

the top of the off fan and pulled back through the operating fan. Therefore, little cooling air was passing through the palletized product. In addition, these fans were not readily accessible.

A simple, homemade, U-tube manometer [9] is adequate for packinghouse personnel to quickly check the static pressure drop at the end of the tunnel away from the fan and immediately correct problems (Figure 12). An additional approach is the installation (wired to fan electric circuit) of easily observed lights for each fan, which are on while the fans operate. However, pressure drop should still be checked periodically, to insure that air is not bypassing the product.

## Temperature measurement/Cooling schedule

### Temperature monitoring

Since the goal of forced-air cooling is to rapidly reduce the temperature of the cooled product the cooler operator must have a method of measuring the temperature of the product being cooled to determine when cooling has been completed. The important management practice of determining when precooling has been completed to the desired temperature has been stressed [8]. Due to daily differences in the initial product temperature, the cooling time to achieve a desired final temperature may vary. The cooling time also varies if the cooling-air temperature cannot be maintained during cooling due to inadequate refrigeration capacity. Another factor which can change the cooling rate is the product size, since larger products cool more slowly than smaller products. In general, doubling the diameter or thickness requires 4 times as long to cool. A precooling schedule should be developed for every precooler and modified as conditions require [8].

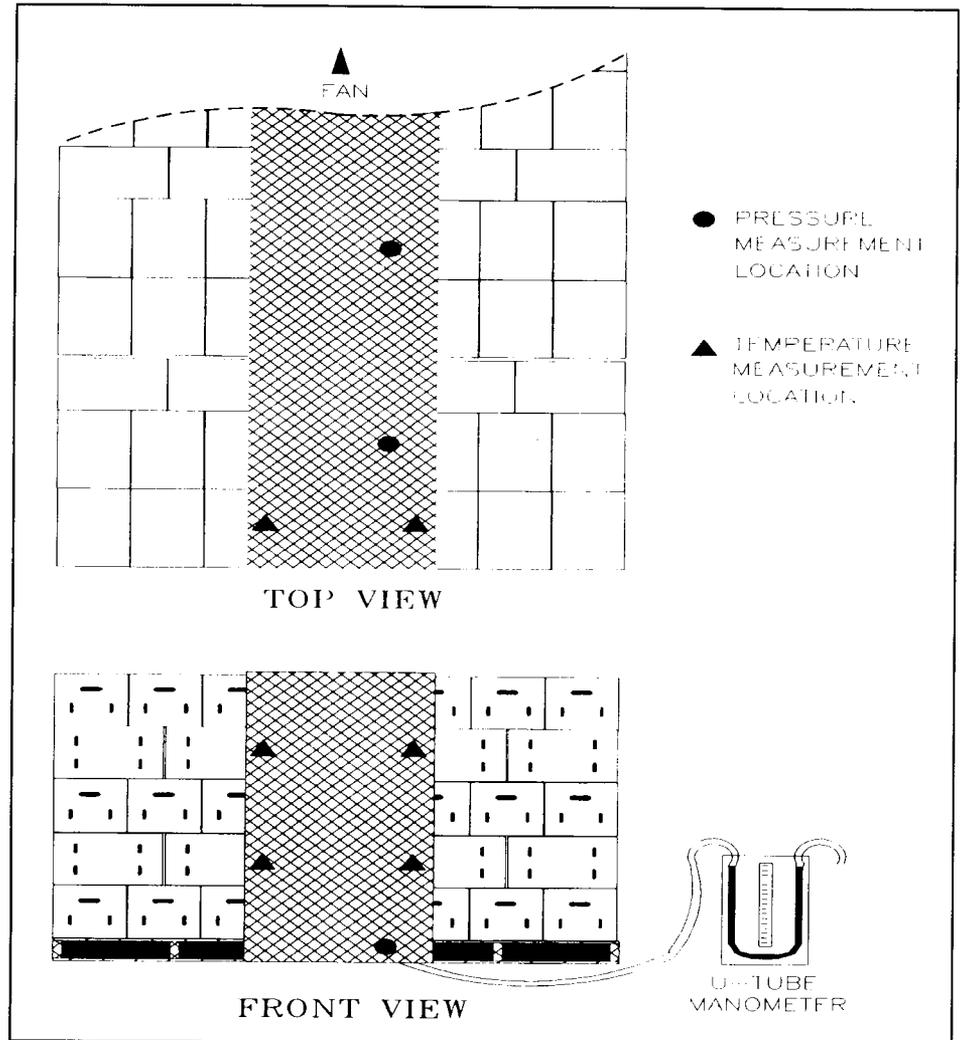


Figure 12. Static pressure drop and temperature measurement locations.

Recent cooling tests [1,9] investigated the variation of cooling as a function of bed effect (the effect due to the depth of the product) and height of the carton on the pallet. The experimental data verified that a bed effect does occur. The product in cartons exposed to incoming air, close to the air entrance cooled more rapidly than product on the opposite side, near the air exit from the pallet into the cooling tunnel. The cooling rate was found to vary with height of the containers on the pallet, although no criterion was established [9]. Additional work is needed to determine the "best" location for sampling temperature.

## Temperature measuring equipment

Dial-type thermometers are commonly used to measure the product temperature during cooling, and the pulp temperature samples are often taken at inadequate locations. These thermometers have a slow response time (minutes) and limited accuracy. Also, it is difficult to precisely locate the probe—the probe may pass through product and measure air temperature inside the carton. The sampling location suggested above is inside the cooling tunnel and not easily reached with a probe-type thermometer (Figure 12). To over-