Texas Natural Resource Conservation Commission
Quality Assurance and Quality Control Plan
In the Preparation of 1999 Emissions Inventory

Melinda Torres and Diane Preusse
Texas Natural Resource Conservation Commission
PO Box 13087 MC-164
Austin, TX 78711
metorres@tnrcc.state.tx.us, dpreusse@tnrcc.state.tx.us

ABSTRACT

The Texas Natural Resource Conservation Commission (TNRCC) contracted with Environ International Inc. to develop a 1999 Emissions Inventory for the State of Texas and to prepare the data for submission to the U.S. Environmental Protection Agency (EPA) for the National Emissions Inventory (NEI). Additionally, various contracts were awarded to supplement a statewide 1999 emissions inventory for the State of Texas. Local governmental organizations, including Councils of Government (COGs), were awarded contracts to complete 1999 Emissions Inventories for their regions. The Technical Analysis Division of TNRCC also developed inventories for the State of Texas for certain source categories. The processing of this data from a variety of sources presented many challenges.

The TNRCC is responsible for performing the Quality Assurance and Quality Control (QA/QC) procedures of this data. These QA/QC procedures include, but are not limited to, running programs created using SAS to check for format, acceptable National Emissions Inventory Input Format (NIF) Codes, and to ensure all mandatory data fields are complete. Data sets from these different sources were created so that Quality Assurance auditors within the TNRCC Technical Analysis Division (TAD) could compare the various emissions inventories submitted and decide which estimates would be used in the final Texas inventory submitted to the EPA. Reconciling conflicting source category data was a priority. This paper will discuss how TNRCC developed and documented data review, data validation and data verification procedures in preparation for submitting emissions inventories to the EPA.

INTRODUCTION

The use of inventory data developed by diverse organizations presented new challenges for the TNRCC TAD Area and Mobile Emissions Inventory Section (AMEIS). Therefore AMEIS staff had to create and standardize QA/QC techniques that could be used with a wide variety of submitted data.

The EPA requires data be submitted to them in NIF Version 2.0 format. We asked all submitters to provide their data to TNRCC in compliance with the NIF Version 2.0 format. The TNRCC developed procedures to document the data received from these

contractors and the local agencies, and also developed a protocol to check the data for accuracy and completeness.

SAS software was chosen to create programs to check the large volume of submitted data for format compliance. To address different emissions estimates submitted for a single source category, comparison of the data based on the method used would be necessary to choose the most accurate data. The AMEIS staff would then use these emissions estimates to create the finished 1999 Texas Statewide Emissions Inventory for EPA submission.

REALITY CHECK AND STRATEGY

The 1999 Inventory represents emissions estimates for the entire state of Texas with 254 counties, of which 16 are designated non-attainment. For these areas, the AMEIS staff began looking at the potential benefits and problems of resolving data inconsistencies. The use of contractors and local agencies to contribute portions of a statewide inventory transitioned the AMEIS from a very centralized function to one that is more decentralized. Problems arose from the use of multiple submitters using different methodologies to calculate emissions and providing data in various formats. The strategy employed to process the multiple data sets and the decentralization of data sources was to:
  (1) Develop an effective QA/QC plan
  (2) Develop the statewide inventory in phases
  (3) Develop auditing tools and reports

The QA/QC Plan

The QA/QC Plan was developed by a QA/QC team whose function was to provide tools for the auditors to make informed decisions about emissions inventory data coming from various providers. That team initially focused on four areas:
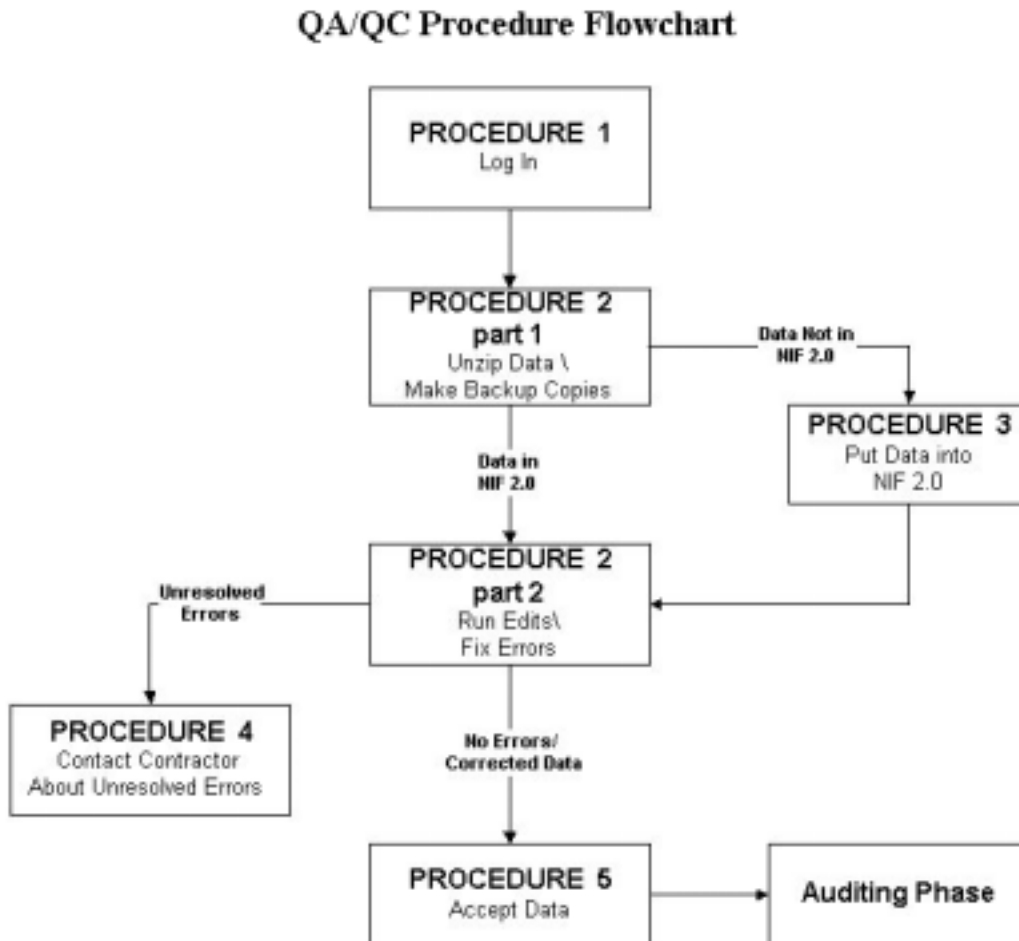 (1) Documentation
  (2) Standardization of the data format
  (3) Centralizing and securing data sources
  (4) Format verification

Documentation

In order to accomplish our goals, all anticipated problems had to be addressed and QA/QC procedures had to be developed. A flowchart of the QA/QC program was created to detail the essential functions of the program (figure 1). Anticipated problems were addressed and QA/QC procedures developed to address them. The QA/QC procedure promoted a well-documented and standardized approach that enabled any member of the staff to QA/QC data by following the designated protocol. The data that

was submitted had to be accessible to all AMEIS staff, which meant establishing a centralized data management system. Staff also had to be trained on all new QA/QC processes. In addition, the QA/QC procedures had to be flexible, since the data submitted to the TNRCC might not meet formatting standards.

Figure 1. QA/QC procedure flowchart

QA/QC Procedure Flowchart

PROCEDURE 1
Log In

PROCEDURE 2
part 1
Unzip Data \
Make Backup Copies

Data Not in
NIF 2.0

PROCEDURE 3
Put Data into
NIF 2.0

Data in
NIF 2.0

PROCEDURE 2
part 2
Run Edits\
Fix Errors

Unresolved
Errors

PROCEDURE 4
Contact Contractor
About Unresolved Errors

No Errors/
Corrected Data

PROCEDURE 5
Accept Data

Auditing Phase

Thorough QA/QC procedures also ensure that all methodologies used to develop an inventory are well documented. This makes it possible for others to review the work and to justify any changes that are made during an audit process. Thus, a period of peer review is built into the QA/QC procedure where data can be evaluated and compared.

Standardization of the Data Format

The AMEIS designated the EPA NIF 2.0 as the standard format for emissions inventory data to be submitted by contractors and/or local agencies. The NIF 2.0 format ensures all data received from various sources are in the same format and use the same

codes. If this format is used, data from different contractors can be easily compared and reviewed during the auditing phase of the QA/QC process.

The NIF 2.0 format shell in ACCESS[1], the NEI Input Format Code Tables[2], and the NIF 2.0 Appendix A[3] are readily available from the EPA. The Appendix A document explains all tables that are required to meet NIF 2.0 specifications and how all codes are used. The EPA can answer any questions about the NIF 2.0 format. By adhering to this required format, each submitter is afforded the opportunity to compare their data against the data posted on the EPA website. Since the NIF 2.0 format is an EPA requirement, other states are also complying. Again, this creates uniformity in data format, which allows for easy comparisons of emissions data between states.

The NIF 2.0 format shell in ACCESS was chosen for several reasons. ACCESS files are relatively easy to manipulate in order to meet the EPA data submission formatting requirements. The ACCESS shell for data input is publicly available and easily downloadable on the EPA website. Also, ACCESS is an "off-the-shelf" software package, which means special programming is not required. In addition, ACCESS has nice editing capabilities built into the program. For example, using the EPA ACCESS shell will not allow the user to continue to the next row of data unless all mandatory fields have input. Now available, the EPA QA/QC tool[4] can be found on the EPA website. This means anyone who uses the ACCESS shell can screen their data utilizing the EPA's QA/QC tool before submitting it to the TNRCC.

Centralizing And Securing Data Sources

Data received by the TNRCC goes through a data registration process. The first step of this process is the login form. The person that receives the data fills out this form. The login form documents general information about the data such as the source type (Area, Nonroad Mobile, Onroad Mobile, Biogenic, or Point Source), and the media in which the data was received (CD, ftp, etc.); contact information of the submitting contractor or local agency; and contact information about the TNRCC staff that received the data.

Next, the QA/QC administrator receives the login form and the data and runs a virus check on the media before the data is accessed. The format of the submitted data is also documented.

The QA/QC administrator is responsible for maintaining the original data sets. Backup CD's are made of the original data. These CD's are kept offsite, which ensures that in the event of a catastrophe, the original data will not be lost. A directory on a network drive is then created and the original data is copied to this drive. This directory has restricted access so that only the QA/QC administrator can replace data. A working directory is created to allow AMEIS staff to download data onto their computers for analysis.

Format Check

After the data has been registered and loaded on the network, it is taken through a NIF 2.0 format check. The format check program was written in SAS by AMEIS staff for each of the four source categories: Biogenic, Nonroad Mobile, Onroad Mobile, and Area. The EPA QA/QC tool was compared to the SAS QA/QC program and was found to take 2-3 hours to check the data. In comparison, the SAS QA/QC program took a maximum of 5 minutes to accomplish the same task. The output from both tools were compared and verified that both QA/QC tools found the same errors. The AMEIS staff chose the QA/QC tool created in SAS to run QA/QC checks on submitted data.

Each data element in a table is checked for proper formatting. For example, each data element has a predefined type and length established by the EPA NIF 2.0 format. The edit program for Area, Nonroad Mobile, Onroad Mobile, and Biogenic also checks the data to make sure that valid codes were used.

Referential integrity between tables, or record types, is then checked. The referential integrity check makes sure that a particular process code has been reported in all correlating tables. For example, for Area and Nonroad Mobile, if a process Source Classification Code (SCC) is reported in the emissions table, it must also be reported in the emissions process and emissions period tables. If the process has any controls then the SCC must also be reported in the control equipment table.

Each record is then checked for duplicates. It is very important to note that duplication must occur in all key fields for an error to occur. SCCs may be reported more than once for each county, but the time period and emissions rate must be different.

The SCC's that are used to describe a process must be EPA approved and are compared to a master EPA SCC list. If the SCC is not found in the EPA list, the program generates an error report. These reports include Detailed Error Reports (figure 2), Duplicate Error Reports, and SCC Error Reports for each record type. A Referential Integrity Error Report and a Summary Error Report summarizing all the Detailed Error Reports are also created (figure 3). If no errors occur then no reports are generated. The AMEIS staff will correct any errors that do not need input by the submitter. Such errors include typos, wrong format of columns, and length of columns. Any errors that require further details will be referred to the contractor or local agency for correction. An Edit Summary is created based on the error reports and is sent to the submitter. The Edit Summary explains any errors that were fixed and any errors that need further information for the AMEIS staff to make corrections. The QA/QC team will arrange individual meetings with contacts from the local agencies that submitted data for the 1999 statewide inventory to present their findings and discuss any necessary corrections.

Figure 2. HTML detailed error report for the emissions record

Figure 3. HTML summary error report for all record types

Development of the Statewide Inventory

The statewide inventory was developed in phases. Phase 1 was to develop the Area, Nonroad Mobile, and Onroad Mobile source inventories for the 16 ozone non-attainment counties. Point source inventories were also submitted to the EPA subsequent to meeting point source QA/QC standards, but point sources are not included in the AMEIS QA/QC program. By first concentrating efforts on the non-attainment counties, the statewide inventory could be compiled and quality assured with the most effort going towards the most critical regions of the state. Phase one deliverables were met.

Phase 2 and Phase III were designated an "added value" phase. The concept of "added value" is the review and audit of data for the remaining counties in the state in an attempt to improve the overall emissions inventory. Phase II focuses on the inventory data that has been submitted by local air quality planning organizations in counties considered as near non-attainment. The auditing of data involves comparing data from these counties to EPA's 1999 Texas Inventory, and to the contracted statewide inventory developed by Environ International Inc. Once the AMEIS staff has compared all of the data from the various sources, results will be sent to the local agency for their feedback and possible incorporation of their data into the 1999 Texas Statewide Inventory. Phase III focuses attainment counties of Texas. Environ International Inc. 1999 statewide inventory and EPA's 1999 Texas Inventory will be compared during this phase.

Automated Tools And Reports

After reviewing and identifying the technical resources of the AMEIS staff, the QA/QC team planned the development of automated data processing tools to assist the emissions inventory auditors in handling the large volumes of data. Training was scheduled for new employees and senior staff to learn the new QA/QC tools. All these factors influenced the decision to select SAS as the primary data manipulation and data management tool.

Auditor's Worksheets

Phase I of the development of the Texas Statewide Inventory was developing a Periodic Emission Inventory (PEI). The PEI is an inventory for all non-attainment counties in Texas and is required by the EPA. During this phase, a comparison was made between the Environ International Inc. 1999 Inventory and the EPA 1999 Inventory for the sixteen non-attainment counties. An HTML audit worksheet was created using a SAS program that highlighted differences between emissions greater than 25% for each SCC (table 1). A team leader in the AMEIS used this comparison to determine the most accurate estimates based on methodology. These changes were given to the QA/QC team to incorporate into the 1999 PEI. Once all changes were completed, reports were developed and given to an AMEIS team leader for final acceptance. Phase I has been completed.

Table 1. HTML auditor's worksheet

Comparison Of 1999 Environ Area Emissions and EPA 1999 Area Emission for Harris County
Base file = Environ
Compare file = EPA_1999

County	SCC	PEI Description	Pollutant	Unit	Environ	EPA	dif	Percent
201	2104006000	Residential/Natural Gas	NOX	TPY	1458.28	1918.8	460.52	24.00
201	2104006000	Residential/Natural Gas	VOC	TPD	0.1	0.08	-0.02	25.00
201	2401070000	Motor Vehicles	VOC	TPD	0.24	0.32	0.08	
201	2401070000	Motor Vehicles	VOC	TPY	62.22	85.59	23.37	27.38
201	2425000000	Graphic Arts	VOC	TPY	2052.9	1606.83	-446.07	27.76
201	2401055000	Machinery and Equipment	VOC	TPD	1.12	1.56	0.44	28.21
201	2401055000	Machinery and Equipment	VOC	TPY	288.19	406.18	117.99	29.05
201	2501060053	Gasoline Service Stations/Stag	VOC	TPY	1054.86	795.04	-259.82	32.68
201	2461800000	Pesticide Application: All Pro	VOC	TPY	75.83	114.29	38.46	33.65
201	2461800000	Pesticide Application: All Pro	VOC	TPD	0.31	0.47	0.16	34.04

Phase II of the 1999 Texas Statewide Inventory is completing comparisons for all near-nonattainment counties. During this phase a comparison is made between the Environ International Inc. 1999 Inventory, the EPA 1999 inventory, and local government organizations' 1999 Inventories. Since several senior members of the AMEIS compare the data instead of the team leader, it was decided to change the HTML audit form into an Excel spreadsheet (table 2). The Excel spreadsheet allows the auditor to document changes on the form. The excel spreadsheet has a column called flag. The flag column is used to draw attention to any problematic areas. If the flag column has 'REVIEW' in the field, the auditor must determine the action required to make the column complete. If the auditor changes the flag column, the reason for the change must be documented in the reason field. Once the audit has been completed, the audit worksheet will be given to an AMEIS team leader for final approval. Once the team leader has accepted the changes, the audit worksheet will be given back to the QA/QC team for Post-Audit Processing. If no errors are found during the Post-Audit Process the data will be used to complete the Statewide Inventory. Once all data is complete, reports will be created and given to an AMEIS team leader for final acceptance. The AMEIS is currently in the process of Phase II.

Table 2. Excel auditor's worksheet

County FIPS	SCC	SCC Description	Pollutant	Day/Year	ENVIRON	NNA	EPA	TNRCC	FLAG	REASON
013	2425000000	Graphic Arts	CO	27		0			REVIEW	
013	2425000000	Graphic Arts	CO	30		0			REVIEW	
013	2425000000	Graphic Arts	NOX	27		0			REVIEW	
013	2425000000	Graphic Arts	NOX	30		0			REVIEW	
013	2425000000	Graphic Arts	VOC	27	0.09	0.03881	0.01		NNA	
013	2425000000	Graphic Arts	VOC	30	24.05	10.0909	4.08		NNA	
013	2440020000	Adhesive (Industrial) Application	CO	27		0			REVIEW	
013	2440020000	Adhesive (Industrial) Application	CO	30		0			REVIEW	
013	2440020000	Adhesive (Industrial) Application	NOX	27		0			REVIEW	
013	2440020000	Adhesive (Industrial) Application	NOX	30		0			REVIEW	
013	2440020000	Adhesive (Industrial) Application	VOC	27	0.01	0.0145	0.01		NNA	
013	2440020000	Adhesive (Industrial) Application	VOC	30	1.38	5.2925	1.38		NNA	
013	2460100000	All Personal Care Products	VOC	27	0.08				NNA	
013	2460100000	All Personal Care Products	VOC	30	30.71				NNA	
013	2460200000	All Household Products	VOC	27	0.05				NNA	
013	2460200000	All Household Products	VOC	30	20.35				NNA	
013	2460400000	All Automotive Aftermarket Products	VOC	27	0.03				NNA	
013	2460400000	All Automotive Aftermarket Products	VOC	30	13.13				NNA	

Phase III will be comparing all attainment counties. The EPA 1999 inventory and the Environ International Inc. 1999 statewide inventory will be compared during this phase. Senior members of the AMEIS will be involved in determining the best estimates based on methodology. Phase III will be initiated upon completion of phase II.

Automated Reports

After the data has passed the QA/QC and auditing process, emissions reports are created from the data. These reports are reviewed by an AMEIS team leader to determine if requested changes were incorporated into the final inventory. Four reports are generated using SAS programs with an HTML output format:
1. A detailed SCC specific report by county and criteria pollutant,
2. A criteria pollutant summary report by county,
3. A criteria pollutant summary report by non-attainment region,
4. A source summary table.

SCC reports

Detailed SCC reports are used by senior emissions inventory staff to audit the emissions data. This detailed report shows the emissions value for each of the criteria pollutants in tons per year (TPY) and tons per day (TPD) for each SCC. The report is generated for a particular county in a specific non-attainment region. The report also shows a brief description of each SCC that appears in that report (Table 3). The Nonroad Mobile detailed report also breaks the report into specific classes. Each class groups similar processes together under one heading. By categorizing the data in this way, anomalies can be found such as snowplow emissions along the Gulf Coast.

Table 3. SCC specific detailed report

1999 Nonroad Emissions for Hardin County, Category - Recreational Marine

SCC	PEI DESCIPTION	VOC TPY	VOC TPD	NOX TPY	NOX TPD	CO TPY	CO TPD
2282005010	Outboard, Gasoline 2-Stroke	3.67	0.0100	0.01	0.0001	1.11	0.0053
2282005015	Personal Water Craft, Gasoline 2-Stroke	1.11	0.0032	0.00	0	0.28	0.0013
2282010005	Inboard/Sterndrive, Gasoline 4-Stroke	4.10	0.0100	0.03	0.0002	1.05	0.0051
2282020005	Inboard/Sterndrive, Diesel	0.00	0	0.01	0.0001	0.00	0
	Total Marine Recreational	*8.88*	*0.0232*	*0.05*	*0.0004*	*2.44*	*0.0117*
1. Values of Zero are due to rounding. 2. Vacant cells indicate emissions could not be displayed within the specified decimal range.							

Summary reports

Nonroad Mobile, Area, and Onroad Mobile sources each have a summary report that shows criteria pollutant emissions totals for each county found within a specific non-attainment region. The totals for each county are then added together to give a total emissions value for the non-attainment region (Table 4).

Table 4. Nonroad mobile source emissions summary report.

1999 Nonroad Mobile Source Summary Beaumont/Port Arthur N/A Region

County	VOC TPY	VOC TPD	NOX TPY	NOX TPD	CO TPY	CO TPD
Hardin	573.43	1.5962	1,286.63	3.5650	2,923.65	9.6996
Jefferson	2,739.96	8.8088	14,278.59	44.9300	20,998.85	77.7094
Orange	437.38	1.3303	2,650.84	7.3807	4,305.70	16.0707
Total	*3,750.77*	*11.7353*	*18,216.06*	*55.8757*	*28,228.20*	*103.4797*

In addition, two other summary reports can be generated for Nonroad Mobile source emissions that show emissions by class at the county level or the non-attainment region level (Table 5).

Table 5. Nonroad mobile source emissions by non-attainment region and class.

1999 Nonroad Mobile Emissions by Beaumont/Port Arthur N/A Region

Class	VOC TPY	VOC TPD	NOX TPY	NOX TPD	CO TPY	CO TPD
Agricultural Equipment	16.75	0.0678	137.21	0.6243	80.72	0.3428
Airport Ground Support Equipment	0.62	0.0016	1.17	0.0032	12.18	0.0335
Aviation	14.69	0.0286	14.92	0.0335	324.76	0.9000
Commercial Equipment	219.25	0.5392	185.93	0.4489	5,068.22	14.1073
Commercial Marine	127.94	0.3300	4,464.97	12.2200	543.44	1.4700
Construction and Mining Equipment	1,033.34	3.4385	9,073.72	30.5849	5,397.35	18.0241
Industrial Equipment	111.94	0.2764	661.38	1.7342	2,789.87	7.5610
Lawn and Garden Equipment	868.55	3.3989	126.12	0.5139	11,571.46	53.1356
Logging Equipment	398.02	1.0556	72.43	0.1906	1,173.12	3.1315
Marine Recreational	767.17	2.0640	5.62	0.0225	212.02	0.9929
Railway	142.33	0.3740	3,466.52	9.4759	356.87	0.9519
Recreational Equipment	50.17	0.1607	6.07	0.0238	698.19	2.8291
Total	*3,750.77*	*11.7353*	*18,216.06*	*55.8757*	*28,228.20*	*103.4797*

Source summary report

Once all of the reports are generated, we are able to illustrate all of the emissions totals in a source summary report for each non-attainment region by criteria pollutant (Table 6). The report shows the emissions totals for each county within a non-attainment region for each of the five source categories (Area, Nonroad Mobile, Onroad Mobile, Biogenic, and Point Source) for each pollutant.

Table 6. Source Summary Report

1999 VOC EMISSIONS – Beaumont/Port Arthur Non-Attainment Area

	POINT		AREA		NONROAD MOBILE	
COUNTY	TPY	TPD	TPY	TPD	TPY	TPD
HARDIN	623.99	1.81	1,274.50	2.2973	573.43	1.5962
JEFFERSON	16,186.48	49.97	6,455.93	17.5606	2,739.96	8.8088
ORANGE	5,016.88	15.33	1,370.22	3.3473	437.38	1.3303
TOTAL	21,827.35	67.11	9,100.65	23.2052	3,750.77	11.7353
	ONROAD MOBILE		BIOGENICS		TOTALS	
COUNTY	TPY	TPD	TPY	TPD	TPY	TPD
HARDIN	920.4	2.31	NA	232.27	3,392.32	240.28
JEFFERSON	5,662.89	14.08	NA	35.49	31,045.26	125.91
ORANGE	1,973.18	4.92	NA	145.06	8,797.66	169.99
TOTAL	8,556.47	21.31	NA	412.82	43,235.24	536.18

CONCLUSIONS

Currently we are developing an Oracle database to hold and maintain our inventories. The goal is to have a data management system, which allows greater security and accessibility. This also gives us the capability to make our data accessible to any customer via the Internet. The QA/QC program developed for the 1999 statewide inventory will be the basis for any future inventories. Once the process becomes fully automated any person in the AMEIS will be able to successfully complete the QA/QC process on any set of data.

ACKNOWLEDGEMENTS

The authors wish to thank Mr. Charlie Rubick and Mr. James Bryant (TNRCC) for their guidance and suggestions during the development of this work. We would also like to thank Ms. Boonsiri Limsakul (ERG) for her programming guidance during Phase I of this project.

REFERENCES

NIF Version 2.0, MS ACCESS Version, Reissued April 2001, U.S. Environmental Protection Agency, [www Document] URL http://www.epa.gov/ttn/chief/nif/index.html

NEI Input Format Code Tables, Originally issued November 2000, Re-issued April 2001, U.S. Environmental Protection Agency, [www Document] URL http://www.epa.gov/ttn/chief/nif/index.html

Appendix A, Instructions and Conventions for Using NEI INPUT FORMAT Version 2.0, November 2000, Re-Issued April 2001, U.S. Environmental Protection Agency [www Document] URL http://www.epa.gov/ttn/chief/nif/index.html

NIF Version 2.0 QA/QC software, U.S. Environmental Protection Agency [www Document] URL http://www.epa.gov/ttn/chief/nif/index.html

KEYWORDS

Emissions Inventory
Area and Mobile Sources
NIF 2.0 Format
QA/QC Procedures
QA/QC Reports
Texas Natural Resource Conservation Commission
TNRCC