Aging Naval Aircraft Study

Naval Research Advisory Committee
Report to the
Assistant Secretary of the Navy
(Research, Development & Acquisition)
Mr. John J. Young, Jr.
26 September 2002
The original document contains color images.
Aging Aircraft

Huge Problem?

and/or

Business Opportunity of Immense Proportions!!!
Aircraft Inventory Management

1 - \( \frac{\text{Fleet Squadron Requirement}}{\text{Total Inventory}} \) = Program A/C Pipeline

- SH-60F 06%
- KC-130R 32%

Program Pipeline ➔ Reinvestment $ ➔ Combat Readiness

Converting Pipeline to Readiness ... Requires a “Revolutionary” Approach
Parts/Component Management

Inventory

$20B

$0

02% Other (Not Ready for Issue)
46% “F” Condition (Not Ready for Issue)
04% “G” Condition (In Depot Awaiting Parts)
08% “M” Condition (In Depot Repair-In Process)
40% “A” Condition (Ready for Issue)

Component Pipeline

Component Pipeline
Reinvestment
Combat Readiness

Converting Inventory to Readiness ...
Requires a “Business” Approach

*Data Source NAVICP Master File as of 1 Jan 1997
Capturing the Opportunities

- Establish Executive Level Ownership
- Integrate Best Business Practices for Combat Readiness
- Exploit Naval Aviation As a Team
- Apply System Engineering Approach
- Demo Weapon Systems “Proof of Concept” Now!
Terms of Reference

- Review the current state of need
- Identify mitigation opportunities
- Link needs and opportunities to S&T

Objectives

- Recommend technology planning, transition, and insertion
- Recommend steps to mitigate cost and readiness impact
Study Scope

• Looked for systemic causes of soaring maintenance costs and declining readiness

• Chose not to focus on one or two “bad actors” with unique Type/Model/Series fixes

• Balanced technology development, technology transition and business processes

• Found aging issues begin early
Panel Membership

Chair:
• Jim Sinnett
  Consultant Boeing (Ret.)

Panel Members:
• VADM Brent Bennitt  Veridian Aeronautics USN (Ret.)
• MajGen George Karamarkovich  Financial Advisor USMC (Ret.)
• MajGen Warren Johnson  Consultant USMC (Ret.)
• Chester Kennedy  Dir. Electronic Tech. Lock. Martin
• Paul Martin  VP Engineering Sikorsky
• Richard Rumpf  Consultant Fmr. PDASN
• LtGen Keith Smith  Consultant USMC (Ret.)
• Dick Spivey  Dir. Advanced Technology Business Bell Helicopter

Study Coordinator
• RADM Walter Massenburg  Asst. Commander, Logistics, NAVAIR USN

Army Science Board Representative:
• Dr. Inderjit Chopra  Professor U of Maryland

Executive Secretary
• Robert Ernst  Head, Aging Aircraft Program, NAVAIR USN
• LCDR Greg Olson  Program Support, Aging Aircraft USN (Ret.)

NRAC Staff Support
• LtCol Bill Waters  Sr. Engineer, Jorge Scientific USMC (Ret.)
Site Visits

- NAVAIR/OPNAV/ONR Briefs - DC
- NADEP and NAS Jacksonville, FL
- Northrop Grumman - St. Augustine, FL
- Boeing Aerospace Support Center - Cecil Field, Jacksonville, FL
- NADEP Cherry Point, NC
- ASC and Aging Aircraft SPO - Dayton, OH
- Delta Air Lines Inc. Atlanta, GA
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<td>Design Build Process and Bold Stroke Initiative (The Boeing Co.)</td>
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<td>Flight Critical Parts (NAVAIR 4.1C)</td>
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<td>Alliance Initiative (CaterpillarLogistics)</td>
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<td>United Kingdom Structures and Avionics Interview*</td>
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*(RAF Wyton) (MOD Abbey Wood)
Related Studies

- National Academy of Sciences, Aging Avionics, 2001
- NPGS Report, ADA-379704, *(Master’s thesis)* Cannibalization study, June 2000
- CBO Report, Effects of Aging on the Costs of Operating and Maintaining Military Equipment, August 2001
- NAVAIR, Aging Aircraft System and Component Repair Growth, September 11, 2001
- Navy IG, Naval Aviation Spares and Readiness, Sept 2001
- CNA Report, Effect of Aging Equipment on Support Costs, November 1, 2001
- NRAC Studies (see Appendix A)
Technology Insertion

Common themes emerge...

- Technology transition depends on focused senior management
- Technology Transition Executive
- Focus on reduced cost
- Long technology insertion cycles
- Gain-sharing incentives for contractors
- Speed up contracting process
- Leverage other sources of R&D
- Integration between S&T and R&D required
Observations

- Tremendous capability exists
- All players want to improve
- No single solution
- Stove piped decisions; Default- Comptroller
- Deferred maintenance and cannibalization kills readiness and personnel retention
- System Engineering/ Reliability Management needed
- No integrated strategy

Opportunities for step improvements exist
Fleet Sailor’s and Marine’s Perspective

Naval Aviation is Broken:
• Record low procurements and mods
• Flying hour program underfunded
• Lack of spares /high cannibalization rates
• Unprecedented maintenance required
• Aircraft on the line are NOT fully mission ready
• Quality of Service impacted
• Shortages of resources limit combat readiness

Frustration is driving professionals out
The Challenge

- Fleet average age is 18.8 years and climbing
- Equipment/ILS not designed for 30+ years
- Costs to sustain combat capability soar
- Readiness continues to decline

READINESS  COSTS
Cannot Just “Buy” Our Way Out

• DOUBLING the number of procurements will only reduce the average age by three years in 2010... and costs >$70 Billion!

• “Repair Only As Necessary” maintenance philosophy will not do the job
  • SLEP/Remanufacture/Block Upgrade / RCM
  • Funded ‘System Engineering’ essential

Funding is Required, but funding alone is not enough
Addressing the Issues...
Eliminate Funding Stovepipes & Fragmented Program Management

$ COMPTROLLERS $
Leadership Team

• “Ownership” at SecNav/CNO/CMC level required to make things happen
  – Charter Leadership Teams
  – Empower PEOs and Program Managers (Budget authority)
  – Program Management to control resources for attainment and sustainment of combat capability

• Guiding Principles
  – Goals and Objectives
  – Business Base metrics
  – Enterprise Wide
  – Best Business Practices
  – Full Resource Control
  – Balanced technology insertion
  – Accountability
Use Best Business Practices

- Identify capabilities that are “world class” discriminators
- Create component centers of excellence within the depot system
- Implement overarching lifecycle analyses
  - System Engineering
  - Maintenance practices
  - Supply Chain Management
  - Make/Buy Decisions
- Program Managers require resources/authority to enforce cross-cutting business decisions
- ROI decisions must be data driven and include readiness, capability, all elements of manpower, infrastructure, and the cost of NOT flying
System Engineering Process
Integrated Business Model

Desired Output
- Increased Availability
- Lower Operating Costs
  Across All Dimensions

Data
Health Monitoring/Sensors

Knowledge
Diagnostics/Prognostics

Performance

Analysis of alternatives
Technology, Remanufacture, Spares, Processes

**Courtesy, USAF Aging Aircraft SPO**
System Engineering Process
Resources and Infrastructure

**Issues**
- Models and Integrated Data
- Fragmented Budget Decisions
- Skill/Experience Levels

**Data**
- Health Monitoring/Sensors

**IT**
- Subject Matter Expertise

**Knowledge**
- Diagnostics/Prognostics

**Performance**
- Sortie Rate, Cost per Hour

**Expertise**
- Prob. Methods
- Fracture Mechanics
- Materials
- Coatings
- Reliability
- Statistics
- Avionics
- Thermodynamics
- Vibration
- Fatigue
- EMI
- Systems
- Propulsion
- Advanced Technologies
Implementing System Engineering is a Problem

- No Single Point of Responsibility, Accountability, and Authority
- Lack of Integrated Analysis and Data
  - “Data Morgue”
  - No Proactive Approach
- Fragmented Budget Decisions and Stove Pipes
- Teams often lack proper mix of critical business, technical and depot expertise
  - Unable to complete proper analysis of alternatives

Turn Data Into Knowledge and Performance
System Engineering Demo

- Systems oriented, ‘Measured’ results, Transition focused
- Step improvement in performance
- “ACARD” -- Advance Concept Affordable Readiness Demo
  - “TOTAL SYSTEM” APPROACH (e.g. E-2C or F/A-18C)
  - TARGETED GOALS for Cost and Readiness
    - Establish MC/FMC, depot in-process time, TOC goals
    - Eliminate 50% aircraft/component pipeline
  - EMPOWER AND RESOURCE ‘Cross Stove Pipe’ Team
    - PMA Lead, OPNAV, NAVAIR, NAVICP, Fleet, NADEP, DLA, Industry, DOE
    - Full System Engineering Approach
    - Identify How to Overcome Impediments to Best Business Practices
    - Incorporate/Integrate ‘Best of Breed’ Concepts/Technologies
      - IMC, RCM, SCM, ERP, LEAN, PPP, Six Sigma, TSPR

Do a Sustainment Sea Trial for Naval Aviation
Creative Contracting Examples
Creative Contracting Examples

- Performance based logistics
  - *Contracts structured with incentives to maximize desired performance*
  - *Share savings with contractor*
- Strategic partnerships
- Long term contracts
  - *Enable investments by industry partners*
- Hybrid contracts
  - *Combine types of contracting in one (e.g. Award & Incentive Fee, T&M)*
- Good examples exist-- Marine Corps MPF Program / APU / F-117 TSPR

Leverage Partnerships
Improve Utilization of Depot Capability and Capacity

- Use existing skills and facilities to reduce costs and improve readiness:
  - *Backshop skills to advantage*
  - *Fast-shop concept (all sources)*
  - *Bonding capabilities for repairs*
- Exploit “Centers of Excellence”
- Exploit public/private partnering arrangements (e.g. APU)
- Ensure availability of tech data and pubs
- Incorporate proven process technology
- Instill “lean & clean” philosophy - *work force ethos*

Leverage Internal Assets
Technology Dilemmas

- Fully Utilizing Information Technology
- Using ManTech for repair processes
- Upgrading Materials Technology
- Synchronizing TYCOMs / S&T communities
  - 42% of the known problems have no solution
  - 12% of degraders that have known solutions are unfunded
- Integrating Capabilities of Services/Industry/other sources
- Strategically Inserting Technology

Leverage Previous Efforts
Integrated Technology Roadmaps
...in short supply

- Understand Fleet Requirements
- Identify Available Alternatives
- Conduct Analysis of Alternatives
  - Readiness
  - Safety
  - TOC
- Develop DETAILED Insertion Plan
  - Resource Allocation
  - Timing

Plan for Success
## Circuit Breaker Technology Roadmap ...a Good Example

### Transition Planning Integral

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
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<tr>
<td>1</td>
<td><strong>Large 400Hz Breaker</strong></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>2</td>
<td><strong>Mini 115VAC Breaker</strong></td>
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<td></td>
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<tr>
<td>3</td>
<td><strong>Mini 28VDC Breaker</strong></td>
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<tr>
<td>4</td>
<td><strong>Mini 230VAC Breaker</strong></td>
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<tr>
<td>5</td>
<td><strong>Remote Reset Capability</strong></td>
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</tbody>
</table>

### Priorities

- **Large 400Hz Breaker**
  - 1999: 600 Navy
  - 2000: 550 FAA
  - 2001: 300 Navy
  - 2002: 400 FAA
- **Mini 115VAC Breaker**
  - 2000: 500/500 USAF & Industry
  - 2001: (300) Navy
  - 2002: 150 USAF
- **Mini 28VDC Breaker**
  - 2003: 300 FAA
  - 2004: 300 FAA
  - 2005: 300 FAA
- **Mini 230VAC Breaker**
  - 2003: 100 USAF
  - 2004: 250 USAF
  - 2005: 100 USAF
- **Remote Reset Capability**
  - 2005: (??)
  - 2006: (??)
  - 2007: (??)
### Example* for a Critical End Item

<table>
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<tr>
<th>System Engineering</th>
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<tr>
<td>- <em>Analysis of Alternatives</em></td>
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<td>- <em>Metrics</em></td>
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<th>Best Business Practices</th>
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<tr>
<td>- <em>Supply Chain Management</em></td>
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<tr>
<td>- <em>Reliability Centered Maintenance</em></td>
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<tr>
<td>- <em>Integrated Funding Decisions</em></td>
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<th>Creative Partnerships</th>
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<th>Technology Insertion</th>
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*From CIP Plan POC: Mr Dave Pauling NAVAIR 4.4

Focus on Readiness
Critical End Item: Engines

Scenario I
Do nothing

- 8400 Firewalls
- 9500 Engines required
## A Critical End Item - Engines

<table>
<thead>
<tr>
<th>Option</th>
<th>Total Cost FY00-12</th>
<th>Min. Engines Available</th>
<th>Recovery Date</th>
<th>Annual Cost (FY12)</th>
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</thead>
<tbody>
<tr>
<td>I Status Quo</td>
<td>19.94B</td>
<td>4800 (FY05/07)</td>
<td>N/A 5200</td>
<td>1.9B/Yr</td>
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<tr>
<td>II Increase Depot Funding, No Process Change</td>
<td>21.92B</td>
<td>6800 (FY05/07)</td>
<td>FY08/09</td>
<td>2.0B/Yr</td>
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<tr>
<td>III Shift to Investment Accounts</td>
<td>19.95B</td>
<td>4800 (FY05/07)</td>
<td>FY11/12</td>
<td>1.5B/Yr</td>
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<tr>
<td>IV Combine II and III Increase Depot and Invest in Process/Technology</td>
<td>20.63B</td>
<td>6800 (FY05/07)</td>
<td>FY08</td>
<td>1.5B/Yr</td>
</tr>
<tr>
<td>V* IV with “Bridge” Funding to Maintain Readiness</td>
<td>21.13B</td>
<td>8300 (FY05/07)</td>
<td>FY02</td>
<td>1.5B/Yr</td>
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</table>

*Estimated
Critical End Item: Engines

Scenario II
Depot $ Plus Up Only

Scenario I
Do Nothing
TOC $19.94B

Scenario II
Depot $ +up
TOC $21.92B
Critical End Item: Engines

Scenario III
CIP/PRL/PPC $ Plus - Up Only

Annual Budgets $M Axis

Scenario I
Do Nothing
TOC $19.94B

Scenario III
CIP/PRL/PPC $+up
TOC $19.95B

# RFI Engines Axis

$1,500

$2,000

Critical End Item: Engines

Scenario IV
Scenario II & III $ Plus Ups

# RFI Engines Axis

Annual Budgets $M Axis

Scenario I
Do Nothing
TOC $19.94B

Scenario IV
II & III Scenario $+up
TOC $20.63B

ACTUAL
Critical End Item: Engines

Scenario IV+Bridge Funding

Additional Current Funding

Investment period

New Baseline

Use “Smart Investments” to Protect Readiness

Scenario I
Do Nothing
TOC $19.9B

Scenario II
Depot $ +up
TOC $21.9B

Scenario III
CIP/PRL/PPC $+up
TOC $19.9B

Scenario IV
II & III Scenario $+up
TOC $20.6B

Opportunity
Hidden Pipeline:
(No ROI metrics address it)

‘Pipeline’ is not available to the fleet

- Two Components
  - **Planned Pipeline**
    » Aircraft -- Typically 17 – 24%
  - ‘**Hidden’ Pipeline - result of declining materiel readiness**
    » Aircraft -- An additional 25%
    » Component -- As much as 200%+

- Pipeline is ‘absorbed’ by turn-around training squadrons
- We retain the entire inventory, but only a fraction is available

Eliminate the cost of NOT Flying
Recommendations

• Provide PEOs and Program Managers with the resource control and authority necessary to comply with SecNav Instruction 5400.15A and best business practices

• Exploit Naval Aviation as a Team
  – *Focus technology transition to implement RCM and reduce Total Ownership Cost*
  – *Immediately implement creative contracting arrangements to fully exploit NADEP and Industry capabilities (e.g. AVDLR)*
  – *Infuse System Engineering Discipline into Naval Aviation Sustainment Process*

• Implement ACARD “Proof-of-Concept” by POM-04

*SecNav, CNO and CMC verify implementation of recommendations by December 2002*
Benefits vs Cost

Aging Aircraft

Investment

Executive Ownership
Best Business Practices
Exploit as a Team
System Engineering
“Proof-of-Concept”
Appendix A
Previous NRAC Studies

November 1992 -- Science and Technology (Techbase Strategy for the Year 2010)
...organizational structure and the management processes of OCNR were intensively reviewed. The Panel concluded that the present organization is not well suited to the new paradigm for S&T and recommends that the CNR create a nearly seamless organization that has an integrated Planning and Assessment staff and a set of Program Directors, organized along the lines of the S&T customers, that manage funds from all three appropriations (6.1, 6.2, 6.3A).

October 1994 -- Naval Research and Development
...report recommends that the DON standup a single Warfare Systems Command that reports directly to the ASN (RD&A) and Chief of Naval Operations, in lieu of the current individual systems commands, creating a central focal point and advocate to address the long-term R&D/Material needs of the Navy.

November 1995 -- Life Cycle Cost Reduction
...the Panel soon found that although numerous opportunities existed for for S&T investment to beneficially impact LCC problems, the underlying problem was a lack of visibility and consideration of LCC implications of decisions made early in the requirements definition and concept development phases of programs where LCCs are largely determined. This general lack of visibility of LCCs was found to continue throughout the life of most systems.
...If allowed to continue, this situation will prevent the DON from re-capitalizing its force structure
...the Panel was unable to identify a [systematic] DON-wide process for reducing O&S costs. In addition to lack of timely availability of historic LCC data, the DON has little, if any, ability to predict future LCCs...

August 1996 -- Review of the Department of the Navy Science and Technology Program by NRAC Visiting Panel
...Federal policies regarding the governance of almost all Federal agencies impose excessive accountability and create employment and staffing obstacles to maintaining a strong S&T staff. The segmentation of R&D funding assignments within the Department of Defense into numerical categories (6.1, 6.2, ..., 6.7) leads to communication and administrative barriers that degrade effectiveness. These communication problems are especially serious between the DON S&T community (ONR, NRL) and the Fleet operations and requirement organizations (SYSCOMS and N091).
...The present process of converting technology into products and services for use by the DON takes far too long...
...One way to increase the pace of technology insertion is to make greater use of industry in all aspects of the development/procurement process, including exploratory development
Appendix A cont.
Previous NRAC Studies (cont.)

June 2001 -- Commercial Science and Technology Panel
...The magnitude of commercial R&D investment is significantly greater than that of the Department of Defense (DoD), and the disparity has been growing for years.
...The panel found that the commercial sector has a comprehensive technology plan and a willingness to share it openly. However, the DON’s ability to influence commercial technology development is minimal, if at all.
...the DON should adopt commercial products “as is” to keep up with certain technologies and save money. The panel also emphasized that the use of open architectures is essential for effective incorporation of the rapid changes in technology...
...The panel recommended that the ASN(RD&A) drive the adoption of commercial systems and establish a policy for exploiting commercial technology...
...The key elements of the recommended panel methodology are to: (1) identify product lines and/or technologies of interest to the DON that are led by the commercial sector; (2) understand those product lines and/or technologies with respect to DON requirements; (3) determine future commercial product stability and development strategy; and (4) incorporate commercial products into the DON investment strategy.

March 2001 -- Quality of Life Report
...Spare parts shortages (and resulting cannibalization from other equipment) underlie workplace dissatisfaction. How frequently and widely the problem of spare parts was mentioned was a real surprise to the panel. The reason for this focus is likely due to how the absence of spare parts demoralizes individuals with respect to their being able to perform their jobs.
...Conclusions – spare parts must be made available when needed
...Recommendations – fix the spare parts problem (SecNav) – aggressively seek opportunities to insert emerging technology into legacy... platforms... for reduction of workload, manning, and cost.. CNR focus technology programs to provide emphasis in this area. SYSCOMS develop criteria for technology insertion into legacy and new systems.
Appendix B

Linked Charts
Structural Repair

- Depots experiencing high level of major structural repair
  - *F-14 Engine rear support bulkhead*
  - *Components “hand manufactured” and not interchangeable*
  - *High manufacturing and Installation time*

Solution:
Leverage advanced manufacturing procedures available in industry

*Strategic Partnership – Attack the Cost of NOT Flying*
Aircraft Wiring

Problem:
- Naval environment is incompatible with long life expectations for wiring
  - Twists and turns
  - Salt water
  - Broken insulation / abuse
- Quickly becomes a safety issue
  - Arcing and Fire
  - Loss of function (including flight critical functions)

What we saw:
- New technology is available (e.g. arc fault circuit breaker, improved materials)
- Replacing wiring harnesses is very labor intensive (expensive)
- Wiring harnesses that are beyond reasonable life were being removed from CH-46’s to facilitate other repairs, rolled up and put back in (not replaced because it was not specified on the “service order”)

Solution: Empower the Workforce to do the RIGHT thing
CARRIER AIRWING IDTC READINESS
by Fiscal Year of Deployment

Days prior to Deployment

OpStat ‘C’ (Deployable)

OpStat ‘B’ (WorkUp)

OpStat ‘A’ (Deployed)

Days prior to Deployment

570 540 510 480 450 420 390 360 330 300 270 240 210 180 150 120 90 60 30

Deployed

Data Source: SORTS
Data Date: 15 OCT 00

Ref: OPNAVINST 5442.2G

Notional
MC/FMC Goal

OpStat ‘A’
(Deployed)

OpStat ‘B’
(WorkUp)

OpStat ‘A’
(Deployed)

FY96 Deployers

FY97 Deployers

FY98 Deployers

FY99 Deployers

FY00 Deployers

FY01 Deployers

NAVTRIT - “Readiness Improvement Team”
Aging Problem

Average Age Trend

Year

Age
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0

Air Force
Navy
Army
Commercial