

Wall Pressure Coefficient (Cp) Details
14x22 Test 662 - 8% Juncture Flow Model with Symmetric Wing
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Datafiles contain:

- WPZ: fitted wall Cps with Juncture Flow model installed and includes effect of the tunnel gradient; $cp = cp_{\text{delta}} + cp_{\text{gradient}}$
- WPZgradient: test section streamwise gradient from empty tunnel runs (due to test section walls and divergence)
- WPZdelta: these are the wall Cps due to model only
- WPZsigma: wall Cp uncertainty (95% confidence level) = ± 0.01
- xtunnel (mm): tunnel station where all the fits were evaluated, these are not the actual orifice locations in the physical tunnel, units are millimeters
- ytunnelnominal (mm): nominal tunnel y for wall orifice rows, this value does not take into account the divergence of the tunnel side walls, units are millimeters
- ztunnelnominal (mm): nominal tunnel z for wall orifice rows, units are millimeters

Origin for xtunnel, ytunnel, and ztunnel is at start of the test section and at the centerline.

New variables to account for total pressure deficit in test section:

- The "WPZ" variables were calculated to include the total pressure deficit in the test section. The current implementation of the 14x22 tunnel calibration does not account for this deficit. New equations were added to account for this deficit (based on data from Test 508 which is what the current 14x22 tunnel calibration is based on). These equations were modified so that the tunnel reference conditions are all referenced to tunnel station 17.75 feet for an empty tunnel.
- Taking total pressure deficit into account causes a change to the static pressure calculation which in turn affects the Cp calculations. This shifts Cps $\sim +0.018$. Accounting for this deficit causes a minimal effect on other tunnel conditions, i.e. Mach, dynamic pressure, velocity, Reynolds number.

Use of data:

- If CFD simulation is done only with model in-tunnel, then "WPZ" is the appropriate variable.
- If CFD simulation is done with model in-tunnel and is tared to an empty tunnel simulation, then "WPZdelta" is the appropriate variable.

Various details for Cp calculations:

14x22 wall static orifices are not pristine orifices and were always intended to be used with a tare process.

Empty tunnel data were used to tare each orifice. Empty tunnel data were also used to estimate the test section streamwise gradient. The empty tunnel data were from the following tests:

Test 635: runs 148, 149, 150, 151, 152, 153

Test 641: runs 5, 7, 8, 53, 54, 55, 59

Test 659: runs 2, 3, 7, 8, 9, 13, 14, 15

Test 662 runs used for these results are from the alpha polars and include runs 332, 333, 334, 348, 349, and 350 (upright runs only). Alpha = 1 degree wall data was interpolated from the above runs, i.e., alpha=1 deg data was not taken during the alpha polars.

Processing:

1) For each wall orifice, fit empty tunnel data versus q (from 10 psf to 140 psf)

2) For each point used from T662, used the fits from step 1 to get the empty tunnel C_p value at the q with the model installed; subtracted the empty tunnel C_p value from the model installed C_p value. This provides a delta C_p between model installed and empty tunnel for each point. But this delta C_p loses the effect of the test section gradient.

3) For a given alpha, and assuming symmetry in the test section, combined delta C_p data from rows 1 and 12; rows 2 and 11; rows 3 and 10; rows 4 and 9; rows 5 and 8; and rows 6 and 7. Used a smoothing spline to fit each combined row and evaluated the spline from $x = 3$ to 40 feet (914 to 12192 mm). This provides the "cpdelta" values.

4) To take the tunnel gradient into account, used empty tunnel data and combined all 12 rows together for each point and did a first order polynomial fit (using data from $x = 3$ feet to 38.5 feet). Then combined all fit information together and did another fit versus q . Using the average q for the model-installed data points, then calculated the tunnel gradient information and evaluated from $x = 3$ to 40 feet. These are the "cpgradient" values.

5) Then calculated "cp" using: $cp = cpdelta + cpgradient$

Cp Uncertainty (95% confidence level):

The uncertainty for WPZ or WPZdelta is dominated by variation in wall pressure coefficients.

Empty tunnel variation for each wall orifice ranges from ± 0.005 to ± 0.010

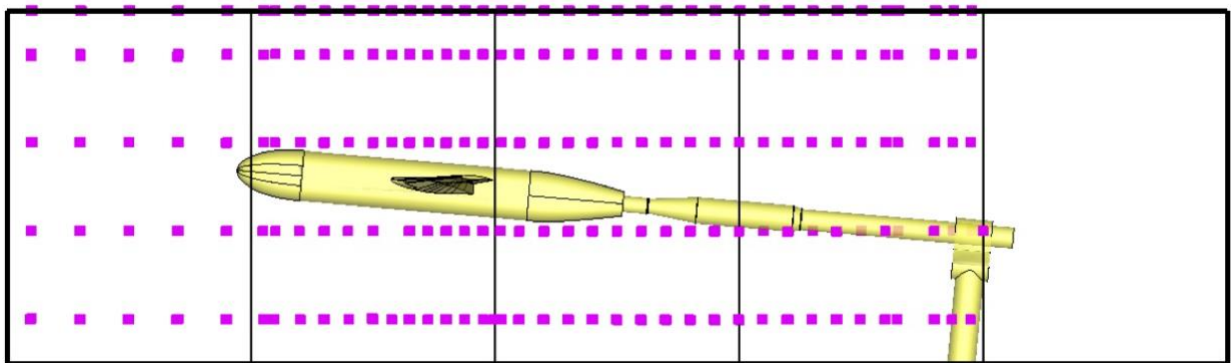
Average variation is ± 0.007

Expected instrumentation uncertainty: ± 0.001 (going to ignore this)

Assumed variation with model installed: ± 0.007

$$\Rightarrow \text{Uncertainty} = \sqrt{0.007^2 + 0.007^2} = \pm 0.010$$

Side view of test section with model (with F6-based wing) at 5 degrees.



Upstream view with model (with F6-based wing) at 5 degrees and wall pressure row numbers.

