**Agenda Item: C.6.12*** | **WORKING PAPER** | **WP No: 160 IFATCA'24**

# VFR Traffic Workload and capacity Study

Presented by PLC and TOC


**SUMMARY**

*Air traffic, both IFR and VFR, is continuously increasing all over the world and at the same time, target levels of safety must be maintained or improved. However, airspace capacity is limited and in close relation with complexity. Two of the multiple factors that generate complexity are the flight rule itself and the conditions under which the flights are operating. The question is how VFR traffic impacts the airspace capacity and airspace capacity should be set.*

*This working paper aims to highlight the need of setting realistic values for airspace capacity, taking into consideration complexity generated by the different flight rules followed within.*


## 1. INTRODUCTION

1.1. Strong air travel growth continues in May as load factor rises to 2019 levels[1] was the headline of the International Air Transport Association (IATA) press release on 5th of July 2023.

1.2. Air traffic is continuously increasing all over the world[2] and, at the same time, target levels of safety must be maintained or improved. Airspace capacity is limited and in a close relationship with complexity. Both of them are related to controller workload given that the controller's workload limit is one of the many factors that determine the capacity of a sector.

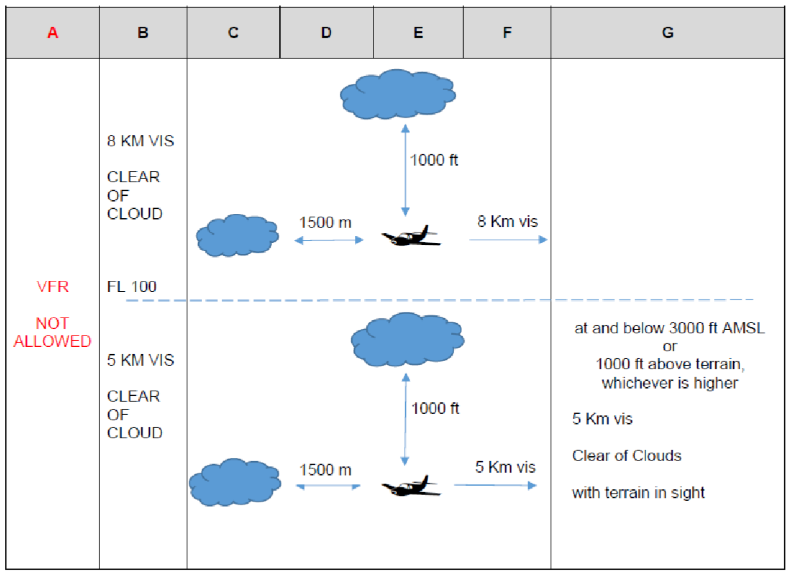
1.3. Cambridge Dictionary defines complexity as "the state of having many parts and being difficult to understand or find an answer to". It is hard to define complexity for aviation, and even harder to determine it.

[1] "Strong air travel growth continues in May as load factor rises to 2019 levels" – IATA, Press Release no. 44, Date 5 July 2023
[2] www.oag.com/coronavirus-airline-schedules-data

Beyond the number of aircraft in the same airspace and the conditions under which the flights are operating, complexity increases significantly when different flight rules are followed.

1.4. For VFR flight at low levels, visual recognition of terrain is fundamental to the operation of the flight. That is why detailed VFR charts are highly appreciated. VFR routes and visual reference points (VRP) are essential even nowadays when most smartphones have Global Navigation Satellite Systems (GNSS) incorporated. Even smart devices can fail and when this happens, pilots have to know exactly where they are and what they should do to complete the flight as planned. Otherwise, if they deviate from route or get lost, the ATC workload increases.

1.5. As it is obvious, visibility has a very important role when flying VFR. When visibility drops significantly, operations get more complex.




1.6. In addition, pilot experience is a very important aspect to be taken into account, since VFR operators are more often, trainees, amateurs or just enthusiast weekend flyers.

1.7. The different rules that controllers have to apply depending on the class of airspace (e.g., class C, D, E etc.) and the flight rules aircraft are operating under (IFR or VFR) result in a multitude of possibilities generating complexity, which is very difficult to quantify. Even so, specific analyses should be conducted in order to identify methods to reduce it.

1.8. Related to this subject, there are a few questions to be answered: how VFR traffic impacts the airspace capacity as well as complexity, how should airspace capacity should be managed, on what conditions special VFR (SVFR) flights should be authorised in controlled zones/areas, etc.

## 2. DISCUSSION

### Airspace capacity and workload concepts

2.1. In 2001, Majumdar and Polak presented a study[3] that aimed to provide a method of determining airspace capacity of Europe using a simulation model of air traffic controller workload.

2.2. They started from the idea that airspace capacity is related to controller workload given that the controller's workload limits determine the capacity of a sector.

"*The capacity of an ATC sector can be defined as the maximum number of aircraft that are controlled in a particular ATC sector in a specified period, while still permitting an acceptable level of controller workload. Note that one is dealing with the number of aircraft controlled - i.e. aircraft whose control generates work for the controllers - rather than the number of aircraft entering, exiting or passing through the sector, in a given period of time. Given this definition, one needs to then determine:*

*• what is meant by controller workload;*

*• how this controller workload is measured; and*

*• what is the acceptable level of controller workload, i.e., the threshold value, at capacity.*"[4]

2.3. Controller workload is a multi-faceted term, with a multitude of definitions and models in the literature.

*"One should note that workload is a construct, i.e., a process or experience that cannot be seen directly, but must be inferred from what can be seen or measured. Research, theory, models and definitions of workload are inter-related and there are numerous reviews of workload and its measurement*."[5]

"*Controller workload assessments can generally be performed by:*

*• self-assessment of the controllers, either by instantaneous techniques, e.g. the SWAT (Wickens, 1992) technique, or by non-instantaneous techniques, e.g. the NASA-TLX method (Hart and Staveland, 1988)*

*• direct observations of the controllers - by other controllers or ATC system experts e.g., detailed non-intrusive techniques*"[6].

2.4. Controller workload is also an individualistic subject. How an experienced ATCO will deal with a certain level of traffic can differ a lot from how an unexperienced ATCO will deal the same level of traffic.

2.5. Since 2001, workload assessment got in 2023 to workload prediction. Five researchers

[3] Transportation Research Record Journal of the Transportation Research Board, 80th Annual Meeting, 2001, Washington, DC - Estimating The Capacity Of Europe's Airspace Using A Simulation Model Of Air Traffic Controller Workload

[4] Transportation Research Record Journal of the Transportation Research Board, 80th Annual Meeting, 2001, Washington, DC - Estimating The Capacity Of Europe's Airspace Using A Simulation Model Of Air Traffic Controller Workload, page 4

[5] Transportation Research Record Journal of the Transportation Research Board, 80th Annual Meeting, 2001, Washington, DC - Estimating The Capacity Of Europe's Airspace Using A Simulation Model Of Air Traffic Controller Workload, page 5

[6] Transportation Research Record Journal of the Transportation Research Board, 80th Annual Meeting, 2001, Washington, DC - Estimating The Capacity Of Europe's Airspace Using A Simulation Model Of Air Traffic Controller Workload

from Arizona State University, USA, published in 2023 a study to propose a method of predicting the level of ATC workload[7]. They started from the idea that "*the workload of the ATCOs can have negative effects on operational safety and airspace usage. To avoid overloading and ensure an acceptable workload level for the ATCos, it is important to predict the ATCOs' workload accurately for mitigation actions*".

**Airspace capacity determination**

2.6. Existing ICAO recommendation and regulation exists within ICAO Doc 9971 to regulate the number of aircraft that can be safely handled by an ATS unit.

"*The number of aircraft provided with ATC service should not exceed that which can be safely handled by the ATS unit concerned. In order to define the maximum number of flights that can be safely managed, the appropriate ATS authority should assess and declare the capacity for control sectors (en-route and terminal control area) and for airports. This capacity is the «declared capacity» for the airspace or airport. Capacity is normally expressed as the maximum number of aircraft that can be accepted over a given period of time at an ATM resource (airspace sector, waypoint, aerodrome, etc.). The normally measured time period is one hour*".[8]

2.7. ICAO acknowledges airspace capacities, airport capacities and, in addition, operational capacity, as follows:

"*The capacity for an airspace sector (terminal or enroute) is defined either as an entry count (maximum number of aircraft entering an airspace sector in a given period of time) or a maximum occupancy count over a specific time period (e.g., 15 minutes). Airspace capacity represents the total number of flights that a controller can handle within a sector*."[9]

"*The ATM capacity of an airport is normally defined as the total number of movements that an airport can handle during a given period of time. The ATM capacity is based on:*

*a) arrival and departure acceptance rates;*

*b) runway(s) in use and mode of operations (mixed or segregated arrivals/departures);*

*c) required separation;*

*d) aircraft speed;*

*e) fleet mix;*

*f) runway occupancy time; and*

g) *aerodrome infrastructure (e.g., availability of parking stands, congestion on the movement area)*."[10]

2.8. Within Annex 11, ICAO defines Declared capacity as,

"*a measure of the ability of the ATC System or any of its sub-system or operating*

---

7 Advanced Engineering Informatics, Volume 57, August 2023, 102113 - Air Traffic Controller Workload Level Prediction using Conformalized Dynamical Graph Learning - Yutian Pang, Jueming Hu, Christopher S. Lieber, Nancy J. Cooke, Yongming Liu

8 ICAO Doc 9971 - Manual on Collaborative Air Traffic Flow Management (ATFM) - Third Edition, 2018, Chapter 3.1

9 ICAO Doc 9971 - Third Edition, 2018, Chapter 3.1.4

10 ICAO Doc 9971 - Third Edition, 2018, Chapter 3.1.5

*position to provide service to aircraft during normal activities. It is expressed as the number of aircraft entering a specified portion of airspace in a given period of time, taking due account of weather, ATC unit configuration, Staff and Equipment available and any other factors that may affect the Workload of the Controller responsible for the airspace*"[11].

"*In addition to the declared capacities for airports and airspaces (and the capacity associated with the strategic airport slot process), ATFM services require knowledge of the operational capacity. Operational capacity is the expected capacity associated with the tactical situation at the airport or airspace. Dynamic factors, including meteorological conditions, CNS*[12] *status, fleet mix and staffing may result in an operational capacity inferior to the declared capacity*."[13]

2.9. ICAO highlights that it would be extremely complex to establish a universal rule to calculate capacity, which can be affected by so many variables and external considerations that standardisation is simply not possible. This is the reason ICAO considers that it is up to each ANSP to decide how to determine its capacity: by choosing from basic methods based on observation or highly sophisticated mathematical models. Despite the method chosen, operational capacities should take into account some additional factors affecting airspace capacity and airport capacity, illustrated separately.

2.10. Capacity for an airspace sector is implying terminal or enroute. But for the aerodrome control zone (CTR) the parameters are not obvious. A CTR is influenced by factors affecting airspace capacity and airport capacity.

2.11. ICAO provides examples of a simplified methodology for determining sector capacity at an area control centre (ACC)[14] and a simplified methodology of determining the airport arrival rate based on the scientific process developed by the Federal Aviation Administration (FAA)[15].

2.12. Airport arrival rate is yet, only one component of capacity for aerodrome control zone (CTR). Unfortunately, ICAO does not provide any example for determining CTR capacity, which would be incredibly difficult at such a high level.

2.13. However, ICAO states that: -

"*Capacity has a cost, but insufficient capacity, which in turn generates delay, has an even greater cost. Both capacity and delay costs are borne by airspace users. It is therefore necessary to determine the level of ATC capacity which can be justified from a cost point of view, i.e., the optimum trade-off between the delay and cost of ATC capacity*".[16]

2.14. ANSP and States would be more interested in increasing the number of aircraft arriving and departing and not considering the workload of the ATCO with unforeseen VFR traffic and as such it is vitally important that ATCO be able to express their subjective workload assessments on a regular basis to ensure continue workload monitorisation.

---

11 ICAO Annex 11, Air Traffic Services – Thirteenth Edition, July 2001

12 CNS - Communications, navigation and surveillance

13 ICAO Doc 9971 - Third Edition, 2018, Chapter 3.1.6

14 ICAO Doc 9971 - Manual on Collaborative Air Traffic Flow Management (ATFM) - Third Edition, 2018, APPENDIX II-C

15 ICAO Doc 9971 - Third Edition, 2018, APPENDIX II-B

16 ICAO Doc 9971 - Third Edition, 2018, APPENDIX II-D

**MONITORING OF SAFETY LEVELS**

2.15. ICAO Document 4444 (PANS-ATM) states that the appropriate ATS authority should establish a formal incident reporting system for ATS personnel to facilitate the collection of information on actual or potential safety hazards or deficiencies related to the provision of ATS, including route structures, procedures, communications, navigation and surveillance systems and other safety significant systems and equipment as well as controller workloads.

**SAFETY REVIEWS**

2.16. "The scope of ATS unit safety reviews should include at least the following issues:

Regulatory issues to ensure that:

f) traffic volumes and associated controller workloads do not exceed defined, safe levels and that procedures are in place for regulating traffic volumes whenever necessary;" [17]

**CAPACITY MANAGEMENT**

2.17. "The capacity of an ATS system depends on many factors, including the ATS route structure, the navigation accuracy of the aircraft using the airspace, weather-related factors, and controller workload. Every effort should be made to provide sufficient capacity to cater to both normal and peak traffic levels; however, in implementing any measures to increase capacity, the responsible ATS authority shall ensure, in accordance with the procedures specified in Chapter 2, that safety levels are not jeopardised."

*Capacity assessment*

"In assessing capacity values, factors to be taken into account should include, inter alia:

a) the level and type of ATS provided;

b) the structural complexity of the control area, the control sector or the aerodrome concerned;

c) controller workload, including control and coordination tasks to be performed;

d) the types of communications, navigation and surveillance systems in use, their degree of technical reliability and availability as well as the availability of backup systems and/or procedures;

e) availability of ATC systems providing controller support and alert functions; and

f) any other factor or element deemed relevant to controller workload." [18]

[17] Doc 4444 – Sixteenth Edition, 2016, Chapter 2.5.2
[18] Doc 4444 – Sixteenth Edition, 2016, Chapter 3.1.2

**PROVISION OF ATS SURVEILLANCE SERVICES**

2.18. “Information derived from ATS surveillance systems, including safety-related alerts and warnings such as conflict alert and minimum safe altitude warning, should be used to the extent possible in the provision of air traffic control service in order to improve capacity and efficiency as well as to enhance safety.” [19]

“The number of aircraft simultaneously provided with ATS surveillance services shall not exceed that which can safely be handled under the prevailing circumstances, taking into account:

a) the structural complexity of the control area or sector concerned;

b) the functions to be performed within the control area or sector concerned;

c) assessments of controller workloads, taking into account different aircraft capabilities, and sector capacity; and

d) the degree of technical reliability and availability of the primary and backup communications, navigation and surveillance systems, both in the aircraft and on the ground.”[20]

**Existing IFATCA policy**

2.19. IFATCA[21] encourages the implementation of ATFM processes provided that:

- “The process achieves an optimum overall performance.
- Air Traffic Controllers and Flow Management Controllers are involved in the design of their local procedures and the determination of capacity values and / or occupancy values.
- The communication between and the compatibility of regional systems is established.
- The tactical capacity is managed on an operational level.
- The process, including restrictions, is transparent to all users.
- Procedures are in place to allow controllers to report occasions where they felt overloaded or sector capacity values were exceeded. Feedback should be given to the reporting controller.

2.20. Regarding the subjects related to Tower control, visual or VFR flights, into IFATCA’s Technical and Professional Manual, the VFR traffic workload has not yet been analysed and there is no policy on this subject.

**Airspace capacity determination based on observation**

2.21. In 2018, ANACNA (Associazione Nazionale degli Assistenti e Controllori della Navigazione Aerea) published a study[22] based on methodical observation, aiming to highlight the peculiarities and workload of Tower Air Traffic Controllers dealing with IFR and VFR high density traffic.

---

[19] Doc 4444 – Sixteenth Edition, 2016, Chapter 8.4.1

[20] Doc 4444 – Sixteenth Edition 2016, Chapter 8.4.2

[21] IFATCA Technical and Professional Manual – Version 66.0, October 2023, chapter 3.26 AIR TRAFFIC FLOW MANAGEMENT

[22] ANACNA - Determinazione del carico di lavoro VFR attraverso l’utilizzo comparativo della metodologia ACAM

2.22. ANACNA analysed traffic within Catania Air Traffic Zone (ATZ) and Catania Airport Fontanarossa (LICC).

2.23. They started the analysis from ICAO Doc 9426 – Air Traffic Services Planning Manual, which states that ‘the Workload of the controller is estimated by summing the time spent on individual tasks’[23] and from EUROCONTROL’s Reorganised ATC Mathematical Simulator (RAMS) methodology, where Controller Workload is defined as ‘the time spent to process all tasks in an interval of time for one executive controller’.

2.24. ANACNA counted the time needed for every controller involved in controlling a flight (GND, COO, TWR) and every action implied. They analysed departing and arriving IFR flights, departing and arriving VFR traffic, as well as VFR flights crossing the aerodrome traffic zone (ATZ).

2.25. If the RAMS method analysed work from five points of view (flight data management, conflict research, radio communications, coordination, radar activity), ANACNA added the time spent for visual contact with aircraft as well.

2.26. The study highlights that: -

“The operational impact of VFR flights resulted to be three times higher than the one produced by IFR flights”.

2.27. Visual search for the aircraft turns out to be a decisive task regarding the insertion of VFR flights into IFR traffic and/or VFR crossing runway extension centrelines or crossing the Aerodrome Traffic Zone (ATZ). In terms of dedicated time, it has a greater weight than the same task performed for IFR traffic.

2.28. Furthermore, the coordination activity in the case of VFR flights is clearly higher compared to the one performed for IFR flights[24].

2.29. VFR flights have different speed categories, use different routes and type of approach, and different reports. Any of this information, in case of coordination, lengthens the message and increases the complexity of it.

**Airspace capacity determination based on mathematical models**

2.30. IFATCA’s Technical and Operational Committee (TOC) have prepared for the 2024 Conference working paper B.5.11 – VFR Flights and Airspace Capacity Model Analyses. The paper presents workload analysis and airspace capacity determinations based on several mathematical models.

2.31. The paper presents the parameters and indicators to be taken into account for analysing delays, identifying best practices leading to increased capacity, detecting the differences and similarities of the models used. In future phases, it could be possible to apply to a common, optimised airport and ATC airspace sector capacity calculation model, enriched with the experience gained in that initial implementation.

2.32. The conclusion of the paper was that with few exceptions, most of the States have little

[23] ICAO Doc 9426 Air Traffic Services Planning Manual, Part II, Section 1, Chapter 1, par. 1.2.5.2. – First Edition, 1984

[24] Annex 1 - Time determination of task performance (ANACNA - Determinazione del carico di lavoro VFR attraverso l’utilizzo comparativo della metodologia ACAM)

practical experience in using a model for calculating capacity stating that,

"*This has an impact on the size of the available database that could be used to adjust constant values in each of the different operational scenarios in the systems of the Region, unlike the FAA, whose databases have been fed with data collected for many years and are constantly updated*."[25]

2.33. A very good practical example of VFR capacity determination is ANACNA's additional paper to its first study. In "ANACNA's approach to VFR capacity"[26], they calculated the maximum number of VFR flights which can be handled by ATCO in a Control zone (CTR). Starting from the aerodrome capacity per hour and the amount of time spent with each IFR traffic, they calculated first the amount of time left for all VFR traffic, and then, based on the time needed to handle one VFR flight, they obtained the maximum number of VFR flights to be handled in CTR.

2.34. A sensible observation from this paper arose: -

"Time is the main finite resource ATCOs have to handle and it affects different cognitive aspects and the decision-making process. For these reasons, time is also the basic aspect to be considered in establishing ATC capacity."[27]

**VFR and Special VFR flight (SVFR) existing regulation**

2.35. **ICAO**

2.35.1. ICAO defines Special VFR flight as a VFR flight cleared by air traffic control to operate within a control zone in meteorological conditions below VMC[28].

2.35.2. ICAO Annex 2 - Rules of the air[29] refers to Special VFR flights in 3.6.2.4 - Weather deterioration below the VMC:

"When it becomes evident that flight in VMC in accordance with its current flight plan will not be practicable, a VFR flight operated as a controlled flight shall:

a) request an amended clearance enabling the aircraft to continue in VMC to destination or to an alternative aerodrome, or to leave the airspace within which an ATC clearance is required; or

b) if no clearance in accordance with a) can be obtained, continue to operate in VMC and notify the appropriate ATC unit of the action being taken either to leave the airspace concerned or to land at the nearest suitable aerodrome; or

c) if operated within a control zone, request authorization to operate as a special VFR flight; or

d) request clearance to operate in accordance with the instrument flight rules."

2.35.3. Doc 4444 stipulates only general conditions for authorisation of Special VFR flights:

[25] WP B.5.11 - VFR Flights and Airspace Capacity Model Analyses, 3.1.6, Singapore 2024

[26] ANACNA – ANACNA's approach to VFR capacity

[27] ANACNA – ANACNA's approach to VFR capacity, Chapter 2.3.1

[28] ICAO Annex 2 – Rules of the air – Tenth edition, July 2005

[29] Doc 4444 – Sixteenth Edition, 2016, Chapter 8.4

“When traffic conditions permit, special VFR flights may be authorised subject to the approval of the unit providing approach control service and the provisions of 7.15.1.3.”

7.15.1.1 Requests for such authorization shall be handled individually.

7.15.1.2 Separation shall be affected between all IFR flights and special VFR flights in accordance with separation minima in Chapters 5 and 6 and, when so prescribed by the appropriate ATS authority, between all special VFR flights in accordance with separation minima prescribed by that authority.

7.15.1.3 When the ground visibility is not less than 1500 m, special VFR flights may be authorised to: enter a control zone for the purpose of landing, take off and depart from a control zone, cross a control zone or operate locally within a control zone.

“Special VFR flights shall not be vectored unless special circumstances, such as emergencies, dictate otherwise.”[30]

“Aerodrome control towers shall, when so prescribed in letters of agreement or local instructions, obtain approval from the unit providing approach control service prior to authorising operation of special VFR flights.”[31]

## 2.36. EASA

2.36.1. In 2012, the European Union Aviation Safety Agency (EASA) published supplementary regulations regarding rules of the air[32], which states that: -

***SERA.5010 Special VFR in control zones***

Special VFR flights may be authorised to operate within a control zone, subject to an ATC clearance. Except when permitted by the competent authority for helicopters in special cases such as medical flights, search and rescue operations and fire-fighting, the following additional conditions shall be applied:

(a) by the pilot:

(1) clear of cloud and with the surface in sight;

(2) the flight visibility is not less than 1500 m or, for helicopters, not less than 800 m;

(3) at speed of 140 kts IAS or less to give adequate opportunity to observe other traffic and any obstacles in time to avoid a collision; and

(b) by ATC:

(1) during day only, unless otherwise permitted by the competent authority;

[30] Doc 4444 – Sixteenth Edition, 2016, Chapter 8.10

[31] Doc 4444 – Sixteenth Edition, 2016, Chapter 10.1

[32] REGULATIONS - COMMISSION IMPLEMENTING REGULATION (EU) No 923/2012 of 26 September 2012, laying down the common rules of the air and operational provisions regarding services and procedures in air navigation and amending Implementing Regulation (EU) No 1035/2011 and Regulations (EC) No 1265/2007, (EC) No 1794/2006, (EC) No 730/2006, (EC) No 1033/2006 and (EU) No 255/2010

(2) the ground visibility is not less than 1500 m or, for helicopters, not less than 800 m;

(3) the ceiling is not less than 180 m (600 ft).

***SERA.8005 Operation of air traffic control service (b) states: -***

Clearances issued by air traffic control units shall provide separation:

(1) between all flights in airspace Classes A and B;

(2) between IFR flights in airspace Classes C, D and E;

(3) between IFR flights and VFR flights in airspace Class C;

(4) between IFR flights and special VFR flights;

(5) between special VFR flights unless otherwise prescribed by the competent authority.

***SERA.8020 Adherence to flight plan (d) states: -***

Weather deterioration below the VMC. When it becomes evident that flight in VMC in accordance with its current flight plan will not be practicable, a VFR flight operated as a controlled flight shall:

(1) request an amended clearance enabling the aircraft to continue in VMC to destination or to an alternative aerodrome, or to leave the airspace within which an ATC clearance is required; or

(2) if no clearance in accordance with a) can be obtained, continue to operate in VMC and notify the appropriate ATC unit of the action being taken either to leave the airspace concerned or to land at the nearest suitable aerodrome; or

(3) if operated within a control zone, request authorisation to operate as a special VFR flight; or

(4) request clearance to operate in accordance with the instrument flight rules.

**SVFR authorisation and impact on complexity and workload**

2.37. As already presented, according to ICAO regulation, ATC may authorise a flight to operate within a control zone “when traffic conditions permit” and ground visibility is not less than 1500 m.

2.38. According to EASA regulation, ATC may authorise a flight to operate within a control zone during day only (unless otherwise permitted by the competent authority), when the ground visibility is not less than 1500 m (or, for helicopters, not less than 800 m) and the ceiling is not less than 180 m (600 ft).

2.39. It can be observed that the only condition for authorising or not a flight as SVFR is the weather: visibility only (ICAO), respective day/night, visibility and ceiling (EASA).

2.40. The point in maintaining the 5000 m value for visibility could be the desire to cautionary remind pilots and/or controllers to pay more attention to flight. Otherwise, if everyone asking for SVFR may obtain the authorisation, the visibility value could be degraded to 1500 m in the first place.

2.41. The answer may be related though to whether there is or there is no other aircraft at the same time in the same area. This aircraft could fly IFR or could ask for SVFR authorisation as well. So how many SVFR flights could be allowed in the same area? Some could ask for a specific number of SVFR flights allowed in the same area at the same time, some could sustain best judgement in approving or not one or more SVFR flights, and others could encourage the use of VFR/SVFR routes.

**Methods for managing VFR flights**

2.42. In order to have the same reference and understanding, it is important to have a published chart with relevant points for VFR flight.

2.43. These points, known as Visual Reference Points (VRPs) should be visible by day and night, easily recognisable, based upon prominent features (e.g., road junctions, buildings, lakes, river confluences or reservoirs) and should ensure no confliction with adjacent aerodromes.

2.44. As the UK Civil Aviation Authority explains, the purpose of a VRP[33] is to facilitate:

a. ATC provision of routing advice within, beneath or adjacent to Controlled Airspace to facilitate access and transit of VFR traffic.

b. ATC provision of routing advice outside Controlled Airspace to assist the deconfliction of traffic using instrument approaches or departure procedures.

c. Radar identification.

Moreover,

“VRPs may be established to support with temporary airspace arrangements notified for special events”[34].

2.45. The use of VRPs will help ATCO ensure VFR traffic integration into IFR traffic flow or to keep them apart. Based on VRPs, there could be defined VFR and SVFR routes, as well as VFR geographical areas and aerodrome traffic zones (ATZ).

2.46. There are situations though when there are no designated routes for VFR/SVFR flights, no visual reference points (VRP) and even no VFR Charts. In those cases, the only instrument at hand is traffic priority, but workload and complexity will increase rapidly.

2.47. Complexity induced by a flight operating SVFR or the increasing workload implied are not mentioned anywhere, even though these are obviously high. It is supposed that ATC will always apply the best judgement.

2.48. Mixed traffic obeying instrument (IFR) and visual rules (VFR) in the same airspace raise complexity. Especially in those moments, ATCO should apply procedures, rules and regulations properly designed and risk assessed.

---

[33] UK CAA - Policy Statement 16 July 2019 - POLICY FOR THE ESTABLISHMENT OF VISUAL REFERENCE POINTS (VRPs), par. 2.1

[34] UK CAA - Policy Statement 16 July 2019 - POLICY FOR THE ESTABLISHMENT OF VISUAL REFERENCE POINTS (VRPs), par. 2.2

### Complexity and methods to reduce it

2.49. As stated before, complexity is very difficult to be quantified. We have seen that air traffic flow management does not take into consideration VFR traffic and there is no scope (or possibility) to change this situation in near future.

2.50. Beside the number of aircraft dealt with, there are many more variables that must be considered. We can record the number of aircraft controlled, we can measure the time needed to perform a task, we can measure the controller's heart rate during performing a task or the impact of noise and temperature of the environment when performing a task. Still, complexity means more than that and the more important task is to identify methods of reducing complexity as much as possible.

2.51. In order to obtain an orderly and expeditious traffic and to prevent complexity getting too high, the structure of the airspace needs standardisation. In addition, rules and procedures are the keys especially within airspace governed by mixed flight rules (IFR and VFR/SVFR).

2.52. In control zones (CTR) and Air traffic zones (ATZ), visual reference points (VRP) are very helpful. Based on them, VFR routes can be defined, as well as dedicated VFR geographical areas where appropriate. That can help with workload management on both sides, pilot and controller: as the pilots can brief themselves and train themselves better before the flight and the controller can send VFR flights into areas clear of IFR traffic, which ease the use of geographical separation.

2.53. In the end, it is all about managing the expectations. Flying a prescribed route with determined characteristics will narrow the path for VFR flights as opposed to allowing the freedom of flying unrestrictedly. This will increase predictability and by that will reduce significantly the controller's workload.

2.54. All information regarding VFR flights should be published on VFR Charts, along with VRPs and VFR/SVFR routes.

2.55. If VFR traffic volume and airspace structure permit, VFR control position with its own control frequency should be taken into consideration.

## 3. CONCLUSION

3.1. VFR traffic impacts airspace capacity as well as complexity.

3.2. As ICAO stated,

"*It would be extremely complex to establish a universal rule to calculate capacity,* which can be affected by so many variables and external considerations that standardisation is simply not possible".

3.3. In order to reduce complexity induced by VFR traffic, ANSPs, at least for busy airports, should define for VFR and SVFR flights guidance visual reference points (VRP), designated routes and procedures.

3.4. MAs should urge ANSPs to consider the likely routes and risks of VFR/SVFR flights and the impact that would have on the air traffic controllers. Mitigations should be put in place to manage the workload of the air traffic controllers.

3.5. Regarding the airspace capacity, the number of aircraft provided with ATC service should not exceed that which can be safely handled by the ATS unit concerned.

3.6. The appropriate ATS authority should determine and declare the airspace capacity for control sectors (control area, terminal area, control zone) and for airports, as the maximum number of flights that can safely be managed.

3.7. For determination of airspace capacity, ICAO's list of criteria[35] should be completed with three more, regarding configuration of airspace, flight rules applied (IFR/ VFR/mixed) and weather conditions (normal visibility operations /low visibility operations).

## 4. DRAFT RECOMMENDATIONS

4.1 It is recommended that the following be accepted as policy and inserted into the TPM:

| ATS 3.47 - VFR AND SPECIAL VFR FLIGHTS |
|---|
| Information regarding VFR flights should be published on VFR charts.<br><br>ANSPs should consider the impact of VFR/SVFR flights on the workload of Air Traffic Controllers and mitigations should be put in place if required.<br><br>If VFR/SVFR traffic volume warrants, and the airspace structure permits, a dedicated VFR control position should be considered.<br><br>When appropriate, ANSPs should determine visual reference points (VRP), designated routes and procedures to manage the workload of the Air Traffic Controllers. |

## 5. REFERENCES


Advanced Engineering Informatics, Volume 57, August 2023, 102113 - Air Traffic Controller Workload Level Prediction using Conformalized Dynamical Graph Learning - Yutian Pang, Jueming Hu, Christopher S. Lieber, Nancy J. Cooke, Yongming Liu

ANACNA - Determinazione del carico di lavoro VFR attraverso l'utilizzo comparativo della metodologia ACAM

Information Paper, IFATCA Conference 2024 - ANACNA's approach to VFR capacity

Doc 4444 – Sixteenth Edition, 2016

ICAO Annex 2 – Rules of the air – Tenth edition, July 2005


[35] ICAO Doc 9971 - Third Edition, 2018, Chapter 3.1.5

ICAO Annex 11 - Air Traffic Services – Thirteenth Edition, July 2001

ICAO DOC 9426 - AN/924 - Air Traffic Services Planning Manual - First (Provisional) Edition – 1984

ICAO DOC 9971- Manual on Collaborative Air Traffic Flow Management (ATFM) - Third Edition, 2018

REGULATIONS - COMMISSION IMPLEMENTING REGULATION (EU) No 923/2012 of 26 September 2012, laying down the common rules of the air and operational provisions regarding services and procedures in air navigation and amending Implementing Regulation (EU) No 1035/2011 and Regulations (EC) No 1265/2007, (EC) No 1794/2006, (EC) No 730/2006, (EC) No 1033/2006 and (EU) No 255/2010

Transportation Research Record Journal of the Transportation Research Board, 80th Annual Meeting, 2001, Washington, DC - Estimating the Capacity Of Europe's Airspace Using A Simulation Model Of Air Traffic Controller Workload

UK CAA - Policy Statement 16 July 2019 - Policy for the establishment of Visual Reference Points (VRPs)

Unregulated VFR Flights and its mitigating procedure – b.5.11 at the 63rd Annual Conference, Singapore, 15-19 April, 2024

**ANNEX 1**

ANACNA - Determinazione del carico di lavoro VFR attraverso l'utilizzo comparativo della metodologia ACAM

## TIME DETERMINATION OF TASK PERFORMANCE

| **Task description** | **Execution time** | | |
|---|---|---|---|
| Flight data management | GND | COO | TWR |
| Control of incoming flight list | 2” | 5” | 5” |
| | | | |
| Search for conflicts | GND | COO | TWR |
| Check flight progress strip on fix designators for potential conflict detection | 2” | 5” | 5” |
| Visual check radar screen for nearby VFR traces and entering ATZ | // | 4” | 5” |
| | | | |
| Eye contact with aircraft | GND | COO | TWR |
| Sighting | 3” | 5” | 5” |
| | | | |
| Radio communications | GND | COO | TWR |
| First a/c call on the ground | 10” | // | 8” |
| Taxi instruction/take-off clearance | 8” | // | 6” |
| Abbreviated FPL/strip marking | 20” | // | 10” |
| Aircraft report on VRP/RHP | 4” | // | 4” |
| In-flight instructions/ground traffic information | 5” | // | 16” |

| Task description | Execution time | | |
|---|---|---|---|
| Coordination | GND | COO | TWR |
| Coordination with neighbouring entities/TWR-GND<br>Closure of flight plans/parking | 6” | 20” | 4” |
| Search routing and exit points on AOIS<br>Logging, CBO | // | 50” | // |
| | | | |
| Radar activity | GND | COO | TWR |
| VFR flight navigation assistance<br>Convergences | // | // | 15” |
| Radar screen observation for VFR paths<br>Entry/Exit | // | 5” | 5” |

| Task description | Execution time | | |
|---|---|---|---|
| Management of Incoming VFR flight<br>NO FPL | GND | COO | TWR |
| Check incoming flight list | 2” | // | 3” |
| Strip marking | 5” | 15” | 8” |
| | | | |
| Search for conflicts | GND | COO | TWR |
| Check strips on fix designators | 2” | 3” | 3” |
| Visual inspection of the ATZ border on radar screen | // | 3” | 4” |
| | | | |
| Eye contact with a/c | | | |
| Visual search of a/c<br>Approach / circuit / manoeuvring area | 3” | 5” | 10” |

| | | | |
|---|---|---|---|
| Communications | | | |
| First call a/c<br>ATZ input, FPL/ABB data | // | // | 8” |
| ATZ input instructions<br>Parking taxi | 5” | // | 5” |
| Instructions to maintain/report VRP | // | // | 5” |
| Route instructions to follow, altitude carryover | // | // | 5” |
| Traffic circuit | // | // | 18” |
| Last communication on the ground<br>GND transfer | // | // | 8” |

| **Task description** | **Execution time** | | |
|---|---|---|---|
| Coordination activities | GND | COO | TWR |
| TWR/GND verbal coordination | 3” | // | 3” |
| Coordination with neighbouring units (if FPL) | // | 25” | // |
| Parking management | // | 25” | // |
| COO support for TWR/GND | // | 3” | // |

| **Task description** | **Execution time** | | |
|---|---|---|---|
| Radar activity | GND | COO | TWR |
| Radar observation for VFR tracks<br>ATZ entry/approach | // | 3” | 5” |
| VFR traffic information<br>Convergence on the same point | // | // | 20” |

**VFR flight crossing ATZ**

| Task description | Execution time | | |
|---|---|---|---|
| Flight data management | GND | COO | TWR |
| Check inbound flight list | // | 2” | 3” |
| FPL/strip marking data writing | // | // | 8” |

| Task description | Execution time | | |
|---|---|---|---|
| Search for conflicts | GND | COO | TWR |
| Check strip fix designators | // | 2” | 4” |
| Radar screen check for VFR paths in the vicinity of ATZ | // | 2” | 4” |

| Task description | Execution time | | |
|---|---|---|---|
| Eye contact with aircraft | GND | COO | TWR |
| VFR a/c search in the vicinity of the airport for reduction of separations | // | 2” | 4” |
| Radar screen check for VFR paths in the vicinity of ATZ for crossings | // | 4” | 8” |

| Task description | Execution time | | |
|---|---|---|---|
| Radio communications | GND | COO | TWR |
| First call of incoming a/c before enter ATZ | // | 3” | 3” |
| Instructions for a/c entering ATZ to report VRP | // | // | 15” |

| | | | |
|---|---|---|---|
| Instructions for flight direction, wait at VRP, report altitude | // | // | 13” |
| Crossing authorization, traffic information | // | // | 18” |
| Last outgoing call before leaving ATZ | // | // | 7” |

| **Task description** | **Execution time** | | |
|---|---|---|---|
| Coordination activities | GND | COO | TWR |
| In/out coordination with neighbouring units | // | 31” | // |

| **Task description** | **Execution time** | | |
|---|---|---|---|
| Radar activity | GND | COO | TWR |
| Check radar screen for VFR paths approaching ATZ | // | 3” | 3” |
| Traffic information to convergent VFR flights | // | // | 20” |

| **Task description** | **Execution time** | | |
|---|---|---|---|
| Coordination activities | GND | COO | TWR |
| In/out coordination with neighbouring units | // | 31” | // |

**IFR flight departing**

| **Task description** | **Execution time** | | |
|---|---|---|---|
| Flight data management | GND | COO | TWR |
| Check flight list | 3” | // | 3” |
| EOBT verification/stand verification | 4” | // | 3” |

| | | | |
|---|---|---|---|
| Check route and type of aircraft | 3” | // | 3” |

| Task description | Execution time | | |
|---|---|---|---|
| Search for conflicts | GND | COO | TWR |
| Stand interactions for simultaneous push back and/or taxiing traffic | 5” | // | 2” |

| Task description | Execution time | | |
|---|---|---|---|
| Eye contact search | GND | COO | TWR |
| Eye contact | 2” | // | 3” |

| Task description | Execution time | | |
|---|---|---|---|
| Coordination activities | GND | COO | TWR |
| In/out coordination with neighbouring units | // | 31” | // |

| Task description | Execution time | | |
|---|---|---|---|
| Radio communications | GND | COO | TWR |
| First call of incoming aircraft / weather information | 6” | // | 4” |
| Taxi instruction / take-off clearance | 4” | // | 5” |
| Clearance for take off / to vacate the runway | 9” | // | 5” |
| Last call before the aircraft leaves the airspace | 5” | // | 4” |

| Task description | Execution time | | |
|---|---|---|---|
| Coordination activities | GND | COO | TWR |
| TWR/GND coordination for efficient aircraft positioning on manoeuvring area | 5” | 3” | 5” |
| Coordination with APP for SID/runway change | 5” | 10” | // |

| Task description | Execution time | | |
|---|---|---|---|
| Radar activity | GND | COO | TWR |
| Radar monitoring | // | // | 5” |

**IFR flight arrival**

| Task description | Execution time | | |
|---|---|---|---|
| Flight data management | GND | COO | TWR |
| Check flight list | 2” | 2” | 2” |
| Standard check | 2” | 2” | 2” |
| Check route and aircraft type | 2” | // | 2” |

| Task description | Execution time | | |
|---|---|---|---|
| Search for conflicts | GND | COO | TWR |
| Stand interactions for simultaneous pushback and/or taxiing traffic | 5” | // | 2” |

| Task description | Execution time | | |
|---|---|---|---|
| Eye contact search | GND | COO | TWR |
| Aircraft observation | 2” | // | 3” |

| Task description | Execution time | | |
|---|---|---|---|
| Radio communications | GND | COO | TWR |
| First call of incoming aircraft / weather information | 3” | // | 5” |
| Taxi instructions | 4” | // | // |
| Instructions to vacate the runway | // | // | 5” |
| Last communication | // | // | 6” |

| Task description | Execution time | | |
|---|---|---|---|
| Coordination activities | GND | COO | TWR |
| TWR/GND coordination | 3” | // | 3” |
| Coordination with APP for track/visual change<br>Coordination with Handling | // | 10” | // |

| Task description | Execution time | | |
|---|---|---|---|
| Radar activity | GND | COO | TWR |
| Radar monitoring | // | // | 10” |

**Summary table of total time of task execution for one flight**

| | Departure |
|---|---|

| | VFR | IFR |
|---|---|---|
| Flight data management | 12” | 16” |
| Search for conflicts | 20” | 7” |
| Eye contact search | 91” | 41” |
| Radio communication | 80” | 28” |
| Coordination activities | 25” | 5” |
| Radar activity | 241” = 4’01” | 104” = 1’44” |
| Total | | |
| | **Arrival** | |
| | **VFR** | **IFR** |
| Flight data management | 32” | 16” |
| Search for conflicts | 15” | 7” |
| Eye contact search | 13” | 5” |
| Radio communication | 54” | 23” |
| Coordination activities | 34” | 16” |
| Radar activity | 28” | 10” |
| Total | 176” = 2’56” | 77” = 1’17” |

| | VFR Crossing |
|---|---|
| | **VFR** |
| Flight data management | 13” |
| Search for conflicts | 12” |
| Eye contact search | 12” |
| Radio communication | 56” |

| | |
|---|---|
| Coordination activities | 31” |
| Radar activity | 24” |
| Total | 148” = 2’28” |

| | IFR Departure | IFR Arrival |
|---|---|---|
| Flight data management | 16” | 16” |
| Search for conflicts | 7” | 7” |
| Eye contact search | 5” | 5” |
| Radio communication | 41” | 23” |
| Coordination activities | 28” | 16” |
| Radar activity | 5” | 10” |
| Total | 104” = 1’44” | 77” = 1’17” |
| Total general | 181” = 3’01” | |

| | VFR Departure | VFR Arrival | VFR Crossing |
|---|---|---|---|
| Flight data management | 12” | 32” | 13” |
| Search for conflicts | 20” | 15” | 12” |
| Eye contact search | 13” | 13” | 12” |
| Radio communication | 91” | 54” | 56” |
| Coordination activities | 80” | 34” | 31” |
| Radar activity | 25” | 28” | 24” |
| Total | 241” = 4’01” | 176” = 2’56” | 148” = 2’28” |
| Total general | 565” = 9’25” | | |