Air Emissions Data Management at the Goddard Space Flight Center

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Abstract

Goddard Space Flight Center in Greenbelt, Maryland, is the home of state-of-the-art laboratories, fabrication, integration and testing facilities, as well as operations capabilities for the full life cycle development of spacecraft and instrumentation.

Data Collection. GSFC has traditional emissions sources such as boilers and generators but also has unique emissions sources originating in the research laboratories and facilities. The latter facilities have little or no automated data collection. Data is transcribed from handwritten logs. The impact of data collection for GHG scope 1 combustion sources was minimal.

Management. All data is entered into a resident Access database. The ongoing maintenance of the database drains resources. Keeping up with new requirements requires time consuming updates but allows for rapid response. Our chemical inventory of HAPs/TAPs is huge but quantity used is small. The chemicals in use are continuously changing. A central automated hazardous materials management system would make this process more accurate and much simpler. Data verification is a major issue whether for boiler/generator operations or Research &Development. Quarterly verification of all permit conditions and data quality is achieved to ensure continuous compliance.

Reporting. The database does it all, but it has the same problem of responding to changes. Challenges arise when the State changes their reporting mechanism on short notice (resident database can be quickly changed). GHG reporting drove very substantive changes.

COTS versus resident database pros and cons will be discussed. Lessons learned will be presented.

Goddard Space Flight Center (GSFC)

National Aeronautics and Space Administration (NASA) GSFC, is located at 8800 Greenbelt Road (MD 193) in Greenbelt, Prince George's County, Maryland; about 15 miles northeast of Washington, D.C. The entire site is currently owned by NASA, and is a major U.S. laboratory for developing and operating unmanned scientific spacecraft. The Center also manages many of NASA's Earth observation, astronomy, and space physics missions. The campus encompasses 1,270 acres, part of which is loaned by the nearby U.S. Department of Agriculture Beltsville Agricultural Research Center (BARC). These grounds include more than 34 major buildings that provide more than 3 million square feet of research, development and office space. Goddard is unique in that these facilities provide for the construction and development of spacecraft software, scientific instruments, and spacecraft. The Baltimore-Washington Parkway runs adjacent to NASA GFSC. The properties adjacent to the site are suburban to the Baltimore-Washington corridor, and include residential and commercial properties.

The Mission of GSFC is to expand knowledge of the earth and its environment, the solar system and the universe through observations from space.

On October 4, 1957, the Union of Soviet Socialist Republics (USSR) launched a small satellite called SPUTNIK I. Closely following this dramatic event, the USSR launched a 1,100-pound satellite named SPUTNIK II on November 5, 1957. Both of these events acted as catalysts for the United States' space exploration effort. NASA was established by the Executive Order of President Eisenhower in October 1955. In August 1958, 550 acres of land titled to the BARC was set aside by the Federal Government for the construction of the Beltsville Space Center. The majority of the land now occupied by GSFC was previously owned by BARC. In October 1958, the Vanguard Rocket Program was transferred from the United States Naval Research Laboratory to NASA. The original core group at GSFC was formed by the scientists involved with Vanguard.

In January 1959, the announcement was made that NASA's various space flight programs would be centralized at the Beltsville Space Center. The construction of the first building began in April 1959. The Beltsville Space Center was renamed the Goddard Space Flight Center in May 1959 in honor of Dr. Robert Hutchings Goddard, the "Father of American Rocketry." The original core buildings were completed during the early 1960's.

GSFC has played an important role in the space satellite program. The manned space program has utilized much of the research and technology developed for the early satellites. The Greenbelt Campus continues to play an important role within NASA with ongoing research, development, testing, and data acquisition and interpretation in the space sciences and earth sciences programs. The GSFC Greenbelt Campus is divided into five sections, including the Main Campus, and the satellite areas (the Magnetic Test Facility, Propulsion Research Laboratory, Antenna Test Range, and Goddard Geophysical and Astronomical Observatory).

GSFC is located in a non-attainment area for ground-level ozone and $PM_{2.5}$ according to federal health standards. The Center is a major source for NO_x (based on the potential to emit, not actual emissions) due to the area's designation of non-attainment for ground-level ozone, and is an area source for hazardous air pollutants. GSFC is a minor source for greenhouse gases (GHGs), assuming that landfill gas is classified as a biogenic fuel. Otherwise, GSFC may be classified as a major source of GHGs.

GSFC Air Emissions

Because of the major source definition for a criteria pollutant, NOx, GSFC has a Title V Air Permit issued by the Maryland Department of the Environment (MDE). The Title V Permit reporting

requirements include an Annual Compliance Certification and an Annual Emissions Certification. MDE has also required that GHG emissions from permitted sources be included in the Annual Emissions Certification.

Permitted Sources

GSFC's permitted sources include three boilers rated at 49.5MMBtu/hour that can burn natural gas, landfill gas, or #2 fuel oil; and two boilers rated at 49.5 MMBtu/hour that can burn natural gas or #2 fuel oil. The boilers provide steam for all of the major buildings on the Center. The Center also has emergency diesel generators that can provide up to 14.75 MW of power, a Semi-Conductor Facility, an Aerospace Coating Shop, and an Electrochemical Plating Shop.

Greenhouse Gas Sources at GSFC that are Scope 1 are the emissions from the boilers, generators, fugitive emissions, and mobile sources directly under the control of NASA. The initial GHG inventory was conducted in response to Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*. This inventory included only Scope 1 and 2 emissions and was completed for Calendar Year 2007 following the World Business Council for Sustainable Development/World Resources Institute Protocol. The MDE requested a CY07 GHG Inventory for the Title V permitted pieces of equipment in the Annual Emissions Inventory. Therefore, the GHG Inventory submitted to MDE included only emissions from the boilers and generators. In addition, MDE did not consider landfill gas emissions as biogenic fuel.

Role of the EMS

After the completion of the first GHG Inventory for Scope 1 and 2, the Environmental Management System (EMS) Core Team designated a completed GHG Inventory a high priority aspect in August 2008. The Environmental Management Plan called for the completion of a Scope 1, 2, and 3 GHG Emissions Inventory and to track pending GHG Regulations. By using the established lines of communication developed by EMS, this allowed for exchange/sharing of information with employees and Center Management. The education of Center Management is proving to be a great help in positioning the Center to respond to pending requirements.

Inventory Development

As part of the inventory development, it is important to define the requirements. Read the GHG Protocol and identify the emissions sources on your facility that are included in the reporting rule. This will ensure that the inventory will meet the regulations. The boundary for the inventory is anything under the direct control of the government. This would include civil servant activities but not necessarily contractor activities. Should contractor vehicles fueled at government pumps be included in Scope 1 or 3? The amount of fuel used by contractor's vehicles at GSFC is minimal. However an inordinate amount of time was spent discussing the issue.

You must determine which protocol you are going to use to calculate the emissions. GSFC selected the WRI/WBCSD and the Federal Energy Management Program Energy Management Data Report. WRI/WBCSD protocol was selected because it is considered the "gold" standard for GHG Inventory development.

Once the protocol has been selected, it is important to identify any existing data collection and management systems. Utilizing existing data collection and management systems eliminates a duplication of effort and often provides a data quality check that would meet first party verification standards. One of the most important things is to determine if the data output is relevant, reliable, comparable, available, and maintainable year-to-year. (eg. Scope 3 commuter miles based on surveys?)

It is important to remember that past Executive Orders have mandated the collection of energy and transportation data that you need to determine emissions. Furthermore, if you have a Title V permit you may already be collecting some of the data you need and are verifying the data to meet your Title V

reporting requirements. You then must determine if the data calculated is appropriate and available when required. Ideally, you want to minimize the number of data sources in order to simplify data collection. One of the data sources we evaluated was our Title V Emissions Database. The database contained fuel use data for all permitted emitters but did not include several smaller space heaters fueled by natural gas. Although the difference was small, the database was determined not to be the appropriate data source for natural gas. The database was selected as the data source for landfill gas (LFG) because this fuel was only used in permitted emitters. We finally settled on using the NASA Environmental Tracking System (NETS) as the data source for natural gas data because this was already the repository of all of the energy data required by Executive Order. The GSA Vehicle Fuel and Mileage database and HVAC refrigerant use records were other data sources used. The selection of data sources must also take into account the requirement that the data be verifiable. How you will conduct the data verification (first or third party) may influence the data source you choose.

Once the data sources have been identified, you need to engage the "keepers" of the data early on. Last minute data demands are usually irritating to the "keepers" and can make the data collection process more than a little difficult. This ensures that both the availability and accuracy of the data meet your needs. Make sure that the data keepers understand why you are collecting the data and its importance in meeting regulatory requirements.

Conducting the initial GHG inventory is more resource intensive because all data must be analyzed for viability and accuracy to ensure it is auditable. Thereafter, you should be able to manage your resources while conducting the inventory. It will not be necessary to have the same exhaustive data evaluation as the first year. We found that it took far more time to collect the data on the insignificant sources such as SF6, HFCs, and PFCs than the Central Power Plant boilers. A good Hazardous Material Management Tracking System would have greatly simplified the tracking of these materials.

The GSFC GHG Scope 1 emissions for Calendar Year 2009 were 10,547 MTCO2e which does not include the emissions from the LFG (a biogenic fuel). It would appear that GSFC has no reporting requirements and future inventories only need go so far as to verify that there have been no significant changes that would push emissions over the reporting limit. The EPA recently finalized an approach for tailoring the PSD/Title V programs to address GHG; however, the EPA has determined there is a need to examine the GHG emissions associated with bioenergy and biogenic sources. If LFG is not determined to be biogenic then we face additional challenges. Compare the potential to emit (PTE) emissions of GHG if the LFG is or is not biogenic:

> The PTE for boiler operations, assuming no LFG and 100% natural gas is 44,120 tons per year CO2e (40,020 MTCO2e).
>
> The PTE, assuming LFG not biogenic, for current operations is 58,720 tons per year CO2e (53,270 MTCO2e).
>
> The difference is due to the makeup of the LFG which is approximately 51% methane and 38% CO_2. This clearly demonstrates that burning LFG is not advantageous for the Center if LFG is not classed as a biogenic fuel.

Sources Other than Power Plant Boilers include the following:

- Emergency Generators – 110 MTCO2e (1% of total)
- Space heaters – 460 MTCO2e (4% of total)
- Mobile Sources – 27 MTCO2e (0% of total)
- There are no SF6, HFCs, and PFCs, and NF3 in measurable amounts
- Fugitive Emissions – no guidance as of yet, but rough data shows much less than 1% of total

Documentation

Regardless of whether the Center is required to submit a GHG Inventory to a regulatory agency, it is crucial that documentation must be kept, if for no other reason than to provide documentation that reporting was not required. Furthermore, keeping accurate records will help in validating the data and provide documentation to satisfy auditors.

Other Issues

There were additional issues at GSFC that affected the collection of data. Annually, we must complete three GHG Inventories: Maryland Department of the Environment Annual Emissions Inventory, EPA's Mandatory Reporting Rule, and Executive Order 13514 requirement. There are different requirements for each of these GHG Inventories which are summarized below:

Regulatory Authority	**MDE GHG Inventory**	**EPA's Mandatory Reporting Rule**	**Executive Order 13514**
Inventory Basis	Calendar Year	Calendar Year	Fiscal Year
Scopes	Limited Scope 1	Limited Scope 1	Scope 1, 2 and 3
GHG	CO_2,CH_4, N_2O, HFC, PFC, and SF_6	CO_2,CH_4, N_2O, HFC, PFC, SF_6, fluorinated gases	CO_2,CH_4, N_2O, HFC, PFC, and SF_6
Landfill Gas	Not biogenic	Biogenic	Biogenic
Units	Tons/year CO_2e	Metric Tons/year CO_2e	Metric Tons/year CO_2e

We had to ensure that data collection resulted in a data set that would satisfy all three of the reports that we had to create. It may seem simple but some of the data sources may have data usable for one report but not another. If the data source contains annual data for a calendar year, you can't use it for the fiscal year reporting. We were fortunate in that all of our data sources were either monthly or quarterly data. This meant that we only had to run reports for differing time frames. We also ran into some confusion because the Mandatory reporting rule included fluorinated gases in addition to HFCs and PFCs. Does this mean we are to include chlorofluorocarbons? An example in the FAQ database for Part 98 seems to indicate that fluorinated gases refers to NF_3 and hydrofluorinated ethers (AKA PFPEs – polyfluorinated polyethers). Is this all we are to consider? There is little data on the global warming potential for many of the PFPEs so calculating the CO_2e becomes problematic.

National Environmental Policy Act (NEPA)

Another GHG inventory that will affect most facilities is determining the climate impacts of a Federal action during the NEPA process. We must comply with the Council of Environmental Executive's "GHG *Emissions and Climate Change inclusion in NEPA.*" This inventory is project specific and although the annual CO_2e for the project may need to be calculated, it is only performed once to determine if there are potential significant impacts. This inventory would include Scope 1, 2, and 3 emissions from sources directly and indirectly related to the project. Currently, the reference point is 25,000 MTCO2e for which an evaluation should be considered. Potentially, the impact on your resources could be significant since the entire scope of the project must be considered in the analysis. As of the preparation of this paper, definitive guidance describing how to conduct the analysis had not yet been released.

Impact on Resources

At GSFC we very quickly became concerned that GHG accounting was going to significantly impact our resources. As we became more involved in the process, we began to collect workload and other resource data so that we could go to management with detailed documentation of resource needs (there is a limit to "*doing more with less*").We broke the requirements down into three categories:

Annual GHG Inventory, Title V and PSD, and Project GHG Inventory/Mitigation (NEPA). For GSFC, we have a mixed civil servant and contractor workforce; we have determined the impacts to each element of the workforce as well as the potential for one-time and recurring Other Direct Costs. We have completed the estimates for The Annual GHG Inventory and Title V aspects. Once the guidance is released for NEPA evaluations we will evaluate the resource needs in that arena too. In all cases, we thoroughly documented increased resource needs that will have to be fulfilled if we are to meet the reporting requirements.

Electronic Data Management

GSFC has used a "home grown" air emissions database for the past six years. The database has served quite well with minimal updating needed. The new GHG reporting requirements make it necessary to significantly change the database if we want to maintain all data in a central repository that meets all reporting requirements. The effort to make the database changes has forced us to reexamine the issue of commercial-off-the-shelf (COTS) versus home grown. At the time the database was initially developed, there really wasn't a product available that did all or even most of what we wanted. Today there are several products that will do everything we want, including GHG reporting. Although these databases aren't inexpensive, when you compare the internal resources needed to maintain the homegrown database, the COTS database wins hands down. We are now in the process of programming funds for a COTS database and will limp along until the new database is brought on line.

Summary

In summary, there are numerous challenges and opportunities in the development of a GHG Inventory. The EMS provided the opportunity to **educate** Center Management on the impacts of GHG regulations and potential impacts to Center resources. State and federal regulations will drive GHG Inventory approaches from determining the type of emissions to the time period. Flexible and transparent data collection and management are even more important for rapid adaptation, modification, recalculation and validation. The data outputs must be relevant, reliable, comparable, available, and maintainable year-to-year. In addition, it is important to assess the data source's continued viability and sustainability for long-term use. Thus using existing Agency data collection and management systems becomes strategic (don't reinvent the wheel!!) in terms of using limited resources wisely. Also, engage local "keepers" of the data early on. The local data "keepers" can easily identify the data gaps. Remember, this is part of larger effort, not an independent effort (sustainability).

Key Words
Greenhouse gas

Emissions Inventory