Integration of GIS Technology with Air Compliance for the Oak Ridge National Laboratory

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INTRODUCTION

The 1990 Clean Air Act Amendments (Amendments) dramatically broadened the scope of air quality compliance, compelling plants with many emission sources to improve their data management. The Environmental Compliance and Documentation Section at Oak Ridge National Laboratory (ORNL) uses a Geographical Information System (GIS) to achieve air quality compliance effectively and with minimum expense. A small group can carry out the large task of tracking and evaluating the wide variety of air emissions at ORNL using the GIS/database system. GIS and database systems are available that run on personal computers and require little training to learn and operate. This allows compliance personnel to have direct input into data management. Low end users can quickly develop systems that meet their specific needs. This paper gives several practical examples of how the ORNL air compliance group developed a simple GIS that improved the efficiency of their organization. The paper discusses how GIS and databases work together. Finally, the paper gives examples of how the Environmental Compliance Section at ORNL uses it to achieve air quality compliance for Titles III and V, NEPA, and NESHAPs.

CLEAN AIR ACT REGULATIONS DATA REQUIREMENTS

The Clean Air Act Amendments of 1990 require large amounts of data collection and organization. Title III of the Amendments has expanded the list of regulated hazardous air pollutants (HAP) from eight to 189 and will establish Maximum Achievable Control Technology (MACT) Standards for major sources of hazardous air pollutants in designated source categories. Major HAP sources will also be subject to Title V permitting provisions. Risk Management Plans for Chemical Accidental Release Prevention, also included under Title III, and proposed by the Environmental Protection Agency (EPA) in the Federal Register (58 FR 54190, October 20, 1993), will drive facilities to track amounts and locations of chemicals. Detailed air emission inventories will be necessary for compliance with permitting provisions under Title V of the Amendments. Title VI of the Amendments will require Ozone Depleting Substance (ODS) equipment, ODS quantities, and ODS recovery/recycling equipment inventories for retrofit/replacement of Class I ODS equipment and other compliance requirements under this Title. The Federal Facilities Compliance Agreement (FFCA) negotiated between the Department of Energy (DOE) and the Environmental Protection Agency (EPA) added many data documentation and tracking requirements for radiological emissions at DOE facilities. The clear message given by these regulations is that facilities must have effective data management plans to maximize limited resources to show compliance with air quality regulations. A geographical information system and computer database work together as ideal tools to solve many problems in demonstrating compliance.

EXPLANATION OF A GEOGRAPHICAL INFORMATION SYSTEM

A GIS is a powerful tool for data management, analysis, and display. The main asset of a GIS is to attach data attributes to graphical entities, and to display these simultaneously. Thus, the GIS allows for rapid transmittal and assessment of large amounts of data and ideas. GIS packages are available on a wide range of hardware and software platforms.

Most GIS packages are able to import AutoCadd or other electronically generated drawings to serve the graphic interface of the software. Many computerized engineering drawing tools do not create "smart images" that the computer recognizes as discreet points or spatial entities located in a spatial framework. A GIS can recognize entities and points in a spatial framework, attach data to them, perform database functions, and calculate areas of polygons. For example, in a Cadd generated map a building may be
represented by a series of lines. In a GIS, the same building would be a closed polygon to which data could be attached. Although it is easy to create maps within a GIS package, it is often faster and more convenient to import Cadd drawings or scanned images.

Most GIS packages will allow the import of data from a common database format. Database design is critical to maximize the advantages a GIS provides. The database must include a spatial data point associated with each record to be displayed in the GIS because the GIS data is based on map positions. Once the GIS contains a database file of spatial points and their associated identification, any other associated database may be geocoded into the GIS quickly and easily. Geocoding is the process by which the GIS associates data with spatial locations. The GIS can also plot points to fix data positions if X and Y coordinates are available. For example, a key file for buildings may contain the X and Y coordinates for the centroid of each building on a map, and the building identifier. Therefore, any data associated with the building can be spatially associated with the map point of the centroid of the building by geocoding data based on the building ID. In this way many data files can be linked and associated with map points if they contain the proper linking identification data. A GIS has all of the functionality of a database, and can be used as such. However, GIS packages are used mainly for data analysis and graphical representation. They are not as easy to use for data input as a database package that allows for the creation of customized input screens. Similarly, the GIS can create queries and reports like those produced by database software. However most GIS packages are currently limited in the ease and variety of data retrieval and display. For the experienced programmer, this presents no problem as most GIS packages are equipped with Standard Data Query Language that can do any database function desired.

Multi-tasking software allows the customized input and output of data to be combined with the analytical and graphical powers of the GIS to get the best of both packages. Some GIS packages can use the files generated in database software. Thus, file updates made in the database software are reflected in the GIS files and vice versa. In a multi-tasking computer environment, the database and the GIS can be pulled up on the same screen and used alternatively. This allows users to get a more in depth look at data or reports stored in database software that are referred to in the GIS. The implicit danger to working simultaneously with the GIS and database is that the user can modify location data in the GIS package, but this change would not be translated over to the database package. The database software file retains the old coordinate location data until it has been updated to match the GIS. Spatial changes in the GIS data must be re-geocoded so that the database software associates its data record with the new spatial coordinates. Geocoding data files to reflect spatial changes in the GIS is a quick and easy process.

GIS IMPLEMENTATION FOR AIR QUALITY COMPLIANCE AT ORNL

The Air Quality branch of the Environmental Compliance Division at ORNL uses MapInfo as its GIS, and FoxPro 2.5 as its master database. Both the database and GIS systems run under the Windows operating system on an IBM PC or equivalent, and require at least two megabytes of RAM to function. Windows applications were chosen because these products all have a similar operational system, and are therefore easy to learn. Additional advantages of the Windows operating environment are its multi-tasking ability and its quick processing speed. ORNL recommends a fast machine (486 60 megahertz) and graphics card (Graphics Ultra video card) to maximize the capabilities of the programs. A laserjet color printer is also recommended to take advantage of the high resolution color graphics the GIS generates.
A key asset to using the MapInfo/FoxPro combination at ORNL is the ease of communication with other departments that these tools facilitate. Because it can import Cadd drawings, MapInfo users at ORNL are able to coordinate with the Engineering department to get the latest most accurate drawings of the facility. Another advantage of this coordination is that each group is working with the same maps, this avoiding confusion when submitting plan drawings to oversight organizations. Efficiency is also improved because one department takes the lead in map development and can serve as a clearing house for map distribution. However, MapInfo so simple that even the most inexperienced user can quickly produce maps once they have been configured and distributed by Engineering’s drafting department. Eliminating the drafting department during the data analysis and representation phase save a great deal of time and money.

In the same way, various departments at ORNL utilize similar data formats and structures to facilitate the exchange of GIS information. A GIS User’s Group at ORNL serves as a clearing house for database information tied to map features. This group promotes common structures that allow Engineering, maintenance, Health Physics, Industrial Hygiene, Occupational Safety, and Environmental Compliance groups to communicate common information. Users participate in this group on a voluntary basis. They submit data associated with map items to a central data directory access through the ORNL vax. Each data file is geocoded into MapInfo, and has qualifiers explaining the accuracy and source of the data. Users are free to download and use files at will. Notices of periodic updates listing new available data files are posted on the plant’s E-mail for all users. Users are free to download and use data at will. This data exchange eliminates redundancy, saves time, and improves the accuracy of each group’s data management system.

The ORNL Environmental Compliance Section uses its GIS and database to manage approximately 2000 air emission points to track for compliance purposes. Various research activities at the lab involve a wide variety of chemicals. Chemicals are not generally used in convenient batch amounts so that usage rates are known and emissions can be estimated from these. Further complications result because experiments take place in many different locations, and start and stop at different times. The following examples show how the GIS is used to assist in compliance with Titles III and VI of the Amendments, NEPA documentation, and the NESHAP requirements of the Federal Facility Compliance Agreement (FFCA) signed between DOE and EPA.

**Common Data Fields**

The GIS uses many data fields that are common to all compliance regulations. Basic location information on the buildings and rooms in the facility must be geocoded. It is also helpful to include data associating facility managers and divisions with locations. Then corrective action compliance issues can be taken up with the correct personnel. This data also assists in compliance analysis to pinpoint and compare compliance problems and successes within divisions or work areas.

**GIS Use for Title III Compliance**

ORNL uses its GIS to collect and analyze data to comply with the requirements of Title III of the 1990 CAA amendments. For these regulations, ORNL must track all of the 189 hazardous air pollutants (HAPs) Title III list to assure that emissions do not exceed 0.1 percent of the threshold limit value at the facility property line. To document compliance with title III, ORNL must compile an emission inventory of each source emitting HAPs, and where this source is vented. The GIS is used to track the progress of the inventory, serving as a map for survey teams, and a record keeper of surveyed areas.
Once inventory data is registered in the GIS, it can be used for title III compliance analysis.

**Inventory Tracking.** ORNL uses the GIS to track the inventory status of emission sources. Tracking when inventories are done and by whom is important in a large facility like ORNL. Furthermore, inventories must be an ongoing process instead of just providing a one-time catalogue of HAPs at the facility. The GIS helps organize field work by keeping up with when inventories were last performed in specific areas. Figure 1 shows a GIS overview of inventory tracking for ORNL.

**Compliance Analysis.** The emission point for the source must be evaluated for compliance with title III air quality standards after the HAPs inventory for each source vented at that point is completed. The GIS can sum emissions for each chemical for all sources venting from a discreet point. Then the GIS database uses an air quality model derived dispersion factor to derive a resulting concentration at the facility property line. The GIS database compares these concentrations to corresponding air quality standards to determine that the facility is in compliance. Compliance personnel can quickly identify emission points that emit enough HAPs to exceed the standard. The GIS provides information on what sources, division, and facility manager are involved if a standard is exceeded. Figure 2 shows a comparison of summed emissions in the GIS with their regulatory standards.

**Accidental Release Management Plan Development.** The GIS assists in developing the accidental release plan for title V by locating likely release points. Maps overlaying the facility also show the predominant wind patterns and nearest exposed members of the public to assist with planning. Figure 5 shows a wind rose for the ORNL area overlain on a map of potential HAPs emission points.

**GIS Use for Title V Compliance**

Title V requires exemption or permitting documentation for all air emission sources at a facility. This documentation must show where emission sources are vented, permit conditions, and exemptions as part of the title V permit. Exemptions are granted based on the definition of a source or the source's emissions. The most efficient way to demonstrate compliance with title V is to compile a source inventory based on exemption or permitting data for each source. A source emission inventory must be included for sources with emission permit conditions and sources that demonstrate exemption by emissions.

**Survey Tracking.** As was shown for title III, the GIS is used to track the progress of the source inventory survey. Field survey forms must be designed to match the database so that information can be uploaded into the GIS system. Field forms should have spatial location data associated with each source's title V data. Figure 3 shows a GIS overview of inventory tracking for ORNL.

**Compliance Analysis.** The GIS can quickly evaluate the title V compliance status for all source at the facility. It can be used to show what emission limits are assigned to emission points based on the permit requirements of sources attached to them. The GIS can be used to track permit inspections, and pinpoint areas or departments that need corrective action to comply with their permits. Figure 4 shows how permits and exemptions are identified using the GIS.

**GIS Use for NEPA Documentation**

ORNL uses the GIS to assist in NEPA documentation and tracking of NEPA projects. These projects are often hard to describe in terms of a single data point identification system since they may cover
large areas. The GIS can be used to trace out the polygonal area of the project and attach NEPA
documentation to this area. Then the GIS can calculate the area of a NEPA project for such air
compliance issue as fugitive dust emissions evaluations. Engineering is often involved in documenting
new projects, so drawings are usually available to import into the GIS from CADD.

**GIS Use for NESHAP Compliance**

ORNL uses its GIS to evaluate all radiological areas at the plant for NESHAP emissions. The FFCA
signed by DOE and EPA requires ORNL to evaluate all radiological areas annually and estimate
radiological emissions and the resulting dose for each. The evaluations may group emissions where
radiological areas have similar emissions in terms of types, emission points, and spatial locations. The
GIS is used to assess emission point groupings. Health Physics personnel at ORNL contribute
radiological area information to the GIS Users group. This data is used by the compliance organization
to locate radiological areas for assessment. Compliance personnel attach data to the GIS showing
whether the area is vented to a monitored stack, or requires emission estimates to determine dose. As
in the previous examples, the GIS tracks the progress of the assessment. Figure 6 shows radiological
areas and their NESHAP designations at ORNL. The GIS also shows what radionuclides are emitted
from which stacks, when the HEPA filter was checked on each stack, and the emission estimation
method used. The GIS also locates the nearest exposed resident, and calculates the distance from
designated stacks to that resident. This information is needed to do NESHAP dose assessment
modeling.

**CONCLUSIONS**

Since implementation of MapInfo for Environmental Air Compliance activities, plant-wide adoption of
the system is occurring. The common forum for data exchange allows compliance groups to pursue
more of a management and planning rather than merely a regulatory role. Field surveys are
implemented by personnel directly involved with the activities and this data is then transmitted via
MapInfo, rather the compliance personnel

GIS technology has proven to be a valuable tool at ORNL in compliance with regulatory requirements
under the Clean Air Act. ORNL has sucessfully implemented a low end, inexpensive GIS/database
system in accomplishment of compliance activities required under Titles III, V, and VI of the 1990
Clean Air Act Amendments, related to NEPA documentation, and required under the Radionuclide
NESHAP FFCA signed between DOE and EPA. The GIS has proven to increase efficiency of database
management and to be an enormous time saver for small Clean Air Compliance staffs.

With the onslaught of regulatory activity related to inactment of the Clean Air Act Amendments of
1990, This system becomes increasingly essential as the regulatory data assesment requirements pile up
while compliance staffs remain small. In addition to the current usage in air compliance permitting and
various required emission inventories, ORNL plans to expand its use of the GIS to save time and money
at the plant.

**REFERENCES**

1. The Clean Air Act 42 U.S.C. 7401q, as Amended by the Clean Air Act Amendments of 1990,
Permitting Status for Building 3500

- exemption 1200-3-9-.04(4)(iii) (1)
- exemption 1200-3-9-.04-4B (4)
- exemptions 1200-3-9-.04-4B & 4I (1)
- exemption 1200-3-9-.04-4GG (1)
- exemption 1200-3-9-.04-4I (9)
- exemption 1200-3-9-.04-4J (1)
- exemptions 1200-3-9-.04-4N & 4I (1)
- PERMITTED (7)

* to be inspected (1)

Figure 4.