MODEL DESIGN RECOMMENDATIONS

Written by Brian Geppert January 3, 2000

This document describes suggestions for the design of the wind tunnel model in order to improve the efficiency and success of the test. It also explains the requirements for any wind tunnel model tested in the Kirsten Wind Tunnel at the University of Washington Aeronautical Laboratory (UWAL). If you have any questions, please contact the Operations Manager at 206-543-0439.

DESIGN SAFETY FACTOR

The model needs to be designed to withstand loads that are five (5) times greater than the predicted loads. The customer will need to provide UWAL with one copy of the stress analysis documentation or documentation showing that the model was been proof-tested to twice the predicted loads.

Any parts that interface with UWAL equipment should be made of steel to avoid gauling since all UWAL model mounting hardware are made of steel.

MODEL MOUNTING

It is important to have the model shop coordinate with UWAL in the design of the model mounting for ensuring that the model will be easy to install. Otherwise, the model may need to be completely disassembled, which means more test time wasted.

MODEL COLOR

If the customer is interested in conducting flow visualization on the model, it is advisable to give the model a high quality, durable paint job using a flat gray color. Gray will help provide enough contrast for flow visualization chemicals and still allow good configuration photos. If gray is not available, then flat black works well, but has the disadvantage of blending the model with the shadows in the photographs.

If trip strips are to be placed on the model, then it is even more important that the paint be durable and resistant to solvents, such as naptha and/or acetone. Otherwise the trip strips may not stick to the model surface, especially if you are using trip dots.

MODEL FIT CHECK

UWAL strongly recommends doing a complete fit check of the model and its parts to ensure that all parts can be installed easily. The customer needs to decide whether to use a UWAL-provided trunnion block or build their own trunnion block for securing the model to the strut. In either case, it is recommended that the customer provide the pins for securing the model to the trunnion block so as to ensure a good fit.

MODEL SHIPPING

UWAL suggests using wooden boxes for containing the model during shipping. It is helpful for unpacking the model if the lids are secured using Phillips-head screws. So that the boxes are easily moved with a forklift or pallet jack, the crate should have an opening in the center of the box that allows passage of forks that are three (3) inches tall and 36 inches wide. Wooden boxes are also useful for storing the model, even if it is not being shipped very far.

INSTALLING THE MODEL

Since the test section of the Kirsten Wind Tunnel is not on the ground floor, the model is normally hoisted into place. This process can be greatly expedited if the model arrives with holes tapped for 3/8-16 bolts (one inch deep) for installing lifting-rings in any part that is awkward to lift, such as the fuselage and wings.

LOCATION OF MODEL MOUNT

The model mount should be located in the model as close as possible to the station location (fore/aft) of the aerodynamic center. By doing this, the pitching moment generated by the lift acting at the aerodynamic center will be minimized. If not, then it is possible for the model to prematurely exceed the pitching moment limit of the UWAL external balance.

FUSELAGE UNDERBODY PANEL

If a strut is to be used to mount the model, then there needs to be an opening in the underbody of the model for allowing the strut to enter the fuselage and attach to the inner structure (hopefully using a trunnion block). UWAL strongly recommends using a body panel that is split so that the model can be installed on the strut and later install the split body panel.

The model designer should also keep in mind that if there is a miscalculation in the angle range of the model, that the body panels should be easy to modify to allow the larger angle range.

STRUT SEAL

Since the underbody panel has an opening for allowing the strut to enter the inner body of the fuselage, the opening can be a source of drag. To reduce the drag a seal should be installed that moves freely around the strut when the model changes angle of attack. Typical seals are made using thick foam that is glued in place. If the foam is not installed properly, then it can be sucked out of the model during the test.

The best solution is to use a sliding metal seal. The underbody panel should be designed to allow two pieces of sheet metal to slide back and forth. The two pieces of sheet metal would have the cutout for the strut and pitch arm. One piece is the front half, the other piece of sheet metal is the rear half of the seal. The two pieces of the seal are held together using springs. See the photo below:

Looking Up at the Underbody Panel and Strut Seal. Model is at the maximum angle of attack.

TRUNNION PINS

UWAL recommends building a model-specific set of steel pins for securing the model to the trunnion block and pitch arm. UWAL does have a limited set of trunnion block pins and pitch arm pins of various lengths. If the customer would like to use existing UWAL pins, please request the pins be sent to the model maker for a fit check. Be certain to specify the length of the pin.

MODEL ACCELEROMETER

UWAL has a precision AlliedSignal QA2000 accelerometer that has been configured to measure angle of attack within 0.001°. If at all possible, the model should be designed to mount the accelerometer inside the fuselage on a flat surface that is aligned with the reference plane of the model (e.g. zero angle of attack line). Please see Section 20 of the Technical Guide to the Kirsten Wind Tunnel (available on our website - www.uwal.org).

INCLINOMETER MOUNT

In order to perform an angle of attack calibration, the model must have a flat surface available for placing the UWAL inclinometer. The flat surface should be aligned with the zero angle of attack reference line of the model. The area of the surface must be a minimum width of two (2) inches and a minimum length of seven (7) inches. The flat surface is only needed temporarily after the model has been installed but prior to running. For example, the flat surface could be inside the model (as long as the inclinometer can be lowered inside and is readable) or it could be where the vertical tail mounts to the body.

TRIP STRIPS

If the customer needs a method for tripping the boundary layer on the model, UWAL recommends using trip dots. UWAL can assist in calculating the trip strip heights if the trip locations are known.

CONTROL SURFACES

UWAL can measure the actual control surface deflections using a portable accelerometer. The accelerometer has a flat surface that is 0.675 x 1.610 inches. In order to mount the accelerometer, a through-hole must be made in each control surface for accepting a dowel pin of one of the following sizes (inches): 3/16, 1/4, 5/16.

PRESSURE PORTS

UWAL can measure surface static pressures on the model if the model is equipped with pressure ports ("taps"). However, the metal pressure tubing must be 0.040 to 0.042-inch outer diameter in order to be compatible with the urethane tubing used to connect to the UAL electronic pressure scanning (EPS) modules. Please contact UWAL for more information.

Keep in mind that if flow visualization chemicals will be applied to the model, that the pressure ports will need to be covered. If the ports are located far away from the flow visualization areas, then the ports can be left uncovered. UWAL recommends locating the pressure ports on the left side of the model, away from the entrance to the test section.