# HO Mesh Generation Guidelines Supplement

Version: 1.0

**3rd Geometry and Mesh Generation Workshop (GMGW-3)**
**4th High Lift Prediction Workshop (HLPW-4)**

The following guidelines are provided for participants in High-Order Technology Focus Group (HO-TFG) for the GMGW-3 and HLPW-4 workshops as a set of supplemental recommendations for how to construct meshes for the test cases and challenges presented by both workshops. This document is not meant to be interpreted as a strict set of requirements but instead as a starting point for meshing the High Lift Common Research Model (CRM-HL) in its full-scale nominal landing configuration (HO-TFG Case 1) and the Juncture Flow Model (JFM) geometry (HO-TFG Case 2). HO-TFG participants should refer to the general meshing guidelines for additional details. These materials are provided specifically for those involved in generating mesh families for high-order flow simulations. Linear and curved meshes up to degree 2 or 3 are anticipated.

## Mesh Family

Generating a mesh family usually consist of creating the first mesh by following the guidelines and then create coarser or finer meshes by applying the appropriate mesh factor to all operations in the construction of the mesh. The general meshing guidelines recommends starting with mesh AAAA and then advance to finer meshes to generate the family.

## Surface Mesh

Surface mesh sizing and spacing guidelines are provided below in Table 1 and are based on $C_{REF}$= 275.8 inches and a wing semi-span = 1156.75 inches for the CRM-HL geometry. The JFM geometry has the reference chord $C_{REF}$= 557.17 mm and a wing semi-span = 1698.5 mm. This table adds coarser meshes to the general meshing guidelines table and omits some of the extremely fine entries.

*Table 1. Recommended HO Surface Mesh Characteristics*

| Mesh | Fuselage Cell Size (Body, Nose, Tail) | Chordwise Spacing (Slats, Wing, Flaps LE/TE) | Spanwise Spacing (Slats, Wing, Flaps Root/Tip) | Cells (Points) on TE† | Mesh Factor |
|---|---|---|---|---|---|
| AAAA | ≤ 9.0% $C_{REF}$ | ≤ 0.900% Local chord | ≤ 0.900% Semi-span | 1(2) | |
| AAA | ≤ 4.5% $C_{REF}$ | ≤ 0.450% Local chord | ≤ 0.450% Semi-span | 2(3) | 1/2 |
| AA | ≤ 3.00% $C_{REF}$ | ≤ 0.300% Local chord | ≤ 0.300% Semi-span | 3(4) | 2/3 |
| A | ≤ 2.25% $C_{REF}$ | ≤ 0.225% Local chord | ≤ 0.225% Semi-span | 4(5) | 3/4 |
| B | ≤ 1.5% $C_{REF}$ | ≤ 0.15% Local chord | ≤ 0.15% Semi-span | 6(7) | 2/3 |
| C | ≤ 1.0% $C_{REF}$ | ≤ 0.1% Local chord | ≤ 0.1% Semi-span | 9(10) | 2/3 |
| D | ≤ 0.75% $C_{REF}$ | ≤ 0.075% Local chord | ≤ 0.075% Semi-span | 12(13) | 3/4 |

Create the coarsest mesh, Mesh Level AAAA, first based on the guidelines in Table 1. Create the next finer member of the mesh family (Mesh Level AAA) by consistently applying changes to surface mesh sizing characteristics by a Mesh Factor of 1/2. Examples of other surface mesh characteristics that would typically be scaled by this factor include node counts, edge lengths, stretching ratios, decay rates and source terms (as possible and/or applicable in your toolset).

Continue creating progressively finer members of the mesh family by repeating this process.

## Farfield

Meshes generated for the CRM-HL should have a minimum distance of 1000 $C_{REF}$ between the Outer Mold Line (OML) and the farfield mesh boundary. The preferred shape of the outer boundary is a sphere (hemisphere for half-plane). If you are creating a mesh family, use the same farfield distance for all refinement levels in the family. Meshes generated for the JFM should have a minimum distance of 100 $C_{REF}$ between the OML and the farfield. Note: The farfield boundary for the JFM is defined in the CAD file provided.

## Volume Mesh

Principal volume mesh characteristics for the CRM-HL mesh families to be generated are included in Table 2.

*Table 2. Recommended HO Volume Mesh Characteristics for CRM-HL*

| Mesh | Initial Wall Spacing Δy (inches) | Corresponding Wall y+ | Boundary Layer Growth Rate | Mesh Factor |
|---|---|---|---|---|
| AAAA | 0.00956 | 9.0 | 2.44140625 | |
| AAA | 0.00478 | 4.5 | 1.5625 | 1/2 |
| AA | 0.00318667 | 3.0 | 1.346521 | 2/3 |
| A | 0.00239 | 2.25 | 1.25 | 3/4 |
| B | 0.00160 | 1.5 | 1.16 | 2/3 |
| C | 0.00106 | 1.0 | 1.10 | 2/3 |
| D | 0.00080 | 3/4 | 1.07 | 3/4 |

Participants are encouraged to create all levels (7) in Table 2. At a minimum, construct 4 levels and bias towards the finest mesh levels you can generate. If you are unable to generate all levels (7), please explain why (identifying and documenting the limiting factors) in your Participant Questionnaire submission.

## Additional Considerations

**LES Off-body Resolution –** If performing LES solutions, the recommended off-body resolution above the wing and in the wake is a length scale that is equivalent to Y+ values between 100 to 500.

Principal volume mesh characteristics for the JFM mesh families to be generated are included in Table 3.

*Table 3. Recommended HO Volume Mesh Characteristics for JFM*

| Mesh | Initial Wall Spacing Δy (mm) | Corresponding Wall y+ | Boundary Layer Growth Rate | Mesh Factor |
|---|---|---|---|---|
| AAAA | 0.052557297 | 9.0 | 2.44140625 | |
| AAA | 0.026278649 | 4.5 | 1.5625 | 1/2 |
| AA | 0.017519099 | 3.0 | 1.346521 | 2/3 |
| A | 0.0131391 | 2.25 | 1.25 | 3/4 |
| B | 0.0087594 | 1.5 | 1.16 | 2/3 |
| C | 0.0058396 | 1.0 | 1.10 | 2/3 |
| D | 0.0043797 | 3/4 | 1.07 | 3/4 |

Participants are encouraged to create all levels (7) in Table 3. At a minimum, construct 4 levels and bias towards the finest mesh levels you can generate. If you are unable to generate all levels (7), please explain why (identifying and documenting the limiting factors) in your Participant Questionnaire submission.