



Funded by the Horizon 2020  
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# Energy- and Size-efficient Ultra-fast Plasmonic Circuits for Neuromorphic Computing Architectures

## Deliverable D1.1 Documentation standards

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<b>Project acronym:</b>	PlasmoniAC
<b>Start/End date:</b>	01/01/2020 – 31/12/2022

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\*) PU = Public ;PP = Restricted to other programme participants (including the Commission Services) ; RE = Restricted to a group specified by the consortium (including the Commission Services) ; CO = Confidential, only for members of the consortium (including the Commission Services)

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## Log of changes

Version	Organization	Changes
V1.0	AUTH	Document created

## Abstract

This report gives an overview of the PlasmoniAC project and its Consortium Members, sets the standards and templates for Deliverables, defines the measures for Quality Assurance, details the reporting procedures and timelines and offers the guidelines for project documentation archiving.

## Keywords

Deliverables, Documentation, PlasmoniAC consortium, PlasmoniAC project overview, Quality Assurance, Reporting, Standardization, Templates

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## List of Abbreviations

EC	European Commission
FR	Final Report
MAC	Multiply-Accumulate
PCo	Project Coordinator
PO	Project Officer
PPR	Periodic Progress Report
WP	Work Package

# 1 Executive Summary

This document is the Quality Assurance Manual for the Deliverables of the PlasmoniAC project. It aims at defining the quality guidelines for the deliverables produced during the project duration (templates, codes, formats, etc.). It also includes common management and technical procedures to follow, as well as methods for detecting possible deviations from the specifications, and correcting them in a timely manner.

## 2 Introduction

### 2.1 Purpose of this document

The objective of this deliverable is to identify the standards to be followed for the project deliverables produced during the project duration (templates, codes, formats, etc.). It also provides the methods for detecting possible deviations from the specifications, and correcting them in a timely manner.

### 2.2 Document structure

The present deliverable is split into following major chapters:

- Project Overview
- Deliverables
- Reporting
- Project Documentation Archiving

### 2.3 Audience

This document is confidential, only for members of the PlasmoniAC Consortium (including the Commission Services).

## 3 Project Overview

### 3.1 Project Identification

<b>Project acronym</b>	PlasmoniAC
<b>Project title</b>	Energy- and Size-efficient Ultra-fast Plasmonic Circuits for Neuromorphic Computing Architectures
<b>Project abstract</b>	<p>PlasmoniAC invests in neuromorphic computing towards sustaining processing power and energy efficiency scaling, adopting the best-in-class material and technology platforms for optimizing computational power, size and energy at every of its constituent functions. It employs the proven high-bandwidth and low-loss credentials of photonic interconnects together with the nm-size memory function of memristor nanoelectronics, bridging them by introducing plasmonics as the ideal technology for offering photonic-level bandwidths and electronic-level footprint computations within ultra-low energy consumption envelopes.</p> <p>Following a holistic hardware/software co-design approach, PlasmoniAC targets the following objectives:</p> <ul style="list-style-type: none"> <li>i) to elevate plasmonics into a computationally-credible platform with Nx100 Gb/s bandwidth, <math>\mu\text{m}^2</math>-scale size and <math>&gt;10^{14}</math> MAC/s/W computational energy efficiency, using CMOS compatible BTO and SiOC materials for electro- and thermo-optic computational functions,</li> <li>ii) to blend them via a powerful 3D co-integration platform with <math>\text{Si}_x\text{N}_y</math>-based photonic interconnects and with non-volatile memristor-based weight control,</li> <li>iii) to fabricate two different sets of 100 Gb/s 16- and 8-fan-in linear plasmonic neurons,</li> <li>iv) to deploy a whole new class of plasmoelectronic and nanophotonic activation modules,</li> <li>v) to demonstrate a full set of <math>\sin^2(x)</math>, ReLU, sigmoid and tanh plasmonic neurons for feed-forward and recurrent neurons,</li> <li>vi) to embrace them into a properly adapted Deep Learning training model suite, ultimately delivering a neuromorphic plasmonic software design library, and</li> <li>vii) to apply them on IT security-oriented applications for threat and malware detection.</li> </ul> <p>Succeeding in its targets will release a powerful artificial plasmonic neuron suite with up to 3 orders of magnitude higher computational efficiencies per neuron and 1 and 6 orders of magnitude higher energy and footprint efficiencies, respectively, compared to the top state-of-the-art neuromorphic machines.</p>
<b>Contract number</b>	871391
<b>Execution</b>	01/01/2020 – 31/12/2022 (36 months)
<b>Type</b>	H2020-ICT-2019-2 Unconventional Nanoelectronics
<b>Web site &amp; social media</b>	<a href="http://www.plasmoniac.eu">http://www.plasmoniac.eu</a> <a href="https://www.linkedin.com/groups/8901360/">https://www.linkedin.com/groups/8901360/</a> <a href="https://twitter.com/Plasmoniac">https://twitter.com/Plasmoniac</a> <a href="https://www.facebook.com/Plasmoniac">https://www.facebook.com/Plasmoniac</a>

Logo



### 3.2 Consortium Members

A Consortium of 10 organizations undertakes the PlasmoniAC project, as shown in Figure 1.



Figure 1: PlasmoniAC Consortium members.

The following table summarizes the partners’ details.

No.	Name	Acronym	Country
1	Aristotle University of Thessaloniki	AUTH	Greece
2	University of Southampton	SOTON	United Kingdom
3	Swiss Federal Institute of Technology in Zurich	ETHZ	Switzerland
4	University of Burgundy - Franche-Comté	UBFC	France
5	French National Center for Scientific Research	CNRS	France
6	Interuniversity Microelectronics Centre	IMEC	Belgium
7	IBM Research GmbH	IBM	Switzerland
8	Association for Applied Micro- and Optoelectronics GmbH	AMO	Germany
9	Mellanox Technologies Ltd	MLNX	Israel
10	VPIphotonics GmbH	VPI	Germany

### 3.3 Contact Information

Information can be electronically disseminated to the whole list of persons involved in the project through the account: [plasmoni@lists.auth.gr](mailto:plasmoni@lists.auth.gr), while information targeted only at the project management team should be send at: [npleros@csd.auth.gr](mailto:npleros@csd.auth.gr).

#### 3.3.1 Physical addresses of the organizations

A following table summarizes the physical addresses of the PlasmoniAC partners:

Acronym	Address
AUTH	KEDEA Building, Tritis Septemvriou, Aristotle University Campus, Thessaloniki, 546 36, Greece
SOTON	University Road, Southampton SO17 1BJ, UK
ETHZ	Rämistrasse 101, 8092 Zürich, Switzerland
UBFC	32 Avenue de l'Observatoire, 25000 Besançon, France

Acronym	Address
CNRS	Rue Michel-Ange 3, 75794 Paris CEDEX 16, France
IMEC	Kapeldreef 75, 3001 Leuven, Belgium
IBM	Säumerstrasse 4, CH-8803 Rüschlikon, Switzerland
AMO	Otto-Blumenthal-Str. 25, 52074 Aachen, Germany
MLNX	Beit Mellanox, 26 Hakidma St., Ofer Industrial Park Yokneam 20692, Israel
VPI	Carnotstrasse 6, 10587 Berlin, Germany

### 3.3.2 Key European Commission contact

Name	Role
Dr. Henri Rajbenbach	Project Officer

*Note:* All partners should contact the *Project Coordinator* for any issue regarding the PlasmoniAC project. The Coordinator will serve as the liaison (proxy) for forwarding requests to the Project Officer and resolving any issues during the project’s implementation.

## 4 Deliverables

The work within PlasmoniAC project has been organized in 7 work packages (WPs). These work packages will be concluded with deliverables that include the basic achievements of the tasks in each work package. The deliverables will be sent to the Commission. **The work package leader is the main author of such a deliverable** (unless it is stated otherwise in the relevant table with the deliverables list and the editors' names). Deliverables will be circulated to the Consortium (the relevant partners) by the partner responsible. The Consortium will read the deliverable and comment on its contents in a timely manner. The responsible partner will modify the deliverable according to the feedback received from the Consortium. The final draft of the deliverable will be sent to the Project Coordinator that will ensure that these reports satisfy criteria on presentation and readability and will also ensure that the reports meet the objectives, which are stated in the contract. If the report is accepted it will be sent to the Commission.

### 4.1 Structure of the deliverable

A deliverable will comprise the following parts:

- **Part I:** *Front Page*, relevant *Author Information* and *Copyright information* – see Annex 1 (Deliverable Template) and pages 1 through 4 of this document;
- **Part II:** *Table of Contents* and *List of Abbreviations* – an index of the deliverables contents is provided, supplemented with the list of abbreviations and their meaning;
- **Part III:** *Executive Summary* – executive summary of the deliverable which includes a concise description of the results coming from the work carried out and conclusions giving recommendations and highlighting the contribution of the results of the deliverable for the deployment of the proposed services;
- **Part IV:** *Deliverable Content* – full description of deliverable content containing the purpose of the document, the document structure, the targeted audience, the terminology used (if necessary) and a description of the methodology used, the work done to achieve the relevant tasks and the detailed results;
- **Part V:** *Bibliography and References* – a list of documents and other key references relevant to the deliverable;
- **Part VI:** *Annexes*:
  - Annexes containing the documents that have been used or produced for the achievement of the tasks;
  - Other supporting data relevant to Part IV.

## 4.2 Project Deliverables

The complete list of the PlasmoniAC deliverables can be seen in the following table.

Del.#	Deliverable name	WP#	Lead	Type	Dissemination	Due Date (month)
D1.1	Documentation standards	WP1	AUTH	Report	PU	2
D1.2	Intermediate project activity and management report	WP1	AUTH	Report	CO	9
D1.3	First periodic project activity and management report	WP1	AUTH	Report	CO	18
D1.4	Final periodic project activity and management report	WP1	AUTH	Report	CO	36
D1.5	Final publishable activity report	WP1	AUTH	Report	PU	36
D2.1	Initial plasmonic neuron device and circuit design, specifications and use case definition	WP2	AUTH	Report	CO	8
D2.2	1 <sup>st</sup> report on software design library and training models	WP2	VPI	Report	CO	14
D2.3	Final plasmonic neuron device & circuit design, specifications & use cases	WP2	IBM	Report	PU	20
D2.4	2 <sup>nd</sup> report on software design library and training models	WP2	VPI	Report	CO	32
D3.1	Report on SiOC material processing & characterization	WP3	UBFC	Report	CO	8
D3.2	1 <sup>st</sup> report on SiN passives & test weighting structures	WP3	SOTON	Report	CO	12
D3.3	1 <sup>st</sup> report on BTO plasmonic modulators & SiOC-based T/O plasmonic waveguides	WP3	ETHZ	Report	CO	16
D3.4	Final report on SiN passives, BTO plasmonic modulators & SiOC-based T/O plasmonic waveguide	WP3	SOTON	Report	PU	22
D4.1	Report on 1 <sup>st</sup> generation of plasmonically-enhanced graphene PDs & InP PhC nanostructures	WP4	AMO	Report	CO	14
D4.2	Report on 1 <sup>st</sup> generation of fully-assembled & characterized plasmoelectronic & nanophotonic activation modules	WP4	CNRS	Report	CO	24
D4.3	Report of fabricated 100 Gb/s NLA integrated circuit	WP4	IMEC	Report	CO	28
D4.4	Report on 2 <sup>nd</sup> generation of fully-assembled plasmoelectronic & nanophotonic activation modules	WP4	MLNX	Report	CO	32
D5.1	Fabrication & characterization of memristor elements & design of plasmonic weights	WP5	IBM	Report	CO	14
D5.2	Fabrication & characterization of plasmonic weight structures & 3D cointegrated axon	WP5	UBFC	Report	CO	20
D5.3	Fabrication and characterization of 4-input linear plasmonic neuron	WP5	SOTON	Report	CO	26
D5.4	Development of fully-assembled linear plasmonic neuron	WP5	MLNX	Report	CO	32
D6.1	Initial definition of neuromorphic plasmonic circuit testing methodology based on simulations & experiments	WP6	AUTH	Report	CO	18
D6.2	Experimental evaluation of plasmonic neurons and performance evaluation in DNN architectures	WP6	AUTH	Report	CO	36
D6.3	Application in DDOS attack detection and benchmarking	WP6	IBM	Report	CO	36
D7.1	Factsheet and project presentation	WP7	AUTH	Report	PU	2
D7.2	1 <sup>st</sup> Project Press Release	WP7	MLNX	Report	PU	2

Del.#	Deliverable name	WP#	Lead	Type	Dissemination	Due Date (month)
D7.3	Website development and setup of social accounts	WP7	AUTH	Report	PU	2
D7.4	PlasmoniAC video presentation	WP7	AUTH	Report	PU	8
D7.5	1 <sup>st</sup> Year Report on market analysis, standardization activities, competitive analysis, dissemination and exploitation plans	WP7	MLNX	Report	CO	12
D7.6	2 <sup>nd</sup> Year Report on market analysis, standardization activities, competitive analysis, dissemination and exploitation plans	WP7	IBM	Report	CO	24
D7.7	Final report on market analysis, standardization activities, competitive analysis, dissemination and exploitation plans	WP7	MLNX	Report	PU	36

### 4.3 Quality Assurance

Quality Assurance procedures address both the process of deliverable preparation, as well as the deliverables themselves, as detailed in the checklists given in Annex 2. More specifically, Quality Assurance within the framework of the PlasmoniAC project is realised at two levels.

At the *first level*, the project aims to develop internal procedures accepted by all partners from which the following will emerge:

- The quality standards of deliverables and their acceptance criteria;
- The standardisation of the deliverables on the basis of the above criteria;
- In-house measures, that will ensure that the project is developing in such a way that the above criteria will be satisfied;
- Definition of the quality-sensitive parameters and their monitoring procedures;
- The control mechanisms internal and/or external of the deliverables;
- The corrective mechanisms.

The *second level* concerns quality assurance of the final product. Support will be provided to the workgroups, at all stages of the development of the system, from the requirement analysis to the marketing of the product in compliance with the international quality standards.

The Project Coordinator assumes the right and the responsibility to ensure, through correct activation of scientific and technical consultants and experts that the scientific content of the activities performed and systems developed in PlasmoniAC follows the guidelines explicated in the project.

The Quality Assurance activities will be established on the basis of experience from EU and international projects. The planning will be performed internally, producing a Quality Assurance plan. The procedures foreseen include:

- *Written contributions*: A document containing the table of content and explanatory text is prepared for each deliverable, and circulated among the partners before the deliverable is distributed. Suggestions may be then included in the final document.
- *Oral reviews* (face to face or distant meetings): The reviews of the deliverable are done during ad-hoc meetings. The author of the deliverable creates a report with comments of the reviewers to improve the document.

### 4.4 Deliverable Editors and Reviews

The following type of review is envisaged for each deliverable:

The editor of the deliverable asks the partners to provide feedback and produce comments, and the author incorporates the comments when he considers it appropriate. If found necessary by the Project Coordinator,

each project deliverable submitted to the Commission may be accompanied by a peer review report. This report may contain information on the procedure used for the peer review, a list of the participants, and the results of the review summarized in Log of Changes. The review results will highlight all major shortcomings detected. In that case, a comment by the Consortium about the actions taken or actions planned as a result of the peer review may be included in the report.

## 5 Reporting

Management reports will be prepared by the Consortium and submitted to the Commission in order to facilitate the efficient monitoring of the progress of the project work. These management reports should be short and formal and reflect the activity done during the period.

### Some recommendations regarding reports:

- use actual project templates;
- keep format and style;
- use KISS-principle (keep it short and simple)
- **but** ensure high quality;
- check the size (in bytes) of graphics, if you intend to incorporate any;
- reduce the size of graphics, if quality can be kept at the same time;
- do not use graphics purely for the aesthetics of the report.

Reporting routines are summarized in the following table:

Document	Prepared by	Sent to	Delivery date	Comments
Periodic progress reports (including Annex 4 from Grant Agreement)	All partners	PCo	Months 9, 18, 36 (Delivered the second week after the reporting period covered)	Template provided based on the EC template PCo will send integrated reports to the European Commission (60 days after the end of the reporting period)
Final report	PCo	PO	End of project	-

All partners report to the Project Coordinator (PCo).

The PCo is responsible for sending the reports to the European Commission (represented by Project Officer – PO). For this purpose, the PCo requires information from each partner in the format specified by the periodic report template.

### 5.1 Periodic Progress Reports

The **Periodic progress reports (PPRs)** detailing the work carried out, progress towards the objectives of the action, resources employed, deviations from the work plan and results shall be submitted to the Commission at the intervals specified in the contract. They shall be short concise reports, summarising the progress of the work in the reporting period and stating a cumulative account of the resources used in the reporting period. The periodical progress reports must enable the Commission to evaluate progress and to ascertain the applicability and potential interest of the project results.

Financial report will accompany the PPR, in the form specified by Annex 4 of the Grant Agreement, providing detailed description of the cost allocation.

Each partner is requested to send his/her Cost Justification to the Project Coordinator by the second week after the reporting period (months 9, 18, 36). The Project Coordinator will compile the contributions from all the partners for the period under consideration and submit the Overview and Results, as well as an integrated cost statement for all the contractors, to the Commission.

## 5.2 Final Report

The **Final Report (FR)** provides an overall assessment of the project and its results.

The Project Coordinator will prepare the Final Report and deliver it to the European Commission 60 days following the end of the last reporting period.

## 6 Project Documentation archiving

The project archive stores the official copies of all relevant PlasmoniAC documents such as deliverables, plans, reports, correspondence, etc.

The archive contains the following types of documentation:

- Deliverables
- Work package plans and progress reports per WP
- Minutes, action items' lists and decision lists
- Official correspondence among the partners
- Official correspondence with EC, including PlasmoniAC project reports and cost statements
- Legal documents (Grant Agreement, Consortium Agreement, amendments, contract with EC etc.)
- Commercial documents
- Any other document of general interest

### 6.1 Filing of Documents

The Project Coordinator is required to keep a file of documents to keep track of the progress of the project. Hence, it is important to file all documents pertinent to the project. The documents filed by the PCo should be at least on the same level as work package deliverables.

Documents not sent to the PCo will not appear in the database. Work package leaders should decide themselves whether or not a certain document is to be filed if such a document is oriented to minor management issues.

It would be much appreciated if work package leaders would identify their documents properly. If the document is not properly designated, the PCo will give a coding and file the document according to the guidelines. When a document is not coded according to the rules given in this document, it must be clear to which category the document belongs. If this is not clear to the PCo, the document will not be filed. This might mean that other work package leaders couldn't retrieve the document. This in turn might put the progress of the project at jeopardy.

### 6.2 Project Web Site

The project website has been established at the following URL:

<http://www.plasmoniac.eu/>

All working documents, including minutes of the meetings between the partners are available in the PlasmoniAC owncloud file repository, and will be migrated to the private password protected area of the website. Each partner has received the login and the password for authorized access.

### 6.3 Document and information flow

Partners are expected to comply with the following guidelines:

- Each partner shall follow the documentation guidelines previously given in order to achieve a common project layout.

- Do not include any logos (company, project, etc.).
- The Project Manager will keep all required logos and will insert if necessary.
- Use of the project-templates is mandatory.
- The Project Manager is responsible for the final layout of reports/deliverables etc.
- The Project Manager reserves the right to reject documents if they if they do not comply with the given format/style guidelines because of the additional workload.
- The Project Manager is responsible for sending the deliverables to the EC.
- The Project Manager will provide an internet service to the project in order to provide public and project-internal information and documents.
- Each partner is responsible to download documents, reports, templates, tables, manuals, action lists etc. from this authorised access.
- The Project Manager will not additionally distribute documents, reports, etc.; he may only provide the information that a new version is available.

**Following tools and formats are mandatory for stipulation<sup>1</sup>:**

- Microsoft Office:
  - Word (doc/docx);
  - Excel (xls/xlsx);
  - PowerPoint (ppt/pptx)
- Graphic formats:
  - vector graphics (eps/ai/svg)
  - raster/bitmap graphics (bmp/jpg/tiff/gif/png)
- Other formats:
  - plain text files (txt)
  - data exchange files (csv)
  - graphic data system (gds)
  - portable document format (pdf)

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<sup>1</sup> Project Coordinator reserves the right to update the list of accepted tools and formats according to the project needs.

## Annex 1: PlasmoniAC deliverable template

See pages 17 through 24.



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# Energy- and Size-efficient Ultra-fast Plasmonic Circuits for Neuromorphic Computing Architectures

## Deliverable DX.Y [Title of the Deliverable]

<b>Programme:</b>	H2020-ICT-06-2019. Unconventional nanoelectronics
<b>Project number:</b>	871391
<b>Project acronym:</b>	PlasmoniAC
<b>Start/End date:</b>	01/01/2020 – 31/12/2022

<b>Deliverable type:</b>	Report
<b>Deliverable reference number:</b>	871391 / DX.Y / v.1.0
<b>Deliverable title:</b>	[Title of the Deliverable]
<b>WP contributing to the deliverable:</b>	WPX
<b>Responsible Editor:</b>	
<b>Due date:</b>	DD/MM/20YY (MXY)
<b>Actual submission date:</b>	DD/MM/20YY (MXY)

<b>Dissemination level*:</b>	PU/PP/RE/CO
<b>Revision:</b>	version X.Y (final)

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\*) PU = Public ;PP = Restricted to other programme participants (including the Commission Services) ; RE = Restricted to a group specified by the consortium (including the Commission Services) ; CO = Confidential, only for members of the consortium (including the Commission Services)

### Author List

Organization	Author(s)
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### Log of changes

Version	Organization	Changes
V1.0		[list major changes]

## Abstract

This report will cover...

## Keywords

[insert keywords]

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## List of Abbreviations

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## 1 Executive Summary

This document presents information regarding the [...] of the PlasmoniAC project.

## 2 Introduction

### 2.1 Purpose of this document

The objective of this deliverable is to present ...

### 2.2 Document structure

The present deliverable is split into following major chapters:

- Project 1
- Project 2

### 2.3 Audience

This document is [option: PU = Public; PP = Restricted to other programme participants (including the Commission Services); RE = Restricted to a group specified by the consortium (including the Commission Services); CO = Confidential, only for members of the consortium (including the Commission Services)].

## 3 [Deliverable Content]

## Style guide:

Normal

No Spacing

## 4 Heading 1

### Heading 1 w/o numbering

#### 4.1 Heading 2

#### Heading 2 w/o numbering

##### 4.1.1 Heading 3

##### 4.1.1.1 *Heading 4*

## Title

### Title 18pt

Subtitle

*Subtle Emphasis*

*Emphasis*

*Intense Emphasis*

**Strong**

Disclaimers 8pt

*Quote*

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---

*Intense Quote*

---

---

SUBTLE REFERENCE

INTENSE REFERENCE

***Book Title***

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Footer

Header

[Hyperlink](#)

## Annex 2: PlasmoniAC Quality Assurance checklists

General Quality Assurance checklists for PlasmoniAC deliverables.

### QA Checklists for Reports

#### Content criteria:

<input type="checkbox"/>	Technical content	All content components are technically correct and consistent.
<input type="checkbox"/>	Scientific content	All content components are scientifically correct and consistent.
<input type="checkbox"/>	Completeness	The scope of the report is sufficiently covered, without gaps.
<input type="checkbox"/>	Clarity	All content components are clearly described without ambiguities, so that there is no lack of understanding the content's substance or the author's positions and intentions.
<input type="checkbox"/>	Detail	There is an appropriate level of detail in the analysis of each content element, providing sufficient information so that all statements, claims, descriptions and conclusions are either made self-evident or adequately articulated.
<input type="checkbox"/>	Consistency	There are no inconsistencies between any content elements and other established and commonly accepted statements, claims, descriptions and conclusions made elsewhere in the project or outside.
<input type="checkbox"/>	Verifiability	All pieces of information, statements, claims, descriptions and conclusions are defensible, strongly substantiated, and can be verified or traced to the appropriate sources of reference.
<input type="checkbox"/>	QA conformance	The final report corresponds faithfully to the approved and reviewed QA specification which has been already supplied.

#### Appearance criteria:

<input type="checkbox"/>	Readability	Comfortable flow of text, good use of the language.
<input type="checkbox"/>	Terminology	All specific terms should be adequately explained, in order to provide the appropriate frame of reference for the reader; a glossary is included.
<input type="checkbox"/>	Definitions of concepts	Definitions of concepts should be included; they must be clear and, if possible, highlighted in order to facilitate the reader.
<input type="checkbox"/>	Structure	The report structure should be coherent and should clearly divide different items and issues, while grouping together the appropriate elements.
<input type="checkbox"/>	Physical presentation	The formatting and physical appearance of the report should be appealing and create a professional impression of output.