

# **Minutes of the First Meeting of the Blue Ribbon Panel for Evaluation of Inflatable Restraint System Performance-Field Data Collection and Analysis**

February 26, 2001

Dr. Susan Ferguson, Senior Vice President, Research of the Insurance Institute for Highway Safety (IIHS) convened the first meeting of the Panel at the IIHS offices in Arlington, Virginia. Each of the attending Panel members introduced themselves and gave a brief synopsis of their respective affiliation, background and interest in the project. A list of the Panel members is attached. Dr. Ferguson informed the attending members that two members, who had agreed to participate on the Panel, were unable to attend the first meeting (Dr. Mark Edwards and Dr. Kennerly Digges). All other panel members were in attendance. Dr. Ferguson also informed the panel that several other potential nominees, who were invited to join the panel, had declined to participate formally because of a perceived conflict between their organizational affiliation and the fact that the program activities are to be funded by the Alliance. These individuals requested to attend panel meetings in an observer status. The names of these individuals were not divulged to the panel. In subsequent discussions, later in the meeting, it was decided by the panel to not invite observer participation, other than by NHTSA.

The formal part of the meeting began with three presentations by various NHTSA staff, detailing the agency's activities relevant to the program objectives of the panel. The first presentation was by Mr. William Walsh, Associate Administrator for Plans and Policy. Plans and Policy has the lead within the agency for coordinating all activities with regard to monitoring the performance of advanced air bag systems. Mr. Walsh said that the agency was originally concerned that depowered air bag systems may not provide adequate protection (particularly to unbelted occupants) in high-speed crashes. However, sufficient data has now been accumulated to show that while depowered air bags have substantially mitigated the problem of air bag induced injury to out-of-position occupants and other occupants close to the air bag at the time of deployment, there has been no reduction in overall effectiveness, indicating that the depowered bags are still providing protection in the more severe crash events. The agency's attention is now being turned to monitoring the performance of advanced air bags in both low-speed crashes with at risk populations as well as high speed crashes, especially with unbelted occupants.

Mr. Walsh detailed the NHTSA approach as including the following elements: real world performance, research tests, technology assessment, biomechanical research on IARV's, compliance margin report, safety belt use including technology and the cost to consumers of the advanced systems. Real world performance will be analyzed using a combination of anecdotal and statistical data sources including: NASS CDS, SCI, CIREN, FARS and CODES. The analytic agenda will include analysis of performance of advanced systems in low speed crashes (0-25 mph) as well as higher speed crashes (25+ mph). The low-speed crashes will include both drivers and adult passengers as well as small children and

children in child seats. In the technology area NHTSA will be attempting to compare the strategy of low risk deployment versus suppression. In this regard, they are interested in deployment thresholds, crash severity/crash type, crash sensor designs and multi-level inflators. In high-speed crashes they will be looking at both unrestrained and restrained occupants of various sizes versus crash type and technology employed (deployment speed/inflator stage, sensor characteristics and crash type).

The technology assessment will survey suppliers and manufacturers in an effort to procure innovative hardware for test and evaluation. The critical focus areas for testing of advanced air bags will include: tests with unrestrained 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentile dummies at 25 and 30 mph and 35 mph restrained 5<sup>th</sup> percentile dummies; 37.5/40 mph offset deformable barrier tests with 5<sup>th</sup> and 50<sup>th</sup> percentile dummies; and, static OOP low risk deployment tests.

Mr. Walsh presented a chart detailing the number of data points that were available for the analysis of air bag effectiveness for fatality and AIS 2+ and 3+-injury reduction in the 4<sup>th</sup> Report to Congress and the Economic Analysis in support of the agency's recent 208 rulemaking on advanced air bags. The point being that very little data is available for making critical decisions about air bag performance.

Mr. Walsh also showed a chart illustrating how few cases we would be able to collect in 2004/5/6 on advanced air bag systems certified to the new requirements in FMVSS 208. Mr. Walsh pointed out that it would be a number of years before sufficient data is available to make estimates of the effectiveness of advanced air bag systems. The point was that it would be a waste of money to start the supplementary data collection effort before MY 2004, when only 35% of the new fleet will be certified as meeting the new performance requirements. If the key remaining issues are associated with occupant protection for bags built to the standard, then we need to collect this "rare" data as quickly as possible.

Mr. Walsh also commented that depowered air bags were not really all that depowered. The majority was not significantly changed at all. We will have 6 years of data on depowered bags and some dual speed bags before certified systems are available. Therefore, the strong recommendation was to delay the supplemental collection until these systems are in use.

Dr. Joseph Carra, Director of the National Center for Statistics and Analysis, NHTSA, delivered a presentation that gave an overview of the NASS system, including the sampling plan, how cases are handled, quality control and dissemination. He stated that the NASS system is grounded in the following principles: representative sampling, detailed crash investigations, quality assurance, confidentiality and data accessibility. The NASS system has two components: GES, which is a statistical sample of all police reported crashes in the primary sampling unit (PSU) geographical areas and the CDS, which is in-depth investigations of crashes involving towed passenger vehicles statistically sampled from PSUs.

The NASS sample design is probability based and has three stages. Stage 1 is PSU selection using a stratification based on geography and type. The selection is proportional to the number of fatal and injury crashes. GES has 60 PSUs and CDS has 24 PSUs, which are included in the GES sample. Stage 2 involves enumeration of the police jurisdictions (PJ) within the selected PSUs again selecting PJs in proportion to number of fatal and injury crashes. Finally, in stage 3 the CDS crashes are stratified by late model vehicle and severity of injury and sampled by weight based on severity. This process results in a disproportionate sampling of the more severe crashes. As an example, 63% of tow away crashes are investigated, even though they only represent 20% of all police reported crashes. The total CDS sample is approximately 4500 cases per year.

Quality control occurs at the two zone centers, which oversee the 60 PSUs, and at NHTSA. Quality is also addressed by the careful selection and training of CDS investigators. The production schedule spans 18 months from case selection until final case availability as an electronic case file. Cases are available as hard copy or electronically on the NHTSA web site or from a storage contractor.

Mr. A.B. Chipî Chidester, Acting Chief of the Crash Investigation Division, NHTSA gave a presentation on what the agency has learned about air bag effectiveness from its SCI and NASS crash investigations and what advanced air bag features are in vehicles today and what we can expect in the future. Mr. Chidester showed charts detailing driver and passenger air bag related fatalities per million vehicle years. The driver fatality rate peaked at nearly 0.5 fatalities/million vehicle years for 1991 model year vehicles and has dropped to nearly zero for the past two model years. Similarly, the child passenger fatality rate peaked in 1995 model year vehicles at 1.1 and has dropped to 0.15 for the 1999 model year vehicles.

As of February, the NASS has investigated 716 cases involving redesigned air bags. NHTSA's SCI teams and Alliance funded partners have investigated another 505 cases. Thus, the agency has already accumulated a sizeable database on redesigned/depowered air bag systems. The results of an analysis of this data will be formally reported at upcoming technical conferences. Mr. Chidester (and as previously reported by Mr. Walsh) said the results are very encouraging. The out of position problem has been largely eliminated (as was shown in the prior charts) while at the same time overall effectiveness levels have remained constant.

NHTSA is currently conducting an Advanced Occupant Protection System Study (AOPSS) to assess the real world performance of advanced air bag systems. These special crash investigations will involve 2000 model year vehicles in frontal crashes with a tow-away severity level. Particular emphasis is being placed on air bag related fatalities, out of position occupants and early problem notification with advanced technologies. Mr. Chidester said that advanced systems may include one or more of the following: rollover sensors, seat weight sensors, seat position sensors, multi-stage inflators, automatic suppression and event data recorders. Mr. Chidester went on to discuss in greater detail some of these emerging technologies and how they are expected

to enhance occupant protection. One chart showed how manufacturers have substantially raised deployment thresholds, particularly for restrained occupants.

Mr. Chidester described a special study that they are conducting with Ford to investigate the real world performance of the advanced air bag systems used in the 2000 Taurus/Sable. The 2000 Taurus/Sable includes a two-stage inflator, which deploys one, or both levels depending on signals received from crash sensors, seat position sensors and restraint usage sensors. For the 2001 model year the number of vehicles with advanced air bag systems has more than doubled. Mr. Chidester emphasized that crash investigations of advanced air bag equipped vehicles will become increasingly more difficult. Without the capability to readout the EDR it will be very difficult to judge things such as time of deployment, level of deployment, etc.

The NHTSA talks were followed by a presentation by Mr. Don Bischoff, an independent consultant, who was hired by the Alliance to research the various options and make recommendations regarding the collection and analysis of field data for the evaluation of inflatable restraint performance. An expurgated version of Mr. Bischoff's report to the Alliance was made available to the panel members prior to the meeting.

Mr. Bischoff briefly reviewed the 7 options that he explored for obtaining additional crash data for making judgments about the injury reducing effectiveness of inflatable restraints. The 7 options were: wring more relevant crashes out of the existing NASS system, expand NASS to investigate additional crashes, utilize NHTSA SCI teams, utilize CIREN centers, utilize Canadian MOT crash investigation teams, expand existing Alliance contracts with UMTRI and Lehman, and supplement FARS case data with EDR readouts to measure crash severity. He discussed the attributes of the data in each option, the feasibility and methodology for gathering the additional cases and an estimate of the per crash costs.

Mr. Bischoff then discussed the questions that we are trying to answer with regard to the performance of inflatable restraints. The original focus was to address NHTSA's concern that depowered air bags may not adequately protect unrestrained occupants in severe collisions and whether this capability is appropriately measured in a 25 or 30 mph fixed barrier test. However, in discussions with senior agency staff, during the development of the paper, it became clear that the agency was now convinced that depowered air bags had substantially mitigated the air bag induced injury problem, while at the same time maintaining the same overall level of effectiveness for fatality reduction. The agency's concerns have thus shifted to an evaluation of advanced technology air bag systems (e.g. multi-level inflators, suppression, advanced sensors, etc) and their ability to further address the problem of injury to out-of-position occupants, while at the same time providing protection to a whole range of occupants (age, size, gender, position, etc) in the myriad of crashes that occur in the real world. The design of an air bag system that provides protection to a range of occupants over a wide range of potential crashes inevitably involves a number of engineering tradeoffs. Likewise, there are a myriad of circumstances that are occurring in real world crashes that lead to the determination of the overall effectiveness of the system. It is these precise tradeoffs that are largely

unknown at this time. To effectively answer this question Mr. Bischoff believes that we need to not only know what these tradeoffs are, but also how often they occur in the real world crash environment. Anecdotal crash data (crashes investigated from a convenience sample) can help answer the first part, but are not of much help with the second part. Thus, his principle recommendation was to obtain additional crash data drawn with some form of statistical sampling plan in order to ascertain how often the individual tradeoffs are occurring in the total crash environment. In this regard, Mr. Bischoff recommended that consideration be given to wringing more relevant cases out of the existing NASS system and expanding the number of NASS cases currently being planned for collection by adding trained crash investigators. Corollary to this recommendation, it was also Mr. Bischoff's belief that plans for sufficient collection of additional anecdotal data were already in place. He believed that this anecdotal data was very important for getting an early readout on how the advanced technologies were performing in individual circumstances. However, over 1000 crashes of vehicles with depowered air bag systems had already been investigated by the end of 2000 and plans are in place at NHTSA and elsewhere to fund investigation of many more in the coming years. Thus, Mr. Bischoff did not believe that it was a cost-effective use of Alliance funds to do additional anecdotal crash investigations.

Mr. Bischoff presented tables developed by Dr. Charles Kahane of NHTSA's Office of Regulatory Analysis and Evaluation, which show the number of NASS and FARS cases that would need to be investigated to provide statistically reliable estimates of differences in effectiveness between advanced and current air bag systems. These analyses revealed that if there were dramatic changes in effectiveness, such as a halving or doubling of effectiveness, that this would show up in one or two years. More subtle changes, such as a 20% change in effectiveness, would take 4 years and the collection of additional cases from that already planned (in the case of the NASS system).

Mr. Bischoff cautioned that special attention would need to be given to the issue of budget augmentation, if it is decided to contract with any of the entities that now administer the NASS, SCI, CIREN or FARS teams. This will entail the legal staffs of NHTSA and the Alliance putting their collective wisdom together to ensure that Congress views the project in a positive light.

Mr. Bischoff also recommended that additional effort on both the part of government and industry needs to be put toward training crash investigators and getting them the tools they need to readout the EDRs that are in many of today's passenger vehicles. This information will become crucial as we move to more sophisticated air bag systems employing multiple levels of deployment, suppression and more sophisticated sensors and deployment algorithms. For example, it will be nearly impossible to ascertain whether one or both levels of the air bag deployed without the EDR readout.

Following the formal presentations the panel began extensive discussion and deliberation on numerous issues surrounding the collection of additional crash data to support the analysis of the effectiveness of advanced air bag systems. Probably the most contentious and at the same time pivotal issue is whether we need statistically representative data to

achieve the objectives of the program. Some argued that if you stick with the original concern of NHTSA (i.e. depowered bags will not adequately protect unrestrained occupants in more severe crashes), then you do not need nationally representative data. Others argued that you need statistically representative data to quantify the injury mitigation tradeoffs that are occurring in real world crashes, particularly as the manufacturers move to more sophisticated systems that employ multiple levels of deployment and other technologies that involve still greater levels of decision making (e.g. suppression technologies). This discussion was intertwined with debate about whether the existing NASS system was the proper venue. Ultimately, it was the consensus that it would probably make sense to use the NASS structure for sampling relevant cases whether or not the sample was probability based and therefore capable of producing national estimates. The NASS system spans the U.S. with its 60 PSUs and thousands of PJs, thus representing an enormous pool of potential relevant crashes with an already existent notification protocol.

There was also extensive discussion about what particular cases to sample. Issues discussed included: restrained vs. unrestrained occupants, age of vehicles, crash severity, direction of impact, crash configuration (i.e. frontal, side, rollover, etc.). There seemed to be consensus on the age of vehicle issue at 0 to 4 years old. The current four-year-old vehicles correspond with the onset of depowering. Four years of vehicles also allow for reasonable sampling of crashes since a fair number of four-year-old vehicles will be in the fleet at any given time.

There also seemed to be consensus that if effectiveness changed appreciably, due to depowering or the use of more sophisticated technologies, that one would expect the larger effect would likely be for the unrestrained occupant. However, it was also agreed that we couldn't ignore the restrained occupant, since the restraint engineers have always argued that inflatable restraint design is a compromise between restrained and unrestrained. As an example, there was discussion that deployment thresholds are being raised and will likely continue to be raised in future designs, particularly for restrained occupants. This will inevitably result in compromises in injury mitigation that future analyses will want to look at. Most also agreed that from a practical standpoint the argument is probably moot, since when the crash is selected for investigation it is rarely known whether restraints were used.

There was extensive discussion over whether you need to investigate any crash configuration other than a pure frontal. Some argued that air bags are designed to work only in frontal crashes and therefore it is a waste of resources to investigate any other crash configuration, if your goal is to evaluate air bag effectiveness. Others argued that air bags deploy in many other crash configurations since there is often a frontal force component. It was also argued that many crashes involve multiple impact events, some of which may have a frontal component of force, some of which do not. The NHTSA people also pointed out that it is also a crash investigator workload issue when you are dealing with a system such as NASS. That is, the crash investigator is charged with investigating X crashes; if he or she is sitting around waiting for a late model serious frontal crash, you may just as well have them investigate a side swipe with a frontal

component of force, rather than do nothing. There did not seem to be consensus on this issue. Since this issue seems to be related to both the technical analysis as well as the crash investigation scheme, it is probably best left to a later date for decision.

Crash severity was another issue that was discussed at length, seemingly without resolution. Some argued for only investigating severe crashes, since that seemed to be the root of NHTSA's concern (depowered air bags would not adequately protect occupants in more severe crashes; however, it would appear that NHTSA has now abandoned this concern and is focusing on the performance of advanced systems). Others argued that injuries to occupants in close proximity to the air bag at time of deployment, particularly in low speed crash events, was just as important an issue. There did seem to be consensus that as we move to some of the new systems with multiple levels of deployment, raised deployment thresholds and suppression, that it will become increasingly important to pay close attention to the tradeoffs occurring in the mid and lower-speed range crashes. Decision on this issue may need to await a final decision on the goals of the project. If it is agreed that the goals should be expanded to include an assessment of the effectiveness of advanced systems as opposed to only depowered systems, then the consensus seemed to be that crashes of all severity levels would need to be investigated.

Dr. Augenstein raised concerns that much of the crash data being collected is not subjected to a multidisciplinary quality assurance program. He argued that there is a real need for multidisciplinary quality assurance for interpretations of injury causation. He noted that in other multi-center studies on other health problems, such as breast cancer, it is typical to have disease levels evaluated by a panel of experts. There was some discussion of Dr. Augenstein's proposal by the panel. The chairman pointed out that while it may be a worthwhile idea, it would draw precious resources away from the data collection and analysis activities. The idea was therefore tabled.

There was extensive discussion of the type of analyses that would need to be done once the data was collected. This discussion, by its very nature, swirled around the related issues of statistically based sampling and the need for nationally representative data. After much discussion, the panel decided that more thought needed to be given to the analysis plan, prior to deciding what data was to be collected. Dr. Maria Segui-Gomez graciously accepted the assignment to prepare a 2-page paper outlining the data analysis needs of the program and an estimate of the cost to complete such work. There was some discussion that a ballpark estimate of costs may be in the \$250-\$300k range.

There was a fairly extensive discussion of the funding available from the Alliance for completion of the project. Rob Strassburger said that the Alliance had committed to funding for 300 additional cases per year over a three-year period. In the ensuing discussion it was not entirely clear what the cost to capture 300 additional cases would be since no decision had been made on the protocol for gathering the cases. In the end, Mr. Strassburger said that he thought that something on the order of \$1.5m per year could be made available. The charts that Mr. Bischoff had prepared to illustrate the tradeoffs in number of cases versus sampling plan for the NASS system were arbitrarily based on a

funding level of \$2m per year. Mr. Bischoff agreed that he would work with NHTSA to recalculate these charts based on funding levels of \$1.5m and \$1.2m (\$1.5m minus \$300k set aside for analysis) per year. The following chart details the new estimates, as well as the prior estimate, of case yield for the different funding levels:

<b>Expected Yield for Alliance Funding Options</b>				
<b>Option</b>		<b>Amount of Funding / Potential Random PSUs</b>		
		<b>\$1,200,000 8 PSUs</b>	<b>\$1,500,000 10 PSUs</b>	<b>\$2,000,000 13 PSUs</b>
<b>Sample - Severe Only</b>		<b>240</b>	<b>300</b>	<b>390</b>
<b>Cost / Case*</b>		<b>\$5,000</b>	<b>\$5,000</b>	<b>\$5,100</b>
<b>Expected Sample Crash Yield</b>	<b>V<math>\geq</math>25mph</b>	<b>30</b>	<b>40</b>	<b>50</b>
	<b>Frontal</b>	<b>20</b>	<b>25</b>	<b>35</b>
	<b>V<math>&lt;</math>25mph</b>	<b>100</b>	<b>123</b>	<b>160</b>
	<b>Frontal</b>	<b>50</b>	<b>60</b>	<b>80</b>
<b>Sample - All Crashes</b>		<b>380</b>	<b>480</b>	<b>620</b>
<b>LMY-Other Injury</b>		<b>140</b>	<b>175</b>	<b>225</b>
<b>LMY-Other Injury</b>		<b>90</b>	<b>115</b>	<b>150</b>
<b>LMY-Fatal or Hospital</b>		<b>150</b>	<b>190</b>	<b>245</b>
<b>Cost / Case*</b>		<b>\$3,150</b>	<b>\$3,150</b>	<b>\$3,200</b>
<b>Expected Sample Crash Yield</b>	<b>V<math>\geq</math>25mph</b>	<b>25</b>	<b>30</b>	<b>40</b>
	<b>Frontal</b>	<b>20</b>	<b>25</b>	<b>30</b>
	<b>V<math>&lt;</math>25mph</b>	<b>180</b>	<b>225</b>	<b>290</b>
	<b>Frontal</b>	<b>100</b>	<b>125</b>	<b>165</b>

NHTSA supplied the following explanation of how the numbers were derived: The assumptions in the paper provided to Mr. Bischoff estimated the cost of staffing a PSU at \$150,000. This included the investigator at the PSU and providing Zone Center oversight and QC support. A funding level of \$2m was assumed, yielding 13 additional PSUs. Hence, \$1.5M and \$1.2M should provide for 10 and 8 PSUs respectively. The estimate of the number of cases available for the 13 PSU sample (as shown in the last column), was derived by distributing the sample over a projected sample of 13 PSUs from the available

36. To estimate the expected samples for 10 and 8 PSUs, the same sampling process was used. Hence the resulting sample sizes would be in the same proportions as in the 13 PSU allocations. The possibility exists for other probability based samples that would increase the i take of sample cases, i.e., add back in all the largest PSUs in some of the 12 strata, but randomly select in the others. Of course, with smaller numbers of PSUs, e.g. 8, this becomes more difficult to do.

The number of additional NASS investigators that were added was based on a NHTSA and NASS contractor based estimate of \$150k per investigator per year amortized over four years. This estimate purportedly included: start up costs such as training of investigators, on going operating expenses, and NASS Zone Center supervision and control. Some expressed concern that this estimate seemed high considering that crash investigator salaries were in the \$30-35k per year range. Dr. Carra agreed to supply greater detail in order to establish the veracity of this estimate. The following charts received from NHTSA explain the derivation of the estimate:

<b>Annual Cost for Operation of a Site</b>	
Start-up (one time only)	\$25,002
Year 1	\$140,934
Year 2*	\$145,867
Year 3*	\$150,972
Year 4*	\$156,256
Total	\$619,031
<b>Average per Year</b>	<b>\$154,758</b>
*inflation factor 3.5%	

<b>Annual Team Level Cost</b>	<b>62.1%</b>
Researcher (TL)	46.2%
Office	6.3%
Vehicle Lease	3.6%
Communications	4.3%
Investigative Equipment	0.5%
Veh / Maint/ Fuel/Ins.	1.2%
<b>Annual Zone Center Level Cost</b>	<b>28.8%</b>
Management	1.9%
Site Visits (3)	2.8%
Training	9.7%
Quality Control*	14.4%
*Coordinator	
*Injury/Case Registry	
<b>Annual Administrative Cost</b>	<b>9.1%</b>

There was discussion about the length of time that it takes to complete a NASS case (the time from when the case is investigated until the final case report is available to the public; NHTSA estimates the average time to be 18 months. Cases typically become available around June 16 of the year following investigation when the final NASS electronic file is produced. Hard copy cases are available from a storage contractor for cases prior to calendar year 1997.). This was judged by many to be excessive for the purposes of getting an early readout of how redesigned air bag systems are performing. Dr. Carra said that he too was concerned about the length of time and that the agency was looking into how it might shorten the timeframe. In particular, the agency is looking into how it might publish an individual case report, as they are completed rather than waiting and publishing the whole year NASS electronic file. Dr. Carra agreed to report back to the panel on this issue.

### **Summary**

#### Issues where consensus was reached

- Use the NASS framework as the primary means of relevant crash notification and selection.
- The occupants of interest are both drivers and passengers, restrained and unrestrained.
- The vehicles of interest are passenger vehicles (i.e. passenger cars, light trucks and SUVs) ages from current model year and the prior four model years.
- Prepare at least a rudimentary analysis plan prior to making final decisions on what data to collect. The idea being to make sure that we have the appropriate data for conducting the analyses the panel recommends.
- Crash severity should include all levels where an inflatable restraint system could be expected to play a role in injury outcome. Note: it remains to be decided if this includes minor severity level crashes where the air bag has previously been implicated in producing injury where one would not have ordinarily expected.
- Verify the NHTSA estimate of \$150k to add a trained crash investigator to the NASS system.
- Attempt to shorten the time from investigation to case publication for NASS cases.

#### Issues discussed that still need resolution

- Do we need probability-based sampling?
- Do we need nationally representative data?
- Do we need to investigate crashes of low severity level? I.e. below the severity level that one would normally expect inflatable restraints to play a role in injury mitigation.
- Should we investigate crash configurations other than pure frontal?

## Issues arising from Larry Schneider's memo

- What would be the most efficient use of resources? Should the monies be used exclusively for NASS cases or include monies set aside for investigations by other organizations such as UMTRI or the Lehman Center?
- Should already existing teams, for example UMTRI, Lehman, other CIREN centers, be utilized to investigate NASS cases? (This may not be possible owing to the confidential nature of police crash reports).
- Should a portion of the funds be set aside to manage the program and compile the data? If we agree this should happen, to whom does this person report?