

Reporting and exchanging air quality information using e-Reporting

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Executive summary

Recent European Union (EU) legislation provides an opportunity to streamline European air quality data reporting and exchange. There is a strong business case to move towards more automated assessment in the area of air quality by organising and harmonising data and information, and by following standardised approaches. This report explores options and identifies the legal requirements necessary in order to update and facilitate the electronic reporting and exchange.

A number of EU legal instruments require EU Member States to monitor and report air quality data. This information is collated, analysed and shared by the European Environment Agency (EEA). To date much of the data is reported electronically by the countries concerned, but not necessarily in the best integrated fashion. The introduction of the European Commission Implementing Decision 2011/850/EU of 12 December 2011 (laying down rules for the air quality directive in force as regards the reciprocal exchange of information and reporting on ambient air quality) provides an opportunity to modernise data reporting, improve data quality, facilitate information sharing and reduce the administrative burden of reporting.

The Implementing Decision applies from 1 January 2014. In order to manage and facilitate the transition process, the Member State's reporting authorities, their data providers and the EEA's operational services will need to work closely together to establish and test the new reporting process.

The EEA, supported by the European Topic Centre for Air and Climate Change Mitigation (ETC/ACM), will assist the Commission to establish and operate the new mechanism for sharing air quality information (e-Reporting). The EEA will design and implement a simplified and streamlined air quality reporting and information exchange mechanism in cooperation with a number of volunteer countries and the Commission. The system will comply with the Implementing Decision, it will fulfil pre-existing commitments to supply in-situ data to the Global

Monitoring for Environment and Security (GMES) Atmospheric Services and it will adhere to the data specifications/services concepts promoted by the INSPIRE Directive as they become available.

Assisted by ETC/ACM, the EEA has evaluated the options for reporting and exchange of information systems. Taking into account the requirements of the Implementing Decision, the EEA analysed the requirements for the design and operation of the new reporting and exchange of information system.

This report discusses the options available for this new system in the area of air quality. It describes functional algorithms, routines, procedures and concepts that are required or beneficial within the e-Reporting system.

This work is being carried out in close liaison with the European environment information and observation network (Eionet). Moreover, the European Commission's Directorate-General for the Environment (DG ENV) has invited countries to participate in the activity of designing e-Reporting and testing the data flows for each type of reporting covered in the Implementing Decision.

The chapter on the logic of e-Reporting describes the legal instruments, activities and rules for e-Reporting, but is independent of any particular IT solution or platform. The procedures presented in this EEA Technical Report are largely those applicable to the current reporting and data exchange mechanism. They are also suitable for the design of the new e-Reporting system. Existing systems are described in detail. Existing quality assurance and quality control (QA/QC) measures that may be adopted for the emergent, streamlined, reporting system have been examined in the light of data maintenance requirements, consistency and continuity of service. The options proposed take into consideration the fact that there are different information and communication technology infrastructures across Europe.

Optimisation techniques and opportunities for their implementation are identified within the data

flows and processes highlighted. The logic behind the existing air quality reporting and information exchange mechanism(s) is presented, alongside that of the Implementing Decision.

Testing of e-Reporting systems commenced in 2011 as part of a pilot study programme. This programme, supported by DG ENV, the EEA and

ETC/ACM, is aimed at testing and optimising file formats for e-Reporting, data management systems, QA/QC routines, aggregation routines and evaluating and developing support for pilot participants. The pilot programme will continue throughout 2012–2013 with a view to preparing operational systems, guidance and support as from 1 January 2014.

1 Introduction

1.1 Background

A number of EU legal instruments require EU Member States to monitor and report air quality data. This information is collated, analysed and disseminated by the European Environment Agency (EEA). At present much of the data is reported electronically by countries in data flows required under a specific legal instrument. As a result, reporting on air quality is not always integrated across all data flows.

The recent introduction of the Commission's Implementing Decision 2011/850/EU provides an opportunity to modernise data reporting, facilitate data sharing and reduce the administrative burden of reporting.

The air quality directives' ⁽¹⁾ implementing provisions ⁽²⁾ will start to apply as of 1 January 2014, two years after adoption. In order to manage and facilitate the transition, the Member State reporting authorities, their data providers and the EEA's operational services will need to work closely together to establish and test a new reporting process.

DG ENV has invited Member States with different national reporting systems for air quality and those with practical implementations of national spatial data infrastructures to participate in pilot studies to test and optimise the e-Reporting mechanism required under the air quality directive (AQD). As of 1 March 2012, thirteen countries have announced their participation in the IPR pilot studies. The list of countries is updated via the so-called Air Quality Portal (<http://www.eionet.europa.eu/aqportal>).

The EEA will establish and operate the mechanism for sharing air quality information (e-Reporting) in line with the AQD IPR requirements, assisted by the ETC/ACM.

1.2 Report objectives and coverage

The EEA aims to develop a simplified and streamlined reporting and information exchange mechanism for air quality data. This mechanism is based on AQD IPR and a shared information system for electronic reporting — aligned with the INSPIRE directive and considering inputs and outputs from the GMES Atmospheric Services.

In order to successfully manage the transition to this new system, close cooperation is needed in the process of establishing, testing and commissioning the new reporting system. This report is a fundamental part of the process, presenting the operational logic for an AQD e-Reporting system. This report describes:

- the legal instruments (decisions and articles) at the origin of reporting requirements;
- the activities required and rules for reporting;
- data themes/flows to be reported;
- existing and emerging systems for reporting;
- current and new timescales for reporting;
- responsibilities and roles within the AQD e-Reporting system;
- routines and solutions that may support Member States under the new AQD e-Reporting system.

The document, which is aimed at data providers in the Member States and other European countries linked to Eionet, is also intended to contribute to the AQD review process. It takes into consideration that information systems and communication technology infrastructures for air quality are at different stages of development across Europe.

This report documents the options available for the new reporting and data exchange system. It documents the underlying rationale, functional algorithms, routines, procedures or concepts that are required or beneficial within the e-Reporting system.

⁽¹⁾ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0050:EN:NOT> and <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2005:023:0003:0016:EN:PDF>.

⁽²⁾ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:335:0086:0106:EN:PDF>.

The report is based on the AQD IPR (2011/850/EU) and supporting guidance documents that are successively being updated. Further updates to the guidance and the content in this report are expected over the transition period. Future versions will be made available through the Eionet Ambient Air Quality Portal ⁽³⁾ which will act as an information sharing platform for e-Reporting.

1.2.1 Structure of this report

An outline structure of this report is presented below for reference.

Chapter 2 presents a view, based on the experiences of the EEA and ETC/ACM, of an optimised system for air quality e-Reporting. The logic of the existing air quality reporting and information exchange mechanism(s) is presented alongside the rationale of the AQD IPR. Routines and checks for consistency in data flows are identified and broadly described where these currently exist, in addition to how these might transfer to the emergent systems.

Chapter 3 focuses on the capacity building needed to support e-Reporting and the subsequent transition to an e-Reporting system. The report provides a summary of the high-level capacities, capabilities and routines required for (or that would assist) e-Reporting and how to obtain a new optimised e-Reporting system. Information from a survey designed to inform and support the understanding of how EU Member States have developed and implemented AQ reporting system(s) under AQD is also presented.

Chapter 4 summarises the main synergies and potential conflicts of e-Reporting with regard to INSPIRE, SEIS (Shared Environment Information System), GMES, the evolution of standards for information sharing, wider Eionet activities and other environmental data flows.

Chapter 5 provides a glossary of acronyms and terms.

⁽³⁾ <http://www.eionet.europa.eu/aqportal>.

2 Logic for e-Reporting

The AQD regulatory framework and its IPR set the requirements for e-Reporting. Business process modelling has been used in this report to capture the implicit logic, rules and data flows for e-Reporting. It also describes the internal and external processes and procedures to communicate rules and data flows effectively to user communities. The term 'logic' is used to describe the functional algorithms, routines and options for the data exchange between a core database and its users, activities and rules – independently of any particular IT solution.

A key feature of this work has been to identify broad IT solutions and proposals to optimise the organisation of data flows for all stakeholders which, at the same time, ensure data quality through QA/QC and more generally through Transparency, Consistency, Completeness, Comparability, and Accuracy (TCCCA).

This analysis is intended to provide advice and suggestions on technical issues. It also considers IT solutions that would facilitate the work of the EEA (assisted by ETC/ACM) and the research communities using air quality data for assessments and scientific purposes. In addition it attempts to reflect the perspectives of both the Member States and those of the EEA and ETC/ACM.

In order to inform and support the understanding of how Member States have developed and implemented their air quality reporting systems under AQD, a selection of generic EU and Eionet country types were canvassed with a survey. The survey questionnaire is outlined in Annex 1 of this report. Anonymous sample outputs are presented in Chapter 3.

The work reported in this section models and compares current and proposed AQD IPR requirements against an idealised set of key criteria and components to be aimed for. Opportunities for the implementation of optimisation techniques are

identified, at a high level, within the data flows and processes identified. These generic opportunities are summarised in Chapter 3 of this report.

2.1 Optimising e-Reporting

Based on EEA and ETC/ACM's experience and information from Member States in 2011, some generic components of an optimised e-Reporting system have been identified. These are presented below and collectively support:

- streamlining administrative tasks;
- improving work flow and data flow management;
- ensuring data consistency and quality (internal and external);
- developing routines and capabilities to process, visualise, interrogate and transform data.

The generic components of an optimised e-Reporting system include:

1. Ensuring data quality and control in the terminology of the Intergovernmental Panel on Climate Change (IPCC) by applying the guiding principles of TCCCA.
2. Performing quality checks which should be as close as possible to the source of the data (e.g. regional networks) to keep the feedback cycle as small and fast as possible.
3. Establishing one contact point per country for all data flows, appointed by the competent authority.
4. Defining one standardised format for delivery of data (three data formats are possible in the current exchange of information (EoI): DEM, ISO and NASA Ames format).
5. Performing QA/QC checks ⁽⁴⁾ focusing on:
 - a. format checks (Consistency);

⁽⁴⁾ These requirements are based on experience from the checks performed on existing air quality data flows.

- b. checks on outliers (Accuracy);
 - c. checks on (calculated) annual means, comparison annual mean current year and previous year (Comparability);
 - d. traceability in resubmissions to document reasons for change (Completeness);
 - e. routines to visualise and to export the data in different formats (Excel, XML, DEM-format) including aggregated statistics (Transparency).
6. Defining a harmonised set of recommended routines, available to all data suppliers performing quality checks.
 7. Providing access to the latest version of the meta information. Meta information should be managed by change i.e. only updates to central metadata records on zones, network, stations measurement configurations and assessment types are required.
 8. Pre-calculating aggregated validated assessment data on the basis of primary validated monitoring data. Calculation of a defined set of aggregated statistics, including exceedances, is part of the standard routines available to the data suppliers. Data flows using aggregated statistics (based on primary validated data) may be pre-populated. These outputs should incorporate the consistency checks outlined in 5. above.
 9. Providing clear rules in IPR guidance documents for:
 - a. accuracy of primary data, aggregations, statistics and exceedances;
 - b. rules for precision especially for compliance exceedances (rounding off before comparison with the limit value or not);
 - c. aggregation;
 - d. timestamps to instantaneous and aggregated measurement data, e.g. time referencing hourly averaged data to the end point of the hour;
 - e. A standard coordinate system to be used (e.g. ETRS89 system) and agreed standardised transformation algorithms for converting from National grid systems or other geographic systems;
 - f. Acceptable limits of accuracy of geographic/spatial information relating to geographic boundaries station location.

10. Where mandatory non-air quality data elements are required by the data flows (e.g. population, land cover data, traffic intensity, LAU/EBM codes, emissions, etc.) these may be sourced from agreed central resources such as Eurostat or EEA data bases. GIS may be used to combine these data with the AQ data.
11. In case of standards (time reference, units, coordinates) there should be conversion routines to convert from the national system to the standard system.

2.2 Pre-existing logic and optimisation techniques

The existing reporting obligations require the Member States to submit a variety of air quality data flows at various designated periods⁽⁵⁾. The names of these air quality data flows are derived, in general, from the Decision or Directive which forms the legal basis of the data submission. They are, however, also presented as discrete data flows to aid understanding and are in fact heavily interdependent. The summer ozone, near real-time (now referred to as up-to-date) and air quality questionnaire data flows, for example, rely on the meta-information provided by the EoI for describing the measurement system. The primary validated monitoring data by the EoI forms the basis for calculating the exceedance and attainment information reported via the air quality questionnaire. The exceedances reported with this data flow should also match those in the data flows related to the air quality plans. The pre-existing AQD data flows are outlined below:

- **Exchange of Information (EoI) (Council Decision 97/101/EC)** <http://rod.eionet.europa.eu/instruments/191>.
This data flow consists of measured ambient air quality data. Meta information on monitoring networks, stations and measuring configuration is required. The observed concentrations (mainly hourly or daily mean concentrations) are submitted once per year (deadline for submission of data is 30 September year X for a reporting year X-1). Data is generally transferred using specially developed software (the DEM). Data collection is wider than the EU-27. All EEA member countries participate.
- **Summer Ozone Reporting (SOR)** <http://rod.eionet.europa.eu/instruments/264>.

⁽⁵⁾ See: <http://rod.eionet.europa.eu>.

This flow was initially based on the Ozone Directive (2002/3/EC) and is now — in a less demanding form — required by the Air Quality Directive (2008/50/EC). After each given summer period, Member States provide information on exceedances of the health related target value for the April-September period. The deadline for reporting is the end of October of each year (year X). The data is transferred in the form of (unprotected) Excel spreadsheets. The data is considered as 'provisional' as the time window between measurements and reporting is too short for a proper validation of the data by the Member States.

The NRT data flow (see below) can also be used to pre-populate SOR exceedances. This has been piloted by the EEA with several Member States.

- **Near-real time data (NRT)** <http://rod.eionet.europa.eu/instruments/264> (referred as *Primary up-to-date provisional assessment data* in the AQD IPR).
This flow consists of hourly measurements of air pollutants such as ozone, nitrogen dioxide, particulate matter, sulphur dioxide and carbon monoxide. This was initiated following a request, from the EEA to Eionet countries, but now also links to the requirement in the AQD for providing information to the general public. The frequency of the data exchange depends on each data provider, but is generally hourly. Depending on the data provider, the data is resubmitted to remove erroneous values submitted earlier. The data is — by definition — provisional/preliminary. Data collection is wider than the EU-27. All Eionet countries participate.
- **Air Quality Questionnaire** <http://rod.eionet.europa.eu/instruments/595>: is based on the Decision 2004/461/EC.
Member States report annually on the status of the ambient air quality in their territory in relation to the limit, target and other threshold values set out in the AQD. The data flow consists of meta information on the national systems for assessment and management of ambient air quality. It further contains information on the assessment of air quality in the designated air quality management zones. This data flow contains in general aggregated data based on monitoring or modelled data. Submission is in the form of unprotected Excel spreadsheets. the

deadline for submission of data is 30 September of year X for the reporting year X-1.

- **Air Quality Plans** <http://rod.eionet.europa.eu/instruments/607>.
Article 23 of the AQD requires that, on observing an exceedance of a limit or target value, the Member State establishes an abatement plan in order to achieve the related limit or target value. Decision 2004/224/EC further specifies how a summary of the overall AQ plan is to be reported on an annual basis. This is in order to provide a headline description and analysis of the exceedance situation with regard to its temporal and spatial extent, the population exposed to levels above the limit value and source apportionment. The plan may be based on and supported by measurements, modelling or a combination of both. A short description of the emission scenarios within the baseline and planned abatement measures in addition to information upon the expected impact of these is required. The deadline for the submission is not later than two years following the year in which the exceedance was first observed.

Detailed information on each of the flows is provided in the following sections in the form of data models, data flows, and a description of timeline and quality controls procedures. Section 2.2.1 sets out the existing air quality data model. Section 2.2.2 presents the logic of the individual reporting data flows that support the regulatory instruments outlined above.

2.2.1 The data models for the existing air quality reporting and information exchange data flows

The EEA and ETC/ACM's understanding and experience of the datasets and information contributing towards existing AQD reporting and information sharing mechanisms is outlined in the data model diagrams presented below. The diagrams presented in Figure 2.1 provide an overview of the organisation of generic data and metadata blocks/elements, as they are configured and managed within countries and centrally in EEA resources such as the European Air Quality Database — AirBase⁽⁶⁾. The diagrams cover data elements and interdependencies relating to:

- an overall AQ data reporting and information exchange system;
- monitoring network configuration;
- monitoring station configuration;
- AQ zoning information and delimitation;

⁽⁶⁾ <http://www.eea.europa.eu/themes/air/airbase>.

Figure 2.1 Components of the existing air quality reporting and information exchange data model

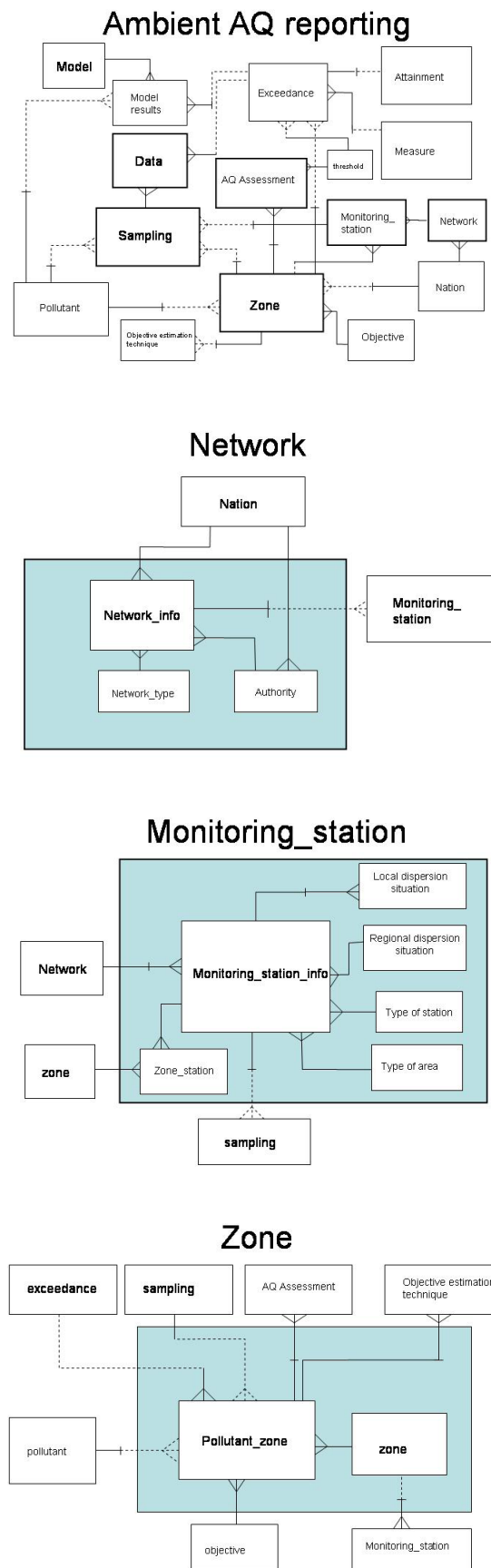


Figure 2.1 Components of the existing air quality reporting and information exchange data model (cont.)

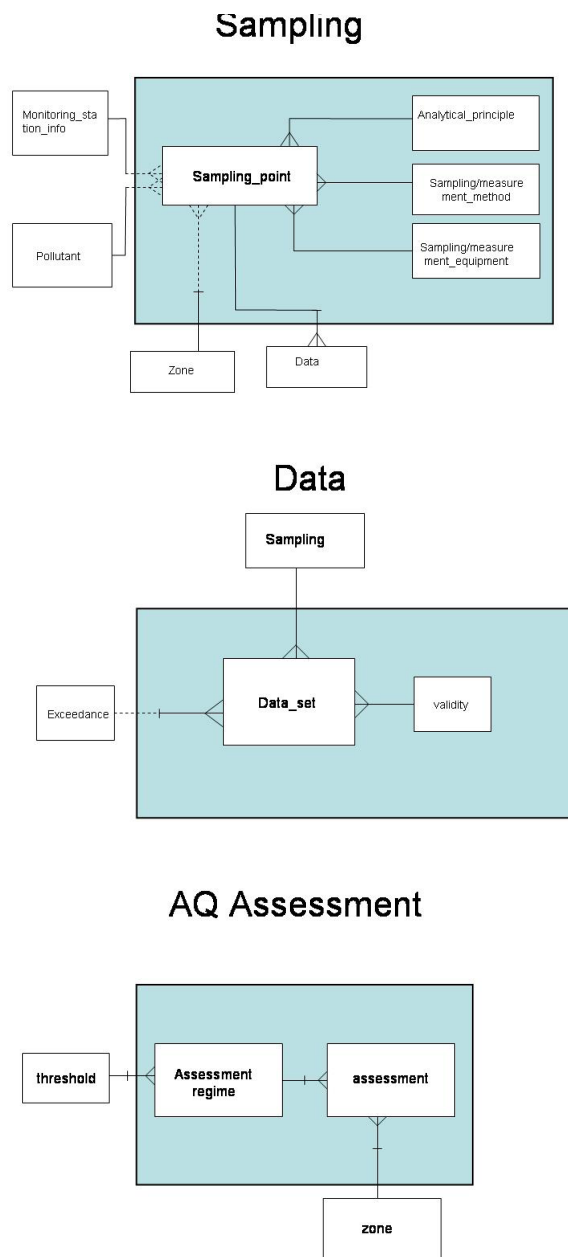
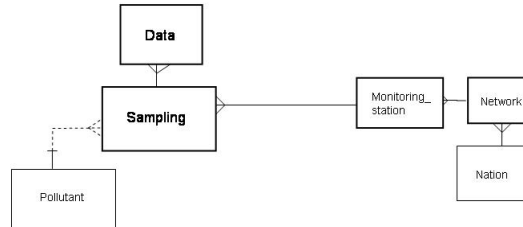


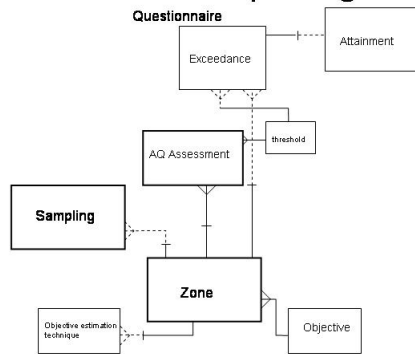
Figure 2.1 Components of the existing air quality reporting and information exchange data model (cont.)

Ambient AQ reporting

Eol reporting +
NRT + SOR

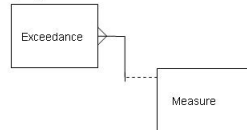


Ambient AQ reporting



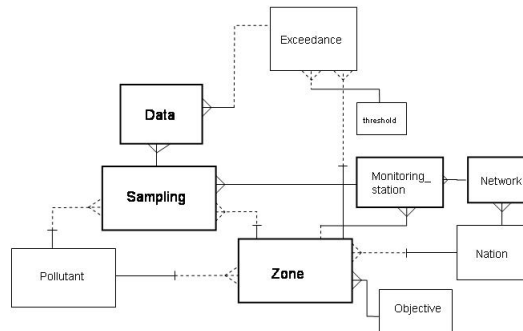
Ambient AQ reporting

Plans and programs



Ambient AQ reporting

AirBase



- sampling point configuration;
- measurement data storage including QA/QC flags;
- AQ assessment information;
- AQ reporting under the EoI Decision, NRT and SOR;
- AQ reporting under the AQQ;
- AQ reporting under the AQ Plans;
- data-model of AirBase.

2.2.2 The logic of existing air quality reporting and information exchange data flows

The function of the individual reporting data flows that support the regulatory instruments outlined above is presented in this section. The data flows have traditionally been organised and managed in groups that underpin reporting and data sharing, for example:

- exchange of information decision;
- the AQ questionnaire;
- summer ozone reporting;
- near-real time datasets;
- AQ plans.

A description of the process has been provided, in addition to some graphical representation.

Exchange of Information Decision (EoI)

A timetable of the core EoI activities and data flow deadlines is presented in Table 2.1. The logic that underpins the EoI data flows is summarised

in Figure 2.2 alongside that of the Air Quality Questionnaire.

Each year the data exchange interface software (DEM) is updated to support bug fixes and new functions. It is then populated with meta-information on known EoI and EMEP (European Monitoring and Evaluation Programme) air quality monitoring stations available in AirBase. Monitoring stations supporting the AQD (via the Air Quality Questionnaire), Summer Ozone and the NRT are also held in AirBase. The resulting pre-filled DEM is distributed to the participating countries in May each year.

By 1 October each year, participating countries are required to submit meta-information and validated primary air quality data in one of the agreed formats and upload it to the EEA Central Data Repository (CDR). Acceptable formats include the DEM (almost all Member States use this), ISO-format (France only) and a DEM compatible format (Germany). If the DEM is used then the data supplier can modify the existing embedded meta information (if circumstances have changed) and may also add new meta information prior to importing the validated primary measurement data. If ISO- or DEM-format files are used, the data supplier creates these files from their own system — there is no pre-filling from AirBase, these files are delivered to the CDR and the ETC/ACM converts them for uploading into the DEM. Even though the EoI data provision deadline is 1 October, since the DEM is released in May it is also possible to deliver the EoI data before the final deadline. Early delivery is under the current procedures only possible if a

Table 2.1 Timetable of EoI activities and data flow deadlines

Date	Activity
1 May year X	Release of the DEM pre-filled with metadata from X-2 by ETC/ACM
Until 1 October year X	Delivery DEMs and DEM/ISO files with year X-1 data
1 October year X to 15 January X+1	Feedback ETC/ACM to MS
1 December year X	First quality checks by EEA
15 December year X	Preliminary version of AirBase
15 January until 9 February Year X+1	Calculation statistics, generation dumps
9 February year X+1	Delivery first version of AirBase to EEA
9 February to 19 February year X+1	Checks by EEA
19 February year X+1	Delivery final version of AirBase to EEA
23 February year X+1	Release of AirBase on EEA Data Service
1 May year X+1	ETC/ACM technical paper presenting the EoI deliveries of year X-1

validated set of primary data for all pollutants can be submitted at once.

It is also possible to deliver EMEP data via the DEM. The deadline for submitting EMEP data is 31 July. The data supplier can send the DEM before this date to ETC/ACM which exports NASA Ames files from the DEM and forward them to EMEP/NILU. The data supplier can continue with the EoI data delivery with the same DEM. No formal checks are performed by ETC/ACM on EMEP data records at this stage.

The first quality checks are processed in the DEM itself. Format checks are performed during the import of meta information and raw data. After importing data the supplier may check the data in various ways. In the period from the date of receipt until 15 January the following year, the data supplied are uploaded to AirBase. During the upload process the meta-information and the raw data are thoroughly checked. Feedback reports are sent to the data suppliers to inform them of which data has been loaded into AirBase. When irregularities have been found data suppliers are requested for feedback, and amendments are processed by AirBase and used to generate an updated DEM submission with traceable version records. A full description of all quality checks is provided on the Eionet web pages ⁽⁷⁾.

On 15 December statistics and exceedances are calculated in AirBase ⁽⁸⁾. The XML/ASCII dumps are produced and sent to the EEA Data Service. These results represent a preliminary version of AirBase. This version contains all delivered EoI data including the feedback that is available. The EEA checks this version and provides feedback to ETC/ACM

On 15 January the following year ETC/ACM begins generating the final version of AirBase. All statistics

and exceedances are recalculated. The XML/ASCII dumps are produced and sent to the EEA. The EEA checks these deliverables and, following EEA approval, AirBase is publicly released at the end of February.

Information reported under the EoI is an Eionet Priority Data flow, legal obligations to this data flow are summarised at: <http://rod.eionet.europa.eu/obligations/131>.

Air Quality Questionnaire (AQQ)

The questionnaires, populated with information provided by the Member States responsible authorities, are uploaded to the CDR by 1 October.

During October the ETC/ACM informs all national contact points on a successful receipt of the questionnaire from CDR. A table is included in this communication that summarises the information received from the Member States. In March the following year (when the updated version of AirBase is available) further feedback is sent to the Member States that focuses on inconsistencies within the AQQ content and with other meta-information provided under EoI reporting data flows (outlined above). The Member States are invited to check the summaries provided by the ETC/ACM and where necessary upload a revised AQQ or individual component form(s) of it to the CDR. All updates received before May are included in the final reporting on the AQQ.

A timetable of the core AQQ activities and data flow deadlines is presented in Table 2.2. The logic that underpins the AQQ data flows is summarised in Figure 2.2 alongside that of the EoI data flows.

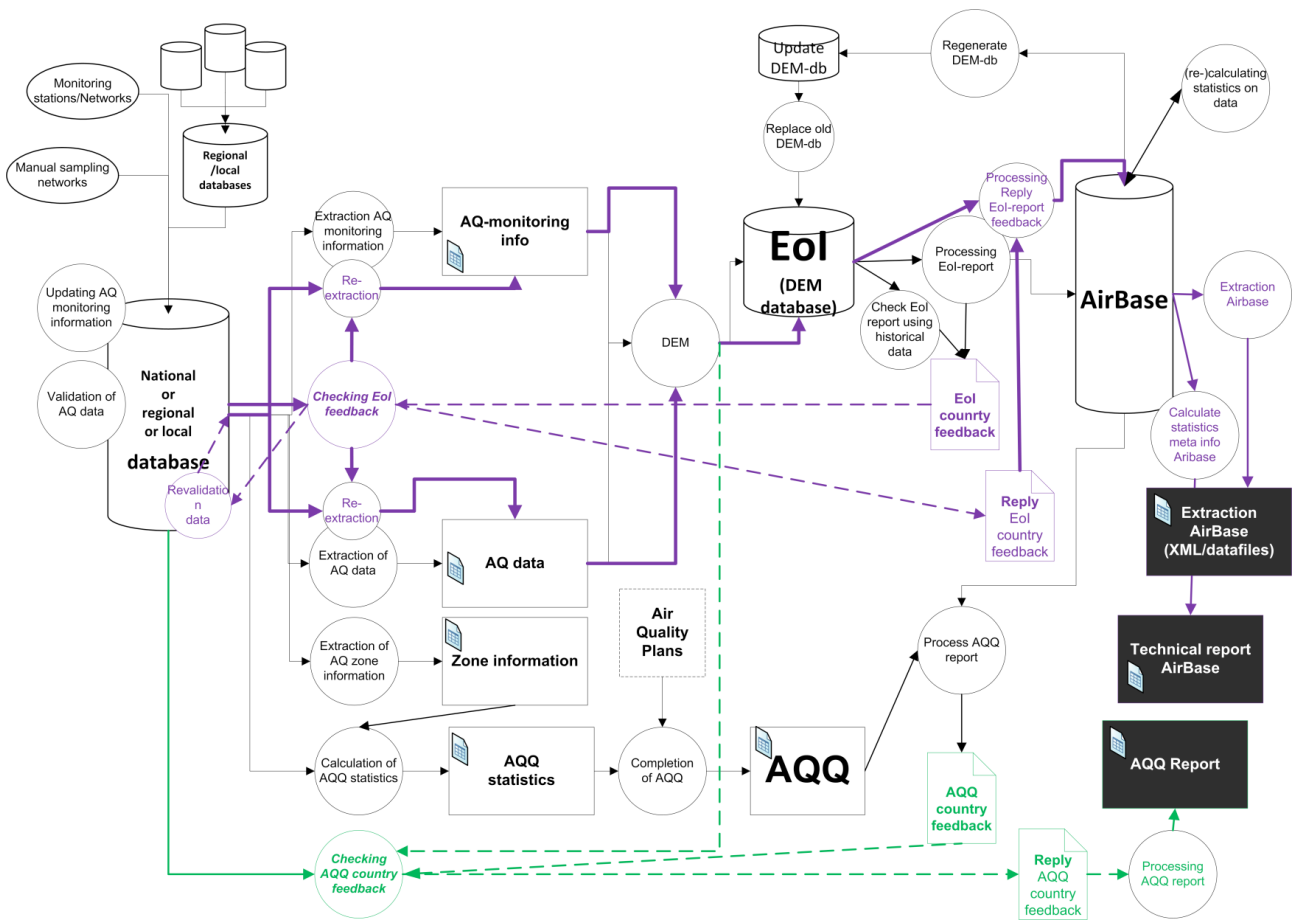
Table 2.2 Timetable of AQQ activities and data flow deadlines

Date	Activity
Until 1 October year X	Delivery questionnaire with year X-1 data
1 October X	Acknowledging of correct receipt
1 December year X	Working draft list of air quality management zones
15 December	Working draft of AQ status maps
February, March year X+1	Feedback (on internal consistency and consistency with EoI information)
1 April year X+1	Annotated table of contents of ETC/ACM technical paper
1 June year X+1	ETC/ACM technical paper
15 July year X+1	Final reporting, including list of zones and maps on questionnaire for year X-1
1 September year X+1	Release of European data set of zones and agglomerations on EEA Data Service

⁽⁷⁾ http://acm.eionet.europa.eu/databases/airbase/other_info.html.

⁽⁸⁾ http://acm.eionet.europa.eu/databases/airbase/aggregation_statistics.html.

Figure 2.2 Logic of current EoI and AQQ data flows



Information reported under the AQQ is an Eionet Priority Data flow, legal obligations to this data flow are summarised at: <http://rod.eionet.europa.eu/obligations/389>.

Summer ozone reporting (SOR)

The ETC/ACM manages the monthly and summer ozone exceedances data flow and, by 30 November each year, prepares a report on the ozone situation over the summer.

The report includes preliminary information describing the situation during the summer period. The preliminary information is based on provisionally validated or unvalidated monitoring data (the level and extent of validation is not reported by the supplying countries).

To manage the monthly and summer ozone data flows, the Member States are required to use a set of predefined reporting forms to deliver their monthly and summer reports to the ReportNet

CDR. Technical guidance documents are provided to facilitate this process. A detailed definition of the information to be reported can be downloaded from the ReportNet Data Dictionary. Moreover, a ReportNet Generic Data Exchange Module (GDEM) has been introduced to facilitate the delivery and validation of ozone exceedance data.

In order to provide information as timely as possible, the summaries of the monthly data provided by the countries are made available on the EEA website (www.eea.europa.eu).

A timetable of the core SOR activities and data flow deadlines is presented in Table 2.3. The logic that underpins the SOR data flows is summarised in Figure 2.3.

Information reported under the SOR is an Eionet priority data flow, legal obligations to this data flow are summarised at: <http://rod.eionet.europa.eu/obligations/386>.

Table 2.3 Timetable of SOR activities and data flow deadlines

Date	Activity
Before 31 May year X	Ozone exceedance/alert threshold information of April
Before 30 June year X	Ozone exceedance/alert threshold information of May
Before 31 July year X	Ozone exceedance/alert threshold information of June
Before 31 August year X	Ozone exceedance/alert threshold information of July
Before 30 September year X	Ozone exceedance/alert threshold information of August
Before 31 October year X	Ozone exceedance/alert threshold information of September + additional ozone information for the foregoing summer period (April to September)
April–September	Overviews of monthly deliveries
30 November	Summary report of the summer season year X
February year X+1	EEA Technical report

Figure 2.3 Logic of current SOR data flows

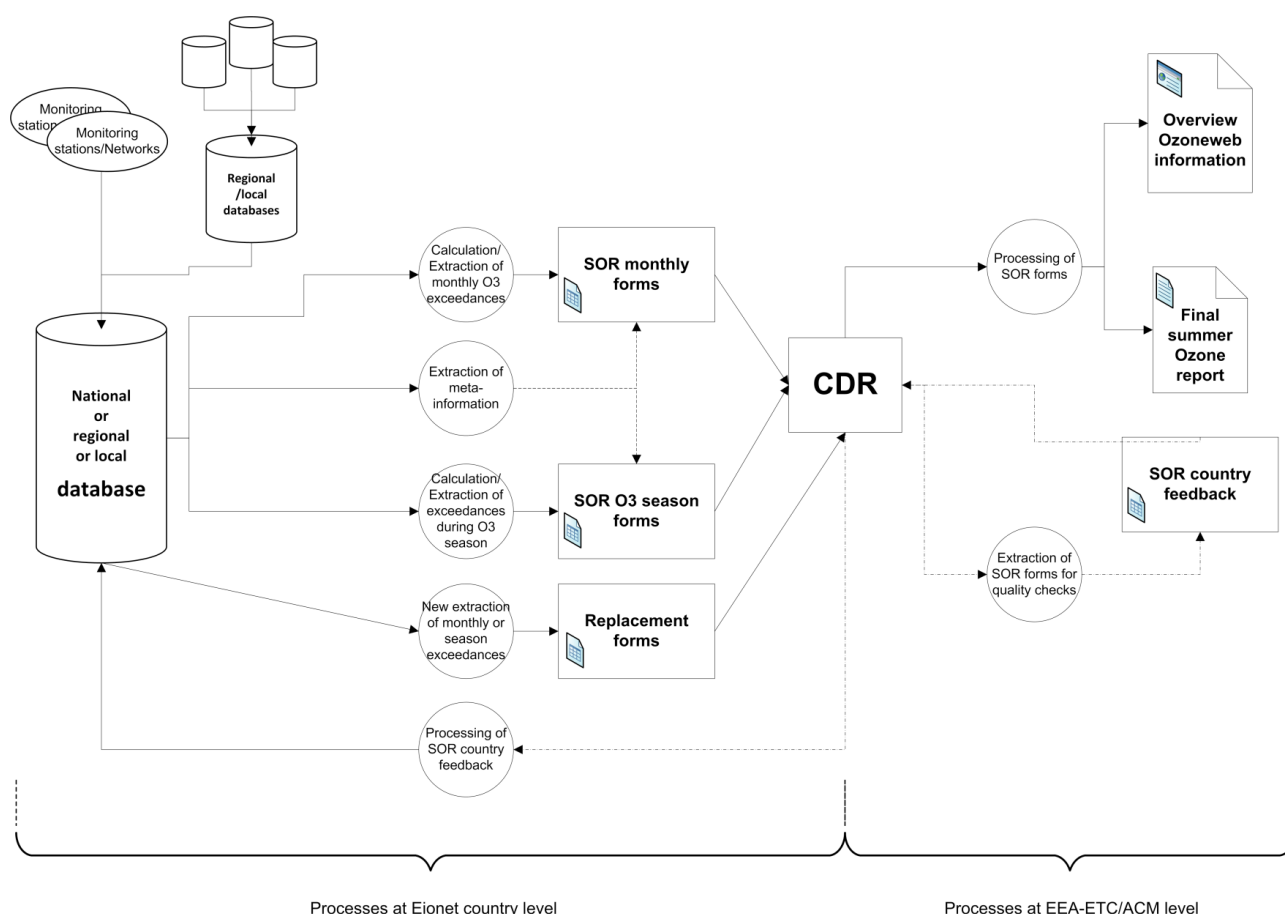


Table 2.4 Time table of NRT activities and data flow deadlines

Date	Activity
On-going	Continuous data exchange of primary up-to-date provisional monitoring data
On-going	Re-submissions of air quality monitoring data
On-going	Continuous data exchange improvement and drop outs
Jan to February year X	Preparation for ozone summer season
Before 31 March year X	Release of updated instructions for data exchange
Before 31 March year X	Internal update of meta information imported from latest release of AirBase. Currently, once per year
April–September year X	Overview of deliverables and exceedances for ozone
30 November	Summary tables of the summer season year X from provisional data

Near real time data reporting (NRT)

The near-real time (NRT) data flow has evolved over time on a voluntary basis with Eionet members. Data providers are invited to exchange provisional/preliminary hourly average concentrations of O₃, NO₂, NO_x, PM₁₀, PM_{2.5}, SO₂ and CO. Since the number of stations and pollutants included by individual data suppliers is variable the EEA and ETC/ACM are encouraging the exchange of all available data.

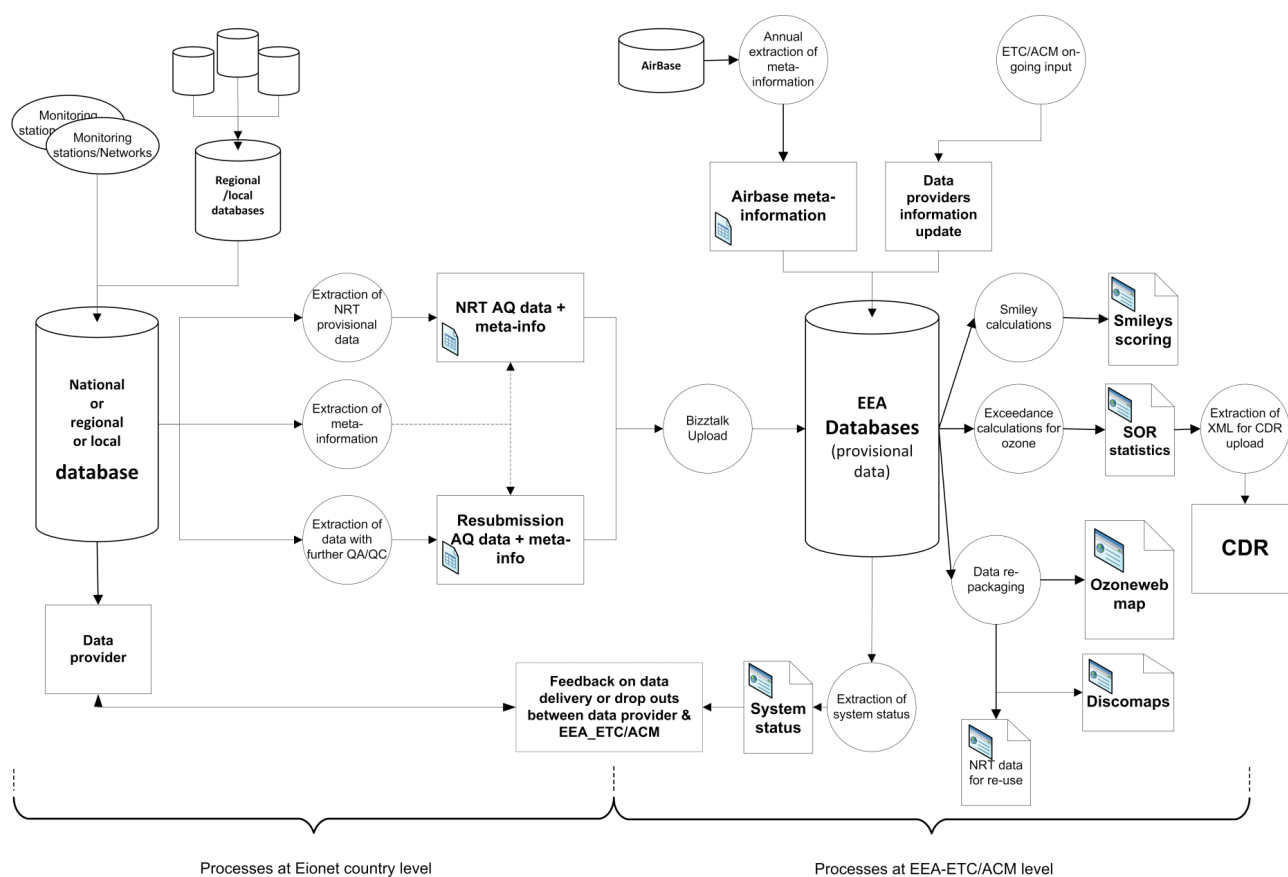
To manage data delivery, EEA and ETC/ACM maintain a set of instructions specifying the preferred data formats for data exchange. The data exchanged is based on ftp push/pull and http post/get technology. The formats for transmission are in the main constrained to XML or CSV although some data providers use bespoke formats. In order to accommodate different formats, the EEA currently uses BizTalk to push the data in the EEA database.

In order to accommodate system modifications to trap erroneous values, data providers are able to resubmit their data when internal QA/QC processes detect and modify erroneous data or whenever data has gone through some initial validation. QA/QC flags are incorporated into the data exchange to distinguish the status of the data being exchanged.

A time table of the core NRT activities and data flow deadlines is presented in Table 2.4. The logic that underpins the NRT data flows is summarised in Figure 2.4.

The EEA provides a service for Eionet countries to export data from the Near Real Time database in xml format to upload it directly to CDR for SOR. The continuous data exchange of hourly provisional ozone data is an Eionet Priority Data flow. Obligations to this data flow are summarised at: <http://rod.eionet.europa.eu/obligations/575>.

Figure 2.4 Logic of pre-existing NRT data flows



Air quality plans

Member States are required to report information on air quality plans (AQPs) relating to Article 23 and Annex XV 2008/50/EC. AQP, previously known as Plans and Programmes, must be established in zones or agglomerations where limit values have been exceeded. The plans should be communicated to the Commission without delay, but not later than 31 December year X+2 for an exceedance reported for year X. Excel forms have been provided with Commission Decision 2004/224/EC to enable MS to summarise the content of the AQP.

AQP must be established and submitted alongside any notification for a time extension (TEN) under Article 22. The Excel forms for reporting AQPs have been enhanced for TEN notifications within COM (2008)403 and SEC (2008)2132. The Commission has indicated that these TEN forms can be used in place of the 2004/224/EC forms for all reporting on AQP. These expanded forms have also formed the basis for the reporting on AQR within the IPR.

AQP must incorporate:

- administrative information on the responsible authorities for the development and implementation of AQPs;
- descriptions of the exceedance situation(s), derived from monitoring data and the results from air quality models;
- source apportionment, derived from the results from air quality models;
- baseline projections of concentrations, derived from the results from air quality models;
- projections of concentrations including the impact of additional measures, derived from the results from air quality models;
- information on measures and the impact of measures on emissions and concentrations.

Legal obligations to this data flow are summarised at: <http://rod.eionet.europa.eu/obligations/513>.

Table 2.5 Timetable of air quality plans activities and data flow deadlines

Date	Activity
X+1	Exceedance situation reported in AQQ
X=1 to X+2	Preparation of Air Quality Plans
X+2	Uploading of Air Quality Plans in CDR

A process to assess TEN notifications and the associated AQP's has been established via a service contract. This is a resource intensive activity and includes the compilation of a database of the summary information provided in the TEN forms.

A timetable of the core AQP activities and data flow deadlines is presented in Table 2.5. The logic that underpins the AQP data flows is summarised in Figure 2.5.

Figure 2.5 Logic of pre-existing Air Quality Plans data flows

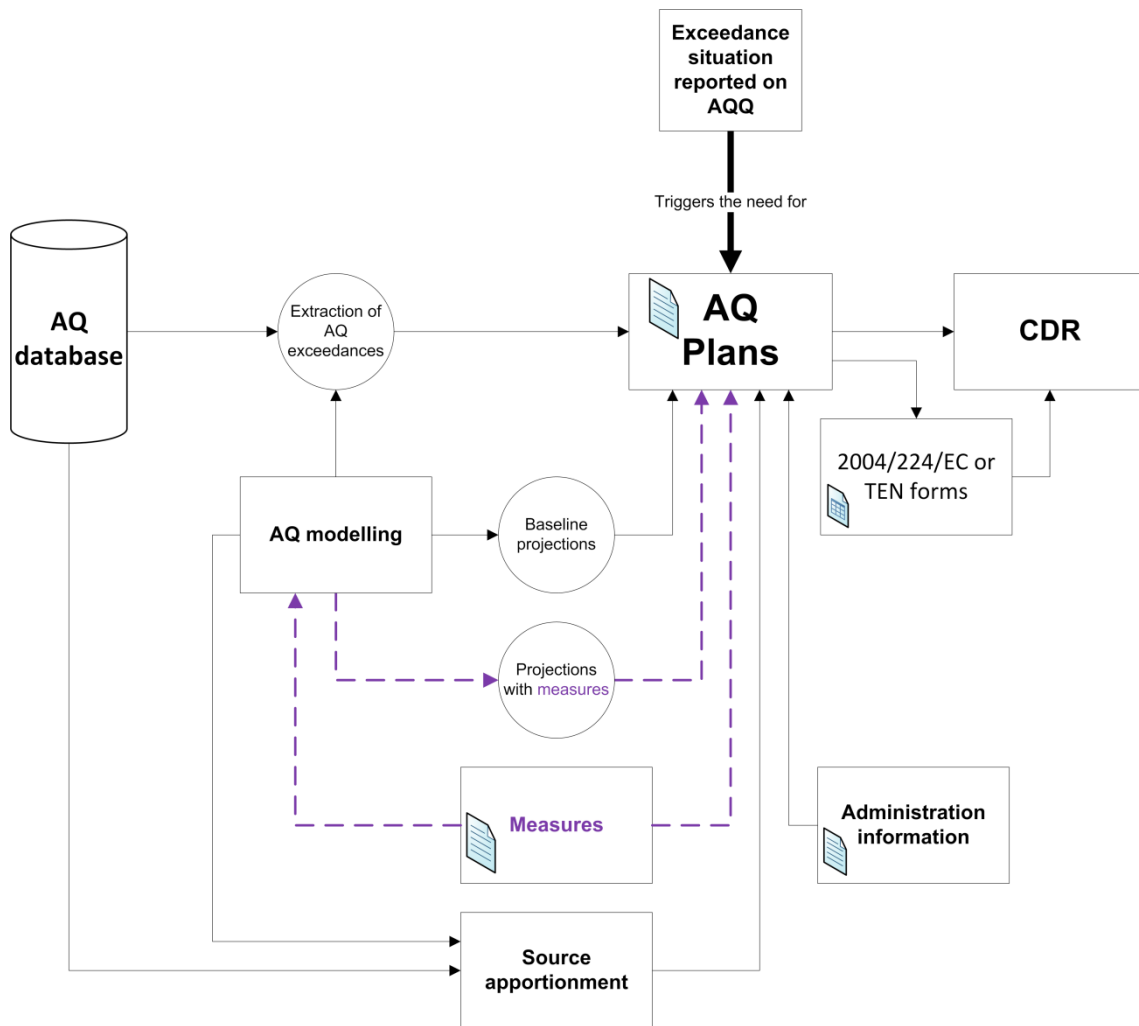
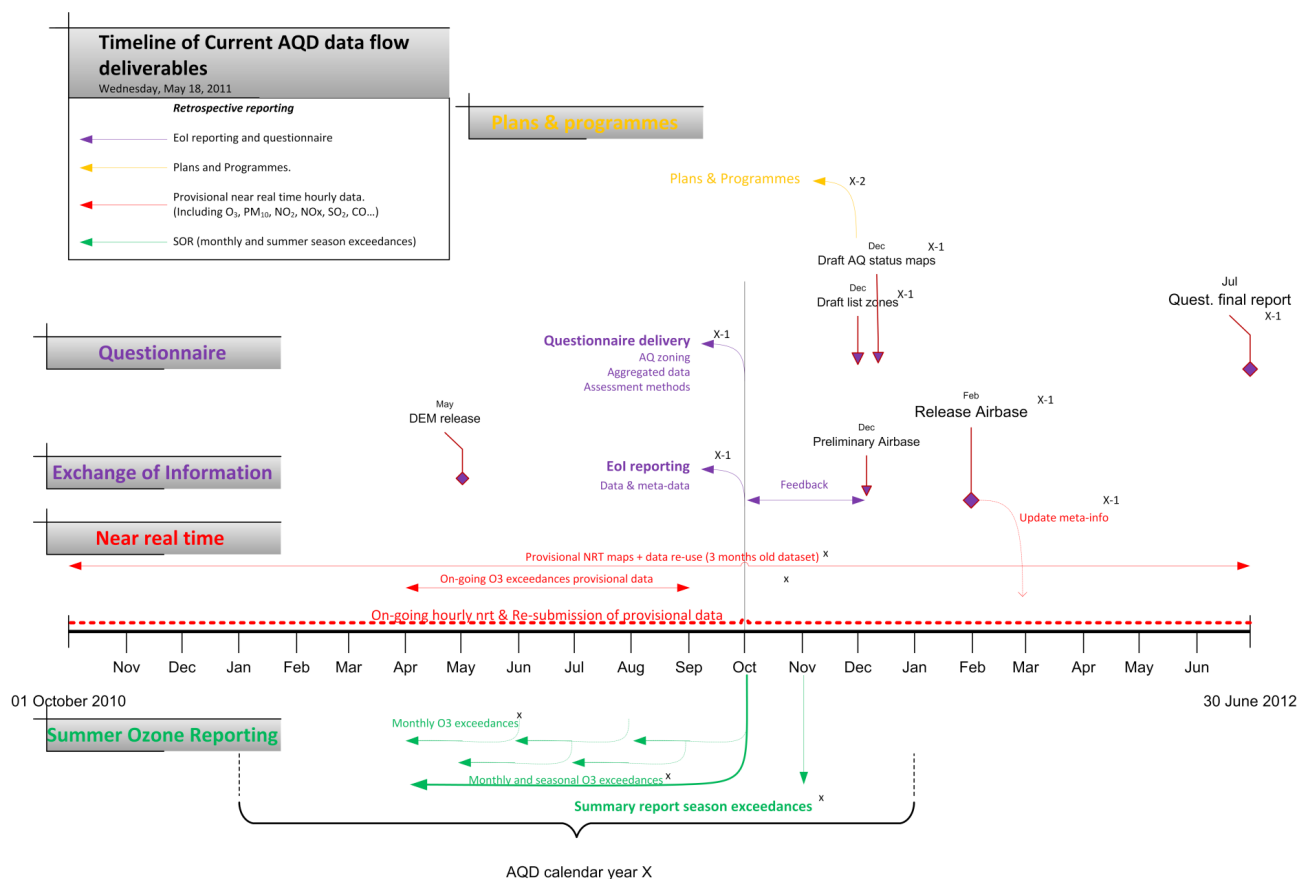


Figure 2.6 Overview of the core data flow deliverables and activities


2.2.3 Timeline for data flows supported by the logic of the pre-existing reporting mechanisms

An overview of the core data flow deliverables and activities supporting the logic of existing AQ reporting and information sharing mechanisms is presented in Figure 2.6.

2.2.4 Quality assurance and control measures implemented by the pre-existing reporting mechanisms

In this section we examine the existing QA/QC measures in operation within the systems and data flows described above. The analysis explores which pre-existing arrangements are already used by the Member States for the maintenance of data consistency and continuity of service and so might be adopted for an emergent and streamlined reporting system.

Exchange of Information (EoI) – QA/QC checks that can be carried out by MS within the DEM

The EoI clearly indicates that the countries are responsible for validation of their own data and a number of QC checks are built into the DEM to assist them. Data suppliers have several opportunities to check the quality of the (meta) data in the DEM prior to upload. Metadata may be added, modified and/or deleted interactively by graphical user interfaces (GUIs) and via import files. Several automatic checks and controls are also performed and error messages and warnings are given for mandatory, essential and desired (but nevertheless important) parameters.

A number of checks are performed on the data values. Information is given on the unit value of the components and outliers are identified based upon default or user defined lower and upper value bounds. Overview statistics may be calculated

from the imported measurement data. Further data checking is facilitated by the use of specified MS Excel formats to enable visual inspection (by graphs, bar charts etc.) of imported measurement data. There is a mapping facility to check whether a station is positioned within country borders and the station position may also be checked in Google Earth. Algorithms exist to check for zero or negative values or statistics and data values which are three times lower or higher than those measured in the previous year. It is also possible to carry out checks on missing data points.

The advantages of an interface like the DEM include:

- The DEM contains a database with all the meta information in AirBase. The data supplier only has to check this meta information and, if necessary, modify, delete and/or add meta information.
- The DEM contains a variety of quality checks – described above. If the data supplier using these checks can correct possible errors immediately, this shortens and accelerates the feedback process considerably.

Exchange of Information (EoI) – QA/QC checks carried out by ETC/ACM on DEM uploads

The ETC/ACM performs several QC checks on uploaded information within AirBase. The results of these QC checks are reported back to the data suppliers and only after confirmation from the data supplier of appropriate or necessary corrective action can AirBase be changed or overwritten.

The ETC/ACM sends a report with the following items:

- components reported;
- outlier checks;
- statistics (annual means). Overviews are generated using statistics calculated from the imported measurement data. The imported data can be checked on: zero or negative statistics or statistics which are 3 times lower or higher than the year before;
- a list of missing data: measurement configurations which delivered data up to year X-2, but not for the year X-1 and/or data until X-1, but not for X-1;

- essential meta data items that are missing (station name, co-ordinates, altitude, type of station, type of area);
- an EMEP overview: overview measurement configurations in EMEP stations for which data have been reported;
- an overview of re-submitted data: data which are already stored in AirBase and are now overwritten by new information;
- an overview of stations and/or measurement configurations which have been marked as 'to be deleted', but where air quality data and/or statistics are attached to these stations and/or measurement configurations;
- an overview of stations and/or measurement configurations which have been marked as 'to be deleted' where no data are attached to these stations and/or measurement configurations.

Exchange of Information (EoI) – QA/QC checks carried out by ETC/ACM on AirBase content

A variety of statistical checks are performed for consistency and continuity in data, including reality checking of real world conditions within AirBase. These include checks for:

- gaps in historical time series;
- strange measurement data;
- check on coordinates;
- duplicated stations;
- stations 'Monthly Ozone', NRT and Questionnaire that are not (yet) in AirBase
- LAU, EBM: Overlay AirBase stations and Euroboundary Map. Determination of NUTS and LAU/EBM codes.

Questionnaire (AQQ) – Acknowledgement of receipt of upload

Within one month of the submission deadline (1 October) a summary report is emailed to all the contact persons listed in the questionnaire. The purpose of this summary report is:

- acknowledgement of receipt;
- check on missing forms;
- confirm that the (sub) forms can be read by counting the number of items listed in each (sub) form.

This summary report is sent in the second half of October. In the accompanying letter Member States are requested to review the summary table and to contact the ETC/ACM in the event of irregularities.

Member States with overdue AQQ submissions are reminded of their legal obligations by including them in a bespoke distribution list for this purpose ⁽⁹⁾.

Questionnaire (AQQ) – Internal checks for consistency

Form 2 of the AQQ defines: zone name, zone code and the pollutant and the protection target (health, ecosystems, and vegetation). Information on area and population is provided on voluntary basis. It is mandatory to provide information on the zone borders. The AQQ guidelines describe several ways in which border information can be provided, but GIS-format (shape files) is recommended. Forms 8 and 9 list zones where the levels exceed or do not exceed the limit values, limit values plus margin of tolerance, target values or long term objectives as given by the Member States for each of the pollutants along with information on total population number and area obtained from external sources.

Information from Forms 2, 8 and 9 is scrutinised for internal consistency; country-specific feedback reports are provided covering:

- correct coding of pollutants and protection targets in Form 2;
- 100 % coverage of territory and population for zone defined for health protection;
- checking the completeness and consistency between zone/pollutant/protection target combination defined in Form 2 with the AQ status information given in Form 8 and 9;
- the availability and completeness of spatial information on zone borders;
- checking a consistent use of zone and station codes throughout the questionnaire.

Further checks are performed on the consistency of the meta-information provided in the AQQ and in the EoI (e.g. for each measuring configuration listed in the questionnaire data should be available in the EoI).

This process commences in March year X+1. Member States are asked to respond to the feedback reports within four weeks. As the definition of zones may have legal implications, it is acknowledged that Member States may need more time to review their zone designation particularly where contributions from regional administrations need to be consulted and collated.

Summer ozone reporting (SOR)

The Generic Data Exchange Module (GDEM) automatically makes basic syntax checks on delivered data and a quality report is generated within in the CDR delivery envelope when errors are detected. The checks are based on the quality rules stored in the ReportNet Data Dictionary ⁽¹⁰⁾ and the report is ready within a few minutes of the data delivery.

The ETC/ACM makes detailed checks to capture inconsistencies, potential errors and deviations from the preferred data structures, on a monthly basis. Data suppliers are asked, via feedback reports from the CDR, to correct inconsistencies and errors (i.e. upload amended reports).

Near real time data reporting (NRT)

Existing NRT systems expect initial screening checks on the provisional data to be carried out locally by data providers prior to upload. These checks by nature are limited in scope, as the data flow is un-validated. However there is an expectation that obvious erroneous data blocks are screened out. The ETC/ACM has provided simple guidance for identifying erroneous and outliers for ozone hourly data which will be included in guidance to support the IPR.

The NRT system accepts the re-uploading of hourly data if a data provider has carried out further QA/QC checks in the data. The data can be resubmitted if there are changes in the numeric values, changes in the status of the data and if erroneous data have been submitted. The system incorporates data flags to distinguish the status of the data (see Box 2.1):

In addition to the QA/QC checks made by the data provider, the ETC/ACM also carries out checks

⁽⁹⁾ Although one national questionnaire is required, Italy delivers separate questionnaires for 21 regions, which complicates the work of the ETC/ACM.

⁽¹⁰⁾ <http://dd.eionet.europa.eu/datasets/2457>.

Box 2.1 NRT QA and QC flags

Quality assurance

Description: A quality assurance flag that indicates whether the data is valid or invalid. The flag can be set to 0 for invalid data or 1 for valid data. This flag is a data provider flag to indicate to EEA that a measurement has been made and whether this measurement is considered valid. Data provided to EEA and flagged 0 will not be shown in the public application. **Blank is assumed to be flagged 1 (valid)**. Note that in the CSV data format, the quality assurance flag applies to a whole day (24 hours), whereas in the XML data format, it applies to a single/specific measurement.

Quality control

Description: A quality control flag that indicates whether the data is preliminary or validated. The flag can be set to 0 for preliminary data or 1 for approved data. Blank is assumed to be flagged 0 (preliminary). Note that in the CSV data format, the quality assurance flag applies to a whole day (24 hours), whereas in the XML data format, it applies to a single/specific hourly value.

on the stations delivering data uploads to ensure consistency between NRT and EoI data flows.

In relation to maximum O₃ levels, the ETC/ACM manually checks for exceedances reported to the system and informs the appropriate data provider when they appear to have occurred.

Finally, at the end of each summer season, ETC/ACM carries out a comparison between ozone exceedance and statistics from monthly SOR deliverables and NRT delivered data.

Air quality plans and time extension notifications

As previously noted Member States need to ensure that they comply with AQD limit values throughout the territory by their respective attainment dates, and that target values are respected to the extent possible. Action is required before the attainment dates when certain assessment thresholds set in the Directives are exceeded, generating a requirement to prepare and implement air quality plans or programmes. Minimum requirements of such plans are given in the directives. The plans need to be available to the public and reported to the Commission within two years after the exceedance has been identified.

When preparing plans and programmes, Member States need to fill in information in specific forms which summarise the plan(s) and communicate these to the Commission, according to Commission Decision 2004/224/EC. A detailed assessment of the plans is not carried out unless an extension of the deadline to comply has been sought.

In order to facilitate the TENs procedure, guidance to Member States has been adopted for the information to be provided and the scope of the conditions. When notifying, Member States are strongly recommended to use the forms established. These forms also serve as a checklist for ensuring that all necessary information has been provided to the Commission.

Following application, the forms and supporting information submitted are scrutinised in detail by the Commission's contractors to assess the body of evidence within the application, prior to a decision-making process on acceptance or objection to the TENs.

2.3 Emerging logic and optimisation techniques

This section sets out the EEA's and ETC/ACM's perspective on the anticipated organisation of AQD data flows under the IPR.

In populating the logic for the new system, the individual instruments (Articles within the AQD IPR Decision) have been evaluated and mapped against reporting data flows. No discrimination has been made between the administrative scales or hierarchies of the responsible parties involved; under the IPR, the schemata to be supplied for transmitting and organising reporting data flows are assumed to be equally applicable to all scales of responsible parties (local, regional, federal or national). Indeed it is this concept that underpins the

realisation of much of the data flow streamlining to be achieved by the emergent system.

An evaluation of the IPR Decision articles has been performed and is presented in Section 2.3.1 and summarised in the new AQD IPR data model presented in Figure 2.7. As part of this analysis, the Articles have been mapped to current reporting requirements as specified by the Air Quality Directives and EoI Decision(s). From this work it is evident that the overall content of data flows in the old and new reporting systems have remained broadly consistent, albeit with some modifications to the mandatory, voluntary and conditional requirements, timing, frequency of data flows and mechanisms or formats for reporting. The organisation of the data flows and their contents has changed in the attempt to remove or reduce duplication in data reporting and to promote efficient and discrete management of similar data types.

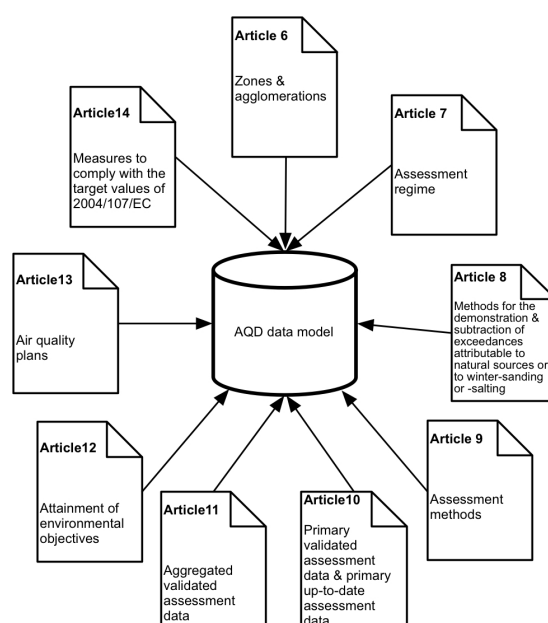
The main changes to the current AQD reporting logic brought about by the 2011 IPR Decision relate to:

- a new specification of the reporting format, data now to be conveyed in XML (rather than ASCII, DEM, ISO, NASA Ames, spreadsheet based etc.);

- XML is not appropriate for very large data volumes (e.g. modelling data), therefore a specification for this format is necessary;
- a reorganisation of the management of data flows;
- a reorganisation of the frequency of reporting for some data flows;
- additional data flows for information items previously not subject to a structure for EU reporting, but on which subsequently successful voluntary agreements for information exchange for ozone (OzoneWeb) and PM₁₀ monitoring were concluded.

One of the benefits of the observations outlined above, that overall the data flow has not changed substantially, is that existing routines and algorithms managed on behalf of the EEA by the ETC/ACM, for checking consistency, QA/QC and providing feedback to responsible parties on submissions, will be incorporated in the new systems. In some cases these routines may be directly transposed to these new systems whereas in others modifications to facilitate data processing will be inevitable. Another is that the emergent system will lead to a more holistic and resilient management of AQ information flows, rather than existing systems, which have been designed ad hoc as policy and research needs have developed.

Figure 2.7 Summary of the emergent AQD IPR data model and data flows



The following sections present the operational business processes and logic of the new AQD IPR. Each obligation to an IPR Decision Article (reporting data flow) has been addressed in turn from a Member State (or other non-EU participating countries) perspective as set out in Articles 6–14 of the 2011 IPR Decision.

A detailed analysis of the routines that may facilitate Member State participation and promote consistency and quality of all data flows is not available at this stage of the development. Pre-existing routines have been set out in previous sections, how these might be optimised for the emergent systems, including additional functionality to meet the particular needs of the preferred XML transmission formats, data extraction requirements for data interrogation, visualisation and reporting are addressed in Chapter 3.

To assist in the visualisation of the IPR deliverables (data flows), a time line presentation of the new AQD annual reporting obligations (relative to the

IPR Decision Articles) is presented in Figure 2.8 below. This schematically presents the timing of obligations to reporting using year X, year X+1 type notation previously used in the AQD IPR, where X relates to the reporting year, X+1 the coming calendar year, X–1 the previous calendar year (for reported annual data), etc.

The IPR Decision Annex II sets out the ten data sets, (or data flows), B to K which are cross-referenced by the Articles (6 to 14). These discrete datasets describe how IPR information will flow down from the data provider to the EEA. In the following text they are referred to as data flows.

A data flow diagram for each reporting obligation outlined in Table 2.6 below is presented in the following section(s), including a brief description of the purpose of each reporting data flow and timescales for reporting. Further details are provided in Chapter 3 drawing on information already present in Sections 2.1–2.2.

Table 2.6 IPR data sets

Data flow by data set	Deadline
(B) Information on zones and agglomerations (Article 6)	31 December, year X–1
(C) Information on the assessment regime (Article 7)	31 December, year X–1
(D) Information on the assessment methods (Articles 8 and 9)	30 September, year X+1
(E1a) Information on primary validated assessment data-measurements (Article 10)	30 September, year X+1
(E1b) Information on primary validated assessment data-modelled (Article 10)	30 September, year X+1
(E2a) Information on primary up-to-date assessment data-measurements (Article 10)	On-going throughout year X, at a frequency appropriate to the assessment method and with a reasonable timeframe
(F1a) Information on generated aggregated data – primary validated measurements (Article 11)	No formal deadline for reporting but needed Art12 reporting by 30 September, year X+1. Aggregation service must be continuously available
(F1b) Information on generated aggregated data – primary validated modelled (Article 11)	No formal deadline for reporting but needed Art12 reporting by 30 September, year X+1. Aggregation service must be continuously available
(F2) Information on generated aggregated data – primary up to-date measurements (Article 11)	No formal deadline for reporting but needed Art12 reporting by 30 September, year X+1. Aggregation service must be continuously available
(G) Information on the attainment of environmental objectives (Article 12)	30 September, year X+1
(H) Information on air quality plans (Article 13)	31 December, year X+2
(I) Information on source apportionment (Article 13)	31 December, year X+2
(J) Information on the scenario for the attainment year (Article 13)	31 December, year X+2
(K) Information on measures (Articles 13 and 14)	31 December, year X+2

2.3.1 INSPIRE use cases to support e-Reporting

Directive 2008/50/EC (AQD) requires that the procedures set out to underpin this Directive are compatible with Directive 2007/2/EC (INSPIRE). Within INSPIRE a process of use case identification has been implemented. Use cases are a mechanism for documenting user requirements and so support successful implementation of INSPIRE across all relevant environmental data themes.

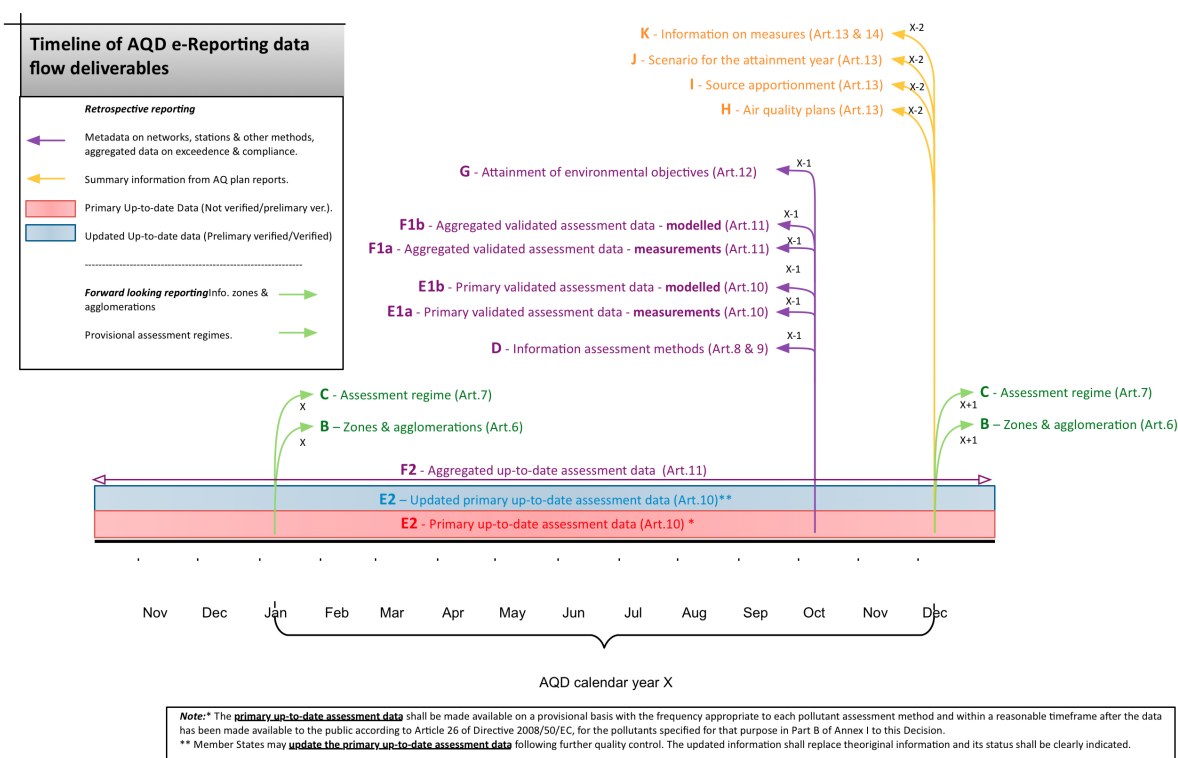
Use case descriptions are comprised of use case diagrams and textual descriptions, these are summarised in the following sections for each of the e-Reporting data flows. They have been created to support both INSPIRE data specification development and network services development and will document the user requirements (Member State, DG-ENV, EEA and citizens) against which the specifications need to be built.

Reporting and exchange of air quality information under the AQD IPR are of relevance to at least four of the INSPIRE Annex II/III data specification areas:

- D2.8.II/III.5 Human Health and Safety (HH);
- D2.8.III.7 Environmental Monitoring Facilities (EF);
- D2.8.III.11 Area management/restriction/regulation zones and reporting units (AM);
- D2.8.III.13-14 Atmospheric Conditions and Meteorological Geographical Features (AC-MF).

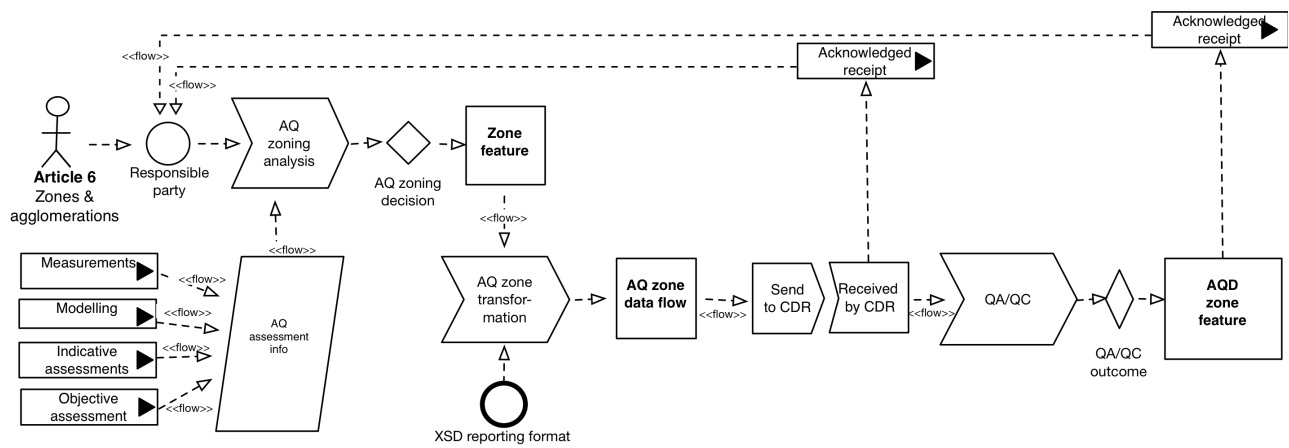
Future electronic reporting of Air Quality data in Europe will need to use the data specifications from all these thematic areas. It is therefore essential that all four consider the use case of e-Reporting. The ETC/ACM and EEA have developed the e-Reporting use cases specifically for this purpose.

Figure 2.8 Timeline for AQD reporting data flows relative to obligations presented by the IPR Articles



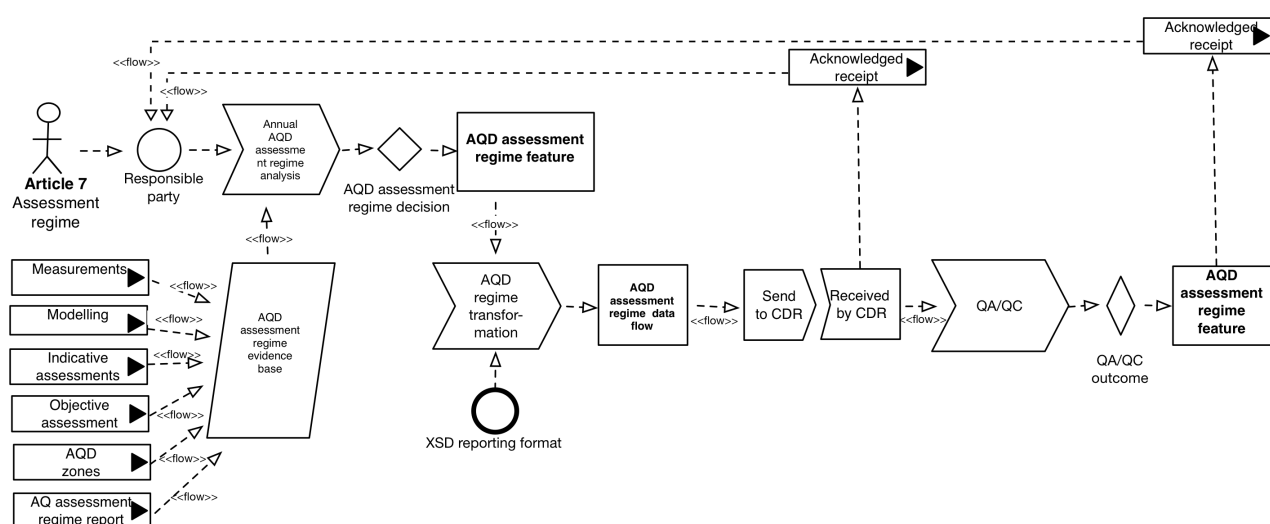
2.3.2 Data flow B – Information on zones and agglomerations (AQD IPR Article 6)

Purpose:	Provision of information on delimitation and types of zones and agglomerations
Timeline:	31 December, year X-1
Legal instrument:	Directive 2004/107/EC Article 3 Directive 2008/50/EC Article 4
Reporting formats, rules and content:	Part B – Annex II (+ Part A – Annex II) [Sect. V – dataset B guidance]



2.3.3 Data flow C – Information on the assessment regime (AQD IPR Article 7)

Purpose:	Provision of information on the assessment regime to be applied in the following calendar year for each pollutant. Allows comprehensive description of the assessment including the modelling and the objective estimation.
Timeline:	31 December, year X-1
Legal instrument:	Directive 2008/50/EC Articles 5 and 9 Directive 2004/107/EC Article 4
Reporting formats, rules and content:	Part C – Annex II (+ Part A – Annex II) [Sect. V – dataset C guidance]



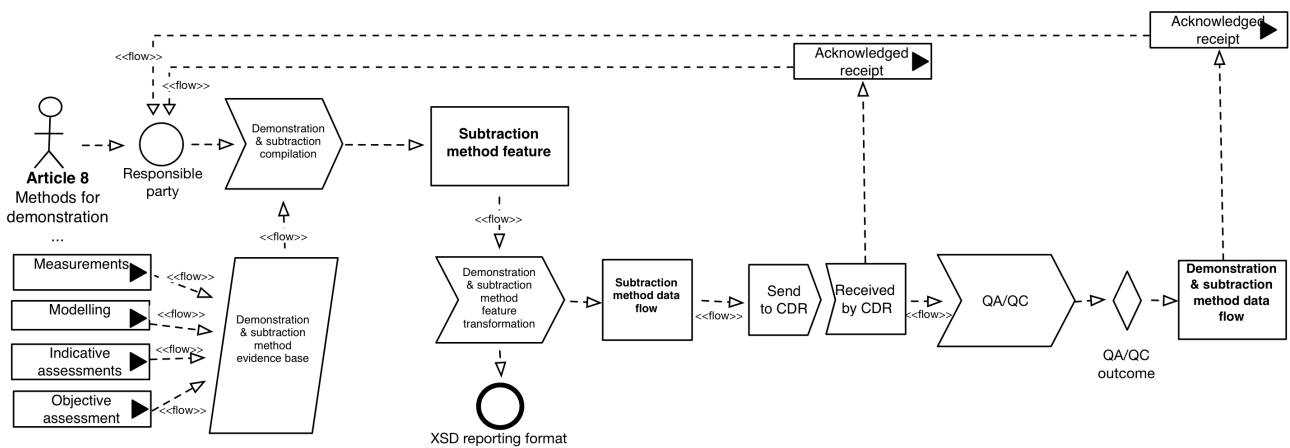
2.3.4 Data flow D – Information on the assessment methods for the demonstration and subtraction of exceedances attributable to natural sources or to winter-sanding or salting data flow (AQD IPR Article 8)

Purpose: Provision of methods used for the demonstration and subtraction of exceedances attributable to natural sources or to winter-sanding or -salting applied within individual zones and agglomerations.

Timeline: 30 September, year X+1

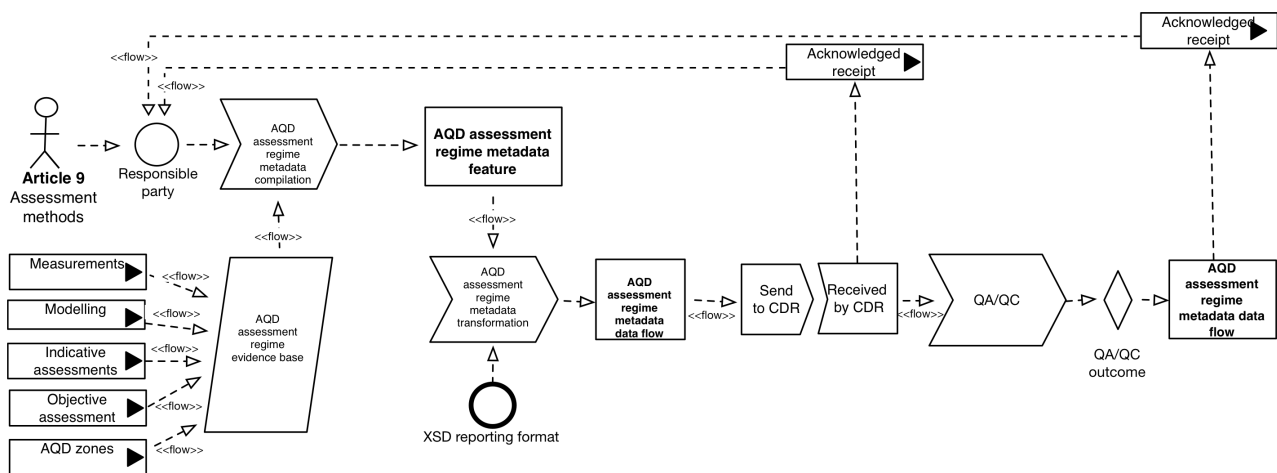
Legal instrument: Directive 2008/50/EC Articles 20 and 21

Reporting formats, rules and content: Part D4.4 – Annex II (+ Part A – Annex II) [Sect. V – dataset D guidance]



2.3.5 Data flow D – Information on the assessment methods (AQD IPR Article 9)

Purpose:	Provision of metadata for the assessment, describing the methods and the supporting information.
Timeline:	30 September, year X+1
Legal instrument:	Directive 2008/50/EC Articles 6, 9 and 10(6) Directive 2004/107/EC Article 4
Reporting formats, rules and content:	Part D – Annex II (+ Part A – Annex II) [Sect. V – dataset D guidance]



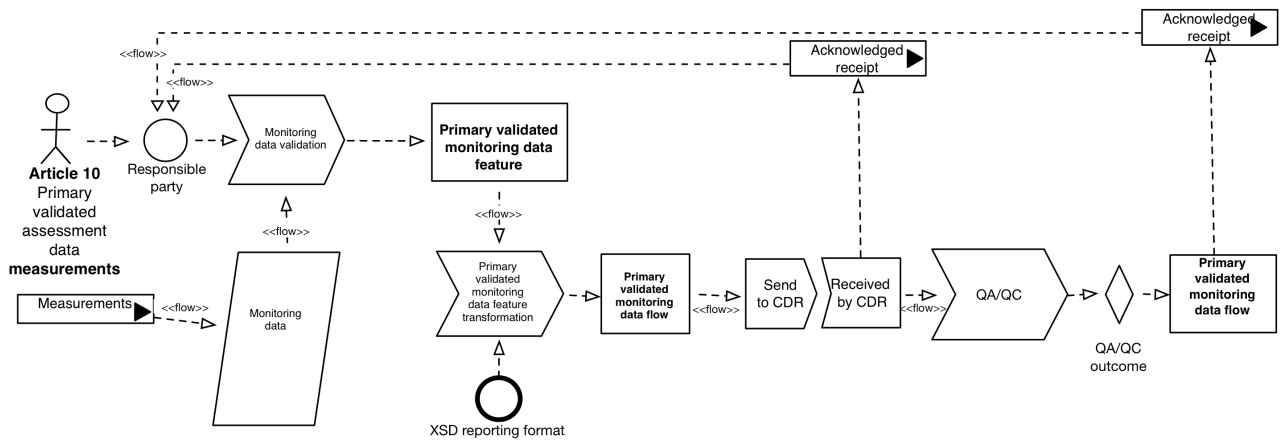
2.3.6 Data flow E1a – Information on primary validated assessment data – measurements (AQD IPR Article 10)

Purpose: Provision for reporting of un-aggregated concentrations levels from fixed stations in order to maintain the existing EoI exchange mechanism on fixed monitoring stations and related data that feeds into Airbase.

Timeline: Year 30 September, year X+1

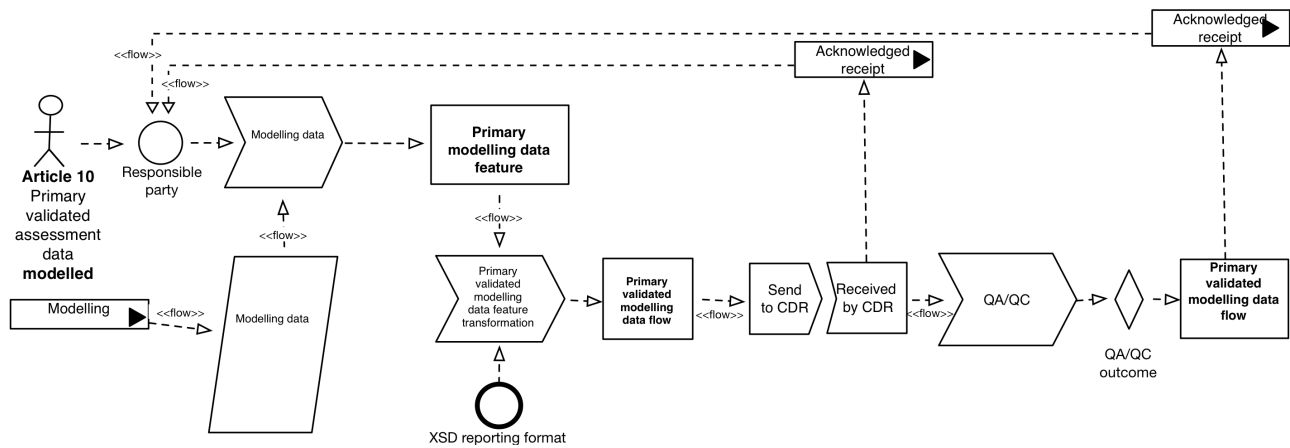
Legal instrument: Directive 2008/50/EC

Reporting formats, rules and content: Part E – Annex II (+ Part A – Annex II) (Data set E1a)



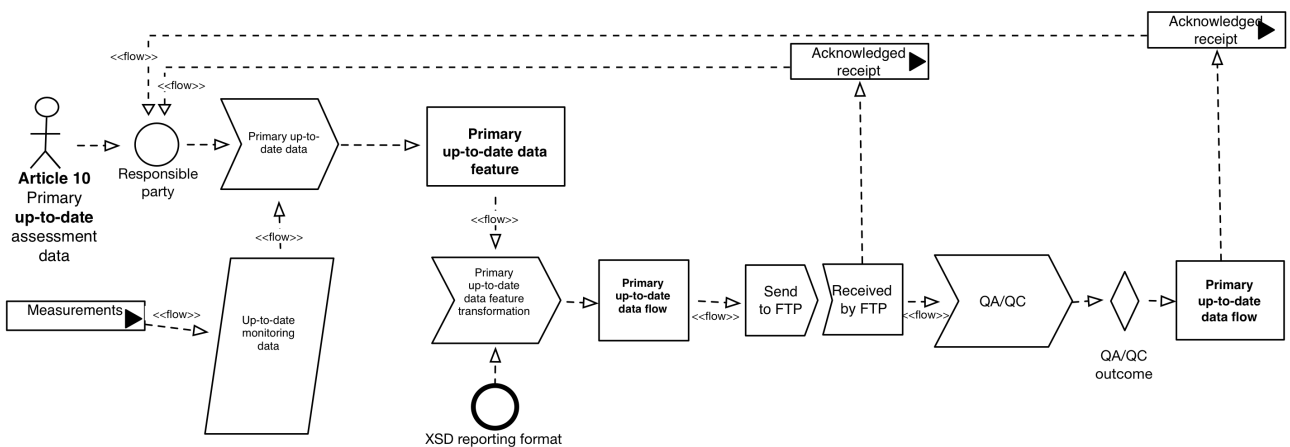
2.3.7 Data flow E1b – Information on primary validated assessment data – modelled data (AQD IPR Article 10)

Purpose:	Provision for reporting of un-aggregated concentrations levels from AQ modelling.
Timeline:	30 September, year X+1
Legal instrument:	Directive 2008/50/EC
Reporting formats, rules and content:	Part E – Annex II (+ Part A – Annex II) (Data set E1b)



2.3.8 Data flow E2a – Information on primary up-to-date assessment data – measurements
(AQD IPR Article 10)

Purpose:	Provision for reporting of NRT information exchange for public covering information and alert thresholds.
Timeline:	On-going throughout year X, at hourly frequency appropriate to the assessment method and with a reasonable timeframe
Legal instrument:	Directive 2008/50/EC Article 26 expanding upon EoI Decision 97/101/EC
Reporting formats, rules and content:	Part E – Annex II (+ Part A – Annex II) (Data set E2)



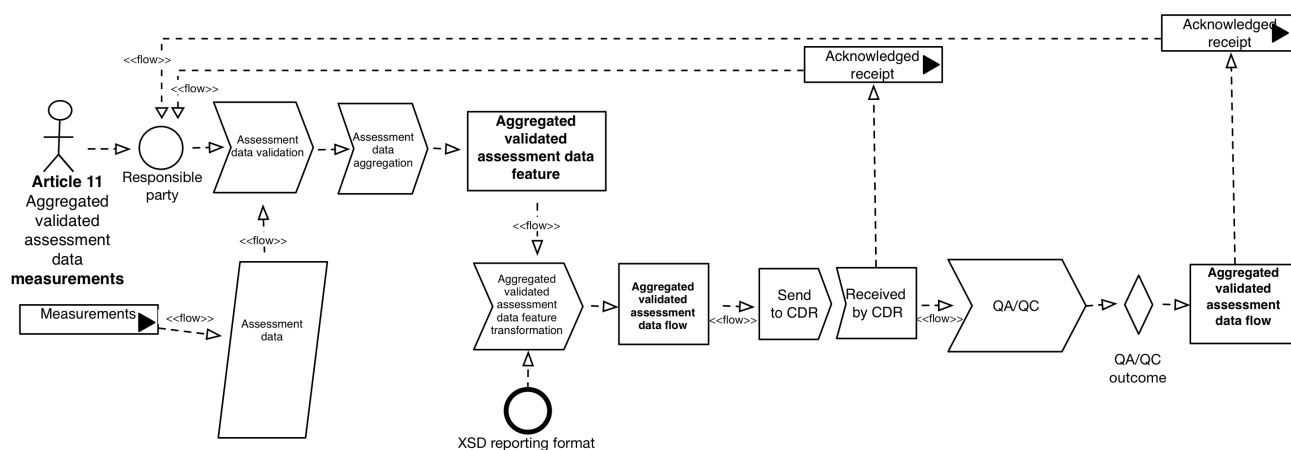
2.3.9 Data flow F1a – Information on aggregated validated assessment data flow – primary validated measurements (AQD IPR Article 11)

Purpose: Provision of validated exceedance information for pollutants with defined environmental objectives (MOTs, LVs, TVs, LTOs, assessment thresholds, annual statistics, including, natural source and winter sanding contributions etc.).

Timeline: No formal deadline. However aggregated data is needed under Article 12 for reporting by 30 September, year X+1 (Aggregation service must be continuously available)

Legal instrument: Directive 2008/50/EC Articles 6, 10, 27(2)b, expanding upon EoI Decision 97/101/EC (Articles 3 and 4)

Reporting formats, rules and content: Part F – Annex II (+ Part B – Annex I) (Dataset F1a)



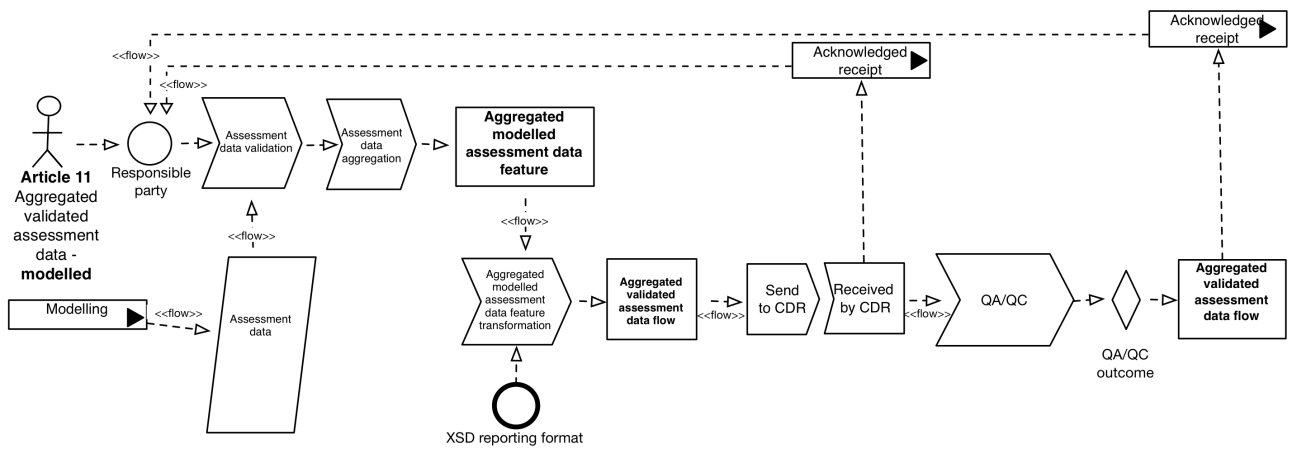
2.3.10 Data flow F1b – Information on aggregated validated assessment data flow – primary validated modelled data (AQD IPR Article 11)

Purpose: Provision of validated exceedance information for pollutants with defined environmental objectives (MOTs, LVs, TVs, LTOs, assessment thresholds, annual statistics, including natural source and winter sanding contributions etc.).

Timeline: No formal deadline. However aggregated data is needed under Article 12 for reporting by 30 September, year X+1 (Aggregation service must be continuously available)

Legal instrument: Directive 2008/50/EC Articles 6, 10, 27(2)b, expanding upon EoI Decision 97/101/EC (Articles 3 and 4)

Reporting formats, rules and content: Part F – Annex II (+ Part B – Annex I) (Dataset F1b)



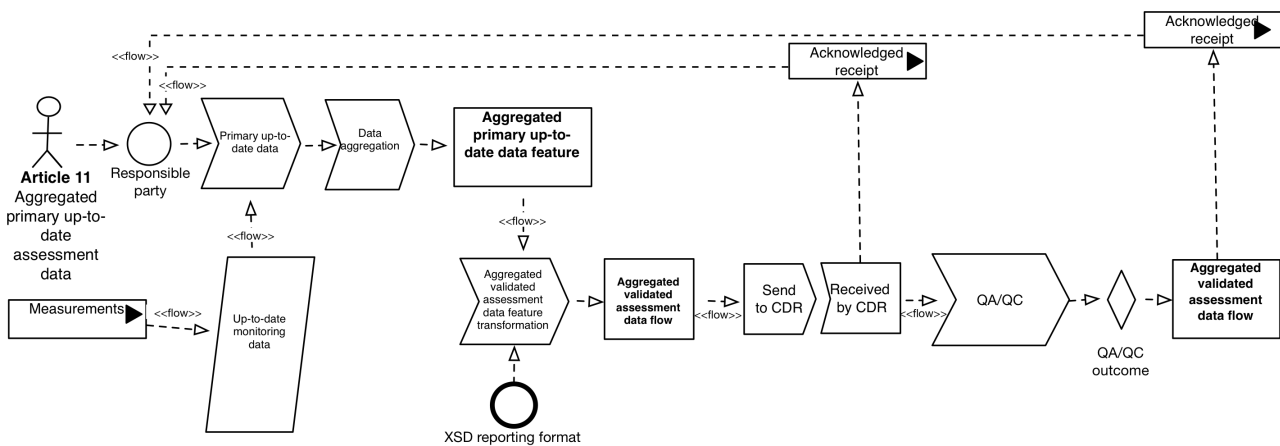
2.3.11 Data flow F2 – Information on aggregated assessment data – primary up-to-date measurements (AQD IPR Article 11)

Purpose: Provision of provisional exceedance information for pollutants with defined environmental objectives (MOTs, LVs, TVs, LTOs, assessment thresholds, annual statistics, including natural source and winter sanding contributions etc.).

Timeline: No formal deadline. However aggregated data is needed under Article 12 for reporting by 30 September, year X+1
(Aggregation service must be continuously available)

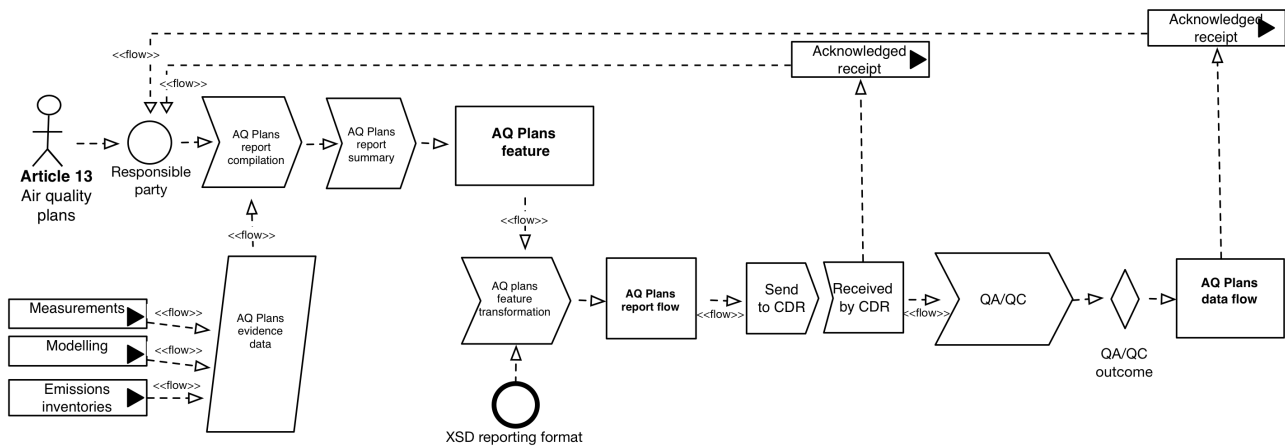
Legal instrument: Directive 2008/50/EC Articles 6, 10, 27(2)b, expanding upon EoI Decision 97/101/EC (Article 5)

Reporting formats, rules and content: Part F – Annex II (+ Part B – Annex I) (Dataset F2)



2.3.13 Data flow H, I, J and K – Information on Air quality plans (AQD IPR Article 13)

Purpose:	Provision for reporting information on AQ plans relating to Annex XV 2008/50/EC, TENs under Article 22 to facilitate exchange of best management practices.	
Timeline:	30 September, Year X+2	
Legal instrument:	2008/50/EC Article 23, expanding upon current Decision 2004/224/EC.	
Reporting formats, rules and content:	Part H – Annex II Part I – Annex II Part J – Annex II Part K – Annex II	(Information on AQ plans), (Information on source apportionment) (Information on the scenario for the attainment year) and (Information on measures) – see Article 14 of IPR



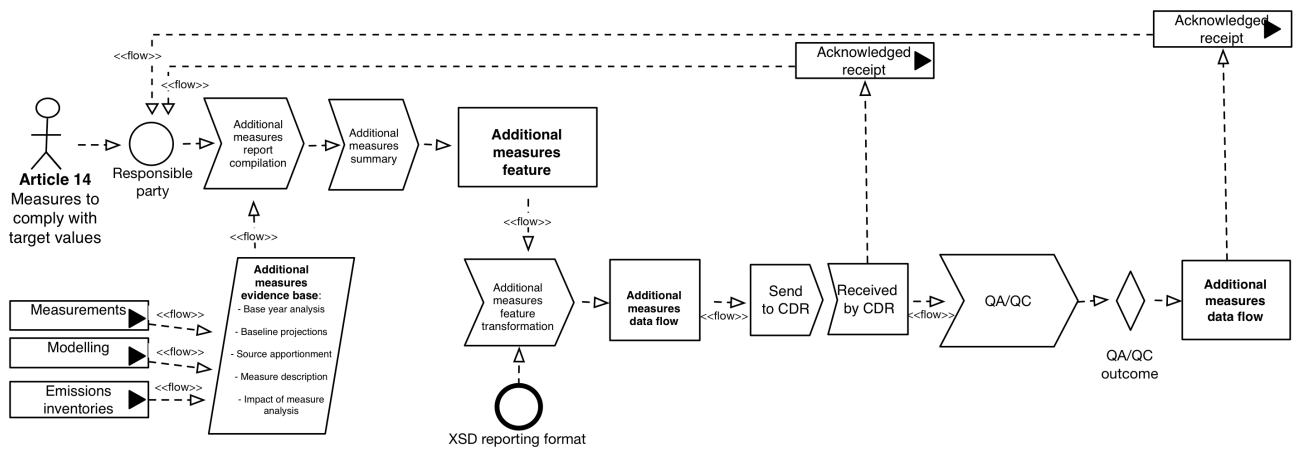
2.3.14 Data flow K – Information on measures to comply with the target values of Directive 2004/107/EC (AQD IPR Article 14)

Purpose: Provision for reporting information on measures taken to attain target values.

Timeline: 30 September, year X+2

Legal instrument: Directive 2004/107/EC Article 5(2)

Reporting formats, rules and content: Part K – Annex II (Information on measures) – see Article 13



2.4 Comparison of emerging AQD IPR data flows with pre-existing data flows

A comparison of the articles of the AQD IPR at the basis of data flows reporting obligations of Member States is presented in this section. The comparison is presented in matrix form in Table 2.7 and describes

activities required, rules and timelines. The IPR Articles are also mapped to pre-existing obligations as set out by the EoI Decision, FWD and AQ Daughter Directives, AQQ and AQ Plans.

A qualitative indicator of the benefit over pre-existing reporting and management approaches is provided for each IPR Article.

Table 2.7 Matrix of emerging AQD IPR data flows with mappings to pre-existing data flows and obligations

IPR component	Legal basis of reporting requirement	Timing/Rules	Description
Article 6 Zones and agglomerations	Directive 2008/50/EC Article 4 Directive 2004/107/EC Article 3	31 December Year X-1 Part B — Annex II +Part A — Annex II [Sect.V- dataset B guidance]	Provision of information on delimitation and types of AQ zones.
Article 7 Assessment regimes	Directive 2008/50/EC Article 5, Article 9 Directive 2004/107/EC Article 4	31 December Year X-1 Part C — Annex II +Part A — Annex II [Sect.V- dataset C guidance]	Provision of information on the assessment regime. Allows comprehensive description of the assessment including the modelling and the objective estimation.
Article 8 Methods used for the subtraction of exceedances attributable to natural sources or to winter-sanding or -salting	Directive 2008/50/EC Articles 20, 21	30 September Year X+1 Part D4.4 — Annex II + Part A — Annex II [Sect.V- dataset D guidance]	Provision of metadata for methods used for the subtraction of exceedances attributable to natural sources or to winter sanding or -salting.
Article 9 Assessment methods	Directive 2008/50/EC Articles 6, 9 and 10(6) Directive 2004/107/EC Article 4	30 September Year X+1 Part D — Annex II + Part A — Annex II [Sect.V- dataset D guidance]	Provision of metadata for the assessment, describing the methods and the supporting information.
Article 10 Primary validated assessment data — measurements	Directive 2008/50/EC Article 6	Year 30 September, year X+1 Part E — Annex II (Dataset E1a) + Part A — Annex II [Sect.V- dataset E guidance]	Provision for reporting of un-aggregated concentrations levels from fixed stations in order to maintain the existing EoI exchange mechanism on fixed monitoring stations and related data that feeds into Airbase.
Article 10 Primary validated assessment data — modelled	Directive 2008/50/EC Article 6	Year 30 September, year X+1 Part E — Annex II (Dataset E1b) + Part A — Annex II [Sect.V- dataset E guidance]	Provision for reporting of un-aggregated concentrations levels from AQ modelling.
Article 10 Primary up-to-date assessment data	Directive 2008/50/EC Article 26 expanding upon EoI Decision 97/101/EC	On-going throughout year X, at hourly frequency appropriate to the assessment method and with a reasonable timeframe. Part E — Annex II (Dataset E2a) + Part A — Annex II [Sect.V- dataset E guidance]	Provision for reporting of NRT information exchange for public covering information and alert thresholds and resubmission.

Benefit	Requirement ^(a)	Current reporting activity
Discrete management of data flow. INSPIRE compliance for spatial feature types Data aggregation efficiencies for regional and federal administrations.	M/C	Decision 2004/461/EC, spreadsheet template Form 2 http://rod.eionet.europa.eu/obligations/389
Discrete management of data flow covering all types of assessment methods. INSPIRE compliance for spatial feature types. Data aggregation efficiencies for regional and federal administrations.	M/C	Decision 2004/461/EC, spreadsheet template Forms 3, 4, 5, 6, 10 http://rod.eionet.europa.eu/obligations/389
Discrete management of data flow. Data aggregation efficiencies for regional and federal administrations. Streamlines information duplicated within 2004/461/EC and 2004/224/EC.	M (C)	Metadata elements of Decision 2004/461/EC, spreadsheet template Forms 3, 7, 19 and 20 http://rod.eionet.europa.eu/obligations/389
Discrete management of data flow covering all types of assessment methods. Data aggregation efficiencies. Streamlines information duplicated within EoI and AQQ data flows.	M	Decision 2004/461/EC, spreadsheet template Forms 21, 22, 23, 24 http://rod.eionet.europa.eu/obligations/389 Decision 97/101/EC amended by 2001/752/EC http://rod.eionet.europa.eu/obligations/131
Discrete management of similar data flow. Streamlines information duplicated within EoI and AQQ data flows. Data aggregation efficiencies for regional and federal administrations.	M V for EoI	All AQ Daughter Directives explicitly required the reporting of this data unless already reported under the EoI Decision 97/101/EC. http://rod.eionet.europa.eu/obligations/137 http://rod.eionet.europa.eu/obligations/138 http://rod.eionet.europa.eu/obligations/390 http://rod.eionet.europa.eu/obligations/131
Discrete management of similar data flow. Data aggregation efficiencies for regional and federal administrations. Streamlines information duplicated within EoI, AQQ, NRT data flows. Voluntary extension of scope to forecast and now-cast data.	M V for EoI	All AQ Daughter Directives explicitly required the reporting of this data unless already reported under the EoI Decision 97/101/EC. http://rod.eionet.europa.eu/obligations/137 http://rod.eionet.europa.eu/obligations/138 http://rod.eionet.europa.eu/obligations/390 http://rod.eionet.europa.eu/obligations/131 No explicit provision for reporting to the Commission. Replaces monthly ozone reporting referring to Directive 2002/3/EC and expands EoI Decision 97/101/EC and its amendments through 2001/752/EC provisions http://rod.eionet.europa.eu/obligations/131 http://rod.eionet.europa.eu/obligations/386

Note: ^(a) M = Mandatory; C = Conditional; V = Voluntary.

Table 2.7 Matrix of emerging AQD IPR data flows with mappings to pre-existing data flows and obligations (cont.)

IPR component	Legal basis of reporting requirement	Timing/Rules	Description
Article 11 Aggregated data — primary validated measurements and modelled	Directive 2008/50/EC Article 6, Article 10, Article 27(2)b expanding upon EoI Decision 97/101/EC (Articles 3 and 4) Directive 2008/50/EC Article 6(5), Article 10(6)	No formal deadline for reporting but needed Art12 reporting by 30 September, year X+1. Aggregation service must be continuously available. Part F — Annex II Dataset: F1a — measurement F1b- modelled Part A — Annex II [Sect.V- dataset F guidance]	Provision of validated exceedance information for pollutants with defined environmental objectives (MOTs, LVs, TVs, LTOs, assessment thresholds, annual statistics, including natural source and winter sanding contributions etc.). Provision for assessment results for pollutants that do not have environmental objectives, but have mandatory monitoring requirements (Hg, VOC, deposition etc.).
Article 11 Aggregated data — primary up-to-date measurements	Directive 2008/50/EC Article 26 expanding upon EoI Decision 97/101/EC	No formal deadline for reporting but needed Art12 reporting by 30 September, year X+1. Aggregation service must be continuously available. Part F — Annex II Dataset: F2 Part A — Annex II [Sect.V- dataset F guidance]	Provision of primary up-to-date exceedance information for reporting up-to-date information exchange for public covering information and alert thresholds and resubmission.
Article 12 Attainment of environmental objectives	Directive 2008/50/EC Articles 13–18, Article 22, Article 27(2)b	30 September, year X+1 Part G — Annex II Part A — Annex I [Sect.V- dataset G guidance]	Make provision for reporting of information on compliance with the limit values and critical levels, and attainment of targets.
Article 13 Air quality plans	2008/50/EC Article 23. Expanding upon current Decision 2004/224/EC based on Article 24 of 2008/50/EC	31 December, Year X+2 Part H — Annex II Part I — Annex II Part J — Annex II Part K — Annex II (+Part A — Annex II) [Sect.V- dataset H, I, J, K guidance]	Provision for reporting information on AQ plans relating to Annex XV 2008/50/EC.
Article 14 Measures to comply with the target value of Directive 2004/107/EC	Directive 2004/107/EC Article 5(2)	31 December, Year X+2 Part K — Annex II + Part A — Annex II	Provision for reporting information on measures taken to attain target values.

Benefit	Requirement (a)	Current reporting activity
Discrete management of similar data flow. Data aggregation efficiencies for regional and federal administrations. Streamlines the data flows of Decision 2004/461/EC Forms 5, 11, 14 and 16. Formalises a consistent reporting mechanism for AQD and EoI data flows and expands this to methods other than fixed measurements. Efficiencies delivered by central data aggregation.	M V for EoI	Decision 2004/461/EC, spreadsheet template Forms 11, 14, 15, 19, 21, 22, 23, 24 http://rod.eionet.europa.eu/obligations/389
Discrete management of similar data flow. Data aggregation efficiencies for regional and federal administrations. Streamlines information within EoI, AQQ, NRT data flows. Voluntary extension of scope to forecast and now-cast data.		No explicit provision for reporting to the Commission. Replaces EoI Decision 97/101/EC and its amendments through 2001/752/EC provisions and summer ozone reporting. http://rod.eionet.europa.eu/obligations/131 http://rod.eionet.europa.eu/obligations/386
Discrete management of similar data flow. Data aggregation efficiencies for regional and federal administrations.	M	Decision 2004/461/EC, spreadsheet template Forms 8–9, 21–24 http://rod.eionet.europa.eu/obligations/389 Decision 2004/224/EC, spreadsheet template Form 2, http://rod.eionet.europa.eu/instruments/607
Discrete management of similar data flow. Data aggregation efficiencies for regional and federal administrations. Makes provision for voluntary exchange of best management practices. Improved and streamlined; data flow currently defined by 224 forms.	M V for EoI	Decision 2004/224/EC, spreadsheet template http://rod.eionet.europa.eu/instruments/607
Discrete management of similar data flow. Previously the structure and the periodicity were not defined. Data aggregation efficiencies for regional and federal administrations. Makes provision for voluntary exchange of best management practices.	M	Decision 2004/224/EC, spreadsheet template http://rod.eionet.europa.eu/instruments/607

Note: (a) M = Mandatory; C = Conditional; V = Voluntary.

3 Capacities and routines to support e-Reporting

This section aims to identify those capacities and routines necessary to facilitate the transition to an AQD e-Reporting system and which would allow administrations to operate efficiently. Recommendations come from the EEA and ETC/ACM.

A summary of high-level capacities, capabilities and routines required or beneficial within an AQD e-Reporting system have been identified with regard to the responsibilities and needs of stakeholders at all levels, comprising:

- Member States;
- EEA, Eionet and contractors roles in supporting DG-ENV;
- DG-ENV;
- Eionet members (countries) which are not EU Member States.

The headline characteristics for an optimised reporting system were outlined in Chapter 2. These have been evaluated and linked to conceptual solutions for the AQD stakeholders outlined above. Ideal target situations are identified in the following sections followed by associated recommendations, where appropriate, relevant to optimising the e-Reporting systems and facilitating transition.

3.1 Timely delivery of data

Earlier deliveries of, for example, automatic measurements, would greatly expedite some assessment activities. However, many countries indicate that it is not possible to bring the publishing (reporting) of AQ data further forward than is currently practised. Therefore the only means to speed up the data flow in this respect is by quick processing of provisional and validated data, during and after the data has reached the data repository. There is also a need to agree on the timing of the data made available.

There are a variety of update rates for provisional and validated data, depending on the target user group needs:

- NRT (target group: public): hourly deliverable with update within 24–72 hours if necessary;
- NRT (target group: GMES Atmospheric Service Provider — primarily MACC project, modellers): delivery within three hours of observations, but possibly up to 24 hours behind time. MACC's aim is to run a synoptic cycle (at 00 GMT, 06 GMT, 12 GMT and 18 GMT). Further information provided by MACC deliverable D_INSITU_1.7 'Report on coordinated NRT in-situ data supply and recommendations for flagging systems';
- NRT (Summer Ozone; target group: public): hourly deliverables with updates on a monthly basis and an update for the April–September period before 31 October;
- NRT (target: other AQ users and research projects): hourly deliverable with update within 24–72 hours to monthly;
- EoI (target group: Eionet and public): Resubmissions for the previous calendar year by 1 October; the release of the updated AQ database (AirBase, now five months after the October deadline) can be shortened by approximately two months if the countries perform their own quality checks (see below). Earlier deliveries of validated data (also for automatic measured data) seem problematic for those MS which need to compile the data collected by regional authorities.

Recommendation 1: there must be clear agreements about the timing of the updates and resubmission of AQ data in order to contribute to making quicker use of the data for assessments.

3.2 Thorough and consistent QA/QC checks for all

Data validation and verification procedures are generally not transparent and consistent across all countries. Moreover, countries are in different stages of development with regard to TCCCA. As a result, it is not always possible to guarantee comparable AQ observations or measurements.

In order to remedy this state-of-play, all countries should carry out checks before submission of data and there is broad agreement that quality checks are best managed and operated close to data source e.g. at local or regional levels, to keep the feedback loops compact and fast. This is important because the scope of the checking work done by the ETC/ACM can be limited if the countries do their own checks, i.e. existing ETC/ACM practices of QA/QC are flowed down to Member States. This is in line with the SEIS principles.

Most countries use the DEM for checking their data whether it be meta information (networks, stations, measurement configurations) and/or the measurement data. Extension of DEM type checks on formats, outliers, (calculated) annual means, missing data, visualise the data and to export the measurement data and the statistics calculated to Member States would offer significant gains.

Recommendation 2: develop and make available comparable standard routines for the IPR to check the data before submission. This is an essential requirement for ensuring data quality and harmonization of data quality checking throughout Europe.

Recommendation 3: agree and develop a set of routines or concepts for standardised quality checks for valid (non-provisional) data in order to guarantee the same level of data quality checking among the countries. Countries may use these routines or develop in-house equivalent procedures based on the concepts developed.

3.3 A centralised, accessible, up-to-date online metadata repository

In most of the countries the data supplier has the possibility to update the meta information based on the national database. This situation is convenient and effective in maintaining up-to-date metadata and could be usefully extended to responsible parties at the AQD level, namely DG-ENV and EEA.

Recommendation 4: maintain up-to-date meta information at European level by submission of change-only updates to the systems. This is comparable with the current situation, enabling the data supplier to update the meta information based on the latest information in a station inventory.

Recommendation 5: based on the information provided by the data supplier, EEA (supported by ETC/ACM) could assess and populate substantial parts of the AQD content under the current practices and emergent IPR practices. Software routines, services and resources may be developed for this purpose thereby reducing country burdens to finalising and checking of data flows. However, even though the development of routines may be within the remit of the EEA assisted by ETC/ACM, responsibility for populating data flows and submission according to IPR remains with the Member State.

3.4 Centralised provision of supporting AQD data

Many countries make use of data from national statistical agencies to source information on contextual AQ related datasets e.g. emission and population data. It is important to note that these data types are closely coupled with analysis and assessment of AQ levels with regard to AQ management.

Data centres can play an important role in taking over the current role of the national AQ data providers. For example, using the stations coordinates in AirBase and the EuroBoundary Maps, NUTS and the LAU2/EBM codes are derived and loaded in AirBase and the DEM. The data supplier may subsequently check and correct LAU2 name and station coordinates as needed. This procedure may also be applied to other AQ data flows.

Recommendation 6: providing that it has already been reported, extract non-specific supporting AQD data from the data centres, and present it to the data suppliers for checking. The EEA (supported by the ETC/ACM) could play an important role in retrieving this information.

3.5 IT solutions compatible with the required XML data provision

None of the countries, bar one, have a fully compatible XML environment.

Recommendation 7: make sure that sufficient conversion routines (e.g. from MS Excel and Access to XML and vice versa) are available.

3.6 Interoperable approaches to modelled data

Most countries use model outputs, at least in part, for fulfilling the requirements of the air quality directives, in particular in relation to assessment thresholds, source apportionment and public information. Several countries are also using modelled data for reporting exceedance information.

A range of models on several scales are available throughout Europe. EEA sees an important role for FAIRMODE (Forum for Air quality Modelling) and its user communities in developing and harmonising practicable modelling guidance in order to promote comparability of modelling, quality of modelled data, uncertainty estimation and interoperability in representation of modelled data.

The introduction of the Implementing Decision 2011/850/EU provides an opportunity to modernise data reporting, improve data quality, and facilitate information sharing. Draft guidance for the Implementing Decision 2011/850/EU on how model results are to be encoded/represented in the e-Reporting data flows is very limited, additional guidance must be worked out.

Recommendation 8: FAIRMODE and its user communities to guide the e-Reporting development with regards to model data representation in the new reporting mechanism and identify priorities for action.

Recommendation 9: as the specifications for Annex III INSPIRE data themes evolve it may be viewed as practicable to extend the e-Reporting data model and schema to accommodate concepts such as primary data from multiple scale modelling provided by GMES. FAIRMODE could have a prominent role in this process.

3.7 Administrative requirements for an optimised AQD e-Reporting system

From current data flows it is clear that there are different administrative levels and hierarchies across Member States and Eionet countries. These vary from a central management bodies like those in Malta to countries like Poland, Italy and Spain where there are several competent authorities operating collecting and reporting AQD data.

Most current data flows have a central contact point that is responsible for the compilation and

submissions of the Member States data. In most cases this arrangement works efficiently. However, for NRT due to the disparate nature of the data flow, the number of contacts points per Eionet country may vary from one to twenty one in the extreme. The nature of this data exchange has made it difficult for some Eionet countries to accommodate the single contact point concept.

The administrative weight carried by IPR will vary in different Eionet countries. However, it will be important that the IT solutions for reporting data incorporates the potential that for some data flows such as 'primary up-to-date provisional data', information can be reported by different competent authorities within a country. It will be up to each Member States to decide how to organise the data flows and who should be the overarching authority to approve final submissions. Multiple delivery points will be needed.

3.8 QA/QC requirements for an optimised AQD e-Reporting system

This section provides an overview of the routines and procedures relevant to the QA/QC of data flows and their content to support the e-Reporting process and reduce the burden on Member States. They have been grouped into two generic routine types: those to be implemented by Member States to check the regular data flows and those to be implemented at national or EEA data holdings to assist in data verification and validation.

3.8.1 Routines to check regular AQD data flows to be implemented by data providers

Metadata

- Management of change by providing updates. Existing meta data (information on zones, networks, stations and measurement configurations) can be added, modified and/or deleted interactively (by screens) and via import files.
- Automatic checks and controls are performed when importing data into the routine.
- Error messages and warnings are given for (missing) mandatory data; warnings should be given when zones designated in relation to the protection of health do not cover the whole territory/population of a country.

- Information is given on the unit value of the components, the station coordinates (ETRS89, accuracy), time reference data etc. Conversion routines to convert from the units, coordinates, time reference used in the national system to the standards in the IPR.
 - Use of a web map service, such as Google Earth, to check the station positions.
- exceedances: hours/days with concentration $> y \mu\text{g}/\text{m}^3$ (with y = limit or threshold value) and the kth highest value (Only SO_2 , NO_2 , PM_{10} , O_3);
 - AOT40: ozone concentrations accumulated dose over a threshold of 40 ppb (Only O_3);
 - SOMO35: ozone concentrations accumulated dose over a threshold of 35 ppb (Only O_3).

Primary data

- Outlier checks. Definition of an upper and lower outlier boundary. Values outside these boundaries are marked as outliers. Upper and lower outlier boundaries are currently set at the national level. A more dynamic approach (e.g. boundaries set in relation to country and station type) might be needed.
- Overviews or report forms with statistics calculated from the reported measurement data to inform on: zero or negative statistics or statistics which are three times lower or higher than the year before.
- Check on missing imported data. Overview of measurement data which have been reported the year before, but not now or data which have been reported now, but not the year before (there is a gap the year before).
- Several export facilities:
 - export meta information;
 - overview of imported data;
 - export raw data in Excel format;
 - export statistics;
 - export in other formats: XML, Google Earth, kml files, Nasa Ames (EMEP).
- Visualisation of imported data: time series, statistics.
- Aggregation/statistics calculation:
 - aggregation of hourly data to daily values; 8-hourly averaged and maximum daily 8-hour mean values for O_3 and CO ;
 - general (hourly, daily): annual mean, 50/95/98 percentiles, maximum values;
 - general (n-day ($n > 1$), n-week, n-month, year and var⁽¹¹⁾ data): annual mean, maximum values;

3.8.2 Routines to check the data in the national database or on EEA Data Service

Development of routines is required for automatic and visual inspection of monitoring data. These routines may also be used for validation of the measurement data and may be useful to ensure that established systems accommodate at least the concepts outlined here. The routines are based on comparisons of aggregated values (statistics) and detailed values (raw data). The comparisons should be done temporally (for statistics: previous/later years and for raw data: time series) and spatially (comparisons with statistics/raw data surrounding stations). The algorithms and software should be made available to the data suppliers for implementing it in the own national database, but can also be used to explore the data in the EEA Data Service.

The routines might contain:

- *Automatic checks:*
 - a. Outliers: same outlier checks as described above, but can be also more advanced: values outside a band around the averaged value are labelled as suspicious. Definition of the bandwidth is for example \pm three times the standard deviation).
 - b. Abrupt temporal changes. Strong changes in concentration might indicate a malfunction of the instruments, but might as well be correct. Information of surrounding stations will be needed to evaluate abrupt jumps.
 - c. Frequently repeating values; this might indicate on problems with units, with rounding, with calibration or with data below detection limits.
 - d. Completeness of AQ assessments, for all zone/pollutant/target combinations of an AQ assessment should be given.

⁽¹¹⁾ The averaging time is the period of the sample (end date/time minus start date/time). If the sample periods of a component differ 25% or more from a constant averaging time, the averaging time has been defined as 'var'.

- *Visual inspection:*
Development of routines to visualise time series in the national database or in the EEA data service. Flexible and interactive systems: graphs by selection of component, time period etc. Also the parameters mentioned above (outliers, abrupt jumps etc.) should be visualised by these graphs.

More advanced statistical methods are possible, but not foreseen initially.

3.9 General IT and wider knowledge requirements for an optimised AQD e-Reporting system

This section provides generic advice at a functional level on the high-level IT capacities, capabilities and routines required or beneficial within an AQD e-Reporting system to achieve optimisation and facilitate transition to the new system.

- 1. Guidance and best practise on AQ data storage:** high-level guidance or recommendation on storage of AQ data centrally ⁽¹²⁾ with a database (rather than spreadsheet) to facilitate the interface between native data systems and transformation to the AQD's XML based data formats for e-Reporting.
- 2. Guidance on data transformation:** Member States may require guidance on data transformation beyond that already published by the INSPIRE process ⁽¹³⁾. Because data providers may store their data in their own (native) structure, data transformation is required and is the process of mapping data elements in native databases or schemas to elements in the AQD e-Reporting schemas prior to submission. There are several high-level options:
 - Bespoke data transformation using the data providers preferred programming language (XSLT or other programming language utilising an XML library extension).
 - Use of proprietary and open source transformation routines such as:

Distributor/Name/Version type	Product type
Interactive Instruments/XtraServer/3.2	Commercial
Safe Software/FME Server/2010	Commercial
Snowflake Software/GO Publisher/1.4	Commercial
Talend/Integration Suite Enterprise Edition/3.2.3	Commercial
1Spatial/Radius Studio/2.1.0.15	Commercial
OSGeo/Deegree Web Processing Service/2.2	Research
Humboldt Project/Humboldt Alignment Editor and	Conceptual
Schema Translation Service/1.0.0-RC1, 2.0.0-M1 respectively	Research
AuScope Limited/AuScope Grid/ version not specified	Research

- 3. An ambient air quality portal and data repository:** the EEA has been mandated to assist DG ENV in managing and maintaining a web-based portal hosting data, information and documentation supporting the AQD and its e-Reporting mechanisms. This resource will be vital in supporting the AQD information to be hosted to include, but not limited to:
 - Guidance or services to convert National grid systems other geographic coordinate systems to ETRS1989
 - QA/QC resources and routines (as specified in Section 3.10)
 - Schema repository hosting
 - Schema documents and metadata
 - Codelists
 - Schema guidance
 - Schema enumeration rules
 - Schema mapping to AQD IPR Annex data elements
 - The AQD data model
 - Data repository
 - Data visualisation services
 - Data download services
 - Resources to fulfil DG-ENV and EEA responsibilities to the compilation of EU ambient air quality information under the AQD in relation to:

⁽¹²⁾ Within any designated responsible or competent body or administration identified at national regional or federal scales.

⁽¹³⁾ <http://inspire.jrc.ec.europa.eu/index.cfm/newsid/10241>.

- AirBase
 - Databases and reports on ambient AQ assessment
 - NRT data flows and short-term threshold exceedances
 - Databases relating to AQ plans
 - Databases on attainment of environmental objectives
 - MS national contact points and INSPIRE node addresses
 - Metadata registry for AQD e-Reporting.
4. **Data visualisation services:** services to enable users to visualise all AQD e-Reporting data flows via user defined queries and view in on-screen forms and as spatial data via a Web Feature Service (WFS) for geographically resolved information. Perhaps requires further coordination with viewing requirements of the QA/QC routines.
5. **Data download service:** services to enable users to:
- Download the AQD e-Reporting data and data flows via user defined queries.
 - Download summary compliance or attainment reports demonstrating exceedance or otherwise of environmental objectives at Member State or AQ zone level. Content of these reports to be defined in conjunction with the ETC/ACM, EEA, DG-ENV.
6. **An AQD e-Reporting transaction log:** storing metadata documents cataloguing all e-Reporting submissions and re-submissions at Member State level.
7. **AQD e-Reporting metadata registry service:** a web registry service that supports the run-time discovery and evaluation of resources such as services, datasets, and application schema.

4 Synergies and conflicts with other initiatives

This chapter presents a summary of the main synergies and (potential) conflicts of e-Reporting with regard to INSPIRE, SEIS, GMES, the evolution of standards for information sharing, wider Eionet activities and other environmental data flows.

4.1 INSPIRE

The status of conformity between the AQD IPR and INSPIRE initiatives is not fully clear at present. This is because the implementation of both initiatives is evolving. The data specifications of Annex III data themes are still under preparation with INSPIRE with several being relevant to the current work on AQD e-Reporting. Until these specifications are formalised it will be difficult to fully assess the conformity of AQD e-Reporting systems with INSPIRE.

Currently available INSPIRE drafts cover AQ e-Reporting to varying degrees:

- The draft guidelines 'D2.8.III.7 Data Specification on Environmental Monitoring Facilities' are currently well aligned with the proposed e-Reporting structure — reporting for air quality directives is included as a use case in the draft guidelines.
- The draft guidelines for 'D2.8.II/III.5 Data Specification on Human Health and Safety' feature a lengthy example on 'Ambient Air Quality and Human Health' and seem well aligned with the needs and preliminary plans for AQD e-Reporting.
- The draft guidelines for 'D2.8.III.13–14 Data Specification on Atmospheric conditions and Meteorological Geographical Features' are currently compatible with the requirements for AQD e-Reporting. These data specifications are mainly written by and for the meteorological community and do not focus on code lists and metadata elements needed for air quality. The data models are, however, suitable for air quality

purposes. A description of the current AQD e-Reporting systems and requirements (including lists of codes to be used), is available as a use case in an appendix on the data specification.

- The draft guidelines for 'D2.8.III.11 Area management/restriction/regulation zones and reporting units' cite the air quality directives' air quality management zones as a use case example for this INSPIRE theme.

When considering conformity with INSPIRE, it is also very important to check for conformity of INSPIRE with the data specifications required by AQD e-Reporting. With the possible exception of inconsistencies in the timelines for delivery of INSPIRE data specifications and that for adoption of the AQD IPR, conformity of the two initiatives is progressing satisfactorily.

4.2 GMES

AQ in-situ data are required by the GMES atmospheric services to improve their model results through assimilation and validation/diagnostics. The currently planned e-Reporting does not conflict with the present GMES requirements, but GMES is likely to suggest additional information to be provided in the future (next 1–2 years). Requirements are mainly connected to the need for improved information about the quality of the measurement data. It is not possible to resolve these issues until the requirements are properly described and a solution meeting the requirements has been found.

A number of pre-operational GMES products are offered via the MACC consortium covering Europe:

- maps and data for regional air-quality forecasts;
- retrospective assessments of air quality;
- identifications of sources of pollution episodes;
- toolbox for evaluating possible emergency emission control measures;
- inputs to local air-quality forecasts, health information and warnings.

More timely delivery of validated data deliverables to MACC via e-Reporting will greatly facilitate MACC product development.

4.3 Other environmental data flows

As described earlier, the current EoI data flow through DEM is aligned with EMEP reporting standards. In order to make reporting manageable for the countries, it is important to maintain this compatibility in the future. Changing the data format into a common XML format may not be compatible with EMEP requirement unless transformation mapping or services are made available or special arrangements are made with NILU (the institute maintaining the EMEP observational database).

4.4 SEIS

The SEIS principles are generally soft guidelines and the currently proposed e-Reporting is well aligned with the idea of having data managed in distributed systems as close as possible to the data owner. There is, however, a need for having centralised facilities available in Europe that collect and store AQ data in both NRT and validated mode and to act as a repository for defining the content of legal documents and the date upon which they were made available — at least in a transition phase. To rely on national or regional data nodes to provide data to European level users (where EEA is one such user) at this point in time would result in an overly fragile system (all servers need to be operational at the same time in order to catch data from all of Europe) and difficult to manage for these users (e.g. modellers would have to access data separately from all the different nodes). The currently proposed e-Reporting system balances

the different needs well, and allows for distributed data management close to the data owners as well as a central node that ensures data are archived and made available to users regularly and operationally.

4.5 JRC lead INSPIRE pilot project in the field of air quality

JRC, DG ENV and EEA are cooperating in a programme to support Member States in meeting their reporting obligations under the AQ Directive. This pilot will operate alongside the IPR pilot and will apply the INSPIRE infrastructure and SEIS principles to the air quality reporting obligations.

This work will build upon earlier work in this area (c.f. SEIS-CAFE project, EEA SENSE and ReportNet). Part of the work will update the current schemata, based on updated INSPIRE data specifications.

4.6 OGC/ISO standards evolution

It may be interesting to note that NetCDF with the CF-convention is being implemented as an OGC standard for Air Quality. This largely stems from the American networking activity revolving around the Datafed.net initiative and their contribution to initiatives under GEOSS Communities of Practice. It should be noted that the CF-standard is not sufficiently mature when it comes to Air Quality measurements and it is mainly reflecting the needs of the modelling community (CF = Climate and Forecasting), but there has been attempts to develop the standard to better-fit measurements. It remains to be seen how this will progress, but it should be noted that the NetCDF-CF format, and its various developments, have gained significant momentum in the past years.

5 Acronyms and terms

5.1 Acronyms

AC-MF	INSPIRE Atmospheric Conditions and Meteorological Features data themes
AQ	air quality
AQD	Air Quality Directive, 2008/50/EC
AQDD	Air Quality Daughter Directive
AQD IPR	Commission Implementing Decision 2011/850/EU
AQQ	air quality questionnaire
AQP	air quality plans
AM	area management and restriction data theme (INSPIRE)
AIRBASE	EEA public air quality database system
Art	Article
ASCII	American Standard Code for Information Interchange
C	conditional
CDR	Central Data Repository (of ReportNet)
CEN	Comité Européen de Normalisation
CF	Climate and Forecasting
CORINE	Coordination of Information on the Environment
CSV	comma separate value
DD	Daughter Directive (relating to air quality under the FWD)
DEM	Data Exchange Module (of Eionet)
DG-ENV	Directorate-General for the Environment (European Commission)
EBM	EuroBoundary Map
EEA	European Environment Agency
Eionet	European Environment Information and Observation Network
ETC/ACM	European Topic Centre on Air and Climate Change Mitigation
EMEP	Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air pollutants in Europe
EF	INSPIRE Environment Monitoring Facilities data theme
EoI	Exchange of Information Decision on Air (ref. 97/101/EC (OJ L 35, 5.2.1997, p. 14–22)
e-Reporting	the process of exchange of regulatory and informative data on air quality under the AQD
ETRS89/ETRS 1989	European Terrestrial Reference System 1989
EU	European Union
EUROSTAT	Statistical Office of the European Communities
Excel	commercial spreadsheet application
FAIRMODE	Forum for air quality modelling
FWD	European Air Quality Framework Directive 96/62/EC

FTP	file transfer protocol
GCM	general conceptual model
GIS	Geographic Information System
GISCO	EUROSTAT GIS data
GMES	Global Monitoring for Environment and Security
GML	geographic mark-up language
GEOS	Global Earth Observation System of Systems
HH	INSPIRE human health data theme
ID	identifier
INSPIRE	Infrastructure for Spatial Information in the European Community (INSPIRE Directive 2007/03/14)
INSPIRE IR	INSPIRE implementation rules
IPR	implementing provisions on reporting (see also ADQ IPR)
IRs	implementing rules
ISO	International Organisation for Standardisation
ISO/TS	ISO technical specification
JRC	Joint Research Centre (European Commission)
KML	keyhole mark-up language
LAU	local administrative unit
LMO	legally mandated organisation
M	mandatory
MACC	Monitoring Atmospheric Composition and Climate
MS	Member State
MySQL	an open source database http
NACE	statistical classification of economic activities (EUROSTAT)
NASA	National Aeronautics and Space Administration (US)
NASA Ames	The NASA Ames Format for Data Exchange
NetCDF	network common data form
NILU	The Norwegian Institute for Air Research
NMVOC	non-methane volatile organic compounds
NRT	near-real time
NUTS	nomenclature of territorial units for statistics
OGC	Open Geospatial Consortium
PAHs	poly-aromatic hydrocarbons
PM	particulate matter.
QA/QC	quality assurance and quality control
ReportNet	Eionet's infrastructure for supporting and improving data and information flows
TENS	time extension notifications
TCCCA	IPCC and UNFCCC guideline principles of transparency, consistency, comparability, completeness and accuracy in reporting
SDI	spatial data infrastructure
SDIC	spatial data interest community
SEIS	Shared Environment Information System
SOR	summer ozone reporting
SQL	structured query language
UML	unified modelling language
URI	uniform resource identifier

URL	uniform resource locator
URN	uniform resource name
UTD	up to date
UTF	Unicode transformation format
UUID	universally unique identifier
V	voluntary
VOCs	volatile organic compounds
WHO	World Health Organisation
WMO	World Meteorological Organisation
XML	extensible mark-up language
XMLT	extensible stylesheet language transformation
XSD	XML schema definition

5.2 Glossary of terms

Application schema	Conceptual schema for data required by one or more applications [ISO 19101].
Conversion rule	Rule for converting instances in the input data structure to instances in the output data structure [ISO 19118].
Data transfer	Movement of data from one point to another over a medium [ISO 19118]. Note that transfer of information implies transfer of data.
Encoding	Conversion of data into a series of codes [ISO 19118].
Eionet priority data flow	For more information about Eionet priority data flows see http://www.eionet.europa.eu/dataflows .
Encoding rule	Identifiable collection of conversion rules that define the encoding for a particular data structure [ISO 19118]. Note that an encoding rule specifies the types of data to be converted as well as the syntax, structure and codes used in the resulting data structure.
Open standard	Standard that is adopted and will be maintained by a not-for-profit organisation in an open decision making procedure available to all interested parties, that is available, distributable and usable either freely or at a nominal fee, and where the intellectual property is made irrevocably available on a royalty-free basis.
Transfer format	Structured representation of data in a file for transfer between systems. Note that typically a machine readable schema will document the structure of the data in the transfer file (e.g. GML (ISO 19136) encodes the application schema in XML Schema).
Spatial data	Data with a direct or indirect reference to a specific location or geographic area.
Spatial data set	Identifiable collection of spatial data.
Transfer protocol	Common set of rules for defining interactions between distributed systems [ISO 19118].
Update spatial data	Modification of parts of a spatial data set. Note that the interchange of a complete spatial data set to replace an older version of the spatial data set is not considered an update to distinguish the different mechanisms required to create and process partial updates.

Annex 1

Questions for the comparison of the current and the optimised situation for the new AQD Implementing Provisions (IPR):

1. *Optimised situation: One national database with the AQ data from the different (local) networks.*
Question: Do you have a national database with the meta data (information on networks, stations and measurement configurations) and the AQ measurement data from the different networks? If you have multiple databases, how many and how are these organised and administered; nationally, regionally federally. Who authorises officially the submission of the EoI, Questionnaire, Near Real Time (NRT), and Summer Ozone Report (SOR)?
2. *Optimised situation: Ensuring data quality (QA/QC) In IPCC terminology: TCCCA (Transparency, Consistency, Completeness, Comparability and Accuracy).*
Question: Are the measurement data validated? Can you please briefly describe your validation activities?
3. *Optimised situation: Quality checks should be as close as possible to the source of the data (e.g. regional networks). Keep the feedback cycle as small and fast as possible.*
Question: Are there, besides the data validation, other checks carried out by the local, regional and national networks?
4. *Optimised situation: Before submitting the AQ data checking of the meta information (networks, stations, measurement configurations) and the measurement data. Possible checks (now available in the DEM): format checks, checks on outliers, checks on (calculated) annual means, missing data, time series anomalies, visualise the data and to export the measurement data and the statistics calculated from these data.*
Question: If you use the DEM for delivering the EoI data, do you use the DEM also to check the data (checks on outliers, statistics, missing data; visualization and/or the export functions)?
5. *Optimised situation: Standard tools have to be available for all data suppliers to perform these quality checks.*
Question: Are there, at a national and/or regional level, standard tools available to check the AQ data? Can you provide a headline description of these?
6. *Optimised situation: Also available to the data supplier: a database prefilled with the latest update of the meta information of network(s), zones, models etc. The data supplier can delete, modify or add meta information in this database.*
Question: Are there on national and/or regional level tools available to easily update the meta information of the networks/stations/ measurement configurations?
7. *Optimised situation: Some non-specific supporting AQD data (e.g. population, land cover data, traffic intensity, LAU/EBM codes etc.) could be derived centrally (by the EEA for example) from other standardised European data sources (e.g. Eurostat). GIS should combine these data with the AQ data.*
Question: Do you also use external sources to combine with AQ data? If yes, please specify these external sources.
8. *Optimised situation: Earlier deliveries of for instance automatically measured Air Quality data as soon as they are available.*
Question: Would it be possible to deliver the automatically measured AQ data earlier in the year?
9. *Optimised situation: Fully compatible IT competency and solutions.*
Question: What is your level of competency with XML, specifically transformation of local database content to XML schema documents? Do you have tools available to support this process? If so please specify.
10. *Optimised situation: Use of models in the national system.*
Question: What type of models do you use in your national system such as for reporting in the questionnaire?

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