial control over the ongoing changes in Web site contents other than for the Toxicology Excellence for Risk Assessment (TERA) site. Readers should use caution and apply expert judgment when considering use of the information from Web sites.

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cal risks and occupational exposures are covered elsewhere in this series (Russum, Greenberg) and, therefore, have not been addressed here. The reader is also referred to Volume 157, Issue 1 of *Toxicology* (2001) that also was devoted to Internet resources for toxicology. Some of the subjects covered include toxicology information resources from the US EPA (Poore et al., 2001), other US government agencies (Brinkhuis, 2001), professional societies (Kehrer and Mirsalis, 2001), fee and non-fee information resources (Wright, 2001), Internet search engines and library catalogs (Wukovitz, 2001), digital education tools (Sharpe et al., 2001), and online resources for news about toxicology and related topics (South, 2001).

The National Research Council of the National Academy of Sciences (NAS) described the process of human health risk assessment in 1983 (NAS, 1983) and subsequently updated their paradigm in 1994 (NAS, 1994). NAS identified four steps for risk assessment. This paradigm has been adopted by risk assessment practitioners and provides a framework to evaluate the toxicity database for chemicals to which humans are or may be exposed, and to attempt to identify and quantify potential risks to health from these exposures. The risk assessment process is also used to estimate levels of intake that are expected to be 'safe'. These values are then used in conjunction with exposure information to determine acceptable levels for concentrations of hazardous chemicals in environmental media. Risk assessment, evaluation of the scientific data, is frequently distinguished from risk management; decision making based in part on the risk assessment information. In making risk management decisions, the risk manager may consider other factors such as economics, technical feasibility, public policy, and/or stakeholder considerations.

Examples of uses for risk assessment information include determining clean-up levels for hazardous waste sites, estimating consumer exposure to a product ingredient, decisions regarding land use, and setting drinking water standards for water supplies. Risk assessment is a multi-disciplined effort involving toxicologists, epidemiologists, biostatisticians, mathematical, and biological modelers, and others. Risk assessment efforts can

range from simple screening exercises to complex, multi-year projects that quantify risks for a range of exposures.

The four steps of the NAS paradigm are briefly described below. Government agencies and international bodies have used the NAS paradigm to provide a framework for their risk efforts, along with more specific guidance for evaluating and quantifying risk for agents causing specific types of effects. Sources for methodology and guidance documents will be noted below.

In the Hazard Identification step, one identifies the contaminants that are suspected to pose health hazards, quantifies the concentrations at which they are present in the environment, and describes the specific forms of toxicity (e.g. neurotoxicity, liver necrosis, and carcinogenicity) that can be caused by the contaminants of concern. The risk assessor then evaluates the conditions under which these forms of toxicity might be expressed in exposed humans. Much of the data needed for this step is primary scientific literature from the fields of toxicology and epidemiology. Conclusions regarding hazard are frequently expressed as a weight-of-evidence regarding the substance's potential to elicit a particular type of effect in exposed humans. This paper will not address resources for seeking primary literature to conduct this step, but rather will highlight sources for existing evaluations conducted by government agencies or other parties. The reader is referred to other papers in this series on specific toxicological endpoints (e.g. carcinogenesis, developmental and reproductive toxicology, and genetic toxicology), as well as the publication by Wright (2001) on searching toxicology databases.

The second step in the NAS paradigm is the Dose–Response Assessment, in which the quantitative relation between the dose and the response is described; this may involve the use of mathematical models. Variability in response, including individual differences in susceptibility would be considered. The result of the dose–response assessment is an estimate of risk, or sometimes an estimate of a 'safe' exposure or threshold for the effect of interest. Much of the data for risk assessment comes from laboratory animal research and in vitro and other alternatives to animal testing,

necessitating the use of scientific judgements to extrapolate to human exposure. A number of government entities (and a few private organizations) conduct evaluations of hazard and dose–response, writing substantial documents that describe and interpret the available data and estimate risks. Many of these documents are now available through the web, as well as compilations of risk estimates and summary information, which has been extracted from them.

Exposure Assessment involves specifying the population that might be exposed to the agent or substance, identifying how exposures can occur, and estimating the magnitude, duration, and timing of the doses to which people might be exposed. Exposure assessments are primarily site and/or situation specific evaluations. They require data on the specific population of interest, for example the exposures of the general public to consumer products and occupational exposures to industrial chemicals. The exposure factors of interest include those related to humans (e.g. human body weights, skin surface areas, food and drinking water consumption, and activity patterns), products (e.g. the frequency, duration, and amount used per task, and the concentration of the chemical of interest), and residences or workplaces (e.g. air changeovers per hour and house and room volumes). Examples of sources for these data are described.

Information from the preceding three steps is integrated into a Risk Characterization. The risk characterization includes a qualitative or quantitative estimate of the probability that any of the hazards will occur in those exposed. An evaluation of the overall quality of the data, the specific assumptions and uncertainties associated with each step, and the level of confidence in the resulting estimates is also included. Those making risk-based decisions will consider the conclusions of the risk characterization along with additional considerations such as costs, technological feasibility, or political climate. This paper will not cover resources in these areas.

There are thousands of web sites that include information that would be potentially useful for those conducting risk assessments. In this paper, we highlight some of these resources, particularly

those that broadly cover an area of risk assessment. Many of these sites include links to other sites and pages that the reader may find useful. Our selection of sources relies heavily on government sites, and primarily US federal sites. Several US federal agencies are at the forefront in human health risk assessment and in making their information available on the web, in particular the (US) Environmental Protection Agency (EPA). We also focused primarily on sites with information freely available to the public and those that we expect would maintain a presence on the web in the future.

Web resources for risk assessment have been organized below roughly along the lines of the NAS paradigm. We first highlight a handful of sites that contain significant basic information and links to other resources. Sections follow on hazard and dose–response information, physical and chemical properties, environmental fate, exposure assessment, risk perception and communication, regulatory information, guidance for conducting risk assessments, training, professional societies, organizations, and discussion groups. A brief description of each site is provided, outlining the types of information the reader will find.

The reader is cautioned that there is no central organization assuring quality of data made available on the web. Users should exercise caution when relying on data and advice and carefully consider the source. The authors of this paper are not responsible for the content of these sites. We do not necessarily endorse any products or services mentioned in this paper or provided via the web resources described. Also, we have no editorial control over the ongoing changes in web site contents other than for the Toxicology Excellence for Risk Assessment (*TERA*) site. Readers should use caution and apply expert judgment when considering use of the information in web sites.

2. General sites

A number of sites that contain substantial collections of information on more than one aspect

of risk assessment, or are gateways for access to other sites of interest have been highlighted in this section. They are presented here in alphabetic order and may be good starting points for general information or in searching for specific information.

2.1. (US) Agency for Toxic Substances and Disease Registry (ATSDR)

<http://www.atsdr.cdc.gov>,

<http://www.atsdr.cdc.gov/cx.html> Science Corner

ATSDR is an agency of the US Department of Health and Human Services. Its functions include public health assessments of waste sites, health consultations concerning specific hazardous substances, health surveillance and registries, response to emergency releases of hazardous substances, applied research in support of public health assessments, information development and dissemination, and education and training concerning hazardous substances. ATSDR publishes Toxicological Profiles for chemicals found at hazardous waste sites and excerpts information from these documents into brief fact sheets (more information on these are found in Section 3 below). The ATSDR Science Corner is a user-friendly gateway to environmental health information and resources.

2.2. (US) Environmental Information Management System (EIMS), US Environmental Protection Agency (EPA)

<http://www.epa.gov/eims/eims.html>

EPA's Office of Research and Development (ORD) is developing EIMS to organize and provide access to EPA resources through a searchable database. Descriptive information will be provided on data sets, databases, documents, models, projects, and spatial data. Users may query using a number of parameters and information on access and downloading of data is provided. This site is a promising new development to make environmental data and information more easily accessible to the public.

2.3. Global Information Network on Chemicals (GINC) <http://www.nihs.go.jp/GINC/index.html>

The GINC is a world wide information network for safe use of chemicals, providing links and access to databases and chemical information systems from organizations and institutions from around the world. It is being developed by the World Health Organisation (WHO), International Labor Organisation (ILO), the United Nations Environmental Program (UNEP), and the Organisation for Economic Co-operation and Development (OECD), with the support of the National Institute of Health Sciences (NIHS Japan). The purpose of the GINC project is to foster generation and circulation of chemical-related information among all countries and international organizations for the promotion of chemical safety. This site has been included here as an emerging web site that is expected to be very useful in the future. The long term goals of the GINC are to help improve data consistency and coherence between different systems; to link projects developed at international and national levels to facilitate dialogue and exchange between them; to help promote a global information network for sound chemicals' management; and to help enhance the capacity of developing countries in establishing and operating their own chemical information systems and networking among themselves. An extensive group of links is provided for government agencies and organizations in the Asia Pacific region of the world.

2.4. International Programme on Chemical Safety (IPCS) <http://www.who.int/pcs/index.htm>

The IPCS is a joint program of the ILO, UNEP, and WHO. The purpose of IPCS is to establish the scientific basis for safe use of chemicals and to strengthen national capabilities and capacities for chemical safety. The organization evaluates chemical risks to human health and the environment and develops methodologies for these evaluations. Risk assessment documents for specific substances are produced by a number of IPCS and WHO programs and activities. These include, Environmental Health Criteria Docu-

ments (EHC), Health and Safety Guides (HSG), Concise International Chemical Assessment Documents (CICAD), Joint FAO/WHO Expert Committee on Food Additives (JECFA), Joint FAO/WHO Meeting on Pesticide Residues (JMPR), WHO Drinking Water Quality Guidelines (WHO/EOS), WHO Air Quality Guidelines for Europe (WHO Regional Office for Europe), and WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification 1998–1999. Some more recent documents may be available on-line and ordering instructions are provided on this site. See also Section 3.3.1 below in Section 3. Risk methods are being developed and internationally harmonized under an IPCS program, see entry in Section 9 below.

2.5. (US) National Center for Environmental Assessment (NCEA), (US) Environmental Protection Agency (EPA)
<http://www.epa.gov/ncea/>

NCEA serves as the EPA national resource center for the overall process of human health and ecological risk assessments, including the integration of hazard, dose–response, and exposure data and models to produce risk characterizations. The office conducts assessments of contaminants and sites of national significance, provides guidance and support to risk assessors, and develops methodologies that reduce uncertainties in current risk assessment approaches. The NCEA web site links to important resources such as the Integrated Risk Information System (IRIS) database (described below in Section 3), copies of major risk assessment documents on major chemicals of interest (e.g. dioxin, mercury), risk assessment guidelines and risk tools, models, and software for conducting dose–response and exposure assessments.

2.6. (US) National Library of Medicine (NLM) TOXNET (Toxicology Data Network)
<http://toxnet.nlm.nih.gov> and as a link from <http://sis.nlm.nih.gov>

TOXNET is a group of databases managed by the NLM's Toxicology and Environmental Health

Information Program. NLM's Specialized Information Services Division manages this program. The data banks and bibliographic files are built, maintained, and funded by several federal agencies. Included is access to NLM's Hazardous Substances Data Bank (HSDB), US EPA's IRIS, the Toxicology Literature Information Online (TOXLINE) files, and several other databases covering genetic toxicology, developmental and reproductive toxicology, and other aspects of toxicology. Also provided is access to the Toxics Release Inventory (TRI), a series of databases focused on the estimated annual releases of toxic chemicals to the US environment.

2.7. RiskWorld—'covering risk news and views'
<http://www.riskworld.com/>

RiskWorld is a comprehensive site developed and maintained by Tec-Com, Inc. It is an excellent starting point to seek risk assessment information on the web. It includes current news releases on risk assessment and related issues, a virtual library of reports and papers, announcements for events, calls for papers, listings for grants and fellowships and job openings. The site has hundreds of links to organizations and societies, databases, software, journals, newsletters, papers, and reports. Information and links are sub-categorized for ease of use.

3. Hazard and dose–response information

Hazard and dose–response information includes information about chemicals that may pose health hazards, descriptions of human health effects from exposure to such chemicals, quantification of concentrations at which the chemicals are present in the environment, quantification of amounts of chemicals to which humans can be exposed to without adverse effects, and descriptions of the toxicity that may be caused by the chemicals. Government agencies typically develop this type of information, and agency-specific information is listed on the respective web sites. Other web sites contain information or links to information from multiple agencies. Listed below

is a selection of hazard and dose–response information resources available on the web. They have been organized into four groups, covering chemical and release information, government sources of risk values, sites that compile data from multiple sources, and example (US) state sources of information.

3.1. Chemical and release information

The following web sites contain information about the use, production, and/or release of chemicals into the environment, as well as the toxic effects of these chemicals. Many of these sites merge information from a multitude of data resources into user-friendly formats.

3.1.1. EXTTOXNET

<http://ace.orst.edu/info/extoxnet>

The EXTension TOXicology NETwork (EXTTOXNET) InfoBase provides information on pesticides, discussion of concepts in toxicology and environmental chemistry, and factsheets. This information has been developed by toxicologists and chemists within the Extension Service of several land-grant universities with the goal of developing unbiased information in a format understandable by the non-expert.

3.1.2. Pesticide Action Network (PAN) Pesticide Database, Pesticide Action Network North America (PANNA)

<http://www.pesticideinfo.org/index.html>

The PAN Pesticide Database is a project of PANNA and has been supported by grants from the US EPA and a number of foundations. The database is a diverse array of information on pesticides from many different sources, providing human toxicity (chronic and acute), ecotoxicity and regulatory information for about 5400 pesticide active ingredients and their transformation products, as well as adjuvants and solvents used in pesticide products. References to data sources are provided.

3.1.3. PollutionWatch

<http://www.scorecard.org/pollutionwatch/>

PollutionWatch is an internet service that pro-

vides information about pollutant releases in Canada. It provides information about local air pollution, including interactive maps that can be accessed by postal code; information on toxic chemicals released by manufacturing facilities; and information about the health risks of pollution. PollutionWatch integrates information from over 100 databases to rank and compare pollution in communities across Canada. PollutionWatch is a joint project of the Canadian Environmental Defense Fund, Canadian Environmental Law Association, the Canadian Institute for Environmental Law and Policy, and Environmental Defense.

3.1.4. Scorecard, Environmental Defence

<http://www.scorecard.org/>

Environmental Defense's Scorecard is an Internet service that provides information about chemical releases in the US. It provides information about local air pollution, including interactive maps that can be accessed by zip code; information on toxic chemicals released by manufacturing facilities; and information about the health risks of air pollution. Scorecard ranks and compares pollution in areas across the US and profiles 6800 chemicals, showing locations in which they are used as well as their hazards. Scorecard integrates over 400 scientific and governmental databases to generate its profiles.

3.1.5. Toxics Release Inventory (TRI), (US) Environmental Protection Agency

<http://www.epa.gov/tri/>

The TRI is a publicly accessible toxic chemical database containing information about the use, manufacture, treatment, transport, or release of toxic chemicals into the environment. The US EPA developed and currently manages this database, as mandated by Section 313. of the Emergency Planning and Community Right-To-Know Act (EPCRA) and Section 6607 of the Pollution Prevention Act (PPA). TRI contains information concerning waste management activities and the release of toxic chemicals by facilities that manufacture, process, or otherwise use them. Using this information, citizens, businesses, and governments can work together to protect the quality of their

land, air, and water. The TRI web site includes TRI Explorer, which provides access to the TRI data that is easy to understand and use.

3.1.6. Office of Pollution Prevention and Toxics (OPPT), (US) Environmental Protection Agency
<http://www.epa.gov/opptintr/>

EPA's OPPT promotes pollution prevention for the control of industrial pollution; safer chemicals through a combination of both regulatory and voluntary efforts; risk reduction to minimize exposure to existing substances such as lead, asbestos, dioxin, and polychlorinated biphenyls; and public understanding of risks by providing understandable, accessible and complete information on chemical risks to the broadest audience possible. OPPT's web site provides links to databases and software (produced by or for OPPT) containing chemical and regulatory information; concerned citizen information; project and program-specific information, such as Chemical Right-to-Know; additional information resources (for example clearinghouses and hotlines); information for students and teachers; and publications, such as fact sheets, Federal Register notices, and reports.

3.2. Government sources of risk values

Government agencies develop a wealth of useful data and information related to risk assessment. This information or data may be the recommended or required values needed for a particular risk assessment. Listed below is a sampling of government organizations.

3.2.1. Chemical toxicity database, Ministry Of Health, Labor and Welfare, Japan (MHLW)
<http://www.db.mhlw.go.jp/ginc/html/db1.html>

The Japanese Chemical Toxicity Database includes data on studies conducted on High Production Volume (HPV) chemicals. There is a summary in English describing each study and the full studies are in Japanese.

3.2.2. European Chemicals Bureau (ECB)
<http://ecb.ei.jrc.it/>

Through its Existing Chemicals work area, the European Bureau (ECB) conducts data collection,

priority setting, and risk assessment of existing chemicals following Council Regulation (EEC) 793/93. Risk assessment documents of Existing Chemicals are available in the Existing Chemicals section of the ECB web site. Through its New Chemicals work area, the ECB is responsible for notification of new chemical substances to be placed on the European Market, and includes risk assessment for new chemicals. See more complete description of ECB in section 11.2.3.

3.2.3. International Agency for Research on Cancer (IARC) <http://www.iarc.fr>

IARC is part of WHO and has a mission to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control. The Agency is involved in both epidemiological and laboratory research and disseminates scientific information through publications, meetings, courses, and fellowships. IARC's web site contains cancer databases and other resources, including the Monographs Database (which contains a complete list of agents, mixtures and exposures, all evaluated with their classifications), the Cancer Epidemiology Database (which provides access to information on the occurrence of cancer worldwide), and IARC's TP53 Mutations Database. It also contains subscription information.

3.2.4. Integrated Risk Information System (IRIS), (US) Environmental Protection Agency
<http://www.epa.gov/iris>

IRIS is EPA's consensus database of information on human health effects that may result from exposure to various chemicals found in the environment. IRIS is administered by EPA's NCEA. These chemical files contain descriptive and quantitative information about oral reference doses (RfDs) and inhalation reference concentrations (RfCs) for chronic noncarcinogenic health effects and hazard identification, as well as oral slope factors and oral and inhalation unit risks for carcinogenic effects. IRIS is widely used in EPA for risk-based decision-making. IRIS can also be accessed through TOXNET.

3.2.5. International Programme on Chemical Safety (IPCS) publications

http://www.who.int/pcs/pcs_pubs.html

As described above in Section 2, IPCS develops a host of publications that are useful for risk assessors. This site provides a listing of its documents, ordering information and, in some cases, summaries of the document and workplans for documents in progress. See also Section 3.3.1.

3.2.6. Maximum Permissible Risks (MPR)

Reports, National Institute of Public Health and the Environment, the Netherlands (RIVM)

http://www.rivm.nl/index_en.html

RIVM develops human-toxicological risk limits (MPRs) for a variety of chemicals based on chemical assessments that are compiled in the framework of the Dutch governmental program on risks in relation to soil quality. These MPR values are published in RIVM reports, many of which can be downloaded from the Publications section of this site. (Otherwise, publications can be ordered from RIVM). A recent example includes, *Re-evaluation of human-toxicological maximum permissible risk levels*, Report # 711701025, 1 June 2001, (<http://www.rivm.nl/bibliotheek/rapporten/711701025.html>) (direct link to Report). The reference list of this report lists earlier RIVM reports with MPRs.

3.2.7. Preliminary Remediation Goals (PRGs), (US) Environmental Protection Agency, Region 9

<http://www.epa.gov/region09/waste/sfund/prg/>

PRGs are risk-based concentrations (derived from standardized equations combining exposure information assumptions with EPA toxicity data) used in the (US) Superfund and the Resource Conservation and Recovery Act programs to help identify areas, contaminants, and conditions that do not require further federal attention at a particular site. This web site contains PRG tables for US EPA, Region 9, as well as InterCalc tables with soil calculations, air-water calculations, toxicity values, and physical and chemical properties data. It also provides additional links to other useful risk assessment resources.

3.2.8. Priority Substances List Assessment

Reports, Environment Canada/Health Canada

http://www.ec.gc.ca/cceb1/eng/final/index_e.html,

<http://www.hc-sc.gc.ca/hecs-sesc/exsd/psap.htm>

The Canadian Environmental Protection Act (CEPA) requires the establishment of a Priority Substances List (PSL) to identify substances that are of priority for assessing whether environmental exposure to them poses a risk to the health of Canadians or to the environment. Over 60 Priority Substances have been evaluated and some of the assessment documents containing tolerable intakes, tolerable concentrations and tumorigenic doses and concentrations for these substances are available through this web site.

3.2.9. Risk Based Concentrations (RBC), (US)

Environmental Protection Agency, Region 3

<http://www.epa.gov/reg3hwmd/risk/riskmenu.htm>

US EPA, Region 3, provides a RBC Table that contains RfDs and cancer slope factors for 400–500 chemicals. These toxicity factors have been combined with ‘standard’ exposure scenarios to derive RBCs (i.e. chemical concentrations corresponding to fixed levels of risk in water, air, fish, soil, and tissue). This information is useful for chemical screening in conducting baseline risk assessments.

3.2.10. Toxicological profiles, Minimal Risk

Values (MRLs) and ToxFAQs™, (US) Agency for Toxic Substances and Disease Registry

(ATSDR) <http://www.atsdr.cdc.gov/toxpro2.html>

Toxicological Profiles

<http://www.atsdr.cdc.gov/mrls.html> *MRLs*

<http://www.atsdr.cdc.gov/toxfaqs.html> *ToxFAQs™*

ATSDR develops Toxicological Profiles for hazardous substances found at National Priority List sites and for the Department of Defense and the Department of Energy on substances related to federal sites. Within these documents, ATSDR develops minimal risk levels (MRLs). Both the Toxicological Profiles and a list of MRLs are available online. Also available is ATSDR’s ToxFAQs™ which is a series of summaries about hazardous substances and their health effects. Information for this series is excerpted from the ATSDR Toxicological Profiles and Public Health

Statements. These fact sheets provide a quick and easy to understand guide with answers to the most frequently asked questions (FAQs) about exposure to hazardous substances found around hazardous waste sites and about the effects of exposure on human health.

3.2.11. World Health Organization (WHO)

<http://www.who.int/dsa/cat98/chemtox8.htm>

Provides a list, description, costs, and ordering information for WHO documents on chemical toxicity and carcinogenicity published between 1991 and 1999. See also Section 3.3.1 below.

3.3. Compiled toxicity information from multiple sources

Some government agencies, non-government organizations, and private companies compile toxicity information on chemicals. In some cases these compilations are available for free, and in other cases, they are available only through the purchase of a CD-ROM or subscription. Several examples of these types of compilations are listed below. Additional resources can be found in Wexler, et al. (2000).

3.3.1. INCHEM, International Programme on Chemical Safety (IPCS) <http://www.inchem.org>

The IPCS INCHEM provides free access to hundreds of publications about chemicals from the international organizations that cooperate with the IPCS. These publications are produced and peer reviewed by teams of experts from around the world, and are intended for a wide range of professionals concerned about the safe use of chemicals. The INCHEM CD-ROM is also available and requires an annual subscription. It is updated semi-annually and is distributed to subscribers in both developed and developing countries. The following information is included on INCHEM: CIS Chemical Information (ILO/CIS), Concise International Chemical Assessment Documents (CICADS), Environmental Health Criteria (EHC) monographs, Health and Safety Guides (HSG), International Agency for Research on Cancer

(IARC) Summaries and Evaluations, International Chemical Safety Cards (ICSC), IPCS/CEC Evaluation of Antidotes Series, Joint FAO/WHO Expert Committee on Food Additives (JECFA) monographs and evaluations, Joint Meeting on Pesticide Residues (JMPR) monographs and evaluations, Pesticide Data Sheets (PDSs), Poisons Information Monographs (PIMs), and Screening Information Data Sets (SIDS) for High Production Volume (HPV) Chemicals.

3.3.2. INTOX, International Programme on Chemical Safety (IPCS) <http://www.intox.org>

The IPCS INTOX Package is a computerized poisons information package designed to assist poison centers, health ministries and other related institutions to efficiently manage information related to poisoning, national product registration, and chemical incidents. The IPCS INTOX Package consists of a database and collection of documents on poisonous substances. Together they provide information on industrial chemicals, pharmaceuticals, household products, agricultural chemicals and plant, fungal and animal toxins, as well as other agents commonly responsible for poisoning. This is a global and multilingual package. INTOX is available by an annual subscription.

3.3.3. International Toxicity Estimates for Risk (ITER), Toxicology Excellence for Risk Assessment (TERA) <http://www.tera.org/iter>

ITER is a free Internet database that contains risk values for over 500 chemicals from Agency for Toxic Substances & Disease Registry (ATSDR), Health Canada, US EPA, and independent parties whose risk values have undergone peer review. ITER provides international risk assessment information in a side-by-side format and explains differences in risk values derived by different organizations. It is the only database that includes risk information from independent parties whose risk values have undergone peer review through TERA's ITER Peer Review Program. ITER helps identify available risk values and compare them across organizations.

3.3.4. Risk Assessment Information System (RAIS), (US) Department of Energy (DOE)

http://risk.lsd.ornl.gov/rap_hp.shtml

The RAIS is a free system that was developed to provide a service-oriented environmental risk assessment expert system. RAIS was initially designed to support the site-specific needs of the DOE Oak Ridge Operations Environmental Management Program, but it has become beneficial to a larger risk assessment audience. The RAIS provides tools for performing basic risk assessment activities, such as PRGs, toxicity values and profiles (including US EPA's IRIS and HEAST), Federal and State guidelines, human health risk models, and ecological benchmarks. In addition, this system provides the risk guidance and directs the user to specific (US) EPA and (US) State guidance necessary for performing risk assessment activities within the Superfund process.

3.3.5. TOMES PLUS®, MICROMEDEX

<http://www.micromedex.com/>

TOMES PLUS® is an extensive collection of proprietary and licensed databases from a variety of sources that is available from MICROMEDIX. This collection provides quick and easy access to medical, hazard, and environmental information for the safe management and handling of chemicals. It consists of the following files: MEDITEXT®, HAZARDTEXT®, INFOTEXT®, HSDB, Chemical Hazards Response Information System, OHM/TADS, IRIS, RTECS, NIOSH Pocket Guide, New Jersey Fact Sheets, and 2000 Emergency Response Guidebook. TOMES PLUS® is available online or CD-ROM, is updated quarterly, and requires an annual subscription.

3.4. Example resources from US state agencies

In the US, some states have developed a variety of web resources that may be useful to risk assessors both within and outside that state. Selected web resources for two states have been highlighted below as examples of the types of information available.

The State of California provides a multitude of useful web sites; a few of these are highlighted

here. The web site for Human & Ecological Risk Division of the Department of Toxic Substance Control (<http://www.dtsc.ca.gov/ScienceTechnology/org.html>) contains supplemental guidance to the Risk Assessment Guidance for Superfund (RAGS), multi-media models for fate and transport, and a model for lead hazard. The web site for the Office of Environmental Health Hazard Assessment (<http://www.oehha.ca.gov/>) has a database of toxicity criteria for various uses in California, guidance for certain types of risk assessments, guidance for probabilistic risk assessment, Public Health Goals for drinking water, and many other topics. Additional sites from California include: the California State Water Resources Control Board (<http://www.swrcb.ca.gov/>), the San Francisco Regional Water Quality Control Board (<http://www.swrcb.ca.gov/rwqcb2/>), the South Coast Air Quality Management District (<http://www.aqmd.gov/>), and the California Air Resources Board (<http://www.arb.ca.gov/homepage.htm>).

Hazardous substances fact sheets, New Jersey <http://www.state.nj.us/health/eoh/rtkweb/>

The New Jersey Department of Health provides fact sheets for individual hazardous chemicals that includes information relating to acute and chronic health hazards, identification, workplace exposure limits, medical tests, handling and storage, definitions, emergency response information for fires, spills and first aid, and other information. This information is employee-oriented exposure risk information that is useful for worker right-to-know issues, as well as training programs.

4. Physical and chemical properties

Understanding a chemical's physical and chemical properties is a key part of performing an exposure and risk assessment. These properties include the molecular weight, physical state, vapor pressure, boiling point, flash point, etc. Key resources include the supplier(s) of a chemical and trade associations associated with a particular class of chemicals (e.g. the Soap & Detergent Association for surfactants). The web sites noted below are examples of sites that provide physical and chemical property information and tools.

4.1. ChemFinder <http://www.chemfinder.com>

This web-based search engine allows for searching a chemical's name or Chemical Abstracts Service (CAS) number, and provides links to and information from numerous web sites. Includes physical properties.

4.2. Datalog <http://www.nisc.com/cis/cisfacts.htm>

Datalog is produced by US EPA and Syracuse Research Corporation (SRC) and contains bibliographic references on the physical and chemical properties and environmental fate for over 23 000 chemicals. This database is one of 20 databases covering 530 000 chemicals available from the National Information Services Corporation's (NISC) Chemical Information System.

4.3. Environmental Chemicals Data and Information Network (ECDIN) <http://ecdin.etomep.net>

Searching a chemical's name or CAS number provides a document that includes information on physical–chemical properties.

4.4. EPI Suite™ (Estimation Program Interface) at the Exposure Assessment Tools and Models Web Site, (US) Environmental Protection Agency <http://www.epa.gov/opptintr/exposure>

This web site will eventually allow all of the following EPI Suite™ models to be downloaded. The EPI Suite™ is a WINDOWS® based suite of estimation models for physical and chemical properties, and environmental fate and transport. It includes estimation programs for LogKOW, KOC, Atmospheric Oxidation Potential, Henry's Law Constant, Water Solubility, Melting Point, Boiling Point, Vapor Pressure, Biodegradation, Bioconcentration Factor, Hydrolysis, Sewage Treatment Plant Removal, Fugacity Modeling, and Multimedia Modeling. The models include KOWWIN™, AOPWIN™, HENRYWIN™, MPBPWIN™, BIOWIN™, PCKOCWIN™, WSKOWWIN™, BCFWIN™, HYDROWIN™, STPWIN™, WVOLWIN™, and LEV3EPI™.

4.5. Hazardous Substances Data Bank (HSDB), (US) National Library of Medicine <http://toxnet.nlm.nih.gov/>

HSDB is a database available through TOXNET (select 'HSDB' and then search for chemical of interest). HSDB allows access to a wide range of physical and chemical property information, toxicology information, etc.

Physical and chemical property estimation programs are also available from private vendors, for example Syracuse Research Corporation (SRC) (<http://esc.syrres.com/interkow/estsoft.htm>). Much of this information is now available for free. Wright (2001) provides additional information about databases related to chemical and physical properties.

5. Environmental fate and transport

Understanding how a chemical might be transformed and the environmental compartments it might enter and be transported in (e.g. water and air) are important parts of a risk assessment. This section notes web sites providing environmental fate and transport information useful for assessing potential consumer, public ('general population'), worker, and environmental exposures to chemicals. One of these web sites is the (US) National Library of Medicine's Hazardous Substance Data Bank noted above. Several other sites are described below.

5.1. DATALOG <http://www.nisc.com/cis/cisfacts.htm>

This site was also noted above as a resource for physical and chemical properties. DATALOG contains bibliographic references on the environmental fate for over 23 000 chemicals. It is produced by the US EPA and Syracuse Research Corporation (SRC).

5.2. Environmental Fate Data Base (EFDB), Syracuse Research Corporation <http://esc.syrres.com/efdb.htm>

This site, partially supported by US EPA, Dupont, and the Procter & Gamble Company, pro-

vides access to several data files, including DAT-ALOG (listed above). BIOLOG, or the Microbial Degradation/Toxicity File, provides sources of microbial toxicity and biodegradation data. CHEMFATE is a data value file containing 25 categories of environmental fate and physical/chemical property information on commercially important chemical compounds. BIODEG contains experimental values relating to biodegradation subjects and BIODEG SUMMARY provides summary evaluation and reliability codes for different test methods, as well as summaries for biodegradability under aerobic and anaerobic conditions.

5.3. Exposure Assessment Tools and Models, (US) Environmental Protection Agency
<http://www.epa.gov/opptintr/exposure>

This site was also noted above as a resource for physical and chemical properties. It will eventually allow EPI Suite™ models to be downloaded, including estimation models for environmental fate and transport. This web site also has several other exposure assessment methods, databases, and predictive models to help evaluate consumer, public ('general population'), worker, and environmental exposures to chemicals, and has a general discussion about the role of exposure assessment and how to appropriately apply models. The other models available via this web site are:

- Chemical Screening Tool for Exposures & Environmental Releases (ChemSTEER). For worker and environmental assessments.
- The Exposure and Fate Assessment Screening Tool (E-FAST). E-FAST provides screening-level estimates of general population, consumer, and environmental exposure. Consumer/population exposures including consumer dermal and inhalation, public drinking water, fish ingestion, and inhalation.
- Graphical Exposure Modeling Systems (GEMS). For public drinking water, fish ingestion, inhalation, and environmental assessments.
- HPV Exposure Assessment Screening Tool

(HPVScreen). HPVScreen is an exposure assessment screening tool that will initially have three major components and multiple subcomponents. Exposure and risk assessors can use the models in HPVScreen to generate conservative estimates of exposure. Assessors can use the multimedia models in HPVScreen to evaluate the distribution of chemicals in the environment. The three current major components are: physical–chemical properties and fate, models for screening-level exposure estimates, and multimedia modeling programs. A report generator will be added by the end of 2002. Eventually a component for estimating environmental releases and occupational exposures will be added to HPVScreen.

- Multi-Chamber Concentration and Exposure Model; also called Multi-Chamber Consumer Exposure Model (MCCEM). For consumer inhalation assessments.
- ReachScan. For public drinking water and fish ingestion, and environmental assessments.
- Source Ranking Database (SRD). For consumer inhalation assessments.
- Use Clusters Scoring System (UCSS). For worker and environmental assessments.
- Wall Paint Exposure Assessment Model (WPEM). For consumer inhalation, and worker assessments of exposures to paint volatiles.

6. Exposure assessment

It is important to know how exposures to a particular chemical can occur, and to estimate the magnitude, duration, and timing of the doses related to the various exposures. Exposure assessments are primarily site and/or situation specific evaluations. Humans can be exposed to chemicals via various environmental media, for example air, soil, water, and food.

Examples of important exposure factors include those related to humans, including body weights, skin surface areas related with various types of exposures, and food and drinking water consumption values. Also important are activity patterns,

for example, the time spent in various types of environments or performing various types of tasks. Factors such as the frequency, duration, and amount used per task, and the concentration of the chemical of interest are important for consumer product assessments, and factors including air changeovers per hour and house and room volumes are important for some types of residential assessments. Key examples of sources for these data are described below.

A major opportunity exists for risk assessors and others to broaden the level of exposure assessment information available via web sites. The exposure information currently available on the web primarily focuses on the US, largely due to US EPA efforts to have this information available on the web. Broadening the exposure information available on the web could include information about human physical characteristics (e.g. country- or region-specific ranges in body weights, drinking water consumption, etc.), the types of residences and workplaces and the exposure factors associated with them (e.g. air changeovers per hour in various types of residences, and how various tasks are performed by consumers and workers), and country- and region-specific ranges of climatic conditions. Any non-US exposure-related information could then be incorporated into web sites providing more globally representative information than that currently offered on the web via US EPA efforts. Noteworthy is that efforts are underway by European scientists to develop a European (multi-country) version of the US EPA's Exposure Factors Handbook.

6.1. (US) Alliance for Chemical Awareness (ACA) <http://www.chemicalawareness.org>

ACA is an effort to support the voluntary US High Production Volume (HPV) Chemical program [a related effort for household cleaning product chemicals in Europe is the 'Human and Environmental Risk Assessment' project (HERA); <http://www.heraproject.com>]. The ACA's goal is to provide information to chemical sponsors on how to place the data in the HPV submissions into a risk-based context. The

technical component of this effort focuses on providing all the information HPV chemical sponsors and others would need to conduct direct and indirect human exposure, occupational exposure, and ecological exposure assessments. The web site provides frameworks for conducting the assessments, access to information about software and databases for conducting the assessments, and resource and training materials.

6.2. Guidelines for Exposure Assessment, (US) Environmental Protection Agency <http://www.epa.gov/nceawww1/exposure.htm>

EPA has issued guidelines for exposure assessment that establish a broad framework that describes the general concepts of exposure assessment including definitions and associated units, and provides guidance on the planning and conducting of an exposure assessment. Guidance is also provided on presenting the results of the exposure assessment and characterizing uncertainty. Additional sections cover reviewing exposure assessments and a glossary of terms.

6.3. Exposure Factors Program Web Site, (US) Environmental Protection Agency <http://www.epa.gov/ncea/jmpprog.htm>

This web page is intended to provide a focal point where the most current information and data on exposure factors can be found, with a focus on information important for US exposure assessments. It provides links to EPA's Exposure Factors Handbook (available as pdf files at this web site) which (1) summarizes data on human behaviors and characteristics which affect exposure to environmental contaminants, and (2) recommends values to use for these factors. The handbook includes discussions of the issues which assessors should consider in deciding how to use these data. It is intended to serve as a support document to EPA's Guidelines for Exposure Assessment. A glossary is included in the Exposure Factors Handbook. Other information on this site includes reports of ongoing research in the field.

6.4. *Pesticides and Human Health Risk Assessment. Policies, Processes, and Procedures, Purdue Pesticide Programs, Purdue University Cooperative Extension Service*
<http://www.agcom.purdue.edu/AgCom/Pubs/PPP/PPP-48.pdf>

Among this publication's sections are ones providing overviews of approaches used for Dietary Exposure Assessment, Occupational Exposure Assessment, Residential Exposure Assessment, and Aggregate Risk Assessment under the Food Quality Protection Act.

7. Risk perception and communication

A large amount of information on how people perceive various types of risks and how information about risks could be communicated is available on the web. A few selected web sites are described below.

7.1. *An evaluation primer on health risk communication programs and outcomes, (US) Agency for Toxic Substances and Disease Registry*
<http://www.atsdr.cdc.gov/HEC/evalprmr.html>

This web site provides an overview of the principles and techniques for health risk communication, including how to develop, pretest, and test a risk communication plan. Also included is a listing of selected risk communication publications.

7.2. *Healthy indoor air for America's homes; indoor air quality*
<http://www.montana.edu/wwwcxair/>

This web site from US EPA, Montana State University, and the US Department of Agriculture (USDA) contains extensive information about various types of indoor air health risks, for example, carbon monoxide, cigarette smoke, radon, and volatile organic compounds (VOCs). The information includes help in identifying and communicating various indoor air-related health risks. This web site has various presentations,

instructional modules, and fact sheets that can help in risk communication.

7.3. *Reporting on Risk, FACSNET*
http://www.facsnet.org/tools/ref_tutor/risk/index.php3

FACSNET is an independent, nonprofit organization in California operating this web site as 'A Free Site for Responsible Press®.' This web site link provides access to the Institute for Environmental Toxicology's (MI State University's) 'Reporting on Risk. A Journalist's Handbook on Environmental Risk Assessment'. If this document is inaccessible via this direct link, go to <http://www.facsnet.org> and first register as a user of this site.

7.4. *The risk communication bibliography: explaining risks to the public, (US) National Cancer Institute* <http://dceps.nci.nih.gov/DECC/riskcommbib/>

Development of this comprehensive source of risk communication information was funded by the Division of Cancer Control and Population at the (US) National Cancer Institute. This bibliography's nearly 400 listings provide an introduction to the risk communication literature, including reports of experiments, theoretical discussions, case histories, how-to manuals, dissertations, and reviews. The bibliography also includes many risk perception-related articles, even those lacking any mention of communication.

8. Government regulations

The web provides a wealth of information for those seeking government regulations for chemicals. However, when conducting a risk assessment, location is critical; one needs to focus on the regulations, guidelines, and guidance values for the jurisdiction of interest. The reader is encouraged to conduct searches for local, state, regional or national regulations that apply to the situation they are assessing. Individual government entities frequently provide information on

their own regulations and guidance. In addition, a number of private companies collect and disseminate regulatory information for a fee.

Many of the organizations described within this paper are US governmental organizations at the federal level. However, there can be overlaps in jurisdiction among agencies that have risk assessment and toxicology in their respective missions and agendas. For instance, a given chemical may be subjected to different regulatory requirements depending upon its use or definition. Adding to the confusion are state, county, and municipal agencies and departments in the US providing additional levels of regulatory compliance. Similar situations may exist in other countries. It is well beyond the scope of this paper to provide a listing of environmental and health agencies for each state, territory, county, and municipality, or even for the US federal government. However, information about how these agencies can be identified is available (Hakkinen et al., 2000). In addition, several recent comprehensive sources of information about chemical-related US and international regulations are available (Bandurraga, 2000a,b; Cowan-Ellsberry et al., 2000).

There are a number of companies that provide assistance in identifying regulations. Below we mention BNA and Ariel as examples of the types of services that are available.

8.1. Ariel <https://alpha.arielresearch.com/web/>

Ariel Research Corporation of Bethesda, MD, USA provides a fee-based source for chemical regulatory information and updates. Ariel currently tracks more than 260 regulatory lists in 32 countries in North America, Western Europe, and Asia Pacific. They plan to add Latin American and Eastern European modules. For each region of the world there is a database that identifies regulations, advisory lists, directives, legislation and compliance guides searchable by chemical name, CAS number, molecular formula, etc. An automatic update service is available by subscription.

8.2. BNA chemical regulation reporter <http://www.bna.com/products/ens/chem.htm>

For subscribers, BNA provides printed and web/e-mail summaries of legislative developments, regulatory changes, industry activities, etc. related to chemicals. Includes information about international developments.

9. Guidance on conducting risk assessment

The practice of risk assessment requires numerous tools and methodologies to meet the particular needs of the project. Most of the risk assessment methodologies are developed and/or adopted by government entities for use in their programs or by others submitting data to the government. The web provides access to many tools and methods available, as well as training materials or on-line courses. Below are listed a selected group of international and US web sites that provide these types of resources.

9.1. Center for Risk Excellence, (US) Department of Energy (DOE) <http://riskcenter.doe.gov>

The Center develops and implements policy practices, guidance, tools, support, and training that result in risk-based decisions that protect both human health and the environment. Its web site offers information and links to sources of information on toxicology and risk assessment tutorials, fact sheets for chemicals, and risk tools. Particularly useful is the 'Dose Assessment' tools (http://risk.lsd.ornl.gov/CRE/CRE_dose_tools.html). This page leads to links to numerous sources of exposure, toxicity, and risk based goals, as well as links to guidance documents for conducting risk assessment. These are primarily from US government agencies. Another DOE site, the Office of Environmental Policy and Guidance (<http://homer.hsr.ornl.gov/oepa/risk/>), also has numerous links to tools, models, and dose and risk assessment databases, particularly for radionuclides.

9.2. IPCS harmonization project

www.ipcsharmonize.org

The IPCS has taken the lead to globally harmonize approaches to the assessment of risk from exposure to chemicals. The project involves scientists and others from many countries and is focused on specific issue areas and within each strives to reach agreement on basic principles. The issue areas include cancer, mutagenicity, reproductive and developmental toxicity, non-neoplastic effect, neurotoxicity, immunotoxicity, and terminology. This site contains reports of meetings and work of the harmonization project in the various issue areas.

9.3. *National Center for Environmental Assessment (NCEA), (US). Environmental Protection Agency* <http://www.epa.gov/ncea/>

See broader description under Section 2 above. EPA's risk assessment guidelines for cancer, mutagenic effects, exposure assessment, chemical mixtures, developmental toxicity, reproductive toxicity, neurotoxicity, and ecological risk assessment are available. Also available at this site are risk tools such as benchmark dose software, categorical regression software, exposure factors program, and the Integrated Model Evaluation System (IMES). Links to IRIS, EIMS, and other sources of information for risk assessment are included.

9.4. *OECD/IPCS database on hazard/risk assessment methodologies*
<http://www.oecd.org/ehs/RA/Risk-Assessment-methodologies.htm>, <http://appli1.oecd.org/ehs/ipcs.nsf> (searchable database)

This database is the outcome of a joint project of the OECD and the IPCS and includes extensive listings and links to hazard/risk assessment methodologies for industrial chemicals and pesticides. Both human health and environmental methodologies are included. The site allows access to links through expanded listings as well as searching by specific criteria, including country or organization, types of chemical, or area of assessment.

9.5. Risk Assessment Forum (RAF), (US)

Environmental Protection Agency
<http://www.epa.gov/ncea/raf/index.html>

The RAF is a standing committee of senior EPA scientists established to promote Agency-wide consensus on difficult and controversial risk assessment issues and to ensure that this consensus is incorporated into appropriate Agency risk assessment guidance. The RAF convenes EPA risk assessment experts in a formal process to study and report on issues from an Agency-wide scientific perspective, resulting in guidance documents that become Agency policy. These documents are frequently called 'purple books' due to the purple covers on RAF documents. In addition, EPA risk assessment guidelines are available at this site. Some RAF documents must be ordered, others are available for downloading.

9.6. *Tools for superfund human health risk assessment, (US). Environmental Protection Agency (EPA),* <http://www.epa.gov/superfund/programs/risk/toolth.htm>

US EPA has developed guidance, policy, and technical tools for use in Superfund human health risk assessments. Both general tools and tools specific to the major steps of the risk assessment process are included, and most of the resources referenced can be downloaded. Resources include, general guidance/policies; planning, scoping and problem formulation; hazard identification and dose–response assessment; exposure assessment; risk characterization; and risk management.

10. Training

There are many web sites that include instructional materials for learning more about toxicology, pesticides, or risk assessment. Others sites include documents or lay person descriptions of risk and exposure assessment that are useful resources. Below is a small sample of some of these resources.

Assessing health risks from pesticides, US EPA's Office of Pesticide Programs <http://www.epa.gov/pesticides/citizens/riskassess.htm>.

Case studies in environmental medicine, (US) Agency for Toxic Substances and Disease Registry <http://www.atsdr.cdc.gov/HEC/csem.html>.

Chemicals & Human Health, Toxicology Problem Set, University of Arizona, Southwest Environmental Health Science Center http://www.biology.arizona.edu/chh/problem_sets/toxicol-tology/toxicology.html.

Health & Environment for the Lay Person, Sciences International, Inc. <http://www.sciences.com/layperson/Default.htm>.

RAIS Tutorial and *What Is Risk Assessment?* Mini course Department of Energy (DOE), the Center for Risk Excellence (CRE), and Bechtel Jacobs Company LLC <http://risk.lsd.ornl.gov/CRE/tutorial.shtml> (Tutorial), http://risk.lsd.ornl.gov/minicourse/rap_whatisra.shtml (Mini course).

Principles of Environmental Toxicology University of Idaho http://www.ets.uidaho.edu/etox_fall01/.

Reporting on risk, FACSNET http://www.facsnet.org/tools/ref_tutor/risk/index.php3

FACSNET is an independent, nonprofit organization in California operating this web site as 'A Free Site for Responsible Press®'. (If document is inaccessible via this direct link, go to <http://www.facsnet.org> / and first register as a user of this site).

Toxicology for the Citizen, Institute for Environmental Toxicology, Michigan State University http://www.iet.msu.edu/Tox_for_Public/toxpub.htm.

Toxicology Tutor I, II, and III, (US) National Library of Medicine, Specialized Information Services (SIS) <http://www.sis.nlm.nih.gov/toxtutor.cfm>.

Understanding risk analysis. A Short Guide For Health, Safety and Environmental Policy Making, Resources for the Future http://www.rff.org/misc_docs/risk_book.htm.

Web site for Educators and Students, State of California's Office of Environmental Health Hazard Assessment <http://www.oehha.ca.gov/education/risk/page1.html>

What is an Exposure Assessment? What is

OPPT's Approach to Exposure Assessment? (US) EPA's Office of Pollution Prevention and Toxics <http://www.epa.gov/opptintr/exposure/docs/exposurerep.htm>, <http://www.epa.gov/opptintr/exposure/docs/opptexpo.htm>.

11. Professional societies, organizations, and discussion groups

Several professional societies focus on risk assessment issues. The Society for Risk Analysis is solely devoted to risk assessment and the International Society of Exposure Analysis (ISEA) covers all aspects of exposure analysis. The Society of Toxicology (SOT) has several specialty sections devoted to risk assessment issues. Other professional societies and organizations, most notably in the occupational field (e.g. American Industrial Hygiene Association, and American Conference of Governmental Industrial Hygienists) also address risk assessment issues. These are described elsewhere in this series.

A number of non-profit organizations and institutes focus on risk assessment. These groups generally conduct research and publish their results, frequently making their work available on their web sites. Several email-based discussion groups are also described below.

11.1. Professional societies

11.1.1. Decision analysis society <http://faculty.fuqua.duke.edu/daweb/>

The Society promotes the development and use of logical methods for the improvement of decision-making in public and private enterprise, including models for decision-making under conditions of uncertainty or multiple objectives; techniques of risk analysis and risk assessment; experimental and descriptive studies of decision-making behavior; economic analysis of competitive and strategic decisions; techniques for facilitating decision-making by groups; and computer modeling software and expert systems for decision support. The web site includes information on references, courses and syllabi, journals

and software, and employment and research opportunities.

11.1.2. International Society of Exposure Analysis (ISEA) <http://www.iseaweb.org/>

ISEA was established in 1989 to foster and advance the science of exposure analysis related to environmental contaminants, both for human populations and ecosystems. The membership promotes communication among all disciplines involved in exposure analysis, recommends exposure analysis approaches to address substantive or methodological concerns, and works to strengthen the impact of exposure assessment on environmental policy. ISEA's newsletters are available from this web site, as are announcements for upcoming ISEA meetings.

11.1.3. International Union of Toxicology (IUTOX) <http://www.toxicology.org/iutox>

IUTOX's members include over 30 societies around the world. Its purpose is to foster international scientific cooperation among national and other groups of toxicologists and promote worldwide acquisition, dissemination, and utilization of toxicology knowledge. The IUTOX web site provides links to the sites of all available member societies.

11.1.4. Risk Assessment & Policy Association (RAPA) <http://www.fplc.edu/affiliations/afforg.htm> (select RAPA)

RAPA's goals are to promote multidisciplinary research on the theory and practice of risk assessment and management, and to foster intellectual exchange. RAPA also seeks to encourage public involvement in risk assessment and management, to examine the use of risk assessment in legislative, regulatory and other policy deliberations, and to study the use of risk analysis in decision making. The web site provides access to issues of RAPA's official journal, Risk: Health, Safety & Environment.

11.1.5. Society for Risk Analysis (SRA) <http://www.sra.org>

SRA is a multi-disciplinary group designed to

provide opportunities to exchange information, ideas, and methodologies for risk analysis and risk problem-solving. The Society publishes a peer-reviewed journal, Risk Analysis, which provides a focal point for new developments in risk analysis for scientists from a wide range of disciplines. The journal covers health risks, engineering, mathematical, and theoretical aspects of risks, and social and psychological aspects of risk such as risk perception, acceptability, economics, and ethics. The Society's newsletter and annual meeting abstracts are available from the web site.

11.1.6. Society of Toxicology (SOT) <http://www.toxicology.org/>

SOT is an organization of scientists who practice toxicology in many areas, including risk assessment. The Society holds annual meetings, publishes journals and a member newsletter, and sponsors continuing education courses. The society addresses toxicological issues of risk assessment issues through several of its specialty sections.

11.2. Other organizations

A number of other organizations not mentioned previously host web sites that are useful to those working in the field of risk assessment. These include non-profit organizations and industry trade groups.

11.2.1. American Chemistry Council (ACC; formerly the Chemical Manufacturers Association) <http://www.cmahq.com>

The ACC is the voice of the US Chemical Industry. The ACC represents the chemical industry on public policy issues, coordinates the industry's research and testing programs [e.g. the Long-Range Research Initiative (LRI)], and administers the industry's environmental, health, and safety performance improvement initiative, known as Responsible Care®. Members include corporations in the chemical and chemical-using (e.g. consumer product) industries.

11.2.2. European Center for Ecotoxicology and Toxicology of Chemicals (ECETOC)

<http://www.ecetoc.org/entry.htm>

ECETOC's focus includes the manufacture, processing, handling, and use of chemicals. ECETOC also cooperates with governmental agencies and other organizations concerned with the effects of chemicals on health and the environment.

11.2.3. European Chemicals Bureau (ECB)

<http://ecb.ei.jrc.it/>

Through its Existing Chemicals work area, the European Bureau (ECB) conducts data collection, priority setting, and risk assessment of existing chemicals following Council Regulation (EEC) 793/93. Risk assessment documents of Existing Chemicals are available in the Existing Chemicals section of the ECB web site, along with information about The International Uniform Chemical Information Database (IUCLID), the European Union System for the Evaluation of Substances (EUSES), and The Harmonized Electronic Data Set (HEDSET). Through its New Chemicals work area, the ECB is responsible for notification of new chemical substances to be placed on the European Market, and includes risk assessment for new chemicals. EUSES was developed from USES (Uniform System for the Evaluation of Substances) as an update which would be fully in line with the package of amalgamated Technical Guidance Documents (TGDs) for new and existing chemicals. USES is an integrated modeling system that uses a single framework for comparing the potential risks of different substances released to multiple environmental media (water, soil, and air) and multiple human exposure pathways (inhalation, ingestion, and dermal). EUSES can be used for indirect human exposures, and for consumer product and worker exposures.

11.2.4. Food safety risk analysis clearinghouse

<http://www.foodriskclearinghouse.umd.edu/>

The food safety risk analysis clearinghouse web site is a resource for those professionals involved risk analysis as it pertains to food safety. The site includes data, tutorials, tools,

models, and links to numerous sources of information related to food safety. There are links to databases and sources of information useful for food safety risk assessments. Scientists from the University of Maryland's Veterinary Medicine Department and the US Food and Drug Administration's Center for Food Safety and Applied Nutrition have created and operate the clearinghouse, which is the responsibility of the Joint Institute for Food Safety and Applied Nutrition, a collaboration between the University of Maryland and the US Food and Drug Administration.

11.2.5. Harvard Center for Risk Analysis (HCRA) <http://www.hcra.harvard.edu>

HCRA attempts to provide a 'big picture' view of public health by comparing and ranking a wide range of hazards, analyzing the results of dealing with those hazards in various ways, and developing sound scientific data identifying policy choices that are most likely to achieve the greatest health, safety, and environmental benefits with the most efficient use of finite resources. The Center's current research programs focus on the areas of motor vehicle safety, medical technology, environmental health, food, agriculture, and children's health. The Center has a newsletter entitled Risk in Perspective, which discusses results of research projects.

11.2.6. International Consumer Products Health and Safety Organization (ICPHSO)

<http://www.icphso.org/>

ICPHSO is dedicated to the health and safety issues related to consumer products manufactured and marketed in the global marketplace. ICPHSO includes a broad range of health and safety professionals and interested consumers, and sponsors workshops to inform and educate manufacturers, importers, distributors, retailers, and others of their product safety responsibilities. Also, ICPHSO provides a forum for the exchange of ideas and sharing of information among government, industry, trade organizations, legal representatives, academia, standards writers, consumer advocates, and interested individuals.

11.2.7. International Life Sciences Institute (ILSI) <http://rsi.ilsa.org/>

ILSI is a nonprofit, worldwide scientific research foundation seeking to improve the well-being of the general public through the pursuit of sound and balanced science. Its goal is to further the understanding of scientific issues relating to nutrition, food safety, toxicology, risk assessment, and the environment. The ILSI Risk Science Institute (RSI) advances and improves the scientific basis of ecological and human health risk assessment through an international program of research, working groups, conferences and workshops, publications, seminars, and training programs. Information on ILSI research activities and publications is available on the web site.

11.2.8. Toxicology Excellence for Risk Assessment (TERA) <http://www.tera.org>

TERA is an independent non-profit research and education organization dedicated to the best use of toxicity data in risk assessment. TERA's mission is to protect public health by developing and communicating human health risk assessment values, improving risk methods through research, and educating the public and others on risk assessment issues. TERA develops risk values; improves methods for human health risk assessment through the Research program; sponsors expert peer review of risk values, methods and research through the Independent Peer Review program; provides technical support, training courses, and risk communication to diverse groups through the Education program; compiles and distributes peer reviewed risk values to the international user community through the International Toxicity Estimates for Risk (ITER) database; and facilitates improved risk assessment and management decisions among industry and government through informed and neutral guidance.

11.3. Internet mailing lists

Online discussion groups help members answer questions about human health risk assessment-related topics, and are a way to share information and perspectives. A number of discussion groups are available via the Internet 'mailing lists' noted

below. For most mailing lists, one can usually obtain more information (e.g. how to subscribe) by sending an e-mail to the listserver address with 'info' and/or 'help' in the body of the message. Other Internet-based mailing lists of possible interest to risk assessors and others have been recently summarized in a book chapter (Wexler et al., 2000).

11.3.1. CHEMRANK

<http://esc.syrres.com/envchem.htm>

This mailing list is for information and discussion about chemical ranking and scoring, and currently has over 200 subscribers. This mailing list can be joined via the web site.

11.3.2. RISKANAL

e-mail: listserv@listserv.pnl.gov

This mailing list was created by the Columbia-Cascades chapter of the Society for Risk Analysis and the Pacific Northwest Laboratory. It has several hundred members from numerous countries, and has helped provide feedback for numerous risk assessment-related questions.

11.3.3. Risk-com

e-mail: risk-com@listserver.itd.umich.edu

A mailing list focussing on risk communication issues.

11.3.4. RISKSCI

email: requests@water.sesep.drexel.edu

This mailing list was created in mid-2000 and is intended to contain discussion of scientific and technical issues surrounding the various aspects of risk assessment, risk management and risk communication. In addition, the policy implications of risk analysis can be discussed.

11.3.5. TOXLIST

e-mail: listserv@esc.syrres.com

This list is intended to contain discussions and other information related to toxicology.

12. Conclusions

The web has become a valuable source of immediate access to information needed for human

hazard identification, dose–response evaluation, exposure assessment, risk characterization, and risk management, along with information on risk perception and risk communication. Some web sites contain substantial collections of information on more than one aspect of risk assessment, for example: RiskWorld, the US EPA's Environmental Information Management System (EIMS) and National Center for Environmental Assessment (NCEA) sites, the (US) National Library of Medicine's TOXNET site, the (US) Agency for Toxic Substances and Disease Registry (ATSDR) site, and the International Programme on Chemical Safety (IPCS) site.

Also valuable to risk assessors are various web sites providing information on the physical and chemical properties of chemicals, the environmental fate and transport of chemicals, government regulations, and guidance and training for performing risk assessments. Several professional societies and other organizations have web sites addressing risk assessment issues and information, and there are Internet mailing lists for online help and for sharing information and perspectives.

It is expected that many additional risk assessment-related web sites will be created in the future, providing valuable information for use around the world. These new sites will also provide information from additional regulatory agencies, professional societies, and other organizations.

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