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AERODYNAMIC RESEARCH LABORATORY

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TEST REPORT
Examination of the wind resistance of the SP-401 HIRL lamp with solar panel mounting

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Report No:...43/CNTA/19/P **Number of Pages:**...13

Research made for:.....**Solutions4GA Sp. z o.o. (S4GA)** .....

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The test object: : ***SP-401 HIRL lamp with solar panel mounting***

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The results of the research given in the Report relate only to the tested objects

Distribution

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1 SUMMARY

The report describes the research carried out in the T-3 wind tunnel of the Institute of Aviation (the test section of the wind tunnel with the diameter of 5 m and the length of 6,5 m) at the level of wind of 240 km/h (67 m/s) and for various angular positions of the tested object (in the full range of 0°-360°).

The **SP-401 HIRL lamp with solar panel mounting** manufactured and delivered by **Solutions4GA Sp. z o.o. (S4GA)** was the test object in this aerodynamic research.

The lamp was tested in working position.

The test was carried out on the basis of guidelines from the: **ICAO Doc 9157 Part 6 point 3.2.2**

" The object should be sufficiently strong and rigid to meet the operational requirements of its normal service at the specified level of wind speed (e.g. 140 km/h (75 kt) with 12,5mm of ice cover). In addition, the object should be capable of surviving a higher level of wind speed (e.g. 210 km/h (113 kt)). In designing, the wind loading should be based upon that historical projection (e.g. 50-year mean recurrence interval)."

and

ICAO Doc 9157 Part 6 point 4.9.1

"Wind. Light fixtures may be exposed to extreme wind loads and/or jet blast. Aerodromes should ensure that elevated runway and taxiway lights are capable of withstanding jet blast velocities from aircraft normally expected to operate. These are typically wind velocities of 480 km/h(260 kt) for all high- and medium-intensity lights and 240 km/h (130 kt) for all other elevated fixtures (low-intensity lights)."

and

FAA AC 150/5345-50B (page 7) point 3.2.2.

"Wind. Exposure to wind speeds up to 150 mph (240 km/h) from any direction."

2 THE LIST OF FIGURES

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4 NOMENCLATURE ANS SYSTEMS OF COORDINATES

β	the angle of a wind flow measured between the direction of the velocity vector and the axis of the test object (measured in a horizontal plane) [°];
t	the temperature in the wind tunnel test section [°C]
V	the velocity of undisturbed flow (of wind) [m/s];

5 THE DESCRIPTION OF THE TEST OBJECT

The **SP-401 HIRL lamp with solar panel mounting** manufactured and delivered by **Solutions4GA Sp. z o.o. (S4GA)** was the test object in this aerodynamic research..

The lamp was mounted on the permanent basis provided by the test orderer in the configuration on the test stand in the T-3 wind tunnel.

Table 1 General data of the SP-401 HIRL lamp with solar panel mounting

The height	430 mm
The width	450 mm
The lenght	528 mm
The mass	14,1 kg

Figure 1 The SP-401 HIRL lamp with solar panel mounting

6 TEST CONDITIONS

The description of the T-3 wind tunnel

The research was made in the T-3 wind tunnel of Aerodynamics Research Laboratory of the Institute of Aviation.

The T-3 Wind Tunnel is a closed-circuit, continuous-flow low speed tunnel with 5 meter diameter open test section. Dimensions of the test section are: the diameter 5 m, the length 6.5 m. The maximal airflow velocity achieved in the open test section is 90 m/s. The 5600 kW electric motor powers 8-bladed fan. Maximal revolutions of the fan is 400 rpm. The wind tunnel control system SST controls the airflow velocity from 1 m/s to 90 m/s.

For the research of non-aeronautical (buildings, ships, etc.) test objects a special flat plate imitating the ground or sea surface is fixed to the test section. Dimensions of this plate are: the width of 5.1 m and the length of 7.5 m. The flat plate boundary layer is manipulated using various pins and boxes to simulate the Earth's surface wind's mean velocity distribution and turbulence profile for various types of terrain.

T-3 Wind Tunnel Basic Data (∅5m)

Type of Wind Tunnel	closed circuit with open test section
Test gas	air
Run time	continuous
Circuit length	134 m
Test section size:	
• the diameter	5.00 m
• the length	6.50 m
Maximal speed	90 m/s
Minimal speed	1 m/s
Maximal dynamic pressure	2000 N/m^2
Maximal Reynolds number, reduced to 1 m	$5.4 \cdot 10^6$

Model position (3D research)

• the angle of attack, α	-40° ÷ +45° or ±90° (after 90° rotation of model on sting)
• the sideslip angle, β	±180°

Model position (2D research)

• the angle of attack, α	±180°

Model support struts, sting, floor mounting

Model size

- airplane: up to 3.5m wing span, up to 3.5m fuselage length
- buildings etc.: up to 3m high or max. $2m^2$ cross section.

Motor and Fan:

Power of wind tunnel AC motor	5600 kW (7600 KM)
Maximal fan revolutions	400 rpm
Fan type	one-stage, 7 m diameter, 8 bladed

Properties of the airflow in the wind tunnel test section:

Turbulence intensity in CTA measurements	0.5%
Turbulence coefficient measured by spherical probe	TF=1.22
The contraction stage	4.84
The irregularity of the velocity field	±0.5%
The irregularity of the sweep angle of the velocity vector for the angle of attack α	±0.5°
The irregularity of the sweep angle of the velocity vector for the sideslip angle β	±0.5°

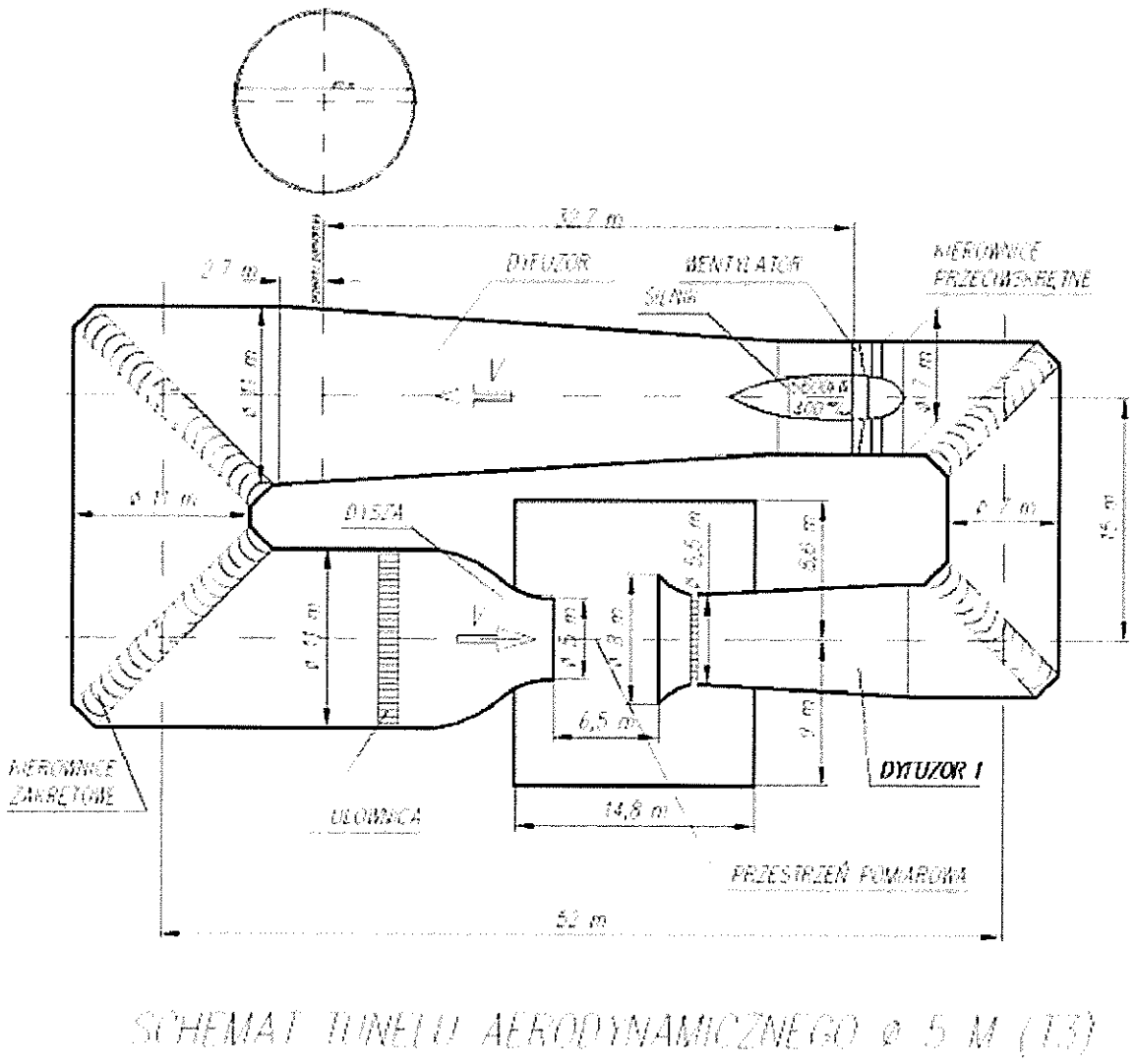

Figure 2 The T-3 wind tunnel scheme (ϕ 5m)

Table 2 The list of measurement equipment used in the test

No.	Name	Designation in the list of measuring equipment	The calibration certificate/ Test of measurement equipment / The date of the last checking
1	The wind tunnel T-3	ILA-101/037/A	Checked before each use
2	Mensor CPT6100 0-10kPa	ILA-101/024/A	152/C/PE/17 Calibrated every 3 years 8 August 2017
	Mensor CPT6100 0-7kPa	ILA-101/025/A	151/C/PE/17 Calibrated every 3 years 7 August 2017
	Mensor CPT6100 0-7kPa	ILA-101/026/A	153/C/PE/17 Calibrated every 3 years 9 August 2017
	Mensor CPT6100 0-7kPa	ILA-101/027/A	150/C/PE/17 Calibrated every 3 years 4 August 2017
	The turntable of the T-3 wind tunnel, horizontal angle range, with a resolution of 0,1°	ILA-101/138/W	3087.1-M12-4180-1180/15 Calibrated every 5 years 13 August 2015
	Digital angle transducer (β1) Heidenhain ROC-414	ILA-101/004/A	Checked before each use
	Digital angle transducer (β2) Heidenhain ROC-414	ILA-101/006/A	Checked before each use
	Line transmitter (β1) TL	ILA-101/005/B	Checked before each use
	Line transmitter (β2) TL	ILA-101/007/B	Checked before each use
	Line receiver (β1, β2) RL (4 kanały)	ILA-101/036/B	Checked before each use

6.1 The test methodology

The device, together with the base provided by the manufacturer, was installed at the test stand of the T-3 wind tunnel.

The device was turned on (the lamp emitted the light in a continuous mode), the test was carried out at the airflow velocity of 67m/s (the mechanical resistance and the correctness of the work of the device was assessed).

Once the set speed has been reached, the test object was rotated around the vertical axis (β) in the range of 0°- 360° (with the angular speed of 18°/min) without stop. (the angle value was displayed on the display and recorded on the surveillance system camera). Additionally, during the whole test at 360°/0°, 270°, 180°, 90° angular positions 5-minute-long tests were carried out.

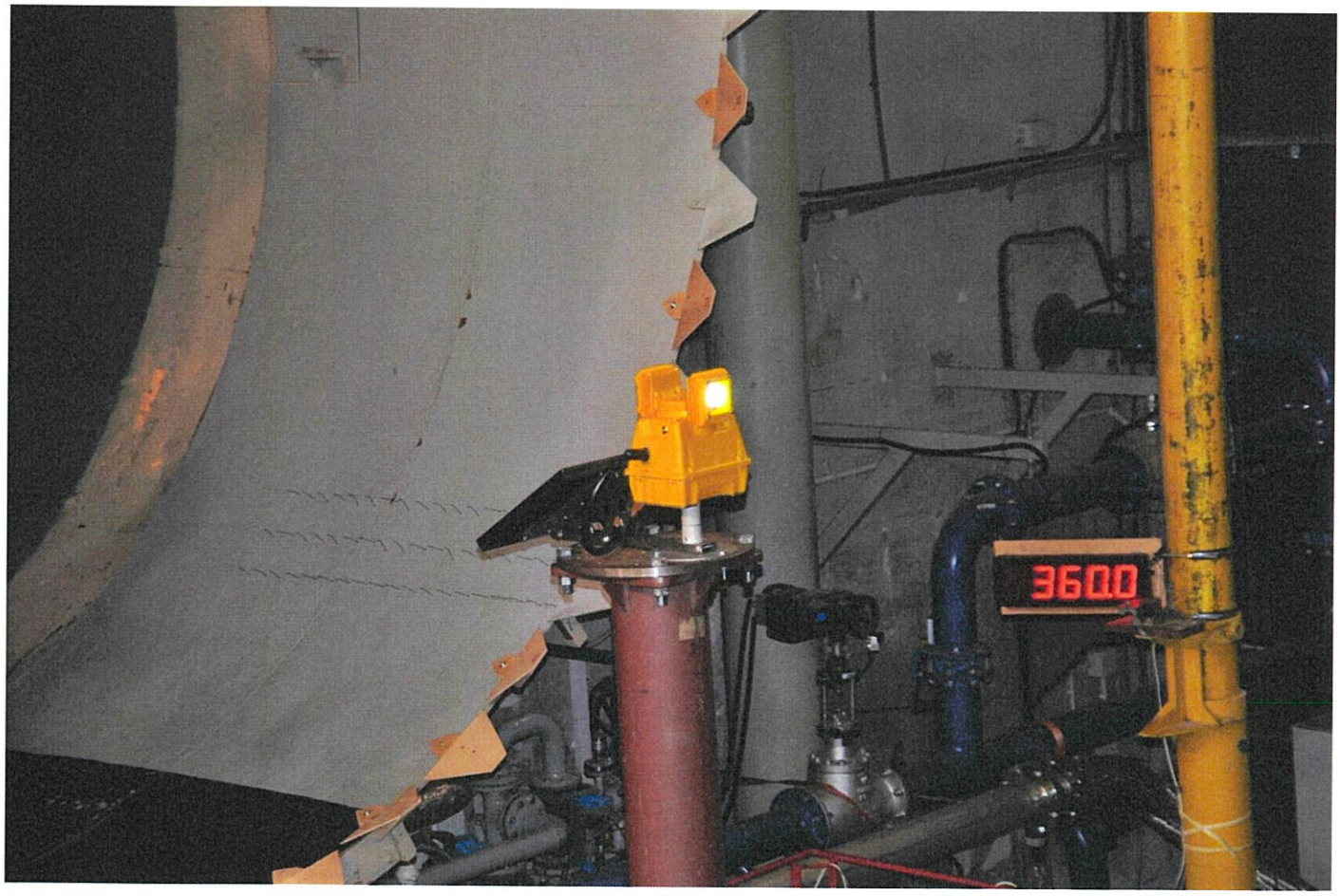

Figure 3 The SP-401 HIRL lamp with solar panel mounting on the test stand in the T-3 wind tunnel

7 RESULTS

The test was carried out within one wind tunnel cycle (run **603.19**). The tunnel monitoring system allowed the inspection of the mechanical condition of the test object and stand without the need to stop the airflow in the facility (by observing from the monitoring system). The correct operation of the device was also validated (during the test, the lamp was turned on).

The test confirmed that the device **is not damaged** when an air flow velocity reaches 240 km/h (67 m/s) regardless of the direction of the inflow.

The device worked **correctly** throughout the entire test.

The test was recorded with two surveillance system cameras.

THE END OF REPORT

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Signature of the author of the report
MSc Eng. Marek Kalski