ATTACHMENT B
PANEL COMMENTS ON MARCH 31, 2009 QPR

NCHRP Project 22-24
Guidelines for Verification and Validation of Crash Simulations used in Roadside Safety Applications
Comments on March 31, 2009 QPR

Panel comments on the March 31, 2009 QPR are included below in a regular font. The research team's responses are shown in an italic font.

Reviewer #1

I have read Malcolm's quarterly report and have the following comments:

1. I had a chance to try out the RSVVP program and feel that it will be a useful addition the simulation community. The program is fairly straightforward to use to get results. Having said that, I am a little worried that a lot of effort is going into making this program, rather than focusing on the ultimate methodology that is need for V&V. Although there are advantages to having everyone using the same method, there are also some disadvantages to having a piece of software that is dedicated to this task.
    a. At some point this research project will end and there will no longer be someone to support this piece of software. As computer operating systems change over the years, there may be issues with getting the program to run.
    b. By using software to do much of the V&V, you have a "closed system," whose inner workings are not necessarily changeable or completely understood. This is O.K., as long as the software is doing what you want. However if there is a "bug" or if one wishes to change a piece of the code, this becomes challenging, especially if there is no designated group who maintains the software.
    c. The final report that is issued with this project needs to include the actual methodologies and algorithms, so that these are preserved and can be reviewed and updated as necessary.

    This is a good point. The RSVVP User's Manual and Programmer's Manual should provide adequate information on doing the calculations and, of course, the final report will document the calculation portion of the procedures as well. A program of some sort, however, is necessary since the calculations are lengthy, not necessarily complex or difficult but they do involve processing thousands of data points from the true and test curves.

2. In the Benchmark cases, I am somewhat troubled by the use of the Geo Metro model to simulate an impact by a Peugeot, even though they have similar inertial properties (although I realize there may be a limited supply of crash tests to take advantage of.) The issues I see are twofold. If you are successful in your validation, the result suggests that vehicle type (and by extension material properties and etc.) does not matter, as long as the V&V is successful. This may in fact be the case, but this issue may be more appropriately addressed in a separate study. On the other hand, if you are unable to validate the Geo Metro simulations, is this because the event and simulation are truly different, or is your evaluation criteria just too stringent? I guess what I am saying is that it seems you have too many variables. First the test truly is not the same as the simulation (something that should be evaluated more at a later date), and second, we are still working to find the correct way to validate test cases.

   Again, a good point. As the reviewer points out there is not a lot of data available so we have to use what we can find. The basic idea, however, is that we do not require crash tests to use exactly the same test vehicles only ones that fit into the appropriate vehicle specifications. The same could be said of a crash test that uses a Ford pickup truck that is compared to an FE simulation using a Chevrolet. It is certainly true that some differences could be due to the vehicle type but since we could make a crash test acceptance with any vehicle type in the 820C group the V&V process should <u>not</u> be sensitive to the particular vehicle. This was the point of the second round of tests in the Round Robin series where several different types of vehicles fitting the 900-kg EN1318 criteria were used.

3. The research group is still evaluating acceptance criteria and I would like to make the comment that emphasis should be placed on keeping the evaluation criteria as simple as possible. Results should be easy to understand, not only by the entity submitting the results, but also the FHWA, and others within the roadside safety community. For instance the QPR details the ability to use local or global coordinates and also resultant accelerations. Although this is useful for the team to understand the best way to analyze the data, ultimately one of these methods (ideally the simplest) needs to chosen as the standard for all analyses to be run.

   We absolutely agree. At this point we have been using a lot of different criteria and different options but ultimately we plan to only use one process in order to keep it simple. This month's QPR details our current thinking on the acceptance criteria and process. For example, we are recommending only using the local data, using the data that was collected (generally accelerations and rotation rates) and we have eliminated all but one of the multi-channel weighting options.

Reviewer #2

In addition to inquiries I sent several weeks ago, I have the following comments about the latest progress report.

1. Acceptance Criteria – I don't really like the "peak values" option. Peak values are very much sampling and filter rate dependent and, I believe, could skew the

results too much. The "inertia properties" would be a pain and might be meaningless depending upon type of data curve one is inputting.

We have eliminated the peak-value and inertial properties options for the multi-channel analysis.

2. The report seems to concentrate on acceleration traces of the vehicle too much. There are other data curves that will be used in RSSVP: such as load cell data, accelerometers attached to hardware devices, strain gauges, string pots, etc. This should be clear in both the text (reports, manuals, etc) as well as in the RSSVP menus and results.

   True but we need to make a distinction. RSVVP can be used for a couple different things. Users can use RSVVP during their development to compare any type of curve or to built PIRTS for vehicle and barrier models. The other option, the one we have probably been discussing the most, is the specific procedure for comparing a crash test and a simulation. In that case, the data will generally be accelerations.

3. Multi-channel seems to be for only the 6 channels from an accelerometer – 3 translation, 3 rotation. I guess I thought it meant I could put in as many or few curves I wanted from various types of singles and then it would give me a general overall view of the correlation. For example, I tried to put in just 2 curves (1) acc of vehicle CG vs time and (2) internal energy vs time, from two separate simulation cases. In RSVVP it prompted me for the next, or 3rd curve, without the option to proceed.

   This has been changed. The old version presumed that there were always six channels in the multi-channel option.
   The weighting scheme used in RSVVP assumes that the input time histories for either the first three curves or the last three curves have the same units or, at least, comparable order of magnitude. In fact, RSVVP normalizes the first three channels and the last three channels by the peak value of the respective group. In your case, you wanted to compare accelerations and energy, which obviously have different units and, eventually different order of magnitude. In order to obtain a correct result you have to make sure that you input the acceleration curve as one of the first three curves and the energy curve as one of the last three curves (or vice versa). Otherwise, RSVVP would consider the two curves like if they have the same units, thus causing a possible improper assignment of the weighting factors. The multi-channel option is really only to be used when comparing a set of instrumentation that are linked (i.e., the accelerometers and rate gyros at the c.g.). Up to three accelerometers and up to three rate gyros would work and up to six accelerometers would work. In the case given by the reviewer, probably the energy curve should be viewed only with the single channel option since the acceleration channels and the energy channel are assuring fundamentally different things. The purpose of the multi-channel option

is not to give a general overall score for all curves but rather its purpose is to provide a way of assessing which are the most important channels in assessing the motion of the vehicle.

4. All of the test cases do not have to end up having good correlation. It helps to have "bad" cases so that things to look for that are bad is often more helpful than finding things that correlate. But, I understand that people supplying the test cases do not want their examples to come off looking bad in public.

   True indeed but we have generally tried to pick examples that we thought were good in most other respects.

5. It sounds like you are making every effort to make available the exact dyna decks and test results being used for the test cases. I support this and think that that is very important. People will want to run the cases themselves as they learn about V & V. That helps reinforce what they'll read about in the reports and give them the training they need to perform V & V on their own with confidence.

   We agree. The LSDYNA decks for the V&V test cases will be made available. In the short term they are available from the project team. We may want to see if the NCAC would be willing to host them in the long term once the final report is completed.

6. I sometimes get negative values for the magnitude (M) in Sprauge-Geers MPC. That's confusing to me and I could not find any place what a negative value means for magnitude.

   A negative simply means that the test case has a generally smaller magnitude than the true case. We have removed the negative in RSVVP so that users can expect that the score starts at zero (perfect) and goes up.

Reviewer #3

Task 8A: Roadside Safety Simulation Validation Program (RSVVP)

This section states, "In a future release of the program, this configuration file may be improved in order to store all of the information necessary to allow a complete reproduction of a previous computer run". I strongly encourage the researchers to make this improvement. The intended use of this program is to support submissions for acceptance of design changes to safety hardware. Therefore, it is important for the approving authority to be able to reproduce the computer run.

We are in the midst of considerable improvements in this area. The configuration file will be essentially a batch file for processing the data files so all the setting will be preserved in the batch file. Our primary reason for doing this was to address an earlier

panel comment about the labor intensive nature of re-doing an RSVVP run but this comment brings up a good point that it is useful documentation of the run itself. In the latest release, RSVPP also creates a copy of the original input curves in a subfolder of the folder where all the results are placed, so there is no need for the user to add the original curves manually. This is a further step in the effort to make a complete documentation of the run. So far the configuration file contains most but not all the necessary information to automatically re-run a previous comparison (some adjustments need to be made in this way). The intention is to add the missing pieces of information to the configuration file relatively soon.

Task 8D: Roadside Safety Model Best Practices Guide

To date, a formal meeting of the panel for NCHRP 22-24 has not been scheduled for this summer in San Antonio. Since NCHRP has not offered to fund travel to San Antonio for the panel members, I do not plan to attend.

I have taken the position that the researcher's earlier proposal to develop a more automated documentation system for LSDYNA models should be tabled until near the end of this project. However, it has become evident that funding from the States for add-on projects will become very tight. An automated documentation system is an interesting tangent, but it is not necessary for successfully accomplishing the objectives of this project. Attachment A shows there is barely enough money remaining to complete this project. Let's use that money to successfully complete the research work that's already underway.

We were not able to arrange a formal meeting at the TRB summer meeting so the panel did not formally meet (certainly many panel members were there and many aspects of the project were discussed). The automated program for self-documenting LSDYNA input files is essentially moot. While the panel has not responded formally we also did not get any clear signal to go ahead so we have shelved that aspect of the project.

Contractual

It is critically important to do the benchmark cases well because this work will give insights into such questions as weighting factors for the PIRTS etc. This has taken more time than originally envisioned and this work is not finished. Therefore, it seems reasonable for the researchers to request a time extension. I recommend that the researchers prepare a revised bar chart schedule and submit a written request for a time extension to NCHRP for consideration by the panel.

The current QPR has a modified schedule as suggested by the reviewer. Several of the vehicle development efforts have only now reached the stage where they are ready to work with the project team so a time extension seems logical to take advantage of these efforts. The request for a no-cost time extension has been made to Mr. Neissner.