Test Case 2: CRM-HL Configuration Buildup

This test case is available to assess the ability of CFD to predict the effect of varying geometric fidelity through component build-up to help isolate specific types of flow physics associated with high-lift aerodynamics. Geometry is provided for four separate geometric configurations of increasing levels of complexity, with simulations to be performed free-air and compared to fully corrected data. Experimental data will be provided from wind tunnel campaigns utilizing both the ONERA [3] and Boeing models, tested at the ONERA F1 and QinetiQ 5m facilities, respectively.

This test case is a duplicate of HLPW5 Test Case 2, as many questions were raised during the course of that workshop that weren't satisfactorily answered. Farfield domain is preferred to be a hemisphere with distance 100*MAC, although other similar "best practice" domain extents are allowed. Additional studies including adding additional complexity may be requested, but will be TFG specific.

Geometry

This geometry is derived from the CRM-HL model geometries of varying component complexity. All configurations include a full empennage (horizontal and vertical stabilizers = HV). The buildup configurations are:

(1) CRM-HL-WBHV: Reference Geoemtry Wing-Body with HV
(2) ONERA_LRM-WBSHV: ONERA model geometry Wing-Body-**Slat** with HV
(3) ONERA_LRM-WBSFHV: ONERA model geometry Wing-Body-Slat-**Flaps** with HV
(4) ONERA_LRM-LDG: ONERA model geometry Wing-Body-Slat-Flaps-**Nacelle** with HV

Validation data for the WBHV subcase is not yet available, but may become available mid workshop. Geometry for this subcase is base on the reference geometry, as this data won't be collected on the ONERA specific CRM-HL. For the other three subcases, the geometry definitions from the as-designed ONERA 1/19.5 model tested in the F1 wind tunnel are utilized. Although small geometric differences are expected between the reference CAD definition and the ONERA model definitions, those differences are well documented, and are expected to be aerodynamically insignificant. Further, the maximum Reynolds number achievable for the WBHV subcase will be slightly lower than that achieved with the ONERA model. This is not expected to have any noticeable impact, but nonetheless the flow conditions for CFD for these cases reflect this difference. These test cases are recommended to be run fully turbulent.

It is not expected that a full study of all geometries in this test case will be required. Each TFG can determine the subcase(s) targeted as the highest priority. Toward the end of the workshop, subcase 2.4 will possibly be used to compare predictive capability across TFGs.

Geometry Reference Quantities

Mean Aerodynamic Chord (MAC)	275.8 inches
Moment Reference Center (MRC)	x = 1325.9 inches, y = 0.0 inches, z = 177.95 inches
Semi-span model reference area (Sref)	297,360.0 in^2
Leading Edge Deflection (reference)	30°
Trailing Edge Deflection (reference)	40° Inboard, 37° Outboard

Case Parameters and Requirements

Geometries	CRM-HL-WBHV ONERA_LRM-WBSHV ONERA_LRM-WBSFHV ONERA_LRM-LDG-HV
Mach Number	0.20
Chord Reynolds Number	5.4×10^6 (subcase 2.1), 5.9×10^6 (subcases 2.2 - 2.4)
Angles of Attack	6-8 alphas (TBD)
Reference Static Temperature	518.67 °R
Reference Static Pressure	14.696 psi
Important Details	• Geometry is provided in full-scale inches • When using a dimensional code, it is recommended to adjust viscosity to a non-physical value to match requested Reynolds number • All simulations are run Free-Air with no tunnel or support systems included • Symmetry boundary condition is typically applied at y = 0.0 inches.

Optional: Increased Fidelity

Several elements of the computational modeling can be investigated to explore sensitivity of solutions. These include, but are not limited to:

- Use of specific wind tunnel model geometry associated with a particular test campaign
- Use of static tunnel aeroelastic deformations
- Performing in-tunnel simulations (either with the test section only, or including expansion/contraction sections)
- Physical tripping or transition modelling
- Systematic mesh refinement

Note that experimental data to help characterize some of the above modeling effects may not be available from every facility. Additional data will be provided as required, and when available, on a case by case basis. It is expected that decisions to explore one or more of these areas in more depth will be left to individual TFGs, with requests for additional data provided to the organizing committee.