Final Project Report

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Abstract

The project has aimed at defining and validating the Airborne Spacing (ASPA) concept in the terminal airspace. It addressed both the Sequencing and Merging (ASPA-S&M) and the Interval Management (ASPA-IM) applications. These ASPA applications establish a set of procedures for controllers and pilots, whereby the controller with support of ground-based tools instructs the aircraft to achieve and/or maintain a given time spacing from a preceding aircraft, while the flight crew is provided with flight deck tools to assist them in complying with the instruction. The validation activities under the scope of the project have been performed via performance analyses of ASPA algorithms, real time simulation and live trial techniques.

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This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
APP	Approach
ASAS	Aircraft Surveillance Applications System, Airborne Separation Assistance System
ASPA	Airborne Spacing
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATSAW	Airborne Traffic Situation Awareness
CAVS	CDTI Assisted Visual Separation
CPDLC	Controller Pilot Data Link Communications
CDTI	Cockpit Display of Traffic Information
CTA	Controlled Time of Arrival
FIM	Flight deck Interval Management
HMI	Human Machine Interface
IFR	Instrument Flight Rules
IM	Interval Management
INTEROP	Interoperability (Requirements)
KPA	Key Performance Area
MOPS	Minimum Operational Performance Standard
NARSIM	NLR ATC Research Simulator
OFA	Operational Focus Area
OSED	Operational Services and Environment Description
RTF	Radiotelephony
RTS	Real Time Simulation

SC	Special Committee
SG	Sub-Group
S&M	Sequencing and Merging
SPR	Safety and Performance Requirements
TMA	Terminal Manoeuvring Area
V&V	Verification and Validation
WG	Working Group

1 Project Overview

The project focussed on the definition and validation of the Airborne Spacing (ASPA) concept in the terminal airspace. It addressed both the Sequencing and Merging (ASPA-S&M) and the Interval Management (ASPA-IM) applications. These ASPA applications establish a set of procedures for controllers and pilots, whereby the controller with support of ground-based tools instructs the aircraft to achieve and/or maintain a given spacing from a preceding aircraft, while the flight crew is provided with flight deck tools to assist them in complying with the instruction.

1.1 Project progress and contribution to the Master Plan

The project contributed to operational improvements TS-0105-A and TS-0108. Both operational improvements are dealing with Airborne Spacing (ASPA) as part of SESAR Step 1 Time Based Operations. TS-0105-A addresses the Sequencing and Merging (ASPA-S&M) application and TS-0108 the Interval Management (ASPA-IM) application.

The objective of ASPA operations is to improve the precision and consistency of inter-aircraft spacing over non-ASPA operations. Benefits result from a decrease in controller communication load per aircraft and more precise inter-aircraft spacing between the ASPA aircraft and target aircraft. The controller communication load per aircraft is reduced due to the fewer speed and vector instructions. The precise spacing can allow for higher runway throughput and more efficient aircraft operations. In section 1.2 the achieved results are discussed.

In both ASPA-S&M and ASPA-IM applications, the controller instruct the flight crew of the ASPA aircraft to perform one of the ASPA manoeuvres to achieve and/or maintain a given spacing with a designated aircraft (also known as target aircraft). The spacing is in time. Although the flight crew is given a new spacing task, separation provision is still the controller's responsibility and applicable separation minima are unchanged.

The Assigned Spacing Goal is selected by the controller, with support of ground-based tools, to provide the value of the desired spacing between the IM Aircraft and Target Aircraft while meeting other operational constraints and considerations. The ASPA applications assume that the inbound sequence has already been built and that it is pre-conditioned.

For the ASPA-S&M application, the target aircraft must fly either the same route as the S&M aircraft or a direct route to the merge point; the merge point is the first point that is common to both the S&M aircraft's and target aircraft's route. The merge point is also the point where the assigned spacing goal has to be achieved at the latest. The ASPA-S&M application involves the Remain Behind and Merge Behind manoeuvres.

For the ASPA-IM application, the target aircraft is not necessarily flying direct to a merge point, i.e. more complex route geometries are also addressed. The point where the spacing goal has to be achieved, as assigned by controller, is also not necessarily the merge point. It could be located beyond the merge point. These two adaptations greatly enhance the opportunities for ASPA to successfully deliver the more precise inter-aircraft spacing and resulting benefits. The manoeuvres envisaged for ASPA-IM are Achieve then Maintain, Achieve-by then Maintain, Follow Heading then Turn and Follow Route then Turn.

The following techniques were used to advance the maturity of ASPA applications:

- Subject matter expert teams. Operational, safety, performance, security and interoperability assessments were performed to derive requirements for the ASPA applications.

- Real time simulations. A number of controller-in-the-loop, pilot-in-the-loop and combined controller-in-the-loop and pilot-in-the-loop simulations were performed to validate requirements and to assess the impact on the key performance areas (KPAs);
- Pre-industrial prototypes in real time simulation and live trial. A number of real time simulations and two flight trials, with the use of airborne and ground-based ASPA prototypes, were performed on Industrial Based Platforms to test the maturity of the main technical enablers (TS-0105-A only);

For ASPA-S&M, V2 and V3 validation activities were performed to fully assess the impact on the KPAs potentially affected by the concept:

- Airport Capacity (runway throughput);
- TMA Airspace Capacity;
- Safety;
- Environmental Sustainability;
- Controller Productivity;
- TMA Variability (time predictability);
- TMA Security; and
- Human Performance.

For ASPA-IM, V1 and initial V2 validation activities were performed. The V2 validation activities to assess of the impact on a sub-set of the KPAs:

- Airport Capacity (runway throughput);
- Environmental Sustainability;
- TMA Variability (time predictability); and
- Human Performance.

The ASPA-IM V1 validation activities were performed involving operational actors (i.e. ATCOs) supported by appropriate mock-ups that allowed to provide feedback on a few aspects of the ASPA-IM operational concept.

The project also had a contribution to operational improvement AUO-0507 'Airborne Spacing Monitoring under IFR'. Validation activities were performed with pilots in the loop and avionics prototypes, addressing acceptability and feasibility from the flight crew point of view.

Code	Name	Project contribution	Maturity at project start	Maturity at project end
TS-0105-A	ASAS Spacing - target direct to a merge point (speed/simple geometry)	Requirements definition. Requirements validation and impact assessment on the relevant KPAs via V2 and V3 validations. R3, R4 and R5 validations.	V1	V2
TS-0108	ASAS Spacing - target not direct to a merge point (speed and	Operational requirements definition. Requirements validation and impact	V0	V1

	lateral/more complex geometry)	assessment on the most important KPAs via an initial V2 validation. V1 validation focussing on particular scope elements.		
AUO-0507	Airborne Spacing Monitoring under IFR (ATSAW Spacing Monitoring)	Initial validation of the ATSAW+ function from the flight crew and aircraft point of view.	V0	V1

1.2 Project achievements

Operational Improvement TS-0105-A of the European ATM Master Plan

A number of controller-in-the-loop and pilot-in-the-loop validations, mainly real time simulations but also two flight trials, were performed to test the feasibility of ASPA-S&M and to test the integration of the ASPA-S&M functions in pre-industrial prototypes, prototypes of both ground automation and aircraft systems.

The results of various validation activities conducted in support of TS-0105-A (SESAR Solution #16) indicate that:

- Both controllers and flight crews provided positive feedback concerning the use of ASPA-S&M procedures in each phase of operations.
- Concerning implementation of the concept it appeared that ASPA-S&M seems more effective when combined with a PBN environment. That is somehow logical as the ASPA-S&M manoeuvres are remain behind and merge behind instructions and consequently require a common route and a fix (merge point) to support the clearance.
- CPDLC obviously reduces the use of RTF and more importantly it simplifies the target identification process and ASPA-S&M clearances.
- Nonetheless workload slightly increases for both controllers and flight crews, it however remains acceptable. There is a risk of an increased “heads-down” in the cockpit that needs to be addressed with a clear and unambiguous sharing of tasks between both crewmembers.
- The flight crews stated that the ASPA-S&M operations are well integrated in current flight crew tasks. The on-board ASPA-S&M function allows to efficiently perform the flight crew tasks with an acceptable level of workload and without degrading other tasks performances.
- Roles and responsibilities of the crewmembers are clearly identified and are considered as appropriate.

However, the results from SESAR1 do not give confidence in the expected benefits of ASPA-S&M: workload is potentially increased, and there is a slight increase in fuel consumption and distance flown. This does not offset the increase in runway throughput. Moreover, the concept has only been tested in a Medium Density/Medium Complexity environment; whereas the related Operational Improvement Step should also include High Density/High Complexity environments.

The results could be used in future R&D on Airborne Spacing. Since the complex geometries may not solve the lack of performance in the simple geometries, TS-0108 definition would require an update since TS-0105-A will be closed.

Operational Improvement TS-0108 of the European ATM Master Plan

An initial ground validation with controllers in the loop was performed to test the feasibility of ASPA-IM operations, a V2-level Real Time Simulation. The ASPA-IM procedure and implementation was highly appreciated by the controllers as was the HMI. However they did indicate that (as a result of the complexity of the IM clearance) the RTF communication load during ASPA-IM operations was critical and recommended, amongst other non IM-related improvements, a further simplification of the IM Clearance.

Controllers also indicated that it is essential for them to know whether the IM clearance is correctly entered into the on-board system and being followed. It was strongly recommended that a technical solution should be presented for the controller to see whether the pilot has selected the proper Target Aircraft ID, the correct Assigned Spacing Goal and whether IM is being executed or not.

The quantitative analysis in general showed that operating on fixed routes will have a positive effect on noise and predictability. For noise, fuel and CO2 emissions this is amplified when flying Continuous Descent Operations (vertical path based on a fixed angle of descent, resulting in nominally near idle thrust settings). When operating ASPA-IM the data shows a small detrimental effect on noise, fuel and predictability, which is traded-off by a significant gain in runway capacity.

It was demonstrated that ASPA-IM has the potential to increase runway throughput compared to radar vectoring in a high-density TMA environment. For continuous descents, IM may increase runway throughput with around 3 landings per hour per runway (8-9%). For stepped descents, the potential increase in number of landings per hour is limited to around 0.5 landing per hour per runway (1-2%).

In summary, it was demonstrated that ASPA-IM enables to a large extent the benefits associated with a fixed arrival/approach route network and continuous descent approaches in a high density TMA environment, i.e., time predictability, fuel efficiency and noise. These results support the premise that for high density operation on fixed routes with CDO, Interval Management is required.

Another controller-in-the-loop exercise looked at the operational need for a tool supporting controllers to provide appropriate spacing goals. The results of the exercise showed that the proposed estimated spacing tool could bring benefits to ASPA-IM Operations, especially to help to choose an appropriate assigned spacing goal before providing the IM Clearance. The tool is all the more needed when the pre-sequencing is off-nominal. The operational need of lateral ASPA-IM manoeuvres was also planned for this exercise but could not be performed due to delays in the algorithm development.

Finally, the project delivered a mature ASPA-IM OSED for TS-0108 of the ATM Master Plan. Note that the ASPA-IM application is in line with the published standards on Airborne Spacing Flight Deck Interval Management (ASPA-FIM) as developed by RTCA SC-186 and EUROCAE WG-51, it is a sub-set of ASPA-FIM.

Operational Improvement AUO-0507 of the European ATM Master Plan

Initial pilot-in the-loop validations were performed to test the feasibility of Airborne Spacing Monitoring, for example the CDTI Assisted Visual Separation on Approach (CAVS) procedure that is an enhancement of current visual separation. The results showed that the new functionalities did not modify the existing task sharing and could be easily integrated in the existing tasks the flight crew has to execute. The workload remained at an acceptable level. Airborne spacing monitoring provided an added value for the operations where the responsibility of maintaining separation is delegated to the flight crew.

1.3 Project Deliverables

The following table presents the relevant deliverables that have been produced by the project.

Reference	Title	Description
D07	IT1 - VREP	This document describes the initial set of validations and in particular its results. These validations addressed the following topics of the ASPA-S&M application: • Termination procedures • Procedures for modifying on-going ASPA-S&M operations

		• Use of CPDLC to support ASPA-S&M • Procedures for non-nominal situations (e.g. risk of loss of separation, go-around, bad weather) • Information needs to support the controller during the initiation and execution of ASPA-S&M • Operational acceptability of the speed behaviour of ASPA-S&M aircraft • Use of ASPA-S&M in current route structures.
D12	IT2 - VREP	This document describes the second set of validations and in particular its results. These validations addressed the following topics of the ASPA-S&M application: • Mental workload and situation awareness of both controllers and flight crews • Nominal procedures in each phase of the ASPA-S&M operation • Usability and appropriateness of the HMI and functions to support the flight crew and controller tasks • Acceptability of speed behaviour of ASPA-S&M aircraft • Procedures after critical safety events, addressing non-nominal situations • Use of CPDLC • Trajectory predictability and aircraft sequencing performance
D31	Stream 2 - State of the art ASPA FIM results	The purpose of this document is to make a state of the art on ASPA applications, so as to bring material for a further work on a scope extension. This document provides an identification of spacing activities outside that of SESAR. It provides an overview of the differences between the RTCA/EUROCAE ASPA-FIM definitions, the FAA IM definitions, and the SESAR ASPA-IM S&M definitions. To complete this overview with concrete possibilities of implementation, a study on Schiphol airport and three scenarios (Madrid, Palma, Lyon), are added. In addition, the recommendations from the SESAR ASPA-S&M validations, which might be taken into account for a scope extension, are reminded.
D34	Stream2 - Initial Validation Path (Technical Note)	This document presents the initial validation path for SESAR Operational Improvement TS-0108. The operational improvement TS-0108, titled "ASAS Spacing - target not direct to a merge point (Speed

		and Lateral/more complex geometry)" is addressing SESAR Step 1. The initial steps of the TS-0108 validation path are defined. Firstly, the conceptual differences with ASPA-S&M (TS-0105-A) and RTCA/EUROCAE ASPA-FIM are analysed. Secondly, the validation topics, objectives and means are identified for the time period 2014-2016. And finally, the proposed validation activities for the time period 2014-2016 are described at a high level.
D47	Stream2 OSED for Airborne Spacing Interval Management (ASPA-IM) in the European ATM System - Rev B	This document contains the Operational Service and Environment Definition (OSED) of the ASPA-IM application for SESAR Step 1, based on Operational Improvement TS-0108 of the European ATM Master Plan. This OSED is dedicated to TS-0108. Although it builds upon the previous Stream1 ASPA-S&M OSED, it is not the continuation of the Stream1 OSED. Indeed, the Stream 1 OSED considers simple geometries, whereas the TS-0108 considers complex geometries, which is not only an evolution from simple to complex, but induces significant hypothesis changes. The second revision of the Stream 2 OSED results from the consolidation of the previous version with the outputs from initial controller-in-the-loop validations. Appendixes include outcomes from studies on possible enhancements of the ASPA-IM concept (e.g., At or Greater Assigned Spacing Goal, Target ETA Transmission). This OSED is considered to be mature, i.e. complete and expected not to be subject to significant changes; it allows the continuation of the validation activities foreseen in SESAR 2020.
D49	Stream2 VALR for ASPA-IM	This document provides the Validation Report for validations related to Operational Improvements TS-0108 and AUO-0507. It reports on the results of validations executed by C-LVNL, DSNA, Airbus and Honeywell. Validations by C-LVNL and DSNA addressed the following topics of the ASPA-IM application: • Impact of ASPA-IM operations on the KPAs runway throughput (landing), fuel efficiency, noise, time predictability, and human performance (workload, acceptability, situation awareness, etc.) • A ground spacing tool to help the controller choose an assigned spacing goal compatible with the overall situation of the two aircraft involved, in order to reduce the number of "unable" situations • The behaviour of the spacing algorithm and potential separation issues in case the

		Achieve-by Point is located beyond the Merge Point And validations by Airbus and Honeywell addressed the following topics of the AUO-0507 (Monitoring Airborne Spacing Monitoring under IFR): • ATSAW+ function in a mainline cockpit: interest of ATSAW+ function in various operational situations, including continuous descent approach. • Procedures for CAVS operations as well as the functional and HMI elements when using the CAVS procedure. Focus on business aircraft pilots.
D50	Stream 1 Consolidated SPR - Rev A	Final ASPA-S&M SPR, including ASPA-S&M OSED, which was updated based on the conclusions and recommendations of several integrated validations. These validations addressed the integration of Enhanced AMAN, CTA/i4D and ASPA-S&M (ref. SESAR Project 05.03)
D51	Stream 1 Consolidated INTEROP - Rev A	Final ASPA-S&M INTEROP, which was updated based on the conclusions and recommendations of several integrated validations (ref. SESAR Project 05.03).

1.4 Contribution to Standardisation

EUROCAE WG-51 / RTCA SC-186

The 05.06.06 work addressed two IM applications as described in the section 1.1. Project 05.06.06 and the associated technical project 9.05, through its individual members, closely followed, reviewed and commented the ASPA-FIM standardisation activities of RTCA SC-186 and EUROCAE WG-51. A number of working papers were prepared and discussed at the joint meetings of WG-4 (of SC-186) and SG-3 (of WG-51) developing the SPR and MOPS for Flight Deck Interval Management.

P05.06.06 concluded that the ASPA-S&M application (TS-0105-A) is a small sub-set of the global FIM standards, the S&M requirements are to a large extent compatible with published FIM SPR ED-195A/DO-328A. The main deviations are (a) that for the S&M Merge manoeuvre the Target Aircraft Intended Flight Path Information processing is simpler than what is defined in the FIM MOPS, because the target aircraft is flying direct to the merge point and the Achieve-by Point is always the merge point, and (b) the ASPA-S&M manoeuvres cannot be suspended.

The ASPA-IM application (TS-0108) requirements are fully in line with the published FIM SPR standard. Note that also the ASPA-IM, while its scope is considerably larger than ASPA-S&M, is also a sub-set of the FIM SPR. For example, en-route operations, distance-based Assigned Spacing Goals and the Final Approach Spacing and Maintain Current Spacing Clearance Types are not in the scope of the ASPA-IM application.

EUROCAE WG-78 / RTCA SC-214

In the P05.06.06 initial OSED and INTEROP documents a set of Controller Pilot Data Link Communications (CPDLC) messages suitable for airborne spacing were progressively developed. In

parallel a “Tiger Team” set up by RTCA/EUROCAE SC-214/WG-78 was tasked with developing a set of CPDLC messages suitable for use with Airborne Spacing - Flight Deck Interval Management (ASPA-FIM) as described in the ASPA-FIM SPR, ED-195()/DO-328().
Close co-ordination was established between SESAR P05.06.06 and the RTCA/EUROCAE Tiger Team. The objective of this co-ordination was to ensure that the message set developed by RTCA/EUROCAE is compatible with SESAR needs and that a sub-set of the full RTCA/EUROCAE CPDLC messages satisfies the needs of SESAR P05.06.06.

RTCA/EUROCAE first issued the standard ED-229 for ATN Baseline 2, which included a set of messages for FIM operation. However, this version was not to be applied before Revision A is published, with possible evolution of the message set, either according to official publication of FIM standard, either as a result of Advanced-IM initiated work. In the meanwhile co-ordination continued with RTCA/EUROCAE to arrive at a satisfactory conclusion that will enable a subset of the Tiger Team CPDLC messages to be used for SESAR ASAS spacing manoeuvres. After the publication of ED-229A revision of ATN B2 standard, in January 2016, the new message set was considered and taken as the reference for CPDLC messages. However, ED-229A provides FIM messages based on a data structure called IMAACD, with no indication for cockpit display. The 05.06.06 proposed wording of the messages was kept, based on ED-229 and previous P05.06.06 work.

1.5 Project Conclusion and Recommendations

Operational Improvement TS-0105-A of the European ATM Master Plan

From a KPA point of view no significant benefits were demonstrated, only slightly positive and slightly negative effects were shown: fuel efficiency is slightly decreased; time predictability, runway throughput (landing) and TMA airspace capacity is slightly increased; safety and security are not negatively impacted.

Open issues are mainly related to the display of information indicating to controllers that the initiation conditions are fulfilled to issue a feasible Merge Behind instruction, these initiation conditions have to take into account the time-to-go or distance-to-go to the location where the instructed spacing goals needs to be achieved. Given the definition of ASPA-S&M, this puts high demands on the pre-conditioning and delivery precision prior to initiating ASPA-S&M (i.e., limiting the initial spacing errors) and on the route structure (i.e., providing sufficient time to correct spacing errors). The combination of the ASPA-S&M definition and typical TMA route structures, that is without sufficiently long straight legs to merge points inside the TMA, is seen as the main contributing factor of the absence of significant benefits for TS-0105-A. It is therefore recommended to reconsider some of the constraining elements of the ASPA-S&M definition. The work that will be undertaken in SESAR 2020 will be based on TS-0108, which did not only look at complex geometries, but also considered an alternative version of TS-0105-A. The main evolutions that are envisaged are:

- The simple geometry manoeuvre is done with procedures allowing more time for the manoeuvre to be executed (e.g. with the achieve-by-point after the merge point, …) and potentially mitigating the large number of airborne UNABLES and the strict requirements to traffic pre-sequencing due to the original TS-0105-A;
- Starting the manoeuvre higher than it was done in SESAR 1. This is closer to the FAA concept, and supports the same concept of allowing more time for the manoeuvre to take place;
- Focus on the use of radiotelephony (RTF) versus datalink (CPDLC/ADS-C);
- Considering the various possibilities of communicating target aircraft intentions to the trailing ASPA aircraft to allow operating ASPA-IM in the case of complex geometries
- Considering the use of “at or greater” spacing goals in medium density TMA operations;

Operational Improvement TS-0108 of the European ATM Master Plan

Initial results looking at the impact on several relevant KPAs (runway throughput, predictability, fuel efficiency and noise) are very promising either as a direct effect of ASPA-IM or as enabled by ASPA-IM. Note that other KPAs, such as human performance, safety, cost efficiency and TMA airspace capacity, were partially addressed.

It is strongly recommended to continue the work on ASPA-IM (TS-0108) in SESAR 2020 (a) to further address the KPAs human performance (in particular workload), safety, security, cost efficiency and TMA airspace capacity in order to demonstrate that the impact on these KPAs will not be negative, (b) to validate the system performance requirements, and (c) to develop and verify technical prototypes for both the ground automation and aircraft.

Operational Improvement AUO-0507 of the European ATM Master Plan

Initial results on human performance and safety aspects are good. It is therefore strongly recommended to continue the work on Airborne Spacing Monitoring (AUO-0507) in SESAR 2020. More evaluations should be made to reach a complete view of the relevance of Airborne Spacing Monitoring to support flight crews during operations in European airspace where separation responsibility is transferred to the flight crew. Furthermore some support must be provided to flight crews so as to help them decide on a relevant minimum distance under which they don't want to go to. For this purpose, information about the wake vortex minima and the local radar minima regulations should be available on board.

Integrated Validations

Two integrated validations involving ASPA-S&M (TS-0105-A) and other SESAR concept elements, such as Enhanced Arrival Management and CTA/i4D, have been performed. It was useful from a technical and operational point of view to address interactions between these concepts as well as the impact on KPAs. Note though that no KPA targets for integrated concepts had been set. It is recommended from a programmatic point of view to reconsider (a) KPA targets for integrated concepts and (b) the involvement and formal responsibilities of the individual concept leads in integrated validations in SESAR2020.

2 References

[1] SESAR Programme Management Plan, Edition 03.00.01

[2] European ATM Master Plan

[3] Multilateral Framework Agreement (“MFA”) signed between the SJU, EUROCONTROL and its 15 selected members on August 11, 2009, amended on 14 June 2010, 19 October 2010 and 2 July 2012

[4] SESAR Project 05.06.06, IT1 - VREP, D07, Edition 00.01.00, June 2011

[5] SESAR Project 05.06.06, IT2 - VREP, D12, Edition 00.01.01, 9 September 2013

[6] SESAR Project 05.06.06, Stream 2 V1 State of the art on ASPA applications, D31, Edition 00.01.02, 29 July 2014

[7] SESAR Project 05.06.06, Stream 2 - Initial Validation Path (Technical Note), D34, Edition 00.01.01, 1 August 2014

[8] SESAR Project 05.06.06, Stream2 OSED for Airborne Spacing - Interval Management (ASPA-IM) in the European ATM System - Rev B, D47, Edition 00.01.00, 23 June 2016

[9] SESAR Project 05.06.06, Stream2 VALR for ASPA-IM, D49, Edition 00.01.00, 31 May 2016

[10] SESAR Project 05.06.06, Stream 1 Consolidated SPR - Rev A, D50, Edition 00.01.01, October 2016

[11] SESAR Project 05.06.06, Stream 1 Consolidated INTEROP - Rev A, D51, Edition 00.01.01, October 2016

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