

A Study on Improving Aircraft Maintenance Licensing System of South Korea for Mutual Recognition Between Countries

Kwon-suk Oh¹, Hakbong Lee¹ and Kwang-Eui Yoo^{1,†}

¹Korea Aerospace University

Abstract

The purpose of this study is to present the internationalization of South Korea's aircraft maintenance certificate for mutual recognition of aircraft maintenance license qualifications among various countries in preparation for an internationalization of the work conducted by the aviation industry. To achieve this objective, this study reviews the aircraft maintenance license training system and compares the standards for aircraft maintenance certification established by the Convention on International Civil Aviation with the standards for issuing domestic aircraft maintenance licenses. This comparative analysis shows that the domestic curriculum of aircraft maintenance licenses differs from international standards. As a result of this study, an improvement plan of the education content was proposed to enable the licensing qualifications of domestic aircraft maintenance licenses to be mutually recognized among different countries.

Key Words: Aircraft Maintenance License, Approved Training Organization, Maintenance Repair Overhaul, Aircraft Maintenance Organization

1. Introduction

Annex 1 (Personnel Licensing) of the Convention on International Civil Aviation prescribes the minimum conditions for achieving an aviation worker license to ensure aviation safety as international standards and recommendations that should be followed by contracting states [1]. These are internationally agreed-upon standards and form the basis of discussing mutual recognition of aviation workers including aircraft maintenance license among countries.

According to Article 33 of Doc 7300, a document on aircraft maintenance qualifications published by the International Civil Aviation Organization (ICAO), certificates and licenses issued to aviation workers by other contracting states must be recognized as valid by other contracting states, provided that the requirements under which such certifications or licenses were issued are equal to or above the minimum standards specified in Annex 1 [2].

The domestic aircraft maintenance licensing system is prescribed in the Aviation Safety Act and related laws, which have been prepared based on the internal standards and recommendations in Annex 1 of the Convention on International Civil Aviation. However, when aircraft

maintenance mechanics apply for employment to airlines in the U.S. and Europe, the aircraft maintenance license of South Korea is not recognized. Therefore, it is necessary to compare the aircraft maintenance licensing system of countries with advanced aviation with the domestic system.

The maintenance licensing system of each country is closely related to the maintenance training system. This study compares the curriculum and assessment method of the aircraft maintenance training system in the Aviation Safety Act with the international standards and the systems of aviation advanced countries. This study then proposes a method of acquiring international competitiveness and mutual recognition for a domestic aircraft maintenance license.

2. International Status of Aircraft Maintenance Licensing System

2.1 International standards for aircraft maintenance licensing

In Annex 1 (Personnel Licensing) of the Convention on International Civil Aviation, an aircraft license holder is called an aircraft maintenance mechanic, technician, or engineer, and each contracting state can select and use one of these terms [3].

According to the ICAO Doc 7192 Training Manual, the scope of aircraft maintenance tasks is divided into line maintenance and base maintenance, and the license types are

classified into airframe, engine (turbine/piston), propeller, avionics, and electrical [4]. In addition, licenses are limited to the aircraft categories of aircraft, airship, and rotary wing.

2.2 Aircraft maintenance license of the FAA

The U.S. Federal Aviation Administration (FAA) classifies aircraft maintenance licenses into two types of limited licenses for mechanic and repairman. The mechanic maintenance license is divided into airframe and powerplant, and the repairman maintenance license permits the performance of maintenance that requires the maintenance technique of fault troubleshooting, which is one level higher than a mechanic or serving as a supervisor [5].

2.3 Aircraft maintenance license of the EASA

The European Aviation Safety Agency (EASA) classifies aircraft maintenance licenses into Categories A, B, and C in accordance with the Part 66 Aircraft Maintenance License (AML) and specifically classifies and defines “Mechanic”, “Technician”, and “Engineer” [6].

Category A (mechanic) is a maintenance license for direct support of aircraft operations including limited simple maintenance and inspections before and after flight. It is an aircraft maintenance license required for line maintenance. Category B1/B2 (technician) requires more skills and knowledge than the mechanic license. It is a skilled level maintenance license that permits the independent performance of fault troubleshooting in each field including aircraft structure, powerplant, and avionics. Furthermore, B3 (technicians) is a small aircraft maintenance license for non-pressurized devices having a maximum takeoff mass of 2,000 kg or lower. Category C (engineer) is a license applied to the base maintenance of the maintenance depot level such as an aircraft airframe crack inspection and a management license for the total aircraft system [7].

The holder of an aircraft maintenance license must maintain 6 months or more of maintenance experience within the past 2 years in accordance with the privileges granted by the aircraft maintenance license.

2.4 Aircraft maintenance license of South Korea

According to the Aviation Safety Act, the aviation worker license is not divided into mechanic, technician, or engineer, and only one aircraft maintenance mechanic license is used. However, according to the amended Aviation Safety Act that takes effect from March 1, 2021, the work scope of the aircraft maintenance license will become dualized. According to the amendment, when someone becomes an aircraft maintenance mechanic, the person can only service aircrafts having a maximum takeoff mass of 5,700 kg. Four years of work experience (2 years upon completion of an Approved Training Organization) is required after obtaining the license to perform maintenance work for aircraft having a maximum takeoff mass

of 5,700 kg or more.

The limited aircraft maintenance license system conforms to the standards of the ICAO. It is divided into aircraft type and work limitations according to Article 81 (Limitation of Certification) of the Enforcement Rule of the Aviation Safety Act.

The type limitations consist of aircraft, helicopter, airship, glider, and aerospace ship. The work limitations consist of airframe, powerplant, propeller, and electronic/electrical/instrument [8].

3. Mutual Recognition System for Aviation Work Safety

Representative examples of mutual recognition agreements between countries related to aviation are bilateral aviation safety agreements (BASAs) and memorandums of understanding (MOUs).

A BASA is adopted between two countries when they acknowledge that they have equal safety systems in civil aviation safety. When a BASA is adopted, the other country's application for certification of aircraft-related products and maintenance can be accepted and implemented in a simplified manner based on the mutual trust of both countries [9]. In February 19, 2008, South Korea (Korea Office of civil Aviation) and the US (FAA) signed a BASA for collaboration in six aviation safety areas (airworthiness, environment, maintenance, operation, pilot training, and aviation training center) [10].

4. BASA Maintenance Implementation Procedure (MIP)

To internationalize aircraft maintenance tasks, the ICAO is preparing for a regulation amendment roadmap for mutual recognition of an Approved Maintenance Organization (AMO) among contracting states beginning in 2024 [11].

The BASA Maintenance Implementation Procedures (MIP) refer to procedures for mutual acceptance of legal/technical systems regarding the aircraft maintenance (repair) and modification by personnel certified by AMO.

According to the ICAO's roadmap, South Korea plans to upgrade its AMO to the level of aviation advanced countries such as the US (FAA). In addition, to promote the independence of the maintenance repair overhaul (MRO), South Korea is preparing for the BASA aircraft maintenance implementation procedure (MIP). Through the BASA-MIP, the US has already agreed on mutual recognition of the AMO with certain countries. The US completed agreements with Canada, Europe (19 EU members), Switzerland, and Singapore up to 2018, and is negotiating for agreements with Brazil and Hungary [11].

The US and Canada signed the BASA-MIP agreement for aviation safety between the FAA and the Transport Canada Civil Aviation (TCCA) on June 12, 2000. The objective of the BASA-MIP agreement between the FAA and the TCCA is to effectively conduct aircraft maintenance of the other country by recognizing the qualifications of the AMOs and aircraft maintenance license and reduce duplicate regulations. As a restriction of the MIP agreement, only the major and general aircraft maintenance tasks that can be performed within 48 h can be mutually recognized. Special maintenance and 1-year cycle inspections cannot be conducted. Furthermore, the MIP is periodically improving the technical problems, improvements, and other requirements through meetings every year [12, 13].

In Asia, only Singapore has signed the BASA with the US. If South Korea signs it as the second nation, it can occupy an advantageous position for receiving MRO orders from neighboring countries in Northeast Asia [14].

Currently, there are only five repair stations in South Korea that have received approval from the FAA. Singapore (53), Switzerland (17) and Brazil (20) have already signed or are negotiating mutual recognition agreements for AMO through the BASA-MIP in the maintenance area with the US. Therefore, the priority of South Korea for signing the BASA-MIP can be relatively low [15].

5. Comparison of Aircraft Maintenance Licensing Systems among International Organizations, Developed Countries, and South Korea

5.1 Comparison between ICAO standards and domestic aircraft maintenance licensing system

5.1.1 Aircraft maintenance system

As the conditions for taking the aircraft maintenance license test according to the ICAO Doc 7192 Training Manual, individual must be 18 years or older in age and have completed three phases of maintenance education.

The three phases of maintenance training consist of Phase One Knowledge Training, Phase Two Skills Training, and Phase Three Experience Training.

Phase One Knowledge Training must be composed of theory subjects for all aircraft maintenance knowledge required for aircraft maintenance practice [16].

As shown in the left column in Table 1, the theory subjects for aircraft maintenance-related knowledge and work performance according to the ICAO Doc 7192 Training Manual are composed of seven subjects in four areas. The right column in this table lists the theory training and written test subjects of South Korea, which are composed of five subjects: aviation laws, general aircraft maintenance, airframe, engine, electronics, electric and instruments. When compared with the ICAO standard, the Human Performance &

Limitations subject is missing. The Human Performance & Limitations subject needs to be included as a major theory subject, given that more than 70% of aviation accidents over the last 20 years were caused by human error [17].

The theory training time for the standard major subjects of the ICAO (Aircraft Engineering and Maintenance) are 800 h for the airframes, 750 h for engines, and 2,135 h for avionics (1,350 h for electrical components, 785 for AFCS). In South Korea, the theory training times are 295 h for airframes, 285 h for engines, and 365 h for electronics, electric and instruments. Thus, much less time is allocated than the international standards, with differences of 2.7-, 2.6-, and 5.8-times these standards, respectively.

Table 1 Comparison of phase 1 knowledge training between the ICAO and Korea

ICAO		Korea		
Subject	Hours	Subject	Hours	
Civil Aviation Requirements, Laws and Regulations	130	Aviation laws	95	
Natural Science and General Principles Of Aircraft	445	General maintenance	265	
Human Performance & Limitations	30			
Aircraft Engineering And Maintenance	Airframe	800	Airframe	295
	Engines, Propeller	750	Engine	285
	Electrical, Instrument	1,350	Electronic/electric /instrument	365
	AFCS*, Navigation, Radio	785		
Test	-	-	5	
Total	4,290	-	1,310	

*AFCS: Automatic Flight Control System

Phase 2 Skills Training must include not only the maintenance (repair) practices for airframe, engine, and avionics, but also the assembly or adjustment of parts through operation inspections.

Furthermore, after diagnosing the defects, disassembly and repair are conducted, followed by judgments regarding replacement before re-assembly and functionality checks. The repair guidelines and design drawings must be shown as well [18].

As indicated in Table 2, the training time is composed of airframes for 1,825 h, engine and propellers for 1,000 h, and

avionics for 3,075 h. Thus, practice time is applied to allow the acquisition of theoretical training in the body. By contrast, the training time in South Korea is absurdly insufficient and the total practice time is less than a third compared to the international standard, as shown in Table 4.

Table 2 Comparison of Phase 2 Skills Training between the ICAO and Korea

ICAO		Korea	
Subject	Hours	Subject	Hours
-	-	General maintenance	165
Airframe	1,825	Airframe	365
Engine and Propeller	1,000	Engine	355
Avionics, Electrical, Instruments, Autoflight, Radio	3,075	Electronics, electrical, and instruments	205
Test	-	-	10
Total	5,900	-	1,100

Phase 3 Experience Training consists of on-the-job training (OJT) or job-oriented aircraft maintenance training in an AMO procedures and amendments [19].

As shown in Table 3, 2 years of maintenance experience in each license area are required, whereas in South Korea, those who received training in ATO can take the test even without experience. According to the ICAO standard, an aircraft maintenance license that combines two types of line maintenance and base maintenance requires aircraft maintenance experience of 4 years, with 2 years each.

In South Korea, those who have completed the training course of 2,410 hours in ATO do not need separate maintenance experience according to the Enforcement Rule of the Aviation Safety Act, Attachment 4 (Airmen certification and experience for application). Those who complete all subjects related to the aircraft maintenance license in colleges need maintenance experience for 6 months after completing the subjects or 1 year before completing the subjects. Applicants who have not received training in the ATO or completed the related subjects must have aircraft maintenance experience of 4 years including maintenance experience of 6 months for the corresponding aircraft type.

Table 3 ICAO’s Phase 3 Experience Training

ICAO		
Category	License	Years
Line Maintenance	Airframe	2
	Engine	2

Base Maintenance	Avionics	2
	Airframe	2
	Engine	2
	Avionics	2

5.1.2 Assessment method

According to the ICAO Doc 7192 Training Manual, people who have completed the three phases of maintenance training (Phase 1 Knowledge, Phase 2 Skills, Phase 3 Experience) could take the license test.

The aircraft maintenance license qualification test is divided into an oral or practical test and an aircraft maintenance practice test. The oral or practical test evaluates the aircraft maintenance theory and technical knowledge, and the practical test evaluates the maintenance procedures (including the system functional test) and maintenance safety and sense of responsibility. The passing criterion is a score of 70% or higher [20].

In South Korea, as well, the passing criterion is 70% or higher for theory and practice.

5.2 Comparison of aircraft maintenance licensing system between FAA and Korea

5.2.1 Aircraft maintenance training system

According to the FAA 14 CFR Subpart D-Mechanics, an FAA aircraft maintenance mechanic must be at least 18 years old, and the license types according to the maintenance area consist of airframe maintenance license (A, airframe) and powerplant maintenance license (P, powerplant). The training course for the license acquisition is composed of knowledge and areas of experience [21].

The knowledge training is composed of three subjects, “general,” “airframe,” and “powerplant” according to the recommendations of the FAA 14CFR Part 147 Aviation Maintenance Technician Schools, which also include practice time for inspection and checking, fault troubleshooting, repair, and overhaul [22]. As shown in Table 4, according to the FAA CFR 147.21 General Curriculum, the total training time is 1,150 h (general 400 + airframe 750/powerplant 750) for airframes and engines, respectively, and 1,900 h (general 400+airframe 750+engine 750) for an A & P Mechanic certificate.

As one large difference from the Korean training program, for the FAA, there are no subjects (time) for aviation laws, electronics, electrical components and instruments, and there is no limited license for aircraft type.

Table 4 Comparison of knowledge between the FAA and Korea

FAA		Korea	
Subject	Hours	Subject	Hours

-	-	Aviation laws	95
General	400	General maintenance	430
Airframe	750	Airframe	660
Powerplant	750	Engine	640
-	-	Electronics/electrical/instrument	570
Test	-	-	15
Total	1,900	-	2,410

For experience training, according to the FAA Part 65.77 Experience Requirement, airframes and powerplants require 1.5 years (18 months) of experience, or 2.5 years (30 months) of experience if an A & P is included, as shown in Table 5 [23].

In South Korea, if the conditions for completing maintenance-related subjects in a regular college are excluded, the experience time is 0.5 to 1.5 years longer than with the FAA. The FAA also acknowledges military experience similar to South Korea.

Table 5 Comparison of experience training between the FAA and Korea

FAA		Korea		
License	Years	License	Years	Condition
-	-	Aircraft type (limited type)	0.5	After completing subjects
-	-		1	Before completing subjects
-	-		4*	Maintenance experience
Airframe	1.5	Electronics/ electrical/ instrument (limited work)	2	After completing ATO
Powerplant	1.5		4	Maintenance experience
A & P	2.5		0.5 (after completing related subjects) to 4 years	
1.5–2.5 years				

* Including 6 months or longer maintenance career for the aircraft type

5.2.2 Assessment method

According to the FAA Part 66, those who complete maintenance training (or maintenance experience) can take the aircraft maintenance license test.

The license test includes theoretical, oral, and practical exams. To pass the test, a score of at least 70% for each exam must be achieved. The questions for the theoretical test are randomly selected from an open question bank [24].

5.3 Comparison of aircraft maintenance licensing system between EASA and Korea

5.3.1 Aircraft maintenance training system

According to the EASA Part 66 Aircraft Maintenance License (AML), the EU aircraft maintenance license requires minimum 18 years of age, and four types of training: basic knowledge, basic experience, aircraft type training, and OJT.

First, the basic knowledge training must be conducted in an educational institution approved by the EASA according to the EASA Part 66.A.25. The subjects consist of 17 modules including Module 1 Mathematics and Module 2 Physics.

As shown in Table 6, the basic knowledge time of the aircraft maintenance license is 800 h for A1 (Aeroplane Turbine), 650 h for A2 (Aeroplane Piston), 2,400 h for B1.1 (Aeroplane Turbine), 2,000 h for B1.2 (Aeroplane Piston), 2,400 h for avionic license B2, and 1,000 h for the non-pressurization device small maintenance license B3. The base maintenance C (Engineer) does not require a separate basic knowledge training time [25].

Table 6 Comparison of basic knowledge training between the EASA and Korea

EASA			Korea	
License	Type	Hours	License	Hours
A*	A1	Aeroplanes Turbine	-	-
	A2	Aeroplanes Piston		
	A3	Helicopter Turbine		
	A4	Helicopter Piston		
B1**	B1.1	Aeroplanes Turbine	Aircraft maintenance mechanic***	2,410
	B1.2	Aeroplanes Piston		
	B1.3	Helicopter Turbine		
	B1.4	Helicopter Piston		
B2	-	All(Avionic)	-	-
B3	-	Aeroplanes (2T MTOM and below)	-	-

*A theoretical time ratio 30%–35%, **B1 theoretical time ratio 50%–60%, ***Aircraft maintenance theoretical time ratio 54%–55%.

In South Korea, there is only one license for an aircraft maintenance, and the training time is comparable to that of the B(Technician) license training course of the EASA.

Second, according to the EASA Part 66.A.30, in the case of A(all), B1.2, B1.4, and B3, 1 year of basic experience training is required when completing an ATO, 2 years when receiving education from a skilled maintenance expert, and 3 years

based on maintenance experience only, as shown in Table 7. In the case of B1.1, B1.3, and B2(all), basic experience is required for 2 years when completing training from an ATO, 3 years when receiving education from a maintenance expert, and 5 years by maintenance experience only. In the case of C (Engineer), 3 years of experience including 6 months of observation of base maintenance tasks is required if the applicant has an academic degree in a technical discipline from university. If the applicant has B1.1/1.3 or B2, 3 years of experience is required, and if the applicant has B1.2/1.4, 5 years of experience is required.

In South Korea, those who have completed education from a ATO can take the test even without maintenance experience. Furthermore, 1 years of experience after completing subjects related to a maintenance license (limited type) at a general educational institution (college) or 6 months before completing professional education in the case of limited work is required to take the test. This system (limited type) is a unique system that cannot be found in ICAO, EASA, or the FAA, and is prescribed in the Enforcement Rule of the Aviation Safety Act, Attachment 4.

Table 7 Comparison of experience training between the EASA and Korea

EASA			Korea		
License	Years	Condition	License	Years	Condition
A(all) B1(2,4) B3	1	ATO	Aircraft Type (limited type)	0.5	After completing the subjects
	2	Education by expert		1	Before completing the subjects
	3	Maintenance experience		4*	Maintenance experience
B1(1,3) B2(all)	2	ATO	Electronics, electrical and instruments (limited work)	2	ATO
	3	Education by expert		4	Maintenance experience
	5	Maintenance experience			
C	3**	Degree or higher	-	-	-
	3	B1(1,3) or B2			
	5	B1(2,4)			
1 (when completed ATO) to 5 years			0.5 (when completed related subjects) to 4 years		

*Including maintenance career for 6 months or longer for aircraft type,
**3 years including 6 months of base maintenance training

Third, the aircraft type training is composed of theoretical training only. According to the EASA Part 66.A.45, in the case of B1.1/B1.2/B2/C licenses, the training time is 150/120/100/30 h for aircrafts with a maximum takeoff weight of 30,000 kg or higher, 120/100/100/25 h for 5,700~30,000kg, and 80/60/60/15 h for below 5,700 kg. For the helicopters, in the case of B1.3/B1.4/B2/C, type training for 120/100/100/25 hours is required, respectively, regardless of weight. The EASA indicates and manages the type of training for a license certificate, whereas in South Korea, private aviation companies manage the training and qualifications autonomously.

Fourth, the OJT must be received within 3 years according to the EASA Part 66.A.45, and its objective is to ensure the ability and experience required to conduct safe maintenance [26]. Furthermore, according to the EASA Part 145, the training must be received only in a maintenance facility of the same type as in the approved aircraft maintenance license, and OJT can be received for both line and base maintenance.

5.3.2 Assessment method

According to the EASA Part 66, only the basic knowledge and type training are assessed among the aircraft maintenance license training courses (basic knowledge, basic experience, type training, and OJT).

The assessment method for basic knowledge consists of three-choice questions and an essay, for which a score of 75% or higher must be obtained. Each module gives three opportunities to take the test again after failing (three-choice questions, essay) after 90 days (30 days if the applicant completes the failed module in an ATO).

The assessment method for type training consists of oral and practical and a test, for which a score of 75% or higher score must be obtained. This test gives three opportunities per year within 3 years. The retest can be taken after 30 days.

In South Korea, those who have a national certificate related to aviation (or FAA certificate) can be exempted for certain subjects during the knowledge examinations. The practical test is exempted for those who have completed professional education and practical experience for 5 years or longer, and are assessed by an oral test only. The passing criteria is a score of 70% or higher for both knowledge and practical tests.

6. Conclusions

To prepare for the internationalization of maintenance in the industry, we analyzed the license standards for aircraft maintenance license required by international conventions and the related regulations of developed countries in comparison with the criteria and training systems for issuing an aircraft maintenance license in South Korea.

The training times showed differences in comparison with

the ICAO. When compared with the US (FAA), the training systems were not much different. However, there were many differences with those of Europe (EASA) in terms of the training subjects, time, and subdivided licenses. Based on the results, this study can present improvement measures for an aircraft maintenance license training system to improve the domestic training courses for an aircraft maintenance license and enable mutual recognition of aircraft maintenance with other countries.

First, the training times (periods) of the international standards need to be applied for the domestic aircraft maintenance training courses (knowledge, skills, experience). The training time (periods) for a domestic aircraft maintenance license is shorter than the international standards and the EASA standards of Europe. Consequently, a high-quality training output cannot be expected unless the training times (periods) are appropriately allocated. Furthermore, the current domestic educational system cannot draw the trust of other countries, which can lower the international competitiveness. Therefore, the domestic license for an aircraft maintenance can experience difficult receiving mutual recognition with other countries.

Second, we propose the addition of “human performance ability” as a theoretical training subject for the domestic aircraft maintenance license training course. This aims to change the human performance and limitations as well as human factors and errors that are currently included in the “general maintenance” topic as a separate major subject. The contents of the human performance ability are also essential for the safety of maintenance work. Among the main causes of aviation accidents over the last two decades, 70% or more were caused by human factors. Therefore, it is necessary to emphasize the importance of human factors in maintenance work as well. Furthermore, the international standard has also selected a topic related to human performance & limitations as a major subject and allocates 30 hours for training in this area.

Third, we propose separating the existing aircraft maintenance licenses into “aircraft maintenance license I (mechanic)” for a basic level and “aircraft maintenance license II (technician)” for a skilled level. The Aviation Safety Act has already announced that two work limitations will be applied to one license for aircraft maintenance license from March 1, 2021. Accordingly, the aircraft maintenance license also needs to be separated. According to the amendment of the Aviation Safety Act, maintenance work is limited to having a maximum takeoff mass of 5,700 kg or lower and more than 5,700 kg. Thus, “aircraft maintenance license I” can be issued a maintenance work license for aircrafts having a maximum takeoff mass of 5,700 kg or lower and “aircraft maintenance license II” for aircrafts more than 5,700 kg. This has the advantage of checking the aircraft maintenance career of individuals (4 years after acquiring license (2 years after completing an ATO) directly from the license certificate without an administrative process to verify it. Furthermore, the

international standards and EASA and FAA for countries with advanced aviation are also using a skilled level maintenance license. Above all, by having a skilled level aircraft maintenance license certified by a government agency, South Korea will be able to negotiate regarding the equal conditions at the minimum level for mutual recognition of aircraft maintenance licenses with other countries.

Through a re-establishment of an aircraft maintenance training system to the international level through the above improvement measures, we expect that the aircraft maintenance licenses of South Korea will be recognized internationally and provide an opportunity for mutual recognition of aircraft maintenance work with other countries.

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