

Bottom-Up Methods of Estimating Depot Level Repairables (DLR) Costs

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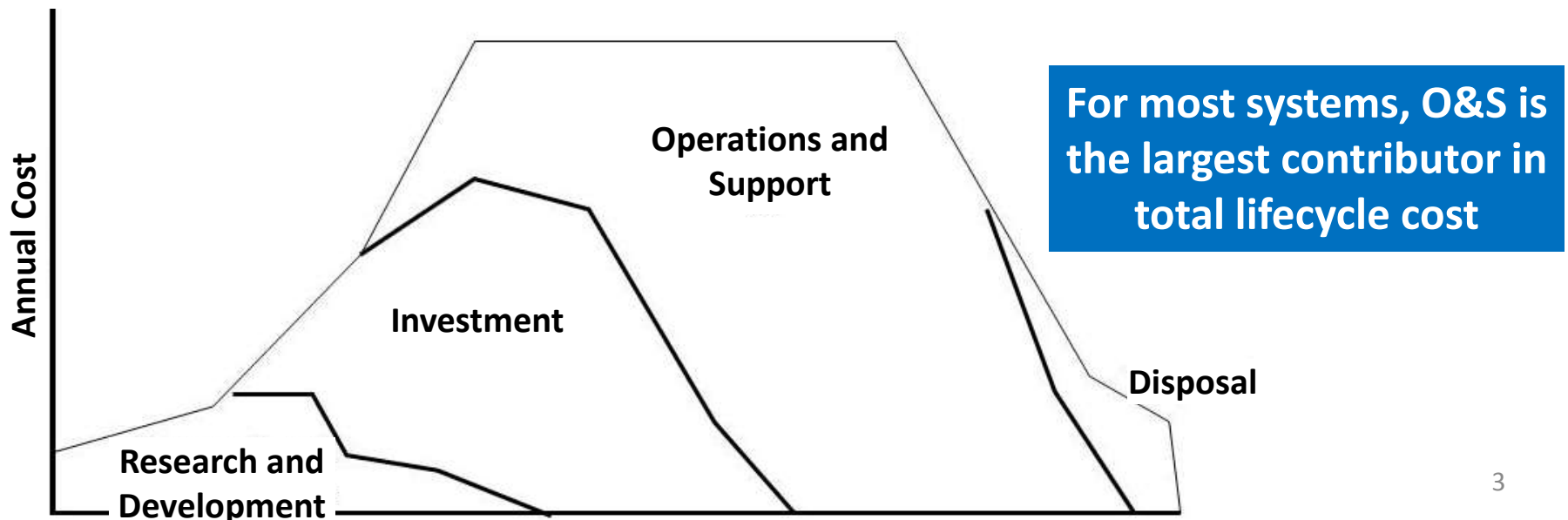
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Outline

- What is O&S?
- What is the typical DoD O&S WBS?
- What are Depot Level Repairables?
- Why Focus on DLRs?
- What is an LRU?
- When Do DLR Costs Begin?
- DLR Business Practices
- DLRs vs Depot Maintenance
- Initial Spares and DLR Carcass Attrition
- DLR Bottom-Up Estimating Methodology

What is DoD O&S?

- Per DoDI 5000.02, Jan 2015: “The purpose of the Operations and Support (O&S) Phase is to execute the product support strategy, satisfy materiel readiness and operational support performance requirements, and sustain the system over its life cycle (to include disposal).”
- Per OSD CAPE O&S Cost Estimating Guide, Mar 2014: “O&S consists of sustainment costs incurred from the initial system deployment through the end of system operations. Includes all costs of operating, maintaining, and supporting a fielded system. Specifically, this consists of the costs (organic and contractor) of personnel, equipment, supplies, software, and services associated with operating, modifying, maintaining, supplying, and otherwise supporting a system in the DoD inventory.”



What is the typical DoD O&S WBS?

- The typical work break down structure (WBS) used in DoD O&S cost estimating is found in the OSD CAPE O&S Cost Estimating Guide (Mar 2014):

Second-Level/Third-Level O&S Cost Estimating Structure

1. Unit-Level Manpower

- 1.1 Operations
- 1.2 Unit-Level Maintenance
- 1.3 Other Unit-Level

2. Unit Operations

- 2.1 Operating Material
- 2.2 Support Services
- 2.3 Temporary Duty
- 2.4 Transportation

3. Maintenance

- 3.1 Consumable Materials and Repair Parts
- 3.2 Depot Level Repairables
- 3.3 Intermediate Maintenance (External to Unit-Level)
- 3.4 Depot Maintenance
- 3.5 Other Maintenance

4. Sustaining Support

- 4.1 System Specific Training
- 4.2 Support Equipment Replacement and Repair

4.3 Sustaining/Systems Engineering

4.4 Program Management

4.5 Information Systems

4.6 Data and Technical Publications

4.7 Simulator Operations and Repair

4.8 Other Sustaining Support

5. Continuing System Improvements

5.1 Hardware Modifications

5.2 Software Maintenance

6. Indirect Support

6.1 Installation Support

6.2 Personnel Support

6.2.1 Personnel Administration

6.2.2 Personnel Benefits

6.2.3 Medical Support

6.3 General Training and Education

6.3.1 Recruit & Initial Officer Training

6.3.2 General Skill Training

6.3.3 Professional Military Education

What are Depot Level Repairables?

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“The DLR element captures the cost the operating unit incurs for DLR items used to maintain the primary system at the unit level. The cost includes direct labor and material for item repairs, attrition, as well as transportation, storage, inventory management, and overhead reflected in the Defense Working Capital Fund surcharge.”

Why Focus on DLRs?

- Along with unit-level personnel, sustaining systems engineering/program management, and software maintenance, Depot Level Repairables (DLRs) are often one of the cost driving elements of system estimates
- Bottom-up methodologies of estimating DLR costs are available and implementing them is an opportunity to improve estimate fidelity

What is an LRU ?

- LRU stands for Lowest Replaceable Unit
 - In the US Air Force, they are called Line Replaceable Units
 - In Naval Aviation, they are called Weapons Replaceable Assemblies, or WRAs
- LRUs and WRAs are the repairable units of a system that can be quickly removed and replaced on the end item by organizational level maintenance to minimize system down time
- Organizational level maintenance can perform limited repairs on LRUs, but, generally, repair is done at intermediate maintenance back shops or at depot
- If intermediate maintenance exists for the LRU, major subassemblies may be removed and replaced, and are called Shop Replaceable Units (SRUs) or within Naval Aviation, Shop Replaceable Assemblies (SRAs)

Failed LRUs and SRUs are turned in to the supply system and returned to the depot where they are repaired; hence the term “Depot Level Repairable” (DLR)

When Do DLR Costs Begin?

- Once systems are delivered to the fleet or field, LRUs can fail, which require depot repair
- In the first few years of fielding, the Original Equipment Manufacturer (OEM) performs depot repair at their production facility
 - Quantities of repairs are small enough to be managed by the contractor
 - Gives DoD time to assess if work volume would justify investment of standing an organic depot repair line, and if so, to what extent
 - These contractor performed depot repairs are called by the Navy Repair of Repairables and behave much like as DLRs, except they are funded with production dollars and are usually part of the acquisition program, not O&S
- If an organic depot is stood up, it starts performing depot repair on DLRs at the Navy Material Support Date (MSD)
 - MSD represents transfer of supply responsibility from contractor to DoD supply organization such as Naval Supply Command
 - From the MSD on, repairs are performed using O&M funds and are part of the O&S phase

DLR costs are formally incurred following MSD

DLR Business Practices

- DLR costs are incurred largely at the organizational level maintenance
 - When maintenance turns in a failed LRU to supply system, that organization is charged the LRU exchange price
 - Exchange Price = Repair Price + Supply Repair Surcharge
 - If maintenance does not have a failed LRU to turn in, that organization is charged the LRU standard price
 - Standard Price = New Procurement Price + Supply Procurement Surcharge
 - However, there are no DLR costs if maintenance removes an LRU, performs authorized repairs and returns it to service
- Note many LRUs turned in by maintenance to supply are not failed, but nonetheless are charged as DLR costs
 - Conversely, an LRU can fail and be returned to service without being turned into supply
 - The relationship between engineering failures and DLR costs has significant overlap, but they are not exactly the same thing

DLRs vs Depot Maintenance

- A source of confusion can be between OSD CAIG CES 3.2 Depot Level Repairables and CES 3.4 Depot Maintenance: What's the difference?
- As previously noted, CES 3.2 DLRs are the LRUs and SRUs of a fleet or field system turned into supply
- On the other hand, CES 3.4 Depot Maintenance is the induction of the system itself into depot for a major maintenance event
 - Depot maintenance occurs on end items such as ships, aircraft, vehicles, and some cases, jet engines
 - DLR failures can occur when end items are inducted at depot, although these are relatively rare occurrences

Initial Spares and DLR Carcass Attrition

- Initial Spares are part of the acquisition program acquired throughout production
- Carcass attrition units are new procurements to replace failed LRUs as part of the O&S phase when depot is unable to perform repair
 - Often rare event, not discretely estimated
 - Acquisition price of carcass attrition units is included in working capital fund supply surcharge in accordance with the DoD FMR

DLR Bottom-Up Estimating Methodology

- If specific LRU information is available for a system, the following methodology can be used:
- $\text{DLR Cost} = \# \text{ of LRU Failures} * \text{Exchange Price}$
 - $\# \text{ of LRU Failures} = \text{LRU Operating Hours per Year} / \text{LRU Mean Time Between Failure}$
 - $\text{Exchange Price} = \text{LRU Acquisition Unit Cost} * \text{Repair Cost Factor} * (1 + \text{supply system surcharge})$
- Thoughts on the above parameters:
 - Operating hours per year should be based on program technical baseline; e.g., flying hours, steaming hours, etc.
 - Mean Time Between Failure (MTBF) data based on MIL-HDBK-217 values
 - MTBF values from MIL-HDBK-217 represent laboratory-like environments and may not be reflective of fielded use
 - Use of MTBF values from MIL-HDBK-217 may require application of a “de-rating” factor to decrement values to represent fielded use
 - Repair cost factor based on commodity historical values, generally between 10% to 60% of the acquisition unit cost
 - Supply system surcharge based on published rates

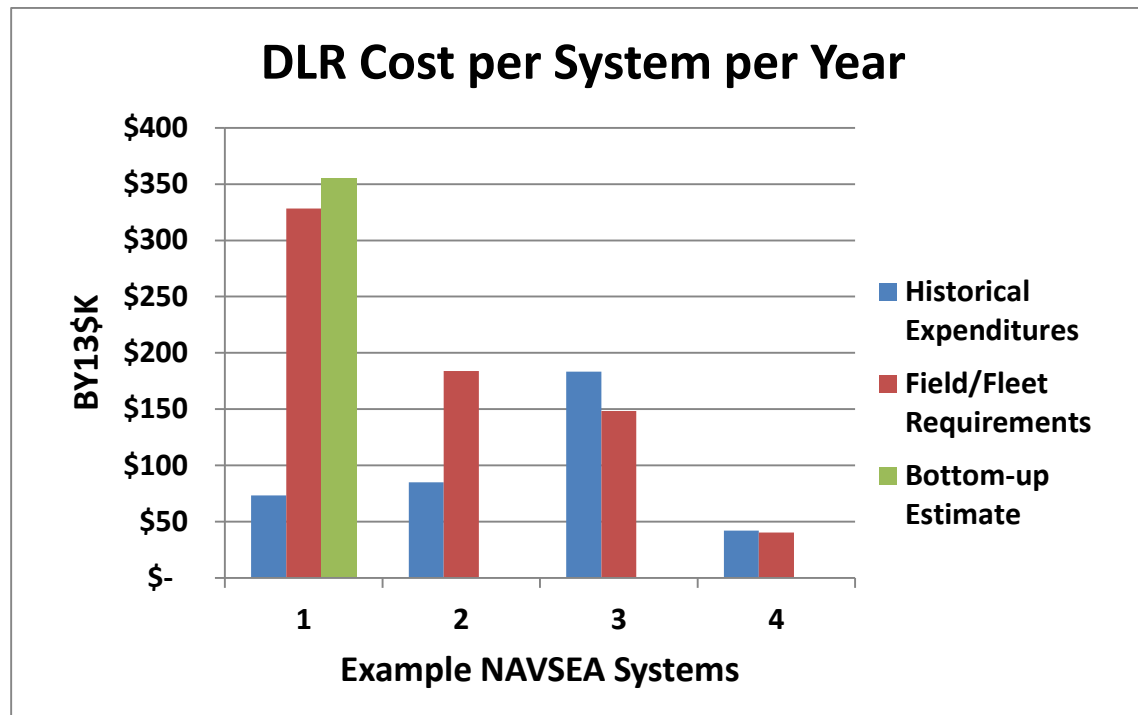
DLR Requisitions (Field/Fleet Requirements)

- If actual field or fleet requisitions are available:
- $\text{DLR Cost} = \text{Field or Fleet Requisitions} * \text{Exchange Price}$
 - Requisitions represent field or fleet requirements, as opposed to funded repairs, which tend to fluctuate based on budgets
 - Requisitions are the record of components received by supply system
 - Note: many components received are found to be properly functioning, but the field or fleet typically still pays the full repair price
 - Requisitions are recorded by National Item Identification Numbers (NIINs), the unique identifier for each item
 - Exchange price is repair cost burdened with supply system cost recovery rate/surcharge; exchange prices are available from:
 - IHS Haystack Gold, subscription required
 - Federal Logistics Data (FED LOG), available to DoD personnel through Defense Logistics Information Service

Approach is useful when actual requisitions are available

Comparing: Expenditures, Requirements, & Bottom-up Estimates

- A comparison of the following DLR costs per system per year follows below:
 - Historical Expenditures: DoD maintains databases of O&S expenditures, including DLRs, called the Visibility and Management of Operating and Support Costs (VAMOSOC)
 - Field/Fleet Requirements: DLR system actual costs based on requisitions (Field or Fleet Requisitions * Exchange Price)
 - Bottom-up Estimate: DLR bottom-up estimating methodology (# of LRU Failures * Exchange Price)



Recommended Future Research

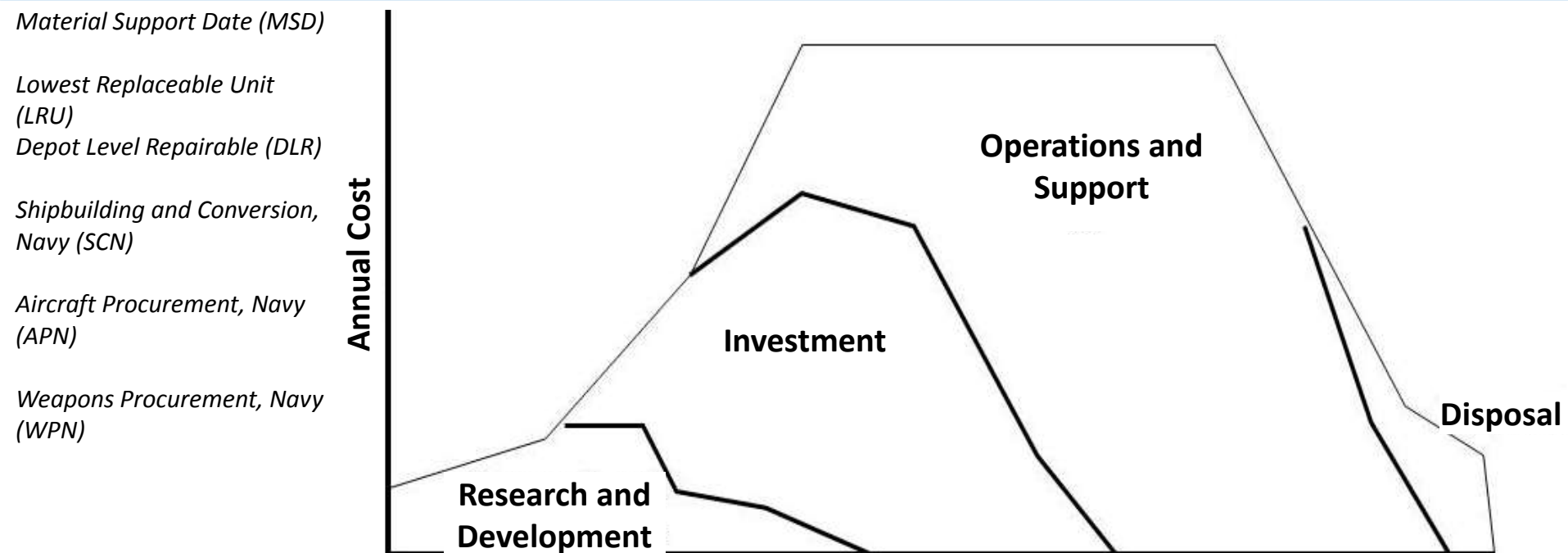
- Reliability
 - Develop derating factors based on outcomes of reliability predictions
 - Allows tuning of factors to specific commodities and environments
 - Collection of enough historic data forms library from which reliability probability distributions may be created
- Acquisition-to-Repair ratio CER
 - NAVAIR developed commodity curves and later, bins to select appropriate CER
 - Recommend global collection of LRU repair and acquisition prices from supply centers to develop CER library
- Examine why differences exist between requisition-based actual DLR costs and expenditures reported in VAMOSC

Acknowledgments

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 - Ms. Jocelyn Tague of Herren Associates

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- **BACKUP**

Navy Sparing & Repairables Concept



Repair of repairables vs Depot level repairables



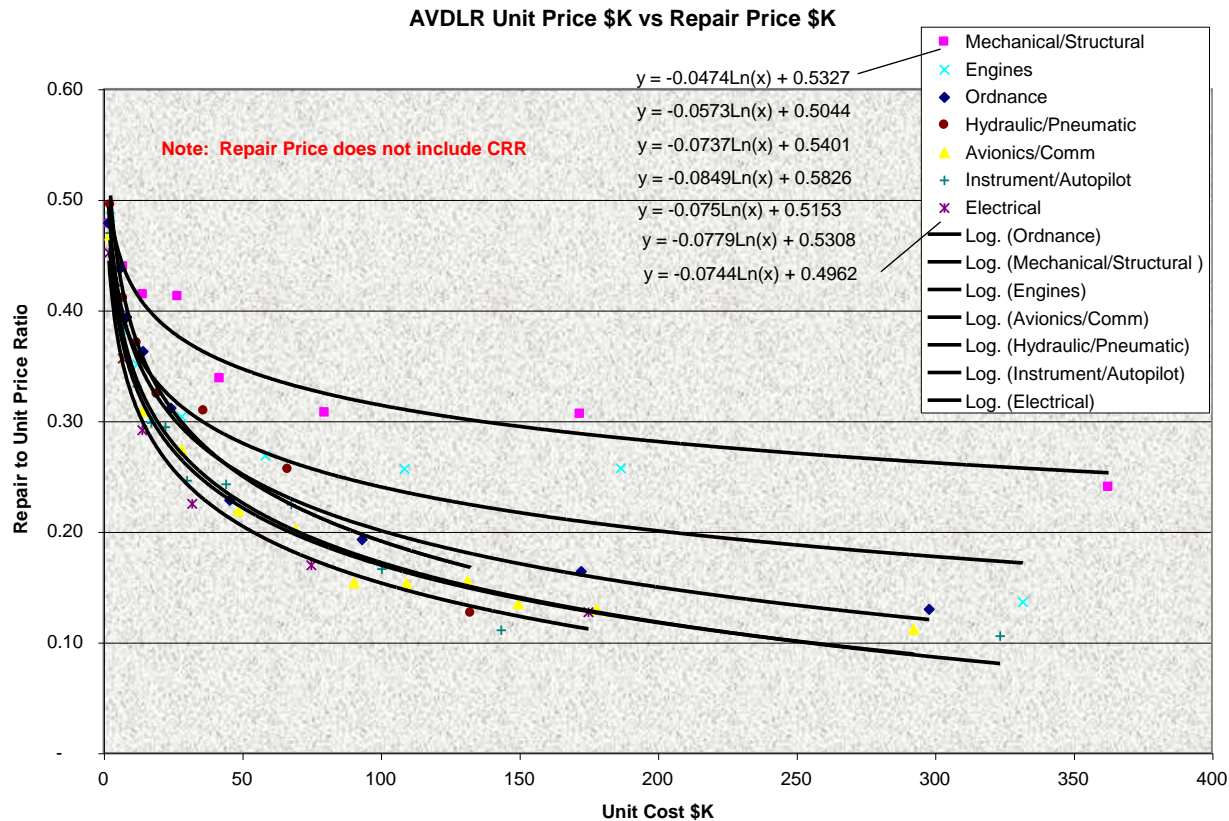
Acquisition vs sustainment



What \$ for initial spares?



AVDLR Handbook: Ratio of Acquisition Unit Price to Repair Price



- Per NAVAIR 4.2 AVDLR Handbook

NAVSUP Cost Recovery Rates aka Surcharges

Historical Budgeted Cost Recovery Rates

	<u>FY92</u>	<u>FY93</u>	<u>FY94</u>	<u>FY95</u>	<u>FY96</u>	<u>FY97</u>	<u>FY98</u>	<u>FY99</u>	<u>FY00</u>	<u>FY01</u>
BP 14 Ship Consumables	26.9%	34.6%	51.8%	58.1%	13.5%	20.0%	48.7%	47.1%	32.1%	36.3%
BP 34 Aviation Consumables	39.2%	46.5%	13.5%	47.9%	13.2%	29.0%	73.7%	43.8%	13.4%	26.3%
BP 81 Procurement (Std)	23.8%	33.4%	56.1%	62.7%	17.8%	34.2%	68.2%	50.2%	33.1%	33.4%
BP 81 Repair (Net)	21.9%	30.0%	51.0%	48.3%	3.4%	17.2%	46.9%	34.5%	12.0%	26.9%
BP 85 Procurement (Std)	7.6%	16.6%	22.0%	56.6%	23.8%	27.6%	55.7%	47.8%	37.7%	36.7%
BP 85 Repair (Net)	25.1%	30.2%	20.2%	36.2%	14.5%	27.9%	56.2%	42.8%	22.6%	20.4%
Composite CRR	22.6%	31.1%	29.5%	48.1%	14.0%	27.4%	57.5%	44.3%	25.3%	26.2%
	<u>FY02</u>	<u>FY03</u>	<u>FY04</u>	<u>FY05</u>	<u>FY06</u>	<u>FY07</u>	<u>FY08</u>	<u>FY09</u>	<u>FY10</u>	<u>FY11</u>
BP 14 Ship Consumables	12.7%	23.0%	now part of BP81 Procurement							
BP 34 Aviation Consumables	8.1%	20.2%	19.5%	16.1%	11.5%	10.0%	13.6%	13.2%	11.0%	14.3%
BP 81 Procurement (Std)	30.3%	45.4%	29.8%	23.4%	21.7%	18.9%	20.8%	16.6%	14.7%	17.7%
BP 81 Repair (Net)	15.7%	24.2%	18.4%	16.7%	19.1%	16.8%	18.1%	19.7%	20.0%	22.1%
BP 85 Procurement (Std)	29.1%	35.4%	47.6%	28.0%	43.8%	42.9%	39.9%	45.9%	47.2%	54.4%
BP 85 Repair (Net)	9.3%	21.3%	16.4%	12.2%	9.8%	6.5%	9.4%	8.2%	6.7%	7.6%
Composite CRR	15.5%	25.5%	22.5%	15.7%	16.4%	13.8%	15.4%	15.1%	13.3%	15.2%

Don't Forget..

- As with any cost risk analysis, make sure to assign correlation between each distribution