

Tools for Continuous Safety Monitoring

Reinhard Menzel, Wietse Post (JRC), Simone Rozzi, Luca Save (Deep Blue)



This study develops and implements tools in support of continuous safety monitoring. Requirements for a 'continuous' safety performance analysis tool are developed. A user interface for the analysis tool is designed, developed, implemented and evaluated. A tool to generate occurrence test data on a large scale is developed and applied. A User Manual is developed as guidance for the use of the analysis tool by interested parties. A usability evaluation and assessment is performed, and the recommendations are used to further improve the tool for continuous safety monitoring.

Coordinator	L.J.P. Speijker (NLR)
Work Package Manager	N. Aghdassi (Avanssa)

Grant Agreement No.	314299
Document Identification	D2.4
Status	Approved
Version	1.1
Date of Issue	25-11-2014
Classification	Restricted

Ref: ASCOS_WP2_JRC_D2.4

Page: 1

Issue: 1.1

Classification: Restricted

This page is intentionally left blank

Ref: ASCOS_WP2_JRC_D2.4
Issue: 1.1

Page: 1
Classification: Restricted

Document Change Log

Version	Author(s)	Date	Affected Sections	Description of Change
1.0	Reinhard Menzel	28/08/2014	All	Version for approval by PMT
1.1	L.J.P. Speijker	25/11/2014	Executive summary, Introduction, Conclusions and recommendations	Update by ASCOS coordinator

Review and Approval of the Document

Organisation Responsible for Review	Name of person reviewing the document	Date
NLR	G. van Es	29-08-2014
CAAi	S. Long, T. Longhurst	30-08-2014
Avanssa	N. Aghdassi	27-08-2014
Institute of Aviation	A. Iwaniuk, B. Dziugiel	28-08-2014
Organisation Responsible for Approval	Name of person approving the document	Date
Avanssa	N. Aghdassi	03-09-2014
NLR	L.J.P. Speijker	25-11-2014

Document Distribution

Organisation	Names
European Commission	M. Kyriakopoulos
NLR	L. Speijker, A. Rutten, M.A. Piers, U. Dees, P. van der Geest, A. Roelen, J.J. Scholte, J.G. Verstraeten, A.D. Balk, E. van de Sluis
Thales Air Systems GmbH	G. Schichtel, J.-M. Kraus
Thales Air Systems SA	B. Pauly
Airbus Defence and Space APSYS	S. Bravo Muñoz, J.P. Heckmann, M. Feuvrier
Civil Aviation Authority UK	S. Long, A. Eaton, T. Longhurst
ISDEFE	M. Martin Sanchez, I. Etxebarria, M. Sánchez
CertiFlyer	G. Temme, M. Heiligers
Avanssa	N. Aghdassi
Ebeni	A. Simpson, J. Denness, S. Bull
Deep Blue	L. Save
JRC	W. Post, R. Menzel
JPM	J. P. Magny
TU Delft	R. Curran, H. Udluft, P.C. Roling
Institute of Aviation	K. Piwek, A. Iwaniuk
CAO	P. Michalak, R. Zielinski
EASA	K. Engelstad
FAA	J. Lapointe, T. Tessitore
SESAR JU	P. Mana
Eurocontrol	E. Perrin
CAA Netherlands	R. van de Boom
JARUS	R. van de Leijgraaf
SRC	J. Wilbrink, J. Nollet
ESASI	K. Conradi
Rockwell Collins	O. Bleeker, B. Bidden
Dassault Aviation	B. Stoufflet, C. Champagne
ESA	T. Sgobba, M. Trujillo
EUROCAE	A. n'Diaye
TUV NORD Cert GmbH	H. Schorcht
FAST	R. den Hertog

Acronyms

Acronym	Definition
ADREP	ICAO Accident Incident Reporting System
AMC	General Acceptable Means of Compliance
ASCOS	<u>Aviation Safety and Certification of new Operations and Systems</u>
ATCSM	ASCOS Tool for Continuous Safety Monitoring
AVG	Average
AWB	Aggregate WorkBench
CFIT	Controlled Flight Into Terrain
EASA	European Aviation Safety Agency
EC	European Commission
ECCAIRS	European Coordination centre for Accident and Incident Reporting Systems
ECF	ECCAIRS Common Framework
ECR	European Common Repository
EU	European Union
GPWS	Ground Proximity Warning System
ICAO	International Civil Aviation Organisation
MTOM	Maximum certificated Take-off Mass
RIMCAS	Runway Incursion and Collision Avoidance System
SPI	Safety Performance Indicator
TCAS	Traffic Collision Avoidance System

Ref: ASCOS_WP2_JRC_D2.4

Page: 4

Issue: 1.1

Classification: Restricted

This page is intentionally left blank

Executive Summary

The objective of ASCOS Work Package 2.4 is to design, develop and implement tools in support of continuous safety monitoring. This study builds on the results of the following ASCOS Work Packages:

- WP2.1 Framework safety performance indicators
- WP2.2 Baseline risk picture for the total aviation system
- WP2.3 Process for continuous safety monitoring

Based on the analysis of the reports of these ASCOS Work Packages, requirements for an analysis tool are developed.

Development of the tool is accomplished starting with a pilot project to test the approach to SPI development and to evaluate the user interface. The development of the tool itself makes use of the experience gained in the pilot project.

Experience in the use of the tool shows it to be quite stable and delivering the requested result.

This report describes the tool.

In addition to the ASCOS analysis tool, a tool to generate occurrence test data on a large scale is developed by the JRC. Use of generated test data avoids issues related to confidentiality of the reported occurrence data and the sensitivity of published results based on such “life” occurrence data.

The development of the ASCOS tool is complemented by the development of a user manual.

Ref: ASCOS_WP2_JRC_D2.4

Page: 6

Issue: 1.1

Classification: Restricted

This page is intentionally left blank

Table of Contents

Document Change Log	1
Review and Approval of the Document	1
Document Distribution	2
Acronyms	3
Executive Summary	5
List of Figures	10
1 Introduction	13
1.1 Background	13
1.2 Objectives	14
1.3 Approach	14
1.4 Structure of the document	15
2 Environment of the tool for continuous monitoring	16
2.1 Legislative environment	16
2.2 Data environment	17
2.3 Software environment	18
3 ASCOS Tool for Continuous Safety Monitoring (ATCSM)	19
3.1 Description	19
3.1.1 General	19
3.1.2 Simple timeline SPI	19
3.1.3 Set comparison SPI – concurrent display of two sets of rates	20
3.1.4 Historic evaluation SPI	22
3.2 SPI visualisation	24
3.2.1 The SPI project window	24
3.3 Management of the ATCSM	27
3.3.1 The “FILE” menu	27
3.3.2 The “PROJECT” menu	28
3.3.3 The “SPIs” menu	33
4 ATCSM Test Data generation	39
4.1 Background	39

Ref:	ASCOS_WP2_JRC_D2.4	Page:	8
Issue:	1.1	Classification:	Restricted

4.2	Scenarios	40
4.2.1	Scenario 1 – Runway incursions	40
4.2.2	Scenario 2 – monitoring occurrences related to auto-flight systems	41
4.2.3	Scenario 3 – monitoring of the reaction of the crew to EGPWS warnings.	41
4.2.4	Scenario 4: Investigating the safety impact of TCAS II version 7.1	42
4.2.5	Implementation of test data generation	43
5	Usability evaluation and assessment	44
5.1	Objective	44
5.2	Methodology	44
5.3	Usability Findings	45
5.3.1	# 1: SPI sub menus disappearing from user view when shrinking the ATCSM Project Window	46
5.3.2	# 2: SPI recalculation options not immediately visible to the user	48
5.3.3	# 3: Lack of clarity between the “File” sub menu, the “Project” menu and the entities they relate to	49
5.3.4	#4: Opening requires the user to open the ATCSM first	50
5.3.5	#5: The application name in the Windows “start menu” differs from the application name appearing on the top of an ATCSM Project window.	51
5.3.6	#6: Library name on the top bar of the main software window not clearly distinguishable	51
5.3.7	#7: Repetitive selection of query text line required in the SPI query builder	52
5.3.8	#8: Ambiguous symbology used for the editing function	53
5.3.9	#9: Difficult to retrieve occurrence data for non-expert users.	53
5.4	Independent usability assessment	55
5.4.1	Comments: Section 2.2.1 “The SPI project window”, subsection “The SPI header”:	55
5.4.2	ATCSM – Control menus	56
5.4.3	Comments: Section 2.3.3 “The SPIs menu”, subsection “The SPI edit window”:	56
5.4.4	Comments: Section 2.3.3 “The SPIs menu”, subsection “The SPI exports”:	56
5.4.5	Conclusions from the usability assessment	56
5.5	Conclusion of the Usability Evaluation	56
6	Conclusions and recommendations	57
6.1	Conclusions	57
6.2	Recommendations	57

Ref: ASCOS_WP2_JRC_D2.4

Page: 9

Issue: 1.1

Classification: Restricted

References 59

Appendix A 60

List of Figures

Figure 1- Example of an SPI based on a single timeline	19
Figure 2 Example of an SPI showing development of two data sets in a merged graph	20
Figure 3 Example of an SPI showing development of two data sets in separated graphs	21
Figure 4 - Image of figure 2 from report of ASCOS WP 2.3	22
Figure 5 - SPI graph showing initial and evaluation area	23
Figure 6 SPI project window	24
Figure 7 SPI summary graph image	25
Figure 8 Individual SPI graph image	25
Figure 9 SPI header	26
Figure 10 SPI criteria display window	26
Figure 11 SPI with legend, averages and trend lines	27
Figure 12 File menu	28
Figure 13 ECCAIRS login window	28
Figure 14 Project menu	28
Figure 15 Base filter definition window	29
Figure 16 ECCAIRS query builder window	29
Figure 17 Exposure data management window	30
Figure 18 Example of an exposure data structure	30
Figure 19 Category management window	31
Figure 20 SPI management window	31
Figure 21 Import/Export sub menu	32
Figure 22 Query import warning window	32
Figure 23 SPI tree after query importation	33
Figure 24 SPIs menu	33
Figure 25 SPI default setting window	34
Figure 26 SPI edit window	35
Figure 27 Example of a query	36
Figure 28 PDF image of an exported SPI	37
Figure 29 Export into Excel - workbook structure	37
Figure 30 Export into Excel - SPI data	37
Figure 31 Export into Excel - SPI graph	38
Figure 32 Recalculate sub menu	38
Figure 33: ATCSM Project View, full screen view.	46
Figure 34: The “Options”, “Recalculate”, and “Export” sub menu disappear after shrinking the ATCSM Project View to a centre-on-screen view.	47
Figure 35. ...also the “Change Style”, and the “Hide/Show” sub menu disappear when shrinking the ATCSM Project View to a half-screen view.	47
Figure 36. The message in red is displayed to the user after modifying/creating a SPI.	48

Ref: ASCOS_WP2_JRC_D2.4
Issue: 1.1

Page: 11
Classification: Restricted

Figure 37. The SPI windows does not provide the option to recalculate the graph (circle 1). At the same time, the recalculate function (circle 2) falls out of user’s immediate focus of attention as it is located outside of the immediate context the user is working on (the SPI window). _____ 49

Figure 38. The “File” menu _____ 50

Figure 39. The “Project” menu _____ 50

Figure 40. The SPI menu _____ 50

Figure 41. The program name displayed on the top of the main ATCSM view differs from the name appearing in the Windows Start menu. _____ 51

Figure 42. Magnified view of the text appearing on the bar on the top of the ATCSM Project window. _____ 52

Figure 43. SPI Query builder _____ 52

Figure 44. The SPI edit window _____ 53

Ref: ASCOS_WP2_JRC_D2.4

Page: 12

Issue: 1.1

Classification: Restricted

This page is intentionally left blank

1 Introduction

1.1 Background

Historically, aviation safety monitoring and safety oversight is performed on basis of a cycle of (multi)-yearly audits. It is recognized that there is a need for monitoring on a more frequent basis, i.e. applying a Continuous Monitoring Approach (CMA) as solution to collecting and analysing more regular information regarding the level of safety. This will allow stakeholders in international civil aviation to base their decisions on the latest information available. The CMA principles are based on a system to monitor safety continuously with the ability to monitor safety performance at all times. Successful implementation will depend on appropriate support tools, procedures and guidance material ensuring synergy between all safety information inputs.

A proper CMA implementation requires the development of specific safety performance indicators for states, airlines, airports, Air Navigation Service Providers as well as for aviation products designed and manufactured. Because there is a necessity to handle large amounts of safety data and exposure data, it will be necessary to use software tools and databases that are designed according to a commonly used taxonomy, such as used in the ICAO Aviation Data Reporting Program (ADREP), the European Central Repository (ECR), and/or the European Coordination Centre for Accident and Incident Reporting Systems (ECCAIRS).

In view of this, in the context of ASCOS WP “Continuous Safety Monitoring”, the Work Package 2.4 is aimed at developing “Tools for Continuous Safety Monitoring” (ATCSM). The tools should enable use of safety data extracted from an ECCAIRS compatible repository (ECR, ADREP or national occurrence databases) complemented with (historical) exposure data as available from existing sources where applicable completed with numbers based on expert judgement. Ultimately the tools will provide an overview (in the form of tables, charts, visual indicators) of the evolution of the safety performance. These tools can be used to also monitor these (and other) safety performance indicators in the future. The ASCOS Tool for Continuous Safety Monitoring (ATCSM) should permit the construction of Safety Performance Indicators as described in ASCOS WP 2.1 “Framework Safety Performance Indicators” (Appendix A “List of Safety Performance Indicators”).

Safety Performance Indicators not based on occurrence reporting are not planned to be covered.

It is expected that some of the proposed indicators may not be constructed due to missing matching entries in the ECCAIRS taxonomy. Consequently, proposals would then have to be made to the ECCAIRS taxonomy working group to enhance the ECCAIRS taxonomy with a view to facilitate its use in the context of ASCOS. While, at the time of writing this document these proposals have not yet been implemented, it is assumed that they will be implemented in due course and so that occurrences reports can be analysed based on the proposed event types.

For the development, it is assumed that the occurrences would become accessible in an ECCAIRS 5 type data base so that standard ECCAIRS 5 software can be used to retrieve and analyse the data. It is also assumed that the user of the tool would be familiar with the ECCAIRS taxonomy and its use in aviation occurrence reporting.

No assumptions are made in respect to the exposure data other than its availability in a format which can be used to provide such data to the ATCSM. The provision/formatting of appropriate exposure data for the proposed safety performance indicators will be the responsibility of the user and the development of such data is outside the scope of ASCOS WP 2.4 “Tools for continuous safety monitoring”.

1.2 Objectives

The main aim is to develop and implement tools in support of continuous safety monitoring. This includes:

- To develop the requirements for a ‘continuous’ safety performance analysis tool;
- To test a proposed approach to Safety Performance Indicator (SPI) development;
- To design, develop, implement and evaluate an user interface for the analysis tool;
- To develop a tool to generate occurrence test data on a large scale, in order to avoid issues related to confidentiality of occurrence data and sensitivity of results based on such “life” occurrence data.
- To develop a User Manual as guidance for the use of the analysis tool by interested parties.
- To perform a usability evaluation and assessment, and use recommendations to improve the tool.

1.3 Approach

The development of the tool is carried out in five phases.

In phase 1, the requirements for the tool are analysed based on the SPIs proposed in ASCOS Work Package 2.1. The majority of these SPIs are timelines of occurrences rates aimed at showing the development of the indicators, the rate of occurrences, over time. It should be noted some of the Indicators proposed by ASCOS WP1 may not be constructed based on occurrence data. They include those related to the number of meetings, the assessment of infrastructural changes, the number of organisations that have fully implemented a Safety management Systems, etc. Such indicators are not taken into account in the context of ASCOS WP2.4.

In monitoring changes in the aviation system related to the introduction of ASCOS approaches, it would be important to be able to compare the effect of ASCOS approaches with parts of the aviation system not affected by the ASCOS approach. For example, it could be helpful to be able to compare the safety performance of a new aircraft type certified following the ASCOS method with the safety performance of similar non-ASCOS certified aircraft types. The capability to develop SPIs for this purpose becomes one of the design requirements.

In ASCOS WP 2.3 “Process for Continuous Safety Monitoring”, it is proposed to monitor SPIs by comparing current developments with historical data. The capability to carry out such type of analysis becomes another design requirement.

In phase 2, a pilot project is developed to determine the feasibility of the approach to constructing safety indicators and to evaluate how the user interface could be enhanced to simplify the use of the tool. SPI’s

Ref: ASCOS_WP2_JRC_D2.4

Page: 15

Issue: 1.1

Classification: Restricted

proposed in WP 2.1 “Framework for Safety Performance Indicators” are developed and the ease of using the tool as well as the quality of the SPI graphs is evaluated.

In phase 3, a revised tool is developed based on the experience in the use of the tools developed in the pilot project. In addition, a user manual is developed. The tool is implemented and tested in the JRC before it being handed over to Deep Blue for evaluation of its usability.

In phase 4, the ASCOS partner “Deep Blue” carries out an evaluation of the usability of the tool. The work is described in Chapter 4. Usability issues are identified.

In addition, the NLR tests the tool and provides recommendations for improvement.

In phase 5, the JRC reviews the comments and suggestions and identifies those that could be addressed on short notice. The tool is revised. The user manual is updated accordingly. The manual is available at request.

The tool is tested using random generated test data. The JRC develops a tool to facilitate the test data generation. The use of random generated test data avoided issues related to access rights to occurrence data, privacy concerns, etc. In addition, the testing of the ATCSM is not impacted by occurrence data quality issues.

Note that SPI graphs shown in this report are developed based on test data and do not reflect reality.

1.4 Structure of the document

Following this Introduction, Section 2 describes the environment (legislative, data, and software) for the development of the analysis tool. Section 3 describes the ASCOS Tool for Continuous Safety Monitoring (ATCSM). Section 4 deals with the generation of (simulated) test data. Section 5 provides the results of the usability evaluation and assessment, and includes initial recommendations for improvement of the tool. Most of these recommendations are implemented. Conclusions and recommendations are provided in Section 6.

2 Environment of the tool for continuous monitoring

2.1 Legislative environment

Much legislation is at hand governing the reporting of occurrence data. On the top, we find the international requirements for States to set up mandatory occurrence reporting system as described in Chapter 5 of Annex 19 – Safety Management - of the International Civil Aviation Organisation ICAO.¹ In addition to the establishment of mandatory occurrence reporting systems, the Annex compels States to also establish a voluntary incident reporting system “to facilitate collection of information on actual and potential deficiencies that may not be captured by the mandatory incident reporting system”.²

At European level, the ICAO requirements for the establishment of mandatory occurrence reporting systems at the level of states were transcribed into Directive 2003/42/EC of the European Parliament and of the Council of 13 June 2003 on occurrence reporting in civil aviation. This Directive has been complemented by two regulations - Commission Regulation (EC) No 1321/2007 of 12 November 2007 laying down implementing rules for the integration into a central repository of information on civil aviation occurrences exchanged in accordance with Directive 2003/42/EC of the European Parliament and of the Council – and Commission Regulation (EC) No 1330/2007 of 24 September 2007 laying down implementing rules for the dissemination to interested parties of information on civil aviation occurrences referred to in Article 7(2) of Directive 2003/42/EC of the European Parliament and of the Council. In addition, REGULATION (EU) No 996/2010 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, provided additional clarification on access to data in the European Common Repository of occurrence reports. In April 2014, Regulation (EU) No 376/2014 of the European Parliament and of the Council of 3 April 2014 on the reporting, analysis and follow-up of occurrences in civil aviation has been published. When it comes into effect in 2015, it will supersede Directive 42/2003 and the two related regulations. Through it, existing requirements have been strengthened and it is expected that its application will lead to a more harmonized manner in which occurrences will be reported in the EU.

Mandatory occurrence reporting within the industry, e.g. from an operator to a manufacturer etc., is governed by REGULATION (EC) No 216/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency and related guidance material in AMC 20-8.³

In summary, there exists a comprehensive legislative framework in the EU in which occurrences are to be collected, analysed and stored. Based on this framework, the occurrences required to permit the construction of the Safety Performance Indicators are available in principle.

¹ ICAO Annex 19, Chapter 5, Standard 5.1.1

² ICAO Annex 19, Chapter 5, Standard 5.1.2

³ General Acceptable Means of Compliance for Airworthiness of Products, Parts and Appliances AMC-20 as contained in EASA ED Decision 2003/12/RM as amended.

2.2 Data environment

Based on the abovementioned legislation, a Common European Repository of occurrences had been established which, by July 2014, contained more than 840 000 reports. All States of the EU plus the associated States – Iceland, Norway and Switzerland report their occurrences regularly.

While thus the mechanism for reporting has been established, issues remain in respect to the quality of the Occurrence data. Review has shown that much of the information essential for analysis is missing. Efforts are under way to improve the quality of the data – notably through aspects of regulation 376/2014⁴ which have made it mandatory to provide essential data. Other efforts aim at providing guidance to States on how to complete the reports, providing feedback related to the completeness of reporting, the development of guidance material, improved user interfaces and developing and deploying data quality verification tools⁵.

The proposed SPI's are rates or ratios based on the frequency of the observed events in the occurrence data pro-rated by the use, the exposure, of the product or part of the aviation system in question. For the use of the ATCSM, usage data of the aviation systems is thus equally important as the occurrence data.

There is no equivalent common European storage for the usage / exposure data as there is for the occurrence reports nor is there a related legislative requirement to establish one. Some usage / exposure data is collected at the level of States, reported to EUROSTAT and made available for use. By June 2014, tests have shown that while EUROSTAT appears to provide the infrastructure to disseminate data e.g. on the usage of aircraft, no actual data could be found for recent years.

In respect to the data provided by EUROSTAT, it is noted that there is some time lag until data has been provided in full by all States. This time lag negates the use of this set of data when trying to monitor on-going activities.

EUROCONTROL collects data on aircraft movements and makes it available based on the analysis of the flight plans filed and the flights executed. In respect to EUROCONTROL, the exposure data is complete for the scope of aviation covered, it is correct and timely. However, EUROCONTROL does not cover most of the general aviation activities – there is no data for flights for which no flight plan was filed. The user of the data must be aware that the EUROCONTROL exposure data covers all IFR flights and only those VFR (Visual Flight Rules) flights which are chargeable. This condition should also be applied to the occurrence data when calculating rates using EUROCONTROL data. Note that the data are not limited to European operators only and covers all flight crossing or entering the states covered by STATFOR.

⁴ Regulation (EU) No 376/2014 of the European Parliament and of the Council of 3 April 2014 on the reporting, analysis and follow-up of occurrences in civil aviation.

⁵ Data Quality Rules for ECCAIRS 5: Occurrence Categories update 4 March 2013, available on the ECCAIRS portal – Support – Usage examples

Ref: ASCOS_WP2_JRC_D2.4
Issue: 1.1

Page: 18
Classification: Restricted

Access to the EUROCONTROL data via their interactive dashboard proved to be cumbersome and some desired data on traffic by aircraft type could not be extracted.

Other usage data is collected within the industry. It covers, among other aspects, information on the usage of individual aircraft. However, not all stakeholder report their data and estimates are used to complete the picture. While such data is in principle very useful to develop occurrence rates for specific aircraft types, it is costly and, because of the reporting issues mentioned above, incomplete.

Irrespective of the data sources used, monitoring the impact of ASCOS on occurrence rates will be a challenge as presently neither occurrence nor exposure data is identified as being related to an ASCOS activity.

2.3 Software environment

The ECCAIRS system has been developed to facilitate the reporting of occurrence data in a common format by Member States to a central European data base, the European Central Repository (ECR). The development of the ECCAIRS system goes back to the 1990th. The present system version is ECCAIRS 5. ECCAIRS comprises of a set of tools to collect, store, integrate, disseminate, verify and analyse occurrence data.

In addition to tools related to the handling of the occurrence data, tools have been developed to maintain the ECCAIRS taxonomy, the ECCAIRS user interface, develop data quality rules, websites etc. In summary, the ECCAIRS system comprises today of a large number of tools specifically developed to facilitate the maintenance of the European Commission's occurrence reporting scheme.

In respect to analysis, ECCAIRS had offered since 2005 a tool to extract information from ECCAIRS data bases for use in Excel spreadsheets. This tool, called the Aggregate Workbench (AWB), is widely used in the community⁶⁷. However, the use of the AWB requires some experience in the handling of Excel as well as knowledge of structure of the ECCAIRS taxonomy. Certain aspects in the reported occurrence data - e.g. the varying use of either local dates or UTC dates or both – complicate the analysis when using AWB. Consequently only those organisations, where related expertise is at hand, can make good use of it. The European Aviation Safety Agency (EASA) provides related training.⁸ With the ASCOS tool specifically aimed at developing time series of occurrence rates, the AWB with its wider scope and different focus will remain a major tool for the analysis of ECCAIRS data.

⁶ See: 2005 ECCAIRS Steering Committee, presentation of the JRC on the AWB Add-In, access via:
<http://eccairsportal.jrc.ec.europa.eu/index.php/hidden-FMS/204/0/?&rootname=scm2005-2presentations>

2006 ECCAIRS Steering Committee, presentation by EASA on the use of the AWB, access via :
<http://eccairsportal.jrc.ec.europa.eu/index.php/hidden-FMS/204/0/?&rootname=scm2006presentations>

2009 ECCAIRS Steering Committee, Workshop on AWB and Dexter, access via:
<http://eccairsportal.jrc.ec.europa.eu/index.php/hidden-FMS/204/0/?&rootname=scm2009presentations>

⁷ See presentation on the use of the AWB for national statistics in Norway:

<http://www.luftfartstilsynet.no/incoming/article9515.ece/BINARY/Workshop+3+Rapportering+av+hendelser.pdf>

⁸ [http://easa.europa.eu/system/files/dfu/TT%20Catalogue_2014_v2%20\(July%202014\).pdf](http://easa.europa.eu/system/files/dfu/TT%20Catalogue_2014_v2%20(July%202014).pdf)

3 ASCOS Tool for Continuous Safety Monitoring (ATCSM)

3.1 Description

3.1.1 General

The ATCSM is a program which interacts with an ECCAIRS 5 occurrence data base and user provided exposure data to develop rates of occurrences, the Safety Performance Indicators (SPI). The SPI is presented in graphical form to the user.

The tool is equipped with menus that facilitate the development and maintenance of libraries of Safety Performance Indicators. Within a given library, the SPIs can be grouped in categories. One level of categorisation is available.

Each SPI in the library represents the combination the results of a query to an ECCAIRS 5 data base and matching exposure data. Exposure data are assigned individually to the SPI’s during development.

The exposure data itself is loaded into the tool by the user at the time of configuring the SPI library.

The ATCSM has been developed to permit the development of SPIs in the form of timelines of occurrence rates, to have the capability to visually compare results from two data sets in respect to certain issues as well as the capability to allow a user to visually compare historic occurrence rates with current occurrence rates.

3.1.2 Simple timeline SPI

In respect to the development of “simple” timelines, the user needs to define the appropriate query to retrieve the occurrence data from the ECCAIRS data base and assign related exposure data.

Example:

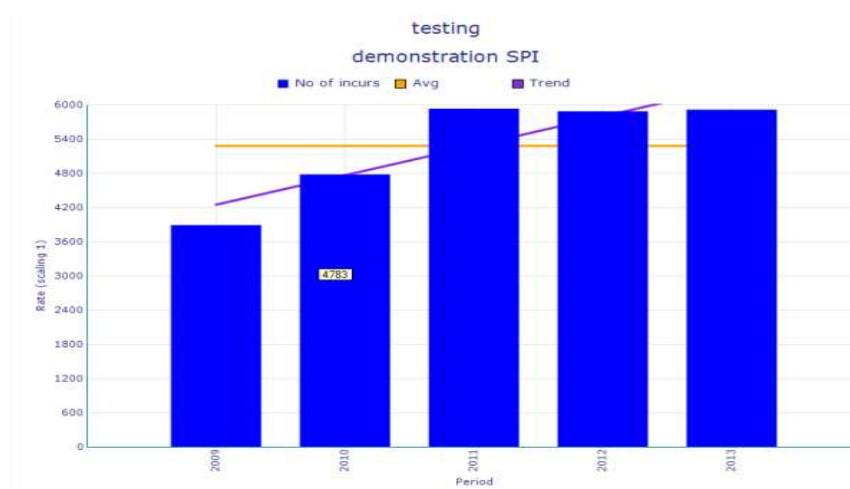


Figure 1- Example of an SPI based on a single timeline

3.1.3 Set comparison SPI – concurrent display of two sets of rates

At the level of the SPI library the user can define two “filters” to identify the two sets of occurrence rates to be displayed in the same SPI graph. One is referred to as the “Base” filter and one as the “Benchmark” filter. For example, the user could define the “Base” filter to select all occurrences in which there was a “correct” crew reaction to a GPWS warning and as the second set using the “Benchmark” filter for those occurrences in which an incorrect crew reaction had been recorded.⁹ Figure 2 shows the two sets merged into one graph, figure 3 shows the two sets in separate graphs. The graphs are based on test data, they are not based on real reporting.

The tool provides a visual indication of the development of rates. However, comparing rates without a proper statistical analysis is not recommended. First confidence intervals have to be determined for each rate to see if the sample size is large enough to calculate accurate rates. Second formal statistical tests should be used to determine if differences in the rates are significant. Trend lines, while looking nice and convincing, may be of questionable statistical validity and should not be used without further in-depth statistical review.

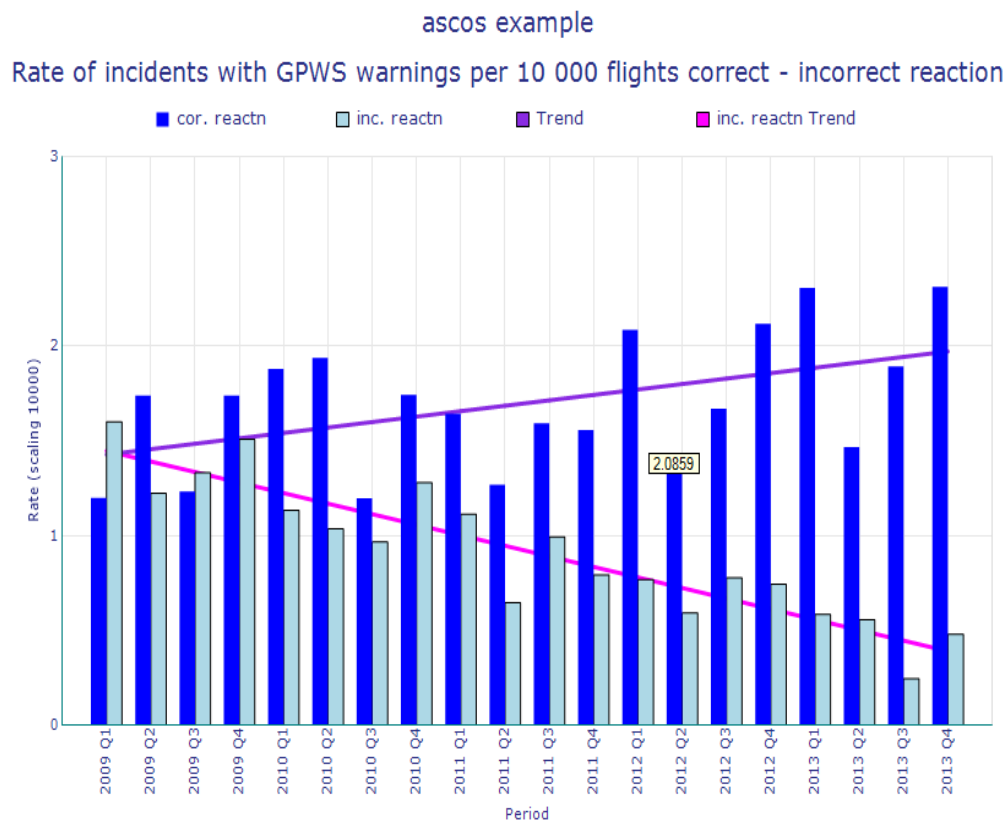
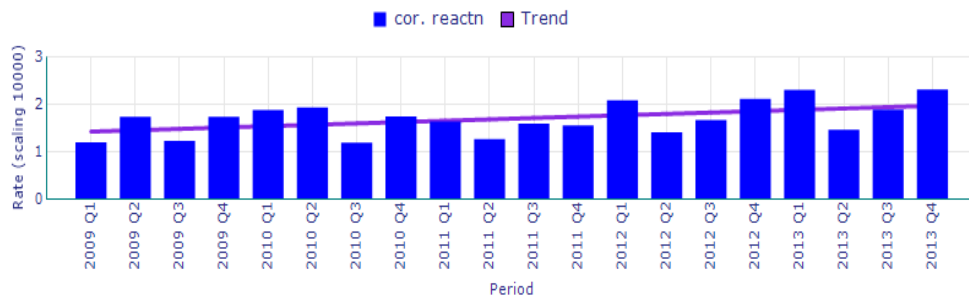


Figure 2 Example of an SPI showing development of two data sets in a merged graph

⁹ Results shown are based on occurrence data generated by the JRC to test the ATCSM

ascos example

Rate of incidents with GPWS warnings per 10 000 flights - correct crew reaction



ascos example

Rate of incidents with GPWS warnings per 10 000 flights - incorrect crew reaction

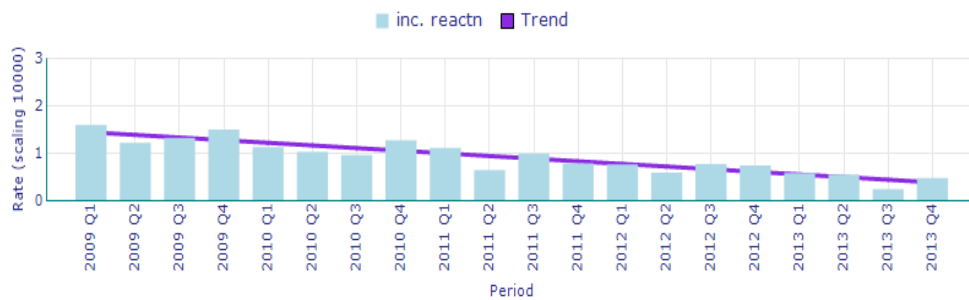


Figure 3 Example of an SPI showing development of two data sets in separated graphs

3.1.4 Historic evaluation SPI

The tool has been developed with a view to permit the evaluation of current data in relation to historic data. The requirement for such type of analysis was outlined in ASCOS Final Report on work Package WP 2.3 which shows on page 27 one way how an alert level could be defined:

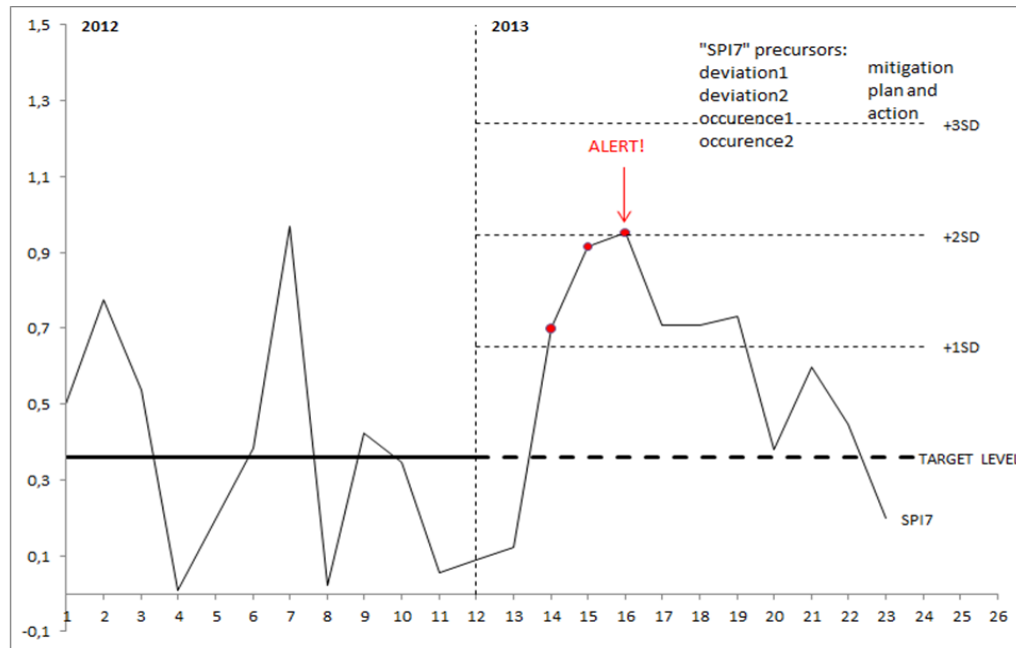


Figure 2: The safety performance monitoring, one SPI example.

Figure 4 - Image of figure 2 from report of ASCOS WP 2.3

Based on this example, the ATCSM was designed to “split” the graph pane into two areas: the left, called “initial” area and the right called “evaluation” area. The dividing line between the two areas can be moved by the user to the left and right as required.

The evaluation area is indicated with a grey background, while the background of the initial area in the SPI graph is white.

The calculations related to the average, standard deviation and trend are based on the visible initial data in the “white area” only, but the lines for averages trends etc., if selected to be shown by the user, are “extrapolated” from the “initial” into the evaluation area. Data points which fall below the average minus one standard deviation in the evaluation area are coloured in green, data points exceeding the average plus one standard deviation are coloured in red.

Below is an example showing a hypothetical number of occurrences with numbers in some month of the evaluation period exceeding the average plus standard deviation in red and one month with the number falling below average minus one standard deviation in green.

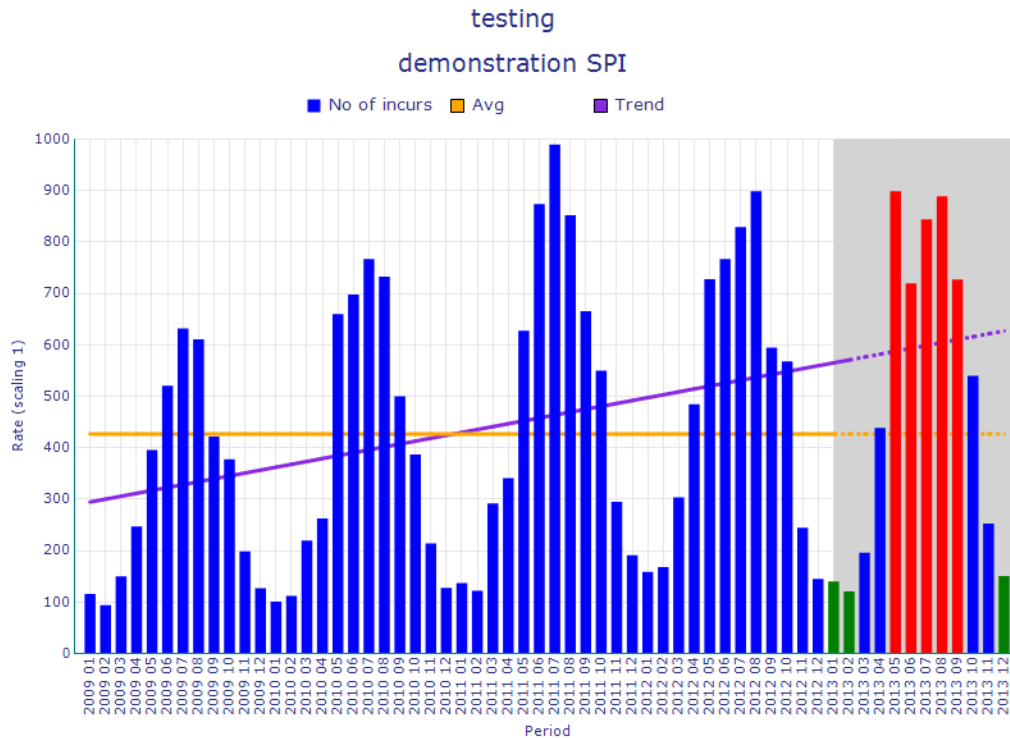


Figure 5 - SPI graph showing initial and evaluation area

3.2 SPI visualisation

3.2.1 The SPI project window¹⁰

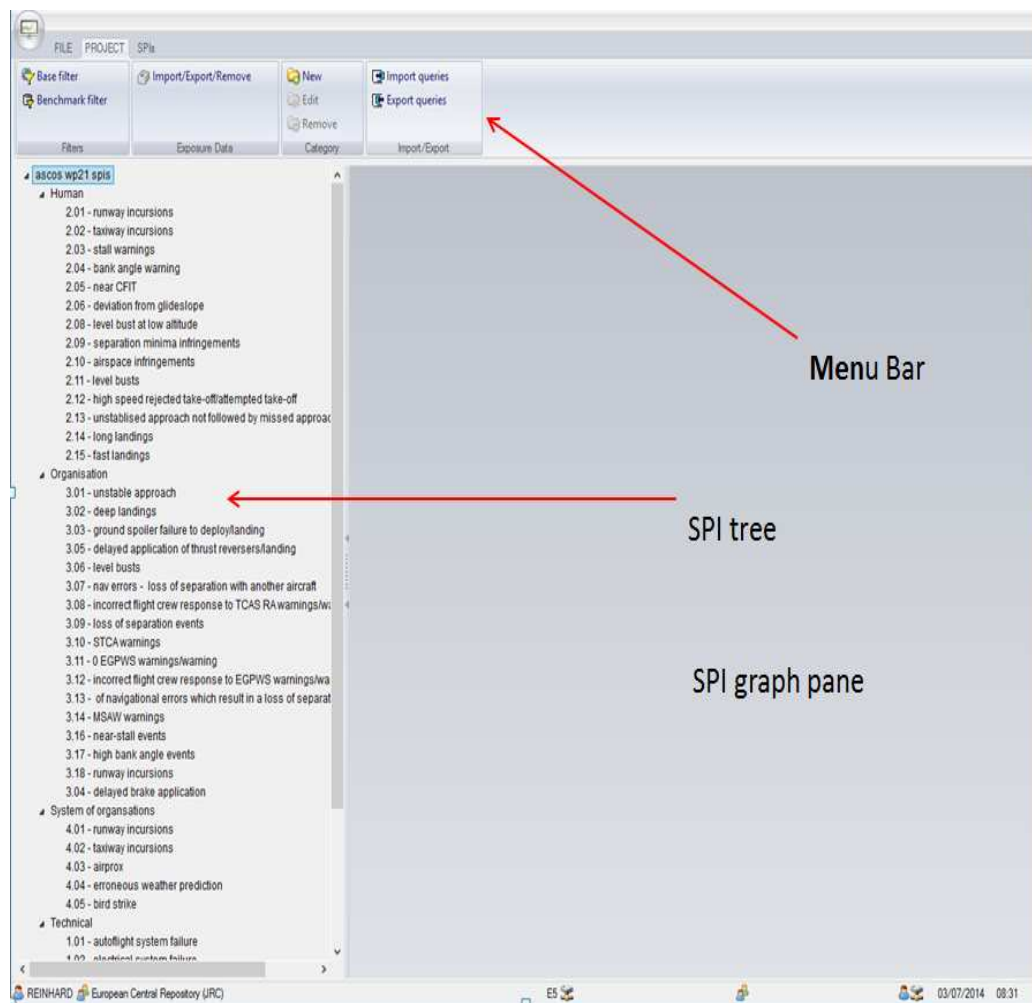


Figure 6 SPI project window

The PROJECT window (above) is divided into three main areas:

- a) The Menu ribbon: Display of the selected main menu (above “PROJECT”)
- b) The SPI tree with the hierarchy of
 - a. SPI project name
 - b. SPI category
 - c. SPI individual name
- c) The SPI graph pane which may be
 - a. Empty (no category, no SPI selected) (as above)
 - b. Showing a summary of all SPI graphs of the selected category

¹⁰ The menu structure has been revised in Phase 5 of the project. The revised approach is described in the user manual. This report refers to the original version developed in phase 3.

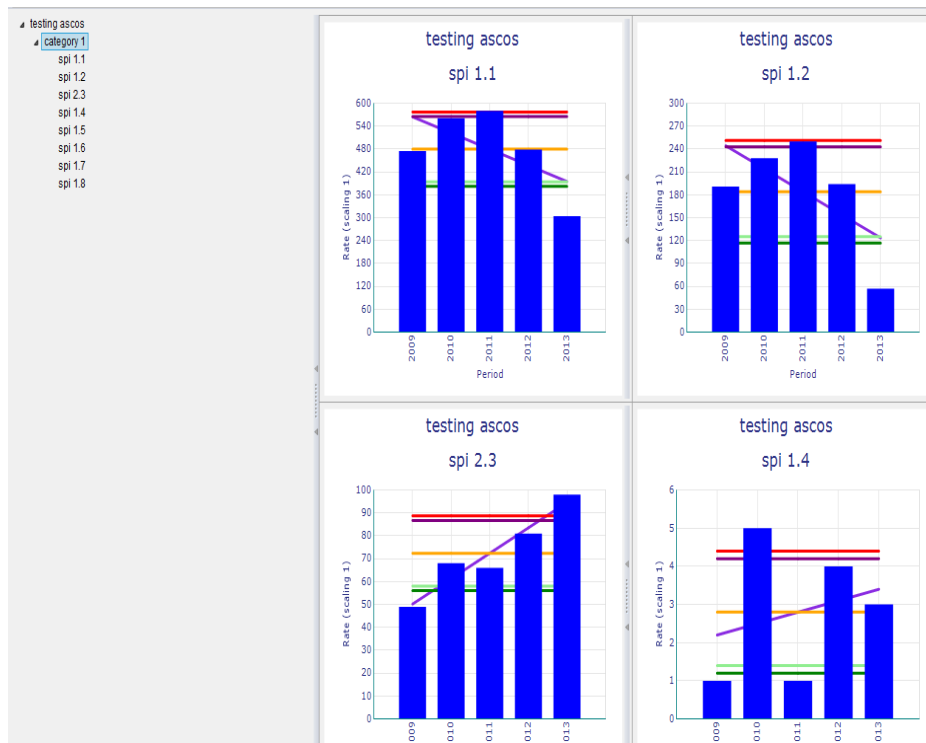


Figure 7 SPI summary graph image

c. Showing the SPI graph of the selected SPI

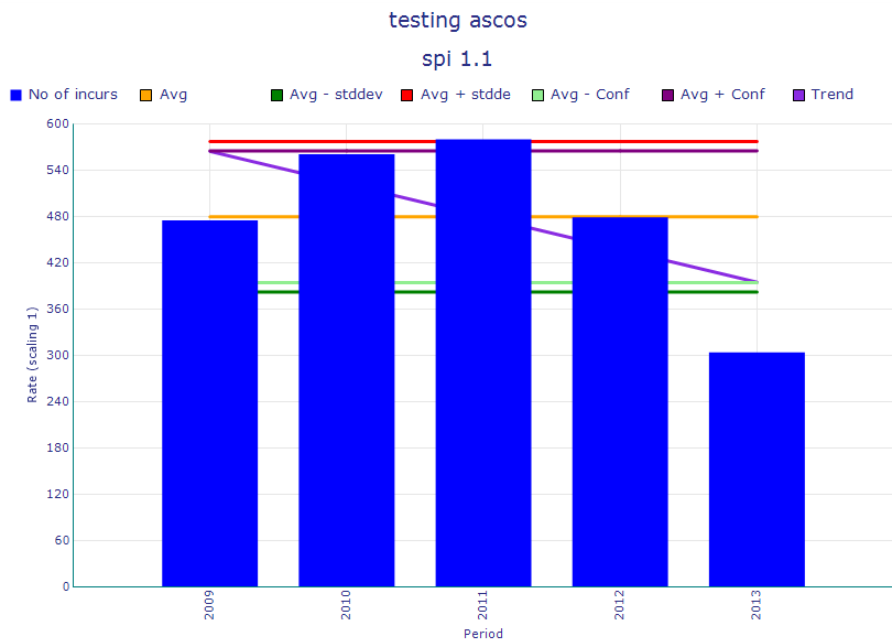


Figure 8 Individual SPI graph image

The **SPI graph** is made up of a header section (in grey) on top of the SPI graph and the SPI graph image showing the SPI graph.

SPI header:

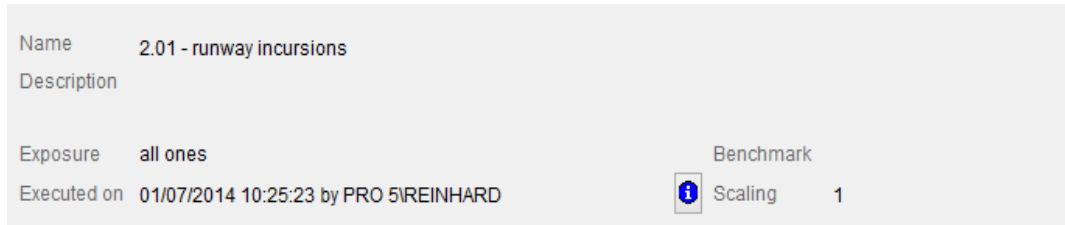



Figure 9 SPI header

The **SPI header** provides information on:

- the **SPI name** – free text;
- the **SPI Description** – free text;
- the **name of the exposure data** set used in the calculation (for the “base” and for the “benchmark”) data set;
- the **name of the user**, the name of the occurrence data base used to calculate the SPI and the time the SPI was calculated;
- the **criteria** used to extract data from the ECCAIRS occurrence data base (by pressing on the , the criteria are displayed in on the SPI graph pane, for example

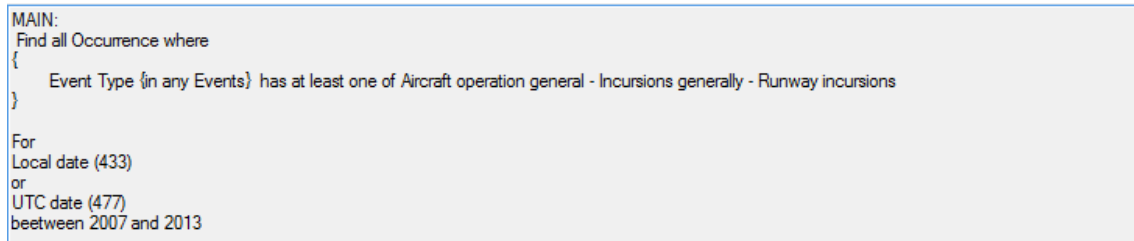


Figure 10 SPI criteria display window

SPI graph pane

The SPI graph pane can be subdivided by the user into an “initial” period and an “evaluation” period. The “initial” period is identified via a white background and the evaluation period is shown with the grey background.

In the area of the evaluation period, data points for which the value is below the average – 1 standard deviation are coloured in green while those data points for which the value is above the average + 1 standard deviation are coloured in red.

A legend may be displayed below the SPI graph title.

The lines for average, trend etc. are shown as solid lines in the initial period but are shown as broken lines in the evaluation period to indicate that they are not influenced by the data belonging to the evaluation period.

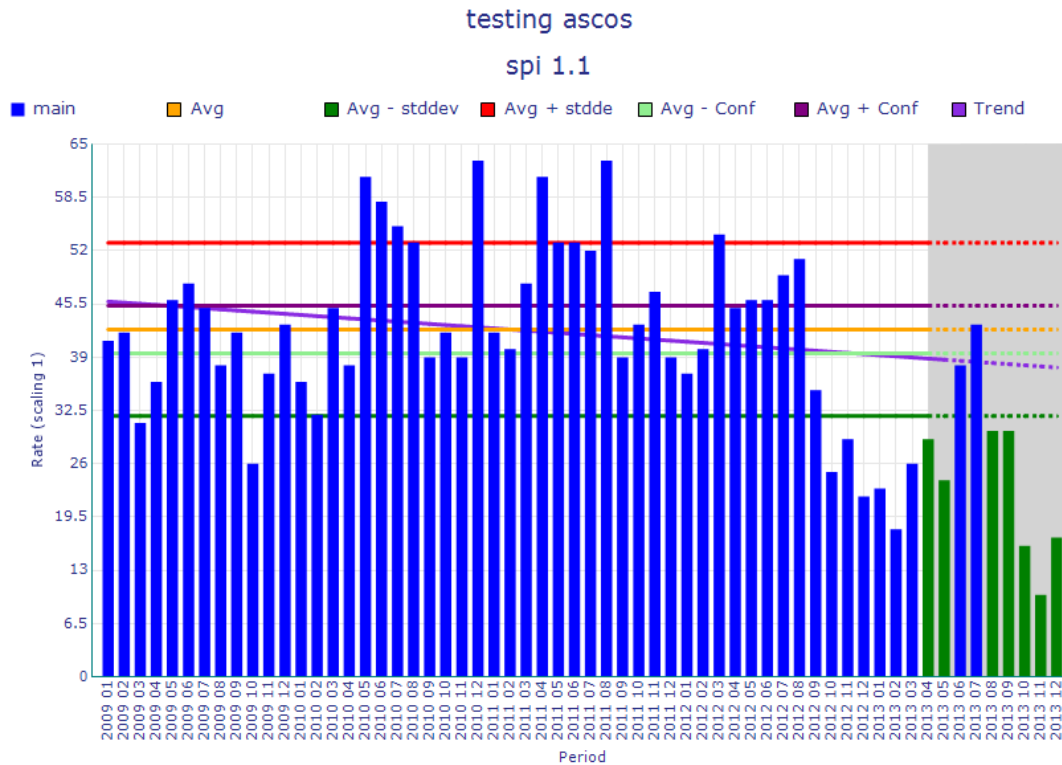


Figure 11 SPI with legend, averages and trend lines

3.3 Management of the ATCSM

The ATCSM is managed through a set of menus.¹¹ They are:

- FILE a menu to manage ATCSM project files and data base connections;
- PROJECT a menu to set global parameters for the project;
- SPIs a menu to manage individual SPIs.

3.3.1 The “FILE” menu

SPI projects are stored as “*.esi” files. They are managed though the “File” sub-menu of the “FILE” menu.

¹¹ The menu structure has been revised in Phase 5 of the project. The revised approach is described in the user manual. This report refers to the original version developed in phase 3.

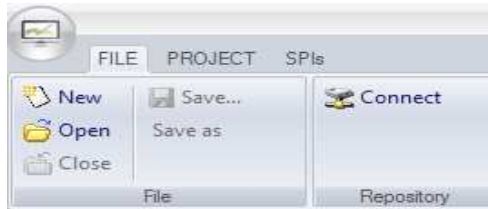


Figure 12 File menu

Before any SPI can be calculated, the tool needs to be connected to an ECCAIRS 5 type data base. To accomplish this, the ECCAIRS login dialogue is triggered when the tool is started:

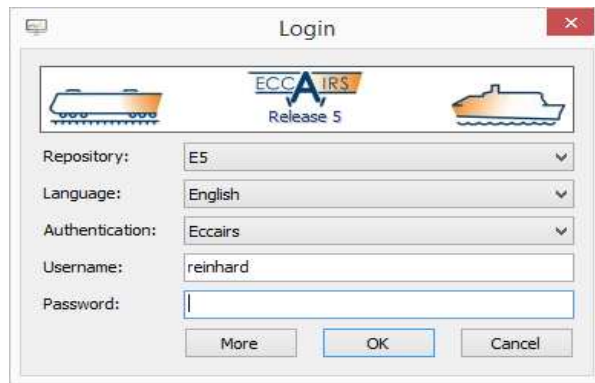


Figure 13 ECCAIRS login window

While in principle the user would need to complete the various options shown above (repository, language, ...), in practice, as seen here, only the password needs to be entered when the other settings have already been set during a previous session and are retained by the system.

Should there be a need to disconnect from the data base in use and to connect to another occurrence data base, the user clicks on the “Connect” icon shown in the “repository” sub menu of the FILE menu of the tool. This triggers the login dialogue. This sub menu is found to the right of the “File” sub menu of the “FILE” menu.

3.3.2 The “PROJECT” menu

The “PROJECT” menu serves to manage general properties of the project.

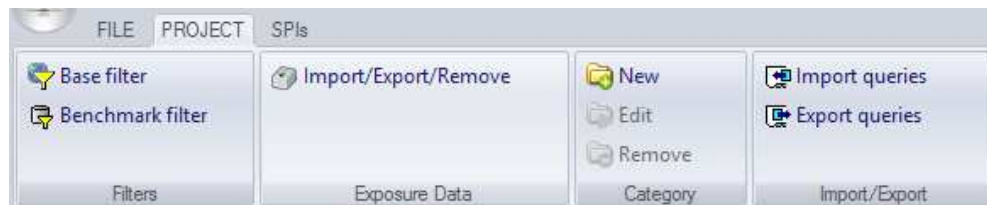


Figure 14 Project menu

They include:

- The **base filter** – defining the “main” data set to be used in the SPI’s;
- The **benchmark filter** – defining the second data set to be used for the SPI’s;
- **Import and export of exposure data;**
- **Management of SPI categories;**
- **Import and export of queries** from/to an ECCAIRS query library.

The ATCSM is designed to provide the user with the capability to compare two data series with each other. For example, the first data series could be the made up of the occurrences reported by one State, while the second one would be made up by occurrences from all other States in Europe. The user would thus be in a position to “compare” the two data sets based on various other criteria.

The “base filter” is a logical expression developed via the ECCAIRS query builder that defines the first data set.

The “Benchmark filter” serves a similar purpose, but defines the second data set of the SPI project, the one that the first data set is to be compared with.

The ECCAIRS query builder dialogue is started by pressing the “Base filter” / “Benchmark filter” in the “Filter” sub-menu of the “PROJECT” menu. The dialogue window appears as follows:

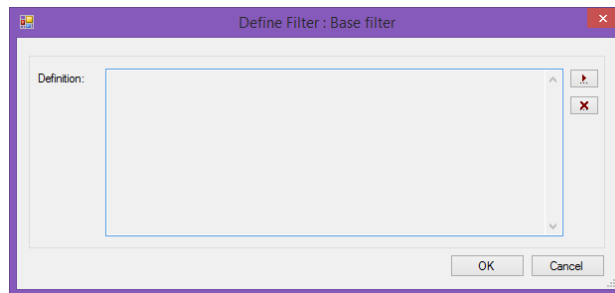



Figure 15 Base filter definition window

Pressing the  in the top right corner open the query builder window of the ECCAIRS system.

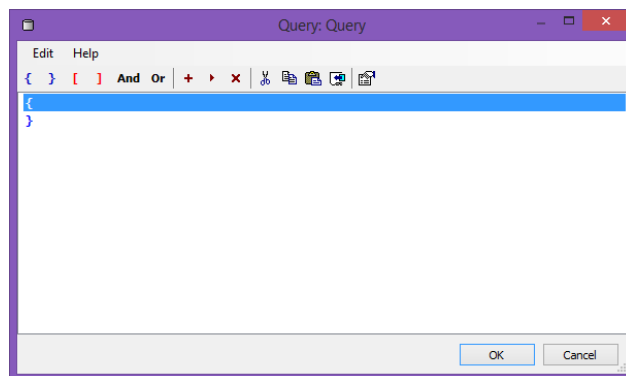


Figure 16 ECCAIRS query builder window

For details of the development of queries, see the E5-ECF-User Manual and the White Paper – ECCAIRS 5 Advanced Querying available on the ECCAIRS portal.¹²

Import / Export of exposure data

Exposure data is uploaded to the ATCSM via the “Exposure data” sub menu of the “PROJECT” menu. By pressing the “Import/Export/Remove” the exposure data management window is opened:

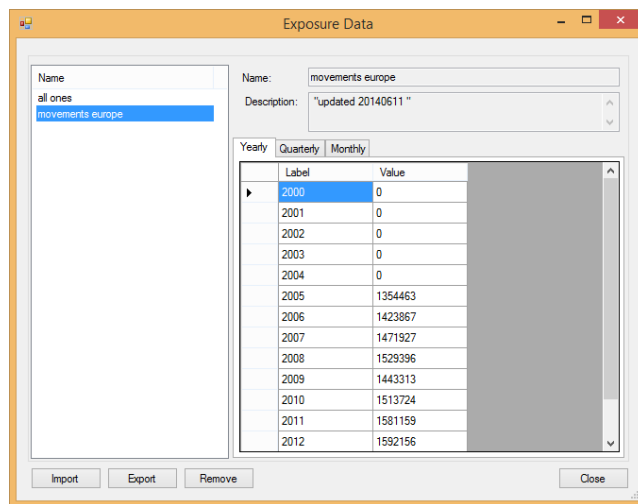


Figure 17 Exposure data management window

Buttons on the bottom permit the import/export/removal of exposure data. Note: the name of the exposure data, appearing in the “name” sub-window, as well as the description are provided as part of the exposure data xml structure as seen in the example below:

```
<EXPOSURE NAME="movements europe" DATE="2014-06-10T15:02:37.2632543+02:00">
  <DESCRIPTION> "updated 20140611" </DESCRIPTION>
  <DATA-PER-YEAR>
    <YV YEAR="2005" VALUE = "1354463" />
    <YV YEAR="2006" VALUE = "1423867" />
    <YV YEAR="2007" VALUE = "1471927" />
    <YV YEAR="2008" VALUE = "1529396" />
    <YV YEAR="2009" VALUE = "1443313" />
    <YV YEAR="2010" VALUE = "1513724" />
    <YV YEAR="2011" VALUE = "1581159" />
    <YV YEAR="2012" VALUE = "1592156" />
    <YV YEAR="2013" VALUE = "1610250" />
    <YV YEAR="2014" VALUE = "228957" />
    <YV YEAR="2000" VALUE = "0" />
    <YV YEAR="2001" VALUE = "0" />
    <YV YEAR="2002" VALUE = "0" />
    <YV YEAR="2003" VALUE = "0" />
    <YV YEAR="2004" VALUE = "0" />
  </DATA-PER-YEAR>
  <DATA-PER-QUARTER>
    <QV YEAR="2014" QUARTER = "3" VALUE = "0" />
    <QV YEAR="2014" QUARTER = "4" VALUE = "0" />
  </DATA-PER-QUARTER>
</EXPOSURE>
```

Figure 18 Example of an exposure data structure

¹² eccairsportal.jrc.ec.europa.eu

Note: the data does not have to be in order. Data series containing duplicate entries will be rejected. When saving the SPI library, the exposure data is included in the resulting “*.esl” file.

Category management

Categories can be added (Option “new”), edited (Option “Edit”) or deleted (Option “Remove”) via the “Category” sub menu of the PROJECT menu. Note that the options “Edit” and “Remove” are only activated once a category has been selected (Selection of a category is indicated by the box around the category name as seen below).



Note: by right clicking on a category name, these edit options are also available. In addition, SPI’s in the selected category can be recalculated. Note: Categories cannot be copied to the clipboard.

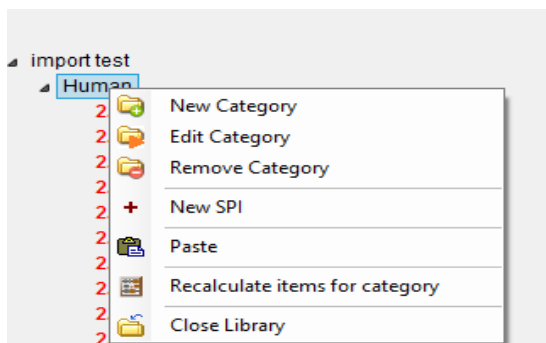
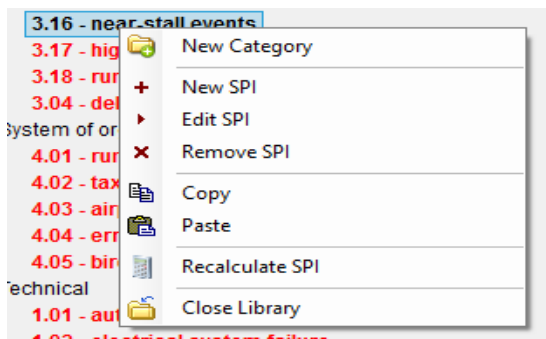


Figure 19 Category management window

Note: right clicking on an SPI provides similar options, but also includes the option to copy the SPI for pasting.



benchmark graph

Figure 20 SPI management window

Import / Export of queries

Note: SPIs, by design, combine query results with exposure data. ECCAIRS queries stored in ECCAIRS query libraries do not contain any reference to exposure data. Consequently, queries imported from an ECCAIRS query library will be flagged as incorrect as exposure data is missing. Similarly, SPIs exported to query libraries and re-imported will be flagged as well since the reference to the exposure data is not exported. Nevertheless, the importation of queries may be quite useful since the use of existing queries reduces the time required to develop SPIs.

Import/Export is controlled via the Import/Export sub menu of the PROJECT menu:



Figure 21 Import/Export sub menu

Import of queries

Pressing the “Import queries” icon in the “Import/Export” sub menu of the “PROJECT” menu will trigger the following message to be displayed”

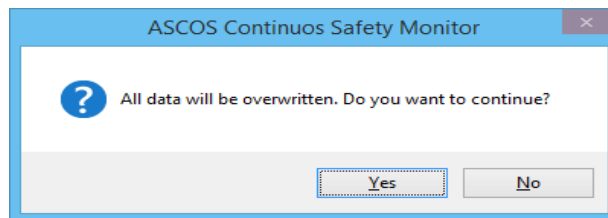


Figure 22 Query import warning window

The intent is to warn the user that the import of queries from the query library will overwrite the existing SPI library.

If the user responds with “OK” a standard file management window will be opened in which the available query libraries (“*.eq1*” files) are displayed. After the import has been completed, the ATCSM displays the SPI tree as seen here:

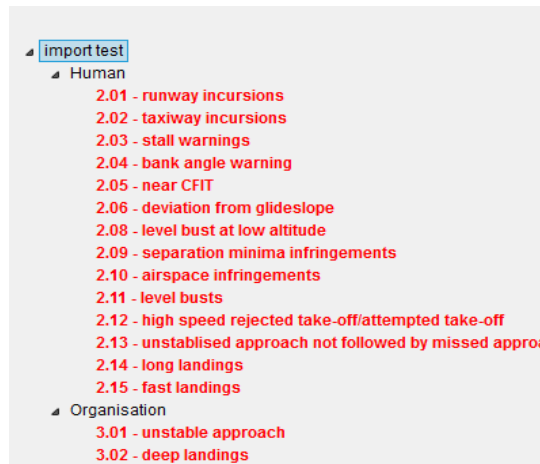


Figure 23 SPI tree after query importation

Note: All SPIs are shown in red as after importation since none of the SPIs has any exposure data assigned. The user needs to assign exposure data for each individual SPI.

Export of SPIs as ECCAIRS queries

Pressing “Export” opens a standard file dialogue in which the user can determine the name and the location of the query library in which the queries of the SPI’s of the project will be stored.

3.3.3 The “SPIs” menu

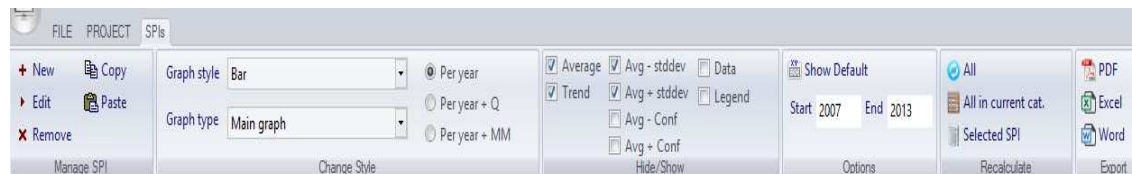


Figure 24 SPIs menu

The SPIs menu is used to manage the parameters controlling the appearance of SPIs as well as recalculation and exporting of SPIs.

Note: Some of the SPI parameters are global – i.e. they apply to all SPI’s in the library, others are SPI specific (local), i.e. they have to be set by the user for each SPI in the library and only apply to the specific SPI.

- **SPI global parameters** are managed through the sub-menus of the “SPIs” menu. They include
 - o Graph style (bar or line graph);
 - o Graph types (single series or two-series display);

- Timeline - level of detail (by year, year and quarter and year and month);
- Additional SPI graph info (lines that are added to the SPI graph. They are turned on/off via the Show/Hide submenu);
- Display of the legend.

With the exception of the date range applied to SPI graphs and legend display, the global parameter can be managed in the “Default” window. The “Default” window is activated when pressing the “Show default” in the “Options” sub menu of the SPIs menu.

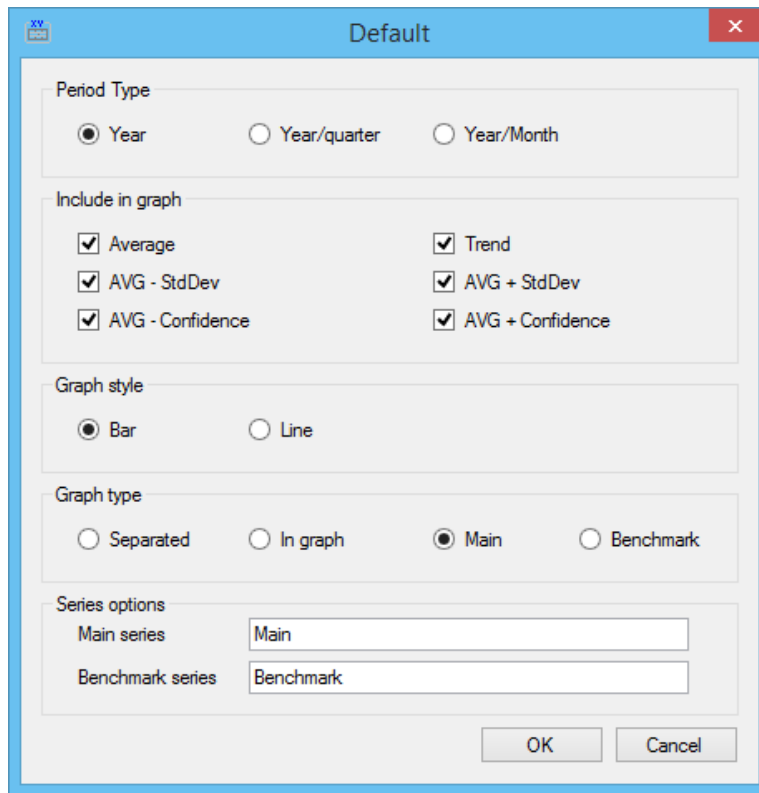
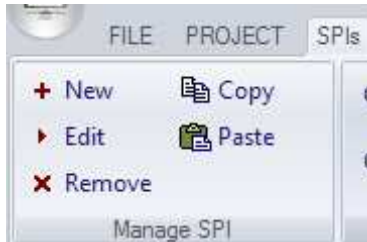


Figure 25 SPI default setting window

Note: the “Series options” parameters (free text) are used to provide the legend text for the “main” and “Benchmark” series.

- **SPI local parameters**
 - SPI title;
 - Benchmark title;
 - SPI Y-axis limitation;
 - SPI scaling;
 - SPI query;
 - SPI exposure data assignments.

SPI local parameters are managed through the SPI edit window that is activated via the “Edit” option in the “Manage SPI” sub menu of the SPIs menu or via right clicking on the SPI name in the SPI tree.



The SPI edit window:

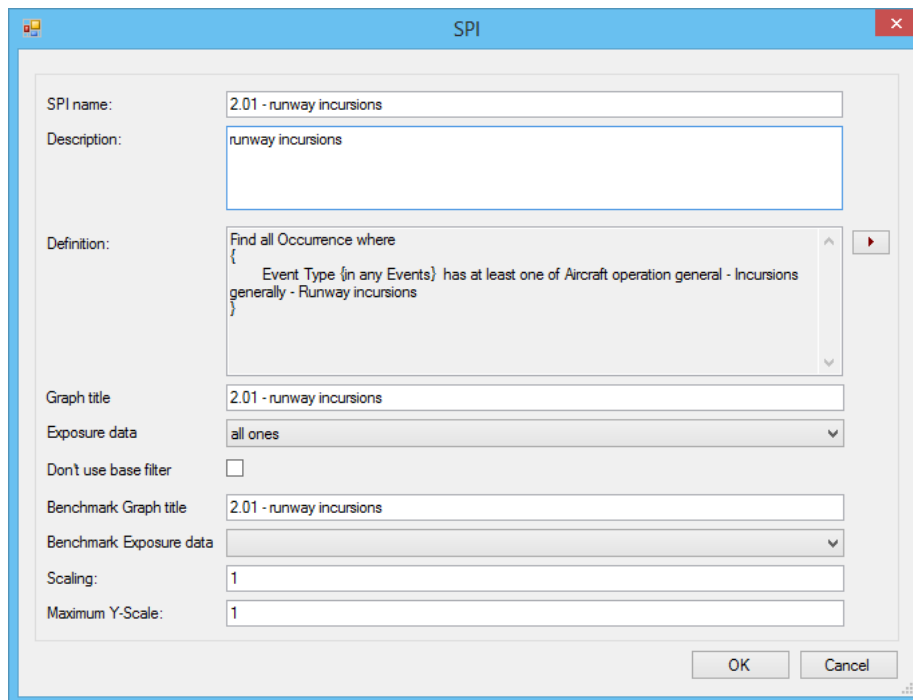



Figure 26 SPI edit window

SPI edit window parameters:

- **SPI name** – Plain text;
- **Description** – Plain text;
- **Definition** – displays the criteria used to extract data from the occurrence data Base. Editing of the criteria (pressing on the  to the right of the definitions) opens the ECCAIRS query builder dialogue window:

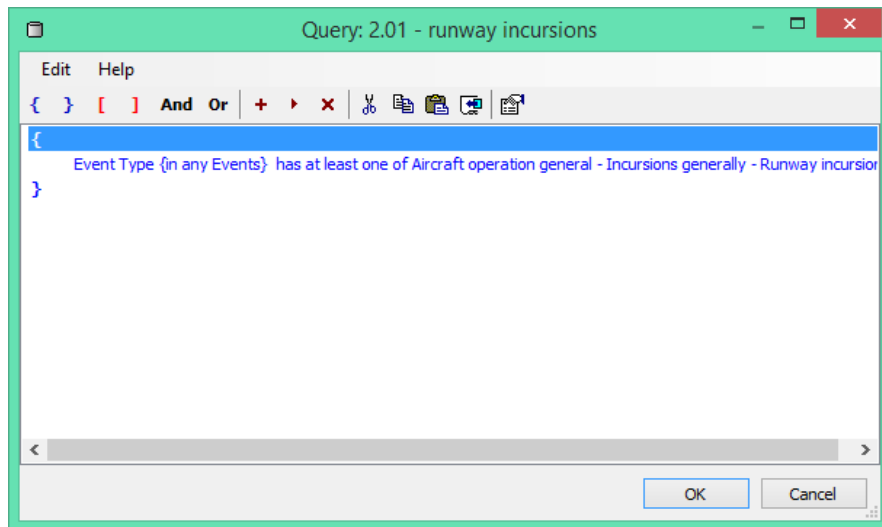
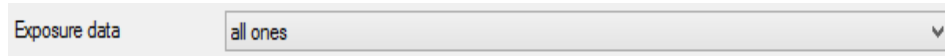



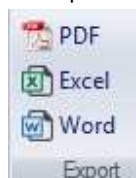
Figure 27 Example of a query

- **Graph Title** - the title to be displayed in the SPI graph;
- **Exposure data** – the name of the exposure data set to be used for the calculation of the rate of the “main” series;



- Pressing the  shows the list of all available exposure data sets;
- **Do not use base filter** - Option to select that the base filter is not to be used. This option may be helpful, if SPIs not related to the main filter are to be shown;
- **Benchmark Graph title** - the title of the “Benchmark graph”. The title line that is used in the second graph of the “benchmark and main graph separated” graph type;
- **Benchmark exposure data** - the name of the exposure data set to be used for the calculation of the rate of the “Benchmark” series;
- **Scaling** - the factor with which the resulting rates are to be multiplied to obtain values in a desired range, e.g. certain accident rates may be shown as “in a million” flights, other rates may be shown as “in a 1000 movements”;
- **Maximum Y scale** - pre-set to 1 – the maximum value applied to the Y-axis. If any value of the series to be displayed exceeds the maximum value listed here, the maximum value of the series is used for the Y axis scaling. This feature is helpful in cases SPIs need to be compared in which the maximum value of the series differs so much that the automatic scaling of the Y-axis differs and thus makes a visual comparison difficult.

- **SPI exports:** Exports are managed through the “Export” submenu of the “SPIs” menu:



The exporting exports the data of the SPI selected in the requested format:

- **PDF:** the image of the SPI graph is exported to a “*.PDF” file.

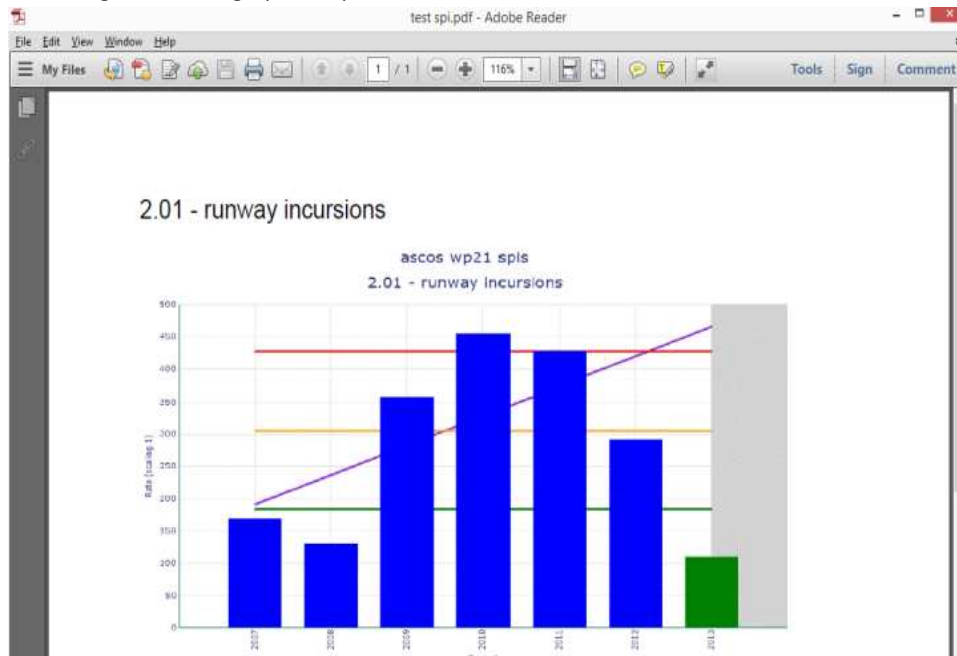


Figure 28 PDF image of an exported SPI

- **Excel:** the data of the SPI and the SPI graph are exported. Note that the SPI graph in Excel is drawn using Excel standard tools and its image differs from the developed by the ATCSM. The resulting Excel file is a workbook with three worksheets:



Figure 29 Export into Excel - workbook structure

The worksheet SPI data contains the data for the SPI:

	A1					
	A	B	C	D	E	F
1	PERIOD	rate	average	avgstddev	avgstddev	trend
2	2007	170	305.6667	183.8024	427.5309	191.5238
3	2008	131	305.6667	183.8024	427.5309	237.1809
4	2009	358	305.6667	183.8024	427.5309	282.8381
5	2010	455	305.6667	183.8024	427.5309	328.4952
6	2011	428	305.6667	183.8024	427.5309	374.1524
7	2012	292	305.6667	183.8024	427.5309	419.8095
8	2013	110	305.6667	183.8024	427.5309	465.4667

Figure 30 Export into Excel - SPI data

The worksheet "SPI" contains the SPI graph.



Figure 31 Export into Excel - SPI graph

Word: The image of the SPI graph in exported to the Word file.

- **SPI recalculation**

There are three options to recalculate SPIs: selected SPI, all in the selected category and all SPI's of the project. Re-calculation is triggered by pressing the related icon in the "Recalculate" sub menu of the "SPIs" menu.

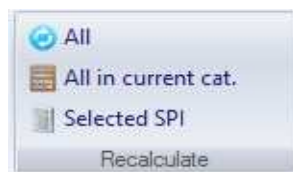


Figure 32 Recalculate sub menu

Note: recalculation of all SPIs in the current category can also be triggered via the category edit pop-up window, recalculation of a specific can be triggered via the SPI edit pop-up window.

Note: Recalculation involves re-querying the data base. Recalculation does not "refresh" the exposure data. Updating exposure data can only be accomplished via the exposure data management sub menu of the PROJECT menu.

4 ATCSM Test Data generation

4.1 Background

Part of the work to be accomplished in ASCOS WP 2.4 was an assessment of the usability and “fit-for-purpose-ness” of the developed safety monitoring tools. In this context, it was planned to use the tool to carry out several hypothetical studies by non-trained staff and evaluate the usability of the tool.

In preparation for these test studies the need for the provision of appropriate test data was noted. Considering the sensitivity with which the aviation community treats reported incident data, it was considered that for testing purposes no real data could be used. Randomly generated occurrence reports were to be used instead. Nevertheless, the occurrence data generated should reflect in some way reality so as to ensure that results of the “analysis” would not be rejected by the user community as completely unrealistic. Given that underlying data was generated and was not based on real reporting, no restrictions exist in respect to the publication of related test results as long as it is made clear to readers and audiences that all data were results of random generations and that any trends depicted in the data were either the effects of statistical noise or were intentionally included when the data was generated.

The use of artificially generated data has the additional advantage that problems frequently noted in “real” data, which include the incomplete reporting of relevant background information, the presence of contradictory data etc. will be avoided. Consequently, the evaluation of the tool will not be impeded by errors in the data.

The test data only contain values of attributes considered relevant to for a given test exercise. No other data were included. Test data can therefore only be used for the purposes generated.

A sufficient number of test reports were to be generated, thus, manual development of test data was ruled out and appropriate automated methods had to be developed.

Some ad-hoc studies were carried out to determine what distribution of the data could be considered reasonable. Results of these studies were used as a base for desired distribution of test data.

Rate calculation can only be carried out based on exposure or movement data. For the test purposes simulated movement data for Europe (EU28) was used. For the occurrences six airports selected as examples for one scenario, the number of movements for each group was simulated.

4.2 Scenarios

Four scenarios for testing the usability of the tool have been proposed as follows:

4.2.1 Scenario 1 – Runway incursions

The scenario calls for an analyst to evaluate the impact of **Runway Incursion and Collision Avoidance System (RIMCAS)** at an airport. In preparation, a study is to be performed to evaluate the impact such a system may have. It was assumed that the system had been introduced at Frankfurt, Geneva and Milano-Malpensa and that Amsterdam, Brussels and Paris (CDG) were assumed not to have such a system. The goal was to determine whether such a system would make a difference.

Two sets of aerodromes were to be compared. The goal was to show that differences between the two sets would be visible based on the different severity distributions which were used for the random generation of the severity of the reports for each of the two groups.

In summary:

- Set of 2473 generated reports covering the time period with 1100 reports for one set of aerodromes and 1373 for the second set. This distribution is aimed to be similar to the levels of activity at the two groups of aerodromes;
- Severity of the occurrence
 - o Based on assumed distribution but with differences in the severity between the two groups;
- Risk grade and occurrence category based on the severity of the occurrence;
- Random dates covering the full test period;
- Encounter geometry – random;
- Evasive action – random;
- Severity classification – random;
- Random selection of vehicles involved but aligned with assumed distribution;
- No aircraft details generated.

Exposure data – simulated number of departures by month, aggregated by quarter and by year.

The results reflect the assumption underlying the data generation that on average the rate of high risk incursions at the group of aerodromes supposedly equipped with the RIMCAS system is lower than in the comparable set, even though the rate of incursions total does not differ significantly.

Interestingly, however, while the trend of the rate of all incursions is flat (as expected), the trend of the rate of high risk incursions varies from one test sample to another due to the effect the random distribution of the low number of test reports bearing a high risk.

4.2.2 Scenario 2 – monitoring occurrences related to auto-flight systems

This scenario calls for a study of auto-flight system failures with a comparison of the last 5 years with the preceding 5 years.

For the purposes of this scenario, one set of data covering the proposed period of 10 years was developed. The reports were generated so that the results should show that no statistically significant change can be observed for the set of data as a whole, apart from some variations resulting from the random generation of the test data set.

In summary:

- 2000 reports generated;
- Distribution by year simulated to be in line with assumed yearly distribution of departures in Europe;
- Distribution by month simulated to be in line with assumed monthly departures in Europe;
- Distribution by day – fully random;
- Distribution by states - random;
- Distribution by aircraft type - random with assumed aircraft distribution;
 - o But excluding helicopters and light aircraft (below 2250 kg MTOM);
- Event phase aligned with general phase (Attribute 391);
- Distribution of event phase of operation random but aligned with values found in Attribute 121 (general phase) of the ECCAIRS taxonomy (Version 2.4.0.0));
- Severity based on assumed severity;
- Damage level (aircraft) aligned with severity;
- Damage level (occurrence) aligned with damage level aircraft;
- Risk grade – aligned with occurrence class.

Results show that, as designed, on average no change in the rate of such occurrences can be observed.

4.2.3 Scenario 3 – monitoring of the reaction of the crew to EGPWS warnings.

A study was to be carried out to determine the effectiveness of training practices in relation to the crew reaction to GPWS warnings.

One data set covering the proposed period of time was developed with the intent to show that, over time, the probability of a correct crew reaction was increasing. To accomplish this, the probability of a correct crew response on a given day was derived using a linear interpolation of the probability from a given lower value assumed at the beginning of the period to a higher at the end of the period.

In summary:

- 2000 reports generated.
- “Crew reaction” randomly generated with an increasing probability of generating “correct” actions and a corresponding decreasing probability of generating “incorrect” actions;
- The date of occurrence - generated at random but with a distribution based on an assumed yearly as well as monthly distribution of departures in Europe;

Ref: ASCOS_WP2_JRC_D2.4

Page: 42

Issue: 1.1

Classification: Restricted

- State of occurrence – random – based on assumed distribution;
- General phase of flight – random – based on assumed distribution;
- Specific phase of flight randomly generated and adjusted to the generated general phase of flight;
- GWPS warning type set to “Terrain” for all occurrences;
- No aircraft model generated (left empty) as this was not considered relevant for the purposes of this study;
- “Time to react” in seconds randomly distributed between 30 and 230 seconds;
- State of occurrence distributed at random;
- Risk grade: randomly generated, but with a reduction of 1 if the crew action generated was “immediate”, i.e. in case the random generated risk level was “high” and the randomly generated crew reaction was “immediate”, the risk level was reduced from “high” to “medium” and from “medium” to “low” correspondingly.

Results show that, as intended, the rate of correct crew behaviour is increasing over time with a corresponding decrease of the rate of incorrect crew behaviour.

4.2.4 Scenario 4: Investigating the safety impact of TCAS II version 7.1

One set of data was developed covering the two year period from 1 January 2012 to 31 December 2013. It was assumed that there was an impact of the introduction of the version 7.1. The impact was simulated through the adjustment of the randomly generated severity level of each record. Based on the corrected severity levels, the related classifications of the occurrence as “incident” or “serious incident” were derived as well as related event types as they are also indicative of the severity of the occurrence. The aircraft type was generated based on an assumed distribution of aircraft. Aircraft characteristics – the mass group, the type of propulsion etc. were added to the test data at a later stage using an aircraft characteristics reference data base.

In summary:

- 2000 reports generated;
- Risk level: random number between 0 and 99, modified by a correction factor based on the date of the occurrence and a user defined target level;
- Aircraft make model: random generated based on an assumed distribution;
- Occurrence class: derived from generated risk level;
- General flight phase: randomly generated;
- Event phase: randomly generated based on observed distribution – but aligned with the general flight phase (ECCAIRS attribute 121);
- Event type: derived from risk level;
- State of occurrence: random generated but based on assumed distribution;
- Date: at random over the period but with a distribution by month to reflect assumed monthly activity in Europe;
- Aircraft characteristics were added to the occurrence reports based on data found in an aircraft characteristics reference data base.

4.2.5 Implementation of test data generation

The basic data to be generated was stored in an Excel worksheet. From this worksheet, the data was reformatted into worksheets formatted to be suitable input to the ECCAIRS TREX¹³ tool. TREX is a tool that permits the creation of ECCAIRS 5 files based on information contained in an Excel workbook.

In addition to the random generated data, several code values were inserted for “static” values. By “static” we mean these values did not change from one test record to another. “Static” attributes include the code for the organisation reporting, the occurrence status etc. They are required to obtain a formally correct ECCAIRS5 occurrence record.

The T-REX tool was developed specifically to simplify the creation of occurrence reports in ECCAIRS 5 format. It takes as input worksheets in an Excel workbook that mirror the entity structure and attribute values of an ECCAIRS occurrence record to generate ECCAIRS5 records. Only with this tool was it possible to create a sufficient number of test records, review them and adapt the generated distribution of the generated values to achieve desired results.

While this approach was used extensively for the testing of the ATCSM, the approach to generate test data based on assumed distributions could be used wherever the use of “real” data in testing occurrence reporting related software is deemed undesirable due to confidentiality issues or when an insufficient number of “real” data is available for testing.

The E5F files created by T-REX were uploaded into a data base for analysis. Results show that, within the expected random fluctuations resulting from the use of randomly generated data, the target distributions of the values were achieved.

¹³ T-REX - Tool for Rolling your own ECCAIRS data using Excel

5 Usability evaluation and assessment

5.1 Objective

This section reports on the results of a heuristic evaluation aimed at discovering the usability criticalities of the current version of the ASCOS Tool for Continuous Safety Monitoring (ATCSM).

Usability refers to the extent to which a software product can be used by a specific user to achieve specified goals. It pertains the “perceptual and physical characteristics of the human-system interface, and includes general issues regarding the ability of users to read, detect, access, and manipulate information.” (Harwood, 1993, p.6). The consideration of usability issues is important to ensure that the users can find what they are looking for quickly and easily, navigate around the product easily, know where they are within the overall structure of the software program, and know the options that are available to them (Tullis & Albert, 2008). Ultimately, the proper handling of usability issues during the development of new software system has the potential to maximize end user acceptability and opportunities for adoption.

It has to be noted that the present evaluation focuses solely on usability aspects. Considerations of fitness for purpose (or domain suitability)—which pertain the degree to which an interactive system allows a user to meet the cognitive demand of the domain—are not addressed in this study. This choice is due to the fact that the evaluation of the fitness for purpose falls under the scope of ASCOS validation exercises planned in the context of ASCOS Work Package 5. These exercises are currently expected to take place during the period November 2014-January 2015.

5.2 Methodology

The ATCSM has been evaluated using the heuristic or expert evaluation method (Nielsen, 1994). This is a consolidated usability inspection method that involves a team of usability specialists to judge whether the features of the user interface under analysis follow basic established usability principles or heuristics. These are general standards that reflect common properties of usable human machine systems. Experimental research has shown that they apply across a wide range of human machine systems. In a typical heuristic evaluation, first the evaluators inspect the interface alone going through it several times to explore how the system performs compared with the heuristics. In the second phase, the evaluators work jointly to compare, refine and aggregate their usability findings.

The heuristic evaluation presented here assumes as potential users of the ATCSM safety practitioners (i) working in the Aviation and/or Air Traffic Management domain(s) for either a manufacturer or a civil aviation authority, and (ii) active in the context of certification of aeronautical products and/or services. This profile is reasonable considering that it is consistent with the target user of the ASCOS main outcome, i.e. the approach to certification of aeronautical products and services, as described by the Work Package 1.

As a user task, the evaluation has considered mostly the definition/retrieval of an occurrence data set. This is because the definition of the exposure data falls outside of the scope of the system under analysis. In a real-life situation, the latter need to be collected using methods and software systems external to the ATCSM. The evaluation has been conducted using a SAMSUNG standard lap top computer. Computer screen size was 13inch.

5.3 Usability Findings

The present heuristic evaluation has identified nine usability criticalities and a corresponding set of 10 high level usability recommendations, as also shown in Table 1. Each usability issue is covered in detail on a dedicated section in the remaining of section 4. It is anticipated that issues from #1 to #8 cover relatively small scope usability issues, which call for incremental improvements of the present version of the ATCSM. Issue #9 addresses a more fundamental (and complex) usability concern that calls for a more substantial improvement.

Table 1. Summary of the usability issues identified in the context of this study

#	Identified Usability Issues (page number is indicated in brackets)	Recommendation(s)
1	SPI sub menus disappearing from user view when shrinking the ATCSM Project Window (p. 46)	1. Ensure that a symbol specific for the SPI submenus remains visible when ATCSM Project view is shrunk
2	SPI recalculation options not immediately visible to the user (p. 48)	2. Place the recalculate option in the context of the SPI window.
3	Lack of clarity between the “File” submenu, the “Project Menu” and the entities they relate to (p. 49)	3.1 Replace the name of the “File” submenu with “Library”. 3.2 Consider moving the current four submenus contained under the “Project” menu under the File (Library) menu.
4	Opening a library requires the user to open the ATCSM first (p. 50)	4. Consider giving the option to the user to launch the ATCSM directly by double clicking on the library file icon available on the desktop.
5	The name of the application displayed in the Windows “start” menu differs from the application name appearing on the top of the ATCMS Project window (p. 51)	5. Use the same software name consistently across different menus and bars.
6	Library name appearing on the top bar of the main software window not clearly readable (p. 51)	6. Replace file path information on the top bar of the ATCSM with the name of the currently open library.
7	Repetitive selection of the query text line required in the SPI query builder (p. 52)	7. When opening the SPI Query builder, the selection bar should appear automatically over the first row of the active window in which a text line appears.
8	Ambiguous symbology used for the editing function (p. 53)	8. For the editing function, use a symbol different from the play (“>”) symbol. Consider the use of a label, either alone or in combination with a symbol.
9	Difficult to retrieve occurrence data for non-expert users (p. 53)	9. Adopt a direct manipulation stile to filter occurrence data.

5.3.1 # 1: SPI sub menus disappearing from user view when shrinking the ATCSM Project Window

When shrinking the ATCSM Project Window from the full screen view to a smaller size view, some SPI sub menus located on the right side of the SPI menu can disappear without leaving any text or symbol displayed that reminds the user of them. This usability concern is illustrated by the figures below. Figure 33 shows a full-screen view of the ATCSM Project Window, and circles in red the sub menus in question, i.e. “Change Style”, “Hide/Show”, “Options”, “Recalculate”, and “Export”. Figure 34 and Figure 35 show a centred-on-screen and a half-screen view respectively of the ATCSM Project Window. Here it is possible to see that the names and options of the sub menus in question have disappeared from the screen either entirely (Figure 2) or in part (Figure 3), without leaving a graphical indication to remind the user of their existence. The remaining empty boxes—circled in red in Figure 34 and Figure 35 —perform poorly as a reminder because they solely signify that some submenus are hidden on the SPI menu, but do not specify which one. In standard desktop applications a symbol and/or a text would normally remain visible to facilitate the recognition of hidden HMI items.

This condition violates a basic usability heuristic according to which the system should minimize the user’s memory load by making options, objects, and actions visible to her/him. For the user, it is easier to recognize information visible on the screen than recalling it in fact. In this specific case, the user wishing to use the required menus has either to enlarge again the ATCSM Project View or to recall from her/his memory the original submenu position.

Recommendation:

1. Ensure that a symbol specific for the SPI submenus remains visible when ATCSM Project view is shrunk.

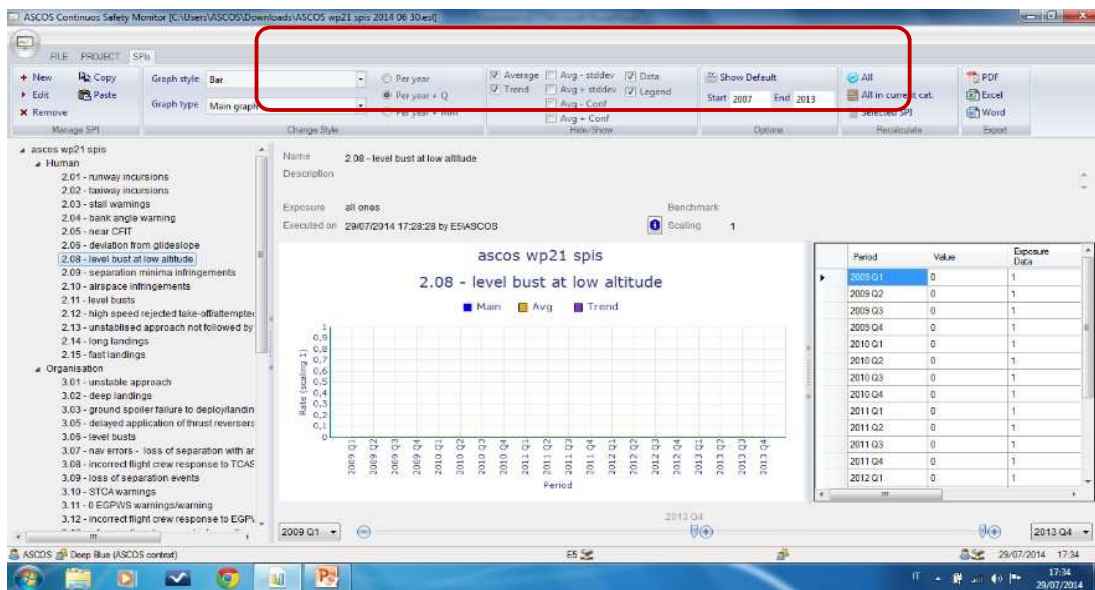


Figure 33: ATCSM Project View, full screen view.

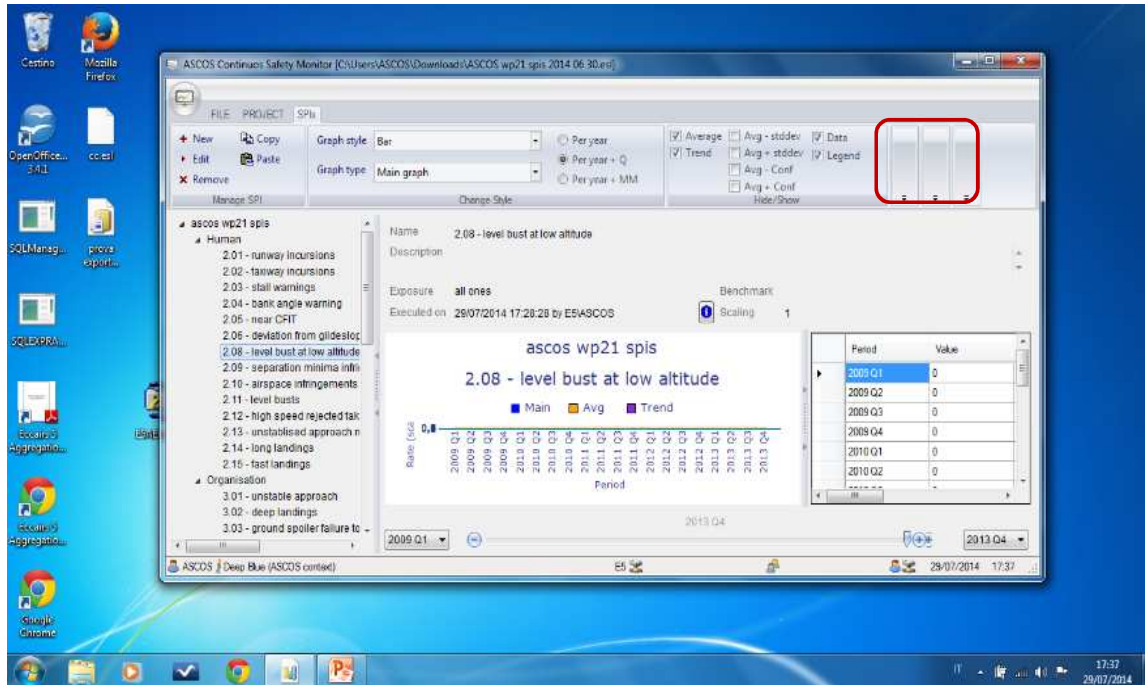


Figure 34: The “Options”, “Recalculate”, and “Export” sub menu disappear after shrinking the ATCSM Project View to a centre-on-screen view.

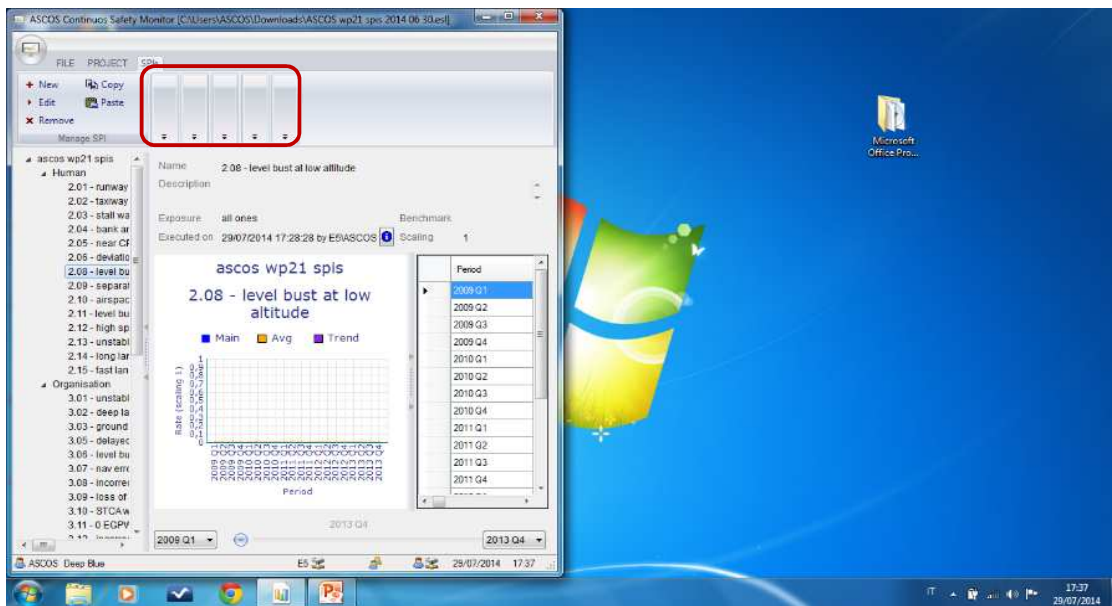


Figure 35: ...also the “Change Style”, and the “Hide/Show” sub menu disappear when shrinking the ATCSM Project View to a half-screen view.

5.3.2 # 2: SPI recalculation options not immediately visible to the user

When an SPI has been created or modified, the natural expectation for the user is that a new graph is created or an existing one is automatically updated. Instead, the user is presented with the following message in red: "Definition has changed and the SPI needs to be recalculated." (see Figure 36). From the perspective of a user unfamiliar with the system, this message is unexpected and creates the impression that something went wrong during the definition of the SPI. In turn, s/he may get stuck because, on the one hand, s/he is under the assumption to have committed a serious error during the editing of an SPI, due, for instance, to having uploaded the wrong set of exposure data; on the other hand, s/he does not see any suggested information about how to recover from the mistakenly assumed error. So, s/he would spend time to check which is the appropriate function that allows to create or update the graph as intended.

To note that the expectation that the SPI calculation should occur automatically—with no additional step after the "ok" button is pressed in the SPI window—, arises because when editing an SPI, the user's options available in the SPI window are restricted to the buttons "ok" to approve the change(s) or "cancel" to reject it; however, these do not include the options for SPI recalculation. These only appear as inactive in the background view, the ATCSM Project View, outside of the immediate window the user is working on, and far from the "ok" and "cancel" buttons (see Figure 37). Consequently it is very unlikely that a user would notice the recalculation submenu when working on/closing the SPI window.

Recommendation:

- Place the recalculate option in the context of the SPI window.

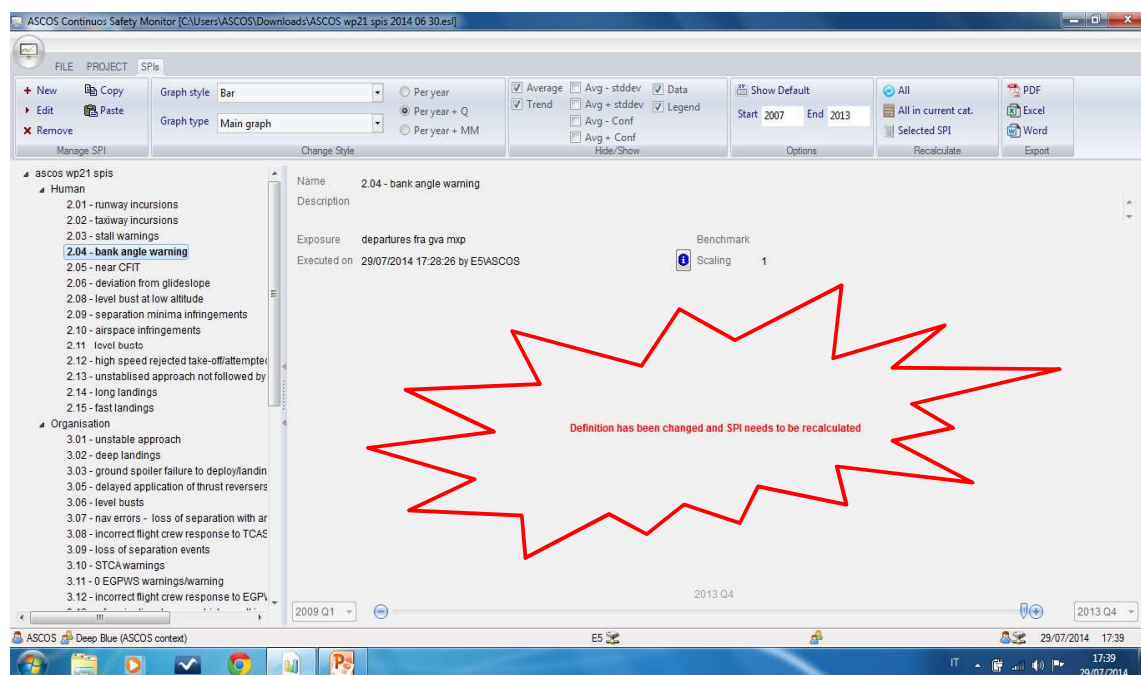


Figure 36. The message in red is displayed to the user after modifying/creating a SPI.

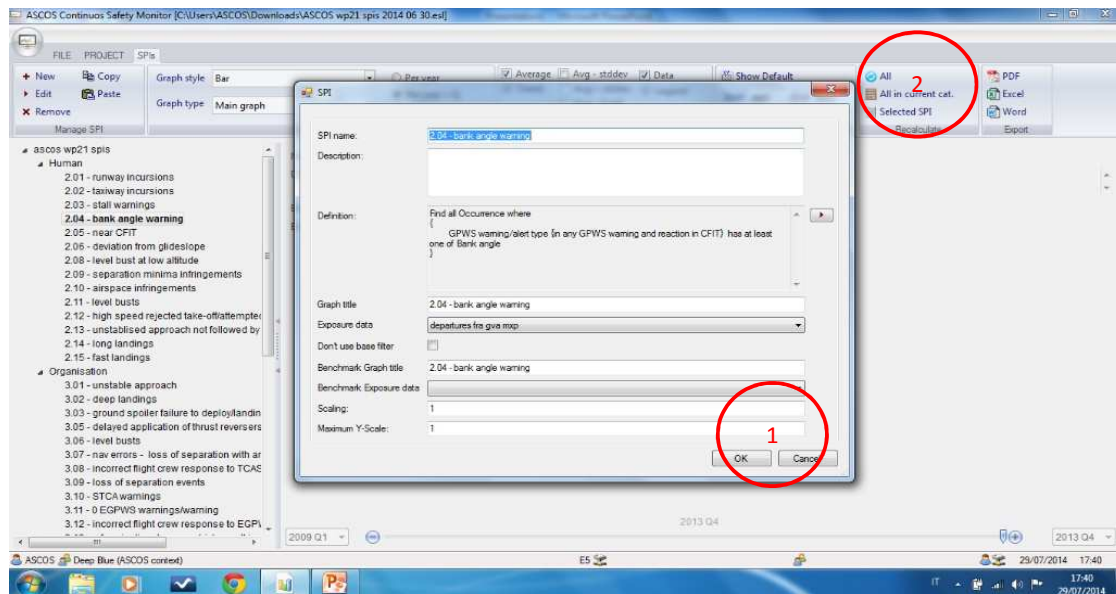


Figure 37. The SPI windows does not provide the option to recalculate the graph (circle 1). At the same time, the recalculate function (circle 2) falls out of user's immediate focus of attention as it is located outside of the immediate context the user is working on (the SPI window).

5.3.3 # 3: Lack of clarity between the “File” sub menu, the “Project” menu and the entities they relate to

In the menu bar, the current “File” submenu (Figure 38) may induce the user to think mistakenly that by opening, modifying, or closing a file s/he would manipulate a different entity than a library (and the SPIs contained in it). This shortcoming creates uncertainty on the user side who may wonder what entity does the “File” menu refers to and how it fits in the context of the ATCSM. As a general rule, the system should show clearly which buttons have an effect on which entity in order for the user to create a correct image of the system she or he is using. For instance, the SPI menu (see Figure 40) creates a correct image of the system because the submenus and options it contains are SPI specific, i.e. they allow the user to manipulate SPIs and their graph. The same clarity should apply also to the other menus and submenus. The ATCSM system should let the user understand that all of the options available under the “File” submenu have an effect on the library that is open at a specific time. This clarity can be achieved by replacing the generic “File” label with the more specific “Library”.

The same problem applies to the “Project” menu Figure 39). Also here the user may be induced to think mistakenly that there exist an additional entity beside library and SPIs, without however having a clear idea of what such a “Project” entity is. The associated submenus—“Filters”, “Exposure Data”, “Category”, and “Import/Export”—appear all options affecting a library as a whole in fact.

Recommendations:

3.1 Replace the name of the submenu “File” with “Library”.

3.2 Consider moving the current four submenus appearing under the “Project” menu under the File (Library) menu.

Figure 38. The “File” menu

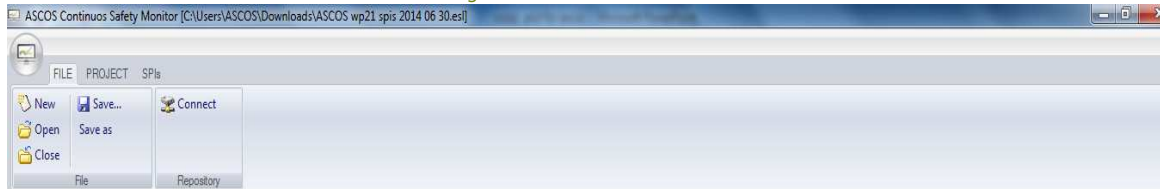
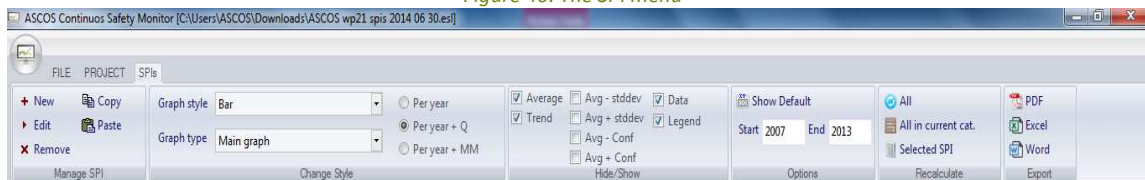


Figure 39. The “Project” menu



Figure 40. The SPI menu



5.3.4 #4: Opening requires the user to open the ATCSM first

The ATCSM user interface is organized around *libraries*. These are containers of SPI(s). When the user opens a new file s/he is actually opening a library of SPIs. Without a library open, the tool cannot be used. So, a user would expect to be able to launch the ATCSM simply by clicking on a given library available on the desktop (or any other file location), analogously to what happens for standard desktop applications (e.g. clicking on a MS Word Document file on the desktop allows the user to open the desired file without having to open MS Word first). With the current version the user is required to launch the ATCSM first, and the opening the file of interest.

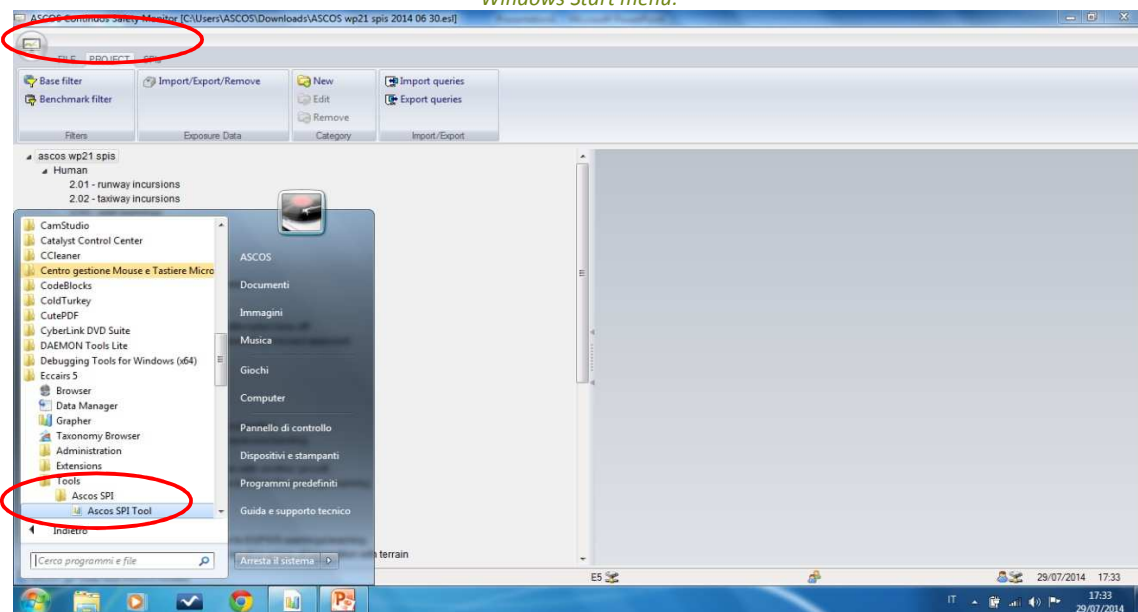
Recommendation:

4 Consider giving the option to the user to launch the programme directly by double clicking on the library file icon

5.3.5 #5: The application name in the Windows “start menu” differs from the application name appearing on the top of an ATCSM Project window.

As shown in Figure 41, the application name appearing on the top of the ATCSM Project Window (“ASCOS Continuous Safety Monitor”) differs from the application name displayed on the Windows start menu (“ASCOS SPI tool”). As a general rule the user should not have to wonder whether different words, situations or actions mean the same thing.

Figure 41. The program name displayed on the top of the main ATCSM view differs from the name appearing in the Windows Start menu.



5.3.6 #6: Library name on the top bar of the main software window not clearly distinguishable

Once the ATCSM is open, the library name appears on the top bar of the main programme window as part of the library file path (see figure below). This format makes it clumsy for the user to read the file name and understanding whether s/he is working on the intended library. The library name the user is working on should be clearly readable, and hence should be presented as a standalone label and not into the file path.

Recommendation:

6 Replace file path information on the top bar of the ATCSM with the name of the currently open library.

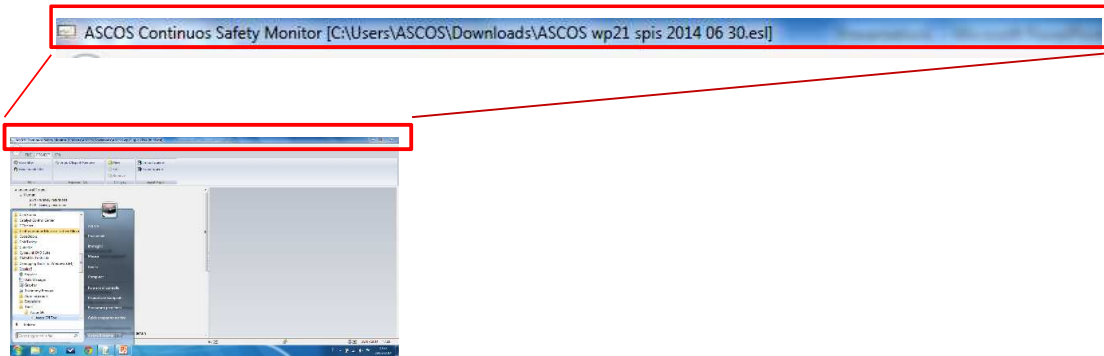


Figure 42. Magnified view of the text appearing on the bar on the top of the ATCSM Project window.

5.3.7 #7: Repetitive selection of query text line required in the SPI query builder

When editing a query in the "SPI Query builder" window, by default the selection blue bar appears on the first row of the active window (see

Figure 43). As the first row usually displays a brace bracket and not a line of text, which is what needs to be modified, the user has to select the first row in which the text line appears. S/he does so by moving the cursors over the text line of interest and by clicking on it. This micro pattern of activity is repeated every time the user opens the SPI query builder in order to add or edit a query. The interaction with the system can be eased by placing the selection bar automatically on the first row in which the text line is available when the SPI query builder window is opened.

Recommendation

7. When opening the SPI Query builder, the selection bar should appear automatically over the first row of the active window in which a text line appears.

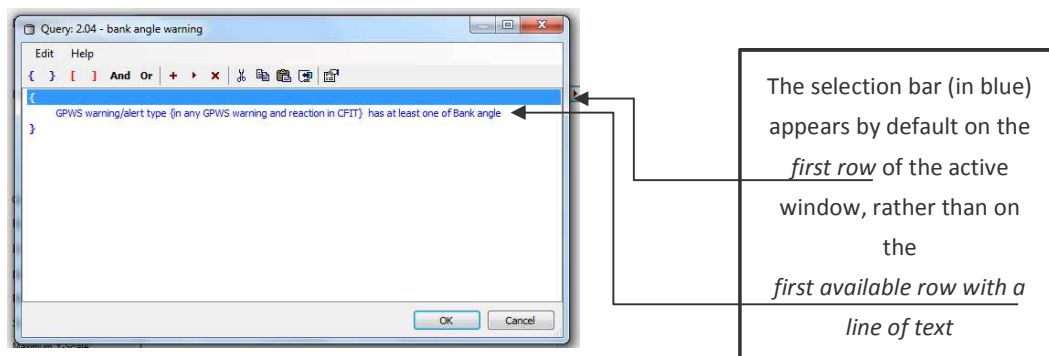


Figure 43. SPI Query builder

5.3.8 #8: Ambiguous symbology used for the editing function

The ATCSM uses consistently the icon “>” for the editing function in different menus. However, the icon “>” is the standard symbol used worldwide for indicating the “play” function. Hence, it comes unnatural for the user to associate this symbol to the editing function if not briefed about it. This can create uncertainty for the user when working on the SPI edit window. During the exploration and familiarization phase with the tool, s/he user may hesitate to press the “>” button available because s/he may assume mistakenly that once pressed this will initiate the execution of a (potentially time consuming) query.

Recommendation

8. For the editing function, use a symbol different from the play (“>”) symbol. Consider the use of a label, either alone or in combination with a symbol.

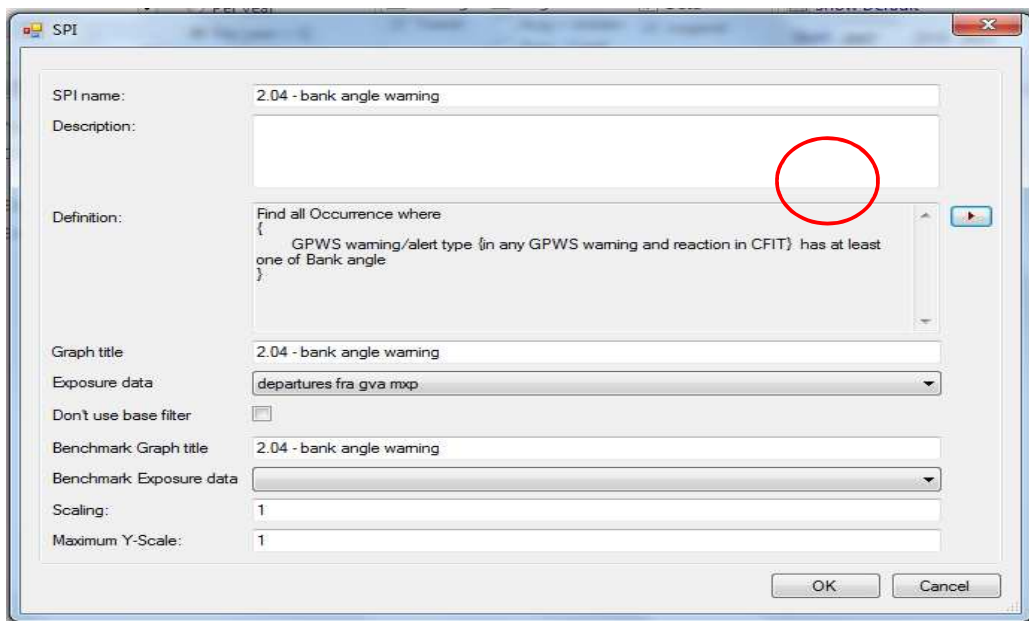


Figure 44. The SPI edit window

5.3.9 #9: Difficult to retrieve occurrence data for non-expert users.

For a user new to the ECCAIRS software it can be difficult to extract occurrence data. The reason why this may be the case is illustrated next.

Switching the mode of thinking from a ‘user perspective’ to a ‘developer’ perspective. When setting the attributes to retrieve a given set of occurrences, the user has to switch thinking mode: in particular s/he has to switch from what we could define a (i) user perspective, in which the main goal is thinking about the search criteria for identifying a given occurrence data set — e.g. concerned aerodrome(s) or airline(s), type of events, etc.—, to a (ii) developer perspective, in which the goal becomes the development of a query needed to

retrieve the relevant data from the ECCAIRS database. Besides differing in term of the user goals (see the Table below), these two perspectives differ also in terms of the task the user has to perform to meet his objective, the focus of attention, and the required knowledge.

Regarding this latter point in particular it can be noted that switching from a user perspective to a developer one brings a major knowledge demands. In fact it requires s/he to have a sufficient knowledge of the ECCAIRS taxonomy, of the syntax needed to interrogate the taxonomy, i.e. to build the query, and familiarity with command line interaction style. Such knowledge cannot be necessarily assumed for a user familiar with general desktop applications but new to ECCAIRS.

Table 2. A comparison of the user and the developer perspective.

	A. User Perspective	→ B. Developer Perspective
(1). Goal	Identify and trace the rate of occurrence of one or a group of safety events over a selected time period	Interrogate the ECCAIRS database to derive occurrence data
(2). High Level Tasks	<ul style="list-style-type: none"> Select the relevant SPI Set the relevant filters to retrieve a given type occurrence data 	<ul style="list-style-type: none"> Select the relevant SPI Build the query to retrieve the desired occurrence data from the ECCAIRS database
(3). Focus of attention	<ul style="list-style-type: none"> SPI graph or group of graph displayed on the 'SPI Pane' 	<ul style="list-style-type: none"> String displayed on the 'Query Window'
(4). Required Knowledge	<ul style="list-style-type: none"> ASCOS SPI, Domain(s) of application (e.g. ATM, Aviation) Geographical area and time period of the safety events of interest 	<ul style="list-style-type: none"> Knowledge of ECCAIRS taxonomy Knowledge of the correct syntax to build a query, in order to interrogate the ECCAIRS database

Further, this knowledge demand has a set of implications regarding how well the tool behaves in terms of 2 important usability aspects, i.e. **learnability** and **memorability**. These aspects refer respectively to (i) how easy it is for the user to acquire the knowledge needed to use the tool and (ii) how easy it is to retain such knowledge over time. From a learnability perspective, it can be observed that because of the knowledge demand described above a user needs to be provided with a sufficient level of training before being able to explore and exploit the power of the system in full autonomy, i.e. without expert assistance. On the other hand, without such a training, there is a significant risk of refusal to use the tool from the user side, even if he or she has gained an initial intuitive understanding of its potential. This is due to two reasons: First, a general user, especially when using the system for the first time, could just count on the information visible on the screen, and this is not sufficient to guide the user to the build-up of a query. Second, the time needed to

familiarize with the system without any expert assistance would exceed significantly the time needed to familiarize with a standard desktop application.

Concerning memorability, it can be noted that SPI definition may not be a frequent task, i.e. something done on a daily or weekly basis. In a nominal scenario focusing on continuous safety monitoring, it is reasonable to expect that once a user defines one or a set of SPIs, s/he will monitor such SPI(s) over a period of time ranging from a few months to a few years without needing to modify the SPI(s) in question. So, the knowledge needed to specify or build a query using the syntax may fade away before the next use, with the end result that the user may not remember how to do things with the system.

Finally, it has to be noted that the time needed to develop the query affect the usage also for a user acknowledgeable with the ECCAIRS taxonomy and command line interaction style. Although such a user can quickly recall from his or her working memory the knowledge needed to operate the system almost unconsciously, s/he would still need to spend time performing the tasks needed to type and build the syntax.

Recommendation

9. Adopt a direct manipulation style to manipulate/retrieve occurrence data. The usability issue described in this section can be avoided by letting the user to retrieve the desired occurrence data by operating a set of filters directly on the SPI graph window. This would simplify the interaction because for two interrelated reasons: first, the user could interact quickly with the filtering option in the same pane in which the object of interest—the SPI graph—appears; second, in doing so he would be saved from the effort of having to build the query manually through a sequence of command lines. To date, the system implements already this interaction style for letting the user to specify the time period of interest for a given SPI in the SPI graph window. A similar mode of interaction could be devised also for allowing the user to manipulate directly other attributes of the occurrence data set.

5.4 Independent usability assessment

An independent evaluation of the ASCOS Tool for Continuous Safety Monitoring (ATCSM) was made by NLR, following the paragraphs of chapters 2 and 3 of the ATCSM User Manual. The description of the tool in the User Manual is clear. All the described items, including SPI visualisation have been selected and evaluated.

5.4.1 Comments: Section 2.2.1 “The SPI project window”, subsection “The SPI header”:

The info button () shows the criteria used to extract data from the ECCAIRS occurrence data base on the SPI graph pane. A distinction is made in a Main-section and a Benchmark-section. In the Benchmark-section both the global and the local SPI criteria are shown. In the Main-section the global criteria, as defined for the base filter in the projects-window, are not shown, only the local SPI criteria.

5.4.2 ATCSM – Control menus

All described menus have been selected and evaluated. As part of the evaluation new projects have been defined and new SPIs have been defined with new criteria built up from scratch. Also criteria have been edited and the SPI have been calculated, recalculated and stored. Queries have been exported and imported. Exposure data has been selected and applied. SPI results have been exported.

5.4.3 Comments: Section 2.3.3 “The SPIs menu”, subsection “The SPI edit window”:

The scaling factor is a little confusing. A scaling factor of 1000 means that the values shown in the graph have been multiplied with a factor 1000. So the shown values are per 1000. This is not made clear in the text on the Y-axis. This is especially confusing when small scaling factors are used (e.g. factor 2 to influence the range of the scale for reasons of comparison). More confusing is that the data pane (made visible with the data thick-mark) does not show the real rate values but instead the scaled rate values. This is not mentioned in the data pane and can easily be missed.

5.4.4 Comments: Section 2.3.3 “The SPIs menu”, subsection “The SPI exports”:

When an export is made to Excel not the real values of the occurrence rates are exported but instead the scaled rate values. When a scaling factor of 1000 has been applied all rates are a factor 1000 the high in the resulting Excel file, as well on the SPI sheet as on the data sheet. This factor is not mentioned in the Excel file.

5.4.5 Conclusions from the usability assessment

The ASCOS Tool for Continuous Safety Monitoring (ATCSM) has been evaluated using the User Manual as a guide. The items described in the User Manual have been selected and evaluated. In the evaluation some items were found that could be improved according to NLR (see also Appendix A).

5.5 Conclusion of the Usability Evaluation

The evaluation has diagnosed nine usability issues with the ATCSM tool. These issues identify shortcomings and areas of discomfort that can compromise the ease of use of the ATCSM. Each usability issue has been provided with a minimum set of high level recommendations that can feed into a subsequent design improvement cycle. In particular, issues from #1 to #8 cover relatively small scope usability issues, which call for incremental changes at the level of the Human-Machine Interface of the present version of the ATCSM. Issue #9 addresses a more fundamental (and complex) usability concern instead. This arises from the knowledge demand the system has on a general user, and calls for software changes aimed at automating the build-up of the ECCAIR database interrogation query.

It has to be noted that the identified issues are reasonable considering the novelty of the application and its maturity level. At the same time addressing them is important to make the potential of the system more transparent to the broad communities of safety and certification experts that may have an interest on the use of the tool in a certification context and beyond.

6 Conclusions and recommendations

6.1 Conclusions

Based on ASCOS requirements, a tool has been developed to facilitate the continuous monitoring of aviation safety. The functioning of the tool has been tested based on randomly generated occurrence test data and simulated usage data. A User Manual has been developed to guide use of the tool by interested parties.

The usability of the tool has been evaluated and assessed by two independent organisations. Recommendations for improvements have been made. All, except one, have been implemented. The user manual has been updated accordingly. The specifics of the improvements made are listed in Appendix A.

The tool provides a picture of aviation safety. This quality of this picture will reflect the completeness and quality of the data. Experience has shown that much effort will be required to obtain the quality data needed to make this picture meaningful.

6.2 Recommendations

Simplifying access to exposure data

The present way to upload exposure data is to read an XML file which complies with a pre-defined structure. However, there is presently no tool at hand that reformats exposure data from the various source data formats to the format in which the data is usable by the tool.

This aspect has been intentionally left open in light of the many formats in which exposure data may be found. In a “production environment”, it would be required to develop additional software to interface between the tool and, e.g., a data warehouse containing the exposure data.

In the selection of the exposure data for the purposes of developing SPI's, the following aspects need to be covered:

- The definition of the part of the aviation industry to be covered - usually expressed through a selection of aircraft involved, the types of operations involved, the aerodromes involved etc.
- The time frame for the observation.

This information is also included in the queries retrieving occurrences. They also would include a time frame, the part of the industry to be covered in addition to the nature of the events to be selected. Consideration should be given to develop queries to extract matching exposure data from a data warehouse based on the information contained in the queries to extract the occurrence data from an occurrence report repository

Consequently, compatible taxonomies must be used for the storage of exposure data and occurrence reports. This is not possible today. It is no surprise. Occurrence data and exposure data have traditionally been collected by different groups and for different purposes.

Improving the control of Safety Performance Indicator (SPI) images

Several global parameters control the image of the SPIs in an SPI library. As a result, all SPIs in a library share the same style settings. While this approach permits the rapid change of the style of all SPIs in a library, it limits the flexibility and requires the user to use multiple libraries when images of different styles are required.

Consideration could be given by developing an approach in which the image of an SPI graph is determined by a “style:” that the user can associate to an SPI. “Styles” would be managed separately and could be stored in a “style library”. The definition of an individual SPI would then be based on:

- The occurrence data query;
- The assignment of exposure data;
- The image control style;
- SPI name, explanation and associated graph titles.

Identification of ASCOS related products in occurrence and usage data

At the time of writing this document (2014), there is no product at hand that has been certified using ASCOS related approaches. If and when products/systems will be certified following the ASCOS approach, it will be necessary to identify such products/systems as ASCOS related so that their safety can be monitored separately from the overall safety of the aviation system.

No such means of identification exists today. This applies to occurrence as well as to usage data.

References

#	Authors(s), Title, Year
[1]	K. Harwood, "Defining Human-Centered System Issues for Verifying and Validating Air Traffic Control Systems," in <i>Verification and Validation of Complex Systems: Human Factors Issues</i> , J. A. Wise, V. D. Hopkin, and P. Stager, Eds. Springer Berlin Heidelberg, 1993, pp. 115–129.
[2]	T. Tullis and W. Albert, <i>Measuring the User Experience: Collecting, Analyzing, and Presenting Usability Metrics</i> , 1 edition. Amsterdam ; Boston: Morgan Kaufmann, 2008.
[3]	J. Nielsen, "Usability inspection methods," in <i>Conference companion on Human factors in computing systems</i> , 1994, pp. 413–414.
[4]	ASCOS Website, http://www.ascos-project.eu
[5]	A.L.C. Roelen (NLR) , J. Verstraeten (NLR) , L. Save (Deep Blue) , N. Aghdassi (Avanssa), Framework Safety Performance Indicators, ASCOS D2.1, Version 1.5, 2014
[6]	N. Aghdassi (Avanssa), A.L.C. Roelen (NLR), A.D. Balk (NLR), Total Aviation System Baseline Risk Picture, ASCOS D2.2, Version 1.3, 2013
[7]	A. Iwaniuk (IoA), P. Michalak (CAA PL), G. van Es (NLR), B. Dziugiel (IoA), W. Miksa (IoA), M. Mączka (IoA), N. Aghdassi (AVA), R. Menzel (JRC), L. Save (DBL), Process for Safety Performance Monitoring, ASCOS D2.3, Version 1.0, 2014
[8]	N. Aghdassi (Avanssa), A.L.C. Roelen (NLR), B. Dziugiel (ILOT) and R. Menzel (JRC), ASCOS WP2 Final Report – Continuous Safety Monitoring, ASCOS D2.5
[9]	A.L.C. Roelen, J.G. Verstraeten, L.J.P. Speijker, S. Bravo Muñoz, J.P. Heckmann, L. Save, T. Longhurst; Risk models and accident scenarios in the total aviation system, at http://www.ascos-project.eu , 2014
[10]	J.G. Verstraeten, A.L.C. Roelen, L.J.P. Speijker; Safety performance indicators for system of organisations, at http://www.ascos-project.eu , 2014
[11]	ICAO Annex 19, Safety Management, First Edition: 14 November 2013.
[12]	General Acceptable Means of Compliance for Airworthiness of Products, Parts and Appliances AMC-20 as contained in EASA ED Decision 2003/12/RM as amended.
[13]	Directive 2003/42/EC of the European Parliament and of the Council of 13 June 2003 on occurrence reporting in civil aviation. exchanged in accordance with Directive 2003/42/EC of the European Parliament and of the Council
[14]	Commission Regulation (EC) No 1321/2007 of 12 November 2007 laying down implementing rules for the integration into a central repository of information on civil aviation occurrences
[15]	Commission Regulation (EC) No 1330/2007 of 24 September 2007 laying down implementing rules for the dissemination to interested parties of information on civil aviation occurrences
[16]	REGULATION (EU) No 996/2010 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, provided additional clarification on access to data in the European Common Repository of occurrence reports.
[17]	Regulation (EU) No 376/2014 of the European Parliament and of the Council of 3 April 2014 on the reporting, analysis and follow-up of occurrences in civil aviation
[18]	REGULATION (EC) No 216/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency
[19]	Data Quality Rules for ECCAIRS 5: Occurrence Categories update 4 March 2013, available on the ECCAIRS portal – Support – Usage examples
[20]	ASCOS Tool for Continuous Safety Monitoring (ATCSM) User Manual

Appendix A

JRC response to recommendations

The JRC reaction to the recommendations made by Deep Blue and the NLR is summarized below. Where possible, recommendations were implemented. For some, the implementation attempted to address the issue concerned but did not follow the precise recommendation. Instead an alternative solution was provided aimed at implementing the intent of the recommendation.

Table 2. Recommendations and JRC reactions

#	Identified Usability Issues (page number is indicated in brackets)	Recommendation(s)	JRC reaction
1	SPI sub menus disappearing from user view when shrinking the ATCSM Project Window (p. 46)	1. Ensure that a symbol specific for the SPI submenus remains visible when ATCSM Project view is shrunk	Implemented, icons added
2	SPI recalculation options not immediately visible to the user (p. 48)	2. Place the recalculate option in the context of the SPI window.	Implemented by a triggering recalculation when closing the SPI edit window
3	Lack of clarity between the “File” submenu, the “Project Menu” and the entities they relate to (p. 49)	3.1 Replace the name of the “File” submenu with “Library”. 3.2 Consider moving the current four submenus contained under the “Project” menu under the File (Library) menu.	Implemented, menus revised
4	Opening a library requires the user to open the ATCSM first (p. 50)	4. Consider giving the option to the user to launch the ATCSM directly by double clicking on the library file icon available on the desktop.	Implemented
5	The name of the application displayed in the Windows “start” menu differs from the application name appearing on the top of the ATCMS Project window (p. 51)	5. Use the same software name consistently across different menus and bars.	Implemented, names aligned
6	Library name appearing on the top bar of the main software window not clearly readable (p. 51)	6. Replace file path information on the top bar of the ATCSM with the name of the currently open library.	Implemented by providing file as well as library name
7	Repetitive selection of the query text line required in the SPI query builder (p. 52)	7. When opening the SPI Query builder, the selection bar should appear automatically over the first row of the active window in which a text line appears.	Superseded: the query text line can already be edited directly by double clicking on the line.

8	Ambiguous symbology used for the editing function (p. 53)	8. For the editing function, use a symbol different from the play (“>”) symbol. Consider the use of a label, either alone or in combination with a symbol.	Implemented, different icon used
9	Difficult to retrieve occurrence data for non-expert users (p. 53)	9. Adopt a direct manipulation style to filter occurrence data.	Not implemented
10	Enhance information provided when pressing the “info” button	The criteria of the queries are shown, however, the information on the “main” filter is missing	Implemented, information on the main” filter added
11	The term “scaling” on the y-axis of the graph is confusing	The user may not understand what is meant by scaling	Implemented, changed the text from “scaling” to “per” as the rates are “per” the scaling factor, e.g. per 100 000 flight, hours etc.
12	The data window does not include information on the scaling factors used	Without the scaling factor being shown, the user is not aware which factor has been applied.	Column containing the scaling factor has been added to the data window and to the exports

One recommendation was not implemented. It concerned “Adopt a direct manipulation style to filter occurrence data.”

The examples shown in the report and the user manual have been drawn up using only some twenty attributes of the ECCAIRS system. The user may wish to note that the ECCAIRS taxonomy, however, is made up from more than 60 nested entities which contain some 900 attributes, for which, in turn, more than 60 000 coded values are possible. In addition, the system contains numerous attributes for free text, numbers and dates. In summary, the visual display and manipulation of a structure of this size and complexity is a challenge, one which could not be tackled within time and resources available for this project.