



# *The IGQ Aeroconical Parachute and Ribbon Drogue for F-35 JSF*

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## *Objective*

- ◆ Present the Capabilities of the :-  
IGQ Aeroconical Parachute  
IGQ Ribbon Parachute
- ◆ Outline their advantages to the Ejection Seat System designers.
- ◆ Show the advantages of the escape system to the user.



## *Background*

- ◆ There have been many advances in the science of Ejection Seat Escape systems.
- ◆ The parachute has an important part to play in surviving an escape.
- ◆ Many systems use 30 year old designs of parachute and deployment systems.
- ◆ Select and Deselect steering required
- ◆ Training Required to optimize advantages



# *System Advantages*

## *Parachute Design Engineer*

### *Goals*

- ◆ To simplify the design of other aspects of the Escape system.
- ◆ Reduce sensitivity to deployment conditions.
- ◆ Improve Escape window.
- ◆ Embody the advances in modern Technologies and materials.



# *System Advantages*

## *Parachute Design Engineer Goals*

- ◆ Provide timely, repeatable and consistent lines first parachute openings reducing:
  - ◆ The likelihood of Malfunction
  - ◆ The random scatter of openings



## *Parachute System Requirements*

- ◆ Single use Item.
- ◆ Simplify the Escape System.
- ◆ Simplify the Parachute System.
- ◆ Improve Tolerance to variations in use.



## *Main Parachute Wish List*

- ◆ Instant Maximum deceleration
  - Regardless of speed and height
  - within acceptable physiological limits
  - for the duration required to achieve  $V_t$
- ◆ 1g exactly for flight duration
  - No oscillation
  - Self steering to avoid obstacles
- ◆ Soft zero approach speed landings



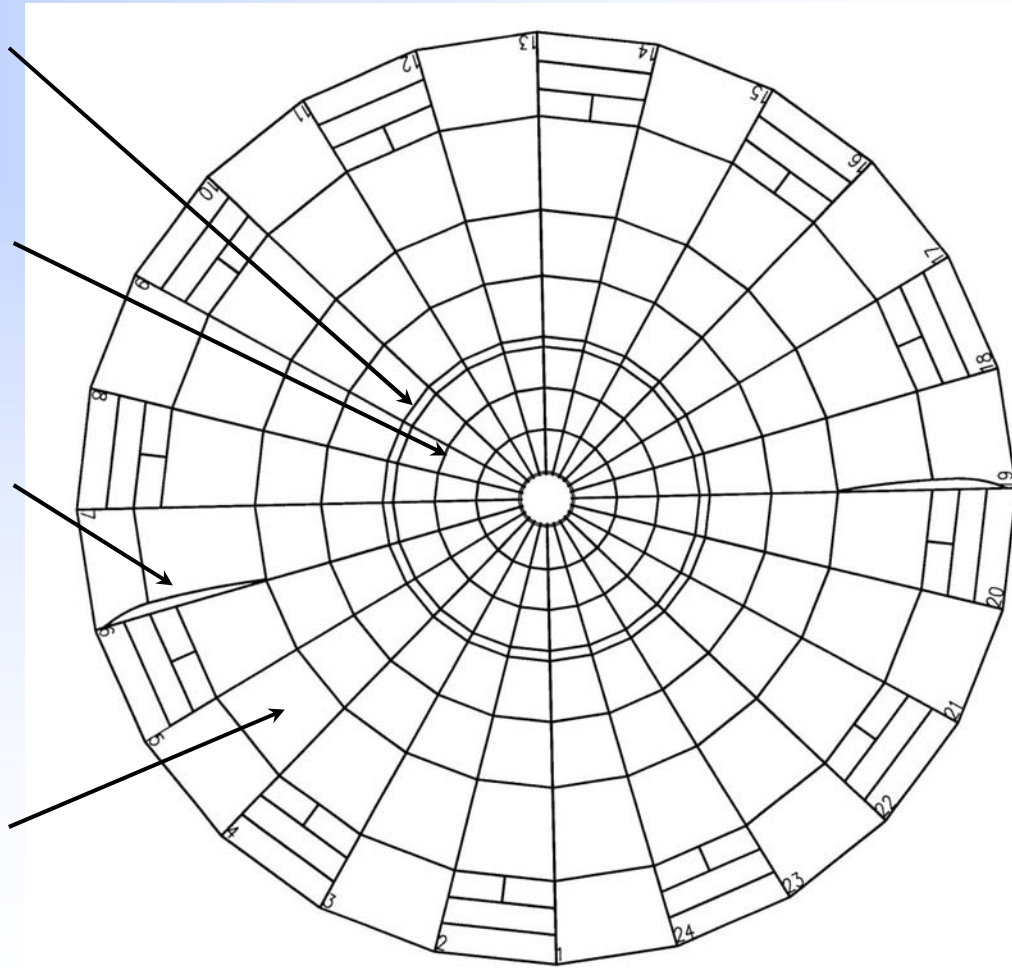
# *The IGQ Aeroconical Parachute*

Inflation Control  
Band

Low Permeability  
Crown

LeMoigne Slot

Medium Permeability  
Lower Canopy





## *LIMIT Technology*

- ◆ The IGQ Aeroconical Parachutes prevent excessive opening loads.
- ◆ Open in “fast” mode at low speed
- ◆ Open in “slow” mode at high Speed



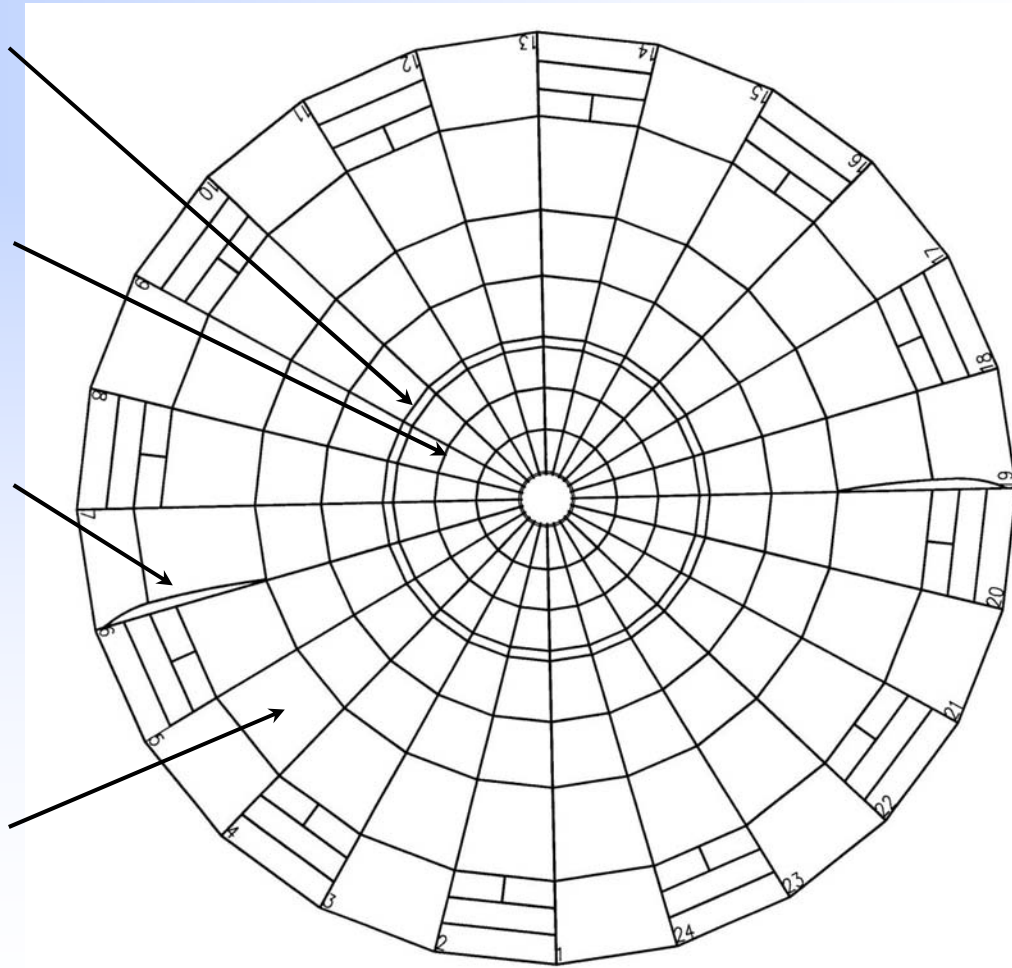
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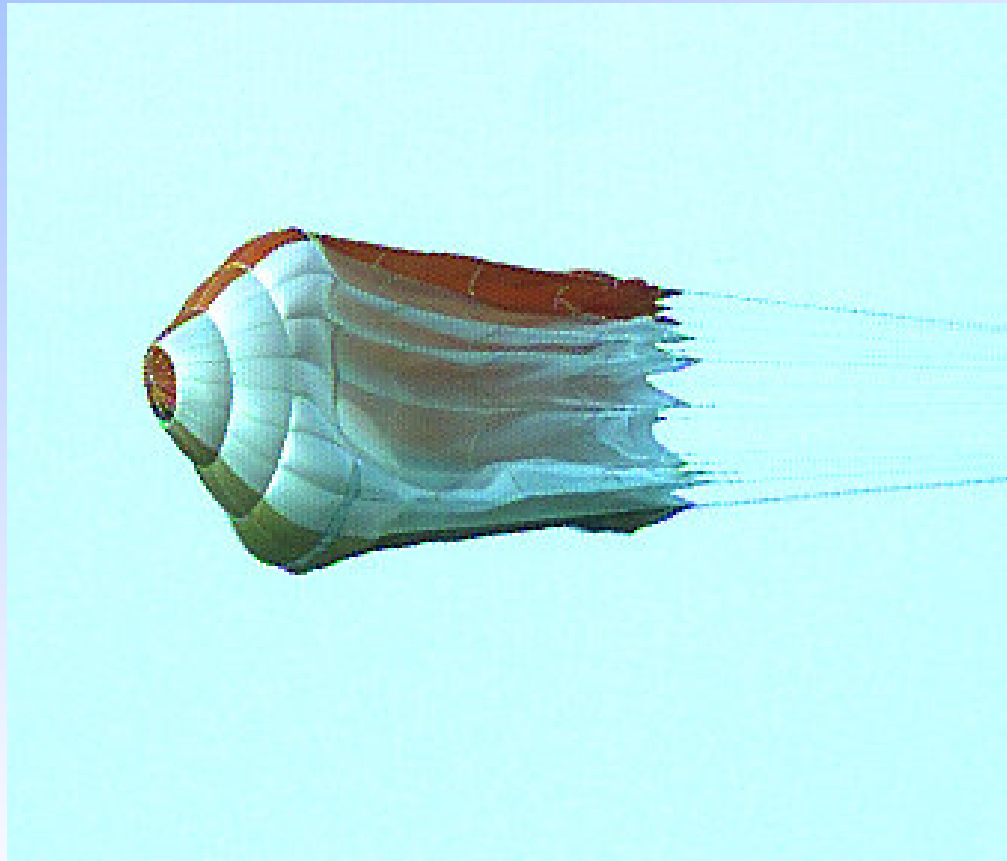
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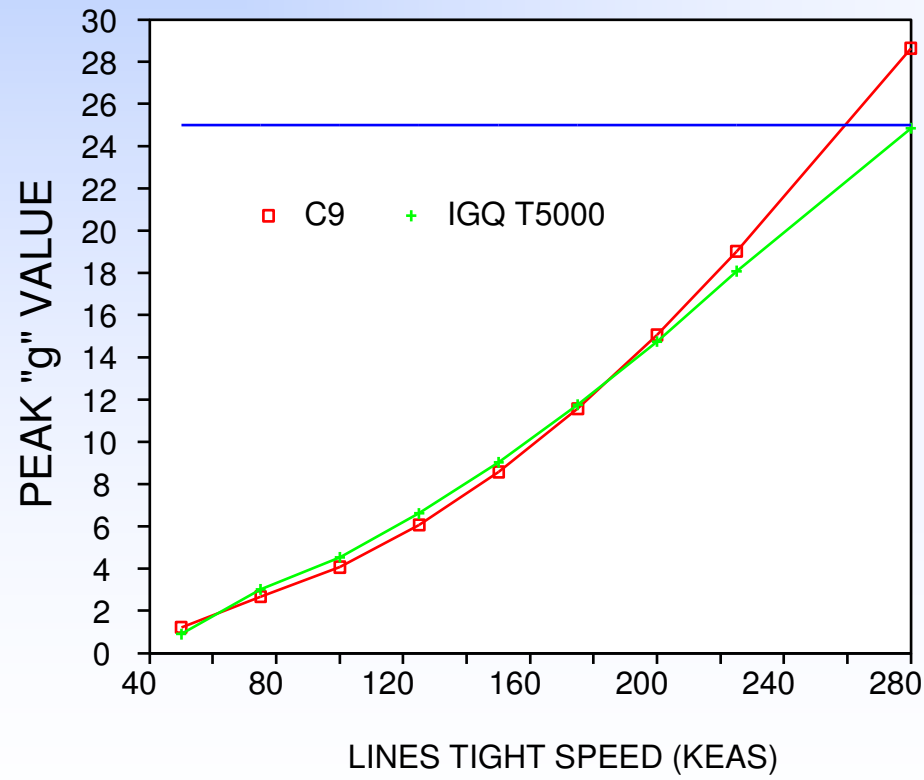


T5000 "Squidged" State



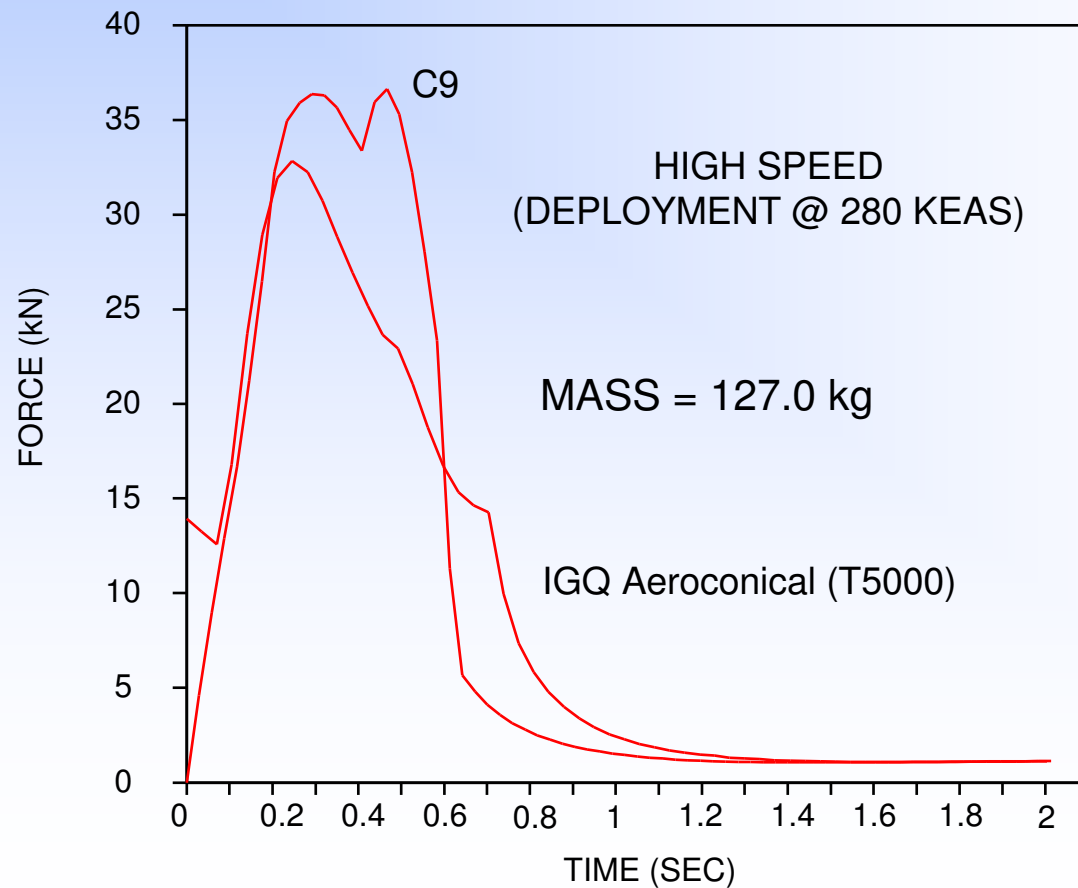


# *Parachute Opening Characteristics*





# *Parachute Opening Characteristics*





## *The IGQ Aeroconical Parachute*

- ◆ LIMIT opening characteristics.
- ◆ Select drive
- ◆ Select Steering
- ◆ De-Selectable Steering and drive
- ◆ Acceptable rate of descent
- ◆ Acceptable weight and bulk
- ◆ Tolerant to mishandling in use



## *Maneuverability*

- ◆ Select Drive by full control deflection
- ◆ Release controls to obtain full drive
  - Forward Speed 8 ft/S
- ◆ Release one control to obtain Max turn
  - Turn rate 20 degrees/S (18 Secs/Full Turn)
- ◆ Both turn and Drive De-selectable by full deflection of both Controls.



# *IGQ T5000 In Service*

<b>Aircraft Type</b>	<b>Country</b>	<b>Seat Type</b>
Gripen	Sweden	Mk S10LS
F-14D,F-18C-F,T-45A/C	USA	Mk 14 (NACES)
F-18C/D	Finland	Mk 14 (NACES)
Typhoon	Europe	Mk 16A
NASA T-38N	USA	Mk US16LN
Rafale	France	Mk F16F
T-6A (JPATS)	USA	Mk US16LA
T-50A	Korea	Mk KR16L
M-346	Italy	Mk IT16D
PC-21	Switzerland	Mk CH16C
Tornado / Jaguar (Retrofit)	UK	Mk10A / Mk9B
C130	UK	HUPRA



# *IGQ T6000 Selected*

**Aircraft Type**

**F35 JSF**

**Country**

**JSF Partner Nations**

**Seat Type**

**Mk 16E**



## *IGQ T5000 vs T6000*

	<b>IGQ T5000</b>	<b>IGQ T6000 (Prov)</b>	<b>C9</b>
<b>Parachute Mass</b>	<b>12.9 lb</b>	<b>14.5 lb</b>	<b>11.5 lb</b>
<b>Number of Gores</b>	<b>20</b>	<b>24</b>	<b>28</b>
<b>Flying Diameter</b>	<b>21.3ft</b>	<b>23.5ft</b>	<b>19</b>
<b>Constructed Area</b>	<b>673 ft<sup>2</sup></b>	<b>808 ft<sup>2</sup></b>	<b>616 ft<sup>2</sup></b>



## *IGQ T5000 vs T6000*

**IGQ T5000**

**IGQ T6000  
(Provisional Data)**

<b>Max Mass</b>	<b>291 lb</b>	<b>337 lb</b>
<b>Min Mass</b>	<b>139 lb</b>	<b>144 lb</b>
<b>RoD (fps)</b>	<b>22.5 at 291 lb</b>	<b>21.5 at 337 lb</b>
<b>Stressing</b>	<b>27.5g at 291 lb</b>	<b>27.5g at 337 lb</b>
<b>Max Drive</b>	<b>8fps at 291 lb</b>	<b>8fps at 337 lb</b>



## *Drogue Parachute Wish List*

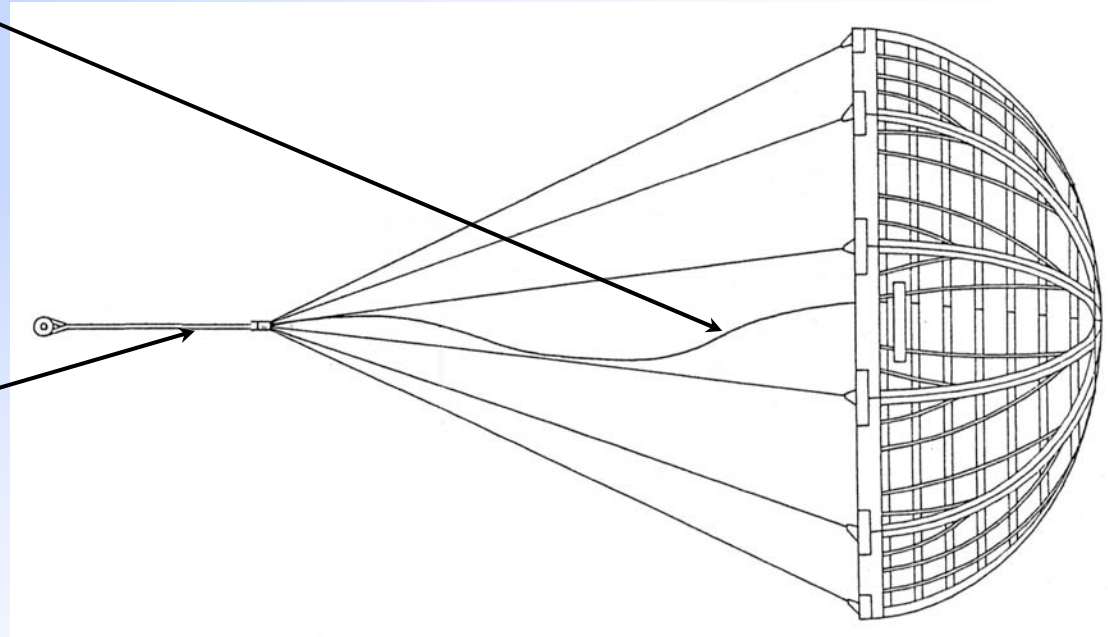
- ◆ Instant Maximum deceleration
  - Regardless of speed and height
  - within acceptable physiological limits
  - Less than 5% over-inflation
- ◆ Reefing Possible
  - Reduce initial deceleration
- ◆ Stability
  - Stabilise the seat to promote consistent Main Parachute deployment



## *The IGQ NACES Ribbon Drogue Parachute*

Anti-squid Centre  
Line

Integral Strop





## *The IGQ JSF Ribbon Drogue Parachute*

Reefing Rings  
Incorporated

Integral Strop  
Removed - Longer  
Rigging Lines relative  
to  $D_0$

Anti-squid Centre line removed

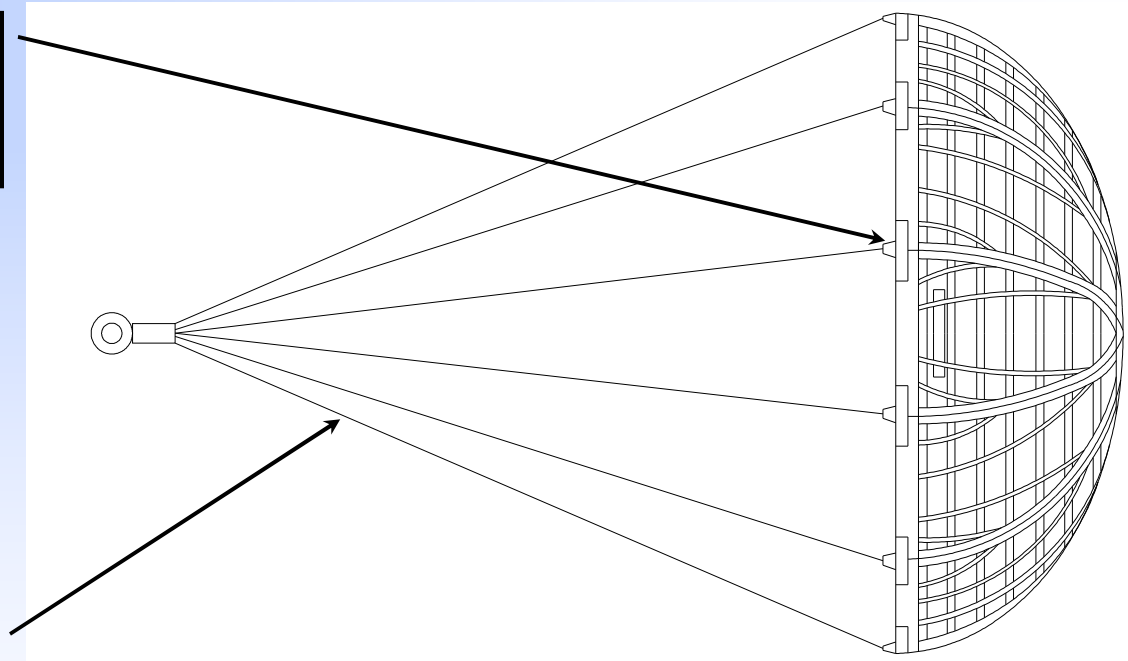




Image Courtesy of MBA Ltd

IGQ Ribbon Drogue Under Test at MBA Langford Lodge



## *The IGQ Ribbon Drogue Parachute*

- ◆ Rapid opening to Reefed and Subsequent De-Reefed Conditions
- ◆ Low Over-inflation Characteristics
- ◆ Acceptable weight and bulk



## *IGQ Ribbon Drogues In Service*

<b>Aircraft Type</b>	<b>Country</b>	<b>Seat Type</b>
F14,F18,T45	USA NACES	Mk 14
EFA	Europe	Mk 16
Rafale	France	Mk 16
T6 (JPATS)	USA	Mk 16L
F18	Finland	Mk 14



# *IGQ Ribbon Drogues Selected*

**Aircraft Type**

**Country**

**Seat Type**

F35 JSF

JSF Partner Nations

Mk 16E

NACES SIP USA

Mk 14



## *Conclusions*

- ◆ Put the best possible Drogue and Main Parachutes in every system old or new.
- ◆ Embody Select steering and drive for maximum survivability.
- ◆ Large increases in performance and safety are available with relatively minor cost implications



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