

## Publishable Summary for 17SIP05 CASoft

### Software to maximize end user uptake of conformity assessment with measurement uncertainty

#### Overview

The purpose of the project was to enable the uptake of established methodologies for risk-based decision-making taking into account measurement uncertainty through the provision of dedicated software. Such software was released and made freely available in April 2020. It allows the user to apply the methodology from JCGM106:2012, as well as the one from the Best Practice Guide from project EMRP JRP NEW04 for a bivariate quantity. The particular need of the primary supporter was also taken into account with a specific function of the software that enables to perform in the same time the calculation of the conformance probability for several independent measurands under a simplified framework.

#### Need

The project's primary supporter was Trescal, a worldwide specialist in calibration and metrology services: verification, calibration, maintenance and management of test and measurement equipment for aerospace, defence, automotive and transport industries. The primary supporter had stated the need of all industrialists to have control of their measurement processes with regard to their manufacturing requirements. The primary supporter had requested that software be made available for the calculation of conformance probability, customer and producer risks and acceptance intervals in order to provide reliable decisions in conformity assessments. Such software would constitute a crucial improvement for them and their clients by offering automated calculations required for the implementation of a rigorous methodology (such as that described in the Best Practice Guide "A guide to decision-making and conformity assessment" (BPG) from EMRP JRP NEW04 and in the reference document JCGM 106:2012) enabling the reduction of manufacturing costs or improving the safety of marketed products. Incorrect decisions may result in economic losses for the producer, and lead to safety or other impact issues for the consumer. The guidance available in the BPG and JCGM 106:2012 provided a methodology to manage the associated risks. However, a wider implementation of the methodology was not possible due to the lack of accessible user-friendly software tools enabling users to perform the necessary calculations and have confidence in their results. The software would constitute also an improvement regarding the software provided in JRP NEW04, which enabled only the calculation of the conformance probability in cases where two output quantities were measured.

#### Objectives

The overall objective is to create end-user impact from the results of JRP NEW04, in particular from the outputs of WP3 dedicated to decision-making in conformity assessment. The project addresses the following objectives:

1. To enable the required calculations for risk-based decision-making in conformity assessment: customer/producer risks, acceptance intervals and conformance probabilities.
2. To support widespread adoption of best practice guidance in risk-based conformity assessments by increasing awareness of the software tool (in objective 1) and the BPG from JRP NEW04.



## Results

**Objective 1: To enable the required calculations for risk-based decision-making in conformity assessment: customer/producer risks, acceptance intervals and conformance probabilities.**

The final output of the project is software which is made freely available to the end-user for performing the required calculations for managing risk in conformity assessment. It is available at <https://www.lne.fr/en/software/CASoft> and runs under any Windows operating computer.

The software can be used after the collection of a measurement result in order to evaluate the conformance probability of the item submitted to a conformity assessment. Such conformance probability then defines a specific producer's risk if the item was rejected or a specific consumer's risk if the item was accepted. Collecting opinions from first users of the software, the primary supporter and members of the project team, it is expected that this kind of calculation will be the main usage of the software. In particular, the dialogue with the primary supporter made it clear that the calibration and testing laboratories as well as most industrialists did not have the required statistical background to encourage the use of prior distributions in their calculations. To this extent, the project team decided to propose a simplified version of the methodology from JCGM106:2012. This led to the development of a specific window, which allows the user to compute the conformance probability for several independent measurands, without the consideration of any prior distribution, in one single run. The primary supporter provided as a typical case, the case of the verification of a multimeter. Such a calibration operation requires some 125 measurements, each being submitted to an individual conformity assessment before making a decision about the conformity of the multimeter. This additional functionality was thought to be important to ensure that the primary supporter would find a software tool useful for its own calculations. It also meant that other calibration and testing laboratories would probably also find a software tool that meet their needs.

The software can also be used with the objective of risk management prior to any measurement operation, either:

- To evaluate proactively the global consumer/producer risk taking into account the acceptance and tolerance intervals, prior information (from historical data for example) and the standard uncertainty associated with the measured value;
- To determine which acceptance interval should be used in order to ensure that a maximum producer's (or consumer's) risk does not exceed a stipulated value.

Navigation through the software was intended to be user-friendly so that the user has to fill in successive information in a logical sequence in order to get the required results. In addition, graphs are provided to the user to help in the visualization and understanding of the results. These graphs are different according to the kind of calculated risk and should help in the uptake of the mathematical underlying concepts of the methodology.

In order to achieve the first objective, a user specification report was prepared and reviewed by the project partners. It defined the functionalities of the software that the consortium agreed to consider as important for the end-user. Such work was performed with input from the primary supporter who participated in the kick-off meeting of the project. This report was then updated with a description of the mathematical methods to be used in the development of the software. These methods also constituted a basis for the verification and validation phase of the software.

As a result, objective 1 can be considered to be achieved as the project's software enables to perform the different calculations that may be required in the context of decision-making in conformity assessment : conformance probability, global risk, acceptance interval.

**Objective 2: To support widespread adoption of best practice guidance in risk-based conformity assessments by increasing awareness of the software tool (in objective 1) and the BPG from JRP NEW04.**

The other final output was a series of communication actions in order to promote the methodology and the developed software. These actions included:

- Articles in the trade press;
  - o One article published in the magazine called "Precision"
  - o One open access paper published after the International Metrology Congress



- One article submitted to NCSLI magazine. A first review required minor changes that were taken into account in a submitted revised version.
- Presentations at conferences and workshops
  - European Network for Business and Industrial Statistics (ENBIS), Budapest, Hungary, Sept 19
  - International Metrology Congress, Paris, France, Sept 19
  - MATHMET Conference, Lisbon, Portugal, Nov 19
- Publicity through the European Center for Mathematics and Statistics in Metrology (MATHMET).
- Publicity through EURAMET website to promote the release of the software

As a result, objective 2 can also be considered as achieved. The communication actions listed above increased awareness in the community that software is available to apply the best practice guidance. In particular, the communications at the end of the project provided the web link for downloading the software and led to the first downloads in the wider community. As the topic of conformity assessment is very broad, the project team has chosen to focus on different aspects of the methodology, including the case of bivariate quantities, providing the opportunity to increase awareness of the Best Practice Guide from JRP NEW04.

### Impact

The dissemination activities undertaken during the project were targeting the primary supporter as well as the future potential users of the software. The primary supporter participated to the kick-off meeting of the project and a meeting with the project coordinator was the occasion to present the objectives of the software to be developed as well as to collect the exact need of the primary supporter. After this meeting, a gap was identified between the general scope of the software (that was thought in the first place as a direct application of the reference document JCGM106:2012) and the operational need of the primary supporter, which can be summarised as below:

- Calculation of specific risks only
- No prior knowledge
- Only Gaussian or Student's t distribution
- Any number of measured items for the same calibration operation (example of a multimeter).

The consortium thought that such need was representative of the need of similar calibration and testing laboratories. As a result, it was decided to add in the software specifications a functionality allowing the user to perform such calculations in order to maximize the probability of uptake of the software. The implementation of this simplified framework for the application of the methodology will enable Trescal to automatically produce the Microsoft Excel templates that can be directly run by CASoft in order to proceed to the calculations.

In order to increase awareness of the software in the wider scientific community, four presentations were given, each with a focus on a different practical point (bivariate case, validation procedure of the software, specific and global risk calculation). Another presentation was made in May 2020 during a online technical day organised by the College Français de Métrologie (CFM), once the software was already available online. The first downloads of the software from users outside the project team were observed.

The three publications also propose to reach different targets, with different levels of complexity. The paper published in 'Precision' was, according to the request from the editor, written without any mathematical formulas in order to reach the wider possible audience. It was accepted in April for a publication in early June, and led to first downloads from users in the United Kingdom mainly. The paper published in the proceedings of the International Metrology Congress was targeting the scientific community interested in the progress in metrology. Many attendees are affected by the revision of standard ISO 17025 in 2017, which requires to explicit and use the decision rule in conformity assessment. Finally, a submission to NCSLI magazine in May 2020 already received a positive opinion from the reviewers and should be published after some minor modifications. It allows to reach an audience outside Europe.

The main impact action is to make available the software. This was done in April 2020. CASoft software is now available at the following web link : <https://www.lne.fr/en/software/CASoft>. A total of 19 downloads was observed until June 15<sup>th</sup>.

Another impact action was to initiate a survey targeting first users of the software. To this extent, two institutes



were contacted: UKAS, the UK national accreditation body, which represents the calibration and testing laboratories and INRIM, the Italian National Metrology Institute. Both recognised the interest of the software for the community, the possibility to use it to compute the risks of an incorrect decision or to validate the calculations made using another tool. They also contributed to the improvement of the software tool by mentioning some graphical bugs that will be corrected in the next couple of weeks after the end of the project.

The partners reviewed guidance documents under development by UKAS and technical discussions concerning guidance documents were published by organisations such as ASME.

In order to facilitate the use of the software, template files are provided to the end user. Some template files were made available using Zenodo website. They are accessible thanks to a dedicated webpage available at <https://zenodo.org/communities/casoftexamples/?page=1&size=20>. They refer to examples taken from JCGM106:2012 and that can be considered as reference data. When using such template with CASoft, the user will be able to validate the use of the software.

Finally, CASoft will have a future impact in project 18NET05 MATHMET. In this network project, one objective is to develop a Quality Management System (QMS) for data and software. CASoft is proposed in this project as a metrology use case to be tested against the QMS. This action will ensure to get confidence in the results produced by the software. As the project involves many other NMIs, it will also participate to the dissemination of the methodology, and increase the total number of downloads.

## List of Publications

[1] A.Allard, N.Fischer, I.Smith, P.Harris and L.Pendril, Risk calculations for conformity assessment in practice, 19th International Congress of Metrology (CIM2019), 2019, available online: <http://dx.doi.org/10.1051/metrology/201916001>

Project start date and duration:		01 June 2018, 24 months
Coordinator: Alexandre Allard, LNE,		Tel: +33 0 1 30 69 13 59 E-mail: alexandre.allard@lne.fr
Project website address: <a href="http://mathmet.org/projects/page-2/">http://mathmet.org/projects/page-2/</a>		
Primary Supporter: Francis Richard, David Vasty, Trescal		
Internal Funded Partners:	External Funded Partners:	Unfunded Partners:
1. LNE, France		
2. NPL, United Kingdom		
3. RISE, Sweden		