Task Force 13 Minutes September 12-13, 2011

Rapid City, South Dakota

Task Force Co-Chair **John Durkos** opened with a welcome to all to Rapid City and thanked Bernie Clocksin for the great venue and arrangements. Day one we get work done. We will have presentations on the web site. The AASHTO Roadside Design Guide has been published and it directly references our website. On the second day we will have presentations on relevant research. The Task Force Group Dinner is at 6:30 at The Chop House. Thanks to Co-Chair Gregg Frederick for help with registration. Thanks to Nick Artimovich for minutes, all of which are posted on the web site for last decade. Thanks also to Art Dinitz, Co Chair Emeritus.

Noted we have internet access and will be using that for on-line drawing reviews.

Break out room is Washington Room upstairs. Members received a flash drive as a souvenir. Have CEU Certificates for attendees, just need to be signed. Mentioned Mary McDonough's auto crash in Hawaii and asked all to sign the T shirt from "The Road to Hana" that Greg Kirchgesner bought, plus a get-well card. Thanks to Will Longstreet for providing a card for TTI's Thomas Motyka who lost his home to the Texas wildfires.

Fudge was provided to all attendees courtesy of www.silkfudge.com. Sorry, but if you didn't attend the meeting you don't get any. I will not fax some to you. You have to order it yourself to see how good it was.

Durkos requested a moment of silence for **Dick McGinnis** who lost a courageous battle with cancer a few months ago. Also for the victims and families of 9-11, the tenth anniversary of which was Sunday.

Gregg Frederick welcomed members to Rural America. Wyoming and the Dakotas are "bridge states" as E-W traffic crosses these states. There are many scenic opportunities. Many challenges as well. The Road Information Program just issued a TRIP report that details dangers of deteriorating rural roads. Deteriorating conditions and lack of safety features lead to higher fatality rate on rural roads. 51% of crash deaths occur on these roads that carry only 21% of traffic. Thanked the Task Force for all your efforts to improve safety. Wyoming had a WZ safety crash last week, doing a chip seal. Traffic control was set up and the flagger stopped the first car. Flagged next vehicle which was a pickup and it did not stop and struck the first car and resulted in a fatal accident. This underscores the necessity and the importance of the work done in our committees.

Funding on a national level is a question mark at best. Highway funding may drop and this will have an effect on states' and contractors' ability to deliver transportation improvement projects. May have to move to just a pavement preservation program. Need a stable funding stream so that contractors can invest in new equipment or innovations with the promise of future funding. Need a long term transportation bill. In Wyoming, 85% of their funding is Federal and a drop in Federal dollars would have a significant effect.

Art Dinitz noted that there are a lot of people around the world who are now promoting a Decade of Action for Road Safety. With 1.3 million people killed every year on roads around the world they realize that something must be done. In the US we have been working on forgiving highways since the 1960's. The rest of the world has the same problems but have not recognized the safety

issue. In India 150 000 deaths per year on roads, but their interest is in infrastructure preservation. Other countries are beginning to realize that there is something that can be done to reduce needless highway deaths.

Did self - introductions around the room. Durkos asked all to sign Decade of Action poster that was made available in Cleveland.

Artimovich reviewed the Subcommittee Activities from Cleveland. (Minutes of previous meetings may be found on the TF-13 web site at: http://www.aashtotf13.org/News-Bulletins.php)

Subcommittee # 1 Publications Maintenance **Will Longstreet** substituted for **Thomas Motyka** and **Mark Bloschock**, neither of which could be at the meeting. If you have a username and password you can review drawings and get to other levels in the website.

Opened the page for the Guide for Standardized Barrier Hardware. Each system had Designator, Family Name, Photo, Test Level, Drawing link, and manufacturers who make it. Opened strong post w beam and explained it in detail. Drawings should be prepared in TF-13 format when submitted to FHWA for acceptance. On line system is under development. Will be able to assign your own designator in the future. That functionality is not yet ready to show to the group.

Showed the TF home page and its links to our guides, left hand column links. We have an AdobeConnect site for the TF and we can review drawings two or three times prior to meetings. For future discussions, here is the Adobe Connect site url:
http://fhwa.adobeconnect.com/aashtotf13

Asked members present with laptops to login. Showed how to add comments. Possible with Adobe 9 but members should get Adobe 10. Once a Tech Rep posts a drawing he/she should schedule a teleconference with commenters to reconcile the comments. Arrange an Adobe Connect presentation through Will Longstreet. There are many drawings awaiting review and we can't accommodate that at the meetings. The AdobeConnect webinars are interactive and you can see the comments being discussed.

Barry Stephens asked if the drawings are to be Shop Drawings or just thumbnail. Longstreet replied that generic products have much more detail than Proprietary drawings. An assembly drawing will have the references on the back to the individual components which will have significant detail. **Durkos** noted that there is only a certain amount of info that you can comment on since the drawings are representing the actual crash tested device.

Cota noted TF-13 has been included in the RDG as the go-to place. The TF-13 site has replaced the hard copy drawings in the appendix. As a state agency, how do we use it? New Hampshire looks at it for reference of dimensions, how does it fit into their design? What are the general dimensions? What are the connections? Look for contact info on proprietary products. Having FHWA Acceptance letter makes it easier. Construction and maintenance people look at the basic information and contact info. This is a very important site. TCRS will try to get more of their state members to participate. **Durkos** asked that TCRS comments and feedback be made to the TF-13 site so that we know what will make it more useful. Artimovich's notes will include this.

[Editor's note. While TCRS appreciates the progress that TF-13 has made toward making our site the useable resource it is today, they hope that we will continue to maintain it by keeping the drawings up to date.]

Each drawing will have a time limit on making comments - comments will be reviewed and drawing finalized. What happens after drawing is completed? Gets voted to be uploaded to on line guide. Voting on line will be in the future.

Frederick noted that drawings take a long time to get approved by TF. Can we post something that included FHWA Acceptance Letter and a description while drawing goes through the TF approval process? **Longstreet** replied that the draft drawing is posted to the site (available to members that have a username and a password) and linked to FHWA Acceptance Letter, but drawing review status is noted as "under review". This can be added as a watermark on the drawing and should note that the device is FHWA Accepted, available for use, but that the drawing details are under review. FHWA process asks for TF13 drawing when you submit your request for acceptance. **Karla Lechtenberg** suggested that the Barrier Guide page should include a link that would have all those drawings that are "In review" in that location. They would be watermarked as such to differentiate them from the drawings that have been reviewed and approved for inclusion in the online guide. [Secretary's note. FHWA Chief Counsel has asked us to revise the wording in our letters. As of November 1, 2011, we will no longer find crashworthy hardware "acceptable for use on the National Highway System." Rather, the hardware will be "eligible for reimbursement under the Federal-aid highway program." We do not expect this to have a significant effect on how the state DOTs treat our crashworthiness letters, but it will take some explaining to some people who think they can get away with using untested hardware as long as there's no Federal money in a project.]

Durkos has recommended artwork for TF-13 guide covers. RDG has been printed. There will be people who have never heard of TF and will learn of us through the RDG. The 1995 Guide will remain on the site as a reference. Need to let folks know that the 2011 guide is on line. **Durkos** showed various cover designs. The "Design Guide feel" was much preferred. Only two voted for the old TF13 based cover artwork. Forward comments to **Durkos or Longstreet**. **Chris** Poole asked "why the date?" if it is a living document? Don't necessarily need a date. **Brad Hoover** (participating by phone link from TTI) noted if there is a date then the full calendar date of the latest update could be shown. We will get back to TTI with our preference; members present did not support a date on the cover thumbnail.

Cota suggested that the cover note it is not a downloadable document but a link to a website.

Subcommittee #2 Barrier Hardware

Reviewed hard copy drawings. SWC17 reviewed again. **Longstreet** used a PowerPoint presentation to introduce the SubComm and the drawings. **Scott Omae** has agreed to be TechRep for Terminals. TechReps are the catalyst to keep drawings moving through the process. There are a number of new drawings to look at, many drawings in the "Ready Tank" as well as existing drawings to be reviewed and updated. There are just too many to review in committee at our two meetings per year. Reviewers may reply to comments by clicking on the comment - do not have to add another sticky note.

SWC17: Although the convention is to have no units shown, this drawing shows tick marks for inches, but they may remain in place. There are a number of component links that don't work yet

but they are being worked on in the overall website construction. Motion to move to "Ready" status. Approved.

SGM24: Nu Guard 27 Median Barrier. "Front" view is only of post. Plan view appears to show a 12" block. Proprietary v non-proprietary should be called out. Statement regarding interchangeability should reference FHWA letter that states this. Mauer was asked if the smaller nu-cor posts need to use deeper blockouts to maintain a straight rail. Frazetta noted that the rail may vary. Discussion ensued as to whether it was appropriate to substitute in the *median barrier* when three nu-guard posts were successfully tested in a run of strong post roadside barrier. Artimovich noted the FHWA acceptance letter does not mention median barrier.

SWC16: Portable concrete median barrier transition. Component FBB01 should show "D" instead of symbol. Pins are not discernable in the top view due to scale. Sheet 5. Arrows to Concrete point to rebars: concrete disappeared from drawings somehow. When concrete is added to the drawing the reinforcing steel will not be shown.

Subcommittee #3 Bridge Railings and Transitions **Kurt Brauner** reported. Renewed request for review group members. Reviewed searchable terms in the web site and review process. Automate with drop down menus? Provide guidance to reviewer. How do you get info if there is no contact info? Who determines if entry is acceptable? If individual working groups approve of drawing it should be OK to move forward.

Should the Transitions website be more like the Hardware Guide or Bridgerail Guide? What info needed? Brainstormed ideas and took notes.

Subcommittee #4 Drainage Hardware: No one to meet with **Kevin Kenerson** but he notes there are new EPA (Environmental Protection Agency) rules that need to be considered. **Durko**s asked that TF members recruit drainage specialists for the subcommittee.

Subcommittee # 5 Sign and Luminaire Supports **Gregg Frederick**. Still need an active industry co chair who regularly attends the meetings. The discussion focused on small sign support guide. Web site functionality is done but have made little progress in drawing review through working groups. Voted to make one final call to manufacturers and have them get their comments back to **Mac Ray.** Need to hear back from manufacturer in order to move it forward. Once that is done just send it up to TF for approval. Subcommittee approval is enough to move it on to Ready Tank. If a member does note a problem then they should contact the subcomm co chair for resolution. This will speed up getting this information forward and on line. Most of the hardware is proprietary and therefore there isn't as much detail required.

Non proprietary items previously published may also be moved to TF13 approved section of website.

Luminaire support guide: 5 pooled fund states participated in **Mac Ray's** webinar and **Ray** asked for direction on how to proceed. Some thought that EPA (Effective Projected Area) calculations should be provided, but this will remain in the matrix but not published in the on line guide. A presentation will be on line to help users understand how to use the guide.

Subcommittee # 6 Work Zones

Barry Stephens substituted for **Ken Smith** and acted as the substitute meeting facilitator as neither of the Co-chairs were able to attend the meeting. **John Durkos** substituted for **Greg Schertz** The principle topic of discussion was a carry-over from several previous meetings; the creation of "Guidelines for Clear Zone and Length of Need Labeling of Crash Cushions". **Stephens** presented the background history of this standardization project and followed this with a list of reasons why the Subcommittee should proceed with the adaptation of labeling guidelines. **Durkos** then presented the reasoning behind why this labeling standard should not be pursued. After hearing the "Pro's" and "Con's", a vote was taken and the majority voted to end this project.

The floor was then opened to discuss other areas where standards may be needed for work zone devices. **Arthur Dinitz** suggested standards for work zone intrusion alarms. The Subcommittee felt that these devices tended to be electronic in nature and standardization, although possibly warranted, did not belong in this Subcommittee. Instead, perhaps ATSSA's Temporary Traffic Control Committee may want to consider this.

Subcomm #7 Certification of Test Facilities. Laboratory Accreditation and Standardization

Ken Opiela offered the following notes:

The testing subcommittee met to discuss plans for a new round of interlab testing. It has been decided that it would be useful to compare the efforts of individual labs in determining the location of the test vehicle CG and then mounting the accelerometer package and generally recording critical vehicle interior and exterior dimensions. The same vehicle would be transferred between labs for these measurements. Each lab would be given about three weeks to complete the effort. Part of the effort still undefined is some non-destructive testing that would allow the capture of acceleration data from the instrumented vehicle to allow analyses of the impacts on critical tests metrics. This effort was noted to be part of requirements under ISO 17025 for labs to maintain their accreditation. It was suggested that the vehicle also be subjected to detailed inertial measures when it is sent to TRC in Ohio. Ten labs (including the FOIL) will be asked to participate. Cost estimates for the transfer of the vehicle were received from commercial car carriers to get to all locations. The manner these would be paid was not determined, but FHWA was asked to consider covering these costs as support for enhanced lab credentials essential to the FHWA barrier acceptance program.

The group also discussed practices relative to the pre-full-scale crash test evaluation of soil effects. It appears that there are some results from these tests that are different than expected, but probably still viable. For example, there may be a need for an upper limit on post forces, even when the deflection limits are not met. This subject was noted to require some additional discussion among the labs and it may be a good candidate for an interlab comparison.

Subcomm #8 No Activity on RXR hardware

Marketing Subcommittee **Rick Mauer** Latest TF newsletter has been distributed and related to the on -line drawing review process. All newsletters should be posted on our website under News and Bulletins. Ask **Keith Cota** to write an article on TCRS and RDG perspective . **Kenerson** offered to publicize Drainage Subcommittee with an article on new EPA requirements. **Dinitz** noted that most of the interest in stormwater management is at the local, not state, level.

News Letter features: Drainage & Phase 2 of EPA Storm water regulations – Kevin Kenerson will type up an article. AASHTO's adoption of TF13 as a source for detailed information on highway safety devices – Keith Cota was asked to draft this up.

New email list to add to our mailing that will draw more drainage people to our meeting – **Artimovich** suggested the AASHTO Subcommittee on Bridges and Structures – T-13 Culverts group.

New Standardization Areas. ITS supports and overhead sign bridges may need standardized breakaway or barrier treatments.

Delineators / channelization. Many states have different series of tests for these short devices. Who could we ask to give a presentation like that?

Other potential topics include Soundwalls; Attachments of devices to the top of barriers; Crash testing of Medical Devices.

Executive Board Meeting
Durkos, Frederick, Takach, Longstreet, Brauner, Cota, Mauer, Kenerson, Bligh, Alberson, Dinitz were in attendance.

Durkos started at 5:20. WZ should be rare that both will be absent and we still support **Schertz** and **Smith** as co chairs.

Small sign supports. **Frederick** is stepping up in position in Wyoming DOT and Keith Fulton – WY state bridge engineer was accepted as State co chair. Either Mike Stenko, Richard Brown or Art Dinitz, all of Transpo, will always be present. Cert of test Facilities - Kelsey Chiu had to cancel for this meeting but is willing to stay on. Lance Bullard is other co chair.

Next meeting location. Montreal, Florida, Omaha? Florida quote was much too high. Travel logistics were too daunting for Montreal. Ron Faller has given three proposals for Omaha. Dick Albin was concerned that spring meeting was too close to Jan TRB. Looks like Omaha is the venue of choice. TCRS problem statements have been coming in too late so need to move up that meeting.

[Secretary's note. The spring meeting will be in Lincoln, Nebraska, after the annual Midwest Pooled Fund Study meeting the week of April 16-20, 2011. TCRS and AFB20 will meet in joint session in mid-summer next year and, very likely, every three years thereafter.]

We are asking for 20-7 funding to review the generic drawings in our Barrier Hardware and Bridge Rail guides. [This was submitted on 9-28-11. Funding of $50,000 was approved.]

Send email to whole mailing list and solicit interest in membership of the Drainage Subcommittee. **Fredrick** suggested Josh Beakely with American Concrete Pipe Association, and Jim Goddard of ADS.

How should TF "Approve" drawings? Should the Working Groups, Subcommittees, or TF vote be needed? Should be no higher than subcommittee, most are so technical that the working group

people are the only ones with the expertise to understand the systems. Barrier subcommittee has all drawings on line, but BR has hard copies reviewed in working groups.

Need to motivate people to review drawings. Should Barrier Subcommittee break into review groups for Guardrail, attenuators, Terminals, etc. ?

Ray is ready to turn over BR, Luminaire, and SS guide to TTI. Transition guide still in progress.

Tuesday September 13, 2011

Review of NCHRP Roadside Related Research

Chuck Niessner, soon to retire from NCHRP, gave his usual excellent summary of relevant research efforts underway. Most of the following active projects may be viewed on the NCRHP website: http://www.trb.org/NCHRP/NCHRPProjects.aspx

NCHRP 12-90 Guidelines for Designing and Shielding Bridge Piers New Project Proposal will be developed in Nov.

NCHRP 16-05 Guidelines for Cost-Effective Safety Treatments of Roadside Ditches
Preparing interim report.

NCHRP 17-11(02) Development of Clear Recovery Area Guidelines
Currently resolving issues with database.

NCHRP 17-43 Long-Term Roadside Crash Data Collection Program
Preparing interim report Panel meeting late Oct early Nov

NCHRP 17-44 Factors Contributing to Median Encroachments and Cross-Median Crashes
Interim report approved.

NCHRP 17-54 Consideration of Roadside Features in the Highway Safety Manual
Develop more quantitative data and crash modification factors to use in the HSM. Conducting Survey

NCHRP 17-55 Guidelines for Slope Traversability
RFP has been issued

NCHRP 17-61 Work Zone Crash Characteristics
Amalgamated project on barrier crashes. Drafting RFP

NCHRP 22-12(03)
Recommended Guidelines for the Selection of Test Levels 2 through 5 Bridge Rails
Executing work plan.

NCHRP 22-14(03) Evaluation of Existing Roadside Safety Hardware Using Updated Criteria
The research has been completed Published as RRD 349. Additional funding for testing cable barriers in median ditches was approved under NCHRP 22-14(4)

NCHRP 22- 20(02) Design Guidelines for TL-3 through TL-5 Roadside Barrier Systems Placed on Mechanically Stabilized Earth (MSE) Retaining Walls
This project is for design forces, not warrants. Concrete barrier is placed directly on top of the wall and a moment slab is used to deal with forces. Conducting simulations on TL3 to TL5 on MSE walls.

NCHRP 22-21 Median Cross-Section Design for Rural Divided Highways
Draft Final report been submitted.

NCHRP 22-22 Placement of Traffic Barriers on Roadside and Median Slopes
Interim report submitted.

NCHRP 22-23 Criteria for Restoration of Longitudinal Barriers
Completed as NCHRP Report 656

NCHRP 22-25 Development of Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems
Completed draft barrier placement guidelines. Should be done by end of the year.

NCHRP 22- 26 Factors Related to Serious Injury and Fatal Motorcycle Crashes with Traffic Barriers
Interim report approved by project panel. Collecting case studies. Getting details from trauma centers on extent of injuries. Not as many severe crashes have been occurring as anticipated.

NCHRP 22-27 Roadside Safety Analysis Program (RSAP) Update
Executing approved work plan. Workshop on new RSAP in January 2012

NCHRP 22-28 Criteria for Restoration of Longitudinal Barriers Phase II
Contract Pending.

NCHRP 22-29 Performance of Longitudinal Barriers on Curves and Super-Elevated Roadway Sections.
Work started June 2011.

Affiliated Committee / Activity Reports

AASHTO: No representative from AASHTO HQ

NACE: National Association of County Engineers. No members went to the annual NACE conference.

ATSSA: **Donna Clark** was unable to attend. Annual ATSSA Traffic Expo begins Monday February 13, 2011, in Tampa, Florida. ATSSA is having a webinar in October on Aesthetic Barriers. ATSSA Guardrail Committee has an Education Task Force that has sponsored a number of webinars on safety hardware including TMAs, Bridgerails, etc.

TRB Committee AFB20: TCRS has 11 proposals to consider this week and will likely send five or so forward with TCRS recommendations. TRB AFB20 last met with us in Cleveland in May. Three subcommittees met: Computational Mechanics, Positive Protection in Work Zones, and International Safety Research. Next meeting will be in January 22-26, 2012.

Dinitz related info on the AASHTO / FHWA visit to Bucharest for Decade of Action. Susan Martinovich spoke on Toward Zero Fatalities.

Old and New Business

We have enjoyed meeting with TCRS each fall and TCRS will discuss that later in the week. TRB Committee AFB20 meets in January and wants their meetings closer to July. TF-13 has the dilemma to push the other meetings further apart while they need to push them closer to mid summer.

Cota noted that one of the reasons for a joint meeting was to get more state representation in TF-13 and that has worked. Travel restrictions on state employees mean that joint meetings are a great advantage. Most state DOT people would not have been able to join TF13 had these been separate meetings. This was a light turnout for TF13 but had four state DOT people in attendance which is pretty good representation. We need state DOT participation, particularly for our Subcommittee Co-Chair positions.

Location of Spring 2012 meeting. Setting up a meeting depends heavily on a local member to coordinate activates. Proposal from Florida had very high hotel rates which were unacceptable. No proposal received from Montreal, but travel restrictions pretty much mean this would not work. We had 3 proposals from Ron Faller for a meeting in Omaha. We will provide details when available.

Next meeting may have Review Group breakout sessions within the Barrier Subcommittee. Ultimately Review Groups will review and approve drawings for posting. SubComm#5 decided that their Working Groups would have the final say on drawing approval. Need to use webinars between meetings to accomplish the drawing reviews.

Artimovich covered a half dozen To Do items.

Technical Presentations:

Karla Lechtenberg: Crash Testing at MWRSF. Had lots of rain and terrible conditions.

MGS without blockouts. Steel post 31" Have a 12" backup plate at each post. 6 foot w6x9 posts. 5/8 inch diameter bolts, 1.5 inches long. 3-11 test ripped off pickup tire but truck redirected. Snagged on one post but occupant risk criteria was OK. Dummy's passenger head broke window. Deflection was 35 inches. Damage concentrated on impact side.

MGS Without blockouts 32 inches maximum height recommended. 3-30 test. Vehicle pocketed in system, but was redirected. Some posts pulled out of the ground which was unusual. Posts not deflecting in strong soil and getting unusual post performance. Occupant risk OK. 29" dynamic deflection. Plan to compare all MGS tests and see what that tells them.

MGS with Southern Yellow Pine posts. 31" 6x8 inch 6 foot long. States wanted crash test verification of FHWA equivalency. 3-31 truck redirected smoothly. Impact side tire ripped off again. Posts snapped rather than rotating a whole lot. No floor pan def on either MGS pickup tests. Wood posts use blockouts. No plans to run wood post w/ o blockout. [MGS has already been tested with round wood posts, w / blockouts, and other woods also tested]

MGS blocked out is preferred because it is safer - the blocked out version does not show the same snagging and has better performance. [TTI ran MGS with 8" blockout and it was a successful test with small car - compared favorably, all numbers OK.] Increased height and moving splices to mid span have been the major improvements in strong post guardrail.

Roger Bligh TTI Crash Testing.

Primarily TxDOT work this past summer. NCHRP 16-05 Bullard is PI Roadside Ditches. Testing done to validate rigid body vehicle dynamic models. 2270P vehicle. CarSim model used. Truck driven over speed bump. Run at different speeds and worked on getting models of suspension to replicate reality.

30-foot wide v ditch with 5.5 to 1 slopes. Towed into ditch. Recorded roll pitch yaw. Compared to simulation. Tests run at various speeds. No damage to truck.

Opiela asked how many tests were run and at what speeds. [Two tests were noted at 42 and 50 mph]. He also asked if they considered using the NCAC bump profile and suggested that if we should standardize the bump profile for assessing vehicle dynamic response. Let's look at the profiles used to date and discuss whether there is a need to standardize and if so, which profile should we use.

Mauer asked why pickup rather than small car? Pickup was available and project was low funded.

Guidance for Minimum Sign for slip base supports. Did FEA parametric study using 10 to 16 square foot signs. Various pipes. Universal triangular slip base. Got significant secondary contact with roof and windshield. Roof def from 5 to 6 inches. OK under report 350 but MASH call for 4 inch max. Needed to find out how small a sign was acceptable, smaller sign needs smaller support and it rotates lower. Selected 12 sq ft sign on BWG-10 support post with “t- bracket.” 7 foot mounting height. Pickup passed with 3.75 inch deflection, but small car failed with greater than 4 inch def. Changed to 14 sq ft sign, BWG-10, seven foot mounting height. Passed at 2.5 inch def. Developed recommendations to TX Dot for Wedge and Socket for signs less than 14 ft square.

31inch TL-2 guardrail transition. Bridge rail snagging under the 31 inch w-beam would be more significant than post snagging. Transition from w beam to thrie, then from thrie to parapet. Thrie "Y" and thrie short piece were ten gage. Successful test with pickup. Used small car to test non symmetrical thrie beam "Y" transition piece. Small car pocketed and nearly spun out. OIV numbers were actually below "recommended" numbers and passed.

31 inch downstream anchor terminal. Texas Turndown outside clear zone for the end anchor downstream. Could small car wedge under turndown? Developed a new end anchorage to avoid snagging. BCT type of anchor. Small car passed.

Anchorage details for T223 rail. Post and beam rail to cast in place deck. Needed new method to anchor rail in 5 inch thick deck. MASH 3-11 passed with no signif damage to deck or rail.

Keith Cota: International Motorcycle Scan Tour. Sept 10-16, 2010. He has a PowerPoint presentation available.

Ken Opiela provided an update on roadside research at the TFHRC Office of Safety R&D. He explained FHWA Road Departure program missions to expand and maintain knowledge, improve methods and tools, develop and evaluate countermeasures, and provide user support.

- Described the Advanced Crash Analysis Program (ACAP) initiated in 2009 & its linkages to the former and current National Crash Analysis Center (NCAC)
- Noted that the Federal Outdoor Impact Lab (FOIL) received accreditation & he noted that there has been a variety of recent test firsts that included 70mph impacts, cameras mounted on the vehicle hood to monitor dummy movements, and rigid pole tests with the Kia Rio to capture crush and pole loadings data.
- Summarized cable barrier analyses efforts that had been underway for more than 4 years that started with trying to understand an underride problem that was occurring in one state and the expansion of efforts using vehicle dynamics analyses (VDA) to investigate the complexities of vehicle-to-barrier interface for various median configurations. It was noted that these efforts were expanded in the recent NCHRP 22-25 project to develop guidelines for cable median barrier placement. It was noted that recent efforts have included analyses of elevated medians & slope rounding effects.
- Described efforts to use simulation to develop a new energy absorbing end treatment for the steel backed timber (SBT) guardrail system and the completion on TL2 testing of it at the FOIL.
- The analyses of the raised block-out option to adjust guardrail height was described noting that the simulation indicated that this approach was viable and that it provided the option for new metrics of system performance.
- Described FHWA efforts to address concerns for NCHRP 350 approved hardware that does not pass MASH evaluations. These included:
    - SUT analyses of TL 4 impact scenarios and the evaluation of a possible retrofit to the 32 inch New Jersey barrier.
    - The simulations of the seven longitudinal barrier tests recently conducted under NCHRP project 22-14(3) using the new Silverado FE model. Side-by-side comparisons of the tests versus simulations were shown for all seven tests noting that even the failures were predicted in the simulations. It was noted that these models and results would be made available to anyone interested in trying to understand the failures or develop retrofits.
- The recently completed NYS bridge rail analyses was shown which featured a new display mode that allowed overlay comparisons of crash results for variations in the barrier features.
- Some examples of unique modeling & simulation applications was presented to demonstrate useful options. These included:
    - Multiple vehicle and criteria evaluations (sign supports)
    - Hidden & special views (transparent concrete and underside views of impacts)
- It was noted that new finite element models have been developed, including
    - Various enhanced tractor-trailer models
    - 2010 Yaris 1100 kg passenger car (MASH compatible)
- Current ACAP research efforts underway include:

- Terrain testing to further validate VDA simulation results and provide data for the slope research.
- Evaluation of the safety performance of barriers on curved and superelevated road sections.
- Analyses of rollovers crashes using empirical crash data and vehicle kinematics to characterize rollover propensities and associated metrics (e.g., rollover thresholds)
- Safety implications of future vehicle designs in angular crashes as a spinoff of a larger NHTSA effort.
- Analyses of infrastructure barriers and their applications.
- Simulating off-tracking crashes to reflect commonly observed phenomena.

- He closed noting the availability of reports on these various research efforts and the sincere interest in getting feedback on these efforts or suggestions for other research needs.

Tuesday Afternoon Joint Session with AASHTO Technical Committee on Roadside Safety

Chris Poole Iowa DOT
Bernie Clocksin SD DOT
Michael Bline, Ohio DOT
Rory Meza Texas DOT
Keith Cota New Hampshire DOT
Rod Lacy Kansas DOT

Three potential topics were on the schedule and voted on as follows:
Supplemental Test criteria for Cable Barrier Systems to MASH – 16 votes
Update of AASHTO Roadside Design Guide – 6 votes
Implementation of MASH- 6 votes

Bligh volunteered to summarize the progress: Cable Barrier Testing. Under 350 only tested on flat, and this would be OK up to 6:1 slopes. This thought was based on old TTI testing. Some states asked for testing on 4:1 slopes rather than having both sides of ditch lined with cables. An ad-hoc matrix was developed to evaluate cables in these 4:1 v-ditches. There was no standardization of ditches, and all labs had differing conditions. With MASH MWRSF was trying to develop a 4-cable generic system that could be placed anywhere in this ditch. Series of tests run at UNL funded by MWRS pooled fund group in 46-foot wide ditch. Ditch width came into question; could a narrower ditch be more critical? UNL tested in wide ditch and TRB under NCHRP 22-14(4) provided TTI some funding for testing in their 30-foot wide ditch. Expected to run tests in both ditches to determine worst case scenario. Some recent tests at UNL were not successful and design modifications are needed prior to TTI's test in the narrow ditch. Proposed matrix includes five tests, but worst case width is yet to be settled. Need to consider that a system that passes in a 4:1 ditch should be retested on the flat.

MWRSF ran a sedan on the flat and it failed. Cable crushed the “A pillar.” Also ran a pickup test that failed.

Proposed matrix:
1. 3-11 test on 46 or 30 foot ditch. Barrier on frontslope 12 feet from SBP
2. 3-10 46 or 30 on front slope located 4ft to 12 ft from SBP
3. 3-10 46 ft Barrier on backslope 4 ft from ditch bottom

4. 3-10 46 or 30 Barrier on backslope 4 ft from back SBP. Vehicle yaws when hits backslope.
5. Mid Size sedan? At critical offset so that veh would go through.
6. 3-11 flat re-validate system under lab conditions
7. 3-10 flat re-validate system under lab conditions

This proposed matrix has been developing over time.
Question: Is 25 degrees the appropriate angle? MWRSF has looked into crash data for penetrations. Looks like 35 degrees is more common angle for these severe events.

Opiela. NCAC did many VDA simulations in an attempt to provide a systematic analytical basis for answering the question. The results confirm that the override limit is at 10-12 feet from the break point and it showed that a 44-48 foot wide ditch would be worst case for the underride condition. He also noted that there are questions about whether a medium size vehicle should be considered given it lands with a greater force and that there needs to be some standardization of the soil conditions in the vicinity of the landing point as it affects the rebound and height of the interface.

Rod Lacy. Kansas & MW been working on cables for some time. One in 40 cable crashes have a serious injury. Trying to make system more robust so it could reduce injuries.

Industry is ready to test, but they want assurance that they are testing to a matrix that will get them an acceptance letter.

There is also a MASH matrix for testing a single CMB at the 1 to 4-foot offset. This matrix ("Matrix B") is much further along.

Slope rounding is also an issue as not every state follows the same pattern

Chris Poole noted that MW pooled fund group likes to push the envelope. MGS has a lot of flexibility. A lot of states have 4:1 ditches but the test issues may lead to concentrating on 6:1 testing and make sure we have a system that works on the majority of medians.

This has been going on a while. Is there a target date for completion? 4:1 ditch issue on hold. Unless additional NCHRP funding becomes available it will not move forward.

Lechtenberg said they are not trying to develop a matrix to accommodate the generic MWRSF system. However their tests have shown there are issues with the ditch testing.

Alberson: Our knowledge of barrier performance has been increasing significantly over recent years. Learning more about the sensitivity of barriers on slopes.

Opiela. Wondered whether the States are holding back because we just don't know what the optimum system is or where they should be placed. This is occurring while the FHWA is promoting the use of median barriers.

Artar noted 25 years ago FHWA got out of the business of developing new barriers. Manufacturers came forward and invested in new designs. Now pooled fund states are getting back into it.

Richard Butler of Brifen weighed in on the same topic and was more specific about an industry concern that “tax dollars” are being used to develop a system that will compete with industry and that the parties developing this system are also writing the crashworthiness requirements. Is this a double conflict?

Cota: do we need to add slope testing of barriers to MASH? What are the criteria affecting these barriers? What is the best configuration for use on slopes? What are the limitations on these barriers? Where can I place it to achieve zero deaths?

States and manufacturers are all asking "what are the criteria for testing on slopes" but money is just not available for testing all these scenarios. We may have to recognize there are some locations where we just shouldn't place barriers.

Should we just adopt Matrix B and not worry about placing the cable "anywhere on the slope?"

Bline noted that guardrails were installed on specially graded roadsides, but cable median barriers were placed on medians that were never designed to have a barrier placed on them.

Lechtenberg: Research has been redirected to study barriers placed on 6:1 to 6:1 ditches.
We won't know which of the tests are critical until we run some of them...

Afternoon Break

Durkos noted that November 4, 2011, **Chuck Niessner** is retiring from TRB / NCHRP. Congratulations.

MASH Implementation. Florida specs call for MASH cable only after July 2012. May be premature as there are no fully tested systems on 4:1 slopes.

Cota related the discussion between FHWA and TCRS re the MASH-350 task force and our proposed guidance to the states regarding the status of the failed devices.

Durkos: States have reacted to FHWA GR Height memo differently. Some are going to MGS. Some are just raising steel strong post w beam.

Cota: Specified a proprietary. 31" system for I-93 in Franconia Notch, but don't want to get in a situation where they have a number of different 31" systems they need to maintain. Are installing two other 31" systems to see how they perform under winter conditions and will evaluate. **Durkos** asked **Cota** to report back to TF13 the results. Mentioned Ohio DOT project with four 31" systems installed. One proprietary system was hit but maintenance crew used standard bolts to repair system. This soured the state on installing proprietary systems. All manufacturers offer training on their system and are glad to provide it to ensure their product is installed correctly.

Stephens: Four issues 1) Take a 350 cushion and attach to a 350 barrier. Do I crash test to 350 or to MASH? 2) Product improvements. Get feedback from the shop as to how to improve the product, improve performance and drive cost down. Now MASH testing is expensive. 3) A new manufacture must test to MASH, a higher level. 4) Legal: Why didn't we establish a sunset date?

Cota thinks a MASH only product has an advantage as some states are going to MASH more and more over the next 5 years.

Durkos: Do we spend the $$$ to develop MASH products and have our foot in the door, or have states say that they are satisfied with 350 products.

Roadside Design Guide. Now that new one is done we can look at current and recent research is critical for next update. Envisions a 3 to 5 year cycle for rewrite.

Durkos again asked TCRS to review TF13 site and give us feedback.

The Joint meeting adjourned at approximately 4:00 pm MDT.

Publications List

September 2011

NCAC Documents Generated for FHWA by Topic:

[A variety of technical reports, working papers, and technical summaries have been generated by NCAC at the direction and funding of FHWA. These documents can be downloaded from the NCAC website at www.ncac.gwu.edu. For more information contact Dr. Steve Kan cdkan@ncac.gwu.edu or Dr. Ken Opiela at Kenneth.opiela@dot.gov.]

Items in italics confirmed as posted 4/30/11. **Items in red are being prepared for posting by GWU Staff.** **Items in blue are being reviewed by FHWA Staff.** Items is regular print are planned documents with expected completion dates in brackets subject to successful completion of current research efforts.

Guardrail Systems:

- *Development of a Finite Element Model for W-Beam Guardrail (G4-1s) (NCAC 2007-T-004)*
- *Evaluating W-Beam Guardrail Height Tolerances (NCAC 2007-T-003)*
- *Effects of Shoulder Drop-Off On W-Beam Guardrail Performance (NCAC 2007-T-002)*
- *Evaluation of Rail Height Effects on the Safety Performance of W-Beam Barriers (NCAC 2007-R-003)*
- *Evaluation of Rail Height Effects on the Safety Performance of W-Beam Barriers (NCAC 2007-W-002)*
- *Applying Vehicle Dynamics Tools to Determine Optimal Median Barrier Placement (NCAC 2008-T-002)*
- *Development of a New End-Treatment for the Steel Backed Timber Guardrail, Phase I: Conceptual Design (NCAC 2009-W-006)*
- *Development of an Energy Absorbing End-Terminal for the Steel-Backed Timber Guardrail Phase IIA: Design of TL2 SBT End Treatment (NCAC 2010-R-002)*
- *Development of an Energy Absorbing End-Terminal for the Steel-Backed Timber Guardrail Phase IIB: Test Level 2 Crash Testing Results (NCAC 2010-R-003)*
- *Safety Performance Evaluation of G4(2w) W-Beam Guardrail with Raised Blockouts (NCAC 2009-T-002)*
- Development of Modified MGS Design for Test Level 2 Impact Conditions Using Crash Simulation (NCAC 2010-W-005)
- Conceptual Design using Simulation of a New End Treatment for Steel-Backed Timber Guardrail (NCAC 2010 –T-003)
- Testing to Support Conceptual Development of a New End Treatment for Steel-Backed Timber Guardrail (NCAC 2010-T-004)

Cable Barriers:

- *Finite Element Modeling and Validation of a 3-Strand Cable Guardrail Systems (NCAC 2004-W-002)*
- *Analyzing the Effects of Cable Barriers Behind Curbs Using Computer Simulation (NCAC 2009-W-008)*
- *Evaluation of the Influences of Cable Barrier Design & Placement on Vehicle to Barrier Placement (NCAC 2008-W-001)*

- *Analyzing the Effects of End-Anchor Spacing & Initial Tension on Cable Barrier Deflection Using Computer Simulation (NCAC 2009-W-007)*
- *Development & Validation of a Model to Evaluate Safety Performance of Cable Median Barriers (NCAC 2007-T-001)*
- *Crash Testing of Retrofits for Generic Cable Barriers Placed on Narrow, 6H:1V Sloped, V-Shaped Medians (NCAC 2007-R-006)*
- *FOIL Cable Median Barrier Retrofit Testing (NCAC 2008-T-001)*
- *Performance Evaluation of Low-Tension, Three-Strand Cable Median Barriers on Sloped Terrains (NCAC 2007-R-005)*
- *Vehicle Dynamics Investigations to Develop Guidelines for Crash Testing Cable Barriers on Sloped Surfaces (NCAC 2010-W-009)*
- *Developing Functional (Design) & Evaluation Requirements for Cable Median Barriers (NCAC 2010-W-008)*
- *Using Vehicle Dynamics Simulation as a Tool for Analyzing Cable Barriers Effectiveness (NCAC 2010-W-006)*
- *Comparing Vehicle Dynamics Analysis Results for Roadside Hardware Evaluations (NCAC 2010-W-007)*
- *Analyzing Potential Interface Effectiveness for Cable Barriers in Asymetrical Median Cross Sections (NCAC 2011-W-001)*
- *Analyzing Potential Interface Effectiveness for Cable Barriers in Elevated Median Cross Sections (NCAC 2011-W-002)*
- Nomographs for Effective Placement of Cable Barriers in Various Types of Medians (NCAC 2010-W-014)
- Slope Rounding Influences on the Trajectories of Vehicles (NCAC 2011-W-004)

Crashworthiness Criteria & Testing:

- *Evaluation of Roadside Hardware Performance under Updated Crashworthiness Criteria (NCAC 2008-W-002)*
- Analysis of the Effects of Construction Tolerances on Bridge Rail Performance (NCAC 2011-W-003)
- Evaluation of the Effects of MASH Vehicles on the Performance of W-Beam Guardrails Using Simulation (NCAC 2009-W-00x)
- Evaluation of the Effects of MASH Vehicles on the Performance of Concrete Barriers Using Simulation (NCAC 2009-W-00x)
- Evaluation of the Effects of MASH Vehicles on the Performance of Sign Supports Using Simulation (NCAC 2009-W-00x)

Vehicle Modeling:

- *Validation of Single Unit Truck Model for Roadside Hardware Impacts (NCAC 2003-W-001)*
- *NCAC Vehicle Model Development Update 2007* (NCAC 2007-T-006)
- *Modeling, Testing, & Validation of the 2007 Chevy Silverado Finite Element Model (NCAC 2009-W-005)*
- *Component & Full-Scale Tests of the 2007 Chevrolet Silverado Suspension System (NCAC 2009-R-004)*
- *Development and Validation of a C2500 Pick-Up Truck Suspension Finite Element Model for Use in Crash Simulations (NCAC 2003-W-003)*
- *Evaluation of Vehicle Dynamics for Single Unit Trucks Traversing Sloped Roadsides & Medians, (NCAC 2009-W-010)*
- *Analysis of Vehicle Trajectories on 4:1 Single Sloped Roadside Terrain (NCAC 2007-W-006)*
- *Development & Validation of a Finite Element Model for a Ford F-250 Pick-up Truck (NCAC 2008-T-003)*
- Development & Validation of a Model of a 2007 Chevy Silverado Pick-up Truck (NCAC 2009-T-002)

- Development & Validation of a Finite Element Model for a Dodge Neon Sedan (NCAC 2007-T-007)
- Development & Validation of a Finite Element Model for a Geo Metro Sedan (NCAC 2007-T-008)
- Development & Validation of a FE Model of a 1994 Chevy C2500 Pick-up Truck (NCAC 2007-T-009)
- Development & Validation of a FE Model of a 2002 Ford Explorer (NCAC 2008-T-004)
- Development & Validation of a FE Model of a 2010 Toyota Yaris Passenger Sedan (NCAC 2011-T-001)
- Selection of an 1100kg Passenger Car for Finite Element Modeling to Support Crash Simulation Efforts (NCAC 2009-W-009)
- Development & Validation of a FE Model of a 2001 Ford Taurus Passenger Sedan (NCAC 2008-T-005)
- Reverse Engineering & Validation of 2001 Ford Taurus Finite Element Passenger Car Model (NCAC 2007-W-005)
- Extended Validation of the 2007 Silverado Finite Element Model (NCAC 2009-T-004)
- NCAC Finite Element Vehicle Model Update 2011 (NCAC 2011-T-003)

Crash Simulation:

- Simulation of MASH Test 3-11 of a Chevy Silverado into a New Jersey Shaped Concrete Barrier , (NCAC 2010-W-001)
- Simulation of MASH Test 3-11 of a Chevy Silverado into a G9 Thrie Beam Guardrail, (NCAC 2010-W-015)
- Simulation of MASH Test 3-11 of a Chevy Silverado into a G4(2W) W-Beam Guardrail, (NCAC 2010-W-002)
- Simulation of MASH Test 3-11 of a Chevy Silverado into a W-Beam Transition, (NCAC 2010-W-004)
- Simulation of MASH Test 3-11 of a Chevy Silverado into a G3 Weak Post Box Beam Guardrail, (NCAC 2010-W-014)
- Simulation of MASH Test 3-11 of a Chevy Silverado into a Modified G2 Weak Post W-Beam Guardrail, (NCAC 2010-W-013)
- Simulation of MASH Test 3-11 of a Chevy Silverado into a G4(1S) W-Beam Median Barrier, (NCAC 2010-W-003)
- Silverado Simulations Report & Summary (NCAC 2010-W-011)
- Comparative Analysis of Vehicle Model Compatibility for Crash Simulations on a Common Impact Scenario (NCAC 2010-W-010)

Concrete Barriers:

- *Safety Performance Evaluation of Concrete Median Barriers for SUTs under Updated Crashworthiness Criteria (NCAC 2008-W-002)*
- *Safety Performance of Portable Concrete Barriers (NCAC 2009-R-004)*
- *Safety Performance Evaluation of Portable Concrete Barriers (NCAC 2007-W-004)*
- *Multi-objective Discrete Design Optimization Algorithm for Portable Concrete Barriers by Coupling Grey Relational Analysis with Successive Taguchi Method (NCAC 2007-W-005)*
- *Evaluation of Portable Concrete Barriers using Finite Element Simulations (NCAC 2002-W-001)*
- Safety Performance Evaluation of Concrete Barriers on Curved and Superelevated Roads (NCAC 2011-W-005)
- Surface Friction Measures for Portable Barriers on Varying Surfaces (NCAC 2011-T-004)

Motorcycles:

- *Opportunities for Safety Improvements to Reduce Motorcycle Crashes in the US (NCAC 2007-W-003)*
- *California Motorcycle Crashes: Roadway & Rider Contributing Factors (NCAC 2010-T-001)*
- *US Single Motorcycle Crashes: An Overview of Roadside Hazards (NCAC 2010-T-002)*

Highway Design and Other Elements:

- *Evaluation of Redesigned Finite Element Simulations of Slip Base Sign Supports (NCAC 2003-W-002)*
- *Safety Performance Evaluation of Secure Mailboxes Using Finite Element Simulation & Crash Testing (NCAC 2004-W-001)*
- Plate Transition from Temporary Concrete Barrier to Permanent Barrier (NCAC 2007-T-005)
- Sign Support Height Analysis Using Finite Element Simulation (NCAC 2004-W-00x)
- Safety Performance Evaluation of Alternative Raised Medians Designs (NCAC 2006-T-001)
- Evaluation of Thrie Beam Transition Designs (NCAC 2007-T-010)
- Studies of Terrain Effects on Vehicle Trajectories (NCAC 2011-W-00x)
- Effect of Friction Versus Bank Angle in the Design of Highway Curves (NCAC 2011-W-00x)

Crash Date Analysis:

- *Leveraging New Technologies to Capture Infrastructure Data to Supplement Roadside Crash Analyses (ACAP 2010-W-001)*
- Highway Features Involved in Rollovers by Vehicle Class and Model Year (NCAC 2011-W-00x)

General Topics:

- *Advanced Crash Analyses Program (ACAP) to Improve Transportation Safety & Security (ACAP 2009-T-001)*
- *Accomplishments of the FHWA/NHTSA National Crash Analysis Program 1993-2008 (NCAC 2009-T-001)*
- *Advanced Crash Analyses Program (ACAP) to Improve Transportation Safety & Security – 2010 Update (ACAP 2010-T-001)*
- Advanced Crash Analyses Program (ACAP) to Improve Transportation Safety & Security – 2011 Update (ACAP 2011-T-001)

ACAP
FHWA Advanced Crash Analysis Program

Technical Summary

ACAP 2011-T-001 Draft Nov 2011

Advanced Crash Analysis Program (ACAP) to Improve Transportation Safety and Security - 2011 Status Report

Background:

The Advanced Crash Analysis Program (ACAP) was initiated by the FHWA Office of Safety R&D of the Turner Fairbank Highway Research Center (TFHRC) in December 2008. ACAP continues FHWA efforts to promote the application of finite element (FE) models and crash simulations to 1) design and analyze various types of roadside hardware (e.g., guardrails, sign supports, and concrete barriers); 2) assess vehicle-to-vehicle and vehicle-to-barrier impact compatibility; 3) investigate the causes of various types of crashes including rollovers; 4) formulate improved guide-lines for the selection and deployment of roadside safety or security hardware; and 5) develop concepts for new roadside treatments. These efforts are expected to result in new treatment options that can be used to mitigate current or emerging safety or security problems; confirm or expand the findings of other analyses and testing, and/or improve hardware application effectiveness.

ACAP will also serve as the platform for FHWA to support a broader spectrum of safety and security research, pioneer the use of new technologies, improve tools and methods, develop new devices, consider the implications of changing conditions, and promote state-of-the-art transfer of findings to public agencies, researchers, and industry. The sharing of models, data, and results that characterized past efforts will continue to support safety and security research and development efforts worldwide.

Objectives:

ACAP objectives are to expand detailed knowledge about crashes, promote the application of emerging methods, enhance understanding of crash dynamics, and improve potential effectiveness of designs, materials, or applications for safety and security elements. Under ACAP, FHWA will continue to collaborate with the National Highway Traffic Safety Administration (NHTSA), the Department of State (DOS), and other organizations to continue advanced crash analyses and research.

Achieving these objectives will primarily involve the following efforts:

- Conduct advanced crash research to assist researchers and engineers in resolving safety and security issues in transportation.
- Advance techniques and tools for crash analyses, including FE modeling, simulation, and vehicle design and dynamics analysis tools and demonstrate their application.
- Maintain a national repository (i.e., knowledge base) of crash videos, films, and documentation.
- Conduct crash and impact testing to provide data for modeling, material characterization, calibration, and validation.
- Disseminate the findings of the research and the applications of the advanced technologies to reap their benefits and accelerate their deployment.
- Support multifaceted outreach and educational opportunities, using state-of-the-art tools, to serve practitioners, decision makers, & students.
- Conduct detailed and clinical analysis of crash data and correlate it to analytical results to expand understanding of crash events.
- Investigate occupant risks in crashes and the effectiveness of mitigation measures.
- Evaluate improved designs and treatments to enhance transportation safety and security.

A key aspect in achieving these objectives is expected to be the continued sharing the resources, findings, data, models, and technologies with others to expedite efforts to address complex safety and security problems. This may involve prospecting in related fields, forming new partnerships to adapt advanced analysis tools, and consideration of novel applications to deal with the complexities of safety and security issues and means to mitigate them.

Scope:

A task order-based contract has been initiated to support the various activities under ACAP. The George Washington University was selected as the contractor for this program after a rigorous, full, and open competition. The contract provides for research and development efforts to support the missions of the FHWA, NHTSA, DOS, and potentially other government agencies. Task Orders under ACAP may involve considerations of all types of vehicles, different roadway and roadside features, varying impact conditions (e.g., speed and angle of crash), and a range of occupant types and positioning.

Under this program the Federal Outdoor Impact Lab (FOIL) and the Vehicle Modeling Lab (VML) will be operated and maintained to allow full-scale and component level testing to provide essential dynamic response data. Testing and engineering efforts in these facilities will be undertaken in accordance with standard AASHTO, DOS, and ASTM protocols as appropriate. The VML will continue to advance technologies to support reverse engineering and the creation of vehicle & hardware finite element models for the simulation of a broad spectrum of crashes.

Task Areas:

The ACAP contract was structured to support research efforts in various subject areas, including:

- Roadside analysis and design
- Impact and material testing
- Development and validation of FE models
- Documentation of research efforts and findings
- Outreach and training
- Infrastructure barrier analysis and testing
- Occupant risk analysis
- Detailed data mining and analysis
- Maintaining and updating the library
- Analyzing feasibility & impacts of new materials
- Providing technical support

Efforts under one or more of these areas will occur as Task Orders are issued by FHWA defining specific objects, approaches, timetables, and products. Table 1 lists the Task Orders that have been initiated since the beginning of the contract. The accomplishments associated with each are noted in italics.

Future Research Challenges:

It is envisioned that ACAP will support efforts to address various future research challenges, including:

- tire-surface interaction and failure modeling,
- enhancing knowledge about occupant risks in crashes,
- fracture models and their applications in crash simulation,
- development and validation of new FE models by reverse engineering,
- analytical studies of motorcycle safety,
- investigations of the effects of using lightweight materials on vehicle safety,
- linkage of vehicle & body models to understand the forces acting on occupants in crashes,
- application of analytic models to address the full gamut of rollover conditions,
- development of improved software tools and application protocols in simulation,
- analyses of vehicle dynamics in road departures,
- analyze rollover crashes and potential remedies,
- investigate, though crash dummy and human body models, the risks to vehicle occupants,
- development of new models or applications (e.g., material fracture or tire-to-surface models) to increase the predictive power of advanced tools,
- support agencies in the investigation of catastrophic crashes,
- enhance the capabilities of safety professionals in the applications of advanced methods,
- maintain & upgrade repository of crash test data,
- analyze & test devices aimed at enhancing safety and infrastructure security,
- optimize designs of safety and security hardware,
- develop state-of-the-art training materials to enhance the capabilities of safety & security professionals,
- investigate the safety implications of the next generation of vehicles, and
- develop techniques and tools for monitoring health and performance of deployed hardware.

These efforts will enhance the understanding the causes of roadside crashes, evaluate the effectiveness various roadside safety treatments, and provide the basis for future crashworthiness requirements.

Products of these efforts will include reports, tech summaries, presentations, FE models, software tools, data sets, and technical assistance. The specific products from any task order effort will be a function of the level of analysis, objectives, audience, and scope defined at the outset.

Contact:

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Table 1 - Advanced Crash Analysis Program Current Research Agenda

Task Order	Title	Objectives/Accomplishments
1	**Project Organization and Kick-Off**	**Objective:** To provide a systematic transition to the new contract & set the basis for management of subsequent Task Order efforts as well as continued maintenance of the FOIL, the NCAC Library, and the finite element models archive. ***Accomplishments:*** *Established contract management system, continued FOIL O&M activities, and provided technical simulation support and problem analyses. [COMPLETED]*
2	**Provide Analysis and Evaluation Support for Roadside Safety Team**	**Objective:** To undertake short-term detailed analyses related to roadside safety issues to develop or improve hardware, enhance deployment, understand the causes of crashes, and/or assist in training agency personnel. These efforts are expected to expand the demonstrated applications of advanced tools and may establish a basis for further analyses. ***Accomplishments:*** *Completed 2010 directives to 1) evaluate performance of raised block-outs for W-beam guardrails, 2) conduct simulation analyses of crash tests of Silverado into common barriers, 3) evaluate the enhanced tractor-trailer model, 4) simulate impacts under MASH criteria, 5) analyze slope testing protocols,6) analyze barriers on curved roadways, and 7) support TRB and TCRS presentations. Completed 2011 directives to 1) analyze of vehicle trajectories for elevated medians, 2) studied effects of variations in bridge rail designs, 3) analyze the influence of slope rounding, 4) evaluate options for TL 2 version of MGS barrier, and 5) generate trace plots for special median configurations, and 6) update past analyses on sign support s. Current efforts are focused on 1) developing improved tire models, 2) analyzing the vehicle dynamics of safety edge treatments, 3) analyzing vehicle compatibility issues, 4) studying crushable nose designs for bogie testing, and 5) analyzing barrier terminal anchorage requirements.*
3	**Operation and Maintenance of the FOIL**	**Objective:** To provide staff to support the basic efforts to operate and maintain the FOIL facility and the various equipment needed for different testing functions and conduct limited testing in support of research efforts. ***Accomplishments:*** *Since the beginning of the contract more than 100 tests (including 30 full-scale) have been conducted and documented. In addition new high speed digital cameras, a new test control computer, various safety devices and tools, and a new storage building have been acquired and put into service. Efforts to secure lab accreditation will be completed in 2011.*
4	**Conduct Efforts to Document and Disseminate Research and Support Outreach Efforts**	**Objective:** To assist the research staff in efforts to 1) generate reports, tech summaries, web materials, and other research products, 2) establish standards for documenting the products under ACAP, 3) support various outreach efforts, and 4) implement a process to track the production of research materials and maintain an on-going catalog of them. ***Accomplishments:*** *The NCAC Website has had 46 new documents added related to work from both the previous and current contracts since the contract began. Many additional documents are being prepared for posting. NCAC staff has organized and conducted various meetings, workshops, and conferences and has participated in various forums to disseminate the findings of the research and keep abreast of advances by others. [COMPLETED]*
5	**Update and Maintain of Vehicle and Hardware Models and Associated Documentation**	**Objective:** To maintain and upgrade the various vehicle and hardware models (e.g., finite element, rigid body), provide support to users, and manage website. ***Accomplishments:*** *The 2007 Chevy Silverado and Toyota RAV4 vehicle models have been added to the array and numerous updates to hardware models have been made and posted. Documentation and website information have been updated. [COMPLETED]*
6	**Analyze Terrain Effects on the**	**Objectives:** To 1) generate the data necessary to verify or update relationships

	Trajectories of Vehicles that Leave the Road	for terrain effects on vehicle trajectories for the current vehicle fleet, and 2) assess the implications on crashworthiness requirements and/or highway design guidelines to promote enhanced safety. ***Accomplishments:*** *Vehicle Dynamics Analyses has been used extensively to understand trajectory effects over a very broad range of road departure conditions. More than 30,000 simulations have been run to capture trajectory data for a range of vehicle types & median configurations. These have been aggregated into proposed guidelines for effective barrier placement. Preparations are underway to conduct trajectory tests at the FOIL during 2011 to provide data to validate the vehicle dynamics analysis results.*
7	**Investigate Causes of Rollover Events for Various Crash Types Using Analytic Methods**	**Objectives:** To 1) undertake detailed analyses of rollover crashes to better understand underlying causes, 2) evaluate the potential effectiveness of new treatments or countermeasures, and 3) investigate whether current design practices can be improved to reduce the contributions to rollovers. It is expected that analytical and simulation methods will be used to assess these effects for various vehicles and impact conditions. The research should focus on rollovers for passenger cars and sport utility vehicles. ***Accomplishments:*** *Literature was reviewed, recent empirical data analyzed, new sources of data explored, and a plan generated for Phase 2 efforts to analyze rollover crashes associated with road features. The draft report is being revised and is expected to be available in 2011. Recommendations for further efforts are being considered for Phase 2 efforts. [COMPLETED]*
8	**Develop Updated Bogie Test Vehicle for the FOIL**	**Objective:** To model, construct, test, calibrate, and document a reusable bogie vehicle to enhance testing capabilities at the FOIL. ***Accomplishments:*** *A bogie vehicle has been fabricated from a Silverado pick-up frame. The stability of this platform has been assessed with tests at the FOIL. Recommendations for improvements to the design & validation have been formulated. [COMPLETED]*
9	**Analyses and Testing of the Improved Infrastructure Security Barriers (DOS)**	**Objective:** To undertake the testing and analyses efforts needed to improve or enhance the infrastructure barrier systems noted above to higher certification levels and to assess barrier performance for combinations or arrays of barriers. ***Accomplishments:*** *FOIL testing of a tubular steel fence and a fixed bollard were successfully completed and documented. [COMPLETED]*
10	**Analysis of Improvements to Infrastructure Barriers to Enhance Performance (DOS)**	**Objective:** To undertake the simulation analyses efforts needed to improve or enhance existing infrastructure barrier systems to achieve higher certification levels, simplify the designs to facilitate construction, and assess barrier performance in combinations or arrays. ***Accomplishments:*** *Crash simulation analyses were completed for the tubular steel fence. Simulations of potential improvements to bollard and knee wall barrier and the effectiveness of various combinations of previously tested barriers have been executed and results provided to the DOS. [COMPLETED]*
11	**Develop and Validate an FE Model for a Small Car (with NHTSA)**	**Objective:** To develop a detailed vehicle finite element model of an 1100kg small car through reverse engineering and then validate the model in accordance with accepted practices to support future crashworthiness analyses related to vehicle and highway safety research. ***Accomplishments:*** *A 2010 Toyota Yaris was procured, subjected to a series of non-destructive tests to capture data for model validation, subjected to reverse engineering, and scanned & meshed to create a finite element model. Teardown and scanning was completed and the initial version of the model developed and validated. This version was released to NHTSA on July 1, 2011. Current efforts are focusing on documentation and preparations to post the model. Efforts have begun to model the interior elements and conduct additional validations of the model.*
12	**Maintain the Crash Tests Library and Continue Digital Conversion**	**Objective:** To support basic management of the crash test library with primary emphasis on supporting the FHWA and NHTSA research efforts, cataloging new items, and continuing efforts to convert existing library materials to digital

	(with NHTSA)	formats. ***Accomplishments:*** *Various materials have been cataloged added to library. The process of converting films and reports to digital formats continues. Efforts to accelerate the digitization process have been investigated.*
13	**Provide On-Going Analysis and Evaluation Support for FE Modeling and Simulation (DOS)**	**Objective:** To provide on-going engineering and analytic support, to include finite element analysis to support research and testing activities, related to the evaluation of anti-ram truck barrier systems and assemblies as needed. ***Accomplishments:*** *Simulations of various modifications to anti-ram barriers or changes to impact conditions were completed and documented. Undertook assessment of the nature of the world truck fleet to determine candidates for a next generation test vehicle modeling effort. [COMPLETED]*
14	**Assess Effectiveness of Child Safety Devices in Rear Seat Placement (NHTSA)**	**Objective:** To use simulation analyses to analyze the risks to child occupants of varying ages in different types of crashes using available restraint devices. The findings will support rulemaking efforts. ***Accomplishments:*** *A report summarizing the modeling of three additional child safety seats and the analysis of occupant risks in rear seat placement has been completed. Based upon the results additional simulations of varying crash conditions will be evaluated.*
15	**Analyses of New Materials on Vehicle Crash Integrity (NHTSA)**	**Objective:** To provide technical support for NHTSA research on potential safety benefits of Plastic and Composite Intensive Vehicles (PCIVs) using current FE models modified to reflect the replacement of components with structural plastics and composites. ***Accomplishments:*** *The selection of structural components to be replaced by plastic or composite materials has been completed. Samples of plastic and composite materials have been manufactured for characterization testing. Efforts to replace parts in the vehicle model and conduct simulations of NCAP tests will begin in mid-2011.*
16	**Occupant Risk Implications of New Vehicle Designs Using Structural Modeling**	**Objective:** To investigate measures that will further improve the self and partner protection of occupants of new vehicle designs through structural and restraint system optimization across real world crash scenarios focusing on light-weighting strategies and power train changes. To assess the implications for angle crashes with roadway features. ***Accomplishments:*** *The contractor submitted a work plan to NHTSA to outline the efforts that will be undertaken. The plan has been accepted and efforts are moving forward on multiple fronts including getting the five base vehicle models ready and formulating the specific changes that will be made to the models to reflect expected future design features. Simulations of NCAP tests with the modified vehicle models will begin in late 2011 to assess the safety implications of the expected design changes.*
17	**On-Going Analyses & Testing of Improved Infrastructure Barriers**	**Objective:** To undertake simulation analyses and testing to improve the design, applicability, constructability, and deployment of previously developed infrastructure barriers for the Department of State. ***Accomplishments:*** *Simulation analyses of combinations of various types of security barriers has been undertaken to determine the combinations and placement requirements for spot hardening of perimeter security. Decisions are pending on the testing of promising combinations.*
18	**Conduct Efforts to Document and Disseminate Research and Support Outreach Efforts (Continuation of Task Order 4)**	**Objective:** To assist the research staff in efforts to 1) generate reports, tech summaries, web materials, and other research products, 2) establish standards for documenting the products under ACAP, 3) support various outreach efforts, and 4) implement a process to track the production of research materials and maintain an on-going catalog of them. ***Accomplishments:*** *TO efforts expected to start in October 2011.*
19	**Update and Maintain of Vehicle and Hardware Models and Associated Documentation**	**Objective:** To maintain and upgrade the various vehicle and hardware models and provide support to users, and manage website. ***Accomplishments:*** *TO efforts expected to start in October 2011.*

	(Continuation of Task Order 5)	
20	**Investigate Causes of Rollover Events for Various Crash Types Using Analytic Methods**	**Objective:** To 1) undertake detailed analyses of rollover crashes to better understand underlying of vehicle kinematics associated with causes, 2) evaluate the potential effectiveness of new treatments or countermeasures, and 3) investigate whether current design practices can be improved to reduce the contributions to rollovers. It is expected that analytical and simulation methods will be used to assess these effects for various vehicles and impact conditions. The research will focus on rollovers for passenger cars and sport utility vehicles. ***Accomplishments:*** *TO efforts expected to start in October 2011*
21	**Develop Updated Bogie Test Vehicle for the FOIL**	**Objective:** To model, improve, test, calibrate, and document a reusable bogie vehicle to enhance testing capabilities at the FOIL. The bogie vehicle fabricated under TO 7 will be refined and tested further. Efforts will include development of crushable nose requirements and formulation of testing protocols under MASH. Efforts to model this bogie will be complete to provide a basis for analyses of future bogie tests. ***Accomplishments:*** *TO efforts expected to start in October 2011.*
22	**Safety Implications of New Vehicle Designs in Roadside Crashes**	**Objective:** The current NHTSA research effort to use FE vehicle models to assess the potential safety implications of emerging changes in vehicle designs in TO 16 will provide a unique opportunity to consider the implications related to roadside hardware. The NHTSA future vehicle models will be used to analyze MASH type angular impacts that will not be looked at under the NHTSA efforts. These simulations will provide an opportunity to consider the implications of changes in the vehicle inertial properties due to alteration of the power plant, the effects of reduced size on occupant risks, and/or assessment of lateral forces on structural integrity of new materials. ***Accomplishments:*** *TO efforts expected to start in October 2011.*
23	**Develop and Validate an FE Model for a Mid-Sized Car (with NHTSA)**	**Objective:** To develop a detailed vehicle finite element model of a mid-sized car through reverse engineering and then validate the model in accordance with accepted practices to support future crashworthiness analyses related to vehicle and highway safety research. ***Accomplishments:*** *TO efforts expected to start in October 2011.*
24	**Optimization, Documentation, & Demonstration of Tractor Trailer FE Model**	**Objectives:** The FHWA initiated efforts to develop an FE model of a tractor-trailer vehicle and recently collaborated with NTRCI to enhance and validate the model. The need exists to 1) modify the code for the current tractor-trailer FE model and/or the simulation control parameters to improve the efficiency of simulation runs, 2) develop alternative versions of the tractor-trailer model, 3) document and post the models on the NCAC website, and 4) demonstrate the usefulness of the model for safety studies. The model may also be further validated, if data from tractor-trailer crash tests is discovered or can be obtained from new crash tests. ***Accomplishments:*** *TO efforts expected to start in October 2011.*