

Design of Experiments

In addition to the preparation for experiments described in the preceding section (Ka), mention should also be made of some of the detailed experiment design issues. Since the designs of facilities and instrumentation are usually particular to the individual experiments, there is little that can be said that is generally applicable. However a few examples might be valuable in highlighting some fairly common issues.

Example [A]: Facility natural frequencies. In the design of either an open or closed loop flow facility it is recommended that the natural frequencies of flow oscillation in that loop (and the structural natural frequencies) be approximately evaluated at the design stage. In evaluating the flow natural frequencies it is normally adequate to use a simple one-dimensional lumped parameter model of the facility of the kind described in section (Bngg). These frequencies should be identifiable in any spectral analyses of the various measurements, particularly the pressure transducer and accelerometer signals. If unsteady flow experiments are to be conducted in the facility it is usually best to avoid excitation frequencies close to those natural frequencies. A subset of these analyses is the evaluation of the natural frequency of the instruments, particularly the pressure transducers. Analyses of remote pressure transducer installation are described in section (Kddd) and often demand particular attention.

Example [B]: Force Balance design. The design of a force balance is a fairly common challenge that almost always involves a compromise between sensitivity and rigidity. [This compromise is only avoided with sophisticated compensation mechanisms that counteract the deflection needed to provide the desired sensitivity. Such mechanisms are usually built in to complex wind tunnel and water tunnel force balances. However, they are not usually practical with other force balances.] In the process of seeking this compromise, it is often appropriate to identify the lowest frequencies of structural oscillation of the balance. Then, seeking to optimize the design, it is often advantageous to choose a design in which these lowest structural oscillation frequencies are close to one another and this will determine the upper limit of the range of frequencies in which reliable measurements can be made. For example, in the design of the balance described in section (Kdeb), the radial location of the flexures was determined by equating the lateral and rotational frequencies of the balance.