The regulatory approach of ICAO, the United States and Canada to Civil Unmanned Aircraft Systems, in particular to Certification and Licensing

Milan A. Plücken

Institute of Air and Space Law

Faculty of Law
McGill University
Montreal, Quebec
August 2011

A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Master of Laws (LL.M.).

ACKNOWLEDGEMENTS

First and foremost, I would like to thank my supervisor Prof. Armand L. C. de Mestral. He was of great support throughout my thesis and an instructive example of how professional excellence and personal modesty can go hand in hand. Whenever he felt his advice would be needed, he supported me with honest and creative comments. Whenever I wanted to go my own way, his wisdom and experience gave me the freedom to choose my route.

I am very thankful for help and advice of Leslie Cary from the International Civil Aviation Organization and Stephen A. Glowacki from the Federal Aviation Administration.

I also would like to thank Henri Rodenburg and Filippo Tomasello from the European Aviation Safety Agency. Although this thesis does not extend to European law, they provided very helpful advice and support on many occasions.

Furthermore I am very grateful for the support of my peers, especially Duncan P. Blake, P. Paul Fitzgerald, Auguste J. Hocking and Patrick M. Schwomeyer. Auguste's impressive language skills allowed me to cover my deficiencies in my second language, while I am also indebted to Duncan for his logistical support and to Emilie Mézi for helping translate the abstract.

The diversity and excellence at the Institute of Air and Space Law was an important component of my experience at McGill. Without spending the year with so many inspiring people, the LL.M. in general and the writing of the thesis in particular would not have been the same.

Special thanks go to Greta Bruns. Her continuous support was a decisive factor of my successful time in Montreal and the development of this thesis.

ABSTRACT

Civil Unmanned Aircraft Systems (UAS) have increased in variety and importance. They offer applications that can replace manned aircraft in certain areas or that are unprecedented by their manned counterparts and unique to UAS. The current national and international regulatory framework for aviation regulates 'aircraft' and does hence generally not differentiate between manned and unmanned formats. However, most of its regulations were developed in the light of manned aircraft making their application to UAS a difficult task. The potential of UAS has been recognized, work on future regulations is underway and the first legal instruments aiming for UAS integration have been developed.

This thesis explains and contrasts the regulatory approaches of the International Civil Aviation Organization (ICAO), the United States and Canada to UAS. Present rules and proposals for future regulations are analyzed. In a closer look, the actual certification and licensing rules for UAS and their resultant operational possibilities are examined and compared.

RÉSUMÉ

Les véhicules aériens civils sans équipage se sont développés en termes d'importance et de variété. Ils offrent des utilisations remplaçant les aéronefs avec équipage dans certains domaines, ou bien même, ils sont utilisés dans des nouveaux domaines qui leur sont désormais uniques. L'actuel cadre juridique en aviation, aux niveaux national et international, règlemente l' 'aéronef' sans généralement dissocier entre ceux qui sont avec ou sans équipage. Cependant, la plupart de ces règlements ont été développés à la lumière de l'aéronef avec équipage, ce qui peut rendre leur application aux aéronefs sans équipage quelque peu difficile. Le potentiel des véhicules sans équipage a été reconnu, des travaux pour une nouvelle règlementation est en cours et le premier instrument légal visant l'intégration de ces véhicules à été développé.

Cette thèse explique et contraste les différentes approches règlementaires relatives aux véhicules sans équipage que peuvent avoir l'Organisation Internationale de l'Aviation Civile, les Etats-Unis et le Canada. Les règles actuelles ainsi que des propositions pour de futurs règlements seront analysés. Plus précisément, l'actuelle certification et les règles d'émission de licence pour les véhicules sans équipages, ainsi que les possibilités opérationnelles de ces derniers seront examinées et comparées.

TABLE OF CONTENTS

ABBREVIATIONS

AC	Advisory Circular
ACI	Airports Council International
AMA	Academy of Model Aeronautics
ANC	Air Navigation Commission
AOC	Air Operator Certificate
Art., Arts.	Article, Articles
ASI	Aviation Safety Inspector
ATC	Air Traffic Control
ATO	Air Traffic Organization
BVLOS	Beyond Visual Line-of-Sight
C2	Command and Control
C3	Command, Control and Communication
CANSO	Civil Air Navigation Services Organization
CARAC	Canadian Aviation Regulation Advisory Council
CARs	Canadian Aviation Regulations
CFR	Code of Federal Regulations
CGAR	Center of Excellence for General Aviation Research
CoA	Certificate of Airworthiness
COA	Certificate of Waiver or Authorization
CRDA	Cooperative Research and Development Agreement
DHS	Department of Homeland Security
DOD	Department of Defence
DOJ	Department of Justice
DOT	Department of Transportation
EASA	European Aviation Safety Agency
ECOSOC	Economic and Social Council
EUROCONTROL	European Organisation for the Safety of Air Navigation
EUROCAE	European Organization for Civil Aviation Equipment
FAA	Federal Aviation Administration

GOA	Government Accountability Office
HALE	High Altitude Long Endurance
IAOPA	International Council of Aircraft Owner and Pilot Association
IATA	International Air Transport Association
ICAN	International Commission for Air Navigation
ICAO	International Civil Aviation Organization
ICCAIA	International Coordinating Council of Aerospace Industries Associations
IFALPA	International Federation of Air Line Pilots’ Association
IFATCA	International Federation of Air Traffic Controllers' Associations
IMO	International Maritime Organization
ITU	International Telecommunication Union
MAAC	Model Aeronautics Association of Canada
MALE	Medium Altitude Long Endurance
MTOW	Maximum Take Off Weight
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NOAA	National Oceanic and Atmospheric Administration
NPAs	Notices of Proposed Amendments
OPA	Optionally Piloted Aircraft
PANS	Procedures for Air Navigation Services
Para	Paragraph
PIC	Pilot in Command
PICAO	Provisional International Civil Aviation Organization
ROA	Remotely Operated Aircraft
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
RPL	Remote Pilot License
RPS	Remote Pilot Station

RPV	Remotely Piloted Vehicle
RTCA	Radio Technical Commission on Aeronautics
SARPs	Standards and Recommended Practices
SFOC	Special Flight Operations Certificate
SUPPs	Regional Supplementary Procedures
TC	Transport Canada
TCAS	Traffic Alert and Collision Avoidance System
UA	Unmanned Aircraft
UAPO	Unmanned Aircraft Program Office
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
UFIT	UAS FAA & Industry Team
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UOC	Aircraft System Operating Certificate
UPU	Universal Postal Union
USC	United States Code
USOAP	Universal Safety Oversight Audit Programme
VLOS	Visual Line-Of-Sight
WHO	World Health Organization
WMO	World Meteorological Organization
WRC	World Radiocommunication Conference

CHAPTER 1: INTRODUCTION

Flying the skies without leaving the ground? A conflicting conception at first glance, but daily routine for pilots of unmanned aircraft. Quite the contrary applies to the regulatory framework for civil unmanned aviation. Certification and licensing seem far away from being routine and the rules applicable seem far away from being specific, coherent and harmonized. The present thesis explains and contrasts the regulatory approaches of the International Civil Aviation Organization (ICAO), the United States and Canada to civil unmanned aviation, in particular to certification and licensing.

An Unmanned Aircraft (UA) is an aircraft flying without a pilot on board. It is remotely controlled by a pilot or it performs its flight autonomously, but normally with the possibility of a pilot to intervene. Simplified, the UA, the control station and the data-link, which connects the UA and the station, comprise the Unmanned Aircraft System (UAS).[1]

UAS vary significantly. The UA can have several different formats, sizes and capabilities, ranging from micro-sized helicopters to jet powered surveillance airplanes. The same applies to the control unit, which can range from a handheld device to a complex facility, and the data-link, which can be a radio transmission or a satellite communication, or everything in between.

As the system varies, the possible applications follow suit. A recent example of a smaller type UAS application is the use of a miniature helicopter to film defects and possible leaks at the damaged nuclear reactor near Fukushima in Japan in 2011.[2] Without placing humans in the hazard of nuclear radiation, details about the catastrophe could be ob-

---

1 Unless otherwise indicated, abbreviations, e.g. UA and UAS, are generally used for the singular and plural forms of the respective terms. Please see Chapter II. C. for an overview of the terminology with regard to unmanned aviation. At this stage, one might expect the term Unmanned Aerial Vehicle (UAV) to be mentioned. However, as will be explained below, on the one hand, the idea of 'aerial vehicle' is not specific enough to legally deal with unmanned aviation, and on the other hand, the system approach in UAS is the appropriate broader concept.

2 CNBC, "Honeywell T-Hawk Aids Fukushima Daiichi Disaster Recovery Unmanned Micro Air Vehicle Provides Video Feed to Remote Monitors", *CNBC* (19 April 2011) ["Honeywell T-Hawk Aids Fukushima"]; The Telegraph, "New video of Fukushima nuclear power plant", *The Telegraph* (12 April 2011) ["New video of Fukushima nuclear power plant"].

tained. Similarly, micro UAS could be used in extreme situations, e.g. to search burning buildings for remaining humans, or in areas of scientific interest, e.g. small wildlife observations. Medium scaled UAS could be used to examine the composition and hazardousness of volcanic ash clouds, like the one emerged from the Eyjafjallajökull in 2010. Remote sensing, communication services and surveillance of pipelines or electric power lines are only a few of several possible applications in that range. UAS of large size could be used for scientific purposes or cargo transportation on national or intercontinental routes. However, UAS used for passenger transportation – an example often raised with a certain skepticism toward the development of unmanned aviation – is not envisioned, at least not for the near future.

More generally, two groups of applications can be subdivided. On the one hand, UAS are capable of replacing certain manned aircraft. On the other hand, UAS can offer applications unprecedented by manned aircraft, in particular possible due to their different sizes or capabilities. It is expected that the major use of UAS will be information gathering and distribution, which is, at least in the anticipated magnitude, a relatively new segment in civil aviation.[3]

As implied in the first paragraph, the regulatory framework for UAS does not seem to be developed to a satisfactory extent. One cannot follow the literal meaning of the renowned Latin phrase '*de minimis non curat lex*' (the law does not care about small things). UAS need a specific legal framework as sophisticated as the regulatory construct that was developed in the light of manned aircraft, in particular when their integration into the national and international airspace is aimed for. If a UA is considered to be an 'aircraft', it thereby falls under the established air law, nationally and internationally. However, as it can be observed when looking at the exemplary application mentioned before, UAS can be significantly different from other aircraft. Fortified cockpit doors, pilots' seatbelts and other onboard pilot and crew related requirements are *per se* contradictory to unmanned

---

3 Tomasello also paints the bigger picture when he envisages that UAS "*will open the way for aviation to enter the third industrial revolution: i.e. towards the 'information society'*", Filippo Tomasello, "Emerging international rules for civil Unmanned Aircraft Systems (UAS)" (2010) 9:4 Aviation and Maritime Journal 1 at 5 ["Emerging international rules for UAS"].

aviation. Collision avoidance systems on a very small UA are similarly as questionable as many other rules elaborated in the light of manned aircraft when applied to UAS. Moreover, the entire system approach of UAS, including the control station, the data-link and the other elements, cannot easily be borrowed from existing aviation regulations.

Irrespective of manned or unmanned aircraft, safety is the paramount concern. UAS need to achieve a level of safety equivalent to manned aviation. Safety with regard to UAS is nevertheless different from the safety in manned aircraft operations. The latter aims primarily, at the protection of pilot, crew and passengers. The former only focuses on the avoidance of interference and collision with other users of the skies and third parties on the ground. Furthermore, the safety of the UAS extends to the entire system and its components, not only to the UA. These differences need to be mirrored in the law.

When linking possible UAS applications with the regulatory approach of different entities, essential distinctions must be made with regard to the general operational and legal environments and their respective users. The present thesis is only concerned with civil unmanned aviation. However, the meaning of ‘civil’ depends on the categories from which it is differentiated. One opposite category of ‘civil’ could be ‘military’. In this case, ‘civil’ contains public and private applications of UAS. While ‘public’ applications are those carried out by the State within its public authority, but not of military nature, ‘private’ refers to individuals or judicial persons using UAS for commercial purposes, i.e. for remuneration, or for non-commercial reason, e.g. experimental or scientific applications. Another category in distinction to ‘civil’ could be ‘state’. Within this categorization ‘state’ includes military and public applications, while ‘civil’ would be the equivalent to the aforementioned subcategory of ‘private’. The categorization on which the present thesis is based, depends on the legal authority chosen to take a leading role the development of unmanned aviation regulations.

Civil UAS regulations can be international and national.

On the international level, the ICAO is the authority for aviation regulations based on the *Convention on International Civil Aviation*[4]. It is comprised of all nations active in civil aviation.[5] International harmonization is the goal to be achieved through Standards and Recommended Practices (SARPs) and non-binding legal instruments, e.g. guidance materials. Harmonization is necessary for safe and orderly operations across state borders. With developing technology and increasing use of UAS, long range operations will gain importance and medium and large UAS are likely to cross those border. Often these operations will need a handover of an UA between control stations in different States, requiring harmonized safety regulations. Additionally, Art. 12 gives ICAO jurisdiction over the high seas, where UAS operations are also likely to occur. As mentioned before, UAS generally fall under ICAO's aviation regulations, but several differences need to be addressed.

Nationally, States have sovereignty over their airspace and their aviation regulations. They set national rules for UAS operations. However, they have also agreed in Art. 37 of the Chicago Convention to follow ICAO SARPs to achieve international conformity. If they deviate from the SARPs they are required to notify the differences pursuant to Art. 38.[6]

Hence, the scope of the present thesis when examining and comparing the regulatory approach of ICAO, the United States and Canada to civil UAS, in particular to certification and licensing, will be channeled by two aspects. First, the system of aviation regulations is significantly international in nature, with ICAO as the civil aviation organization and the driving force for harmonization, which places it in a particular position. Second, the meaning of 'civil' is thus determined by the Chicago Convention which delineates the regulatory authority of ICAO. Art. 3 makes the convention applicable to civil aircraft and

4 *Convention on International Civil Aviation* 15 UNTS 295, 61 US Stat 1180, (entered into force 4 April 1947) [*Chicago Convention*].

5 As of May 2011 the Chicago Convention had 190 member States, *Current lists of parties to multilateral air law treaties - Chicago Convention* <http://www2.icao.int/en/leb/List%20of%20Parties/Chicago_EN.pdf> [*Current lists of parties to multilateral air law treaties - Chicago Convention*].

6 The legal value of ICAO Annexes, in which the SARPs are contained, on the one hand and the requirements in Art. 37 and 38 Chicago Convention on the other are subject to extensive debate. Please see Chapter 3, B. 1. b. with further references for this problem.

excludes state aircraft from its reach[7], while state aircraft explicitly include "*military, customs and police services*".[8]

Within the tri-fold examination in the thesis, nationally, the regulatory approach of the United States and Canada to UAS will be reviewed. The United States is the largest and most advanced user of, and market[9] for, UAS.[10] Canada is of special interest because of its geographical characteristics, its dependency on aviation and its developed aviation regulations, placing Canada in a good position for UAS integration. Canada's regulatory approach is also of particular interest in the light of commonalities and differences with its southern neighbor.

One might ask about the situation in Europe. The United States and Europe are the major players with regard to applications and regulations for UAS. However, if Europe were to be included in the present thesis, breadth would prevail over depth. Given the relatively small number of up to date legal examinations of UAS regulations coupled with the rapid development and the clarity needed in the process of understanding and finally rule-making, breadth would presumably not be able to contribute much to the discussion.

---

7 Even if not international state aircraft air law exists and the Chicago Conventions does not apply to state aircraft, state aircraft generally *de facto* follow certain ICAO SARPs, e.g. rules of the air, as long as the state/military operation permits.

8 See for the contradiction inherent to Art. 3 Chicago Convention, that it denies applicability to state aircraft in Art. 3 (a) but requires in Art. 3 (c) that "*(n)o state aircraft of a contracting State shall fly over the territory of another State or land thereon without authorization by special agreement or otherwise, and in accordance with the terms thereof*", *inter alia* Ruwantissa Abeyratne, "Regulating unmanned aerial vehicles - Issues and challenges" (2009) European Transport Law 503 at 514 ["Regulating UAV"].

9 See on the UAS market: Matthew T DeGarmo, *Issues Concerning Integration of Unmanned Aerial Vehicles in Civil Airspace*, report for MITRE Corporation (Virgina: MITRE Corporation, 2004) at para 1.4.2 [*Issues Concerning Integration of UAV*]; JAA/Eurocontrol, "UAV Task-Force - Final Report" (2004) Joint JAA/Eurocontrol Initiative on UAVs at para 2.1 ["UAV Task-Force Report"]; Douglas M Marshall, "Unmanned Aerial Systems and International Civil Aviation Organization Regulations" (2009) 85 North Dakota Law Review 693 at 699 ["UAS and ICAO Regulations"]; Laurence R Newcome, *Unmanned Aviation - A Brief History of Unmanned Aerial Vehicles* (Reston: American Institute of Aeronautics and Astronautics, 2004) at 127 ff [*Unmanned Aviation History*]; William Reynish, "UAVs Entering the NAS", *Avionics Magazine* ["UAVs Entering the NAS"].

10 With regard to the United States civil aviation regulations Maneschijn highlights: "*(o)f the many examples of civil aviation regulations in the more than 180 ICAO member states, the USA FAA regulations are arguably the most comprehensive, having evolved since 1926 to a substantially steady state. ICAO and various national authorities often use the Federal Airworthiness Regulations (FAR), or the FAA developed model regulations, as guidance for their own policies*" A Maneschijn et al, "A proposed reference framework for unmanned aerial vehicle and system airworthiness requirements" (2007) The Aeronautical Journal 345 at para 3.3 ["Reference framework UAV and system airworthiness requirements"].

Between ICAO on the one hand, and the States examined on the other, the regulatory development with regard to UAS is not unidirectional prescribed by ICAO. As international standards are in their development phase, States interested in timely civil UAS operations need to elaborate their own rules parallel to the international development. Reciprocal influence makes this a particularly interesting stage. Additionally a situation where the States and ICAO develop new regulations simultaneously offers the rare opportunity of international harmonization *ab initio*.

A closer look within the examination of the regulatory approaches of ICAO, United Stated and Canada to civil UAS will be placed on certification and licensing. The certification of aircraft and the licensing of its personnel are essential parts of the regulatory framework of aviation and both serve the important concern of safety. On the basis of the division of the traditional areas of aviation – operations, equipment and personnel – certification and licensing are the prerequisites for operations. Central to the certification of the aircraft is the Certificate of Airworthiness (CofA). In the interest of safety, an aircraft must be designed, constructed and operated in compliance with the appropriate airworthiness requirements of the State of registry of the aircraft.[11] If these standards are met, the aircraft is issued a CofA declaring the aircraft fit to fly.[12] Licensing is the act of authorizing defined activities which should otherwise be prohibited due to the potentially serious results of such activities being performed improperly.[13] An applicant for a license must meet certain stated requirements proportional to the complexities of the task to be performed.[14] The examination of these basic regulatory requirements for UAS operations allows to compare the regulatory approach of ICAO, the United States and Canada in a more specific context.

Several other practical and regulatory difficulties are surrounding UAS, especially the problem of the limited capability of UAS, respectively their pilots, to 'detect, sense and avoid', i.e. the ability of the pilot to see potentially conflicting traffic and to avoid colli-

---

11 ICAO, Secretariat, *Annexes 1 to 18*, (Montreal: ICAO, 2007) at Annex 8 [*Annexes 1 to 18*].
12 Ibid.
13 Ibid Annex 1.
14 Ibid.

sions, is seen as a major hurdle to UAS operations and integration.[15] On the one hand, this aspect is of such importance, that it would be impossible to incorporate it into the present thesis in all details. On the other hand, the ability of UAS to be fully integrated into the national and international airspace and into air traffic services[16] is the second step.[17] Prior to this, safe flight of the UAS and the avoidance of ground collisions have to be dealt with. This issue can be dealt with by certification and licensing, which is the first step. However, this and many other aspects of UAS regulations cannot be completely separated from each other. If, for instance, certification requires the installation of collision avoidance systems or air traffic communication equipment, no clear line between the two elements of certification and licensing on the one hand, and the operational aspects of rules of the air and air traffic management on the other hand, can be drawn. Therefore aspects which interplay with certification and licensing will be described where necessary.

Other issues like accident investigation[18], aerodromes[19], liability[20], insurance[21] with respect to UAS can be separated more easily and are not part of the present thesis.[22]

---

15 See on the 'detect, ense and avoid' problem of UAS *inter alia*: J Asmat et al, with the collaboration of MITRE Corporation, *Unmanned Aerial Collision Avoidance System (UCAS)*, report for Department of Systems Engineering and Operations Research, George Mason University (Fairfax: 2006) [*Unmanned Aerial Collision Avoidance System (UCAS)*]; Elmar Giemulla, "Unbemannte Luftfahrzeugsysteme – Probleme ihrer Einfügung in das zivile und militärische Luftrecht" (2007) 56:2 Zeitschrift für Luft- und Weltraumrecht 195 at 207 ff ["Einfügung in das zivile und militärische Luftrecht"]; Ryan J Kephart, *Comparison of See-and-Avoid Performance in Manned and Remotely Piloted Aircraft*, (Master of Science, Russ College of Engineering and Technology of Ohio University, 2008) [*Comparison of See-and-Avoid Performance in Manned and Remotely Piloted Aircraft*]; Andrew R Lacher, David R Maroney & Andrew D Zeitlin, *Unmanned Aircraft Collision Avoidance - Technology Assessment and Evaluation Methods*, report for The MITRE Corporation (McLean: MITRE, 2007) [*Unmanned Aircraft Collision Avoidance*] as well as Chapter 2 D.

16 See *inter alia* ICAO Annex 11, 13th edition July 2001, which for this reason will not be subject to further examination.

17 Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 6.

18 See the already amended ICAO Annex 13 which explicitly includes UAS; please see Chapter 3, B. 2. h.

19 See for indications of possible airport or airfield requirements of UAS, Chapter 2, E. 1.

20 Whereas the important system of the *Convention for the Unification of Certain Rules Relating to International Carriage by Air*, 12 October 1929, [*Warsaw Convention*] and its amendments and the *Convention for the Unification of Certain Rules for International Carriage by Air*, 28 May 1999, ICAO Doc 9740, (entered into force 4 November 2003) [*Montreal Convention*] are only of relevance if cargo or passenger transportation by UAS will emerge, the third party liability regime of the *Convention on Damage Caused by Foreign Aircraft to Third parties on the Surface*, 7 October 1952, ICAO Doc 7364, (entered into force 4 February 1958) [*Rome Convention*] and its successors, while not yet in force, the *Convention on Compensation for Damage Caused by Aircraft to Third Parties*, 2 May 2009, Doc 9919, (not in force), [*General Risks Convention*] and the *Convention on Compensation for Damage to Third Parties, Resulting from Acts of Unlawful Interference Involving Aircraft*, 2 May 2009, ICAO Doc 9920, (not in force), [*Unlawful Interference Compensation Convention*] generally applies to UAS.

As mentioned repeatedly, the primary reason for the required regulations on the international and national level is safety. However, especially in the light of civil UAS ambitions, legal certainty and opportunities of development for the UAS industry is also of importance. Users, manufacturers and others in the UAS community need to know their rights and responsibilities. A limited regulatory framework is the reason for slower development of civil UAS due to higher risks in a less regulated area.[23] Like a circle, increasing applications encourage regulation and legal certainty encourages investment and development. In this respect the major players function as an example for the rest of the international community, which closely examines their regulatory advances.

As civil unmanned aviation is legally in its infancy, the present thesis requires certain steps and certain weightings which are not as prominent in other more settled legal fields. It sets itself at risk, to be ahead of its time. However, the idea is not to analyze a finished endeavor, but to explain the present situation and to examine and compare the regulations and proposals on UAS in particular to certification and licensing with the ambition to help with its understanding and development.

With regard to the overall context, Stephen A. Glowacki puts it aptly: "*What we've*

---

21 UAS regulations are necessary to achieve predictability needed for the insurance industry; see for an introduction to UAS insurance Geoffrey Christopher Rapp, "Unmanned Aerial Exposure: Civil Liability Concerns Araising from Domestic Law Enforcement Employment of Unmanned Aerial Systems" (2009) 85 North Dakota Law Review 623 at 646 f ["Civil Liability of UAS in Law Enforcement"].

22 See for several other issues related to UAS, e.g. humanitarian law problems, privacy violations and tort law Brendan Gogarty & Meredith Hagger, "The Laws of Man over Vehicles Unmanned: The Legal Response to Robotic Revolution on Sea, Land and Air" (2008) 19 Journal of Law, Information and Science 74 ["Laws of Man over Vehicles Unmanned"]; Chris Jenks, "Law from Above: Unmanned Aerial Systems, Use of Force, and the Law of Armed Conflict" (2009) 85 North Dakota Law Review 649 ["Law from Above"].

23 See *inter alia* Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 1; Brendan Gogarty & Meredith Hagger, "Laws of Man over Vehicles Unmanned" *supra* note 21, at para 13; JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9; Anna Masutti, "A Regulatory Framework to introduce Unmanned Aircraft Systems in Civilian Airspace (Presentation)" (2010) Workshop of the European Space Policy Institute: Opening Airspace for UAS in the Civilian Airspace 1 at 3 ["UAS Regulatory Framework"]; NASA, with the collaboration of T H Cox *et al.*, *Civil UAV Capability Assessment (Report Overview)*, report for NASA (Washington D C: NASA, 2004) at 4 [*Civil UAV Capability Assessment (Report Overview)*]; Timothy M Ravich, "The Integration of Unmanned Aerial Vehicles into the National Airspace" (2009) 85 North Dakota Law Review 597 at 601 ["Integration of Unmanned Aerial Vehicles into the National Airspace"].

experienced with UAS is almost a retrograde action in terms of trying to understand aviation. In many ways, we're forced to re-evaluate the same things we thought we understood."[24] This thesis will hopefully provide a useful contribution in the process of re-evaluating and re-learning of air law in the light of UAS.

The structure of the present thesis will be as follows:

In the second chapter, the thesis will elaborate on the concept of unmanned aviation. The historical development of unmanned aviation is briefly explored before turning to a consideration of present and possible future applications. The applicable terminology will be explained and definitions will be compared as a basis for further examination. To understand the specificities and special characteristics that UAS regulations need to account for, their technical background will be shown.

The subsequent three chapters will examine the existing rules and the proposals made for future regulations of UAS by ICAO, the United States and Canada.

In the sixth chapter a closer look will be taken on the certification of UAS and licensing of their personnel under ICAO and within the United States and Canada. First, the concept of certification and licensing will be briefly examined. Then, important differences to manned aircraft and their personnel will be pointed out to explain the difficulties in legally handling UAS and to elaborate which specificities need to be accounted for in the regulations. After that, the meaning of 'safety' with regard to UAS will be specified. Finally the actual certification and licensing rules for UAS and resultant possible operations will be examined and compared.

---

[24] FAA UAS Program Policy and Regulatory Lead Stephen A. Glowacki cited in: Tom Hoffmann, "Eye in the Sky - Assuring the Safe Operation of Unmanned Aircraft Systems" (2010) FAA Safety Briefing 20 at 21 ["Eye in the Sky"].

CHAPTER 2: UNMANNED AIRCRAFT SYSTEMS

A. Historical development of unmanned aviation

Unmanned aviation has been part of the aviation history for long, albeit not as prominent as it has become in the last decades.[25] Given the long lasting dream of man to fly himself, this is not surprising.

UA were primarily developed for military reasons. While kites and unmanned balloons[26] were used for military purposes already a long time ago[27], the most prominent example of an early UA is the 'Kettering Bug' of 1914. It was an aerial torpedo in the form of bi-plane, which drops its explosive load when the engine stops due to distance calculations made in beforehand.[28] Between the World Wars the first remotely controlled UA was built[29] and target drones[30] were developed to train antiaircraft-gunners. Of significance was the invention of the 'Fieseler Fi 103', better known as the V-1 bomb, during World War II by the German Luftwaffe, which was capable of a relatively precise autonomous flight of

---

25 The history of unmanned aviation is relevant to the understanding of the requirements of UAS regulations as these areas are interrelated with technical developments. However, the contribution of historical breadth to the legal analysis in the present thesis is limited. Therefore this subchapter only gives a short overview; for extensive historical information see Lars Hoppe, *Le statut juridique des drones aéronefs non habités* (Marseille: Presses Universitaires d'Aix-Marseille, 2008) [*Le statut juridique des drones*]; Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9; Mark E Peterson, "The UAV and the Current and Future Regulatory Contruct for Integration into the National Airspace System" (2006) 71 Journal of Air Law and Commerce 521 ["The UAV and the Current and Future Regulatory Contruct"]; for a review of Lars Hoppe's dissertation see Angela Seidenspinner, "Book review: Hoppe Lars, Le statut juridique des drones aéronefs non habités, Presses Universitaires d'Aix-Marseille, 2008" (2010) 59:1 Zeitschrift für Luft- und Weltraumrecht 135 ["Book review: Hoppe"]; Kimon P Valavanis, *Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy* (Tampa: Springer, 2007) [*Advances in Unmanned Aerial Vehicles*]; all with further references.

26 *Remote Piloted Aerial Vehicles: An Anthology* <http://www.ctie.monash.edu/hargrave/rpav_home.html> [*Remote Piloted Aerial Vehicles: An Anthology*] with further references to kites.

27 Valavanis mentions that the ancient Greek engineer Archytas is said to have invented the first UA, a mechanical pigeon, in the 4th century BC, which was recorded as having flown some 200 meters, Kimon P Valavanis, *Advances in Unmanned Aerial Vehicles*, *supra* note 24 at para 2.1.1.

28 Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 23 ff; Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 1.

29 The 'Sperry Messenger' is deemed to be the first remotely controlled aircraft; Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 1.2; Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 31 ff.

30 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 1.2.

over 250 km.[31] In the Korean and Vietnam wars the United States extensively used more sophisticated UA, not only of destructive capability but also applied for reconnaissance.[32] In the 1970's and 1980's Israel was the most eminent developer of unmanned aviation and influences its advancements since then.[33] After the first Iraq war and the conflicts around the former Yugoslavia the use of military UAS was well established and intensified in every conflict thereafter.

Technological advances stimulated by military uses and new challenges ignited the interest in civil unmanned aviation in the 1990's, which rapidly generated a multitude of applications. For instance the NASA and the Aerovironment Corporation developed solar-powered aircraft, e.g. 'Pathfinder' and 'Helios', for scientific operations, in particular environmental monitoring, which could operate at high altitudes for weeks.[34] In the agricultural sector, for example, Japan entered the arena in 1986 with the development of unmanned helicopters for the spraying of crops and is now the most extensive user of civil UA for these purposes.[35]

Examples of further civil uses are presented in the following.

---

31 *The V-1 Flying Bomb* <http://www.vectorsite.net/twcruz_2.html> [*The V-1 Flying Bomb*]; Mark E Peterson, "The UAV and the Current and Future Regulatory Contruct" *supra* note 24, at 542; the V-1 (Vergeltungswaffe 1) was the predecessor of the cruise missile; today missiles are generally not considered UA.

32 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 1.2; Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 83 ff.

33 See for example Israel Aerospace Industries (IAI) in the military sector of which privatization plans were reported recently, The Economist, "IAI takes wing - Israel's biggest defence firm is getting ready for privatisation", *The Economist* 2011:March 3 ["IAI takes wing"].

34 The 'High Altitude Solar (HALSOL)' UA of 1983 was one of the famous predecessor of 'Pathfinder' and 'Helios'; Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 1.2; Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 117 ff; William Reynish, "UAVs Entering the NAS", *supra* note 9.

35 Whereas the first UA helicopters were remotely controlled, later models performed most of their operations autonomously, Brendan Gogarty & Meredith Hagger, "Laws of Man over Vehicles Unmanned" *supra* note 21, at para 2.1; Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 127, who states that 1565 of such unmanned helicopters are in use with 6000 operators licensed to operate them (2004); *China testet unbemannten Hubschrauber* <http://videos.t-online.de/unbemannter-hubschrauber/id_46290384/index> [*China testet unbemannten Hubschrauber*] contains the example of a nearly regular sized unmanned helicopter; William Reynish, "UAVs Entering the NAS", *supra* note 9.

B. Actual and possible civil applications

Civil applications for UAS are manifold. As explained in the introduction, 'civil' applications are those performed for commercial purposes, i.e. for remuneration, or for non-commercial reason, e.g. experimental or scientific applications, but not within the public authority of a State. Aircraft used by the military and other public entities, e.g. police or border control, are considered 'state aircraft' by Art. 3 of the Chicago Convention and therefore fall outside the scope of ICAO' authority. State applications, as explained in the introduction, are beyond the ambit of the present thesis.

It is however not always possible to draw a clear line between 'public' and 'civil' applications.[36] Dependant on the State in question, some applications may require public authority, while in other States the same operations could be performed as 'civil'. Hence, the following examples include some applications which could be performed by either civil or state UAS.

---

[36] Typical public applications performed by state aircraft are: police functions, law enforcement surveillance, drug surveillance and interdiction, surveillance of traffic, port security, coastal protection, border control, search and rescue, humanitarian aid, emergency response, monitoring of sensitive sites, (forest) fire detection and suppression; see
Association for Unmanned Vehicle Systems International (AUVSI), *Fire Fighting Tabltop Excercise 2010*, report for AUVSI AUVSI, 2010) [*Fire Fighting Tabltop Excercise*]; Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at paras 1.4.2 and 3; Brendan Gogarty & Meredith Hagger, "Laws of Man over Vehicles Unmanned" *supra* note 21, at para 8; Lars Hoppe, *Le statut juridique des drones*, *supra* note 24 at 461 f; Michail Kontitsis & Kimon Valavanis, "A Cost Effective Tracking System for Small Unmanned Aerial Systems" (2010) 57 J Intell Robot Syst 171 at 171 f ["Cost Effective Tracking System"]; Robert Koulish, "Blackwater and the Privatization of Immigration Control" (2008) 20 Saint Thomas Law Review 462 at 480 who explains the idea of a 'virtual fence' also by using UAS ["Privatization of Immigration Control"]; Douglas M Marshall, "Dull, Dirty, and Dangerous: The FAA's Regulatory Authority Over Unmanned Aircraft Operations" (2007) Issues in Aviation Law and Policy 10085 at 10091 ["FAA's Regulatory Authority"]; J R Martinez-de-Dios et al, "Multi-UAV Experiments: Application to Forest Fires", in A. Ollero & I. Maza, eds, *Mult. Hetero. Unmanned Aerial Vehi., STAR 37* (Berlin: Springer-Verlag, 2007) ["Multi-UAV Application to Forest Fires"]; Pablo Mendes de Leon, "Building the regulatory framework for introducing the UAS in the civil airspace European Regulation for light UAS below 150 KG?" (2010) 9:4 Aviation and Maritime Journal 1 at 2 ["Regulatory framework for light UAS"]; *NASA Supports UAS Fire Mapping Efforts on California Fire* <http://www.nasa.gov/centers/dryden/news/NewsReleases/2006/06-45.html> [*Fire surveillance in California*]; Geoffrey Christopher Rapp, "Civil Liability of UAS in Law Enforcement" *supra* note 20, at 623 ff; William Reynish, "UAVs Entering the NAS", *supra* note 9; Vasilios Tasikas, "Unmanned Aerial Vehicles and the Doctrine of Hot Pursuit: A New Era of Coast Guard Maritime Law Enforcement Operations" (2004) 29 Tul Mar LJ 59 ["Unmanned Aerial Vehicles and the Doctrine of Hot Pursuit"]; Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 5.

Actual and possible applications are: crop dusting[37], oil and gas company uses[38], surveillance of pipelines or electric power lines[39], motion picture and television production[40], media reporting and broadcasting[41], cargo transportation[42], aerial photography[43], high altitude imaging[44], hyper-spectral imaging[45], soil moisture imaging[46], in-situ atmospheric monitoring[47], cartographic photography[48], wildlife protection and surveillance[49] (e.g. registration of sea animals and plants[50]), resource exploration[51], precision agriculture remote sensing[52], commercial fisheries support[53], collision impact testing[54], sensing the depth and the quality of water[55], environmental research and air quality management and control[56], digital mapping and planning[57], land management[58], ground transportation moni-

---

37 William Reynish, "UAVs Entering the NAS", *supra* note 9.

38 A Ginati, S Gustafsson & J Juusti, "Space, the essential component for UAS - The case of Integrated Applications - "Space 4 UAS" (Presentation)" (2010) Workshop of the European Space Policy Institute: Opening Airspace for UAS in the Civilian Airspace 1 at 25 ["Space 4 UAS"].

39 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 1.4.2; Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35, at 10091; William Reynish, "UAVs Entering the NAS", *supra* note 9; Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 5.

40 Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35, at 10091; Pablo Mendes de Leon, "Regulatory framework for light UAS" *supra* note 35, at 2.

41 Matthew T DeGarmo & Gregory M Nelson, "Prospective Unmanned Aerial Vehicle Operations in the Future National Airspace System" (2004) MITRE Corporation, Center for Advanced Aviation System Development 1 at para 1.2 ["UAV in Future National Airspace System"]; Stefan A Kaiser, "Legal Aspects of Unmanned Aerial Vehicles" (2006) 55:3 Zeitschrift für Luft- und Weltraumrecht 344 at 349 ["Legal Aspects of UAV"]; Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 5.

42 Stefan A Kaiser, "Legal Aspects of UAV" *supra* note 40, at 362; Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35, at 10085; John V McCoy, *Unmanned Aerial Logistics Vehicles: A Concept Worth Pursuing?*, [unpublished, archived at Fort Leavenworth, Kansas] [*Unmanned Aerial Logistics Vehicles*] (for military cargo use); William Reynish, "UAVs Entering the NAS", *supra* note 9 at 1 who states Frederick Smith (FedEx) advocacy for unmanned interncontonental freighters; Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 5.

43 Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35, at 10091.

44 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 1.4.2.

45 Ibid.

46 Ibid.

47 Ibid.

48 Pablo Mendes de Leon, "Regulatory framework for light UAS" *supra* note 35, at 2.

49 Michail Kontitsis & Kimon Valavanis, "Cost Effective Tracking System" *supra* note 35, at 171 f; Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35, at 10091.

50 Pablo Mendes de Leon, "Regulatory framework for light UAS" *supra* note 35, at 2.

51 Michail Kontitsis & Kimon Valavanis, "Cost Effective Tracking System" *supra* note 35, at 171 f.

52 Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35, at 10091.

53 Ibid.

54 Timothy W Horton & Robert W Kempel, "Flight Test Experience and Controlled Impact of a Remotely Piloted Jet Transport Aircraft" (1988) NASA Technical Memorandum 4084 1 ["NASA Remotely Piloted Jet Transport Aircraft"].

55 Pablo Mendes de Leon, "Regulatory framework for light UAS" *supra* note 35, at 2.

56 Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35, at 10091.

57 Ibid.

toring and control[59], communications services[60], natural hazards research and monitoring[61], environmental monitoring and mapping[62], sea ice flow observations[63], plume dispersion and tracking[64] and aerosol source determinations[65], general earth observation[66], maritime surveillance[67], oil spill detection[68], chemical spill monitoring[69], disaster control and management[70] (e.g. Fukushima nuclear catastrophe[71]), meteorology services[72] and other environmental sensing[73], exploration of earthquakes[74], volcanic eruptions and volcanic ash clouds[75], exploration of chemical clouds[76], nuclear, biological and chemical sensing and tracking[77], flood mapping[78] and general pollution control[79].

---

58 Ibid.

59 Ibid; Kapseong Ro, Jun-Seok Oh & Liang Dong, "Lessons Learned: Application of Small UAV for Urban Highway Traffic Monitoring" (2007) 45th AIAA Aerospace Sciences Meeting and Exhibit 1 ["Application of Small UAV for Urban Highway Traffic Monitoring"].

60 Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35, at 10091.

61 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 1.4.2.

62 Ibid.

63 Ibid.

64 Ibid.

65 Ibid.

66 *Earth Observations and the Role of UAVS (several documents)* <http://www.nasa.gov/centers/dryden/research/civuav/civ_uav_doc-n-ref.html> [*Earth Observations and the Role of UAVS (several documents)*].

67 Matthew T DeGarmo & Gregory M Nelson, "UAV in Future National Airspace System" *supra* note 40, at para 1.2.

68 Michail Kontitsis & Kimon Valavanis, "Cost Effective Tracking System" *supra* note 35, at 171 f.

69 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 1.4.2.

70 Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35, at 10091; M Quaritsch et al, "Networked UAVs as aerial sensor network for disaster management applications" (2010) 127:3 Elektrotechnik & Informationstechnik 56 ["Networked UAVs as aerial sensor network for disaster management applications"]; William Reynish, "UAVs Entering the NAS", *supra* note 9.

71 CNBC, "Honeywell T-Hawk Aids Fukushima", *supra* note 2; The Telegraph, "New video of Fukushima nuclear power plant", *supra* note 2.

72 Pablo Mendes de Leon, "Regulatory framework for light UAS" *supra* note 35, at 2.

73 J Borges de Sousa & G Andrade Goncalves, "Unmanned vehicles for environmental data collection" (2008) Clean Techn Environ Policy / Springer ["Unmanned vehicles for environmental data collection"]; Haiyang Chao, *Cooperative Remote Sensing and Actuation Using Networked Unmanned Vehicles*, (PhD, Utah State University, 2010) [*Cooperative Remote Sensing and Actuation Using Networked Unmanned Vehicles*]; Matthew T DeGarmo & Gregory M Nelson, "UAV in Future National Airspace System" *supra* note 40, at para 1.2.

74 Pablo Mendes de Leon, "Regulatory framework for light UAS" *supra* note 35, at 2.

75 A Ginati, S Gustafsson & J Juusti, "Space 4 UAS" *supra* note 37, at 25; Pablo Mendes de Leon, "Regulatory framework for light UAS" *supra* note 35, at 2; Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 5.

76 Pablo Mendes de Leon, "Building the regulatory framework for introducing the UAS in the civil airspace European Regulation for light UAS below 150 KG?" Ibid. at 2 ["Regulatory framework for light UAS"].

77 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 1.4.2

78 Ibid.

79 Pablo Mendes de Leon, "Regulatory framework for light UAS" *supra* note 35, at 2.

This non-exhaustive enumeration will broaden as regulation and technology advance.[80]

In contrast to the applications mentioned before, which can be named 'aerial work'[81], the use of UAS for passenger transport is not unilaterally rejected or advocated. Some see passenger transport as a possible application in line with cargo use of UAS.[82] Others predict that UAS will not transport passengers, at least not in the foreseeable future.[83] Despite the fact that a significant part of most flights are already controlled by an automatic system, the public acceptance of passengers being flown without a human pilot in the cockpit remains questionable.

In general, UA could either replace manned aircraft or offer applications not performable by their manned counterpart. In the former case, the often called "dull dirty and dangerous"[84] operations could be performed by UA, which are able to fly over an extended period of time, perform repeating maneuvers multiple times, at presumably lower cost[85], with less fuel consumption, less CO2 emission, less noise and in circumstances where the loss of the aircraft is probable. In the latter case, as several of the above mentioned examples indicate, the major task of UA will be information gathering and distribution,[86] espe-

---

80 See for further examples and references Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 1.4.2; Brendan Gogarty & Meredith Hagger, "Laws of Man over Vehicles Unmanned" *supra* note 21, at para 8; Lars Hoppe, *Le statut juridique des drones*, *supra* note 24 at 461, 62; NASA, *Civil UAV Capability Assessment (Report Overview)*, *supra* note 22 at 1; Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9; Geoffrey Christopher Rapp, "Civil Liability of UAS in Law Enforcement" *supra* note 20, at 624 f.

81 Giorgio Guglieri et al, "A Survey of Airworthiness and Certification for UAS" (2011) 61 J Intell Robot Syst 399 at 407 ["Survey of Airworthiness and Certification"]; JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at 6.3.3; Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 8.

82 Lars Hoppe, *Le statut juridique des drones*, *supra* note 24 at 463; JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 1.4.

83 Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 5.

84 See for example Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35.

85 On the one hand, regulation, e.g. extensive certification and licensing requirements, could also be a cost raising factor, which would force smaller manufacturers out of the market, NASA, *Civil UAV Capability Assessment (Report Overview)*, *supra* note 22 at 4, on the other hand it has to be differentiated between manufacturing costs, which could be similar to manned aircraft as the whole UAS has to be build, and operating cost, which are likely to be significantly lower, Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 131.

86 Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 5.

cially in circumstances where manned aircraft cannot fly technically, or pilots and crew cannot be exposed to certain hazards.[87]

C. Terminology and definitions

The terminology and definitions with regard to civil unmanned aviation are of importance when analyzing the different approaches of ICAO, United States and Canada with regard to civil UAS. To adequately compare the respective regulations and proposals, the objects in question need to be circumscribed and defined. The ICAO on the one hand and the United States and Canada on the other, are different entities and therefore not directly comparable. As ICAO's mandate is harmonization of regulations by developing international standards, which affect the United States, Canada and all other member States, the following explanations and definitions focus on ICAO's approach to UAS. If however, despite the fact that the States influence ICAO's UAS regulatory development, substantially different parameters with regard to the terminology and definitions are found in the particular State regulations, the differences will be highlighted in the following and in the respective chapters.

1. Unmanned Aircraft (UA)

The terms 'Unmanned Aircraft' as well as 'Unmanned Aircraft System' have been used unquestioned so far in this thesis. However, their meaning must be explained and their use must be justified.

a. Unmanned

'Unmanned' describes a situation where there is no physical presence of people in control. While the term is generic, with regard to aviation it means that no pilot or crew are

---

87 For example volcanoes, hurricanes, poisonous or electromagnetic zones, ITU, *Consideration of appropriate regulatory provisions for the operation of unmanned aircraft systems* Resolution 421 (WRC-07) [*Resolution 421 (WRC-07)*].

present in or on the object that is flying. The term ‘unpiloted’[88] is narrower as it could suggests that no pilot is in control, a situation only given in fully autonomous flights.[89] Similarly the term ‘pilotless’ could raise doubts about the existence of a pilot. However, the latter has a particular status, as it is used in Art. 8 of the Chicago Convention, which will be examined in Chapter 3. The term ‘uninhabited’[90] is broader as it excludes every human from being on the aircraft, and therefore would hinder the transportation of people by UAS, e.g. regular passengers or for example wounded people in emergency situations. Hence, ‘unmanned’ includes autonomous flight and does not exclude passenger transportation *per se*.

b. Aircraft

aa. UA and other ‘vehicles’

The term ‘Unmanned Aerial Vehicle’ (UAV) was, at least until recently, the most widely used term in the field of unmanned aviation.[91] Following its literal meaning, the generic term ‘vehicle’ describes “*something used as an instrument of conveyance*“[92]. It is combined with ‘aerial’ to express that the vehicle moves through the air and to exclude ground transportation. Similarly, the term Remotely Piloted Vehicle (RPV) describes the broad vehicle concept, but excludes autonomous vehicles. Both terms originated in the military. While ‘RPV’ was used during the Vietnam War and afterward, ‘UAV’ came into

---

88 Used for example in Joanne Irene Gabrynowicz, “Commercial High-Altitude Unpiloted Aerial Remote Sensing: Some Legal Considerations” (1996) 62:3 Photogrammetric Engineering & Remote Sensing 275 [“Commercial High-Altitude Unpiloted Aerial Remote Sensing”].

89 Please see the next subchapter (c.) for the different degrees of autonomy.

90 Used for example in NASA, with the collaboration of T H Cox *et al.*, *Civil UAV Capability Assessment (Report)*, report for NASA (Washington D C: NASA, 2004) [*Civil UAV Capability Assessment (Report)*]; the term ‘uninhabited’ could nevertheless be more gender neutral than ‘unmanned’, as Peterson highlights: “*it almost goes without mentioning that the term ‘UAV’ or ‘Unmanned Aerial Vehicle’ is not necessarily gender-neutral. While it could be argued that the term ‘man’ is universally seen as a gender-neutral term, ‘unmanned aerial vehicle’ may actually be a euphemism for an aircraft piloted completely by women*“ Mark E Peterson, “The UAV and the Current and Future Regulatory Contruct” *supra* note 24, at note 38.

91 Very common, albeit in the military context is the term ‘drone’, which supposedly emerged in association to the DeHavilland Queen Bee radio-controlled UA, Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 4.

92 ‘Vehicle’ in *Black's Law Dictionary*, 9th edn, (Eagan: West Group, 2009) [*Black's Law Dictionary*].

general use since the 1990s.[93] The focus on 'aircraft' emerged with possible civil uses. While in the military context, a exact delimitation between aircraft and vehicle is not of paramount relevance, national civil aviation authorities and ICAO have the mandate to regulate and administer 'aircraft'. Air law, is generally concerned with (manned) aircraft and not with (manned) 'aerial vehicles'. The objects in question hence benefit from being considered aircraft, as no new 'aerial vehicle' law needs to be elaborated separately.

ICAO defines 'aircraft' as "*(a)ny machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.*"[94]

In the United States Code (USC) 'aircraft' means "*any contrivance invented, used, or designed to navigate, or fly in, the air*"[95] and the Code of Federal Regulations (CFR) states that *"(a)ircraft means a device that is used or intended to be used for flight in the air*"[96].

In Canada the Aeronautics Act defines 'aircraft' as "*any machine capable of deriving support in the atmosphere from reactions of the air, and includes a rocket*"[97] while the Canadian Aviation Regulations (CARs) define only narrower terms, e.g. 'aeroplane', 'airship' and 'balloon'.[98]

As a result, the objects in question generally fall within these broad definitions and hence qualify as 'aircraft' for the purposes of civil aviation regulations under ICAO, and in the United States and Canada. There 'aircraft' status is not only desirable[99], but legal real-

---

93 Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 1.

94 The Chicago Convention itself does not contain a definition of 'aircraft'. This definition can be found in various ICAO Annexes, e.g. Annex 8, 11th edition July 2010, 1. Definitions. Please see Chapter 3, B. 1. b. for a brief overview of the problem of the legal value of the Annexes and further references.

95 49 United States Code (USC) § 40102 (a) (6).

96 14 Code of Federal Regulations (CFR), Part I, § 1.1.

97 Aeronautics Act, RSC, 1985, c. A-2), 3. (1).

98 CARs, Part I, Subpart 1, 101.01 (1).

99 However, for manufacturers of micro or small UAS it could also be an advantage if their product would not be considered aircraft and hence be subject to less regulation, Mark E Peterson, "The UAV and the Current and Future Regulatory Contruct" *supra* note 24, at 529 f.

ity.[100] Within those definitions, the United States version is the broadest as it does not require any atmospheric support. The ICAO definition is the narrowest, as is requires such support and excludes "*reactions of the air against the earth's surface*" from its ambit; the way a rocket would create propulsion. The Canadian definition ranges in between those two, as atmospheric support is required, but rockets are expressly included.

Surprisingly at first glance, the CARs sections[101] about UA regulate 'Unmanned Air Vehicles'. Despite this denomination, these vehicles are defined as "*a power-driven aircraft, other than a model aircraft, that is designed to fly without a human operator on board*"[102]. As a result, this definition reaffirms their 'aircraft' status, even when called 'Unmanned Air Vehicles'.[103]

Civil aviation is unanimously concerned about 'aircraft' in the respective entities and precludes further discussion on that matter.[104] If a given vehicle cannot be considered an aircraft, it will not be regulated by the aircraft regulations. In this case, it needs to be examined if and how the respective entities regulate such vehicles.

bb. UA and model aircraft

Model aircraft[105] can fall under the definitions of 'aircraft' of ICAO, the United States and Canada. However, model aircraft are not UA. The Canadian definition of Unmanned Air Vehicles excludes them explicitly. In the United States, UA are distinguished

---

100 See for the question, if the member States are bound by ICAO's 'aircraft' definition or if they can deviate from them: Douglas M Marshall, "UAS and ICAO Regulations" *supra* note 9, at 700 ff; interestingly Maneschijn, while reaffirming the 'aircraft' status of UA, proposes to take the rules for reusable launch vehicles into account when developing UAS regulations, A Maneschijn et al, "Reference framework UAV and system airworthiness requirements" *supra* note 10.

101 CARs, Part VI, Subpart 2, 602.41.

102 CARs, Part I, Subpart 1, 101.01 (1).

103 Masutti also uses the term 'Unmanned Air Vehicle' Anna Masutti, "Proposals for the Regulation of Unmanned Air Vehicle Use in Common Airspace" (2009) 34:1 Air and Space Law 1 ["Proposals for UAV Regulation"], however, there seems to be no difference between 'Unmanned Aerial Vehicle' and 'Unmanned Air Vehicle'.

104 See for the question of 'aircraft' vs 'vehicle' *inter alia* Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 4 f; Mark E Peterson, "The UAV and the Current and Future Regulatory Contruct" *supra* note 24, at 528 ff.

105 Model aircraft are generally operated by remote control in specific designated areas for recreational purposes.

from model aircraft and cannot be operated under the model aircraft status.[106] The ICAO UAS Circular 328, which will be studied intensively in Chapter 3, reaffirms that model aircraft fall outside the provisions of the Chicago Convention.[107] Additionally the idea of 'model' does not fit to UA, as UA are not exact models of existing manned aircraft in *strictu sensu*, but rather separate types of aircraft.[108]

Given the fact that, on the one hand, some small UA are controlled in a similar manner and have similar capabilities as the average model aircrafts used by modelers, and on the other hand, that some model aircrafts can reach a significant size and weight[109], the distinction between UA and model aircraft is sometimes not easily made.[110] The regulators want to abstain from over-regulating hobbies but at the same time, all possible UA should be covered. Because of the technical overlapping, the delimitation is often made on the basis of the aircraft's purpose.[111] Model aircraft are deemed to be used for 'recreational purposes', while UA are used for non-recreational purposes. Similar to the question of the actual 'use' when distinguishing between civil and state aircraft,[112] the question if the aircraft is used for recreational purposes or not can create inconsistent results and can dilute legal certainty. If someone would fly a UA, which is normally used for surveillance, just for entertainment in leisure time, it could be deemed a model aircraft. When a modeler takes picture with an onboard camera and sells them afterward, it could be considered as a commercial UA.

---

106 See Advisory Circular (AC), FAA, *AC 91-57 - Model Aircraft Operating Standards* (Washington: FAA, 1981) [*AC 91-57*] and FAA, *Federal Register Notice - Clarification of FAA Policy*, Docket No FAA-2006-25714 (Washington: FAA, 2007) [*Clarification of FAA Policy*], which will be examined in Chapter 4.

107 ICAO, Secretary General, *Unmanned Aircraft Systems (UAS)*, Circular Cir 328 AN/190 (Montreal: ICAO, 2011) at para 2.4 [*UAS Circular*].

108 Missiles, as "*single mission throw away product(s)*", Stefan A Kaiser, "Legal Aspects of UAV" *supra* note 40, at 349, are generally not considered civil UA as they are not designed for civilian use or for integration into the civil aviation system in general, Mark E Peterson, "The UAV and the Current and Future Regulatory Contruct" *supra* note 24, at 532.

109 See examples of such model aircraft on *Large Model Association* <http://www.largemodelassociation.com/> [*Large Model Association*].

110 See for the similarities and differences of micro/small UA and model aircraft as well as a proposal for European regulation of 'Light UAV Systems' JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at Annex 1.

111 FAA, *Notice of Policy: Unmanned Aircraft Operations in the National Airspace System*, Docket No. FAA-2006-25714 (Wahington: FAA, 2006) at 5 [*Unmanned Aircraft Operations in the National Airspace System*]; ICAO, Secretary General, *UAS Circular*, *supra* note 106 at para 2.4.

112 Please see Chapter 3. A. 3. c. aa.

As a result of the respective documents, model aircraft are not UA. However, the distinction between models and UA can sometimes be difficult. The way ICAO, the United States and Canada handle model aircraft and distinguish them from UA will be explained in the respective chapters.

c. Remotely Piloted Aircraft and autonomous UA

The concept of RPV mentioned above, was adapted by ICAO to the 'aircraft' status. The Remotely Piloted Aircraft (RPA) hence describes an UA which is controlled by a pilot from a remote location and excludes autonomous UA operations. What matters, is the degree of autonomy. If the UA operates completely autonomously, and without any form of human intervention, it cannot be qualified as an RPA. Nevertheless, as already mentioned in the introduction, the use of fully autonomous[113] UA is not likely to happen, at least not in the near future. However, temporary fully autonomous flight could be undertaken as a backup in the case of total loss of the Data-Link.[114] On the one hand, the technology in not yet developed enough to secure safe and reliable complete autonomous flights.[115] On the other hand, and legally more relevant, every operation needs a responsible person. This requires that a pilot must have the possibility to take over control of the UA, whenever it will be necessary.[116] Additionally, there still is a reluctance to hand over certain decisions to a fully autonomous machine. Hence, the focus of UA development and regulation will most likely be on UA that are completely or partially remotely controlled, or at least remotely controllable in special situations.

---

113 See for the increasing use of and reliance on artificial intelligence in several areas: David Allen Larson, "Artificial Intelligence: Robots, Avatars, and the Demise of the Human Mediator" (2010) Ohio State Journal on Dispute Resolution 105 ["Artificial Intelligence"] and for other unmanned vehicles (ground and water): Brendan Gogarty & Meredith Hagger, "Laws of Man over Vehicles Unmanned" *supra* note 21.

114 Please see on these aspects HaiYang Chao, YongCan Cao & YangQuan Chen, "Autopilots for Small Unmanned Aerial Vehicles: A Survey" (2010) 8:1 International Journal of Control, Automation, and Systems 36 ["Autopilots for Small Unmanned Aerial Vehicles"]; JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 7.8.

115 Brendan Gogarty & Meredith Hagger, "Laws of Man over Vehicles Unmanned" *supra* note 21, at para 11.4.

116 Stefan A Kaiser, "Third Party Liability of Unmanned Aerial Vehicles" (2008) 57:2 Zeitschrift für Luft- und Weltraumrecht 229 at 232 ["Third Party Liablity of UAV"].

d. Definitions

ICAO defines an UA in the UAS Circular, a non binding document explained in detail in Chapter 3, as *"(a)n aircraft which is intended to operate with no pilot on board*"[117] and a RPA, as the narrower concept, as "*(a)n aircraft where the flying pilot is not on board the aircraft*"[118].

In Canada an UA is "*a power-driven aircraft, other than a model aircraft, that is designed to fly without a human operator on board*"[119]. The exclusion of model aircraft also applies to the ICAO concept as explained before and therefore creates no difference. The 'power-driven' requirements however, excludes balloons[120], gliders[121] and gyroplanes[122] from UA as they are defined as 'non-power-driven' aircraft. As the Canadian definition of 'aircraft' includes rockets, those could also be UA.[123] Nevertheless, the use of rockets as civil UA is unlikely.

In the United States, civil UA are defined in the FAA Order 8130.34A[124], which will be examined in detail in Chapter 4. Therein, a UA is "*(a) device used or intended to be used for flight in the air that has no onboard pilot. This includes all classes of airplanes, helicopters, airships, and translational lift aircraft that have no onboard pilot. Unmanned aircraft include only those aircraft controllable in three dimensions and, therefore, exclude traditional balloons and unpowered gliders*"[125].[126] This definition covers autonomous UA

---

117 ICAO, Secretary General, *UAS Circular*, *supra* note 106 at Glossary; the definitions introduced by the UAS Circular do not have official status with ICAO.

118 Ibid.

119 CARs*,* Part I, Subpart 1, 101.01 (1).

120 "*'(B)alloon' - means a non-power-driven lighter-than-air aircraft*", ibid.

121 "'*(G)lider' - means a non-power-driven heavier-than-air aircraft that derives its lift in flight from aerodynamic reactions on surfaces that remain fixed during flight*", ibid.

122 "*'(G)yroplane' - means a heavier-than-air aircraft that derives its lift in flight from aerodynamic reactions on one or more non-power-driven rotors on substantially vertical axes*", ibid.

123 Aeronautics Act, RSC, 1985, c. A-2), 3. (1).

124 FAA, *Order 8130.34A - Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft* (Washington: FAA, 2010) [*Order 8130.34A*].

125 Ibid Appendix F, i.

126 The FAA formerly used also the term Remotely Operated Aircraft (ROA), Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 5.

and RPA, as in both cases no pilot is aboard. It further reaffirms that all types of aircraft can also be unmanned, but excludes traditional balloons and unpowered gliders from the UA ambit.

All definitions focus on the aspect that no person is in control aboard the aircraft. They include autonomous UA and RPA. In contrast to the idea of 'uninhabited', as mentioned before, these definitions do not exclude the possibility of transport of humans.

2. Unmanned Aircraft System (UAS)

a. System approach

The UA cannot be operated entirely on its own as a manned aircraft could. The pilot is not aboard the aircraft, but is located remotely and its control commands need to reach the UA. Even in the case of a fully autonomous flight, the UA often relies on data transmitted to the UA to navigate autonomously or it often requires other elements, e.g. take-off or landing equipment. As the term 'Unmanned Aircraft' alone would not appreciate this whole concept, the term Unmanned Aircraft System (UAS) emerged as the appropriate term.[127] The UAS describes the whole set of technology needed to operate an UA. It includes the UA, the control station, the Data-Link, and further components. Their basic technical specificities are described in the following subchapter. The system approach reflects the reality of UA operations, but creates several new challenges for their regulation. In particular with regard to certification and licensing, these new components need to be addressed. The way this is done or proposed by ICAO, the United States and Canada, will be examined in the respective chapters.

b. Definitions

---

[127] ICAO decided in 2007 to use the term UAS, ICAO, Air Naviagation Commission, *Progress Report on Unmanned Aerial Vehicle Work and Proposal for Establishment of a Study Group*, Working PaperAN-WP/8221 (Montreal: ICAO, 2007) at 3 [*Progress Report on UAV and Proposal of Establishement of UASSG*].

ICAO defines the UAS as "*(a)n aircraft and its associated elements which are operated with no pilot on board*"[128]. The equivalent to the RPA on the system level, the Remotely Piloted Aircraft System (RPAS), is defined as "*(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*"[129].

The aforementioned FAA Order 8130.34A defines UAS as "*(a)n unmanned aircraft and its associated elements related to safe operation, which may include control stations, data links, support equipment, payloads, flight termination systems, and launch/recovery equipment*"[130].

The definitions of ICAO and the United States are triggered toward the same concept. Both express the system approach but are worded openly to allow several elements of the system and possible future components to be covered. While this makes the definition imprecise, it reflects the fact that UAS regulations and technology are in their developing phase. As the RPA is the focus of the technological and regulatory development, the RPAS, i.e. the system approach applied to RPA, will be of equivalent importance. ICAO's definitions of RPA and RPAS reflect this reality and offer a narrower concept within the UA and UAS approach.

The CARs do not contain a definition of UAS. The relevant sections only refer to the 'Unmanned Air Vehicles' without mentioning the system approach explicitly. The Final Report of the UAV Working Group[131], which will be discussed in detail in Chapter 5, proposed to define UAS as "*the unmanned air vehicle(s), control station(s) and any other*

[128] ICAO, Secretary General, *UAS Circular*, *supra* note 106 at Glossary.
[129] Ibid; the herein mentioned components are also defined in the UAS Circular and will be explained in the course of the thesis.
[130] FAA, *Order 8130.34A*, *supra* note 123 at Appendix F, j.
[131] Transport Canada, *Unmanned Air Vehicle Working Group Final Report* (Ottawa: Transport Canada, 2007) [*UAV Working Group Final Report*].

elements required for flight“[132]. This definition would have the same breadth as the definitions of ICAO and the United Stated, including its openness to further developments.

Several other terms and abbreviations exist in the field of unmanned aviation. The ones explained before are the most basic in civil UAS regulations. As other terms become relevant in the subsequent chapters, they are explained respectively.

D. Technical and operational background

UAS have several characteristics that differentiate them from manned aircraft. The aforementioned UAS elements will be explained briefly to understand the difficulties in handling unmanned aviation. In the following, the basic technical fundamentals will be established, on which the regulations and proposals by ICAO the United States and Canada can be examined. Legal considerations that are linked to the respective technical aspects will be noted. The terminology used, is the one that ICAO proposes for future regulation.[133]

1. UA

UAS can perform a variety of tasks, as mentioned above. This variety is mirrored by a multitude of UA types and models, which can be subdivided into different classifications. Those serve to group the different capabilities on the one hand, and to manage the different hazards to safety on the other hand. As a result, they can be a basis for tailored regulations.

The following classifications are a very basic and simple differentiation of UA based on their size and weight, which serves to illustrate the practical range of UAS and

---

[132] Transport Canada, *UAV Working Group - Final Report* (Ottawa: Transport Canada, 2007) at para 13.2 [*UAV Working Group - Final Report*]; Transport Canada, *UAV Working Group Final Report*, *supra* note 130 at para 13.2.

[133] See ICAO, Secretary General, *UAS Circular*, *supra* note 106 at Glossary.

their technology and applications. The legal classification of UAS is a very difficult and controversial issue, which will be touched upon in Chapter 6.[134]

a. Micro and small UA

Micro UA are generally of few centimeters in size and grams in weight.[135] They can have, for instance, the form of micro helicopters or are shaped like birds or insects.[136] As examples of miniaturization in robotics, their capabilities are considerable for their size but often limited, at least for now, to video and audio collection and transmission. Small UA are often below one meter of size and some kilograms of weight, while they have the capability to carry diverse payloads[137] of a few kilograms.[138] Micro and small UA have in common, that they fly at low altitudes and operate at moderate speed and range.[139] Take offs can be done by a hand or catapult and landings can be performed on open fields or by capturing devices.[140] This category of UA clearly belongs to the group of UA mentioned above, that offers new applications unprecedented by manned aircraft.

b. Medium UA

Medium UA can reach the size and weight of typical manned aircraft, while the category of Medium Altitude and Long Endurance (MALE) is the most common.[141] Suc-

---

134 Please see Chapter 6, B. 3.

135 See for one of many examples G C H E de Croon et al, "Design, aerodynamics, and vision-based control of the DelFly" (2009) 71:1 Int' L J On Micro Air Vehicles at 262 ["Design, aerodynamics, and vision-based control of the DelFly"].

136 See for example *Robot Hummingbird Spy Drone Flies for Eight Minutes, Spies on Bad Guys* <http://www.foxnews.com/scitech/2011/02/18/robot-hummingbird-spy-drone-flies-minutes-spies-bad-guys/> [*Robot Hummingbird Spy Drone*], a state aircraft in this case, which could be use identically for civil purposes.

137 Payloads can often include electro-optical sensing systems and scanners, infra-red systems, radars, dispensable loads, environmental sensors, *Unmanned Aerial Vehicle Systems Association* <http://www.uavs.org/> at UAS Components [*UAVS Association*].

138 Stefan A Kaiser, "Legal Aspects of UAV" *supra* note 40, at 345.

139 Ibid.

140 Ibid.

141 Please see for a recent overview of the different types and models, especially MALE, Eric H Biass & Roy Braybrook, "Compendium Drones 2010, Supplement to Armada Issue 3/2010" (2010):3 Armada International ["Compendium Drones 2010"].

cessful military types[142] in this category can be the basis for civil medium UA.[143] They can also belong to the other group of UA mentioned above, the one which is capable of replacing manned aircraft in several instances. To fulfill this function, they need to be operated in similar circumstances as manned aircraft. They require the utilization of airspace typically used by manned aircraft and their operating speed and range can be similar to those of manned aircraft or go far beyond. Take offs and landings require adequate facilities.[144] Coordination with the existing air traffic is key to integration in the non-segregated[145] airspace. Medium UA bear the greatest potential conflict with manned aviation.

c. Large UA

Large UA operate at high altitudes and can fly over an extended period of time. In distinction to MALE, their most prominent category is High Altitude Long Endurance (HALE). Examples include turbojet powered UA with wingspans of large passenger aircraft, which can operate at or above 18 kilometers of altitude at a speed of around 850 km/h over 35 hours at a time[146], to HALE built for scientific research, flying solar powered at 30 km of altitude for days or even weeks[147]. They do not replace manned aircraft but instead offer applications that could for instance compete with existing satellite services.[148] Their size requires airfields or airports for take off and landing and they need to traverse controlled airspace during climb and descend.[149]

2. Remote Pilot Station

---

[142] E.g. the General Atomics MQ-1 Predator or the Northrop Grumman RQ-4 Global Hawk. See also Laurence R Newcome, Unmanned Aviation History, *supra* note 9 at 101 ff.

[143] JAA/Eurocontrol, “UAV Task-Force Report” *supra* note 9, at 5.

[144] Mark E Peterson, “The UAV and the Current and Future Regulatory Contruct” *supra* note 24, at 534.

[145] Please see D. 6.

[146] M Amouzegar & D Snyder, RAND Corp, *Project Air Force*, Presented to the U.S. Air Force (2005) in Douglas M Marshall, “UAS and ICAO Regulations” *supra* note 9, at 695.

[147] Jeff Bauer, “NASA Dryden Flight Research Center”, 59, in UVS International, ed, *UAS Yearbook - UAS: The Global Perspective* (Paris: Blyenburgh & Co, 2009), vol 7 [“NASA Dryden Flight Research Center”]; Stefan A Kaiser, “Legal Aspects of UAV” *supra* note 40, at 346; *Dryden Flight Research Center* <http://www.nasa.gov/centers/dryden/news/FactSheets/FS-068-DFRC.html> [*Dryden Flight Research Center Website*]; Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 117 ff.

[148] Stefan A Kaiser, “Legal Aspects of UAV” *supra* note 40, at 346.

[149] Ibid.

The Remote Pilot Station (RPS) is the device or facility from which the pilot controls the UA. Dependent on the individual UA but generally guided by the classifications mentioned before, the RPS can vary significantly. Micro and small UA are mostly controlled by handheld or vehicle based devices, which often also serve to display the data collected by the UA, e.g. audio and video. Medium and large UA require a more sophisticated RPS. Ground based control equipment, e.g. radio or satellite transmitter and radar, help to manage the flight of the UA. Onboard cameras and radars submit additional information to control the UA. The RPA can be ground based, installed on a ship or located on manned aircraft[150]. RPS can possess the capability of controlling more than one UA at time. Apart from being controlled by a RPS, UA can perform autonomous operations previously programmed or uploaded in the course of the flight. Partially autonomous flights, similar to the use of an autopilot in manned aviation, are frequent. Fully autonomous flights, as mentioned before, are unlikely to be used. Even in the case of fully autonomous flights, the UA is often provided with navigational information from a RPS or downloads its payload data to the RPS.[151]

While the UA, notwithstanding its different characteristics, is an aircraft which could follow the guidance of manned aircraft regulations, the RPS has no equivalent in manned aviation. The RPS needs to be included in the certification process, and a whole set of certification requirements have to be established. In particular, it has to be decided if the RPS is certified together with the UA or if it requires a separate certification.

3. Data-Link

The Data-Link connects the UA and the RPS. It generally performs two different functions. The first function is that it allows the Remote Pilot to control the flight of the UA, which is called Command and Control (C2). As mentioned within the examples of

---

150 *NATO AWACS progress: Full Control of an unmanned airborne system* <http://www.aco.nato.int/page272203947.aspx> [*AWACS UAS Control*].

151 Stationary RPS are often equipped with an avionics flight display, navigation systems, system health monitoring and prognostics display, graphical images and position mapping, secure communications systems and inward data processing equipment, *UAVS Association* (webpage), *supra* note 136 at 'UAS Components'.

applications, the major segment of applications of civil UAS will be information gathering and distribution. The information collected by the various possible payloads of the UA needs to be submitted to the RPS or other facilities for further usage. This communication or payload link is the second function of the Data-Link. The two functions together are called Command, Control and Communication (C3). The Data-Link is generally established by radio or satellite communication. Data-Link systems can range from a simple transmitter to a complex networked communications system that uses a variety of communications modes including the internet and satellite.[152]

The use of satellite services for UAS can significantly increase their capabilities.[153] While a ground based radio transmission Data-Link is normally limited in range, a satellite based Data-Link allows a nearly world-wide coverage and thereby extended operations in altitude and range.[154] Additionally the amount of data to be transferred, especially with complex payload, e.g. high resolution cameras, can be handled more efficiently by using satellite services. Satellites could establish the C3 Data-Link and also be used for ATC communication, in the case of UAS integration in the controlled airspace.[155] Practically, UAS and satellites could be used in conjunction, especially with their different advantages with regard to remote sensing.[156]

The Data-Link requires radio frequencies.[157] As frequencies with certain bandwidths are already a scarce resource, the potential growth of UAS use will increase this

---

152 Giorgio Guglieri et al, "Survey of Airworthiness and Certification" *supra* note 80, at para 2.4.4.1.

153 See for a list of UAS applications that would particularly benefit from satellite services Pablo González, "Civil applications of UAS: The way to start in the short term (Presentation)" (2010) Workshop of the European Space Policy Institute: Opening Airspace for UAS in the Civilian Airspace 1 at 4 ["Opening Airspace for UAS"].

154 A Ginati, S Gustafsson & J Juusti, "Space, the essential component for UAS - The case of Integrated Applications - "Space 4 UAS" (Presentation)" at 25 ["Space 4 UAS"].

155 Ibid 27.

156 While satellites can provide a global picture, UAS could provide local details, Pablo González, "Civil applications of UAS: The way to start in the short term (Presentation)" ibid. at 11 ["Opening Airspace for UAS"]; Pat Norris, *Watching Earth from Space: How Surveillance Helps Us - and Harms Us* (Chichester: Springer Praxis Books, 2010) at 262 [*Watching Earth from Space*].

157 See for details on UAS spectrum requirements, *inter alia*, John Taylor (ICAO), "Preparations for WCR-12 - WRC-12 Agenda Item 1.3 on UAS (Presentation)" (2010) Cairo 19-20 September 2010 ["WRC-12 Agenda Item 1.3 on UAS (Presentation)"].

problem.[158] The International Telecommunications Union (ITU) is already considering respective regulatory provisions for UAS frequencies and put this issue on the agenda of the 2012 World Radiocommunication Conference (WRC).[159]

With regard to certification, the defining of the requirements for the reliability, integrity, and availability of the Data-Link is of particular importance.[160] It also needs to be discussed, if the the control and payload Data-Links need to be certified seperately or can be certified as a unit.

4. UAS Personnel

A UA is controlled from the RPS. The 'Remote Pilot' is the individual that uses the flight controls to navigate the UA. As the term 'personnel' indicates, the pilot may not be the only one concerned with the operation of the UA. Besides the pilot there can be a 'UAS Operator'[161] and further personnel, e.g. a 'RPA Observer'[162], dependant on the complexity of the UAS in question and the respective regulations. The UAS Operator is not a natural person, as the Remote Pilot is, but the legal entity responsible for organizing the flight operations.[163] The manner in which UAS personnel are regulated by ICAO, the United States and Canada will be explained in the respective chapters.

---

158 JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 7.13.

159 ITU, *Resolution 421 (WRC-07)*, *supra* note 86; ITU, *2012 World Radiocommunication Conference - Agenda and References* at para 1.3 and 2.1 [*2012 World Radiocommunication Conference - Agenda and References*]; frequency spectrum for aviation is approved by the ITU WRC, which meets every three to four years. Because of the requirement to establish an agenda three years in advance of the next WRC, the UAS community was not successful in establishing an agenda item for discussion or decision at the 2007 meeting, ICAO, Technical Commission Assembly, *ICAO Collaboration on Frequency Spectrum Requirements for Unmanned Aircraft Systems (UAS) Operations*, Working PaperA36-WP/150 (2007) at para 2.1 [*Frequency Spectrum Requirements for UAS*].

160 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 2.4.4.4; the Data-Link can also be subject to hostile hacking and jamming (aspects of data security and 'digital warfare'), ibid para 2.2.3; Brendan Gogarty & Meredith Hagger, "Laws of Man over Vehicles Unmanned" *supra* note 21, at para 11.4.3; Stefan A Kaiser, "Legal Aspects of UAV" *supra* note 40, at note 37; Jaysen A Yochim, *The Vulnerabilities of Unmanned Aircraft System Common Data Links to Electronic Attack*, (Master of Military Art and Science, Faculty of the U.S. Army Command and General Staff College, 2010) [*Vulnerabilities of Unmanned Aircraft System Common Data Links to Electronic Attack*].

161 ICAO, Secretary General, *UAS Circular*, *supra* note 106 at e.g. Glossary and para 2.6; Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 5 ff.

162 ICAO, Secretary General, *UAS Circular*, *supra* note 106 at e.g. Glossary and para 7.10.

163 Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 5.

5. Other elements of the UAS

Additional to the basic components mentioned before, further elements can be part of the UAS, e.g. emergency recovery systems or flight termination systems.[164]

6. Airspace

While the aforementioned elements are part of the UAS itself, airspace is the environment in which the UA operates. Art. 1 of the Chicago Convention reaffirms the customary international law rule, that the State has "*complete and exclusive sovereignty over the airspace above its territory*".[165] Over the high seas, ICAO has jurisdiction pursuant to Art. 12 Chicago Convention, which should be read in conjunction with Annexes 2, 6, 11 and 12[166], and makes ICAO's role with regard to UAS operations in the airspace over the high seas even more decisive.[167]

---

164 As explained for example in the JAA/Erocontrol UAV Task-Force Report: "*In most of the current UAV draft materials, Flight Termination Capability or System is defined as 'a controllable parachute or automatic pre-programmed course of action used with UAV Systems to terminate flight in case of a critical failure'.*" JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 7.7.

165 Horizontally, Art. 2 declares that the territory in this respect "*shall be deemed to be the land areas and territorial waters adjacent thereto under the sovereignty, suzerainty, protection or mandate of such State*". Vertically, the delimitation between airspace and outer space is unclear, but not (yet) of relevance for the use of UAS, as they do not operate at such heights; see the discussion between 'spacialists', *inter alia* UN COPUOS, *Definition and Delimitation of Outer Space*, Legal Subcommittee UN COPUOS, A/AC 105/484 (1991) [*Definition and Delimitation of Outer Space*], discussed in Bess C M Reijnen, *The United Nations Space Treaty Analysed* (Gif-sur-Yvette: Editions Frontières, 1992) at 98 [*The United Nations Space Treaty Analysed*]; UN COPUOS, *Approach to the Solution of the Problems of the Delimitation of Airspace and Outer Space (reissued version of 28 March 1979)*, Legal Subcommittee UN COPUOS, A/AC 105/C 2/L 121 (1979) [*Approach to the Solution of the Problems of the Delimitation of Airspace and Outer Space (reissued version of 28 March 1979)*] (working paper prepared by the Soviet Union which defined outer space as the region beyond an altitude of 100 kilometers above sea level), discussed in Bin Cheng, "The Legal Regime of Airspace and Outer Space: the Boundary Problem" (1980) 5 Annals of Air and Space Law 323 ["The Legal Regime of Airspace and Outer Space: the Boundary Problem"], and 'functionalists', Ram S Jakhu, "The Legal Status of the Geostationary Orbi" (1982) 7 Annals of Air and Space Law 333 at 337 f ["The Legal Status of the Geostationary Orbi"]; Bin Cheng, "International Responsibility and Liability for Launch Activities" (1995) 20 Air & Space L 297 ["International Responsibility and Liability for Launch Activities"].

166 I H Ph Diederiks-Verschoor, *An Introduction to Air Law*, 8 ed (Alphen aan den Rijn: Kluwer Law International, 2006) at 38 [*Introduction to Air Law*].

167 Please see for details on ICAO's jurisdiction, Chapter 3, A. 2.

Within national airspace several airspace classes[168] exist, which are either 'controlled', i.e. where ATC has some form of positive executive control over aircraft flying in that airspace, or 'uncontrolled', i.e. where ATC does not exert any executive authority but may act in an advisory manner. Generally areas of higher traffic density are controlled, while areas of lower density, low altitude[169] and very high altitudes are often uncontrolled. Micro and small UA fly at low altitudes and therefore generally operate in uncontrolled airspace.[170] MALE may require the utilization of controlled airspaces which are typically used by manned aircraft. HALE may need to traverse controlled airspace when they ascend to their operating altitude or descend for landing.[171] Irrespective of controlled or uncontrolled airspace, aircraft respectively their pilots require the capability of 'see and avoid', i.e. the ability of the pilot to see potentially conflicting traffic and to avoid collisions.[172] In case of UAS, the pilot on the ground cannot literally 'see', except the UAS is operated in visual line-of-sight (VLOS). Therefore the traditional concept of 'see and avoid' is replaced by a 'detect, sense and avoid' requirement. This 'detect, sense and avoid' ability is as yet limited in UAS operations due to technical reasons.

Another distinction within national airspace, in particular in the light of UAS, can be made between 'segregated' and 'non-segregated' airspace.[173] These are not formal terms or types of airspace. 'Segregated airspace' describes a part of the national airspace, controlled or uncontrolled, restricted to a special use, where all others than the designated users are excluded.[174] 'Non-segregated airspace' hence, describes the remaining airspace.

---

168 ICAO's Annex 11, covers airspace classifications (Chapter 2, Section 2.6 and Appendix 4); however, the actual airspace classes vary from State to State.

169 Except in the proximity to airports where control zones extend the controlled airspace to the ground.

170 Stefan A Kaiser, "Legal Aspects of UAV" *supra* note 40, at 345; Stefan A Kaiser, "Identifying Regulatory Parameters to Integrate UAS into Civilian, Non-Segregated Airspace (Presentation)" (2010) Workshop of the European Space Policy Institute: Opening Airspace for UAS in the Civilian Airspace 1 at 5 ["Identifying Regulatory Parameters"].

171 Stefan A Kaiser, "Legal Aspects of UAV" *supra* note 40, at 346.

172 The 'see and avoid' function requires the pilot, under suitable visibility conditions, to maintain a visual lookout for other aircraft and if necessary, initiate maneuvers to avoid a potential collision. Ultimately the pilot is responsible, irrespective of any third party separation services, e.g. ATC, or technology-based separation support, e.g. a Traffic Alert and Collision Avoidance System (TCAS); see ICAO Annex 2.

173 Please see for an illustrative figure of the different airspaces in which UAS could be operated ICAO, Aeronautical Communications Panel, *Considerations on categories of airspaces for the work of the WRC-11 - A.I. 1.3*, ACP-WGF18/WP-02 Rev 1 (Montreal: ICAO, 2008) at Figure 1 [*Considerations on categories of airspaces*].

174 'Segregated' airspaces are generally fixed, but a bubble of segregated airspace around the UA which

The concept of segregation is utilized for UAS operations to avoid hazards to other aircraft in flight and people and property on the ground. Therefore segregated airspaces are often created in areas where population is thin and for a limited periods of time to not affect regular air traffic too long. For military uses, e.g. with the help flight corridors[175], this might be sufficient. Civil UAS however, as many of the abovementioned applications show, would benefit significantly from integration in the non-segregated airspace also above populated areas. Especially MALE UA can possess the capability of replacing manned aircraft in the same environment where the latter operate.[176] The integration of UAS in the non-segregated airspace puts high demands on UAS regulations and is seen as the major challenge with regard to civil unmanned aviation.[177] In the respective chapters, the status of UAS integration into non-segregated airspace will be examined.

7. Handover

The 'handover' of a UA is an operational aspect which describes the situation where control of a UA is passed from a Remote Pilot at one control station to another Remote Pilot who may be at another control station.[178] It can be a handover from one Remote Pilot to another in the same RPS, e.g. because of a regular work shift, or it may be between two RPS located far away from each other or even in different States. The last situation in particular underlines the importance of international harmonization to maintain safety in international UAS operations. While in manned aviation a change of the responsible pilots during a long distance flight is usual, a change of the RPS in flight results in a change of the whole composition of the UAS itself.

---

moves with the UA is also possible. Whilst the use of fixed volumes of 'segregated' airspace is relatively simple to implement, moving volumes of airspace require a significant amount of work prior to each mission.

175 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 2.3.8.

176 Future cargo or passenger transportation would be impossible, if UAS could not operate in non-segregated airspace.

177 Reece A Clothier, Neale L Fulton & Rodney A Walker, "Pilotless aircraft: the horseless carriage of the twenty-first century?" (2008) 11:8 Journal of Risk Research 999 at 1003 ["Pilotless aircraft: the horseless carriage of the twenty-first century?"]; Anna Masutti, "Proposals for UAV Regulation" *supra* note 102, at 2; Geoffrey Christopher Rapp, "Civil Liability of UAS in Law Enforcement" *supra* note 20.

178 JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 7.14.

The aspect of handover cannot be dealt with separately as it involves all elements mentioned before. It therefore adds another level of complexity to UAS regulations. With regard to certification and licensing in particular, it is linked to several issues. It raises the questions if the UA and the RPS are certified separately or as one unit. Also of relevance is the recognition of the airworthiness certificate and the pilot license in the case of international operations as well as the issue of the transfer of the responsibility for the conduct of the UA, as the identity of the Remote Pilot and the UAS Operator must be clear at all times.

CHAPTER 3: ICAO AND UAS

In the present chapter, ICAO's regulatory approach to UAS will be examined. In the first part, its organization and scope as well as its jurisdiction over UAS will be briefly described before an analysis of selected provisions of the Chicago Convention and its annexes with regard to UAS will be undertaken. In the second part, the work of ICAO on UAS, in particular of the UAS Study Group (UASSG), will be examined and probable future developments will be highlighted. This chapters' more general view provides a basis for the examination of ICAO's current position with regard to certification of UAS and licensing of its personnel in Chapter 6.

A. Organization and jurisdiction

1. Organization and scope

ICAO was created with the signing of the Chicago Convention on 7 December 1944 and started its work on 4 April 1947.[179] It is a specialized agency of the United Nations (UN) and the permanent body charged with the administration of the principles laid out in the Chicago Convention. ICAO was established as the instrument to ensure international cooperation and the highest possible degree of uniformity in regulations, standards, procedures, and organization regarding civil aviation.[180] The Chicago Convention serves as ICAO's constitution and prescribes that the organization consists of an Assembly, a Coun-

---

[179] The Chicago Convention was signed on 7 December 1944 by 52 States. Pending ratification of the Convention by 26 States, the Provisional International Civil Aviation Organization (PICAO) was established, which functioned from 6 June 1945 until 4 April 1947. By 5 March 1947 the 26th ratification was received and ICAO came into being on 4 April 1947. In the same year, ICAO became a specialized agency of the UN linked to Economic and Social Council (ECOSOC). See for more details on ICAO *inter alia*: Paul Stephen Dempsey, *Public International Air Law* (Montreal: Institute and Center for Research in Air & Space Law, 2008) vol 1, at 49 ff [*Public International Air Law*]; I H Ph Diederiks-Verschoor, *Introduction to Air Law*, *supra* note 165 at 13 ff; Stephan Hobe & Nicolai von Ruckteschell, eds, *Kölner Kompendium des Luftrechts* (Cologne: Carl Heymanns Verlag, 2008) vol 1 at 29 ff [*Kölner Kompendium des Luftrechts*]; *International Civil Aviation Organization* <www.icao.int> [*ICAO Website*]; Douglas M Marshall, "UAS and ICAO Regulations" *supra* note 9; Michael Milde, *International Air Law and ICAO* (Utrecht: Eleven International Publishing, 2008) at 41 ff [*International Air Law and ICAO*].

[180] Douglas M Marshall, "UAS and ICAO Regulations" *supra* note 9, at 697.

cil of limited membership and a Secretariat.[181] The chief officers are the President of the Council and the Secretary General.[182] ICAO cooperates with other international organization[183] and non-governmental organizations[184].

The aims and objectives of ICAO can be found in Art. 44, which are:

> (...) *to develop the principles and techniques of international air navigation and to foster the planning and development of international air transport so as to:*
> *(a) Insure the safe and orderly growth of international civil aviation throughout the world;*
> *(b) Encourage the arts of aircraft design and operation for peaceful purposes;*
> *(c) Encourage the development of airways, airports, and air navigation facilities for international civil aviation;*
> *(d) Meet the needs of the peoples of the world for safe, regular, efficient and economical air transport;*
> *(e) Prevent economic waste caused by unreasonable competition;*
> *(f) Insure that the rights of contracting States are fully respected and that every contracting State has a fair opportunity to operate international airlines;*
> *(g) Avoid discrimination between contracting States;*
> *(h) Promote safety of flight in international air navigation;*
> *(i) Promote generally the development of all aspects of international civil aeronautics*.

To achieve these goals with the highest possible degree of uniformity throughout the member States, ICAO creates SARPs, which are issued in the IACO Annexes, Procedures for Air Navigation Services (PANS), Regional Supplementary Procedures (SUPPs) and Guidance Material in several formats. SARPs and guidance materials will be ad-

---

181 Art. 43 Chicago Convention; the Secretariat is not mentioned explicitly in the Chicago Convention, but it's foreseen existence can be inferred from Art. 59 and 60 ('Personnel', where the Secretary General is mentioned) and Art. 54 h) ('Mandatory functions of the Council', where the appointment of the Secretary General is regulated).

182 Art. 51 and 54 Chicago Convention.

183 E.g. the World Meteorological Organization (WMO), the International Telecommunication Union (ITU), the Universal Postal Union (UPU), the World Health Organization (WHO), and the International Maritime Organization (IMO).

184 The most prominent cooperating organization with regard to manned air transport are: the International Air Transport Association (IATA), the Airports Council International (ACI), the International Federation of Air Line Pilots' Associations (IFALPA), and the International Council of Aircraft Owner and Pilot Associations (IAOPA).

dressed more closely in the course of this chapter.

The United States deposited the instrument of ratification on the 9 August 1946.[185] Canada ratified the convention on the 13 February 1946.[186]

2. Jurisdiction over UAS

The letters of ICAO's acronym set the stage for its jurisdiction[187]. As 'international (air service)' means "*an air service which passes through the air space over the territory of more than one State*"[188], national UAS operations do not directly fall under the regime set forth by the Chicago Convention and its annexes. The high seas and the airspace above it are beyond the jurisdiction of any State.[189] To prevent a legal vacuum and to guarantee safe and orderly operation in the airspace over the high seas, the State agreed on ICAO's jurisdiction over air navigation in this airspace. Art. 12 of the Chicago Convention stipulates that "*(o)ver the high seas, the rules in force shall be those established under this Convention*", which should be read in conjunction with Annexes 2, 6, 11 and 12,[190] underlining ICAO's broad geographical jurisdiction.[191] 'Civil' as the category to which the Convention is applicable excludes 'state' aircraft.[192] Within 'aviation' the decisive term is 'aircraft'. As examined above, most of the flying objects of civil unmanned aviation fall within ICAO's definition of 'aircraft' as "*(a)ny machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface*"[193]. This definition includes various types of aircraft, e.g. aeroplanes, heli-

---

185 *Current lists of parties to multilateral air law treaties - Chicago Convention* (webpage), *supra* note 5.
186 Ibid.
187 'Jurisdiction' is in this context understood in the meaning of 'competence'.
188 See Art. 96 (b) Chicago Convention.
189 Art. 87 of the *United Nations Convention on the Law of the Sea*, 10 December 1982, 1833 UNTS 3, [*UNCLOS*].
190 I H Ph Diederiks-Verschoor, *Introduction to Air Law*, *supra* note 165 at 38.
191 See for more details on the ICAO regime over the high seas *inter alia* Ruwantissa Abeyratne, "Regulating UAV" *supra* note 8, at 509 ff; Michael Milde, *International Air Law and ICAO*, *supra* note 178 at 37 ff.
192 See the analysis of Art. 3 of the Chicago Convention (B. 2. a.) for further details on the aspect of 'civil' and 'state' aircraft as well as the remarks in the introduction.
193 The Chicago Convention itself does not contain a definition of 'aircraft'. This definition can be found in various ICAO Annexes, e.g. Annex 8, 1. Definitions. Please see Chapter 2, C. 1. b. for more details on the aircraft definition and UAS.

copters, gliders and free balloons.[194] As long as the objects fall under the definition of 'aircraft', ICAO's jurisdiction over the subject matter of UAS is undisputed. This is manifested in Art. 8 of the Chicago Convention, which regulates 'Pilotless Aircraft', and is reflected by ICAO's intensive work on UAS, both to be explained in this chapter. The status of ICAO as an 'organization' of international law has influence on its 'law-making'[195] functions and requires that the states implement ICAO's decisions in their national law.

B. Regulatory Approach

1. Chicago Convention and ICAO Annexes

a. Chicago Convention

The Chicago Convention is applicable to civil UAS, as explained before. As the convention does not differentiate between manned and unmanned aircraft, all provisions *prima facie* apply equally to both. However, some provisions are more relevant to UAS than others, while again others are relatively irrelevant, due to the fact that the Chicago Convention was primarily written in the light of manned aircraft engaged in passenger and cargo transport.

b. ICAO Annexes

As mentioned frequently throughout this thesis, worldwide uniformity of aviation safety standards, practices and procedures is necessary for a safe and orderly international aircraft operations. To achieve this uniformity Art. 37 of the Chicago Convention provides that ICAO "*shall adopt and amend from time to time, as may be necessary, international standards and recommended practices and procedures*". Art 37 contains a list of possible SARPs but is worded openly to allow the creation of others than the ones listed.[196] The

---

194 See for an illustrative table of the different types of aircraft Annex 7, 5th edition July 2003, Table 1.

195 Please see B. 1 b. with further references.

196 Art. 37 of the Chicago Convention lists the following subjects: "*(a) Communications systems and air navigation aids, including ground marking; (b) Characteristics of airports and landing areas; (c) Rules*

convention itself does not define 'standards' and 'recommended practices', but their definitions were made in several subsequent ICAO Assembly Resolutions:

> *Standard – any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognized as* necessary *for the safety or regularity of international air navigation and to which Contracting States* will conform *in accordance with the Convention; in the event of impossibility of compliance,* notification to the Council is compulsory under Article 38 of the Convention[197]
>
> *Recommended Practice – is any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognized as* desirable *in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States* will endeavour to conform *in accordance with the Convention. States are invited to inform the Council of non-compliance*[198]

The SARPs established by ICAO[199] are grouped into the annexes of which 18 have been elaborated so far.[200]

The annexes are not an integral part of the Chicago Convention and therefore they do not have the same legal value. This aspect coupled with the possibility in Art. 38 for a

---

of the air and air traffic control practices; (d) Licensing of operating and mechanical personnel; (e) Airworthiness of aircraft; (f) Registration and identification of aircraft; (g) Collection and exchange of meteorological information; (h) Log books; (i) Aeronautical maps and charts; (j) Customs and immigration procedures; (k) Aircraft in distress and investigation of accidents; and such other matters concerned with the safety, regularity, and efficiency of air navigation as may from time to time appear appropriate".

197 Assembly Resolution A36-13, Appendix A., emphasis added by the author.

198 Assembly Resolution A36-13, Appendix A., emphasis added by the author.

199 See for details on the process of the elaboration and adoption of SARPs *ICAO Website* (webpage), *supra* note 178; Michael Milde, *International Air Law and ICAO*, *supra* note 178 at 156 ff.

200 Annex 1 - Personnel Licensing, Annex 2 - Rules Of The Air, Annex 3 - Meteorological Service For International Air Navigation, Annex 4 - Aeronautical Charts, Annex 5 - Units Of Measurement To Be Used In Air And Ground Operations, Annex 6 - Operation Of Aircraft, Annex 7 - Aircraft Nationality And Registration Marks, Annex 8 - Airworthiness Of Aircraft, Annex 9 – Facilitation, Annex 10 - Aeronautical Telecommunications, Annex 11 - Air Traffic Control Service Flight Information Service Alerting Service, Annex 12 - Search And Rescue, Annex 13 - Aircraft Accident And Incident Investigation, Annex 14 – Aerodromes, Annex 15 - Aeronautical Information Services, Annex 16 - Environmental Protection, Annex 17 - Security Safeguarding International Civil Aviation Against Acts Of Unlawful Interference, Annex 18 - The Safe Transport of Dangerous Goods By Air.

State to depart from the standards and procedures if the State finds it impossible to comply, led to an extensive discussion on the legal meaning of the SARPs and the binding force of standards in particular.[201] This discussion is however a generic problem in relation to all annexes. As it has no decisive relevance to ICAO's UAS approach, it will not be elaborated in the present thesis.

In the following, the provisions of the Chicago Convention and their related annexes, which have the most impact on civil UAS operations are highlighted and partially analyzed.

2. Particular provisions of the Chicago Convention and ICAO Annexes

a. Art. 3

Art. 3 (Civil and state aircraft) of the Chicago Convention is worded as follows:

> *(a) This Convention shall be applicable only to civil aircraft, and shall not be applicable to state aircraft.*
> *(b) Aircraft used in military, customs and police services shall be deemed to be state aircraft.*
> *(c) No state aircraft of a contracting State shall fly over the territory of another State or land thereon without authorization by special agreement or otherwise, and in accordance with the terms thereof.*

---

[201] See *inter alia* and with further references: Charles Alexandrowicz, *The law making functions of the specialised agencies of the United Nations* (London: 1973) at 40 ff [*The law making functions of the specialised agencies of the United Nations*]; Thomas Buergenthal, *Law-making in the International Civil Aviation Organisation* (New York: 1969) at 88 ff [*Law-making in the International Civil Aviation Organisation*]; Jochen Erler, *Rechtsfragen der ICAO* (Cologne: 1967) at 134 ff [*Rechtsfragen der ICAO*]; Chrsitian Giesecke, *Nachtflugbeschränkung und Luftverkehrsrecht* (Cologne: 2006) at 37 ff [*Nachtflugbeschränkung und Luftverkehrsrecht*]; Michael Milde, "Enforcement of Aviation Safety Standards – Problems of Safety Oversight" (1996) 45 Zeitschrift für Luft- und Weltraumrecht 3 at 5 ff ["Enforcement of Aviation Safety Standards – Problems of Safety Oversight"]; Michael Milde, *International Air Law and ICAO*, *supra* note 178 at 165 ff; John Montgomery, "The Age of the Supersonic Jet Transport: Its Environmental an Legal Impact" (1970) Journal of Air Law and Commerce 577 at 604 ["The Age of the Supersonic Jet Transport: Its Environmental an Legal Impact"]; Otto Riese, *Luftrecht* (Stuttgart: 1949) at 85 ff [*Luftrecht*]; Gregor Rosenthal, *Umweltschutz im internationalen Luftrecht* (Cologne: 1989) at 154 [*Umweltschutz im internationalen Luftrecht*]; Astrid Skala, *Internationale technische Regeln und Standards zum Umweltschutz-recht* (Cologne: 1982) at 164 ff [*Internationale technische Regeln und Standards zum Umweltschutz-recht*].

> *(d) The contracting States undertake, when issuing regulations for their state aircraft, that they will have due regard for the safety of navigation of civil aircraft.*

The provisions of Art. 3 make the Chicago Convention applicable to civil aircraft and exclude state aircraft from its range, as explained in various instances within the present thesis.[202] However, neither the convention nor the annexes define 'state aircraft'. Art. 3 (b) names three different services that are deemed to be performed by state aircraft: military, customs and police. However, these examples are not exhaustive. States have qualified state aircraft pursuant to their national legislation and international practices.[203] Art. 3 (b) is worded "*(a)ircraft* used *in (...)*". As a result, not the aircraft type nor its formal registration, but the 'use' of the aircraft determines if the aircraft in question is a state aircraft or a civil aircraft.[204] Even if there is no universally accepted definition of state aircraft, an aircraft is generally recognized as 'state aircraft' when it is under the control of a State and used exclusively by that State for State purposes.[205] While this method of delimitation between state and civil aircraft may reflect state practice, the dependence on the criterion of the actual use does not foster legal certainty. As a result with regard to the number of UAS covered by the convention, at least at present, Art. 3 of the Chicago Convention excludes the majority of UAS applications from ICAO regulations, as these applications are military or police services and therefore performed by state aircraft.

b. Art. 8

Art. 8 (Pilotless aircraft) is the only provision of the Chicago Convention explicitly concerned with UA.[206] It reads as follows:

---

202 Nevertheless, if state aircraft request to integrate into the civil ATM system they are required to comply civil aviation rules or to conclude special agreements. Additionally ICAO can play an important role in improving the cooperation and coordination between civil and military authorities.

203 Pablo Mendes de Leon, "Regulatory framework for light UAS" *supra* note 35, at 2.

204 Ibid; Michael Milde, *International Air Law and ICAO*, *supra* note 178 at 70 ff.

205 Paul Stephen Dempsey, *Public International Air Law*, *supra* note 178 at 47 f; I H Ph Diederiks-Verschoor, *Introduction to Air Law*, *supra* note 165 at 40; Michael Milde, *International Air Law and ICAO*, *supra* note 178 at 70 ff; Hans J Schlochauer, ed, *Wörterbuch des Völkerrechts*, 2 ed (Berlin: De Gruyter, 1962) [*Wörterbuch des Völkerrechts*].

206 Tomasello states that already the International Commission for Air Navigation (ICAN) recognized UA, Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 1.

> *No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft.*

The wording "*aircraft capable of being flown without a pilot*" is not very specific. It is the explanation of the article's headline "*pilotless aircraft*", a term nowhere defined in the Chicago Convention or its annexes. It could suggest either that there is simply no pilot aboard the aircraft or that the aircraft is flown entirely without any pilot intervention, not even from a remote location. It hence could express the concepts of 'remotely piloted' and 'fully autonomous' UA. As mentioned within the historical development of unmanned aviation, remotely piloted UA, such as target drones, and fully autonomous UA, as the Kettering Bug and its successors, existed both at the time of the emergence of the Convention.[207] The drafters therefore supposedly had those two types in mind, and also considered a civil use of them, when including Art. 8 in the Chicago Convention. The wording "*shall be so controlled*" is as same as unspecific as the explanation for 'pilotless aircraft'. It certainly expresses the requirement of some form of control over the UA. It seems to incline toward the concept of 'remotely controlled' as the UA could be navigated in real time by the remotely located pilot. However, even if this narrow understanding of 'control' would apply, the wording of the whole sentence with regard to the control aspect teaches, that "*the flight (...) shall be so controlled*". Hence, not the UA needs to be controlled, but the flight in general. The control of the flight is also the main idea of fully autonomous UA, as they do not fly randomly through the air but are only reasonable if their flight is controlled, even if the aircraft itself is not controlled by a pilot in real time while it is flying. Therefore, Art. 8 covers both RPA and fully autonomous UA within the term 'pilotless aircraft'. This understanding was also expressed by ICAO's Eleventh Air Navigation Conference, where it stated, while using the term UAV, that:

---

[207] Marshall states that "*(a)rticle 8 was presumably included in recognition of the destruction of persons and property precipitated by Nazi Germany's deployment of guided missiles and bombs over England during the war that was still raging over Europe and the Pacific at the time the Convention participants first met*" Douglas M Marshall, "UAS and ICAO Regulations" *supra* note 9, at 699.

> *(a)n unmanned aerial vehicle is a pilotless aircraft, in the sense of Article 8 of the Convention on International Civil Aviation, which is flown without a pilot-in-command on-board and is either remotely and fully controlled from another place (ground, another aircraft, space) or programmed and fully autonomous*.[208]

The second sentence of Art. 8 of the Chicago Convention expresses the paramount principle that UA should not compromise the safety of (civil) aircraft.[209] Safety was the main reason for the restrictive provision of Art. 8, as those 'pilotless aircraft' were not subject to any specific regulation and international standards at that time.

With regard to 'civil' and 'state' aircraft, the provisions of Art. 3 seem clear. As a result, Art. 8 should only be concerned about 'civil' UA. However, the expression in the second sentence "*in regions open to civil aircraft*" would be superfluous if only civil UA would be covered, as they are not allowed to fly in any other regions. Art. 8 of the Chicago Convention therefore also applies to state aircraft, marking another case where the provisions of Art. 3 are not given full effect within the same convention.[210] While the second sentence adds thereby new requirements[211] to state aircraft operations, the first sentence has no additional meaning for state aircraft alongside Art. 3 (c), which contains a similar authorization requirement.[212]

It also requires that "*each contracting State undertake(s) to insure*" that pilotless aircraft do not endanger civil aircraft. This expresses the obligation of the contracting States to develop a national regime to integrate UAS.[213] Coupled with the fact that the drafters in the first place and ICAO in the following decades made no further rules with regard to UA, the Chicago Convention could be understood as to favor national regulation

---

208 ICAO Eleventh Air Navigation Conference (22 September to 3 October 2003).

209 Stefan A Kaiser, "Legal Aspects of UAV" *supra* note 40, at 349

210 E.g. Art. 3 (c), (d), and Art. 3 bis of the Chicago Convention.

211 Whereas the requirements of Art. 3 express basically the same concerns.

212 What needs to be noted, is that Art. 3 (c) extends the authorization requirements for state aircraft besides the overflight to "*land thereon*". This requirement is missing in Art. 8 of the Chicago Convention. However, this is not crucial, as it is virtually impossible to land on a territory without overflying at least a minimum of the same.

213 Mark E Peterson, "The UAV and the Current and Future Regulatory Contruct" *supra* note 24, at 178.

over an international regime under the Chicago Convention.[214] However, this aspect needs to be seen in conjunction with the jurisdiction of ICAO over international aviation. Almost every element of aviation is also regulated on a national level as a result of the sovereignty of States over their airspace reaffirmed in Art. 1 of the Chicago Convention. As soon as the UA operation crosses State borders, the State in which airspace the aircraft is intended to enter can require compliance with the minimum standards established by ICAO. In the case of high seas operations, ICAO SARPS are binding on aircraft operation. The reluctance of the Convention and ICAO can therefore not be understood as a general preference of national regulations. However, as will be examined in the course of the present thesis, the idea that the States develop national UAS regulation in advance of ICAO SARPs could have been the drafter's intention or just a factual development.

With regard to the question of 'aircraft' or 'vehicle', the denomination "*pilotless aircraft*" could be understood as reaffirming the 'aircraft' status of the objects in question.[215] But Art. 8 only says that aircraft capable of being flown without a pilot are "pilotless aircraft". It does not specify that an unmanned flying machine with particular characteristics is an 'aircraft'. The general definition of aircraft is still necessary to determine if the convention and its Art. 8 is applicable. Therefore the argument that Art. 8 reflects the aircraft status is a circular argument.

As soon as UAS operations cross borders, a "*special authorization*" is required and the flight needs to be operated "*in accordance with the terms of such authorization*". Art. 5 of the Chicago Convention that allows aircraft in non-scheduled air services "*to make flights into or in transit non-stop across its territory and to make stops for non-traffic purposes without the necessity of obtaining prior permission*" is overruled by the *lex specialis* of Art. 8 of the Chicago Convention.[216] The 'special authorization' requirement is a central element of future UAS operation. As for now, it hinders routine international operations of UAS.[217]

---

214 Stefan A Kaiser, "Legal Aspects of UAV" *supra* note 40, at 349.
215 *Inter alia*, ibid 348.
216 Ibid 349.
217 Please see further details in Chapter 6, C. 1.

c. Art. 12; Annex 2

Art. 12 (Rules of the Air) of the Chicago Convention is of particular importance to UAS operations. It reads as follows:

> *Each contracting State undertakes to adopt measures to insure that every aircraft flying over or maneuvering within its territory and that every aircraft carrying its nationality mark, wherever such aircraft may be, shall comply with the rules and regulations relating to the flight and maneuver of aircraft there in force. Each contracting State undertakes to keep its own regulations in these respects uniform, to the greatest possible extent, with those established from time to time under this Convention. Over the high seas, the rules in force shall be those established under this Convention. Each contracting State undertakes to insure the prosecution of all persons violating the regulations applicable.*

Art. 12 requires ICAO member States to adopt measures to ensure that persons operating an aircraft within its territory comply with the air traffic rules of the respective State. The Rules of the Air specified in Annex 2 (Rules of the Air), which mainly consist of general rules, visual flight rules, and instrument flight rules apply without exception over the high seas and over national territories to the extent that they do not conflict with the rules of the State being over flown. Art. 12 is therefore an important basis for international harmonization.

UAS need to comply with the Rules of the Air to operate nationally and internationally. For instance, in visual flight conditions collisions have to be avoided in accordance with the principle of 'detect, see and avoid'.[218] As the capability of the Remote Pilot to 'see and avoid' or, due to the fact that UAS cannot literally see because the pilot's eyes are missing on board, 'detect and avoid', is very limited so far, as explained above, compliance with the Rules of the Air tailored for manned aircraft is impossible.

---

[218] Annex 2, 10th edition July 2005, para 3.2.

Furthermore Annex 2 elaborates on the responsibility of the Pilot-in-Command (PIC). Standard 2.3.1 requires that "*(t)he pilot-in-command of an aircraft shall, whether manipulating the controls or not, be responsible for the operation of the aircraft in accordance with the rules of the air, (...)*". In consequence, to fulfill the present Annex 2 requirements, a person needs to be assigned the responsibility and authority for the UA. This excludes fully autonomous UA, where no pilot has the possibility of intervention by using the controls, from its reach. A standard which could possibly address the handover of an UA between different Remote Pilots cannot be found in Annex 2.

As explained in the introduction, the present thesis is not in particular concerned with specific regulations of the operational part but with the regulations of the equipment and personnel of UAS. However, as will be mentioned in Chapter 6, capability of 'detect, sense and avoid' can be a major prerequisite for compliance with certification and licensing requirements.

What nevertheless needs to be noted with regard to Annex 2, is that it contains SARPs for unmanned free balloons, which are used e.g. for weather exploration. Unmanned free balloons are fully autonomous UA. Standard 3.1.9 (Unmanned free balloons) of Annex 2 reads:

> *An unmanned free balloon shall be operated in such a manner as to minimize hazards to persons, property or other aircraft and in accordance with the conditions specified in Appendix 4.*

Appendix 4 to Annex 2 contains several specificities for unmanned free balloon uses. Their operation requires a prior[219] authorization from the State from which the launch is made[220] and generally needs an authorization from any State across which it is operated[221]. It needs to be operated in accordance the conditions specified by the State or States

---

[219] Annex 2, Appendix 4, para 2.3.
[220] Annex 2, Appendix 4, para 2.1.
[221] Only "*light balloon(s) used exclusively for meteorological purposes and operated in the manner prescribed by the appropriate authority*" are generally exempt from this requirement, Annex 2, Appendix 4, para 2.2.

overflown[222] and in the case of high seas operations prior coordination with the respective air traffic services authority is demanded.[223] Normally seven days before the intended flight, a 'pre-flight notification' is needed.[224] Appendix 4 contains several further restrictions and requirements.

What becomes apparent when reviewing these very restrictive provisions about unmanned free balloons is, that they, unlike the ideal for UAS, were never meant to be integrated in the airspace system and into 'non-segregated' airspace in particular. They are only accommodated and seen as a hazard that other aircraft have to avoid. Hence, the attention the Appendix creates at first sight in the light of UAS operations is unjustified. It does not contain provision relevant to UAS integration, it merely accommodates the small group of UA of unmanned free balloons.

d. Art. 20; Annex 7

Art. 20 (Display of marks) of the Chicago Convention requires, that "*(e)very aircraft engaged in international air navigation shall bear its appropriate nationality and registration marks*". This provision is elaborated in Annex 7 (Aircraft Nationality and Registration Marks). While MALE and HALE UA will most likely have no difficulty complying with the marking requirements, small and especially micro UA will often not be able to display the required information in the required size and legibility due to their miniature size. As long as no requirements for these UA classes are set, they are banned from international operations. This will however not often be an issue, as micro and small UA are unlikely to be operated internationally because of their limited range and capacities.[225]

e. Art. 29; Annex 9

222 Annex 2, Appendix 4, para 2.4.
223 Annex 2, Appendix 4, para 2.6.
224 Annex 2, Appendix 4, para 5.1.
225 Cross-border operations of micro and small UA are only likely to happen when they are applied near or along the border. Border operations in general could involuntarily lead to international operations when the aircraft accidently crosses the border, e.g. due to wind or navigation errors.

Art. 29 (Documents carried in aircraft) of the Chicago Convention reads as follows:

> *Every aircraft of a contracting State, engaged in international navigation, shall carry the following documents in conformity with the conditions prescribed in this Convention:*
> *(a) Its certificate of registration;*
> *(b) Its certificate of airworthiness;*
> *(c) The appropriate licenses for each member of the crew;*
> *(d) Its journey log book;*
> *(e) If it is equipped with radio apparatus, the aircraft radio station license;*
> *(f) If it carries passengers, a list of their names and places of embarkation and destination;*
> *(g) If it carries cargo, a manifest and detailed declarations of the cargo.*

It requires several documents to be carried in the aircraft in international navigation. While (e) – (g) only apply if certain conditions (radio apparatus, passenger, cargo) are met, (a) – (d) are obligatory in any case. Dependent on the size of the UAS, the requirements could cause difficulties, as micro and certain small UA are not spacious enough to carry those documents in paper form. Annex 9 (Facilitation) contains detailed standards on documentations but is triggered towards a facilitated transport of persons and cargo and facilitated service at international airports, but does not provide details on the documents of Art. 29 (a) – (d) of the Chicago Convention.

Furthermore, the requirement of carrying the licenses for each member of the crew established in Art. 29 (c) could be problematic in long distance or long duration UAS operations. Art. 29 of the Chicago Convention is written in the light of manned aviation, where the crew remains unchanged throughout the flight. In the case of a handover, as described in the previous chapter, the UAS crew changes during the flight, making the initial documents incoherent with the actual crew.

f. Arts. 31 , 32 and 33; Annexes 1 and 8

Arts. 31 (Certificate of airworthiness) and 32 (License of personnel) are the basis for certification and licensing. Art. 33 (Recognition of certificates and licenses) of the Chicago Convention regulates the mutual recognition of certificates and licenses if they are in line with ICAO SARPs. Annexes 1 (Personnel Licensing) and 8 (Airworthiness of Aircraft) elaborate on Art. 31 and 32. These article and annexes will be examined when opposing ICAO's approach to the regulations of the United States and Canada in Chapter 6. However, it should be noted in advance that none of the articles or annexes in question are UAS specific nor contain particular provisions about UAS.

g. Art. 36

Art. 36 (Photographic apparatus) of the Chicago Convention regulates that "*(e)ach contracting State may prohibit or regulate the use of photographic apparatus in aircraft over its territory*". Its underlying principle is the sovereignty of States over their airspace manifested in Art. 1 of the Chicago Convention. This provision, while not the most prominent in the convention, can affect the majority of UAS operations. Primarily, the supposedly significant part of UAS operations involved in surveillance are concerned, as their use of photographic apparatus is their main source of collecting information. The wording "*may prohibit or regulate*" allows such information gathering as long as it is not forbidden or regulated. This requires the operator to investigate if such prohibitions or regulations exist, but gives the respective freedom if they do not. "*Photographic apparatus*" is not defined in the Convention. It can be understood as being limited to classical photographic equipment, which existed at the time of the drafting of the convention. To also cover the modern sophisticated means of information collection, e.g. infrared and thermal imaging, it must be interpreted widely. Moreover most of the remaining UAS, which are not primarily concerned with surveillance, will be subject to this provision, as, due to the missing eyes of the pilot aboard, apparatus for video transmission or similar equipment are essential to almost all UAS navigations.

h. Annex 13

Annex 13 (Aircraft Accident and Incident Investigation) is not in the focus of the present thesis. However, Annex 13 needs to be highlighted as it is the only annex which has been amended so far to explicitly include UAS.[226] The latest amendment of the annex changed the definitions of 'accident'[227] and 'serious incident'[228] and explicitly differentiates between manned and unmanned aircraft. Prior to this change those definitions applied only in the timeframe "*between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked*"[229], a requirement *per se* not satisfiable in most[230] UA operations.

3. Intermediate results

The Chicago Convention and hence the ICAO Annexes regulate aircraft. All articles of the convention and all annexes therefore generally apply to both manned and unmanned aircraft. However, almost all provisions are tailored to the former. When the articles of the Chicago Convention and the SARPs in the annexes are applied to UAS, numerous difficulties arise, of which some of the most visible were highlighted before. The whole system is build around manned aircraft, making the incorporation of UAS in the existing framework a difficult task. The only provision explicitly concerned about UA is Art. 8 of the Chicago Convention. This article shows that the drafters of the convention were aware of UA and the possible hazard these could create to manned aviation. Unfortu-

---

226 Annex 13, 10th edition July2010.

227 "*An occurrence associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked,* or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down *(...)*", Annex 13, Chapter 1, "*Accident*", emphasis added by the author.

228 "*An incident involving circumstances indicating that there was a high probability of an accident and associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked,* or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down.", Annex 13, Chapter 1, "*Serious incident*", emphasis added by the author.

229 Annex 13, 9th edition July 2001.

230 The requirements of the former versions of the definitions could only be fulfilled, if UA would be used for passenger transport. As mentioned above, this is not foreseen in the near future. However, the amended definitions in Annex 13 seem to preclude this option as they infer, that in all UA operation no persons are aboard the UA, as the part of the definition dealing with UA does not contain this possibility but on the other hand the part for manned aircraft cannot be applied as UA are still considered 'unmanned' even if they transport passengers.

nately from today's perspective but understandable from the perspective of that time, Art. 8 does not provide details on UA and their interplay with manned aviation but restricts their use by requiring a special authorization for international operation. For most of the time of the convention's almost 70 years of existence, Art. 8 was sidelined. In the recent years however, it is mentioned in every publication about UAS; not because it is a masterpiece of draftsmanship providing a rich legal source for future UAS operations but because it is the only conventional indication available. Given the strict requirements of Art. 94 of the Chicago Convention and the lengthy and difficult process required to change the convention, an amendment of Art. 8 seems unlikely. The more flexible annexes, in charge of keeping harmonized regulation up with the times and providing necessary details for aviation regulations, follow the predetermined focus of the convention on manned aircraft. Several difficulties become apparent when applying the SARPs to UAS. No specific UAS SARPs exist so far, and, except for the definitions of Annex 13, UAS are nowhere mentioned explicitly in the annexes. On this basis, possibilities for international UAS operations under the current regime of ICAO are very limited.

C. Work on UAS

The inadequate situation of UAS in the Chicago Convention and the annexes was recognized by ICAO. In the following, ICAO's work on UAS will be explained.

1. Questionnaire and informal meetings

ICAO's work on UAS officially started on 12 April 2005, when the Air Navigation Commission (ANC)[231] requested the Secretary General to consult selected States and international organizations with regard to present and future civil UAS[232] issues.[233] The results of the questionnaire, which was dispatched to forty-three States and nine international organizations and responded by twenty-two States and four international organizations,

---

[231] The Air Navigation Commission is regulated in Chapter X (Arts. 56 ff) of the Chicago Convention.

[232] At that time ICAO used the then more common term 'UAV'.

[233] ICAO, Air Naviagation Commission, *Results of a Consultation with Selected States and International Organization with Regard to Unmanned Aerial Vehicle (UAV)*, AN-WP/8065 (Montreal: ICAO, 2005) at para 1.1 [*Questionnaire Results*].

highlighted the importance civil UAS were expected to gain in international aviation.[234] The integration into non-segregated airspace was however considered difficult, mainly due to a lack of 'detect, sense and avoid' technology.[235] Nevertheless, some of the requested States reported that they had implemented procedures for the issuance of special authorizations for UAS operations required by Art. 8 of the Chicago Convention.[236] Twelve States and four international organizations expressed an "*urgent need for the development of ICAO provisions and guidance material related to international civil UAV operations, beyond what is currently available*"[237].

In the following two years ICAO held two informal meetings on UAS. The first was held in May 2006 and concluded that:

> *although there would eventually be a wide range of technical and performance specifications and standards, only a portion of those would be necessary for inclusion as ICAO Standards and Recommended Practices (SARPs) and that ICAO was not the most suitable body to lead the effort to develop specifications. However, it was agreed that there was a need for harmonization of terms, strategies and principles with respect to the regulatory framework and that ICAO should act as a focal point.*[238]

The meeting also requested that UAS work should be given a high priority in ICAO.[239]

The second meeting was held January 2007.[240] It was agreed that "*there was no specific need for new ICAO SARPs at this early stage*"[241]. However, the meeting concluded that

---

[234] Ibid para 2.2.
[235] Ibid para 2.3.
[236] Ibid para 2.5.
[237] Ibid para 2.6.
[238] ICAO, Air Naviagation Commission, *Progress Report on UAV and Proposal of Establishement of UASSG*, *supra* note 126 at para 2.1.
[239] Ibid para 2.2.
[240] Ibid.
[241] Ibid para 3.2.

> *ICAO should coordinate the development of a strategic guidance document that would guide the regulatory evolution that, even though non-binding, would be used as the basis for development of regulations by the various organizations and States.*[242]

It was also concluded that the mentioned guidance document "*would then serve as the basis for achieving consensus in view of later development of SARPs*"[243].

With regard to the detailed technical specifications, it was agreed that those were adequately developing by the Radio Technical Commission on Aeronautics (RTCA)[244] and the European Organization for Civil Aviation Equipment (EUROCAE)[245] and that ICAO should concentrate on its mandate for international harmonization.[246]

Interestingly, the second meeting expressed that "*there was a unique opportunity to ensure harmonization and uniformity at an early stage and that all ICAO work efforts should be based on a strategic approach and should support the emerging work of other regulatory bodies*"[247]. Also ICAO's role as a 'focal point' was reaffirmed.

---

242 Ibid.

243 Ibid.

244 The Radio Technical Commission on Aeronautics (RTCA) is a private, not-for-profit corporation that develops consensus-based recommendations regarding communications, navigation, surveillance, and air traffic management system issues, *RTCA* <www.rtca.org> [*RTCA*]; see for details on RTCA's efforts with regard to UAS Giorgio Guglieri et al, "Survey of Airworthiness and Certification" *supra* note 80, at para 3.6.

245 The European Organization for Civil Aviation Equipment (EUROCAE) is a non profit making organization which was formed at Lucerne (Switzerland) in 1963 to provide a European forum for resolving technical problems with electronic equipment for air transport, *EUROCAE* <www.eurocae.net> [*EUROCAE*]; see for details on EUROCAE's efforts with regard to UAS Giorgio Guglieri et al, "Survey of Airworthiness and Certification" *supra* note 80, at para 3.5.

246 Already in the questionnaire it was concluded that "*consistent with Resolution A35-14, Appendix A, Resolving Clause 4, and considering the already demanding work programme of the Organization associated with budgetary constraints, the Secretariat strongly recommends that ICAO utilize, to the maximum extent appropriate and subject to the adequacy of a verification and validation process, the outcome of the work of RTCA and other standards-making organizations*", ICAO, Air Naviagation Commission, *Questionnaire Results*, *supra* note 232 at para 3.5.

247 ICAO, Air Naviagation Commission, *Progress Report on UAV and Proposal of Establishement of UASSG*, *supra* note 126 at para 3.3.

With regard to the system approach and the appropriate terminology, the meeting suggested that the term 'UAS' should be used henceforth within ICAO; a step made in line with RTCA and EUROCAE agreements.[248]

2. UAS Study Group

After the two informal meetings mentioned before, the ANC established the UAS Study Group (UASSG) in 2007.[249]

Study groups in general are small groups comprised of experts sent by member States and organizations to assist the Secretariat of ICAO in a consultative capacity to advance the progress on selected technical tasks.[250] Their work may involve the development of initial proposals for the amendment of annexes and PANS.[251] Study groups work by correspondence and meetings and their terms of reference and work programs are set by the ANC.[252]

The UASSG is comprised of now sixteen member States (Australia, Austria, Brazil, Canada, China, France, Germany, Italy, Netherlands, New Zealand, Russian Federation, Singapore, South Africa, Sweden, United Kingdom and the United States) and eight international organizations (Civil Air Navigation Services Organization (CANSO), European Aviation Safety Agency (EASA), EUROCAE, European Organisation for the Safety of Air Navigation (EUROCONTROL), IAOPA, International Coordinating Council of Aerospace Industries Associations (ICCAIA), IFALPA, International Federation of Air Traffic Controllers' Associations (IFATCA)).[253] The representatives have a diverse background, e.g.

---

248 Ibid.

249 Ibid para 4.

250 ICAO, UASSG, *First Meeting - Summary of Discussions*, UASSG/1-SD (2008) at Appendix B, para 1.1 [*First Meeting*].

251 Ibid.

252 Ibid Appendix B, para 1.1 and 2.5.

253 Leslie Cary, "Unmanned Aircraft Systems/Remotely-piloted Aircraft (Presentation)" (2010) Second Training Course of Regional Officers at 3 ["Unmanned Aircraft Systems/Remotely-piloted Aircraft (Presentation)"].

regulators, inspectors, air traffic controllers as well as others with technical background.[254]

The first meeting of the UASSG took place in April 2008.[255] Is was agreed that the UASSG is the centre of UAS work within ICAO and that it would work together with the other panels, study groups and bodies of ICAO.[256] The work would be coordinated mostly via email and a secure website and rarely by meetings.[257] The meeting decided to build three task groups to review the existing annexes with the goal of "*identifying gaps between existing SARPs and ones needed for accommodation of unmanned aircraft systems*"[258]. In relation to the analysis of the articles and annexes above, it needs to be noted that the change of the 'accident' definition in Annex 13 was proposed already within this first UASSG meeting.[259] With regard to the specific technical standards, it was decided that an agreement with the standard making organization[260] is desired and that the UASSG will not elaborate these standards itself.[261]

The terms of reference of the UASSG were set as follow:

> *In light of rapid technological advances, to assist the Secretariat in coordinating the development of ICAO Standards and Recommended Practices (SARPS), Procedures and Guidance material for civil unmanned aircraft systems (UAS), to support a safe, secure and efficient integration of UAS into non-segregated airspace and aerodromes.*[262]

The work program of the UASSG reads:

> *1. Serve as the focal point and coordinator of all ICAO UAS related work, with the aim of ensuring global interoperability*

---

254 Leslie Cary, "International Civil Aviation Organization UAS Study Group", in UVS International, ed, *UAS Yearbook - UAS: The Global Perspective* (Paris: Blyenburgh & Co, 2010) at 51 ["UAS Yearbook - UASSG"].
255 ICAO, UASSG, *First Meeting*, *supra* note 249.
256 Ibid para 3.1.2.
257 Ibid paras 3.1.1 and 3.1.3.
258 Ibid para 3.5.2.
259 Ibid para 3.4.2.
260 E.g. RTCA and EUROCAE.
261 ICAO, UASSG, *First Meeting*, *supra* note 249 at para 3.6.1.
262 Ibid Appendix C.

and harmonization;
2. Develop a UAS regulatory concept and associated guidance material to support and guide the regulatory process;
3. Review ICAO SARPS, propose amendments and coordinate the development of UAS SARPS with other ICAO bodies;
4. Contribute to the development of technical specifications by other bodies (e.g., terms, concepts), as requested; and
5. (...)[263]

The meeting also agreed on the general structure of the ICAO Circular on UAS, which will be subject to the next subchapter.

3. UAS Circular

In March 2011 the edited version[264] of the ICAO UAS Circular[265] was published.[266] The UAS Circular is the first comprehensive document on UAS issued by ICAO.

Its foreword describes the general objective:

> *The goal of ICAO in addressing unmanned aviation is to provide the fundamental international regulatory framework through Standards and Recommended Practices (SARPs), with supporting Procedures for Air Navigation Services (PANS) and guidance material, to underpin routine operation of UAS throughout the world in a safe, harmonized and seamless manner comparable to that of manned operations. This circular is the first step in reaching that goal.*[267]

The concrete purpose of the Circular is set out in its first chapter:

> *The purpose of this circular is to:*
> *a) apprise States of the emerging ICAO perspective on the integration of UAS into non-segregated airspace and at aero-*

---

[263] Ibid.
[264] The unedited version was already available online in Fall 2010, *ICAO Website* (webpage), *supra* note 178.
[265] ICAO, Secretary General, *UAS Circular*, *supra* note 106.
[266] The work on the UAS Circular started in 2008, ICAO, Coucil, *Annual Report of the Council*, Doc No 9916 (Montreal: ICAO, 2008) [*Annual Report of the Council 2008*].
[267] ICAO, Secretary General, *UAS Circular*, *supra* note 106 at Foreword.

dromes;
b) consider the fundamental differences from manned aviation that such integration will involve; and
c) encourage States to help with the development of ICAO policy on UAS by providing information on their own experiences associated with these aircraft.[268]

The UAS Circular is structured in seven chapters and one appendix. A glossary explains the basic terms. These terms, e.g. RPS and Remote Pilot, are used throughout the present thesis, as explained in the previous chapter. It is important to note, that none of the UAS specific definitions is a formally recognized ICAO definition.[269] The first chapter (Introduction) introduces the subject and repeats the remarks on the first and second informal meeting.[270]

Chapter 2 (ICAO Regulatory Framework) highlights ICAO's regulatory framework and explains Art. 8 of the Chicago Convention. It is stated that all UA, autonomous or remotely piloted, are covered by Art. 8.[271] However, it is concluded that fully autonomous will not be able to integrate in the foreseeable future. Hence, fully autonomous UA as well as unmanned free balloons and "*other types of aircraft which cannot be managed on a real-time basis during flight*"[272] are excluded from the Circular's ambit. As explained within the question of UA vs. model aircraft[273], the UAS Circular states that model aircraft, normally used for recreational purposes are not UA and fall outside the Chicago Convention.[274] Unfortunately the circular missed the chance to elaborate on the sometimes difficult distinction between UA and model aircraft. Also passenger transport by UA is expected not to happen in the foreseeable future, but is seen as a distant possibility.[275]

It is stated that the development of a complete regulatory framework will need many years and that "*close adherence to the guidance material will facilitate later adop-*

268 Ibid para 1.6.
269 Ibid Glossary.
270 The same text can be found in ICAO, Air Naviagation Commission, *Progress Report on UAV and Proposal of Establishement of UASSG, supra* note 126 at paras 2 and 3.
271 ICAO, Secretary General, *UAS Circular*, *supra* note 106 at para 2.2.
272 Ibid.
273 Please see Chapter 2, C. 1. b.
274 ICAO, Secretary General, *UAS Circular*, *supra* note 106 at para 2.4.
275 Ibid para 2.7.

tion of SARPs and will ensure harmonization across national and regional boundaries during this development phase"[276].

In the third chapter (Overview of UAS), inter alia, the general operational concepts, the system approach and UAS applications are explained.

The fourth chapter (Legal matters) analyses certain articles of the Chicago Convention and their meaning with regard to UAS. With regard to ICAO's view on Art. 8 of the Chicago Convention, paragraph 4.4 of the circular needs to be highlighted:

> *Second, emphasis was placed on the significance of the provision that aircraft flown without a pilot "shall be so controlled as to obviate danger to civil aircraft", indicating that the drafters recognized that "pilotless aircraft" must have a measure of control being applied to them in relation to a so-called "due regard" obligation similar to that of State aircraft. In order for a UAS to operate in proximity to other civil aircraft, a remote pilot is therefore essential.*[277]

Even if, as stated above, the circular expresses that Art. 8 is applicable to all UA, this interpretation seems to infer that the focus of Art. 8 is on RPA. In ICAO's analysis, the control requirement is linked to the 'aircraft'. As explained in this authors analysis above, the wording of Art. 8 is clear insofar as it states that "*the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft*"[278] thereby requiring the 'flight' to be controlled not the aircraft.[279] Hence, any preference for RPA cannot be read out of Art 8. Nevertheless, RPA will supposedly be the UA to be successfully integrated in future, as technically the integration without a Remote Pilot seems very difficult and legally a responsible PIC is required in Annex 2.

Chapter 5 (Operations) addresses the operational aspects of UAS and explains the SARPs in the annexes relevant to it. The requirement of the PIC to 'detect, sense and

---

[276] Ibid para 2.10.
[277] Ibid para 4.4.
[278] Emphasis added by the author.
[279] Please see B. 2. b.

avoid' is highlighted and it proposed that the SARPs as such do not significantly change, but that new methods of identifying collision hazards have to be developed.[280] The Circular states that: "*(b)oth the aircraft and the remote pilot station will need to incorporate aspects of this functionality to achieve the complete technical solution required as part of the RPA operational approval*"[281]. It is also mentioned that not only other aircraft, but also terrain has too be identified and avoided.[282] Several other operational elements are mentioned and the most important specificities of UAS that have to be addressed are mentioned, e.g. with regard to air traffic service[283], equipment[284], ATS/Remote Pilot communications[285] and aerodromes[286].

The sixth chapter (Aircraft and Systems) highlights the specificities of the system approach and also mentions the handover of UAS, also between different states.[287] The different possibilities of certifying the UAS and the RPS, as a unit or separately, are explained.[288] Also the requirement of certifying the Data-Link is expressed and a new UAS operator certificate is proposed.[289] Several other UAS relevant elements are mentioned, e.g. the RPS[290], nationality and registration marks[291], aeronautical communications[292], frequency spectrum[293] and environmental protection[294].

In the seventh chapter (Personnel) the element of personnel licensing is very briefly mentioned and Annex 1 as basis for UAS personnel licensing and the specificities of UAS that need to be addressed in possible changes of that annex are highlighted.

---

280 ICAO, Secretary General, *UAS Circular*, *supra* note 106 at para 5.2 and 5.4.
281 Ibid para 5.6.
282 Ibid.
283 Ibid para 5.8 ff.
284 Ibid para 5.13 ff.
285 Ibid para 5.14 ff.
286 Ibid para 5.23 ff.
287 Ibid para 6.1 and 6.2 ff.
288 Ibid para 6.5 and 6.6.
289 Ibid para 6.8 and 6.9.
290 Ibid para 6.19 ff.
291 Ibid para 6.24 f.
292 Ibid para 6.33 ff.
293 Ibid para 6.44 ff.
294 Ibid para 6.48 ff.

Generally, the UAS Circular provides an excellent overview of UAS and their position in ICAO's regulatory framework. Although the circular addressed all major aspects that need to be taken into account for future UAS SAPRPs, it often only states what the difficulties are, explains the relevant articles and annexes and sometime proposes a possible solution. Only a few details are given and no concrete regulatory guidance is provided. However, the circular is a very good basic document which generally sets the direction in which the efforts will go and assures that the parties interested share the same understanding of UAS and their associated difficulties.

4. UAS Manual

An UAS Manual will be the next step toward ICAO UAS SARPs. It is planned to be published in the beginning of 2013.[295] This date is not randomly chosen as an international symposium on UAS will start on the 3 April 2013[296] and the UAS Manual should serve as a further ICAO guidance within this symposium.

The Manual will elaborate in more detail on the main issues already addressed in the UAS Circular and provide explanation as well as implementation guidance for the future SARPs.[297]

5. Outlook

The amendment of the existing annexes and the elaboration on UAS specific SARPs will be a demanding task for the UASSG in the next several years.[298] Therefore the UASSG assessed all annexes to identify the aspects that need to be amended to integrate

---

295 Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 8.

296 Saulo Da Silva, "ICAO UAS - Update from the UASSG (Presentation)" (2010) NPF/SIP/2010-WP/14 Workshop on the development of National Performance Framework for Air Navigation Systems (Nairobi, 6-10 December 2010) ["Update from the UASSG (Presentation)"].

297 ICAO, UASSG, *First Meeting*, *supra* note 249 at 3.5.1.

298 See for a brief description of the expected amendments Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 8.

UAS.[299] The definitions of 'accident' and 'serious incident' in Annex 13 have already been changed.[300] The next expected step will be a new Appendix 4 to Annex 2 to facilitate the 'special authorization' requirement contained in Art. 8 of the Chicago Convention.[301] This important step can be expected in November 2012.

D. Evaluation

In the interim conclusion it was highlighted, that the current regulatory framework of ICAO makes international civil UAS operations difficult. ICAO's work on UAS promises a comprehensive solution for these deficiencies. The major aspects that hinder the integration of civil UAS are being addressed by the UASSG. The limited regulatory extent of Art. 8 of the Chicago Convention and its cautions approach to UAS operations were acknowledged. Given the fact, that an amendment of Art. 8 is very unlikely, the focus is placed on the amendment of existing SARPs and the development of new UAS specific SARPS. The UAS Circular gives a basic overview of ICAO position with regard to UAS and allows the alignment of national developments to the way that ICAO is planning to advance.

However, some critical remarks on ICAO approach can be made. It can be questioned if ICAO's first official contact with UAS in 2005 was too late. On the one hand, as explained in the second chapter of the present thesis, unmanned aviation used for other fields than the military started about twenty years before ICAO decided to consult the States in its first questionnaire. In this same questionnaire some States reported their advances in national UAS regulations and expressed the "*urgent need*"[302] for ICAO regulation. Given the fact that the UAS Circular and the future UAS Manual will have no binding force and that the development of UAS SARPs is a "*lengthy effort*"[303] which will need another several years, definitive ICAO regulations and the supposed need for them deviate

[299] This task was set at the first meeting of the UASSG ICAO, UASSG, *First Meeting*, *supra* note 249 at 3.5.2; its completion was reported in 2010 by Leslie Cary, "UAS Yearbook - UASSG", *supra* note 253 at 51.

[300] Please see B. 2. h.

[301] Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 8.

[302] ICAO, Air Naviagation Commission, *Questionnaire Results*, *supra* note 232 at para 2.6.

[303] ICAO, Secretary General, *UAS Circular*, *supra* note 106 at para 2.10.

significantly in terms of time. On the other hand, ICAO's hesitant approach needs to be seen in the light of the technical developments. Even if UAS exist since decades, their level of reliability only increased slowly.[304] While UAS for military applications are generally operated in areas where a ground collision is unlikely to create severe damage and the risk of mid-air collisions is manageable due to the control of the often non-congested military airspace, civil UAS applications are more likely to be conducted over populated areas and to conflict with existent air traffic. Today the technology has advanced significantly but still no technical solution is available to compensate the limited ability of UAS to, *inter alia*, 'detect, sense and avoid'. ICAO's mandate is the establishment of regulations for a "*safe and orderly*"[305] development of international civil aviation. In the light of safety of people and property on the ground as well as in the air, the restrictive handling of civil UAS is understandable. ICAO cannot choose the scientific and economic interest of the UAS industry over the safety of aviation.

Nevertheless, ICAO is not only in charge of sheltering civil aviation from hazard but also of promoting and developing its safety in the light of emerging technologies. ICAO cannot be blamed for acting to late, but maybe for acting to passively and to slowly. After ICAO started its efforts on UAS in 2005, it needed two years to establish a study group. The UASSG is comprised of a limited number of States and international organization, which helps reaching a consensus among the States mainly concerned with UAS. However, the UASSG took nearly three years to establish the non-binding UAS Circular, of which its structure was already set in 2008. This is notable in particular, when considering that ICAO decided to leave the development of technical specifications to the standard-making entities RTCA and EUROCAE. The circular provides an excellent overview over UAS and their difficulties to be integrated into the non-segregated airspace. However, it does not provide many details. Given the fact that the States and the industry have to wait for further two years to get another non-binding guidance, this approach could lag behind the expectations. As the States themselves develop UAS regulations, the opportunity of harmonization right from the start could be threatened. In this regard it has to be noted, that

---

[304] Please see for more details with regard to the meaning of 'safety' with regard to UAS, Chapter 6 B. 3.
[305] Preamble of the Chicago Convention.

the States most concerned about UAS are represented in the UASSG. The UASSG can serve as a forum for the States to check and align their national regulations and create new guidance and SARPs in line with the most suitable regulations. Harmonization right from start could therefore mean that the most influential States use the UASSG to bring future international regulation in coherence with their national UAS regulatory framework. This seems to be incoherent with other ICAO areas where SARPs generally steer national regulations. Remarkably in this respect is already, that ICAO chooses to publish guidance and implementing advice before having the SARPs ready which have to be implemented. This could work as a smoother way to create final harmonization without facing too many Art. 38 deviations.[306] It could also be an indication of the industry's and State's pressure, that ICAO should take the leading role in the development of UAS regulations.

ICAO has been and will undoubtedly be the authority for international aviation regulations which also affect national regulations. It has established a coherent and far reaching regulatory framework that steadily increases the safety in aviation. With regard to its way toward UAS regulations however, certain aforementioned particularities have to be noted. ICAO's approach to UAS definitely enforces safety in aviation. The time will tell, if it also supports the development of civil UAS with a similarly strong impetus.

[306] Unfortunately some States do not make use the possibility of Art. 38 of the Chicago Convention and simply do not follow the SARPs without notifying their deviation. For that reason, the ICAO established the Universal Safety Oversight Audit Programme (USOAP) to bring the States' regulation in accordance with the SARPs. If the way chosen by ICAO with regard to UAS will not minimize this problem, future UAS SARPs have to be included in the USOAP.

CHAPTER 4: UNITED STATES REGULATORY FRAMEWORK FOR UAS

The United States is the largest and most advanced user of, and market[307] for, UAS. While it is known for using UAS for military operations, also civil uses have an extensive history in the United States. Its aviation regulations are generally highly advanced and constitute examples for other States' national laws.[308] In the present chapter, the United States' regulatory approach to civil UAS will be examined. In a similar manner as the previous ICAO Chapter, the relevant authorities and their jurisdiction will be briefly mentioned before the present regulatory approach on the one hand, and the work on UAS on the other hand will be explained. In contrast to the previous chapter, the very extensive aviation regulations of the United States would make an analysis of the generic provisions endless. Instead, after examining the general applicability, the UAS specific, or at least very relevant, legal instruments will be examined.

A. Authorities and jurisdiction

In the United States, the Federal Aviation Administration (FAA) is the authority which regulates and oversees all aspects of civil aviation. The FAA was created by the Federal Aviation Act of 1958[309] and is part of the Department of Transportation (DOT).[310] It derives its rulemaking and regulatory power from Title 49 of the United States Code (USC).[311]

---

[307] See on the UAS market: Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at 1-15; JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at 2.1; Douglas M Marshall, "UAS and ICAO Regulations" *supra* note 9, at 699; Laurence R Newcome, *Unmanned Aviation History*, *supra* note 9 at 127 ff; William Reynish, "UAVs Entering the NAS", *supra* note 9.

[308] With regard to the United States civil aviation regulations Maneschijn highlights: "*(o)f the many examples of civil aviation regulations in the more than 180 ICAO member states, the USA FAA regulations are arguably the most comprehensive, having evolved since 1926 to a substantially steady state. ICAO and various national authorities often use the Federal Airworthiness Regulations (FAR), or the FAA developed model regulations, as guidance for their own policies*" A Maneschijn et al, "Reference framework UAV and system airworthiness requirements" *supra* note 10, at 3.3.

[309] *Federal Aviation Act*, P.L. 85-726, 72 Stat. 731 (Approved 23 August 1958) at ["Federal Aviation Act"].

[310] *Federal Aviation Administration (FAA)* <www.faa.gov> [*FAA Website*].

[311] With regard to certification 49 USC § 44702 (a) (General Authority and Applications) prescribes: "*The Administrator of the Federal Aviation Administration may issue airman certificates, type certificates, production certificates, airworthiness certificates, air carrier operating certificates, airport operating*

In line with its mandate, the FAA developed a multitude of regulations, rulemaking processes, certifications, advisory materials, special authorizations, policy documents and directives for the operation of civil aircraft in the United States.

B. Regulatory approach

In this subchapter, some of the aforementioned legal instruments which are developed for or at least are relevant to UAS are highlighted.

1. Title 14 Code of Federal Regulations

As already demonstrated in the second chapter, UA fall under the United States definitions of aircraft.[312] The USC, as the compilation and codification of the general and permanent federal laws of the United States, defines 'aircraft' as "*any contrivance invented, used, or designed to navigate, or fly in, the air*"[313].

Another definition can be found in Title 14 of the CFR. This title contains regulations prescribed by the FAA within its above mentioned regulatory authority. They regulate a variety of aspects of civil aviation, e.g. aircraft[314], airmen[315], airspace[316], air traffic and general operating rules[317], certification and operations of air carriers and operators for compensation or hire[318], schools and other certificated agencies[319], airports[320], and naviga-

---

certificates, air agency certificates, and air navigation facility certificates under this chapter". Operational aspects are covered by 49 USC § 40103 (b) (Use of Airspace): "*(2) The Administrator shall prescribe air traffic regulations on the flight of aircraft (including regulations on safe altitudes) for -*
(A) navigating, protecting, and identifying aircraft;
(B) protecting individuals and property on the ground;
(C) using the navigable airspace efficiently; and
(D) preventing collision between aircraft, between aircraft and land or water vehicles, and between aircraft and airborne objects".

312 Please see above, Chapter C. 1. d.
313 49 USC § 40102 (a) (6).
314 14 CFR Parts 21-49.
315 14 CFR Parts 61-67.
316 14 CFR Parts 71-77.
317 14 CFR Parts 91-105.
318 14 CFR Parts 119-135.
319 14 CFR Parts 141-147.
320 14 CFR Parts 150-161.

tional facilities[321]. They define aircraft as *"a device that is used or intended to be used for flight in the air*"[322].

As both definitions cover UA, Title 14 of the CFR and all its regulations of 'aircraft' are generally applicable to UA. However, the CFR does not contain specific UAS regulations.[323]

What nevertheless is specifically regulated are unmanned free balloons[324]. These fall under the aforementioned definition of aircraft and are unmanned. Similar to the regulation of unmanned free balloons in Appendix 4 to ICAO Annex 2, the use of this type of UA is heavily restricted. The respective regulations aim to accommodate unmanned free balloons in the national airspace without creating risk to other airspace users rather than integrating them in the regular air traffic. The restrictions and requirements expressed may allow the reasonable use of unmanned free balloons. In contrast, the types of UA presented in Chapter 2 of the present thesis generally do not fit under this concept and even if they would, the restrictions would decrease their benefits. Also these regulations focus solely on the aircraft and are far away from the system approach of UAS.

Furthermore, it needs to be mentioned that ultralight vehicles are regulated in 14 CFR Part 103.[325] The definition of 'ultralight vehicles'[326] reveals that these vehicles

---

[321] 14 CFR Parts 170-171.

[322] 14 CFR § 1.1.

[323] Since recently UAS are at least mentioned explicitly in 49 CFR § 830.2, please see below C. 1.

[324] 14 CFR § 101.31 - 101.39. (Definitions).

[325] See also FAA, *AC 103-6 - Ultralight Vehicle Operations-Airports, ATC, and Weather* (Wahington: FAA, 1983) [*AC 103-6 - Ultralight Vehicle Operations-Airports, ATC, and Weather*]; FAA, *AC 103-7 - The Ultrlight Vehicle* (Washington: FAA, 1984) [*AC 103-7 - The Ultrlight Vehicle*]; Sudie Thompson, "FAA Regulation of Ultralight Vehicles" (1983-1984) 49 Journal of Air Law and Commerce 591 ["FAA Regulation of Ultralight Vehicles"].

[326] 14 CFR § 103.1: *For the purposes of this part, an ultralight vehicle is a vehicle that:*
(a) Is used or intended to be used for manned operation in the air by a single occupant;
(b) Is used or intended to be used for recreation or sport purposes only;
(c) Does not have any U.S. or foreign airworthiness certificate; and
(d) If unpowered, weighs less than 155 pounds; or
(e) If powered:
(1) Weighs less than 254 pounds empty weight, excluding floats and safety devices which are intended for deployment in a potentially catastrophic situation;
(2) Has a fuel capacity not exceeding 5 U.S. gallons;
(3) Is not capable of more than 55 knots calibrated airspeed at full power in level flight; and

need to be manned. Hence, despite certain possible similarities between ultralight vehicles and some UA, the latter could not be operated under the rules for ultralight vehicles. As ultralight vehicles are the only 'vehicles' regulated by FAA and no general definition of 'vehicle' can be found in Title 14 of the CFR, UA fall only under the definition of 'aircraft' and hence have to be operated under the 'aircraft' regulations and cannot be operated under a nonexistent 'vehicles' regime.[327]

2. Certificate of Waiver or Authorization

Irrespective of the lack of specific UAS regulation, a Certificate of Waiver or Authorization (COA) can be granted by the FAA to allow UAS operations in the national airspace. As UAS are not able to meet all the stringent rules set forth in the regulations[328], which were developed in the light of manned aircraft, they are generally excluded from flying outside of 'segregated' airspaces. The COA *waives* the requirement to comply with all regulations or *authorizes* the operation of UAS despite their inability to comply with all regulations. A COA is issued on a per-case basis upon application after the FAA Air Traffic Division has performed an intensive analysis to determine that the UAS can achieve an equivalent level of safety with that of manned aviation.[329]

On 13 March 2008 the FAA published the *Interim Operational Approval Guidance 08-01, Unmanned Aircraft Systems Operations in the U. S. National Airspace System*[330] which is the successor of the AFS-400 Policy Memo 05-01, *Unmanned Aircraft Systems Operations in the U.S. National Airspace System – Interim Operational Approval Guid-*

(4) Has a power-off stall speed which does not exceed 24 knots calibrated airspeed.

[327] This aspect refers to the question of 'aircraft vs. vehicle' raised in Chapter two of the present thesis. Naming UA 'unmanned vehicles' as it was done within the concept of UAV would not help to operate them in the United States.

[328] E.g. the detect, sense and avoid requirements.

[329] K Dalamagkidis, K P Valavanis & L A Piegl, "Current Status and Future Perspectives for Unmanned Aircraft System Operations in the US" (2008) 52 J Intell Robot Syst 313 at para 4.3 ["Future Perspectives for UAS in the US"].

[330] FAA, *Interim Operational Approval Guidance 08-01* (Washington: FAA, 2008) [*Interim Operational Approval Guidance 08-01*].

ance[331]. This document provides guidance and information to the FAA personnel concerned with COA applications.[332] It constitutes the basis for the evaluation of the level of safety required for issuing a COA and contains details on several important aspects, e.g. definitions[333], UAS airworthiness[334] and continued airworthiness[335], flight operations[336] and personnel qualifications[337].

A FAA Fact Sheet[338] explains the principles on which a COA is generally based:

> *- The COA authorizes an operator to use defined airspace and includes special provisions unique to each operation. For instance, a COA may include a requirement to operate only under Visual Flight Rules (VFR) and/or during daylight hours. Most COAs are issued for a specified time period (up to one year, in most cases)*
>
> *- Most, if not all, COAs require coordination with an appropriate air traffic control facility and may require the UAS to have a transponder to operate in certain types of airspace.*
>
> *- Due to the UASs inability to comply with 14 CFR 91.113 (see and avoid), a ground observer or an accompanying "chase" aircraft must maintain visual contact with the UAS and serve as its "eyes" when operating outside of airspace that is restricted from other users*.[339]

The COA has been well received so far. As of 15 July 2010 247 active COA were in existence and 153 applications were pending.[340]

---

331 FAA, *AFS-400 UAS Policy 05-01 - Unmanned Aircraft Systems Operations in the U.S. National Airspace System - Interim Operational Approval Guidance* (Washington: FAA, 2005) [*AFS-400 UAS Policy 05-01*].

332 FAA, *Interim Operational Approval Guidance 08-01*, *supra* note 329 at para 1.0.

333 Ibid para 3.0.

334 Ibid para 6.0.

335 Ibid para 7.0.

336 Ibid para 8.0.

337 Ibid para 9.0.

338 FAA Unmanned Aircraft Program Office, *Fact Sheet - Unmanned Aircraft Systems (UAS)* (Washington: FAA, 2010) [*UAS Fact Sheet*] please see also FAA, *Notice JO 7210.766 - Unmanned Aircraft Operations in the National Airspace System (NAS)*, Notice JO 7210.766 (Wahington: FAA, 2011) [*Notice JO 7210.766*].

339 FAA Unmanned Aircraft Program Office, *UAS Fact Sheet*, *supra* note 337.

340 Ibid.

However, a COA can only be issued for a 'public' UAS.[341] The term 'public aircraft' is defined in Title 49 of the CFR[342] and includes UAS owned and operated by the United States government or a government of a State, the District of Columbia, or a territory or possession of the United States. The operators of public aircraft can include Department of Defense (DOD), Department of Justice (DOJ), Department of Homeland Security (DHS), National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), State or local agencies and qualifying universities. As a result, under no circumstances a COA can be issued for a civil UAS. Furthermore, the UAS operated as 'public aircraft' under a COA are often considered 'state aircraft' by the United States in the sense of Art. 3 of the Chicago Convention and hence fall outside of ICAO's jurisdiction over international aviation.

3. Model aircraft

As discussed in Chapter 2 of the present thesis, model aircraft are 'aircraft' in the sense of the United States' regulations as they are also *"a device that is used or intended to*

---

[341] FAA, *Interim Operational Approval Guidance 08-01*, *supra* note 329 at para 4.0; see also on the COA: Timothy M Ravich, "Integration of Unmanned Aerial Vehicles into the National Airspace" *supra* note 22, at 608; in particular for law enforcement: Joseph J Vacek, "Big Brother will soon be watching you - or will he? - Constitutional, Regulatory, and Operational Issues Surrounding the Use of Unmanned Aerial Vehicles in Law Enforcement" (2009) 85 North Dakota Law Review 673 at 686 ["Big Brother will soon be watching you"].

[342] 49 USC § 40102:
(41) 'public aircraft' means any of the following:
(A) Except with respect to an aircraft described in subparagraph (E), an aircraft used only for the United States Government, except as provided in section 40125 (b).
(B) An aircraft owned by the Government and operated by any person for purposes related to crew training, equipment development, or demonstration, except as provided in section 40125 (b).
(C) An aircraft owned and operated by the government of a State, the District of Columbia, or a territory or possession of the United States or a political subdivision of one of these governments, except as provided in section 40125 (b).
(D) An aircraft exclusively leased for at least 90 continuous days by the government of a State, the District of Columbia, or a territory or possession of the United States or a political subdivision of one of these governments, except as provided in section 40125 (b).
(E) An aircraft owned or operated by the armed forces or chartered to provide transportation or other commercial air service to the armed forces under the conditions specified by section 40125 (c). In the preceding sentence, the term "other commercial air service" means an aircraft operation that
(i) is within the United States territorial airspace;
(ii) the Administrator of the Federal Aviation Administration determines is available for compensation or hire to the public, and
(iii) must comply with all applicable civil aircraft rules under title 14, Code of Federal Regulations.

be used for flight in the air"[343]. Nevertheless, model aircraft are not specifically addressed in Title 14 of the CFR.

In 1981 the FAA published the Advisory Circular (AC) 91-57, *Model Aircraft Operating Standards*[344]. AC 91-57 sets basic rules for model aircraft operations and "*encourages voluntary compliance*"[345] with them.[346] It was recognized that model aircraft can create hazards to manned aircraft and to persons and property on the ground.[347] The operating rules established for model aircraft are the following:

> *a. Select an operating site that is of sufficient distance from populated areas. The selected site should be away from noise sensitive areas such as parks, schools, hospitals, churches, etc.*
>
> *b. Do not operate model aircraft in the presence of spectators until the aircraft is successfully flight tested and proven airworthy.*
>
> *c. Do not fly model aircraft higher than 400 feet above the surface. When flying aircraft within 3 miles of an airport, notify the airport operator, or when an air traffic facility is located at the airport, notify the control tower, or flight service station.*
>
> *d. Give right of way to, and avoid flying in the proximity of, full-scale aircraft. Use observers to help if possible.*
>
> *e. (...)*[348]

Despite these restrictions and the aiming toward 'typical' model aircraft, civil UAS have been operated under the AC 91-57 regime for commercial purposes.[349] This led the FAA to address model aircraft again in a Policy Notice, *Unmanned Aircraft Operations in*

---

343 14 CFR § 1.1.
344 FAA, *AC 91-57*, *supra* note 105.
345 Ibid para 1.
346 Ibid.
347 Ibid para 2.
348 Ibid para 3; supposedly the 400 ft altitude limit is linked to the 500 ft minimum safe altitude for manned aircraft operating anywhere except in 'Class G' (uncontrolled) airspace, 14 CFR Part 71, Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35, at 10099.
349 FAA, *Unmanned Aircraft Operations in the National Airspace System*, *supra* note 110.

the National Airspace System[350], which was published in 2007. The relevant policy statement reads as follows:

> *The FAA recognizes that people and companies other than modelers might be flying UAS with the mistaken understanding that they are legally operating under the authority of AC 91-57. AC 91-57 only applies to modelers, and thus specifically excludes its use by persons or companies for business purposes.*[351]

This statement needs to be linked to the explanation of the AC 91-57 within the policy, where it is stated that the purpose of the circular is to provide guidance to "*persons interested in flying model aircraft as a hobby or for recreational use*"[352]. In the same manner the Interim Approval Guidance explained above states that "*AC 91-57 shall not be used as a basis of approval for UAS operations and is applicable to recreational and hobbyists use only*"[353]. It also clarifies that the COA process is not open to hobbyists and amateur model aircraft.[354]

As a result, UAS are not allowed to be operated under the model aircraft regime in the United States' airspace. Given the restrictions made by the AC 91-57 only micro and small UA could possibly benefit from AC 91-57, even in the case it would be applicable. However, as some applications of micro and small UA are useful in the proximity to populated areas, a even more limited number of UA applications, e.g. for wildlife surveillance, would theoretically fit in the model regime. MALE and HALE UA generally operate far beyond the restrictions of AC 91-57.

Even if the model aircraft regime cannot serve as a legitimate basis for civil UAS operations, some remarks need to be made. First, the AC is a non-binding document. Although advisory materials are generally followed, a legal binding format would strengthen

---

[350] Ibid.
[351] Ibid.
[352] Ibid.
[353] FAA, *Interim Operational Approval Guidance 08-01*, *supra* note 329 at para 4.0.
[354] Ibid.

the enforcement aspect in the case of UAS being operated under the model regime.[355] Second, it is worth recognizing how the Policy Notice and the Interim Operational Approval Guidance interpret the AC 91-57. The former documents ascribe the AC 91-57 to cover model aircraft used for 'hobby' or 'recreational use'.[356] While this use might be generally the purpose for modelers when they fly their models, it is nowhere mentioned in the AC 91-57. The circular as such could also be understood as allowing commercial operations, as long as the aircraft is a model aircraft, which itself could be understood in *strictu sensu* as an unmanned model of a full-scale aircraft, and the restrictions contained in the AC 91-57 are obeyed. One could assume that the FAA realized this problem when the interest in civil UAS rose and gave the circular *ex post* its recreational interpretation. Third, and linked to the aspect mentioned before, neither the AC 91-57 nor the Policy contain a definition of 'model aircraft'. The issuance of the Policy shows, that a clear delimitation of model aircraft and some UA is difficult and that such a problem was not foreseen in 1981 when the AC 91-57 was published. A definition would be helpful and could contribute to the clarification of the requirement of 'recreational purpose'.

4. Special Airworthiness Certificate – Experimental Category

Civil aircraft must obtain a FAA airworthiness certificate. However, civil UAS are not able to comply with the requirements set out in Part 21 of Title 14 CFR for a standard CofA that would, when also other requirements are satisfied, allow routine operations in the United States' airspace. As mentioned above, UAS are nowhere mentioned explicitly in Title 14 of the CFR. An airworthiness certificate, whose requirements are compliant by civil UAS, is the Special Airworthiness Certificate – Experimental Category (SAC-EC). The SAC-EC and related documents will be explained in Chapter 6, which focuses on certification and licensing and contrasts the approaches of ICAO, the United States and Canada.

---

355 Please see for problem of the enforcement of the model aircraft regime: Douglas M Marshall, "FAA's Regulatory Authority" *supra* note 35, at 10.099 ff.

356 FAA, *Unmanned Aircraft Operations in the National Airspace System*, *supra* note 110; FAA, *Interim Operational Approval Guidance 08-01*, *supra* note 329 at para 4.0.

C. Work on UAS

1. Organization and objectives

The United States recognized the potential benefits that UAS could offer and the present regulatory restrictions that civil UAS have to encounter. To address these concerns the FAA is actively working on UAS integration and more sophisticated UAS rules. Routine access of UAS to the United States airspace is the long term goal to be achieved.

Organizationally the FAA created the Unmanned Aircraft Program Office (UAPO)[357] and the Air Traffic Organization (ATO) UAS Office.[358] Their task is to elaborate how the current aircraft regulations can be amended and how new UAS specific rules can be developed. Several certification teams have been established to work on UAS relevant changes and aspects, e.g. 14 CFR Part 1 (Definitions), 14 CFR Part 21 (Certification Procedures for Products and Parts), 14 CFR Part 23 (Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes) and 14 CFR Part 27 (Airworthiness Standards: Normal Category Rotorcraft) as well as ground control station technology and automatic take-off and landing technology.[359]

The FAA requested RTCA to work with the UAS industry and to elaborate UAS standards.[360] RTCA's primary task will be to develop recommendations on how UAS should handle C3 communications and how the difficult 'detect, sense and avoid' problems can be resolved.[361]

---

357 FAA Unmanned Aircraft Program Office, *UAS Fact Sheet*, *supra* note 337;
Government Accountability Office (GOA), *Report: Unmanned Aircraft Systems - Federal Actions Needed to Ensure Safety and Expand Their Potential Uses within the National Airspace System*, GAO-08-511 (Wahington: GOA, 2008) at 4 [*GOA - UAS Report*].

358 FAA Unmanned Aircraft Program Office, *UAS Fact Sheet*, *supra* note 337.

359 FAA (Doug Davis) & EASA (Yves Morier), "Unmanned Aircraft Systems: Considerations for Certification and Interoperability (Presentation)" (2008) US/Europe International Aviation Safety Conference 1 at 4 ["UAS: Considerations for Certification and Interoperability"].

360 FAA Unmanned Aircraft Program Office, *UAS Fact Sheet*, *supra* note 337.

361 Ibid.

FAA is also coordinating with stakeholders in the UAS community with the goal to define operational and certification requirements.[362] The UAS FAA & Industry Team (UFIT) was created and in 2009 and Cooperative Research and Development Agreements (CRDA) were concluded with AAI Corporation, General Atomics Aeronautical Systems and GE Aviation Systems.[363] On the international level the FAA is active participating in the UASSG[364], as well as several UAS organization and groups.[365]

A first recent change of the regulations can be observed. In accordance with the already amended ICAO Annex 13[366], the definition in 49 CFR § 830.2 for 'aircraft accident' has been amended and a new definition of 'unmanned aircraft accident' has been included. They read as follows:

> *Aircraft accident means an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage. For purposes of this part, the definition of "aircraft accident" includes "unmanned aircraft accident," as defined herein.*
>
> *Unmanned aircraft accident means an occurrence associated with the operation of any public or civil unmanned aircraft system that takes place between the time that the system is activated with the purpose of flight and the time that the system is deactivated at the conclusion of its mission, in which:*
> *(1) Any person suffers death or serious injury; or*
>
> *(2) The aircraft has a maximum gross takeoff weight of 300 pounds or greater and sustains substantial damage.*[367]

---

362 Ibid.

363 FAA (Ardyth Williams/James Sizemore), "Integrating Unmanned Aircraft Systems (UAS) into the Global ATM System (Presentation)" (2009) at 16 ["Integrating UAS into Global ATM System (Presentation)"].

364 Please see above, Chapter 3, C. 2.

365 E.g. the Joint Authorities for Rulemaking on Unmanned Systems (JARUS), Ron van de Leijgraaf, "Joint Authorities for Rulemaking on Unmanned Systems (JARUS)", in UVS International, ed, *UAS Yearbook - UAS: The Global Perspective* (Paris: Blyenburgh & Co, 2010) ["UVS Yearbook: JARUS"].

366 Please see above, Chapter 3, B. 2. h.

367 49 CFR § 830.2.

2. Small UAS

The most concrete developments toward UAS regulations so far and the supposedly first rules to be implemented will be on small UAS. Market surveys in 2008 indicated that the majority of UAS that are likely to be developed in the next decade will be under 20 pounds (9.07 kilograms).[368] To legally address this development a Small UAS Aviation Rulemaking Committee (Small UAS ARC) was established in 2008[369] which had its initial committee meeting on 27-29 May 2008.[370] The FAA summarizes the difficulty of the process of elaboration small UAS rules, when it states that *"(e)nsuring the safety of all airspace users while not putting undue burdens on small UAS operators is a challenging task*"[371]. The committee aims to address these concerns. The variety of its members expresses the holistic approach to this matter. Government departments, pilots and aircraft owners associations, research associations and universities, manufacturers and other members of the UAS community participated in the Small UAS ARC.[372]

On 1 April 2009 the Small UAS ARC published a *Comprehensive Set of Recommendations for sUAS Regulatory Development*[373]. These recommendations cover several important elements of small UAS and their operations, e.g. delimitation to model aircraft[374]; operating rules and limitations[375]; differentiation between subgroups of small UAS[376]; personnel[377], including pilots[378], observers[379] and instructors[380]; aircraft and sys-

---

368 FAA (Doug Davis) & EASA (Yves Morier), "UAS: Considerations for Certification and Interoperability", *supra* note 358, at 3.

369 FAA, *Small Unmanned Aircraft System Aviation Rulemaking Committee*, Order 1110.150 (Wahington: FAA, 2008) [*Small Unmanned Aircraft System Aviation Rulemaking Committee*]

370 FAA (Doug Davis) & EASA (Yves Morier), "UAS: Considerations for Certification and Interoperability", *supra* note 358, at 3.

371 FAA Unmanned Aircraft Program Office, *UAS Fact Sheet*, *supra* note 337.

372 Small Unmanned Aircraft System Aviation Rulemaking Committee, *Comprehensive Set of Recommendations for sUAS Regulatory Development* (Washington: FAA, 2009) at "i" [*sUAS Recommendations*].

373 Ibid , 'sUAS' stands for small UAS.

374 Ibid Subpart A.

375 Ibid Subpart B.

376 Ibid para 9 ff.

377 Ibid Subpart C.

378 Ibid para 15.

379 Ibid para 16.

380 Ibid para 17.

tems[381], including registration, identification and marking[382], initial and continuing airworthiness[383] as well as alternative means of compliance[384].

This documents contains (only) recommendations that require further FAA action and have to undergo the whole rulemaking process. Nevertheless, some important aspects need to be highlighted, which particularly deal with some of the most eminent problems of UAS integration mentioned throughout the present thesis.

First, the delimitation between model aircraft and (small) UAS is addressed. 'Model aircraft' are defined as a:

> *sUAS used by hobbyists and flown within visual line-of-sight under direct control from the pilot, which can navigate the airspace, and which is manufactured or assembled, and operated for the purposes of sport, recreation and/or competition.*[385]

This definition bases model aircraft also on the purpose of 'recreational' use, but adds the requirement "*which is manufactured or assembled*"[386] which further narrows the definition.

The recommendations further differentiate between model aircraft that are operated in accordance with "*accepted set of standards established and administered by a community based association*"[387] and hence are exempt from possible future regulations following the committee's recommendations, and other model aircraft which are not operated in accordance with those standards[388]. For each group detailed recommendations are made, which go far beyond the few general principles expressed in the AC 91-57.

[381] Ibid Subpart D.
[382] Ibid para 19.
[383] Ibid para 20 and 21.
[384] Ibid Subpart E.
[385] Ibid para 1, Definitions.
[386] Ibid.
[387] Ibid para 2.1.
[388] Ibid para 3.

Second, the limited ability of the Remote Pilot of a UAS 'detect, sense and avoid', is handled for small UAS by imposing several operation limitations and considerations, inter alia: daylight operations[389], VLOS requirements[390], prohibited areas[391], rules regarding other aircraft, e.g. right-of-way rules[392] and general operational considerations, e.g. take-off and landing areas and pre-flight procedures[393].

Third, small UAS are further divided into subgroups (Group I[394], Group II[395], Group III[396], Group IV[397] and a reserved Group V[398]) which are differentiated by their physical characteristics and subject to additional operational limits.

Fourth, several details on the personnel requirements for small UAS operations are elaborated.[399] A small UAS pilot certificate[400] is introduced and eligibility criteria[401], aeronautical knowledge[402] and flight proficiency requirement[403] are set and a medical certificate[404] is required. Also observers[405] and instructors are dealt with[406].

Fifth, the aircraft and the system are addressed: registration, identification an markings[407] and in particular airworthiness certification requirements[408] are elaborated recognizing the specific characteristics of small UAS.

---

389 Ibid para 4.1.
390 Ibid para 4.3.
391 Ibid para 4.6.
392 Ibid para 5.4.
393 Ibid para 6, 6.1 and 6.4.
394 Ibid para 9.
395 Ibid para 10.
396 Ibid para 11.
397 Ibid para 12.
398 Ibid para 13 (reserved).
399 Ibid para 15.
400 Not required for Group I small UAS, ibid para 15.4.
401 Ibid para 15.2.
402 Ibid para 15.5.
403 Ibid para 15.6.
404 Ibid 15.8.
405 Ibid para 16.
406 Ibid para 17.
407 Ibid para 19.
408 Ibid para 20.

The FAA received these recommendations and is currently drafting a proposed rule.[409] While the Small UAS ARC recommendations represent the first detailed regulatory preparatory work on small UAS, several of them were not based on a general consensus within the committee.[410] As they are 'recommendations' the degree of similarity of the future proposed rules and these initial recommendations is uncertain. The UAS Fact Sheet states that the proposed rules are scheduled for being published at mid-2011, while the final rule is envisioned for the end of 2012.[411] At the time of the writing of this thesis, unfortunately the proposal was not yet published.

D. Summary and evaluation

UAS are not specifically regulated in Title 14 of the CFR. But, as they are aircraft, the existent regulations generally apply. However, as these regulations were developed in the light of manned aviation, their appropriateness for UAS is limited. The statement of the FAA Center of Excellence for General Aviation Research (CGAR) that "*only* 30*% of current manned aviation regulation applies, as it is, to UASs;* 54*% may apply or may require revisions and* 16*% does not apply*"[412] can be seen as a general indication of this problem.

Unmanned free balloons are nevertheless specifically addressed by the regulations and can be operated in the United States airspace. On the one hand, unmanned free balloons do not represent the sophisticated types and applications that have been developed and could create a new segment of civil aviation, as their capabilities are very limited, especially in comparison to the UA presented in Chapter 2. On the other hand unmanned free balloons do not have Remote Pilot, a Data-Link and a RPS and hence do not constitute an UAS.

The recently established UAPO is working on the amendment of the current aircraft regulations and the development of new UAS specific rules. The FAA cooperates with the

[409] FAA Unmanned Aircraft Program Office, *UAS Fact Sheet*, *supra* note 337.
[410] Recommendations marked with a dot in the document did not represent general consensus.
[411] FAA Unmanned Aircraft Program Office, *UAS Fact Sheet*, *supra* note 337.
[412] K Dalamagkidis, K P Valavanis & L A Piegl, *On Integrating Unmanned Aircraft Systems into the National Airspace System* Springer, 2009) at 110 [*On Integrating UAS into NAS*].

UAS community and RTCS and also actively participates in the UASSG.

The COA is a UAS specific permission to operate UAS in the United States airspace. Several details were elaborated on UAS certification and licensing. Unfortunately the COA is limited to public applicants.

Model aircraft are not specifically regulated in the CFR but specified documents clarify that model aircraft are used for recreational purposes only and that UA operable under the model aircraft regime. Unfortunately, a definition of 'model aircraft' that would give the delimitation of model aircraft and some UA more legal certainty is not provided. Under the premise that FAA wants to regulate UAS but does not want to over-regulate model aircraft, a clear differentiation is necessary.

The recommendation of the Small UAS ARC address this problem and offer a definition and detailed proposals for the operation of model aircraft. This however, could lead to an increase of regulation of modelers.

Detailed proposals on the regulation of small UAS were made, as theses are expected to be the most produced type in the near future and the ones closest to integration. Also the general approach to address small UAS separately and the creation of different subgroups reflects the reality of the multitude of UAS types and capabilities.

Given the extensive and ambitious work program of the FAA, it is evident that the FAA acknowledged the benefits that UAS could create for aviation and the requirement for a more adequate regulatory construct. The integration of UAS into the United States' airspace seems possible. Unfortunately, all brilliant proposals and ideas are all dreams of the future.

At present, the only possibility to operate a civil UAS in the United States' airspace is the SAC-EC, which will be explained in more detail in Chapter 6.

Similarly as within the critique of ICAO's approach to UAS, it could be asked if the United States and the FAA in particular acted too late, too slowly or too passively. But here again, the argument rebutting this presumption is safety. The FAA is responsible for the safety of the United States' airspace. UAS integration can only go as far as it does not endanger other users of the airspace or compromises the safety of persons or property on the ground. Given the various safety concern, in particular the missing 'detect, sense and avoid' capability, and the resultant restrictions to UAS operations, for now, integration does not go very far.

CHAPTER 5: CANADIAN REGULATORY FRAMEWORK FOR UAS

Canada is a significant user and developer of UAS,[413] while not to the extent of its southern neighbor.[414] Its geographic characteristics attract UAS applications. Extensive road, rail, electricity and pipeline networks need to be controlled and a lengthy border with the United Stated requires continuous protection. Wildlife, environmental and industrial monitoring, aerial photography and other scientific or commercial uses of UAS are appealing unmanned alternatives in Canada. Given the highly developed aviation environment in Canada paired with the mostly sparsely congested airspace, Canada has the opportunity to take a leadership role in developing UAS regulations and in integrating UAS without risking other airspace users and people and property on the ground. In the present chapter, Canada's regulatory approach to civil UAS will be examined. Similar to the previous chapters, the relevant authorities and their jurisdiction are briefly pictured before the present regulatory approach on the one hand, and the work on UAS on the other hand, will be explained. In the same manner as within the United States Chapter, no analysis of all possibly relevant provisions will be attempted due to their large number. Rather the focus will be place on an examination of the UAS specific, or at least highly relevant, legal instruments.

A. Authorities and jurisdiction

The Minister of Transport[415] was given the authority to establish aviation regulations pursuant to the Aeronautics Act of 1958[416]. Section 4.2 describes the Minister's responsibilities:

> *The Minister is responsible for the development and regulation of aeronautics and the supervision of all matters connected with aeronautics and, in the discharge of those responsibilities, the Minister may*
> *(a) promote aeronautics by such means as the Minister*

---

413 Wayne Crowe, "Canadian UAS Community", 100, in UVS International, ed, *UAS Yearbook - UAS: The Global Perspective* (Paris: Blyenburgh & Co, 2010) at 100 ff ["Canadian UAS Community"].

414 Please see above in the Introduction (with further notes).

415 At present Denis Lebel, *Transport Canada* <http://www.tc.gc.ca/> [*TC Website*].

416 Aeronautics Act, RSC, 1985, c. A-2.

considers appropriate;
(b) construct, maintain and operate aerodromes and establish and provide other facilities and services relating to aeronautics;
(c) (...);
(d) undertake, and cooperate with persons undertaking, such projects, technical research, study or investigation as in the opinion of the Minister will promote the development of aeronautics;
(e) control and manage all aircraft and equipment necessary for the conduct of any services of Her Majesty in right of Canada;
(f) establish aerial routes;
(g) (...);
(h) take such action as may be necessary to secure by international regulation or otherwise the rights of Her Majesty in right of Canada in international air traffic;
(i) (...);
(j) cooperate or enter into administrative arrangements with aeronautics authorities of other governments or foreign states with respect to any matter relating to aeronautics;
(k) investigate, examine and report on the operation and development of commercial air services in, to or from Canada;
(l) (...);
(o) undertake such other activities in relation to aeronautics as the Minister considers appropriate or as the Governor in Council may direct.[417]

The aviation regulations developed by Transport Canada[418] (TC), the department within the government of Canada headed by the Minister of Transport, and passed by the Minister are the Canadian Aviation Regulations[419] (CARs). The CARs were adopted in 1996 but have been amended several times since. Another important instrument is the Standards[420], which are TC's way of clarifying the regulations.

B. Regulatory approach

417 Aeronautics Act, RSC, 1985, c. A-2, Section 4.2.
418 Please see *TC Website* (webpage), *supra* note 414 for details.
419 SOR/96-433.
420 Please see *TC Website* (webpage), *supra* note 414 for details.

In the present subchapter, the regulation of UAS in the CARs and in relevant standards will be highlighted.

1. Canadian Aviation Regulations

As it has already been explained in Chapter 2 of the present thesis, the Aeronautics Act defines 'aircraft' as "*any machine capable of deriving support in the atmosphere from reactions of the air, and includes a rocket*"[421] and hence covers UAS, while the CARs do not contain a general definition of aircraft.

But, the CARs explicitly regulate 'Unmanned Air Vehicles'.

Section 101.01 (1) defines an Unmanned Air Vehicle as "*a power-driven aircraft, other than a model aircraft, that is designed to fly without a human operator on board*"[422]. This definition clarifies, that Unmanned Air Vehicles are 'aircraft' despite their denomination as 'vehicles'. Hence, the 'Unmanned Air Vehicles' within the Canadian regulatory approach are UA within the sense of this thesis and the regulatory approaches of ICAO and the United States. The definition is very specific when it requires that no human operator is on board, allowing other persons to be carried by the UA as long as they are not operators. As a result, possible future passenger transport by UA is not precluded. Model aircraft are excluded from the Unmanned Air Vehicles regime by definition. The 'power-driven' requirement additionally excludes balloons[423], gliders[424] and gyroplanes[425] from the Canadian UA ambit as these are defined as 'non-power-driven' aircraft. As the definition of 'aircraft' in the Aeronautics Act includes rockets, those could also be UA within the Canadian framework.[426] Nevertheless, the use of rockets as civil UA is very unlikely. A definition of UAS is however not provided by the CARs.

---

421 Aeronautics Act, RSC, 1985, c. A-2, Section 3. (1).
422 CARs, Part I, Subpart 1, § 101.01 (1).
423 "*'(B)alloon' - means a non-power-driven lighter-than-air aircraft*", ibid.
424 "*'(G)lider' - means a non-power-driven heavier-than-air aircraft that derives its lift in flight from aerodynamic reactions on surfaces that remain fixed during flight*", ibid.
425 "*'(G)yroplane' - means a heavier-than-air aircraft that derives its lift in flight from aerodynamic reactions on one or more non-power-driven rotors on substantially vertical axes*", ibid.
426 Aeronautics Act, RSC, 1985, c. A-2, Section 3. (1).

Apart from the more general inclusion into the CARs by providing a definition of 'Unmanned Air Vehicles', a specific certificate for UAS operations in Canadian airspace is also foreseen, which will be addressed in the next but one subchapter.

2. Model aircraft

Before turning to more specific UAS regulations in the CARs, Canada's approach toward model aircraft needs to be explained. As it frequently became apparent throughout the present thesis, the delimitation between model aircraft and some UA is necessary to develop adequate regulations on UAS integration on the one hand, and to keep model aircraft flown by modelers unregulated to the greatest extent possible on the other hand.

The definition of Unmanned Air Vehicles mentioned before excludes model aircraft. However, to make this exclusion reasonable, it has to be determined what is covered by 'model aircraft'. Section 101.01(1) of the CARs defines 'model aircraft' as "*an aircraft, the total weight of which does not exceed 35 kg (77.2 pounds), that is mechanically driven or launched into flight for recreational purposes and that is not designed to carry persons or other living creatures*"[427].

Model aircraft are *prima facie* UA as they are 'aircraft' and "*not designed to carry persons or other living creatures*". Of importance are two specificities of the definition. First, model aircraft are subject to a weight limit of 35 kg. Second, model aircraft can only be used for recreational purposes. Hence, heavier models, even if they are flown for recreation, are not considered 'model aircraft' but rather Unmanned Air Vehicles. On the other hand, all micro and most small UA do not fall under the Canadian model regime, because even if they are below 35 kg, they are used for non-recreational purposes.

In comparison to ICAO and the United States, Canada's aviation regulations contain a definition of model aircraft. In the light of increasing UAS applications, this repre-

---

[427] CARs, Part I, Subpart 1, § 101.01 (1).

sents a legal advantage. As one decisive criterion for the delimitation between UA and model aircraft, the definition uses the aircraft's weight, providing legal certainty as no discussion can arise about the meaning of a certain weight limit. Anyhow, the definition stipulates the criterion of 'recreational purposes', which seems to reflect a general consensus as it is also embraced within the ICAO UAS Circular. Unfortunately, the meaning of 'recreational' is not specified in the definition and no further restrictions are expressed to obviate, for example, the possibility of operation genuine commercial or scientific UA once as a Unmanned Air Vehicle and once a as model aircraft, only dependant on the actual purpose of the use. However, the weight limit reduces this probability to smaller UA.

3. Special Flight Operation Certificate

The operation of an Unmanned Air Vehicles in Canadian airspace requires a Special Flight Operations Certificate (SFOC), which will be explained in more detail in the next chapter, when the different approaches of ICAO, the United States and Canada to UAS certification and licensing are explained.

C. Work on UAS

Canada recognized the future importance of UAS and the growing desire in the UAS community[428] for more sophisticated regulations. In the following, the organizational and substantial developments toward UAS integration into the Canadian airspace will be briefly highlighted.

1. Organization and objectives

The increasing interest in UAS was mirrored by an increasing volume and enhanced complexity of applications for SFOC. In December 2006 TC's branch for general aviation created the Unmanned Air Vehicle Working Group on the joint initiative of the

---

[428] Wayne Crowe, "Canadian UAS Community", *supra* note 412.

government and the UAS industry.[429] The goal of this working group was to develop a regulatory framework for all aspects of UAS operations.[430] In September 2007 the working group published a detailed report[431] proposing several amendments and new rules to develop a future Canadian regulatory framework for UAS.[432] This report will be explained in the next subchapter.

As a result of the working group's report and in particular because of inefficiencies within the SFOC application process, TC created the SFOC Review Working Group.[433] This second group elaborated a Staff Instruction published in 2008, which will be explained in line with the SFOC in Chapter 6.

A third working group[434], the UAV Systems Program Design Working Group, was established by TC in 2009.[435] This working group is a Canadian Aviation Regulation Advisory Council (CARAC) working group.[436] The CARAC was established to improve TC's approach to consultation and rulemaking as well as the regulatory system in general.[437] It is a joint undertaking of the government and the aviation community.[438] The purpose of the group and the relation to the CARAC are summarized by the group's terms of reference:

> *The purpose of this new Unmanned Air Vehicle (UAV) Systems Program Design Working Group is to make recommendations for amendments to existing regulations and standards and to introduce new regulations and*

---

429 Transport Canada, *UAV Working Group Final Report*, *supra* note 130 at 2.
430 Ibid.
431 Ibid.
432 For details please see below, C. 2.
433 Transport Canada, *Speaking Notes for Martin J. Eley Director General, Civil Aviation to Deliver at the Unmanned Systems Canada Conference 2010* (Ottawa: Transport Canada, 2010) [*Speaking Notes Martin J. Eley*].
434 This working group was created upon the request of a UAV Steering Committee created by TC in 2009 which was dissolved afterwards, Transport Canada, *Unmanned Air Vehicle (UAV) Systems Program Design Working Group - Terms of Reference*, RDIMS No. 5705889(E) (Ottawa: Transport Canada, 2010) at 1 [*UAV Systems Program Design Working Group - Terms of Reference*].
435 Transport Canada, *Speaking Notes Martin J. Eley*, *supra* note 432; Transport Canada, *UAV Systems Program Design Working Group - Terms of Reference*, *supra* note 433 at 1.
436 Transport Canada, *UAV Systems Program Design Working Group - Terms of Reference*, *supra* note 433 at 1.
437 Please see *TC Website* (webpage), *supra* note 414.
438 Ibid.

> *standards for UAV operations in accordance with the UAV Working Group 2007 Final Report. These recommendations will require justifications since they will ultimately serve as the basis for Transport Canada to develop the Notices of Proposed Amendments (NPAs) that will be presented to the CARAC Technical Committee. In addition, recommendations will be made for any non-regulatory instruments that will be required to promote the safe integration of routine UAV operations in Canadian airspace.*[439]

The working group held its first meeting in October 2010 while three subgroups began their work in November 2010.[440] Similar to the United States approach, the focus will first be placed on small UAS.[441] The working group will elaborate requirements associated with the operation of different categories in different phases, from smaller UAS to also MALE and HALE[442], which will take several years for completion.[443]

Canada is also participating in the ICAO UASSG[444], it cooperates with the United States[445] and it is active in other UAS organizations[446].

2. Unmanned Air Vehicle Working Group Final Report

The initial terms of reference of the Unmanned Air Vehicle Working Group were triggered toward "*medium to long-range, medium altitude, beyond line-of-sight UAV operations in Canadian airspace*"[447] but subsequently the working group placed the focus on "*small lightweight UAVs operated at low to medium altitudes beyond visual range*"[448] in line with expected near term market developments. With reference to United States fore-

---

439 Transport Canada, *UAV Systems Program Design Working Group - Terms of Reference*, *supra* note 433 at 1.
440 Transport Canada, *Speaking Notes Martin J. Eley*, *supra* note 432.
441 Ibid.
442 Transport Canada, *UAV Systems Program Design Working Group - Terms of Reference*, *supra* note 433 at 4 and 5.
443 Ibid 7.
444 Please see above, Chapter 3, C. 2.
445 FAA (Doug Davis) & EASA (Yves Morier), "UAS: Considerations for Certification and Interoperability", *supra* note 358, at 14.
446 E.g. in JARUS, Ron van de Leijgraaf, "UVS Yearbook: JARUS", *supra* note 364.
447 Transport Canada, *UAV Working Group Final Report*, *supra* note 130 at para 2.0.
448 Ibid para 3.0.

casts the report states that UAS "*that fly at low altitude and weigh less than 10 Kg are expected to make up approximately 80% of civil production*"[449].

With regard to international operations of UAS and in particular interesting for the present thesis the report stated:

> *The majority of the Working Group recommendations are focused on the domestic use of UAVs since, at present, regulations have yet to be established by the International Civil Aviation Organization (ICAO) and other regulatory agencies. Ultimately the intent is to conform to ICAO standards and to have similar regulations governing UAV flights to allow transparent cross-border operations with the United States.*[450]

After explaining the organizational aspects, e.g. membership[451] and meetings[452] the report briefly outlines the key recommendations which are elaborated throughout the report.[453] A roadmap of the actual status of the industry and the various stakeholders is provided[454] before the report proposes certain amendments to definitions[455] as well as the introduction of new terminology[456]. Herein the system approach is expressed by defining UAS as "*the unmanned air vehicle(s), control station(s) and any other elements required for flight*".[457]

A classification scheme is generally based on the maximum take-off weight (MTOW) where 35 kg is the first limit[458], which is already set by the model aircraft regime, and the second limit is placed at 150 kg, in line with regulations of EASA and the North Atlantic Treaty Organization (NATO)[459].

---

449 Ibid 2.
450 Ibid para 5.0.
451 Ibid para 7.0.
452 Ibid para 8.0.
453 Ibid para 11.1.
454 Ibid para 12.
455 Ibid para 13.1.
456 Ibid para 13.2.
457 Ibid.
458 Ibid para 14.0.
459 Ibid.

Several other aspects are addressed, e.g. aircraft registration and marks[460] and pilot and systems operator competencies and licensing[461]. Furthermore airworthiness and continuing airworthiness proposals are made[462], where a Aircraft System Operating Certificate (UOC) is foreseen in the long term to replace the SFOC for UAS below 150 kg.[463] Also amendments of Part VI of the CARs were proposed[464], *inter alia* a general right of way regulation that treats manned and unmanned aircraft alike[465]. Additionally the working group recommended to further monitor the outputs of standard making organizations.[466] Finally, the already mentioned creation of the UAV SFOC Review Working Group is proposed.[467]

D. Summary and evaluation

Canada's situation of a highly developed aviation environment coupled with the mostly sparsely congested airspace offers a special opportunity for UAS integration into Canadian airspace. The CARs expressly regulate 'Unmanned Air Vehicles'. The regulations offer a definition of 'Unmanned Air Vehicles' and set out the requirement and some details of the SFOC. A definition of UAS or other rules addressing the system approach however, cannot be found in the regulations.

Model aircraft are defined in the CARs, marking another progress of Canadian regulation and providing more legal certainty. While the latter is increased by the 35 kg weight limits, the criterion of 'recreational purposes' would benefit from further clarification.

---

460 Ibid para 15.0.
461 Ibid para 16.0.
462 Ibid para 18.0.
463 Ibid para 18.2.
464 Ibid para 20.0.
465 Ibid para 20.1.
466 Ibid para 22.3.
467 Ibid para 23.2.

The specific, but limited, regulation of ‘Unmanned Air Vehicles’ within the CARs is an legal advance in comparison to the United States and the regulatory approach of ICAO. The way in which the SFOC, as the certificate for UAS operations in Canada, allows UAS operations different from the United States will be explored in the next chapter.

With the task to improve current processes and to elaborate the future Canadian regulatory framework for UAS, several working groups have been created. These led in particular to a Staff Instruction and a Final Report.

While the Staff Instruction, which will be explained in line with the SFOC in the next chapter, was made to provide guidance to the actual regulatory situation, the Final Report of the Unmanned Air Vehicles Working Group constitutes a comprehensive proposal for an amendment of the regulations and gives an idea of Canada’s future regulatory approach to UAS.

Similar to the United States, the proposals focus on small UAS. This is obvious not only because these UAS are expected to be the most growing category in the near term, but also because they are the easiest to integrate, as they generally rarely interfere with regular air traffic unlike MALE and HALE UAS.

The proposal for classifications as such is an advance, in particular in comparison to the ICAO UAS Circular which, even if published four years later, does not offer any guidance to classification. However, the 35 kg rule was already preset by the model aircraft regime mentioned above and the 150 kg limit deviates from EASA and NATO. In the light of international harmonization, the orientation on other regulatory bodies is nevertheless very helpful.

The proposed right of way rules are interesting in two regards. First, the small UAS, which are expected to be the near term objective of the regulations, do not necessarily conflict with regular air traffic and therefore the question of right of way might not always occur. Second, equivalent right of way rules of manned and unmanned aircraft requires, at least in beyond visual line-of-sight (BVLOS) operations, ‘detect, sense and avoid' capability of UAS to decide and execute these right of way rules. However, a technology which could provide these functions is not available today and its successful application is most probably years ahead.

With regard to the terminology it is interesting that 'Unmanned Air Vehicles' are by their own definition specified as 'aircraft'. The Final Report then proposes a new definition of 'Unmanned Aircraft Systems' which, at least with regard its wording, seems not very coherent with the 'vehicles' regulations. Hence, the term 'Unmanned Air Vehicle' remains questionable, in particular when, apart from the international emerging consensus on 'aircraft', even the own departmental working groups propose 'Unmanned Aircraft' regulations.[468]

Concerning the depth of the recommendations the report lists the aspects that are not covered by the working group.[469] This quite extensive numeration contains unfortunately many very important aspects of UAS integration.

---

[468] Already the Staff Instruction, explained in detail below, recognizes this difference between the terminologies but reaffirms that Unmanned Air Vehicles are part of a system: "*The FAA has introduced new terminology for UAVs, namely UAS – unmanned aircraft systems. This terminology has now been adopted by several other countries. While the terms are synonymous, the legal terminology in Canada is still UAV- unmanned air vehicle. Despite a difference in terminology, there is agreement that UAVs are part of a system that includes the unmanned air vehicle(s), control station(s) and any other elements required for flight*" Transport Canada, *Staff Instruction (SI) No. 623-001 - The review and processing of an application for a Special Flight Operations Certificate for the Operation of an Unmanned Air Vehicle (UAV) System*, Staff Instruction (SI) No 623-001 (Ottawa: Transport Canada, 2008) at Section 2.1 (1) (a) [*Staff Instruction*].

[469] The terms of reference of the Unmanned Air Vehicle Working Group state: "*Priority will be given to operational and airworthiness issues. Initial outputs will not, however, define specific airworthiness codes or equipment standards for the aircraft, the command, control and communication systems, or the ground control station. Additionally, the Working Group will not address:*

- Sense and avoid systems or requirements;
- Spectrum management;
- Security matters (control links and control stations); or
- Special air traffic management considerations.

While it may be necessary to discuss these aspects of UAV operations during the meetings, these topics will not be pursued in detail at this time" and the Final Report continues:
"*In addition to the above items, it should be emphasized that the following items were also not addressed/assessed in Working Group discussions, and therefore, were not taken into account when developing recommendations:*

- UAVs operating inside buildings or underground;
- UAVs with passengers on board;
- Very large UAVs (e.g., transport category size);
- Micro UAVs (e.g., miniature dragonfly size);
- Establishing a minimum weight or size limit for applying regulations;

Given these aforementioned characteristics of the report, its contained work plan on integration is not only very ambitious, but rather very unrealistic, as a "*complete and safe integration*"[470] is foreseen to be reached in 2012.

As also mentioned with regard to ICAO and the United States, safety is the primary concern when it comes to UAS integration. Martin J. Eley from TC explains: "*(f)or this industry to realize its potential, we need a regulatory framework that first ensures public safety and second enables the development of the UAV sector*"[471]. Once this regulatory balance is achieved, the jurisdictions in question will be a significant step closer to UAS integration.

- Multiple UAVs controlled by one station;
- Disposable UAVs; and
- Approval for manufacturers of UAVs with a MTOW 150 Kg and below"; Transport Canada, *UAV Working Group Final Report*, *supra* note 130 at para 5.0.

470 Ibid para 12.2.

471 Transport Canada, *Speaking Notes Martin J. Eley*, *supra* note 432.

CHAPTER 6: APPROACHES TO UAS CERTIFICATION AND LICENSING

In the previous chapters the general regulatory approaches of ICAO, the United States and Canada to UAS have been explained. In this chapter, a more specific focus will be placed on certification of UAS and the licensing of UAS personnel. These are the two first basic prerequisites for UAS operations and UAS integration in the national and international airspace. Also in the previous chapters, the work on UAS regulations was highlighted and several proposals toward specific and comprehensive UAS regulations were presented. However, these proposals have not yet found their way into actual regulations and most of them are far away from being implemented. The present chapter first mentions certification and licensing in general, explains the differences to manned aviation that need to be considered and discusses the meaning of 'safety' with regard to UAS. Then a more detailed explanation of the present possibilities and requirements for UAS uses under ICAO and within the United States and Canada follows. Hence, the purpose is to illuminate what the law on UAS is today, not what it should be or what it eventually might be in the future.

A. Certification of aircraft and licensing of personnel

The certification of aircraft and the licensing of pilot and crew are essential parts of the regulatory framework of aviation and prerequisites for aircraft operations. Central to the certification of the aircraft is the Certificate of Airworthiness (CofA). Two different approaches can be used in the process of granting a CofA. In manned aviation the globally adopted approach is to apply defined codes of airworthiness requirements to the design of any aircraft.[472] The aircraft must be designed, constructed and operated in compliance with the appropriate airworthiness requirements of the State of registry of the aircraft.[473] If these requirements are met a Type Certificate for the approved design and CofA to individual

[472] Giorgio Guglieri et al, "Survey of Airworthiness and Certification" *supra* note 80, at 401; JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 6.3.1.1.

[473] ICAO, Secretariat, *Annexes 1 to 18*, *supra* note 11 at Annex 8.

aircraft are given declaring the aircraft fit to fly.[474] To the greatest practical extent no presumptions are made of the purposes for which the aircraft will be used.[475] The second approach is to set an overall safety target for the aircraft, which requires the assessment of an acceptable level of risks, i.e. the number of fatalities and/or injuries per hour of flight, and takes into account the defined application and the operating environment.[476] To achieve the required safety objective, potential hazards can be addressed by a combination of equipment and operational requirements.[477]

Licensing is the act of authorizing defined activities which should otherwise be prohibited due to the potentially serious results of such activities being performed improperly.[478] An applicant for a license must meet certain stated requirements proportional to the complexities of the task to be performed.[479]

The purpose of certification of the aircraft and licensing of the personnel is safety. This safety is generally tri-fold, consisting of flight safety, safety of other aircraft in flight and safety of public on the ground.

This general approach of achieving aviation safety through certification and licensing has proven successful for manned aircraft and also constitutes the basis for UAS operations. However, different characteristics of manned aircraft and UAS as well as their respective personnel make the application of the existing regulations, which were developed in the light of manned aircraft, to UAS difficult and require a change of the focus of safety regulations.

---

474 JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 6.3.1.1; Walter Schwenk & Elmar Giemulla, *Handbuch des Luftverkehtsrechts*, 3 ed (Cologne: Carl Heymanns Verlag, 2005) at 278 [*Handbuch des Luftverkehtsrechts*]; ICAO, Secretariat, *Annexes 1 to 18*, *supra* note 11 at Annex 8.

475 JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 6.3.1.1.

476 Giorgio Guglieri et al, "Survey of Airworthiness and Certification" *supra* note 80, at 401; JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 6.3.1.1.

477 JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 6.3.1.1.

478 I H Ph Diederiks-Verschoor, *Introduction to Air Law*, *supra* note 165 at 13-24; ICAO, Secretariat, *Annexes 1 to 18*, *supra* note 11 at Annex 1.

479 ICAO, Secretariat, *Annexes 1 to 18*, *supra* note 11 at Annex 1.

B. Special characteristics of UAS

In the present chapter, these different characteristics will be explained. The clarifying of the differences with regard to UAS and their personnel serves two aspects. On the one hand, the difficulties that UAS encounter when the current regulations are applied can be understood. On the other hand, the approaches of ICAO, the United States and Canada to certification of UAS and licensing of their personnel can be evaluated on that basis. Only if the special characteristics are observed, reasonable certification and licensing requirements can be established to allow UAS operations while assuring aviation safety.

1. Distinctive features with regard to certification

a. Size and weight of the aircraft

While also manned aircraft vary significantly in size and weight, e.g. from a small general aviation to a large commercial transport aircraft, the range between different UAS is even wider. UA ranging of a few grams[480] up to several tons[481] need to be covered by UAS regulations, while a certain gradation of regulatory intensity seems to be adequate.

b. Applications

Manned aviation is mainly concerned with transport of persons or goods, which normally leads to point-to-point routes.[482] Many UAS applications instead consist of information gathering activities, which often result in continuous and lengthy flights over

---

480 See for one of many examples G C H E de Croon et al, "Design, aerodynamics, and vision-based control of the DelFly" *supra* note 134, at 262.

481 E.g. the Northrop Grumman RQ-4 Global Hawk, see Giorgio Guglieri et al, "Survey of Airworthiness and Certification" *supra* note 80; *RQ-4 Block 20 Global Hawk* <http://www.as.northropgrumman.com/products/ghrq4b/index.html> [*RQ-4 Block 20 Global Hawk*].

482 K Dalamagkidis, K P Valavanis & L A Piegl, "Future Perspectives for UAS in the US" *supra* note 328, at 315.

certain areas. This type of operations is named 'aerial work'[483]. The majority of regulations however, are tailored for the specificities of 'air transport'.

c. Abnormal flight termination

In manned aviation an aircraft crash, or an 'abnormal flight termination'[484], is considered a catastrophic accident that should be avoided as much as possible due to the high probability of fatalities associated with it.[485] An UA lost in contrast (only) constitutes a economic damage if a controlled crash over unpopulated areas can be managed. Therefore the certification also needs to cover flight termination systems, which allow a 'safe' crash, e.g. in the case of a loss of communication.[486]

d. Autonomy

While a manned aircraft can be at least partially controlled by an auto-pilot system, the pilot is physically present in the cockpit at all times and directly controlling the flight. As explained in Chapter 2, the degree of autonomy of UA can vary from remotely controlled over partially autonomous to fully autonomous UA.[487] These different levels require appropriate certification, e.g. with regard to their reliability and failure procedures.

e. UAS

The most important difference between manned and unmanned aviation with regard to certification is the system approach. In manned aviation, the aircraft as such is certified, while also other parts can be certified separately, e.g. engines, which nevertheless belong

483 JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 6.3.3.1; Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 8.

484 Giorgio Guglieri et al, "Survey of Airworthiness and Certification" *supra* note 80, at 402.

485 K Dalamagkidis, K P Valavanis & L A Piegl, "Current Status and Future Perspectives for Unmanned Aircraft System Operations in the US" (2008) 52 ibid.313 at 315 ["Future Perspectives for UAS in the US"]; K Dalamagkidis, K P Valavanis & L A Piegl, *On Integrating UAS into NAS*, *supra* note 411 at para 6.1.2.

486 See *inter alia* Giorgio Guglieri et al, "Survey of Airworthiness and Certification" *supra* note 80, at 419.

487 Pleas see Chapter 2, C.1. c.

to the aircraft as such.[488] When the aircraft certification requirements, which were developed in the light of manned aircraft, are followed unchanged for UA, they demand that UA must be built in a certified manufacturing facility, using approved methods and materials, and subject to oversight throughout the process.[489] A flight inspection to ensure the safety of the aircraft follows this production process.[490] While, these certification specificities work for manned aircraft, they may not be adequate for unmanned aviation, where the UA is only one element of a system[491]. In unmanned aviation the UA is unable to fly by itself and hence cannot be airworthy alone. It requires the whole system described in Chapter 2 consisting of the RPS, the Data-Link and other elements.[492] All parts of the system need to be considered in the certification process, may they be certified as a single unit or separately.

The aspect of a handover of a UA between different RPS or within the same RPS creates further difficulties in this respect, as either the elements of the system or the composition of the responsible personnel changes within the same operation. An UA will not always be controlled from the same RPS using the same Data-Link.[493] In manned aviation neither the parts of the aircraft nor the crew is generally changeable after take-off.

Linked to this aspect is the question, if the whole UAS, including the UA, is certified as a unit or if UA and RPS are certified separately.[494] The latter approach would better accommodate the aforementioned handover and create flexibility when controlling different UA from one RPS.

2. Distinctive features with regard to licensing

Resultant of the diversity and range of the equipment, UAS personnel and their respective requirements differ as well. Variations also exist in manned aviation where pilots

---

488 Walter Schwenk & Elmar Giemulla, *Handbuch des Luftverkehtsrechts*, *supra* note 473 at 255.
489 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 2.4.4.1.
490 Ibid.
491 Ibid.
492 Pleas see Chapter 2, C. 2.
493 ICAO, Secretary General, *UAS Circular*, *supra* note 106 at para 6.1.
494 Ibid para 6.6.

are licensed for different flight operations (private, commercial, instrument and airline) and are provided type ratings for the aircraft flown.[495] All pilots must pass tests to prove adequate knowledge and proficiency relative to the type of operation they intend to fly.[496] In unmanned aviation the range is wider. On one side of the spectrum, micro and small UA can be controlled in VLOS similar to remotely controlled model aircraft. On the other side, multiple UA of different sizes and capabilities could be controlled from a sophisticated RPS by one Remote Pilot.[497] Dependant on the degree of autonomy, the pilots can be required to constantly navigate the UA or intervene only in critical situations or to change the parameters of a programmed flight.

Pursuant to this, the licensing requirements for Remote Pilots will depend on the characteristics of the UA and the operational environment. Remote Pilots controlling MALE UA in the vicinity of populated areas, in interaction with manned air traffic in the airspace and on airports, would likely require a Remote Pilot with extensive certification criteria similar to a commercially licensed, instrument rated pilot of a manned aircraft.[498] In contrast, Remote Pilots of small UA engaged in environmental monitoring in unpopulated areas may require minimal or no licensing at all.

Another special characteristic inherent to unmanned aviations is the physical separation of pilot and aircraft. While the pilot of a manned aircraft has a good situational awareness in flight due to natural sensors of the human body, which provide the pilot with information about accelerations, vibrations, noise and smell, paired with the instruments aboard the aircraft, the oversight of the Remote Pilot is limited to what is submitted to the RPS or what is visual from the Remote Pilot's position.[499] In a 'Nintendo-like'[500] environment the Remote Pilot's perception of the flight is substantially different.[501]

---

495 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 2.4.5.
496 Ibid.
497 K Dalamagkidis, K P Valavanis & L A Piegl, *On Integrating UAS into NAS*, *supra* note 411 at para 6.5.
498 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 2.4.5.
499 K Dalamagkidis, K P Valavanis & L A Piegl, "Future Perspectives for UAS in the US" *supra* note 328, at 315.
500 Stefan A Kaiser, "Third Party Liablity of UAV", *supra* note 115, at note 12.
501 See for details on the 'human-machine-interface': K Dalamagkidis, K P Valavanis & L A Piegl, "Future Perspectives for UAS in the US" *supra* note 328, at 315; Giorgio Guglieri et al, "Survey of Airworthiness and Certification" *supra* note 80, at 402; JAA/Eurocontrol, "UAV Task-Force Report"

In the case of a handover due to lengthy or distant operations, the Remote Pilot needs to confer the control to another Remote Pilot, may it be in the same RPS, e.g. due to a regular work shift, or between RPS in distant locations[502]. The aspect of a possible change of the pilot in flight, in particular between different RPS, needs to be included in the Remote Pilot licensing requirements. Also the UAS Operator may change in case of a handover.[503] With regard to the payload of the UA, a Remote Pilot could also function as the operator of the payload imposing additional task and aspects that need to be considered in the license.

As already mentioned in Chapter 2, the Remote Pilot may not be the only one involved in the UAS operation. There may be involved an ‘UAS Operator’[504], which is not a natural person, as the Remote Pilot is, but the legal entity responsible for organizing the flight operations[505], and further personnel, e.g. a ‘RPA Observer’[506]. The personnel can be categorized in persons, e.g. the Remote Pilot and other people participation in the operation as well as technicians, and organizations, e.g. the operators and maintenance organizations.[507] These other persons and organization concerned with the UAS may require licenses as well, which have to account for their different positions and tasks.

Generally the licensing requirements of the Remote Pilot and other personnel are highly dependent on the whole system and the different applications. This also underlines the need for regulations addressing not only the UA but the whole UAS. Similar to the question if the UA and the RPS are certified as a unit or separately, it needs to be decided, if the Remote Pilot’s license is based on an affiliation between the pilot and the UA or be-

---

supra note 9, at para 7.10; Stefan A Kaiser, “Third Party Liablity of UAV”, *supra* note 115, at note 12.

502 Pleas see Chapter 2, D. 7.

503 Stefan A Kaiser, “Legal Aspects of UAV” *supra* note 40, at 349.

504 ICAO, Secretary General, *UAS Circular*, *supra* note 106 at e.g. Glossary and para 2.6; Filippo Tomasello, “Emerging international rules for UAS” *supra* note 3, at 5 ff.

505 Filippo Tomasello, “Emerging international rules for UAS” *supra* note 3, at 5.

506 ICAO, Secretary General, *UAS Circular*, *supra* note 106 at e.g. Glossary and para 7.10.

507 JAA/Eurocontrol, “UAV Task-Force Report” *supra* note 9, at para 6.3.3.3.

tween the pilot and the RPS.[508] This is also of particular importance, when a handover between different states occurs.

The position of a Remote Pilot outside the UA could also have influence on the medical licensing requirements, as the physical stress is presumably lower that in the cockpit of a manned aircraft.[509] However, physical fitness and mental alertness may also be required to a significant degree to prevent the Remote Pilot from neglecting the duties due to the more 'comfortable' environment in the RPS, where the pilot is not directly affected by incidents or accidents of the UA.

3. 'Safety' in UAS operations

The aforementioned characteristics influence the meaning of 'safety' in UAS operations and hence alter the requirements to achieve this safety. With regard to the process of developing adequate safety regulations, Tomasello states that "*regulating aviation safety in fact means identifying potential hazards, assessing the related risks, defining possible mitigation measures and imposing them to aviation stakeholders, through rules*"[510].

The very nature of UA, i.e. with no pilot aboard, results in a different set of possible hazards and their associated risks. In manned aviation an accident or incident necessarily puts human life at risk, may it be of numerous people in passenger transport or of a single pilot in general aviation. In contrast, the crash of an UA does not endanger life inside the aircraft.[511] Economic damages connected to the loss of the aircraft, could be mitigated through insurance.[512]

UAS safety therefore focuses on mitigating the hazards of ground collisions endan-

---

[508] ICAO, Secretary General, *UAS Circular*, *supra* note 106 at para 7.2.
[509] Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 2.4.5; Elmar Giemulla, "Einfügung in das zivile und militärische Luftrecht" *supra* note 15; Stefan A Kaiser, "Legal Aspects of UAV" *supra* note 40, at 356.
[510] Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 6.
[511] This aspect however might change, when UA passenger transport becomes feasible and desirable.
[512] Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 6.

gering people on the surface and mid-air collisions with other aircraft.[513]

The special characteristics of UAS and the variety of applications, sizes and types determine the risk of ground and mid-air collisions. For example, the with regard to the applications, continuous surveillance in a populated area, which can be a typical task of a UAS, creates a higher probability of a ground collision than overflight of a manned aircraft on its point-to-point transport route.[514] To address these differences and to elaborate respective certification and licensing requirement different approaches to UAS classifications have been elaborated. A classification can be based on the MTOW. The MTOW correlates with the expected kinetic energy imparted at impact, which itself is considered to be the primary factor affecting the probability of fatalities.[515] The heavier the UA gets, the greater is the risk of fatalities in case of a ground collision. Another method of classification is based on the altitude of the operation, which allows one to take the mid-air collision risk better into account, as UA are more likely to collide in altitudes of higher air traffic.[516] The above mentioned degree of autonomy can also serve a classification, where the remotely piloted, partially autonomous and fully autonomous UA create different hazards.[517]

The risk also depends on the Remote Pilot's location outside the UA. As explained above, the different circumstances of the Remote Pilot results in a more limited situational awareness compared to the pilot inside the cockpit of a manned aircraft, which could lead to more incidents and accidents. The general mishap rate of UAS has been higher than traditional manned aircraft[518] and a significant number of UAS accidents have been attributed to human errors[519]. In the consequence, the advantage of taking the pilot out of the aircraft, which eliminates the risk of the pilot being exposed to hazards, can entail increasing risks

---

513 Tomasello also highlights the risks of collision with other aircraft or vehicles during ground operations; and collision on the ground on a runway, ibid.

514 Giorgio Guglieri et al, "Survey of Airworthiness and Certification" *supra* note 80, at 402.

515 Please K Dalamagkidis, K P Valavanis & L A Piegl, *On Integrating UAS into NAS*, *supra* note 411 at para 6.3.1 (with further references).

516 Ibid para 6.3.2.

517 Ibid para 6.3.3.

518 Geoffrey Christopher Rapp, "Civil Liability of UAS in Law Enforcement" *supra* note 20, at 627 (with further references).

519 K Williams (2004), "A summary of unmanned accident/incident data: Human factors implications", DOT/FAA/AM 04-24.

for people on the ground and in other aircraft in flight.[520] This needs to be addressed by adequate licensing and training of Remote Pilots. Higher mishap rates in general also underline the necessity of specific certification and licensing regulations of UAS and their pilots before integration into national and international airspace can occur safely.

As a result, the focus of safety in unmanned aviation is different than in traditional manned aviation and dependant on a variety of aspects. What nevertheless remains the same is the goal. UAS need to achieve the same overall equivalent level of safety as manned aircraft.[521] The different characteristics and the same goal need to be taken into account for the certification of UAS and licensing of its personnel.

However, UAS do not only create additional risks, they can also offer safety benefits for aviation. DeGarmo summarizes this aspect in his extensive study as follows:

> *While much attention focuses on safety risks posed by UAVs, considerably less attention is given to potential safety benefits. Many of the new technologies and procedures being researched for UAVs have the potential to improve safety for both manned and unmanned aircraft. Advances in UAV automation, sensor detection systems, communications, data exchange networks, and monitoring systems will have direct and positive influences on all aircraft.*[522]

4. Interdependence with other regulations affecting UAS operations

As already indicated in the introduction, certification of the UAS and licensing of its personnel are important prerequisites for safe UAS applications, but by far not the only ones.[523] On the operational side, several aspects need to be considered, e.g. the frequently mentioned right-of-way rules and the 'detect, sense and avoid' capability linked thereto.

---

520 A Hobbs & S Herwitz, "Human factors in the maintenance of unmanned aicraft" (2005) (Washington: FAA) at 4 ["Human factors in the maintenance of unmanned aicraft"] (with further references).

521 See, *inter alia*, Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 2.1; JAA/Eurocontrol, "UAV Task-Force Report" *supra* note 9, at para 7.6; Anna Masutti, "Proposals for UAV Regulation" *supra* note 102, at 1; *TC Website* (webpage), *supra* note 414.

522 Matthew T DeGarmo, *Issues Concerning Integration of UAV*, *supra* note 9 at para 2.1.

523 DeGarmo states that "*(a)llowing routine and safe access of UAVs to civil airspace involves numerous issues that touch on nearly every aspect of the aviation technical, operational, and legal system*", ibid 2.

Future UAS integration will require said capabilities and coordination with ATC. The more developed these capabilities will become, the more integration into non-segregated airspace will be possible and in turn the more of these technologies will be required in the certification process. Other aspects that will expand into certification and licensing are security related, e.g. measures against jamming and hacking of the Data-Link[524] or security of the RPS facilities. These aspects, in particular the missing ‘detect, sense and avoid’ capability, influence the extensiveness of the certificate, i.e. the type, range and complexity of the allowed operation, and ultimately the degree of integration.

C. Certification of UAS and licensing of its personnel

On the basis of these characteristics relevant to UAS certification and licensing, the existing certification and licensing possibilities under ICAO and within the United States and Canada will be analyzed.

1. ICAO

As already highlighted in the introduction and in Chapter 3, ICAO’s approach to UAS certification and licensing cannot be compared on the same level to the approaches of the United States and Canada. Even though ICAO was established as an international organization to achieve international harmonization of regulations to enhance safe and orderly international aviation, the individual States have full sovereignty over their airspace and their regulations.[525] However, the States also agreed in Art. 37 of the Chicago Convention to follow ICAO SARPs and, if they deviate from the SARPs, to notify the differences between their national regulations and the SARPs pursuant to Art. 38.[526] This relationship between ICAO and its member states, ultimately based on their different status as subjects of public international law and the different purposes, forbids a direct comparison of the respective ‘regulations’. However, if the Chicago Convention or its annexes would prescribe rules for certification and licensing of UAS, the States would be required to follow

524 Stefan A Kaiser, “Third Party Liablity of UAV”, *supra* note 115, at 234.
525 Please see Chapter 3, A. 2.
526 Please see Chapter 3, B. 1. b.

this lead and implement UAS regulations that would mirror at least the minimum standards expressed in the SARPs.

a. Art. 31 and Annex 8

The legal basis of the CofA is Art. 31 (Certificate of airworthiness) of the Chicago Convention. It reads as follows:

> *Every aircraft engaged in international navigation shall be provided with a certificate of airworthiness issued or rendered valid by the State in which it is registered.*

Art. 31 applies to manned and unmanned aircraft and establishes the requirement of a CofA for international operations. The CofA must be issued or rendered valid by the State of registry of the aircraft. This article does not provide any details on the requirements or the process for issuing a CofA.

The sophisticated rules on the CofA are elaborated in Annex 8. It was first adopted in 1949 and addresses airworthiness and continued airworthiness requirements for fixed wing aircraft and rotary wing aircraft. The latest edition is the eleventh edition from July 2010. Annex 8 consist of seven main parts that cover the following airworthiness aspects: Definitions (Part I), Procedures for Certification and Continuing Airworthiness (Part II), Large Aeroplanes (Part III[527]), Helicopters (Part IV[528]), Small Aeroplanes (Part V), Engines (Part VI) and Propellers (Part VII).

Annex 8 is applicable to all aircraft, but it was developed in the light of manned aircraft. It contains no specific Standards on UA or UAS. The applicability provisions of the respective parts prescribe the general ambit of the annex.

Part III (Large Aeroplanes), Standard 1.1.3 states that:

---

527 Also Parts III A and III B exist.
528 Also Parts IV A and IV B exist.

> *Except for those Standards and Recommended Practices which specify a different applicability, the Standards and Recommended Practices of this part shall apply to aeroplanes of over 5 700 kg maximum certificated take-off mass intended for the carriage of passengers or cargo or mail in international air navigation.*

Part IV (Helicopters), Standard 1.1.2, reads as follows:

> *The Standards of this part shall apply to helicopters intended for the carriage of passengers or cargo or mail in international air navigation.*

Part V (Small Aeroplanes), Standard 1.1.2, states that:

> *Except for those Standards and Recommended Practices which specify a different applicability, the Standards and Recommended Practices of this part shall apply to all aeroplanes having a maximum certificated take-off mass greater than 750 kg but not exceeding 5 700 kg intended for the carriage of passengers or cargo or mail in international air navigation.*

Fixed-wing UA are only covered by the annex if they exceed 750 kg, which excludes all fixed-wing micro and small UA. As highlighted above, micro and small UA (fixed and rotary wing) are projected to constitute a significant part of the UAS market in the near future. Rotary wing UA would be generally covered irrespective of their weight.

All Standards require the intended use for 'carriage of passengers or cargo or mail'. Almost all civil UAS presently available were not developed for these transport operations. Passenger transport is not envisioned in the foreseeable future and cargo transport requires large cargo UA, which have not been developed successfully so far and which have to be integrated in the regular air traffic. As highlighted in Chapter 2 of the present thesis, UAS are being developed to conduct 'aerial work', a category not regulated in the annex.

Also, even if the general applicability to 'aircraft' includes UA, the annex does not contain any standards about the other elements of the system. The RPS and the Data-Links are not covered by Annex 8, neither by general aircraft standards nor by specific provisions.

If rotary-wing UA or over-750 kg fixed-wing UA would be used for cargo transport in the future, they could fall in the ambit of Annex 8. To consider until then the payload of the UA as 'cargo', would conflict with the literal meaning of 'cargo', as "*the goods or merchandise conveyed in a ship, airplane, or vehicle*"[529], which reflects the fact that cargo is loaded at one location and unloaded at another, which is generally not the case with UAS payload.

In summary, on the one hand, Annex 8 does not contain Standards applicable to the whole system, and on the other hand the UA, as the flying element of that system, could only be covered by the annex if it is used for transport and, in the case of aeroplanes, weights over 750 kg. Without going into the details of the over 200 page long Annex 8 with several hundreds of Standards, this potentially covered group of UA, which, like all UA, cannot fly without the other elements of the system, would even so not be able to satisfy the sophisticated Standards developed in the light of manned aircraft contained in Annex 8.

b. Art. 32 and Annex 1

The legal basis of the licensing of the aircraft personnel is Art. 31 (License of personnel) of the Chicago Convention. It states that:

> *(a) The pilot of every aircraft and the other members of the operating crew of every aircraft engaged in international navigation shall be provided with certificates of competency and licenses issued or rendered valid by the State in which the aircraft is registered.*
> *(b) Each contracting State reserves the right to refuse to rec-*

[529] *Cargo*, Merriam-Webster, 2011 [*Merriam-Webster*].

ognize, for the purpose of flight above its own territory, certificates of competency and licenses granted to any of its nationals by another contracting State.

Hence, UAS personnel needs to be licensed if engaged in international operations. Art. 32 establishes the general licensing requirement for personnel while Annex 1 contains the detailed SARPs.[530] The annex was first adopted in 1948 and the latest edition is the tenth edition from July 2006. Annex 1 is comprised of six chapters covering the following aspects of personnel licensing: Definitions and General Rules (Chapter 1), Licenses and Ratings for Pilots (Chapter 2), Licenses for Flight Crew Members other than Licenses for Pilots (Chapter 3), Licenses and Ratings for Personnel other than Flight Crew Members (Chapter 4), Specifications for Personnel (Chapter 5), Medical Provisions for Licensing (Chapter 6).[531]

As same as Art. 31 of the Chicago Convention and Annex 8, Art. 32 and Annex 1 were generally developed in the light of manned aircraft. The pilot provisions were specifically drafted for on-board pilots.[532] The annex does not contain standards on the Remote Pilot and does not take into account its distant location and the special characteristics related to this paramount difference to manned aircraft. Also other UAS personnel, e.g. UAS observers, as well as the UAS or the UA as such are not mentioned in the annex.

Nevertheless, and different to Art. 31 and Annex 8, where a certification of the UAS is not foreseen and the certification only of the UA is very difficult, the Remote Pilot could at least be trained and certified as a regular onboard pilot.[533] This would however not respect the significant differences to manned pilots and could be obviously inadequate, e.g. for some micro and small UA flow in VLOS, which can be controlled similar to model aircraft.

---

530 The general requirement is reaffirmed in Annex 1, 10th edition July 2006, 1.2.1: "*A person shall not act as a flight crew member of an aircraft unless a valid licence is held showing compliance with the specifications of this Annex and appropriate to the duties to be performed by that person*".

531 Also further appendixes and attachments exist to this Annex.

532 Leslie Cary, "UAS Yearbook - UASSG", *supra* note 253 at 52; ICAO, Secretary General, *UAS Circular*, *supra* note 106 at para 4.13.

533 Giorgio Guglieri et al, "Survey of Airworthiness and Certification" *supra* note 80, at 403; Mark E Peterson, "The UAV and the Current and Future Regulatory Contruct" *supra* note 24, at 568.

c. Interim result

The articles in the Chicago Convention on certification and licensing as well as the annexes that were developed on that basis do not contain explicit rules on UA or UAS. As ICAO does not prescribe those specific UAS SARPS on certification and licensing, the member States have nothing specific to implement in this regard.

Nevertheless, as the convention and the annexes apply to 'aircraft' and 'pilots', they are generally applicable to UA and their Remote Pilots. The respective standards actually available in the annexes were elaborated in the light of manned aircraft with pilots aboard. Neither the system approach nor the special characteristics of UA and Remote Pilots can be adequately accounted for in the present regulations. While the Remote Pilot could be licensed as a regular pilot, ignoring the significant differences to manned aircraft pilots, the UA as such is not successfully certifiable under the existent ICAO rules and the whole system cannot be addressed. As a result, international operations of civil UAS based solely on the existing articles and annexes are not possible under ICAO.

d. Assembly Resolution A36-13, Appendix G

That certification of UAS and licensing of its personnel is not foreseen in the Chicago Convention and its annexes and hence, at least with regard to certification of the UAS, is not possible under the current regulation, does not mean that the member states are hindered from developing their own regulations. As it was indicated in the previous chapters, the United States and Canada, already have UAS certification and licensing rules in place and are actively working on further regulatory instruments to allow integration of UAS in the national airspace. These national possibilities however, except where special agreements between states are concluded, do not allow international UAS operations for which the ICAO has jurisdiction. Art. 33 of the Chicago Convention, which is important in this regard, reads as follows:

> *Certificates of airworthiness and certificates of competency and licenses issued or rendered valid by the contracting State*

> *in which the aircraft is registered, shall be recognized as valid by the other contracting States, provided that the requirements under which such certificates or licenses were issued or rendered valid are equal to or above the minimum standards which may be established from time to time pursuant to this Convention.*

The requirement to recognize foreign CofA and licenses for personnel applies to all aircraft, manned or unmanned. However, the second part of the sentence demands that the respective requirements for national certification and licensing are "*equal to or above the minimum standards which may be established from time to time pursuant to this Convention*". As SARPs for UAS certification and licensing are missing, no obligation to recognize national UAS certificates and licenses exists.

Assembly Resolution A36-13, Appendix G addresses this general difficulty and reads as follows:

> *2. pending the coming into force of international Standards respecting particular categories, classes or types of aircraft or classes of airmen, certificates and licences issued or rendered valid, under national regulations, by the Contracting State in which the aircraft is registered shall be recognized by other Contracting States for the purpose of flight over their territories, including landings and take-offs.*[534]

This requires member States to generally recognize national UAS certificates and licenses. The ICAO UAS Circular explains the meaning of this Assembly Resolution for international UAS operations:

> *While ICAO is developing SARPs for RPAS, States are encouraged to develop national regulations that will facilitate mutual recognition of certificates for unmanned aircraft, thereby providing the means to authorize flight over their territories, including landings and take-offs by new types and categories of aircraft.*[535]

---

534 ICAO, Assembly, *Resolution A36-13*, A36-13 (2007) [*Assembly Resolution A36-13*].
535 ICAO, Secretary General, *UAS Circular*, *supra* note 106 at para 4.15.

Hence, because of the Assembly Resolution, Art. 33 of the Chicago Convention does not generally hinder the recognition of certificates and licenses as an important prerequisite for international operations.

Nevertheless, two important aspects of this resolution with regard to UAS need to be considered. First, the Assembly Resolution covers 'airmen'. The term 'airman' or 'airmen' is nowhere defined in the annexes and only rarely appears in ICAO documents. It is part of FAA terminology[536] and covers a variety of personnel, e.g. (on-board) pilots, flight navigators, flight engineers, flight attendants, flight instructors, ground instructors control tower operators (not air traffic controllers), aircraft dispatchers, ground inspectors, mechanics, repairmen and parachute riggers,[537] but not Remote Pilots. The Assembly Resolution therefore does not help recognizing licenses for Remote Pilots, which are specific to unmanned aviation. Second, the resolution does not alter the special authorization requirement of Art. 8 of the Chicago Convention. Even if a certificate has to be recognized pursuant to the resolution, international UAS operation would still depend on the overflown state's authorization.

In summary, Assembly Resolution A36-13, Appendix G, provides the basis for mutual recognition of certificates and licenses when respective SARPs are not (yet) in place. In the case of UAS however, this advantage is reduced by the exclusion of Remote Pilots and the special authorization requirement of Art. 8 of the Chicago Convention. To address theses aspects, ICAO proposes an amendment of the resolution to cover Remote Pilots[538] and an inclusion of a new Appendix 4 to Annex 2 to facilitate the 'special authorization' requirement[539].

2. United States

As mentioned in Chapter 4, UA or UAS are nowhere mentioned explicitly in Title

---

536 *FAA Website* (webpage), *supra* note 309, http://www.faa.gov/licenses_certificates/airmen_certification/.
537 Ibid.
538 ICAO, Secretary General, *UAS Circular*, *supra* note 106 at para 4.15.
539 Filippo Tomasello, "Emerging international rules for UAS" *supra* note 3, at 8.

14 of the CFR, but, as they are aircraft, said title applies. Civil UAS are however not able to comply with the requirements set out in Part 21 of Title 14 CFR for a standard CofA that would, when also other requirements are satisfied, allow routine operations in the United States' airspace. An airworthiness certificate, whose requirements are compliant by civil UAS, is the Special Airworthiness Certificate – Experimental Category (SAC-EC). The SAC-EC is issued to operate an aircraft that does not have a type certificate or does not conform to its type certificate and is in a condition for safe operation.[540]

The SAC-EC is regulated in 14 CFR §§ 21.191, 21.193, and 21.195 and applicable to all civil aircraft, manned or unmanned.

On 27 October 2010 the FAA published the Order 8130.34A – *Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft*[541]. This Order elaborates on 14 CFR §§ 21.191, 21.193, and 21.195 and provides procedures and requirements for airworthiness certification of civil UAS and licensing of its personnel.[542]

---

540 *FAA Website* (webpage), *supra* note 309. The General Atomics Altair was the first civil UAS to receive an experimental airworthiness certificate, see *General Atomics* <http://www.ga.com/news.php?read=1&id=84&page=9> [*General Atomics Aeronautical Systems' Altair Receives FAA's First Commercial UAS Airworthiness Certificate*].

541 FAA, *Order 8130.34A*, *supra* note 123; its previous version was published in 2008, FAA, *Order 8130.34 - Airworthiness Certification of Unmanned Aircraft Systems*, Order 8130.34 (Washington: FAA, 2008) [*Order 8130.34*]. The amended version includes Optionally Piloted Aircraft (OPA). OPA are aircraft where a pilot is aboard but which can also temporarily be remotely controlled from a RPS. Even when the aircraft is actually controlled from the RPS, the PIC will always be the pilot sitting in the aircraft. The OPA is still a manned aircraft. See also FAA, *Memorandum - Unmanned Aircraft Systems (UAS) Certification Status, Optionally Piloted Aircraft, and Accidents involving UAS* (Washington: FAA, 2008) [*Memorandum - Unmanned Aircraft Systems (UAS) Certification Status, Optionally Piloted Aircraft, and Accidents involving UAS*]; FAA, *Notice JO 7210.766*, *supra* note 337. OPA are will not be examined in the present thesis.

542 The certification requirement is reaffirmed in FAA, *Order 8130.34A*, *supra* note 123 at Chapter 3, Section 1, para 3: "*In no case may any UAS or OPA be operated as civil unless there is an appropriate and valid airworthiness certificate issued for that UAS or OPA. (...) The FAA must conduct a safety evaluation and inspections necessary to verify proper completion of the certification procedures listed below, including any other inspections deemed appropriate for that certification*". Pleas note that in the United States a registration of the UA is a prerequisite for issuance of an SAC-EC, ibid Chapter 2, Section 1, para 4.

The procedures contained in the Order apply to FAA manufacturing and airworthiness Aviation Safety Inspectors (ASI).[543] An applicant can use the Order as guidance for a SAC-EC application.

The Order consists of three chapters and seven appendixes[544]. Chapter 1 contains the introduction and Chapter 2 lays out the policies and procedures on aircraft registration and airworthiness certificates. Chapter 3 focuses on the SAC-EC. The following definitions contained in Appendix F are of particular importance:

> *Unmanned Aircraft (UA). A device used or intended to be used for flight in the air that has no onboard pilot. This includes all classes of airplanes, helicopters, airships, and translational lift aircraft that have no onboard pilot. Unmanned aircraft include only those aircraft controllable in three dimensions and, therefore, exclude traditional balloons and unpowered gliders.*[545]
>
> *Unmanned Aircraft System (UAS). An unmanned aircraft and its associated elements related to safe operation, which may include control stations, data links, support equipment, payloads, flight termination systems, and launch/recovery equipment.*[546]

Also the term 'airworthiness' as the basis for the CofA and in particular the SAC-EC is defined:

> *Airworthy. An unmanned aircraft system (UAS) is airworthy if the aircraft and all of the other associated support equipment of the UAS are in condition for safe operation. Special emphasis must be placed on the integrity of the data link. If any element of the systems is not in condition for safe operation, then the UA would not be considered airworthy.*[547]

---

543 Ibid Chapter 1, para 1.
544 Appendix A. Sample Operating Limitations, Experimental: Research and Development, Market Survey, and/or Crew Training; Appendix B. Sample Operating Limitations for Optionally Piloted Aircraft; Appendix C. Sample Program Letter for Unmanned Aircraft Systems for an Experimental Certificate; Appendix D. Safety Checklist; Appendix E. Administrative Information; Appendix F. Definitions; Appendix G. FAA Form 1320-19, Directive Feedback Information.
545 FAA, *Order 8130.34A*, *supra* note 123 at Appendix F, i.
546 Ibid Appendix F, j.
547 Ibid Appendix F, a.

Hence, the Order shares the concepts of UA and UAS explained in the present thesis and is therefore evaluable on the basis of the previous chapters.

In the following the most important aspects of the SAC-EC for UAS certification and licensing in the United States are highlighted, based on the above mentioned regulations and the guidance in Order 8130.34A.

a. UAS certification: SAC-EC and Order 8130.34A

First, the purposes for which a SAC-EC can generally be issued are listed in 14 CFR § 21.191 (Experimental certificates):

> *Experimental certificates are issued for the following purposes:*
>
> *(a) Research and development. Testing new aircraft design concepts, new aircraft equipment, new aircraft installations, new aircraft operating techniques, or new uses for aircraft.*
>
> *(b) Showing compliance with regulations. Conducting flight tests and other operations to show compliance with the airworthiness regulations including flights to show compliance for issuance of type and supplemental type certificates, flights to substantiate major design changes, and flights to show compliance with the function and reliability requirements of the regulations.*
>
> *(c) Crew training. Training of the applicant's flight crews.*
>
> *(d) Exhibition. Exhibiting the aircraft's flight capabilities, performance, or unusual characteristics at air shows, motion picture, television, and similar productions, and the maintenance of exhibition flight proficiency, including (for persons exhibiting aircraft) flying to and from such air shows and productions.*
>
> *(e) (...)*
>
> *(f) Market surveys. Use of aircraft for purposes of conducting market surveys, sales demonstrations, and customer crew*

training only as provided in §21.195.

(...)[548]

The Order 8130.34A downsizes these options as it only permits the issuance of a SAC-EC to UAS for the purposes of research and development, crew training or market survey.[549] These aspects are defined in Chapter 3 of the Order.[550] As a result, no commercial UAS operations are possible in the United States.[551]

Second, a SAC-EC is issued on a case-by-case basis upon application and requires an extensive safety evaluation. 14 CFR § 21.193 (Experimental certificates: general) requires:

> *An applicant for an experimental certificate must submit the following information:*
>
> *(a) A statement, in a form and manner prescribed by the FAA setting forth the purpose for which the aircraft is to be used.*
>
> *(b) Enough data (such as photographs) to identify the air-*

---

548 The omitted passages are concerned with amateur-built aircraft, primary kit-built aircraft, light-sport aircraft.

549 FAA, *Order 8130.34A*, *supra* note 123 at Chapter 2, Section 2, para 1.

550 Ibid Chapter 3, Section 2, para 1:
"a. Research and Development. Under § 21.191(a), UAS are eligible for an experimental certificate for the purpose of research and development. The applicant may conduct research to determine whether an idea warrants further development. This includes testing new design concepts, aircraft equipment installations, operating techniques, or new uses for aircraft. In addition, the operation of a chase plane or other aircraft not otherwise eligible for a standard or an experimental certificate (but necessary for use in direct connection with the R&D project) is considered to be within the scope of this purpose.
b. Crew Training. Under § 21.191(c), UAS are eligible for an experimental certificate for the purpose of training the applicant's flight crews. These flight crews would normally be the manufacturer's employees necessary to be trained in experimental aircraft. Training must be accomplished by flight instructors certificated in accordance with 14 CFR part 61.
c. Market Surveys. Under § 21.191(f), U.S. manufacturers of UAS may apply for an experimental certificate for the purpose of market surveys, sales demonstrations, and customer crew training. The applicant must ensure the provisions of § 21.193(d)(2) and (d)(3) are met by providing the FAA ASI with the estimated time or number of flights required for the market survey operation, as well as the area or itinerary over which the operations are to be conducted. Customer crew training must be accomplished by flight instructors certificated in accordance with 14 CFR part 61.
The FAA ASI must ensure the applicant meets the provisions of § 21.195, Experimental certificates: Aircraft to be used for market surveys, sales demonstrations, and customer crew training. These provisions must be met before issuing the experimental certificate".

551 This is reaffirmed in ibid Appendix A, para 1, f: "*Operation Exceptions. No person may operate this UA to carry property for compensation or hire (§ 91.319(a)(2))*".

> *craft.*
>
> *(c) Upon inspection of the aircraft, any pertinent information found necessary by the FAA to safeguard the general public.*
>
> *(d) In the case of an aircraft to be used for experimental purposes—*
> *(1) The purpose of the experiment;*
> *(2) The estimated time or number of flights required for the experiment;*
> *(3) The areas over which the experiment will be conducted; and*
> *(4) Except for aircraft converted from a previously certificated type without appreciable change in the external configuration, three-view drawings or three-view dimensioned photographs of the aircraft.*
>
> *(...)*

These requirements are specified in the Order where the applicant is required to submit a 'program letter' explaining the elements listed above and give information on several other aspects of the UAS.[552] Special characteristics of UAS are addressed, when, *inter alia*, the applicant has to provide information on the UAS capabilities with regard to 'containment', i.e. "*with the ability of the aircraft to be contained within the boundaries of the proposed flight area*"[553], 'lost link', i.e. "*the sequence the UA will follow in the event command and control is lost*"[554] and 'flight recovery', i.e. in the case of a permanently lost link an "*independent means to safely terminate the flight must be provided*".[555] If FAA finds that an acceptable risk is reached, a visit of the proposed flight test area occurs within 30-60 days for inspection and review of the UAS and for observation of a flight test.[556]

---

552 Ibid Chapter 3, Section 1, para 3 a.
553 Ibid Chapter 3, Section 1, para 3 a (1).
554 Ibid Chapter 3, Section 1, para 3 a (2).
555 Ibid Chapter 3, Section 1, para 3 a (3), further details are contained in ibid Appendix A, para 9 a ("*Flight Termination. In accordance with (applicant name) program letter, dated (date), flight termination must be initiated at any point that safe operation of the UA cannot be maintained or if hazard to persons or property is imminent*") and b ("*Lost Link Procedures. In the event of lost link, the UA must provide a means of automatic recovery that ensures airborne operations are predictable and that the UA remains within the flight test area*").
556 Ibid Chapter 3, Section 1, para 3 c and d.

Third, of particular interest is also the limitation of airspace to be used for the UAS operation. This is indicated in 14 CFR § 21.193 (d) (3), related to the aforementioned 'containment' and further specified in Chapter 3, Section 2 of the Order.

> *All UAS flight testing operations must be limited to the assigned flight test area. This is required until the aircraft is shown to be controllable throughout its normal range of speeds and execution of all maneuvers. In addition, the aircraft must not have demonstrated any hazardous operating characteristics or design features. The flight test area may or may not be expanded depending on the availability of an additional area that is remote and sparsely populated.*[557]

Hence, UAS operations under the SAC-EC can take place in predetermined areas, which can be extended over sparsely populated areas, but operations over populated areas are not permissible under a SAC-EC.[558]

Fourth, other operating limitation are generally associated with an SAC-EC, which are based on 14 CFR § 91.319[559]. Accordingly, Chapter 3, para 5, b., reads as follows:

---

[557] Ibid Chapter 3, Section 2, para 4 b.

[558] Also flight testing from an airport in densely populated area is addressed: "*(2) In the case of flight testing an aircraft from an airport surrounded by a densely populated area (but with at least one acceptable approach/departure route of flight), the FAA must ensure a route of flight is selected that subjects the fewest persons and least amount property to possible hazards. The description of the area selected by the applicant and agreed to by the FAA must be made a part of the operating limitations.*
(3) In the case of an aircraft located at any airport surrounded by a densely populated area and lacking any acceptable approach/departure route of flight, the FAA must deny the airworthiness certificate; the FAA must write a letter to the applicant stating the reason(s) for denying the proposed flight test area. The applicant must be advised to relocate the aircraft to an airport suitable for flight testing.", ibid Chapter 3, Section 2, para 4 b (2).

[559] Title 14 CFR § 91.319 - Aircraft having experimental certificates: Operating limitations.
"*(a) No person may operate an aircraft that has an experimental certificate—*
(1) For other than the purpose for which the certificate was issued; or
(2) Carrying persons or property for compensation or hire.
(b) No person may operate an aircraft that has an experimental certificate outside of an area assigned by the Administrator until it is shown that—
(1) The aircraft is controllable throughout its normal range of speeds and throughout all the maneuvers to be executed; and
(2) The aircraft has no hazardous operating characteristics or design features.
(c) Unless otherwise authorized by the Administrator in special operating limitations, no person may operate an aircraft that has an experimental certificate over a densely populated area or in a congested airway. The Administrator may issue special operating limitations for particular aircraft to permit takeoffs and landings to be conducted over a densely populated area or in a congested airway, in accordance with terms and conditions specified in the authorization in the interest of safety in air

> *Operating limitations can vary greatly from one UAS to the next based on system requirements and operating location. The ASI may impose any additional limitations deemed necessary in the interest of safety.*[560]

Operating limitations are therefore heavily dependant on the UAS and the operating limitations in question. The open wording of the stated paragraph gives the FAA a broad discretion when considering operating limitations. In the appendixes examples of such operating limitations are provided, e.g. the requirements to operate only during daylight hours and in VFR conditions as well as to request the issuance of a Notice to Airmen (NOTAM) at least 24 hours before flight.[561]

---

commerce.
(d) Each person operating an aircraft that has an experimental certificate shall—
(1) Advise each person carried of the experimental nature of the aircraft;
(2) Operate under VFR, day only, unless otherwise specifically authorized by the Administrator; and
(3) Notify the control tower of the experimental nature of the aircraft when operating the aircraft into or out of airports with operating control towers.
(e) No person may operate an aircraft that is issued an experimental certificate under §21.191(i) of this chapter for compensation or hire, except a person may operate an aircraft issued an experimental certificate under §21.191(i)(1) for compensation or hire to—
(1) Tow a glider that is a light-sport aircraft or unpowered ultralight vehicle in accordance with §91.309; or
(2) Conduct flight training in an aircraft which that person provides prior to January 31, 2010.
(f) No person may lease an aircraft that is issued an experimental certificate under §21.191(i) of this chapter, except in accordance with paragraph (e)(1) of this section.
(g) No person may operate an aircraft issued an experimental certificate under §21.191(i)(1) of this chapter to tow a glider that is a light-sport aircraft or unpowered ultralight vehicle for compensation or hire or to conduct flight training for compensation or hire in an aircraft which that persons provides unless within the preceding 100 hours of time in service the aircraft has—
(1) Been inspected by a certificated repairman (light-sport aircraft) with a maintenance rating, an appropriately rated mechanic, or an appropriately rated repair station in accordance with inspection procedures developed by the aircraft manufacturer or a person acceptable to the FAA; or
(2) Received an inspection for the issuance of an airworthiness certificate in accordance with part 21 of this chapter.
(h) The FAA may issue deviation authority providing relief from the provisions of paragraph (a) of this section for the purpose of conducting flight training. The FAA will issue this deviation authority as a letter of deviation authority.
(1) The FAA may cancel or amend a letter of deviation authority at any time.
(2) An applicant must submit a request for deviation authority to the FAA at least 60 days before the date of intended operations. A request for deviation authority must contain a complete description of the proposed operation and justification that establishes a level of safety equivalent to that provided under the regulations for the deviation requested.
(i) The Administrator may prescribe additional limitations that the Administrator considers necessary, including limitations on the persons that may be carried in the aircraft."

[560] FAA, *Order 8130.34A*, *supra* note 123 at Chapter 3, Section 2, para 5 b.
[561] Ibid Appendix A, para 8, a and e.

Finally, it needs to be noted that a SAC-EC for UAS is issued for a duration of one year or less.[562] It can be amended in case of changes in the operating limitations.[563]

b. Personnel licensing: Order 8130.34A

The §§ 21.191, 21.193, and 21.195 on the SAC-EC, as a CofA, obviously do not contain regulations on UAS personnel licensing. Regulations on personnel licensing can be found in 14 CFR Part 61 (Certification: Pilots, Flight Instructors, and Ground Instructors). These regulations do not contain specific licenses or requirements for Remote Pilots or other UAS personnel.

In Appendix A to Order 8130.34A it is expressed that the existent regulations on personnel licensing generally apply to UAS operations under a SAC-EC:

> *Compliance with 14 CFR Part 61 (Certification: Pilots, Flight Instructors, and Ground Instructors) and Part 91 (General Operating and Flight Rules). Unless otherwise specified in this document, the UA pilot-in-command (PIC) and (applicant name) must comply with all applicable sections and parts of 14 CFR including, but not limited to, parts 61 and 91.*[564]

The special requirements for UAS personnel are then elaborated in the same appendix.

First, the UA pilot is addressed. The requirements for the PIC read as follows:

> *a. UA PIC Roles and Responsibilities.*
> *(1) The UA PIC must perform crew duties for only one UA at a time.*

---

562 Ibid Chapter 3, Section 2, para 2 b.
563 Ibid Chapter 3, Section 2, para 3 b.
563 Ibid Chapter 2, Section 3, para 3 b.
564 Ibid Appendix A, 1. b.

> *(2) All flight operations must have a designated UA PIC. The UA PIC has responsibility over each flight conducted and is accountable for the UA flight operation.*
> *(3) The UA PIC is responsible for the safety of the UA as well as persons and property along the UA flight path. This includes, but is not limited to, collision avoidance and the safety of persons and property in the air and on the ground.*
> *(4) The UA PIC must avoid densely populated areas (§ 91.319) and exercise increased vigilance when operating within or in the vicinity of published airway boundaries.*[565]

These rules express the general concept of the PIC being responsible for the aircraft and its safe operation transferred to the UA and the UA pilot. In (4) the above mentioned operating limitations are addressed from the pilot's perspective.

With regard to the actual licenses required the appendix states that:

> *(1) The UA PIC must hold and be in possession of, at a minimum, an FAA private pilot certificate, with either an airplane, rotorcraft, or powered-lift category; and single- or multiengine class ratings, or the military equivalent, appropriate to the type of UA being operated.*
> *(2) The UA PIC must have and be in possession of a valid second-class (or higher) airman medical certificate issued under 14 CFR part 67, Medical Standards and Certification.*[566]

Hence, no specific Remote Pilot License is foreseen for UAS operations in the United States' airspace under a SAC-EC. The Remote Pilot must rather have at a minimum a FAA private pilot certificate, a license for manned aircraft, and at least a second-class airman medical certificate.

UA PIC currency, flight review and training are also specified in the appendix.[567] Furthermore 'supplemental UA pilot(s)', as "*(a)ny additional UA pilot(s) assigned to a*

[565] Ibid Appendix A, 5. a.
[566] Ibid Appendix A, 5. b.
[567] Ibid Appendix A, 5. c.

crew station during UA flight operations"[568] are addressed, which assist the Remote Pilot and do not need to be a licensed pilot.[569]

In the case of UAS operations for the purpose of crew training, the regulations require that the flight instructor is certificated in accordance with 14 CFR Part 61.[570]

While the Remote Pilot is a pilot licensed for manned aircraft and only some further requirements are expressed, Appendix A also contains more details provisions on the 'observer' as a person specific to UAS operations. The role of the UAS Observer is "*to provide the UA PIC(s) with instructions to maneuver the UA clear of any potential collision with other traffic*"[571].

The responsibilities of the observer mirror the above mentioned requirements and restrictions of the SAC-EC and read as follows:

> *(1) The observer must perform crew duties for only one UA at a time.*
> *(2) At no time will the observer permit the UA to operate beyond the line-of-sight necessary to ensure maneuvering information can be reliably determined.*
> *(3) At no time will the observer conduct his/her duties more than (TBD) laterally or (TBD) vertically from the UA.*

---

568 Ibid Appendix A, 5. d (1).

569 Ibid Appendix A, 5.:
"*d. Supplemental UA Pilot Roles and Responsibilities.*
(1) Any additional UA pilot(s) assigned to a crew station during UA flight operations will be considered a supplemental UA pilot.
(2) A supplemental UA pilot assists the PIC in the operation of the UA and may do so at the same or a different control station as the PIC. The UA PIC will have operational override capability over any supplemental UA pilots, regardless of position.
(3) A supplemental UA pilot must perform crew duties for only one UA at a time.
e. Supplemental UA Pilot Certification. The supplemental UA PIC need not be a certificated pilot, but must have successfully completed a recognized private pilot ground school program.
f. Supplemental UA Pilot Currency, Flight Review, and Training.
(1) All UA pilots must maintain currency in unmanned aircraft in accordance with (applicant name) company procedures.
(2) All UA pilots must have a flight review in unmanned aircraft every 24 calendar months in accordance with (company name) procedures.
(3) All UA pilots must have successfully completed applicable (applicant name) training for the UAS."

570 Ibid Chapter 3, Section 2, para 1 b.

571 Ibid Appendix A, 5. c.

> *(4) An observer must maintain continuous visual contact with the UA to discern UA attitude and trajectory in relation to conflicting traffic.*
> *(5) An observer may be positioned in a chase aircraft. When a chase aircraft is used, it must maintain a reasonable proximity, and must position itself relative to the UA to reduce the hazard of collision in accordance with § 91.111, Operating near other aircraft. When the observer is located in a chase aircraft, the observer's duties must be dedicated to the task of observation only. Concurrent duty as pilot of the chase aircraft is not authorized.*
> *(6) Observers must continually scan the airspace for other aircraft that pose a potential conflict.*
> *(7) All flight operations conducted in the flight test area must have an observer to perform traffic avoidance and visual observation to fulfill the see-and-avoid requirement of § 91.113, Right-of-way rules: Except water operations.*[572]

The requirement to obviate BVLOS operations and to maintain continuous visual contact with the UA limits the geographic extend of the operations and is also dependant on the size and the visibility of the UA. The use of a chase aircraft may extend the operations, which still need to be inside the flight test areas set within the SAC-EC. A manned chase aircraft following the UA however seems only reasonable in the development an testing phase but not in (future) 'normal' UAS operations.

The observer must meet the same licensing requirements as the Remote Pilot, hence must have at a minimum a FAA private pilot certificate and at least a second-class airman medical certificate.[573]

3. Canada

[572] Ibid.

[573] Ibid Appendix A, 5. h. The program letter necessary for the application of a SAC-EC mentioned above requires accordingly: "*Licenses and certificates***.** *Applicants will be informed that the FAA will request evidence of FAA pilot's license and/or medical certificates. Personnel not requiring a certificate, but required to have successfully completed an FAA-accepted pilot ground school, must ensure the written examination results are available to the FAA. These documents must be made available at any time upon request of the FAA, and will be verified during the safety evaluation or the meeting referenced in paragraph 3d below*", ibid Chapter 3, Section 1, para 3 c (3) (d).

The operation of an UAS in Canadian airspace requires a Special Flight Operations Certificate (SFOC), or an Air Operator Certificate (AOC). Section 602.41 (Unmanned Air Vehicles) of the CARs states:

> *No person shall operate an unmanned air vehicle in flight except in accordance with a special flight operations certificate or an air operator certificate.*[574]

The AOC is the standard certificate for manned aircraft, requiring compliance with a multitude of regulations, such as the 'see and avoid' requirements, which are obviously tailored toward manned aviation and not satisfiable by UAS.[575] Hence, the SFOC is the only possibility to operate civil UAS in Canada. The specific information required by TC to consider an application are contained in Standard 623 (Unmanned Air Vehicle).

> *(1) The following standards apply to the application for and the operation of an unmanned aeroplane, rotorcraft or airship pursuant to CAR 602.41.*
> *(2) An application for a Special Flight Operations Certificate for the purpose of conducting the flight of an unmanned aircraft other than an unmanned free balloon or a model aircraft shall be received by the appropriate Regional Transport Canada General Aviation Office, at least 20 working days prior to the date of the proposed operation or by a date mutually agreed upon between the applicant and Transport Canada.*
> *(3) The following constitutes an application for a Special Flight Operations Certificate for the purpose of operations in paragraph (1) above:*
> *(a) the name, address, and where applicable, the telephone number and facsimile number of the applicant;*
> *(b) the name, address, and where applicable the telephone number and facsimile number of the person designated by the applicant to have operational control over the operation (Operation Manager);*
> *(c) method by which the Operation Manager may be contacted directly during operation;*
> *(d) the type and purpose of the operation;*

---

[574] CARs, Part VI, Subpart 2, § 602.41.

[575] Transport Canada, *Staff Instruction*, *supra* note 467 at Section 4.3 (2): "*At present, it is Transport Canada policy that Special Flight Operations Certificates, not Air Operator Certificates, be issued to persons wishing to operate civil UAVs in Canada*".

(e) the dates, alternate dates and times of the proposed operation;
(f) a complete description, including all pertinent flight data on the aircraft to be flown;
(g) the security plan for the area(s) of operation and security plan for the area(s) to be overflown to ensure no hazard is created to persons or property on the surface;
(h) the emergency contingency plan to deal with any disaster resulting from the operation;
(i) the name, address, telephone and facsimile numbers of the person designated to be responsible for supervision of the operation area (Ground Supervisor), if different from the Operation Manager during the operation;
(j) a detailed plan describing how the operation shall be carried out. The plan shall include a clear, legible presentation of the area to be used during the operation. The presentation may be in the form of a scale diagram, aerial photograph or large scale topographical chart and must include at least the following information:
(i) the altitudes and routes to be used on the approach and departure to and from the area where the operation will be carried out;
(ii) the location and height above ground of all obstacles in the approach and departure path to the areas where the operation will be carried out;
(iii) the exact boundaries of the area where the actual operation will be carried out;
(iv) the altitudes and routes to be used while carrying out the operation;
(k) any other information pertinent to the safe conduct of the operation requested by the Minister.[576]

On the 27 November 2008 a *Staff Instruction - The review and processing of an application for a Special Flight Operations Certificate for the Operation of an Unmanned Air Vehicle (UAV) System*[577] became effective. This document provides the respective TC inspectors with the information, procedures and guidelines necessary to process an application and prepare a SFOC.[578] It also serves as guidance to potential applicants of a SFOC.[579]

---

[576] CARs, Part VI, Standard 623.65(d) (Unmanned Air Vehicle).
[577] Transport Canada, *Staff Instruction*, *supra* note 467.
[578] Ibid Section 1.1 1 (a).
[579] Ibid Section 1.1 1 (c).

In the following, the important aspects of the SFOC for UAS certification and licensing in Canada are highlighted.

a. UAS certification: SFOC and Staff Instruction

First, the Staff Instruction outlines three applications processes. The first is the general application process for an SFOC for UAS, while the second aims for UAS remotely controlled within visual range and under 35 kg of weight and the third applies to UA that would otherwise be considered model aircraft except they are too heavy for model aircraft but are operated for recreational purposes.[580] This division is a result of the 'model aircraft' definition explained above.[581]

Second, the purposes for which a SFOC can be issued are listed in Section 4.2, which states that "*UAVs may be used for experimental, demonstration, developmental or commercial purposes (...)*"[582]. The Staff Instruction however does "*not address all the safety issues associated with UAVs operating with passengers carried on board or UAVs operating inside buildings or underground*"[583].

Third, the SFOC is issued on a case-by-case basis upon application which requires the applicant to provide information on all aspects of the UAS, its personnel and the operation. The basic information to be provided is expressed in Standard 623 while the respective sections of the Staff Instruction contain further requirements for detailed descriptions of a multitude of capabilities and characteristics of the 'air vehicle'[584] the control station[585] the communication links[586] and the payload.[587]

Fourth, a SFOC is generally issued for a certain area with further requirements to

---

580 Ibid Section 4.5.
581 Please see above, Chapter 5. B. 2.
582 Transport Canada, *Staff Instruction*, *supra* note 467 at Section 4.2 (1).
583 Ibid Section 4.3 (2).
584 Ibid Section 5.2.
585 Ibid Section 5.3.
586 Ibid Section 5.4.
587 Ibid Section 2.3 (1) (b).

protect persons and property on the ground. Section 5.5, for example, requires:

> *(8) A detailed plan describing how the operation shall be carried out. The plan shall include a clear, legible presentation of the area to be used during the operation.*
> *(9) The security plan for the area(s) of operation and security plan for the area(s) to be overflown to ensure no hazard is created to persons or property on the surface.*
> *(10) The emergency contingency plan to deal with any disaster resulting from the operation.*[588]

Issuance for specific areas does not mean that only areas without other air traffic have to be chosen. This becomes apparent when operating and flight rules, in particular right of way rules in relation to manned aircraft are addressed:

> *(p) General Operating & Flight Rules -*
> *(i) In general, UAVs should be operated in accordance with the rules governing the flights of manned aircraft.*
> *(ii) It is policy to include a condition in the SFOC that states that the unmanned air vehicle shall give way to manned aircraft, however, this may not be practical in all cases, so the Inspector will have to make a determination if this condition is appropriate to the operation*.[589]

Fifth, alongside the case-by-case evaluation and the limitation on a certain area goes the issuance for a particular mission, which however can be broadened subsequently. Section 5.1 states that:

> *Initially, the Certificate applicant can expect the SFOC to be issued for each specific mission. A Certificate applicant will not be granted a long-term authority (i.e. one year), and/or an authority that is not site specific, without a history of demonstrating that the operations have been conducted in a safe manner. Once an initial application has been made and a Certificate has been issued, subsequent SFOC applications should be able to be expedited. For example, if the mission changes, but other parameters remain the same (same UAV system, same UAV pilot) then the focus in processing the next*

---

[588] Ibid Section 5.5 (8), (9), and (10).
[589] Ibid Section 8.15.

> *application will be placed on assessing the suitability of the area used for the operation. Where the operating environment and the mission requirements change, the set of safety requirements that the Minister will impose will change accordingly.*[590]

Sixth, further operating limitations are generally contained in the SFOC. As Section 6.0 states:

> *Operating conditions will vary depending on aircraft performance capabilities, equipment on the UAV (i.e. payload), mission requirements, operating environment, complexity of the operation (i.e. multiple UAVs) etc. Therefore, the sample Certificate below outlines an extensive, although not exhaustive, list of conditions.*[591]

The mentioned sample certificate then provides examples of possible conditions. On the one hand, it outlines key conditions, e.g. safety of operation, insurance requirement, adherence to the data provided in the application, advising of affected authorities/persons affected (aerodrome operator, landowner, tenant, etc.), safe landing possibility in the area in case of an emergency landing, time of the operation (day/night), weather minima for operations, maximum altitude, distance form inhabited structures such as buildings, vehicles, vessels and other persons, who are not associated with the operation, prohibition of flight over spectators, coordination with ATC, issuance of a NOTAM and reporting requirements concerning occurrences.[592] On the other hand, it lists additional conditions, e.g. only one UA in flight at any one time and compliance with ATC instructions.[593]

Seventh, micro and small UAS can be certified in a 'simplified application process' for UAS remotely controlled within visual range and under 35 of weight kg.[594] If all detailed eligibility criteria in Section 7.4 apply, the UAS can be certified in said process. Otherwise the are required to undergo the regular process.[595] Section 9 contains the appli-

---

590 Ibid Section 5.1 (2).
591 Ibid Section 6.0 (2) p.
592 Ibid Section 6.5.
593 Ibid Section 6.6.
594 Ibid Section 7.0.
595 Ibid Section 7.3.

cation process for "*unmanned air vehicles that would otherwise be considered model aircraft*"[596] with certain facilitations for members of the Model Aeronautics Association of Canada (MAAC) or the Academy of Model Aeronautics (AMA).[597]

b. Personnel licensing: Staff Instruction

The Staff Instruction generally differentiates between the 'UAV Pilot[598], the 'Observer'[599], the 'Payload Operator'[600] and the 'System Maintainer'[601].

The 'UAV Pilot' is defined in Section 2.3 as:

> *A crew member actively exercising control of the UAV and/or monitoring the state and progress of the UAV, in an automatic or programmed flight mode, from the control station.*[602]

Important with regard to the licensing of the UAS pilot and also answering the question, if UA and UAS are certified as a unit or separately, is the following passage in the Staff Instruction: "*When considering a request for operating approval, the system as a whole will be assessed including an assessment of the operating personnel*"[603]. Hence, not only all the elements of the system are considered in one certificate but also the personnel involved in the operations.

---

596 Ibid Section 9.1 (1).

597 Ibid : "*The purpose of this section is to provide guidance to Inspectors and Certificate applicants for SFOC applications involving unmanned air vehicles that would otherwise be considered model aircraft except they are too heavy to meet the definition of model aircraft. Certificate applicants operating UAVs for recreational purposes who are not MAAC members or do not hold AMA Flight Permits will be required to make application for an SFOC in accordance with the guidance provided in either Sections 1-4 or Section 5 of this staff instruction, as applicable*".

598 Ibid Section 5.5 (14).

599 Ibid Section 5.5 (14) (g).

600 Ibid Section 5.5 (14) (h).

601 Ibid Section 5.5 (14) (i).

602 Ibid Section 2.3 (r), a 'crew member' is defined as: "*In subsection 101.01(1) of the CARs, crew member is defined as "a person assigned to duty in an aircraft during flight time". In the case of an unmanned aircraft system, it means a person assigned to duty with respect to the operation of an unmanned air vehicle system during flight time*" ibid Section 2.3 (g).

603 Ibid Section 4.2 (1).

When it comes to the UAV Pilot an 'Information Note' highlights:

> *The Aeronautics Act states: "pilot-in-command" means, in relation to an aircraft, the pilot having responsibility and authority for the operation and safety of the aircraft during flight time. This responsibility and authority applies even though the pilot is external to the aircraft. The use of the term "pilot" in this staff instruction, however, is not intended to suggest that the pilot is necessarily qualified as a crew member of a manned aircraft.*[604]

Section 603.66 (Certification Requirements) and 603.67 (Issuance of Special Flight Operations Certificate) of the CARs accordingly require:

> *603.66 No person shall conduct a flight operation referred to in Section 603.65 unless the person complies with the provisions of a special flight operations certificate issued by the Minister pursuant to Section 603.67.*
>
> *603.67 Subject to section 6.71 of the Act, the Minister shall, on receipt of an application submitted in the form and manner required by the Special Flight Operations Standards, issue a special flight operations certificate to an applicant who demonstrates to the Minister the ability to conduct the flight operation in accordance with the Special Flight Operations Standards.*

The UAV Pilot may not necessarily therefore hold a pilot license. The Staff Instruction rather requires that "*(t)he UAV pilot must be able to control the UAV throughout its design parameters and potential operating conditions, including dealing correctly with emergencies and system malfunctions*"[605]. To guide inspectors "*in establishing that the knowledge, experience, training and skill for all personnel conducting UAV flight operations is appropriate to the UAV system for all locations and airspaces within which the UAV will be operated*"[606] the instruction lists several aspects categorized in 'general', 'knowledge', 'experience', 'training', 'skill' and 'currency'.[607] Within this list the criterion

---

[604] Ibid Section 5.5 (14).
[605] Ibid Section 5.5 (14) (1).
[606] Ibid.
[607] Ibid.

of "*(h)old or have held a Pilot Permit or Licence or military equivalent*"[608] (general) is a indicator just as "*(h)old or held an ATC licence*"[609] (general) and also e.g. "*(e)xperience operating manned aircraft*"[610] (experience) or "*(e)xperience operating model aircraft*"[611] (experience). This flexible approach allows to take the special characteristics of different UAS and operations into account.[612]

An Observer is defined as:

> *(a) person assigned and trained to perform duties as a crew member associated with collision avoidance, such as continuously monitoring the UAV and the airspace (e.g. for other traffic, clouds, obstructions and terrain) both around and sufficiently beyond the UAV.*[613]

Observers assume the 'detect, sense and avoid' function, which is not sufficiently developed in unmanned aviation.[614] They are required to "*maintain visual contact with the UAV at all times while scanning the immediate environment for potential conflicting traffic*"[615] and to "*maintain constant communication with the UAV pilot in order to provide instructions on required manoeuvering to steer clear of other aircraft where a potential for*

608 Ibid Section 5.5 (14) (1) (a) (i).
609 Ibid Section 5.5 (14) (1) (a) (ii).
610 Ibid Section 5.5 (14) (1) (c) (i).
611 Ibid Section 5.5 (14) (1) (c) (ii).
612 An 'Information Note' explain these differences relevant to the evaluation of the Remote Pilot qualification: "*The amount of interaction between the UAV pilot and the unmanned air vehicle ranges across a broad spectrum from a direct control-type system to a fully automated vehicle. In the case of some UAVs, the pilot has no direct control over pitch, bank or power settings. The pilot tells the air vehicle the performance that is desired and the air vehicle's onboard computer translates that into control inputs. The performance of the air vehicle is relayed back to the UAV pilot through the human computer interface in the control station. With other UAVs, UAV pilot intervention is required to control the air vehicle. The pilot manually controls the flight surfaces of the air vehicle during take-off and landing. With other UAVs, rudder pedals, throttle and joystick are all housed in the control station. The psychomotor (eye-hand-foot coordination) skills and cognitive skills required to fly UAVs vary drastically from air vehicle to air vehicle. It is not fair to assume that because one UAV is larger and more complex than another UAV that the workload for the UAV pilot is proportional. Mental work overload may cause loss of situational awareness but not cause loss of control, which may not necessarily be the case with a small UAV*." ibid Section 5.5 (14) (1) after (f).
613 Ibid Section 2.3 (j).
614 Ibid Section 5.5 (14) (1) (g) (i).
615 Ibid; 'visual contact' is defined as "*(u)naided (other than corrective lenses) direct visual observation of the UAV by a crew member*", ibid Section 2.3 (t).

conflict exists“[616]. The visual contact requirement and the general task of providing ‘detect, sense and avoid’ functions of the Observer make the issuance of an SFOC for BVLOS operations difficult. TC states on its website, that more and more applications for BVLOS operations are made but that:

> “*(u)ntil that time arrives (availability of reliable DSA technology), UAV operators proposing to operate beyond visual range need to be aware that, depending on the mission and the operating environment, it may not be possible to find ways to safely integrate the operation with the manned aircraft*”[617].

Indicators of adequate qualification of Observers are listed in the Staff Instruction and an ‘Information Note’ provide details on different situations to assist inspectors in their findings.[618]

The Payload Operator is defined as “*(p)erson (s) trained to operate the payload system, and in some cases, manage the flight profile*“[619]. Payload Operators are only addressed when the pilot has a dual role and also performs the function of the payload operator as this dual performance may create additional risks.[620]

For the System Maintainer, another list of indicators of adequate qualification is provided.[621]

4. Summary and comparison

In the following, similarities and differences between the aforementioned approaches to certification of UAS and licensing of their personnel will be summarized in direct opposition. As explained above, ICAO’s approach cannot be compared on an equiva-

---

616 Ibid Section 5.5 (14) (1) (g) (i).
617 *TC Website* (webpage), *supra* note 414; ‘DSA’ stands for ‘detect, sense and avoid’.
618 E.g. in the case where the observer is located in a chase aircraft.
619 Transport Canada, *Staff Instruction*, *supra* note 467 at Section 2.3 (l).
620 Ibid Section 5.5 (14) (1) (h) (i).
621 Ibid Section 5.5 (14) (1) (i).

lent level to the approaches of the United States and Canada. The difficulty of such confrontation between the organization's and the states' way of handling UAS does however unfortunately not become relevant. Under current ICAO regulations civil UAS cannot be certified and no international operations of civil UAS are possible. No specific UAS SARPs exist that would require implementation in the national laws. Hence, the comparison is limited to the national level, United States and Canada, where civil UAS are certifiable and their personnel can be licensed to allow civil UAS operations.

In Canada specific 'Unmanned Air Vehicle' regulations have been included in the CARs, which can be seen as a legal advance in comparison to the United States where UAS certification and licensing is not explicitly addressed. As UA are aircraft, the aviation regulations, which generally apply to 'aircraft', include UA also in the United States. The certification of UAS in the United States is possible under the SAC-EC, while Canada's UAS are certified under the SFOC. In both states, the vast majority of certification requirements and details is not provided in the general or respectively specific regulations, but in UAS specific guidance material for the authorities responsible for issuing a SAC-EC or SFOC. The advance of UAS specific regulations in Canada is hence limited, as in Canada and the United States a generally similar process leads to the certification of UAS, irrespective of the specificity of the underlying regulations.

The general certification approach in both states is the 'target safety' approach explained above. No extensive body of standards exists for UAS. The goal is to achieve an equivalent level of safety of unmanned and manned aviation. To achieve this safety target, UAS are certified in accordance with an acceptable level of risk of ground and mid-air collisions and not in accordance with predefined standards. In the United States and Canada the certifiability of UAS is evaluated on a case-by-case basis, taking into account the possible variety of UAS and operational environments. Similar factors determine the range and breadth of a certificate that fulfills the safety target. In both States the UA and the other elements of the system are certified as a unit.

The most significant difference between the two approaches is that in Canada commercial UAS operations are possible, while in the United States civil UAS operations are limited to the purposes of research and development, crew training and market survey. Hence, in Canada commercial UAS projects are given the opportunity of development, to test market demand and to pay for themselves. A very important sector is allowed to enter the market for UAS and its applications, marking a considerable advance of the unmanned aviation environment in Canada. The range of possible applications is significantly broadened, within the also remarkable limits of the SFOC, and an important step toward a holistic UAS integration is done.

In both states, special flight areas for the UAS operations are foreseen which generally are located over sparsely populated areas. However, the individual assessment of each application can allow some extensions in both States dependant on the safety level of the UAS and the operating environment. For example, in the United States flight testing from an airport in densely populated area can be permissible as long as a route of flight is selected that put the fewest persons and least amount of property in hazards.

UAS certification in the United States and Canada always includes operating limitations. As the achievement of the safety target is complicated by technological shortcomings of UAS, e.g. the limited capability of the Remote Pilot to 'detect, sense and avoid', restrictions of the operations are needed to compensate risks created by specificities of the UAS and its personnel. BVLOS operations are difficult in the United States and Canada as continuous visual contact with the UA is required.

Several special characteristics of UAS and specific safety measures, e.g. a abnormal flight termination management, are addressed by the guidance documents of both states while the Canadian Staff Instruction contains more details on several aspects and 'Information Notes' provide practical information to adequately evaluate the UAS safety.

Of particular importance is the Canadian possibility of a 'simplified application process' for UAS remotely controlled within visual range and under 35 kg of weight. This is an, albeit simple, classification, which cannot be found that way in the United States framework. In both states the certificate validity is limited in time.

A significant difference between the two states also exists with regard to personnel licensing. While in both states' licensing aspects are the minor part of the guidance documents, the United States elaborations on personnel licensing are less extensive than the Canadian ones. This is due to the fact that, although specific requirements for the PIC with regard to the actual operation are provided, the licensing of the pilot generally follows the licensing requirements already established in the light of manned aircraft. No UAS specific license is required but at a minimum, an FAA private pilot certificate or the military equivalent, appropriate to the type of UA being operated. In Canada neither a specific Remote Pilot license is foreseen. However, the pilot does not need to be necessarily qualified as a crew member of a manned aircraft. The assessment of the operating personnel is included in the overall SFOC process. The Staff Instruction provides indicators to evaluate the qualification of the remote Pilot in relation the UAS and the operational environment.

Observers are in both states an important part of the UAS personnel as they assume the 'detect, sense and avoid' function and are accordingly covered in more detail by the respective guidance documents. In the United States, Observers have to fulfill the same licensing requirements as the pilot, while in Canada, also as same as the pilot there, their qualification is assessed in the process of issuing of the SFOC.

The aspect of a handover between different pilots within the same RPS or between different RPS is not addressed adequately by the two States. Also Data-Link certification should be covered in more detail.

International operations of civil UAS are not foreseen within the SAC-EC and the SFOC and their respective guidance documents. The benefits of the Assembly Resolution A36-13, Appendix G do not become relevant. National certificates that would have to be recognized indeed exist with the SAC-EC and the SFOC, but, as long as these are not triggered toward international UAS operations, the ICAO resolution is pointless.

Generally, the United States' Order 8130.34A and Canada's Staff Instruction are by their very nature (only) guidance material elaborated for the respective instructors when assessing an application for a SAC-EC[622] or SFOC respectively. Therefore they are not made to cover every possible aspect or provide detailed requirements as certification standards would. They rather are intentionally general, although some aspects are described in detail, to allow a flexible handling of applications taking into account the variety of UAS and operating environments as well as the fast technological development. A broad discretion affects legal certainty but seems necessary at the present stage of UAS certification and licensing.

---

622 From July 2005 to July 2010 the FAA issued 71 experimental certificates to 17 different aircraft types, of which 14 were active in July 2010. From the FAA's perspective "*(t)hese certification efforts provide an excellent opportunity for the FAA to work with manufacturers and to collect vital technical and operational data that will help improve the UAS airworthiness certification process*", FAA Unmanned Aircraft Program Office, *UAS Fact Sheet*, *supra* note 337. Given the restrictions of the SAC-EC and the number of certificates issued on the one hand, and the illegal operations of commercial UAS under the model regime on the other hand, it can be supposed that other members of the UAS community, especially the ones interested in commercial UAS operations, are highly interested in having a more developed framework in place.

CHAPTER 7: CONCLUSION

Unmanned aviation is developing considerably. It offers new areas of applications or the replacement of manned aircraft in certain operations.

The current legal environment for UAS does not allow to tap their full potential. Internationally, civil UAS operations are not possible under the requirements established by ICAO. Assembly Resolution A36-13, Appendix G offers a solution only with regard to certification, but not for the Remote Pilots licenses. Nationally, the United States and Canada allow civil UAS uses. These are however only possible in narrow confines and with certain restrictions.

In every instance, one of the first arguments made with regard to the present regulatory framework is that UA are 'aircraft' and therefore the existent aircraft regulations apply. Applying a regulatory framework to different subjects who belong to the same generic term is legally unquestionable. Given the similarities of manned and unmanned aircraft on the one hand and especially the authority and jurisdiction of the entities concerned on the other hand, it is furthermore demanded in substance.

However, at least practically, the strength of this argument in the present regulatory environment is questionable. If it would really contribute significantly to UAS regulation and integration, more civil UAS would fly the skies. The seal 'aircraft' helps to calm the worries that UAS could operate in a legal vacuum. When the present regulations concerning aircraft are imposed to UAS, they apply, but they do not always help. On might even go as far as to say, that the aircraft status of UAS in the current regulatory framework keeps many civil UAS grounded. The regulatory construct that is developed to permit safe, orderly and seamless national and international aviation has reached a remarkable level of comprehensiveness and efficiency – for manned aircraft, in whose light the present regulations were developed. The law-makers generally cover aspects existent or foreseeable. The application of most of the aircraft regulations to UAS was presumably not in foreseen when those regulations were created.

The difficulties do not only result from the fact that aviation regulations were not made for UAS. It also results from the fact, that UAS are not yet made for safe integration. Safety is the most important concern in aviation and no exception can be made for UAS. The most significant difference to manned aircraft constitutes at the same time the most significant difficulty: the missing pilot aboard. UAS currently do not allow the Remote Pilot to sufficiently 'detect, sense and avoid' aircraft and other hazards. Several other technical aspects also need further development and the training for Remote Pilots needs to cope with the differences to onboard pilots. As long as Remote Pilots are not trained accordingly, UAS technology is not more mature in general and not capable of compensating the missing pilot aboard in particular, other methods, namely certification and licensing with only limited operational freedom, are required to maintain safety in aviation.

The question, if UAS are handled adequately by ICAO, the United States and Canada therefore also depends on the expectations of the interrogator. If one expects the regulations to keep exact pace with the rapid development of UAS technology, applications and ideas and to allow more and more integration of UAS in the national and international airspace with the goal of manned and unmanned aviation sharing the skies, the limited possibilities available today are disappointing. If one expects UAS to guarantee the same safety as manned aircraft, follow the same rules as manned aircraft, develop the same safety relevant capabilities as manned aircraft and integrate seamlessly in the established aviation system, the existing limitations are necessary.

The certification and licensing possibilities for UAS and their personnel currently available in the United States and Canada reflect this reality. The chosen 'safety target' approach mirrors the development stage of UAS. However, this approach is a short term solution. Based on a complicated individual assessment, the particular shortcomings of a particular UAS are addressed by particular limitations. This certification and licensing approach does not serve for the desired integration and routine certification of UAS.

The future of UAS will depend on the integrity and the development of the regulatory framework in which they operate. The legal opportunities given to UAS to develop as a demonstrably safe aviation application will influence the future of UAS and at the same time these legal possibilities will themselves depend on the technical development of said UAS capabilities. It is, therefore, an interplay between enhancing and integrating UAS on the one hand and maintaining an efficient aviation regulatory system, in particular with regard to safety, on the other hand. This will require cautious, well considered but at the same time open and progressive legal development.

This development has already started in several proposals for UAS regulations under ICAO and within the United States and Canada. Several issues are addressed, albeit in a different complexity.

In the long term, where routine certification of UAS, licensing of their personnel and operations in the national and international airspace are desired, it will be necessary to establish a comprehensive and generic system of certification and licensing standards. This requirements-based approach has been proven successful for manned aircraft and is likely to be successful for UAS and will also allow type certification. It is familiar to the aviation industry and generally requires no particular, UAS- and operational environment-specific, restrictions and limitations to address airworthiness uncertainties. As a result, it offers greater operational freedom.

Until this level is reached, a step by step integration process is likely to occur. As one of the first steps, United States and Canada place a focus on more integration of micro and small UAS in the short term. Also integration in controlled airspace will precede integration in uncontrolled airspace, as in the former ATC can mitigate much of the risk and compensate the insufficient ‘detect, sense and avoid’ capabilities.

To successfully achieve the long term goal and permit cross-border operations, international harmonization and coordination is required. When on both levels the regulatory framework is in its development phase, reciprocal influence can generally lead to fruitful harmonized results. The present situation shows, that, although the general approach is similar, the majority of aspects is not sufficiently harmonized between the United States and Canada to facilitate international operations. ICAO assumes its required leading role in this aspect, and emphasized the rare opportunity of harmonization right from the start. Given the fact, that the UAS Circular published this years is the first general guidance on UAS, this harmonization *ab initio* is a demanding task in the light of several member states which already developed their first own UAS regulations years ago.

One aspect of particular importance and preferably also subject to a harmonized approach are classifications, with different requirements associated to each class based on perceived associated risks. The regulations to be developed and implemented need to account for the great variety of UAS. While the aspects of 'not one size fits all' also applies to manned aircraft, the range of, UA, RPA, Data-Links and other elements of the UAS is significantly wider. While today the broad discretion of the authorities allows one to take the significant differences between different UAS into account, classifications will be an important factor for a successful long term standard-based approach.

All these processes will take time. Hopefully they will allow UAS to unfold their potential of revolutionizing aviation.

BIBLIOGRAPHY

Primary sources

International treaties

United Nations Convention on the Law of the Sea, 10 December 1982, 1833 UNTS 3.

Convention for the Unification of Certain Rules Relating to International Carriage by Air, 12 October 1929.

Convention on International Civil Aviation 15 UNTS 295, 61 US Stat 1180, (entered into force 4 April 1947).

Convention on Damage Caused by Foreign Aircraft to Third parties on the Surface, 7 October 1952, ICAO Doc 7364, (entered into force 4 February 1958).

Convention for the Unification of Certain Rules for International Carriage by Air, 28 May 1999, ICAO Doc 9740, (entered into force 4 November 2003).

Convention on Compensation for Damage Caused by Aircraft to Third Parties, 2 May 2009, ICAO Doc 9919, (not in force).

Convention on Compensation for Damage to Third Parties, Resulting from Acts of Unlawful Interference Involving Aircraft, 2 May 2009, ICAO Doc 9920, (not in force).

Intergovernmental and nongovernmental organization materials

ITU, *Consideration of appropriate regulatory provisions for the operation of unmanned aircraft systems* Resolution 421 (WRC-07).

______, *2012 World Radiocommunication Conference - Agenda and References*.

JAA/Eurocontrol, "UAV Task-Force - Final Report" (2004) Joint JAA/Eurocontrol Initiative on UAVs.

UN COPUOS, *Approach to the Solution of the Problems of the Delimitation of Airspace and Outer Space (reissued version of 28 March 1979)*, UN COPUOS, Legal Subcommittee, A/AC 105/C 2/L 121 (1979).

______, *Definition and Delimitation of Outer Space*, UN COPUOS, Legal Subcommittee, A/AC 105/484 (1991).

ICAO resolutions, guidance and other materials

Cary, Leslie, ICAO, “Unmanned Aircraft Systems/Remotely-piloted Aircraft (Presentation)” (2010) Second Training Course of Regional Officers.

Current lists of parties to multilateral air law treaties - Chicago Convention online: ICAO <http://www2.icao.int/en/leb/List%20of%20Parties/Chicago_EN.pdf >.

Da Silva, Saulo, ICAO, “ICAO UAS - Update from the UASSG (Presentation)” (2010) NPF/SIP/2010-WP/14 Workshop on the development of National Performance Framework for Air Navigation Systems (Nairobi, 6-10 December 2010).

ICAO, Air Naviagation Commission, *Results of a Consultation with Selected States and International Organization with Regard to Unmanned Aerial Vehicle (UAV)*, AN-WP/8065 (Montreal: ICAO, 2005).

______, Air Naviagation Commission, *Progress Report on Unmanned Aerial Vehicle Work and Proposal for Establishment of a Study Group*, Working Paper, AN-WP/8221 (Montreal: ICAO, 2007).

______, Assembly, *Resolution A36-13*, A36-13, (2007).

______, Assembly, Technical Commission, *ICAO Collaboration on Frequency Spectrum Requirements for Unmanned Aircraft Systems (UAS) Operations*, Working Paper, A36-WP/150 (2007).

______, Coucil, *Annual Report of the Council*, Doc No 9916 (Montreal: ICAO, 2008).

______, Secretariat, *Annexes 1 to 18*, (Montreal: ICAO, 2007).

______, Secretary General, *Unmanned Aircraft Systems (UAS)*, Circular, Cir 328 AN/190 (Montreal: ICAO, 2011).

______, Panel, Aeronautical Communications, *Considerations on categories of airspaces for the work of the WRC-11 - A.I. 1.3*, ACP-WGF18/WP-02 Rev 1 (Montreal: ICAO, 2008).

______, UASSG, *First Meeting - Summary of Discussions*, UASSG/1-SD, (2008).

Taylor , John, ICAO, “Preparations for WCR-12 - WRC-12 Agenda Item 1.3 on UAS (Presentation)” (2010) Cairo 19-20 September 2010.

United States laws, guidance and other materials

FAA, *AC 91-57 - Model Aircraft Operating Standards* (Washington: FAA, 1981).

______, *AC 103-6 - Ultralight Vehicle Operations-Airports, ATC, and Weather* (Wahington: FAA, 1983).

______, *AC 103-7 - The Ultrlight Vehicle* (Washington: FAA, 1984).

______, *AFS-400 UAS Policy 05-01 - Unmanned Aircraft Systems Operations in the U.S. National Airspace System - Interim Operational Approval Guidance* (Washington: FAA, 2005).

______, *Notice of Policy: Unmanned Aircraft Operations in the National Airspace System*, Docket No. FAA-2006-25714 (Wahington: FAA, 2006).

______, *Federal Register Notice - Clarification of FAA Policy*, Docket No FAA-2006-25714 (Washington: FAA, 2007).

______, *Interim Operational Approval Guidance 08-01* (Washington: FAA, 2008).

______, *Memorandum - Unmanned Aircraft Systems (UAS) Certification Status, Optionally Piloted Aircraft, and Accidents involving UAS* (Washington: FAA, 2008).

______, *Notice JO 7210.766 - Unmanned Aircraft Operations in the National Airspace System (NAS)*, Notice JO 7210.766 (Wahington: FAA, 2011).

______, *Order 8130.34 - Airworthiness Certification of Unmanned Aircraft Systems*, Order 8130.34 (Washington: FAA, 2008).

______, *Order 8130.34A - Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft* (Washington: FAA, 2010).

______, *Small Unmanned Aircraft System Aviation Rulemaking Committee*, Order 1110.150 (Wahington: FAA, 2008).

______, Unmanned Aircraft Program Office, *Fact Sheet - Unmanned Aircraft Systems (UAS)* (Washington: FAA, 2010).

______, (Ardyth Williams/James Sizemore), “Integrating Unmanned Aircraft Systems (UAS) into the Global ATM System (Presentation)” (2009).

______, (Doug Davis) & EASA (Yves Morier), “Unmanned Aircraft Systems: Considerations for Certification and Interoperability (Presentation)” (2008) US/Europe International Aviation Safety Conference 1.

Federal Aviation Act, P.L. 85-726, 72 Stat. 731 (Approved 23 August 1958).

Government Accountability Office (GOA), *Report: Unmanned Aircraft Systems - Federal Actions Needed to Ensure Safety and Expand Their Potential Uses within the National Airspace System*, GAO-08-511 (Wahington: GOA, 2008).

NASA, with the collaboration of Cox, T H, et al, *Civil UAV Capability Assessment (Report Overview)*, report for NASA (Washington D C: NASA, 2004).

______, with the collaboration of Cox, T H, et al, *Civil UAV Capability Assessment (Report)*, report for NASA (Washington D C: NASA, 2004).

Hoffmann, Tom, “Eye in the Sky - Assuring the Safe Operation of Unmanned Aircraft Systems” (2010) FAA Safety Briefing 20.

Horton, Timothy W & Robert W Kempel, “Flight Test Experience and Controlled Impact of a Remotely Piloted Jet Transport Aircraft” (1988) NASA Technical Memorandum 4084 1.

Small Unmanned Aircraft System Aviation Rulemaking Committee, *Comprehensive Set of Recommendations for sUAS Regulatory Development* (Washington: FAA, 2009).

Canadian laws, guidance and other materials

Transport Canada, *UAV Working Group - Final Report* (Ottawa: Transport Canada, 2007) online: Transport Canada <http://www.tc.gc.ca/eng/civilaviation/standards/general-recavi-uavworkinggroup-2266.htm >.

______, *Unmanned Air Vehicle Working Group Final Report* (Ottawa: Transport Canada, 2007) online: Transport Canada <http://www.tc.gc.ca/eng/civilaviation/standards/general-recavi-uavworkinggroup-2266.htm >.

______, *Staff Instruction (SI) No. 623-001 - The review and processing of an application for a Special Flight Operations Certificate for the Operation of an Unmanned Air Vehicle (UAV) System*, Staff Instruction (SI) No 623-001 (Ottawa: Transport Canada, 2008).

______, *Speaking Notes for Martin J. Eley Director General, Civil Aviation to Deliver at the Unmanned Systems Canada Conference 2010* (Ottawa: Transport Canada, 2010) online: Transport Canada <http://www.tc.gc.ca/eng/civilaviation/opssvs/directorgeneral-speeches-1333.htm >.

______, *Unmanned Air Vehicle (UAV) Systems Program Design Working Group - Terms of Reference*, RDIMS No. 5705889(E) (Ottawa: Transport Canada, 2010) online:

Transport Canada <http://wwwapps.tc.gc.ca/saf-sec-sur/2/npa-apm/t_c_m_d.aspx?lang=eng&m_id=235 >.

Secondary sources

Books and dissertations

Alexandrowicz, Charles, *The law making functions of the specialised agencies of the United Nations* (London: 1973).

Buergenthal, Thomas, *Law-making in the International Civil Aviation Organisation* (New York: 1969).

Chao, Haiyang, *Cooperative Remote Sensing and Actuation Using Networked Unmanned Vehicles*, (PhD, Utah State University, 2010).

Dalamagkidis, K, K P Valavanis & L A Piegl, *On Integrating Unmanned Aircraft Systems into the National Airspace System* (Springer, 2009).

Dempsey, Paul Stephen, *Public International Air Law* (Montreal: Institute and Center for Research in Air & Space Law, 2008), vol 1,.

Diederiks-Verschoor, I H Ph, *An Introduction to Air Law*, 8 ed (Alphen aan den Rijn: Kluwer Law International, 2006).

Erler, Jochen, *Rechtsfragen der ICAO* (Cologne: 1967).

Giesecke, Chrsitian, *Nachtflugbeschränkung und Luftverkehrsrecht* (Cologne: 2006).

Hobbs, A & S Herwitz, “Human factors in the maintenance of unmanned aicraft” (2005) (Washington: FAA).

Hobe, Stephan & Nicolai von Ruckteschell, eds, *Kölner Kompendium des Luftrechts* (Cologne: Carl Heymanns Verlag, 2008), vol 1,.

Hoppe, Lars, *Le statut juridique des drones aéronefs non habités* (Marseille: Presses Universitaires d'Aix-Marseille, 2008).

Kephart, Ryan J, *Comparison of See-and-Avoid Performance in Manned and Remotely Piloted Aircraft*, (Master of Science, Russ College of Engineering and Technology of Ohio University, 2008).

Martinez-de-Dios, J R, Luis Merino, Anibal Ollero, Luis M Ribeiro & Xavier Viegas, "Multi-UAV Experiments: Application to Forest Fires", in A. Ollero & I. Maza, eds, *Mult. Hetero. Unmanned Aerial Vehi., STAR 37* (Berlin: Springer, 2007).

Milde, Michael, *International Air Law and ICAO* (Utrecht: Eleven International Publishing, 2008).

Newcome, Laurence R, *Unmanned Aviation - A Brief History of Unmanned Aerial Vehicles* (Reston: American Institute of Aeronautics and Astronautics, 2004).

Norris, Pat, *Watching Earth from Space: How Surveillance Helps Us - and Harms Us* (Chichester: Springer Praxis Books, 2010).

Reijnen, Bess C M, *The United Nations Space Treaty Analysed* (Gif-sur-Yvette: Editions Frontières, 1992).

Riese, Otto, *Luftrecht* (Stuttgart: 1949).

Rosenthal, Gregor, *Umweltschutz im internationalen Luftrecht* (Cologne: 1989).

Schlochauer, Hans J, ed, *Wörterbuch des Völkerrechts*, 2 ed (Berlin: De Gruyter, 1962).

Schwenk, Walter & Elmar Giemulla, *Handbuch des Luftverkehtsrechts*, 3 ed (Cologne: Carl Heymanns Verlag, 2005).

Skala, Astrid, *Internationale technische Regeln und Standards zum Umweltschutz-recht* (Cologne: 1982).

Valavanis, Kimon P, *Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy* (Tampa: Springer, 2007).

Yochim, Jaysen A, *The Vulnerabilities of Unmanned Aircraft System Common Data Links to Electronic Attack*, (Master of Military Art and Science, Faculty of the U.S. Army Command and General Staff College, 2010).

Scholarly articles, reports and presentations

Abeyratne, Ruwantissa, "Regulating unmanned aerial vehicles - Issues and challenges" (2009) European Transport Law 503.

Asmat, Jose, Brett Rhodes, Jessica Umansky, Chris Villavicencio & Amir Yunas, with the collaboration of MITRE Corporation, *Unmanned Aerial Collision Avoidance System (UCAS)*, report for Department of Systems Engineering and Operations Research, George Mason University (Fairfax: 2006).

Association for Unmanned Vehicle Systems International (AUVSI), *Fire Fighting Tabltop Excercise 2010*, report for AUVSI (AUVSI: 2010).

Bauer, Jeff, “NASA Dryden Flight Research Center”, 59, in UVS International, ed, *UAS Yearbook - UAS: The Global Perspective* (Paris: Blyenburgh & Co, 2009).

Biass, Eric H & Roy Braybrook, “Compendium Drones 2010, Supplement to Armada Issue 3/2010” (2010) 3 Armada International.

Borges de Sousa, J & G Andrade Goncalves, “Unmanned vehicles for environmental data collection” (2008) Clean Techn Environ Policy / Springer.

Cary, Leslie, “International Civil Aviation Organization UAS Study Group”, in UVS International, ed, *UAS Yearbook - UAS: The Global Perspective* (Paris: Blyenburgh & Co, 2010).

Chao, HaiYang, YongCan Cao & YangQuan Chen, “Autopilots for Small Unmanned Aerial Vehicles: A Survey” (2010) 8:1 International Journal of Control, Automation, and Systems 36.

Cheng, Bin, “The Legal Regime of Airspace and Outer Space: the Boundary Problem” (1980) 5 Annals of Air and Space Law 323.

______, “International Responsibility and Liability for Launch Activities” (1995) 20 Air & Space L 297.

Clothier, Reece A, Neale L Fulton & Rodney A Walker, “Pilotless aircraft: the horseless carriage of the twenty-first century?” (2008) 11:8 Journal of Risk Research 999.

Crowe, Wayne, “Canadian UAS Community”, 100, in UVS International, ed, *UAS Yearbook - UAS: The Global Perspective* (Paris: Blyenburgh & Co, 2010).

Dalamagkidis, K, K P Valavanis & L A Piegl, “Current Status and Future Perspectives for Unmanned Aircraft System Operations in the US” (2008) 52 J Intell Robot Syst 313.

de Croon et al, G C H E, “Design, aerodynamics, and vision-based control of the DelFly” (2009) 71:1 Int’ L J On Micro Air Vehicles.

DeGarmo, Matthew T, *Issues Concerning Integration of Unmanned Aerial Vehicles in Civil Airspace*, report for MITRE Corporation (Virgina: MITRE Corporation, 2004).

______ & Gregory M. Nelson, “Prospective Unmanned Aerial Vehicle Operations in the Future National Airspace System” (2004) MITRE Corporation, Center for Advanced Aviation System Development 1.

Gabrynowicz, Joanne Irene, "Commercial High-Altitude Unpiloted Aerial Remote Sensing: Some Legal Considerations" (1996) 62:3 Photogrammetric Engineering & Remote Sensing 275.

Giemulla, Elmar, "Unbemannte Luftfahrzeugsysteme – Probleme ihrer Einfügung in das zivile und militärische Luftrecht" (2007) 56:2 Zeitschrift für Luft- und Weltraumrecht 195.

Ginati, A, S Gustafsson & J Juusti, "Space, the essential component for UAS - The case of Integrated Applications - "Space 4 UAS" (Presentation)" (2010) Workshop of the European Space Policy Institute: Opening Airspace for UAS in the Civilian Airspace 1.

Gogarty, Brendan & Meredith Hagger, "The Laws of Man over Vehicles Unmanned: The Legal Response to Robotic Revolution on Sea, Land and Air" (2008) 19 Journal of Law, Information and Science 74.

González, Pablo, "Civil applications of UAS: The way to start in the short term (Presentation)" (2010) Workshop of the European Space Policy Institute: Opening Airspace for UAS in the Civilian Airspace 1.

Guglieri, Giorgio, Valeria Mariano, Fulvia Quagliotti & Alessandro Scola, "A Survey of Airworthiness and Certification for UAS" (2011) 61 J Intell Robot Syst 399.

Jakhu, Ram S, "The Legal Status of the Geostationary Orbi" (1982) 7 Annals of Air and Space Law 333.

Jenks, Chris, "Law from Above: Unmanned Aerial Systems, Use of Force, and the Law of Armed Conflict" (2009) 85 North Dakota Law Review 649.

Kaiser, Stefan A, "Legal Aspects of Unmanned Aerial Vehicles" (2006) 55:3 Zeitschrift für Luft- und Weltraumrecht 344.

______, "Third Party Liability of Unmanned Aerial Vehicles" (2008) 57:2 Zeitschrift für Luft- und Weltraumrecht 229.

______, "Identifying Regulatory Parameters to Integrate UAS into Civilian, Non-Segregated Airspace (Presentation)" (2010) Workshop of the European Space Policy Institute: Opening Airspace for UAS in the Civilian Airspace 1.

Kontitsis, Michail & Kimon Valavanis, "A Cost Effective Tracking System for Small Unmanned Aerial Systems" (2010) 57 J Intell Robot Syst 171.

Koulish, Robert, "Blackwater and the Privatization of Immigration Control" (2008) 20 Saint Thomas Law Review 462.

Lacher, Andrew R, David R Maroney & Andrew D Zeitlin, *Unmanned Aircraft Collision Avoidance - Technology Assessment and Evaluation Methods*, report for The MITRE Corporation (McLean: MITRE, 2007).

Larson, David Allen, “Artificial Intelligence: Robots, Avatars, and the Demise of the Human Mediator” (2010) Ohio State Journal on Dispute Resolution 105.

Maneschijn, A, T Jones, T W von Backström & L A Ingham, “A proposed reference framework for unmanned aerial vehicle and system airworthiness requirements” (2007) The Aeronautical Journal 345.

Marshall, Douglas M, “Dull, Dirty, and Dangerous: The FAA's Regulatory Authority Over Unmanned Aircraft Operations” (2007) Issues in Aviation Law and Policy 10085.

______, “Unmanned Aerial Systems and International Civil Aviation Organization Regulations” (2009) 85 North Dakota Law Review 693.

Masutti, Anna, “Proposals for the Regulation of Unmanned Air Vehicle Use in Common Airspace” (2009) 34:1 Air and Space Law 1.

______, “A Regulatory Framework to introduce Unmanned Aircraft Systems in Civilian Airspace (Presentation)” (2010) Workshop of the European Space Policy Institute: Opening Airspace for UAS in the Civilian Airspace 1.

McCoy, John V, *Unmanned Aerial Logistics Vehicles: A Concept Worth Pursuing?*, [unpublished, archived at Fort Leavenworth, Kansas].

Mendes de Leon, Pablo, “Building the regulatory framework for introducing the UAS in the civil airspace European Regulation for light UAS below 150 KG?” (2010) 9:4 Aviation and Maritime Journal 1.

Milde, Michael, “Enforcement of Aviation Safety Standards – Problems of Safety Oversight” (1996) 45 Zeitschrift für Luft- und Weltraumrecht 3.

Montgomery, John, “The Age of the Supersonic Jet Transport: Its Environmental an Legal Impact” (1970) Journal of Air Law and Commerce 577.

Peterson, Mark E, “The UAV and the Current and Future Regulatory Contruct for Integration into the National Airspace System” (2006) 71 Journal of Air Law and Commerce 521.

Quaritsch, M, K Kruggl, D Wischounig-Strucl, S Bhattacharya, M Shah & B Rinner, “Networked UAVs as aerial sensor network for disaster management applications” (2010) 127:3 Elektrotechnik & Informationstechnik 56.

Rapp, Geoffrey Christopher, “Unmanned Aerial Exposure: Civil Liability Concerns Araising from Domestic Law Enforcement Employment of Unmanned Aerial Systems” (2009) 85 North Dakota Law Review 623.

Ravich, Timothy M, “The Integration of Unmanned Aerial Vehicles into the National Airspace” (2009) 85 North Dakota Law Review 597.

Reynish, William, “UAVs Entering the NAS”, *Avionics Magazine* <http://www.aviationtoday.com/av/categories/military/1139.html >.

Ro, Kapseong, Jun-Seok Oh & Liang Dong, “Lessons Learned: Application of Small UAV for Urban Highway Traffic Monitoring” (2007) 45th AIAA Aerospace Sciences Meeting and Exhibit 1.

Seidenspinner, Angela, “Book review: Hoppe Lars, Le statut juridique des drones aéronefs non habités, Presses Universitaires d'Aix-Marseille, 2008” (2010) 59:1 Zeitschrift für Luft- und Weltraumrecht 135.

Tasikas, Vasilios, “Unmanned Aerial Vehicles and the Doctrine of Hot Pursuit: A New Era of Coast Guard Maritime Law Enforcement Operations” (2004) 29 Tul Mar LJ 59.

Thompson, Sudie, “FAA Regulation of Ultralight Vehicles” (1983-1984) 49 Journal of Air Law and Commerce 591.

Tomasello, Filippo, “Emerging international rules for civil Unmanned Aircraft Systems (UAS)” (2010) 9:4 Aviation and Maritime Journal 1.

Vacek, Joseph J, “Big Brother will soon be watching you - or will he? - Constitutional, Regulatory, and Operational Issues Surrounding the Use of Unmanned Aerial Vehicles in Law Enforcement” (2009) 85 North Dakota Law Review 673.

van de Leijgraaf, Ron, “Joint Authorities for Rulemaking on Unmanned Systems (JARUS)”, in International, in UVS International, ed, *UAS Yearbook - UAS: The Global Perspective* (Paris: Blyenburgh & Co, 2010).

News reports, websites and dictionaries

Black's Law Dictionary, 9th edn, (Eagan: West Group, 2009).

CNBC, “Honeywell T-Hawk Aids Fukushima Daiichi Disaster Recovery Unmanned Micro Air Vehicle Provides Video Feed to Remote Monitors”, *CNBC* (19 April 2011) online: CNBC <http://www.cnbc.com/id/42672108/Honeywell_T_Hawk_Aids_Fukushima_Daiichi_Disaster_Recovery_Unmanned_Micro_Air_Vehicle_Provides_Video_Feed_to_Remote_Monitors >.

China testet unbemannten Hubschrauber online: T-Online <http://videos.t-online.de/unbemannter-hubschrauber/id_46290384/index >.

Dryden Flight Research Center online: NASA <http://www.nasa.gov/centers/dryden/news/FactSheets/FS-068-DFRC.html >.

Earth Observations and the Role of UAVS (several documents) online: NASA <http://www.nasa.gov/centers/dryden/research/civuav/civ_uav_doc-n-ref.html >.

Economist, The, “IAI takes wing - Israel’s biggest defence firm is getting ready for privatisation”, *The Economist* 2011:March 3 online: The Economist <http://www.economist.com/node/18281744?story_id=18281744&CFID=164246165&CFTOKEN=55184493 >.

EUROCAE online: EUROCAE <www.eurocae.net >.

Federal Aviation Administration (FAA) online: FAA <www.faa.gov >.

General Atomics online: General Atomics <http://www.ga.com/news.php?read=1&id=84&page=9 >.

International Civil Aviation Organization online: ICAO <www.icao.int >.

Large Model Association online: Large Model Association <http://www.largemodelassociation.com/ >.

Merriam-Webster, 2011, online: Merriam-Webster <http://www.merriam-webster.com/dictionary/cargo >.

NASA Supports UAS Fire Mapping Efforts on California Fire online: NASA <http://www.nasa.gov/centers/dryden/news/NewsReleases/2006/06-45.html >.

NATO AWACS progress: Full Control of an unmanned airborne system online: NATO ACO <http://www.aco.nato.int/page272203947.aspx >.

Remote Piloted Aerial Vehicles: An Anthology online: RPAV <http://www.ctie.monash.edu/hargrave/rpav_home.html >.

Robot Hummingbird Spy Drone Flies for Eight Minutes, Spies on Bad Guys online: Fox News <http://www.foxnews.com/scitech/2011/02/18/robot-hummingbird-spy-drone-flies-minutes-spies-bad-guys/ >.

RQ-4 Block 20 Global Hawk online: Northrop Grumman <http://www.as.northropgrumman.com/products/ghrq4b/index.html >.

RTCA online: RTCA <www.rtca.org >.

The V-1 Flying Bomb online: Greg Goebel <http://www.vectorsite.net/twcruz_2.html >.

The Telegraph, "New video of Fukushima nuclear power plant", *The Telegraph* (12 April 2011) online: The Telegraph <http://www.telegraph.co.uk/news/worldnews/asia/japan/8444895/New-video-of-Fukushima-nuclear-power-plant.html >.

Transport Canada online: Transport Canada <http://www.tc.gc.ca/ >.

Unmanned Aerial Vehicle Systems Association online: UAVS <http://www.uavs.org/ >.