

Model Attitude Measurement Working Group:

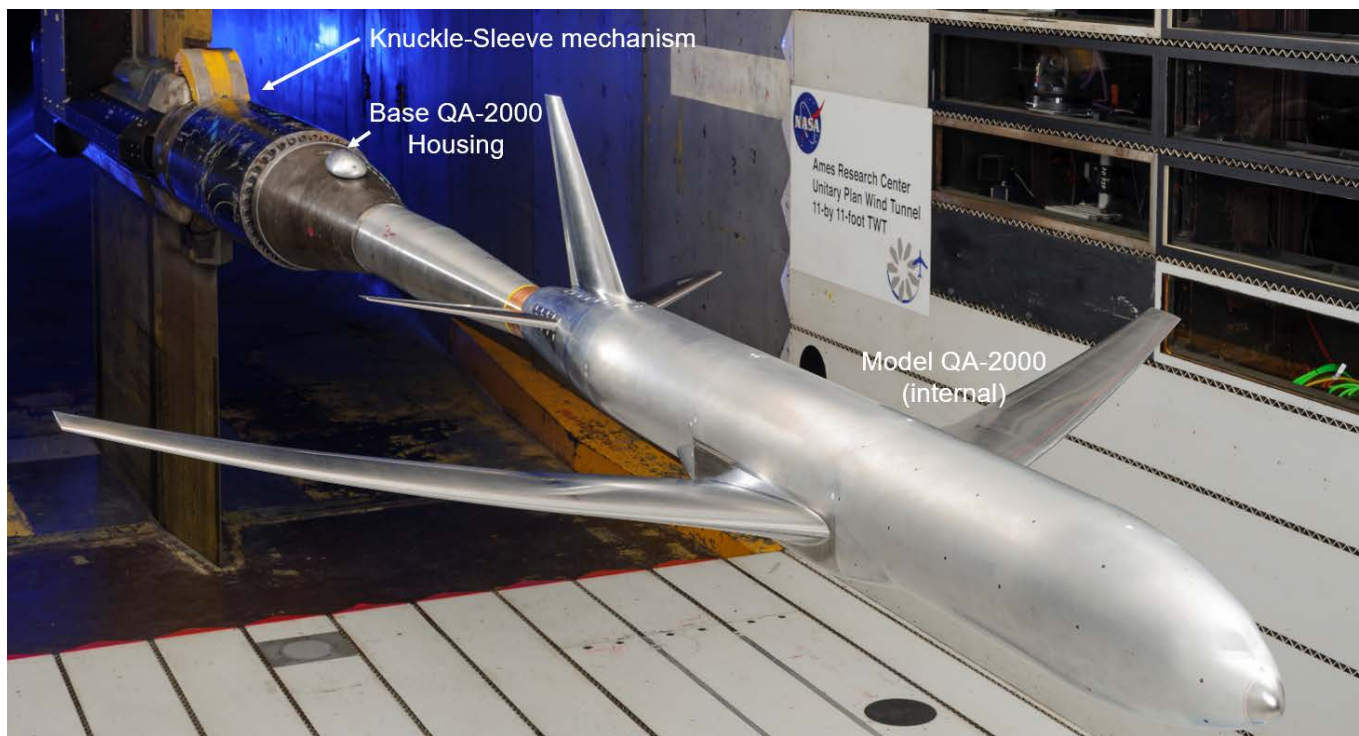
Facility Model Support & Angle
Determination Process Survey



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Facility Name:	NASA Ames UPWT: 11-ft TWT		

General Facility Description: Transonic Wind Tunnel with an 11x11-ft test section built for production full-span or semi-span testing.

Model Support Description: Full span models typically utilize a F&M balance, sting, and primary adapter, mounted to the Sting Model Support System. Model positioning is accomplished using a hydraulically driven Knuckle-Sleeve mechanism where both components have a 7.5° bend—allowing for any wings-level alpha-beta combination that can be prescribed in a 15° half-angle cone.



Model Attitude Determination Description (for model positioning or control):

1. The Facility Control System calculates the forward kinematics which reads balance signals and uses test configuration data and other FCS feedback data to produce the angles described in the Model Attitude kinematics.
2. Uses the current Model Attitude to determine an incremental set point towards the desired Model Attitude.
3. Calculates the inverse kinematics which converts the incremental Model Attitude angles into Knuckle and Sleeve set points.
4. Calculates the accompanying strut set point to keep the model on tunnel centerline.

- Knuckle and Sleeve and Strut are driven to the set points in a coordinated manner.
- The process is constantly repeated at 20hz unless the Test Staff configure the model support to stop during data taking (in which case once the model is within tolerance of a desired set point, the control system only repeats step 1 until the data point acquisition is complete).

The Data System does an independent calculation of the kinematics as well as recording important Facility Control System data. If applicable, the data system also records Q-Flex accelerometer outputs from sensors at the sting base and within the model for data reduction.

Model Attitude Determination Description (for measurement data):

$$\begin{bmatrix} u' \\ v' \\ w' \end{bmatrix}_{bod} = \underbrace{[Y_{IRB}][P_{IR\alpha}][R_{IRF}]}_{\text{BALANCE TO BODY}} \underbrace{[Y_{\omega}][P_{\gamma}][R_{\lambda}]}_{\text{STING DEFLECTION}} \underbrace{[R_{\Delta\phi}]}_{\text{TWIST}} \underbrace{[Y_{\Delta B}][P_{\Delta A}][R_{\phi}]}_{\text{FIXED BEND}} \underbrace{[P_A][Y_B]}_{\text{VARIABLE SUPPORT ANGLES}} \underbrace{[P_{A_{STR}}][Y_{B_{STR}}]}_{\text{STREAM ANGLE}} \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

$$\alpha_{bod} = \tan^{-1} \left(\frac{w'_{bod}}{u'_{bod}} \right) \quad \beta_{bod} = \sin^{-1}(-v'_{bod}) \quad \phi_{bod} = \phi + \Delta\phi + \lambda + IRF$$

