ICB

Industry Consultation Body

ICB Position Paper

Impact of RPAS on ATM

Remotely Piloted Aircraft Systems (RPAS) are increasingly common in European skies and are expected to continue to grow dramatically in the coming years. The burgeoning industry offers a range of applications and facilitates new growth across markets including manufacturing, film and agriculture. However, RPAS expansion faces numerous obstacles (safety, security, various social issues) and the regulatory challenge lies in addressing these issues in a harmonised way, whilst still allowing the RPAS market to thrive.

The ICB has identified a number of RPAS integration principles to achieve this in a safe and secure manner. The principles are based on RPAS not compromising the current ATM system, and RPAS regulations being adaptable to change.

RPAS technology is developing faster than the operational concept, and the technology is driving discussion more than the operational concept. It is, of course, difficult to regulate when there is no clear purpose. The ICB therefore recommends that a vision and (extensible) CONOPS are established.

Many RPAS issues are inter-related and so need to be addressed holistically. It is also difficult to generalise as one size does not fit all: risk, performance and operation-based categorisation all have a part to play. At the same time, there are new stakeholders (e.g. drone manufacturers, professional and recreational users), many of whom are aviation novices, and all stakeholders need to come together to address the challenges in a holistic, staged way. The ICB therefore recommends that ongoing management is required with sufficient technical and operational expertise to address the current and future questions on RPAS integration. A concrete proposal is given for integration arrangements.

1 BACKGROUND

Developed originally for military operations, Remotely Piloted Aircraft Systems (RPAS) ('drones') now cover an increasingly diverse range of applications from farming and surveying RPAS to hobbyist quadcopters. Large-scale commercial RPAS projects have been announced covering concepts for low-altitude transportation of goods and wireless internet connection via high-altitude balloons in active development. The industry is experiencing significant growth: the SESAR European Drones Outlook Study[1] predicts 7 million leisure drones and 400,000 commercial and government units to be operating in Europe by 2050, with a drone marketplace valued at €15 billion.

Under ICAO terminology, RPAS are a subset of unmanned aircraft, as set out in the table below.

Name	Abbreviation	Description
Unmanned Aircraft	UA	An aircraft which is intended to be operated with no pilot on board
Remotely Piloted Aircraft	RPA	An aircraft where the flying pilot is not on board (subset of UA)
Unmanned Aircraft System	UAS	An aircraft and its associated elements which are operated with no pilot on board
Remotely Piloted Aircraft System	RPAS	A set of configurable elements consisting of a remotely-piloted aircraft, its associated remote pilot station(s), the required command and control links and any other system elements as may be required, at any point during flight operation

Table 1. ICAO unmanned aircraft terminology[2]

RPAS are used by hobbyists and professionals with a range of applications in film, search and rescue, surveillance and monitoring, infrastructure inspection, survey and agriculture. Within these areas RPAS provide a means to conduct work which to do it manually may otherwise be prohibitively dangerous or costly. Indeed, RPAS have numerous potential applications in airport operations that could increase the efficiency of processes and drive cost and performance improvements. RPAS success, therefore, fosters numerous European industries including aviation itself. Notably, the SESAR European Drones Outlook Study[1] states the ability to operate in Very Low Level (VLL) airspace (< 150m) is a key enabler for market expansion.

Integration into non-segregated airspace to allow market growth is important but must address safety and security issues, as well as social concerns such as data protection, public liability, noise and privacy. Some large RPAS have already been integrated into controlled airspace and, more generally, RPAS flying in controlled airspace are not expected to be a major issue as they are, and will be, required to abide by the ATM and avionics fit rules of the airspace in which they fly. However, smaller RPAS have the potential to negatively impact Air Traffic Management (ATM) as they are harder to detect and there is less knowledge of their intended mission available to ATC.

[1] http://www.sesarju.eu/sites/default/files/documents/reports/European_Drones_Outlook_Study_2016.pdf

[2] http://www.icao.int/meetings/uas/documents/circular%20328_en.pdf

Regulating rapid advances in technology is also challenging and effective regulation is made harder because many recreational users of RPAS lack aviation knowledge. Breeches of rules need to be detectable and enforceable, which can be difficult. In short, RPAS expansion faces numerous obstacles and the regulatory challenge lies in mitigating these issues in a harmonised way, whilst still allowing the RPAS market to thrive.

2 REGULATORY PROGRESS

Regulatory development in Europe was launched with the European Commission study on UAS[3] in 2007. An ICAO Circular in 2011 (Cir 328 AN/190)[4], *Unmanned Aircraft Systems*, was the first step towards a fundamental international regulatory framework, advocating international harmonisation. A call for action to enable the progressive integration of RPAS into civil airspace from 2016 was heard at the European Summit in December 2013.

European developments continued with the publication of the final report[5] of the European RPAS Steering Group (ERSG) in June 2013. The Commission's Communication on *Opening the aviation market to the civil use of remotely piloted aircraft systems in a safe and sustainable manner* (COM (2014) 207[6]) concentrated on civil use for RPAS and responded to the call of the European manufacturing and service industries to remove barriers to the introduction of RPAS in the European single market. It presented RPAS forecasts, both in technology and economics, advocating support for a strong, competitive manufacturing industry by mitigating social concerns. The Conference on Remotely Piloted Aircraft Systems in Riga[7], March 2015, then saw the first high-level political discussion at EU level on integration into non-segregated airspace, safety, security, data protection and privacy.

Following the Riga Conference, EASA was tasked to develop a regulatory framework for RPAS operations and proposals for the regulation of low risk drone operations. A Notice of Proposed Amendments (A-NPA 2015-10) on the *Introduction of a regulatory framework for the operation of drones*[8] proposed three categories: 'open' (low risk), 'specific operation' (medium risk) and 'certified' (high risk), each with different safety requirements.

EASA's Technical Opinion[9] was developed in parallel to the draft modifications to Regulation (EC) No 216/2008 'Basic Regulation' included in the *Aviation Strategy to Enhance the Competitiveness of the EU Aviation Sector*[10], both published in December 2015. The Opinion includes 27 proposals for a regulatory framework for low risk

[3] http://ec.europa.eu/dgs/home-affairs/e-library/documents/policies/security/pdf/uav_study_element_2_en.pdf

[4] http://www.icao.int/Meetings/UAS/Documents/Circular%20328_en.pdf

[5] http://www.sesarju.eu/newsroom/all-news/european-rpas-roadmap-published-and-available-download

[6] http://ec.europa.eu/transport/modes/air/doc/com(2014)207_en.pdf

[7] https://eu2015.lv/images/news/2016_03_06_RPAS_Riga_Declaration.pdf

[8] https://www.easa.europa.eu/system/files/dfu/A-NPA%202015-10.pdf

[9] https://www.easa.europa.eu/system/files/dfu/Introduction%20of%20a%20regulatory%20framework%20for%20the%20operation%20of%20unmanned%20aircraft.pdf

[10] http://ec.europa.eu/transport/modes/air/aviation-strategy/

operations of all unmanned aircraft. To achieve safe integration, EASA recommends in the proposed Regulation on Unmanned Aircraft Operations[11] new rules particular to each of the three proposed categories and safety promotion material. It notes responsibilities of Member States for certain actions e.g. registration of UAS, airspace restrictions, detection of non-compliances and enforcement. Feedback will be used to develop the NPA.

Rule Making Task .0230 *Regulatory framework to accommodate unmanned aircraft systems in the European aviation system*[12] was established to act on safety concerns, the lack of harmonisation of rules at EU level and authorisation issues and will conclude in 2017.

Most recently, the EC High Level Conference in Warsaw in November 2016 outlined the concept of 'U-Space' as the foundation for secure and safe drone operations and where, in principle, everyone should have access to low level airspace.

Some steps also have been made towards standardisation. EUROCAE Working Groups 73 and 93 were set up to focus on RPAS operations across airspace classes and Visual Line of Sight (VLOS) operations respectively. Recently merged, the new Working Group 105 is developing a series of standards.

3 INTEGRATION PRINCIPLES

Member States' regulatory approaches to RPAS vary widely and are not synchronised when regulations change. Member State definitions of weight categories, maximum height of operations and line-of-sight vary widely and whilst some have stringent regulations in place (including banning all commercial use) others have not regulated at all. A harmonised approach to integration is crucial to cultivating and exploiting a European market and safe and secure operations.

The ICB recognises the importance of RPAS to economic growth, but attention should be drawn to the following principles to prevent conflict with manned aviation and to mitigate negative repercussions:

1) RPAS should not reduce the current level of aviation safety;
2) RPAS should not impair the operation of other aircraft;
3) RPAS regulations should be adaptable to change.

The text below expands on these principles and includes explanation as to how RPAS should be integrated.

3.1 RPAS should not reduce the current level of aviation safety, nor impair the operation of other aircraft

The existing ATM system is reliable and the introduction of RPAS should not reduce the current level of safety nor impair the operation of other aircraft. The ATM system requires an understanding of what aircraft are operating, where they are flying, and the risks to maintaining safe and normal air traffic service. Smaller RPAS in particular pose some risks to this. The implications of these requirements are set out in the following sub-sections.

[11] https://www.easa.europa.eu/system/files/dfu/UAS%20Prototype%20Regulation%20final.pdf

[12] https://www.easa.europa.eu/system/files/dfu/ToR%20RMT.0230%20Issue%201.pdf

3.1.1 Knowledge of what aircraft are operating

All RPAS should be registered

The ICB believes there are significant advantages if all RPAS are registered. This should be used as an educational tool, at point-of-purchase, to ensure basic awareness for RPAS users (see later for details). Registration also offers security benefits when RPAS can be identified in the event of a security breach (especially if ADS-B or geo-fencing has been disabled). Driven by their sheer numbers and level of turnover, registration at the national level is most pragmatic, but will require national level enforcement.

Categorisation should be based on RPAS performance and use

RPAS are difficult to categorise due to the range of sizes and uses. EASA's Prototype Regulation declares categories based on weight. This contrasts with the FAA's UAS classification which is based on nature of operations. The ICB advocates an alternative approach where all RPAS should be subject to categorisation based on performance and use. This is because performance and purpose divisions can more precisely capture risk associated with high-performance unmanned aircraft and different operation types including model aircraft. Weight will, in any case, constrain performance.

Consideration must also be given to the differences in operations of RPAS taking off from runways and those that do not; the latter requires further restrictions on fly zones and hence categorisations may be constrained by different geo-fencing boundaries.

Finally, and equally crucial, categorisation needs to be easy for users to understand.

3.1.2 Awareness of where aircraft are flying

The SESAR 2020 RPAS Exploratory Research Call[13] will explore Unmanned Traffic Management (UTM) to identify CONOPS and define high-level requirements of specific functionalities. These will have to enable the high-level U-Space vision. It is noted that the UTM concept is still under development; however, it can be considered to be the management of unmanned aircraft in low altitude civilian airspace by providing pilots the information needed to establish safe separation minima.

UTM is a prerequisite and an enabler to successful integration of RPAS

Integration of RPAS Command and Control with general civilian air traffic is paramount and RPAS should need to 'log on' (Plug and Fly) to a digital communications network, with all control information logged. Logging on also enables RPAS to access real-time geo-fencing remapping from the network. The location of RPAS is not required for ATM / ATCOs at all times – especially in areas of low altitudes or low intensity operations. Instead, the system should know RPAS locations, and ensure ATM is aware only when necessary.

However, Europe is at an early stage in terms of defined functionality and requisite regulation for an operational UTM as part of U-Space. UTM is centred on the timeliness, reliability, quality and appropriateness of data exchange. UTM functionalities may need to be established iteratively, consistent with development of the technology. SESAR research should better explain the UTM vision and ultimately, aviation stakeholders and especially ANSPs need to be involved in the UTM definition.

[13] https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/calls/h2020-sesar-2016-1.html#c,topics=callIdentifier/t/H2020-SESAR-2016-1/1/1/1/default-group&callStatus/t/Forthcoming/1/1/0/default-group&callStatus/t/Open/1/1/0/default-group&callStatus/t/Closed/1/1/0/default-group&+identifier/desc

Interoperability between ATM and UTM is a key factor in the provision of safe ATM services. Active engagement of ANSPs in UTM will ensure safe and fair integration for all airspace users. ANSPs should be involved in developing UTM, especially in the integration of VLL operations in the vicinity of aerodromes. Such involvement will ensure interoperability and so responsibilities will need to be defined accordingly.

RPAS should be fully conspicuous within airspace

The ICB believes that full conspicuity is necessary. Initially, ADS-B will be necessary for RPAS conspicuity as, whilst UTM may use a different communications network to ATM, they should be interoperable. However, spectrum may be an issue and with the rapid growth of RPAS this could lead to 1090MHz saturation. This will require the use of other technologies (eg Universal Access Transceivers (UAT), Global System for Mobiles (GSM), 4G or 5G, Internet of Things (IoT), etc) that must avoid congestion affecting either Command and Control or surveillance applications.

Wherever possible, conspicuity should enable separation of the RPAS from other airspace users to avoid additional avionic carriage requirements. However, in shared airspace low-cost equipment, or cost mitigating strategies, may be required and should be developed.

Technologies should not be specified in regulation

New technologies and/or different spectrum allocations may be available in the future. 'Detect and avoid' functionalities have been developed by the ICAO RPAS Panel but traffic avoidance may also rely on new technology (e.g. point-to-point links). Using performance-based regulation, and avoiding specifying particular technologies, will help avoid regulations becoming out-of-date.

3.1.3 Understanding of risks

The current safety barriers for RPAS are considered weak and unadjusted to reality. Civil insurance and liability for incidents caused by RPAS fall outside of the ATM scope. Anticipated technical innovations will enable RPAS to fly higher, faster and longer in the near future which only heightens safety concerns.

Airspace incidents should be reported

Growth in the RPAS industry has coincided with a growth of reported incidents in proximity to airports, yet incident data are not routinely logged, or are logged inaccurately. It is therefore hard to quantify operational risk to people, other aircraft and ground infrastructure.

To limit risk from RPAS flights, EASA's Opinion advocates limitation zones and defines minimum safe distances from persons on the ground and other airspace users. The US has also recently commissioned an Unmanned Aircraft Safety Team to reduce accident rates and a Drone Advisory Committee to develop policy for future RPAS use.

For airspace incidents to be understood, the ICB recognises:

- Future collection of incident data is necessary in order to specify the risk and quantify the effectiveness of any regulatory response. Mandatory Occurrence Reports (MOR) should be standardised and who collects them, with what meta-data, needs to be urgently considered.
- Standardised contingency operations and emergency management are necessary. This needs to cover lost links and/or radio failure, flights over populated areas and intentionally terminating a flight.

- Manufacturers are responding to safety issues, for example, with self-enforced or remotely-enforced real time geo-fencing, but they also offer a communications channel to individual users.
- 'Weather-fencing' ought to be considered – should a unit fly in weather conditions beyond that approved for the RPAS, the user would do so at their own risk and invalidate any insurance.
- Research into RPAS collisions is necessary. Previous analyses into bird strikes are not comparable with inevitably different crash properties due to the RPAS build materials and power sources.
- Hazards may also exist where Command and Control data are spoofed or RPAS are used as a weapon.

Airworthiness of all aircraft should be improved

Incidents relating to the RPAS' physical and technical performance including battery and power failure, loss of control links and airframe failure are not routinely logged. To assure airworthiness of RPAS, the ICB believes that data collection of RPAS technical failures is required in order to measure the risk and assess the effectiveness of any regulatory response.

RPAS pilots should be made aware of risks through appropriate training

Safety incidents are not always a result of intentional violation of rules. Ignorance of airspace rules is a significant problem. The EASA Opinion asserted that compliance with safety guidelines can be ensured by evidence of pilot competence. This could be achieved at point-of-purchase and registration – information provided for every owner, and demonstration of such knowledge required for successful registration.

The level of training and demonstrated knowledge should be regulated by the intended use and operation of the RPAS; for example, pilots operating RPAS in airspace subject to ATM should have a higher level of training than those operating leisure drones at VLL.

A challenge remains to ensure pilots with self-builds or RPAS purchased overseas are risk aware and knowledgeable on the required training.

Operating RPAS responsibly will protect public safety and, were liability to be mandated, education and knowledge of relevant regulation will then be required.

Cyber-security should be paramount

Cyber-risks are also high for RPAS operation. Points of attack and failure include RPAS Command and Control, UTM and the interface(s) between UTM and ATM. Very high levels of availability and integrity will be needed, with due confidentiality where data protection is required. Integrated and resilient systems are needed 'by design' and 'by default' to mitigate cyber-risks. For example, the 'Plug and Fly' concept provides a future means of dynamic tracking and (if possible to securely implement) eventual centralised override.

3.2 RPAS regulations should be adaptable to change

CONOPS and regulations risk being rapidly out-of-date in the fast moving RPAS industry and its technology trends. RPAS capabilities will improve massively: drones flying much higher, fuel cells increasing flight time and carbon fibre construction causing detection issues are some of the expectations. RPAS functions will expand with these innovations. Whilst technical mitigations will also improve, regulation needs to be prepared for these changes.

Controls enabled by technology innovations should be utilised

As well as challenges, technology improvements bring opportunities. Current regulations do not consider management of risks through technical controls, but improvements in technology can help mitigate risk and should be recognised in future regulation. For example:

- 'Geo-fencing', where RPAS are configured to fly only within set boundaries, noting that it is crucial that geo-fencing boundaries are dynamic and include AIRAC data and that users should be updated and notified of changes (e.g. through NOTAMS, or SWIM in the future).
- 'Go-home' features, that can be based on operation type; 'go-home' is a configuration that would allow an RPAS to autonomously return to the launch position or instead to an alternative location for maintenance or inspection. Routing is important here.

Integration of RPAS may need updated airspace definitions

RPAS operation within Class E, F and G airspace requires all pilots to observe the Rules of the Air and operate 'see and avoid' practices. However, the small size of most RPAS means they are often inconspicuous to other airspace users. Current airspace categorisation is therefore not compatible with the use of RPAS, as 'detect and avoid' cannot be considered analogous to 'see and avoid' from a manned aviation perspective. The redefinition of airspace or introduction of new classifications of airspace may be necessary for successful integration of RPAS.

4 ICB RECOMMENDATIONS

RPAS integration will be a pivotal moment in the future of European ATM. The introduction of millions of RPAS, with their wide range of operations and performance characteristics, will make airspace and ATM inherently more complex. Whilst VLL RPAS operations in Class G airspace should not affect ATS/ATC, they do impact on ATM. RPAS have the ability to disrupt many established ATM ideas, and so need to be integrated carefully.

This poses numerous challenges and currently European ATM is lacking a clear vision to drive a CONOPS and means to navigate these issues. Many of the issues are inter-related and so need to be addressed holistically. It is also difficult to generalise as one size does not fit all: risk, performance and operation-based categorisation all have a part to play. Finally, there are new stakeholders - both within the aviation market (e.g. drone manufacturers, and professional and recreational users), and outside the aviation market (e.g. technology companies). These new stakeholders will help drive the industry forward, but need to come together to address the challenges in a holistic, staged way.

The ICB therefore recommends a European RPAS vision and an RPAS Integration Committee / Working Group. Due to the fast paced nature of the RPAS sector, these recommendations, which build on current work, must be carried out as soon as possible to protect the interests of European aviation.

Alongside these recommendations is the need for investment to make the vision and implementation a reality. The SESAR European Drones Outlook Study[1] highlights the need for the EU to review levels of funding into R&D in order to stimulate the emerging marketplace and establish an EU-level ecosystem. For example, the paper states a need

for an additional EUR 200 million in R&D over the next 5-10 years to address gaps related to VLL activities.

4.1 The aviation industry needs a European RPAS vision

RPAS technology is developing faster than the operational concept, and the technology is driving discussion more than the operational concept. It is difficult to regulate and guide development when there is no clear purpose and vision. Widespread operation of RPAS in VLL airspace means that today's ATM principles need to be thoroughly re-examined.

Changes coming from RPAS developments may well be a game-changing paradigm shift, meaning that the aviation environment needs to change both in operations and regulations. It is not yet clear what the desired outcome is in 10, 15 years, etc. nor how to achieve it. It seems impossible for ATM to 'keep RPAS out' and so need to change to a risk-based, performance-based approach rather than a fixed requirement-based approach.

A European RPAS vision is needed to articulate and elaborate this. The ICB recommends that the Commission initiates this work. Practically it will be a synthesis of the U-Space concept, planned European ATM Master Plan revision, EASA safety rules and JARUS work coming together and presenting a coherent vision. CONOPS will then describe how this can be achieved, and will need to be extensible and delivered in stages.

4.2 Europe needs an RPAS Integration Committee / Working Group

Ongoing management is required with sufficient technical and operational expertise to address the current and future questions in integrating RPAS in ATM. The Commission should use an RPAS Integration Committee / Working Group[14] to guide and deliver the European Vision. This body provides a single focus needed to orchestrate currently fragmented RPAS initiatives.

Regulatory progress for RPAS has started with EASA's RMT.0230 *Regulatory framework to accommodate unmanned aircraft systems in the European aviation system* which should produce a set of 'Baseline Rules' before its closure in 2017. The aim is to establish a minimum level of regulation to ensure the safety of RPAS integration. However, the fast evolving nature of RPAS means that strict rules and definition of operation types will likely soon be obsolete. A staged approach is therefore necessary, adapting and building on Baseline Rules to allow and control new types of operation, technical controls, etc. The ICB, noting the role of RMT.0230, also recognises the need to ensure consistency across RMTs to reduce duplication and harmonise effort.

One possible approach to implementing suitable arrangements is to establish both a new RPAS Rule Making Task to issue necessary regulations and a complementary Integration Committee / Working Group to collect information on the developing industry. This could work as follows:

- A new **RPAS RMT** is established with an extensible ToR; the ToR can be updated and extended as necessary after each deliverable for regular alignment with RPAS use and risk. This RMT would have the capacity to produce new Rules in addition to the 'baseline', to adapt to the changing industry. These Rules would be published in response to inevitable change and reflect what is necessary to

[14] The DGAC's Civil Drone Council is an exemplar model at the national level. It maintains links between various stakeholders and helps to develop the drone market in France and for exports. The regulatory requirements and implications necessitated representation by all stakeholders.

regulate without overly limiting RPAS operations. The iterative approach allows changes to be made effectively by reducing the risk of delays; uncertainty is reduced and appropriate regulation is developed through manageable incremental changes. This iterative arrangement, that should include all major manned aviation partners, provides the staged but coherent approach to regulation.

- A new **Integration Committee / Working Group** is established to run in parallel with the new RMT and will act as an RPAS integration body for Europe. The group would be concerned with overseeing data collection and defining operational concepts. New findings, including those concerning new operational concepts and incidents, would help to formulate recommendations to the new RPAS RMT. This group would also maintain an incident reporting function, essential to continually evaluate the risk of RPAS operations. This group would also try to accommodate submission of new operational requests and from them develop, maintain and manage a repository of coherent and well-aligned CONOPS for RPAS use cases. The group would also advise on registering all RPAS.
- Outputs from **EUROCAE WG 105** should also be adopted into the Working Group's use of operation recommendations where compliance may only be achieved if standards are satisfied.

This arrangement is shown in the diagram below. Note that one way of practically recognising this arrangement is by expanding the role of EASA to run the Integration Committee / Working Group with appropriate representation from all impacted stakeholders. The Commission's recently announced Task Force structure, specifically the Standards and Regulations Working Group, could fulfil this role if it has the envisaged interface with RPAS users and has the above defined roles.

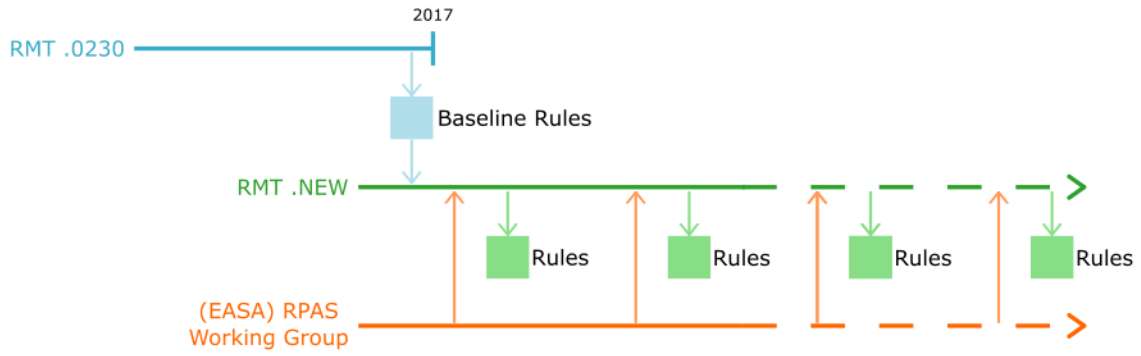

Figure 1. Diagram showing the proposed arrangement of the new RPAS RMT and Integration Committee / Working Group. 'Baseline Rules' to be published by the current RMT.0230 will form the foundation Both work in parallel and would build on the 'baseline rules'. Regular input on new operational concepts and safety information from the Working Group will assist in the development of new Rules to reflect the changing environment.