HAZ-MAP: A PROJECT TO MAP OCCUPATIONAL TOXICOLOGY INFORMATION INTO A RELATIONAL DATABASE

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Introduction

Haz-Map® is a relational database of occupational toxicology that has been freely accessible on the website of the National Library of Medicine since 2002. The goal of Haz-Map is to collect into one database the best information available regarding occupational exposures and diseases and to support the early recognition and prevention of work-related diseases.

The Haz-Map database demonstrates a new technique for distilling, classifying, indexing, summarizing, and disseminating scientific information. This technique is called knowledge mapping. The need for knowledge mapping is great because there is so much information about occupational exposures and diseases; it is easy to get lost in the details. Mapping means to start with the big picture and then to draw in the details.

Figure 1: A Map of Geographical Information

This technique became possible only in the last 15 years with recent technological developments:

✓ Personal computers;
✓ User-friendly relational database software;
✓ An explosion of knowledge in the fields of occupational toxicology, industrial hygiene, epidemiology, and infectious diseases; and
✓ The availability of the World Wide Web for finding information about chemicals and also for publishing that information.

Methods

The whole database contains interconnected tables of not only chemicals and diseases, but also of signs & symptoms, hazardous job tasks, jobs, industries, industrial processes, and hobbies. Distilling refers to the process of sifting through the information for inclusion or exclusion. Only the most useful information is included. Using selected references from the scientific literature, the author added to the database any chemical or biological agents linked to occupational asthma, toxic pneumonitis, chronic bronchitis, neuropathy, Parkinson's syndrome, methemoglobinemia, aplastic anemia, hemolytic anemia, contact dermatitis, chloracne, liver injury, kidney injury, and simple or chemical asphyxiation.

Category	Adverse Effects
Lung Toxin	Asthma, Pneumonitis, Chronic Bronchitis, and Fibrosis
Neurotoxin	Neuropathy, Parkinson's Syndrome, and CNS Solvent Syndrome
Hematotoxin	Methemoglobinemia, Aplastic Anemia, and Hemolytic Anemia
Dermatotoxin	Contact Dermatitis, Chloracne, and Skin Burns
Carcinogen	Known, Probable, or Possible
Other Tissue Toxin	Hepatotoxin, Nephrotoxin, and Reproductive Toxin
Other Poison	Organophosphate, Carbamate, Organochlorine, Uncoupler, Chemical Asphyxiant, and Simple Asphyxiant

**Table 1:** Each chemical is tagged for all associated adverse effects.
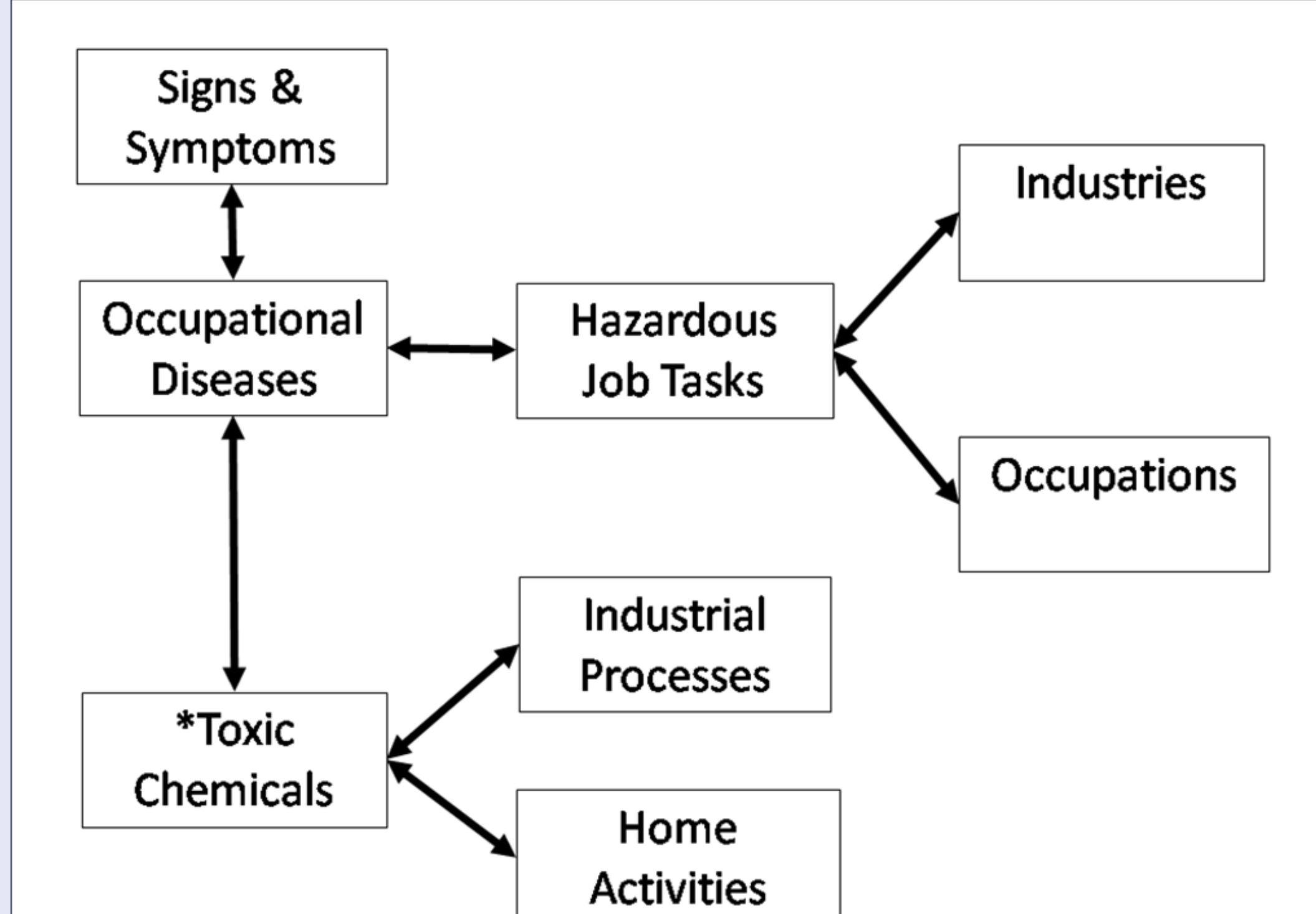
Figure 2: Eight Major Tables in Haz-Map

*This is also referred to as the Agents table. Most records are toxic chemicals, but there are also biological agents in this table, e.g., natural latex rubber.

There are two main levels in the knowledge domain of occupational toxicology: chemicals (toxicity) and diseases (hazards). Adverse effects are at the chemical level—what the chemical can do as observed in animal experiments and human poisoning cases. Symptoms are on the hazard level—what has been reported in cases of occupational diseases. Hazard evaluation takes into account both the toxicity of the chemical and the opportunity for significant exposure to occur in the workplace.

TABLE	CODING SYSTEM
Occupations (Jobs)	SOC
Industries	NAICS
Findings, Diseases	ICD-9

Table 2: Standard coding classification systems are used for these four tables.

Microsoft Access®, a relational database, was used to build Haz-Map. The tables in Haz-Map are linked so that queries will find all diseases that match a job and a symptom or all chemicals that match an adverse effect and an industrial process.

The following features of an electronic relational database make it ideal for displaying and updating the specific information needed for decision support:

✓ The pertinent knowledge domain, i.e., hazardous chemicals and occupational diseases, has already been surveyed and mapped;
✓ All information has been indexed using a controlled vocabulary;
✓ All information has been classified using hierarchical categories; and
✓ The software (Microsoft Access) allows instantaneous sorting and querying.

Users can find detailed information in Haz-Map by drilling down with queries or categories. This is like zooming-in on a Google map; all information is in the context of the whole.

Results

There are 225 occupational diseases profiled in the database. Each disease is linked to symptoms, hazardous job tasks, and causative chemicals. The web-based user interface allows one to find all chemicals that match specific search criteria or all chemicals in a major category or subcategory. For example, one can find all chemicals used as disinfectants that are documented causes of allergic contact dermatitis or occupational asthma. The user can also retrieve all solvents in the subcategory "Ketones."

Since 2006 the number of chemical profiles in the database has grown from 1400 to 5700. In the past year, the author added 22 fields to the Agents table to capture animal data from systematic and summarized monographs recently published by both the Environmental Protection Agency (EPA) and the Organisation for Economic Co-operation and Development (OECD). See Figure 3. Eight of the animal effects are coded from 1 to 4 with 1 being the strongest effect and 4 being no effect or not classifiable.
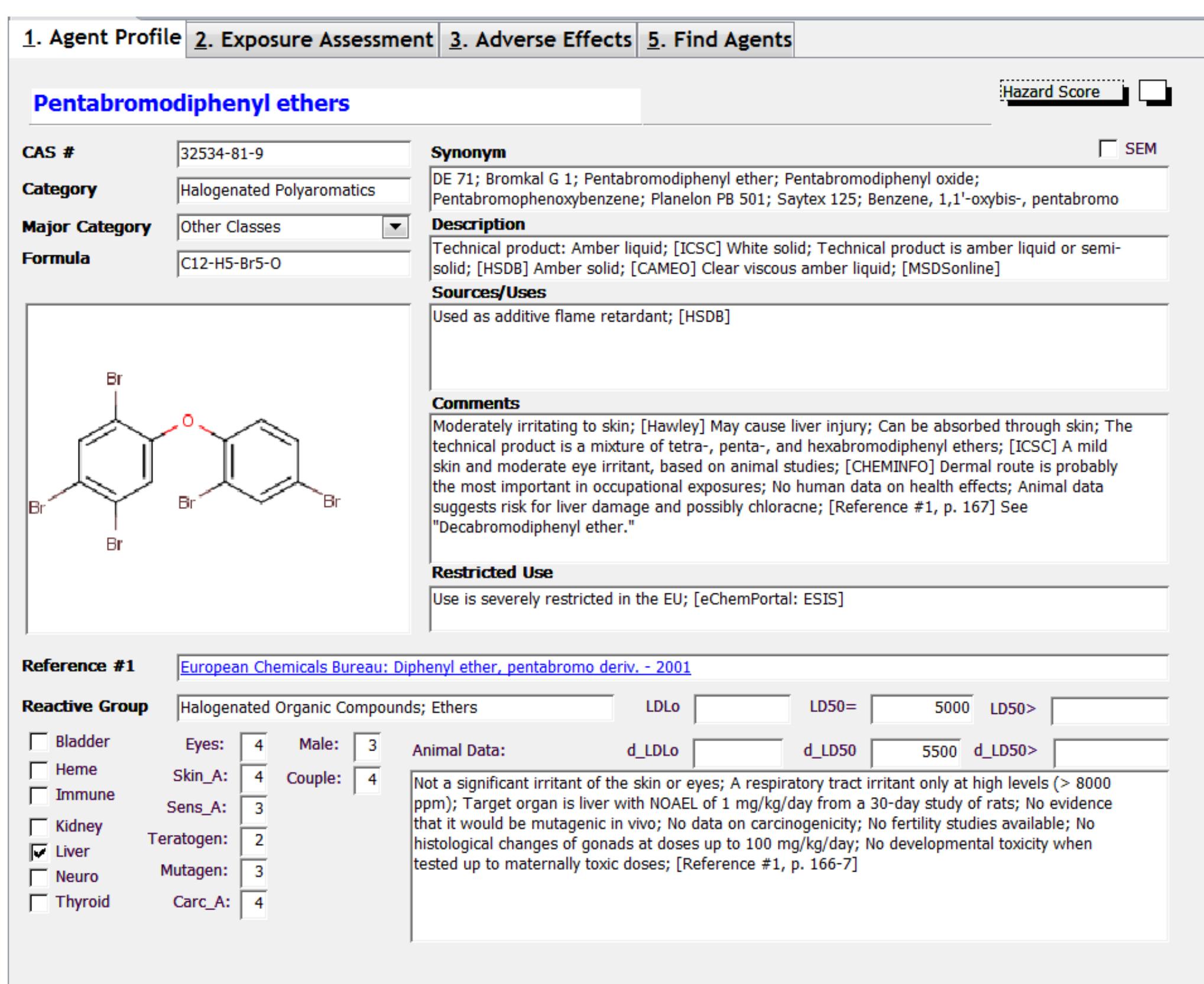
Figure 3: This is the first tab of the Agents form in the Microsoft Access version of Haz-Map. The 5800 agents are classified into 12 major categories: Metals, Solvents, Pesticides, Mineral Dusts, Toxic Gases & Vapors, Plastics & Rubber, Nitrogen Compounds, Other Classes, Other Uses, Dyes, and Radiation & Physical Agents. References [in brackets] document the information sources.
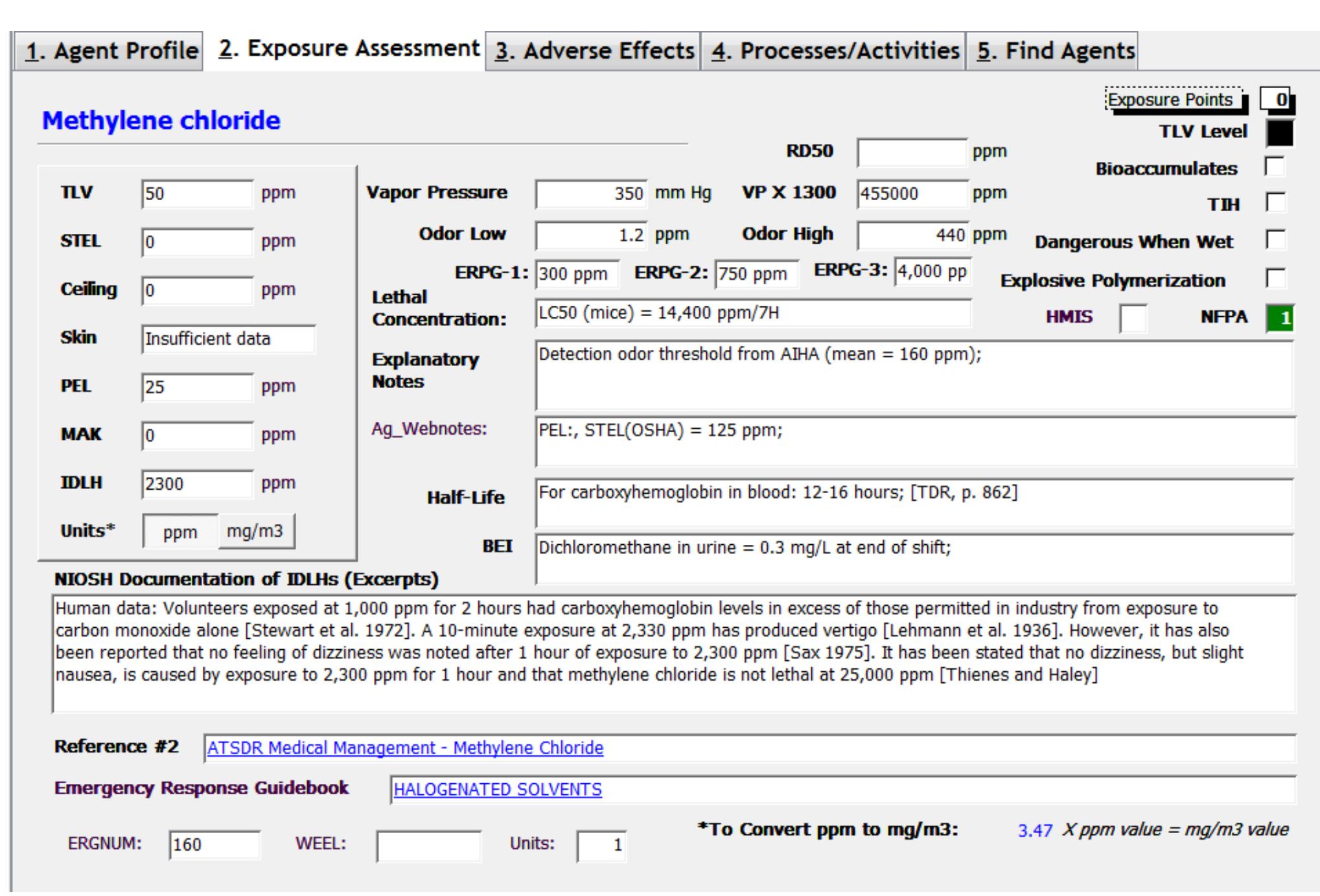
Figure 4: The second page of the Agents form is the Exposure Assessment page. The information on this page was selected to help the clinician estimate the dose received by the exposed worker. What are the recommended exposure limits for this chemical? What is the vapor pressure, odor threshold, half-life, and biological exposure index (BEI)?
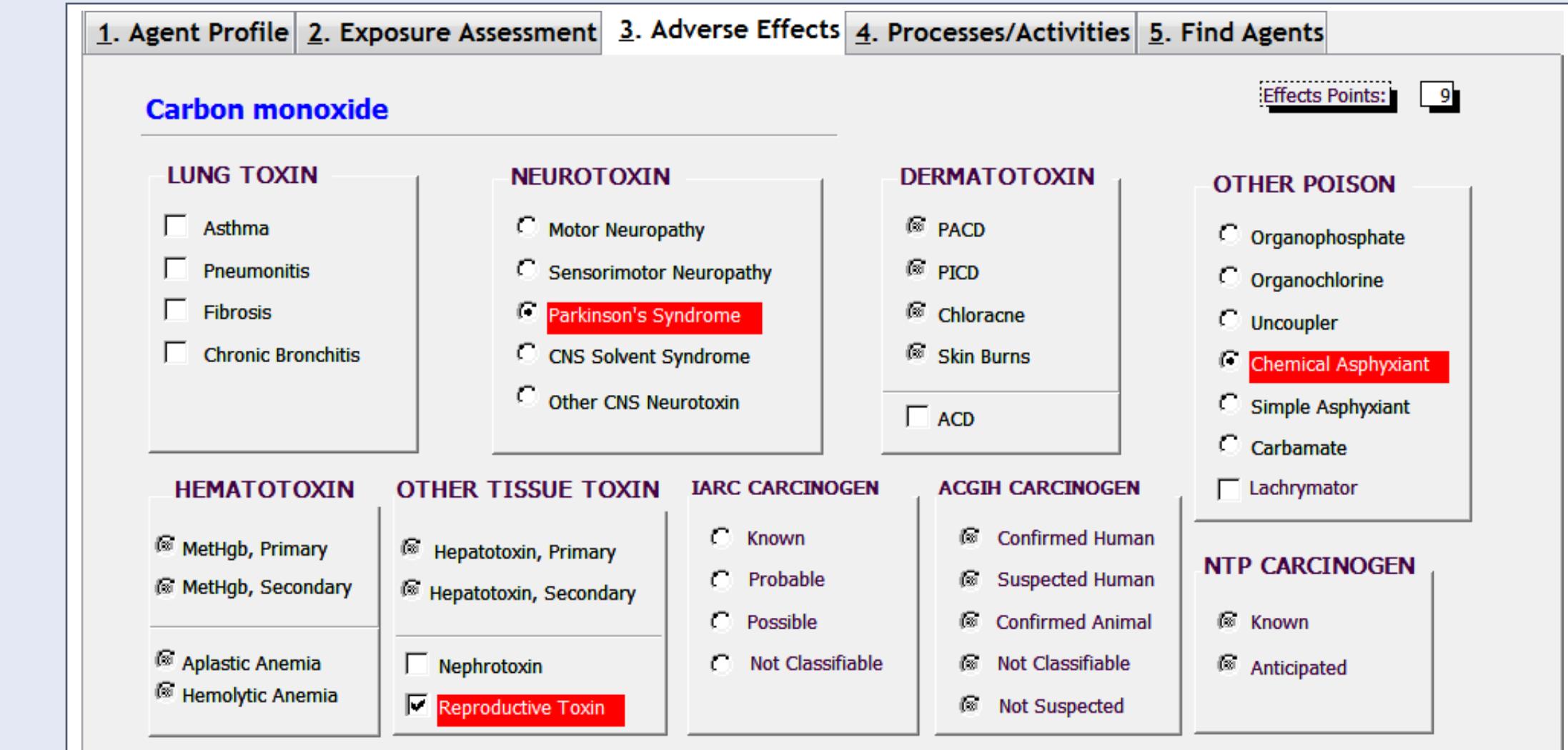
Figure 5: The third tab of the Agents form shows an adverse effect profile for each agent in terms of carcinogenic potential (IARC) and organ systems affected. Pentachlorophenol is an example of an Uncoupler that can poison cellular respiration. ACD stands for allergic contact dermatitis, while PACD and PICD are abbreviations for photoallergic and photoirritant contact dermatitis.
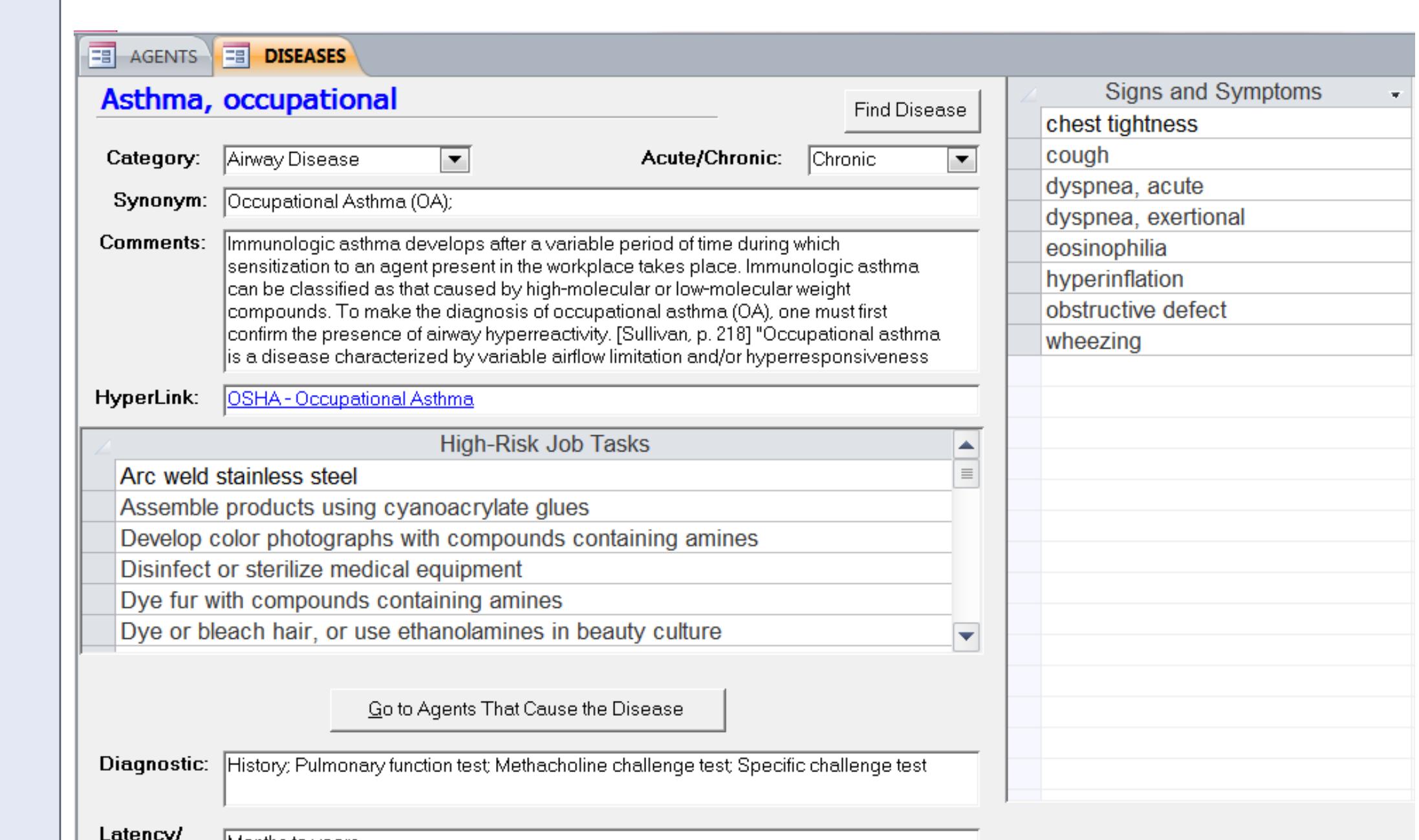
Figure 6: This is the Diseases form displaying information for occupational asthma, one of 225 occupational diseases in the database. Diseases are classified into nine categories: Airway, Acute Poison, Chronic Poison, Infection, Pneumoconiosis, Metals, Skin, Hypersensitivity Pneumonitis, and Cancer.

Figure 7: This is the homepage of the web version of Haz-Map published by the National Library of Medicine. Notice the tabs on this page for **Glossary** and **References** .
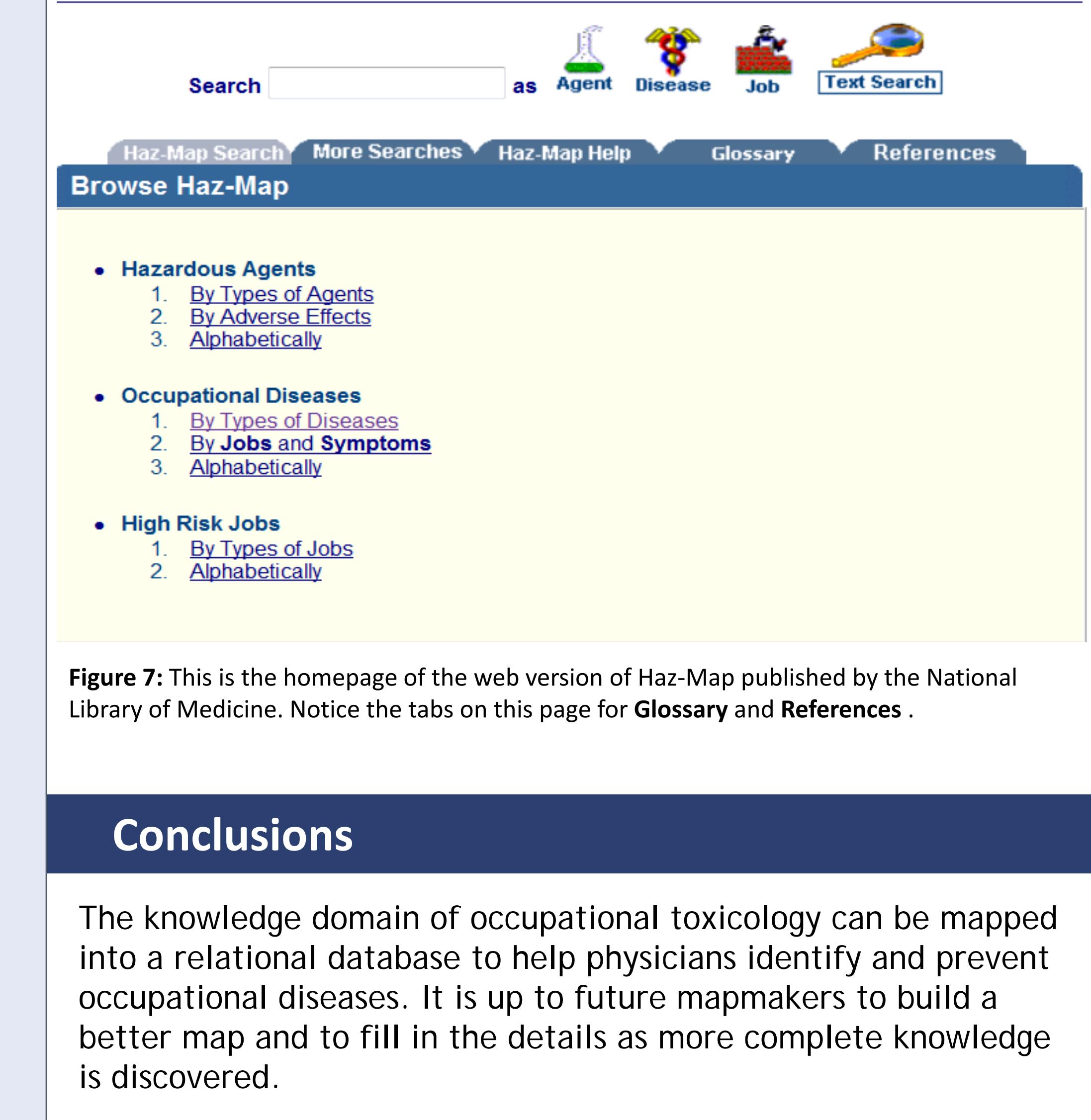
Conclusions

The knowledge domain of occupational toxicology can be mapped into a relational database to help physicians identify and prevent occupational diseases. It is up to future mapmakers to build a better map and to fill in the details as more complete knowledge is discovered.