A large cargo airplane is parked on a tarmac with its front cargo door open. The door is open, revealing the interior of the cargo compartment. A white truck is parked next to the airplane, and a white truck is parked in the foreground. The sky is blue with some clouds. The text "A COST-BENEFIT ANALYSIS FOR THE INSTALLATION OF FIRE SUPPRESSION SYSTEMS IN CARGO COMPARTMENTS OF CARGO AIRPLANES" is overlaid on the image in yellow, bold, sans-serif font. The text is arranged in six lines, centered horizontally. The background shows the tarmac, the airplane, and the sky.

**A COST-BENEFIT ANALYSIS  
FOR THE INSTALLATION OF  
FIRE SUPPRESSION SYSTEMS  
IN CARGO COMPARTMENTS  
OF CARGO AIRPLANES**

# Freighter Cost Benefit Analysis

**We would like to thank**

***The U.S. Federal Aviation Administration and  
the U.K. CAA***

**for giving us the opportunity to work  
on this interesting project**

# Freighter Cost Benefit Analysis

- ✓ **The NTSB recommended that fire suppression systems be installed in the cargo compartments of all cargo airplanes operating under 14 CFR Part 121.**
- ✓ **Currently, Class E cargo compartments, which are the primary cargo compartment type used in US cargo airplanes, do not require fire suppression systems.**

# Freighter Cost Benefit Analysis

- ✓ In response to this recommendation, FAA has requested that a cost/benefit analysis be carried out relating to the installation of on-board fire detection and extinguishment systems in cargo airplanes.

# Freighter Cost Benefit Analysis

- ✓ The analysis assessed whether fire suppression systems, fitted to the upper deck cargo bays of cargo airplanes, type certificated to FAR Part 25 and operating under FAR Part 121, are likely to be cost beneficial.

# Freighter Cost Benefit Analysis

**Analysis carried out for aircraft types grouped into weight categories**

<b>WEIGHT CATEGORY</b>	<b>AIRCRAFT MAXIMUM TAKE-OFF WEIGHT</b>
<b>B</b>	<b>12,500 lb to 100,000 lb</b>
<b>C</b>	<b>100,000 lb to 250,000 lb</b>
<b>D</b>	<b>250,000 lb to 400,000 lb</b>
<b>E</b>	<b>Greater than 400,000 lb</b>

# Freighter Cost Benefit Analysis

Potential benefits will result from a reduction in:

- ✓ Injuries (Fatal and Serious)
- ✓ Damage incurred to the aircraft and its cargo, and
- ✓ Damage that might be incurred to property on the ground.



# Freighter Cost Benefit Analysis

Potential costs are those incurred from:

- ✓ **System Installation**
- ✓ **Operation (Fuel Burn, Maintenance, etc.)**



# Freighter Cost Benefit Analysis

## Benefit Analysis based on:

- ✓ Monte Carlo model
- ✓ Statistical distributions derived from data on in-service airplanes and accident information.

# Freighter Cost Benefit Analysis

The Monte Carlo model was based on the following Benefit equation:

$$\frac{\textit{Benefit}}{\textit{Year}} = \frac{\textit{Accidents}}{\textit{RTM}} \times \frac{\textit{RTM}}{\textit{Year}} \times \frac{\textit{Cost}}{\textit{Accident}}$$

**RTM = Revenue Ton Miles**

# Freighter Cost Benefit Analysis

**Accident Rate (Accidents per RTM)  
based on US cargo fleet experience  
over the period 1967 to 2007:**

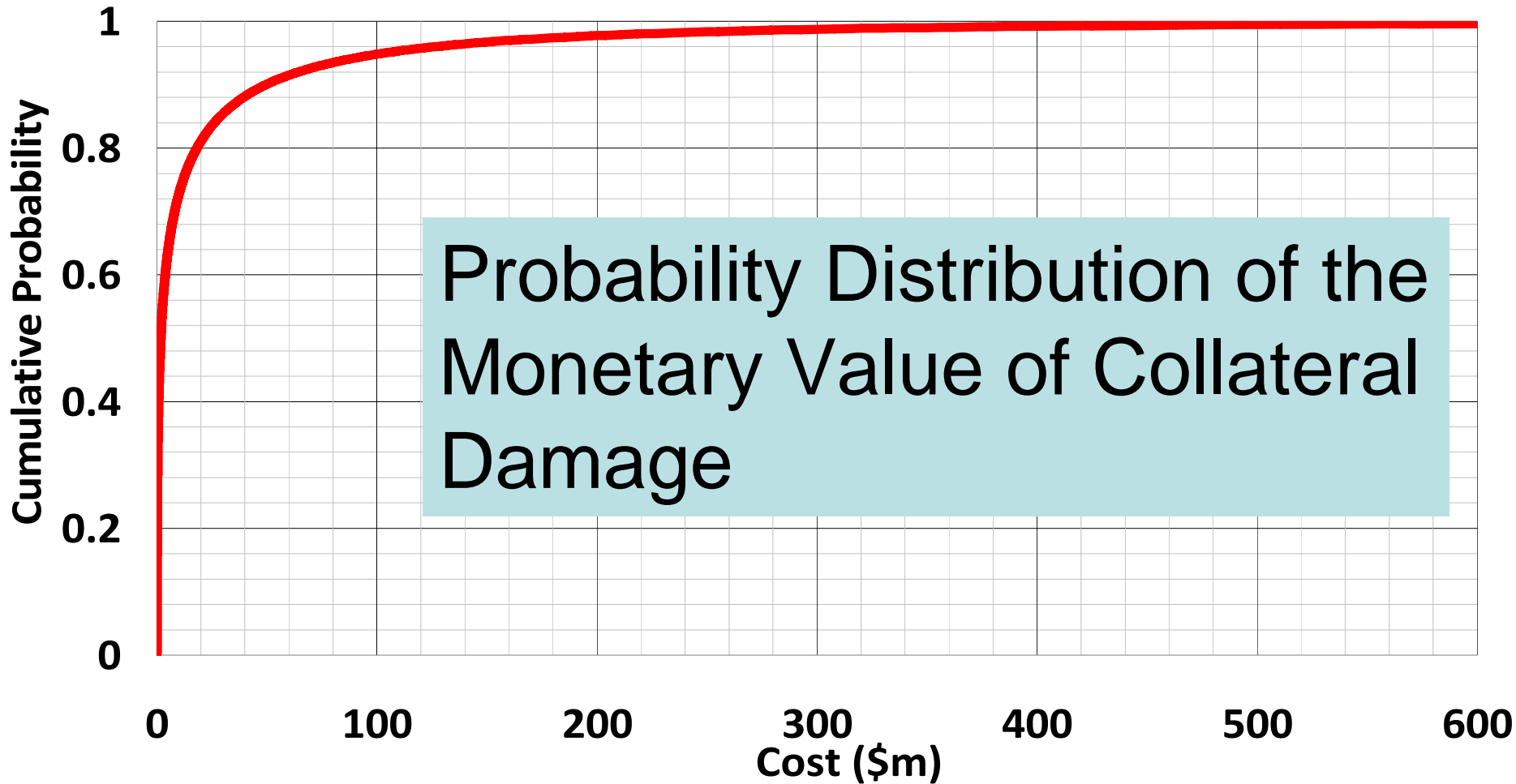
- ✓ Four accidents caused by cargo compartment fires
- ✓ Approximately 545,200,000,000 Revenue Ton Miles

# Freighter Cost Benefit Analysis

## Cost of Collateral Damage

**Based on an analysis of accident data it was assessed that approximately one in eighteen freighter aircraft fire accidents are likely to result in some degree of Collateral Damage.**

# Freighter Cost Benefit Analysis



# Freighter Cost Benefit Analysis

## Cost Assessments based on:

- The new Type F Cargo Compartment (considered for combi aircraft) using a Halon type fire suppression system together with suitable cargo compartment liners. The data used in the cost assessment was based on that contained in the ARAC document relating to main deck class B cargo compartments.



  
cargolux

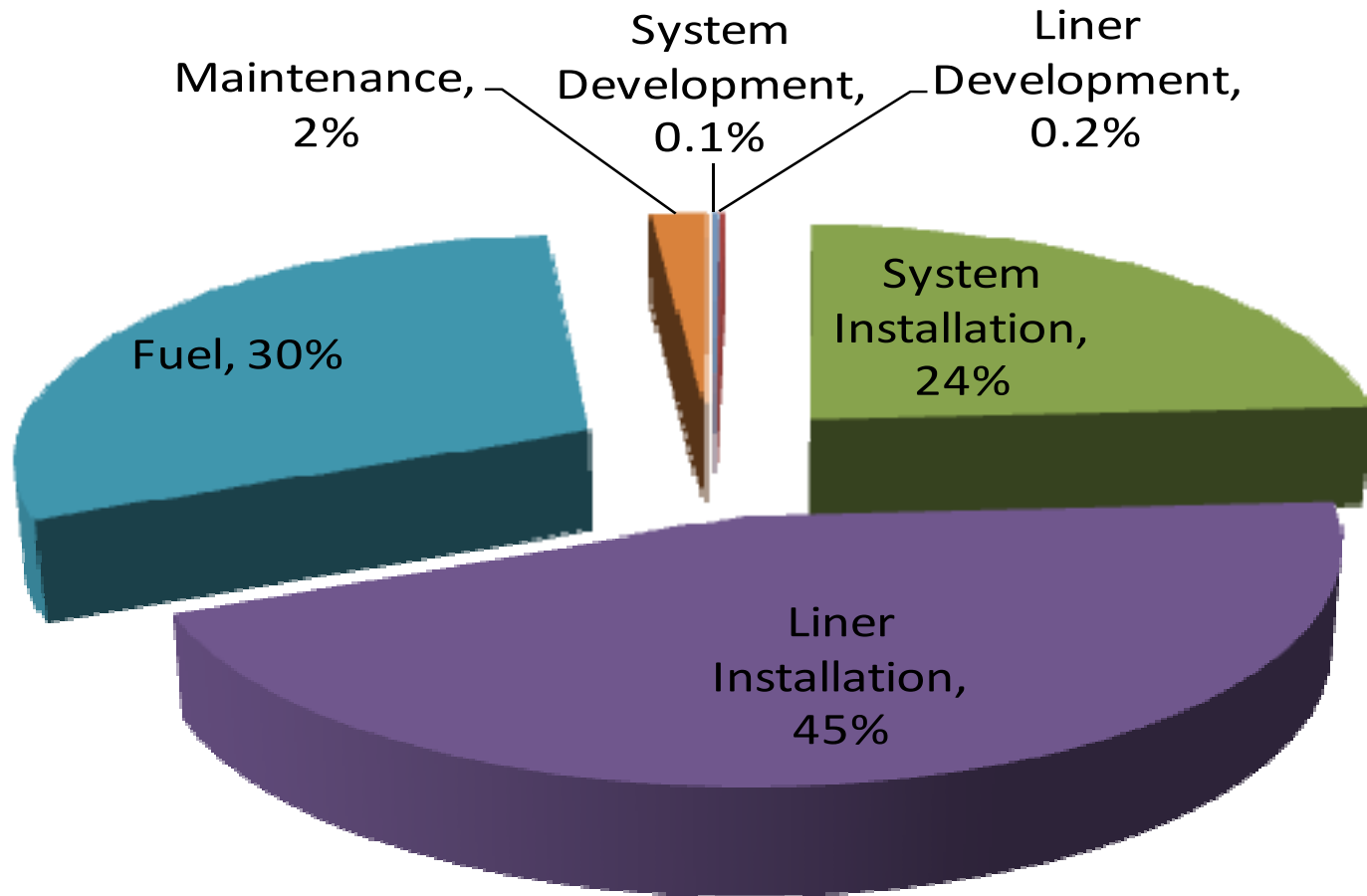
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# Conclusions - Costs

# Freighter Cost Benefit Analysis

## Conclusions: Cost



# Freighter Cost Benefit Analysis

## Conclusions: Cost

<b>Weight Category</b>	<b>Total Cost per Aircraft per Year</b>
<b>B</b>	<b>\$50,791</b>
<b>C</b>	<b>\$156,053</b>
<b>D</b>	<b>\$290,182</b>
<b>E</b>	<b>\$446,008</b>

# **Conclusions - Benefits**

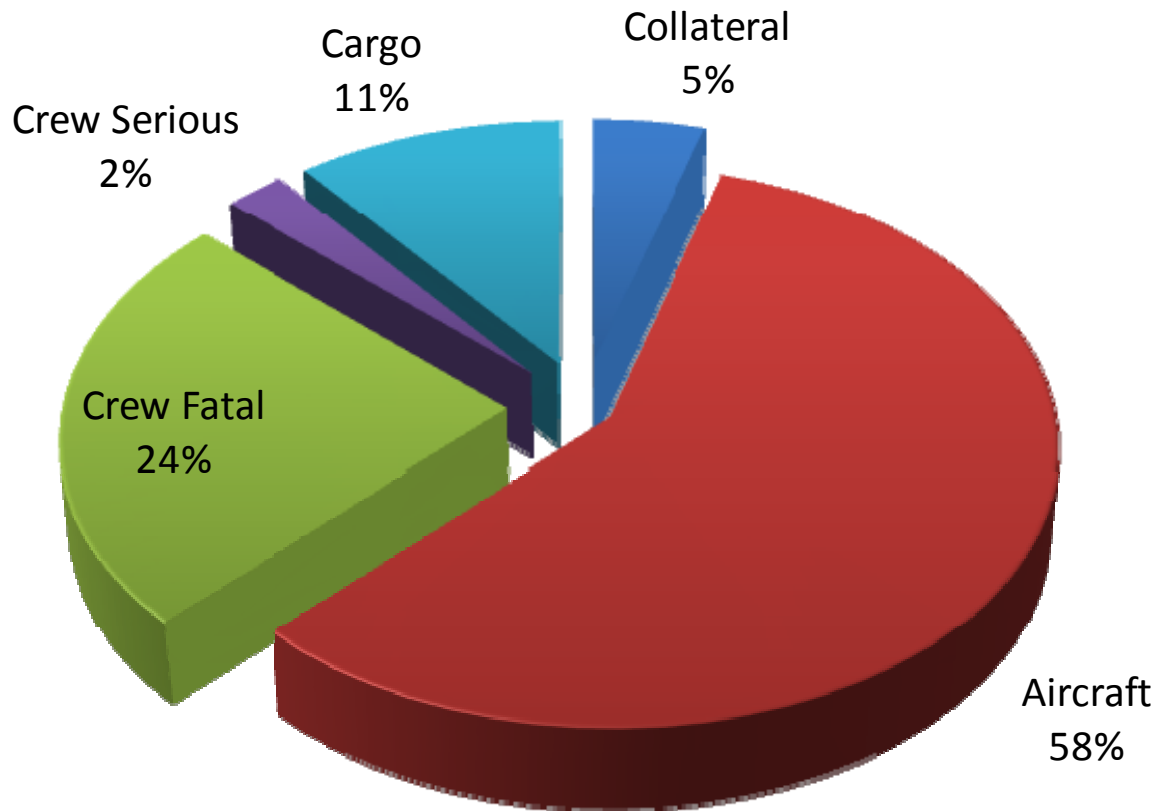
# Freighter Cost Benefit Analysis

## Conclusions: Benefit

- ✓ **Collateral damage costs do not appear to contribute significantly to the prediction of benefit.**
- ✓ **Crew injuries (fatal and serious combined) are a significant factor in the prediction of benefit.**
- ✓ **Aircraft value is the largest contributor to the prediction of benefit.**

# Freighter Cost Benefit Analysis

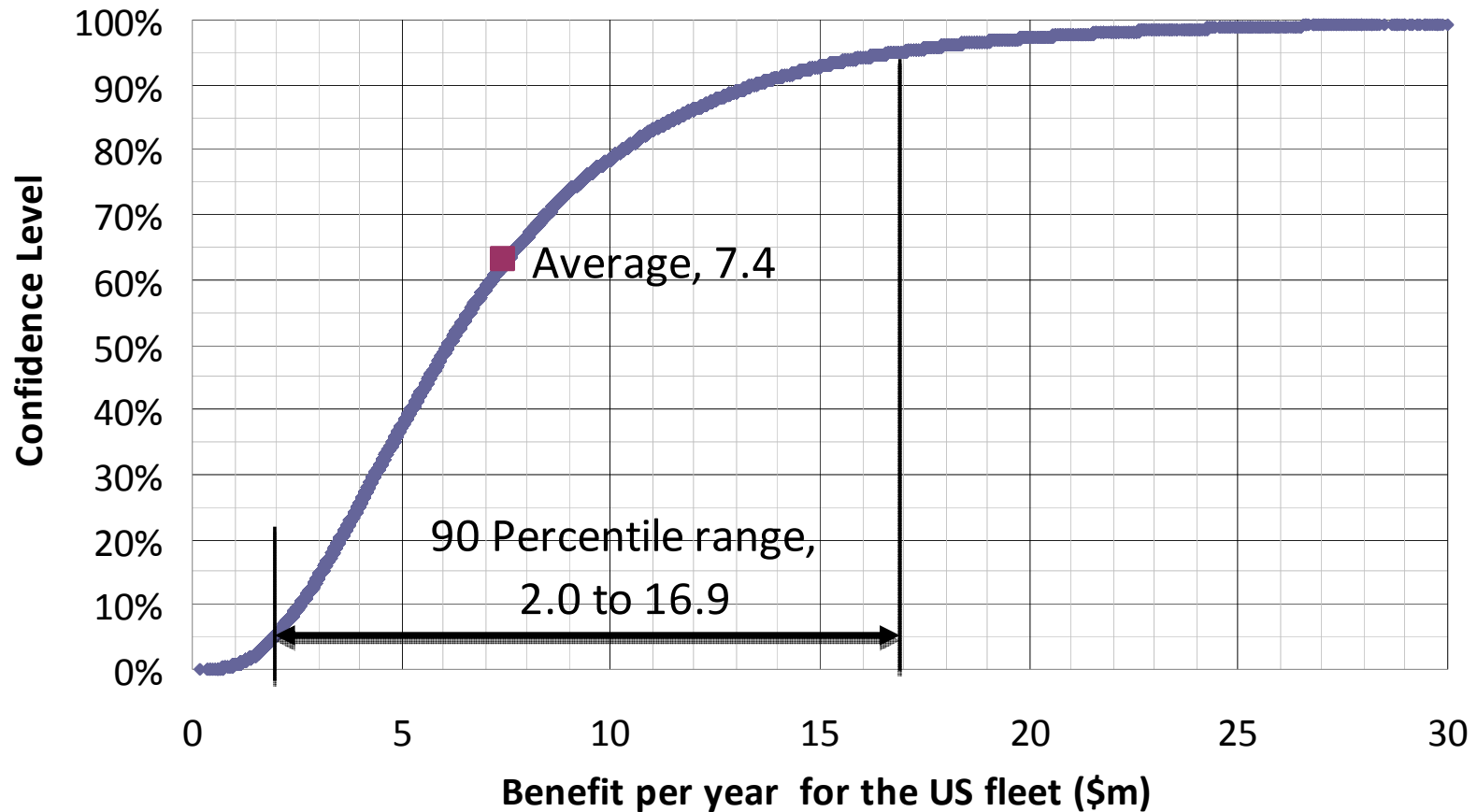
## Conclusions Cost Breakdown:



1715\\Model\\Issue 2 - Summary of Results.xlsx

# Freighter Cost Benefit Analysis

## Conclusions: Benefit



1715\\Model\\Issue 2 - Summary of Results.xls



# Freighter Cost Benefit Analysis

## Conclusions: Benefit

<b>WEIGHT CATEGORY</b>	<b>BENEFIT</b>
<b>B</b>	<b>NEGLIGIBLE</b>
<b>C</b>	<b>\$640</b>
<b>D</b>	<b>\$4,100</b>
<b>E</b>	<b>\$19,900</b>

# Freighter Cost Benefit Analysis

## Conclusions: Cost v Benefit

<b>Weight Category</b>	<b>Average Benefit per Aircraft per Year</b>	<b>Total Cost per Aircraft per Year</b>	<b>Cost Benefit Ratio</b>
<b>B</b>	<b>NEGLIGIBLE</b>	<b>\$50,791</b>	<b>N/A</b>
<b>C</b>	<b>\$640</b>	<b>\$156,053</b>	<b>244</b>
<b>D</b>	<b>\$4,100</b>	<b>\$290,182</b>	<b>71</b>
<b>E</b>	<b>\$19,900</b>	<b>\$446,008</b>	<b>22</b>

# Freighter Cost Benefit Analysis

## Conclusions:

- ✓ **Halon fire suppression systems, or alternatives that are likely to be developed for below floor cargo compartments, are unlikely to be cost beneficial for the main deck cargo compartments of cargo aircraft of any weight category.**

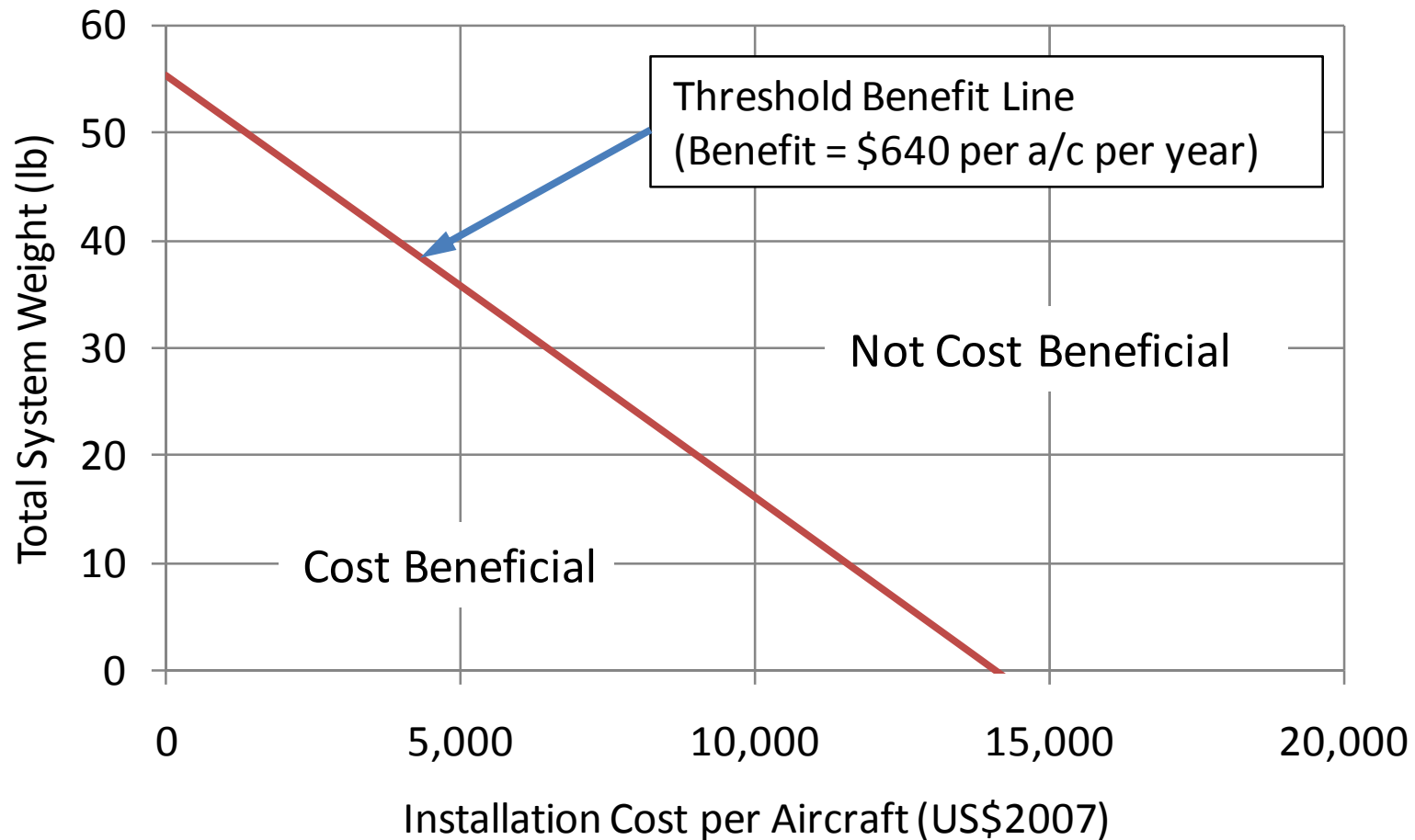
# Freighter Cost Benefit Analysis

## Conclusions:

- ✓ However, other fire suppression systems may prove to be cost beneficial.

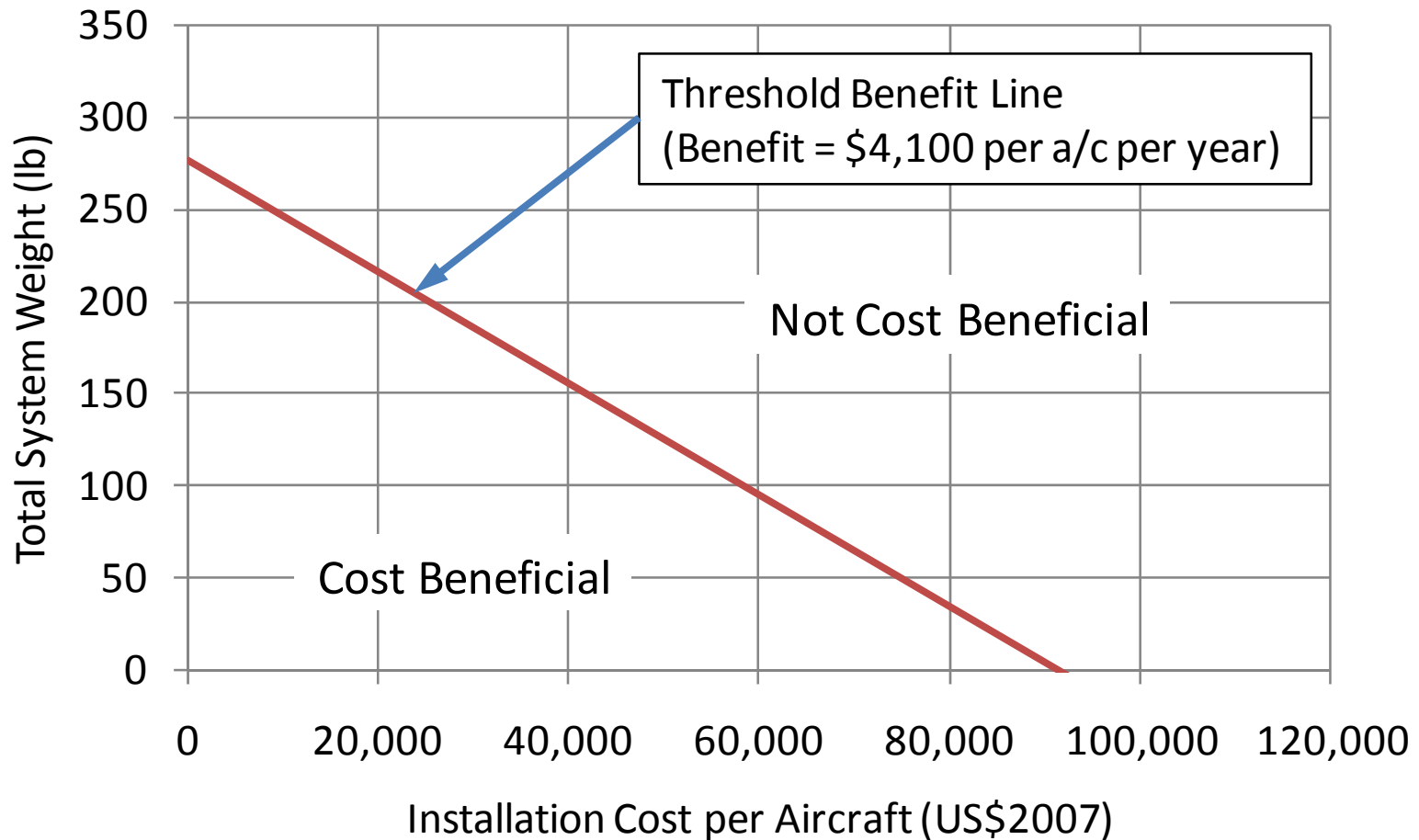
# Freighter Cost Benefit Analysis

## Conclusions: Weight Category C:



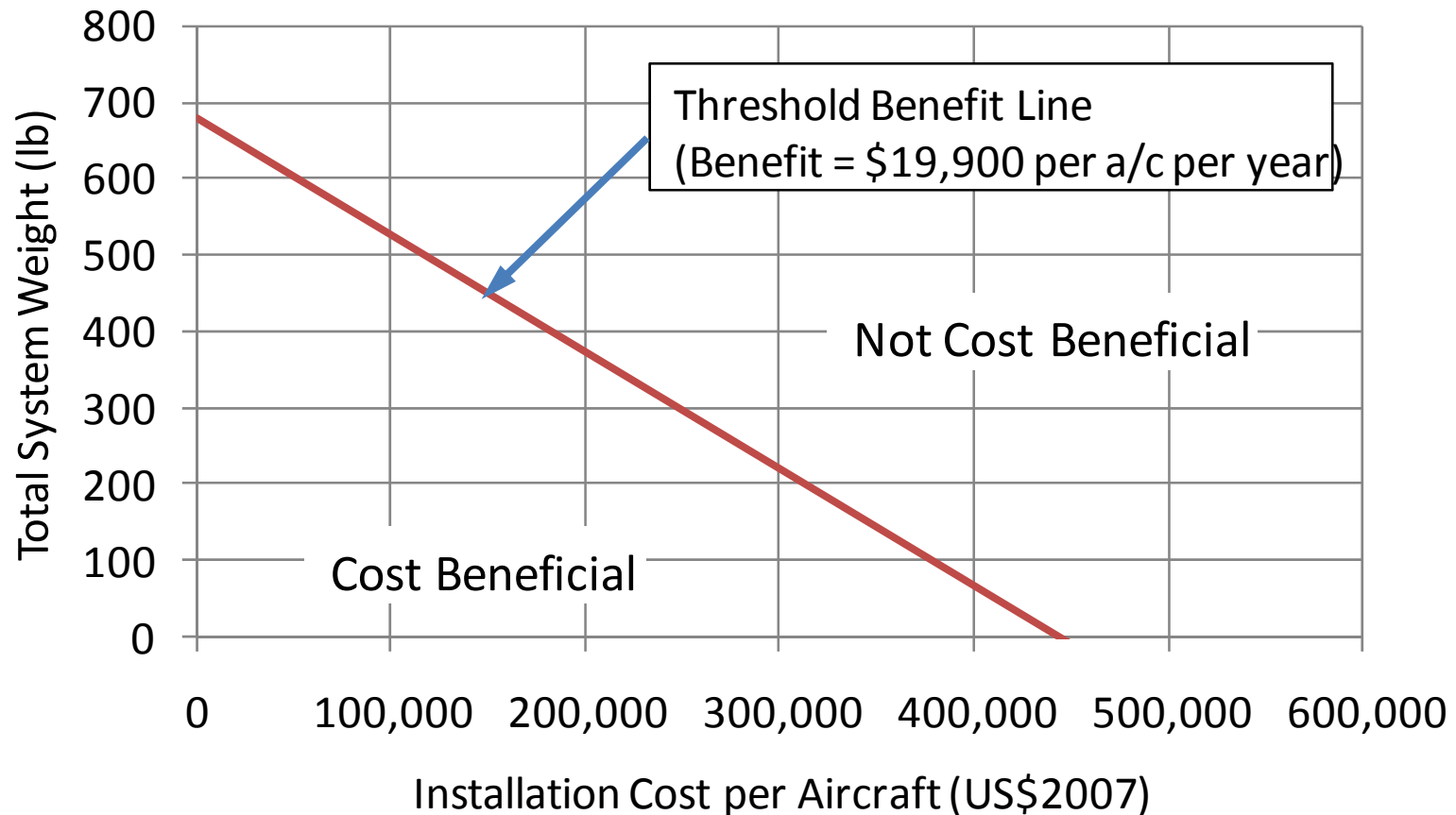
# Freighter Cost Benefit Analysis

## Conclusions: Weight Category D:



# Freighter Cost Benefit Analysis

## Conclusions: Weight Category E:





# Freighter Cost Benefit Analysis

## The Report:

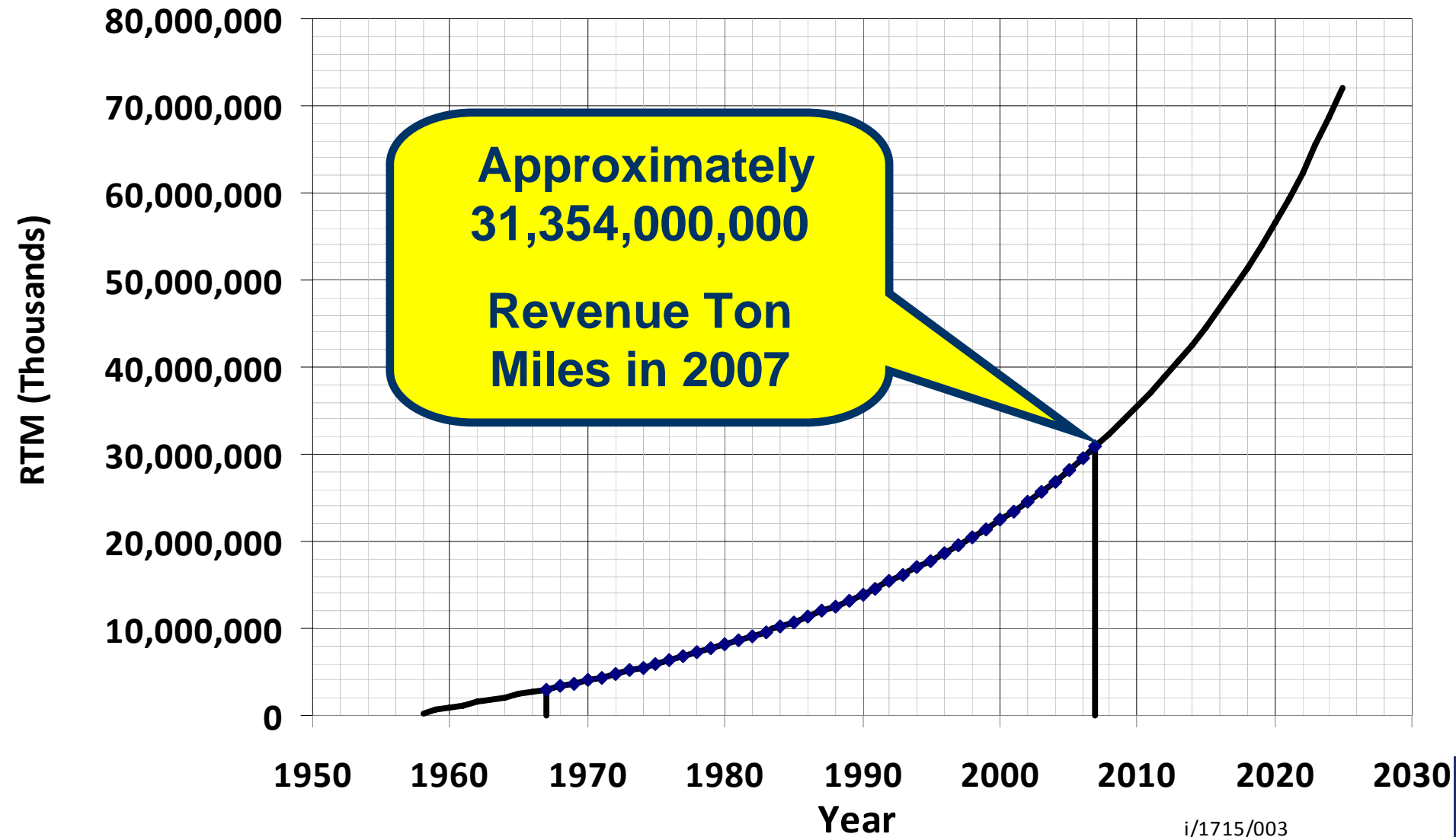
**DOT/FAA/AR-09/17 “A Cost-benefit Analysis For The Installation Of Fire Suppression Systems In Cargo Compartments Of Cargo Airplanes”**

may be obtained from the FAA website

**<http://www.fire.tc.faa.gov/pdf/09-7.pdf>**

**Thank you**  
**Any Questions?**

# Freighter Cost Benefit Analysis

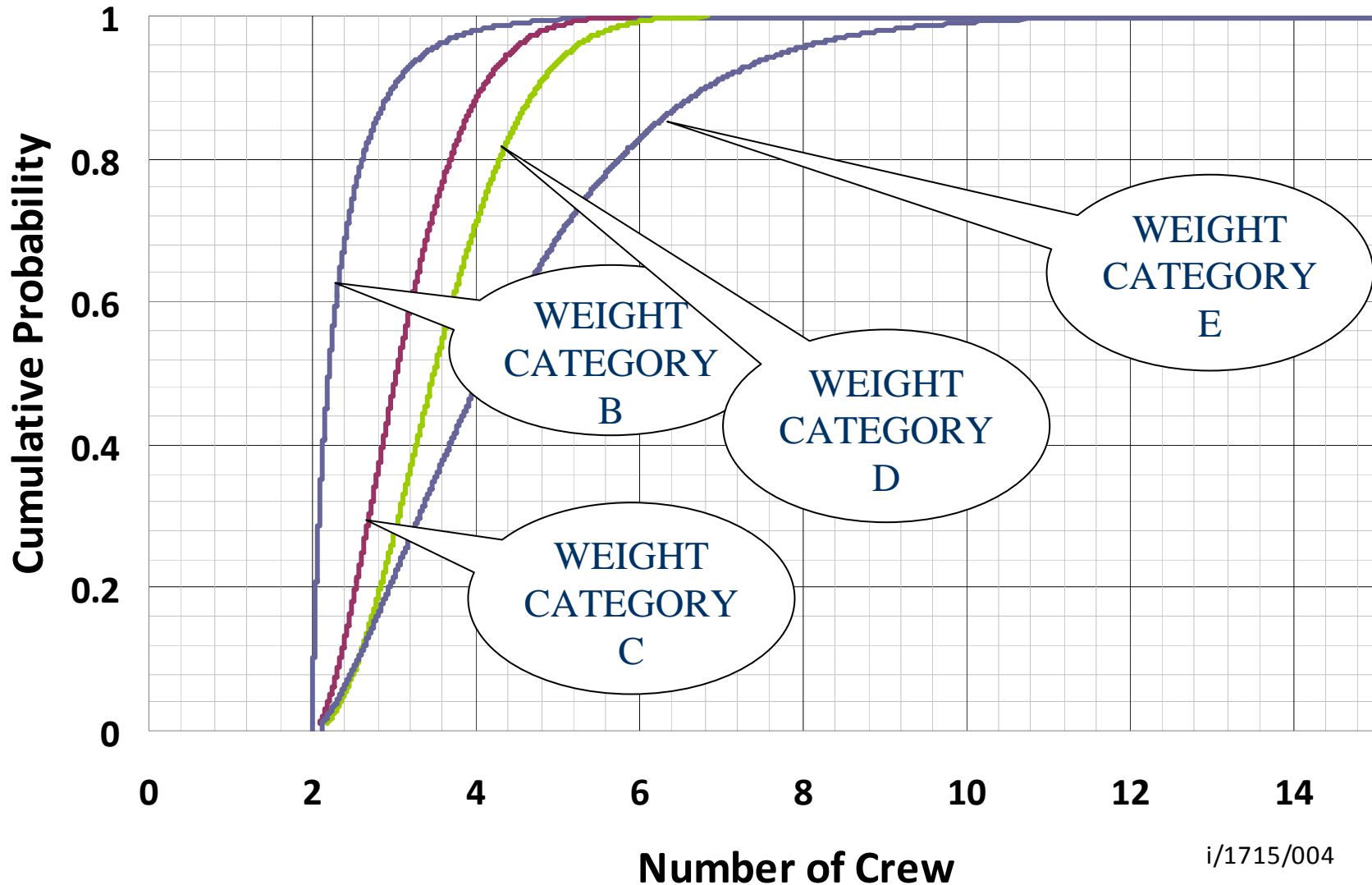


# Freighter Cost Benefit Analysis

## Assessed Number of Revenue Ton Miles for 2007 :

WEIGHT CATEGORY	REVENUE TON MILES (2007)
B	13,500,000
C	1,764,400,000
D	6,107,900,000
E	23,468,600,000

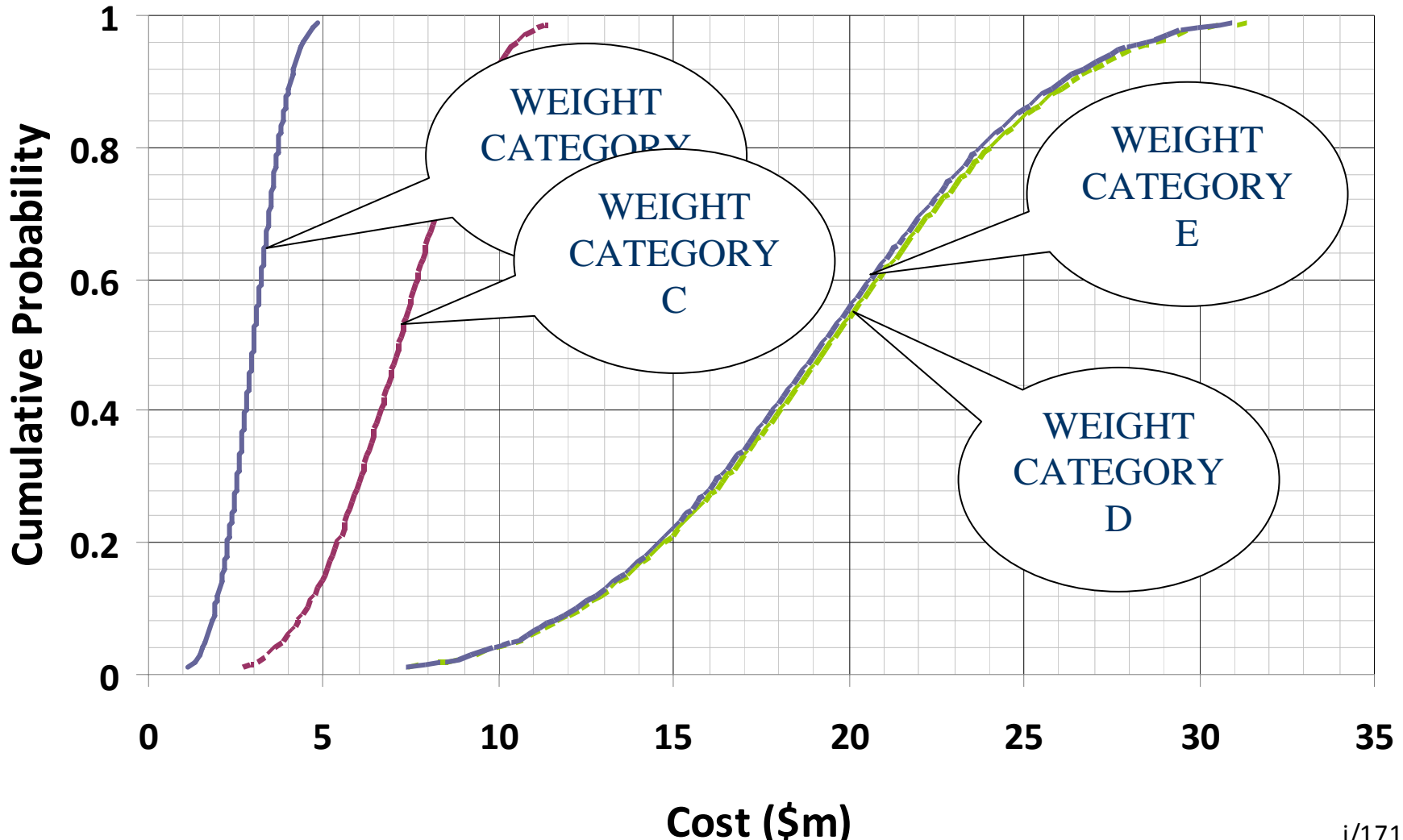
# Freighter Cost Benefit Analysis



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# Freighter Cost Benefit Analysis

## Aircraft Value



# Freighter Cost Benefit Analysis

Assessed Average Cargo Value per flight for US Cargo Fleet 2007:

<b>WEIGHT CATEGORY</b>	<b>CARGO VALUE (\$ MILLIONS 2007)</b>
<b>B</b>	<b>0.14</b>
<b>C</b>	<b>1.1</b>
<b>D</b>	<b>2.6</b>
<b>E</b>	<b>4.1</b>

# Freighter Cost Benefit Analysis

## Cost per Accident based on:

### Primary Damage

- Crew Injuries (Fatal and Serious)
- Damage incurred to the aircraft and its cargo, and
  
- Damage that might be incurred to property
- Personnel Injuries (Fatal and Serious)