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Functional Assessment of Unattended Child Reminder Systems

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16. Abstract

Leaving an unattended child in a parked automobile can lead to heat stroke and death, even if only left for a few minutes. Child deaths from automobile-related heat stroke occur with lower frequency than those that occur in traffic crashes, but the nature of these completely preventable deaths warrants special attention. A young child's inability to exit the vehicle on his/her own combined with a low tolerance for elevated temperatures requires that children never be left unattended in an automobile.

The National Highway Traffic Safety Administration has conducted research and supported public awareness efforts in an attempt to address the problem of children dying of heat stroke after being left unattended in a parked vehicle or by gaining access to a parked vehicle. The largest subset of fatalities is children who have been unintentionally left in the vehicle by the driver or caregiver upon arrival at the destination. Acknowledging that technology may help to prevent cases of forgotten children, NHTSA has investigated electronic reminder devices developed specifically to address this problem. With this document, NHTSA describes observations of system capabilities and outlines its new methodology for a functional assessment of both add-on and integrated reminder systems. The document includes results from the functional assessments of several of these commercially available products. The test methodology presented in this document may help innovators bring more robust child safety products to market.

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Definitions

Activated: A child is present in the child restraint and the reminder system is ready to issue notifications at specified trigger events

Add-on: A product or system purchased by a consumer (user) and added to a motor vehicle or child restraint

ATD: anthropomorphic test device, also known as a crash test dummy

CFR: Code of Federal Regulations

CPS: Child Passenger Safety

CRS: child restraint system

Detection: Sensing that a child occupant is seated in the child restraint system

FF: forward-facing

FMVSS: Federal Motor Vehicle Safety Standard

Integrated: A system built-in to a motor vehicle or child restraint by the original equipment manufacturer

OBD-II: on-board diagnostics

RF: rear-facing

Seat Bight: The intersection of the seat back and seat bottom (where belts frequently emerge and where or near where lower anchorages are placed in a passenger vehicle)

Unattended Child Reminder System (UCRS): A set of components intended to lower the risk of children being left behind and suffering heat stroke in automobiles

Summary

The National Highway Traffic Safety Administration has conducted research and supported public awareness efforts in an attempt to address the problem of children dying of heat stroke after being left unattended in a parked vehicle or by gaining access to a parked vehicle. The largest subset of fatalities is children who have been unintentionally left in the vehicle by the driver upon arrival at the destination. Acknowledging that technology may help to prevent cases of forgotten children, NHTSA has investigated electronic reminder devices developed specifically to address this problem. The reminder systems investigated in this effort use various methods to detect the presence of children and deliver notifications to caregivers at specific events such as when the vehicle trips end or if the children have not been removed from the vehicles after the drivers walk away. Notification methods varied, but include audible alerts and smartphone alerts. With this document, the testers describe observations of system capabilities and outline the methodology for a functional assessment of both add-on and integrated reminder systems. The testing applications described in this report cover issues such as child size and notification delivery, and NHTSA believes they can help innovators bring more robust child safety products to market. The document includes results from the functional assessments of several of these commercially available products.

Introduction and Background

Leaving an unattended child in a parked automobile can lead to heat stroke and death, even if only left for a few minutes. Child deaths from automobile-related heat stroke occur with lower frequency than those that occur in traffic crashes, but the nature of these completely preventable deaths warrants special attention. A young child's inability to exit the vehicle on his/her own combined with a low tolerance for elevated temperatures requires that children never be left unattended in vehicles.

Hyperthermia is the term used to describe an elevated body temperature without a change in the body's temperature set-point. Elevated body temperature occurs when the body is unable to dissipate the heat it produces and absorbs in situations of prolonged exposure to high temperatures, such as being trapped in an enclosed vehicle parked outdoors. The body's response to excessive heat is initially manifested by mild heat illnesses such as heat edema, heat rash, or heat cramps. Once the core body temperature exceeds 38°C, heat exhaustion sets in with flulike symptoms and decreased cardiac output. Further increase in the core temperature beyond 40°C is classified as heat stroke, which is a life-threatening condition characterized by mental status changes and a lack of sweating (Nixdorf-Miller, Hunsaker, & Hunsaker, 2006). Other features of heat stroke include hot and dry skin, tachycardia, and gastrointestinal symptoms such as nausea and vomiting (El-Radhi, Carrol, Klein, & Buchanan, 2009).

Thermal regulation characteristics are different for children than they are for adults. Children are less able to dissipate heat when subjected to extreme conditions caused by rigorous activity or environmental conditions. Children have a higher ratio of surface area to body mass, which contributes to heat absorption in extreme environmental conditions. Their smaller blood volume limits their ability to transfer heat from the core to their periphery, which is where heat would be transferred to the

environment. Another major thermal regulation difference with children is their sweating mechanism, which is not as effective when compared to that of adults (Falk, 1998). These factors make children highly susceptible to the development of heat stroke in hot environments such as what may be found in an enclosed parked vehicle.

During 2014, there were at least 30 heat stroke deaths of children in automobiles according to data collected by a researcher at San Jose State University (Null, 2014). Null claims that from 1998 to 2014, on average 38 children have died each year due to automobile-related heat stroke in the United States. A NHTSA survey of non-traffic incidents in 2007 found that hyperthermia (heat stroke) was the third most common non-traffic motor-vehicle-related fatality scenario for children 14 and younger (NHTSA, 2009a).

In the mid-1990s, soon after the widespread introduction of passenger-side air bags, the issue of placing children in the rear seats was widely publicized due to the increase in air-bag-induced fatalities of children seated in the first row (Figure 1). Efforts to encourage parents and caregivers to buckle their children in the rear seats were successful, and air bag-induced fatalities began to decrease by the year 2000 (NHTSA, 2009b). This time period saw an increase in the number of children dying of heat stroke in automobiles, hypothesized to be the result of children in the second row being less noticeable to the caregiver, and thus, forgotten and left unattended upon reaching the destination (Null, 2015).

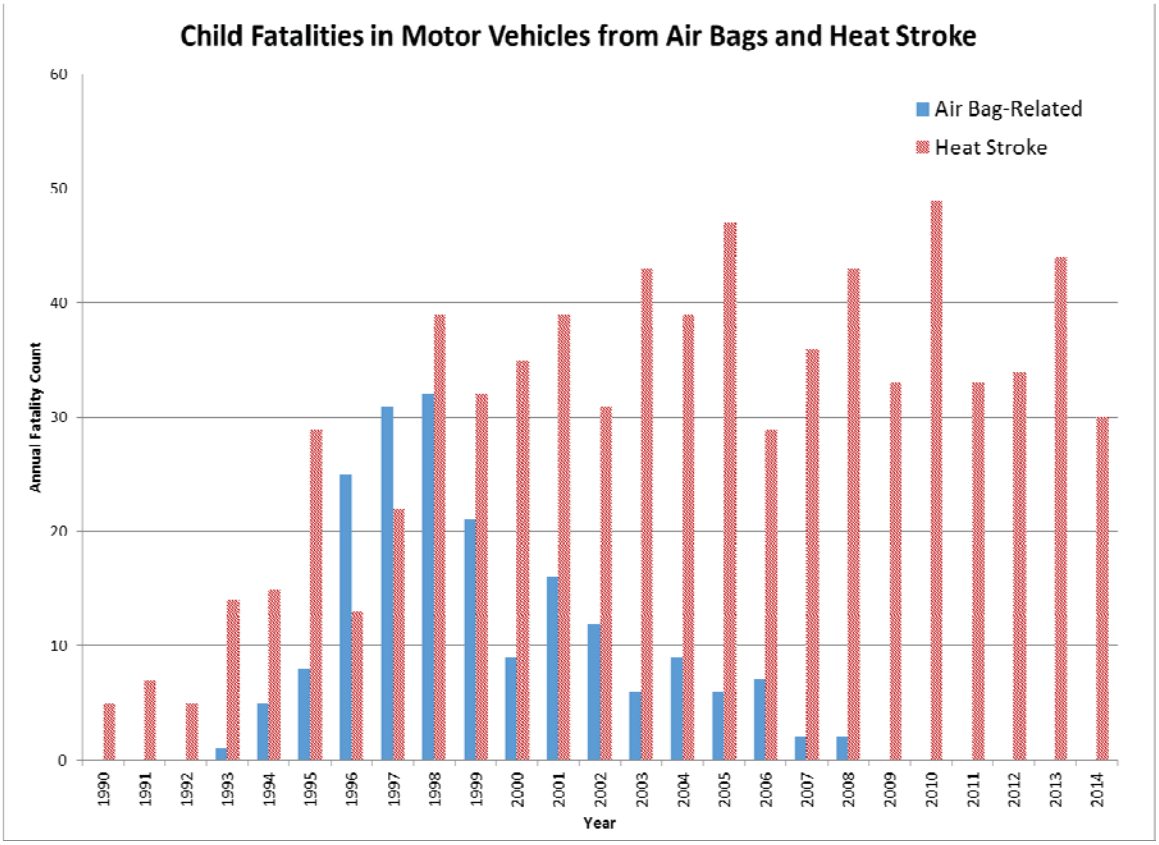

Figure 1: Child deaths due to frontal air bags and heat stroke. Air bag fatality counts are for children in the first row due to frontal air bags, regardless of restraint condition (NHTSA, 2009b). Heat stroke fatality counts are from Null (2015).

Not all instances of child heat stroke deaths in automobiles occur as the result of being left behind by a caregiver at the end of a vehicle trip. Some children gain access to a parked vehicle to play or for other reasons, and are subsequently unable to exit before suffering heat stroke. In some cases, children are intentionally left behind in parked vehicles. Based on a review of case data collected by Null, approximately half of all child heat stroke deaths in vehicles are the result of unintentionally leaving the child in the vehicle, about 29 percent are children playing in unattended vehicles, and 18 percent are intentionally left by caregivers (Null, 2014).

During the past decade, the number of child fatalities due to vehicular heat stroke has remained relatively constant. Figure 2 shows the number of fatalities, broken down by the circumstances, by year as reported by Null through media and legal document searches for the past decade (Null, 2014). Null's data collection efforts may not capture all fatal cases, so these numbers should be considered a minimum count, nor are the cases corroborated with death certificate reviews.

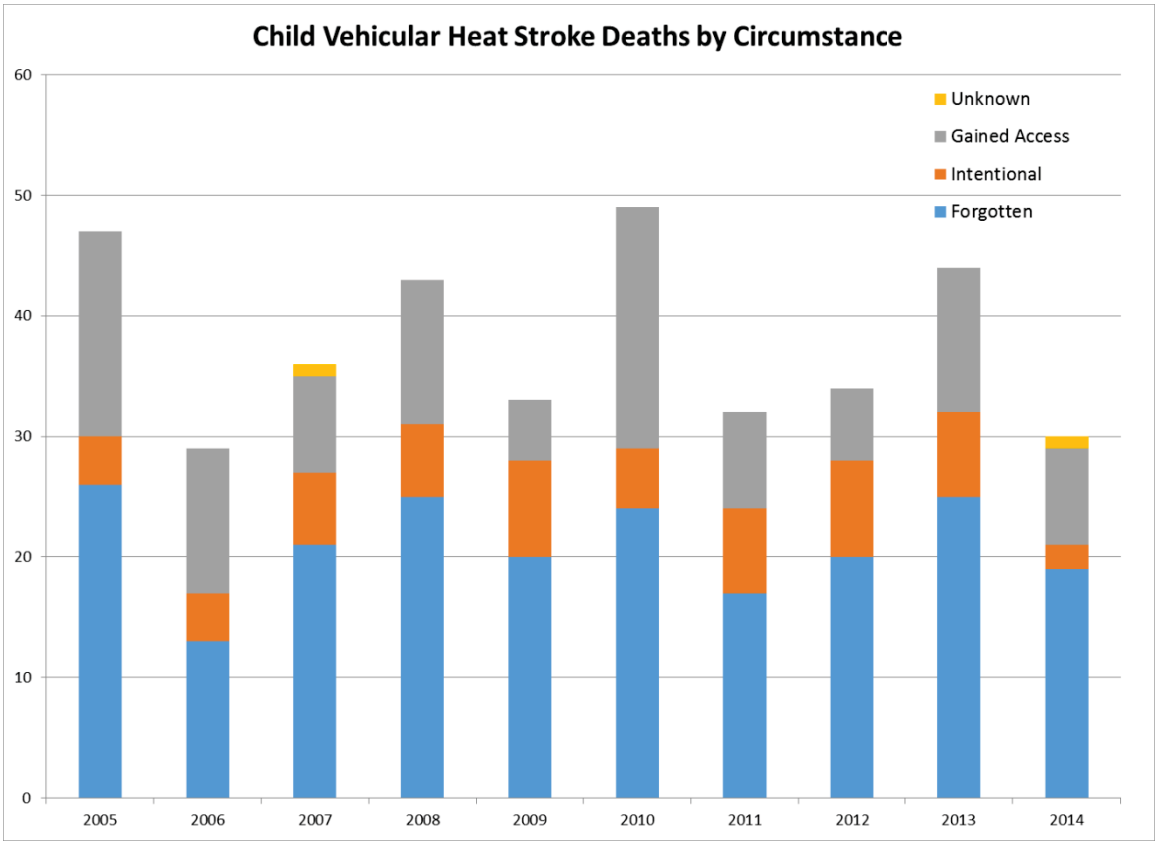

Figure 2: Annual counts of child heat stroke deaths in motor vehicles shown by circumstances. Fatality counts and circumstances are from Null (2014).

NHTSA has conducted educational campaigns and facilitated town hall meetings to raise awareness of the problem. The content of the educational campaigns has targeted all three circumstances under which children die of heat stroke in vehicles – unintentionally left-behind, intentionally left-behind, and gained-access. One of the most important messages is to inform caregivers about the dangers associated with leaving a child in a parked vehicle, even for a few minutes, due to the rate at which interior temperatures rise. The messaging also highlighted the importance of not allowing children to play in parked vehicles and to keep vehicles locked when not in use. Even on relatively mild days, it only takes a few minutes for the interior temperature to reach dangerous levels. A vehicle heating study by McLaren, Null, and Quinn, (2005) found that the average temperature rise was 1.8° C (3.2° F) per 5-minute interval on a sunny day, though the rate of temperature rise is greatest in the first half-hour. The messaging has included suggestions for having the driver leave something like a cellular phone or briefcase in the back seat to further increase the likelihood of checking the back seat after parking the vehicle.

Another approach to reduce the incidence of vehicular heat stroke involves countermeasures to help minimize the risk of children being left behind in vehicles. These countermeasures are mostly aimed at preventing cases involving unintentionally left-behind children, and may include devices such as simple visual and tactile reminders for the driver, electronic reminders added to a child restraint system, and

systems integrated with vehicle electronics and restraint systems. Since about half of the deaths involve children who were forgotten by the caregiver upon reaching their destination, devices that provide a reminder to the caregiver have the potential to address the largest subset of cases.

NHTSA began investigating potential technology-based solutions to the forgotten child problem in 2011 by funding a study to assess the marketplace and evaluate electronic products available to provide reminders to the caregiver when a child was left in a vehicle. At the time, three products met the criteria of being commercially available, add-on, technology-based systems. The study, conducted by the Children's Hospital of Philadelphia (CHOP) and released in 2012 (Arbogast, Belwadi, & Allison, 2012), concluded that the products demonstrated some inconsistent behavior and required a considerable level of effort from the caregiver for proper operation. The systems did not reliably recognize the presence of the child surrogates and presented the users with sporadic audible signals during on-road testing. Since that time, additional aftermarket products have been examined by NHTSA. Those products included a child restraint seat with built-in Bluetooth smartphone connectivity and a replacement chest clip transmitter with vehicle-based receiver. The CHOP evaluation procedure was tailored specifically for each of those products, and incorporated knowledge about each system's design into the specifications of the procedure. The evaluations were conducted under contract, and test reports from those evaluations are available in the NHTSA Component Test Database (test numbers c01189 and c01190).

NHTSA has identified more devices intended to prevent children from being forgotten that entered the marketplace in late 2014. Furthermore, some of the products that were previously evaluated had been updated by the manufacturers to improve performance. All these products focus on children seated in child restraint seats and were available for purchase by the public. Appendix A provides a summary description of the following systems:

- Aviso Child-in-Car Alert (Aviso Reminder Systems, LLC)
- ChildMinder Elite Pad System (Baby Alert USA)
- ChildMinder SoftClip (Baby Alert USA)
- Forget Me Not (Beverly Marketing)
- SOS (SWG Safety)
- Suddenly Safe 'N' Secure Wireless Child Protection System (Suddenly Safe 'N' Secure Systems, Inc.)
- True Fit I-Alert C685 (The First Years)

Purpose and Objective

The transportation authorization law signed on July 6, 2012, Moving Ahead for Progress in the 21st Century Act (MAP-21), stated that the Secretary of the Department of Transportation "may initiate research into effective ways to minimize the risk of hyperthermia or hypothermia to children or other unattended passengers in rear seating positions." The law specifically mentions technology capable of providing alerts regarding child passengers, which has been a focus of NHTSA research. Technology-based aftermarket reminder products intended to reduce the risk of leaving a child in a parked vehicle

exist in the marketplace, and more are under development. These products may comprise a part of the overall solution to the problem of child deaths due to heat stroke in vehicles.

The focus of this effort is to provide the public with observations of, and an assessment methodology for, technology that is intended to lower the risk of children being left behind and suffering heat stroke in automobiles. Based on experience gained during earlier research and evaluation of such unattended child reminder systems (UCRS), NHTSA seeks to objectively identify the presence of key functions and provide a limited assessment of product repeatability with this functional assessment. The outcome of the functional assessment can provide consumers with information about system capabilities and will facilitate objective comparisons among different systems. This document includes findings gathered during functional assessment evaluations of several commercially available UCRS products.

To date, NHTSA is unaware of a UCRS integrated into a motor vehicle by the manufacturer, but the assessment methodology contained in this report is intended to potentially apply to those types of systems as well.

A particular outcome of the functional assessment does not constitute an endorsement by NHTSA, or a designation of a UCRS being compliant with any safety standard.

Scope

NHTSA recognizes that many countermeasure approaches could be taken to prevent child deaths due to heat stroke in automobiles, but the content in this document is intended for technology-based products that address the problem of CRS-seated children unintentionally left in a vehicle. The cases involving forgotten children present the greatest opportunity for reminder systems to reduce the incidence of these deaths. Not only do forgotten children represent the largest subset of vehicular heat stroke deaths, the events leading up to these incidents may have potential to be altered by reminders or alerts when the circumstances exist for a child to be left behind. As such, the scope of this document applies to UCRS that positively detect the presence of a properly restrained child in a child restraint seat and deliver notifications to the driver (caregiver) at specific events that occur in conjunction with a typical vehicle trip or when a child has been left behind.

NHTSA acknowledges that a reminder system does not necessarily require a child presence detection capability. While reminders provided by systems without child detection capabilities may help to reduce the occurrence of left-behind children, the testers chose to only consider systems that include this technological capability. The inability of a system to determine the presence of a child leads to reminders being issued regardless of whether a child is present.

There are many different types of reminders that could be employed to reduce the risk of leaving a child behind in a parked vehicle. This document is geared toward systems that provide audible, visual, and/or haptic notifications, either inside the vehicle or in the vehicle's vicinity, and/or telecommunication-based notifications delivered through a user's smartphone or other telecommunication system.

The child occupants considered under this procedure are limited to those who ride in harness-based child restraint seats. The majority of children who have died from vehicular heat stroke are age 3 or younger (Null, 2014). Focusing on children 3 and younger is expected to address nearly all of the fatalities based on the age distribution of the forgotten children as reported by Null (2014). Figure 3 shows the cumulative distribution of the child age for unintentionally left-behind deaths due to heat stroke of cases occurring from 1998 to 2014. The youngest occupants considered are newborns.

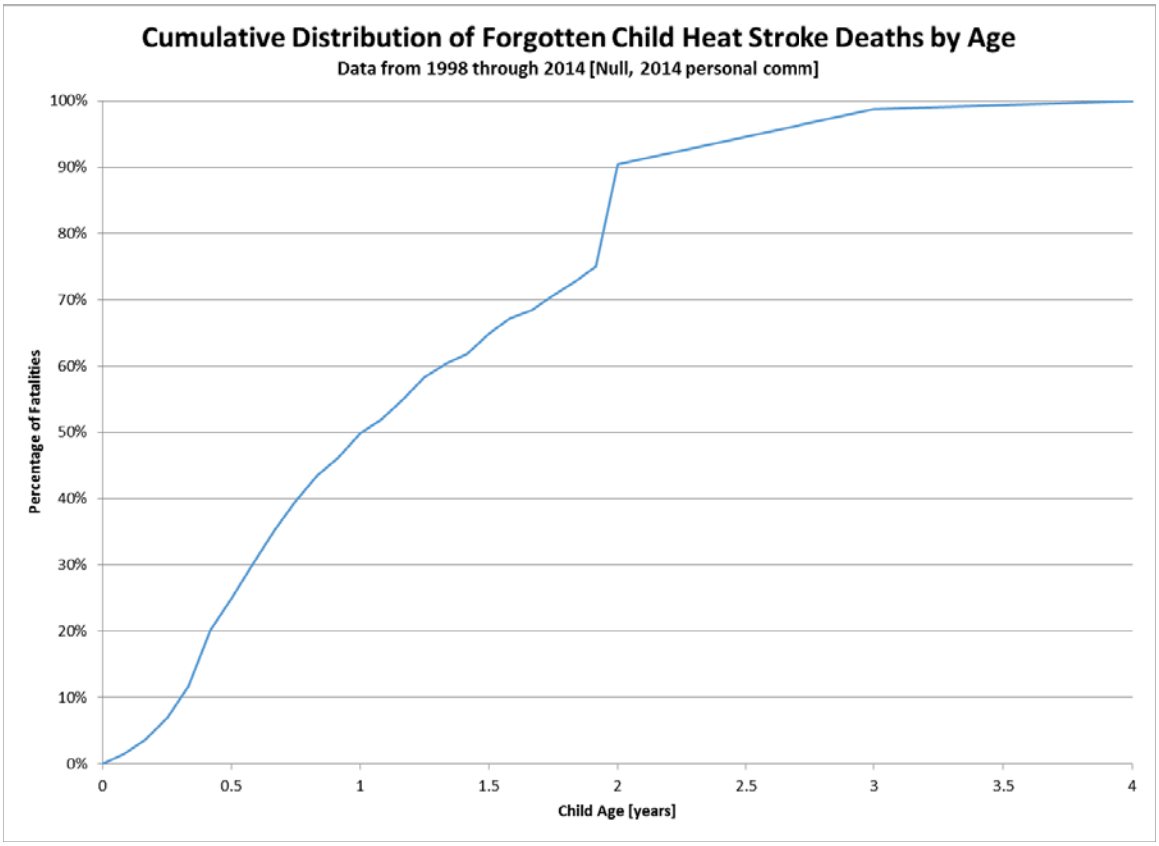

Figure 3: Cumulative distribution of age among unintentionally left-behind child heat stroke deaths from Null (2014). Note that child age before two years is typically reported in months, leading to a smoother curve up to 23 months.

While laws regarding child restraint use differ by State, the procedures within this document apply to children seated in infant carriers, convertible seats, and combination seats used in harness mode. Some technology solutions may cover children seated in booster seats or on the vehicle seat directly, but evaluation of such conditions is not within the scope of this document. The procedures described for the functional assessments make the further assumption that the child is properly seated and restrained in the child restraint system. This is a condition that may differ based on the particular child restraint system considered, but one which demonstrates the best effort of the parent or caregiver to properly secure their child for motor vehicle travel. Cases of misuse, which include improper child restraint selection or installation, improper harness use, and abnormal child positioning, are not addressed by this document.

Some of the prior technology evaluations funded by NHTSA have included misuse and extreme conditions, such as subjecting the device to liquid spills. NHTSA recognizes that misuse conditions and extreme conditions may affect an electronic reminder system, but acknowledges that differences in technologies and design approach may make these considerations unique to each product and difficult to describe for this generalized functional assessment.

UCRS Observations and Capabilities

This section describes features and capabilities of unattended child reminder systems that help form the basis of the functional assessment. These features and capabilities were identified through prior research and hands-on use of existing commercially available products, including those evaluated by CHOP (Arbogast, Belwadi, & Allison, 2012) and in other NHTSA evaluations (NHTSA Component Test Database tests c01189 and c01190). These features form the basis for the functional assessment, and are described here as an introduction to the reasoning behind the components of the procedure. The features described here are not to be construed as design requirements, and cannot be considered universal given that some approaches to UCRS design may utilize technologies and capabilities not envisioned at the time this document was written. These observations focus on the fundamental functions of a technology-based system intended to prevent a child from being left unattended in a vehicle.

Occupant Size and CRS Types

This document is aimed at systems intended for properly restrained children up to three years of age, as described in the Scope. NHTSA has established three reference ages, and associated physical sizes, to be considered in the functional assessments – ranging from zero months to 36 months. These reference ages cover the different child restraint types and orientations likely to be used for the target population. NHTSA acknowledges that regulatory ATDs may not be readily available to entities wishing to conduct these assessments, so is instead describing the 50th percentile length (or height) and weight of children at three reference ages based on Centers for Disease Control and Prevention (CDC) growth charts (Table 1). Table 1 also includes ranges defined by the first and third quartiles. The target values provided are an average of the male and female 50th percentile values, while the target range is based on the 25th percentile female and 75th percentile male values, though the differences between males and females in this age range are small. The models and sizes of the representative ATDs are also provided for comparison purposes, since ATDs may be used as child surrogates in the assessments. Whether using a live human child or an ATD, the objective is for the test surrogate to spatially represent the target child size and provide a realistic weight distribution in the child restraint. The newborn occupant size is expected to provide the most challenging detection scenario for systems that rely on the occupant to trigger a weight or presence sensor.

Table 1: Reference child ages and specifications

Child Age		*Length (cm)*	*25%-75% range*	*Weight (kg)*	*25%-75% range*
0 months	Males	50.0	48.2 – 51.8	3.5	3.2 – 3.9
	Females	49.3	47.7 – 51.0	3.4	3.1 – 3.7
	Target	**49.7**	**47.7 – 51.8**	**3.5**	**3.1 – 3.9**
	CAMI ATD [1]	51.9	n/a	3.4	n/a
12 months (11.5 months from CDC tables)	Males	74.9	73.0 – 76.9	10.2	9.4 – 11.0
	Females	73.2	71.2 – 75.1	9.4	8.7 – 10.1
	Target	**74.1**	**71.2 – 76.9**	**9.8**	**8.7 – 11.0**
	CRABI-12 ATD [2]	74.0	n/a	10.0	n/a
36 months (35.5 months from CDC tables)	Males	94.6	92.1 – 97.3	14.3	13.2 – 15.4
	Females	93.6	91.0 – 96.3	13.8	12.8 – 15.0
	Target	**94.1**	**91.0 – 97.3**	**14.1**	**12.8 – 15.4**
	H-III3C ATD [3]	94.5	n/a	16.2	n/a

1 Denton ATD, Inc., product specifications for CAMI newborn, 6-month-old or 20 lb infant, dated June 19, 2006.
2 Humanetics Innovative Solutions, www.humaneticsatd.com/crash-test-dummies/children/crabi-12-month-old, accessed February 12, 2015.
3 Humanetics Innovative Solutions, www.humaneticsatd.com/crash-test-dummies/children/hybrid-iii-3-year-old, accessed February 12, 2015.
Note: In 2010 Denton ATD was merged into Humanitics.

For add-on systems that include a user-installed sensing element in the CRS shell, inconsistency in child detection by the pressure-sensitive pads in the prior product evaluations demonstrates the need for a range of occupant sizes to be evaluated in multiple child restraint types and orientations. The CHOP study concluded that the CRS shell contours and padding thickness likely played a role in sensor function. In order to simulate a variety of potential real-world use cases, the functional assessment may be performed using multiple CRS depending on applicability and compatibility for a given UCRS product design (i.e., do not evaluate a product in a forward-facing convertible seat if it is intended for use only in infant carriers).

Product literature was not always explicit about appropriate use cases – some UCRS did not include clear guidance in the documentation regarding the appropriate age or size range and the type and orientation of child restraint systems in which it is intended to be used. Products that a consumer adds to a child restraint seat sometimes required multiple trial installations in order to find the best sensor location. Child restraint shell designs and harness routing locations were found to interfere with the sensing elements of some products. Diversity among child restraint designs and configurations may present challenges for some UCRS designs.

Occupant Presence Detection

NHTSA has evaluated products with two primary means of child detection – direct and indirect. Direct systems have used a force- or pressure-sensitive element to determine that a child is seated in or removed from the CRS. Other potential direct detection methods could use capacitance or video imagery to determine child presence. Indirect systems have used a switch in the chest clip that determines chest clip closure, which those systems assume indicates a child is seated in the CRS.

The direct-sensing UCRS products generally provided immediate feedback, either by audible tones, illumination of an LED, or through the smartphone interface, to the user upon detection of the child in the CRS. In cases where no immediate feedback was provided, additional steps were required by the user to determine whether the child was detected.

Activation and Confirmation

Following the detection of the child in the CRS, either via direct or indirect sensing, the UCRS enters an activated state either automatically or as a result of further user action. NHTSA has evaluated systems that require varying levels of manual user action for system activation. Some systems do not require any additional action, beyond those normally associated with securing a child in a CRS at the beginning of a vehicle trip, for activation. Others require the user to press a button or slide a switch on a fob, or open an application on a smartphone. For some products, the user is prompted by an audible reminder to perform the additional actions. For products that don't provide a reminder to the user that further action is required, the UCRS will not enter an activated state and will not provide reminders when user-activation is not completed. Systems integrated with vehicle electronics are activated by switching on the vehicle power or driving the vehicle above a set speed.

The UCRS studied during development of this document varied in their issuance of confirmations once activated. One system provided no indication of system status at the beginning of the trip. Those that required additional user actions indicated they had entered an activated state either by audible means or through the smartphone interface.

Issuance of Notifications and Alerts

The primary purpose of a UCRS is to issue notifications for the purpose of preventing a child from being left in a parked motor vehicle. Such notifications can be categorized as either a convenience reminder at the end of a vehicle trip or an alert that a child has potentially been left unattended at the end of a vehicle trip. An end-of-trip reminder may occur when the vehicle's power is disengaged, or when the conditions otherwise suggest the trip has ended (for systems that do not interface with the vehicle). The purpose of the end-of-trip reminder is to provide a reminder to the driver or caregiver that a child is seated in the child restraint upon reaching the destination.

The UCRS may have the ability to determine whether a child has been left behind in a parked vehicle, after a vehicle trip has concluded, and issue an alert of a potential unattended child situation. The left-behind circumstances have been defined in various ways, such as by a distance the caregiver has moved

away from the vehicle or a specific duration after the end-of-trip that the child has remained in the CRS. In some cases, the left-behind notification has been persistent until addressed by the user, by requiring that the user reenters the vehicle to remedy the cause of the alert.

Other notifications included in the systems evaluated to date include those for a low battery and to indicate that the child has left the seat while the vehicle is in motion. These notifications indicate to the driver or caregiver that the UCRS may not provide the expected reminder and notification features at the end of the trip.

Smartphone Interface

NHTSA has evaluated two UCRS with smartphone integration capabilities. Both use a Bluetooth connection to wirelessly link the CRS-based components and the smartphone, and both require installation of a mobile application (app) to interface with the system. One of the products was evaluated with both Google Android and Apple iOS hardware, but the other product was only compatible with Apple's iOS at the time the work was conducted. Although the smartphone models used were not the most recently released hardware, NHTSA used the most up-to-date versions of the smartphone operating system and mobile application during the evaluations.

The implementation of the app differed for the two UCRS evaluated for development of this document. One entered an activated state automatically, as long as Bluetooth was enabled on the smartphone. The other required the user to actively open the app to activate the system upon placing the child in the CRS prior to a vehicle trip. With either system, the UCRS was not able to provide notifications through any means other than the smartphone. If the smartphone were to shut off during a vehicle trip as a result of a low battery, the UCRS would no longer provide any notifications or alerts. Another factor that was found to affect the notifications was the customization of settings within the smartphone's operating system. It was possible in some cases to silence the audible notifications by enabling the phone's silent mode.

Potential Effects on CRS Crash Performance

NHTSA has concerns that the addition of hardware to a CRS may potentially affect its performance in a crash. NHTSA specifically has concerns about some UCRS products that feature a harness chest clip-based component to indirectly determine child presence. This requires replacing the original CRS chest clip with the UCRS chest clip. However, child restraint manufacturers caution against replacing the harness chest clip due to its integration into the CRS's safety performance. One of the two chest clip products evaluated during the development of this document stated it was only suited for use in rear-facing configurations, but the other provided no guidance in its installation manual. Both of the chest clip products instructed the user to replace the original CRS chest clip with the UCRS chest clip. Additionally, it is not known whether the addition of sensor pads or other components between the CRS shell and cover have any adverse effects on CRS performance.

NHTSA has not conducted any dynamic testing with the UCRS products installed on the CRS. NHTSA believes that UCRS product manufacturers should consider the requirements of Federal Motor Vehicle

Safety Standard (FMVSS) Number 213 (49 CFR Part 571.213) in designing their products in order to ensure an adequate level of safety in vehicle collisions.

Functional Assessment Scenarios (Test Procedure)

The following procedures describe a laboratory-based simulation of potential real-world scenarios to assess the operating characteristics of unattended child reminder systems. These procedures were assembled to assess basic system operation, such as whether a product exhibits specific features, and repeatability of the child presence detection function. The procedures are not intended to evaluate the performance of a UCRS in every possible scenario that could occur in the real-world. Unattended child reminder systems are considered by NHTSA to be a supplement to other safeguards against unintentionally leaving a child in a vehicle.

Prerequisites for Functional Assessment

Test Vehicle

In order to most faithfully represent the conditions under which UCRS systems may be used, the functional assessment was performed using a modern mass-market production passenger vehicle. The procedures involved the CRS being properly installed in a second-row seating position. The make, model, and model year of the vehicle complied with all requirements stated by the manufacturers of the reminder systems and CRS. Further, for increased testing flexibility from a child restraint system installation perspective, the vehicle included lower anchors and tethers for children (LATCH) in the second row outboard seating positions.

Smartphone

Some UCRS products require a smartphone for setup and/or use. Although there are many smartphone platforms (e.g., Android, iOS, Windows Phone) and even more hardware options, NHTSA chose to use hardware and operating system combinations that met the requirements for the UCRS under evaluation (Android and iOS). The most up-to-date version of the respective operating system was installed on the smartphone prior to the evaluations. The smartphones had an active cellular connection with data service to facilitate any telecommunication-based notification delivery (e.g., SMS, e-mail, 911). Since individual smartphone configuration settings (tones, volumes, profiles, etc.) may affect the assessment of delivery notification, the phone was configured to provide audible notifications (i.e., the ringer was not turned off or placed in silent mode). Prior to conducting the evaluation, the most up-to-date version of the UCRS mobile application was downloaded and installed.

Child Occupant Surrogates

The evaluation procedure was devised for use with UCRS products designed for newborns up through children 3 years old who ride in harness-based child restraint seats. Understanding that some products may not be intended for all of the child sizes represented by that range, the procedure was designed based on three child occupant size specifications within that range. The evaluations were only conducted with the appropriate size child occupants based on each product's design. The three occupant sizes correspond to newborn, 12 months, and 36 months, as described in the UCRS

Observations and Capabilities section. The selected occupant sizes are represented by anthropomorphic test devices, though the procedure is not limited to only using the standardized ATDs. In cases where the ATD is not available, human beings may be used. NHTSA used ATDs in its assessments.

Newborn (0-Month-Old): The newborn occupant surrogate has a mass between 3.1 and 3.9 kg and a length between 47.7 and 51.8 cm. The CAMI Newborn ATD specified in 49 CFR, Part 572, Subpart K meets the mass and length specifications for the UCRS Newborn surrogate.

12-Month-Old: The 12-month-old occupant surrogate has a mass between 8.7 and 11.0 kg and a length between 71.2 and 76.9 cm. The CRABI-12 twelve-month-old ATD specified in 49 CFR, Part 572, Subpart R meets the mass and length specifications for the UCRS 12-month-old surrogate.

36-Month-Old: The 36-month-old occupant surrogate has a mass between 12.8 and 15.4 kg and a height between 91.0 and 97.3 cm. The Hybrid III 3-year-old ATD specified in 49 CFR, Part 572, Subpart P meets the stature specification for the UCRS 36-month-old surrogate, but is slightly heavier than the established range based on the CDC growth charts. Despite the increased mass, the Hybrid III 3-year-old ATD is considered suitable for use as a 36-month-old child surrogate in this UCRS assessment.

Child Restraint System Specifications

NHTSA chose to evaluate the UCRS in multiple CRS types and models, as applicable, to ensure robust operation in a variety of CRS shapes and configurations. Based on the age and size range described for the target population of this procedure, potential CRS types include rear-facing infant carriers, convertible seats in rear-facing or forward-facing mode, and combination seats used in forward-facing harness mode. All-in-one seats used in rear-facing or forward-facing harness mode could also be used, if appropriate.

Miscellaneous Test Equipment

In addition to the UCRS, CRS, child surrogates, smartphone, and vehicle, a few other pieces of test equipment were used to perform the assessments.

Batteries: A supply of suitable batteries was available to ensure the UCRS were fitted with fresh or fully charged batteries during the assessments.

Digital Camera: A digital camera was used to take digital still photographs of the installations and assessments.

Fasteners: In order to secure UCRS hardware to the CRS, a supply of various tapes and adhesive hook-and-loop strips was available during the assessments.

Electronic timer: The electronic timer was used to measure the amount of time between actions and UCRS notification delivery.

Tape measure or distance measuring wheel: The tape measure or distance measuring wheel was used to measure the distance from the vehicle where the left-behind notification is issued, and should be capable of measuring a distance of at least 100 meters.

Applicable Test Configurations

Using Table 2, NHTSA established the applicable combinations of child size, CRS, and orientation to use for each product evaluated in the functional assessments. The selection of the applicable combinations was based on the usage guidelines for the UCRS, while also conforming to CRS weight and size constraints. Note that there are limitations with the use of some UCRS with detachable infant carriers, and the applicability of the functional assessments differed depending on the nature of the UCRS design.

Table 2: Surrogate/CRS configurations

Surrogate age/size	Infant Carrier	Convertible	Combination
Newborn	RF	RF	n/a
12-Month-Old	RF	RF	n/a
36-Month-Old	n/a	RF	n/a
	n/a	FF	FF

RF=rear facing, FF=forward facing

System Installation and Setup

The manufacturer's guidelines for UCRS installation and use were followed at all times during the assessments. Furthermore, the vehicle owner's manual and CRS user guides were followed for CRS installation purposes. The test technicians used their best judgment to determine the appropriate product-specific process.

If a UCRS required installation at the vehicle level (e.g., drew 12V power from vehicle or interfaces with OBD-II port), the testers completed the vehicle-level installation steps prior to beginning the functional assessments. The testers installed as much of the system as possible while still allowing for the CRS to be removed from or installed into the vehicle. The testers followed the manufacturer's installation guidelines and documented the vehicle-level installation with photographs.

CRS-level installation was performed for each CRS that was used in the assessments. All CRS were properly installed into the subject vehicle according to manufacturer's instructions and based on CPS best practices. The testers used the LATCH straps to install the CRS in its evaluations, though installation with the three-point seat belt is also suitable. Installation of the UCRS components in the CRS was performed in a manner that facilitated removal without subjecting the CRS or UCRS components to damage, so that the UCRS could be evaluated in multiple CRS (e.g., using hook-and-loop or double-sided tape for temporary installation). The testers documented the CRS-level installation with photographs. The testers also configured the user-adjustable distance settings to their midpoint setting, unless otherwise specified in the user guide.

Configuration of the smartphone and any required apps ensured proper hardware and software versions were used. Prior to conducting the functional assessments, the testers ensured the smartphone and UCRS were communicating as required. In some cases, the testers performed parts of the assessment with adjustable settings varied to study the effects.

Child Occupant Presence Detection Repeatability Assessment

The Child Occupant Presence Detection Repeatability Assessment, hereafter referred to as detection assessment, evaluates the repeatability of the UCRS's ability to detect that a child has been seated in a child restraint seat. The procedure represents a typical sequence of events that would occur at the beginning of a vehicle trip. The detection assessment was performed for all applicable occupant sizes and in all applicable CRS configurations from Table 2. For each CRS and orientation evaluated, the CRS-based UCRS hardware (e.g., pressure pad, transmitter) was installed in the CRS, and the CRS installed in the vehicle, prior to each combination's assessment. Any electrical connections between the CRS-based components and the vehicle were made at this time.

The detection assessment began with the vehicle parked on a flat, level surface (inside or outside). The vehicle power was off at the beginning of the assessment. The child surrogate was placed in the CRS and positioned according to the CRS manufacturer's guidelines for the particular occupant size being assessed.

The surrogate was placed in the seat buttocks first, with its back resting against the backrest of the CRS. The surrogate was dressed in a manner such that the legs were free to facilitate proper strap positioning. The pelvis, torso, and head of the surrogate were centered laterally in the CRS. Once the surrogate was positioned appropriately, the harness straps were routed, fastened, and tightened as appropriate. No additional material was placed underneath the child aside from the CRS cover. The dummy positioning procedures specified in FMVSS Number 213 (49 CFR Part 571.213 S10) were followed given the use of ATDs.

Next, the testers determined whether or not the UCRS had detected the presence of the child. Positive detection of the child, depending on the product, was indicated by an audible tone, smartphone alert, or illuminated display. If a UCRS did not provide the user with an indication that the child's presence had been detected, the testers performed any further steps to obtain indication from the system that the detection was successful. For example, one UCRS did not provide indication that it had activated until driving the vehicle and turning off the power.

Once positive detection was confirmed, the testers removed the child surrogate from the CRS and repeated the assessment for a total of three trials. The testers then recorded the results in a table similar to that shown in Table 3, with additional columns to cover all of the child, CRS, and orientation combinations.

Table 3: Child Presence Detection Repeatability Assessment Data Table Example		
	Configuration 1	**Configuration 2**
CRS Type	Infant carrier	Convertible
CRS Model	Graco Snugride	Evenflo Triumph
Orientation	Rear-facing	Forward-facing
Child/Surrogate	4 week old boy, 3.7 kg, 50.5 cm	HIII 3yo ATD
Detection Trial #1	✓	✓
Detection Trial #2	✓	✓
Detection Trial #3	✓	✓
Notes	Sensor positioning was made difficult due to harness strap location, but performance was acceptable	

Following the detection assessment, the testers used Table 4 to identify the characteristics of the UCRS activation features.

Table 4: Activation Operational Features		
Feature	**Result**	**Description**
Audible Presence Detection Confirmation	Yes or No	Indicate whether the UCRS provides an audible confirmation when the child's presence has been detected. This confirmation may occur when the child is placed in the seat or once the vehicle's power has been engaged (for systems with a vehicle interface).
User Action Required for Activation	Yes or No	Indicate whether the user must perform any additional actions, beyond those normally associated with properly securing a child in a CRS at the beginning of a vehicle trip, to activate the UCRS. Closing a chest clip or turning on the vehicle power is not considered an additional action.
User Action Confirmation	Yes, No, or n/a	Indicate whether the UCRS provides an audible confirmation when the system is activated following a user action. This feature is only applicable if the user must perform an action to activate the UCRS.

End-of-Trip Notification Assessment

The End-of-Trip Notification Assessment, hereafter referred to as EoT assessment, identifies the UCRS behavior at the end of a typical vehicle trip. The procedure represents a typical sequence of events that would occur when the vehicle's power is disengaged and includes removal of the child from the CRS. The EoT assessment was performed with one applicable child, CRS, and orientation combination from Table 2. The CRS-based UCRS hardware (e.g., pressure pad, transmitter) was installed in the CRS, and the CRS installed in the vehicle, prior to the EoT assessment.

The EoT assessment began with the vehicle parked on a flat, level outdoor surface. The vehicle power was off at the beginning of the assessment. The child surrogate was placed in the CRS and positioned according to the CRS manufacturer's guidelines for the particular occupant size being used for the EoT assessment. Once the child surrogate was positioned appropriately in the CRS, the harness was fastened and tightened as appropriate. the testers confirmed the UCRS detected the child and entered an activated state by performing any user actions necessary to complete activation of the UCRS.

The vehicle's power was switched on (e.g., engine started or powertrain in "Ready" state), though the vehicle's radio and ventilation system were turned off to minimize cabin noise. The testers allowed the vehicle to run for at least one minute. If the product design required vehicle motion/driving to enter an activated state, the testers drove the vehicle such that any specific activation criteria were met (e.g., exceed 5 km/h) and returned the vehicle to the designated test location. With the vehicle parked, the testers shut off vehicle power while monitoring for any audible notifications from the UCRS. To avoid confusion with other chimes, the testers ensured headlights were off and driver's door was closed with key removed from ignition switch. Ten seconds after shutting off power, the testers opened the driver's door and exited the vehicle to remove the child from the CRS.

After opening the rear door, the testers unfastened the CRS harness and removed the child from the CRS. The testers observed whether the UCRS provided an audible notification that the child had been removed. The testers noted whether any further user action was required at that time to fully deactivate any component of the UCRS.

Following the EoT assessment, the testers used Table 5 to identify the characteristics of the UCRS notification features.

Table 5: End-of-Trip Operational Features		
Feature	**Result**	**Description**
End-of-Trip Reminder Notification	Yes or No	Indicate whether the UCRS provides an audible reminder notification at the end of the trip. The end of the trip is defined as the period up to one minute after disengaging the vehicle's power once parked. This audible reminder is considered a convenience notification.
Audible Child Removal Notification	Yes or No	Indicate whether the UCRS provides an audible notification upon removal of the child from the CRS indicating that the system has been deactivated. This notification is similar to the Presence Detection Confirmation in that it indicates to the user that the child detection status has changed. Cessation of an End-of-Trip Reminder Notification upon removal of the child constitutes a Child Removal Notification, as it provides an audible indication that the system status changed.
End-of-Trip User Action Required	Yes or No	Indicate whether the user must perform any additional actions, after removing the child from the CRS at the end of a vehicle trip, to deactivate the UCRS.

Left-Behind Alert Assessment

The Left-Behind Alert Assessment identifies the UCRS behavior under circumstances representing those that would occur when a child was forgotten in a parked vehicle at the end of a trip. The procedure represents a typical sequence of events that would occur when the vehicle's power is disengaged, but the child is not removed from the CRS and the driver walks away from the vehicle. The Left-Behind Alert Assessment was performed with one applicable child, CRS, and orientation combination from Table 2. The CRS-based UCRS hardware (e.g., pressure pad, transmitter) was installed in the CRS, and the CRS installed in the vehicle, prior to the Left-Behind Alert Assessment.

The Left-Behind Alert Assessment began with the vehicle parked on a flat, level outdoor surface with a clear straight path of up to 100 m for walking away from the vehicle perpendicularly from the driver's side. The vehicle power was off at the beginning of the assessment. The testers fully lowered all side windows to provide adequate ventilation and to be able to monitor any audible notifications from the UCRS during the assessment. The child surrogate was placed in the CRS and positioned according to the CRS manufacturer's guidelines for the particular occupant size being used for the Left-Behind Alert Assessment. Once the surrogate was seated appropriately, the harness was fastened and tightened as appropriate. The testers confirmed the UCRS has detected the child and has entered an activated state by performing any user actions necessary to activate the UCRS.

The vehicle's power was switched on (e.g., engine started or powertrain in "Ready" state), though the vehicle's radio and ventilation system were turned off to minimize cabin noise. The vehicle was allowed to run for at least one minute. If the product design required vehicle motion/driving to enter an activated state, the vehicle was driven so that all specific activation criteria were met (e.g., exceed 5

km/h) and the vehicle was returned to the designated test location. With the vehicle parked, vehicle power was disengaged, the vehicle was exited, and all vehicle doors were closed.

The test technician began timing with the electronic timer, and immediately walked away from the vehicle. The test technician walked in a straight line along the pre-determined 100 m long path at a casual walking speed (a typical walking speed of about 1.4 m/s was targeted, though no attempt was made to eliminate variability). While walking away from vehicle, the test technician monitored the UCRS components for audible notifications. The time and distance from the vehicle at which a notification of a left-behind child was issued was recorded. Whether the notification was provided to the user (key fob, smartphone, etc.), to the vehicle surroundings (horn, alarm, flashing lights, etc. emanating from the vehicle), or whether forms of telecommunication were invoked (SMS, e-mail, 911, etc.) was also recorded.

If no notification was provided prior to the 100 m distance being reached, the UCRS components were monitored from this location for another ten minutes and the time at which a notification was provided was noted.

Once the left-behind notification was received, the test technician remained at that location for one minute to determine whether the system required cancellation or if the notification automatically self-canceled within one minute. No action to cancel the notification was performed during this time. After one minute passed, the test technician began walking back toward the vehicle while observing whether self-cancellation of the alert occurred.

Upon returning to the vehicle, the rear door was opened to remove the child from the CRS. The test technician noted whether the left-behind notification cancelled upon removal of the child from the CRS if the notification was not already canceled. The test technician noted if any further action beyond removal of the child was required to cancel alarm.

The Left-Behind Alert Assessment was repeated for a total of three trials. The testers then recorded the results in a table similar to that shown in Table 6.

Table 6: Left-Behind Alert Assessment Data Table

		Configuration 1
CRS Type		Convertible
CRS Model		Evenflo Triumph
Orientation		Forward-facing
Child/Surrogate		HIII 3yo ATD
Left-Behind Trial #1	**Distance (m)**	33.0
	Time (min:sec)	0:24
Left-Behind Trial #2	**Distance (m)**	32.4
	Time (min:sec)	0:24
Left-Behind Trial #3	**Distance (m)**	34.5
	Time (min:sec)	0:25
Notes		

Following the Left-Behind Alert Assessment, the testers used Table 7 to indicate the characteristics of the UCRS notification features.

Table 7: Left-Behind Operational Features

Feature	Result	Description
Left-Behind Notification	Yes or No	Indicate whether the UCRS provides an audible alert when a left-behind situation has occurred. A left-behind situation will usually be based on time or distance.
Left-Behind Notification Recipients	User, Vehicle Surroundings, Telecommunication	Indicate where or how the left-behind alert was delivered. "User" applies to notifications delivered to the driver/caregiver via a fob or smartphone that the driver/caregiver is presumed to be holding. "Vehicle surroundings" applies to the area inside and around the vehicle. "Telecommunication" applies to notifications sent to persons or systems through telephone, SMS, or e-mail. Include all recipients to whom the UCRS is capable of delivering Left-Behind Notifications.
Left-Behind In-Vehicle Cancellation	Yes, No, or n/a	After the notification is delivered, does permanent cancellation of the left-behind notification require the user to return to the vehicle's cabin?
Snooze Function	Yes, No, or n/a	Indicate whether the UCRS left-behind alert has a snooze feature that temporarily silences the notification without returning to the vehicle's cabin.

Mid-Trip Temporary Deactivation Assessment

The Mid-Trip Temporary Deactivation Assessment, hereafter referred to as MTD assessment, evaluates the UCRS behavior in circumstances in which the child is temporarily removed from the CRS while the vehicle is underway. The assessment includes a short-term (approximately 2 seconds) and long-term (5 minutes) removal of the child. The short-term removal simulates the potential loss of detection from rough roads, potholes, or the shifting of the child in the CRS. The long-term removal simulates a long-term loss of detection from the child moving to a different position or leaving the CRS during the trip. The MTD assessment considers the immediate UCRS response upon removal and restoration of the child in the CRS, as well as the end-of-trip or left-behind response following the removal event. The MTD assessment was performed with one applicable child, CRS, and orientation combination from Table 2. The CRS-based UCRS hardware (e.g., pressure pad, transmitter) was installed in the CRS, and the CRS installed in the vehicle, prior to the MTD assessment.

The MTD assessment mimics the EoT assessment, but includes a removal of the child from the CRS during the simulated vehicle trip. The MTD assessment began with the vehicle parked on a flat, level outdoor surface. The vehicle power was off at the beginning of the assessment. The child surrogate, was

placed in the CRS and positioned according to the CRS manufacturer's guidelines for the particular occupant size being used for the MTD assessment. Once the child surrogate was seated in compliance with the manufacturer instructions, the harness was fastened and tightened as appropriate. It was confirmed that the UCRS detected the child and entered an activated state by performing any user actions necessary to activate the UCRS.

The vehicle's power was switched on (e.g., engine started or powertrain in "Ready" state), though the vehicle's radio and ventilation system were turned off to minimize cabin noise. The vehicle was allowed to run for at least one minute. If the product design required vehicle motion/driving to enter an activated state, the vehicle was driven such that any specific activation criteria were met (e.g., exceed 5 km/h) and the vehicle was returned to the designated test location. With the vehicle parked, but still powered on, the child was removed from the CRS for approximately 2 seconds and then returned to the CRS. The UCRS behavior from this short-term deactivation was observed both when the child was removed and when the child was returned to the CRS. The vehicle power was shut off while monitoring for any audible notifications from the UCRS. To avoid confusion with other chimes, headlights were off and the driver's door was closed with the key removed from ignition switch. Ten seconds after shutting off power, the driver's door was opened and the test technician exited the vehicle to remove the child from the CRS.

The MTD assessment was repeated, but with the child removed from the CRS for a duration of 5 minutes.

Following the MTD assessment, the testers used Table 8 to indicate how the UCRS responded to temporary mid-trip deactivations.

Table 8: Mid-Trip Deactivation Features		
Feature	**Result**	**Description**
Child Out-of-Seat Notification – 2-Second Trial	Yes or No	Indicate whether the UCRS provides an audible notification when the child is removed from the CRS for the 2-second trial.
Child Restoral Notification – 2-Second Trial	Yes or No	Indicate whether the UCRS provides an audible notification when the child is returned to the CRS after the 2-second trial.
End-of-Trip Reminder or Left-Behind Notification – 2-Second Trial	Yes, No, or n/a	Indicate whether the UCRS provides an audible reminder notification at the end of the trip or in left-behind circumstances following the 2-second temporary deactivation trial. The end of the trip is defined as the period up to 1 minute after shutting off the vehicle's power once parked.
Child Out-of-Seat Notification – 5-Minute Trial	Yes or No	Indicate whether the UCRS provides an audible notification when the child is returned to the CRS after the 5-minute trial.
Child Restoral Notification – 5-Minute Trial	Yes or No	Indicate whether the UCRS provides an audible notification when the child is returned to the CRS after the 5-minute trial.
End-of-Trip Reminder or Left-Behind Notification – 5-Minute Trial	Yes, No, or n/a	Indicate whether the UCRS provides an audible reminder notification at the end of the trip or in left-behind circumstances following the 5-minute temporary deactivation trial. The end of the trip is defined as the period up to 1 minute after shutting off the vehicle's power once parked.

Observations and Findings

The functional assessments presented in this document were developed based on laboratory experience using several UCRS products in simulated real-world conditions. Differences in operational features among the products evaluated during the development process, combined with the knowledge that future products may incorporate even more varied operating characteristics, led to the creation of a generalized procedure. The intent was to develop a set of functional assessments that are agnostic to the specifics of a UCRS design, can identify key features of a UCRS, and serve as an evaluation tool for a range of interested parties.

The functional assessments described in this document were conducted for six commercially available UCRS products. The tests presented in this report were performed using a 2014 Hyundai Tucson 5-door compact utility vehicle. Child surrogates included the CAMI Newborn ATD, CRABI-12 twelve-month-old ATD, and Hybrid III 3C three-year-old ATD. Two infant carrier-style CRS were used: Evenflo Discovery 5 and Graco Snugride. Two convertible-style CRS were used: Evenflo Triumph and Evenflo Tribute. Table 9 provides specifications for the CRS and indicates the configurations suitable for the functional assessments based on the sizes of the child surrogates.

Table 9: CRS specifications and applicability for functional assessment child sizes					
CRS	**Weight Range (kg)**	**Height Range (cm)**	**Newborn (CAMI)**	**12 month old (CRABI-12)**	**36 month old (Hybrid III 3C)**
Evenflo Discovery 5	2.3 – 10.0	48 – 74	RF	RF	n/a
Graco Snugride Classic Connect	2.3 – 10.0	Up to 73	RF	RF	n/a
Evenflo Tribute 5	2.3 – 15.8 RF 9.0 – 18.0 FF	At least 48 RF Up to 101 FF	RF	RF FF	 FF
Evenflo Triumph Advance	2.3 – 15.8 RF 9.0 – 22.6 FF	At least 48 RF Up to 127 FF	RF	RF FF	 FF
RF=rear facing, FF=forward facing					

Findings from the functional assessments are provided in Appendix B. An additional commercially available product, SOS, was evaluated separate from this test protocol and yielded information similar to that shown in Tables 3 through 8; results are shown in Appendix B. The seven products were diverse in their design and operating requirements, but were all capable of detecting child presence and delivering some form of notification to the user. Table 10 shows a comparison of the UCRS operating characteristics from the functional assessments.

The generalized procedure devised for the functional assessments was followed for six of the seven products listed in Table 10. Differences among the products required some level of judgment to be exercised by the test technicians in order to accommodate individual product characteristics, but the assessments were capable of yielding the results on UCRS function as intended. The UCRS products generally functioned as expected, though there were occasions where the systems exhibited unusual behavior including unexpected beeping and smartphone application crashes. Systems that use a weight- or pressure-sensing element in the CRS frequently required some level of trial and error to find a suitable sensor position.

Some of the products evaluated required more user interaction than others. Some required user actions that, if not completed, would lead to the system not functioning properly.

Table 10: UCRS comparison	Aviso	ChildMinder Elite Pad	ChildMinder SoftClip	Forget Me Not	SOS[1]	Suddenly Safe 'N' Secure	True Fit I-Alert
Audible Presence Detection Confirmation	Yes	Yes	Yes	No	No	No	Yes
User Action Required for Activation	No	Yes	Yes	Yes	No	Yes	No
User Action Confirmation	n/a	Yes	Yes	Yes	n/a	Yes	n/a
End-of-Trip Reminder Notification	Yes	No	No	No	Yes	No	Yes[2]
Audible Child Removal Notification	No	Yes	Yes	No	No	Yes	No
End-of-Trip User Action Required	No	No	No	No	No	Yes	No
Left-Behind Notification	Yes	Yes	Yes	Yes	No	Yes	Yes
Left-Behind Notification Recipients	Vehicle surroundings	User (fob)	User (fob)	User (smartphone)	n/a	User (fob)	User (smartphone), Telecommunication (e-mail, SMS)
Left-Behind In-Vehicle Cancellation	Yes	No	No	No	n/a	No	No
Snooze Function	No	No	No	No	n/a	No	Yes

[1] The SOS was previously subjected to a different overall procedure, and the functional characteristics based on the descriptions given in this document were determined based on the outcome of the prior SOS evaluation (NHTSA Component Test Database test number c01190)

[2] I-Alert senses vehicle motion and determines end-of-trip based on a user-adjustable duration of no vehicle motion

UCRS Product Descriptions and Functional Assessment Results

Aviso Child-in-Car Alert

The Aviso is an add-on vehicle-based and CRS-based system that interfaces with the vehicle's power and horn. A sensing strip placed on the CRS shell under the CRS fabric cover detects the child's presence by flexing under the weight of the child, and is connected to a control module mounted to the vehicle's interior. The control module includes electrical connections to the vehicle's horn, constant 12 V power, and switched 12 V power. Because the Aviso is integrated into the vehicle, there is no need for additional batteries. The Aviso requires vehicle-level installation and is compatible with most types of CRS that remain in a vehicle. The Aviso is not well-suited for use with detachable infant carriers.

Initial setup of Aviso requires installation by a skilled automotive technician familiar with vehicle electronics due to its interface with the vehicle's 12 V power and the horn relay. The consumer (vehicle owner) installs the flexible ribbon sensor into the CRS, which may require multiple trials to find the best location for detecting the child when seated without interfering with the harness straps. Due to differences in CRS shell shapes and locations of harness straps, some CRS required more trials than others to mount the sensor in a way that reliably detected the presence and absence of the child. Figure 4 shows the sensor ribbon installation in two convertible CRS for the functional assessment.

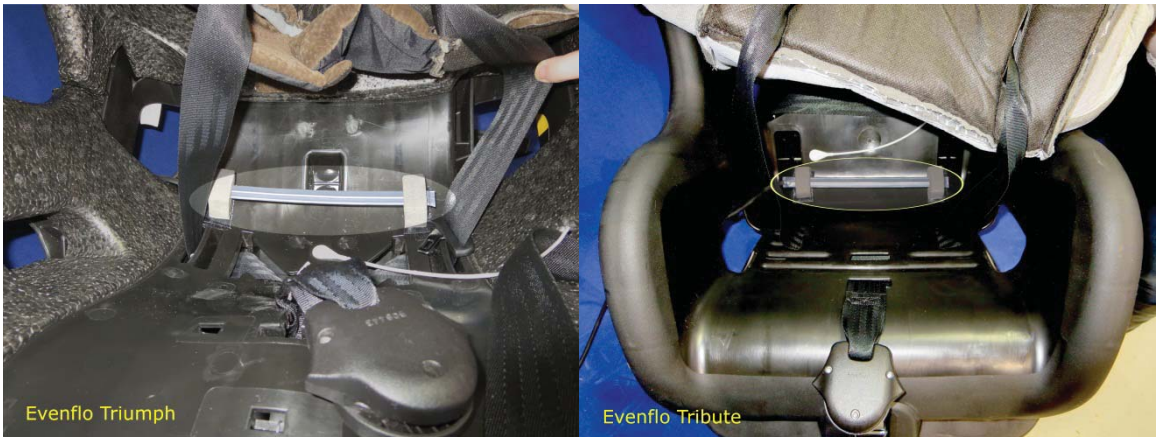

Figure 4: Aviso sensor ribbon installed in Evenflo Triumph (left) and Evenflo Tribute (right) convertible CRS. The sensor ribbon is located in the seat bight region of both CRS pictured and is highlighted in an ellipse.

After the user had found a suitable location for the sensor ribbon, the Aviso demonstrated repeatable child detection for all the child, CRS, and orientation combinations evaluated for the detection assessment (Appendix B, Table 1). The Aviso was evaluated in two detachable infant carriers. Removing the detachable portion of an infant carrier with the child strapped in place, as may be common in real-world usage, would require the sensor ribbon to be disconnected from the control module every time the infant carrier was removed from the vehicle and then reconnected when the carrier was placed back in the vehicle. For the NHTSA evaluation, the infant carrier remained attached to the base in the vehicle while the child was removed from the carrier.

Once installed and set up, the Aviso required no additional action from the user during normal operation. As shown in Table 10, the Aviso provides a detection confirmation tone when the child is placed in the CRS, issues an end-of-trip convenience reminder when the vehicle power is shut off, and issues a left-behind alert a fixed time after the vehicle power is shut off if the child has not been removed from the CRS. The system did not provide any notifications when the child left the CRS, but reactivated automatically when the child was returned to the CRS for the mid-trip deactivation.

The confirmation tone and convenience reminders are emitted from a speaker in the control module, which is mounted in the vehicle's cabin. The left-behind alert includes a chime from the same speaker, followed by sounding of the vehicle's horn. Once the left-behind alert has started, stopping the alert requires cycling the vehicle's power or removing the constant 12 V power to the Aviso. The Aviso does

not allow the user to pause the left-behind alert, though the alert is not issued until 9 minutes and 25 seconds after the vehicle power has been shut off. The delay time for the alert is fixed.

ChildMinder Elite Pad System

The ChildMinder Elite Pad System is an add-on CRS-based system that relies on a fob for delivering notifications to the user. A pad placed on the CRS shell under the CRS fabric cover detects the weight of the child and is connected to a transmitter module, which the user affixes to the outer shell of the CRS. The transmitter module and fob require user-replaceable batteries to operate. The ChildMinder Elite Pad is a user-installed system compatible with most types of CRS. When used with an infant carrier the system will remain activated whenever a child is in the CRS, regardless of whether the carrier is installed in the base in the vehicle.

Initial setup of the ChildMinder Elite Pad requires the user to place the sensing pad into the shell of the CRS, near where the child's pelvis rests, and route a thin cable through to the outer side of the shell where the transmitter must be affixed. The thin cable broke during the assessments. Varying geometry among the different CRS used in the assessments required different approaches to pad placement and cable routing. Pad placement in the same seat differed for forward-facing and rear-facing modes. Figure 5 shows the pad placement in an infant carrier and convertible CRS for the functional assessment.

Figure 5: ChildMinder Elite Pad installed in Evenflo Discovery 5 infant carrier (left) and Evenflo Triumph convertible (right) CRS. Note that the pad position shown for the Evenflo Discovery 5 was a trial position, which demonstrated intermittent results, and was not the final position used in the evaluation. The sensor pad has been highlighted in the seat bight region.

The ChildMinder pad demonstrated repeatable detection performance once the best location was found. The detection assessment showed repeatable detection for all configurations evaluated (Appendix B, Table 3).

After the child is seated in the CRS and the pad detects its presence, the transmitter module begins to emit audible tones, as well as flashing LEDs, signaling that the system must be activated. Activation is achieved with the user pressing the button on the fob. If activation is not completed, the audible notification continues until the child is removed from the CRS. Once activated, a confirmation tone is

provided and an LED flashes on the transmitter module and on the fob. As shown in Table 10, the ChildMinder Elite Pad does not provide an end-of-trip notification, which is a result of the system not incorporating vehicle status into its logic.

If the child leaves the seat at any time, the transmitter module immediately beeps. The system did not require reactivation when the child was out of the seat for the 2-second assessment. For the 5-minute assessment, the system required reactivation when the child was placed back in the seat.

The left-behind notification varied among the three trials, and was issued when the test technician had walked 22 to 37 meters from the vehicle. The distance at which the left-behind alert begins is not user-adjustable. The beeping associated with the left-behind notification could not be cancelled unless the technician walked back toward the vehicle or removed the child from the CRS.

ChildMinder SoftClip

The ChildMinder SoftClip is an add-on CRS-based system, which relies on a fob for notification delivery. A retrofit chest clip, which replaces the original CRS chest clip, contains a transmitter and closure switch. The chest clip transmitter module and fob require user-replaceable batteries to operate. The ChildMinder SoftClip is a user-installed system compatible with harness-based CRS. When used with infant carriers, the system will remain activated whenever a child is buckled in the CRS, regardless of whether the carrier is installed in the base in the vehicle.

Setup of the ChildMinder SoftClip involves removal of the CRS harness chest clip, which is then replaced with the SoftClip chest clip. The product documentation does not state any limitations regarding CRS type, orientation, or child mass. The SoftClip can be installed on the harness straps without unthreading the harness straps, though this would result in the CRS being fitted with two chest clips and the product packaging indicates the SoftClip should replace the original CRS chest clip. Figure 6 shows the SoftClip installed on the straps of a convertible CRS.

Figure 6: ChildMinder SoftClip installed on harness straps of an Evenflo Triumph convertible CRS. Note that the OEM chest clip was not removed for this assessment.

The ChildMinder SoftClip was not subjected to the full range of child, CRS, and orientation combinations due to its presence sensing being indirect based on clip closure. Table 5 in Appendix B shows the detection assessment results, which indicate repeatable detection for both configurations tested.

After the child is seated in the CRS and the SoftClip is fastened, the ChildMinder chest clip transmitter begins to emit audible tones, as well as a flashing LED, signaling that the system must be activated. Activation is achieved with the user pressing the button on the fob. If activation is not completed, the audible notification continues until the chest clip is opened. Once activated, a confirmation tone is provided and an LED flashes on the chest clip and on the fob. As shown in Table 10, the ChildMinder SoftClip does not provide an end-of-trip notification, which is a result of the system not incorporating vehicle status into its logic. If the chest clip is opened at any time, the transmitter immediately beeps. The system did not require reactivation when the clip was opened for the 2-second assessment. For the 5-minute assessment, the system required reactivation when the clip was reclosed.

The left-behind notification was issued when the test technician had walked about 17 meters from the vehicle. The left-behind alert distance is not user-adjustable. The beeping associated with the left-behind notification could not be cancelled unless the technician walked back toward the vehicle or unfastened the chest clip.

Forget Me Not

The Forget Me Not is an add-on CRS-based system, which relies on a user's smartphone for notification delivery. The Forget Me Not may be purchased with a fob for notification delivery, though the fob was not available at the time of the assessment. A pad placed on the CRS shell under the CRS fabric cover detects the weight of the child and is connected to a transmitter module, which the user affixes to the outer shell of the CRS. The transmitter module requires a user-replaceable battery to operate, and the system relies on a Bluetooth Low Energy connection with the smartphone. A specialized app must be

installed and running on the smartphone. The Forget Me Not is a user-installed system compatible with most types of CRS. When used with infant carriers, the system will remain activated whenever a child is in the CRS, regardless of whether the carrier is installed in the base in the vehicle.

Initial setup of the Forget Me Not requires the user to place the sensing pad into the shell of the CRS near where the child's pelvis rests and route the cable through to the outer side of the shell where the transmitter must be affixed. Pad placement in the infant carriers differed for the newborn and 12-month-old due to the different child masses and weight distributions not triggering the sensor consistently. Figure 7 shows the pad placement in an infant carrier and convertible CRS for the functional assessment. The Forget Me Not also requires installation of an app on the user's smartphone.

Figure 7: Forget Me Not (bear face-shaped pad) installed in Evenflo Discovery 5 infant carrier (left) and Evenflo Tribute convertible (right) CRS.

Once a suitable location had been found for the sensor pad after a few trials, the Forget Me Not demonstrated good repeatability for the detection assessment. Table 7 of Appendix B shows the results in the tested combinations.

For the Forget Me Not to enter an activated state, the user must have the app open on the smartphone when the child is placed in the CRS or at some point after placing the child in the CRS. The app screen displays a notification that the seat is occupied, and this indicates a connection has been established between the transmitter and the smartphone. The transmitter does not provide an audible notification that the user must perform any actions to activate the system, and failure to open the app on the smartphone results in the system not being activated. Table 10 shows that the Forget Me Not does not provide an end-of-trip notification, since the system does not detect vehicle status. If the child is removed from the seat, the app immediately detects the seat is unoccupied. In the 2-second assessment, the app switched back to the occupied state when the child was returned to the seat. After one minute and twelve seconds out of the seat for the 5-minute assessment, the smartphone provided a message and tone that the phone lost connection with the transmitter. For the 5-minute assessment, the system required reactivation when the child was placed back in the seat.

The left-behind notification distance is user-adjustable from within the app. The notification distance varied among repeat trials regardless of the setting. With the range set to the maximum distance, the alert was issued when the technician had walked 38 to 55 meters from the vehicle. On the medium range setting, the alert was issued at a range of 15 m to 21 m. Product documentation states a range between 0.6 m and 18.3 m, though actual range would vary based on several factors. The left-behind notification displays messages on the smartphone screen and provides an audible tone, even if the phone is locked or another app is in use. The notification stopped when the smartphone was moved back in range of the CRS.

SOS

The SOS is an add-on vehicle- and CRS-based system that interfaces with the vehicle's OBD-II port. A retrofit chest clip, which replaces the original CRS chest clip, contains a transmitter and closure switch. The chest clip transmitter module is equipped with a non-replaceable battery. The receiver module connects to the vehicle's OBD-II port, which supplies 12 V power and vehicle status data. The SOS is a user-installed system compatible with rear-facing harness-based CRS.

Setup of the SOS involves removal of the CRS harness chest clip, which is then replaced with the SOS chest clip. The product documentation states the SOS should only be used in rear-facing configurations. The receiver for the SOS should be plugged into the vehicle's OBD-II port, and a one-time initialization procedure performed.

The SOS was not subjected to the functional assessments as described in this report, though functional characteristics are shown in Table 10 and partial results from similar assessments are included in Tables 15 and 16 of Appendix B. A full test report, using a customized test procedure, is located in the NHTSA Component Test Database under test number c01190.

Suddenly Safe 'N' Secure Wireless Child Protection System

The Suddenly Safe 'N' Secure Wireless Child Protection System is an add-on CRS-based system, which relies on a fob for notification delivery. A pad placed on the CRS shell under the CRS fabric cover detects the weight of the child and is connected to a transmitter module, which the user affixes to the outer shell of the CRS. The transmitter module and fob require user-replaceable batteries to operate. The Suddenly Safe 'N' Secure Wireless Child Protection System is a user-installed system compatible with most types of CRS. When used with infant carriers, the system remains activated when a child is in the CRS, regardless of whether the carrier is installed in the base in the vehicle unless the user manually switches the transmitter off.

Initial setup of the Safe 'N' Secure requires the user to place the sensing pad into the shell of the CRS near where the child's pelvis rests and route a cable through to the outer side of the shell where the transmitter must be affixed. Varying geometry among the different CRS used in the assessments required different approaches to pad placement and cable routing. Figure 8 shows the pad placement in an infant carrier and convertible CRS for the functional assessment.

Figure 8: Suddenly Safe 'N' Secure pad (blue pouch) installed in Graco Snugride infant carrier (left) and Evenflo Triumph convertible (right) CRS.

The sensor pad detected the child for the Safe 'N' Secure system in all tested configurations (Appendix B, Table 9).

The Safe 'N' Secure transmitter includes a manual power switch, and must be turned on for the system to function. With the transmitter's power switched on, the pad can detect the presence of the child. When the child is placed in the CRS, an LED on the transmitter module begins to flash, but no audible detection confirmation is provided to the user. At this time, the user must slide a switch on the fob to activate the system, which provides an audible confirmation. If activation is not completed, the system will not provide any further notifications. As shown in Table 10, the Safe 'N' Secure does not provide an end-of-trip notification, which is due to the system not detecting vehicle status. If the child leaves the seat while the system is activated, the fob emits an audible tone and vibrates. For the short-term (2-second) temporary loss, the fob silenced and the system re-linked when the child was replaced in the CRS. For the 5-minute temporary loss, the fob continued to emit the tone and vibrate until the child was replaced in the CRS.

The left-behind notification distance is user-adjustable from a dial on the fob, and was set, according to the user guide, to provide the notification at a separation distance of 6 to 10 feet (approximately 2 to 3 meters) from the transmitter. The left-behind notification, which includes an audible tone and vibration of the fob, was issued when the test technician had walked about 6 meters from the vehicle. The beeping and vibration of the fob could be cancelled by walking back toward the vehicle or by sliding the power switch on the fob to the "off" position.

True Fit I-Alert C685

The True Fit I-Alert C685 is a convertible CRS with an integrated UCRS monitor, which relies on a user's smartphone for notification delivery. The CRS shell incorporates a control module and two switches that detect the weight of a child in the CRS. The control module contains a rechargeable battery, and must be removed from the CRS shell for charging. The system relies on a Bluetooth connection with the smartphone. A specialized app must be installed on the smartphone.

The True Fit I-Alert C685 is installed in a motor vehicle much like any other child restraint seat. The UCRS portion of the I-Alert is built in to the seat, with sensors located on the seat bottom and seat back. The sensor switches are activated by the weight of the occupant, and only one of the two switches needs to be depressed for the detection to function. Figure 9 shows the I-Alert CRS with the cover removed. As part of the setup process, the Bluetooth pairing process needs to be performed between the I-Alert and smartphone.

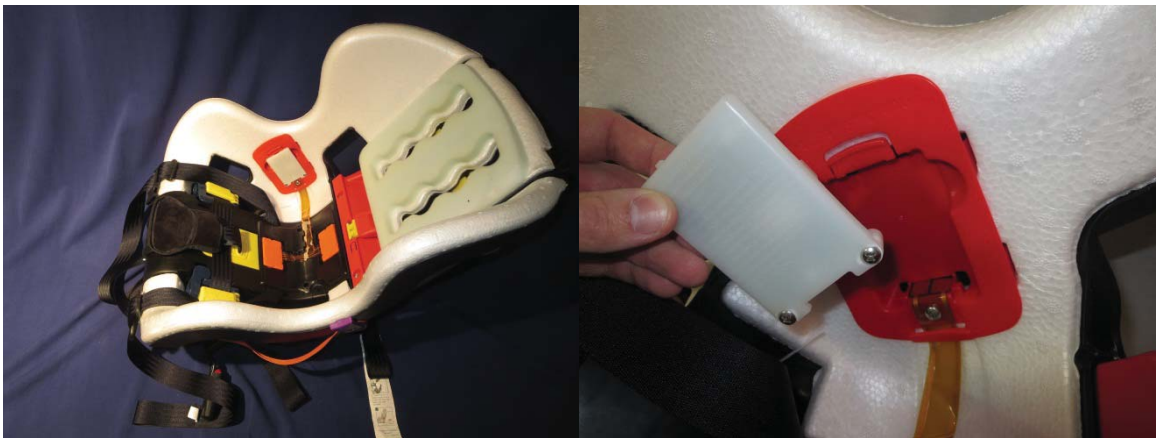

Figure 9: True Fit I-Alert C685 child restraint with cover removed (left), and the removable transmitter module (right). The two switches are the orange rectangular areas shown in the base of the CRS along the midline on either side of the seat bight.

The I-Alert C685 sensors demonstrated good repeatability for detection of the child in all of the configurations tested (Appendix B, Tables 11 and 13).

For the I-Alert to enter an activated state, the user must have Bluetooth enabled on the smartphone when the child is placed in the CRS. The app does not need to be open on the phone in order for detection to occur, and the smartphone displays a message on the screen and emits a notification tone when the child is detected. No further action is required from the user at this time, as indicated in Table 10. Once activated, the app displays some information about the CRS status, and the system detects vehicle motion using an accelerometer in the transmitter module housed in the CRS. The I-Alert cannot detect the vehicle's power status to offer a true end-of-trip reminder, but it does monitor vehicle motion and can issue a notification after the vehicle sits still for a user-adjustable amount of time (1 to 5 minutes). This audible notification, which also displays a message on the smartphone screen, does not require any action from the user. If the child leaves the seat at any time while activated, the smartphone emits a tone and displays a message that the child has left the seat. For the 2-second and 5-minute deactivation tests, the system reactivated when the child was replaced in the seat without any user action.

The left-behind notification was triggered by the loss of the Bluetooth connection between the transmitter and the smartphone, and varied between 46 meters and 66 meters for the two smartphone types used in the assessment. The smartphone provided an audible tone, vibration, and a screen message that could be temporarily dismissed (snooze feature) by tapping the on-screen button. The app

can be configured to deliver SMS and e-mail messages when a left-behind event occurs, though this feature was not assessed. The left-behind alert distance is not user-adjustable.

Limitations

An attempt was made to develop a generalized procedure suitable for use with a diverse range of UCRS products. As technology improves, capabilities of UCRS may make the functional assessment procedures described in this document obsolete. Advances in occupant sensing and communication protocols may require assessment procedures that were not envisioned at the time this document was written.

The functional assessments were devised to provide a laboratory-style evaluation of UCRS functionality, and lack the rigorous prescribed conditions and methodology of a regulatory evaluation. Some aspects of the functional assessments require the test technician to use their best judgment due to operational differences in the UCRS design relative to the specifics of the described assessment procedure.

Also, these procedures are intended to assess the capabilities of the UCRS and if they perform specific functions, but they do not evaluate the effectiveness of the alerts and notifications in terms of whether they elicit the appropriate responses from the driver or caregiver. The procedures were developed based on the premise that the user would follow the manufacturer's guidelines and act in good faith when using such a product.

Another limitation of this assessment procedure is that it represents an idealized set of circumstances. While those circumstances were intended to represent a typical use-case, real-world conditions vary widely and may introduce factors that compromise UCRS behavior.

The results presented in this report were from tests using ATDs. While ATDs generally represent the weight distribution and size of a human, their composition may not provide an accurate representation of a live child for this type of static evaluation. The stiffness of the ATD flesh and the joint ranges of motion may limit the ATDs ability to conform to the CRS in the same way as a live child, which may have potential implications for sensor activation.

Conclusion

NHTSA has conducted research on electronic unattended child reminder systems and has developed a new generalized functional assessment methodology to document system capabilities. The functional assessments offer product developers a set of testing applications that may be used to benchmark their designs and to improve system performance. The focus of this procedure on children 3 or younger was based on the majority of the forgotten children who have died from heat stroke being below that age and seated in CRSs. The assessment was performed for seven products available during the study period. The generalized procedure was suitable for use with differing system designs, and has potential to also be used with integrated vehicle-based systems. The results show that the aftermarket systems evaluated in the study detect the presence of the child and issue notifications to the user, though the method of operation differed among the seven products. ATDs representing three child sizes were

detected by the systems installed in four CRS of differing configurations. The level of required user interaction varied among the systems tested, and some required no additional input from the user after initial installation.

Based on the observations made from evaluation of commercial products and knowledge of the circumstances leading up to child heat stroke deaths due to being left behind in automobiles, NHTSA has concluded that unattended child reminder systems would ideally incorporate the following features.

- No effect on CRS crash performance (if add-on system type)
- Minimal additional action from driver/parent to operate following initial installation
- Provide feedback to user to indicate functionality
- Provide end-of-trip convenience reminder and left-behind alert
- Incorporate fail-safe features
- Robust operating capabilities – battery life, temperature range, appropriate child size, compatible CRS type, etc.

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Appendix A – Technology Catalog

Guide to UCRS product features

Type	OEM or add-on	Is system factory-installed in vehicle or CRS, or added by consumer?
Location	Vehicle, CRS, Both	Does the device interact with the vehicle, CRS, or both?
Presence Detection	Direct or indirect	Does occupant detection method determine presence directly (e.g., force) or indirectly (e.g., chest clip)?
Presence Sensing	Force, clip closure, video, etc.	What method of sensing is used to determine occupant presence?
Left-behind Condition	Power shut-off, distance, etc.	What triggers the left-behind status to issue alert?
Notification Source	Fob, vehicle horn, smartphone, etc.	Through what means is the notification delivered?
Notification Method	Audible, haptic, visual, etc.	What type of notification is provided via the notification source?
Vehicle Interface	None, 12V, OBD-II, etc.	On which vehicle electronic systems does the system rely?

ChildMinder Infant-Toddler Elite Pad System

Baby Alert International

Type	Add-on
Location	CRS
Presence Detection	Direct
Presence Sensing	Pressure/weight
Left-behind Condition	Fob separation distance from CRS
Notification Source	Dedicated fob
Notification Method	Audible, visual
Vehicle Interface	None

ChildMinder SoftClip System

Baby Alert International

Type	Add-on
Location	CRS
Presence Detection	Indirect
Presence Sensing	Chest clip closure
Left-behind Condition	Fob separation distance from CRS
Notification Source	Dedicated fob
Notification Method	Audible, visual
Vehicle Interface	None

Custom Deluxe Padded Child Safety Seat Alarm

Suddenly Safe 'N' Secure Systems, Inc.

Type	Add-on
Location	CRS
Presence Detection	Direct
Presence Sensing	Pressure/weight
Left-behind Condition	Fob separation distance from CRS
Notification Source	Dedicated fob
Notification Method	Audible, haptic
Vehicle Interface	None

True Fit I-Alert C685 Car Seat

TOMY, The First Years

Type	OEM
Location	CRS
Presence Detection	Direct
Presence Sensing	Pressure/weight
End-of-trip Detection	Smartphone separation distance from CRS
Notification Source	Smartphone
Notification Method	Audible, visual, haptic, SMS
Vehicle Interface	None (CRS can sense vehicle motion)

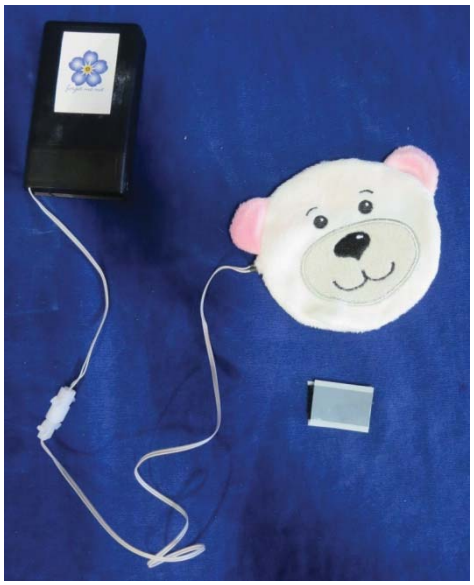
Small Ones Safety (SOS)

SWG Safety

Type	Add-on
Location	Vehicle and CRS
Presence Detection	Indirect
Presence Sensing	Chest clip closure
Left-behind Condition	n/a
Notification Source	OBD-II plug
Notification Method	Audible
Vehicle Interface	12V and status monitor via OBD-II

Forget Me Not (name changed to Sunshine Baby)

Beverly Marketing Management



Type	Add-on
Location	CRS
Presence Detection	Direct
Presence Sensing	Pressure/force
Left-behind Condition	Smartphone (or fob) separation distance from CRS
Notification Source	Smartphone or fob
Notification Method	Audible, visual, haptic
Vehicle Interface	None

Aviso Child-in-Car Alert

Aviso Reminder Systems, LLC

Type	Add-on
Location	Vehicle* and CRS
Presence Detection	Direct
Presence Sensing	Pressure/weight
Left-behind Condition	Time after ignition off
Notification Source	Chime and horn
Notification Method	Audible
Vehicle Interface	12V, horn circuit

* Requires installation by skilled technician

Appendix B – Functional Assessment Results

Assessment Date: 12/17/14, 12/18/14, and 12/22/14

UCRS Product: Aviso Child-in-car Alert **Smartphone model:** n/a **Smartphone OS**: n/a

Vehicle: Hyundai Tucson **Newborn surrogate**: CAMI **12 month-old surrogate**: CRABI **3 year-old surrogate**: Hybrid III

Table 1 Child Presence Detection	**Infant Carrier 1**		**Infant Carrier 2**		**Convertible 1**			**Convertible 2**		
CRS Model	Evenflo Discovery 5		Graco Snugride		Evenflo Triumph			Evenflo Tribute		
Orientation	**RF**	**RF**	**RF**	**RF**	**RF**	**RF**	**FF**	**RF**	**RF**	**FF**
Surrogate	**Newborn**	**12 mo**	**Newborn**	**12 mo**	**12 mo**	**3 yo**	**3 yo**	**12 mo**	**3 yo**	**3 yo**
Detection Trial #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Detection Trial #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Detection Trial #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notes			Placement of the sensor in the Graco Snugride was difficult due to interference with harness straps and the carrier detaching mechanism							

Enter ✓ if detected or ✗ if not detected for each detection trial with each applicable child/CRS/orientation configuration

Notes:

- Reset of system by cycling vehicle power was necessary after every detection trial.
- The assessment was conducted with two detachable infant carrier-style CRS, though such use would be impractical as it prohibits easy attachment and detachment of the carrier from the base.
- If CRS is occupied when trip ends, the system provides 10 seconds of chimes when vehicle power is switched off. If the child is not removed after 8 minutes double chimes sound (inside vehicle) for 45 seconds, then the vehicle horn alarm begins.
- Timer was started when vehicle power was turned off.

Assessment Date: 12/17/14, 12/18/14, and 12/22/14

UCRS Product: Aviso Child-in-car Alert

Table 2 Operational Features	Response or Units	Result	Notes
CRS Model		Evenflo Triumph	
Orientation		RF	
Surrogate		12 mo CRABI	
Audible Presence Detection Confirmation	*Yes or No*	Yes	Aviso manual states the system "may or may not" chime when seating child, but it sounded the chime for every trial in NHTSA testing
User Action Required for Activation	*Yes or No*	No	
User Action Confirmation	*Yes, No, or n/a*	n/a	
End-of-Trip Reminder Notification	*Yes or No*	Yes	Chimes for 10 seconds when vehicle power is disengaged
Audible Child Removal Notification	*Yes or No*	No	
End-of-Trip User Action Required	*Yes or No*	No	The system deactivates when the child is removed from the CRS – no further action required from user
Left-Behind Notification	*Yes or No*	Yes	45 seconds of double chimes and then horn alarm
Left-Behind Notification Recipients	*User, Vehicle Surroundings, Telecommunication*	Vehicle Surroundings	Chimes to vehicle interior and horn to vehicle surroundings
Left-Behind In-Vehicle Cancellation	*Yes, No, or n/a*	Yes	Once the left-behind notification starts, user must cycle vehicle power
Snooze Function	*Yes, No, or n/a*	No	
Left-Behind Trial #1	[m]	n/a	System is time-based and does not rely on distance for left-behind notification
	[mm:ss]	9:25	
Left-Behind Trial #2	[m]	n/a	
	[mm:ss]	9:25	

Left-Behind Trial #3	[m]	n/a	
	[mm:ss]	9:26	
Child Out-of-Seat Notification – 2-Second Trial	*Yes or No*	No	
Child Restoral Notification – 2-Second Trial	*Yes or No*	No	
End-of-Trip Reminder or Left-Behind Notification – 2-Second Trial	*Yes, No, or n/a*	Yes	Chimes still occurred when vehicle power was switched off
Child Out-of-Seat Notification – 5-Minute Trial	*Yes or No*	No	
Child Restoral Notification – 5-Minute Trial	*Yes or No*	No	
End-of-Trip or Left-Behind Reminder Notification – 5-Minute Trial	*Yes, No, or n/a*	Yes	Chimes still occurred when vehicle power was switched off

Assessment Date: 12/16/2014 and 12/23/2014

UCRS Product: Baby Alert USA ChildMinder Elite Pad **Smartphone mode**: n/a **Smartphone OS**: n/a

Vehicle: Hyundai Tucson **Newborn surrogate**: CAMI **12 month-old surrogate**: CRABI **3 year-old surrogate**: Hybrid III

Table 3 Child Presence Detection	**Infant Carrier 1**		**Infant Carrier 2**		**Convertible 1**			**Convertible 2**		
CRS Model	Evenflo Discovery 5		Graco Snugride		Evenflo Triumph			Evenflo Tribute		
Orientation	**RF**	**RF**	**RF**	**RF**	**RF**	**RF**	**FF**	**RF**	**RF**	**FF**
Surrogate	**Newborn**	**12 mo**	**Newborn**	**12 mo**	**12 mo**	**3 yo**	**3 yo**	**12 mo**	**3 yo**	**3 yo**
Detection Trial #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Detection Trial #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Detection Trial #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notes	Sensor was placed in back of seat bight		Newborn – Sensor was placed in back of seat bight 12 mo - Sensor was placed in bottom of seat bight		Sensor was placed in back of seat bight			Sensor was placed in bottom of seat bight		

Enter ✓ if detected or × if not detected for each detection trial with each applicable child/CRS/orientation configuration

Notes:

- The wiring at the connector for the pad was fragile and broke during set-up; the pad was replaced for further testing.
- Fresh batteries were installed prior to testing.
- Base unit did not always sound an alarm during left-behind testing, even though the fob provided a notification as expected.
- Elite Pad packaging says the left-behind notification distance is 15 feet**,** while user's manual states 15 meters.

Assessment Date: 12/16/2014 and 12/23/2014

UCRS Product: Baby Alert USA ChildMinder Elite Pad

Table 4 Operational Features	Response or Units	Result	Notes
CRS Model		Evenflo Triumph	
Orientation		RF	
Surrogate		HIII 3YO	
Audible Presence Detection Confirmation	*Yes or No*	Yes	Base unit emits beeps and its green LED flashes until activated
User Action Required for Activation	*Yes or No*	Yes	User must press button on fob to activate system
User Action Confirmation	*Yes, No, or n/a*	Yes	After pressing button on fob, the base unit stops beeping. At this time, a red LED flashes on the base unit while a green LED flashes on fob
End-of-Trip Reminder Notification	*Yes or No*	No	System cannot determine end-of-trip
Audible Child Removal Notification	*Yes or No*	Yes	Base unit beeps and its green LED flashes, then fob beeps twice and its green LED flashes
End-of-Trip User Action Required	*Yes or No*	No	Removing child causes base unit and fob to flash and beep twice indicating the system has detected removal of child and deactivated
Left-Behind Notification	*Yes or No*	Yes	User manual states left-behind notification is triggered "8 seconds after a distance of 15 meters" between the fob and base unit
Left-Behind Notification Recipients	*User, Vehicle Surroundings, Telecommunication*	User	Fob beeps and its green LED flashes
Left-Behind In-Vehicle Cancellation	*Yes, No, or n/a*	No	When back within 15 meters, the alarm stops When child is removed during left behind notification alarm, the fob continues to beep and flash green while the base unit stops alarming and beeps twice (audible child removal notification)

			Fob would only stop alert when the child is put back in the seat
Snooze Function	*Yes, No, or n/a*	No	
Left-Behind Trial #1	[m]	22.0	
	[mm:ss]	0:15	
Left-Behind Trial #2	[m]	36.9	
	[mm:ss]	0:25	
Left-Behind Trial #3	[m]	28.4	
	[mm:ss]	0:19	
Child Out-of-Seat Notification – 2-Second Trial	*Yes or No*	Yes	Base unit emits beeps, but fob does not as long as child is returned to the CRS within 2 seconds
Child Restoral Notification – 2-Second Trial	*Yes or No*	Yes	Base unit beeping stops as long as child is returned to the CRS within 2 seconds
End-of-Trip Reminder or Left-Behind Notification – 2-Second Trial	*Yes, No, or n/a*	Yes	
Child Out-of-Seat Notification – 5-Minute Trial	*Yes or No*	Yes	Base unit emits beeps, then fob beeps to indicate system has automatically deactivated
Child Restoral Notification – 5-Minute Trial	*Yes or No*	Yes	System required reactivation by pressing button on fob when returning child to CRS
End-of-Trip Reminder or Left-Behind Notification – 5-Minute Trial	*Yes, No, or n/a*	Yes	

Assessment Date: 12/17/2014, 12/22/2014, and 12/23/2014

UCRS Product: Baby Alert USA ChildMinder SoftClip **Smartphone mode**: n/a **Smartphone OS**: n/a

Vehicle: Hyundai Tucson **Newborn surrogate**: n/a **12 month-old surrogate**: CRABI **3 year-old surrogate**: Hybrid III

Table 5 Child Presence Detection	**Convertible 1**		
CRS Model	Evenflo Triumph		
Orientation	**RF**	**RF**	**FF**
Surrogate	**12 mo**	**3 yo**	**3 yo**
Detection Trial #1	✓	✓	n/a
Detection Trial #2	✓	✓	n/a
Detection Trial #3	✓	✓	n/a
Notes			

Enter ✓ if detected or ✗ if not detected for each detection trial with each applicable child/CRS/orientation configuration

Notes:

- Fresh batteries were installed prior to testing.
- Since the SoftClip does not use weight-based detection, it was not necessary to test a full spectrum of child sizes and CRS. Two configurations were tested with one CRS model for familiarization.

Assessment Date: 12/17/2014, 12/22/2014, and 12/23/2014

UCRS Product: Baby Alert USA ChildMinder SoftClip

Table 6 Operational Features	Response or Units	Result	Notes
CRS Model		Evenflo Triumph	
Orientation		RF	
Surrogate		HIII 3YO	
Audible Presence Detection Confirmation	*Yes or No*	Yes	Clip emits beeps and its green LED flashes until armed
User Action Required for Activation	*Yes or No*	Yes	User must press button on fob to activate system
User Action Confirmation	*Yes, No, or n/a*	Yes	After pressing button on fob, clip stops beeping and its red LED begins flashing. A green LED flashes on fob once activated
End-of-Trip Reminder Notification	*Yes or No*	No	System cannot determine end of trip
Audible Child Removal Notification	*Yes or No*	Yes	Clip beeps and its green LED flashes, then fob beeps twice and its green LED flashes
End-of-Trip User Action Required	*Yes or No*	No	Removing child causes clip and fob to flash and beep twice indicating the system has detected removal of child and deactivated
Left-Behind Notification	*Yes or No*	Yes	User manual states left-behind notification is triggered "8 seconds after a separation distance of 15 feet" between the fob and base unit
Left-Behind Notification Recipients	*User, Vehicle Surroundings, Telecommunication*	User	Key fob beeps and its red LED flashes. The clip also emits alarm sound
Left-Behind In-Vehicle Cancellation	*Yes, No, or n/a*	No	When back within 15 feet, the alarm stops When you remove the child, the alarm stops and the child removal cancellation beeps and flashes occurs
Snooze Function	*Yes, No, or n/a*	No	
Left-Behind Trial #1	[m]	18.0	

	[mm:ss]	0:11	
Left-Behind Trial #2	[m]	18.0	
	[mm:ss]	0:11	
Left-Behind Trial #3	[m]	16.4	
	[mm:ss]	0:11	
Child Out-of-Seat Notification – 2-Second Trial	*Yes or No*	Yes	Clip emits beeps, but fob does not as long as child is returned to the CRS within 2 seconds
Child Restoral Notification – 2-Second Trial	*Yes or No*	Yes	Clip beeping stops and fob emits a beep similar to activation confirmation
End-of-Trip Reminder or Left-Behind Notification – 2-Second Trial	*Yes, No, or n/a*	Yes	
Child Out-of-Seat Notification – 5-Minute Trial	*Yes or No*	Yes	
Child Restoral Notification – 5-Minute Trial	*Yes or No*	Yes	System required reactivation by pressing button on fob when returning child to CRS
End-of-Trip Reminder or Left-Behind Notification – 5-Minute Trial	*Yes, No, or n/a*	Yes	

Assessment Date: 1/7/15

UCRS Product: Forget Me Not Kid Alarm **Smartphone model:** iPhone 6+ **Smartphone OS**: 8.1.2

Vehicle: Hyundai Tucson **Newborn surrogate**: CAMI **12 month-old surrogate**: CRABI **3 year-old surrogate**: Hybrid III

Table 7 Child Presence Detection	**Infant Carrier 1**		**Infant Carrier 2**		**Convertible 1**			**Convertible 2**		
CRS Model	Evenflo Discovery 5		Graco Snugride		Evenflo Triumph			Evenflo Tribute		
Orientation	**RF**	**RF**	**RF**	**RF**	**RF**	**RF**	**FF**	**RF**	**RF**	**FF**
Surrogate	**Newborn**	**12 mo**	**Newborn**	**12 mo**	**12 mo**	**3 yo**	**3 yo**	**12 mo**	**3 yo**	**3 yo**
Detection Trial #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Detection Trial #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Detection Trial #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notes	Sensor was placed in back of seat bight Sensor did not detect when placed in bottom of seat bight	Sensor was placed in back of seat bight Sensor did detect in bottom of seat bight	Sensor was placed in back of seat bight Sensor did not detect in bottom of seat bight	Sensor was placed in bottom of seat bight Sensor did not detect when in back of seat bight	Sensor was placed in seat bottom					

Enter ✓ if detected or × if not detected for each detection trial with each applicable child/CRS/orientation configuration

Notes:

- Fresh batteries were installed prior to testing.
- App must be running in foreground on phone screen when child is placed in seat.
  - We found if app was running, but not opened in foreground, the child was not detected in the seat.
  - Once child detected with app open, app would continue to monitor in background even if phone was in sleep mode.
- All testing performed with app running on screen and phone set to not go to sleep for 5 minutes (max).
- ATD must be in seat in order to maintain connection to Bluetooth.

- App software version was 0.21.50(446).
- Left-behind notification is a repeating sound with flashing red pop up message visual on screen, while in Bluetooth range.
- Loss of Bluetooth notification is a one-time tone with visual text on screen changed to “baby seat not found!” (No pop up message).

Assessment Date: 1/7/15

UCRS Product: Forget Me Not Kid Alarm

Table 8 Operational Features	Response or Units	Result	Notes
CRS Model		Evenflo Tribute	
Orientation		RF	
Surrogate		HIII 3YO	
Audible Presence Detection Confirmation	*Yes or No*	No	If app is running in foreground (on screen), confirmation of child presence is displayed
User Action Required for Activation	*Yes or No*	Yes	App must be running in foreground (on screen)
User Action Confirmation	*Yes, No, or n/a*	Yes	The app displays that the seat is occupied
End-of-Trip Reminder Notification	*Yes or No*	No	Cannot sense end of trip
Audible Child Removal Notification	*Yes or No*	No	Only change is text on screen
End-of-Trip User Action Required	*Yes or No*	No	Visual on screen when child is not detected in seat No left-behind notification will result
Left-Behind Notification	*Yes or No*	Yes	Adjustable proximity - alarm occurs when device is out of set proximity. Audible and visual
Left-Behind Notification Recipients	*User, Vehicle Surroundings, Telecommunication*	User	iPhone App
Left-Behind Cancellation	*Yes, No, or n/a*	No	Automatically when the device is within 3 ft (approximately 1 m) of seat Also, canceled when Bluetooth connection was lost
Snooze Function	*Yes, No, or n/a*	No	
Left-Behind Trial #1	[m]	19.9	Testing completed with proximity setting in app at midpoint (76) Alerted and immediately the app closed
	[mm:ss]	0:15	

Left-Behind Trial #2	[m]	14.8	Testing completed with proximity setting in app at midpoint (76)
	[mm:ss]	0:10	
Left-Behind Trial #3	[m]	20.8	Testing completed with proximity setting in app at midpoint (76)
	[mm:ss]	0:14	
Left-Behind Trial #4	[m]	16.8	Testing completed with proximity setting in app at maximum (100)
	[mm:ss]	0:29	Lost Bluetooth connection notification
Left-Behind Trial #5	[m]	38.0	Testing completed with proximity setting in app at maximum (100)
	[mm:ss]	0:22	Lost Bluetooth connection notification
Left-Behind Trial #6	[m]	55.1	Testing completed with proximity setting in app at maximum (100)
	[mm:ss]	0:35	Lost Bluetooth connection notification
Child Out-of-Seat Notification – 2-Second Trial	*Yes or No*	No	
Child Restoral Notification – 2-Second Trial	*Yes or No*	No	
End-of-Trip Reminder or Left-Behind Notification – 2-Second Trial	*Yes, No, or n/a*	Yes	
Child Out-of-Seat Notification – 5-Minute Trial	*Yes or No*	Yes	Bluetooth disconnected after 1 minute 12 seconds resulting in audible tone from smartphone
Child Restoral Notification – 5-Minute Trial	*Yes or No*	Yes	The app had to be running in foreground for system to become active (as when seating child at beginning of trip)
End-of-Trip Reminder or Left-Behind Notification – 5-Minute Trial	*Yes, No, or n/a*	Yes	

Assessment Date: 12/23/14, 12/29/14

UCRS Product: Suddenly Safe 'N' Secure Pad **Smartphone mode**: n/a **Smartphone OS**: n/a

Vehicle: Hyundai Tucson **Newborn surrogate**: CAMI **12 month-old surrogate**: CRABI **3 year-old surrogate**: Hybrid III

Table 9 Child Presence Detection	**Infant Carrier 1**		**Infant Carrier 2**		**Convertible 1**			**Convertible 2**		
CRS Model	Evenflo Discovery 5		Graco Snugride		Evenflo Triumph			Evenflo Tribute		
Orientation	**RF**	**RF**	**RF**	**RF**	**RF**	**RF**	**FF**	**RF**	**RF**	**FF**
Surrogate	**Newborn**	**12 mo**	**Newborn**	**12 mo**	**12 mo**	**3 yo**	**3 yo**	**12 mo**	**3 yo**	**3 yo**
Detection Trial #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Detection Trial #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Detection Trial #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notes	Newborn – Sensor was placed on back of seat bight 12 mo – Sensor was placed in seat bight		Sensor was placed in bottom of seat bight		Sensor was placed in seat bight For testing with 3YO FF, sensor needed readjusted back into place after every test			Sensor was placed in bottom of seat bight For testing with 3YO FF, sensor needed readjusted occasionally		

Enter ✓ if detected or **×** if not detected for each detection trial with each applicable child/CRS/orientation configuration

Notes:

- Fresh batteries were installed prior to testing.
- Variable distance dial was set for issuing notification at ~6 feet (~ 1.8 m) and taped as directed in user manual.
- Subsequent left-behind trials conducted with distance dial set at maximum value (50 feet [15 m]).
- Manual instructs that after child is removed from vehicle to turn the key fob off.

Assessment Date: 12/23/14, 12/29/14

UCRS Product: Suddenly Safe 'N' Secure Pad

Table 10 Operational Features	Response or Units	Result	Notes
CRS Model		Evenflo Triumph	
Orientation		RF	
Surrogate		12 mo CRABI	
Audible Presence Detection Confirmation	*Yes or No*	No	Transmitter and key fob blink red when ATD is detected but no sound is emitted
User Action Required for Activation	*Yes or No*	Yes	User must slide power switch on key fob to complete activation after child is seated
User Action Confirmation	*Yes, No, or n/a*	Yes	Fob emits beeps
End-of-Trip Reminder Notification	*Yes or No*	No	Does not sense end of trip
Audible Child Removal Notification	*Yes or No*	Yes	When ATD is removed from CRS after having been detected, the key fob emits solid red light, beeps, and vibrates; there is no blinking on transmitter
End-of-Trip User Action Required	*Yes or No*	Yes*	Removing child causes the child removal alarm which is solid red, beeping, and vibrating (the same as left-behind notification) to continue Owner's manual instructs to turn off fob after removing child
Left-Behind Notification	*Yes or No*	Yes	
Left-Behind Notification Recipients	*User, Vehicle Surroundings, Telecommunication*	User	Solid red light, beeping, and vibrating on key fob
Left-Behind In-Vehicle Cancellation	*Yes, No, or n/a*	No	Upon returning to vehicle (within signal radius) alarm automatically stops, but user does not have to enter vehicle for any reason. Additionally, user could turn key fob off to stop alarm
Snooze Function	*Yes, No, or n/a*	No	
Left-Behind Trial #1	[m]	5.8	User-adjustable dial on fob set to issue alert at a distance

			of six feet (1.8 meters) from vehicle per user guide recommendation
	[mm:ss]	0:04	
Left-Behind Trial #2	[m]	6.0	User-adjustable dial on fob set to issue alert at a distance of six feet (1.8 meters) from vehicle per user guide recommendation
	[mm:ss]	0:04	
Left-Behind Trial #3	[m]	5.3	User-adjustable dial on fob set to issue alert at a distance of six feet (1.8 meters) from vehicle per user guide recommendation
	[mm:ss]	0:03	
Left-Behind Trial #4	[m]	8.8	User-adjustable dial on fob set to maximum distance
	[mm:ss]	0:07	
Left-Behind Trial #5	[m]	10.9	User-adjustable dial on fob set to maximum distance
	[mm:ss]	0:07	
Left-Behind Trial #6	[m]	9.6	User-adjustable dial on fob set to maximum distance
	[mm:ss]	0:06	
Child Out-of-Seat Notification – 2-Second Trial	*Yes or No*	Yes	
Child Restoral Notification – 2-Second Trial	*Yes or No*	Yes	
End-of-Trip Reminder or Left-Behind Notification – 2-Second Trial	*Yes, No, or n/a*	Yes	
Child Out-of-Seat Notification – 5-Minute Trial	*Yes or No*	Yes	
Child Restoral Notification – 5-Minute Trial	*Yes or No*	Yes	
End-of-Trip Reminder or Left-Behind Notification – 5-Minute Trial	*Yes, No, or n/a*	Yes	

Assessment Date: 1/6/15

UCRS Product: True Fit I-Alert **Smartphone model:** Samsung Galaxy S5 **Smartphone OS**: Android 4.4.2

Vehicle: Hyundai Tucson **Newborn surrogate**: CAMI **12 month-old surrogate**: CRABI **3 year-old surrogate**: Hybrid III

Table 11 Child Presence Detection				
CRS Model	I-Alert			
Orientation	**RF**	**RF**	**RF**	**FF**
Surrogate	**Newborn**	**12 mo**	**3 yo**	**3 yo**
Detection Trial #1	✓	✓	✓	✓
Detection Trial #2	✓	✓	✓	✓
Detection Trial #3	✓	✓	✓	✓
Notes	Zone 1	Zone 1	Zone 2	Zone n/a

Enter ✓ if detected or × if not detected for each detection trial with each applicable child/CRS/orientation configuration

Notes:

- Rechargeable battery was fully charged at beginning of testing with I-Alert
- The Zones in the notes refer to the preset recline ranges in the CRS

Assessment Date: 1/6/15

UCRS Product: True Fit I-Alert (Android 4.4.2)

Table 12 Operational Features	Response or Units	Result	Notes
CRS Model		I-Alert	
Orientation		FF	
Surrogate		HIII 3YO	
Audible Presence Detection Confirmation	*Yes or No*	Yes	Sounds and displays reminder to belt child when child is initially placed in CRS after Bluetooth connection
User Action Required for Activation	*Yes or No*	No	Child must be in seat to pair Bluetooth App is always monitoring - no button tap necessary
User Action Confirmation	*Yes, No, or n/a*	n/a	No user action
End-of-Trip Reminder Notification	*Yes or No*	Yes*	Text on screen changes to vehicle not moving *Visual, audible, and haptic (vibration) reminders (which tell total amount of time passed) that child is still in seat and vehicle is not moving
Audible Child Removal Notification	*Yes or No*	No	No sound - only change is text on screen Visual 'child out of seat' Changes to disconnected when out of seat too long
End-of-Trip User Action Required	*Yes or No*	No	Visual change on screen when child is removed from seat No alarm results
Left-Behind Notification	*Yes or No*	Yes	Caused by being out of Bluetooth range Red visual alert with sound and vibration Must be dismissed on screen
Left-Behind Notification Recipients	*User, Vehicle Surroundings, Telecommunication*	User, Telecommunication	Android I-Alert App (can send text and email messages)
Left-Behind In-Vehicle Cancellation	*Yes, No, or n/a*	No	Have to tap button on smartphone screen to dismiss
Snooze Function	*Yes, No, or n/a*	Yes	The user can tap the on-screen button to pause the alert, but it reappears every minute

Left-Behind Trial #1	[m]	45.7	
	[mm:ss]	0:29	
Left-Behind Trial #2	[m]	46.3	
	[mm:ss]	0:31	
Left-Behind Trial #3	[m]	48.7	
	[mm:ss]	0:33	
Child Out-of-Seat Notification – 2-Second Trial	*Yes or No*	Yes	App indicated the child was out of seat
Child Restoral Notification – 2-Second Trial	*Yes or No*	Yes	
End-of-Trip Reminder or Left-Behind Notification – 2-Second Trial	*Yes, No, or n/a*	Yes	
Child Out-of-Seat Notification – 5-Minute Trial	*Yes or No*	Yes	The longer duration removal resulted in disconnection of Bluetooth
Child Restoral Notification – 5-Minute Trial	*Yes or No*	Yes	Restoration of child produced similar events as at beginning of trip
End-of-Trip Reminder or Left-Behind Notification – 5-Minute Trial	*Yes, No, or n/a*	Yes	

Assessment Date: 1/6/15

UCRS Product: True Fit I-Alert **Smartphone model:** iPhone 4 **Smartphone OS**: iOS 7.1.2

Vehicle: Hyundai Tucson **Newborn surrogate**: CAMI **12 month-old surrogate**: CRABI **3 year-old surrogate**: Hybrid III

Table 13 Child Presence Detection				
CRS Model	I-Alert			
Orientation	**RF**	**RF**	**RF**	**FF**
Surrogate	**Newborn**	**12 mo**	**3 yo**	**3 yo**
Detection Trial #1	✓	✓	✓	✓
Detection Trial #2	✓	✓	✓	✓
Detection Trial #3	✓	✓	✓	✓
Notes	Zone 1	Zone 1	Zone 2	Zone n/a

Enter ✓ if detected or × if not detected for each detection trial with each applicable child/CRS/orientation configuration

Notes:

- Rechargeable battery was fully charged at beginning of testing with I-Alert
- Unit had difficulty connecting to Bluetooth on a few occasions.
- ATD must be in seat in order to connect to Bluetooth.
- The Zones in the notes refer to the preset recline ranges in the CRS

Assessment Date: 1/6/15

UCRS Product: True Fit I-Alert (iOS 7.1.2)

Table 14 Operational Features	Response or Units	Result	Notes
CRS Model		I-Alert	
Orientation		FF	
Surrogate		HIII 3YO	
Audible Presence Detection Confirmation	*Yes or No*	Yes	Sounds and displays reminder to belt child every time when child is placed in CRS after Bluetooth connection
User Action Required for Activation	*Yes or No*	No	Child must be in seat to pair Bluetooth App is always monitoring - no button tap necessary
User Action Confirmation	*Yes, No, or n/a*	n/a	No user action
End-of-Trip Reminder Notification	*Yes or No*	Yes*	Text on screen changes to vehicle not moving *Visual, audible, and haptic (vibration) reminders that child is still in seat and vehicle is not moving (Does not tell total amount of time passed)
Audible Child Removal Notification	*Yes or No*	No	No sound - only change is text on screen Visual 'child out of seat' Changes to disconnected when out of seat too long
End-of-Trip User Action Required	*Yes or No*	No	Visual change on screen when child is removed from seat No alarm results
Left-Behind Notification	*Yes or No*	Yes	Caused by being out of Bluetooth range Red visual alert with sound and vibration Must be acknowledged
Left-Behind Notification Recipients	*User, Vehicle Surroundings, Telecommunication*	User, Telecommunication	iPhone I-Alert App (can send text and email)
Left-Behind In-Vehicle Cancellation	*Yes, No, or n/a*	No	Have to manually tap button to acknowledge
Snooze Function	*Yes, No, or n/a*	Yes	The user can tap the on-screen button to pause the

			alert, but it reappears every minute
Left-Behind Trial #1	[m]	54.6	
	[mm:ss]	0:40	
Left-Behind Trial #2	[m]	61.5	
	[mm:ss]	0:41	
Left-Behind Trial #3	[m]	66.8	
	[mm:ss]	0:44	

Assessment Date: 11/24/14

UCRS Product: SOS (for gas/diesel powertrain) **Smartphone model:** n/a **Smartphone OS**: n/a

Vehicle: 2014 Ford E-Series **Newborn surrogate**: n/a **12 month-old surrogate**: CRABI **3 year-old surrogate**: Hybrid III

Table 15 **Child Presence Detection**		
CRS Model	Graco MyRide 65	
Orientation	**RF**	**RF**
Surrogate	**12 mo**	**3 yo**
Detection Trial #1	✓	✓
Detection Trial #2	✓	✓
Detection Trial #3	✓	✓
Notes		

Enter ✓ if detected or × if not detected for each detection trial with each applicable child/CRS/orientation configuration

Notes:

- Complete activation of SOS requires the vehicle to be driven over 5 mph.
- Results taken from NHTSA Component Test Database test number c01190.

Assessment Date: 11/24/14

UCRS Product: SOS (for hybrid and start/stop powertrain) **Smartphone model:** n/a **Smartphone OS**: n/a

Vehicle: 2013 Toyota Prius **Newborn surrogate**: n/a **12 month-old surrogate**: CRABI **3 year-old surrogate**: Hybrid III

Table 16 Child Presence Detection		
CRS Model	Graco MyRide 65	
Orientation	**RF**	**RF**
Surrogate	**12 mo**	**3 yo**
Detection Trial #1	✓	✓
Detection Trial #2	✓	✓
Detection Trial #3	✓	✓
Notes		

Enter ✓ if detected or × if not detected for each detection trial with each applicable child/CRS/orientation configuration

Notes:

- Complete activation of SOS requires the vehicle to be driven over 5 mph.
- Results taken from NHTSA Component Test Database test number c01190.

Assessment Date: 12/24/15

UCRS Product: SOS

Table 17 Operational Features	Response or Units	Result	Notes
CRS Model		Graco MyRide 65	
Orientation		RF	
Surrogate		CRABI 12 mo	
Audible Presence Detection Confirmation	*Yes or No*	No	
User Action Required for Activation	*Yes or No*	No	
User Action Confirmation	*Yes, No, or n/a*	n/a	No user action
End-of-Trip Reminder Notification	*Yes or No*	Yes	Occurs when vehicle power is switched off
Audible Child Removal Notification	*Yes or No*	No	
End-of-Trip User Action Required	*Yes or No*	No	
Left-Behind Notification	*Yes or No*	No	
Left-Behind Notification Recipients	*User, Vehicle Surroundings, Telecommunication*	n/a	
Left-Behind In-Vehicle Cancellation	*Yes, No, or n/a*	n/a	
Snooze Function	*Yes, No, or n/a*	n/a	
Left-Behind Trial #1	[m]	n/a	
	[mm:ss]	n/a	
Left-Behind Trial #2	[m]	n/a	
	[mm:ss]	n/a	
Left-Behind Trial #3	[m]	n/a	
	[mm:ss]	n/a	

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