### 2.1.2 TOLERANCES ON IMPACT CONDITIONS

Most testing agencies use vehicular tow and cable guidance systems to propel a vehicle into a test article. Although these propulsion and guidance systems are reasonably accurate, modest variations in impact speed and angle are not uncommon. However, large deviations from target impact conditions can significantly alter the severity of a test. Thus, reasonable limits must be established for both impact speed and angle. Testing agencies have demonstrated an ability to control impact speeds within a range of ±2.5 mph (4.0 km/h) from the target condition and to obtain actual impact angles within ±1.5 degrees of the desired value. Therefore, these limits are selected as the maximum tolerance for impact speed and angle. For crash tests with a target speed of 44 mph (70.0 km/h) or more, the actual impact speed should be no less than 2.5 mph (4 km/h) below the desired impact speed. For tests involving vehicle redirection, the impact angle should be no more than 1.5 degrees below the target value. Tolerances for crash tests with a target speed below 30 mph (50.0 km/h) are limited only by vehicle kinetic energy as described in the following paragraphs.

The severity of an impact is normally measured in terms of impact severity (IS) for crash tests involving vehicle redirection and kinetic energy (KE) for crash tests involving end-on impacts or breakaway devices. IS, as defined in Equation 2-1, has been shown to be a good indicator of the magnitude of loading on a longitudinal barrier.

$$IS = \tfrac{1}{2} M \left(V \sin \theta\right)^2 \qquad \text{(Eq. 2-1)}$$

Where:

| | | |
|---|---|---|
| IS | = | impact severity, kip-ft (kJ) |
| $M$ | = | vehicle mass, lb (kg) |
| $V$ | = | impact speed, ft/s (m/s) |
| $\theta$ | = | impact angle, degree |

Total vehicle kinetic energy (KE), as defined in Equation 2-2, is considered a better measure of the severity of all head-on or end-on impacts, including tests of breakaway devices, crash cushions, terminals, and truck-mounted attenuators. Note that KE is also used as the measure of crash severity for oblique impacts on the ends of terminals and crash cushions.

$$KE = \tfrac{1}{2} M V^2 \qquad \text{(Eq. 2-2)}$$

Where:

| | | |
|---|---|---|
| KE | = | kinetic energy, kip-ft (kJ) |

Even when test speeds and impact angles are within the acceptable tolerances, the IS or KE values of a crash test can be unacceptably low. For this reason, an additional limiting condition is applied to the IS and KE values for full-scale crash tests. IS values for tests involving vehicular redirection and KE values for high-speed tests involving end-on impacts must be no more than 8 percent below the target values. For most full-scale crash tests, excessive impact speeds and angles do not improve the likelihood of a successful test. Therefore, excessive speed and angles are not considered to be a cause for failing these tests, provided all impact performance evaluation criteria are met. The exceptions to