RAPIDS Evolution

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ABSTRACT

RAPIDS was developed as the principal component of the Great Lakes Regional Air Toxic Emissions Inventory Project and is the first multi-jurisdictional toxic pollutant emissions inventory system developed. It was designed for use by local agencies to manage specific and detailed information and to integrate this information at a variety of summary levels over an entire region. It manages emission information for criteria air contaminants, air toxics, and green house gasses for stationary, mobile, and area sources, and it can manage information on solid waste streams, and effluent discharge. Emission estimates are constructed using approved methodologies from a consistent and common base of information, ensuring a compatibility of derived information between jurisdictional agencies and corporations.

Windsor Technologies continues to make enhancements and improvements to the functionality of RAPIDS. Recent developments include the addition of NEI export capability and an emission factor selector. A web interface is being added and the emissions estimator function now calculates significantly faster. Finally, numerous environmental agencies have integrated the RAPIDS data model and functionality to their enterprise systems. A number of commercial organizations are integrating RAPIDS into their enterprise systems.

INTRODUCTION

The degradation of water quality in the Great Lakes has been a concern for at least the last two decades. A reduction in dissolved oxygen levels, which is caused by a buildup of phosphorus and other nutrients, known as eutrophication, has produced an overabundance of algae in the Great Lakes. Point source wastewater discharges, which are dumped directly into the Great Lakes or through feed streams and rivers through, for example, sewage treatment plants, were initially considered the major cause of the problem. Though water pollution control efforts, which focused on wastewater point sources, have gradually reduced eutrophication, researchers noticed that concentrations of certain toxic pollutants were actually increasing as wastewater point source discharges were brought under control. These pollutant increases are thought to be associated with atmospheric deposition and the subsequent run-off of contaminated waters into the Great Lakes (GLC, 1993).

In the 1986, the Governors of the eight Great Lakes States (i.e., Wisconsin, Minnesota, Illinois, Indiana, Ohio, Michigan, Pennsylvania, and New York), and in 1988, the Premier of the Province of Ontario, Canada, signed the Great Lakes Toxic Substance Control Agreement (TSCA) (CGLS, 1986) which committed the participants to cooperate in ***"...quantifying the loadings of toxic substances originating from all sources, with the purpose of developing the most environmentally and economically sound control programs."*** Under the TSCA, the Great Lakes States are working together through an interstate compact agency, the Great Lakes Commission (GLC), on a four-phase program to develop a regional database of air toxic emissions data and estimates (GLC, 1998a). In Phase 1, the technical specifications were developed for a regional air toxics database. In Phase 2, the development of an airtoxics protocol was developed that identified the source categories believed to emit one or more of the seventy-nine target compounds (e.g. mercury) or family of compounds (e.g. polycyclic aromatic hydrocarbons [PAH]). In this phase the approach to develop an emission factor database for the target compounds and the development of an air toxics emission inventory Quality Assurance/Quality Control Plan was completed. In addition, RAPIDS was used to estimate regional point and area source air toxics emissions.

In Phase 3, the RAPIDS database was populated with appropriate data and stationary source and area source air toxic emissions were estimated for the Great Lakes Region. In Phase 4, the requirements for the RAPIDS mobile source air toxics emissions estimates module were developed and implemented. These sources included on-road, non-road and aircraft emission sources. The US EPA Non-road Model approach was implemented into RAPIDS. An initial airtoxics inventory for the Great Lakes region was developed for 1993 (GLC, 1998b) and a more comprehensive inventory was developed for 1996 (GLC, 1999)

Currently, RAPIDS is being enhanced by implemented the NEI export capability and an emission factor selector. A web interface is also being added and the emissions estimator function is being updated to provide much better processing throughput.

WHAT IS RAPIDS?

RAPIDS was developed using a “regulatory independent” approach to ensure that regulatory changes would not impact the ability to track and manage data. The RAPIDS data model has been defined without regard to specific regulatory requirements and is consistent with the conventional understanding of how business and industry are organized, how equipment is identified, and how equipment is used. This generic development approach enables this application to be used for both industry and government business support.

RAPIDS, the Regional Air Pollutant Inventory Development System, is a client/server system consisting of an Oracle back-end database (versions 7.3.x and 8i) designed using Oracle CASE tools, and a "suite" of front-end applications developed using PowerBuilder. It is also available in a stand-alone version that utilizes the Sybase SQL Anywhere database.

RAPIDS is designed to estimate air toxics emissions from stationary, area and mobile source and to deliver the emissions estimates in a form suitable for use in air quality modeling, water quality modeling, and uploading to the US EPA's National Emission Inventory database. The primary functions of RAPIDS are as follows (GLC, 1998c):

- The RAPIDS data base – the Oracle data repository
- Source Selector – groups sources together to perform RAPIDS functions;
- The FIRE upload application – loads emissions factors from FIRE into RAPIDS
- Data import/export application – imports/exports emissions data/estimates to/from RAPIDS
- Query application – performs ad-hoc queries of the RAPIDS data base
- QC checker – performs various statistical checks of the emissions data/estimates in RAPIDS
- Report generator – generates standard reports such as the Tier 1, 2, and 3 reports
- Data converter – converts RAPIDS data into NEI transaction records
- Emissions estimator – estimate emissions using different emissions estimate techniques

THE RAPIDS INFORMATION STRUCTURE

RAPIDS has a data model that provides maximum flexibility in the types and volume of data that can be stored. The RAPIDS data model is:

Based Upon Conventional and Not Regulatory Principles. The core entities of the data model are independent of regulatory definition. Entities and attributes included in a regulatory requirements data model tend to be volatile, requiring frequent revisions in response to new legislation. The RAPIDS data model has been defined without regard to specific regulatory requirements and is consistent with the conventional understanding of how business and industry are organized, how equipment is identified, and how equipment is used.

Applicable to Both Public Agencies and Private Industry. RAPIDS can be used government regulatory agencies, and by corporations and/or individual facilities to manage environmental, process, or product data. The core RAPIDS data model is applicable to both governments and corporations, and is able to manage information sets associated with differing needs. It facilitates accurate, efficient, and cost-effective reporting and information transfer.

Multimedia Support. The RAPIDS data model, while designed to store and manage emissions data and estimates, provides a framework for managing multimedia and product-related data at the most resolved level. RAPIDS can also store and manage any type of monitoring data (e.g., air and water discharge, process, product monitoring) to provide full integration of all facility information.

Logical and Physical Representation of a Facility. The RAPIDS data model allows you to describe a facility from both a logical and a physical perspective. For example, input and output streams for each process are physically associated with a connection at a device. An accurate physical and logical representation of product and waste streams offers users,

particularly in industry, the ability to develop applications (e.g., process flow) that are dependent upon the proper representation of the linkages between various device/process combinations.

Upwardly Compatible With Existing Systems. The RAPIDS data model hierarchy is consistent with that used by most other systems. However, the RAPIDS data model enables data to be managed at a more resolved level (typically required by industry) than most other models.

Flexibility. The RAPIDS data model is object-oriented and modular. For certain applications, such as emissions inventory development, only certain entities and relationships may be required. As other needs develop, additional entities and relationships can be incorporated without the need to redesign the entire data model.

RAPIDS BUSINESS SUPPORT

RAPIDS has application software that supports:

Facility Descriptive Information. RAPIDS maintains and integrates descriptive information about geographic areas, multiple facilities and their locations and key contacts, physical infrastructure, processes, process control and process streams. This information is maintained in a hierarchy of levels of detail so that high-level overview information is intimately linked with drill down layers of specifics. Corporate standards can be set within RAPIDS to ensure that descriptive information is compatible between facilities.

Production Tracking. RAPIDS allows information on production to be maintained and summarized at a variety of levels of detail and timelines to support tracking and analysis. Metrics for production can be established at a corporate level to ensure that comparable information is collected and maintained at every facility.

Process, Schedule, Process Control, and Process Streams. RAPIDS maintains and integrates information on industrial processes, control technologies employed, and their operating schedules and characteristics. RAPIDS can maintain a descriptive base on the flow of materials and contaminants through a processing sequence and any potential fugitive losses and capture efficiencies.

Base Quantity (Fuel usage). RAPIDS provides an ability to establish corporate metrics for base quantities that are associated with production, to ensure that a consistent base of information is maintained within and between facilities, area and/or mobile sources.

Emissions Information. RAPIDS maintains emission information on Criteria Contaminants, Air Toxics, and Green House Gasses from Facility, Area and Mobile Sources. This emission information can be the result of a direct measurement and/or a derivation based on standardized emission estimate techniques. Emission Information is maintained at a variety of timelines and levels of detail ranging from corporate totals to individual emissions from specific processes within a facility. Emission Metrics and standards of derivation can be established at a corporate level to ensure a compatibility of information with a corporation, and a compatibility of information with government standards.

Solid Waste, Effluent and Waste Water Discharge. In addition to managing air emission information, RAPIDS is capable of maintaining information on water and solid waste streams in a corresponding level of detail.

Emission Classification/Codings and Factors based on FIRE (US EPA Factor Information REtrieval system). RAPIDS includes the emission, speciation and mass-balance factors used by FIRE and the corresponding base of Source Code Classifications (SCC) and Area

Mobile Source (AMS) codes so that information can be derived from and/or contrasted with government approved methods. RAPIDS currently contains FIRE Version 6.23 emission factors.

Quality Assurance and Quality Control. Quality assurance/quality control (QA/QC) checks and routines on the emissions data and estimates, including range checks, outlier checks, acceptable value checks, missing value flags, distribution checks and other statistical techniques to identify suspicious or unacceptable data.

Information Reporting. RAPIDS provides for a variety of summary reports based on geographic area, specific facility, industrial process, and a variety other filtering criteria.

Information Exchange (Import and Export in Standard Formats). Conversion of facility source emissions data and estimates into U.S. EPA's National Emission Inventory (NEI) Version 2.0 transaction format to be able to upload to a central repository.

RAPIDS ENHANCEMENTS

There are a number of enhancements currently being developed. They include:

Emission Factor Selection. RAPIDS is being modified to provide functionality for the user to check and/or select a specific emission factor to be used for calculating the emission estimates. The generic speciation factor lookup would associate SCC codes with emission profiles and factors. By selecting an emission factor from any level (generic, state, county, source, or process), RAPIDS would create a new process-specific factor with the current date so that the emission estimator would use this factor. Also, criteria and toxic factors could be used. Reports can show which emission factors the emission estimator used to calculate the estimates.

Data Mart/Web Reporting Interface. A set of de-normalized roll-up tables is being implemented in RAPIDS. This Data Mart approach would use roll-up tables to store summary information and then run the reports from these roll-up tables to minimize performance problems. These roll-up tables would be created inside a separate reporting database that uses a database refresh process to transfer data from the main RAPIDS database into the Data Mart. Periodically, the data in the Data Mart can be refreshed to reflect any corresponding data that has changed in the main RAPIDS database. The refresh process can be set up to run for any desired period, e.g., once a week, once a day, or every hour.

Batch Emission Estimator Function. The Batch Emission Estimator would allow RAPIDS users to save the criteria for Emission Estimator runs and data exports, and then be able to initiate each run from the command line. This would allow users to set up the various runs as batch jobs via the scheduling utility in Windows.

Emission Estimator Enhancements. The emission estimator is currently undergoing a number of enhancements, including:

- Modifying some of the programming constructs to allow the estimator to run quicker
- Remove options that are not used and improve the calculation protocol table to make it easier to use
- Develop a protocol for emission factors in equation format
- Provide true source specific emission factors (as opposed to process specific emission factors)

RAPIDS USE

Over the last few years RAPIDS has received wide acceptance for use in wide airtoxics inventories by government entities. In addition, a number of commercial organizations are starting to use RAPIDS also.

Government Entities. RAPIDS is currently being used by numerous agencies in many jurisdictions, including all of the Great Lakes States and Ontario. In addition, a number of states have used the RAPIDS data model and functionality as the basis of Agency systems, including the Michigan DEQ and the Wisconsin DNR. RAPIDS was used to help develop airtoxics inventories for Melbourne, Australia and Hong Kong.

Currently Alberta Environment in Canada is integrating the RAPIDS data model into its Agency-wide multi-media enterprise system. The Ohio EPA is looking at using the RAPIDS data model as part of its next generation air systems.

Commercial Organizations. A number of international commercial organizations are looking at using RAPIDS as the basis of a facility data management tool to track criteria and airtoxics emission information. An international mining firm is evaluating it for use at all of its facilities worldwide.

CONCLUSION

Enhancements to the RAPIDS to support the development of air toxics emissions estimates have been briefly described. These enhancements will enable the Great Lakes States in estimate air toxics emissions more efficiently. For a complete description of the mission of the Great Lakes Commission, one can visit their website at http://www.glc.org. For a complete description of the RAPIDS computer system, one can see the web site http://www.glc.org/air/rapids/rapids.html.

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