March 2009

Recent Developments in the Field of Ejection Seat Parachutes

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Objective

- Present the Capabilities of the Airborne Systems Aeroconical Parachute
  - Type 5000
- Decribe the work conducted in the last 5 years on ejection seat parachutes
  - Type 6000 Parachute JSF – MBA Mk16E
  - Slotted parachutes
- Look forward to the work to be conducted next
  - Type 5000 Light Weight
  - Future Airborne Systems New Jersey Programme

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

Parachute Design Engineer Goals

- To simplify the design of other aspects of the Escape system.
- Reduce sensitivity to deployment conditions.
- Improve Escape window (including increased pilot mass).
- Embody the advances in modern Technologies and materials.

Main Parachute Wish List

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

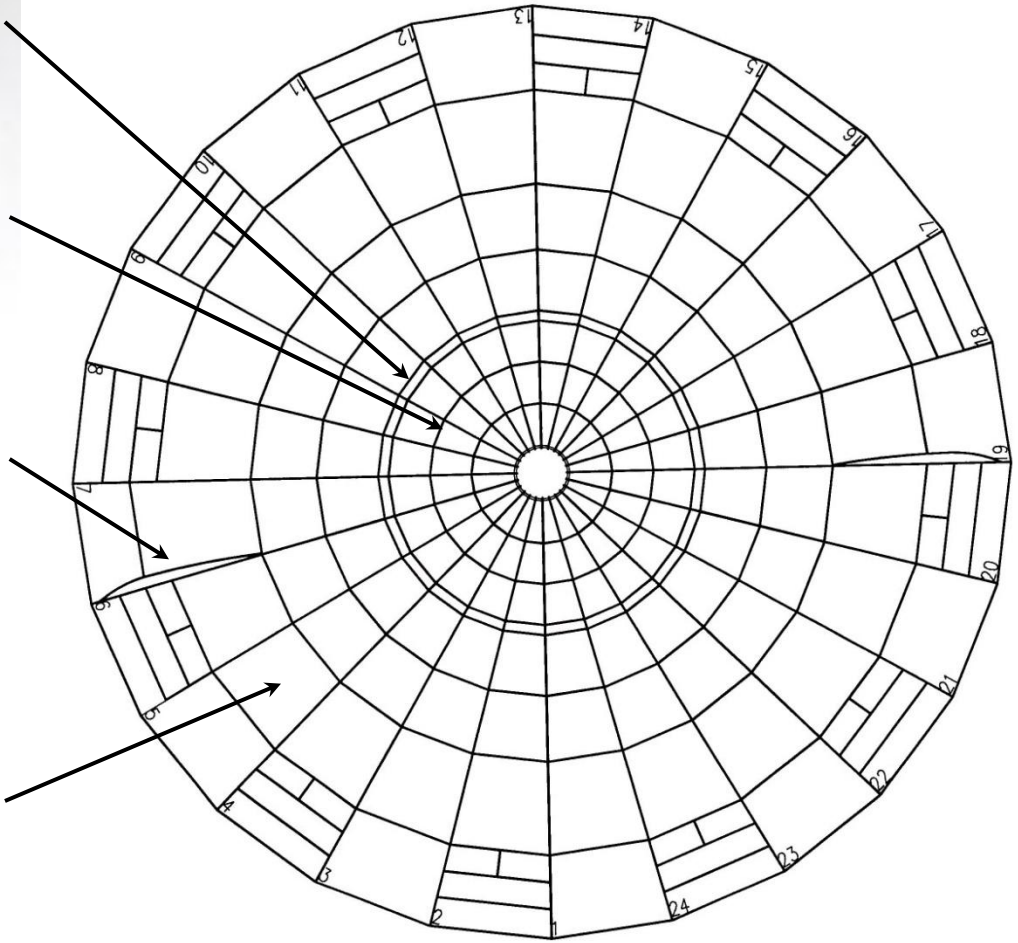
The ASE Aeroconical Parachute

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

The ASE Aeroconical Parachute

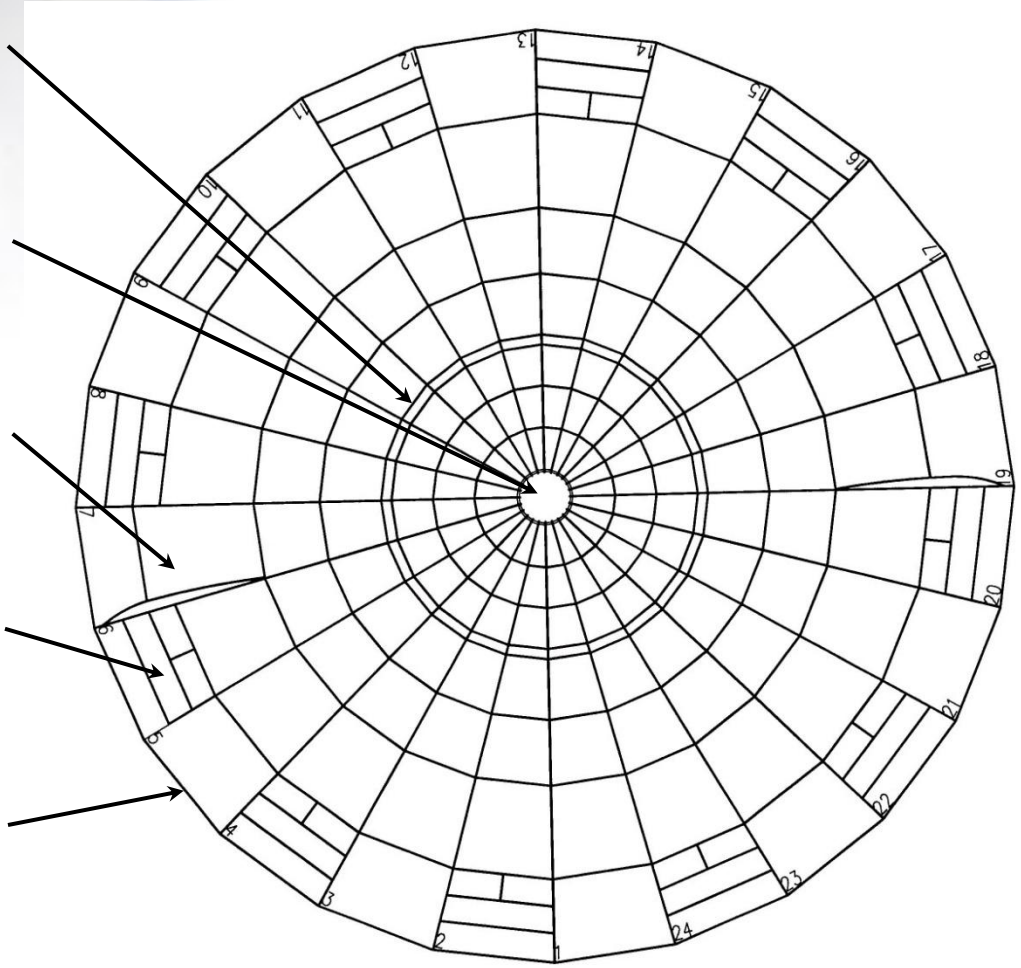
Inflation Control Band

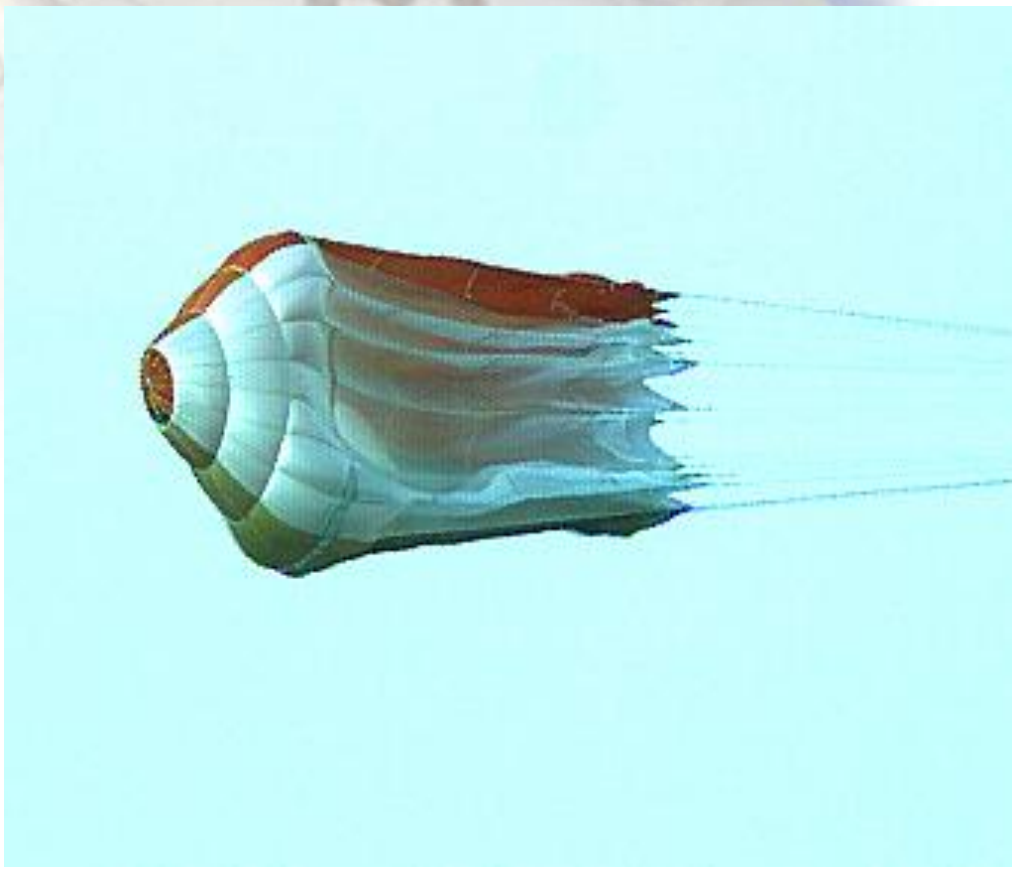
Parachute Vent
Kevlar reinforced

LeMoigne Slot
Selectable Drive

Water Pocket

Parachute Hem
Kevlar reinforced





T5000 “Squidded” State

The Aeroconical Parachute

- LIMIT opening characteristics.
- Select drive
- Select Steering
- De-Selectable Steering and drive
- Acceptable rate of descent
- Acceptable weight and bulk
- Tolerant to damage and 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.

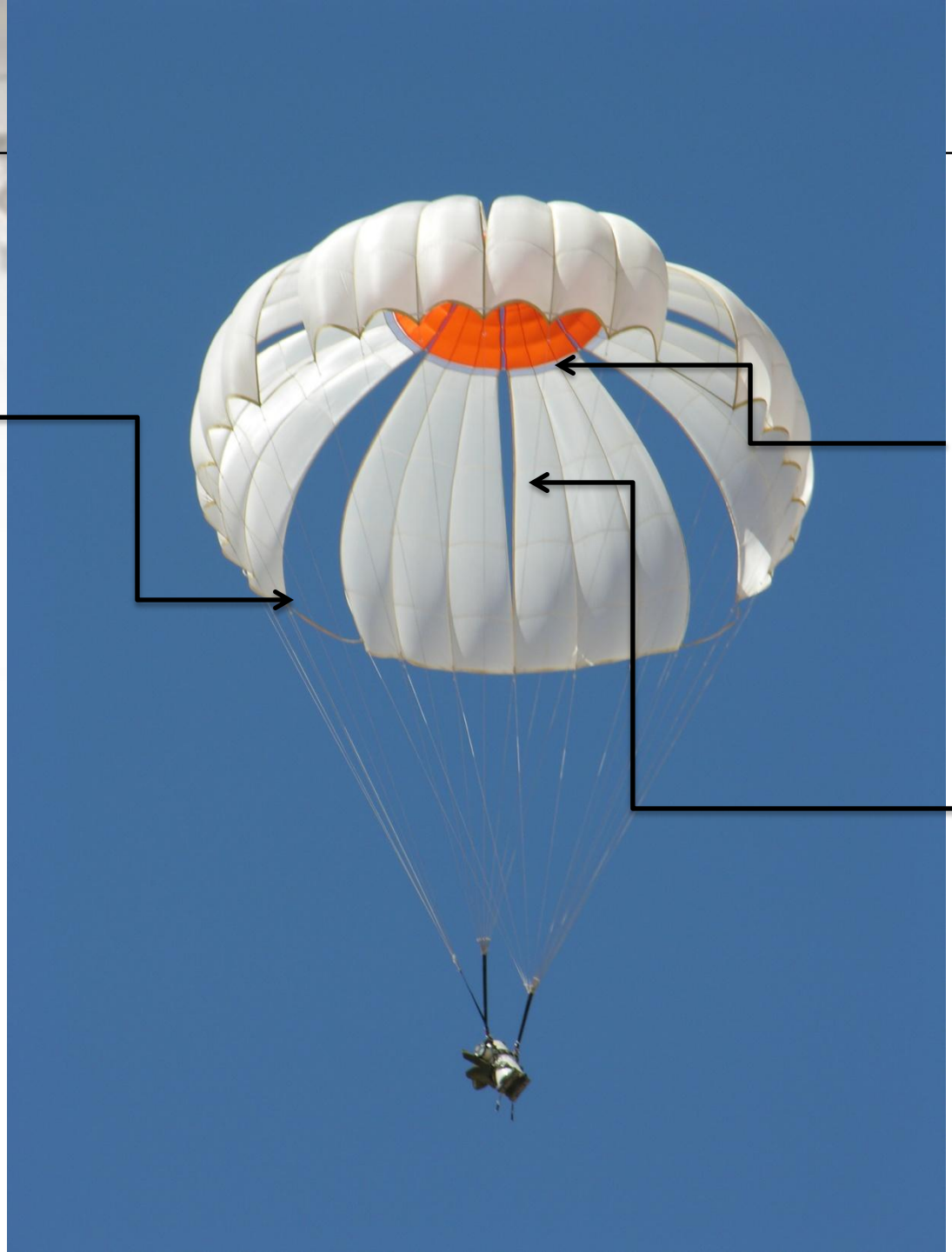
So that's the Background!

- T6000 development and testing has absorbed much of the effort over the last 5 years
- Slotted Parachutes
  - Sponsored by MoD / QinetiQ
  - Morphing the Aeroconical profile with a K36 style parachute
    - Full slots to the hem (creating 4 arms)
    - Crown slots – convensional hem

B25 “Pacific Princess” – Test Platform
Instrumented Pipeman Test Dummy

Early Phase Parachute Deployment

Slotted “Maltese Cross” Aeroconical Parachute


Full slot to hem with control band
inflation control band
Partial slot from ICB to top of Panel 1

Extended Skirt Maltese Cross – late stage inflation

Standard Profile Type 6000 with Inflation Control Band and Crown Slots

Slotted Aeroconical 337lb suspended, 200 Knots

Headline Conclusions

- Slotted Aeroconical capable of very high velocity deployment (~300kts)
  - Below 25g resultant
- Slotted Parachutes in General
  - Tendency to Arm Tuck – Arm control bands required
  - Tendency to rotate – build tolerance?
  - Greater edge binding / seam area leads to an increase in weight and bulk
- T6000 with Slotted Crown
  - Slight increase in performance did not warrant the increased complexity of construction

So what's Next

- Type 5000 Light Weight
  - Displace Type 1000 with a parachute more aligned to today's crew size
  - Affordability of modification high priority

Light Weight Aeroconical

- Requirement Summary
- T1000 Parachute in Mk 10 seat being used with heavy pilots (300lb suspended) – high RoD (~27fps).
- New parachute needs to:-
  - Be capable 144lb (130lb desirable) - 300lb (RoD, 0-0, max g etc)
  - Pack into current Mk 10 headbox using wine press / tooling (T1000 weighs 12.6lbs)
  - Have same repack cycle (no pyrotechnics)
- Options:
  - Retain duplex drogue or change to lighter drogue
    - Duplex drogue is heavy / bulky but is a qualified product
    - NACES type ribbon or guide surface drogue would require less volume but delta qualification more complex

Existing System. T1000 Duplex Drogue

MBA photograph

ASE T5000 vs T6000 vs T5000LW

	T5000	T6000	T5000LW
Parachute Mass	13.0 lb	14.5 lb	11.9 lb
Number of Gores	20	24	20
Flying Diameter	21.3ft	23.5ft	~21.3ft
Constructed Area	673 ft^2	808 ft^2	673 ft^2

T5000 vs T6000 vs T5000LW

	T5000	T6000	T5000LW
Max Mass	291 lb	337 lb	~300 lb
Min Mass	139 lb	144 lb	~130 lb
RoD (fps)	22.5 at 291 lb	21.5 at 337 lb	~22.5 at 300 lb
Stressing	27.5g at 291 lb	27.5g at 337 lb	~27.5g at 300 lb
Max Drive	8fps at 291 lb	8fps at 337 lb	~8fps at 300 lb

Light Weight Aeroconical – Test Hardware

- 1st Phase Testing took place in Eloy Az, Jan 2009.
- T5000LW
- T5000 Parachute with weight reduction measures
  - Heavy crown fabric replaced with lighter material
  - Kevlar reinforcing removed from cross seams below ICB
  - Water pocket construction / attachment redesigned
  - Heavier T6000 vent tape used – strength contingency
- Drogues
  - MBA 5’ Drogue + extractor, ASE guide Surface + extractor

T5000LW / 5’ Drogue

T5000LW / Guide Surface Drogue

Heavyweight high speed drop

Preliminary Results

- Parachute opening performance very encouraging
  - low g but with relatively quick opening time
- Excellent parachute strength
  - Drogue bridle to crown attachment method proven to be robust – tested at 338lbs
- Good Rate of Descent
  - Lower 2/3 of canopy flying slightly more open – increase suspended weight to 300lb with no detectable increase in RoD

Next Stage Testing

- Martin Baker Meteor Tests
  - 2 system level tests – conducted March 09
- ASE B25 Testing
  - 6 high speed tests (3 heavy 3 light) – now
- Man Rating Testing
  - May / June 09, ~30 tests
  - Live jump – June 09
- MBA System Level Testing
  - Late Summer 09 (TBC)

ASNJ Future Programme

- Develop a Ram Air parachute system capable of Ejection Seat Use.
  - Deploy in a fully braked condition – if pilot is unable to fly the parachute total velocity should be the same as current ejection seat parachutes
  - Escape and Evasion capability vastly increased in most circumstances.
  - Possibly sequence opening using a parachute mounted electronic sequencer

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