Seaplane Traffic in the Republic of Croatia

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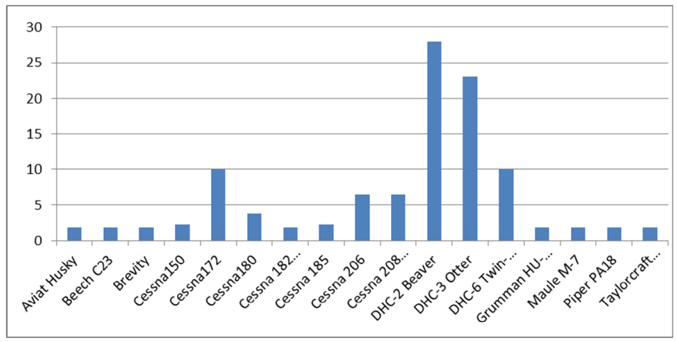
***Abstract*— Seaplane traffic in the European Union has been growing constantly over the last decade. The International Air Transport Association (IATA) predicts an even higher annual growth rate of the seaplane traffic in the near future. The development of seaplane services results from the capacity overload of the existing airports and the demand for point-to-point connections with minor destinations. Due to the length of its coastline and other natural features, the Republic of Croatia is one of the EU member states experiencing a rapid increase in seaplane traffic. The state has been forced to amend a number of acts and regulations. In 2016 seaplane service network in Croatia consists of 16 destinations. Seaplane service was not recognized in Croatia law. Therefore, implementation such service needed previous revision of Croatia legislation. This includes researching of influence to environment, especially to pollution of air, water and influence of noise. Because of need of positioning of seaplanes port in maritime ports which are crowded during the season, maritime study of safety of traffic due to positioning of seaports and public perception regarding the safety of maritime traffic.**

Keywords-Seaplane; Traffic, Safety; Seaplane Service in the Republic of Croatia.

I. INTRODUCTION

The seaplane traffic in the European Union has been growing by 5% per year [8]. The International Air Transport Association (IATA) predicts an even higher annual growth rate of the seaplane traffic in the near future. The development of seaplane services results from the capacity overload of the existing airports and the demand for point-to-point connections with minor destinations [8]. The European Union experiences a considerable increase in sites intended for building seaplane ports, especially on lakes and islands. 24% of EU's smaller aircraft are intended for passenger transport.

The development of the seaplane traffic started some 80 years ago, but the basic seaplane design has not changed much over the years. One of the reasons may be the relatively small share of seaplanes in the overall Commercial Air Transport. Most of them have been operated by private persons for non-commercial purpose. The ones engaged in liner service, they have been mostly used for connecting minor destinations and transporting a small number of passengers. However, the advantage of a seaplane service over a standard air service lies in the simplicity and low cost of the seaplane port infrastructure. In addition, seaplane ports do not charge high dues that otherwise affect the airfare considerably. Manoeuvring features of these crafts, while on the sea surface, are similar to those in seagoing vessels.



Graph 1. Share of small aircraft manufacturers in the EU fleet (%) [8]

Across the world, there are a number of places with extensive seaplane traffic. The examples include:

- Maldives – where seaplane services connect more than 40 dispersed tourist destinations with land-based airports. 24 Twin Otter craft perform over 150 flights daily, including scenic flights.
- Vancouver – where Vancouver Harbour Air Company operates 50 seaplanes connecting Vancouver Harbour with smaller 20-minute range destinations.
- Sea Air company has tried to establish a similar airline service in Greece, using 22 Twin Otter craft.
- Harbour Air Malta operates a liner service between Valleta and Gozo Island for weekenders and businessmen, in addition to performing scenic flights.

II. LEGISLATION OF THE REPUBLIC OF CROATIA

The transport of goods and passengers by maritime law in Republic Croatia, between Croatia's seaports represents the maritime cabotage that includes the coastal cabotage. The latter includes:

1. Seaborne transport of passengers and/or goods between mainland-based seaports without calling at the islands;
2. Supply provided to the offshore facilities: seaborne transport of passengers and/or goods between any

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ports, plants or structures within the epicontinental shelf of the Republic of Croatia;

3. Insular cabotage, i.e., seaborne transport of passengers and/or goods between:

- Mainland-based seaports and ports at one or more islands;
- Ports at islands.

The establishment of seaplane traffic has led to the necessity of adapting the national *Maritime Code* and other relevant acts and regulations as this type of commercial maritime traffic has not been experienced before.

Croatia's legislation has been examining foreign acts, regulations and conventions referring to seaplanes, including the regulations that are internationally adopted and incorporated into the *International Convention on Safety of Life at Sea* (SOLAS 74), *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78), *International Load Line Convention* (LOADLINE 1966), *International Convention on Tonnage Measurement of Ships* (TONNAGE 1969), and Ordinance regulating specific security, safety and other measures when handling dangerous substances in port areas. In addition to general national regulations, the Regulations on navigation and order in ports specifically comply with the Ordinance on terms and methods of maintaining order in ports and conditions for using ports, the Ordinance on determining the class and limit of hazardous substances that can be handled in ports, the Ordinance on terms and methods of performing activities in free zones, and the Plan of ship waste management in the area under jurisdiction of the Port Authority. Other ordinances are the Ordinance on handling hazardous substances, conditions and forms of seaborne transport, loading and discharging of hazardous substances, bulk and other cargoes in ports, and on prevention of spreading oil spills in ports, the Ordinance on terms and methods of maintaining order in ports and other parts of internal waters and territorial seas of the Republic of Croatia, the Ordinance on amendments to the Ordinance on the safety of maritime navigation in internal waters and territorial sea of the Republic of Croatia and on the conditions and methods of performing the surveillance and regulation of the sea traffics, as well as the relevant regulations and technical requirements stipulated by *Croatian Register of Shipping* and by competent authorities of the flag-states where the above Conventions do not refer to some of their vessels.

Because, seaplanes are crafts which are considered being boats during manovring to the water and planes during flying to air, new regulations must be in short relation with international air regulation.

These restrictions and regulations can be found in: *National regulations are harmonized with European regulatory framework, given in this particular 'air traffic' part by Basic and implementing Regulations (Regulation (EC) No 216/2008, and Commission Regulation (EU) No 965/2012*, *Act on airports*, *Maritime Demesne and Seaports Act*, *Ordinance on water airports.*

Until 2012, the national legislation did not regulate the sites and conditions of seaplane landing and taking off operations, and the latter were treated as the emergency operations.

For establishing the commercial seaplane traffic it is of great importance to regulate the "seaports" as a dedicated water area (including all facilities, installations and equipment), entirely or partially intended for movement, take-off, water landing (alighting) and accommodation of seaplanes.

III. IMPACT OF SEAPLANES AND WATER AERODROMES ON THE ENVIRONMENT

Water airdromes have only a minor effect on the features and the overall shape of the existing scenery, due to the fact that these facilities use parts of seaports that are already engaged in accommodation of vessels and handling maritime traffic.

According to the analyses carried out by the project FUSETRA – Future Seaplane Traffic [9], aircraft should be more affordable, safer, cleaner and quieter in order to meet the criteria of the environmental sustainability of the air traffic. Sustainability may be defined in various ways, but it is generally agreed that the concept of sustainability implies responsible exploitation of natural resources worldwide. In terms of sustainable use of resources, one of the EU goals is to halve the emission of carbon dioxide (CO2) by 2020 and to reduce noise pollution and nitrogen oxide emission (NOx) by 80% in comparison to the values recorded in 2000 [9].

Figure 1. ECA Water aerodrome in Split [30].

During the flight, i.e., the period between taking off and landing on the water, the environmental impact of a seaplane is equal to the impact of any other aircraft. Various studies on the effects of seaplanes on the environment have been carried out primarily by seaplane owners [24]. The most comprehensive study was conducted by American military engineers (USACE) [25], concluding that seaplanes do not harmfully affect:

- Air quality,

- Water quality,
- Soil quality,
- Wildlife,
- Fisheries,
- Hydrology.

Water aerodromes affect local surface water circulation to some extent due to the small draft of the pontoon infrastructure whose designed draft usually amounts to 0.35 m, but they do not affect deep water circulation at all. As this infrastructure creates shadow and reduces the light below, some effects on the marine life should be taken into consideration.

The noise created under water cannot be calculated from the noise above water because the sources are different. Air noise primarily results from the seaplane's engine operation and movement of the craft through the water when landing or taking off. It should also be noted that, unlike vessels, seaplanes do not discharge sewage or oily waters, and that their hulls are not treated with toxic antifouling paints. There are no toilettes in seaplanes so that there is no risk of discharging faecal waste into the sea [12]. Furthermore, the exhaust emissions produced by seaplanes are released into the atmosphere high above the sea level, thus minimising the direct harmful impact on the marine environment [30].

TABLE 1. ESSENTIAL CHARACTERISTICS OF JET A1 FUEL WITH REGARD TO HEALTH, SAFETY AND ENVIRONMENT SOURCE: [19]:

Characteristic	Unit	Value
pH value (concentration and temp.):		Not applicable
Ebullition point / area:	°C	145.0 – 300.0
Flash point:	°C	38.00 (min)
Volatility:	(solid/gaseous):	Not applicable
Explosion limits:	vol. %	No data
Oxidation properties:		No data
Vapour pressure:	Pa	No data
Density at 15°C:	kg/m	775.0 – 840.0
Solubility (type of solvent indicated):	g/L	Not applicable
Solubility in water:	g/L	Not applicable
Octanol/water partition coefficient:	logPow	Not applicable
Viscosity (kinematic) at 100°C:	mm2/s	< 8.000
Vapour density (at 15°C):	kg/m3	No data
Evaporation rate:		No data
Auto-ignition temperature:	°C	260 – 410
Conductivity:	pS/m	50 – 600

Seaplane engines are not cooled by means of heat exchangers (water coolers) as is the case in marine engines so that there is no seawater circulating around the engines. After the engine shutdown, the excess fuel is collected in specially designed accumulators that are regularly emptied to prevent marine pollution.

TABLE 2. COMPARISON OF TEMPERATURE PROPERTIES FOR SOME FUELS [27]

Fuel	Flash point	Auto-ignition temperature	Freezing point
Ethanol (70%)	16.6°C	363°C	
Petrol (Gasoline)	− 43°C	246°C	
Diesel	> 62°C	210°C	
Jet fuel	> 38°C	210°C	
Jet A	> 38°C	210°C	< − 40°C
Jet A-1	> 38°C	210°C	< − 47°C
JP5	> 60°C		< − 46°C
JP7	> 60°C		
Jet B	− 18°C		
Kerosene	> 38°C – 72°C	220°C	
Biodiesel	> 130°C		

Seaplane engines are not cooled by means of heat exchangers (water coolers) as is the case in marine engines so that there is no seawater circulating around the engines. After the engine shutdown, the excess fuel is collected in specially designed accumulators that are regularly emptied to prevent marine pollution.

During the manoeuvring of the seaplane on the sea surface, there is little or no turbulence of water at the seabed. Therefore, the sediments on the sea bottom that some forms of benthic life depend upon are not disturbed [24].

The impact of a seaplane on the mechanical properties of the sea mass is negligible due to the fact that the craft's entire propulsion system is above the water level.

The most common jet fuel used by seaplanes is JET A1. According to its chemical composition, JET A1 is the kerosene grade fuel (refined paraffin). This fuel is stable when properly stored and used, i.e. when not exposed to heat sources, flames, sparks and excessive temperatures. Incomplete combustion may result in CO (carbon monoxide), SOx (sulphur oxides) or H2SO4 (sulphuric acid) [19].

Jet A1 fuel is produced in compliance with international standards with a flashpoint above 38°C and the lowest pure point temperature of - 47°C [27].

In the Republic of Croatia, fuel bunkering is defined and regulated by *Ordinance on handling hazardous substances, conditions and forms of seaborne transport, loading and discharging of hazardous substances, bulk and other cargoes in ports, and on prevention of spreading oil spills in ports* (Official Gazette: 51/05, 127/10, 34/13, 88/13), *Ordinance on terms and methods of maintaining order in ports and other parts of internal waters and territorial seas of the Republic of Croatia* (Official Gazette 90/05), and by *Ordinance on water airports* (Official Gazette 36/14).

Standards for emissions from aircraft are internationally defined and incorporated into the legislation of each member state of the International Civil Aviation Organization (ICAO) [28]. Article 123 of *Croatia's Air Transport Act* (Official Gazette: 69/09, 84/11, 127/13) states that "noise and exhaust gases produced by a taking-off and landing aircraft must be below maximum allowed limits for the noise level and exhaust gases, as defined by ordinances referring to this Act and complying to the relevant EU regulations". Presently, Croatia's legislation does not contain regulations defining maximum levels of exhaust gases produced by aircraft, but the *Air Protection Act* (Official Gazette: 130/11, 47/14) and related sub-law regulations have been harmonised with the effective *EU's Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe* [28].

TABLE 3.COMPARISON OF AIR TRAFFIC TO OTHER EMISSION SOURCES SOURCE: [6]

FUEL CONSUMPTION			
Air traffic (million tons/year)		Total (million tons/year)	
176		3140	
EMISSIONS			
Pollutant	Air traffic (million tons/year)	Other sources (million tons/year)	Source
CO_2	554	20,900	Combustion of fossil fuels
H_2O	222	45 525,000	Oxidation of methane into the stratosphere; Evaporation from the Earth's surface
NO_x	3.2	2,9 ± 1,4 90 ± 35	Transfer stratosphere – troposphere; Anthropogenic sources
CO	0.26	600 ± 300 1490	Oxidation of methane Anthropogenic sources
CH	0.1	90	Anthropogenic sources
Soot	0.0025	-	-
SO_2	0.176	0.0625 134	Stratospheric aerosol; Combustion of fossil fuels

The International Civil Aviation Organization (ICAO), through the Committee on Aviation Environmental Protection (CAEP) responsible for defining regulations and new standards related to noise and emissions from aircraft, has made efficient efforts in further reduction and restriction of emissions produced by aircraft engines which harmfully affect the environment [28].

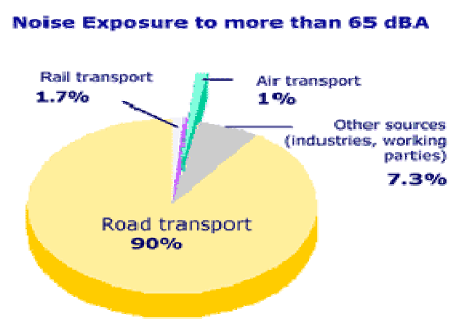
As a member of ICAO, Croatia is obliged to comply with the standards described in the Book II of the Annex 16 to the ICAO Convention on International Civil Aviation [16].

These standards define the limits that the aircraft engines have to meet regarding the emissions of nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOC) and smoke point. The standards do not define the limits for particulate matter (PM) that also results from fossil fuel combustion, but there are a number of states whose national legislation define the boundary limits for PM as well.

Fuel consumption of seaplanes per minute of flight is larger than fuel consumption in seaborne vessels, and the emission of CO2 is larger correspondingly [9]. However, the distance covered by seaplanes per minute is much greater. The distance of 100 nautical miles is covered by a seaplane operating in Europe in 60 minutes, whereas an average fast surface vessel would take 180 minutes [16].

The introduction of a new seaplane service increases the overall seaport traffic and exhaust emissions, and yet this harmful influence on the environment is not enough strong to compromise the air quality. Furthermore, seaplanes use JET A-1 fuel (kerosene) that does not contain some of the volatile organic compounds (VOC) that are present in marine heavy fuel oils. Jet fuel also contains less sulphur so that, correspondingly, smaller SOx emissions are recorded.

One of the major obstacles to the growth of seaplane services is insufficient familiarization with the environmental impacts of this form of transport. The ICAO, through the already mentioned Committee on Aviation Environmental Protection (CAEP), has been efficient in further reduction and restriction of noise produced by aircraft engines, which harmfully affects the environment [28].



Graph 2. Exposure to noise over 65 dB in the European Union [29]

According to the data presented by the European Commission, only 1% of noise over 65 dB is created by air traffic, while the share of road traffic amounts to 90% [29]. The major problem is the noise produced by seaplanes during taking off and landing operations. The noise is estimated at 75 dB (A), i.e. well over ambient noise. Taking into consideration that during these relatively short periods a seaplane creates more noise than a vessel under way, the take-off/landing zone should be designed in such a way that flying over inhabited areas at low height is avoided. Evans [7] measured the noise produced by a 650 ccm Kawasaki scooter; the noise amounted to 83 dB (A) at low speeds and

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up to 90 dB (A) at high speeds [7]. Examples of various noise levels are shown in Table 4.

TABLE 4 EXAMPLES OF NOISE LEVELS FOR VARIOUS OPERATIONS [9]

Noise	Noise level (in dB)
Military aircraft	120+ dB(A)
Scooter (Jet ski)	110 dB(A) on lake
All-terrain vehicles	85 dB(A) during general operations
Planing boat	65-95 dB(A) on lake
Seaplane	75 dB(A) only on take-off over an area of 300 m (20 sec)
Car interior	68-73 dB(A) at 30 mph (50 km/h)
Normal conversation	65 dB(A)

TABLE 5 CROATIA'S MAXIMUM PERMISSIBLE NOISE LEVELS IN OPEN ENVIRONMENT [15]

Noise zone	Purpose of the environment	Maximum permissible noise emission level LRAeq in dB(A)	
		Day (Lday)	Night (Lnight)
1	Zone intended for rest, recovery and therapy	50	40
2	Zone intended exclusively for habitation and residence	55	40
3	Zone of mixed purpose, mostly for housing	55	45
4	Zone of mixed purpose, mostly business area with housing	65	50
5	Business zone (production, industry, warehouses, services)	▪ At the building plot boundary within the zone, the noise must not exceed 80 dB(A) ▪ At this zone's boundary, the noise must not exceed permissible noise levels in the neighbouring zone(s)	

The noise level produced by seaplanes is higher than the noise levels for other surface vessels but is not within the range that is considered harmful [9]. Regulation on the maximum permissible noise levels in the environment in which people work and live (Official Gazette 145/04) defines 5 noise zones, depending on their purpose and time during the day. These levels are shown in Table 5.

Maximum noise load in Croatia is expected during tourist season. Presently the seaplane operations are scheduled only during daytime so that the annoying noise levels are avoided at night. Increased seaplane noise is produced only during taking off and landing. As these operations are performed at the regulatory distance of 300 meters off the coast, it can be concluded that the noise does not considerably affect the observed area.

IV. IMPACT OF SEAPLANES ON SAFETY

In Europe, there are various regulations governing the seaplane traffic. Many of them are rather strict, particularly with regard to the safety and environment preservation. In many countries these regulations have become obsolete and are neither in line with demands for seaplane services nor in line with the latest seaplane aviation technologies [4].

- Major obstacles to the development of seaplane traffic arise from:
- Prejudice and public perception regarding the safety of maritime traffic,
- Strict regulations, and
- Inability to build infrastructure for seaplane accommodation.

Seaplane traffic is governed by regulations on seaborne and airborne transport. According to the COLREGS [1][2][7] definition, a seaplane is a craft designed for manoeuvring in air and on water surface. There has been a significant growth in the development of seaplane services over the last five years, particularly in the USA, Canada and Australia [20]. Pontoons and jetties for seaplane accommodation have been increasingly built in China as well. The great demand for seaplane services has resulted in a number of projects and studies related to seaplane traffic, in particular regarding the effects of seaplane traffic on the maritime traffic in ports.

FUSETRA identified the requirements for seaplanes, passengers, operators and manufacturers in Europe. With reference to the FP5 project, concluded that the seaplane traffic in Europe has a great potential due to the development of Europe's transport network and the abundance of rivers, lakes and islands. He established the standards for 11 major Polish ports capable of accommodating seaplane [9].

In 1994, the US Federal Aviation Administration (FAA) released the Advisory Circular for seaplane bases and associated facilities, replaced by the amended Advisory Circular in 2013 [16]. When discussing the safety of navigation of seaplanes and vessels in ports, the collision risks can be analysed by using DEMETEL method [15], [23]. So far, only partial studies on seaplane traffic and its effects on maritime traffic have been published. They use the simulation of traffic flow in ports by applying queueing theory [4], [6] multiple factor method and the simulation of dominance by applying Arena software for simulating heterogeneous traffic of vessels and seaplanes. The principle of analysing individual system components [7], [8], [9] and other theories and methods were also used. So far, the only licensed seaplane operator in the Republic of Croatia is European Coastal Airlines (ECA). The company has more than 200 employees. Its fleet consists of eight De Havilland Twin Otters and one Grumman G 21 Goose. Twin Otter seaplanes connect over 16 destinations in Croatia and Italy (Figure 23) and the corporate plans include expanding of operations to Montenegro and Albania. In 2015, ECA performed 24,000 flights transferring 221,000 passengers [30].

Canadian De Havilland DHC-6 Twin Otter is a STOL (Short Take-off and Landing) (Figures 3 and 4) seaplane manufactured by Viking Air Company. It has been designed to carry passengers and/or cargo, and is able to perform landing and take-off operations using floats, wheels or skis. It has been the best-selling passenger seaplane model ever, able to accommodate 19 passengers.

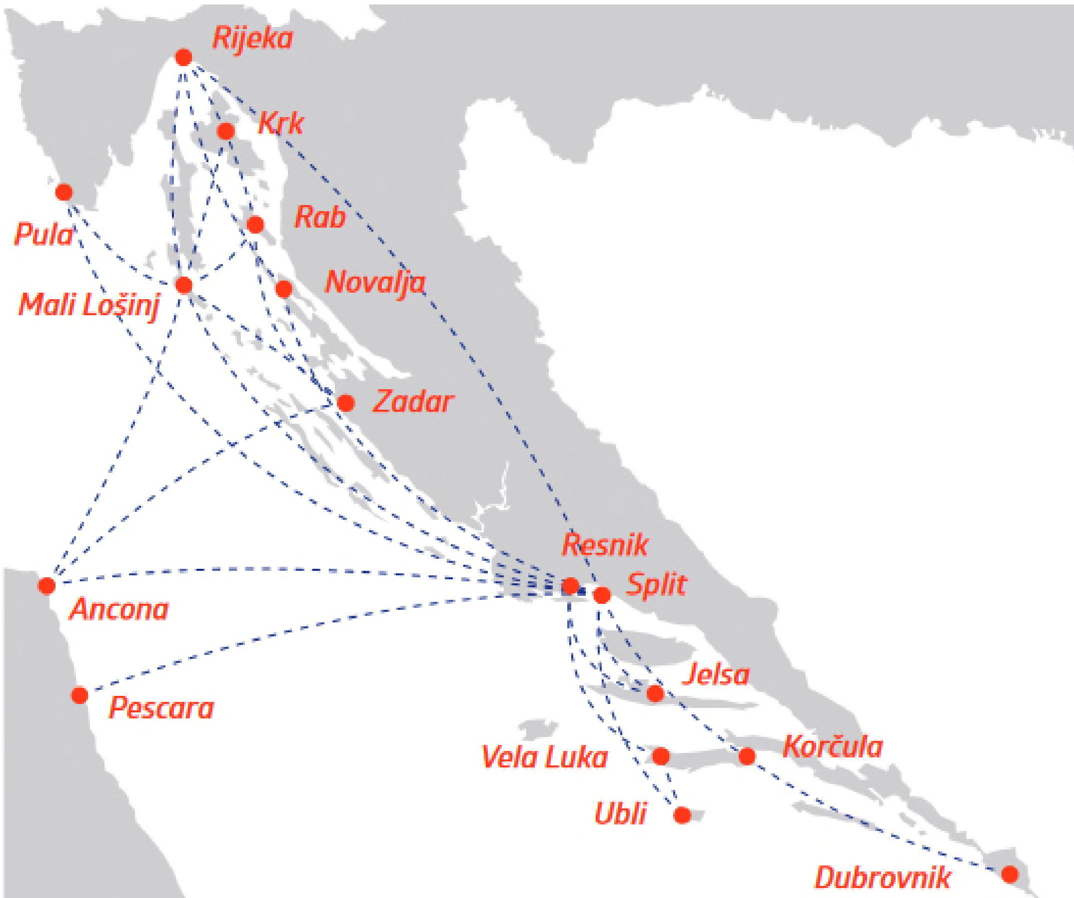


Figure 2. ECA's seaplane destinations in Croatia and Italy [30]

Figure 3. DHC-6 Twin Otter.

Seaplane navigation performance is observed through:

- Manoeuvrability, and
- Traffic features.

Manoeuvring performance of seaplanes during taxiing is similar to the performance of surface vessels, but it differs considerably during take-off and landing operations.

Cruise speed during take-offs and landings ranges from 40 to 108 knots). Compared to the speed of vessels when approaching or leaving port (5-10 knots), it is obvious that the seaplane speed during take-off and landing operations is about 10 times higher than in boats and ships. Given the seaplanes' high speeds in a relatively confined area, it is important to give way to seaplanes when performing these operations. Taking off operations take place at the distance of 350 m from the area allocated for manoeuvring [2][3].

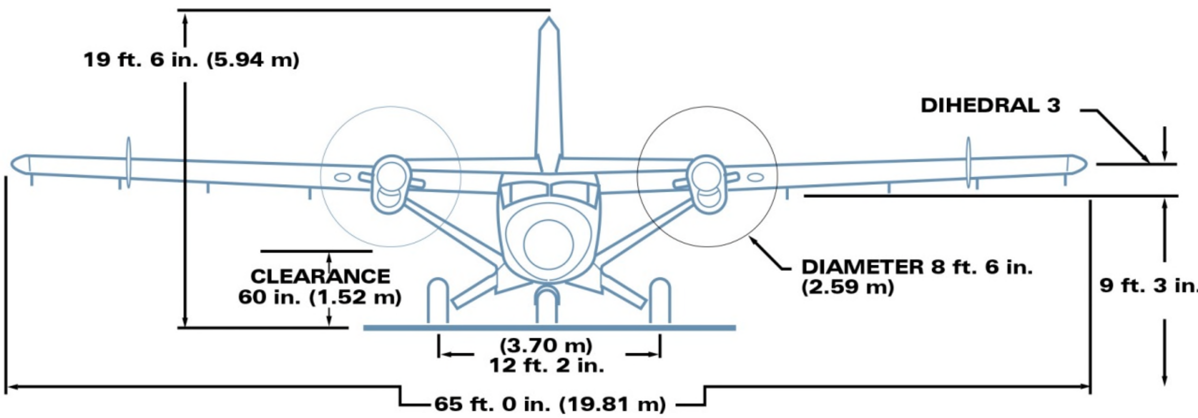


Figure 4. Dimensions of the DHC-6 Twin Otter's wing span and propellers. [13]

When performing take-off and landing over the areas intended for such operations in Croatia, seaplanes do not comply with the regulations on general restrictions of speed, otherwise imposed on surface vessels. If the seaplanes perform commercial air service they can take off or land only in the area allocated for these operations, i.e., at least 300 meters off the coats, except in case of emergency or force majeure.

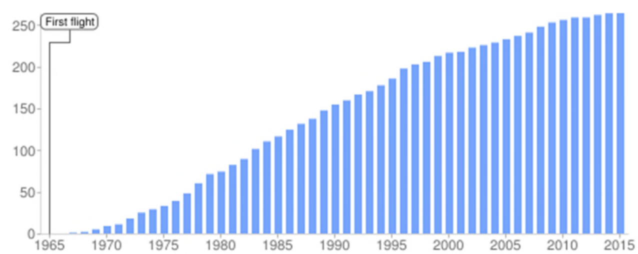
Landing and take-off operations are usually allowed only during daylight, in suitable meteorological conditions that ensure good visibility. All participants in maritime traffic within the seaplane landing and take-off areas have to manoeuvre with caution. All vessels, yachts and boats with or without mechanical propulsion have to leave the area dedicated to take-off and landing of seaplanes not later than 30 minutes before these operations take place, and act according to the instructions given by the seadrome operator who is authorised to ensure and take adequate security and safety measures in line with relevant statutory regulations.

TABLE 6. MANOEUVRING FEATURES OF THE DHC-6 TWIN OTTER SEAPLANE. [12]

FEATURES	
Engines PT6A-34	
Taking off (runway)	406 m / 1,333 ft.
Flying over 50 ft. obstacles before starting to land	562 m / 1,843 ft.
Taking off (water)	374 m / 1,227 ft.
Flying over 50 ft. obstacles before starting to land	599 m / 1,965 ft.
Climb rate (per minute)	427 m / 1,400 ft.

The seaplane pilots have to perform the landing and take-off manoeuvers after making sure that the landing/take-off area is clear of any other maritime traffic participants. The area is usually properly marked with lights, buoys, daybeacons and daymarks in compliance with specific regulations and is marked in navigation charts issued in official maritime publications.

The wind strength and direction affect the seaplane's movement during take-off and landing operations. Windward take-off (towards the wind) considerably reduces the take-off distance. A DHC-6 Twin Otter typically requires 374 meters for taking off (Table 6), 300 meters for landing operation and 40-80 meters for stopping after touching the water. The seaplane may extend the stopping distance on the water to reduce hull stress and improve passengers' comfort. However, in emergency the craft is able to come to a halt 40 meters after touching the water surface. Strong winds and waves higher than 1.5 m may impede landing and take-off operations [5]. Turning the seaplane on the water is performed by means of the rudder and engines. As the DHC-6 Twin Otter is a double-engine craft, the rudder is fitted to the seaplane's tail but the two controllable pitch propellers ensure excellent manoeuvrability.



Graph 3. The total cumulative number of accidents for DHC -6 Twin Otter. [16]

TABLE 7. TYPE OF ACCIDENT DHC-6 TWIN OTTER, 2013-2015. [16]

Type	Location	Type of accident	Number of victims	Year
DHC-6 Twin Otter 400	Anadyr Airport, Russia	Failure of the landing gear	0	2014
DHC-6 Twin Otter 300	Maldives	Sinking on landing	0	2015
DHC-6 Twin Otter 300	Maldives	This meeting of the plane during the removal of the dock one of them	0	2015
DHC-6 Twin Otter	Enarotali Airport, Indonesia	Fly out to the runway	0	2015

300				
DHC-6 Twin Otter 300	Tequesquitengo Airport, Mexico	Fly out to the runway	0	2014
DHC-6 Twin Otter 300	La Tabatière Airport, Canada	Fly out to the runway	0	2014
DHC-6 Twin Otter 300	Woitape Airport, Papua New Guinea	Fall on approachin airport	4	2014
DHC-6 Twin Otter 300	USA, Boulder City Municipal Airport	Collision with helicopter	0	2014
DHC-6 Twin Otter 300	Nepal	Drop	18	2014
DHC-6 Twin Otter 310	Kudat Airport, Malaysia	Fly out to the runway	2	2013
DHC-6 Twin Otter 300	Jomsom Airport	Fly out to the runway	0	2013
DHC-6 Twin Otter 300	Greenland	Impact against a reef on landing	0	2013
DHC-6 Twin Otter 300	Sam Neua-Nathong Airport, Laos	The coup in the trees on takeoff	0	2013
DHC-6 Twin Otter 300	St. Anthony Airport, Canada	Fly out to the runway while landing in difficulty	0	2013
DHC-6 Twin Otter 300	Mount Elizabeth, Antarctica	Drop	3	2013
DHC-6 Twin Otter 300	Alifu Dhaalu Atoll, Maldives	The coup in while	0	2012
DHC-6 Twin Otter 300	Laguna Caballococha, Peru	Landing on rough weather, sinking	0	2012

TABLE 8. NUMBER OF ACCIDENT DHC TWIN OTTER 6-300/400. [16]

Year	DHC Twin Otter 6-svi	6-300	6-400	Accident with deats	Number of victims
2006	6	5		2	13
2007	7	6		4	42
2008	10	8		3	22
2009	7	5		3	31
2010	5	5		1	22
2011	6	5		2	8
2012	3	2		/	/
2013	6	6		2	5
2014	6	5	1	2(6-300)	22
2015	5	3		/	/

DHC-6 Twin Otter has been developed throw navigation equipment in period since it has been in operation. According to graph 3, the number of accident rapidly grow up, but this trend is followed by increasingly number of seaplanes in operation and increasing number of traffic in water aerodromes and airports.

According to Table 7, it might be concluded that most of accident are happening on airports. This type of airplane is easy and under influence of wind, especially during landing. Statistics show that victims were only in cases of dropping of seaplanes.

From the Table 8 it can be concluded that the annual average occur around 2 accidents with fatal consequences for the entire world fleet of Twin Otter DHC 6-300 / 400 , for different purposes and design. Given the number of aircraft it gives the approximate probability of an accident with fatal consequences about 3x10-3 per year per aircraft. Most of the accidents is a result of failures, strikes, adverse weather conditions, and mostly occur during landing and take-off. Collisions with ships not registered in the records of accidents [11].

V. CONCLUSION

Croatia is one of the first EU member states which launched the commercial seaplane service as a faster alternative way to reach destinations inland and abroad. However, this service is not public and it is used mostly during summer season. Other EU states with similar experience include Poland, Denmark and Greece. The limiting factors for the development seaplane traffic in the Republic of Croatia included insufficient information and familiarization with this type of transport that was, consequently, not recognized by the national legislation. However, over the last years, Croatian legislation has introduced a number of regulations and ordinances in order to create legal framework for seaplane traffic operations, in particular related to the entrance of seaplanes into ports, their landing, taxiing and taking off within port areas and the construction of seaports.

After years of legislation and investment issues, European Coastal Airlines became the first licensed seaplane operator in Croatia. In addition to the national and local governments, the venture was supported by the AdriSeaplanes project co-funded by the European Union and the IPA – Adriatic Cross-Border Cooperation Program. European Coastal Airlines presently maintains regular flights connecting 16 destinations in Croatia and Italy, and plans to expand operations over the rest of the Adriatic Sea by establishing seaports in Montenegro and Albania.

Various studies and research conducted across the world indicate that the seaplane traffic is safe and not presenting a serious threat to the air and marine environment. The development of this type of transport and the increasing demand indicate that the seaplane traffic is likely to grow considerably in the coming years, for the benefit of holiday-makers and the residents of 66 inhabited islands of Croatia.

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