

# **TECHNICAL GUIDE To Assist the Implementation of Child Restraint Systems (CRS)** IN LOW- AND MIDDLE-INCOME COUNTRIES



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This guide was prepared for the Global Road Safety Partnership, a hosted programme of the International Federation of Red Cross and Red Crescent Societies. Michael Griffiths was the lead author, with significant contributions from Dr Judy Fleiter, Miranda Hysell, and Taifur Rahman.

Mr Griffiths has extensive research and field experience in mechanical and biomedical engineering and held the position of Principal Research Scientist, Head of the Engineering and Medical Section of the New South Wales government's Traffic Accident Research Unit. This position included responsibility for the management of Crashlab, which went on to conduct most of the development work on CRS Standards and CRS Consumer programmes in Australia. He was foundation member of the ISO/22/36 Working Group 2 on Child Restraint Systems which developed ECE R44 and ECE R129, and continues as a long-term member of the Australian Standards Committee on Child Restraint Systems. He initiated and implemented the concept of restraint fitting stations and the Australian consumer program CREP which compares the safety of CRS. He was also a member of France's "International Task Force on CRS", and a member of the Advisory Board of Children Hospital of Philadelphia's "Partners" study of CRS performance in the USA.

Mr Griffith's first exposure to child restraints in crashes occurred in 1978 while conducting on scene in-depth investigations of crashes, where research teams were dispatched at the same time as the ambulance. He still has a graphic memory of attending a head-on crash where both front-seated parents died in an older model car, while the child survived, uninjured, in a child seat in the rear seat of the car. Alongside the child seat was a blood-stained handmade card reading Happy Mother's Day in a child's scrawl.

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# **MODULE 1:**

## **Introduction and How to Use This Technical Guide**

This Technical Guide has been developed to complement an international programme of work undertaken by the Global Road Safety Partnership to improve the safety of children when using the road. The information in this Guide is intended to assist the introduction of child restraint systems (CRS) into a country once the political commitment has been made to create the necessary regulations.

This Guide:

- assumes that a separate programme of preparatory work has resulted in creating the necessary political will to introduce regulations which will be effective in bringing about widespread use of child restraint systems (CRS) in covered road vehicles;
- assumes that the appropriate expert resources are available to draft the required regulations; and
- aims to provide information on how to establish the necessary technical and consumer support to achieve effective implementation of universal use of CRS.

Regulations need to:

- be preceded by representative surveys to measure the availability of upper and lower anchorages in the existing and prospective (new cars) vehicle fleet
- choose CRS Standards that are appropriate to the economic circumstances, and vehicle fleet, of the jurisdiction (nation/state/ province etc.)
- include provision of consumer support systems, such as Fitting Stations, to achieve correct choice and correct use of CRS
- include provision for how the regulations will be enforced
- identify a system for allowing the ongoing use of CRS obtained by early adopters

- address the issue of requiring future vehicles to have the necessary anchorages for CRS
- where appropriate, identify requirements for the use of CRS on public transport vehicles, from urban taxis through to trains.

This Guide is arranged in modules to allow ready access to information most relevant to the needs of a particular jurisdiction. The reader can determine which module/s to access based on what role they play in delivery of the implementation of the correct and appropriate use of CRS in a jurisdiction. Before introducing regulations for the use of CRS, it is essential to know two things:

**1.** What anchorages for CRS are currently available in the vehicle fleet, and

**2.** What anchorages for CRS are required by existing regulations for new vehicles.

This information needs to be considered when choosing what Standards a jurisdiction's CRS need to comply with. For example, if most of the vehicles in your jurisdiction do not have ISOFIX lower anchorages, you will not be able to safely secure CRS compliant with European Standard R129. To find out what anchorages the vehicles have, a survey of anchorage systems in both the current vehicle fleet and new car showrooms should be done - see Module 4. If your responsibility is to assess the appropriate Standards that your CRS should be approved to, you will find guidance in Module 5. If you are developing regulations for the mandatory use of CRS, you will need to consider enforcement procedures and the necessary training of enforcement officers see Module 8. Ultimately, whatever CRS is chosen by a jurisdiction, parents and carers will need assistance with information on how to choose the appropriate CRS and how to install it correctly in a vehicle – this process is described in Module 8.

## MODULE 2: Occupant Protection Systems - How They Work

#### 2.1. Safe packaging of vehicle occupants

Before the introduction of occupant restraint systems, such as seatbelts and child restraints, crashes often resulted in occupants sustaining serious injury or death because they were ejected from the vehicle, or thrown violently forwards to impact with the dashboard, steering wheel or other parts of the hard and unforgiving vehicle interior.

Seatbelts were originally developed to stop passengers and pilots falling out of the open cockpit of airplanes during acrobatic manoeuvres. During the First World War, engineer Hugh de Haven was the sole survivor of an airplane crash in which others died. He was inspired to make a study of why he survived, and others did not. He concluded that he survived because of the combination of his seatbelt and sufficient space in the cockpit area for his head and upper torso to avoid heavy impact. He published a study of how people survived high falls in a book "Mechanical Analysis of Survival in Falls from Heights of 50 to 150 Feet". In 1942, he established a crash injury research project at Cornell University (Buffalo, USA). In 1955, he and a colleague patented the first modern three-point retractable seatbelt. His motor vehicle injury research team was later renamed the Automobile Crash Injury Research Group in 1953.

#### People knew more about protecting eggs in transit than they did about protecting human heads<sup>1</sup>. Hugh de Haven

Occupant protection systems are an essential element of a total system of safe packaging of the human body within the container of the cabin of a motor vehicle. These systems play a critical role in restraining the human body to help it cope with the forces that occur when a crash happens or when a vehicle slows quickly or stops suddenly. More information about the impact and importance of mandating adult and child restraints in vehicles can be found in this resource: *Seat-belts and Child Restraints: A Road Safety Manual for Decision-Makers and Practitioners*, 2009, World Health Organization.

Restraints work by coupling the body to the chassis of the vehicle, so that while the vehicle exterior is crushing, as the original speed of travel is reduced to zero, the occupant is having their speed reduced over the longest possible distance and time. A seatbelt or CRS does this by attaching your body as directly as possible to the chassis of the vehicle. Other things can help manage deceleration of the body as a vehicle slows. Examples include the use of an anti-submarining seat base<sup>2</sup> and, in frontal impacts, an airbag to 'catch' and more gently decelerate the face/head.

In parallel with the evolution of restraint systems, vehicle manufacturers have developed:

- crushable exterior structures that yield and absorb energy
- cabin space with sufficient space so that flail of the upper torso and head can occur without heavy impact on the vehicle interior
- smooth padded interiors without projecting hazardous features.

Additional information about occupant protection systems is widely available. Here is a <u>link</u> to the Centre for Road Safety that is part of the New South Wales (NSW) government in Australia.

# 2.2. Securing a Child Restraint System to a car

Because CRS are not built into the car, two attachment systems are needed to:

- 1. attach the CRS to the car, and
- 2. attach the child to the CRS.

There are different ways to attach a CRS to the car, with each method having a lower anchorage and something to prevent forward flail or forward movement of the upper part of the CRS where the head is located.

- Lower anchorages can be provided by ISOFIX which are small diameter, round metal bars located at the intersection of the seat base cushion and seat back, known as the seat bite. This is the European system.
- Alternatively, flexible webbing linkages can be mounted from the ISOFIX bars to the rear lower corners of the CRS. Flexible lower anchorages are generally used in North America.
- The oldest system, which remains highly effective, is for the lap part of the seatbelt to pass around or through the base of the CRS.

The European system allows two methods of limiting forward flail, either:

**1.** top tether webbing strap to an upper top tether anchorage, which is a small diameter metal bar typically mounted near the top of and/or behind the seat back, or

**2.** a leg from the floorpan to the front of the CRS.

The Australian and North American systems use a webbing strap to a top tether anchorage to prevent forward flail.

#### 2.3. Securing a child in the CRS

The forces from the restraint system need to be applied to the more robust sections of the human body.

- For an adult, this is with the lap part of the seatbelt restraining the bony pelvis, and the sash part of the seatbelt applying a distributed load over the rib cage.
- For children, with less well-formed bony structures, the loads are applied in an even more distributed manner by two shoulder/sash straps, a lap belt, and crotch straps.

Nearly all CRS use a six-point harness which consists of two shoulder webbing straps, two lap webbing straps, and single or twin webbing crotch straps. Work is underway with CRS and vehicle designs so that a child can also benefit from the protection of a side curtain airbag in a crash where there is a significant side-on impact.



## **MODULE 3:**

## A Short History of Early Adopters' Experience with CRS in the 1980s



The first mandatory laws requiring the wearing of seatbelts in cars occurred in December 1970 in the Australian state of Victoria. By January 1972, every Australian state had mandatory seatbelt wearing laws, making it the first country to achieve this. Observations of the injuries sustained by children in road crashes then led to a realisation that children are not small adults. Children need a smaller size seat, a shorter squab/base with more harness straps for their less developed torso, head and necks.

The need to secure CRS to the vehicle led to an Australian requirement that all new vehicles sold for road use from January 1976 must have holes in structurally sound panels of the "rear parcel shelf" that were suitable for a bolt to take the load of the top tether strap for the CRS. Internationally, this was the first engineering requirement specific to safe travel of children in cars. In the same year, Australia introduced a Standard requiring that the CRS be tested dynamically on a crash sled. Between 1976 and 1980, use of CRS became mandatory in most Australian States.

In many of the early adopter (high income) countries, the introduction of mandatory CRS use laws followed voluntary community adoption rates of approximately 50%, after effective education programmes were deployed. No matter what methods have been used by countries that have introduced CRS, regulation has always been required to make further progress towards the goal of universal use.

Unfortunately, experience from the early adopter countries illustrates that the complexities of attaching

the CRS to the vehicle, and the child to the CRS, sometimes resulted in more than half of the devices being incorrectly installed, or the child being unsafely placed within the CRS. This is an important lesson that can be avoided by countries seeking to mandate CRS use today.

In NSW, Australia's most populous state, the Government's Traffic Accident Research Unit's, (TARU) Crashlab (a crash testing facility) attempted to assist parents and carers by providing one-to-one hands-on assistance with the correct fitting of CRS to vehicles at its Sydney-based facility. The large demand for assistance showed that there was a need to provide one-to-one direct assistance to the wider community on the correct and safe fitting of CRS on a much greater scale throughout NSW, in urban and rural areas. In 1985, Crashlab developed a comprehensive manual which included detailed instructions on how to:

- select the appropriate size CRS;
- securely anchor it to the vehicle; and
- harness a child appropriately in the CRS.

The manual also provided instructions on how to resolve most of the common problems encountered by people using CRS. At the time, Australia had a vehicle fleet with an average age of well above 10 years. Therefore, the manual included detailed instruction (specific to vehicle types/models) on how to retrofit anchorages in older vehicles. TARU's Crashlab then partnered with the NSW Motoring Club, the NRMA, to establish 60 Fitting Stations throughout the state with the aim of providing access to CRS information and fitting support in urban and rural areas. In 2020, there were over 300 Fitting Stations across the state of NSW.

CRS Standards have evolved as lessons were learned from the real-world performance of good design features of CRS in real crashes in many countries. This technical guide contains information gleaned from these early experiences about the practical engineering and human support systems to assist effective compliance with regulation, with the ultimate aim of elimination of injury to child car occupants. Additional information about a range of related topics, including recommendations and supporting evidence, can be found in the following publication: Neuroscience Research Australia and Kidsafe Australia: *Best Practice Guidelines for the Safe Restraint of Children Travelling in Motor Vehicles*, 2<sup>nd</sup> Edition. Sydney: 2020.

# **MODULE 4:**

# Surveys – Measuring Availability and Usage of CRS and Anchorages

Before deciding what CRS Standards should be regulated, it is necessary for a jurisdiction to determine what CRS anchorages are routinely available in the *existing car fleet and the prospective fleet of new cars*. This is essential because different CRS Standards require different anchorages. For example:

- European Standard ECE R129 requires lower anchorages called ISOFIX, and preferably an upper anchorage, for each CRS position
- the Australian and New Zealand, and North American Standards require top tether anchorages for rear seat positions where it is intended to be able to fit CRS.

Another important difference between European Standard ECE R129, and Australian and New Zealand Standard AS/NZS1754, and North American CRS Regulations, is that vehicles fitted with anchorages for European Standard ECE R129 typically only have two seating positions fitted with ISOFIX. It is usually only possible to carry two child occupants in a vehicle reliant upon CRS designed to meet the requirements of ECE R129. In countries with small families (e.g., one to two children), this is not a problem. However, in countries where larger families are more common, this can compromise usage of restraints or force families into larger, more expensive vehicles with three rows of seating.

#### 4.1. Retrofitting Anchorages

Australian Design Rules have required provision for top tether anchorages since 1976. As a result, most vehicle manufacturers make routine provision of the structural requirements for such anchorages, whether they are required by a country's vehicle regulations or not. Similarly, because of the requirement for top tether anchorages in North America, vehicle manufacturers have tended to provide a structural base component for such anchorages routinely in vehicles, no matter what their intended market.

The routine retrofitting of top tether anchorages through Fitting Stations across Australia for over 40 years shows that retrofitting top tether anchorages is generally a relatively simple, low-cost modification. Whilst it is technically possible to retrofit lower ISOFIX anchorages, it is very expensive and may void a vehicle warranty. Therefore, it is recommended that this practice be strongly discouraged or prohibited, depending on a country's regulatory environment.

#### 4.2. Conducting Surveys to Assess CRS Anchorage Availability

When assessing the availability of anchorages, it is important that surveys be "weighted" so that they represent the population of family vehicles, and parent and carer practices, for the broad range of rural/urban and low/middle income populations of the country.

Unfortunately, the assumption that vehicle manufacturers will always comply with regulatory requirements for installation of safety equipment is not always accurate, unless surveys/ audits are rigorously conducted to measure levels of compliance. This is not necessarily a deliberate omission by vehicle manufacturers, but rather, an outcome of the complexity and variations of requirements for safety and environmental features on vehicles by different countries.

GRSP has assisted various countries with the implementation of CRS laws. These experiences have shown that in several countries, the vehicles on sale in new car showrooms do not necessarily have the child restraint anchorages required by the nation's vehicle regulations. This means that it is necessary to have pre-regulation surveys of vehicles in new car showrooms, to assess what the actual availability of anchorages is in new vehicles. It is also necessary to survey the availability of anchorages in the existing vehicle fleet.

## 4.2.1. Assessing the Availability of CRS Anchorages in Used Vehicles

It is necessary to review the numbers of each vehicle brand and model in a country's registration records to assess the vehicles that are most commonly used for transporting children. Once the brands and models of these vehicles are identified, inspections of a weighted sample can be made of the existing fleet.

## 4.2.2. Assessing the Availability of CRS Anchorages in New Vehicles

Reviewing the number of registered passenger vehicles provides guidance on which vehicles (brands and models) need to be inspected. Businesses selling these brands of vehicle can then be located and visited. At the business that sells new cars (e.g., new car showroom), the staff who will be conducting the inspection need to introduce themselves and seek approval for internal access to the vehicles on sale. It may be appropriate to discuss this with the staff of the showroom before the visit occurs. Preferably, a salesperson might assist in showing the locations of the anchorages to the person conducting the inspection. An assessment can be made about whether anchorages are readily visible. It is possible that some anchorages are hidden under the seat or vehicle trim, as shown in these two images.



Sometimes, inspections have revealed that anchorages are technically fitted, but are fitted in such a manner that it would not be possible to easily fit a CRS to them. That is, the vehicle manufacturer may have complied with the technical specification of the regulation, but not with the intention, which is to be able to access that anchorage point to attach a CRS. In the case of top tether anchorages, it is useful to inspect the rear parcel shelf from underneath (i.e., through the boot/ trunk), if anchorages cannot be readily seen from an initial viewing from the top. An anchorage may be present. However, it is important to assess whether there is a structural panel on the rear parcel shelf that appears likely to allow robust retrofitting of a top tether anchorage.

When inspecting vehicles for anchorages, it is useful to measure the availability of:

- a top tether anchorage in each seating position in second and third rows of seating, and
- Iower anchorages (ISOFIX) in each seating position in second and third rows of seating.

Where the vehicle has a cargo compartment, it is important to distinguish between a possible cargo tie down point and a top tether anchorage.

#### 4.2.3. Assessing Anchorage Availability of the Existing Vehicle Fleet – Ensuring a Representative Sample is used

It is necessary to conduct surveys across the breadth of the population, including rural and urban families, and different socio-economic levels of society. A good starting point can be to use a country's registration records to identify the most popular types of vehicle (i.e., vehicle brands, models and year of production). This will need to be supported by an observational survey in different urban/rural and socio-economic regions to assess which vehicle brands, models and years are likely to be carrying child occupants.

Once the target vehicle population of family vehicles has been identified, there is need for first-hand inspection to assess the extent of CRS anchorage availability. Inspections of this nature require access to the interior of a vehicle, and therefore will need to be conducted while the vehicle is stationary, with the owner's consent. This type of survey aims to identify the availability of upper and lower anchorages in the existing fleet of family vehicles so that an informed decision can be made about what CRS Standards are appropriate for the anchorages available in the current vehicle fleet.

# 4.3. Surveying the Standards Compliance of CRS Available for Retail and Online Sale

When conducting a survey of the CRS already on sale and in use in the community, it can be difficult to assess what Standards, if any, the CRS claims to comply with. Standards marks are not always on prominent surfaces, and when found, can be difficult to distinguish from miscellaneous manufacturer marks. Module 5.8 contains information on how to verify certification for CRS that claim to comply with European, Australian and New Zealand, and USA and Canadian Standards.

# 4.4. Surveys of Current CRS that are used in the Existing Vehicle Fleet

To understand the current level of CRS use in a community, the survey needs to answer these questions:

- Is the child in a CRS or not?
- Is the choice of CRS appropriate for the child?
- Is the CRS correctly attached to the vehicle?
- Is the child correctly harnessed to the CRS?
- Is the CRS compliant with a recognised Standard?

#### 4.5. Survey Methodology

#### **Quantitative:**

Surveys measuring whether a CRS is being used or not (the quantitative component) can be conducted in a range of settings. Roadside observational studies can provide information about the proportion of children that are restrained. Roadside observers can record whether a child is seated in a CRS by observing through the vehicle window (i.e., no direct interaction needed). However, it is also possible to conduct a more detailed survey by observing more closely, once a vehicle has stopped. For instance, it is possible to determine whether a child is restrained or not, by conducting surveys in car parks or similar locations, where vehicle drivers can be recruited, as they enter the car park. Surveys can also be conducted at locations where vehicles are momentarily stopped, such as traffic lights. Some survey methodologies have attempted to use traffic light observations to measure quality of restraint usage, including appropriate choice of restraint size, correct attachment of the restraint to the vehicle, and correct harnessing of the child to the CRS (the qualitative components). However, it is difficult to reliably measure this much information in a short time with no access to the vehicle interior.

#### **Qualitative:**

Surveys measuring quality of usage (qualitative), such as correct CRS for child, CRS correctly anchored to car, or child correctly harnessed to the CRS, are better performed in locations such as car parks in large shopping centers, or if targeting certain age groups, outside childcare facilities, pre-schools, schools, or sporting complexes might be useful locations. For a qualitative survey, the researcher needs to be able to approach the driver/parent/carer, obtain consent, and then make an in-vehicle assessment of correct choice of CRS, correct attachment to the vehicle, and correct harnessing of the child to the CRS.

A useful example of an appropriate methodology can be found in a paper by Julie Brown and colleagues<sup>3</sup> and is detailed in Appendix A. This is the methodology used by the Government of NSW, Australia since the 1980s. It is included here as a reference, however, there is scope for more sophisticated systems using contemporary technological aids.

#### Additional information about assessing the current status of CRS use can be found in this manual:



Seat-belts and child restraints: a road safety manual for decisionmakers and practitioners London, FIA Foundation for the Automobile and Society, 2009

## MODULE 5: How to Choose Appropriate CRS Standards

# 5.1. Evolution of CRS Standards in early adopter jurisdictions

Countries that were world leaders in the introduction of Standard for CRS include Sweden, Australia, USA, UK, and some European nations. As a result, the primary Standards for CRS from high-income motorised countries are:

- Europe (UK and Sweden's membership of the European Union resulted in them adopting European Standards)
- USA (because of the large, shared border and commonalities of language, Canadian Standards have, by necessity, become almost identical to USA Standards)
- Australia and New Zealand.

As the first country to adopt mandatory adult seatbelt restraints (1971), then CRS (1980), Australia was the first to experience the flaws and strengths of the early models of child restraint systems. Most early lessons resulted from the inability of a CRS to prevent injury in a specific crash type. The test laboratory was then used to develop design changes which prevented that injury recurring.

Injuries to children resulting from inadequacies of CRS in the field also provided the 'political will' to drive ongoing development of the Standard. Sometimes, it requires a particularly poor performance of a CRS in a crash, resulting in severe or fatal injury, to direct attention to an inadequacy, and, to gain the political will for further improvements in a CRS Standard.

The typical process for evolution of a CRS Standard in an early adopter country has been:

- initially, a Standard is written and covers information about what appears to be the best available features in CRS that are known or available to a researcher. Hopefully due diligence will extend to international enquiries. Obvious flaws are identified and prohibited by dynamic test or visual examination of the CRS
- as the range of CRS that are approved to the fledgling Standard demonstrate failure or success in protecting from injury, the desirable features are incorporated into the Standard, following development of a laboratory-based test
- whilst a recent tool to assist CRS evolution includes more biofidelic test dummies (The Q series), it is useful to note that the past 40 years of CRS development have been guided by real children in real crashes.

#### 5.2. Range of Standards available

The CRS Standards to consider are European R44 and R129, USA FMVSS 213, Canadian CFMVSS213, and Australia and New Zealand AS/NZS1754.

Some countries intending to make CRS use mandatory tend to first consider the more basic European "International Standard ECE R44 for early use with the possible intention of moving to the more demanding European Standard ECE R129 in the longer term.

Whilst called "International", the R44 and R129 are primarily European Standards. When assessing the integrity of a Standard, it helps to be aware that having many countries and vested interests voting on developments to a Standard has advantages and disadvantages.

The Standard with the longest history of field testing and comprehensive laboratory crash test requirements is the Australian and New Zealand Standard, which first introduced dynamic crash sled tests in 1976<sup>4</sup>.

The basic European CRS Standard R44 is mostly for "universal" CRS - that is, CRS which are installed in vehicles restrained by the adult seatbelt system alone, without the use of upper (top tether) or lower (ISOFIX) anchorages.

The more demanding European Standard, R129, is exclusive to CRS and vehicles with lower ISOFIX anchorages. Until most motor vehicles in a jurisdiction are fitted with ISOFIX lower anchorages, R129 CRS can only be used in newer, often more expensive vehicles. For the broader population, particularly lower socioeconomic groups, there is an ongoing need for universal product approved to R44 or better alternative National Standards, such as USA, Canadian, or Australian and New Zealand Standards.



When choosing which CRS Standards to mandate, consider how to maximise the total reduction in injury that can be achieved. Sometimes, more injury can be prevented by getting most children into some form of approved CRS, rather than a small number of children into the best available CRS to the toughest Standard.

It is prudent for regulations to allow equivalent Standards for CRS as determined by the appropriate Government entity. The safety equivalence of CRS needs to take into account the mix of the vehicle fleet in which the CRS will be used. For example, restricting CRS to a Standard which only allows integrated lower anchorages will considerably limit which vehicles are suitable for CRS.



CRS approved to a broader range of national Standards can provide access to more affordable CRS for lower socio-economic groups.

Mature Standards include European R44, European R129, Australian and New Zealand Standard AS/ NZS1754, US Standard FMVSS 213, Canadian Standard CFMVSS 213.

The latter three (3) all have the advantage of offering high levels of crash performance with a top tether strap. Top tether anchorages are a relatively easy retrofit, making them suitable for a country with an older vehicle fleet.

# 5.3. Durability, toxicity, and other requirements of a Standard

Apart from how well a CRS protects a child in a crash, there are many other aspects of the restraint to consider, including: materials, construction, ease of use of buckles, and long term durability. These issues are important considerations and are necessary to control so that when a crash occurs, the structural and functional components of the CRS haven't been degraded by usage and time.

All Standards have specific requirements for durability, corrosion, and other tests of a product's components' capacity to continue to offer safe protection as they are exposed to aging and use. Some Standards incorporate these requirements within the Standard, while others prescribe separate Standards, usually within the same Standards organisation.

Some examples of CRS component durability are:

- The Australian and New Zealand Standard AS/ NZS1754 includes product conformity (i.e. batch testing), of flammability, salt spray testing, toxicity, UV stabilisation, durability.
- The US Standard FMVSS 213, and its near equivalent Canadian Standard CFMVSS213, include requirements for flammability, webbing breaking strength, webbing abrasion, buckle abrasion, resistance to light, resistance to micro-organisms, corrosion resistance, temperature tolerance, buckle release activation, and partial engagement.

European Regulations R129 and R44 include requirements for corrosion, dust resistance, webbing strength, light conditioning, and adjuster tests.

The extent to which these durability requirements need to be specified is, to a degree, dependent upon the consumer regulations required in a country and how regulations are written, so that a product which is designed to do a certain job has the adequate durability to continue offering that level of performance as it is exposed to wear and tear and ageing processes.

# 5.4. Safety differences between CRS Standards

Generally, each of the mature CRS Standards cited in Section 5.2 has different sled tests to assess the crash test performance of CRS. As at 2021, R129 and AS/ NZ1754 are the most rigorous, however correctly used CRS approved to any of these Standards offer a major improvement in safe travel for children compared to unrestrained or an adult seatbelt.

In choosing appropriate CRS Standards, a more important difference to consider is the method by which the restraint systems are allowed to, or are required to, anchor the restraint system to the vehicle. There is little value in choosing a CRS Standard which requires anchorages that are not readily available in the vehicle fleet that transport children.

Children are almost universally secured into the CRS by a 5- or 6-point harness. Although some shield (instead of harness) type CRS are still allowed, their effectiveness is highly controversial amongst CRS injury biomechanics experts. Fortunately, the means by which children are secured in a child restraint is generally an area of commonality among all mature Standards.

#### 5.5. Crash test performance of CRS

The dynamic crash tests conducted on a sled are intended to be representative of conditions to which a CRS will be exposed in a real crash (see photographs below of various tests, courtesy of Crashlab). The broader the range of dynamic crash tests, the broader the range of crash situations the Standard attempts to provide protection for. Generally, it is the dynamic crash test results and ease of use which ultimately determine the overall level of safety offered by a CRS. More information on how CRS are tested can be found at the <u>website of ChildCarSeats</u>.

#### **Frontal impact test**



Side impact test



**Oblique impact test** 



#### 5.5.1. Frontal impact tests

- European R44 has a frontal impact test requiring a peak velocity within the range of 48 to 50 km/h, and g forces within the range of 20 to 28g.
- European R129 has a frontal impact test requiring a peak velocity within the range of 50 to 52 km/h, and g forces within the range of 20 to 28g.
- USA FMVSS 213 has a frontal impact test requiring a peak velocity within the range of 45 to 48 km/h, and g forces within the range of 19 to 25g.
- Australian and New Zealand Standard has a frontal impact test requiring a peak velocity within the range of 49 to 51 km/h, and g forces within the range of 24 to 34g.

#### 5.5.2. Rear impact tests

- European R44 has a rear impact test requiring a peak velocity within the range of 30 to 32 km/h, and g forces within the range of 14 to 21g.
- European R129 has a rear impact test requiring a peak velocity within the range of 32 to 34 km/h, and g forces within the range of 14 to 21.
- USA FMVSS 213 has a rear impact test requiring a peak velocity within the range of 29 to 32 km/h, and g forces within the range of 14 to 18g.
- Australian and New Zealand Standard AS/NZS 1754 has a rear impact test requiring a peak velocity within the range of 32 to 34 km/h, and g forces within the range of 14 to 20g.

#### 5.5.3. Lateral/side impact tests

- European R44 and USA FMVSS 213 do not include side impact tests.
- European R129 has a side impact test with a moving intruding door requiring a peak velocity within the range of 23 to 26 km/h.
- Australian and New Zealand Standard has two side impact tests, one with a door where the door is intruding at 32 to 34 km/h and one without a door where the peak velocity change is 32 to 34 km/h, and g forces within the range of 14 to 20g.

#### 5.5.4. Inverted/upside down tests

The Australian and New Zealand Standard has a unique inverted/upside down test. It was created to test for ejection in rollover. The test requires a peak velocity within the range of 16 to 18 km/h, and g forces within the range of 8 to 15g.

#### 5.6. Tabular summary of Standards requirements

#### **VEHICLE CONNECTIVITY**

		LOWER ANCHOR		ANTI FLAIL			
STANDARD	STANDARD Seatbelt ISOFIX rigid Latch ISOFIX flex		Top tether	Leg	Sash part of seatbelt		
European R44	Lap part of seatbelt	X	Adaptor strap available	X	X	$\checkmark$	
European R129	X	√	X	√ or leg	√ or top tether	X	
AS/NZS 1754	√	$\checkmark$	√	√	X	X	
FMVSS 213	√	√	√	√	X	X	
CFMVSS 213	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	X	X	

#### **CRASH TEST REQUIREMENTS**

	ENERGY	FRONT TEST		REAR TEST		SIDE TEST			INVERTED		
STANDARD		ΔV	G	ΔV	G	Open bench seat		Intruding door		ΔV	G
						ΔV	G	ΔV	G		
European R44	To be determined	48-50	20-28	30-32	14-21	None	None	None	None	None	None
European R129	To be determined	50-52	20-28	32-34	14-21	None	None	23-26	N/A	None	None
AS/NZS 1754	To be determined	49-51	24-34	32-34	14-20	32-34	14-20	32-34	N/A	16-18	8-15
FMVSS 213	To be determined	45-48	19-25	None	None	None	None	None	None	None	None
CFMVSS 213	To be determined	?	?	?	?	None	None	None	None	None	None

#### **PARENT/CARER SUPPORT FEATURES**

STANDARD	SEATED SHOULDER HEIGHT MARKINGS	PUBLISHED CONSUMER SAFETY RATING	EXPIRY DATES	CERTIFICATION	BATCH AUDITING
European R44	X	√	Rare ?	Third party audited	To be determined
European R129	X	$\checkmark$	Rare ?	Third party audited	To be determined
AS/NZS 1754	√	√ CREP	None	Third party audited	√
FMVSS 213	X	√IIHS	Common	Self-certification	X
CFMVSS 213	X	?	Common	Self-certification	X

#### 5.7. Brief Summary of Test Requirements

The dynamic test requirements of the Australian and New Zealand Standard AS/NZS1754 generally require the CRS to manage the highest level of energy. European Standard R129 and the Australian and New Zealand Standard AS/NZS1754 are, as of 2021 the more demanding Standards available.

While the requirements of the US and Canadian Standards are less demanding, their forward flail is controlled by top tether straps, which can provide high levels of head protection, and top tether anchorages are a relatively easy retrofit for countries with an older vehicle fleet.

For countries with a large proportion of the population in low to mid socio-economic groups, there is potentially a strong case for recognising USA and Canadian Standards, because they have the potential to offer a larger range of more affordable CRS. This approach can offer a higher overall level of protection to child passengers.

# 5.8. Validating CRS Manufacturers Claims of Compliance with Standards

Conformity of CRS to National Standards is regulated by the relevant government organisations. European regulations R44 and R129 have to accommodate CRS product certification over all the member countries. The way that different jurisdictions assess conformity is described in the following sections.

## 5.8.1. Assessing Compliance with European Standards R44 and R129

R44 and R129 are both administered by the United Nations *World Forum for the Harmonisation of Vehicle Regulations* (WP.29). WP.29's rules and procedures are governed by international treaties as described in the *World Forum for the Harmonisation of Vehicle Regulations* WP29 - <u>here</u>.

The fundamental Agreement is known as "The 1958 Agreement concerning the adoption of uniform technical prescriptions for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles and the conditions for reciprocal recognition of approvals granted on the basis of these prescriptions".

UN Member States which have signed the Agreement are technically obliged to recognise/ accept each other's type-approvals to UN Regulations. However, some signatories, such as Australia, do not accept R44 and R129. As noted earlier, Australia pioneered the use of mandatory seatbelts for adults in 1971, followed by a new Standard for CRS in 1976 before the introduction of R44 in 1981 and R129 in 2013. Australia only allows CRS approved to the Australia and New Zealand Standard-ANZS 1754.

In Europe, each Member State typically operates its

own national Type-Approval Authority that is part of a government agency. These Type-Approval Authorities issue a certificate of approval specific to each CRS product and are ultimately responsible for the whole process. However, they usually contract out the work to a designated Technical Service. Each Type-Approval Authority might work with several Technical Services, even for the same UN Regulation. These Technical Services do not have to be in the same country as the Type-Approval Authority and are often commercial companies that are independent of government.

A list of Type-Approval Authorities and their Designated Technical Services for R44 (p. 93) and R129 (p. 263) can be found <u>here</u>.

There is a vetting process before a Type-Approval Authority accepts a Technical Service and everything must be reported to the UN. For example, the United Kingdom's Transport Research Laboratories (TRL) commenced a commercial service offering R44 and later R129 type-approvals. It became a designated Technical Service for the UK Type-Approval Authority (VCA), the Netherlands (RDW), and later, a Technical Service for the German Type-Approval Authority (KBA). Each application required extensive documentation and audits. Although the type-approval certificates are issued by the Type-Approval Authority, the first point of contact for a CRS manufacturer is usually a Technical Service. That is typically a matter of proximity to the CRS manufacturer; other factors include cost and timeliness.

When attempting to verify the approval of a product, the first check is the type-approval label. This shows the country (and hence Type-Approval Authority) that issued the certificate and also the type-approval number. Whilst these things could potentially be forged, a Government Standards organisation can contact the Approval Authority to check whether the approval number matches the product. There is no online register of approval or similar. Nevertheless, the system has proven to be reasonably reliable. The Type-Approval Authorities and major R44/R129 Technical Services regularly meet to discuss issues of interpretation<sup>5</sup>.

## 5.8.2. Assessing Compliance with Australian and New Zealand Standards AS/NZS1754

#### 5.8.2.1 How to check certification

Compliance of child restraints with the Australian and New Zealand Standard 1754 can be checked on the SAI Global Certification <u>Register</u>.

This Register is publicly accessible so that an interested party (e.g., a government department, individua citizen), can verify that the CRS has achieved certification with SAI Global. The Register allows you to check the original certification of the product, and also that the product continues to be certified. The search result displays the company name, the production site, and the Standard. Australian manufacturers currently use multiple production sites to manufacture their CRS. Each individual site is assessed independently and each product from those sites is assessed individually. To view the scope of the certification to which the product is approved, the searcher clicks on the license number or manufacturers name.

A SAI Global registered company can choose to display a copy of their SAI Global certification credentials on their own website. They do this by copying the URL link from the SAI Global Register's license page<sup>6</sup>.

#### 5.8.2.2. The Role of the Standard

The Australian and New Zealand Standard AS/NZS1754 is the mandatory Standard nominated in the legislation that controls what can be sold and what can be used on public roads in Australia. New Zealand allows CRS approved to a broader range of Standards.

AS/NZS1754 has been evolving since the mid-1970s. Many updates with more demanding requirements have been added since then. Consumer legislation controls what can be sold, and road rules control what can be used on public roads. They both specify what versions of the Standard the CRS must comply with.

#### 5.8.2.3. What CRS can be sold in Australia

The Australian Competition and Consumer Commission (ACCC) mandates which child restraints can be sold in Australia. Consumer Protection Notice No. 3 of 2014 states that the following three editions of the Australian and New Zealand Standard can be sold in Australia:

- Australian/New Zealand Standard AS/NZS 1754:2013, Child restraint systems for use in motor vehicles, approved by Standards Australia and published on 7 June 2013; or
- Australian/New Zealand Standard AS/NZS 1754:2010, Child restraint systems for use in motor vehicles, published 24 February 2010 as amended by, and incorporating, all amendments approved and published by Standards Australia prior to that date; or
- Australian/New Zealand Standard AS/NZS 1754:2004, Child restraint systems for use in motor vehicles, published 8 November 2004 as amended by, and incorporating, all amendments approved and published by Standards Australia prior to that date.

#### 5.8.2.4. Granting Certification to a CRS

The system for certification is a third-party system. That is, the testing is not conducted by the organisation which creates the Standard, or SAI Global which is the certifying authority. Rather, testing and visual examination is delegated to independent external audited test facilities. The main certification body recognised by JAS/ANZ is SAI Global Services. JAS/ANZ is a facility recognised by the Trans-Tasman Mutual Recognition Act 1997 between Australia and New Zealand.

# Joint Accreditation System of Australia and New Zealand

Framework



Joint Accreditation System of Australia and New Zealand is an accreditation authority and framework, with the purpose to enhance national, trans-tasman and international trade via accreditation to achieve international recognition for the excellence of Australian and New Zealand goods and services. JAS-

ANZ provides a certification mark for use on goods and services that meet accreditation requirements.

SAI Global conducts certification testing and approval for child restraints to AS/NZS1754:2013. That is, SAI Global will only certify child restraints to the latest edition of the Australian and New Zealand Standard AS/ NZS1754.

SAI Global publishes a Product Compliance Program Type 5, in a document which sets out the requirements of the SAI Global Certification Scheme. This document needs to be read in conjunction with the relevant Standard, SAI Global Technical Schedules, the Rules of Use for the relevant certification trademark, and SAI Global Terms and Conditions.

## 5.8.2.5. How does a CRS Manufacturer achieve certification to AS/NZS1754

To initiate product certification, SAI Global require the following:

- Product Testing Type Testing and ongoing Batch verification testing in accordance with the requirements of AS/NZS1754:2013 and Technical Schedule
- Initial Certification and Surveillance Audits The manufacturing and design requirements are initially assessed through the initial certification audit, which is a two-part process administered by SAI Global.

**1)** Part One is assessment of the factory's quality assurance system to ensure compliance with ISO 9001 and SAI Global; Technical Schedule to AS/ NZS1754 and PCP.

**2)** Part Two is assessment for the actual individual product, components, sub assemblies, and final assembly; traceability of components, and test results.

There are also ongoing surveillance audits. The frequency of such audits is determined by SAI Global. A routine surveillance audit is a check to verify that nothing has changed from the initial Part One and Part Two audits. It aims is to verify the traceability

requirements, including that the batch verification dynamic testing has been conducted in line with the test frequency, as specified in Technical Schedule AS/ NZS1754 (also specified in AS/NZS1754:2013).

- License Renewal The License to distribute each CRS model expires 5 years from the initial certification date. The license can be renewed upon confirmation that the product can demonstrate ongoing compliance with the current Standard.
- License Endorsement Modifications or additions to the child restraints may be included in the License during the period of validity of certification. These modifications or additions can take the form of;
  - Modification to a certified Product
  - Addition to the list of certified Products
  - Change of brand or trade name
  - Change in name or address of the Licensee.

SAI Global has a Technical Schedule TS 1754 (AS/ NZS1754:2013 Child Restraint Systems for use in Motor Vehicles). This Technical Schedule describes the following;

- Design Control
- Product Specification Brand name, Model No., Model Name, Type Designation
- Testing Process Test listed In Table 5.1 of AS/ NZS1754:2013
- Test Laboratory
- Production Inspection and Batch Testing.

#### 5.8.2.6. An example of Certification

Assessment of confirmation of compliance to the Standard during the certification process typically takes in excess of 28 dynamic crash tests for a convertible rear facing infant restraint-forward facing child car seat, covering the age range from birth up to 4 years. The only crash test facility authorised to conduct the original certification testing of a child restraint to AS/ NZS1754 is the NSW State Government's Crashlab. The process for seeking certification includes:

- The child restraint manufacturer makes an application to SAI Global
- SAI Global requests Crashlab to conduct the Dynamic tests and Visual Assessment.

The other testing required for certification (not conducted by Crashlab) includes:

- webbing
- metal parts

- toxicity
- plastic stability.

Once a CRS obtains certification to the requirements of the Standard, SAI Global publishes that information on its website, so that there is public access to the data which has been used to certify compliance with the requirements of AS/NZS1754:2013. The system is intended to ensure that the process of certification is transparent.

Should a CRS product fail to meet the requirements of certification during assessment by Crashlab, the CRS manufacturer has to show what rectification they have made to fix any initial non-conformance. This process prevents a manufacturer from "laboratory" shopping until their product achieves a pass. CRS Batch Verification testing is overseen through a strict product batch register which is audited annually by SAI Global.

## 5.8.3. Assessing Compliance with USA Standard FMVSS213

The USA has a self-certification system which delegates full responsibility to the CRS manufacturer to conduct the necessary testing including visual assessments to ensure that the CRS complies with FMVSS213. The USA Federal Government used to conduct audits by purchasing a limited sample of some CRS and subjecting them to the full requirements of FMVSS213. If any CRS were found to be non-compliant or deficient, that information was publicised, and CRS manufacturers were required to show cause.

The USA's CRS using community is mostly reliant upon the pressure resulting from the possibility of litigation against a CRS manufacturer to ensure that CRS manufacturers' products comply with FMVSS213. If litigation occurs, a CRS manufacturer's primary defence is to be able to demonstrate that the CRS was tested and passed all requirements of FMVSS213. The need to be able to successfully defend litigation attempts is likely to be a factor with some CRS manufacturers in the USA, to ensure that their CRS are fully compliant with the mandated standard of FMVSS213. CRS manufacturers maintain their own records of individual CRS numbering with the intention that it can be traced back to production batches.

The American Academy of Paediatrics attempts to maintain an updated list of all CRS alleging certification to FMVSS213. If there is a need to check whether CRS are legitimately certified to the USA's FMVSS213, then the individual CRS manufacturer can be contacted, and should be able to supply the necessary confirmation or otherwise as to whether the numbered Standards approval labels on the CRS were validly issued.<sup>7</sup>

# MODULE 6: Regulations – Basic Regulations and Options

# 6.1. Regulation requiring mandatory use of CRS in vehicles<sup>8</sup>

Regulations governing the introduction of mandatory CRS use must be sufficiently comprehensive so that they can address the common challenges experienced in relation to CRS. In early adopter countries in the 1980s, regulations tended to develop as needs arose. This approach can result in a poorly coordinated 'patchwork' of documents.

However, this outcome need not occur today. Countries that are about to adopt mandatory CRS use have the advantage of knowing in advance about the wide extent of regulation required and can, therefore, collate all of the requirements and years of evidence into a succinct document. A good example of a comprehensive, simple, and readable document is the 2019 Philippine's Republic Act number 11229, also known as the 'Child Safety and Motor Vehicles Act'. A complete copy is available via this link.

The Implementing Rules and Regulations (IRR) for the Republic Act 11229 can be accessed via this <u>link</u>.

Comprehensive regulations for the mandatory use of CRS should include:

- Names of all the relevant Government organisations with responsibility for the implementation of the quality of the product, correct choice of product and correct use of product
- A statement of the policy and intention of the Regulation which can then provide a guide for any future clarification of the purpose of the detail in the Regulations
- Definition of all terms used in the Regulations
- What private vehicles the rules apply to. For example, in the Philippines, it is described as all covered vehicles
- Consideration of what are appropriate and achievable usage of CRS in public vehicles. There are different needs for CRS in taxis which are conventional sedan vehicles, compared to CRS in large buses
- An initial exemption for 2- and 3-wheeler vehicles and mid-size buses with side facing seats, whilst simultaneously developing a plan for phasing out the transport of children in such vehicles
- Specifics of what constitutes correct use and specifics of what is prohibited

- When the rule applies, for example, when the vehicle is moving or when the motor is running
- Definitions of appropriate CRS for children of different ages and sizes
- Specifics of how the CRS should be attached to the vehicle
- Specifics of how the child should be harnessed to the CRS
- Exemptions For example, when the child is of sufficient height and size to be able to safely use an adult seatbelt or medical exemptions. To prevent fraudulent or inappropriate use, it is important that medical exemptions are **not** widely obtainable from local doctors, and that they only apply for short periods of time (not indefinitely). Some early adopter countries found that if exemptions become widespread, there is a decline in enforcement, with a resulting reduction in compliance levels
- A Regulation about whether children can travel in the front seats and whether CRS should be allowed to be placed in the front seats
- Are CRS manufacturers allowed to have expiration dates? The research evidence base does not support the case for expiration dates. Nevertheless, if there is an expiration date, it is suggested that there should be a regulatory requirement that the date be visually evident so that a consumer can consider the potentially short life of the CRS before making their purchase
- Which CRS Standards are recognised? i.e., European Standards are R44 and R129, or other National Standards such as the US, Canada and Australia
- The process for checking credentials of CRS manufacturers' claims of compliant product
- An approval process for existing CRS (i.e., CRS in use before regulations were introduced). People who bought a CRS should not be punished for possibly having purchased a CRS to a Standard which is not ultimately accepted. Therefore, there is a need to have a system where CRS purchased before the rule can be assessed, and an informed judgement made as to whether the restraint is safe for ongoing usage. In the Philippines, this is done by trained officers who make a check to see if the child restraint is approved to a recognised

National Standard. If the child restraint is approved to a recognised National Standard, it is given a label from the Philippine's Standards Organisation with a hologram which makes it difficult to forge. This retrospective approval system should only be available for a limited time of no more than one year. A longer period of retrospective approval could be abused, as a way of bypassing consumer standards and vehicle regulation. For example, a longer time would allow parents/carers to get retrospective approval for less effective CRS

- Each child restraint must have an instruction manual. Widespread internet access means that the manual might consist of a quick start instructional guide, and then provide reference to a website or YouTube or similar
- Establishment of fitting stations including accreditation and training of fitters (See Module 8)
- Determination of who can deliver the training of fitters
- Need for an enforcement regime including allocating the responsibility for enforcement of CRS usage to the relevant Government Departments
- A training program for enforcers of CRS usage
- The detail of the enforcement procedure including provision for training so that enforcement is done in a manner that does not cause distress to children
- Detail of penalty for nonuse, incorrect use, or inappropriate use of the CRS
- Details of an adjudication process where a penalty is challenged
- Consumer protection including a process for consumer complaints and protection relating to the quality and Standards approval of the CRS
- A routine check of retail and online sources of CRS to see if the products are approved to appropriate Standards
- A schedule of specific penalties for different offence types; for example, driver not compliant with CRS use laws, or CRS distributors selling unapproved CRS, or drivers using unapproved CRS, or forgery of Standards approval
- Planning for publicity and marketing programmes to educate the public about why CRS are needed and how to choose and fit CRS correctly
- Schemes to assist the accessibility and affordability of CRS to lower income groups
- Consideration of inclusion of a regulation that nonapproved CRS cannot be manufactured or imported into the country for sale / use
- Provision for review of the effectiveness of the Regulation within a few years of introduction

# 6.2. Enforcement Procedures to Encourage Correct Usage of CRS

Enforcement is a critical component of implementing legislation. The opportunity for quality enforcement of correct CRS use in some early adopter countries was limited because enforcement was generally the responsibility of General Duties Police who often did not have adequate knowledge about the correct use of a child restraint system. Fortunately, lessons have been learnt from these early enforcement experiences, and an example of good practice applies in the Philippines where all enforcing police officers will be required to have undertaken a Level 1 CRS Fitters' course. Mandating training for enforcement agents may not be necessary in every jurisdiction, but consideration should be given to including CRS enforcement in the curriculum of enforcement training academies.

A good model for enforcement procedures should include descriptions of the training that enforcement officers will need so that they are able to recognise:

- inappropriate selection of a CRS for the child,
- incorrect attachment of the CRS to the car,
- incorrect harnessing of the child to the CRS.

It is also useful to include instruction for enforcement officers on how to conduct their inspection without causing distress to the child or other vehicle occupants. A good example is the Philippines Regulation RA11229 *Provisions for Child Safety*, a complete copy of which can be found <u>here</u>.

As described in the World Health Organization's 2009 guide: *Seat-belts and child restraints: a road safety manual for decision-makers and practitioners*, enforcement efforts should be visible, repeated, well publicized, and consistent. The following points are recommended for CRS enforcement:

- enforcement be directed to locations where the likelihood of stopping a vehicle transporting children is high (e.g., roads leading to schools, kindergartens, shopping centres);
- the enforcement operation is carried out in such a way that drivers/parents and children are not exposed to passers-by;
- the operation is, nevertheless, carried out in a highly visible manner, with signage and notifications to other road users to promote a general deterrent effect of enforcement operations; and
- the enforcement checkpoint also includes CRS local providers, Fitting station staff etc., who can provide drivers/ parents on scene with all relevant information and assistance in the correct installation of CRS in the vehicle (this might be particularly useful in the early stages of implementing a new law).

Some useful recommendations for enforcement personnel on how to approach children can be found in this document prepared by the United Nations: *Training Programme on the Treatment of Child Victims and Child Witnesses of Crime for Law Enforcement Officials*, United Nations, April 2015. Additional discussion about enforcement of occupant restraints can be found in *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Officers*, 2020.

The enforcing officer needs to know:

- When the requirement for CRS applies to a vehicle (e.g., when the vehicle is moving, when the motor is running, when the driver's seat is occupied?)
- How to find lower ISOFIX anchorages and upper top tether anchorages.
- How a CRS needs to be attached to those anchorages.
- Information on how to secure a CRS with the adult seatbelt only, if there are no upper or lower

anchorages points.

- How to determine if the CRS is the best one for the child. Australia and New Zealand have a shoulder ride height line integrated into the CRS, which is the best determinant of torso fit within a CRS. However, other Standards are still dependent upon advice based on child's age/weight/height.
- Any webbing straps attaching the CRS to the vehicle, or the child to the CRS, need to be firmly buckled without twisted straps.
- The shoulder/sash component of an adult seatbelt must pass across the centre of the child's chest, and not the neck.
- The lap part of the adult seatbelt must fit across the top of the child's thighs and hips, not pressing rearward against the abdomen.
- Children taller than 1.5 metres can use the regular adult seatbelt rather than a CRS.

Type of CRS	Age Group (approximate range)	Height (approximate)
Rear-facing child seat	Infants - (from 0 to 6-15 months depending on the Standard)	2 feet, 8 inches (2'8) and below
Forward-facing Child seat	Toddlers and pre- schoolers (from 6-15 months up to 4-5 years depending on the Standard)	Between 2'3 – 4'4
Booster Seat	School-aged children or children who have outgrown the child seat but are not fully able to use the adult seat belt (4 -12 years)	Between 4' – 4'11
Convertible Seat	Can cover various age groups	Adjustable as the child grows

#### This table provides a rough guideline of the restraint types for children of different ages and sizes.

#### 6.3. CRS Product Safety Standards Labels

The following labels indicate what Standards the CRS complies with.





#### UN Regulation No. 129 (UN R129)





The letter "E" in a circle and the country code of the state responsible for approval (e.g. "1" for Germany)

Approval number (00 for the series of amendments with subsequent approval number, in this example: "2439")

The designation of the Regulation 129 including the series of amendments (here: 00)

#### Australian AS/NZS 1754



#### **Canadian CFMVSS 213**



# USA FMVSS 213

#### 6.4. Possible Regulatory Inclusions

Regulations can be strengthened by including:

- Prohibition on children being left in a motor vehicle without the presence of an adult parent or carer.
- A description of what a law enforcement officer should and can do if they encounter a child unattended by an adult parent or carer in a vehicle.
- A rule disallowing a child to sit in the front seat whilst a vehicle is being driven or the engine is running.
- A requirement that the laws can only be enforced by a law enforcement officer who has undergone a specific training course on correct use of CRS.
- The circumstances in which a law enforcement officer is permitted to make an assessment of correct restraint of a child.
- Clarity as to whether enforcement of a CRS regulation can be a primary offence.
- Where the non-compliance is of a relatively minor nature, provision empowering the law enforcement officer to advise or assist with rectification.
- Provision for a law enforcement officer to direct a vehicle to a fitting station.

- Note requiring that the enforcement be conducted without causing distress to a child occupant.
- Note requiring that all the communications be through the driver of the vehicle, with no direct communication with the child allowed.
- Note clarifying that neither the child nor the child restraint can be required to be removed from the vehicle by the law enforcement officer.

# 6.5. Guidelines for Training and Deputation of Enforcement Officers

Unlike the wearing of a seatbelt, the correct selection and usage of a child restraint is a more complex matter. Regulations can hence usefully include:

- Development and description of the training module
- A requirement that all CRS law enforcement officers have undergone the necessary training
- Formal recognition and deputisation of law enforcement officers empowered to enforce correct use of CRS.

# MODULE 7: Types of CRS

#### 7.1. Introduction

Infants should be rear-facing so that crash acceleration loads are applied through their back, at close to right angles to their spine, with their head directly supported by the restraint, independent of their neck. As children grow, their skeletal structures strengthen. They can then transition from rear-facing, where the optimum condition will be having the loads applied at right angles through the child's spine, until they are forward-facing, where the deceleration loads are applied to their torso through a five (5) or six (6) point harness.

In the 1980s, the initial perceived dangers of turning a child around too early, were that the neck was not sufficiently developed to sustain heavy frontal impacts without injury. The age at which different jurisdictions advise about children transitioning from rear-facing to forward-facing in a six (6) point harness differs. Some experts recommend that the criterion is when a child's neck muscles can support its head (approximately 4 + months of age), whereas other experts recommend it is when a child can sit up (approximately 6 + months of age).

Some jurisdictions, particularly Sweden, strongly maintain that children need to be rearward facing until beyond the age of five. Whilst Sweden accepts the European Standards indicating a 15 months transition, its consumer programme recommends an older transition age. The Swedish preference for CRS to be rear-facing led to a practice of infant CRS being located in the front seat so parents could see the child's face. This became a major hazard when front seat dash mounted front airbags were first introduced. By contrast, more than three decades of monitoring outcomes of actual crashes in Australia has found that a child can safely transition to forward-facing at five to six months of age<sup>9</sup>.

Whilst the ISO (International Standards Organisation) Standard for Child Restraints recommends 15 months as the transition age from rearward to forward facing, this was not an evidence-based decision. Rather, it was a compromise between the different views of member Countries of the ISO CRS committee.

The Australian and New Zealand turnaround age of approximately six months is evidence-based, following a history (since 1976) of children being forward facing from the age of five to six months without any reports of neck injury in severe frontal impacts. Whilst Australia's first Standards Approved infant restraint in the mid-1980s fitted most children, some bigger children had to graduate into forward-facing seats at the age of 5 months. When the neck injury controversy arose in Europe, NSW's Crashlab alerted the Spinal units and Coronial Forensic pathologists at Children's hospitals in Australia, asking to be notified of any neck injuries to children in forward-facing CRS. As Crashlab did not receive any reports of a child receiving a neck injury in a (correctly attached CRS without intrusion into occupant space) forward-facing child seat, it deduced that the evidence from actual crashes is that, from a head and neck injury perspective, it is safe for children to be forward-facing from the age of 6 months on<sup>10</sup>.

The 1980s cases of head and neck injuries in forwardfacing CRS were mainly from European jurisdictions which did not have operational anti-forward flail device on the CRS, such as a top tether. In other cases, the child's shoulders were not restrained by the harness. This allowed the child's upper torso to flail forward to the extent that the head impacted with some part of the vehicle interior. The combination of head impact while the neck was in tension resulted in neck injury. A possible biomechanical explanation for this is that in heavy frontal crashes, the neck of child in a CRS with top tethers are in strong flexion (rather than tension) and are better constrained so their head cannot impact the vehicle interior. When a child first changes from rearfacing to forward-facing, European and Australian and New Zealand Standards require that they be secured by a five- or six-point harness, including shoulder, leg/ pelvic and crotch straps.

In Australia in the 1970s, experience with four-point harnesses demonstrated that children could slide down under the lap component of the webbing harness. The pressure of the webbing on their neck restricted breathing, sometimes fatally. These findings led to a recall and an urgent Standards revision to include a design requirement that CRS must have crotch straps. Despite initial concerns, there have never been any reports of long-term injury to the genitalia region in heavy frontal impacts from crotch straps. There have been occasional reports of transient "haematuria" (blood in the urine), but no reports of long-term consequences.

As the child develops, they can transition from a forward-facing CRS with harness, to a booster, which elevates the child so that the geometry of both the lap and sash parts of the adult seatbelt safely secure the child's torso. Also, a side curtain airbag in the vehicle can offer further protection to the child's head. Eventually, the child can safely transition into an adult seatbelt.

#### 7.2. Securing the CRS to the Vehicle and Anti-flail Devices – Anchorages including Seatbelts, Top Tethers, Legs and ISOFIX

To offer the optimal level of protection, CRS need to be firmly anchored to the vehicle structure. Learning how to optimise the secure attachment of a CRS to a vehicle structure was an evolutionary process. The means of attaching early CRS to the vehicle included: drilling holes and bolting up to 4 webbing straps to the vehicle's structure, and adapting the adult 3-point (lap/ sash) seatbelt to attach the CRS to the vehicle.

Early research found that the lap part of the 3-point (lap/sash) seatbelt could provide good restraint of the lower part of the child seat/infant restraint, but the geometrical requirements of the sash part of the seatbelt required to provide good restraint to an adult, meant that the sash part of the adult seatbelt could not adequately limit the forward flail of the upper part of the child seat, thus exposing the child's head and neck to injury. In the early 1970s, test laboratories found that an effective way to limit this flail (with its associated high

risk of head injury to the child) was to fit a top tether strap which directly secured the top of the CRS to the "parcel shelf" of vehicles.

The USA pioneered the use of top tether straps, however authorities perceived there would be insurmountable difficulties with ensuring top tethers were correctly fitted and used, so other options were sought. In Australia, the perceived problem of poor usage of top tether straps was largely resolved by the establishment of networks of Fitting stations which offered direct support to parents and carers. Provision of top tether anchorages for CRS became a mandatory requirement in all new passenger vehicles in Australia in 1976. The success of top tether straps in preventing head injury to children was presented by Australian researchers at international road safety conferences. Top tethers subsequently came into use in other countries, including Canada, France, and USA by 2000.

#### Forward-facing CRS with top tether





In Australia, top tether anchorages are required in private passenger vehicles, in vehicles used as taxis, and in several rows of seating in intercity coaches (not urban buses which allow standing). Initially, the top tether anchorage provision was a structurally sound member of the rear "parcel shelf" into which a bolt could be fitted. Later, the top anchorage became a closed loop or bar onto which a hook could be directly fastened.

Under the auspices of WP29, the International Standards Organisation Committee for Child Restraint Systems initially developed a four-point anchorage

**Rear-facing CRS with leg** 

system intended to securely and firmly locate each corner of a child restraint. However, later, this became a two-point rigid bar anchorage system located at the seat bite, which became known as ISOFIX. The CRS then requires an anti-flail device which can be either a top tether strap, or a leg projecting forward from the child restraint and bracing on the floor pan of the vehicle's rear seat(s).

Some perceived potential disadvantages with "legs" are that they are dependent upon the strength of the vehicle's floorplan and impose substantially higher loads on the ISOFIX anchorage bars<sup>11</sup>.

#### Forward-facing CRS with leg



# 7.3. Convertibles – Advantages and Disadvantages

Convertibles were originally CRS that could be changed from rear- to forward- facing mode to extend the age range they could accommodate. In recent years, convertibles in forward-facing mode have extensions which allow for larger torso sizes, thereby extending the range for which the CRS can be occupied.

Some advantages of convertibles include:

- when used in a family vehicle, it is a once-only purchase which provides safe restraint for a child as he/she grows
- grandparents and carer organisations, can safely transport a wide range of ages of children with one type of restraint.

Some disadvantages of convertibles include:

- The adaptations required to achieve the wide range of age use can impose design restrictions that limit the ability of the CRS to be optimised for a particular age range. Some CRS have optimal performance for one age range, and adequate, but not optimal, protective performance for other age ranges. Some CRS offer adequate, but sub-optimal, performance across most age ranges.
- The need to be able to turn a CRS around from rear-facing to forward-facing means that there are several methods of attachment to the vehicle. The availability of alternative attachments to the vehicle

makes the task more complex, with an increased likelihood of misuse. The need for multiple harness systems (i.e., from an infant to a forward-facing older child) can make the task for the parent/carer more complex, with an increased likelihood of misuse. Surveys have found that convertibles have a significantly higher rate of misuse, compared to single function CRS. The potential for misuse can be overcome by a parent or carer taking more care and/or making use of expert Fitting services when changing modes. The latter can increase total cost.

It costs more to make a CRS which can perform in multiple modes, to the extent that it may not be cheaper to purchase a convertible for one child. Where there are multiple children of different ages, it can be cheaper to purchase CRS that are specific to the age range of children as they grow.

There is a wide disparity between researchers' concerns about the potential for misuse of convertible CRS, and CRS manufacturers, retailers, parents and carers. Researchers' concerns are driven by the potential for misuse and the subsequent reduced protection from injury in a crash. Parents and carers are generally convinced of economic and convenience advantages. Ultimately, there is a need to improve designs, instructions and support, to reduce the potential for misuse and reduce potential injuries and fatalities.



Rear/forward facing convertible in rearward-facing mode

Rear/forward facing convertible in forward-facing mode



## MODULE 8: Assisting Parents/Carers with Correct Use of CRS

Because of the potential for parents and carers to choose the wrong restraint, incorrectly attach the restraint to the car, or incorrectly harness the child to the restraint, there is a need for support systems to ensure that everything is safely in place, so that, if a crash happens, the child will be protected as intended. Fitting stations are excellent sources of this kind of support for parents and carers.

#### 8.1. Fitting Stations

#### 8.1.1. Origin of Fitting Stations in New South Wales, Australia

In the mid-1980s, the NSW Government's Traffic Accident Research Unit (TARU) ran a multi-media behaviour change campaign called "What About Me?". The campaign highlighted the disparity between the safe restraint of adults compared to children in Australia. With the ultimate aim of improving the use of CRS, the concept of having the child ask "what about me?" sought to empower unrestrained children in cars to ask for protection, thereby improving their parents' understanding of the need to use a CRS.

To assess effectiveness, the quantity and quality of CRS usage before and after the campaign was measured by observational surveys of CRS use in vehicles. The campaign was successful in increasing CRS overall use. However, the qualitative component revealed that approximately 50% of CRS were not used correctly: either incorrect use of CRS for the child, CRS incorrectly attached to the vehicle, or child incorrectly harness into the CRS.

It is hypothesised that up until that time, the voluntarily early users of CRS were primarily vigilant early adopter parents and carers who went to considerable effort to ensure that the restraint was safely installed. Motivated parents and carers who contacted TARU were invited to visit to have their CRS installed at TARU's Crashlab. Following the increased demand for these services following the "What About Me?" campaign, it quickly became evident there was a need for statewide assistance of parents and carers to ensure correct fitment and use of CRS.

In 1985, two new staff were engaged to be trained as mobile fitters and a comprehensive manual was developed to provide a reference source. This manual included information such as how to safely fit all available CRS models, including retrofitting top tether anchorages. The following year, two vans were fitted out as mobile fitting stations, delivering fitting services throughout the state of NSW. The demand for services was high and it became evident that there was a need for a wide network of Fitting stations. In 1987, a network of 60+ Statewide Fitting stations was launched in NSW, mostly using existing NRMA workshops<sup>12</sup>. Gratis public liability insurance for Fitting stations from the Government's compulsory third party insurer was arranged. At the time of publication, there are more than three hundred (300) Fitting stations in NSW.

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In the mid-1980s, a media communications program in New South Wales was extraordinarily successful in promoting the use of CRS. Whilst awareness and usage increased, there was a high proportion of incorrect use.

The behavioural scientists who managed the communications campaign approached their engineering colleagues and requested help to solve the misuse problem through engineering means. This cross disciplinary collaboration was essential to creating the organisational "will" to find the resources to establish a statewide network of Fitting Stations to assist parents/carers.

The NSW Government has a paid contractor for management of the Fitting stations network, and continues to administer a programme which includes:

- Ongoing updating and development of a Fitting Stations Manual supplied at no charge to Fitting stations
- Training of fitters at no charge
- Auditing of the quality of Fitting station services.

#### 8.1.2. Managing CRS Misuse

The potential for misuse, and the consequent need for assistance with the selection and installation of CRS continues to be reported as a global problem. Almost since its inception, the International Standards Organisation Child Restraints Systems Committee, under WP29, has trialed various tools to objectively measure the quality and safety of use and fitment of CRS.

The level of expert assistance offered to parents/carers with correct installation of CRS varies considerably from jurisdiction to jurisdiction. In the USA, the development of the manuals for fitters and the training of fitters is a Federal service, whilst the services are delivered by organisations in local State and County jurisdictions.

The most recent jurisdiction to adopt the Fitting stations concept is the Philippines. They had the advantage of

seeing how misuse was dealt with in other countries and applied these learnings to develop a comprehensive strategy for delivery of Fitting services.

You can access a copy of the Fitting Stations Manual as developed in NSW, Australia via this <u>link</u>.

You can also access a copy of the USA's Fitting Stations Manual (Technician Manual) from this <u>link</u>.

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The role of government in managing Fitting stations varies from state to state in Australia. In New South Wales, Fitting stations are audited and accredited by government. However, in some other states, where there is a lack of government accreditation of Fitting stations, there is potential for misinformed advice to be provided to the public because of a lack of regulation of content.

With correct use of CRS being a frontline form of injury prevention, Government accreditation of Fitting stations is strongly recommended.

#### 8.1.3. Considerations for Fitting Stations

A statement of objectives for a Fitting station could usefully include:

- A program to ensure uniform standards and certification of fitters within the relevant Government and commercial agencies;
- Two grades of fitter training and stations:
  - Level One: Qualified fitters and Fitting stations are trained to competently assist with choice of the correct CRS for the child, and to install it in a vehicle where the appropriate upper or lower anchorages are available.
  - Level Two: Qualified fitters and Fitting stations are trained to retrofit upper anchorages.
- An accreditation system requiring uniform standards, procedures and fees for Government and commercial fitting stations;
- A standardised training programme and certification system for the two grades of fitters.
- An important aspect to include in regulatory structures and guidelines is that it is children who use CRS, so that Fitting stations and their fitters need to be child friendly workplaces, where fitters and their colleagues are aware of the needs and safety of children.

#### 8.1.4. Auditing of Fitting Stations

There is a need for random audits of Fitting stations to ensure that the quality of fitments is maintained. Some early experiences from Australia illustrated the importance of the need to prohibit anyone other than trained, recognised and audited fitters from naming themselves a Fitting Station. It is strongly recommended that 'self-declared experts' who do not have the appropriate training and quality control mechanisms must be discouraged in order to properly protect children.

#### 8.1.5. Inclusions in a Fitting Station Manual

The Fitting Station Manual should be developed by the appropriately qualified Government department, and should include:

- General road safety principles;
- Relevant consumer laws on which child restraints can be sold;
- Relevant road regulations on use of child restraints in vehicles;
- Proper selection of CRS for varying child ages and sizes;
- Details of correct installation of the CRS in vehicles;
- Details of correct harnessing of child within the CRS;
- General description of the types of CRS available;
- General description of the anchorage systems required in vehicles.

#### 8.1.6. Fitters for Vehicles with Anchorages (Level 1 Fitters)

A common experience in some of the early adopter countries when introducing CRS was that problems were frequently encountered with the correct choice of a CRS for the child, the correct attachment of the CRS to the car, or the correct restraint of the child within the CRS.

It is important to ensure there is sufficient control of the standard of delivery of information and services at Fitting stations so that the information provided to parents/carers is accurate and consistent with best practice. Having clear guidance manuals is necessary to ensure this outcome.

There are many options as to how Fitting stations are established and managed, ranging from governmentmanaged and regulated services at fixed premises, to weekend services by volunteers in shopping centre car parks. In New South Wales, it was dealt with by generally persuasive, rather than regulatory means. Once the staff at a Fitting station had undergone the appropriate training, they received accreditation which came with a large sign with the appropriate government logos visibly displayed on the premises.

#### Exemplar sign issued by NSW Government





A Pop-Up Level One Fitting Station in Australia 2020 (Covid 19 friendly)

The support offered to Fitting Stations included:

- If a Fitting station satisfied the requirements of the Government, then it received a large official sign with the appropriate Government logos, establishing it as a Government-authorised Fitting station. In some cases, the sign included a logo from a highly credible organisation known to have child safety as its first focus, such as, Kidsafe, or in NSW, the motoring organisation known as NRMA.
- Because it is illegal to put up a sign implying you are a Government-recognised authority if you are not, there was some control over of who could claim to be an authorised Fitting station.
- The training of Fitting stations' fitters is provided for free by the Government organisation.
- Copies of the handbooks and manuals are provided for free by the Government organisation.
- Public liability insurance was initially provided for free by the Government organisation in cooperation with NSW injury insurers.

## 8.1.7. Fitters for retrofitting anchorages (Level 2 fitters)

Some vehicles do not have top tether anchorages or lower ISOFIX anchorages. CRS need to be either:

- restrained by the three-point seatbelt only, or
- have a seatbelt restraining the lower portion of the CRS and have a top tether anchorage retrofitted to prevent flail of the upper portion of the CRS.

Retrofitting of top tether anchorages can require:

- removal of trim, to then find that there is a hidden top tether anchorage, or
- Iocation of a sound structural portion of the rear parcel shelf or cargo area, drilling a hole and mounting a bolt.

Level 2 fitters need access to some workshop tools, and some skills in using those tools. In Australia, a complete survey of all common make and model passenger vehicles was conducted and structurally safe locations for the drilling of a hole for a top tether anchorage was provided in manuals prepared for Level 2 Fitting Stations. A comprehensive Manual was prepared to support the initial training. A complete copy of the most recent edition of the Australian State NSW Government's Manual can be found <u>here</u>.

The training of fitters has previously been conducted "face to face" in workshops with the necessary tools. However, at the time of writing, COVID-19 restrictions were in place worldwide, so "face to face" instruction was not feasible. Therefore, the Global Road Safety Partnership, in partnership with KIDSAFE AUSTRALIA and colleagues in the Philippines, developed a programme to deliver online training for Level 1 fitters in the Philippines. The virtual training is supported by instructional videos incorporating local presenters. Work is underway to develop a suite of universal video modules to better assist remote training of fitters. The videos will aim to ensure better provision of uniform up to date training, which takes account of evidence-based research and anticipated improvements in engineering features to assist correct use.

#### 8.2. Shoulder Ride Height Lines

Studies of child occupant safety in cars have consistently reported that a significant misuse problem is children riding in CRS which are either too small or too big for the child. Information on how to determine when a child should progress to the next CRS has historically been communicated by way of height or weight or age. However, parents do not always know the height and weight of their child, particularly as the child moves out of the infant and toddler stage. Without directly measuring heights and weights, parents often make inaccurate estimations.

At present, laws relating to CRS generally specify age, height or weight, or a mixture. It is well-established that for legislation to be effective, it must be accompanied by appropriate enforcement to encourage compliance. Without a realistic enforcement tool readily available to enforcement officers, poor enforcement is likely. Laws based on weight/height and age of child are difficult to enforce at the roadside. It is not realistic to expect police to carry weight scales and a tape measure, or for parents to carry a child's birth certificate with a photograph for identification.

In 2007, Australia's Crashlab conducted research investigating how to best categorise children by age, height and weight to determine which size CRS was best, or whether they were big enough to use an adult seat belt. The study identified the potential for the concept of a 'safe ride height' line. That is, both CRS and passenger vehicle rear seats could be marked with a seated 'safe ride height' line.

Seated shoulder height is the most important determinant for good shoulder harness or sash seatbelt fit. There are common community examples of safe height indicators at fairgrounds and amusement parks where a minimum height is needed to ensure safe retention of the child in the ride seat. These systems work because the regulatory 'height mark' is immediately visible to both the users and enforcers. In

the case of fairgrounds, if your head is not above the line, you are not allowed to enter the ride. The selfevidence of the mark also assists parents and carers to explain to children why they are too small to ride.

In June 2009, the Safe Ride Height Line concept was presented to an international audience at the ESV Conference in Stuttgart, Germany. In August 2009, Neuroscience Australia conducted a survey of the usefulness of ride height lines. The study found shoulder height labelling of child safety seats and booster seats considerably assisted parents and carers in making appropriate restraint selections for children. In 2015, the Australian and New Zealand Standard for Seatbelts incorporated ride height lines as a mandatory feature in CRS.

In 2007, a group of researchers in Australia were attempting to find a better way of a helping parents choose the correct size CRS for their child. Someone suggested you could use "Ride Height Lines" as used in fun and

This led to a discussion of standing heights and eye heights marked in all sorts of places on vehicles. It was eventually agreed that seated shoulder height was the most practical marker.

The 'safe ride height' line is tailored for each type of restraint system. There is a lower 'safe ride height' line for a child who is not big enough, and an upper 'safe ride height' line for a child who needs to graduate into a bigger restraint.

By introducing a 'safe ride height' line based on seated shoulder height, the task of determining child age or stature for the purpose of enforcing booster rules is assisted.



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theme parks.

The concept of 'safe ride height' lines could be extended to passenger vehicles' rear seats. It is important to note that this does not solve the problem of rear seat base/ squabs which are too long for 10-year-old children's thighs. This is a separate matter which needs to be resolved with the automotive industry.

A 'safe ride height' line on the rear seats of vehicles would better communicate the suitability of the rear seat for children using adult seat belts. It could also give vehicle manufacturers guidance on the required geometry of the sash component of the seatbelt.

Some examples of shoulder ride height lines on Australian CRS. The Standard is currently under review which will hopefully lead to requirements for better placement and conspicuity of the shoulder ride height lines to assist parents/carers to choose the correct CRS and to enable the police to readily enforce CRS laws.



5 year old girl with a shoulder height below the nominal safe ride height line

13 year old boy with shoulder height above the nominal safe ride height line.





#### 8.3. Expiration Dates

#### 8.3.1. Overview

In some countries, CRS manufacturers use an expiration date on the restraint. The implication is that it is no longer safe to use the CRS after that date. A CRS manufacturer might mark an expiration date on their CRS because they may not be confident about the durability of the materials or longevity of the construction of the CRS. There may also be commercial reasons for adding an expiration date such as reducing product life so as to increase product sales.

USA-based CRS manufacturers refer to a USA Manufacturers Alliance for Child Passenger Safety (A CRS industry body) Harmonized Statement on "Expiration Dates". The publication suggests that a CRS's components may have deteriorated to the extent that the product could no longer be used as intended. The Statement reported that the benefits of Expiration Dates included discouraging second-hand CRS use and replacing them with CRS incorporating advances in safety technology. The CRS manufacturers publication does not reference any real world or laboratory-based studies on aged used CRS.

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The idea that a CRS might wear out through time and usage is not unreasonable. However, laboratory-based research programmes in Australia over the last 30 years have consistently found that if a child restraint system looks okay and the buckles fasten appropriately, then it will perform satisfactorily.

From the perspective of affordability and social equity, secondhand child restraint systems can offer affordable access to safe transport for lower socioeconomic families. It is recommended the CRS be cleaned and visually inspected before reuse.

## 8.3.2. Discussion of the research on occupant restraint durability

Research into the durability of seatbelt systems commenced before mandatory use in Australia in 1970. The NSW Government's crash test facility, now known as Crashlab, conducted high frequency load cycling of webbing materials, high frequency latching and unlatching of buckle/tongues, accelerated exposure to dust, salt spray, extremes of temperature and to solar UV degradation. Seatbelts in Australia had to pass these tests before they were accepted for use. The initial requirements for seatbelt webbing in Australian were unique to the extent that some premium imported motor vehicles had to have their seatbelt systems or components of their seatbelt systems changed before they could be registered for use on Australian roads. In 1985, Crashlab considered whether Australia's status as an early adopter of widespread use of seatbelts might also make it the first country to experience degradation in performance of seatbelts in crashes. Throughout 1986 – 1991, Crashlab conducted tests on aged, used crashed seatbelts. The research did not support a case for widespread replacement of seatbelts because of age or crash involvement where the seatbelt still appeared intact and operational.

In the late 1980s, interest in the ongoing safety performance of CRS in rental schemes led to Crashlab conducting research on aged used infant restraints. Before each child restraint was tested, a non-expert assessment was conducted to see if the CRS was safe for use. This was a simple visual assessment to determine whether the buckles still engaged, and the presence of any evident nicks or cuts in the webbing or cracks in the shell. This simple visual review of safety was intended to replicate a non-expert assessment of a parent, not a microscopic examination from an expert in a crash test facility. The subsequent crash test programmes in 1987 and 1988 found no degradation in performance following several years of continuous usage in CRS rental schemes<sup>13</sup>.

Performance of aged, used CRS were again assessed in 2020. The research team in New South Wales acquired a range of aged used CRS from a rental scheme, with some of the CRS in excess of 15 and 20 years of age. Each restraint was subjected to the dynamic test requirements of the Australian Consumer Program (Child Restraint Evaluation Program CREP) which has impact energies in the order of 25% greater than the requirement of the Australian Standard, significantly more demanding than any international CRS Standard. Each CRS survived the multiple high energy tests, thereby continuing to offer the level of protection required by the Australian Standard. Besides testing at energy levels of 25% over and above that required in the Standard, the tests were conducted using the higher biofidelity Q Series test dummies. This 2020 test program concluded that the older CRS continue to offer safety performance required of the Australian Child Restraint Standard<sup>14</sup>.

## 8.3.3. Conclusions and Recommendation on CRS expiration dates

Based on real world and test laboratory scientific assessments, it is concluded that there is no evidentiary basis for expiration dates on CRS. In the Philippines, draft regulations require that a CRS manufacturer who has marked an expiry date must display it prominently on the CRS so that the shorter service life of the CRS can be taken into account by the parent/carer at the time of purchase. This requirement should discourage CRS manufacturers from displaying overly conservative expiry dates.

#### 8.4. CRS Correct Use Instruction Options/ Media

#### 8.4.1. Choosing the Correct CRS

It is vital that parents/carers have sufficient information to help them choose the correct CRS for their child. In countries where CRS have been long-established, this can be a relatively easy choice. With a new baby, you start with an infant restraint, and upsize as your child grows out of their current CRS.

It is important for parents/carers to understand whether a CRS is suitable for an infant only, or whether they can purchase a convertible model which can extend the age at which the CRS will provide safe travel for their child. Past experience indicates that most countries that have adopted mandatory use of CRS also have a choice of websites which provide good quality advice on how to choose a CRS correctly. In most countries, this includes a government website, and a website from the organisation associated with preventing accidental injury to children.

In Australia, a number of the State Governments and automobile associations combined to have a single website. The attraction of this approach is that it avoids potential for ambiguous or conflicting advice. This site is <u>www.childcarseats.com.au</u>

In Romania, work is being undertaken to establish the first CRS checking programme in that country (in Cluj-Napoca). The programme aims to offer facilities so that parents can bring their child restraint systems and cars to a government facility and have the CRS checked by trained technicians. At least one private sector-supported location for the child seat check programme is also being explored, and the training of personnel is being coordinated by a local NGO. Planning is also underway to develop a digital application which will allow parents to enter their child's biometric information and receive guidance on the proper CRS to use as well as receive notifications on when to move the child to the next stage in child restraint systems. More information on this project can be found on the <u>GRSP website</u>.

More information on consumer support programmes can be found in Section 9.

## 8.4.2. Individual CRS Make/Model User Manuals and User Instructions

All Standards have a requirement that the CRS comes with a detailed manual providing information on correct choice of CRS to suit your child, correct attachment of the CRS to the car, and correct harnessing of the child to the CRS. Manuals typically include information on maintenance of the CRS.

However, manuals can get lost, and sometimes, complexities arise as manuals try to both assist parents and carers with correct use, while also trying to include all the information believed necessary to reduce the potential for future litigation. This extensive amount of information in manuals often leads to the development of the equivalent of a "quick start" guide to provide simpler instructional advice. Printed manuals are a relatively outdated form of communication. In the contemporary environment, many parents look to the internet for assistance. With the potential for video instructions so readily available, printed manuals can seem an outdated way of providing instruction. It is hoped that CRS manufacturers will provide online sources of instructions for each CRS model. Some CRS have QR codes which provides a quick link for the user to access instructions, making this a convenient approach to provision of accurate information for parents/carers.

#### 8.4.3. Support by Virtual Fitting Stations

In some jurisdictions, researchers and practitioners are experimenting with virtual Fitting stations. This is the equivalent of a regular Fitting station, but with a high level of one-to-one interaction online, so that the virtual fitter can make a visual assessment of the CRS and its installation and provide one to one advice. This option may become a more viable and cost-effective alternative to physical Fitting stations<sup>15</sup>.

#### 8.4.4. Potential 'SMART' CRS

In earlier committee meetings for the development of an International Standards Organisation Child Restraint System, the committee determined a list of features that the chosen Standard should include if:

- it had been correctly attached to the vehicle, and
- the child correctly harnessed.

This was to include a visually evident display of safe or unsafe attachment to the parent/carer. This idea did not progress because it was viewed as impractical to achieve economically with the technology available in the 1980s-early 1990s. However, the current availability of low-cost sensors, electronic chips, Bluetooth medium, and widespread proliferation of smartphones suggests there may no longer be any technical impediment to achieving the aim of a 'SMART' CRS that incorporates the features described above. The sensors could report to a phone App and provide detailed advice on how to achieve optimal fit of CRS to vehicle and child to CRS.

#### 8.5. Fitting Support in the USA

In general, there are no fixed site Fitting stations in the USA which can conduct modifications such as retrofitting top tether anchorages. Many maternity hospitals have fitting services/assessments which generally require a booking or a fixed weekly or similar time. The USA Federal Government issues the guidelines and necessary materials for supporting fitting services. You can download a copy of the USA's Fitting Stations Manual (Technician Manual) from here.

Fitting services are typically held four to six times a month in rotating locations – for example at an Ambulance Station one month, a Fire Brigade another, and a shopping centre another month. One fitting service in the USA is run by <u>Safekids</u>.

# MODULE 9: Consumer Programmes

#### 9.1. The need for Consumer Programmes

In middle- and high-income countries, the acceptance of the need for CRS has created a large market for CRS over several decades. The range of products is large, the age and size range covered by available CRS varies, and there is also large price variation. Parents and carers continue to find it difficult to know which is the safest CRS for their child. In the absence of an objective consumer program parents/carers cannot know which is the safest CRS for their child.

Australia has the Child Restraint Evaluation Program (CREP – see details in the next section) which provides advice on both crash test performance and ease of use. An informal review in 2020 indicated that the most expensive CRS are not necessarily the best. In some cases, the less costly CRS offered the best or equivalent safety performance. There is a need to investigate this relationship further.

For all the reasons described above, parents and carers have a real need for consumer programs which provide guidance on:

- what kind of CRS to purchase (i.e. a convertible, or a dedicated forward- or rear-facing CRS), and
- what price CRS they should choose.

CRS consumer programs achieve several important tasks. They provide guidance to parents and carers on what is the best value for money of the CRS available. They also provide an incentive to CRS manufacturers to have an ongoing programme of improving the safety offered by their restraints. Eventually this leads to a raising of the baseline of mandatory standards which drives improved performance of the non-innovator CRS manufacturers.

#### 9.2. Australian Consumer Programme (Child Restraint Evaluation Program-CREP)



Until the late 1980s, most CRS for the Australian market were developed and manufactured by two Australianowned companies. Both were closely involved in the development of the Australian Standard, and they competed against each other on who could provide the safest restraint, particularly taking advantage of the unique top tether anchorages which had been required in new vehicles in Australia since 1976.

The availability of top tether anchorages meant that the Australian Standard could have more demanding requirements, compared to CRS dependent upon attachment to the vehicle by the three-point seatbelt system only. In the late 1980s, the two companies were merged and sold to an overseas manufacturer. It quickly became evident that there was a likely trend for manufacturers to modify product which had been developed for overseas markets, rather than CRS developed to optimise their performance because of the availability of top tether anchorages.

The NSW Government's crash test facility found that some of the modified product only just passed the Standard, whilst previous product developed specifically for the Australian Standard had passed by large margins. The CRS consumer programme, CREP, grew out of the concern about the likelihood of a reduction in the overall level of protection offered to children in crashes.

The aim of CREP was to influence consumers in their choice of products. It also hoped to motivate CRS manufacturers to develop CRS that were at least equal to the best currently available and create competition to develop the best performing CRS. When CREP launched, it had much more demanding assessment criteria than the current Standard. The consumer program also evaluated ease of use, that is, overcoming the potential for misuse<sup>1617</sup>.

The founding partners for CREP were the NSW Government's Traffic Authority's Crashlab, and the NSW Automobile Association (NRMA). The partnership was subsequently joined by various State road authorities and motoring organisations from across Australia. www.crep.com.au

#### 9.3. European Consumer Programmes



The European CRS Consumer Programme is managed by a consortium of consumer organisations and automobile clubs. It is known as the European Test Consortium (ETC) but is sometimes informally named after one of the major organisations involved, such as ADAC, or Stiftung Warentest. As part of this programme, the dynamic performance of CRS is assessed in front and side impacts. Issues such as ergonomics, ease of use, and toxicity are also assessed.

Whilst there is only one comprehensive European CRS consumer programme, it is published on a number of websites such as ADAC: Allgemeiner Deutscher Automobil-Club with each organisation implying they conducted the tests. The British consumer association, Which?, publishes the results on their website, and a subscription fee is required to access <u>here</u>. The German consumer group ADAC offers some publicly accessible information on their <u>website</u>. It is the same test program as the British Which?, but the ADAC site shows some of the headline results.

Separately, there is a PLUS test in Sweden. It mainly comprises a severe frontal impact test with limits on the neck force which can only be met by the Swedishpreferred rear-facing CRS.

#### 9.4. USA Consumer Programmes



The American Association of Pediatrics maintains a listing of all CRS and their suitability for different age ranges.

Consumer reports <u>website</u> provides comparative ratings of CRS.

The Insurance Institute of Highway Safety (IIHS) <u>website</u> currently provides comparative ratings of booster seats.

#### 9.5. China Consumer Support



In China, CRS is widely available and is similar to UNECE 44. However, there is no national legislation requiring its use. Some organisations have taken it upon themselves to increase public awareness about how to choose and properly install the correct CRS. They conduct outreach at maternal hospitals with expecting parents, develop websites and apps to help select a CRS, train and certify Child Passenger Safety Technicians, and run CRS check events around the country. This work provides crucial CRS support to parents especially in the absence of a national law.

## MODULE 10: Communicating for Behaviour Change

# 10.1. Introduction to Behaviour Change Campaigns

When a state, province, or country has implemented a program successfully, there can be a hope that if others use the same methodology, they will get the same successful outcome. This is not necessarily true. Early experiences of communications (marketing/ advertising) about mandatory CRS use in countries such as New Zealand, Australia, Europe and North America, occurred in the mid-1980s, in a significantly different environment from the contemporary world. Some differences include:

- In the 1980s, communications and mass media campaigns were conducted through traditional media outlets (television, radio and print), long before the internet, with Google appearing in 1998, Wikipedia in 2001, and smartphones appearing in 2007.
- The wearing of seatbelts by adults had been well established.
- In the 1980s, women's career-related expectations had grown to the extent that they were competing with the traditional caregiver role in developed countries.

For these reasons, behaviour change programmes in countries wishing to mandate CRS in future will need to consider different forms of communication for messages targeted at parents and carers than those used in the early adopter countries. It is also important that campaigns measure more than message recall.

In the past, the success of advertising campaigns was measured by whether people could recall having seen/ heard/read of the media campaign, and the extent of their recall of that message. Assessment of the effectiveness of changing behaviour was generally absent. Traditional advertising media was intended to change people's buying habits, that is, to make one consumer product more attractive than another. It wasn't until behavioural scientists became involved, and evidence-based/scientific methodology was applied, that the structuring of the media communication, and success in changing behaviour were evaluated to assess the effectiveness of social marketing for behaviour change.

# 10.2. Examples of Early Marketing of CRS use

Two campaigns that were successful in increasing the use of CRS in the mid-1980s were based on the perspective of the unrestrained child. As already described in Section 8.1.1, in NSW, the "What about me?" campaign delivered the message from a child's perspective: all the adults in the car are wearing their seatbelts, but why is the child not restrained? A similar methodology and similarly successful campaign in France was called "What about the children?".

Early promotion of CRS in the USA was primarily through the Safe Kids organisation and paediatricians. Safe Kids issued promotional material and continues to assist some fitting services. Paediatricians took responsibility for promoting the widespread usage of CRS in the USA. The American Academy of Pediatrics <u>website</u> has the most comprehensive list of approved CRS, arranged so that it guides the reader to the range of CRS that are suitable for the age/size of the child.

As noted above, much has changed since these early media campaigns were conducted, and situations differ from country to country. This does not mean that low- and middle-income countries contemplating mandatory use of CRS cannot learn from the prior experience of other countries. However, with cultural, economic, and political differences, it is important to remember that what worked in one country may not be applicable elsewhere. This might be due to differences in beliefs about the ability of restraints to save lives, misperceptions about an adult's ability to safely hold a child in their arms during a crash, cultural beliefs and practices, differences in socio-economic circumstances (for example, percentage of car ownership) or differences in the vehicle fleet (some countries have a very high proportion of two-wheelers).

The nature of the persuasive communications required to change parent and carer behaviour when introducing CRS to the first generation of adults who did not have the experience of growing up in a CRS, is different to the communications required to achieve behaviour change in subsequent generations. In most of the early adopter countries, the use of seatbelts had been well established before CRS were introduced. The changes in communication media since the mid-1980s and the sometimes near simultaneous introduction of restraint systems for adults and children in low- and middleincome countries will almost certainly need different strategies.

## MODULE 11: Access to CRS for Low-Income Families

#### 11.1. Rental and loan schemes

Rental schemes are best located in a recognised national charity which has the aim of preventing accidental injury to children. In the USA, that is the organisation known as Safe Kids. In Australia, schemes are mostly managed by KidSafe, or sometimes maternity hospitals.

In Australia, an early adopter country, the Government initially subsidised infant restraint loan/hire schemes based at maternity hospitals, to coincide with the mandatory requirements of the law, and deal with issues such as affordability for lower socio-economic groups and large families. These schemes ensured that infant restraints were readily available for newborns, no matter what the socio-economic background of the family.

In the earlier years, there were also some commercially operated rental schemes successfully co-existing with subsidised schemes. The successful business models for commercial schemes tended to rely on renting the infant restraints which typically have short periods of use from 6 to 15 months, to attract the user, and then making their profit from selling the CRS for children as they grew. The initial Government-subsidised rental schemes were limited to infant restraints and became closely coupled with hospital policies that an infant would not be discharged from the hospital unless picked up in a vehicle with an appropriate infant restraint fitted.

Charity-affiliated CRS rental organisations such as KidSafe can get CRS donated, heavily subsidised, or via favourable prices from the individual CRS manufacturers. Some charity-based organisations can also keep their overheads low by having a mix of volunteer and paid staff. After initial purchase costs and staffing, the next highest cost is the maintenance and checking required of each restraint after return and before being re-rented. A quick visual scan is not sufficient. A typical cleaning and checking process requires:

- removal of the harness and all anchor plates
- removal of the cover
- machine washing of covers and harnesses
- sometimes harness straps need supplementary hand cleaning
- a separate clean of the shell
- inspection of any anchor plates for rust or other corrosion
- inspection of the plastic shells for any signs of cracking or deterioration
- sometimes components such as harnesses need to be replaced

Restraint rental schemes need to establish relationships with CRS manufacturers so that the rental schemes can buy replacement parts at reasonable prices from the original CRS manufacturer. Some child charitybased organisations have found that they can make a small profit from the rental schemes which then crosssubsidises some of their other activities which they cannot charge for.

There is a particular specialist rental market for restraints for low birth weight babies, and for children with physical or behavioural disabilities. Rental schemes can provide better access for these restraint types which may be more difficult to find, because the relatively small demand does not justify the usual retailers stocking them.

The cost at which infant restraints can be rented is dependent upon:

- the initial acquisition cost of the infant restraints
- the maintenance costs between each hiring
- staff costs
- overheads.

Most of the early hire schemes were heavily, if not entirely, subsidised by State Governments in Australia. However, some of these services eventually became integrated as part of local hospitals or local health service providers.

#### 11.2. Are the most expensive CRS the best?

It is understandable that people might assume that the most expensive CRS offers the greatest level of protection in a crash. However, this in not necessarily true. Australia has a consumer programme which compares the dynamic crash test performance and ease of use of CRS. A 2020 preliminary review of the safety performance of CRS by purchase cost indicated that the more expensive CRS **do not offer** any additional protection compared to some of the CRS at the cheaper end of the price range. Some of the more expensive CRS performed less well in consumer evaluation programmes than cheaper models.



The common consumer experience is that the more money you spend, the better quality product you purchase. It is reasonable that a parent/carer buying a CRS might have the same expectation.

However, preliminary review of CRS consumer crash test programmes indicates that price is not a predictor of best safety performance.

## **APPENDIX A**

The information below describes a sampling methodology which is derived from this paper: Brown J, Hatfield J, Du W, Finch CF, Bilston LE. *Population-level estimates of child restraint practices among children aged 0-12 years in NSW, Australia*. Accident Analysis & Prevention 2010; 42(6): 2144-2148.

#### Sample design:

A multistage stratified, clustered random sample plan is used to collect data representing the population of children. Geographically, the sample should include Metropolitan, Metropolitan Fringe, Regional and Rural areas. Probability proportional to size sampling is used to distribute sampling units (e.g., Local government areas) across the strata, and simple random sampling is then used to select the geographical areas for representative sampling.

Within each randomly selected area, baby/child health clinics, pre-schools, day care centres, and primary schools are identified as sites where the probability of child attendance is relatively equal for any child. Initially an inspection should be conducted to assess suitability for data collection. Sites are suitable if they allow for adequate, safe observation of the restraints worn by child occupants (both in situ, i.e. within the vehicle, and with the child out of the car), with minimal impact on normal traffic flow. Children are randomly chosen as the vehicle arrives at the selected sample site. In vehicles where there is more than one child, the child who had had the most recent birthday is selected, irrespective of their age.

#### Data collection at the chosen site:

Trained researchers attend the sites over the period corresponding with drop off times at pre-schools and primary schools, and morning and afternoon sessons at early childhood health clinics. Eligible vehicles are approached as they arrive, and the driver of the vehicle is invited to participate. All refusals should be recorded, along with the reasons for non-participation.

Once a driver agrees to participate, the researcher makes initial observations with the child in the restraint within the vehicle. Once the child leaves the vehicle, a structured interview is conducted with the driver while a detailed examination of the restraint installation is conducted. The height and weight of the child are measured.

#### Variable descriptions and definitions:

Use of restraints by children with weights within the defined limits of the restraint (as defined by the relevant Standard) is coded as "appropriate" and use by children with weights outside the weight limits of their restraint are coded as "inappropriate".

Incorrect use refers to incorrect installation of and/or securing of a child in a restraint system. For example, incorrect installation involves the restraint not being correctly secured to the vehicle by the vehicle seat belt system, and incorrect securing involves the child not being correctly secured by the internal harness system.

Each form of incorrect use is coded as an 'installation' error or a 'securing' error and is rated as minor, moderate, or serious, based on the likely threat of injury and/or the likely degradation in protection.

Rating assessments are based on evidence published in laboratory studies investigating the influence of incorrect use (Hummel et al, 1997; Lalande et al, 2003; Lesire et al, 2007; Bilston et al, 2007), and crash studies demonstrating the real world effect of incorrect use (Gotschall et al, 1997; Brown et al, 2006; Bulger et al, 2008). An attempt can also be made to ensure that assessments are consistent with other observational studies that have included incorrect use severity ratings (Eby and Kostyniuk, 1999; Decina and Lococa, 2005). Minor errors are those known to have no deleterious effect on the protection provided, e.g. less than 25mm of slack in the restraint and/or anchorage system. Moderate to serious errors are those known to substantially increase injury risk. A full description of all errors is provided in Brown et al (2010; Brown J, Hatfield J, Du W, Finch CF, Bilston LE. The characteristics of incorrect restraint use among children traveling in cars in New South Wales, Australia. Traffic Injury Prevention 2010; 11(4): 391-8).

A 'quality of restraint' use variable describes restraint status. Based on observations described above, children are coded as being unrestrained, using their restraint incorrectly only, using their restraint inappropriately only, using their restraint incorrectly and inappropriately, or using their restraint optimally. Restraint types are described as rearward facing restraints, forward facing restraints, child safety harnesses, or booster seats, according to restraint type definitions described in the relevant Standard; and seatbelts (including both lap only and lap/sash belts). Booster seats are used with either an adult lap/sash or a child safety harness. Booster seats used with a child safety harness are coded as booster seats only. Therefore, those restraints coded as child safety harness refer to the use of a child safety harness alone. For purposes of analysis you can group restraints into dedicated child restraints (rearward facing restraints, forward facing restraints, child safety harnesses or booster seats) and seatbelts. Restraints are also categorised as 'convertible' or 'single mode'. Convertible restraints are designed for use in more than one mode, i.e. restraints that can be used both rearward and forward facing, and forward-facing restraints that convert to booster seats.

For descriptive purposes, child weights are collapsed into the following weight categories: 0-9kg, 9.1-13.9kg, 14-17.9kg, 18-26kg, 27-32kg, > 32kg, and 'not measured'. Whilst ideally the survey staff would weigh children, in reality weights are parent/carer estimates. Child age at the time of observation is coded in years rounded to last birthday and in some analyses are collapsed into three categories: 0-3 years, 4-8 years, and 9+ years, as commonly reported in the child restraint literature.

#### Data analysis:

Data analysis can be performed using SAS version 9.2 (SAS Institute, 2008). Sample weights are constructed using standard weighting procedurs as outlined by Lohr (1999) and Korn and Graubard (1999). Post-stratification weighting for age distribution variations and both over and under sampling at different sites is used to generate population-level figures for the nation/state / province under review. Population weighted estimates of the proportion of children in each 'quality of restraint use' category can be generated using the SURVEYFREQ procedure, to estimate variance and corresponding 95% confidence intervals (CI). The significance of associations between incorrect use, the severity of incorrect use, restraint type, and appropriateness of restraint are evaluated using univariate logistic regression via the SAS SURVEYLOGISTIC procedure Odds ratios (OR) and 95% CI are calculated, relative to a baseline or reference category for each independent variable.

# REFERENCES

<sup>1</sup> *Mechanical Analysis of Survival in Falls from Heights of 50 to 150 feet*, Hugh de Haven, 1942.

<sup>2</sup> Submarining refers to the lower part of the human body slipping beneath the lap section of a seatbelt when a crash occurs. Seats can have a backwards slope (ramp) of the seat cushion to help prevent this occurring.

<sup>3</sup> Brown J, Hatfield J, Du W, Finch CF, Bilston LE. *Population-level estimates of child restraint practices among children aged 0-12 years in NSW, Australia.* Accident Analysis & Prevention 2010; 42(6): 2144-2148.

<sup>4</sup> The lead author was working at the NSW Government's TARU laboratory when this happened.

<sup>5</sup> The content of this section was primarily provided by Costandinos (Dinos) Visvikis, Director, Industrial Relations, Child Safety, Cybex. Dinos gained his CRS expertise whilst a researcher at UK's Transport Research Laboratory (TRL).

<sup>6</sup> The content of this section was primarily provided by Derek Wainohu, QA & Product Eng Manager, InfaSecure. Derek gained his CRS expertise working at Australia's NSW Government Crashlab.

<sup>7</sup> The content of this section was primarily provided by Miriam Manary, Lead Research Engineer, Biosciences Department, University of Michigan Transport Research Institute. Miriam gained her CRS expertise at UDA's UMTRI working with CRS pioneers such as Kathy Weber.

<sup>8</sup> The information in this section has been developed based on experiences of the Global Road Safety Partnership in supporting government agencies and the NGO community in the Philippines through the GRSP Road Safety Grants Programme. In 2019, the Child Safety in Motor Vehicles Act was enacted, making use of a child restraint system mandatory for all children aged 12 years and below. Following the enactment of this law, GRSP supported local partners to assist in providing technical input for the formulation of the Implementing Rules and Regulations. The lead author of the current document, Mr Michael Griffiths, provided extensive technical support throughout this process. <sup>9</sup> *Protecting Children in Car Crashes: the Australian Experience*, Paine M, Griffiths M, Brown J, Case M, Johnstone O, ESV 2003, Paper 193.

<sup>10</sup> *Protecting Children in Car Crashes: the Australian Experience*, Paine M, Griffiths M, Brown J, Case M, Johnstone O, ESV 2003, Paper 193.

<sup>11</sup> As at 2020, the effects of these higher loads have **not** been quantified.

<sup>12</sup> NRMA is a state-based motoring support organisation in New South Wales.

<sup>13</sup> TARU Special Reports, 1987-131, 1988-102, 1988-103, 1988-121, 1988-154 – Brown J, Kelly P, Griffiths M.

<sup>14</sup> Dynamic Frontal Crash Performance of Old and Used Child Restraint Systems, White T, Kent N, Griffiths M, Bilston L, Brown J. (2021), Traffic Injury Prevention, Volume 22, Issue 7.

<sup>15</sup> Schwebel, DC, Tillman, MA, Crew, M, Muller, M, Johnston, A (2017). Using interactive virtual presence to support accurate installation of child restraints: Efficacy and parental perceptions, Journal of Safety Research, 62:235-24. doi: 10.1016/j.jsr.2017.06.018.

<sup>16</sup> *The Australian Child Restraint Evaluation Program*, (2007), Suratno B, Job S, Leavy D, Brown J, Paine M, Magedara N, Kelly P, Griffiths M, Haley J, Case M, ACRS Conference Proceedings.

<sup>17</sup> Recent results and observations from the Australian Child Restraint Evaluation Program (CREP), Brown J, Suratno B, Kelly P, Griffiths M, Paine M, Haley J, Case M, Leavy D, Job S.

## **Global Road Safety Partnership**

# Seneva Office

c/o International Federation of Red Cross and Red Crescent Societies P.O. Box 303 Chemin des Crêts, 17 Petit-Sacconex, 1209 Geneva Switzerland Email: grsp@ifrc.org Tel: +41 22 730 4249 Fax: +41 22 733 0395

#### <mark>ង</mark> Kuala Lumpur Office

Menara Tokio Marine Life, Level 10, 189 Jalan Tun Razak, 50400 Kuala Lumpur, Malaysia Tel: +603 9207 5700

### Sudapest Office Budapest, Váci út 30. 4.em.,

1132 Hungary Tel: +36 1 888 4500

For more information about how to join the Global Road Safety Partnership please visit our website **www.grsproadsafety.org** 

