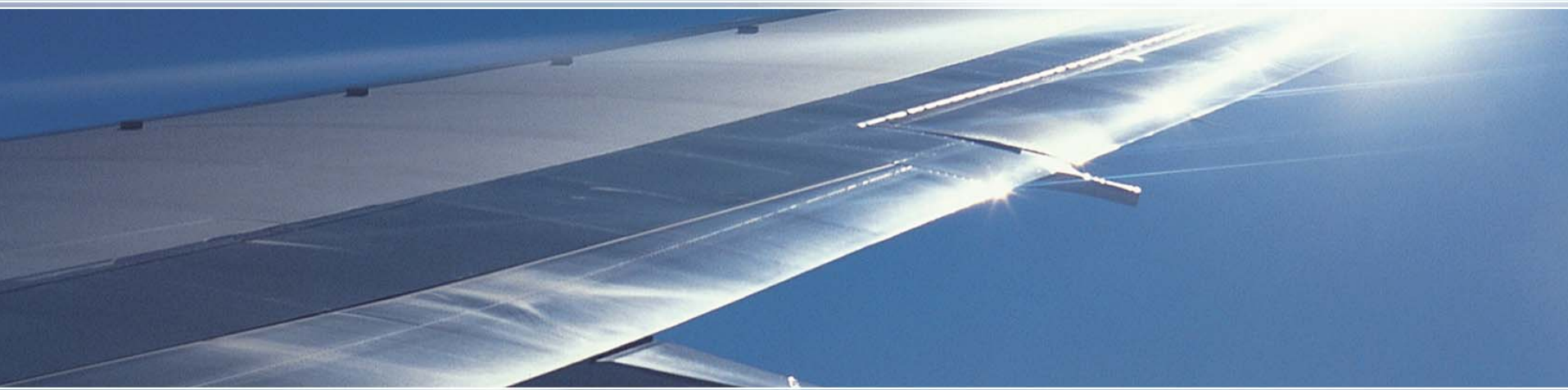
Australian Government
Civil Aviation Safety Authority

Automotive Child Restraint types and their installation in Transport Category Aeroplanes



5th Triennial International Aircraft Fire & Cabin Safety Research Conference
Atlantic City, USA, 30 October 2007

Mark Bathie
Airworthiness Engineer – Crashworthiness, CASA

Australian situation

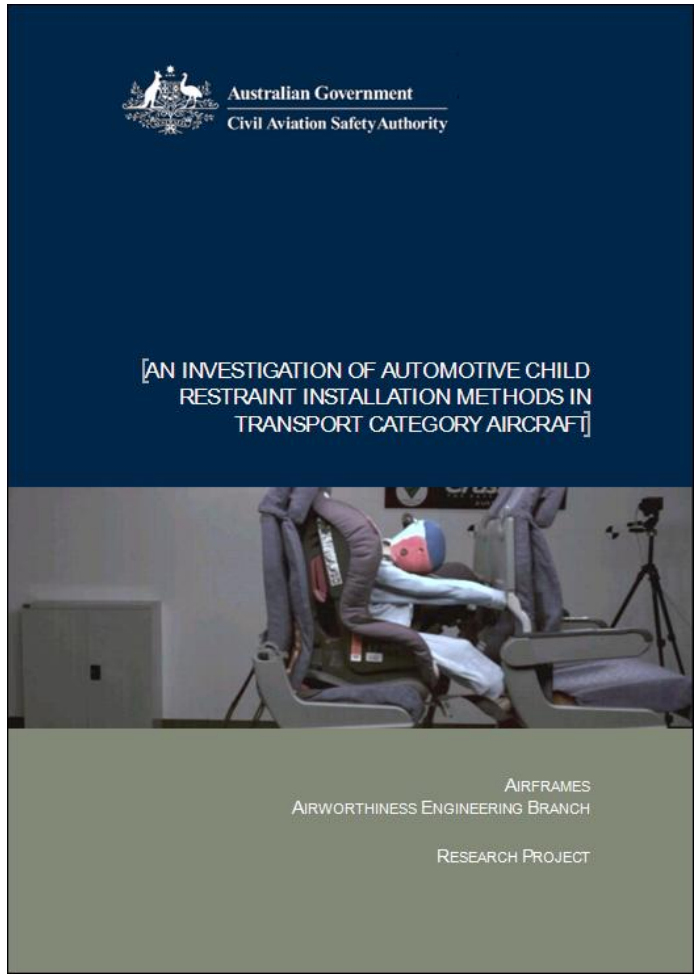
- Australian Standard for Child Restraints in Motor Vehicles has required top tether use since 1975.
- CASA requires installation of CRS in accordance with manufacturer's instructions – installation in aircraft requires top tether use for Australian CRS.

Australian Aviation Situation

- CAR 251(1) "….. seat belts shall be worn by all crew members and passengers….."
- CAR 251(3) "CASA may direct that a type of safety harness ….. be worn in place of a seat belt….."
- CAO 20.16.3 Para.13.2(1) "An infant may be carried in the arms or on the lap of an adult passenger, in a bassinet or in an infant seat….."
- CAAP 235-2(1) Para 2.1 "An infant carried in the arms of an adult passenger (lap held) must be restrained….."

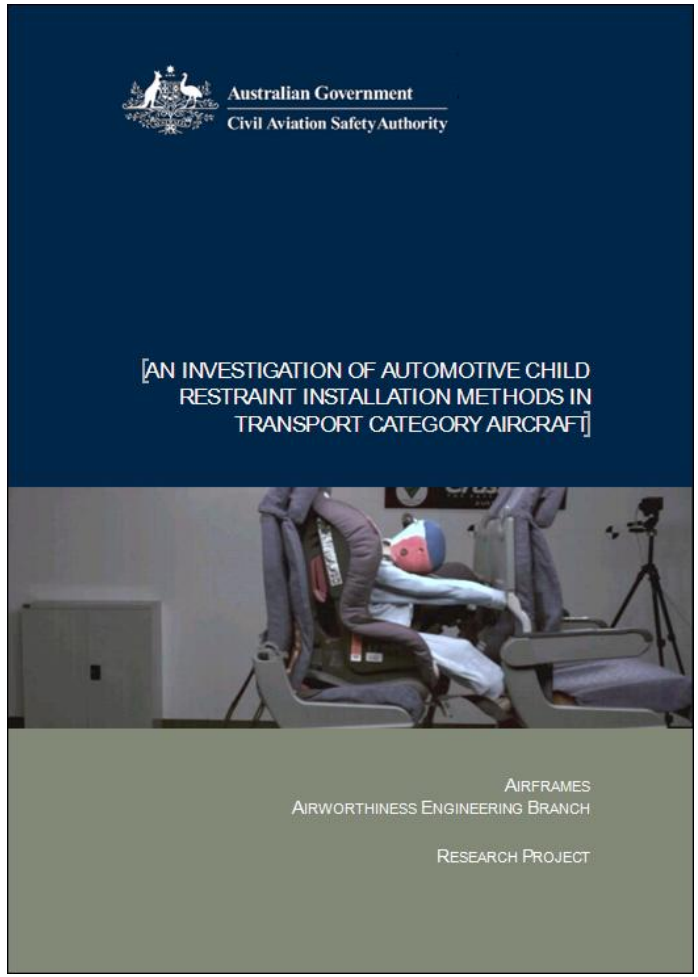
The Research

- Concentrated on dynamic performance.
- Focus on Australian indigenous configuration issues.
- Results applicable to worldwide operations.



The Research

1. Top Tether contribution to dynamic performance.
2. Alternative to top tether.
3. ISOFIX type CRS.



Test Setup

- Impact-with-Rebound Sled
- TSO-C39b Airline Double Economy Class Seat with breakover limiting devices.
- P series child ATDs
- Hybrid III (Automotive) Adult ATDs
- Two CRS per test shot

Test Criteria

- FAA TSO-C100b ‘Child Restraint Systems’
  - Test severity
  - Instrumentation
  - Pass/fail criteria, and
- Australian Standard AS/NZS1754:2004 ‘Child Restraint Systems for use in motor vehicles’.
  - ATD and ATD installation
  - Supplemental pass/fail criteria

Top Tether

- Doubles installation effort.
- Bulkhead anchors not practical.
- Is it effective?

Belt Angles


S050469
0.00 ms
S060469
Crashlab


B050468
0.00 ms
B060468
Crashlab

Top Tether test results

		Max. Head Acceleration (3ms clip)	HIC36	Max. Head Excursion	Max. Upper Thorax Acceleration (3ms clip)	Max. CRS displacement (@ belt path)
Rear facing – P3/4	Safe-n-Sound	49.2g	280		39.7g	
	IGC Gosafe	50.1g	295		53.0g	~6.5 in (165 mm)
Forward facing – P3	Safe-n-Sound	80.8g	499	35.5 in (902 mm)	53.0g	~12 in (305 mm)
	IGC Gosafe	113.9g	944	36.7 in (932 mm)	42.9g	~13 in (330 mm)

Belt Angles

Alternate restraint mechanism

- Remove the use of the Top Tether.
- Add horizontal restraint mechanism.
- Improve CRS performance.
- Part already available on every aircraft.

Alternate restraint mechanism


5050467
0.00 ms
Crashlab

Extension Belt test results

		Max. Head Acceleration (3ms clip)	HIC36	Max. Head Excursion	Max. Upper Thorax Acceleration (3ms clip)	Max. CRS displacement (@ belt path)
Forward facing – P3	IGC Gosafe (lap belt only)	-	-	-	44.6g	-
	IGC Gosafe (Lap belt and extension belt)	58.8g	501	33.6 in (853 mm)	37.8g	~10 in (254 mm)

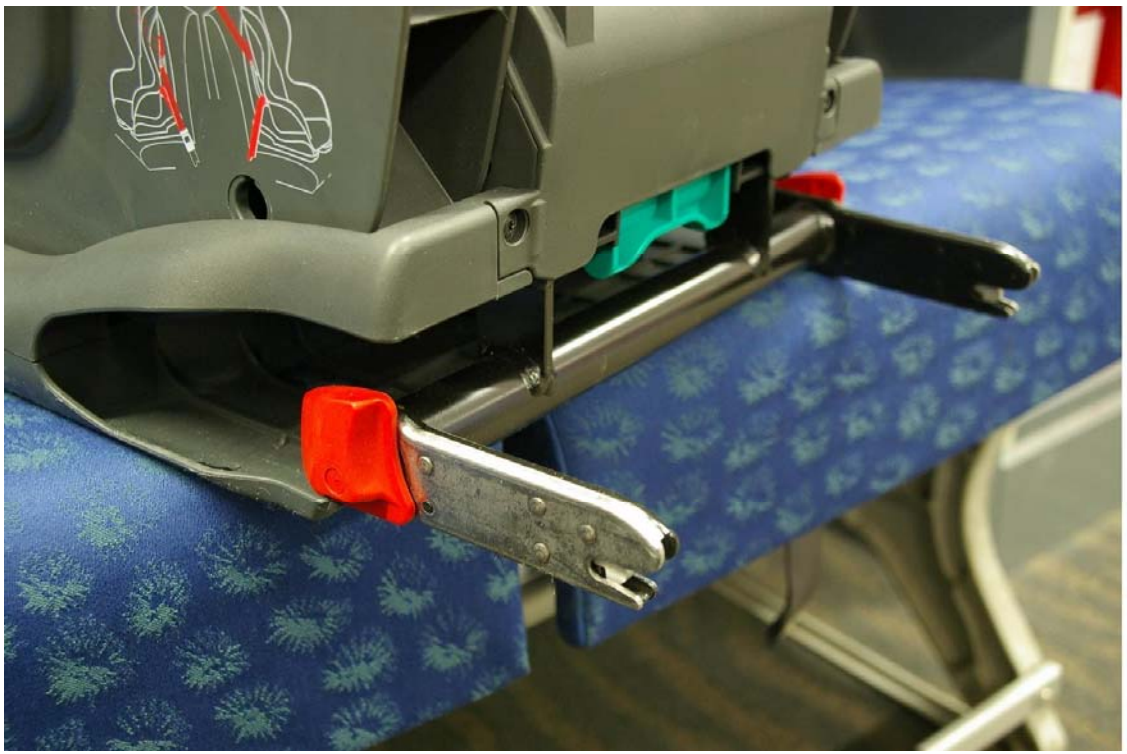
Top Tether

Extension Belt

ISOfix

- Aircraft lap belt not used.
- CRS mechanically fastened to seat.
- Rigid link.
- Two 40mm long Ø6mm round bars in seat bight.

ISOfix



ISOfix Restraints


B050466
0.00 ms
B050466
Crashlab

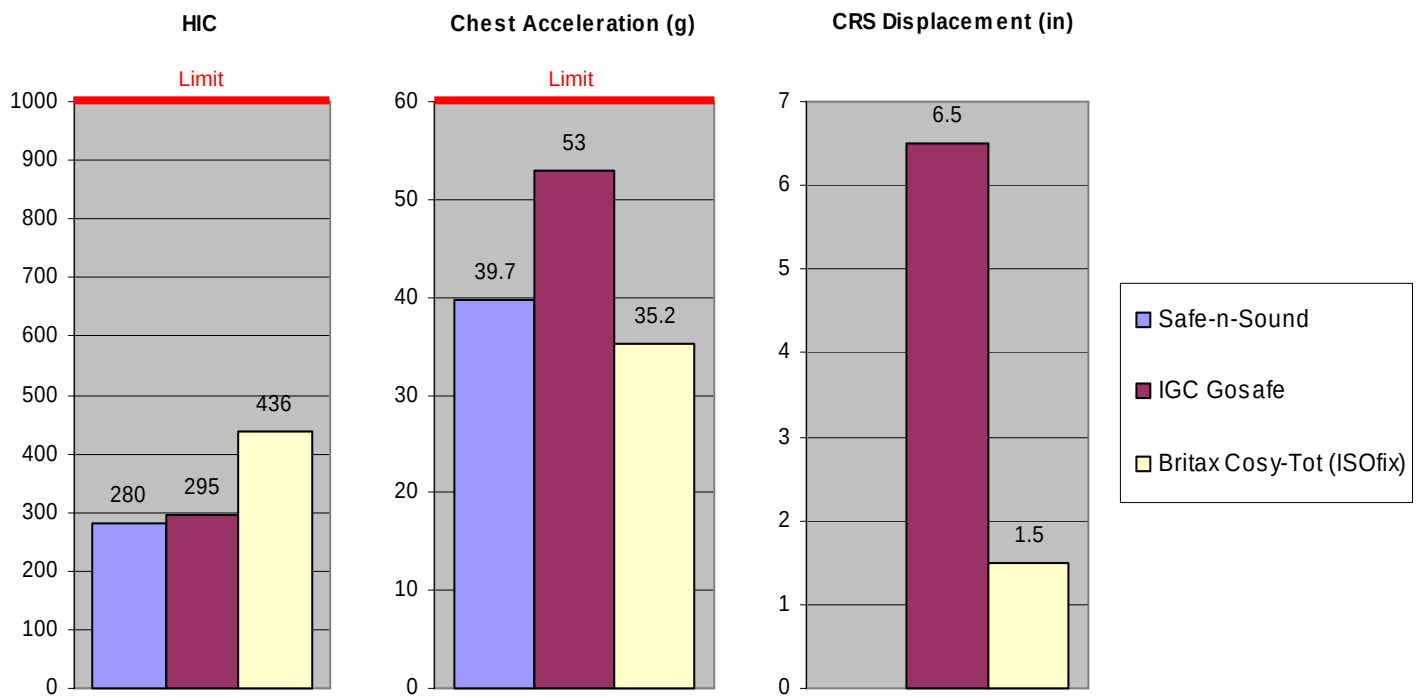
ISOfix test results

	Max. Head Acceleration (3ms clip)	HIC36	Max. Head Excursion	Max. Upper Thorax Acceleration (3ms clip)	Max. CRS displacement (@ belt path)
Britax 'Cosy-Tot' ISOfix (RF)- P3/4	57.2g	436		35.2g	~1.5 in (38mm)
Britax 'Duo-Plus' ISOfix (FF) – P3	63.6g	276	27.0 in (686 mm)	32.4g	~2.5 in (64 mm)

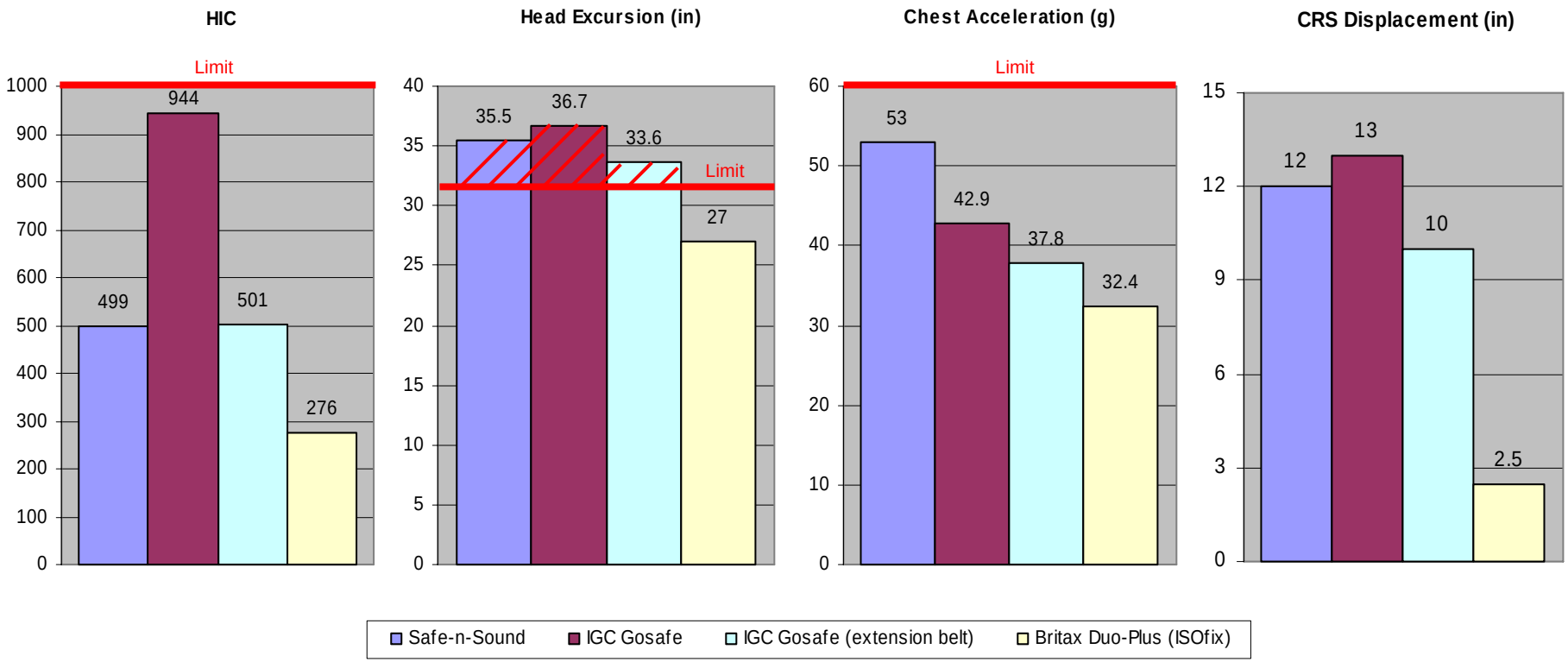
Top Tether

ISOfix

Comparative results – Rear facing



Comparative results – Forward facing



ISOfix modification

ISOfix modification

ISOfix modification

ISOfix modification

ISOfix concerns

- Failure of the CRS due to:
  - Overload of the lower anchorage from persons knees seated behind.
  - Pressure applied via the additional seat back loading from impact from behind.
- Increased injury to persons seated behind due to:
  - Femur compression/localised knee damage from interaction with the lower anchorage.
  - Increased HIC from reduced seat back breakover.

Adult/ISOfix interaction

- Most concerns not realised
  - Knees of 50th percentile ATD restrained before reaching lower anchorage and lower limbs pass below lower anchorage.
  - HIC below limits.
  - Child ATD injury levels not varied.
- Adult head rotation severe


0,00 ms

‘ISOfix with rear Pax’ test results

		Max. Head Acceleration (3ms clip)	HIC36	Max. Upper Thorax Acceleration (3ms clip)	Max Femur Load	Max. CRS displacement (@ belt path)
Child ATD	Britax ‘Cosy-Tot’ ISOfix (RF)- P3/4	53.6g	419	41.0g		
	Britax ‘Duo-Plus’ ISOfix (FF) – P3	36.0g	148	34.0g		~3 in (165 mm)
Adult ATD	Hybrid III behind Britax ‘Cosy-Tot’ ISOfix (RF)- P3/4	92.2g	813	25.3g	2.11,1.21 kN (957, 549 lbs)	
	Hybrid III behind Britax ‘Duo-Plus’ ISOfix (FF) – P3	90.2g	902	26.4g	1.30,1.89 kN (590, 857 lbs)	

Recommendations

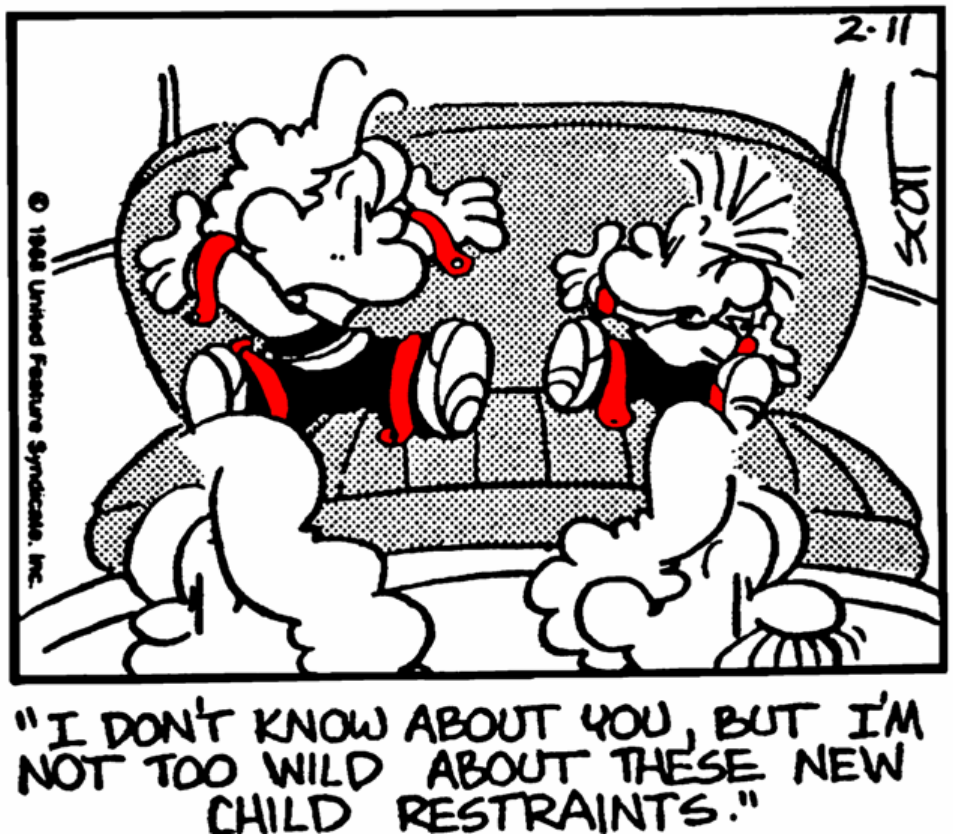
- Infants and small children should travel in their own seat, in an appropriately sized and fitted child restraint system.
- Revisions to CASA's Advisory material.
- Minimum standards for lower anchorages in aircraft seating need to be developed.
- ISOfix further testing:
  - Retesting with neck instrumentation in adult ATD.
  - Retesting with 95th percentile male ATD.
  - Similar assessment for LATCH CRS.

Recommendations

- Airline encouraged to fit lower anchorages to window seats, and the centre seats of twin aisle aircraft, were there is no risk of injury to anybody seated behind, i.e in front of bulkheads, lavs/galleys, floor level exits or floor mounted rear facing cabin crew positions.

http://www.casa.gov.au/airworth/papers/index.htm

Questions ?


2-11
SCOTT
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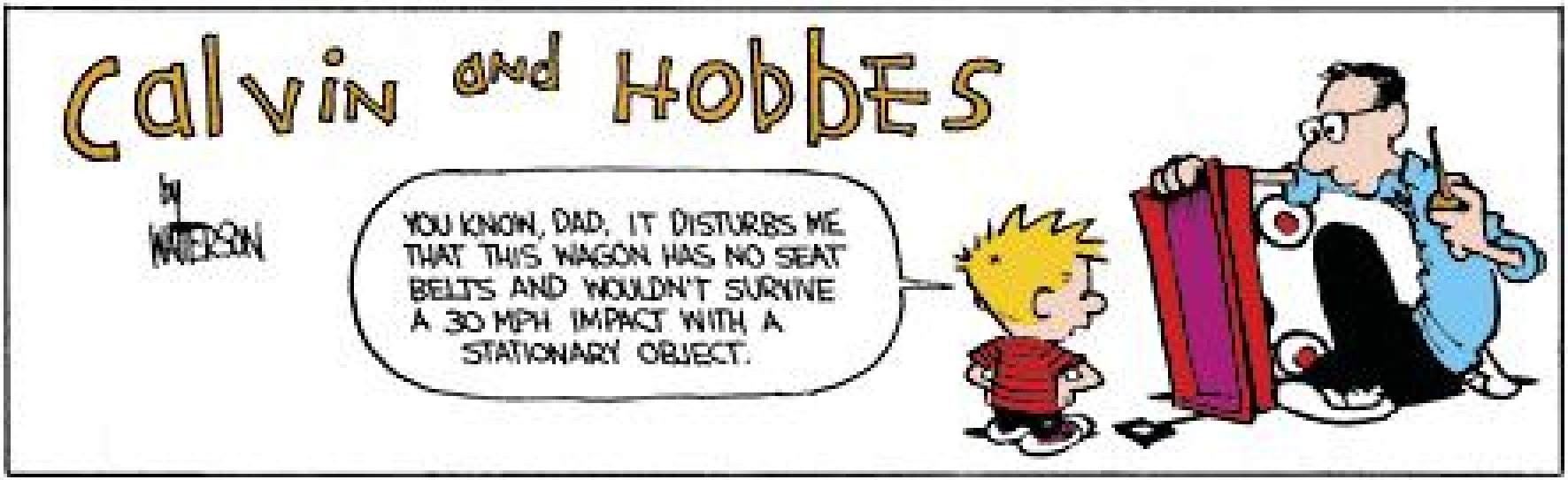
"I DON'T KNOW ABOUT YOU, BUT I'M NOT TOO WILD ABOUT THESE NEW CHILD RESTRAINTS."


Calvin and Hobbes
by
WATTERSON
YOU KNOW, DAD. IT DISTURBS ME THAT THIS WAGON HAS NO SEAT BELTS AND WOULDN'T SURVIVE A 30 MPH IMPACT WITH A STATIONARY OBJECT.