

Review of Automation Policies

Presented by TOC and PLC

SUMMARY

The paper examines existing policies in the TPM about automation such as WC 10.2.5 on human factors and TRNG 9.2.5 on controllers training. The purpose of this analysis is to check their validity and relevance regarding developed automation systems.

1. INTRODUCTION

- 1.1. In the dynamic landscape of Air Traffic Management (ATM), the integration of automation has emerged as a transformative force with the potential to reshape operational efficiency and safety. With a commitment to enhancing data exchange, ensuring integrity, and balancing human-machine collaboration, the paper seeks to harness the advantages of automation while safeguarding the central role of air traffic controllers (ATCOs). In this analysis, the key principles and considerations put forth by the policies, shedding light on their implications for ATM, human factors, legal responsibility, and the delicate equilibrium between technology and human expertise.
- 1.2. The recent introduction of technologies such as Artificial Intelligence and Machine Learning (AI and ML) algorithms in ATM, seem to alter the ATCO's job functions and hence the training requirements.
- 1.3. The paper analyses policies about automation in the IFATCA Technical and Professional Manual (TPM) and will determine whether they are still valid or if they need updating.

2. DISCUSSION**2.1. Background**

- 2.1.1. Automation in ATM generally refers to the condition of operating with equipment that requires reduced human intervention. Automation can be utilised as fully or semi-automated systems.

- 2.1.2. Over the years, automation has proven beneficial in many areas of ATM like reducing the workload on ATCOs (automated data exchange between ATS units removes the need for verbal estimates for every single aircraft), reducing the risk of human errors (for example Short Term Conflict Alert (STCA), Medium-Term Conflict Detection (MTCD), Minimum Safe Altitude Warning (MSAW), enhancing situational awareness (for example Mode S), improving efficiency.
- 2.1.3. The implementation of new systems and tools used by ATCOs is a key element in improving efficiency and quality of service provided. Traffic levels that are increasing yearly cannot be reached without it. Higher levels of automation are central enablers for the entire ATM system to meet these challenges.
- 2.1.4. It is important to note that for the moment automation in ATM is used only as a supporting tool for information and suggestions to ATCOs. It does not make decisions on its own. At the same time there are a lot of ongoing projects that are looking into possibilities for self-generated clearances and full automation in some aspects of the work.
- 2.1.5. One example of scientific research on the topic is the Project Bluebird led by The Alan Turing Institute of the UK, with the assistance of NATS, the ANSP in the UK. It is a project that aims to use a probabilistic ML to deliver safer, more efficient and predictable air traffic control (The Alan Turing Institute, 2024).

2.2. Existing policies

- 2.2.1. IFATCA's policies on automation can be found in different sections of the TPM. The paper will examine if there is a need for creating new policies about introductions in ATM that can be qualified as automation, or modifying the existing policies.
- 2.2.2. One of these policies is WC 10.2.5 AUTOMATION / HUMAN FACTORS:

Automation shall improve and enhance the data exchange for controllers. Automated systems shall be fail-safe and provide accurate and incorruptible data. These systems shall be built with an integrity factor to review and crosscheck the information being received.

The human factors aspects of Automation shall be fully considered when developing automated systems.

Automation shall assist and support ATCOs in the execution of their duties.

The controller shall remain the key element of the ATC system.

Total workload should not be increased without proof that the combined automated/human systems can operate safely at the levels of workload predicted, and to be able to satisfactorily manage normal and abnormal occurrences. Automated tools or systems that support the control function shall enable the controller to retain complete control of the control task in such a way so as to enable the controller to support timely interventions when situations occur that are outside the normal compass of the system

design, or when abnormal situations occur which require non-compliance or variation to normal procedures.

Automation should be designed to enhance controller job satisfaction.

The legal aspects of a controller's responsibilities shall be clearly identified when working with automated systems.

A Controller shall not be held liable for incidents that may occur due to the use of inaccurate data if he is unable to check the integrity of the information received.

A Controller shall not be held liable for incidents in which a loss of separation occurs due to a resolution advisory issued by an automated system.

Guidelines and procedures shall be established in order to prevent incidents occurring from the use of false or misleading information provided to the controller.

The number of items displayed on one label and the number of items/information displayed on the current screen should be set after a dedicated study. Safety tools should not be deactivated (IFATCA, 2023).

- 2.2.3. Policy development over time
- 2.2.4. A Working Paper was prepared for the 1990 Acapulco Conference, but this was withdrawn during the proceedings of Committee C. Although the working papers were prepared for information purposes only, certain objections to the content of the paper resulted in it being withdrawn and the subject retained on the Work Programme of SC4 for further consideration. During further discussion on this subject, SC4 decided to broaden the topic to include all aspects of Automation and the Controller, rather than focus specifically on Mode S implications. Although the subject of Automation and the ATCO involves Technical and Legal aspects, this Working paper, prepared by SC4, concentrates on the Human Factors considerations (IFATCA, 1991).
- 2.2.5. The following year, 1991, at the conference in Trinidad and Tobago, the base of today's policy was introduced.
- 2.2.6. Analysing each part of WC 10.2.5 separately
- 2.2.7. In order to have a better understanding of the significance and validity of the policy quoted in 2.2.2. each part of it will be separately analysed.
- 2.2.8. ***“Automation shall improve and enhance the data exchange for controllers. Automated systems shall be fail-safe and provide accurate and incorruptible data. These systems shall be built with an integrity factor to review and crosscheck the information being received.”***
- 2.2.9. Enormous amounts of data drive decisions in ATC. It is important that this data is accurate and reliable. As the data that ATCOs take into account when making a

decision increases, it is essential to have information from the system if some of the data is corrupted or maybe not accurate enough.

- 2.2.10. This policy has been examined and does not need an update at this time.
- 2.2.11. ***“The human factors aspects of Automation shall be fully considered when developing automated systems.”***
- 2.2.12. Recognizing the importance of human factors is essential when developing automated systems. Automation should consider human operators' capabilities and limitations to ensure seamless interaction between technology and controllers.
- 2.2.13. This policy has been examined and does not need an update at this time.
- 2.2.14. ***“Automation shall assist and support ATCOs in the execution of their duties. The controller shall remain the key element of the ATC system.”***
- 2.2.15. IFATCA supports a human-centric approach so ATCOs remain the heart of the ATM system. High levels of automation lead to a revision of ATCOs' duties. New systems are likely to alter the tasks that the human is supposed to do. They should be implemented to assist and not to take over the ATCO's execution of his/her duties.
- 2.2.16. This policy has been examined and does not need an update at this time.
- 2.2.17. ***“Total workload should not be increased without proof that the combined automated/human systems can operate safely at the levels of workload predicted, and to be able to satisfactorily manage normal and abnormal occurrences. Automated tools or systems that support the control function shall enable the controller to retain complete control of the control task in such a way so as to enable the controller to support timely interventions when situations occur that are outside the normal compass of the system design, or when abnormal situations occur which require non-compliance or variation to normal procedures.”***
- 2.2.18. The first sentence of the policy mentions the combined human/machine system to operate safely and “*satisfactorily manage normal and abnormal occurrences*”. It is suggested that this should be changed to only “*unusual occurrences*”. Normal situations are the main purpose of the operation of this system. It is not expected for such a system to be unable to manage normal situations satisfactorily.
- The rest of the policy has been examined and does not need an update at this time.
- 2.2.19. ***“Automation should be designed to enhance controller job satisfaction.”***
- 2.2.20. It is generally recognised that educated personnel with higher levels of skill and status (which includes ATCOs) find that their main source of satisfaction in a job lies in its intrinsic interest to them (Herzberg, 1957). A satisfying job should require effort, provide a challenge, and make use of the person's skills. Automation may

well reduce the effort of certain tasks and the stress associated with them but may lead to loss of job satisfaction by taking away some of the intrinsic interests of the job, and the perceived 'control' over certain functions. It is widely accepted that the challenges of the ATCO's job are one of the main reasons that ATCOs enjoy their profession. Even working under difficult circumstances, sometimes with inadequate equipment and with high traffic levels, ATCOs may well perceive they are working very hard, possibly under great stress, but afterwards they will generally accept that they have achieved a great deal in dealing with a complex and busy situation – and will find an element of satisfaction. A reduction of workload through automation, to the point that job satisfaction is reduced, can lead to boredom and general discontent (Imroz, Sadique, & Trambadia, 2022).

2.2.21. The only amendment proposed here is to change the word “*enhance*”. Job satisfaction is not something that needs to be enhanced by automation. It is there but with new automation that is implemented it can easily be reduced or even lost. It is proposed the word “*enhance*” be replaced by “*take into account*”.

2.2.22. The last three sentences of the existing policy are about the liability of the human controller:

“The legal aspects of a controller’s responsibilities shall be clearly identified when working with automated systems.

Controllers shall not be held liable for incidents that may occur due to the use of inaccurate data if they are unable to check the integrity of the information received.

Controllers shall not be held liable for incidents in which a loss of separation occurs due to a resolution advisory issued by an automated system.”

2.2.23. The policy is designed to provide legal clarity and protection for controllers working with automated systems. It acknowledges the inherent challenges of real-time decision-making and potential limitations in verifying data integrity by explicitly stating non-liability in situations involving inaccurate data or loss of separation due to automated advisories.

2.2.24. The scope of the policy is clear and does not need any change but it can be slightly reworded in order to be shorter but to remain strong. It is proposed to be: *“Legal responsibilities for controllers using automated systems shall be explicitly defined. Controllers shall not be held liable for incidents resulting from inaccurate data if unable to verify its integrity or for a loss of separation due to an automated resolution advisory.”*

2.2.25. ***“The number of items displayed on one label and the number of items/information displayed on the current screen should be set after a dedicated study. Safety tools should not be deactivated.”***

2.2.26. This policy has been examined and does not need an update at this time.

- 2.2.27. The policy outlined in TRNG 9.2.5 AUTOMATION CONTROLLER TRAINING addresses the essential aspect of training for air traffic controllers. The existing policy states that:

Controllers required to operate in an automated air traffic control system should receive relevant instruction in automatic data processing for ATC.

Formal training should be established for all ATC personnel in the theoretical and practical procedures associated with the automated ATC system.

The above training should be carefully integrated with the implementation of each stage of the automated ATC system.

The implementation of automated systems shall include sufficient training, including the Human Factors aspects of automation, prior to using new equipment. The level of training is a major factor in determining the level of traffic that can be safely handled until all controllers have gained enough hands-on experience.

- 2.2.28. Policy development over time.
- 2.2.29. The very first paper on this topic was presented in 1978 in Copenhagen. It was accepted as information material but SC 5 requested to look further into the matter. The first version of this policy was formulated in 1979 (WP No. 23, Brussels, Belgium, 23-27 April 1979).
- 2.2.30. A review of the whole training section in the TPM was placed in 2007 as it was thought to be outdated and too extensive (WP No. 164, Istanbul, Turkey, 16-20 April 2007).
- 2.2.31. Back then it was mainly considered to ensure that controllers receive proper training in using the automated ATC system. Nowadays there are a lot of advanced systems that are operated by ATCOs and need also to be taken into account when speaking about automation in general.
- 2.2.32. Analysing each part of TRNG 9.2.5 separately.
- 2.2.33. The policy outlined in TRNG 9.2.5 addresses the essential aspect of training for air traffic controllers who operate in joint human-machine systems. This policy emphasises the importance of adequately preparing controllers to work effectively and safely within automated environments. In order to further analyse the policy specified in 2.2.27 each part of it will be addressed individually.
- 2.2.34. ***“Controllers required to operate in an automated air traffic control system should receive relevant instructions in automatic data processing for ATC.”***
- 2.2.35. Automation is supposed to support the human in the execution of his/her duties. It is superfluous to refer to the human as working *“in the system”* as written in the policy. After examination it is suggested that the preposition *“in”* should be replaced with *“as part of”*.

- 2.2.36. In many places automated systems that operate with flight data are in place (for example Network Manager in Europe) and ATCOs are no longer expected to have a deeper understanding of what these flight data systems are doing (EUROCONTROL, n.d.).
- 2.2.37. The key word in this part of the policy is “*relevant*”. It has different meanings for different systems and levels of automation. Even though ATCOs are not expected to have a deeper understanding of how the data processing works, they still need a level of knowledge that is relevant in order to perform their tasks.
- 2.2.38. This policy has been examined and does not need an update at this time.
- 2.2.39. **“*Formal training should be established for all ATC personnel in the theoretical and practical procedures associated with the automated ATC system.*”**
- 2.2.40. The policy highlights the significance of both theoretical and practical training in the context of automated ATC systems. Theoretical training equips controllers with the necessary knowledge of the underlying principles and concepts of automation. Practical training ensures that controllers gain hands-on experience in using the automated ATC system effectively.
- 2.2.41. The policy is strong and valid but it can benefit from an addition regarding fallback procedures. It is important for ATCOs to be trained and gain relevant experience in situations of automation failure. If training more than once a year is provided ATCOs would be confident enough to safely manage such situations. The following is suggested to be inserted in the policy:
- “...including automation failure and fallback procedures at least once every year”.
- 2.2.42. **“*The above training should be carefully integrated with the implementation of each stage of the automated ATC system.*”**
- 2.2.43. The policy emphasises the need for close integration between training and the implementation of each stage of the automated ATC system. This approach ensures that controllers receive training that is relevant and tailored to the specific automation features being introduced. Effective integration prevents a disconnect between theoretical training and practical application.
- 2.2.44. This policy has been examined and does not need an update at this time.
- 2.2.45. **“*The implementation of automated systems shall include sufficient training, including the Human Factors aspects of automation, prior to using new equipment.*”**

- 2.2.46. Human factors aspects are also a subject of the other policy analysed in this paper - WC 10.2.5 (para 2.2.11). The term used there is “*developing*” which does not only mean writing a code but the whole process of defining, designing, testing, training, and implementing a new software application or program.
- 2.2.47. As this is a subject that is covered in other policies, it is proposed this part of the policy be removed.
- 2.2.48. **“The level of training is a major factor in determining the level of traffic that can be safely handled until all controllers have gained enough hands-on experience.”**
- 2.2.49. The policy acknowledges that the level of training received by controllers is a critical factor in determining the safe capacity for handling air traffic. Controllers' proficiency in using automated systems, on the other hand, directly affects their ability to manage traffic efficiently and respond to unexpected situations.
- 2.2.50. It is suggested the term “*level of training*” be replaced by “*level of proficiency*”.

2.3. **The term “ATC system” in the existing policies**

- 2.3.1. The term “*ATC system*” as used in both policies does not capture the other functions of air traffic management (ATM) performed by ATCOs. ATM is defined as: The aggregation of the airborne and ground-based functions (air traffic services, airspace management and air traffic flow management) required to ensure the safe and efficient movement of aircraft during all phases of operations (ICAO, 2016).
- 2.3.2. ATM as an umbrella term describes a broader set of functions beyond air traffic control. This definition makes ATC a subset of ATM and hence more appropriate to use “*ATM system*” instead of “*ATC system*” in these policies.

2.4. **AI and ML as automation**

- 2.4.1. The application (or expected) of new technologies such as AI, ML and deep learning (DL) in ATM has brought new complexities not previously anticipated by the existing policy. Currently, automation is used to aid the ATCO in traffic management decisions, but new applications in the foreseeable future seek to alter this position, and the function of the ATCO thereby.
- 2.4.2. It is believed that future ATCOs' duties would be more of a passive control than active one (Metzger & Parasuraman, 2001). The existing training policy on automation should be modified to anticipate and align with this evolving direction, addressing the challenges it may present.
- 2.4.3. It is imperative that the abilities of the ATCO are reinforced to match the demand that the new level of automation is bringing to the ATM environment. This suggests that the ATCO at the centre of the ATM system should have sufficient knowledge of the system, especially regarding AI and ML applications, to be able to intervene during unusual situations such as emergencies or system failures.
- 2.4.4. It then calls for more rigorous training of the ATCO in emerging technologies like AI and ML, among others as applied in ATM. This will enhance the capacity of the

ATCO to act appropriately in response to unusual situations. This is supported by IFATCA policy on AI and ML (AAS 1.20) which states the following:

Artificial Intelligence and/or Machine Learning based systems should only be implemented as decision support systems and shall not replace the decision of the ATCO.

Where an ATCO is responsible for decision making, and in the event that system tools fail or are not available, the ATCO should always have the capacity to safely manage their area of responsibility (IFATCA, 2022).

- 2.4.5. Prior to the introduction of new automation of any kind, ATCOs are usually given training to be able to utilise the new equipment or technology. However, this is likely to be insufficient when applied to AI and ML technologies.
- 2.4.6. AI and ML applications are more sophisticated intrusions to the ATM system and might be more complex in understanding how it works for the average ATCO without a thorough and in-depth training.
- 2.4.7. A human-centered AI – HCAI (IBM, n.d.) is one example of an approach that gives opportunities for ATCOs to gain knowledge about AI systems throughout the whole process of development and also training on how to use these systems.
- 2.4.8. It is suggested the following text should be added to policy TRNG 9.2.5 – Automation Controller Training:

AI systems or applications in ATM shall be human-centred throughout the whole development process. ATCOs shall be thoroughly trained and introduced to the new concepts, including AI systems and ML algorithms, to be able to handle all traffic situations, and also during unforeseen situations such as emergencies or system failure.

3. CONCLUSION

- 3.1. The principles outlined in policy 10.2.5 are still valid. By emphasising the importance of seamless data exchange, reliability, the importance of human factors and clear responsibilities, the policy places controllers at the centre of the ATM system harmonising human-machine collaboration.
- 3.2. Policy addressing automation in air traffic management should strive for greater generality, focusing on overarching principles rather than specific instances. By adopting a broader approach, the policy can provide guidance that accommodates evolving technologies and scenarios, ensuring its relevance across various contexts within the dynamic field of air traffic management.
- 3.3. The existing TRNG 9.2.5 policy on automation controller training does appear to be relevant and important, even in the context of advancements like AI and ML technologies. The principles outlined in the policy, such as formal training, integration with system implementation, human factors considerations, and the correlation between training and operational capacity, remain valid and essential for ensuring the safe and effective operation of air traffic control systems.
- 3.4. However, as technology continues to evolve, including the integration of AI and ML, there may be aspects that could benefit from additional clarification or adaptation. For instance, the policy could be updated to include specific training components

related to AI and ML systems, human-AI interaction, ethical considerations in AI use, and handling potential biases introduced by automated technologies.

- 3.5. While the core principles of the existing policy remain relevant, an update could help to address the unique challenges and opportunities posed by AI and ML technologies in ATM. It would be prudent to assess the current training programmes and identify areas where the policy might be enhanced to reflect the integration of these technologies, ensuring that controllers are adequately prepared to operate in the evolving technological landscape while maintaining safety and efficiency standards.
- 3.6. This means ATCOs should be given regular training and refreshers regarding updates in the use of AI-based ATM applications. This will ensure that the ATCO is always abreast with the current technology/automation and able to utilise it appropriately for the task at hand. Furthermore, it will enhance the ability of the ATCO to intervene in the event of emergencies, unusual occurrences, or system failure.
- 3.7. The revision of TRNG 9.2.5 regarding rigorous and regular refresher training mentioned above will also address any deficiency in the capacity of the ATCO to handle his area of responsibility in the event of system failure as mentioned in IFATCA policy AAS 1.20 referred to in paragraph 2.4.4.

4. RECOMMENDATIONS

- 4.1. The existing IFATCA WC 10.2.5 AUTOMATION / HUMAN FACTORS policy is:

Automation shall improve and enhance the data exchange for controllers. Automated systems shall be fail-safe and provide accurate and incorruptible data. These systems shall be built with an integrity factor to review and crosscheck the information being received.

The human factors aspects of Automation shall be fully considered when developing automated systems.

Automation shall assist and support ATCOs in the execution of their duties.

The controller shall remain the key element of the ATC system.

Total workload should not be increased without proof that the combined automated/human systems can operate safely at the levels of workload predicted, and to be able to satisfactorily manage normal and abnormal occurrences. Automated tools or systems that support the control function shall enable the controller to retain complete control of the control task in such a way so as to enable the controller to support timely interventions when situations occur that are outside the normal compass of the system design, or when abnormal situations occur which require non-compliance or variation to normal procedures.

Automation should be designed to enhance controller job satisfaction.

The legal aspects of a controller's responsibilities shall be clearly identified when working with automated systems.

A Controller shall not be held liable for incidents that may occur due to the use of inaccurate data if he is unable to check the integrity of the information received.

A Controller shall not be held liable for incidents in which a loss of separation occurs due to a resolution advisory issued by an automated system.

Guidelines and procedures shall be established in order to prevent incidents occurring from the use of false or misleading information provided to the controller.

4.2. It is recommended that the updated policy is:

IFATCA TPM (2024), WC 10.2.5 – Automation / Human Factors

Proposal:

Automation shall improve and enhance the data exchange for controllers. Automated systems shall be fail-safe and provide accurate and incorruptible data. These systems shall be built with an integrity factor to review and crosscheck the information being received.

The human factors aspects of Automation shall be fully considered when developing automated systems.

Automation shall assist and support ATCOs in the execution of their duties.

The controller shall remain the key element of the ATC ~~ATM~~ system.

Total workload should not be increased without proof that the combined automated/human systems can operate safely at the levels of workload predicted, and to be able to satisfactorily manage ~~normal and abnormal occurrences~~ **unusual occurrences**. Automated tools or systems that support the control function shall enable the controller to retain complete control of the control task in such a way so as to enable the controller to support timely interventions when situations occur that are outside the normal compass of the system design, or when abnormal situations occur which require non-compliance or variation to normal procedures.

Automation should be designed to ~~enhance~~ **take into account** controller job satisfaction.

~~The legal aspects of a controller's responsibilities shall be clearly identified when working with automated systems.~~

~~A Controller shall not be held liable for incidents that may occur due to the use of inaccurate data if he is unable to check the integrity of the information received.~~

~~A Controller shall not be held liable for incidents in which a loss of separation occurs due to a resolution advisory issued by an automated system.~~

~~Guidelines and procedures shall be established in order to prevent incidents occurring from the use of false or misleading information provided to the controller.~~ Legal responsibilities for controllers using automated systems shall be explicitly defined. Controllers shall not be held liable for incidents resulting from inaccurate data if unable to verify its integrity or for a loss of separation due to an automated resolution advisory.

The number of items displayed on one label and the number of items/information displayed on the current screen should be set after a dedicated study. Safety tools should not be deactivated.

- 4.3. The existing IFATCA TRNG 9.2.5 AUTOMATION CONTROLLER TRAINING policy is:

Controllers required to operate in an automated air traffic control system should receive relevant instruction in automatic data processing for ATC.

Formal training should be established for all ATC personnel in the theoretical and practical procedures associated with the automated ATC system.

The above training should be carefully integrated with the implementation of each stage of the automated ATC system.

The implementation of automated systems shall include sufficient training, including the Human Factors aspects of automation, prior to using new equipment. The level of training is a major factor in determining the level of traffic that can be safely handled until all controllers have gained enough hands-on experience.

- 4.4. It is recommended that the updated policy is:

IFATCA TPM (2024), TRNG 9.2.5 – Automation Controller Training

Proposal:

Controllers required to operate in ~~an~~ **as part of** an automated air traffic control ~~ATM~~ system should receive relevant instructions in automatic data processing for ATC.

Formal training should be established for all ATC personnel in the theoretical and practical procedures associated with the automated ~~ATC~~ **ATM** system, ~~including automation failure and fallback procedures at least once every year.~~

The above training should be carefully integrated with the implementation of each stage of the automated ~~ATC~~ **ATM** system.

~~The implementation of automated systems shall include sufficient training, including the Human Factors aspects of automation, prior to using new~~

equipment. The level of training proficiency is a major factor in determining the level of traffic that can be safely handled until all controllers have gained enough hands-on experience.

AI systems or applications in ATM shall be human-centred throughout the whole development process. ATCOs shall be thoroughly trained and introduced to the new concepts, including AI systems and ML algorithms, to be able to handle all traffic situations, and also during unforeseen situations such as emergencies or system failure.

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