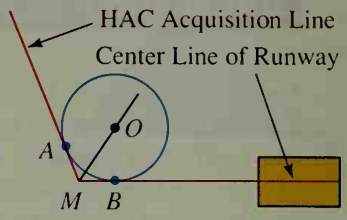

The points A' and B' where the shuttle's turn begins and ends can be determined by looking at the ground track. The figure at the right shows what you would see if you were high above the ground looking straight down on the ground track and runway. A' and B' are directly above A and B, which are located as follows: Extend the HAC acquisition line and the center line of the runway to meet at M. Bisect the angle at M and choose point O on the bisector so that a circle with center O and radius 20,000 ft will be tangent to the sides of the angle. Call the points of tangency A and B. $\odot O$ is the base of the Heading Alignment Cylinder and A' and B' are on the cylinder directly above A and B.

Normally the shuttle approached the cylinder at 800 ft/s and turned along its surface by lowering one wing tip so that the wings formed an angle of about 45° with the horizontal (called the *bank angle*). Under high-speed conditions the shuttle would have approached the cylinder at 1000 ft/s. This would have required a bank angle of about 57° to follow the surface of the cylinder. Unfortunately, at that bank angle, the shuttle would have lost lift, and the astronauts would have lost some of their control capability.

NASA has refined the guidance system so that the shuttle can be safely landed even under these adverse circumstances. Now, instead of following the surface of a cylinder, it spirals along the surface of a cone called the *Heading Alignment Cone*. Once every second during this part of the landing the shuttle's computers recompute the radius of turn necessary to keep the shuttle on the surface of the cone. Now even under most high-speed conditions the bank angle will not exceed approximately 42°. At point Q the shuttle is heading directly toward the runway; it leaves the cone and continues along a straight course to touchdown.