VERIFICATION OF SAIL-FLIGHT TESTING PROCEDURES OF WING-IN-SURFACE EFFECT CRAFT ON ENGINEERING FLIGHT SIMULATOR

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Abstract

This paper presents subject of Sail-Flight Test Program constructed for the Wing in Surface Effect Craft (WiSE) 8 'Undan', which is conducted on the WiSE Engineering Flight Simulator (WiSE-EFS). This paper discusses the result and evaluation of test data, and compares it with the predicted performance of a WiSE Craft. The program includes: On-water maneuvering test, Take-off and Landing, In-Ground Effect (IGE) cruise, IGE maneuvering, Out-of-Ground Effect (OGE) Cruise and OGE maneuvering. The configurations subjected to variation are the fuel, center of gravity, and the aileron-rudder interconnection system. Several failures are also induced, including engine and flight control system failures. The result and findings, along with the experience in sail-flight testing a WiSE craft, are described in the end of this paper.

1 General Introduction

Flight test of an aircraft is a fundamental process in the development and advancement of aeronautical knowledge. It is performed in order to validate the operation and systems on an aircraft, and also to provide data to construct the Operation Flight Manual. Ships, on the other hand, have a different kind of test, called a sea trial. It is a full scale trial to determine ship maneuvering characteristics and maneuverability as a reaction to water rudder and engine actions. Both of them (flight test and sea trials) could be implemented for a Wing-in-Surface Effect (WiSE) craft, a vehicle which undergo both flight and on-water experience on its operation. The term 'Sail-Flight Test Program' is then used to cluster the flight test and sea trials of a WiSE Craft. This Sail-Flight test program is constructed by the cooperation of the Indonesian Agency for the Assessment and Application of Technology (BPPT) and Bandung Institute of Technology (ITB), in order to validate the performance of their experimental WiSE craft, The WiSE-8 'Undan'. This WiSE craft is described briefly in section 1.1.

Since the WiSE 8 Undan is still in development stage, the Flight-Sail Test program cannot be verified. A simulator is then used as an alternative to examine the test program itself. The so-called WiSE Engineering Flight Simulator (WiSE-EFS) is primarily developed by BPPT and ITB. This simulator is described briefly in section 1.2.

1.1 Wise 8 Craft, 'Undan'

The general configuration of WiSE 8 Craft can be observed in Figure 1, as follows:

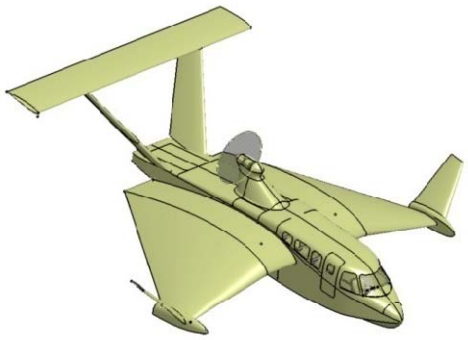

Fig. 1 The WiSE 8 Craft 'Undan'

The W iSE 8 Craft des cription in this paper is taken from Ref [3].

1.2 WiSE Engineering Flight Simulator

for pilot fa miliarization, m an-machine interface an alysis, also tes t and evaluation to obtain feedback on design and developm ent process (see Figure 1) (R ef [2]). T his EFS is integrated with the en gineering control center, where engineers cou ld set a scen ario of th e simulated f light, inc luding the W iSE craf t configuration, weather condition, and even systems failure.

Ref [1] describes the various activities and aspects of Sail-Flight Test Engineering that must be considered when planning, conducting, and reporting the test program.

2 Sail-Flight Tests

2.1 Development Test

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2.2 Sea Trial Test

On water maneuvering performance of a winged ship or wate r handling will be judg ed based on maneuvering criteria which are characteristic of several m aneuvers. On-water m aneuverability of the winged ship craf t m ay be significantly influenced by hydrodynam ic interaction with the sea bottom , banks and other vessels passing nearby. In addition, win ds, waves, currents and tides also affect on-water m aneuverability. These on-w ater m aneuvers and th eir criteria, as well as th e required num erical values, are described in this sub-chapter.

Prediction of on-water m aneuverability performance in the design stage enables a designer to take appropriate m easures in good time to achieve compliance with IMO standards. In the f ull s cale s ea tria ls f or the v alidation of on-water m aneuvering prediction m ethods, the trials do not have to be carried out in full load conditions. Once the prediction m ethod is validated it m ay be used to de monstrate compliance with IMO standard for a craft in full load conditions.

The post- trials subm ittal is to be p resented in the form shown in Appendix 6. In addition to this form , inform ation on environm ental conditions should be reported, including strength and mean direction of waves and wind.

The required water handling maneuvers are:

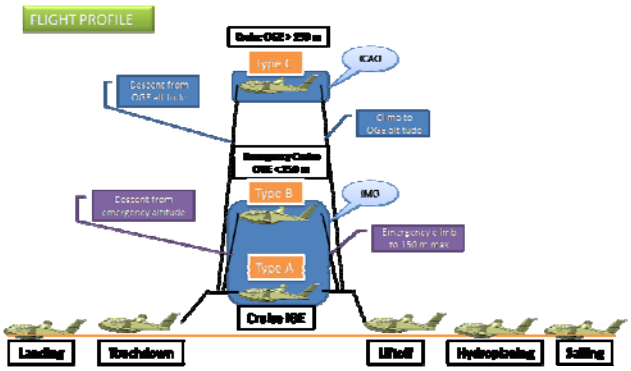
- Turning Test
- Zigzag Test
- Pull Out Test
- Spiral Test

2.3 Flight Test

The definition of flight phase for a wing-in-surface effect craft is divided into three categories [101]:

1) Type A, refers to IM O standard, a wing-in-surface effect craft that cannot operate without ground effect at all and only flies in ground effect altitude.
2) Type B, refers to IMO standard, a wing-in-surface effect craft with the capability to temporarily increase its flying height beyond the extent of ground eff ect up to 150 m eter. It cannot m aintain flight without ground effect, kinetic energy (speed) is converted into potential energy (height).
3) Type C, a wing-in-surface effect craft that is capable of sustained flight without ground effect at altitudes exceeding th e m inimum

safe altitude for an aircraft as prescribed by ICAO.



The flight test part of wing-in-surface effect craft incorporating minimum performance and handling quality test.

2.3.1 Minimum Performance Test

Performance is the flying quality which has the most influence upon commercial sales and success. The first considerations are takeoff and landing performance, or known as airfield performance, and the four fundamental basic flight maneuvers upon which performances are based: straight-and level flight, turns, climbs, and descents. All controlled flight consists of either one, or a combination or more than one, of these basic maneuvers.

Those basic maneuvers of the aircraft will also be applied for a wing-in-surface effect craft to assess its flying quality. But as for a Type B wing-in-surface effect developed in this case, straight-and level flight and turns are performed in ground effect altitude while climb and descent are categorized as emergency maneuver performed until maximum altitude of 150 meters only.

- Cruise-in-Ground Effect
- Turning-in-Ground Effect
- Landing
- Climb
- Descent

2.3.2Handling Quality Test

- Static Longitudinal Stability
- Maneuvering Stability
- Longitudinal Control Power
- Static Lateral Directional Stability
- Dynamic Lateral Directional Stability

3 Engineering Flight Simulator Test Program

3.1 Sea Trials Test Program

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3.2 Flight Test Program

3.2.1 Turning Test

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$$E=mc^2 \qquad (1)$$

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Book titles should be in *italics*, followed by a 'full stop'. Proceedings or journal titles should be in *italics*. Only the first letter of the title should be capitalised in the article name. For instance

3.3.2 Example

References

[1] Smith J, Jones B and Brown J. *The title of the book*. 1st edition, Publisher, 2001.

[2] Smith J, Jones B and Brown J. The title of the conference paper. *Proc Conference title*, where it took place, Vol. 1, paper number, pp 1-11, 2001.

[3] Smith J, Jones B and Brown J. The title of the journal paper. *Journal Name*, Vol. 1, No. 1, pp 1-11, 2001.

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