PRTRVAL: A SOFTWARE TOOL FOR THE VALIDATION OF EUROPEAN POLLUTANT RELEASE AND TRANSFER REGISTER EMISSIONS DATA

Maria Dios[1], Marta Moran[1], Fabio Carrera[1], Cesar Pombo[1], Jose A. Souto[1], Juan J. Casares[1], Agustin Diaz[2], Aurora Saez[2]

[1] Department of Chemical Engineering; University of Santiago de Compostela; 15782 Santiago de Compostela, Spain (ja.souto@usc.es)
[2] Laboratorio de Medio Ambiente de Galicia, Consellería de Medio Ambiente, Territorio e Infraestructuras, Xunta de Galicia, Spain

Abstract: The European Pollutant Release and Transfer Register (E-PRTR) is the Europe-wide emissions register that provides easily accessible environmental information about industrial facilities in Europe. In this context, reporting of E-PRTR data to the European Commission requires that the Member States assess the quality of the data submitted. Errors or omissions from these data should be detected during the review process, in order to be corrected, claiming accurate and, also, additional information to the industrial sources. In order to check and validate E-PRTR data, PRTRVal software tool was developed and applied to the Galician region industrial facilities; this software provides a systematic procedure to the validation of industrial emissions, applying a bottom-up approach (based in the flowsheeting analysis of every facility) to obtain a reference inventory. It combines both standard (EMEP/CORINAIR, U.S. EPA, IPCC, etc.) and facilities specific emission factors, and their activity factors yearly reported. Application of this validation procedure to the atmospheric E-PRTR data in Galicia shows that 45% of the 2010 emissions reported by the industries need either correction or complementary information. In addition, the omission of information represented 22% of the errors.

Key words: *Emissions inventory, E-PRTR, bottom-up approach, data validation.*

INTRODUCTION

A significant percentage of anthropogenic emissions are generated in industrial facilities, i.e. greenhouse and acid gases, photo-oxidants precursors, heavy metals, etc. Thus, the quality and reliability of these emissions data from significant point sources is essential on the characterization of the emissions from a region (Saarinen, 2003a). Since 2008 (from the previous EPER register), the European Pollutant Release and Transfer Register (E-PRTR) provides access to key environmental industrial data across the European Union and EFTA countries (European Commission, 2006). Yearly, around 28,000 industrial plants from 65 different economic activities report their data to E-PRTR, including 91 air, 89 water and 79 soil pollutants; as well as off-site transfers of waste from the potential sources.

E-PRTR emissions data are reported by the facilities to either regional or national authorities, who are responsible of gathering and checking this information. Then, these datasets are provided to the European Commission and the European Environment Agency (http://prtr.ec.europa.eu/); as they are individually obtained following a bottom-up approach, integrating results from continuous emission monitoring systems, specific emission factors and fuels properties (Winiwarter & Schimak, 2005), E-PRTR data should be a valuable information. However, despite their worth to scientific community, these emissions are undervalued and underutilized (Styles et al., 2009).

The quality of the emissions information is very difficult to assess, since methodologies of reporting and input data, and assumptions strongly vary between the facilities; even for a same facility, they can vary year by year. Although several emission estimation guidebooks focused in the submission of information to the E-PRTR are available, there has not been defined a common strategy to embrace the whole process of emission compilation and/or calculation at facility level (Saarinen, 2003b).

This need of transparency and reproducibility in emission validation leads to the development of an environmental software tool: PRTRVal. A methodology for the evaluation of the E-PRTR register is proposed and applied to Galicia (NW of Spain) industrial facilities, through the PRTRVal software tool. Also, an analysis of the results obtained for 2008 and 2010 E-PRTR emissions data in this region was done, also identifying the origin of errors in the emissions data declared by the industrial facilities.

METHODOLOGY

The validation of emissions reported to E-PRTR is based on the comparison of the emissions with a reference emission inventory, yearly developed with both standard and specific emission factors, and the activity parameters submitted by the facilities involved. This methodology leads to the approval, correction or rejection of the emissions submitted, before they were included in E-PRTR register or even afterward, as a verification procedure prior to the use of emissions data with either scientific or management purposes.

Reference inventory

The calculation of the reference inventory should be understood as a systematic and organized procedure (Figure 1), with a careful application of the methodology that guarantees the estimated emission values are the best approximation to the actual values.

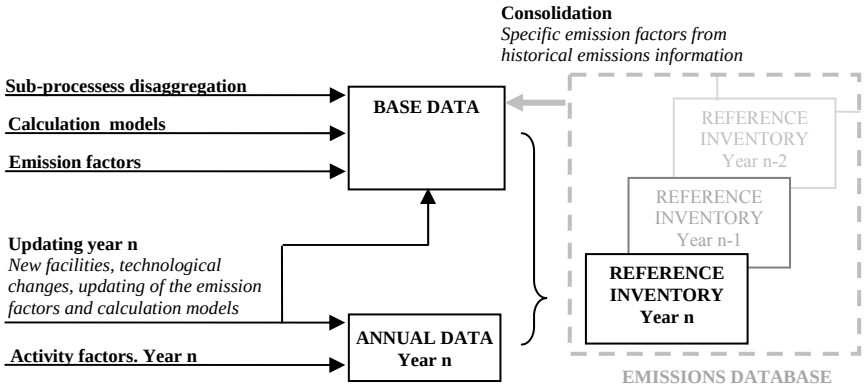


Figure 1. Calculation procedure of the reference emissions inventory.

This calculation is based on the analysis of the flowsheet of each industrial facility, identifying the sub-processes included in each plant or activity, their emission sources and related pollutants. Source Classification Codes, SCC (U.S. EPA, 1995), were used, as a highly detailed industrial sources classification. Next, compilation in a sources database of the appropriate calculation models and emission factors was done, from different standard sources (EEA, 2009; U.S. EPA 1997-2012; IPCC, 2006). When it is possible, either facility specific emission factors or SCC-specific emission models were also included in this database. In fact, specific emission factors can be developed from historical emission data provided by each source (Dios et al., 2013). As any inventory, this database is specific of a sources set, but it is independent from the sources activity; therefore, it remains practically constant from year to year over a region, although some annual updates are required.

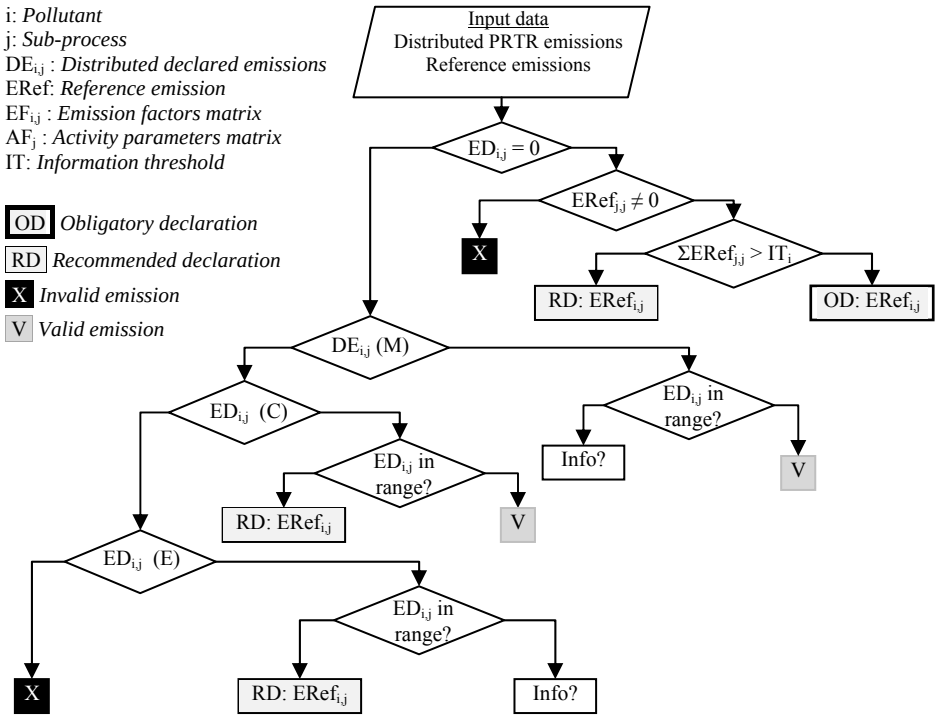


Figure 2. Flow diagram of the validation procedure for E-PRTR emissions data.

With this sources database, the next step is referred to a specific year: the activity parameters. Its values have to be in agreement to the annual sources database updating process, which requires to review and to include (when necessary) new facilities and to modify the current ones because of their technological updates, changes in the fuels or raw materials, etc. All these updates require to add and/or to modify the corresponding emission factors.

Finally, the emissions from each facility are obtained as the sum of their sub-process emissions, calculated by the application of suitable emissions models, standard and specific emission factors, and their activity values (i.e., fuel consumption, energy production, etc.) for each sub-process (Casares et al., 2005). This reference emissions inventory can be considered as a standard and realistic approach to the actual industrial emissions of a region.

Validation methodology

E-PRTR declared emissions are validated by comparison to the reference emissions inventory. In Figure 2, validation process is defined by means of a logic flow diagram, considering not only the declared emissions values, but also their uncertainty, by means of their calculation method: measured (M), calculated (C) and estimated (E), following PRTR recommendations on the calculation method.

In order to establish whether a declared emission value can be considered as acceptable, a maximum deviation respect to the value from the reference database is required. This acceptable deviation range is selected in order to obtain either a more accurate or a more feasible emissions inventory.

In Figure 2, first, it is necessary to check whether the declared emission value is zero. If yes, and the reference value is not zero, an error in the declared emissions is detected: the declared emission must be corrected by the reference value. If the sum of the emissions from all the activities is higher than the pollutant emission threshold, the declaration of this corrected emission is obligatory; if it is lower, the declaration is just recommended, although a zero value will not be acceptable.

Then, the diagram leads to the next logical level to decide if the emission is declared as measured (M). If it is true and the value falls within the deviation range respect to the reference value, the declared emission is validated. If not, it is necessary to check if the emission value is consistent with: the concentration and emission rate values reported by either the facility or any Certified Measurement Institution (CMI), the measurement methods, etc. In case of inconsistency, the declared emissions will be corrected using the parameters supplied by either the CMI or the facility. If these corrections are not feasible, the declared emission is swapped by the reference value, and declared as calculated (C).

In the next level, if the emission value is declared as calculated (C) and it falls within the deviation range respect to the reference emission, the declared value is valid. If not, it is necessary to check the calculation methods and emission factors applied by the facility. After this checking, a proposal to swap the declared value by the reference value (as estimated, E) can be done.

Finally, if the declared emission is reported as estimated (E) and its value falls within the deviation range respect to the reference emission, the declared value is valid. If not, it is necessary again to analyze more carefully the reported information; but the reference value is given priority, as a recommended value for declaration (as calculated, E). Although this validation procedure is designed as systematic as possible, a detailed analysis of the reported information is usually necessary, in order to explain the detected mistakes and their weaknesses, and to correct them.

RESULTS AND DISCUSSION

In order to appropriately evaluate results obtained with PRTRVal software, an analysis of the misinformation and errors was carried out for the atmospheric E-PRTR database at Galicia, in 2008 and 2010 reporting years (submitted in 2009 and 2011, respectively). In this case, a wide deviation range was adopted: a declared emission is accepted if it falls within the range defined by the third part to three times the reference emission.

This case was carried out considering all the facilities registered in this regional PRTR database: 139 in 2008 year and 133 in 2010 year. The pairs “total emission of pollutant i from facility f” were analyzed, identifying the type of errors detected during the revision procedure (Table 1); also, each pair can be affected by one or more type of errors. Of course, although errors were quantified, practically all of them were corrected by either the supply of complementary information or the correction of the calculations; in order to guarantee the declaration of a validated PRTR inventory.

Table 1. Classification and description of errors in the emissions data declared by the industrial facilities.

Type of Error	Description
Type 1 Errors related to non-declaration	1.1. The facility wrongly declares not to be affected by E-PRTR. 1.2. Non-declared emission sources (chimneys, diffuse sources, etc.). 1.3. Omission of pollutants with significant (over threshold) emissions.
Type 2 Lack of information	2.1. Lack of operation parameters: production, concentrations, gases flow. 2.2. Emission calculations not correctly justified. 2.3. Lack of information about measurement methods. 2.4. Absolutely lack of information.
Type 3 Calculation errors	3.1. Misidentification of emission with other parameter (i.e. concentration). 3.2. Units error. 3.3. Error in the combination of several emission sources. 3.4. Specific errors: i.e., to identify PM10 as PST, or COT as NMVOC. 3.5. Wrong emission factor. 3.6. General calculation error.
Type 4 Minor errors	4.1. Limit of detection (LOD) of the experimental method is not reached. The emission is declared as 10-50% of the LOD value. 4.2. Variation of the LOD among measurements. 4.3. Wrong declaration of the emissions method code (M/C/E). 4.4. Experimental measurements not representative/from a different year.
Type 5 Null / Zero declaration	5. No measurements or calculations were set up: Declaration of emission as zero is directly rejected.
Type 6 Other	6. Uncorrected errors after the submission of complementary information. The reported emissions are directly rejected.

Statistics of these errors for 2008 and 2010 years are shown in

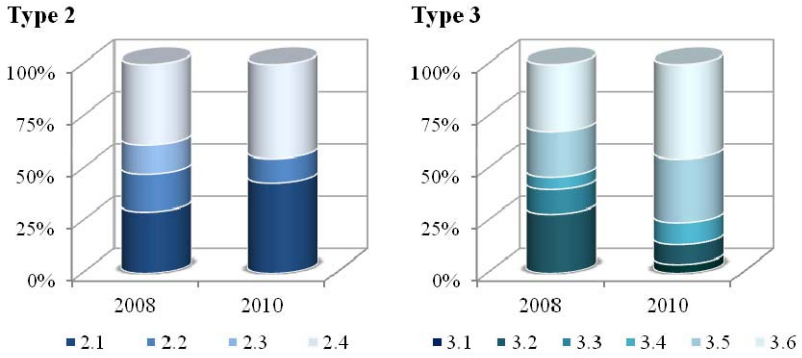
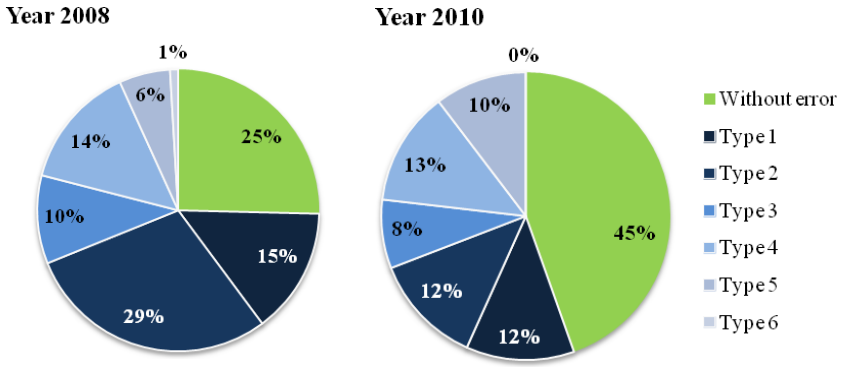


Figure 3a. For 2008 year, 1183 pairs emission/facility were analyzed, and only 29% of them had no errors. This percentage is higher in 2010, 45% from the 1083 declared pairs emission/facility.



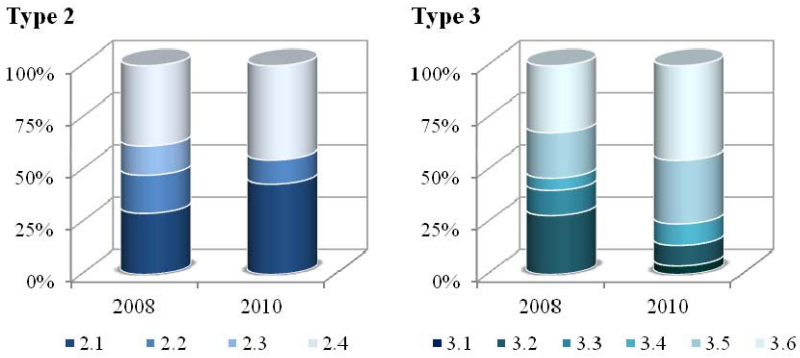


Figure 3. Statistical analysis of the errors in the emissions declared by the facilities to E-PRTR 2008 and 2010 in Galicia: (a) Errors type distribution; (b) comparative analysis of type 2 and 3 errors.

Also, a detailed analysis of the errors type 2 and 3 were carried out (Figure 3b), as these errors could be easily avoid by the facilities with their previous verification of the submitted information. Type 2 and 3 errors represent 39 and 14% of the total errors in 2008 year, respectively; and 22 and 14% in 2010, respectively. About the type 2 errors (Absolutely lack of information), error 2.4 is highlighted: the industrial facility declared emissions data without any kind of explaining information about either the measurement (if any) or the calculations methods; its percentage decreased from 2008 to 2010. Concerning type 3 errors, error 3.6 (General calculation error) is a consequence of the lack of interest from the facility in this declaration procedure, keeping constant in both years.

CONCLUSIONS

A methodology for the validation of the E-PRTR, coded in the PRTRVal software tool, is presented and tested over Galicia region. Comparison of the results obtained with PRTRVal between 2008 and 2010 E-PRTR inventories evaluation shows a significant percentage of declared emissions which required corrections, in order to improve the quality of PRTR submitted data. However, this percentage will reduce from 79% in 2008 to 55% in 2010, showing the growing environmental conscience from the industrial sector, and the experience gained along the years with both EPER and PRTR registers. However, in 2010 this percentage was still high, with a lot of these errors repeated year by year for the same facility, regarding the same pollutant. Therefore, a trustworthy verification by the facility of the information, before being submitted, can avoid a significant percentage of these observed errors.

This validation of E-PRTR data extends the applicability of this emissions inventory, as it can be considered more realistic than other bottom-up inventories based in standard emissions factors; because validated E-PRTR inventory also includes specific emissions parameters from the industrial facilities in the region, as experimental measurements or facility-specific emission factors. Currently, this validated E-PRTR inventory is applied instead of EMEP inventory (only for industrial sources) in both the *PRESAXIO* regional air quality forecast system (http://www.presaxio.es) (Souto et al., 2013) and, also, in the Galicia regional government air quality forecast (http://www.meteogalicia.es).

ACKNOWLEDGEMENTS

This work was developed under contract “Validation of E-PRTR Galician emission inventory” (Laboratorio de Medio Ambiente de Galicia, Xunta de Galicia). Maria Dios research grant was supported by “Maria Barbeito” PhD Programme (Xunta de Galicia).

REFERENCES

Casares, J.J., R. Rodríguez, P. Maceira, J.A. Souto, S. Ramos, M. Costoya & A. Saez, 2005. Inventory, analysis and projection of industrial air pollution emissions in Galicia. University of Santiago de Compostela, Spain, 282 pp. (in Spanish)

Dios, M., J.A. Souto & J.J. Casares, 2013. Experimental development of CO_2, SO_2 and NO_x emission factors for mixed lignite and subbituminous coal fired power plant. *Energy,* DOI 10.1016/j.energy.2013.02.043.

EEA, 2009. EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009. Technical Report No 6/2009. Copenhagen: European Environment Agency.

European Commission, 2006. Guidance Document for the implementation of the European PRTR. European Commission, Brussels, May 2006, 142 pp. Accessible on PRTR website: http://prtr.ec.europa.eu/

IPCC, 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories., Hayama, Japan: National Greenhouse Gas Inventories Programme. Intergovernmental Panel on Climate Change.

Saarinen, K., 2003a. Monitoring total emissions from industrial installations. *Environmental Science & Policy*, 6(4), 367–376.

Saarinen, K., 2003b. A method to improve the international comparability of emission data from industrial installations. *Environmental Science & Policy*, 6, 355–366.

Souto, J.A., S. Saavedra, A. Rodriguez, M. Dios, D. Cartelle & J.M. Vellon, 2013. Evaluation of the *PRESAXIO* air quality forecasting system: PBL schemes WRF comparison and air quality modeling validation. *Proceedings of 15th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes*, Madrid, Spain.

Styles, D., E. O'Leary & M.B. Jones, 2009. Measuring the environmental performance of IPPC industry: II. Applying the Environmental Emissions Index to quantify environmental performance trends from routinely reported data. *Environmental Science & Policy*, 12 (3), 243–256.

U.S. EPA, 1995. Source Classification Codes and Emission Factor Listing for Criteria Air Pollution. EPA 454/R-95-012. Office of Air Quality Planning and Standards. U.S. Environmental Protection Agency.

U.S. EPA, 1997-2012. Compilation of Air Pollutant Emission Factors AP 42, Fifth Edition. Volume 1: Stationary Point and Area Sources. Office of Air Quality Planning & Standards. U.S. Environmental Protection Agency.

Winiwarter, W. & G. Schimak, 2005. Environmental software systems for emission inventories. *Environmental Modelling & Software*, 20, 1469-1477.