clear explosion. These are called 'hard' targets. Estimates of the hardness of Soviet and American missile silos are not readily available but it is generally assumed that US silos can withstand up to 2,000 pounds per square inch (psi) and Soviet silos 2,000-5,000 psi. One of the options considered for deploying the new MX missile was to house them in superhardened silos capable of withstanding 25,000 to 50,000 psi.

The probability that a given warhead will destroy a silo of a given hardness is known as the Single Shot Kill Probability (SSKP).[2] It is related to warhead yield, accuracy and the hardness of the target as shown by the following equation:

$$SSKP^* = 1 - 0.5^{\frac{(8.41\ Y^{2/3})}{(H^{0.7}\ CEP^2)}}$$

OVERALL RELIABILITY (OAR) AND TERMINAL KILL PROBABILITY (TKP)

A ballistic missile has five stages of operation: launch phase, boost phase, separation, penetration and detonation. Each stage can be assigned a specific reliability, that is, the probability that it will not fail in that stage. The missile's overall reliability (OAR) is a product of the reliabilities at each individual stage of flight:

OAR = Reliability at stage 1 × reliability at stage 2 × reliability at stage 3 × reliability at stage 4 × reliability at stage 5.

Values for the OARs of Soviet and American missiles are not publicly available and can only be estimated. Reliability is an extremely important variable. The overall reliability (OAR) of a missile is used to determine the probability that a given warhead will reach and destroy its target. This is known as Terminal Kill Probability (TKP).[3]

$$TKP = SSKP \times OAR$$

Thus, the probability of a warhead destroying its target (SSKP) may be 70%, but if the missile has an overall reliability (OAR) of only 50% (i.e., only 50% of those fired will complete all five stages of operation), then only 35% of the total warheads fired will reach and destroy their targets. Therefore OAR can be a significant factor in the evaluation of strategic forces. A relatively simple case in which these equations can be examined is to hypothesize that the Soviet Union uses 1,000 SS-18 warheads (100 missiles) to attack the 1,000 American ICBMs. It is assumed that the American missiles are in silos hardened to 2,000 psi, OAR is assumed to be 70%, and the other values are taken from the accompanying tables:

SS-18

$$SSKP = 0.654$$
$$TKP = SSKP \times OAR$$
$$= (0.654) \times (0.70)$$
$$= 0.46$$

In sum, 46% of 1,000 warheads or 460 warheads could be expected to hit and destroy their targets.

WHO'S AHEAD

The values used in the following discussion are taken from the accompanying tables. The figures used in the tables are those generally accepted by the sources discussed earlier in this paper. Differences of opinion among the sources are footnoted.

Ballistic Missiles

The Soviet Union maintains a large percentage of its nuclear forces on land and, as can be seen in the tables below, these missiles are generally larger in throw-weight and yield than their American counterparts. In contrast, the Americans maintain a smaller percentage of their nuclear forces on land. This difference in emphasis between the two sides has contributed to American fears that US ICBMs are vulnerable to a Soviet first strike.

A move to mobile, land-based missiles might help to alleviate some of the fears of vulnerability on both sides. Mobile missiles would be far more difficult to target, and a much larger number of incoming warheads would be required to destroy them.

The Soviets are currently ahead of the US in this area, having already deployed about 72 of the single-warhead, mobile SS-25, and are close to deploying the ten-warhead, rail-mobile SS-24.

Although the USSR has more ballistic missile *submarines* and submarine-launched ballistic *missiles* (SLBMs) than the US, the United States has more SLBM *warheads* (5,632) than the Soviet Union (3,143) and these are, on the whole, more capable than many of the Soviet SLBM warheads.

* To estimate SSKP, the CEP must be given in nautical miles (nm) and the hardness (H) in pounds per square inch (psi).