



712CD

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Original title on 712 A/B: AoAs Across the Milestones

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Report Documentation Page

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1. REPORT DATE 01 JUN 2007	2. REPORT TYPE N/A	3. DATES COVERED -	
4. TITLE AND SUBTITLE Analyses Of Alternatives (AoAs) Across The Milestones		5a. CONTRACT NUMBER	
		5b. GRANT NUMBER	
		5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)		5d. PROJECT NUMBER	
		5e. TASK NUMBER	
		5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Marine Corps Combat Development Command Quantico, VA 22134		8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)	
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited			
13. SUPPLEMENTARY NOTES See also ADM202526. Military Operations Research Society Symposium (75th) Held in Annapolis, Maryland on June 12-14, 2007, The original document contains color images.			
14. ABSTRACT			
15. SUBJECT TERMS			
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified	UU
			18. NUMBER OF PAGES 52
			19a. NAME OF RESPONSIBLE PERSON

ANALYSES OF ALTERNATIVES (AoAs) ACROSS THE MILESTONES



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Senior Analyst
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Purpose of an AoA

- **An Analysis of Alternatives (AoA) can:**
 - **Illuminate risk, uncertainty, and relative advantages and disadvantages of alternatives**
 - **Show sensitivity to changes in key assumptions**
 - **Help decide whether military/economic benefit is worth the cost**
 - **Help to refine requirements documents (CDD, CPD)**
 - **Address “affordability” ...**
 - **The degree to which the life-cycle cost of a program is in consonance with the long-range investment and force structure plans of the ...Component**

AoA Issues at Various Milestones

- **Broader, more general questions at early milestones; more focused as the program matures**
- **Case Study for the Expeditionary Fighting Vehicle (EFV)***
 - **Milestone I: Concept Development**
 - **Milestone II: Engineering Development**
 - **Milestone C: Limited Rate Initial Production (LRIP)**

How have the questions/issues changed to support these different decision points?

*Formerly the Advanced Amphibious Assault Vehicle (AAAV)

Outline

- **Background**
- **Milestone I COEA**
- **Milestone II AoA**
- **Milestone C AoA Update**
- **Conclusions**

Previous History of Amphibious Vehicles

- **LVT-7 begins fielding in 1972**
 - Slow swimming (~7 knots)
 - Weapon station: 50-caliber machine gun
- **Late 1970s: LVA program to develop fast swimmer**
 - COEA: technology couldn't support program
- **Early 1980s: Upgrade to AAV7A1**
 - Upgunned weapon station: 50-cal/40mm grenade launcher
- **Mid 1980s: LVT(X) program to enhance firepower**
 - COEA: Military benefit not worth the cost
- **Late 1980s: AAV program born**
 - Fast swimmer and enhanced firepower

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Milestone I Cost and Operational Effectiveness Analysis (COEA)

- **Helped to refine the Operational Requirements Document (ORD)**
- **Narrowed the field from the broad array of possible candidates**
- **Supported the Technology Development Strategy**

Summary of Milestone I COEA

- **Examined 13 alternatives**
 - **Fast swimmers: AAV(F); AAV7A2(F)**
 - **Slow swimmers: AAV 7A1; AAV(S); AAV7A2(S); submersible**
 - **Non-swimmers: Bradley; LAV-25; M113A1; APC(X); FIFV**
 - **Non vehicles: All surface (LCAC); All air (MV-22)**
 - **And also mixes**
- **Screened out alternatives based on cost & performance**
 - **AAV7A2(F); submersible; LAV-25; FIFV; all air; Bradley**
 - **Bradley placed back in mix by ASN (RD&A)**
- **Supplemental analysis examined mixes and modular construction of AAVs**

Summary of Milestone I COEA (Cont)

- **AAAV(F) best performer and most effective**
 - Used campaign-level model (AWM) on 2 scenarios
 - MOEs: Loss exchange ratio; force movement; fraction surviving; ship-to-shore timelines
 - Influencing factors: speed (faster build-up) and firepower
- **But also substantially more expensive**
 - Not so if we account for number of ships to carry 3 MEBs
- **Procurement strategies**

(Fast swimmers for all amphibs; slow swimmers for rest)

 - Some advantages of higher effectiveness at lower cost

Outline

- **Background**
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What Should a Milestone II AoA Include?

- **Answer depends on:**
 - What was included in Milestone I AoA/COEA
 - What has changed since?
- **Contention:**
 - Milestone II AoA should avoid duplication as much as possible
 - It should focus on the key issues of the time
- **Above all, remember goal is to support decision on whether or not to proceed into SDD**
 - Not narrowing down design decision
 - Not nailing down detailed fielding plan

COMPONENTS OF AoA

- **Develop alternatives**
- **Effectiveness analysis**
- **Logistics supportability**
- **Cost analysis**
- **Historical comparisons**
- **Affordability analysis**
- **Conclusions**

Alternatives

**AAV RAM/
REBUILD (RS)**



**AAV IMPROVED
AAV(I)**

- Achievable performance improvements
- Substantial cost savings (over AAAV)

AAAV

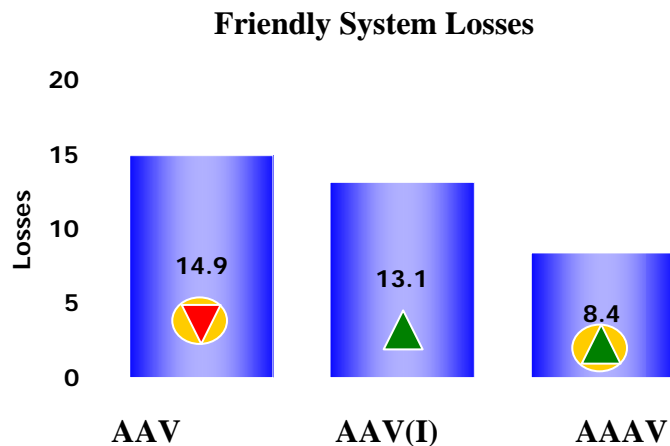
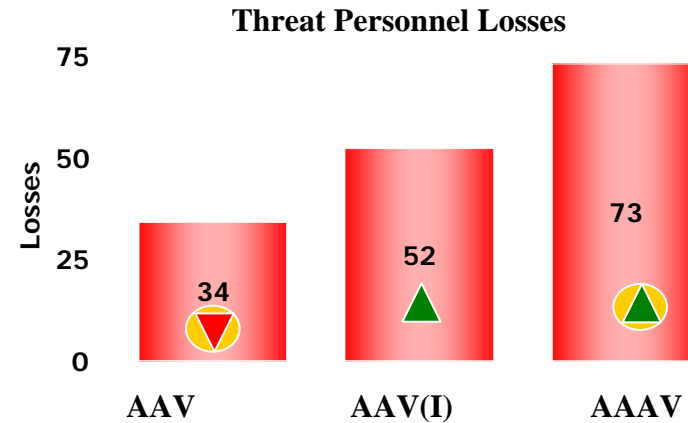
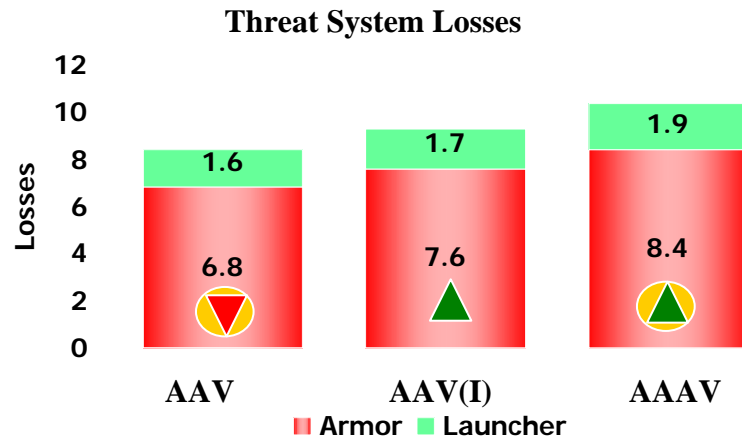





**Reduced
Procurement
Objective**

**Stretched
procurement**

- **Mixed fleet**
 - AAAV, AAV(RAM/RS)
 - AAAV, AAV(I)

Results: Maneuver at Sea (LPS 3) Night; High Tech Threat; AAVs Ride



-  Statistically worse than all alternatives
-  Statistically better than Baseline (AAV)
-  Statistically better than all alternatives

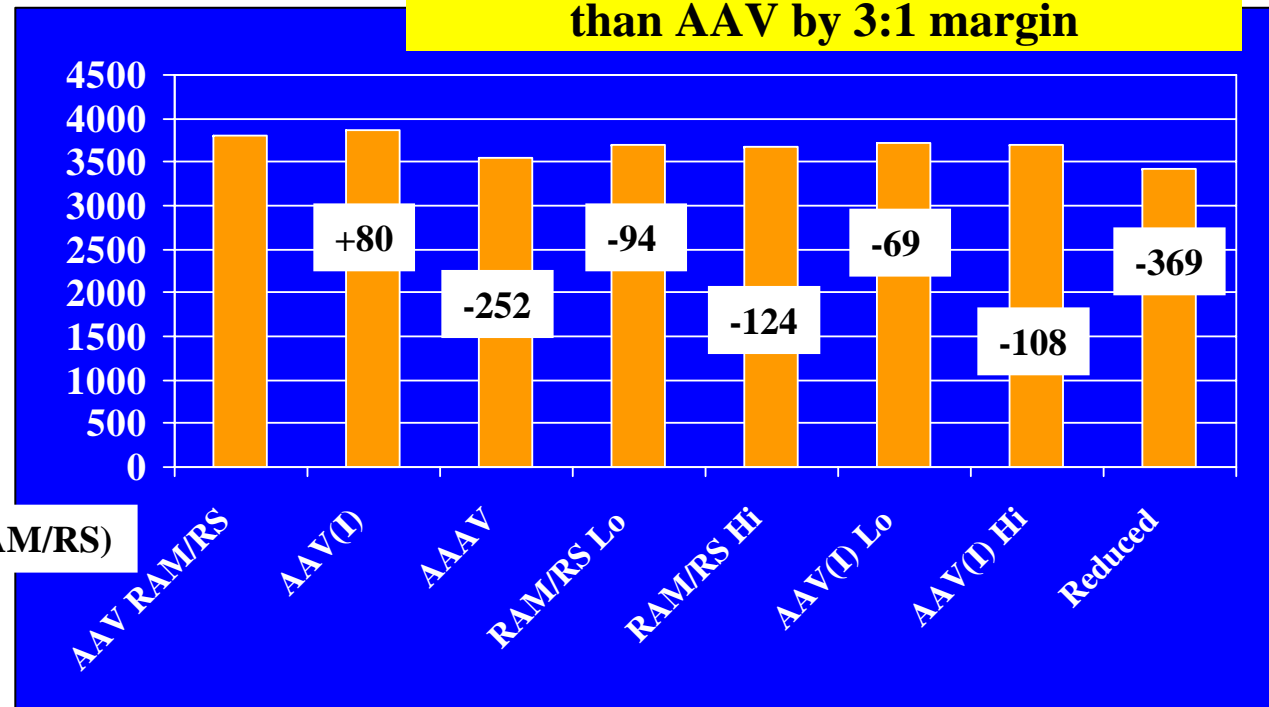
Logistics Supportability

- Reliability

	AAV RAM/RS	AAV(I)	AAAV
MTBOMF (hours)	43.5	37.2	70.0
MTTR (hours)	2.3	2.4	1.5

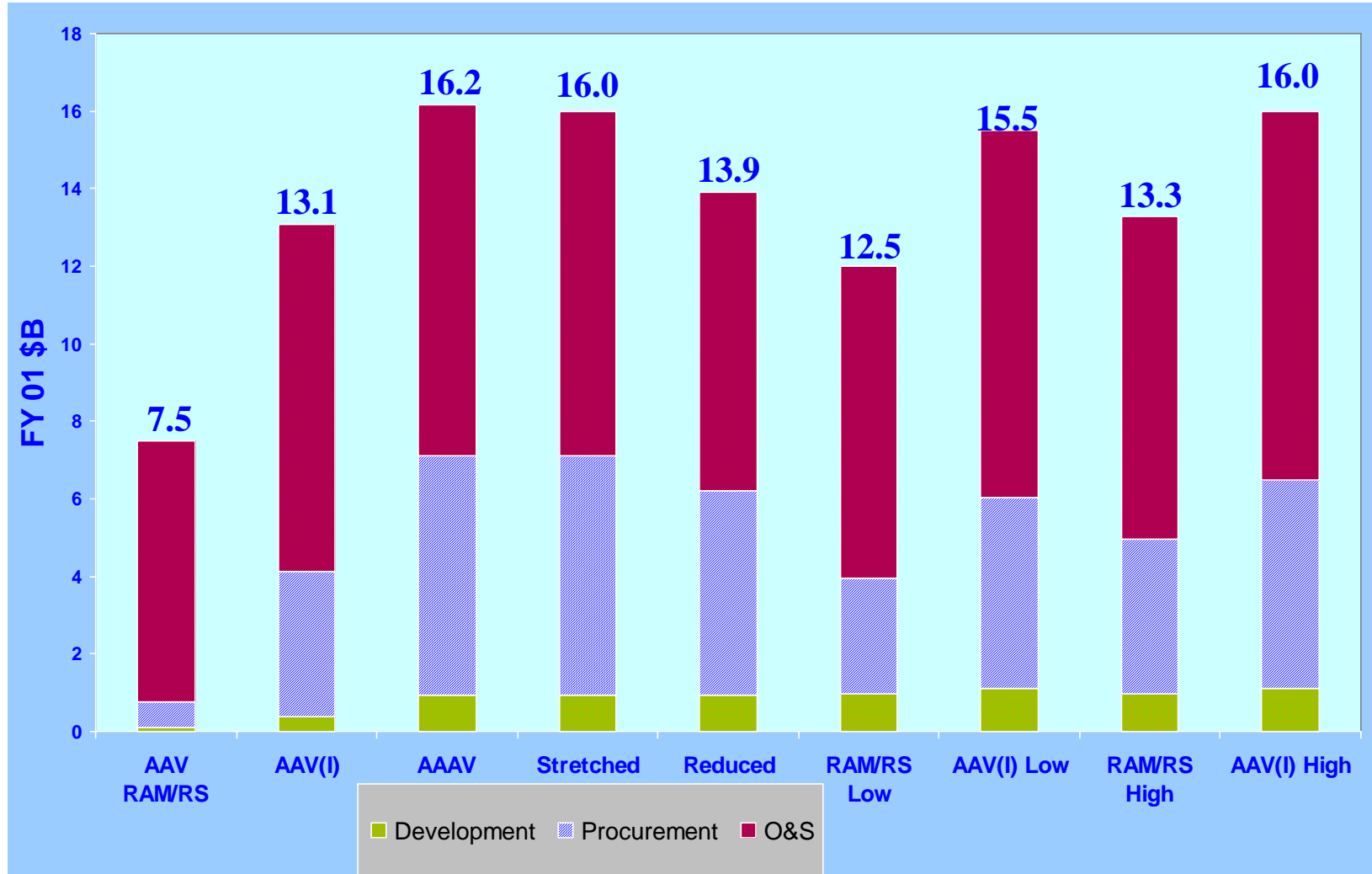
Maintenance ratio: AAAV better than AAV by 3:1 margin

- Personnel



Change from baseline (AAV RAM/RS)

Summary Life-Cycle Costs (By Phase)



Conclusions

- **AAAV substantially better in performance and effectiveness than other alternatives**
- **Stretched procurement address near-term bow wave, but not long-term affordability**
- **Reduced procurement achieves significant savings but with some operational risk**
- **AAV RAM/RS mixed fleets provide substantial savings, with benefits of AAAV, but also add some operational risk and maintainability issues**

Recommendations

- **Decision at hand is whether or not to proceed into E&MD for the AAV**
- **All viable alternatives contain AAV**

- **Proceed into E&MD for AAV**
- **Weigh RAM/RS mix and procurement strategies against affordability concerns in near-term (POM 04?)**

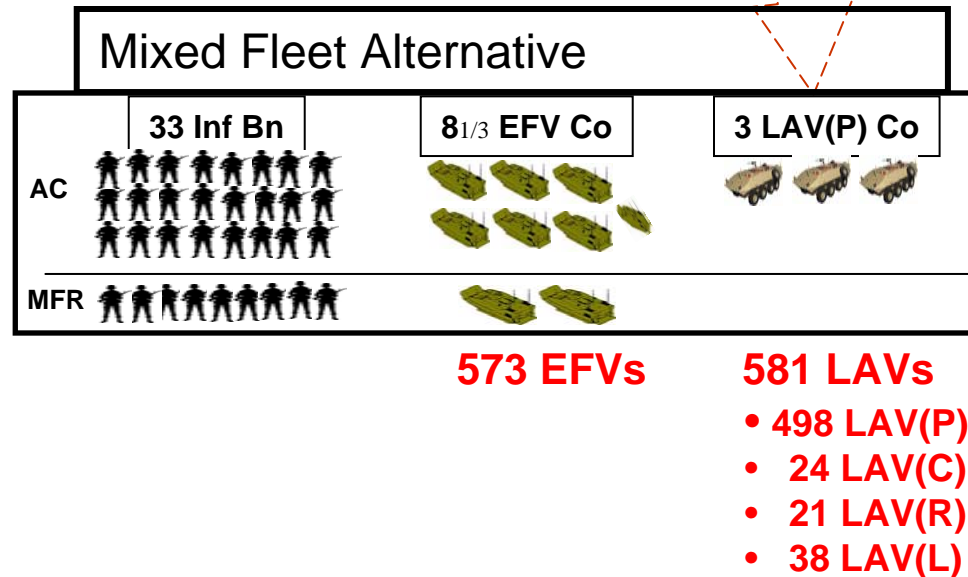
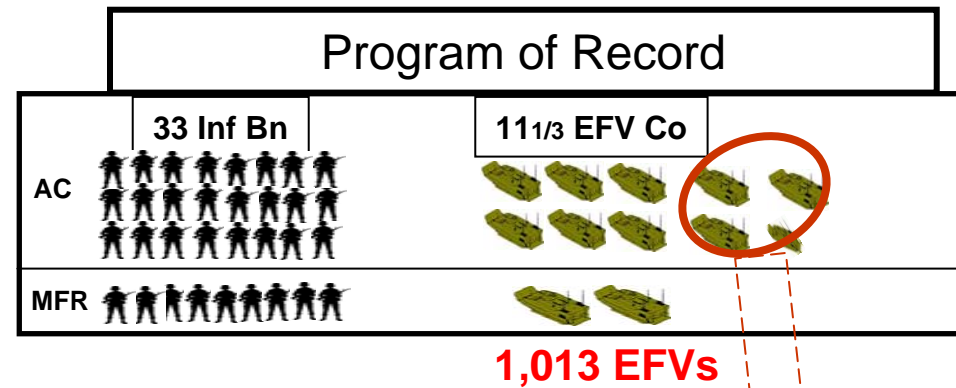
Outline

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Milestone C AoA “Update”

- **Several things have changed since last Milestone and AoA**
 - Reliability KPP decreased
 - Costs have increased
 - Program changed to reflect SPG direction
- **OSD requested AoA update to address changes**

Alternatives



Life Cycle Cost Estimates

FY07\$B (40 year life)

	RDT&E	Procurement	O&S	AVTB	Facilities	Total
EFV POR	\$0.9	\$10.9	\$15.6	\$0.1	\$0.06	\$27.5
Mixed Fleet	\$1.0	\$8.0	\$13.4	\$0.1	\$0.06	\$22.5

O&S Cost Implications of Reduced Reliability (in \$B FY07)

	<u>70 hours MTBOMF</u>	<u>43.5 hours MTBOMF</u>
POR (1,013 EFVs)	\$15.27	\$15.64
Mixed Fleet (573 EFVs)	\$10.32	\$10.54

Summary

- **Mixed-Fleet alternative maintains significant forcible entry capability**
 - Two MEBs as directed by SPG
 - All amphibs and MPF(F) equipped with EFVs
- **LAV(P) augmentation provides equivalent tactical lift capability**
 - Enhances potential for support to Irregular Warfare
- **Mixed Fleet saves \$3B PMC, \$5B life-cycle**
- **Mixed Fleet increases risk in training (EEAP) and MCOs (reduced firepower)**
- **Reliability changes increase overall O&S by about 5%**
- **EFVs still required for forcible entry**

Mixed Fleet a viable option for future Marine Corps capabilities

Outline

- **Background**
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Conclusions

- **Alternatives will be broader at earlier milestones**
- **Level of detail will typically increase at later milestones**
- **Milestone C AoAs are the exception**
 - **Only required when specific areas demand additional investigation**

It is important to continually bear in mind the decisions to be made at the milestone when structuring the AoA

There is no “cookbook solution” to performing and AoA – they must be customized for each milestone

Backups

Limitations of Analysis

- **Effectiveness**

- Only addresses “pure” alternatives

Summary explores operational implications of others

- Does not fully account for command and control capabilities

Provided equivalent C-variants in all alternatives

- Limited to two scenarios

Did extensive exploration in vignette analysis, and sensitivity analysis

- **Logistics**

- Not completely independent estimates (reliability, operational profile)

Included sensitivity analyses in cost analysis

Limitations of Analysis (Continued)

- **Cost analysis**

- Alternatives are not always directly comparable (age of alternatives, phasing, etc.)

Attempted to even playing field as much as possible: Total vehicle-years; added substantial SLEPs

- Did not account for contractor logistics support

This could theoretically provide benefit to all alternatives; because it is yet to be substantiated, and would not be a discriminator, it was not considered.

Effectiveness Analysis Scenarios

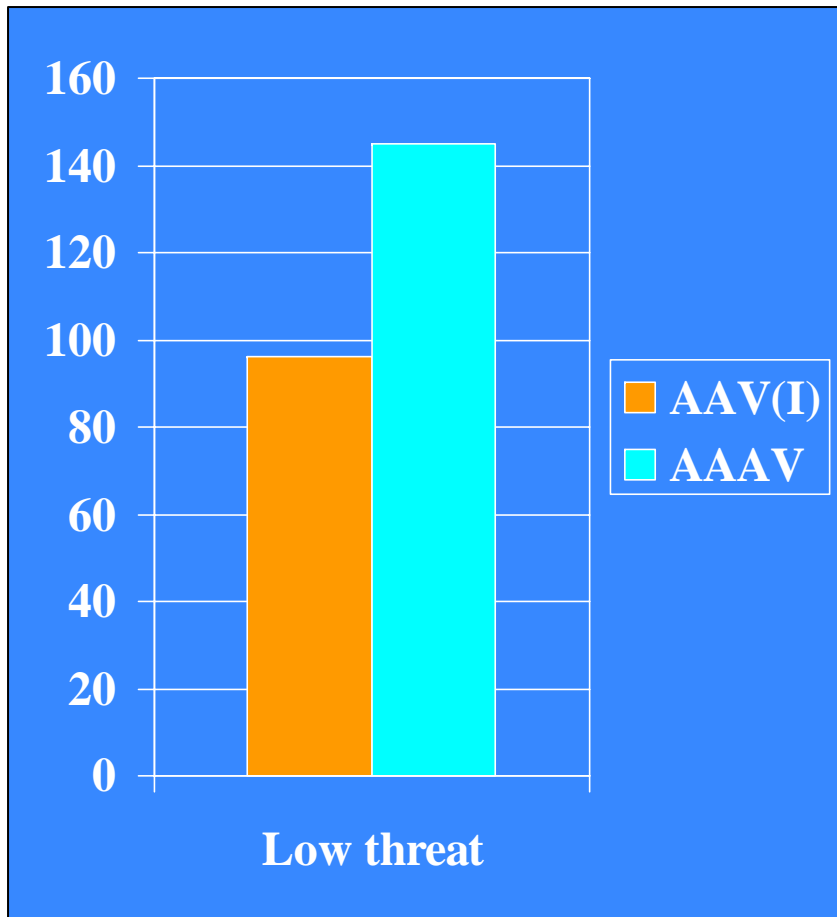
- **Vignettes**
 - **Smaller, more focused**
 - Maneuver at sea
 - Meeting engagement
 - Hasty defense
 - Attack on a deliberate defense
 - **Use for exploring system capabilities, sensitivities**
- **Scenarios**
 - **Use for main runs--operational-level analyses**
 - MTW-E -- amphib assault
 - Lesser Regional Contingency (LRC) - SLOC

Scenario Sensitivities

- **Threat levels**
 - Projected vs. high technology threat
- **Day vs. night**
- **Maneuver at sea**
- **Water Speed: 20 kn (threshold) vs 25 kn (objective)**
- **NBC Threat**

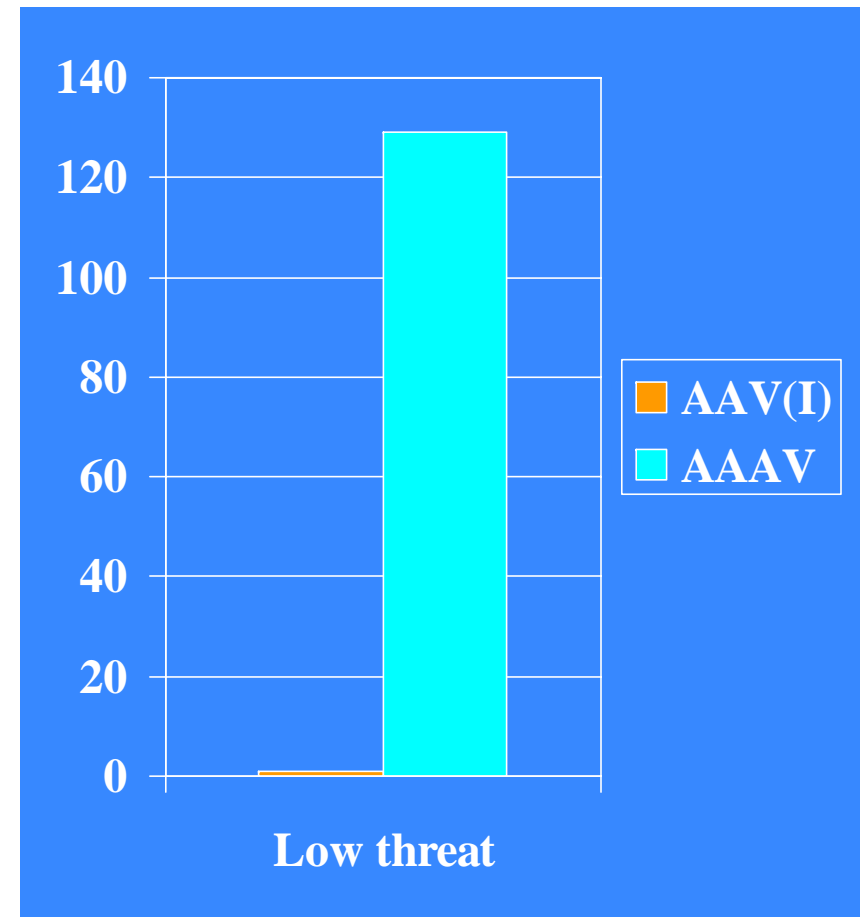
Effectiveness Summary (Comparison of MOEs)

Comparison to AAV RAM/RS



Maximum Score: 224

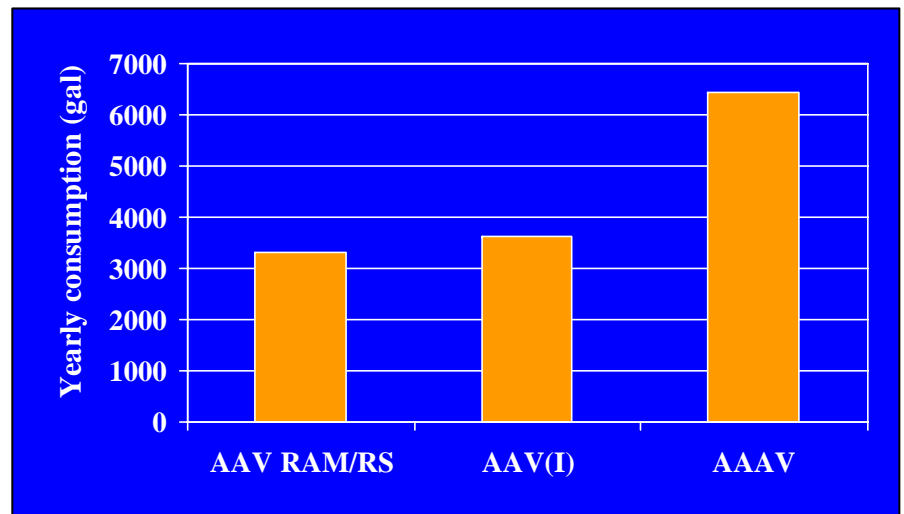
Comparison to each other



Maximum Score: 224

Logistics Supportability (Cont.)

- **Fuel consumption**
 - Based on 150 hours/yr
 - Alternatives comparable on a per-mile basis
 - Sensitivity analysis



Munition	Rounds per Active Vehicle per Year
40mm	576
.50 cal	3,370
7.62mm (on C- and R-variants)	650
30mm	1,100
7.62mm (on AAAV-P)	4,500

Historical Analysis

- **Examine historical Marine Corps operations**
 - **STARLIGHT (VietNam); URGENT FURY (Grenada); SHARP EDGE (Liberia); DESERT STORM (Iraq); RESTORE HOPE (Somalia)**
 - **Of these, which could have benefited from AAVs?**
- **Similar analysis for projected future operations**
 - **Selected from Dynamic Commitment vignettes**
 - **NEO and peacekeeping/HA operation**

Historical Analysis (Continued)

- **AAAV would provide better:**
 - **Operational flexibility: Better exploit STOM**
 - Eliminate operational pause
 - Reduce chances of landing on defended beaches
 - **Operational tempo: Allows fully capable night operations**
 - **Firepower and survivability: Collective protection**
- **AAAV also has two major shortcomings:**
 - **Lack of three-shot line charge**
 - **Reduced cargo-carrying capacity**

Conclusions (Pure Alternatives)

- **AAAV substantially better in performance and effectiveness than other alternatives**
- **AAV(I) buys some increase in effectiveness**
 - Still has significant operational shortfalls
 - Life-cycle cost over 80% that of AAAV
- **AAV RAM/RS substantially lower in effectiveness**
 - Significant operational shortfalls

Eliminate AAV(I) and AAV RAM/RS pure alternatives from further consideration

Conclusions

(Procurement Strategies)

- **Stretched Procurement**
 - Achieves nothing toward long-term affordability
 - Addresses near-term bow wave
 - Saves about \$300M/yr PMC during peak years (2008-10)
 - Pushes an additional \$800M further down the bow wave
- **Reduced Procurement**
 - Achieves actual near-term savings of \$900M (PMC)
 - Adds additional savings of \$1.3B in long term (O&S)
 - Incurs some risk from fleet reductions

These strategies warrant further consideration in conjunction with affordability concerns

Conclusions (Mixes)

- **Eliminate AAV(I) mixes**
 - Almost as expensive as AAAV, with less effectiveness
- **RAM/RS mixes provide substantial savings with added benefit of AAAV**

	<u>AAAV</u>	<u>Low Mix</u>	<u>High Mix</u>
Life Cycle (\$B)	16.2	12.0	13.3
Procurement (\$B)	6.2	3.0	4.0

- **Affordability: Low mix can reduce expenditures by almost \$300M/yr throughout DPP**

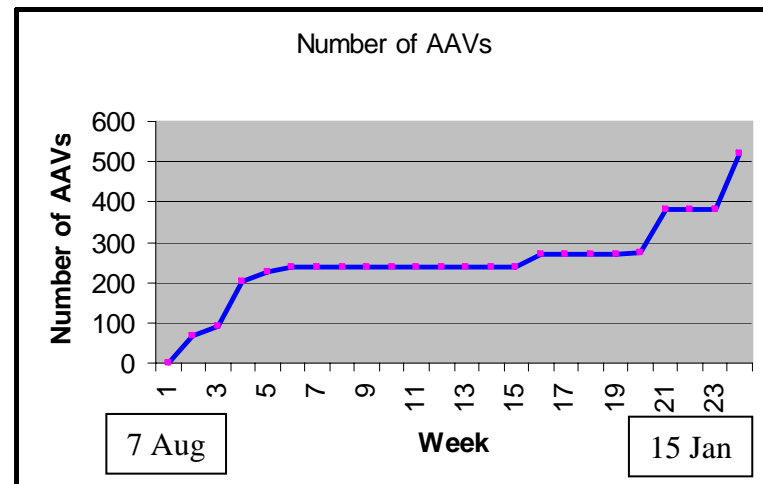
Concerns About Mixes

- **Effectiveness of mixed fleets**
 - **Serious concern – leads to increased operational risk**

however

- **“Loading up” of all amphibious ships requires**

(2.5 MEBs) x (103 amtracs/MEB) x (85% avail.) = 219 amtracs



Concerns About Mixes (Cont.)

- **Overhead of maintaining two fleets of vehicles**
 - Cost analysis incorporated much of this
- **Problems with training with two different vehicles**
- **Operational risk**
 - Can reduce effectiveness in 2nd, near-simultaneous MTW
- **Age of AAV RAM/RS**
 - Basic hull would approach 50 years
however
 - Current assessment of hull is that it is adequate
 - Alternative (and corresponding cost) includes substantial SLEP during mid-life

Capabilities Comparison

- **CONOPs**
 - Both alternatives provide 2 MEBs forcible entry capability
 - Both alternatives equip MPF(F) with EFVs
 - POR provides infantry battalion EFV capability at 29 Palms, vice company for Mixed Fleet
 - Mixed Fleet provides less threatening alternative for lesser contingencies

EFV versus LAV(P) Comparison

- **Survivability**
 - Blast and ballistic protection comparable
 - Mine protection better for EFV

Capabilities Comparison (Cont)

EFV versus LAV(P) Comparison

- **Firepower**
 - **EFV significantly more capable**
 - **30mm stabilized cannon vice pintel-mtd 7.62mm MG**
- **Mobility**
 - **LAV offers no surf or open-ocean mobility**
 - **Must ride on connectors from ship to shore**
 - **Land mobility comparable on open terrain, but tracks always more capable than wheels**

Shipboard Implications (for 2015 Notional MEB)

	Square (1000 sq ft)	Weight (1000 lbs)
EFV	35.3	6,272
LAV	42.9	7,348

- **Relative differences significant (LAV over EFV)**
 - 22% increase in square; 17% increase in weight
- **Absolute increase for entire MEB only 2%**
- **Only impact on MPF-legacy or black-bottom**
 - Both alternatives have EFVs on amphibians and MPF(F)

Assumptions

- **Actual procurement costs for current EFV prototypes used to project average unit costs in production**
- **Delivery profile and fielding plans based on POM-08**
- **Excursion assessed additional impact of rate reduction from POR**
- **RDT&E effort, with 7 prototypes, necessary to convert the existing LAV-L into a personnel carrier estimated by PM LAV**
- **For procurement, LAV-L used as an analogy for LAV-(P). For O&S costs (e.g., operating hours), LAV-25 used as an analogy.**

Rate Effect Excursion

- **Basic assumption was that learning (cost improvement) curve accounts for rate**
- **However, we ran a sensitivity analysis adding in an additional, partial reduction due to rate**
 - Modeled with a rate slope of 95%
 - Adjusted costs to align POR costs
- **EFV procurement costs in Mixed Fleet alternative rise from \$6.65B to \$6.87B**
 - Increase of 3% in Average Unit Cost

MS C Update analysis – Surface STOM

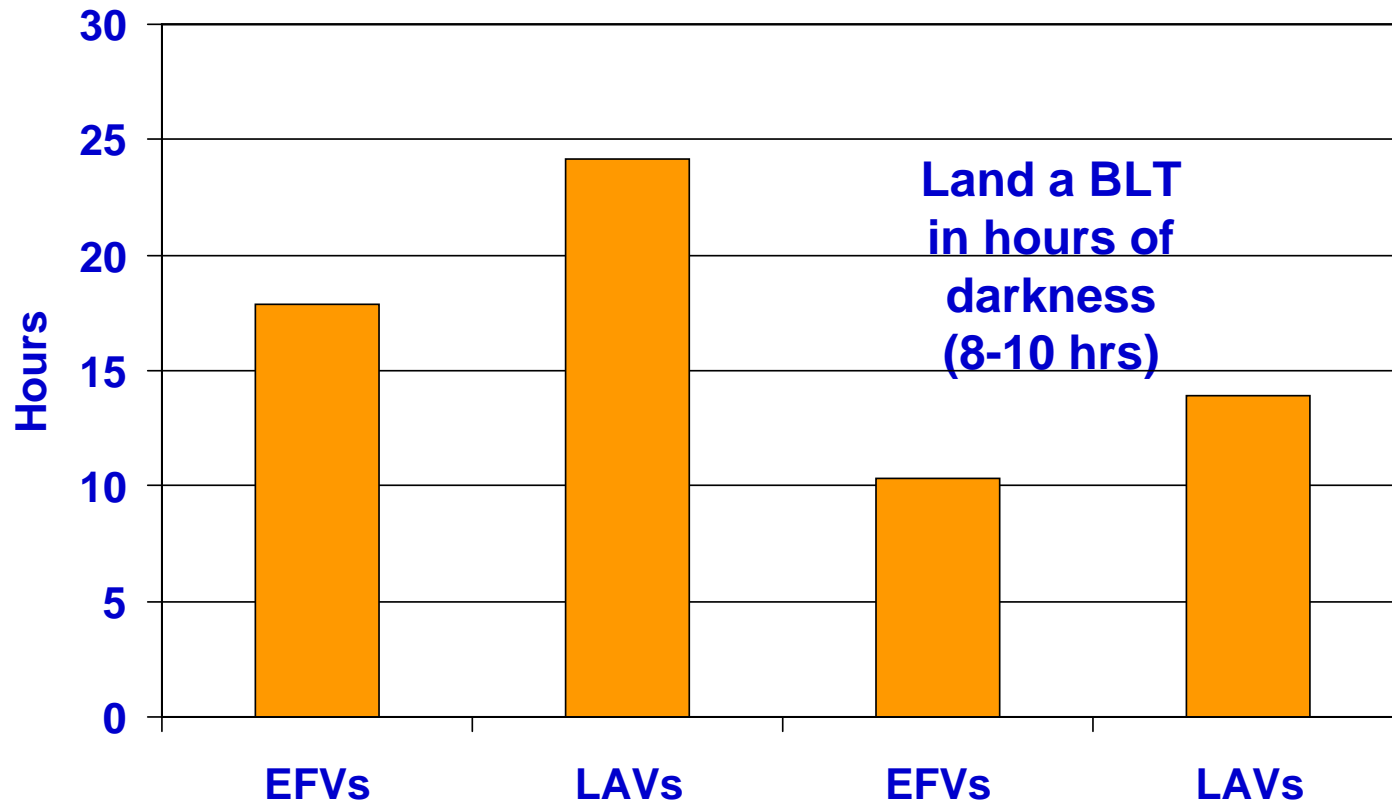
Forces Going Ashore

- Two BLTs with:
 - 2 – Infantry Battalions
 - Each with EFV or LAV Company
 - 2 – Tank Companies
 - 2 – LAR Companies
- 2 – Combat Engineer Spt Dets
- 2 – DS CSS Companies
 - 2 – LAAD Detachments
 - 2 – LW155 Batteries

<u>Item</u>	<u>EFV-equipped</u>	<u>LAV-equipped</u>
PAX	3,818	3,818
EFV	98	0
Tank	28	28
HMMWV wpn carrier	70	70
HMMWV cargo/comm	238	238
LW 155	12	12
LAV	56	290
MTVR	98	98
LVSR	38	38
LCAC Loads	143	193

Surface STOM Results

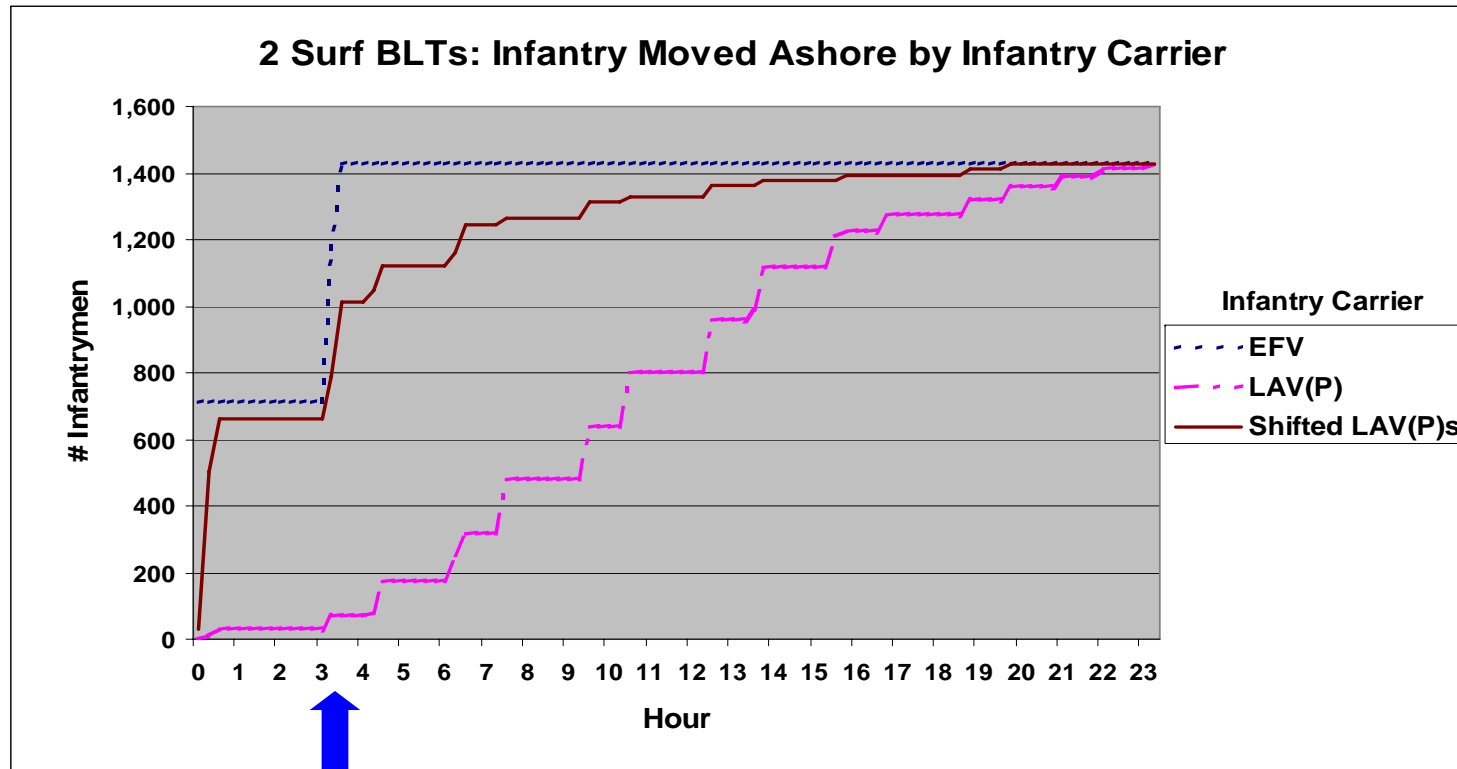
Time to Complete Landing



2 Surface BLTs

1 Surface BLT

Infantry Moved Ashore Over Time



Infantrymen landed in 3.5 hours with :

- LAV(P)s: 71
- Shifted LAV(P)s: 1,014
- EFVs: 1,426

Purpose

Analyze the impact of any changes to the reliability requirements of the EFV

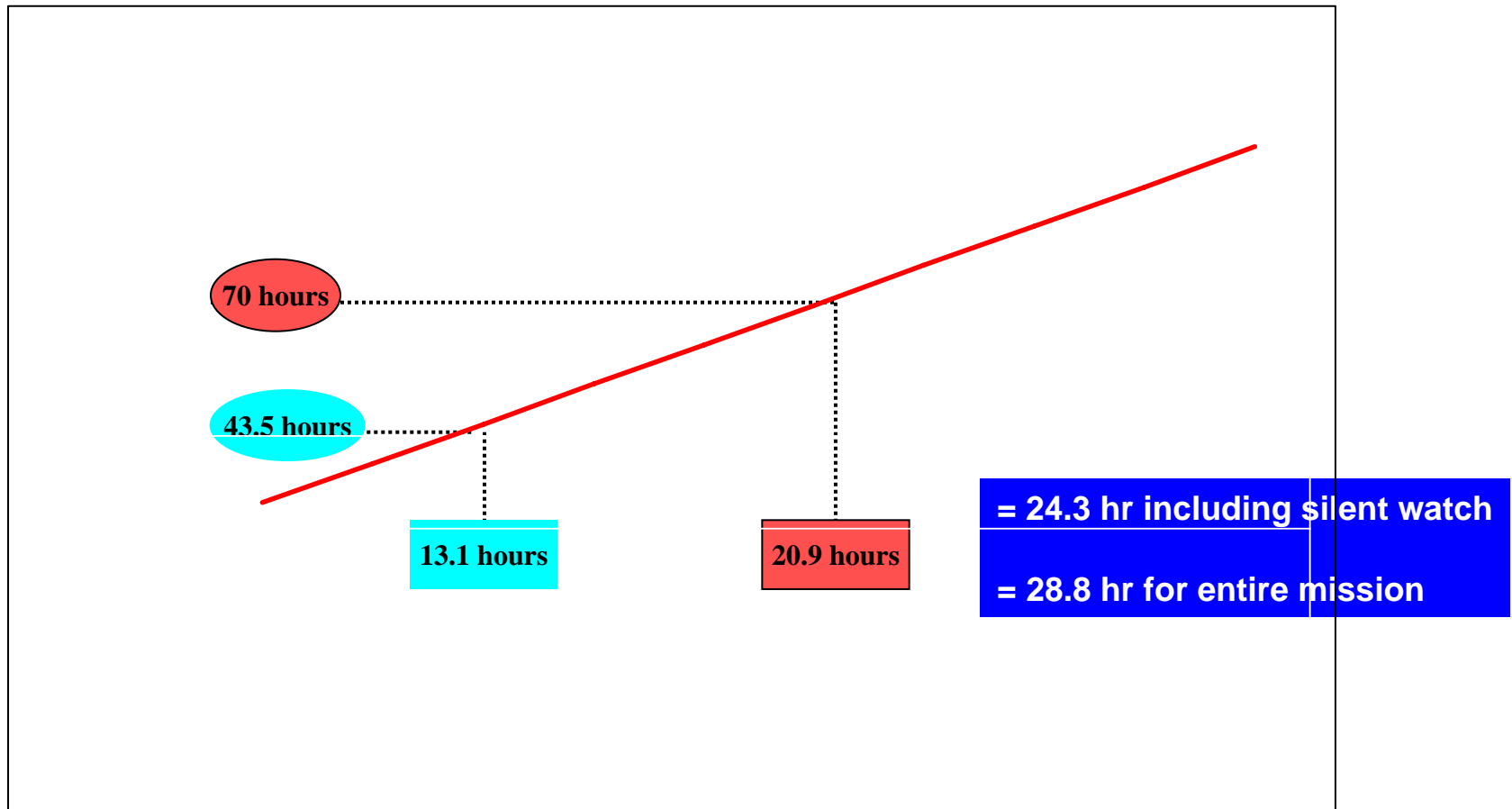
- **Original Threshold: 70 hrs Mean Time Between Operational Mission Failure (MTBOMF)**
- **Revised KPP: 43.5 hrs MTBOMF**
- **Rationale**
 - **Comparable systems significantly lower**
 - **Mission profiles used in derivation unrealistic**

Reliability Comparisons

Program	ORD Req't	Normalized Req't MTBOMF	Demonstrated at MS III
AAAV	70 Hrs MTBOMF	70 Hrs	N/A
AAV RAM/RS	43.5 Hrs MTBOMF	43.5 Hrs	58 Hrs
ABRAMS	320 MMBOMF ¹	32 Hrs	42 Hrs
BRADLEY	280 MMBOMF ¹	28 Hrs	36 Hrs
CRUSADER	62 Hrs MTBSA (SPH) 104 Hrs MTBSA (RV)	62 Hrs (SPH) 104 Hrs (RV)	N/A
GRIZZLY	21 Hrs MTBOMF	21 Hrs	N/A

Relation between Mission Duration and MTBOMF (Objective)

Initial goal: 75%* probability of completing the mission



Initial KPP (70 hours MTBOMF) actually achieved 74% mission reliability