DPW7 Cases – Rev I 5/27/2022

Note: The NASA High Speed Common Research <u>Wing-Body configuration</u> is used for all cases (tail, nacelle, pylon not to be included)

1. **CRM Wing-Body Grid Convergence Study:** Use at least 4 grids of the 6-member baseline grid family for this study. - Preferably, we would like Participants to use all 6 members of the Family. Use 3.00-deg LoQ AE CRM geometry

   Case 1a. Re = 20M (Required): Flow conditions are: M = 0.85; Re = 20 million; fixed CL = 0.58 +/- 0.0001; Reference temperature = -250°F; 3.00-deg LoQ AE CRM geometry. Grid convergence study on Baseline LoQ R30 grids.

   Case 1b. Re = 5M (Optional): Flow conditions are: M = 0.85; Re = 5 million; fixed CL = 0.58 +/- 0.0001; Reference temperature = 100°F; 3.00-deg LoQ AE CRM geometry. Grid convergence study on Baseline LoQ R5grids.

   Use at least 4 grids of the 6-member baseline grid family for this study. - Preferably, we would like Participants to use all 6 members of the Family.

2. **CRM Wing-Body Alpha Sweep:** Angle-of-attack sweeps will be conducted at two Reynolds numbers using the LoQ aero-elastic deflections measured in the ETW Wind Tunnel Test. Flow conditions are:

   Case 2a. Re = 20M (Required): M = 0.85; Re = 20 million, Reference temperature = -250°F. Use Baseline LoQ R30 grids.

   Case 2b. Re=5M (Optional): M = 0.85, Re = 5 million, Reference temperature = 100° F. Use Baseline LoQ R5 grids.

Use the Medium Baseline aero-elastic grids for the appropriate Reynolds number family.

Angle of Attack sweep:

CL = 0.50	2.50-deg LoQ AE CRM geometry
a = 2.75°	2.75-deg LoQ AE CRM geometry
a = 3.00°	3.00-deg LoQ AE CRM geometry
a = 3.25°	3.25-deg LoQ AE CRM geometry
a = 3.50°	3.50-deg LoQ AE CRM geometry
a = 3.75°	3.75-deg LoQ AE CRM geometry
a = 4.00°	4.00-deg LoQ AE CRM geometry
a = 4.25°	4.25-deg LoQ AE CRM geometry

3. **CRM Wing-Body Reynolds Number Sweep At Constant CL (Required):** Flow conditions are: M = 0.85, <u>CL = 0.50</u>, medium grids;

   - Re = 5M, LoQ – R5 grid using 2.50-deg LoQ AE CRM geometry, Reference temperature = 100° F (Same LoQ R5 medium grid solution from Case 2b)
   - Re=20M, LoQ – R30 grid using 2.50-deg LoQ AE CRM geometry, Reference temperature = -250° F (Same LoQ R30 medium grid solution from Case 2a)
   - Re=20M, HiQ – R30 grid using <u>2.50-deg HiQ AE CRM geometry and R30grid, Reference temperature = -182° F</u>

- Re=30M, HiQ – R30 grid using 2.50-deg HiQ AE CRM geometry and R30grid, Reference temperature = -250° F

4. CRM Wing-Body Grid Adaptation – Alpha Sweep [Optional]: Angle-of-attack sweep for the CRM Wing-Body using an adapted grid family provided by the participant. Flow conditions are: M = 0.85; Re = 20 million; Reference temperature = -250°F Start the adaptation process from the appropriate Baseline LoQ mesh or aeroelastic geometry. Additional cases can be run for Re = 5 million; Reference temperature = 100°F. Participants are to document the adaptation process.

Angle of Attack sweep – (preferred priority):

CL = 0.58	3.00-deg LoQ AE CRM geometry
a = 4.00°	4.00-deg LoQ AE CRM geometry
a = 3.50°	3.50-deg LoQ AE CRM geometry
a = 4.25°	4.25-deg LoQ AE CRM geometry
a = 3.25°	3.25-deg LoQ AE CRM geometry
a = 3.75°	3.75-deg LoQ AE CRM geometry

(Please order results in Angle-of-Attack monotonic order)

5. Beyond RANS [Optional]: Solution technologies beyond steady RANS such as URANS, DDES, WMLES, Lattice Boltzmann, etc. Flow conditions are: M = 0.85; Re = 20 million; Reference temperature = -250°F. Baseline grids not provided.

Case 5a. Single solution at fixed alpha producing CL ~ 0.58 (Case 1a should help find the alpha)

Case 5b. Alpha Sweep (including Case 5a), as many as possible:

Angle of Attack sweep – (preferred priority):

CL = 0.58	3.00-deg LoQ AE CRM geometry (run with fixed alpha that results in CL ~ 0.58)
a = 4.00°	4.00-deg LoQ AE CRM geometry
a = 3.50°	3.50-deg LoQ AE CRM geometry
a = 4.25°	4.25-deg LoQ AE CRM geometry
a = 3.25°	3.25-deg LoQ AE CRM geometry
a = 3.75°	3.75-deg LoQ AE CRM geometry

(Please order results in Angle-of-Attack monotonic order)

6. CRM WB Coupled Aero-Structural Simulation [Optional]: Flow conditions are: M = 0.85; Re = 20 million; Reference temperature = -250°F. Use the Medium Baseline NoQ Re=30M grid. Single solution at CL = 0.58 and/or an alpha sweep, coupled with computational structural analysis. Static aeroelastic deflections calculated starting from the undeformed NoQ geometry.

The FEM model to be used for Case 6 is the model located at this link on the CRM website:

https://commonrsearchmodel.larc.nasa.gov/fem-file/wingbodytail0-deg-configuration/

The name of the file is: CRM-mode-tet4-001-den-noEng_sk.bdf_.zip

A modal analysis was done in 2016 by extracting the modes using Abaqus for this same FEM model. The modes are given in files at the bottom of the CRM website on this page:

https://commonresearchmodel.larc.nasa.gov/fem-file

Specifically:

https://commonresearchmodel.larc.nasa.gov/wp-content/uploads/sites/7/2016/06/CRM_30_Modes_first_half.tar_.gz

https://commonresearchmodel.larc.nasa.gov/wp-content/uploads/sites/7/2016/06/CRM_30_Modes_second_half.tar_.gz

Note that the FEM model includes the horizontal tail, which is NOT to be included in this analysis. Also note that the FEM model is for the full airplane because there is structural asymmetry between the left and right sides of the model. ETW deflection data was measured on the Left-Hand Side wing. A full aircraft CFD model (rather than the half model grids currently supplied for DPW-7) will likely be required to combine with the full airplane FEM. Symmetrically mirroring the CFD grid and/or resulting flow solution can be done to combine with the FEM model.

Undeflected NoQ geometry/grids for NTF Wind Tunnel Model WITHOUT Nacelle/Pylon and tail to be used as a starting point.

Angle of Attack sweep – (preferred priority):
CL = 0.58
a = 4.00°
a = 3.50°
a = 4.25°
a = 3.25°
a = 3.75°
(Please order results in Angle-of-Attack monotonic order)