Protecting Children in Car Crashes: The Australian Experience

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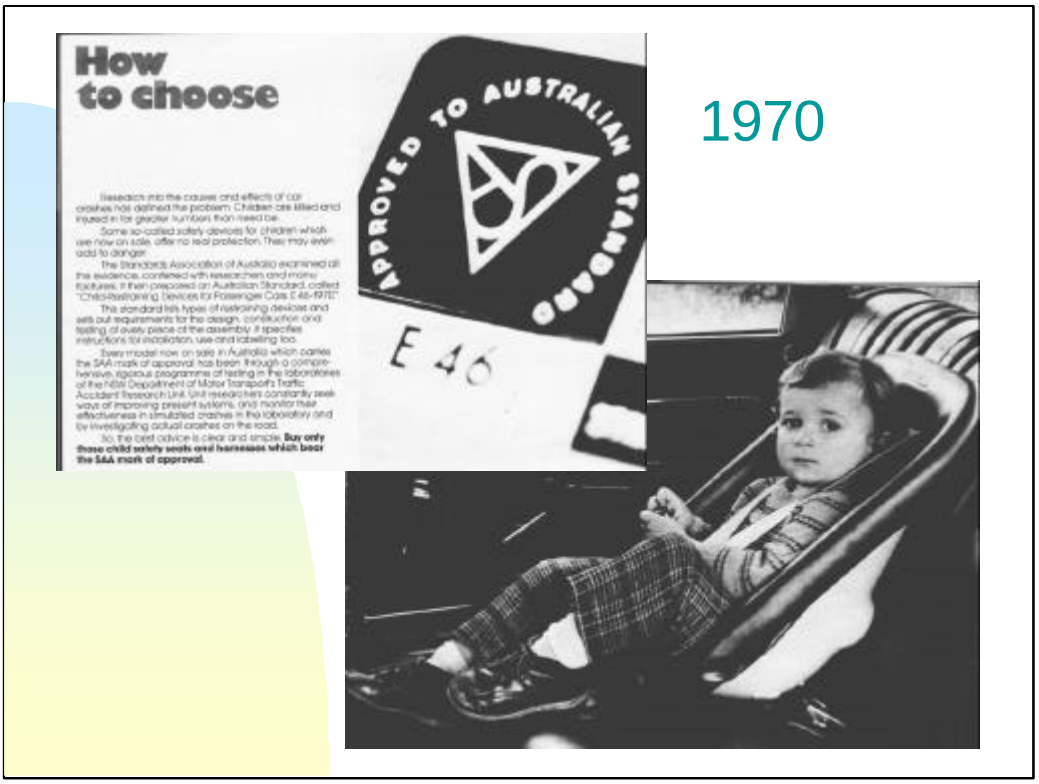
Vehicle Design and Research P/L

Introduction

- The proven effectiveness of Australian child restraint systems (CRS) can be traced, in part, to the research conducted over four decades.
- The successes (and failures) of that research are relevant to current activities in the US, Europe and Japan



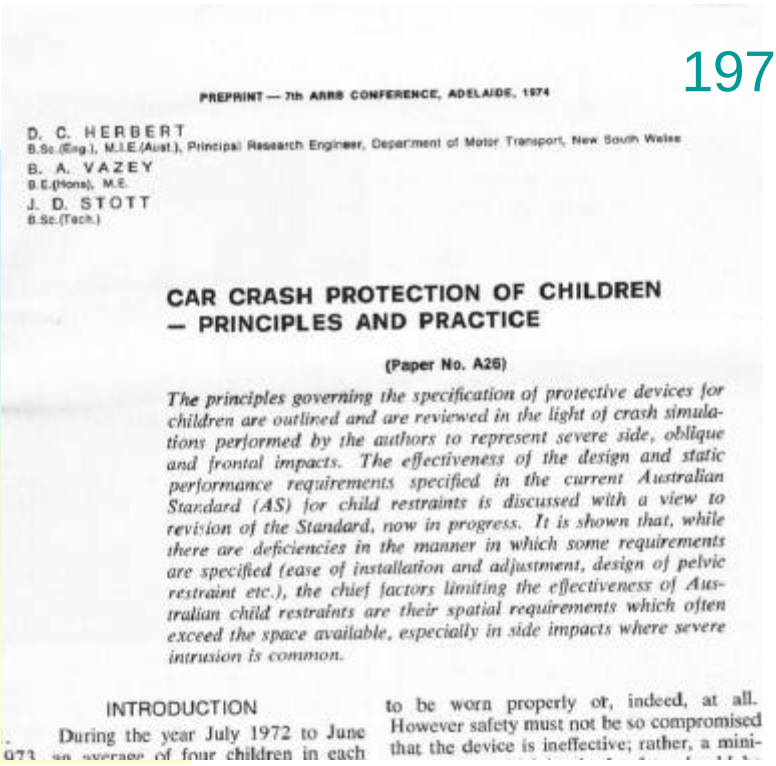
•In 1964 a Panel of Doctors was formed to investigate child occupant safety. Dr John Lane provided advice about injury tolerances, based on light plane crashes.

•This work led to the issue of Australian Standard E46 in 1970.

•This is an early forward facing child seat that, like the LATCH system, uses a top tether and two special lower attachments. Not all vehicles had adult seat belts in the rear seat in those days

•Problems with loose adjustment of the lower attachments were observed.

1974



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CAR CRASH PROTECTION OF CHILDREN — PRINCIPLES AND PRACTICE

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The principles governing the specification of protective devices for children are outlined and are reviewed in the light of crash simulations performed by the authors to represent severe side, oblique and frontal impacts. The effectiveness of the design and static performance requirements specified in the current Australian Standard (AS) for child restraints is discussed with a view to revision of the Standard, now in progress. It is shown that, while there are deficiencies in the manner in which some requirements are specified (ease of installation and adjustment, design of pelvic restraint etc.), the chief factors limiting the effectiveness of Australian child restraints are their spatial requirements which often exceed the space available, especially in side impacts where severe intrusion is common.

INTRODUCTION

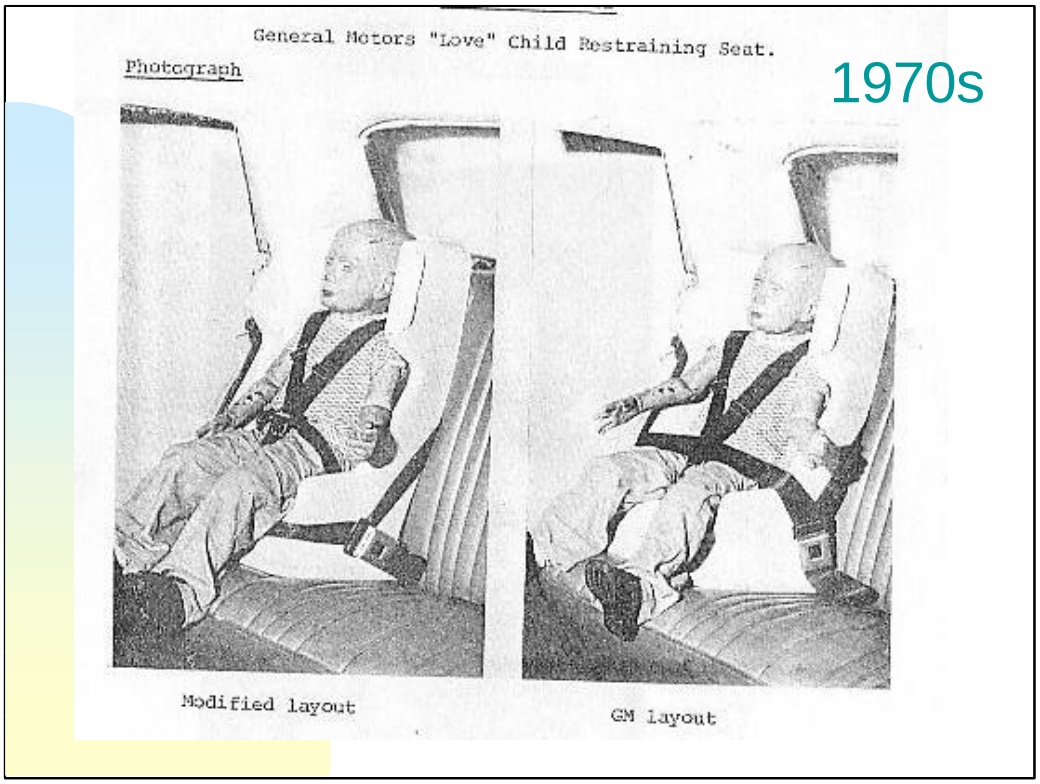
During the year July 1972 to June 1973 an average of four children in each

to be worn properly or, indeed, at all. However safety must not be so compromised that the device is ineffective; rather, a mini-

- In 1975 the Standard was completely rewritten (AS1754).
- Largely a result of research by the NSW Traffic Accident Research Unit (TARU)
- A Landmark TARU paper identified the principles of crash protection for young children.
- This built on the earlier work of Lane and others.
- Also raised the issue of airbags and unrestrained children.

1970s

- By 1974, most Australian CRS were forward-facing, with a harness and crotch strap. Many used a top tether in combination with the adult seat belt.
- The TARU authors supported this approach and stated the importance of preventing head contacts by limiting forward excursion
- In 1976 ADR34 required top tether anchorage points on the parcel shelf of all sedans. Also AS1754 introduced dynamic CRS tests. Essentially all CRS in Australia have had top tethers since then (27 years).



•Modification of a US design resulted in a CR very similar to the popular and highly effective SnS Series 3 child seat.

•The modified design is on the left. Note the introduction of a separate lap portion of the harness and that the adult seat belt passes along the lower front of the CRS

AS1754/ADR 34 - Unique features

1. Top tether
2. Single point adjust
3. Six-pt harness
4. Rear seat only
5. Careful specification of top anchorage location
6. Special infant dummy for infant capsule tests

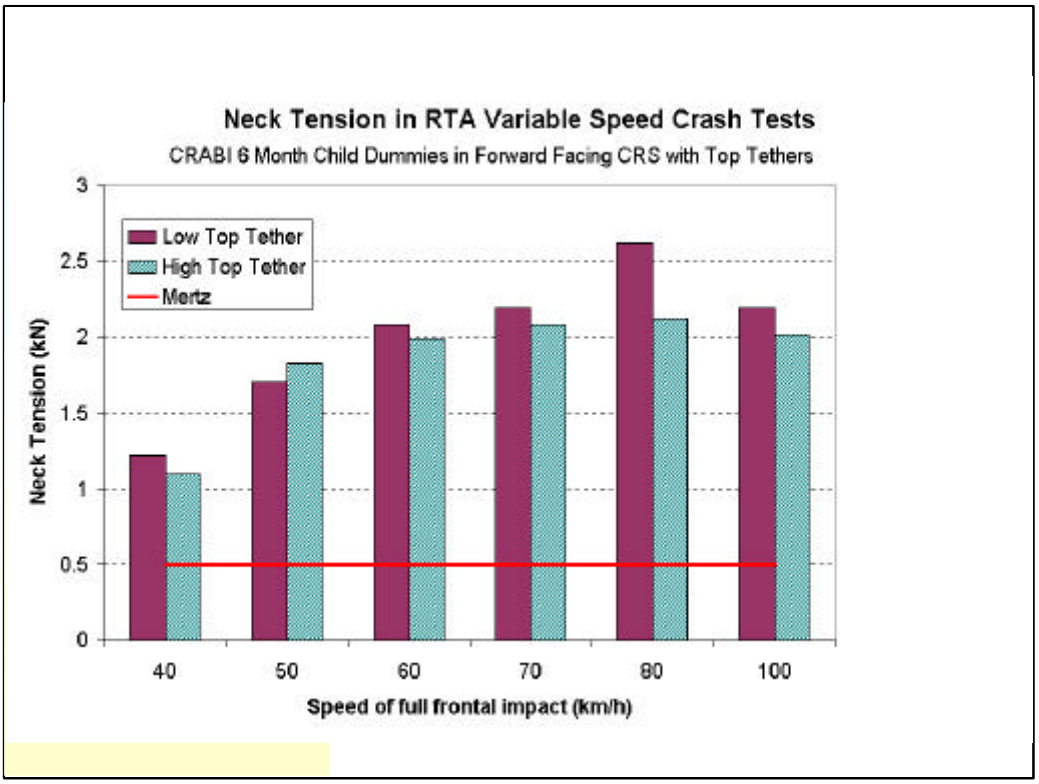
1980s & 90s

- Dynamic testing using sleds - research for Australian Standards, ISO and Child Restraint Evaluation Program (CREP)
- From 1999 CRS have been included in crash tests conducted by ANCAP
- CR usage surveys identify types of misuse - last was in 1998.
- From time to time in-depth crash studies are conducted

- In the mid 1990s NSW Crashlab conducted a series of full frontal crash barrier tests up to 100km/h
- Child dummies were placed in forward-facing child seats in the rear seat

Variable Speed Crash Tests

- Parcel shelf deceleration and child dummy measurements levelled off at around 70km/h
- For the child dummies the 100km/h crash was considered to be “survivable” since there were no head contacts and injury measurements were similar to the 60km/h crash.



•The CRABI 6 month dummies had neck transducers. These showed that, in the 50km/h crash, neck tension exceeded 1.5kN but did not increase much beyond this in higher speed tests.

• So already at 50km/h neck tensions were three times the levels proposed by Mertz

•IF 500N actually represents a 5% risk of AIS3+ neck injury then we could expect 1500N to involve a 50% risk. According to this we should be seeing a great many neck injuries in Australia.

•So let's look at real crash experience in Australia.

Child Seats in Real World Crashes

- NSW authorities have been monitoring all child occupant fatalities since the 1970s. There have been no cases of CRS fatalities from deceleration forces alone, in the absence of gross misuse, head contacts or intrusion
- Confirmed in the 1993 CAPFA Study of 247 children involved in serious car crashes (most escaped serious injury)
- Included nine cases of children in FF-CRS where the Delta-V was 50km/h or more

FIGURE 8 - Collision with tree in country; child in restraint in centre rear position uninjured (13513)

FIGURE 9 - Head-on collision with another car; eighteen-month-old girl in child restraint in left rear position uninjured (18613)

FIGURE 10 - 1992 Ford Falcon, change of velocity in frontal collision over 60 km/h; nine-month-old in forward-facing Type B seat sustained only bruising (27013)

FIGURE 11 - Toyota Tarago in which three adults killed; three-year old centre seat, second row, sustained broken arm and lacerations from flying glass (28214)

Conclusions of CAPFA Study

- “There are few safety devices that are as effective as child restraints…the only injuries caused by deceleration alone were bruising and abrasion from [webbing]”
- "restraint design should place a high priority on the minimisation of excursion of the upper body in order to prevent head contact"

Neck Tension Limits

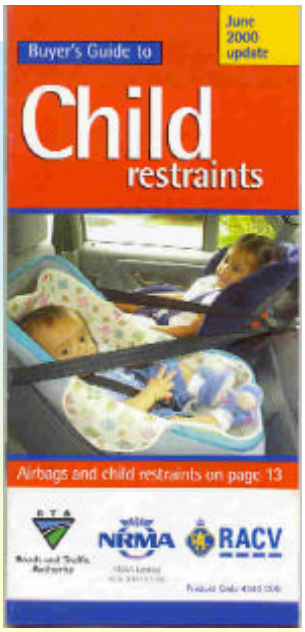
- The lesson from careful in-depth investigations is that the young child's neck can withstand large tension loads due to the inertia of the head but is easily injured by a combination of axial and shear loads (i.e. head contacts)
- Estimated that, since 1975, at least 250 Australian children in FF-CRS have been involved in FATAL frontal crashes where delta-V was 50km/h or more. Most were uninjured and NONE had serious neck injuries from deceleration forces alone. Many more would have been involved in non-fatal crashes at similar delta-Vs.

Neck Tension Limits

- We could expect simulations of these crashes with CRABI dummies to produced neck tensions in excess of 1500N. Hence the Australian data indicate that the 5% injury risk level is well in excess of 1500N *for CRABI dummies*.
- There are no reliable real world cases or biomechanical data on which neck tension limits for child dummies can be based
- In any case, the injury criteria apply to specific models of child dummy. Identical RTA sled tests produced a head deceleration of 200g in a TNO dummy and 60g in a CRABI dummy.

Neck Tension Limits

- Current/proposed neck limits are based on scaling down adult limits and scaling up some tests (for obstetrics) using stillborn infants in the late *18*00s. Evidently there is an error in the assumptions that have been made.
- In an evaluation of proposed amendments to FMVSS213 (CRS), NHTSA states “No system has yet been tested that will pass the proposed [Nij neck injury] requirement for forward-facing CRABI dummy tests. The feasibility of this test is thus uncertain...It is possible that the proposed neck injury requirement might be too stringent...” - WE AGREE!



CREP

- Buyer's Guide to CRS
- Operated in Australia since the mid-1990s
- Australian Standard tests *plus*
  - Frontal impact @ 56km/h, 34g
  - 45^{o} Side impact
  - For the side impacts a door structure is simulated
  - P6 dummy in frontal, P3/4 in others

CREP 45º SIDE IMPACT

ANCAP tests

International Developments

- Co-author Michael Griffiths has been the Australian representative on the ISO child restraint committee since it was formed in the 1980s
- Different philosophies led to an impasse in the introduction of a world standard.
- Finally ISOFIX developed with two lower anchorage points and “a means to limit pitch rotation of the CRS”
- Most countries now recognise the benefits of top tethers. For example, the US LATCH system

Scope for Improvement

- Side impact performance (ISOFIX and padded side wings should help)
- Reducing misuse (improved anchorage locations and use of tell-tales for correct installation)
- NCAP tests combine CRS with vehicle and can identify compatibility problems

Vehicle Design Issues

Luggage tie-down can be confusing

Top tether relies on seat structure to resist forward movement

Location of top tether anchorages

- •Ease of fitting and ease of adjustment.
- •Luggage interference
- •Seat compliance might allow too much forward excursion
- •Confusion with luggage tie downs (maybe tag the CR anchorages)

Conclusions

- 30 years of real world crashes show that Australian CRS perform exceptionally well.
- Child dummy injury measurements should NOT be used as a primary means of rating CRS performance.
- Concerns about neck injury risk for young children *firmly restrained* in forward facing child seats are unfounded.
- Priority should be given to limiting forward head excursion to minimise risk of head contacts.

Conclusions

- ISOFIX lower anchorages will help in Australia BUT we need to deal with
  - Transporting several children.
  - Potential misuse (prefer self-tensioning lower tethers)
- Monitor vehicle design trends
  - Improve compatibility between CRS and vehicle
  - Accessibility of top tether anchorages
  - Confusion with cargo tie downs
  - Excessive forward movement due to seat motion.

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