EXECUTIVE SUMMARY

ES.1 INTRODUCTION

To support its role as Systems Integrator (SI), the Coast Guard (CG) needs to establish and continually update a strategic plan for the acquisition, operation, and sustainment of capabilities necessary in achieving organizational goals. Key to this strategic plan is a repeatable, comprehensive process that identifies alternative capabilities and Fleet mix solutions that will meet future mission requirements in an efficient, effective, and affordable manner. The CG Fleet Mix Analysis (FMA), chartered by the Deputy Commandants for Operations (DCO) and Mission Support (DCMS) and led by the Assistant Commandant for Capability (CG-7), is designed to provide a rigorous analytical basis to support this strategic plan, the CG Business Case, and future major systems acquisitions.

The core objectives of the FMA are to:

- Validate operational mission requirements and performance gaps.
- Identify actual or projected future asset performance parameters.
- Develop and assess notional, alternative Fleet mixes against mission requirements.
- Assess the cost effectiveness of notional, alternative Fleet mixes.

This initial phase of the FMA is intended to address offshore surface and aviation capabilities. Follow-on FMA phases will assess capabilities needed for coastal and inland missions as well as emerging missions, such as Arctic operations and those of the Deployable Operations Group (DOG).

ES.2 BACKGROUND

In 2002, the CG contracted with Integrated Coast Guard Systems (ICGS) to design the Integrated Deepwater System (IDS) to recapitalize the Fleet using a system-of-systems approach. The IDS was designed as a replacement for the Legacy Fleet of 1998. Following the attacks of 9/11, at the Commandant's direction, the Deepwater Sponsors' Office conducted a performance gap analysis (PGA) (Reference 1) to determine if the Fleet, as planned, would meet emerging mission requirements. The PGA determined that the IDS would have significant capability gaps; however, the CG decided not to make significant changes in the IDS Fleet mix because of fiscal constraints. The CG did approve 11 asset capability changes/upgrades to the IDS, including airborne use of force (AUF), an improved flight deck on the national security cutter (NSC), and organic airlift. These changes were included in the 2004 IDS Mission Needs Statement (MNS) Update (Reference 2) and System Performance Specification v2.0 (Reference 3). The resulting fleet from the 2004 IDS Mission Needs Statement (MNS) is referred to throughout the report and in other sources as the $24B fleet, based on preliminary estimations.

The MITRE Corporation subsequently validated the PGA process and its analytical methods and recommended similar periodic reassessments. In their opinion, "The Deepwater PGA process,

and the resulting analytical results, was likely the most complete and comprehensive campaign-level study conducted by any uniformed service in recent times" (Reference 4).

Since the PGA, mission requirements have continued to evolve, new technologies have become available, and new systems have come online. The CG Ports, Waterways, and Coastal Security (PWCS) mission has matured, and Rotary Wing Airborne Interdiction (RWAI) and Airborne Use of Force (AUF) assets are in the field. Supporting systems such as Rescue 21 and the Nationwide Automated Identification System (NAIS) have reached initial operational capability (IOC) and are improving CG Maritime Domain Awareness (MDA) and responsiveness. New platforms, including the National Security Cutter (NSC), re-engined H-65 helicopter, and C-144A medium-range surveillance aircraft, have either joined the Fleet or are undergoing operational testing. In addition, the CG has selected a source and design for the new fast response cutter (FRC) and has finalized operational requirements for the future offshore patrol cutter (OPC). Although the CG's understanding of actual asset capabilities has improved, these changes have created uncertainty over future mission performance of the current program of record (POR). To reduce this uncertainty, the CG needed to conduct a comprehensive analysis that incorporates these changes and projects future mission performance.

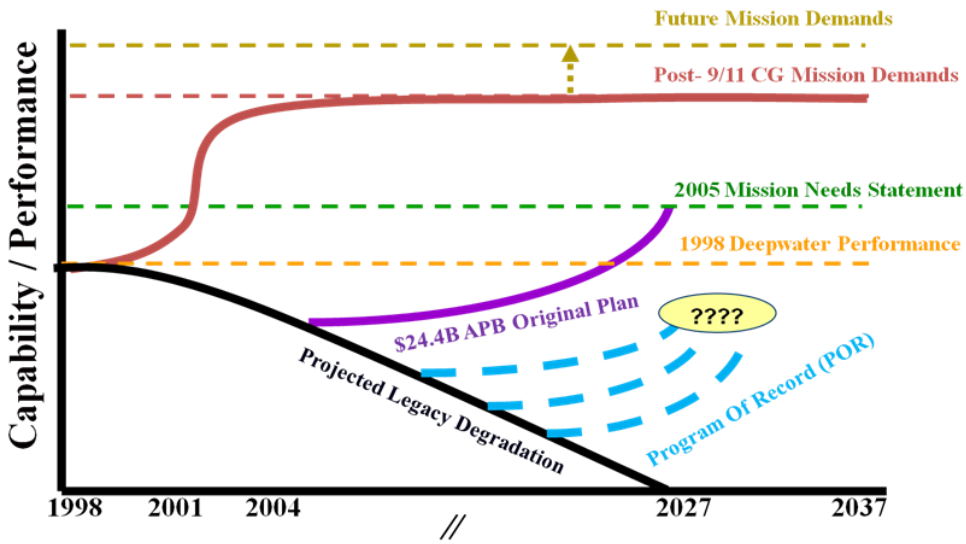


Figure ES-1 Current Level of System Performance

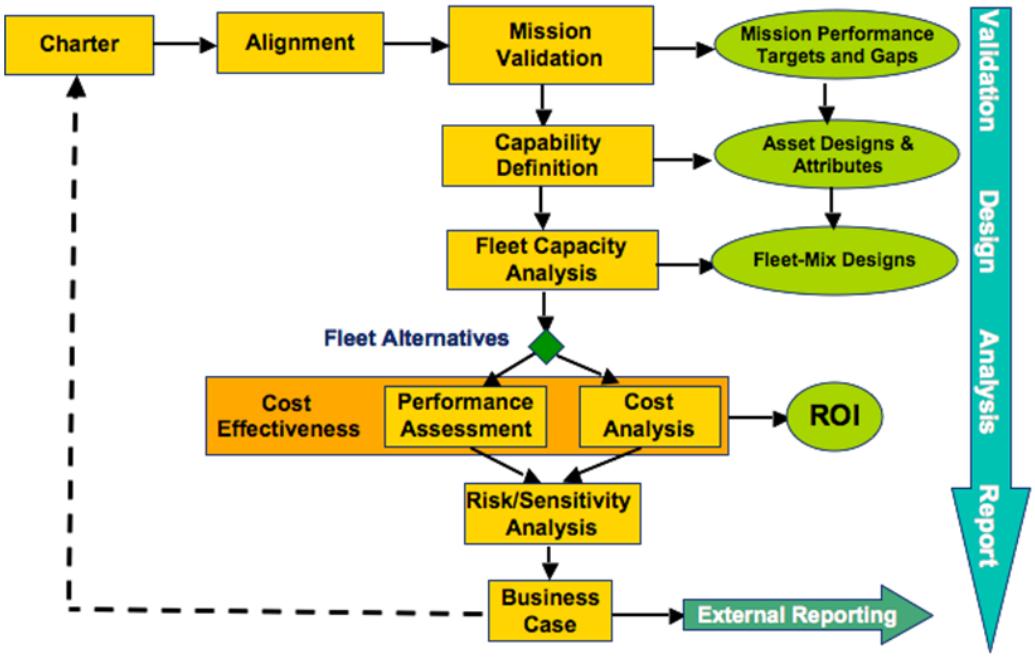
As figure (ES-1) shows, legacy capabilities and performance is decaying rapidly while planned recapitalization of assets are taking longer to complete and meet 2005 Mission Needs Statement. In 2010, the House and Senate passed the Coast Guard Authorization Act, prohibiting the CG from using a private-sector entity as the lead System Integrator (LSI) for future Deepwater procurements. While the CG had been performing these duties on other acquisitions, based on an enhanced ability to manage the overall acquisition and ensure accountability in line with the legislation, the CG assumed the role as the LSI for all major acquisitions.

ES.3 METHODOLOGY

The FMA process is a repeatable and analytically rigorous methodology based off the post-9/11 PGA process, upgraded to include CG risk assessment tools and other industry best practices. Designed with built-in flexibility, the FMA process allows for easy exploration of data

sensitivities, such as variations in mission demand levels, capability parameters, or concepts of operations (CONOPS). The flowchart in Figure ES-2 displays the 10 FMA analytical phases, starting with a senior leadership charter and culminating with a business case.

The remainder of this Executive Summary steps through each phase of the FMA.



ROI – Return on investment.

Figure ES-2 FMA Analytical Process

ES.4 CHARTER

A DCO/DCMS charter (Reference 5) directing the FMA was signed on 24 October 2008. The charter outlined FMA objectives and tasks and established an FMA Study Group consisting of an Executive Steering Committee (ESC), Guidance Team (GT), and Project Team that included an overall Project Officer and Integrated Product Teams (IPTs) representing air, surface, Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR), cost and logistics, and operational planning. In total, more than 100 CG subject matter experts (SMEs) supported the FMA.

ES.5 ALIGNMENT

The alignment phase defined the scope of the FMA and established key assumptions and constraints that guided the Project Team. During this phase, a detailed analysis plan provided a study methodology, a Plan of Action and Milestones (POA&M), a list of key assumptions and constraints, and a comprehensive list of questions that the FMA should answer. Primary scope, assumptions, and constraints are listed below.

ES.5.1 SCOPE

- The FMA explored the projected Fleet mix requirements to meet the CG's 11 statutory missions in FY2025. Mission requirements were based on nine Mission Performance Plans (MPPs) and an assessment of critical activities, such as training and support, which consume asset mission availability.
- The FMA included all CG aviation (fixed- and rotary-wing), all white-hull cutters (FRC up to NSC), and all applicable C4ISR systems.
- The FMA focused on activities in the offshore and aviation operating environment. Offshore and aviation are defined in the FMA as being generally 50+ nautical miles offshore and/or requiring extended presence. The FMA also considered missions within 50 nautical miles that consume air asset availability.
- The FMA used the 2007 CG Fleet, as defined in the 2007 Modeled CONOPS and the "Deepwater" POR as Baselines for comparative performance and cost analysis.

ES.5.2 ASSUMPTIONS

- Preliminary Operational Requirements Document (P-ORD) thresholds were used for the OPC.
- The OPC and NSC will operate 230 days away from homeport (DAFHP). No specific crewing method is assumed (i.e., crew rotation concept [CRC]).
- The HC-144A will operate at 800 programmed flight hours (PFH) per year.
- U.S. Navy out-of-hemisphere (OOH) (2.0 OPC/NSC) and Joint Interagency Task Force South (JIATF-S) (7.0 OPC/NSC) support was consistent with the FY2010 demand.
- Additional acquisition/next generation platforms have the same capabilities and cost as the FMA Baseline Fleet mix cutters and aircraft (e.g., the next-generation short range recovery (SRR) helicopter is an MH-65C).

ES.5.3 CONSTRAINTS

- The High Latitude regions of the ice shelf and Deployable Operations Group (DOG) mission requirements were not considered.
- No specific MDA performance measures have been established to model.
- 87-ft coastal patrol boat (CPB), 225-ft seagoing buoy tender (WLB), Department of Defense (DoD)/Department of Homeland Security (DHS), and foreign asset contributions were considered, but force level requirements for 87-ft CPB, 225-ft WLB, DoD/DHS and foreign assets were not assessed.
- Additional shore facilities (e.g., schools, berthing, simulators/training aids, etc.) beyond those directly associated with platforms (e.g., piers, hangars, etc.) are not included in costs.

- Cost impacts to training system, aviation, vessels, and boat maintenance infrastructure, and supporting personnel were not studied in detail.
- The need for non-operational/shore billet increases commensurate with the projected increases in operational manning was not assessed and is not included in costs.
- All cost estimates are rough order of magnitude (ROM) and are not budget quality.
- The FMA did not conduct a formal future risk assessment.
- Additional specific assumptions utilized for modeling, simulation, and costing are included in their respective chapters of the final report.

ES.6 MISSION VALIDATION

The mission validation phase established a Baseline for current mission performance, projected operational demands, and mission requirements for a future system of CG assets. During this phase, nine MPPs covering the CG's 11 statutory missions were developed by the Assistant Commandant for Marine Safety, Security, and Stewardship (CG-5) program offices, which were supplemented with other, critical operational requirements (e.g., training, support, etc).

Table ES-1 MPPs Mapped to CG Mission Programs

CG Strategic Goal	CG Deepwater Mission (per MSMP V2.1)	CG Statutory Mission Program	MPPs
Maritime Safety	SAR	SAR	SAR
	IIP		
	FVI	Marine Safety	Marine Safety
Maritime Stewardship	Maritime Pollution Enforcement and Response Lightering Zone Enforcement	MEP	MER
		AtoN	Waterways Management
		Ice Operations	
	LMR	LMR	LMR/Law Enforcement
		OLE	
Maritime Security	Drug Interdiction	Drug Interdiction	Drug Interdiction
	AMIO	Migrant Interdiction	Migrant Interdiction
	PWCS	PWCS	PWCS
	DefOps	Defense Readiness	DefOps
	GLE		
Other-Assessment Areas	NDAD Organic Heavy Airlift		
	MDA		
	Intel Exploitation		

SAR – Search and Rescue
IIP – International, Ice Patrol
LMR – Living Marine Resources
OLE/GLE – Other/General Law Enforcement

FVI – Foreign Vessel Inspection
MEP – Marine Environmental Protection
MER – Marine Environmental Response
AtoN – Aids to Navigation
NDAD – Non-Deepwater Aviation Demands
AMIO Alien Migrant Interdiction Operations
PWCS – Ports, Waterways, and Coastal Security
DefOps – Defense Operations
MSMP – Modeling and Simulation Master Plan

MPPs are a critical link in establishing programmatic guidance and achieving the CG's strategic vision and serve as a primary driver for the development of the annual Strategic Planning Direction (SPD) via the Standard Operational Planning Process (SOPP). MPPs:

- Span the current and five ensuing fiscal years.
- Describe measures and assessments used to gauge results and identify gaps.
- Include current goals and objectives for program outcomes and supporting processes.
- Identify key initiatives and indicate the means to be employed – and corresponding benefits, targets, and milestones – to achieve the stated goals and objectives.
- Identify key factors that could affect achievement of strategic goals and objectives.

A snapshot of select MPP metrics is shown below in Table ES-2.

Table ES-2 Snapshot of Select MPP Metrics

Mission (MPP)	Performance Measure	FY2007 Actual (%)	FY2008 Actual (%)	FY2009 Target (%)	FY2010 Target (%)	FY2011 Target (%)	FY2012 Target (%)	FY2013 Target (%)	FY2014 Target (%)	FY2015 Target (%)	FY2025 Target (%)
SAR	Percent of people in imminent danger saved in the maritime environment	76.6	76.8	76	77	77	77	78	78	78	90
LMR/OLE	Observed compliance rate	96.3	95.4	97	97	97	97	97	97	97	97
	EEZ incursion interdiction rate	19.20	16	16	16	16	16	16	16	16	16
CD	Removal rate for cocaine from non-commercial vessels in maritime transit zone	32.6	33.8 est.	29	17.1	18.7	20.2	21.8	23.3	23.3	40
AMIO	Migrant interdiction rate	65.2	62.7	65	66.6	73.9	74.8	75.3	76.1	76.6	90
	CG interdiction rate	42.1	46.9	50	50	50	50	50	50	50	90

Not all MPP metrics used in the FMA could be modeled. In these cases, the FMA developed metrics that best satisfied MPP intent. For example, the MPP metrics for DefOps are based on Status of Resources and Training System (SORTS) ratings. This metric cannot currently be modeled; however, the FMA-developed metric for DefOps, Planned OOH Deployment Fill Rate, can be.

In addition to quantitative metrics, MPPs also contain qualitative mission elements that drive resource requirements. The two primary qualitative elements considered in the FMA were Effective Presence and Suitable Interdiction Asset. These elements are difficult to measure and rely heavily on operational commander expertise to assess sufficiency.

The mission validation phase also included extensive data collection, consisting of series of interviews with district and area operational planning SMEs, a review of previous studies, and an analysis of historical data. Collectively, they established the CG's future "world of work" for the FMA effort.

ES.7 CAPABILITY DEFINTION

The capability definition phase defined CG asset attributes, explored asset options for future Fleets, and assessed asset suitability for performing regional missions. During this phase, the FMA conducted an in-depth review of asset technical publications and operational data and held a series of IPT conferences with highly experienced aviation, surface, and C4ISR SMEs from across the CG to gain insights on the strengths and weaknesses of current and future CG capabilities.

The Air IPT expressed concerns over the ability to achieve 1200 C-144A PFH, increased training requirements due to AUF, the service life of rotary-wing aircraft, and the integration of future unmanned aerial system (UAS) platforms. Other key outcomes included the extensive use of C-130s for logistics (Alaska and the Continental U.S.) and H-65 icing limitations.

The Surface IPT expressed strong desires for increased speed, sea keeping, and on-station endurance in the future OPC over the 210-ft and 270-ft (WMECs) and had concerns about CRC and the ability to operate 230 DAFHP. The Surface IPT also identified gaps in situational awareness and surveillance support from land- and cutter-based aviation and Helicopter Interdiction Tactical Squadron (HITRON) support for JIATF-S missions.

The C4ISR IPT identified gaps in Blue Force tracking, bandwidth, and physical and operational security. The C4ISR IPT also expressed the need to develop robust Common Operating Picture (COP) and Shipboard Signals Exploitation Spaces (SESSs) to increase operational effectiveness and interoperability.

ES.7.1 AIR ASSETS

Table ES-3 FMA Air Assets

Platform	Asset Type	Asset Specification	Mission Capability	Asset Class and Aliases
	LRS	Max Speed: 320 kt Max Endurance: 14 hr Max Range: 4,127 nmi Employment: 800 PFH	Long Range SAR, Law Enforcement, Homeland Security, MDA, IIP, MEP, Heavy Airlift and Transport	HC-130H/J, Hercules
	MRS	Max Speed: 240 kt Max Endurance: 11 hr Max Range: 2,086 nmi Employment: 800 PFH	Medium Range SAR, Law Enforcement, Homeland Security, MDA, MEP, Heavy Airlift and Transport	HC-144A, MPA, CASA, Ocean Sentry
	MRR	Max Speed: 180 kt Max Endurance: 6 hr Max Range: 700 nm Employment: 700 PFH	Land Based, SAR, Law Enforcement, Homeland Security (Including AUF), MEP, Airlift and Transport	MH-60J/T, JayHawk, Sikorsky
	SRR	Max Speed: 175 kt Max Endurance: 3.5 hr Max Range: 400 nmi Employment: 700 PFH	Land and Cutter Based, SAR, Law Enforcement, Homeland Security (Including AUF), MEP and Transport	MH-65C, Dolphin, CBH, MCH
	TUAV	Max Speed: ~110 kt Max Endurance: ~4 hr Max Range: ~400 nmi Employment: ~600 PFH	Cutter-Based MDA	UAS-CB, Eagle Eye VUAV
	SUAV	Max Speed: ~260 kt Max Endurance: ~16 hr Max Range: ~3,200 nmi Employment: ~800 PFH	Land-Based MDA	UAS-LB, Global Hawk HAEUAV

LRS – Long Range Surveillance
MRS – Medium Range Surveillance
MRR – Medium Range Recovery
SRR – Short Range Recovery
TUAV – Tactical Unmanned Aerial Vehicle
SUAV – Strategic Unmanned Aerial Vehicle

ES.7.2 SURFACE ASSETS

Table ES-4 FMA Surface Assets

Platform	Asset Type	Asset Specification	Mission Capability	Asset Class and Aliases
	LRC	Length: 418 ft Displacement: 4,500 lt Max Speed: 28 kt Range: 12,000 nmi Endurance: 60 days Berthing: 144 Employment: 230 DAFHP	SAR, Law Enforcement, Homeland Security, DefOps, and MEP	National Security Cutter, NSC, WMSL, Bertholf, Legend Class
	MRC	Length: TBD Displacement: TBD Max Speed: 25 kt Range: 7,500 nmi Endurance: 45 days Berthing: 120 Employment: 230 DAFHP	SAR, Law Enforcement, Homeland Security, DeOps, and MEP	Off-shore Patrol Cutter, OPC, WMSM, WMSM-OPC
	SRC	Length: 154 ft Displacement: 353 lt Max Speed: 28 kt Range: ~3,000 nmi Endurance: 7 days Berthing: 26 Employment: 2,500 hr/yr	SAR, Law Enforcement, Homeland Security, DefOps, and MEP	Fast Response Cutter, FRC, WPC, Sentinel
	Seagoing Buoy Tender	Length: 225 ft Displacement: 2,000 lt Max Speed: 15 kt Range: 6,000 nmi Endurance: 21 days Berthing: 50 Employment: 1,800 hr/yr	AtoN, SAR, Law Enforcement, Homeland Security, and MEP	Sea-going Buoy Tender, 225-ft WLB, Juniper
	CPB	Length: 87 ft Displacement: 91 lt Max Speed: 25 kt Range: 900 nmi Endurance: 3 days Berthing: 12 Employment: 1,800 hrs/yr	SAR, Law Enforcement, Homeland Security, and MEP	Coastal Patrol Boat, 87-ft CPB

LRC – Long Range Cutter
MRC – Medium Range Cutter
SRC – Short Range Cutter
CPB – Coastal Patrol Boat

ES.7.3 C4ISR ASSETS

Table ES-5 FMA C4ISR Assets

System Name	Capability Provided
COP	The COP provides operational awareness to the asset. The COP is a multidimensional visualization of the operational space that extends the influence and capabilities of each individual element, or "node," in the network – including cutters and aircraft. The COP generated for a single asset is made up by many data sources, applications, and viewers.
Vessel Monitoring System (VMS)	VMS is a tool for the successful monitoring, control, and surveillance (MCS) of fisheries activities. VMS provides a fishery management agency with accurate and timely information about the location and activity of regulated fishing vessels.
NAIS	NAIS is a two-way maritime data communication system that provides vessel and navigational data, including vessel location, course, speed, and cargo information for enhanced maritime awareness.
Rescue 21	Rescue 21 provides direction-finding capability and digital selective calling for response to mariners in distress and allows protected communications for law enforcement and homeland security operations.
Long Range Identification and Tracking System (LRIT)	LRIT is an International Maritime Organization (IMO) system designed to collect and disseminate vessel position information received from IMO member state ships that are subject to the International Convention for the Safety of Life at Sea (SOLAS). The U.S. CG operates an International Data Exchange (IDE) in support of the IMO and the international maritime community. The CG maintains a National Data Center (NDC) that monitors IMO member state ships that are 300 gross tons or greater on international voyages and either bound for a U.S. port or traveling within 1000 nmi of the U.S. coast.
Ship's Signals Exploitation Space Ship's Signals Exploitation Equipment (SSEE)	The SSEE program allows the operators to monitor and analyze signals of interest within the SSES aboard a variety of ship classes. The SSEE system evolved from the AN/SSQ-80 Local Monitoring Subsystem (LMS) and the TRUMP system, which provide a basic cryptological analysis capability. The SSEE system can contribute to the detection, identification, and location of targets near to and over the horizon.

ES.8 FLEET CAPACITY ANALYSIS

The Fleet Capacity Analysis (FCA) combined information developed in the mission validation phase, the capability definition phase, and a Warfare Analysis Laboratory Exercise (WALEX) to produce an objective Fleet mix and incremental Fleet mix alternatives. To develop the objective Fleet mix, the FMA used three independent teams with unique force projection tools or methodologies – the Database Enhanced Center for Naval Analysis (CNA) IDS Asset Assessment Tool (CIAAT) Model (DECMv2), the Mission Effectiveness Asset Needs Model (MEAN), and a qualitative analysis by a panel of CG SMEs – to develop a force structure that was aligned with MPP capability and capacity targets. Each team applied their methodology using a common set of asset characteristics and mission demands to develop a zero-based force mix (capable of meeting all mission requirements) projection. The results from these independent projections were considered as three "lines of position" (LOPs) and were consolidated to form a conceptual "fix."

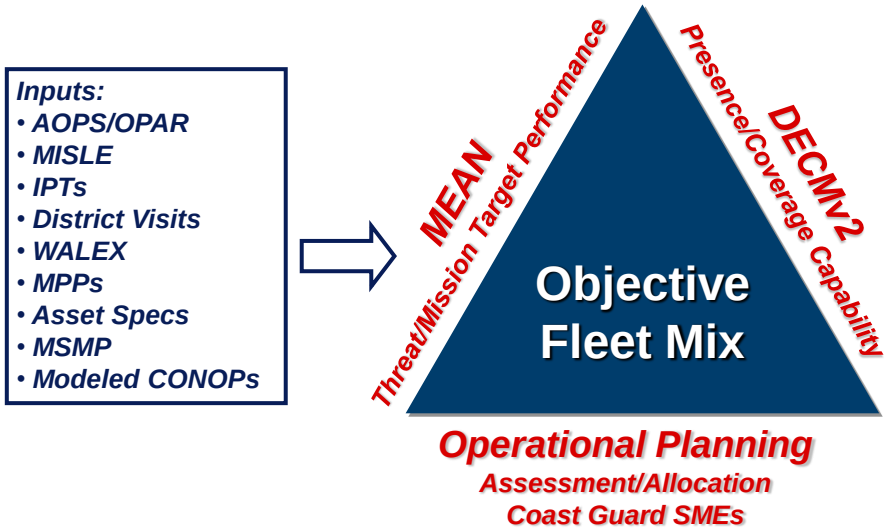


Figure ES-3 Objective Fleet Development

This "fix" was fine-tuned following analyses of preliminary modeling results combined with additional aircraft training and maintenance requirements. The final reconciled objective mix, broken down by operational asset requirements per operating region, is shown below in Table ES-6.

Table ES-6 Objective Mix Asset Quantities

Domain	Type	Operating Region							Spare/ Training	Total
		NE	SE	D11/13	D/14	JIATF-S	AK	Intl		
Surface	NSC	0	0	0	0	5	0	4	0	9
	OPC	7	16	6	5	15	8	0	0	57
	FRC	12	50	15	5	0	9	0	0	91
Air	C-130	5	5	3	7	4	12	0	8	44
	C-144a	8	38	7	0	0	0	0	12	65
	H-60	20	34	20	0	0	12	0	20	106
	H-65	27	56	24	13	39	14	7	43	223
	UAS-LB	0	8	3	2	2	0	0	7	22
	UAS-CB	0	0	3	4	5	0	4	3	19

The final FMA objective fleet was calculated to be roughly twice the size of the existing "Deepwater" POR. To help quantify performance trade-offs and return on investment (ROI), the FMA developed a series of incrementally more-capable mixes bridging the objective fleet and POR. Most notably, while NSCs were modeled in Alaska in the POR, to achieve the higher level of performance in support of the Defense Ops in the objective fleet mix, 4 NSCs were programmed to the international op area and Alaska was subsequently covered by additional OPCs. This move was necessary to accomplish the DoD 2.0 coverage requirement; however, based on its range and endurance, the NSC remains a more effective asset than the OPC for

Alaska. Following guidance from the Assistant Commandant for Marine Safety, Security, and Stewardship (CG-5), increments were developed using a risk-based prioritization of mission gaps based on the National Maritime Security Risk Assessment (NMSRA) methodology. Using NMSRA, the FMA compared the expected performance level of the POR against targets established in the MPPs to quantify the risk of each mission gap. Mission gaps were then prioritized according to the amount of risk associated with each gap – from "very high" to "very low" – as summarized in Table ES-7.

Table ES-7 NMSRA Mission Gap Prioritization (POR Versus MPPs)

Mission	Alaska (D17)	Northeast (D1, D5, and D9)	Southeast (D7 and D8)	West (D11, D13, and D14)
Drug Interdiction				
LMR				
Migrant Interdiction				
OLE				
PWCS				
SAR				

Risk Classifications are For Official Use Only and not releasable to the public.

Building off the POR, the first incremental mix addressed "very high" risk mission gaps. Each subsequent increment addressed the next highest remaining risk gaps. The low and very low gaps remaining were combined and filled in the final increment, the objective mix, rather than being split into separate increments, to maintain roughly equivalent cost increases between mixes. The NMSRA mission gap prioritization and incremental mix strategies were reviewed and endorsed by a team of CG-5 program managers. Summaries of the mission gaps addressed in each Fleet mix are provided in Figure ES-4 below.

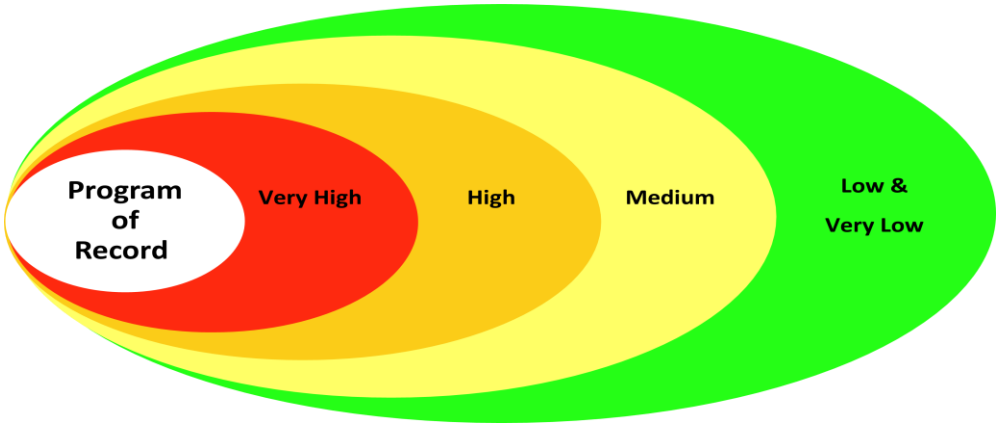


Figure ES-4 FMA Incremental Mix Layers

The POR defined in the FMA is based on the MSMPv2.1, Change 1 (Reference 6) and associated Modeled CONOPS, Fully Built Out (FBO) Addendum (Reference 7), adjusted to reflect current "as delivered or expected" conditions. Critical changes from the original 2004 MNS Fleet assumed in the POR included:

- Reduced PFH for the HC-144A from 1200 to 800 based on an initial capabilities assessment of the feasibility of completing the additional hours.
- Increased AUF training allocation for rotary-wing aircraft, resulting in reduced operational flight hours (OFH)
- High Altitude Endurance UAV (HAEUAV) was replaced with UAS – Land Based (UAS-LB).
- Eagle Eye Vertical Takeoff/Landing Unmanned Aerial Vehicle (VUAV) was replaced with UAS – Cutter Based (UAS-CB).
- Reduced operating hours for the FRCs from 3,000 to 2,500.

FMA-1 (Very High Risk) builds off the POR and addresses gaps in mission and operational areas determined to be Very High Risk.

FMA-2 (High Risk) builds off FMA-1 and addresses gaps in High Risk mission mission and operational areas.

FMA-3 (Medium Risk) builds off FMA-2 and addresses gaps in Medium Risk mission and operational areas.

FMA-4 (Low and Very Low Risk) builds off FMA-3 and addresses gaps in Low and Very Low Risk mission and operational areas.

Force level requirements for each incremental mix are shown in Table ES-8 below.

Table ES-8 Alternative Fleet Mix Asset Quantities

Offshore/Aviation Platforms	2004 PGA MNS/ POR	FMA-1	FMA-2	FMA-3	FMA-4
NSC	8	9	9	9	9
OPC	25	32	43	50	57
FRC	58	63	75	80	91
HC-130	22	32	35	44	44
HC-144A	36	37	38	40	65
H-60	42	80	86	99	106
H-65	102	140	159	188	223
UAS-LB	~~4~~	19	21	21	22
UAS-CB	~~42~~	15	19	19	19

ES.9 PERFORMANCE ASSESSMENT

The performance assessment phase assessed and compared the modeled operational effectiveness of the four FMA incremental Fleet mixes, the Deepwater POR, the original 2004 MNS Fleet, and the 2007 CG Fleet. Modeling was conducted using the accredited CG Maritime Operational

Effectiveness Simulation (CGMOES) campaign-level model in accordance with a validated FMA experiment plan (Reference 8). Each Fleet mix was modeled against a common, expected demand level for 30 1-yr iterations. CGMOES modeled the relative differences in operational effectiveness of notional Fleets against a known Fleet Baseline (FY2007 in this case) to provide a critical piece of data in estimating future mission success. However, CGMOES results should not be used for direct comparison with real-life performance. CGMOES results indicate incremental improvements of the FMA Fleets consistent with the targeted regional-missions gaps. A complete operational effectiveness assessment, with results broken down by region, mission, and asset class, is included in the final report.

Surveil, Detect, Classify, Identify, and Prosecute (SDCIP) are the core elements of the CG operational spectrum and are key indicators of asset contribution to system operational effectiveness. The results in Figure ES-5 show the resulting modeled relative differences in SDCIP over the 2007 Fleet for the other fleets modeled. Due to projected increased capability of future assets, the 2004 MNS Fleet, POR, and FMA systems showed significant improvement in SDCIP performance. As was expected, there was a drop in Detection, Classification, Intercept (DCI) between the proposed 2004 PGA MNS Fleet and the POR, which finally recovers in FMA-3. This drop is due primarily to the cancellation of the Eagle-Eye VUAV, reduction in C-144 PFH, and reduction in FRC operating hours. The increase in P between the proposed 2004 PGA MNS Fleet and the POR is primarily due to the improved surface asset modeled Concept of Operations. In other words, by spending less effort detecting, classifying, and identifying targets, and more surface effort prosecuting in the modeled POR, the fleet was able to effect more prosecutions. In the case of the FMA mixes, increased capacity of assets coupled with a more efficient balance of surface, air, and C4ISR assets contributes to the significant improvements.

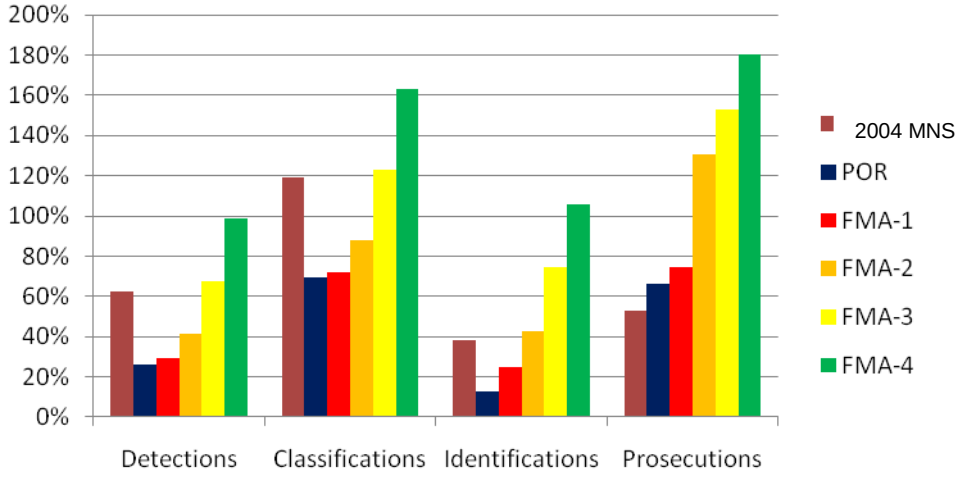


Figure ES-5 Relative Modeled SDCIP Improvements over 2007 Fleet

In addition to SDCIP, CGMOES results provide greater granularity and insight into the operational effectiveness of individual missions and MDA through 76 measures of effectiveness (MOEs). Many of these MOEs relate directly to performance measures outlined in the MPPs. A comparison of select CG-wide CGMOES MOEs is shown below in Figure ES-6. As noted, the performance measures show an overall general increase in effectiveness from the current fleet through the POR. Performance is compared to the expected performance of the original 2004 Deepwater Fleet established in the 2004 PGA MNS. Following the SDCIP results, the POR sees

a drop in intercepts (DCI but not P) in high-threat LMR and OLE and also sees a drop in Maritime Security (MARSEC) 1 fill rate. This, again, is primarily due to changes with the VUAV, C-144, and FRC asset type contributions noted above. This comparison also reflects the expected improvements in mission performance among the FMA incremental mixes. This data does show a small decrease in cocaine seized from FMA-2 and FMA-3. This decrease does not reflect degradation in performance, but rather the result of statistics on a low number of events.

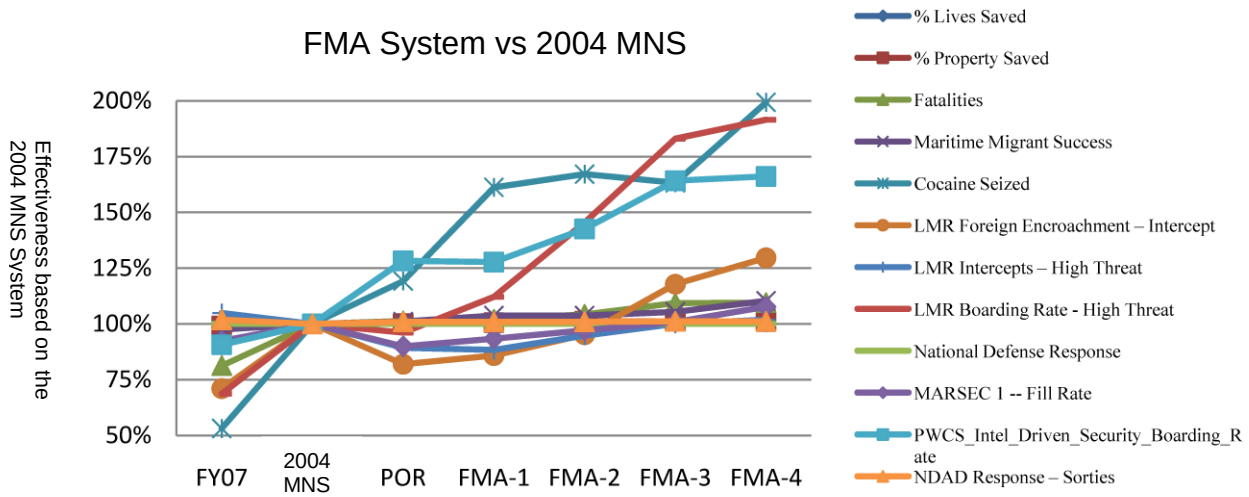


Figure ES-6 CG-Wide Measures – Compared to the 2004 MNS System

Of the 76 CGMOES MOEs, the FMA identified seven metrics that best reflected the key mission level performance stipulated in the Deepwater Acquisition Program Baseline (APB) (Reference 9). These MOEs, which are all either MPP targets or closely aligned with MPP intent, included:

- ***Drug*** – Percentage of Cocaine Seized
- ***AMIO*** – Percentage of Migrants Interdicted
- ***LMR*** – Boarding Rate for High-Threat Fisheries
- ***OLE*** – Intercept Rate
- ***SAR*** – Percentage of Lives Saved
- ***PWCS*** – Intelligence Driven Security Boarding Rate
- ***DefOps*** – Planned OOH Deployment Fill Rate

Figure ES-7 shows the relative improvements attributed to each FMA increment over the 2007 CG Fleet based on these seven metrics. The POR shows significant improvements over the 2007 Fleet, especially in LMR and CD. As was expected, FMA-1 shows significant improvements in DefOps and CD; FMA-2 and FMA-3 show significant improvements in LMR, OLE, and PWCS; and FMA-4 shows significant improvements in AMIO. In addition, FMA-1, which targeted CD, showed a significant improvement in AMIO, and FMA-4, which targeted AMIO, show significant improvement in CD. This "by-catch" is due to the common threat vectors and targets shared by the AMIO and CD missions. The SAR mission shows only a slight increase in performance because the 2007 CG Fleet has a robust SAR posture, leaving very little room for improvement.

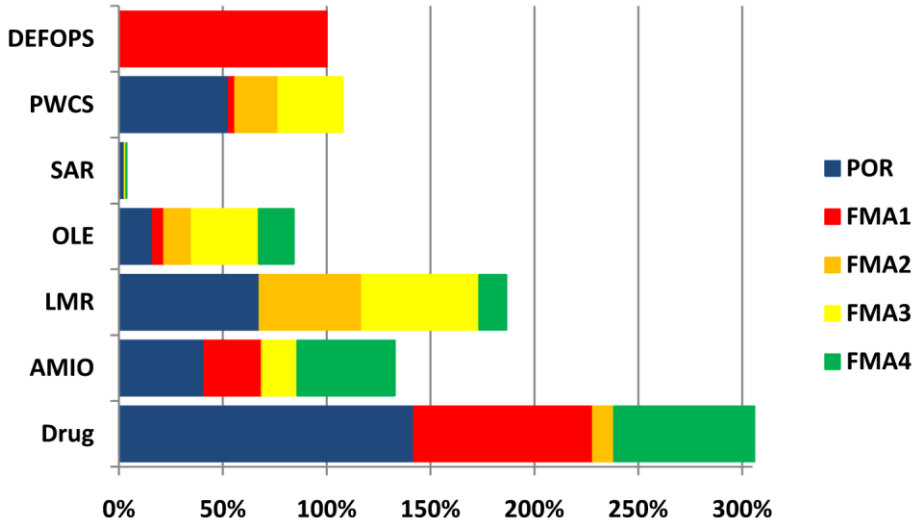


Figure ES-7 Relative Modeled Improvement over the 2007 CG Fleet

To evaluate the expected operational effectiveness of real-life FMA incremental mixes against real-life performance targets, the FMA developed a simple mission gap grading scheme based on suitable capability, sufficient capacity, and modeled MOEs. The assessment was provided by senior CG SMEs representing mission, platform, and district and area offices through a series of 16 conferences at which the results of the FCA and CGMOES modeling were presented and assessed for compliance with MPPs.

ES.10 COST ANALYSIS

The cost analysis phase provided a ROM total ownership cost (TOC) of the FMA Fleet mixes and POR. The FMA cost analysis methodology was developed following guidance from CG doctrine and Government Accountability Office (GAO) best practices. The methodology consisted of a cost data collection phase followed by a cost analysis phase. FMA cost estimates are not budget quality.

In the cost data collection phase, an Assistant Commandant for Engineering and Logistics, (CG-4) led Cost and Logistics IPT supported by appropriate CG SMEs provided the best available life cycle cost data (actual, contractual, historical, or estimated) for each of the life cycle events considered in TOC (acquisition, manning, maintenance, overhaul/service life extension programs [SLEPs], and infrastructure). During this phase, the FMA also developed two build-out schedules: an aggressive schedule based on industrial capacity and a conservative schedule based on notional fiscal constraints to establish a level annual acquisition process for each FMA increment.

In the cost analysis phase, the life cycle costs were related to life cycle events and then combined to determine the total operating costs for each of the platforms over the FY2009 to FY2050 operating period. Uncertainty was incorporated by applying probability distributions to each of the life cycle costs and life cycle events and rolled up using a Monte Carlo simulation. A sensitivity analysis was also conducted to identify what costs had the most significant impact on the TOCs and where the most cost risk was located.

The cumulative TOC for each FMA alternative is listed in Table ES-10, along with a 90% prediction interval about the expected cost.

Table ES-10 Cumulative TOC in 2050, Constant FY2009$B

ROM Cumulative TOC in 2050		Expected Cost	Constant FY2009$B
FMA Alternative	**Lower 90% Probability Bound**		**Upper 90% Probability Bound**
POR	$132	$134	$136
FMA-1 Aggressive	$161	$163	$166
FMA-1 Conservative	$157	$160	$162
FMA-2 Aggressive	$181	$184	$187
FMA-2 Conservative	$174	$176	$179
FMA-3 Aggressive	$197	$200	$203
FMA-3 Conservative	$185	$188	$191
FMA-4 Aggressive	$215	$218	$222
FMA-4 Conservative	$201	$204	$208

The cumulative acquisition and procurement cost is a lower level cost element of the TOC and are listed for the FMA alternatives in Table ES-11, along with a 90% prediction interval. Of note, this acquisition cost includes the beginning of the recapitalization of the new fleet by FY2050.

Table ES-11 Cumulative Acquisition and Procurement Cost in 2050, Constant FY2009$B

ROM Cumulative TAC in 2050		Expected Cost	Constant FY2009$B
FMA Alternative	**Lower 90% Probability Bound**		**Upper 90% Probability Bound**
POR	$37	$39	$40
FMA-1 Aggressive	$45	$47	$49
FMA-1 Conservative	$44	$46	$48
FMA-2 Aggressive	$52	$54	$57
FMA-2 Conservative	$51	$54	$56
FMA-3 Aggressive	$57	$59	$62
FMA-3 Conservative	$56	$58	$61
FMA-4 Aggressive	$62	$65	$69
FMA-4 Conservative	$61	$64	$67

Figure ES-9 graphically depicts the differences in acquisition costs between the POR, average aggressive build schedule, and average conservative build schedule over the FMA life cycle.

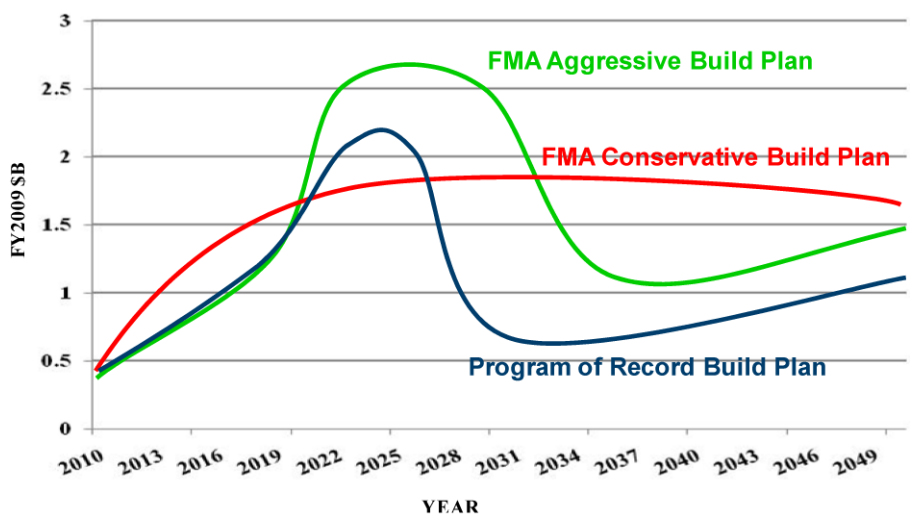


Figure ES-9 Comparison of FMA Build Schedules

Sensitivity analysis provided several insights. Early in the FMA life cycle, acquisition costs dominate the sensitivity analysis. The OPC acquisition cost is the number-one cost driver prior to 2030. The FRC acquisition cost is the number-two cost driver, followed by NSC acquisition cost. As the program matures, the lifetimes and other life cycle events begin to gain importance. If the life of the cutters can be extended, then TOC decreases as the longer lives postpone replacement by future platforms. Conversely, if the life of the cutters is shorter than expected, TOC increases due to the need for earlier replacement. By 2050, the number-one cost driver is the OPC service life, which is included in Figure ES-9 as a recapitalization requirement.

ES.11 COST EFFECTIVENESS

The cost effectiveness phase combined the results from the performance assessment and cost analysis phases to show relative improvements in operational effectiveness versus cost. TOC and AC&I roll-ups for each mix were calculated for both conservative and aggressive build-out schedules using FY2009 constant dollars. For effectiveness, the FMA developed a method to "roll up" the seven APB-related mission metrics using three different weighting schemes. The first scheme assumed that all missions were equally weighted, the second scheme applied weights according to NMSRA, and the third scheme applied weights corresponding to the percentage of CG operational expenditures (for FY2008) attributed to FMA assets. In addition, the uncertainty in both cost and effectiveness was calculated and a 90% confidence interval ellipse was developed for each mix. The resulting AC&I cost-effectiveness relationship of the FMA mixes is shown in Figure ES-10.

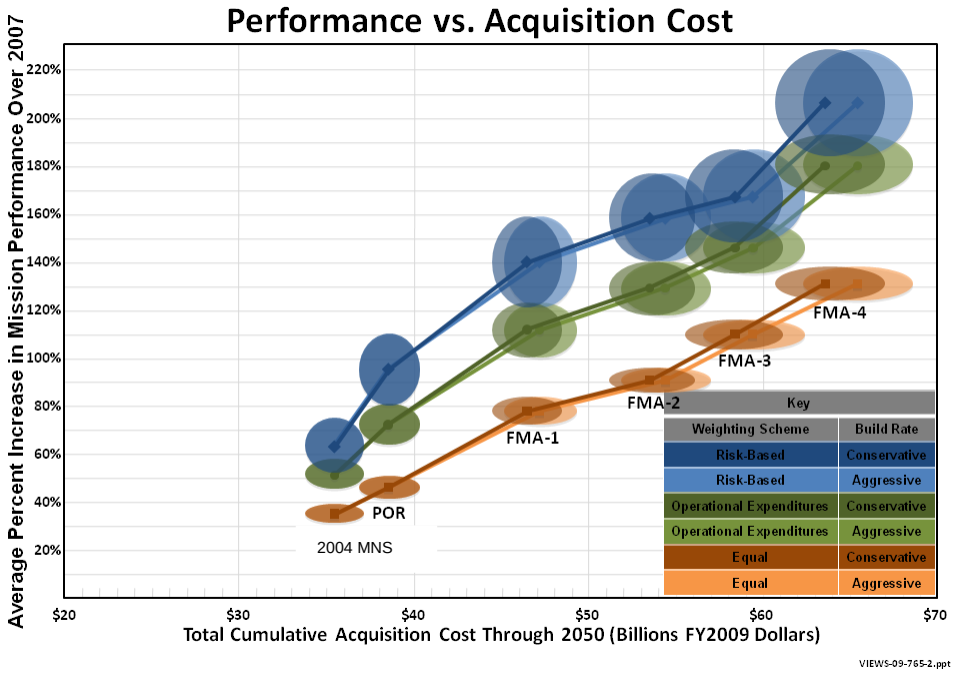


Figure ES-10 Cost (AC&I) Versus Effectiveness of FMA Mixes

The summary metric shows a substantial increase in performance across all Fleet mixes. The overall shape of the performance versus cost curve primarily follows the CD and LMR modeled results, with the largest increases in FMA-1 and FMA-4 and more moderate increases in FMA-2 and FMA-3. This is likely due to the fact that LMR is a "target-rich environment" and CD is a "high-impact" mission where more assets can immediately increase target detections and ultimately boardings and prosecutions. In contrast, PWCS (intelligence-driven boardings) and OLE (foreign fishing vessel incursions) have lower target densities, so the additional assets assigned to missions may provide increased surveillance and domain awareness without large increases in detections or prosecutions.

ES.12 RISK AND SENSITIVITY ANALYSIS

The risk and sensitivity analysis phase identified FMA issues or assumptions that threaten the FMA force level and force mix results. Risk analysis examined the impacts and potential mitigation strategies if key asset characteristics or CONOPS are not achieved. Sensitivity analysis compared the FMA's assumed FY2025 demand levels against the five future scenarios identified in the CG's 2008 Evergreen Study (Reference 10) to highlight potential impacts on the FMA objective mix.

Risks were categorized by asset type: surface, air, and C4ISR. Identified risks and potential mitigation strategies are summarized in Table ES-12.

Table ES-12 Summary of FMA Risks and Mitigation Strategies

Asset	Potential Risk	Rationale	Mitigation Strategies
Major Cutters	DAFHP (230 days)	A reduction in DAFHP will result in decreased presence and operational effectiveness.	Improve endurance, improve CONOP efficiency, or increase asset levels.
P-ORD OPC	Speed (25 kt)	A reduction in speed will result in additional operational limitations and reduced operational effectiveness.	Improve endurance to compensate and swap OPCs for NSCs.
	Sea Keeping (SS5)	A reduction in sea keeping will result in additional operational limitations and reduced operational effectiveness.	Swap OPCs for NSCs
	H-60 Interoperability	Inability to land and hangar the H-60 will result in decreased interoperability and will limit future rotary wing	None. Other agency assets may be needed to support missions.
FRC	Op hr (2,500)	New asset. A reduction in Op Hours will result in decreased operational effectiveness.	Improve endurance, improve CONOP efficiency, or increase asset levels.
HC-144A	PFH (800 hr)	New asset. Change in PFH, such as an increase from 800 to 1,200 or a decrease from 800, will impact airframe numbers.	An increase in PFH will decrease asset levels, and a decrease in PFH will increase asset levels. Alternate assets (UAS) is also an option.
UAS	TBD	New technology. Early in acquisition process. FMA assumed cutter based UAS was "Fire Scout"-like and the land based UAS was "Predator-like.	Pends actual UAS CONOPs. May result in UAS asset level changes or changes to manned aircraft asset levels
Rotary Wing	AUF (Training)	AUF training requirements are significantly higher than non-AUF. Changes to AUF CONOPs and demands directly impacts asset levels,	Develop clear demand requirements for AUF and PWCS. Conduct a study to optimize rotary wing training that includes deployment centers.
COP	TBD	New Technology. Should improve MDA. May highlight the need for additional prosecution assets.	Pends actual implementation to fleet-wide operations. Should be modeled to assess potential impacts.
SCIF	TBD	New Technology. Should improve MDA. May highlight the need for additional prosecution assets.	Pends actual implementation to fleet-wide operations. Should be modeled to assess potential impacts.

Through Project Evergreen, the Coast Guard periodically conducts scenario-based long-term planning to identify core action strategies to ensure the Coast Guard remains effective in any plausible future operating environment. As part of the FMA, a sensitivity analyses assessed how implementation of Project Evergreen core action strategies influence CG missions and FMA objective mix asset levels. The FMA found that while the POR is critical to implementing the Evergreen core action strategy, the objective fleet mix provides robust capacity to best achieve long term goals and objectives.

ES.13 CONCLUSIONS AND RECOMMENDATIONS

The FMA offshore and aviation study concluded that the POR will improve performance. However, to meet long term objectives, greater capacity will be needed. This conclusion was supported through a comprehensive and analytically rigorous FMA process and is consistent with the PGA and two independent studies conducted by the center for Naval Analyses (CAN) (Reference 11) and the RAND Corporation (Reference 12). Table ES-13 compares FMA operating hour requirements against those stated in the 2004 MNS.

Table ES-13 FMA Operating Hour Requirements Relative to the 2004 MNS

		FMA Op Hour Requirements Compared 2004 MNS								
		2004 MNS	**FMA-1**	**Delta (%)**	**FMA-2**	**Delta (%)**	**FMA-3**	**Delta (%)**	**FMA-4**	**Delta (%)**
Surface	Major Cutter	135,620	169,740	24	215,280	58	244,260	79	273,240	100
	Patrol Cutter	174,000	157,500	-9	187,500	8	200,00	15	227,500	31
Air	Fixed Wing	61,600	59,400	-4	64,200	4	72,200	17	89,800	46
	Rotary Wing	136,920	141,500	3	158,850	16	183,900	34	209,400	53

This study also concluded that the POR will not meet all future MPP requirements but is an improvement over the CG's 2007 Fleet. FMA force levels were driven by several factors:

- Major cutter levels were driven primarily by JIATF-S CD, OOH deployments, and the requirement to provide effective presence in LMR, OLE, and AMIO patrol areas. Major cutter DAFHP and finalization of OPC requirements could also have a significant impact on major cutter levels.
- Patrol boat levels were driven by SAR and PWCS response requirements and the requirement to provide effective presence in LMR and AMIO patrol areas. The reduction in annual FRC operating hours from 3000 (originally planned) to 2500 (currently planned) also factored into the increased FRC requirements identified in the incremental and objective fleet mixes.
- Fixed-wing aircraft levels, including UAS-LB, were driven primarily by MDA requirements derived from the MPPs, along with other transport, heavy airlift, and support demands. The reduction of HC-144A PFH from 1200 to 800 factored into increased asset levels over the POR. Likewise, the reduction also presents an opportunity to reduce FMA force levels if the HC-144A can operate above 800 PFH.
- Rotary-wing aircraft requirements, including UAS-CB, were driven primarily by SAR and PWCS readiness requirements and cutter deployments. Mature requirements on PWCS aviation needs will impact rotary-wing asset levels.

As an input to the CG Strategic Plan, the FMA process was purposely designed to be flexible and repeatable so that it could be modified to address ever-changing realities. Through the course of this study, the FMA team identified several areas for improvement. These areas are listed as recommendations below:

- MPPs will be evaluated for explanation to include regional campaign plans that outline objective and threshold requirements tailored to that region.
- MPPs that use national targets, such as CD, should identify the CG contribution.
- The AMIO MPP target of 90% interdiction rate will be validated.
- The CG will evaluate the clear requirements and demand levels for MDA, heavy airlift, aviation transport, and rotary-wing support to PWCS.
- Detailed OPC, C4ISR, and UAS trade-off analysis will be conducted to evaluate impacts to future operational effectiveness.
- FMA cost analysis will be evaluated for expansion to include training system, aviation maintenance infrastructure, fiscal environment, and shoreside support personnel and infrastructure.
- CG risk and other mission prioritization models will undergo recurring verification, validation, and accreditation (VV&A).