## 3. Benefits

Benefits were developed by estimating the total annual expected accidental and operational oil outflow avoided as a result of each measure. The estimate the annual reduction in the number of barrels spilled as a result of the measures, the total annual accidental and operational oil outflow was estimated both before and after the measure was implemented. The accidental oil outflow estimates for grounding and collisions were annualized using historical spill data provided in the regulatory assessment for the NPRM and verified through an independent calculation using worldwide casualty data. Lloyd's Maritime Information Services Casualty Information System was analyzed for a sample of tank vessels drawn from Clarkson's Tanker Register to estimate the per-vessel annual probability of having grounding and collisions. The

analysis resulted in annual grounding and collision probabilities of 0.026 and 0.017, respectively, for an existing tank vessel moving oil through U.S. waters in 1990.

The accidental oil outflow estimates are also presented using both Regulation 13F and 13G calculations. The Regulation 13F calculations are based on a probabilistic methodology, described in "Interim Guidelines for the Approval of Alternative Methods of Design and Construction of Oil Tankers Under Regulation 13F(5) of Annex I of MARPOL 73/78" (IMO Marine **Environmental Protection Committee's** Resolution MEPC 37/14; December 23, 1994), which uses currently available accident damage statistics for tank vessels. To obtain the total accidental oil outflow, the average bottom outflow estimate was combined with the average collision outflow estimate by using a weight of 0.6 for grounding damage and

a weight of 0.4 for collision damage. The Regulation 13G calculations are more deterministic, as described in MEPC Resolution 64(36) entitled, "Guidelines for Approval of Alternative Structural or Operational Arrangements as Called for in Regulation 13G(7) of Annex I of MARPOL 73/78." Both calculations take into account hydrostatic pressure from the cargo oil and the outside sea water in the case of bottom damage. They also allow for 50 percent capture by double bottom tanks in cases where bottom damage extends through these tanks. To estimate the reduction in the expected annual oil outflow as a result of the measures, the annual oil outflow for the vessel after the measure was implemented was subtracted from the total oil outflow of the baseline tank vessel. Table 3 summarizes the estimated oil outflows after implementation of each measure.

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