

DDG-51 FLT IIA SS6 Roll Reduction

LT Thomas Deeter, USN; LT Michael Liu, USN

An increase in sea states across the globe has started to affect the areas in which U.S. warships may operate. U.S. warships are designed to structurally withstand sea state six, but the crew effectiveness drops in high sea states as safety mishaps become more likely. We reviewed the effects the addition of roll mitigation tanks and larger bilge keels had on the existing DDG-51 FLT IIA hullform roll acceleration and safety mishaps caused by excessive roll.

Five separate models (active roll mitigation tank, passive roll mitigation tank, small bilge keel, medium bilge keel, large bilge keel) were created and analyzed for effects on top speed, maximum stress, Motion Induced Interruptions (MII), Motion Sickness Index (MSI), and RMS Roll Angle. The model results were compared to baseline values via a normalized performance value. Cost estimates for each model were generated from the MIT 2N cost model. Performance to cost comparison led to the conclusion that the small bilge keel option was the optimal conversion.

Type	Top Speed (knots)	Max Stress (psi)	MII (case/minute)	MSI (% in 2 hrs)	RMS Roll Angle	Cost of Conversion
Baseline	30.00	17260	0.34	18.40	4.06°	NA
Small Bilge Keel 6922487	28.23	15888	0.22	19.15	2.25°	\$6,922,487
Medium Bilge Keel	27.33	15001	0.19	19.28	2.09°	\$9,521,281
Large Bilge Keel	26.47	14401	0.17	19.40	1.97°	\$12,121,614
Active Roll Mitigation Tank	30.63	17905	0.14	19.78	1.88°	\$68,122,464
Passive Roll Mitigation Tank	30.63	17905	0.12	19.70	1.76°	\$71,323,397

