Expert Environmental Management System (Expert EMS) for Shipyards

Principal Investigator Contact Information:

Bhaskar Kura, Ph.D., P.E.,
Associate Professor of Civil & Environmental Engineering
Associate Director of Maritime Environmental Resources & Information Center (MERIC)
University of New Orleans
Engineering Building, Room 828
New Orleans, LA 70148, USA
Ph.: (504)280-6572; Fax: (504)280-5586
bkura@uno.edu

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Project Summary

This summary presents the details of an expert system recently developed by the author and his team at the University of New Orleans under a grant from the Office of Naval Research (ONR) through the Gulf Coast Region Maritime Technology Center (GCRMTC). The expert system can be defined as a system that is capable of assisting ship/boat building and repair yards with:

- Tracking materials (abrasive materials, paints, solvents, weld rods, and others) consumed and work done;
- Estimating multimedia waste quantities (air pollutants, pollutants discharged in wastewater, solid/hazardous wastes);
- Generating automated compliance reports (annual emission inventory reports, toxics release inventory (TRI) reports, annual hazardous waste reports, and discharge monitoring reports); and
- Supporting decisions to minimize multimedia waste generation, minimize environmental impact, and achieve environmental compliance.

Various modules to quantify emissions from major shipyard processes, namely, blasting, painting, solvent degreasing, welding, cutting, wastewater/storm water handling and treatment were included. Ability to generate automated reports has been included using Data Report Designer and Adobe Acrobat. Reports generated by the expert system can be used for
compliance purposes as well as for internal management. A help file was completed, providing information on shipyard processes and environmental controls which can be an effective tool in training environmental personnel. The software has a feature to notify the environmental personnel of a shipyard’s potential non-compliance in advance of reaching the preset emission/discharge limits and suggests remedial steps to avert non-compliance scenarios.

**Painting Module** - Quantification of Volatile Organic Compounds (VOC) resulting from painting can be calculated in this module. Information from Material Safety Data Sheets (MSDS) for most common marine paints used in shipyards is also included in this module. Compliance evaluation procedures with respect to National Emission Standards for Hazardous Air Pollutants (NESHAP) are included in this module.

**Cutting Module** - Quantification of air emissions from cutting operations is included in this module. Air emissions are further classified into criteria pollutants and metal (HAP) emissions.

**Welding Module** - MSDS information for most common filler metals is included in this module. Air emissions are quantified using EPA emission factors and from the authors’ other related projects. Solid wastes are quantified based on the waste factors for filler rods and filler wires.

**Blasting Module** – The module captures Toxicity Characteristic Leaching Procedure (TCLP) test results for virgin and used abrasives. Air emissions can be quantified within this module using EPA emission factors and from the authors’ own research projects. Solid/hazardous waste quantification procedures are also incorporated.

**Wastewater Module** - This module helps to evaluate and monitor performance of various wastewater treatment units employed by the shipyard. The user can enter the influent and effluent concentration of pollutants, which are stored in the database. Performance of the treatment unit can be assessed using the graph control used in this module.

**Discharge Monitoring Reports** - The user can enter the concentrations of various parameters required to monitor at an outfall. The software cautions the user in situations where the concentration of a particular parameter exceeds the limit stipulated in the National Pollutant Discharge Elimination System (NPDES) permit. The module also helps assess the trend in a parameter’s concentration over a particular period of time.

**Natural Gas Combustion Units** - This module quantifies the air emissions released from the combustion of natural gas. Natural gas combustion is employed in boilers for generation of steam. The air emissions are further classified into criteria pollutant emissions and organic emissions. EPA emission factors are used to quantify air emissions.

**Fuel Tank Emissions** – The Fuel used in shipyards is stored in tanks. VOC emissions result from fuel tank operations like adding fuel, cleaning tanks, and venting from storage tank rooftops. This module quantifies emissions from fuel tanks using EPA emission factors.
Help File - A help file has been included in the software, which provides information on shipyard processes, and wastes resulting from the processes. The module also provides information on different pollution control units employed in shipyards.

Compliance Reports - Compliance and internal reports such as monthly, quarterly, semi-annual, annual Air Emissions Inventories; monthly NESHAP Compliance Reports; Tier II Reports; semi-annual and annual Hazardous Waste Generation Reports; Discharge Monitoring Reports; and the Toxic Release Inventory (TRI) - Form R Reports can be completed using Adobe Acrobat. A special control was designed in Visual Basic, which would enable information to be transferred from the database to appropriate fields in Adobe Acrobat form.

The expert system developed has numerous advantages, some of which are cited below:

- Need for only one time data entry on facility information, sources of air pollution, outfall information, air permit requirements, and wastewater permit requirements which saves time and improves productivity of the environmental personnel.

- Emission factor information is already contained in the expert system, so the system requires only entry of material usage data.

- Material composition information has to be entered only once and the system captures the information from the database when the material is used subsequently. This will be very valuable as shipyards hundreds, and possibly thousands, of times may use the same set of paints.

- NESHAP compliance is verified using the system and the rolling average values of emissions of VOC as well as specific air pollutants.

- The expert system will allow the environmental manager to actually manage and minimize multimedia emissions instead of simply assisting in regulatory compliance. Tools provided will assist in reviewing historical trends of wastewater pollutants (e. g., BOD, COD, oil & grease, pH, copper, nickel, manganese, TBT, and others), criteria pollutants (PM$_{10}$, PM$_{2.5}$, CO, NO$_x$, SO$_2$, Pb, O$_3$), and hazardous air pollutants (e. g., benzene, xylene, styrene, methyl ethyl ketone etc.) to troubleshoot and develop appropriate management plans.

- Useful in training new employees with respect to environmental affairs of shipyards.

- Several environmental tasks can be easily done using the expert system.

UNO is commercializing this software with the help of a distributor under the trade name, Expert EMS. The P.I. is working on similar systems for other industry sectors.