FULL-SCALE WIND-TUNNEL TEST OF ACTIVE FLOW CONTROL AT THE WING/PYLON/ENGINE JUNCTION

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Objectives

- To develop WT model, install AFC hardware and systems to suppress separation
- To prepare and carry-out large scale WT tests with/without AFC for TRL4 demonstration

Relatively small cutout

Standard nacelle

Relatively large cutout

Large nacelle for UHBR engine
Subsonic wind tunnel T-101 TsAGI

Test section dimensions:
- Nozzle cross section: 24×14 m (elliptic)
- Flow velocity: up to 45-50 m/s
- Re (MAC=3.259m): 11.2×10^6
- Total pressure: atmospheric
- Temperature: environmental
- Mach number: 0.15

Large-scale WT
AFLONEXT model in WT

Total parts for manufacturing: 1983
Total standard parts: 9807
Total parts: 11790

- DLR F-15 configuration
- 2.5D high-lift
- Underwing throughflow nacelle for UHBR engine
- Sref = 16.29 m²
- MAC = 3.259 m
- Wing sweep angle 28°
CFD, CLmax regime

- Separation in pylon wake
- Similar to aircraft configuration
- Different critical AoA
AFLoNext model overview

- **Length of Model**: ~7900 mm
- **Width of Model**: ~6000 mm
- **Span of Wing**: 5000 mm
- **Sweep Angle**: 28°
- **Weight**: ~5500 kg

**Components**:
- FAIRING OUTBOARD
- LEADING EDGE OUTBOARD
- SLAT OUTBOARD
- LEADING EDGE
- SJA-insert
- PJA-insert
- PYLON
- NACELLE
- LEADING EDGE INBOARD
- SLAT INBOARD
- SIDE PLATE OUTBOARD
- WINGBOX
- TRAILING EDGE
- FLAP
- SUPPORT OF THE MODEL
- SIDE PLATE INBOARD
- FAIRING INBOARD
- FAIRING OF THE CCD - CAMERA
- BALANCE
Trailing edge + flap

Wingbox

Trailing edge

Ribs

Flap

Number of parts – 247
Leading edge for PJA

Air supply for the PJA - insert
Leading edge for the SJA - insert

Top panel for SJA/PJA LE

Cover

Top panel for SJA/PJA LE

SJA - insert
Measurements

- Balances
- Minitifts
- Cp

Number of taps - 380
Wind tunnel tests, September 2017

PJA installed
Experimental results, strake

- NO stall due to separation in pylon wake even without strake
- There is a potential for AFC
Mini-tufts, with strake

AoA -> linear regime

No separation

AoA -> ~CLmax

Separation

- Minitufts show that separation in pylon wake starts to grow which can be suppressed by AFC
- There is the deviation from linear CL(AoA) curve which can be suppressed by AFC
PJA installation
Experiments, PJA, $V=30 \text{ m/s}$

- Reference configuration with strake
- Blue – PJA with $M_j\sim0.6$, close to reference
- Brown – PJA with $M_j\sim0.86$
- Green – PJA with $M_j\sim1$
- Monotonic effect with increase of jet intensity
Experiments, PJA, V=30 m/s, Cp, AoA=max
Experiments, PJA, minitufts

$\text{AoA = max, No jet}$

$\text{Separation upstream of PJA}$

$\text{AoA = max, With jet}$

$\text{Fully attached downstream of PJA}$
Experiments, PJA, different free-stream velocities

- Noticeable effect for all speeds

V=40 m/s

V=48 m/s

CL(AoA)
Experiments, PJA, no strake

- Monotonic increase of effect due to increase of intensity
- $\Delta CL$ is approximately the same as in case with strake

$V = 48 \text{ m/s}$

$CL(\text{AoA})$

$0.1$

$2 \text{ deg}$
SJA and equipment installation
SJA, experiments, V=30 m/s

- Frequency sweep then AoA sweep with optimal F
- No optimal F on balances
- Very small scale
- SJA effect within scale of accuracy / repeatability

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Summary

• WT model has been developed, PJA and SJA hardware and systems have been installed

• Large-scale WT tests without/with PJA and SJA have been carried out in T-101 TsAGI WT

• PJA essentially increases CL values near CLmax regime

• Cp-distributions and minitufts show that this increase is due to suppression of separation in pylon wake region

• There is no essential difference in CL and minitufts due to SJA