Wind tunnel testing of the IAR 99 SOIM aircraft equipped with means for discovery and control of weather risk phenomena

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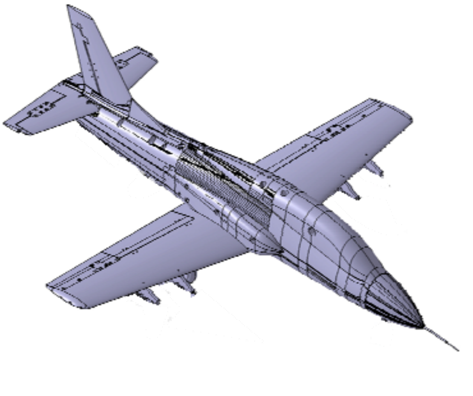
Abstract: *This paper presents wind tunnel tests on an IAR 99 SOIM model equipped with means for discovery and control of weather risk phenomena. In order to obtain the aerodynamic characteristics of the new configuration of the IAR 99 SOIM necessary for its validation, a test program has been conducted in the transonic wind tunnel with a 1:14 scale model of the respective configuration. Reactive unguided projectile launchers, gas generators and containers for other equipment needed to detect and combat extreme weather were attached on the 1:14 scale IAR 99 SOIM model.*

Key Words: COMAEROPREC, wind tunnel

AIRBORNE COMPLEX PRESENTATION

As part of the realization of an airborne complex capable of a combined action on extreme weather events, wind tunnel experiments on the IAR 99 SOIM scale model equipped with means for discovery and combat of such phenomena were considered necessary.



The IAR 99 SOIM scale model used for the experiments has been built based on the standard drawings and catalogs of IAR 99 and has a modular design. The most important module is the center fuselage, to which almost all other modules are attached (forward fuselage, inlet plugs, rear fuselage and semi-wings) and which contains the strain gauge balance.

Experiments took place in the trisonic wind tunnel on the 1:14 scale model of the IAR-99 SOIM, equipped with the TASK 2.0 MK XXVI A six-component internal strain gauges balance of the mobile frame type, with a diameter of 2in = 50.8mm and a length of 8.9in ≈ 226mm.

At the chosen scale, the reference geometric values of model will be:

- Wing surface area in horizontal projection S_m=18,71/196=0,095459m^2;
- Wing span theoretical in horizontal projection b_m=9,85/14=0,703571m;
- Mean aerodynamic chord, wing horizontal projection CMA_m=0,140207m.

Model details are given in [3].

Scale models of the unguided reactive projectile launcher, precipitation stimulation devices and a container for various other equipment (radar, video equipment, etc.) were attached on the IAR 99 SOIM scale model. Design and execution of these stores were based on the following reference documentation:

- Design of CCP container for weather sensors;
- Design for the radar container;
- Design for DSP;
- Design for LPRND.

The models for the weather container, radar and DSP were attached on pylons 1,2,3,4 and the ventral pylon of the IAR 99 SOIM upgraded model for aerodynamic loads (forces and moments).

The test program of IAR 99 1:14 scale model is presented in the table below:

Configuration	Beta	Mach = 0.5	Mach = 0.62	Mach = 0.75
AFOV + X +P	0°	7508	7509	
AFOV + P + LPRN	0°	7510	7511	
AFOV+P+LPRN+CRE+CES+DSP	0°	7512		7513
AFOV+P+LPRN+CRE+CES+DSP	4.93°	7514	7515	

P1	P3		P4	P2
LPRN	CES	DSP	CRE	LPRN

α – incidence
β – yaw
X – no store attached
P – pylons
CRE – container on pylon 4 – interior
CES – container on pylon 3 – interior
LPRN –PRND launcher on exterior pylons
DSP – rainfall stimulation device

PREPARATION AND DEPLOYMENT OF THE TEST PROGRAM

The preparation and testing operations were carried out according to the Quality Assurance Manual of the Trisonic Wind Tunnel [5]. At the same time, in addition to regular testing programs a series of operations were performed consisting in changes made to operating procedures caused by the particular nature of this paper.

The preparatory operations carried out were the following:

a) Installation of the KULITE 25 psid transducer inside the strut cavity for pressure measurement at the model base; checking of electrical and pneumatic connections, excitation adjustment;

b) Installation by the technicians of the pressure tubing at the model base model trough the telescopic sting all the way to the Kulite transducer;

c) Installation by the technicians of the TASK 2.0 MKXXVI balance in the telescopic sting , under the supervision of the experimental program coordinator;

d) Installation of the sting and balance assembly in the wind tunnel under the supervision of the experimental program coordinator; the telescoping sting was adjusted and blocked at the specified length, the balance cable was secured in the adaptor area ;

e) Electrical connection of the TASK balance cable to the Data Acquisition System, adjustment and measure of the excitation voltage, balancing bridges check, gain and filter adjustment of the SCXI-1120 amplifier and SCXI-1141 filtering block channels;

f) Check of the balance connections (correspondence of signals and signs) by manual loading of each component separately and signals monitoring using an oscilloscope simulation program;
g) balance calibration check by applying standard weights, restoring the balance to the starting position (horizontal) and reading all the balance channels and the incidence encoder;
h) calibration of the CEC-200 electro manometer, KULITE ± 25 psid and Druck 3.5 and 4 bar transducers, computation of the calibration coefficients, update of the Master File;
i) computation of the balance-sting elastic deflection coefficients using the data obtained at the balance calibration, update of the Master file;
j) installation of the scale model in the wind tunnel under the supervision of the program coordinator, in strict compliance with the model designer's instructions;

SPECIAL OPERATIONS

Because of the danger of balance and sting overload under the influence of dynamic loads (vibrations) on the model, for this test program some special precautions and modifications of installation normal operating procedures were necessary, such as changing the connection system of amplifiers and conditioners in accordance with balance signal and mode of excitation (excitation voltage, FS value, filters).
Other required special operations were:
a) modification of the blow down automatic control and data acquisition programs by introducing program modules that monitor balance signals and verify overload criteria after each reading of data throughout the run, including stopping the run if an overload is detected;
b) monitoring program for wind off balance loading, in order to test the operation of the overload detection instructions by manual loading
c) extension of the balance monitoring function during model movement to the first angle, ensuring that these data are particularly marked for not being included in data processing
d) changing the data processing in terms of enlarging the regression range at 100 readings and dividing the run into 25 points, each point having a 100 readings regression.

TEST PROGRAM DEVELOPMENT

After installing the model, before starting the experiments all holes for bolts and pins were filled with china clay and leveled smooth to the model contour.

Also in this phase an initial version of the MASTER aerodynamic data file was prepared, containing the geometric reference values of the model, the balance coefficients, excitation voltages, calibration data, gains, coefficients of elastic deflection, model configuration, data file structure etc.

Before each run a copy of the MASTER file was created which was updated with the description of the experience, test parameters, atmospheric pressure and ambient temperature for the calculation of corrections. This copy was used by the run program to extract operating parameters of data reading and incidence mechanism, and it was completed after the end of experience with information on the recorded data to make possible further processing. Before each run, according to established procedures, the test program coordinator established the system and experimental configuration (Mach number, stagnation pressure), estimated the aerodynamic loads, fixed the limits of variation of the incidence, and recorded the parameters in the operating documents and in the specific run

MASTER file. The operating parameters which determine the test procedure for the transonic test chamber (perforated walls) are the following:

- Mach Number
- Stagnation pressure
- Nozzle contour (reference)
- Adjusting the second throat (<Second Throat-ST>)
- Setting the contraction (<Contraction Joint-CJ>)
- Adjusting the side flaps (flap Entry <Side SEF>)
- Setting upper and lower flaps (Flaps-TBF> <Top and Bottom)
- Opening discharge valve (Valve <Blow-Off BOV>)
- Perforated walls porosity (4%)
- Divergence of upper and lower walls of the chamber transonic
- Variation in incidence mode - continuous (<Sweep>)
- Incidence variation speed. - 3 ° / s
- Angle of incidence range
- Model roll angle
- Atmospheric pressure
- Ambient temperature.

Some of these parameters are registered on a special form that is given to installation operators while other parameters are registered in the MASTER file that is read by the run program and is updated after the run with a series of data regarding the test, the number of data read in each phase, date and time of test, etc.

Before each run the tunnel operators record and adjust the operating parameters, check the excitation and zeros of analog channels, load the run program and Master File into the process computer and then start the automatic testing sequence.

The runs were executed immediately after the necessary pressure in the wind tunnel tanks was reached, this being required in order to avoid possible problems caused by high values of pressure over the shutoff and bypass valves as well as by faulty seals losses.

Before each run the excitation voltages of the balance and KULITE transducers were adjusted and the measuring bridges were balanced. After each run the bridge balancing was checked to detect any drift of the zero indication, and no phenomenon of such nature was noticed. To correct the data measured by balance with the effect of model weight and initial channel offset, a pretare was automatically performed before every run by reading all the channels at the incidence limits of -15°, +25° and 0° . Atmospheric pressure was measured and recorded continuously for corrections to the absolute pressure electro manometer indications. Model incidence was varied continuously during the experience, between the established limits, with the speed of 3°/sec.

The signals from the balance sensors, pressure transducers, as well as other signals that indicate the model incidence, control valve position, etc. were amplified using SCXI amplifiers, filtered, converted to numerical values and recorded in the computer memory every 4-5 milliseconds.

Immediately after each experience the measured parameters were represented on the computer screen in graphical form using a special program made for validating the experience's success.

After each run the raw data were examined in order to detect any abnormalities in operation or data, after which they were transferred to computer for processing the experimental results. At the same time the tunnel was open and the model was examined.

This was followed by the preliminary processing and interpretation of results, recording any observations in the coordinator's registry book, setting of parameters for the next run or establishing any other needed action (tests of the systems, model, or computer programs, stop or continue the experiments).

RESULTS AND CONCLUSIONS

Comparison charts for the lift, drag and pitching moment coefficients depending on the incidence angle are given below for the three Mach numbers at which experiments were performed.

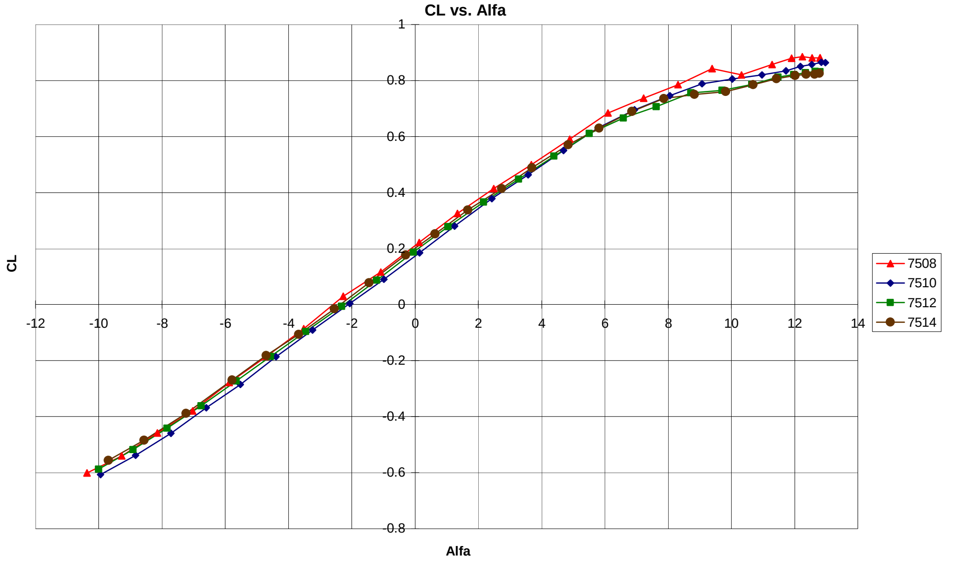


Fig. 1 The coefficient of lift C_L

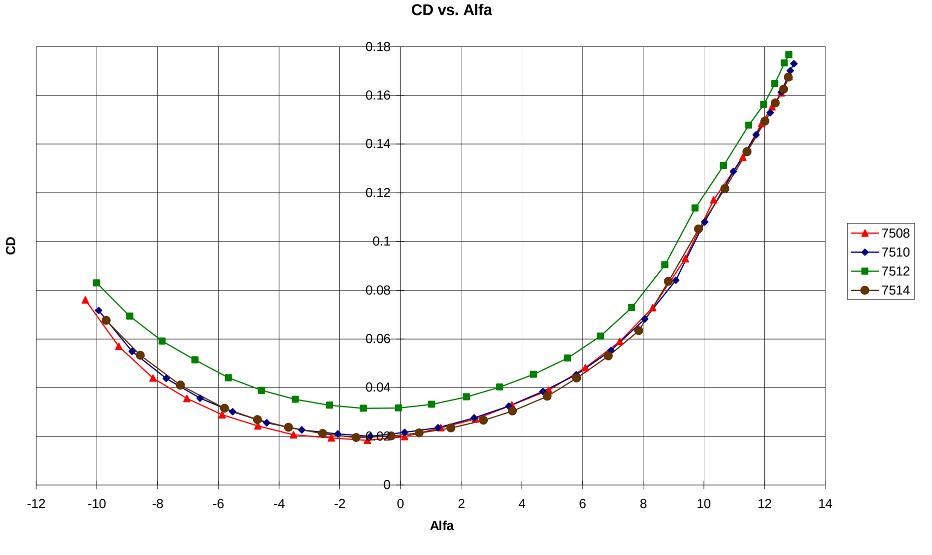


Fig. 2 The drag coefficient C_D

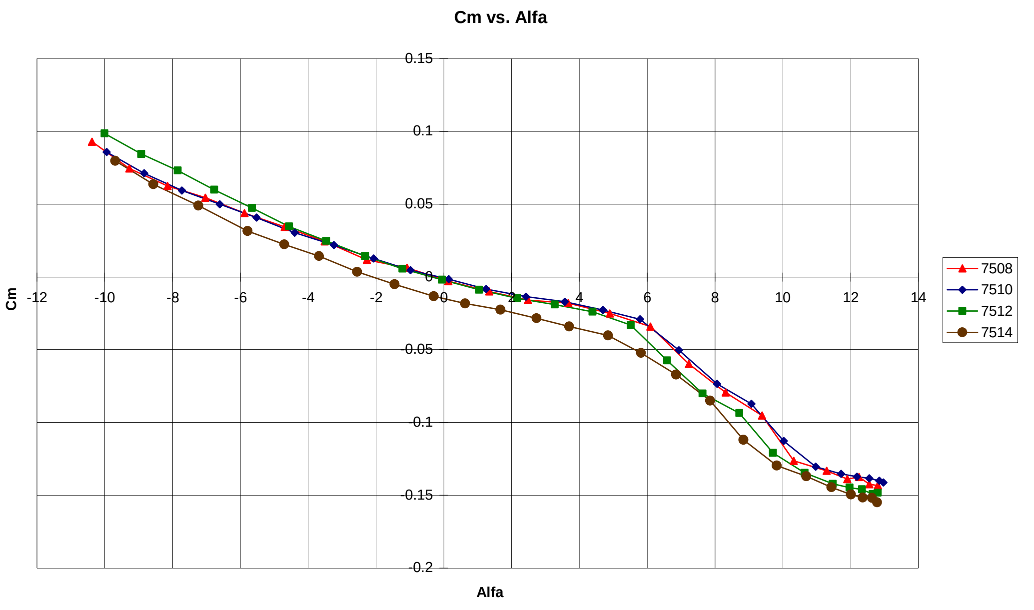


Fig. 3 The pitching moment coefficient C_m

The following are the coefficients of lift, drag and pitching of the plane for M = 0.5 from these experiences with the same model results in the report C-2127/1998, gust 6857

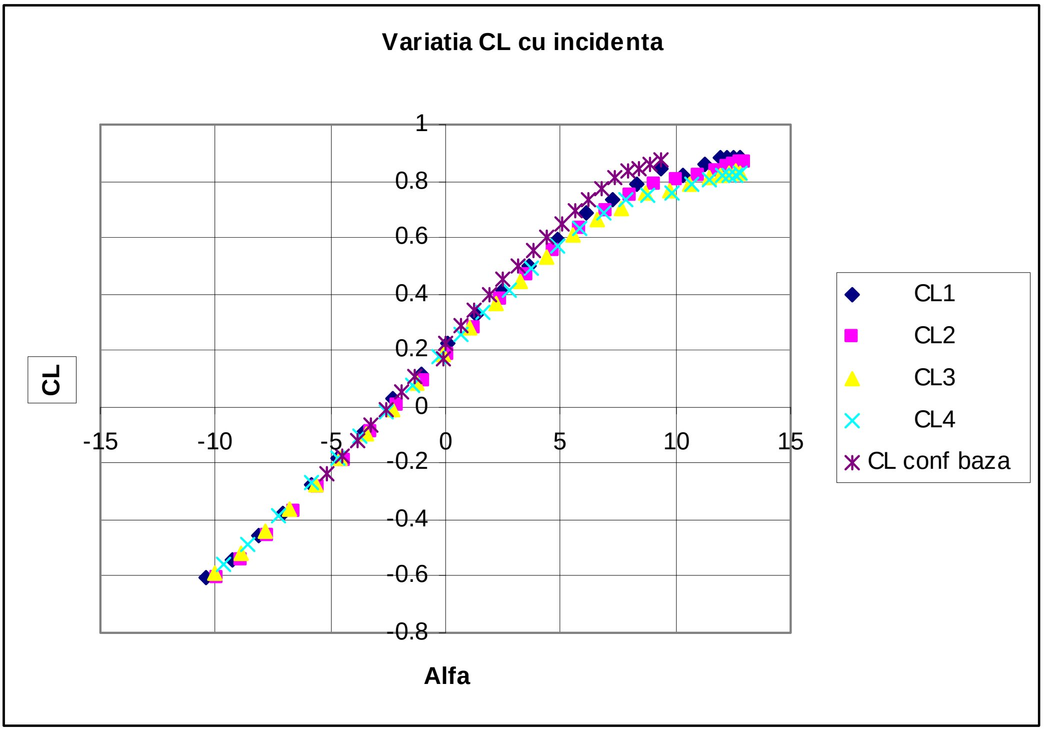


Fig. 4 The coefficient of lift C_L with the same model results in the report C-2127/1998, gust 6857

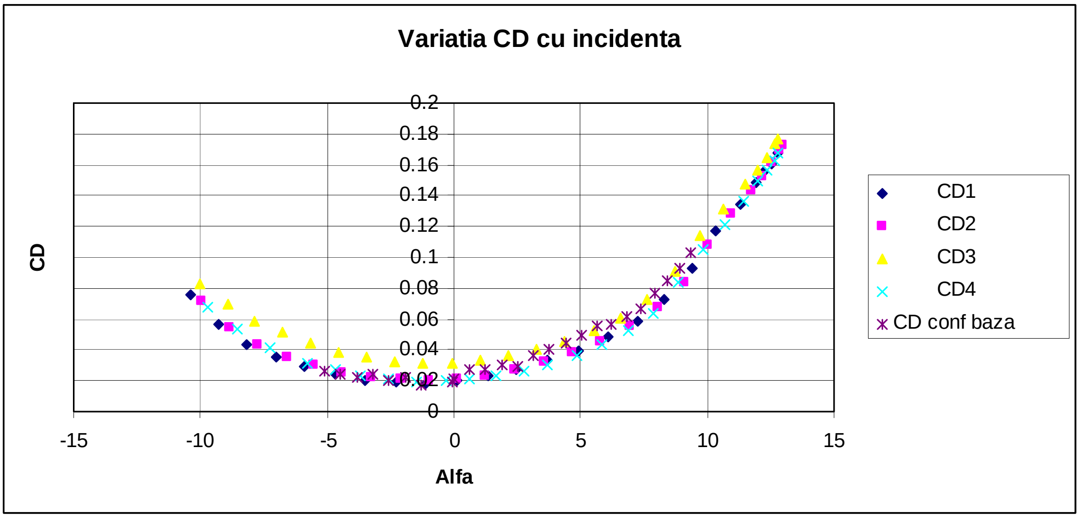


Fig. 5 The drag coefficient C_D with the same model results in the report C-2127/1998, gust 6857

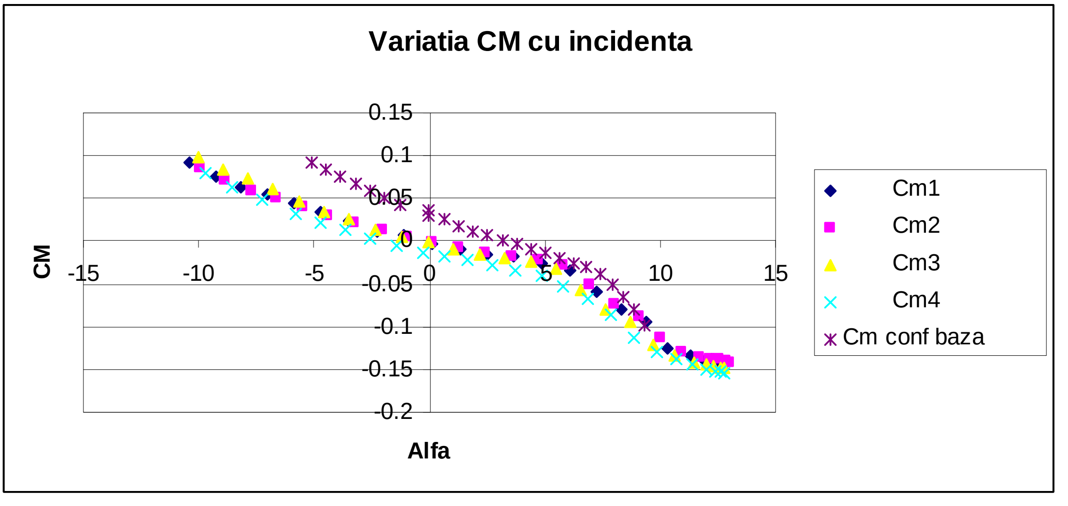


Fig. 6 The pitching moment coefficient C_m with the same model results in the report C-2127/1998, gust 6857

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