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Draft Manuals and Procedures for MLS Data Collection and Equipment Operation Including Plans for MLS Shakedown Test

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CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

In 1992, the Texas Department of Transportation (TxDOT) developed the Texas Mobile Load Simulator (TxMLS) manufactured by Victoria Machine Works (VMW), a steel fabrication company in Victoria, Texas. The equipment went through a series of tests at a site near Victoria. Reports have been published describing this work (Chen 1997; Hugo 1996 and 1997; Lee 1997; and Pilson 1995 and 1997).

In 1995, the MLS was moved to the Ft. Worth District to conduct a comparative study of two rehabilitation processes on U.S. 281 near Jacksboro, Texas. The results of these tests and test procedures have been documented in a number of reports (Chen 2001; Hugo 1999). During the operation of the TxMLS in Jacksboro, the useful life of a number of mechanical components of the TxMLS were reached or exceeded. A number of repairs and technical adjustments were made to keep the equipment operating to the end of this test series.

In 1999, a contract was signed with RGB, Inc. and a complete renovation of the TxMLS was undertaken, because it had fulfilled its original design life on field test sections. This renovation was undertaken to address several observed problems and to improve the performance and reliability of the TxMLS. The major planned improvements included:

- New axle bogies
- New drive chain mechanism
- Reposition (lower) the two drive motors on separate support cradles
- Rebuild the load rails
- Redesign the load wheels and associated bearings
- Install new strain gauge system for monitoring tire loads
- New hydraulic system to set axle loads

The new hydraulic system will allow operators to apply more uniform loads and set the load levels more quickly. The heavy drive motors have been moved to separate cradles that position them closer to the ground.

This rehabilitation effort proved to be a sizable task and a number of critical elements had to be redesigned several times in the process.

1.2 FORMULATION OF THE TEXAS ACCELERATED PAVEMENT TEST CENTER (TXAPT)

In 2001, TxDOT decided to undertake the development of a center for accelerated pavement testing (APT) at a fixed facility in Texas. TxDOT administration decided that a fixed facility might provide more output from the equipment, and thus a better payout on the investment over the short term than use on inplace highways. There were also some concerns for safety and the cost of operating the equipment on existing highways.

After several rounds of negotiations, detailed proposals were received from the Texas Transportation Institute (TTI) and the Center for Transportation Research (CTR) for setting up a permanent Texas accelerated pavement test center. After careful review and many conferences and discussions, TxDOT selected CTR to set up the TxAPT Center, under the leadership of Dr. W. Ronald Hudson as Center Director, with a permanent facility to be located at The University of Texas at Austin, J.J. Pickle Research Campus (PRC) in north Austin.

1.3 BACKGROUND OF THE PROPOSED SITE

A number of site characteristics, active research operations, and physical facilities at PRC make it an excellent site for the proposed activity. Dr. Ken Stokoe, a senior CTR researcher, directs a very unique National Science Foundation (NSF) research activity at PRC. The “Large Scale Mobile Shaker and Associated Instrumentation for Dynamic Field Studies of Geotechnical and Structural Systems” is the only such activity funded by NSF in the United States. It is planned as a 14-year research effort, which is funded at approximately $3 million for the first four years. Among many other elements related to the TxAPT research effort, this activity has Rolling Dynamic Deflectometer (RDD) and Stationary Dynamic Deflectometer (SDD) hardware and instrumentation. Dr. Stokoe has used these devices in conjunction with the TxMLS and has offered all of his equipment, instrumentation, and experience to the CTR TxAPT team.

The Ferguson Structural Engineering Laboratory, located within walking distance of the proposed TxAPT test site, has an active machine shop. TxAPT repairs requiring welding or machining of certain parts could be accomplished within that facility. Also nearby is the Center for Electro-Mechanics, which has extensive machine shop capabilities and could be called upon to provide supplemental TxAPT support. Dr. David Fowler, a CTR researcher and Director of the International Center for Aggregates Research, operates his Materials Research Center in Building 18B, within walking distance of the proposed site. Testing equipment and facilities for a broad range of pavement materials' characterization and evaluation are available in Building 18B. The Center for Research in Water Resources has extensive office and laboratory space about one-half mile east of the proposed TxAPT operations site. CTR has ongoing relationships with all of these centers and activities and can easily foster support activities ranging from TxMLS repairs to office space. Additionally, the Pickle Commons Building is available for large or small group meetings and presentations, with virtually any type of catered meal service. Through recent administrative changes, the College of Engineering has operational control of PRC. As an element of the College, CTR has full access and use of PRC's assets.

Highway access to PRC is excellent and ample free parking is available for visitors. UT operates a shuttle bus service from PRC to the main campus and headways are 30 minutes for an approximately 30 minute one-way trip. Rail transportation of the large TxMLS device to PRC is very feasible because the Union Pacific main track traverses PRC and the track is adjacent to the likely MLS sites. Access to PRC by visitors based outside Austin is provided easily by the new Austin Bergstrom International Airport.

A map depicting two possible locations for the TxAPT facility is shown in Figure 1.

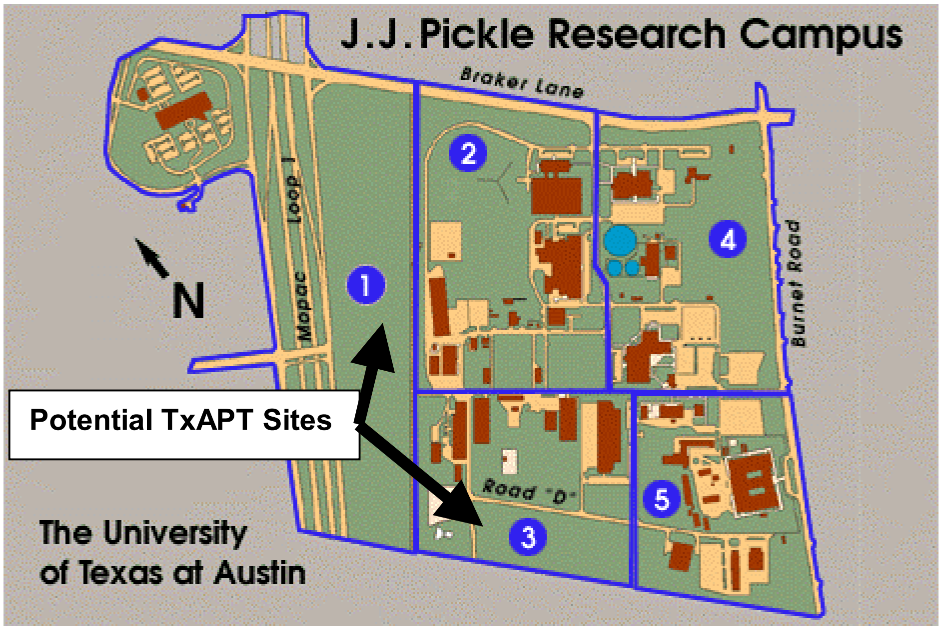

Figure 1. Site Map of Pickle Research Campus and Potential TxAPT Sites in Sectors 1 and 3

1.4 COOPERATIVE FEATURES

A fully cooperative operating scenario for the proposed facility is envisioned with CTR providing the Center director and the Texas Transportation Institute (TTI) and other major universities providing advisory group members for coordination. The director will work closely with the TxDOT program coordinator to ensure that the sponsor's wishes are carried out faithfully. Further cooperation will be ensured by the appointment and use of a Center Operating Advisory Group (OAG) comprising representatives of pavement-related research universities, two representatives of TxDOT, and two or three outside members. This group should remain small—10 people maximum—and will advise the director, while obviously all research coordination decisions will be made by the appropriate TxDOT group.

Offices and support activities will be made available at the facility for out-of-town research staff while their work is being carried out at TxAPT. We will afford all users our full cooperation.

1.5 INITIAL CONTRACTUAL ARRANGEMENTS

After the selection of CTR to develop the TxAPT Center, several meetings were held to discuss the administrative relationships that were necessary to make the Center function. Ultimately, an implementation contract, Project 5-1924-01, was selected as the mechanism for funding the initial construction and development of the site. A second contract (Project 0-9900) was written to provide the ongoing support necessary for Center operations. Dr. Ronald Hudson was selected as center director, and Mr. Ron White as senior research engineer to provide full-time support for the development and ongoing operation of the Center. Ms. Sharon Campos was selected as the administrative associate to handle the critical details of administration, data processing and storage, and meeting arrangements and documentation, which are vital to the TxAPT Center. In 2003, Dr. Tom Rioux was added as a part-time data manager, responsible for processing and Web-based development to insure proper continuity of data, storage, processing, and dissemination.

1.6 OPERATING ADVISORY GROUP

Dr. Hudson envisioned in the initial submission of the TxAPT Center proposal, that an OAG would be set up and function throughout the life of the Center. The group was planned to include key TxDOT personnel and a minimum of three or four external individuals with experience in APT at other locations. The group's first meeting was held on October 17, 2002. The initial makeup of the committee was as follows:

Virgil Anderson, Consultant
German Claros, RTI, TxDOT/Austin
Jim Freeman, TxDOT/Paris
Ken Fults, CST/M&P, TxDOT/Austin
John Harvey, UC/Davis
Ronald Hudson, Director, TxAPT, CTR, UT/Austin
Paul Krugler, Director, Research & Technology Implementation Office, TxDOT
Dallas Little, Senior Research Fellow, TTI/Texas A&M
Carl Monismith, Professor, University of California at Berkeley
Mike Murphy, CST/M&P, TxDOT/Austin

Soheil Nazarian, Professor, University of Texas/El Paso
Tom Scullion, Research Associate, TTI/Texas A&M
Ken Stokoe, Professor, UT/Austin
Ron White, TxAPT/CTR, UT/Austin
Tom White, Professor, Mississippi State University
Andrew Wimsatt, TxDOT/Ft. Worth

The OAG has met three times and provided expert advice in the development of the initial project and plans for the TxAPT Center.

1.7 ADMINISTRATIVE AND TECHNICAL REVIEW PROCEDURES

It should be noted that TxAPT would not function as a separate research agency within TxDOT or CTR. Rather, it will be an operating group for the TxMLS and will provide support for APT of all kinds for TxDOT. The funding of projects to be carried out through TxAPT, as currently planned, will be funneled through the Research Oversight Committee of TxDOT and through the RMC-1, Pavement and Materials Construction Division Research Management Committee. The chairman of RMC-1 will function as a member of the OAG to provide close coordination, and Dr. German Claros the secretary of RMC-1, is functioning as the project director for our key projects at the present time.

At the outset, it was envisioned that the TxAPT Center would be operated as an "open" shop and that all universities throughout the state would be eligible to carry out research at the facility. TxAPT Director Dr. Hudson, and immediate TxAPT staff will not supervise individual research projects. Rather, funding for individual projects will be open to all research agencies and personnel outside the Center. It was originally envisioned that the first project (Project 0-4574), entitled "Determine Impact of HB 2060 Permits on Texas Load Zone Roads," would be carried out as the Pilot Study for the Center, under Dr. Hudson's direction. Owing to a variety of reasons, this was later changed and the plans were set up to operate a single shakedown test for the TxMLS equipment on the TxAPT site under the direction of Dr. Hudson and the TxMLS coordinator, Dr. Dar-Hao Chen. The remainder of Project 0-4574 was transferred as a separate project with Dr. Jorge Prozzi serving as research supervisor.

It will be very difficult to complete all debugging processes for the TxMLS on a single shakedown section. Therefore, it is essential that close coordination be maintained throughout the entire process of testing for Project 0-4574.

Following the completion of Project 0-4574, a companion Project 0-4843 will be conducted entitled "TxDOT Base Designs Using APT; a Validation of Project 0-4358," under the leadership of Dr. Tom Scullion, Texas A&M, TTI. This project is paired with Project 0-4574 because the APT data collected for Project 0-4574 will also be used to supplement the data collected for Project 0-4843. The initial test pavement constructed for both projects contains three different types of bases-8 inches thick, covered with 1½" of compacted hot mix asphalt concrete. Data from Project 0-4574 will be collected on the portion of the pavement constructed with typical TxDOT base material (Texas Standard Specification Item #247). Dr. Scullion's project will use the remaining half of the test facility that has been constructed with a new base specification (Item #245), which has a coarser gradation than the 247 base. The 245 base is laid in two different sections and was obtained from two different rock quarries; one from a relatively hard aggregate source and one from a medium to soft aggregate. By pairing these two projects, the data from Project 0-4574 can be used for multiple purposes, thus magnifying the benefit of the data from TxAPT.

1.8 DATA COLLECTION AND PLAN FOR THE FUTURE

It must be remembered that a piece of mechanical equipment such as the TxMLS has a finite operational lifetime. This was aptly illustrated by the 4-year life of the original TxMLS. Even though significant improvements are being made, this equipment will also wear out during a normal depreciation process. With this in mind, it is critical that all plans for TxAPT take full benefit of research capabilities to magnify the results obtained and wherever possible to use each dataset several times in conjunction with other projects.

1.9 FAILURE MODE EVALUATION

Generally, APT involves several failure modes, but most prominent are rutting, failure, and fatigue failure. Historically, rutting failure can be evaluated in a relatively fewer number of load applications. In Indiana, for example, heavy loads are applied and rutting comparisons on various mixes are made with less than 50,000 load applications on each test section.

Fatigue evaluation, i.e. overall pavement performance, often requires several million-load applications under normal conditions. In the case of Portland Cement Concrete pavements, a 13- or 14-inch slab might be selected for testing with the TxMLS. In such cases, as many as 30 million typical axle loads would be required, and the TxMLS equipment might wear out before the very thick concrete pavement yielded performance failure.

Keeping this in mind, it is critical that experiments be selected and set up to take full advantage of the equipment and the data collected. This means that relatively thin pavement sections should be selected for the early tests that will yield performance results for fewer than one million load applications. If performance curves, i.e. the number of load applications versus roughness or conversely versus pavement serviceability index, can be carried in under a million load applications, the shape of the performance curve may be well defined. This would ensure that there are indicators or markers early in the life, perhaps at one-third the total performance predictors that will vastly multiply the benefits of APT and maximize the benefit of the TxMLS.

This has yet to be evaluated totally but it is critical in the planning of TxAPT Center operations.

CHAPTER 2 ORGANIZATION FOR SHAKEDOWN TESTING

2.1 BACKGROUND

Typically, APT centers worldwide have a unified organizational structure. All operation activities for the centers are carried under single leadership. Currently, that is not the case at TxDOT. The TxMLS is operated under the direction of the Materials and Pavement Group of TxDOT. Dr. Dar-Hao Chen is the TxDOT APT systems manager, under the leadership of Dr. Mike Murphy. The construction and operation of the physical test pavements are under the leadership of TxAPT Center Director Dr. W. Ronald Hudson, with the support from Research Associate Ron White, and strong input from TxDOT RTI Project Director Dr. German Claros.

In this regard, there is a tripartite group responsible for the results of APT in Texas. Furthermore, a research supervisor under the leadership of yet another project director carries each test project. Each of these projects, their research supervisor, and project director will also have critical needs to fulfill their goals and objectives within time and budget limitations. This diverse organizational structure creatures potential problems and requires close coordination and interaction with the various entities. This coordination and interaction will be assisted by advice from the Operating Advisory Group, the Pavement Technical Advisory Panel (TAP-1), and the Research Management Committee (RMC-1) for Pavements, Materials and Construction.

It is especially important that the data collection and equipment operational procedures for the newly renovated TxMLS be thoroughly shaken down as part of the shakedown test, under Project 0-9900, and that additional details be developed and coordinated under Project 0-4574. Appendix A summarizes the discussions that have been carried out with respect to the relationship among the entities involved in accelerated pavement testing. The TxAPT Center is responsible for providing a facility and for collecting, cleansing, processing, and analyzing data in order to make it available to the Research Supervisor, Project Director and all other interested parties. The TxAPT Center is also responsible for maintaining a Web site, which makes it available and describes the activities that are being carried out as part of the Center activities.

2.2 SHAKEDOWN DETAILS

Typically, it is desirable to have a complete written plan for each aspect of a shakedown test. A draft of such details has been prepared, but things are variable and the equipment itself is still under development, as is the instrumentation and site construction. In this regard, all the plans that have been developed for the shakedown test are very fluid and subject to change over the next 12 months. This is yet another reason why the Pilot Study itself will function as a more complete shakedown test. As previously indicated, the original plan of TxAPT was to use the entire four sections of Project 0-4574 for the detailed shakedown test and definition of procedures. Under current plans, we will do as complete a job as possible within the one shakedown pavement, which will be documented and monitored for subsequent projects to validate and improve those procedures.

2.3 INSTRUMENTATION AND DATA COLLECTION PROCEDURES

Under the leadership of Dr. Dar-Hao Chen, TxDOT is in the process of updating and modifying its proposed data collection procedures for the shakedown test. The best that can be provided in this report is a draft of procedures (Appendix B) that have previously been used. As previously indicated, these are fluid and we have every intention of seeing that they are finalized as part of the shakedown test. There has been considerable discussion of the proposed instrumentation, and Appendix C provides numerous meeting minutes that summarize the discussions that have been carried out during this period. Later in this report, we will outline the various types of instruments and their importance in the shakedown activities.

2.4 CRITICAL DATA

Support data – such as characteristics of the materials, evaluation of stiffness, load response under seismic and falling weight deflectometers – is critical. This includes crack, profile, and rutting history, as well as changes in pavement deflection response over time and load applications. These elements are critical to the APT process.

CHAPTER 3 RENOVATION OF TxMLS

3.1 BACKGROUND

In July 2002, the Texas Accelerated Pavement Test Center (TxAPT) established a temporary site for moving the Texas Mobile Load Simulator (TxMLS) from Livingston, Texas, to the J.J. Pickle Research Campus. The temporary pad was paved on July 24, 2002. At that time, there were a number of issues that required clarification with the renovation contractor, RGB, Inc. In general, four design elements required further attention.

1. Complete hydraulic piping design, purchase, and install hydraulic piping and fittings.
2. Design and install new "collector arm" mast assembly.
3. Install new wiring from collector to electrical junction box.
4. Develop specification and purchase digital radios for transmitting strain gage signals.
5. Replace broken strain gages, install strain gage wires/connectors.
6. Deliver completed drawings and schematics.

Since that time, considerable progress has been made in the renovation of the TxMLS. The Texas Department of Transportation's (TxDOT) legal staff met with RGB and negotiated a partial payment schedule for them to complete their work one step at a time. The power rails were redesigned and reattached, making a much broader circle, which made it easier for the power rails to stay attached. This lower profile will provide considerably less vibration and better contact for the power rails.

3.2 DRIVE SHAFTS

Next, the drive shafts were machined and installed. An attempt was made to start it was made, after pulling through manually. After one revolution, the CV joint on the drive shaft failed. Several iterations were made to improve and increase the size of the CV joint. At one time it made several revolutions, but it always failed. Consultants reviewed the system. Old drive shafts were replaced with heavy-duty truck drive shafts. This required correction of the length of the drive shafts, which are different for each of the motor mounts. In one case, up to 100 revolutions were reached before the joints failed. During one series of test revolutions the cable that applies the load to the wheels broke, and destroyed a portion of the power rail installation. Because it broke under considerable force, it rebounded against the sides of the TxMLS carriage. This broken cable has been replaced and the power rails have been repaired and replaced. Many iterations have been made with the drive shafts. As of September 1, 2003, no final solution to the drive shaft problem had been reached.

3.3 STRAIN GAUGES FOR LOAD MEASUREMENT

All of the strain gauge load cells have been fabricated by the manufacturer and are ready for installation. These are bending strain gauges and are subject to error because of misplacement of the load from one wheel to the other on the dual wheels. Dr. Lee, an expert on weight-in-motion systems, held discussions with the TxMLS staff. He strongly recommended that new strain gauges be fabricated using shear strain gauges that are not subject to error owing to load placement, and are much more stable in evaluating load delivered by the individual wheels on the axles. At this writing, this aspect of the program is still being evaluated and no measurements have yet been made of load calibrations of either type of strain gauge. In the initial run of the TxMLS, it is intended to use the Captelss to calibrate the strain gauges and determine their accuracy in measuring applied loads.

CHAPTER 4 INSTRUMENTATION SHAKEDOWN

4.1 WEATHER STATION

A complete weather station has been set up as part of the Texas Accelerated Pavement Test Center (TxAPT) facility. The weather station has been used previously with the Mobile Load Simulator (MLS) at each of its field locations. However, the equipment had not been used for a period of about 3 years. TxAPT requested that it be set up at The University of Texas, J. J. Pickle Research Campus (PRC) facility well in advance of construction, in order that the weather history for 3 months prior to construction could be recorded. During the week of April 1, 2003, the weather station was set up at the TxAPT construction site, but would not operate. After investigation, it was found that the interior of the system was full of water. No one knows exactly how the water got in, but it had accumulated over time. The recording center and data collection elements were replaced with new parts. The weather station was made fully operational on August 21, 2003, and data collection began on June 27. The contractor began excavation on June 16, 2003.

4.2 MOISTURE CELLS

It was decided early in the process that moisture cells would be installed in the test pavement. A number of choices were available. One possibility was the iButton, which has been used previously in concrete moisture testing by Dr. Frank McCullough on Project 0-1700, "Improving Portland Cement Concrete Pavement"; Project 5-1700, "Using iButtons in CRC Pavements"; and Project 0-1778, "Texas Rigid Pavement Database."

Ron White obtained several humidity iButtons from Mr. Dossey and ran a simple test to determine if these sensors could be used to monitor moisture in the soil. The preliminary tests show that additional research is required to determine if the iButton humidity sensor is suitable.

Dr. Richard Liu of the University of Houston developed the main moisture sensor devices. The development was paid for under an Interagency Contract (IAC) from Texas Department of Transportation (TxDOT) Construction Materials and Pavements Division (CST/M&P). Several meetings were held with Dr. Liu and there was a discussion of the type and length of cables to be installed. An installation plan was developed as shown in Figure 1. This diagram illustrates the depth and location for the moisture cells. Appendix D is the proposed moisture sensor installation procedures developed by John Bilyeu of TxDOT.

4.3 TEMPERATURE MEASUREMENTS

TxAPT also developed some temperature sensors with iButtons using the same source as the moisture sensors. The TxMLS had previously used thermocouples, however, they are quite expensive, particularly given the special thermocouple wire that must be utilized. We will compare the accuracy and durability of the thermocouples and iButtons during the first shakedown test on the new TxAPT site.

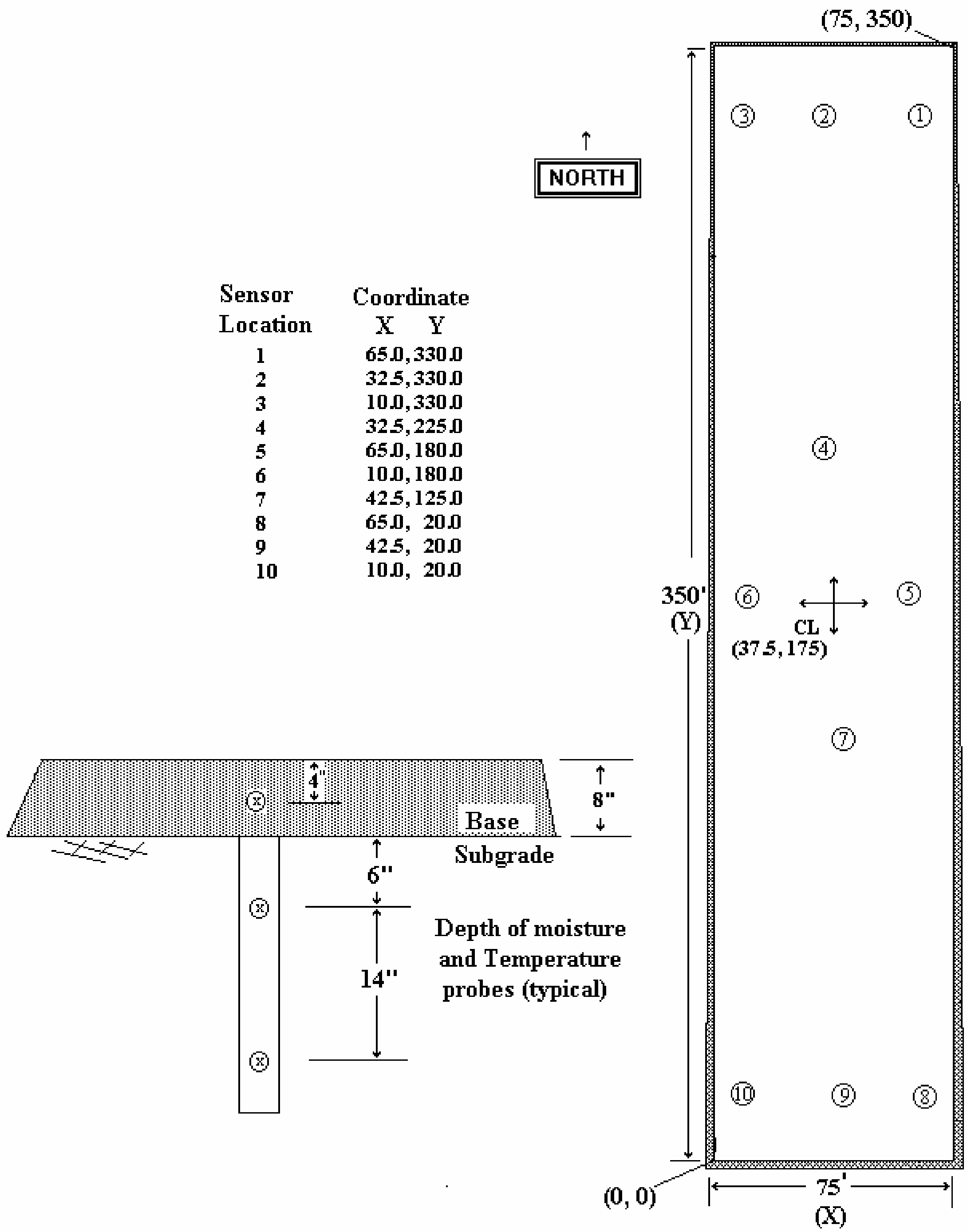

Figure 2.

As constructed layout of moisture and temperature probes.

4.4 CRACK DETECTION

Several methods have been used for crack detection on accelerated pavement testing (APT) and other pavement evaluation. On previous uses of the TxMLS, detailed maps of cracks using Mylar have been used. This is far beyond the need of the method as far as we can determine and no plans to use such Mylar maps have been set up for this project. Dr. Liu, University of Houston, has developed a camera for crack detection and recording. That equipment has been provided to TxDOT, and will be examined as part of the shakedown results. However, early examinations suggest that the camera is not precise enough to detect small cracks. In the shakedown test and the early phase of testing, we plan to use visual observation of cracks and hand recording of cracks by human observers. If the observers are trained and do accurate work often, then good results can be obtained, which are more precise than the general records of cameras.

4.4 PROFILE MEASUREMENTS

TxDOT has a profile-measuring device, which has been used previously with the TxMLS. A new profiling device was commissioned and paid for by TxDOT to be developed by Dr. Richard Liu at the University of Houston. That device was delivered to Austin, Texas, in spring 2003. However, it has many problems that have not yet been resolved. The ends of the profiler were not synchronized and there was error introduced into the results. Mr. Cy Helms and other TxDOT staff have been working to improve this device. It will be debugged and further information recorded during the shakedown tests. TxDOT has advised that the old profiler and other devices will be ready for debugging and testing during the shakedown test.

4.6 MULTI-DEPTH DEFLECTOMETER (MDD)

MDDs have been widely used with APT for many years. They were first developed in South Africa and have been used with the TxMLS from its inception. A complete description of the device and how it operates can be obtained at Dynatest's Web site at http://www.dynatest.com/hardware/CSIR/mdd.htm. The Texas Transportation Institute (TTI), with Mr. John Ragsdale performing the installation and development, has installed the MDDs used in the shakedown test. A complete set of recording equipment is available with the MLS equipment and will be operated by TxDOT.

4.7 CAPTELS LOAD MEASURING EQUIPMENT

The Captels static/dynamic load-monitoring system will be installed in the shakedown section to compare loads delivered by the axles to the measured strains with the load-sensing strain gages. TxAPT will perform an analysis to determine the impact of axle speed and weight on strain gage accuracy and verify the strain gage system is not sensitive to temperature. The day-to-day output from the strain gage system will also be monitored to evaluate the stability and reliability of the system.

Weigh-in-Motion (WIM) sensors manufactured by Kistler Instrumentation will also be installed in the shakedown section. The output of these sensors will be evaluated to determine if they could replace the installation of the Captels sensors in future test sections.

Recently, TxDOT purchased several low profile static wheel load-weighing platforms manufactured by Load-O-Meter. These will be evaluated as a possible tool for resetting the load each time the TxMLS is raised.

4.8 GEOPHONES

TxDOT, in conjunction with Dr. Soheil Nazarian at The University of Texas/El Paso, installed geophones in the embankment and base of the first test pavements. These devices will be evaluated according to future plans being developed by Dr. Nazarian and TxDOT.

4.9 TEST PLAN FOR THE SHAKEDOWN TEST

A draft test plan for the shakedown test was initially prepared by Dr. Dar-Hao Chen and is shown in Table 1. This test plan was discussed with Dr. Chen and others. Testing intervals are shown as follows:

1. Testing to be conducted at any interval:
   a. Record rolling MDD, strain gauge, and dynamic Captels data.
   b. Download the weather data every week, regardless of when the other data is collected. This way, we can fix (frequent) weather station problems right away with a minimum of data loss. If the weather station is down, record manual temperature data hourly (12 points per day).

2. After approximately 3,200 repetitions, the data collection will be as follows:
   a. Do transverse profiles once.
   b. Collect pavement images with camera on laser profiler.
   c. Collect P-SPA and full SPA data on the same positions as before.
   d. Do regular FWD, remembering the two new points, 4.5C and 7.5C.
   e. Conduct FWD-MDD tests.
   f. Record the static weight using the Captelss load cell, MLS strain gauge data, and portable wheel load scale data as the loads are set.
   g. Record the MDD voltage readings.
   h. Check and record the tire pressures.

   Follow the same procedure at 10k, 32k, 100k, and 320k repetitions.

1. After a large number of applications (approximately 320,000 axles), data will be collected as usual, except for the MDD and FWD. A summary of the data collection plan is shown in Figure 2.

For reference and possible consideration in this test, Appendix E presents the test procedure that was used on U.S. 59 test pad R31 in 1999-2000. This is added as an appendix for ready reference and may be used to modify the testing to be carried out in the shakedown test.

Table 1. Test Plan for Shakedown test : PRC001 (DRAFT)

Prior to Testing

1. Install 4 thermocouples inside the MLS as shown in Fig. 1. Set them near the 10.5m line so that the wires can be run through the Captels drain. The thermocouples installed in the wheelpaths (one 820mm left of center and one 820mm right) will be at a depth of 0.75in. Install two thermocouples at the centerline, one at 0.75in and one on the surface. Connect the thermocouples to the weather station. Install using sawcuts to countersink the wires. If all wires are run out the Captels's drain, a larger PVC pipe will probably be needed.
2. Do regular FWD tests with the load plate at the 27 locations shown in Fig. 1. The FWD trailer should be turned around when collecting at the 9m and 10.5m gridlines so that the geophones remain on the test pad.
3. Do transverse profiling using the mechanical and laser profiler. Run the transverse profiles twice for the initial collection.
4. Collect pavement images with camera on laser profiler.
5. Spray-paint a spot 8 ¾" from the MDD centers and let that be the center of the FWD plate for FWD-MDD testing. We can circle the load plate with paint so the FWD can easily be put in the same FWD-MDD position, and forget recording the FWD-MDD distances. An alternative method is to mark the pad where the FWD trailer tires or nose wheel end up. Do the three (4-load) FWD drop series at that location and another 4-drop series at about 18" on center. Measure the anchor movement using the 7th sensor for all series, this time only.
6. Conduct P-SPA, and Full-SPA tests from 3 to 9m that includes left, center and right wheel paths.
7. Conduct 3 DCP tests at the locations shown in Fig. 1. These may be moved later due to MLS clearance issues.
8. Record the static Captels data, strain gauge, and scale data as the loads are set.
9. Record the MDD voltage readings.
10. Do GPR test to obtain layer thickness profile.

Data Collection		Loading		Environment			CAPTEL		Profile			Cracking		MDD	FWD		Seismic	
Repetitions (2)	Date	Axle Load	Tire Pressure	Surf. Temp.	Air Temp.	Moisture	Static	Dynamic	Laser Profiler	Mech. Profiler (4)	Straight Edge (4)	Camera	Manual (4)	MDD	Peaks	MDDs	P-SPA	SPA (b)
0		34	100	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
3,200		34	100	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	
10,000		34	100	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	
32,000		34	100	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	
100,000		34	100	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	
320,000		34	100	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
640,000		34	100	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	
1,000,000		34	100	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

Figure 3. Summary of the Data Collection Plan

CHAPTER 5 SUMMARY

5.1 SUMMARY

In summary, the shakedown test will be anything that is needed to evaluate all of the possible instrumentation and methodologies under review for use with the Mobile Load Simulator (MLS) at the Texas Accelerated Pavement Test Center (TxAPT). We have tried to set up a regular plan, but this may be modified as necessary during these very early shakedown procedures. A more well-defined, precise plan will be used in the first test in Project 0-4574, which was originally scheduled to be carried out by the TxAPT Center, but has now been transferred to the leadership of Research Supervisor Dr. Jorge Prozzi.

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APPENDIX A

MEMORANDUM OF AGREEMENT
(Revised October 2, 2003)

OPERATIONS AND CONTROL OF TxAPT/MLS TESTING ACTIVITIES

MEMORANDUM OF AGREEMENT
(Revised October 2, 2003)

OPERATIONS AND CONTROL OF TxAPT/MLS TESTING ACTIVITIES

NOTE:

This memorandum was drafted June 2, 2003, and circulated to the attendees listed below, plus Mr. Paul Krugler, RTI; and Dr. Randy Machemehl, Director, CTR. This revised agreement reflects all comments from the group.

INTRODUCTION

There have been many discussions over the past year about operations and control of testing activities and operations of the MLS equipment during an actual test. There has been a general consensus based on information from the California Accelerated Pavement Center that it was highly desirable to have an agreed upon Test Plan involving all parties for each individual test. Once a Test Plan is agreed to, a Test Master would be appointed to carry out that test in accordance with the Test Plan. Any deviations from that agreed upon plan would be discussed immediately with other members of the coordinating committee for that test, but that only the Test Master, or his designated representative, would have the authority to alter a test plan.

The reason for this approach is to ensure maximum operating efficiency for the MLS equipment, to provide maximum benefit and return on investment for TxDOT and the State of Texas. There have been misunderstandings and concern about this approach and who would carry out which functions. A meeting was held at the CTR conference room on May 28, to discuss these matters and to define an agreed approach. Attending this meeting were Mr. Jeff Seiders, Dr. Dar-Hao Chen, Mr. Gary Graham and Dr. Mike Murphy, all of TxDOT Pavements and Materials Group; Dr. German Claros, TxDOT, RTI, and Mr. Ron White and Dr. W. Ronald Hudson, TxAPT, CTR.

In this meeting, Dr. Hudson laid out the concepts of a Test Plan and Test Master and the need to have an agreement and a plan for moving forward. Dr. Murphy pointed out that it was TxDOT's plan to use Dr. Chen as Chief of Operations for the MLS and also as Test Master. Thereafter followed significant discussion about various aspects of the approach and the resulting role of the TxAPT Center in future operations. The purpose of this document is to define the roles of persons involved, commit those to writing and have them edited by all concerned persons so that a final memorandum of agreement can be prepared and signed by all parties; or provided to all under the signature of the appropriate person in TxDOT for our guidance. The approach stated by Dr. Murphy for the Pavement and Materials team is that Dr. Chen will control all operations in each individual test and will serve as Test Master, in close cooperation with the individual Research Supervisor. Drs. Claros and Hudson raised some concerns about this decision. The consensus however, was that Dr. Chen will be responsible for preparing all future Test Plans for the operation of the MLS in collaboration with each Research Supervisor for the individual tests and serve as Test Master.

The first test to be conducted will be the shakedown test, since that activity has been reduced to a single test section and since there are many unanswered questions, only a general Test Plan will be devised among the interested parties. Dr. Chen is urged to prepare such a plan in conjunction with Dr. Claros, Dr. Hudson and Mr. White. This initial plan will not be as rigorous as subsequent funded research but will guide the shakedown test.

The first complete Test Plan will involve Project 0-4574, "Determine the Impact of HB 2060 Permits on Texas Load Zone Roads" and will be developed by Dr. Chen in conjunction with Dr. Jorge Prozzi and his staff. Dr. Hudson and Mr. White will participate in discussing and editing the Plan and in the committee. Dr. Claros will participate as representative of RTI, RMC-1, the funding agency. Other persons selected by TxDOT will sit on the committee, but the specific committee in each case will be clearly defined in writing, the Chairman to be selected by Dr. Murphy and Dr. Claros or a designated RTI representative.

The second plan will be for Project 0-4358 "Materials, Specifications, and Construction Techniques for High Performance Flexible Base" to evaluate special base materials and new base specifications. Dr. Chen, in conjunction with the RS will prepare this Test Plan for review of the committee.

It is recommended Dr. Chen prepare a draft test plan for the shakedown test by approximately August 1, 2003, for discussion with the selected committee, which would be appointed at that time.

ROLE OF TxAPT CENTER

During the discussion and following the decision that the Test Master would be Dr. Chen, Dr. Claros raised the question of the purpose and role of TxAPT. This was discussed at some length with Dr. Murphy expressing ideas he has developed over the last three years. In the final analysis, it was outlined that the primary role of TxAPT will be to:

1. Provide the necessary test facility, which it is doing under current construction contracts,
2. Be the repository for APT data,
3. Provide methods for cleansing, processing, storing and dispersing that data as needed,
4. Provide miscellaneous support to the testing operations, as requested,
5. Advise on all aspects of the testing as a member of various committees,
6. Maintain close coordination and cognizance with other accelerated pavement test centers and testing results available from other sources to avoid duplication,
7. Provide overall planning, input and guidance to accelerated pavement test programs for TxDOT,
8. Assist in the formulation of an APT research program,
9. And assist in the operations and data collection phases as desired by TxDOT.
10. Provide Test Manager or Assistant Test Manager.
11. TxAPT will maintain an ongoing accumulation of data collected on all research projects.
12. It is anticipated that TxAPT staff will provide an ongoing theoretical basis for analyzing the data and accumulating data results to provide broader benefits of MLS testing beyond that on any individual research project.

13. TxAPT staff will have ongoing knowledge of accelerated pavement testing procedures and of details that affect predicted results. They will share these results with each individual project and Research Supervisor, however the OAG, including Dr. Murphy, Dr. Chen and Mr. Jeff Seiders agreed that TxAPT should provide peer review for all reports associated with accelerated pavement testing projects. This will not replace the normal review process of reports through RTI, but will provide RTI and the Research Supervisor with input regarding the interpretation of accelerated pavement test data in the broader scheme of pavement evaluation.
14. Assist with dissemination of results from accelerated pavement test center to help define the benefits of accelerated pavement testing, both statewide and nationally.
15. Continue to assess both the benefit and cost of accelerated pavement testing for TxDOT. With this information, assess the benefit cost/ratio for maintaining an accelerated pavement test facility in Texas.

At the Operating Advisory Group on September 23, 2003, it was agreed by all present, including Mr. Jeff Seiders, Dr. Chen, Dr. Claros, and Dr. Murphy that Mr. Ron White, or other TxDOT representative will serve as the "Test Master" or "Deputy Test Master" as applicable. This is indicated on the attached organizational diagram. As it now stands, in some cases, Mr. Ron White will serve as "Test Manager" with Dr. Chen serving as "Assistant Test Manager". In other situations, Dr. Chen will serve as "Test Manager" and Ron White will serve as "Assistant Test Manager".

Mr. Ron White and TxAPT staff will participate in the data collection; make appropriate suggestions for further cleansing, processing and storage on a daily basis.

<u>DATA HANDLING</u>

It was agreed that TxAPT would receive a copy of raw data in electronic form, the morning following the day it is collected. Dr. Chen has stated that in his operation, TxDOT will only keep and store the data that is corrected and cleansed by Cy Helms or his representative, because it has worked the best in the past. TxAPT requests that a copy of Cy Helms pre-processed data also be provided to TxAPT within three days of its collection. TxAPT would like to receive this second set of data in exactly the format and contents that will be stored by TxDOT. We will retain the raw data provided, but will also store the data provided by TxDOT in the pre-processed version.

TxAPT needs each data set to be furnished with a written commentary as to what has been done to the data, what adjustments has been made and what problems were discerned and adjusted.

In an email memo dated May 28, Dr. Chen clarified his understanding and stated "Ron White or other CTR employees will be at the jobsite during the data collection to observe, monitor or assist data collection without directing the MLS operations/data collections." It will be important to edit this section of this memorandum of agreement and try to better define the role that Dr. Claros outlined for Mr. White or other TxAPT employees in terms of serving as Deputy Test Master and involvement in data collection. I gather from Dr. Chen's memo that he does not agree with the proposal to use Mr. White or TxAPT staff as Deputy Test Master or any others in the testing. This is fine with TxAPT, as we have no proprietary interest, but we need a clear understanding of our responsibilities.

DATA FLOW TO RESEARCH SUPERVISOR

One thing that was not clarified in the meeting is data flow to the Research Supervisors. It was implied that the data will be dispensed only by TxAPT Center so that the data being distributed will be uniform for all potential users. However, Dr. Chen has already proposed that a different set of data will be stored by TxDOT and this needs to be clarified since it already creates divergence of the data which could be considered to be definitive for any given test. We have suggested that TxDOT provide TxAPT with a copy of the data they actually intend to store. In this approach, the only repository of the actual original data will be at TxAPT and two copies of the pre-processed (Helms) data will be available, one at TxAPT and one at TxDOT. If TxAPT is to provide the data to the supervisor, then both sets we maintain could be provided, or it could be clearly defined which dataset is being provided to the Research Supervisor.

THE ROLE OF INDIVIDUAL PROJECT RESEARCH SUPERVISORS

Individual Research Supervisors will be heavily involved in the preparation of test plans for their individual tests. A Master Test Plan will be devised with sub test plans for each individual pad or test site to be run within their experiment. The Research Supervisor will work with Dr. Chen in preparing the draft plan and either the RS or Dr. Chen, or a chairman, will convene a committee meeting to review the Test Plan and agree on its operation. This committee will involve the RS, the Test Master, representatives of TxAPT, and other interested parties, such as the PD, PC, and etc. selected and appointed by TxDOT. RTI will also be represented. Dr. Murphy and Dr. Claros, or a designated RTI representative, will jointly select each committee chairman.

OVERALL DATA REVIEW AND ANALYSIS

It was the strong recommendation of the Operating Advisory Group on September 23, 2003, which included participation of Mssrs. Seiders, Murphy, Claros and Chen, that there should be an ongoing, broader data evaluation perspective of TxAPT. This will help insure that the broadest possible knowledge of data analysis of ongoing accelerated pavement test data be brought to bear on the accumulated findings of accelerated pavement testing. Beyond that, this can be done on an individual project. It also will help insure input from other accelerated pavement test centers can be utilized to provide the best overall results from the MLS data.

REPORT PEER REVIEW

After reviewing this document, the OAG committee strongly recommended that the TxAPT also serve as a peer review group for reports involving the TxAPT Center. This would not replace the peer review to be carried out under normal RTI procedures, but would provide an additional component within 30 days of the draft of a submitted report, to the Research Supervisor and his staff to ensure that any aspects of the report take full advantage of the accelerated pavement test knowledge gained from previous tests and from the broader interaction of TxAPT Center.

SUMMARY

It should be clearly understood that the Research Supervisor does not have the authority to stop the test or change the Test Plan in any way. This can be done by the Test Master and should, if at all possible, be cleared by the individual test coordinating committee in advance. No changes should be approved that will shorten the life of the MLS equipment, interfere with subsequent testing schedules, or provide any kind of danger or damage not thoroughly evaluated in advance.

There are many kinds of tests, for example thick concrete pavements, which could be set up that would consume a considerable portion of the viable life of the renovated MLS. This is an extreme example, but is an example of why the Research Supervisor cannot control the activities. It is highly desirable that TxAPT and/or TxDOT continue to consider the portion of the time of the MLS lifecycle that will be consumed with any given test.

ONGOING PLANNING ON THE BENEFIT OF ACCELERATED TESTING TO TxDOT

In the concept for creating TxAPT, there was originally a strong desire to have TxAPT provide cohesion and leadership in the planning for long term benefits of accelerated testing in Texas and to maintain continuity with other test centers. It is still important that these activities be carried out and that the activities continue to be focused on high payoff items of benefit to the Engineer Director of TxDOT and to the State of Texas. If these goals are not kept in mind and adhered to, there is a possibility that the successful accelerated testing in TxDOT will be in jeopardy.

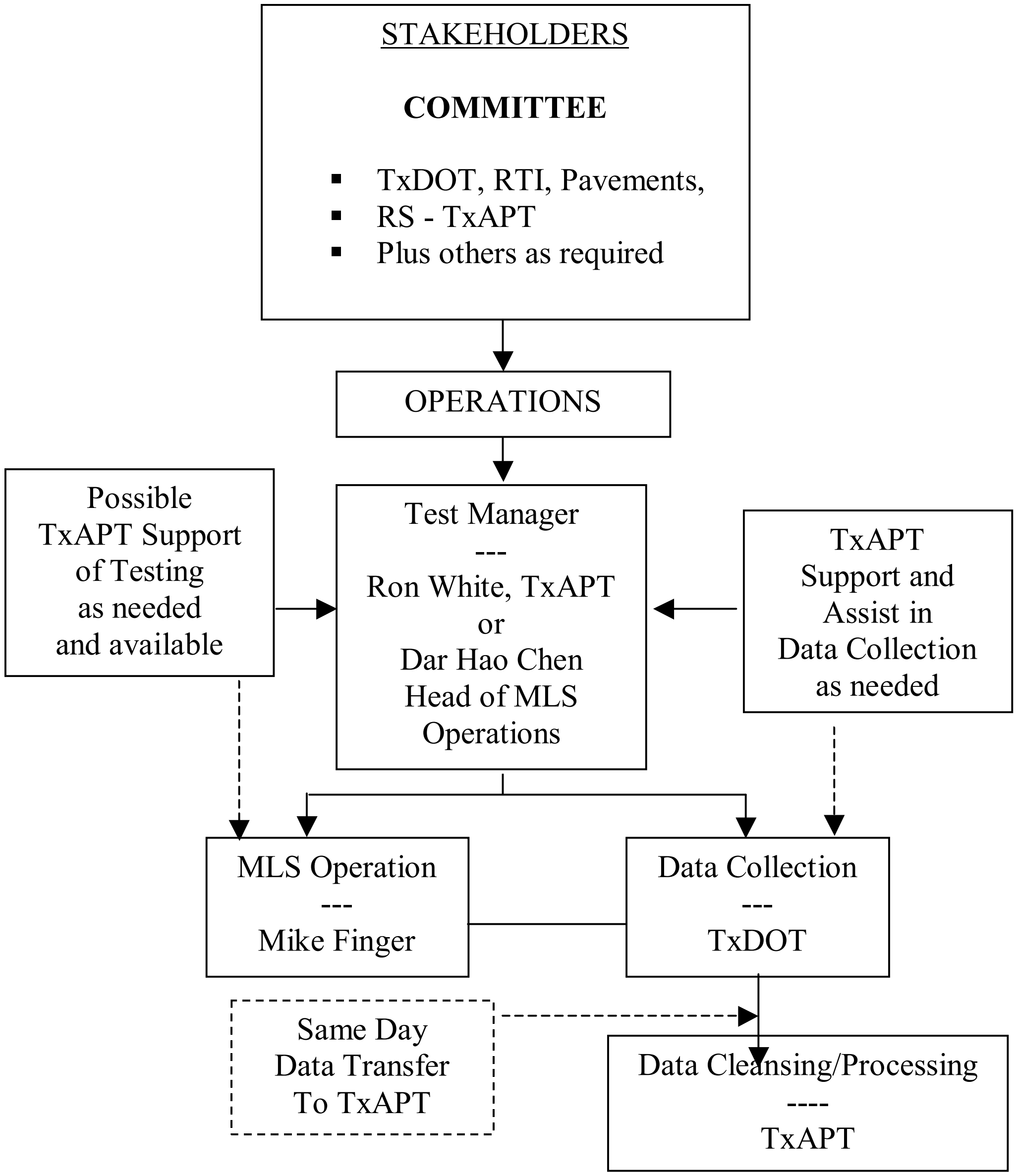
In order to continue a long term planning phase and continuity for the future it is recommended that the Operating Advisory Group (OAG) be maintained and continue to meet at least once a year to provide focus and leadership for the activities.

After review and edit, an agreement should be reached and signed for future operations.

ORGANIZATION DIAGRAM

The following diagram defines relationships:

ORGANIZATIONAL CHART – FIELD OPERATIONS AT TxAPT CENTER



APPENDIX B

TxDOT INSTRUMENTATION AND DATA COLLECTION PROCEDURES
(PRINTED AS RECEIVED FROM TXDOT)

CAPTEL'S

Captel's

Static Weights

1. Go to *START, SHUTDOWN, RESTART THE COMPUTER IN MS-DOS MODE,* select *YES*
2. @ C:\WINDOWS, type **cd**, press **enter**
3. Type **weight2**, press **enter**
4. At the information screen, hit **enter**
5. Go to **weighing mode**, select **static weighing**
6. Enter **2** for the number of axles, click on **OK** *or hit* **enter** *2 times*
7. With #1 ready to go onto the scales, the person jogging the machine will ask you to zero. Press **Z**, look at the weights and when both read 0lbs. tell them "zero". *(At the top of the screen you will see a drawing of a vehicle with the front wheel flashing. This lets you know which axle you are weighing, front or rear, for this ticket)*
8. When you are told to weigh it, first look at the weight, if it is heavy or light, the weights must be adjusted. Tell them to power down.
9. When asked, read the weights to them and let them know when they are at the correct weight. At this time, press **enter**. Look in the lower left corner of the screen and you will see it reading the left and right.
10. After this has been done, tell them to lock the nuts down.
11. After the front axle has been moved off the scale, you will zero again by pressing **Z**, let them know you are zeroed, they will jog the rear on and adjust the loads if needed.
12. After the weights are corrected, press **enter**
13. When this weight is recorded, you will return to the main screen with a information screen, press **enter**
14. A control ticket screen will come up, press **enter**
15. When asked if you want to save and print the ticket, press **enter**
16. At the information screen with the file number, press **enter**. You may want to write this number down in case a mistake is made on one of the bogies and the weight will have to be reset.
17. Repeat this process until all bogies have been weighed, go to **weigh mode**
18. Go to **exit**
19. At the DOS prompt, type **exit**, press **enter**, Windows will then restart.

Dynamic Weights

1. Go to *START, SHUTDOWN, RESTART THE COMPUTER IN MS-DOS MODE,* select *YES*
2. @ C:\WINDOWS, type cd\, press **enter**
3. Type **weight2**, press **enter**
4. At the information screen, hit **enter**
5. Go to **weighing mode**, select **automatic mode**
6. Someone outside will give you a 3,2,1 count down. At a hair after 1, press **T**
7. If you do not see a sequence error, you have a good trigger. If you do see one, ask for another trigger until you get a good sequence.
8. Let it run for 1 minute or so then press **esc**
9. Go to **exit**
10. At the DOS prompt, type **exit**, press **enter**, Windows will then restart

- *You may get a red screen with an error. If this happens, hit a key and you will return to the main screen.*

FWD/MDD PROCEDURES

PROCEDURE FOR FWD/MDD DATA COLLECTION

NOTE: *POWER MUST BE ON AND THE SWITCH SET AT 1/2 (half) POWER. USE ALL CAPITAL LETTERS FOR INPUT.*

Input Site No.: [2] **[enter]**

Number of channels: 3
Calibration Factor:
50
50
50

Is this a truck test? (Y/N) [N] **[enter]**

Enter trigger channel number (1 - 10): [1] **[enter]**

Enter the ABSOLUTE voltage difference
(Suggested range: FROM 0.05 volt TO 0.30 volt)
(RECOMMENDED VALUE: 0.15 volt)
? [.2] **[enter]**

Enter 'N' for Negative and 'P' for Positive pulse: [N] **[enter]**

TRIGGER LEVEL IN BINARY = 32

Enter 'S' to start data acquisition: [S] **[enter]**

NOTE: *After collecting data hit enter three times to get past the graphing of the data collected.*

The data file is at c:\QPRO\MDD\A.PRN
Enter 'Q' to plot deflection data in QUATTRO PRO: [ENTER]

Enter FWD load: [***Get information from FWD and enter it here. IE. 5780***]

The data filename is F05780.PRN

Enter 'Y' to change the data file name: [Y] **[enter]**

TYPE IN REQUIRED FILE NAME AND [ENTER].

```
********************************************
*  CHOOSE YOUR OPTIONS   1, 2, 3, OR 4     *
*  1. To run a new truck.                  *
*  2.  To rerun.                           *
*  3.  To plot in Quattro Pro.             *
*  4.  To exit the program.                *
*  Your choice is ....                     *
```

[2] **[enter]**
(Choose 2 to rerun until you have finished the data collection)

MDD's

During The Run

1. Turn both of the boxes on above the data collection computer in the RV
2. Ensure that the switches on the boxes are set to 1/2 - computer
3. At the main screen on the computer you will see an icon titled SMDD, double click on the icon
4. The program will then load up, press s
5. Wait for a 3,2,1 count down then press enter, and data collection will begin
6. Hit enter when prompted to continue
7. Continue hitting enter through the plots
8. Plots will stop and you will the be asked to name the file (i.e., 20k, 40k,...)
9. DO NOT TURN OFF THE BOXES. When the machine has been stopped, you will need to ensure that there are no bogies in the proximity of the MDD's.
10. You will then put the switches to full - static
11. Turn the number dial to 1
12. Use the Fluke and place the leads in the lugs above the number dial
13. Make sure the Fluke is set to measure DC voltage and read the 4 channel voltages, and logging them in the MDD book.

FWD/MDD

1. Switches must be set to 1/2-computer
2. Input Site No: **1, enter**
3. Is this a truck test? **N, enter**
4. Is Automatic Trigger Required? **Y, enter**
5. Enter Trigger Channel Number (1-10) **1** for left wheel path, **4** for right wheel path, **enter**
6. Enter the Absolute Voltage Differences: **.1, enter**
7. Enter "N" for Negative and "P" for Positive **N, enter**
8. Trigger level in Binary = **281, enter**
9. Enter "S" to start data collection: **s**
10. Press **enter** after 3,2,1 count down
11. Hit **enter** 3 times to get past the plots
12. The data file is at c:\QPRO\MDD\A.PRN
13. Enter "Q" to plot deflection data in QUATTRO PRO: **enter**
14. Enter FWD load: **enter**
15. Enter "Y" to change the data file name: **Y, enter**
16. Type in the **file** name, **enter** *Here are examples of file names*

L_1_1.prn	R_1_1.prn
L_1_2.prn	R_1_2.prn
L_1_3.prn	R_1_3.prn
L_1_4.prn	R_1_4.prn

These are examples for the fist series of drops. The L & R is for which wheel path, the next number is for the series, the next number is for the drop number in that series. ***You will perform 3 sets of 4 drops***

17. You will then be shown 4 options. If you are still continuing on one of the wheel paths, press **2** and **enter**. If you are finished with the wheel path, type **1** and **enter** and go through the set up again and at step 5, enter the new wheel path.
18. When you are finished with data collection, press number **4** at menu screen and **enter**. At the DOS prompt, type **exit** and hit **enter**.

PROCEDURE FOR MDD DATA COLLECTION

NOTE: *POWER MUST BE ON AND THE SWITCH SET AT FULL POWER. USE ALL CAPITAL LETTERS FOR INPUT.*

Input Site No.: [2] **[enter]**

Number of channels: 3

Calibration Factor:
50
50
50

Is this a truck test? (Y/N) **[Y] [enter]**

Enter the speed of truck (MPH): **[12] [enter]**
Note: Speed changed from 20 MPH to 12 MPH per TTI

Enter the length of vehicle in feet: [120] **[enter]**

Is automatic trigger required? (Y/N): [N] **[enter]**

Enter 'N' for Negative and 'P' for Positive pulse: [N] **[enter]**

Enter 'S' to start data acquisition: [S] **[enter]**

NOTE: *After collecting data hit enter three times to get past the graphing of the data collected.*

The data file is at c:\QPRO\MDD\A.PRN
Enter 'Q' to plot deflection data in QUATTRO PRO: [ENTER]

The data filename is T05780.PRN

Enter 'Y' to change the data file name: [Y] **[enter]**

TYPE IN REQUIRED FILE NAME AND [ENTER].

Notice:

Power reading's for both FULL *and* Half *Power switch settings are as follows*:

1. Power input should be (+ [plus] or - [minus]) 15 *volts*

2. All Three sensors should show a voltage reading of between (+ [plus] or - [minus]) 5 *volts*

SNC

DATA COLLECTION PROCEDURE

STANDARD FWD

- Hook up cable from data collection cart to FWD
- Power up computer
- Type FWD, hit enter
- Power on processor at bottom of data collection cart (large green button - system on)
- Hit enter
- Enter name of operator (to clear the line, press F1), hit enter
- Hard copy? enter
- Car in park? enter
- At the option screen, look above #1, this is the test currently loaded. If anything besides MLS is there, type in 18, press enter.
- You will see a lot of names, we only use MLS, MLS_MDD or WHOLEHIST. But for this test you will need to select MLS. Type in 4, press enter.
- At option screen hit enter
- Cancel time of day? enter
- Existing File? enter - unless you are continuing a test, or have had to back out of the system for some reason. Then you would enter in the file name and continue where you left off.
- Roadway? enter
- Subsection? enter
- Station? enter
- Lane? enter
- Temp? enter
- Condition? enter
- Filename? Type in XXX.fwd (axlecount.fwd). Press F1 to clear line or characters after filename, hit enter.

  You are now ready to begin drops at the specified locations (see attached). At this point, you can also see where your file is being saved - c:\temp\XXX.fwd.

- When you are set up over first drop, press F1
- You will hear a beep, look in the upper left corner, and you will see that it is asking for a station - see attached, press F1 to clear line, type in station and press enter.

* You will make drops at the 12M, 10.5M and 9M in the opposite direction of traffic

- After drop is completed, you will hear a beep, do not the FWD until you hear this beep. Move to the next location and press F1 when in position. Repeat this process until all drops have been completed.

  To exit the program completely, meaning you are not going to anymore FWD data collection

- Hold SHIFT and press F8, then select to exit system (9) and press enter
- Backup FWD? enter

  To continue testing, see Whole History or FWD_MDD

WHOLE HISTORY

- Hold SHIFT and press F8
- Press enter
- Enter name of operator (to clear the line, press F1), hit enter
- Hard copy? enter
- Car in park? enter
- At the option screen, look above #1, this is the test currently loaded. If anything besides WHOLEHIST is there, type in 18, press enter.
- You will see a lot of names, we only use MLS, MLS_MDD or WHOLEHIST. But for this test you will need to select WHOLEHIST, type in 5, press enter.
- At option screen hit enter
- Cancel time of day? enter
- Existing File? enter - unless you are continuing a test, or have had to back out of the system for some reason. Then you would enter in the file name and continue where you left off.
- Roadway? enter
- Subsection? enter
- Station? enter
- Lane? enter
- Temp? enter
- Condition? enter
- Filename? Type in XXX.fwd (axlecount.fwd). Press F1 to clear line or characters after filename, hit enter.

  You are now ready to begin drops at the specified locations (see attached). At this point, you can also see where your file is being saved - c:\temp\XXX.fwd.

- When you are set up over first drop at the 6M line, press F1

You will hear a beep, look in the upper left corner, and you will see that it is asking for a station - see attached, press F1 to clear line, type in station and press enter.

- Once the left, right and center wheel paths have been done,

FWD/MDD

- Set up at MDD. You need to split the MDD with the pad and 1st geophone
- Open the panel on the FWD
- Turn key to manual on
- Press RP
- Press LC
- Press LP/RW till plate and geophone are low but not touching the ground. Adjust the FWD putting the MDD as close to being in the middle as possible. Press LP/RW and put the pad on the ground. Measure from the FWD pad to the center of the MDD cover. Write this down and turn in with data. Set the brake on the trailer, or chalk the wheels.
- Press RP until the plate is up and catches engage
- Turn key back to the off position and close the door
- At the option screen, look above #1, this is the test currently loaded. If anything besides MLS_MDD is there, type in 18, press enter.
- You will see a lot of names, we only use MLS, MLS_MDD or WHOLEHIST. But for this test you will need to select MLS_MDD. type in 6, press enter.
- At option screen hit enter
- Cancel time of day? enter
- Existing File? enter - unless you are continuing a test, or have had to back out of the system for some reason. Then you would enter in the file name and continue where you left off.
- Roadway? enter
- Subsection? enter
- Station? enter
- Lane? enter
- Temp? enter
- Condition? enter
- Filename? LMDD.FWD or RMDD.FWD, hit enter
- Press F1
- Station will be which set you are doing. You will perform 3 sets of 4 drops, so stations will be 1,2 or 3, hit enter. Press F1 to clear line. Let the MDD operator know when you have completed your seating drops.

* SEE FWD_MDD FOR COMPUTER IN RV

- When RV is ready, give a 3,2,1,drop count and hit enter
- Continue this till all 4 drops have been completed
- It will ask you to enter the temp. Look on the screen and locate the surface temp and enter it in, hit enter.
- To begin next series, press F1
- Enter station (2,3), hit enter. Press F1 to clear line.
- Repeat above till the series of 3 runs have been completed
- Hold SHIFT and press F8, then select to exit system (9) and press enter
- Backup FWD? enter

To continue testing, see Whole History

FWD_MDD FOR COMPUTER IN RV

- Turn on MDD boxes and place switch at 1/2 mode
- Go to start, restart in MSDOS mode
- At c:\windows, type cd\, hit enter
- Type cd qb45, hit enter
- Type mdd96tti.exe, hit enter
- Site # 1
- Truck Test n
- Auto Trigger y
- Channel 1 for left wheel path
- 4 for right wheel path
- Voltage .1
- Pulse n wait at this point until the FWD operator has done his seating drops and is waiting for you. If you proceed and have to wait, the system will kick you out when you attempt data collection
- Type s (DO NOT HIT ENTER)
- When FWD operator says 1 in his 3,2,1,drop countdown, hit enter
- Hit enter to continue when prompted at bottom of screen
- Hit enter through graphs, ensure that they look OK. If you notice a lot of static in the wave form, pass this on to Mike. You will only see a wave form on half of the screens you enter through, because you are only looking at on MDD.
- Q to plot? enter
- FWD load? enter

- Change filename? Y, enter
  Filenames are as follows

Left MDD	Right MDD
L_1_1.prn	R_1_1.prn
L_1_2.prn	R_1_2.prn
L_1_3.prn	R_1_3.prn
L_1_4.prn	R_1_4.prn

wheelpath_series_drop#.prn

- Hit enter after typing in filename
- At the menu, type 2, press enter
- Type in S
- Let FWD operator know you are ready, and he will begin the countdown again, hit enter at 1 in his 3,2,1,drop countdown. Repeat this till the series is down for that wheelpath.
- When the series is completed, type 1 to run a new truck. The only thing different to be entered is the trigger channel.
- When finished with FWD drops, choice exit system from the menu, hit enter
- Type exit c:\, hit enter
- Using the Fluke meter, you need to measure the voltage on both boxes and all 3 channels and log it in the book.

DOWNLOADING THE MDD DATA

- Go to Explorer
- Go to QPRO
- Go to MDD
- Locate your files, highlight them and drag to the appropriate directory. This is where you will also find the data from the end of the run.

DOWNLOADING THE FWD DATA

- Go to c:\
- Type cd temp, hit enter
- Type dir/p, hit enter
- Locate and remember the name of your files

- Insert a blank disk into the A drive
- Type copy XXX.FWD to a: , hit enter

DOWNLOADING PROFILE DATA

- At c:\, type cd logger, hit enter
- Locate your files (*.trn, *.lng)
- Insert a blank disk into the A drive
- Type copy *.TRN or *.LNG to a: , hit enter. *This can only be done if you have remembered to delete all of the TRN and LNG files prior to data collection. This is done by going to c:\logger and typing del *.lng, hit enter and y when asked. Then do the same with *.trn.* If deletion of files was not done, it will be easier to go into File Manager in Windows and dragging your files over to the A: drive.

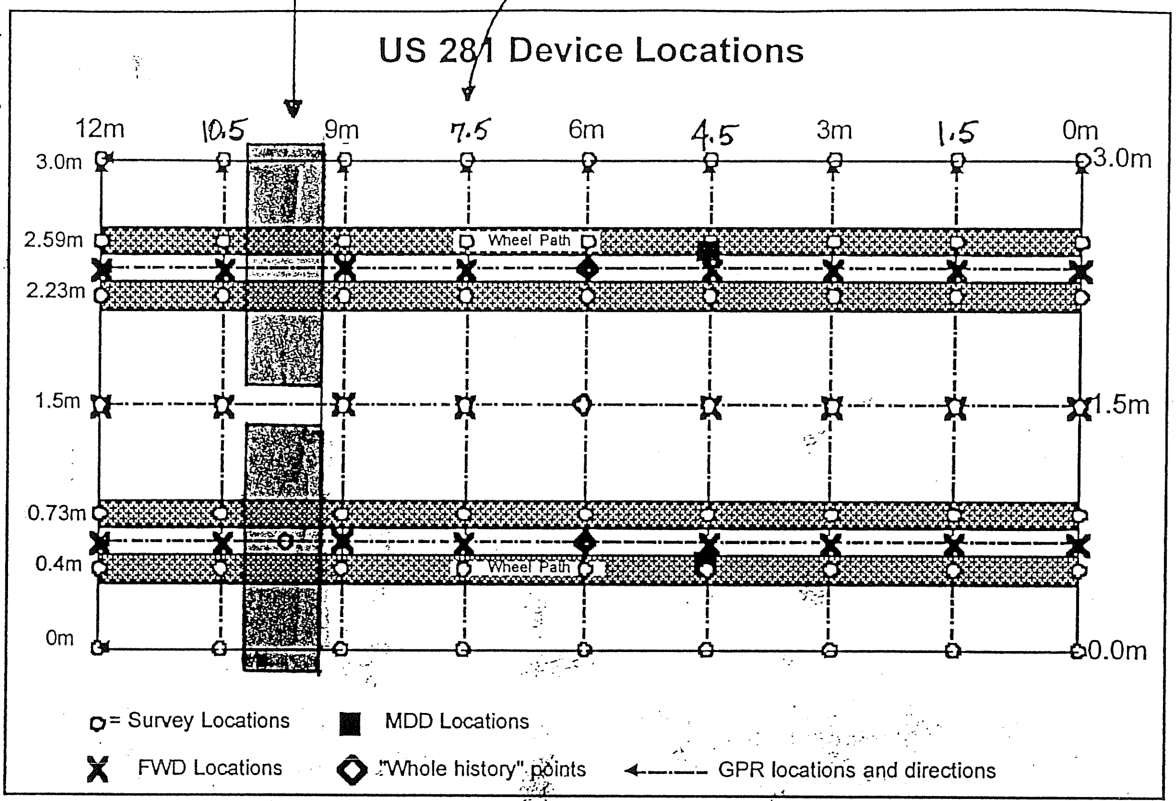
CAPTEL'S

GO PAST MDD (DO NOT SPLIT OR BE DIRECTLY ON)
LAST TO DO, THEN TURN FWD AROUND

R WHOLE HISTORY & FWD REG

C/ CENTER

B/ LFT



STANDARD FWD DATA COLLECTION PROCEDURE

1. Hook up gray cable from data collection cart to FWD.

2. Remove PIN from front of FWD.

3. On top of the cart set switch on black box to "B" (FWD).

4. Turn on the 9000 processor located on the middle shelf of data collection cart. The large green button is the on switch.

5. Power up computer

6. During boot up the computer will pause at "Press R to retry or ESC to continue". At this time press the ESC key to continue.

7. Enter the current Date Press the enter key.

8. Enter the current Time Press the enter key.

9. Now at the C:\> prompt type in FWD (This is the FWD V 20 Program) and press the enter key

10. At the "Make your choice" screen you should see the number 1 flashing. If this is correct then press the enter key.

11. Enter name of operator. Your name. (NOTE: to clear part or all of the line, simply press the F1 key.) Press the enter key.

12. Hard copy? Press the enter key. (NOTE: only gives you the choice of either Enter (Return)/Y=Yes. The Enter (Return) key always means NO.)

13. Car in park? Press the enter key.

14. The option screen now appears, look directly above #1, this is the test that is currently loaded. If there is anything besides FWDREG then type in 18 and press the enter key. Now you will see a list of test names; we only use FWDREG, FWDHIST or FWD_MDD. For this test you will need to select FWDREG by type in the number located next to the test name and then press the enter key.

15. After returning to the option screen if it shows the correct test name then press the enter key. (Else go to line 14 above and select the correct test to continue).

16. Cancel time of day? Press the enter key.

17. Existing File? Press the enter key. (**NOTE:** IF you wish to continue using a previous test, or have had to back out of the program for some reason. Then you should press the Y key and then input the file name you wish to use. At the "*Do you want to* ERASE ALL TEST DATA *in the current file?* Return /Y = Yes" press the Enter key.

18. Roadway? Press the enter key.

18. Subsection? Press the enter key.

19. Station? Press the enter key.

20. Lane? Press the enter key.

21. Temp? Press the enter key.

22. Condition? Press the enter key.

23. Filename? To enter a file name do so by pressing the F1 key to clear the line. Then use this format to enter the filename: i.e. *pd1_xxk.fwd;(examples:* pd1_0k.fwd, pd1_2_5k.fwd, pd1_5k.fwd, pd1_10k.fwd, pd1_20k.fwd, pd1_40k.fwd and etc.). The 1 indicates the Pad being tested and the other numbers indicate the number of axles.

24. You are now ready to begin drops at the specified locations (see attachment for FWD Drop Locations. NOTE: that arrows indicate direction of trailer.). At this point, you can also see where your file is being saved i.e. c:\temp\XXX.fwd.

25. When you are set up over first drop, press the F1 to start collecting the data. The FWD will start doing its seating drops. At this time you will hear a beep, look in the upper left corner of the screen, you will see that it is asking for a station location number, do so by pressing the F1 key to clear line and type in station number then press the enter key. After the drop is completed, you will hear a beep, do not move the FWD until you hear this beep. Pressing the F6 (Comment) key and enter the Time and Temperature readings for the First, Middle and last drop of the test

26. Now move to the next location and continue testing by pressing the F1 key when in position. Repeat this process until all drops have been completed. See FWD Drop Locations attachment for stations.

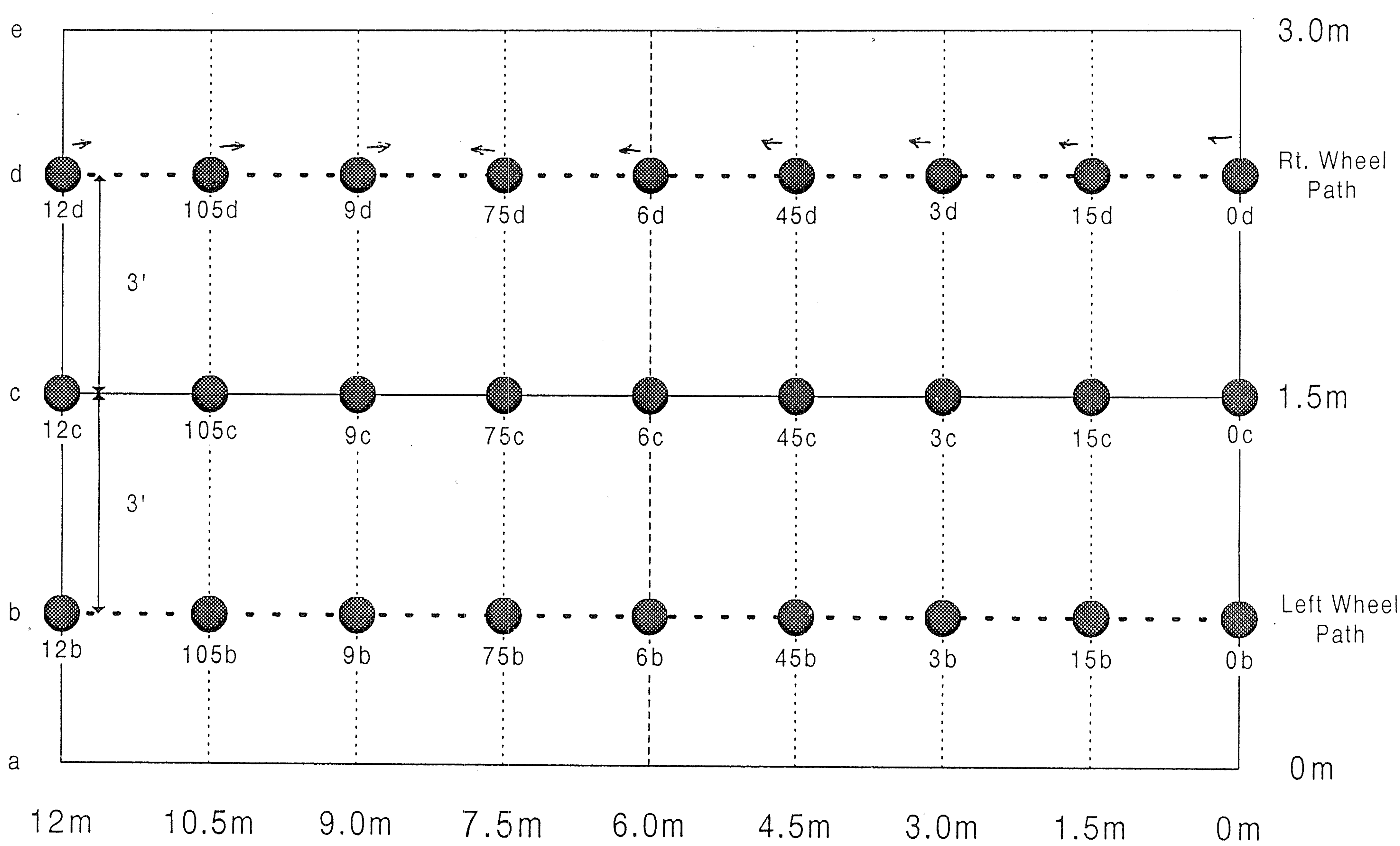
NOTE: You will make drops at the 12M, 10.5M and 9M in the opposite direction of traffic. See FWD Drop Locations attachment. The program will not allow you to use the "D" for some reason, therefor only use the number by its self.

27. When all testing has been completed and you are ready to exit the program you may do so by holding down the SHIFT key and pressing the F8 key. This will close the data file and take you back to the "Make your choice "screen.

28. To exit the FWD program select number 9 by pressing the number 9 key and then press the enter key.

29. When asked if you want to backup the changes made to the FWD program? Press the enter key

FWD Drop Locations



FWD PROCEDURES

<FWDHIST> Use FWD program #5

1. Comments in a DOS.txt file to include Time/Temperature reading prior to starting and at the end
2. Use 6b, 6c, and 6 for station locations
3. Use filename i.e. *wh1_xxk.fwd*
   wh1_0k.fwd
   wh1_2_5k.fwd
   wh1_5k.fwd
   wh1_10k.fwd
   wh1_20k.fwd
   wh1_40k.fwd

<MDD_FWD> Use FWD program #6

1. ***Measure distance between face of the plate and center of MDD before moving ***and block the wheels.
2. Comments in a DOS.txt file to include Time/Temperature readings prior to starting and at the end.
3. Use 1,2,3 for station locations depending on series of drops.
4. Use filename i.e. Lfwd_1.fwd
   Lfwd_2.fwd
   Lfwd_3.fwd
   Rfwd_1.fwd
   Rfwd_2.fwd
   Rfwd_3.fwd

*Need Power Readings and Measurements.

Inside the RV

1.	MDD boxes set at half power	
2.	Input site:	1
3.	Is this a truck test? (Y or N)	N
4.	Is Automatic Trigger Require?	Y
5.	Enter Trigger Channel Number (1-10)	1 for left wheel path 4 for right wheel path

6. Enter the Absolute Voltage Differences: .1
7. Enter "N" for Negative and "P" for Positive N
8. Trigger level in Binary = 281
9. Enter "S" to Start data acquisition: S, press enter to start
10. Use filename i.e. L_1_1.prn
    L_1_2.prn
    L_1_3.prn
    L_1_4.prn
    R_1_1.prn
    R_1_2.prn
    R_1_3.prn
    R_1_4.prn

These are examples for the first series of drops. The L & R are for which wheel path, the next number is for the series, the next is the drop number in that series.

PROFILE FILENAMES

Transverse	Longitudinal
S1_0M.TRN	SIL_0M.LOG
S1_1_5M.TRN	SIL_3M.LOG
S1_3M.TRN	SIL_6M.LOG
S1_4_5M.TRN	SIL_9M.LOG
S1_6M.TRN	SIL_0M.LOG
S1_7_5M.TRN	SIR_3M.LOG
S1_9M.TRN	SIR_6m.LOG
S1_10_5M.TRN	SIR_9m.LOG
S1_12M.TRN	

<MDDREG>

USE FILENAME IE: Pd2_40k.PRN
Pd2_80k.PRN
etc.

NEED Power Readings

24 After drop is completed, you will hear a beep, do not the FWD until you hear this beep. Move to the next location and press F1 when in position. Repeat this process until all drops have been completed.

25 To exit the program completely, meaning you are not going to anymore FWD data collection

Hold SHIFT and press F8, ~~then select~~ down the to exit system (9) and press enter
Backup FWD? enter

To continue testing, see Whole History or FWD_MDD

WHOLE HISTORY

Hold SHIFT and press F8
Press enter
Enter name of operator (to clear the line, press F1), hit enter
Hard copy? enter
Car in park? enter
At the option screen, look above #1, this is the test currently loaded. If anything besides WHOLEHIST is there, type in 18, press enter.
You will see a lot of names, we only use MLS, MLS_MDD or WHOLEHIST. But for this test you will need to select WHOLEHIST, type in 5, press enter.
At option screen hit enter
Cancel time of day? enter
Existing File? enter-unless you are continuing a test, or have had to back out of the system for some reason. Then you would enter in the file name and continue where you left off.
Roadway? enter
Subsection? enter
Station? enter
Lane? enter
Temp? enter
Condition? enter
Filename? To input a Filename do the following:
Press F1 to clear line or characters.
Then enter a filename by typing in *pd1_xxk.fwd. (Where pd#* equals the Test Pad Number, followed by the under bar (Hold down the shift key and press the minus key and then enter the Axel count (i.e. pd1_0k.fwd, pd1_2_5k.fwd, pd1_5k.fwd, pd1_10k.fwd, pd1_20k.fwd, pd1_40k.fwd, etc.)). Then press the enter key.

<FWDREG> Use FWD program

1. Comments in a DOS.txt file to include Time/Temperature

Dynatest FWD FIELD PROGRAM, Edition 10. 881025

FWD DATA FILE DESCRIPTION.

File Type: RANDOM BASIC UASCII Text File.
Line Length: 32 or 80 Characters per line (excl. CR+LF terminators). The wide format includes test results in English Units.

A file consists of 36 lines of "Header" information followed by TEST DATA, Comments etc. and ends with a line containing "EOF".

Items are located within fixed fields indicated by [X,Y], which defines the first and last character positions.
Further, justification is NOT defined, so leading AND/OR trailing spaces within the fields must be expected.

"Reserved" fields may hold any characters and should be ignored.

IMPORTANT: The system does not currently include an EDITOR which assures integrity with the format as outlined herein.
So, if you intend to edit fwd data files AND process edited files by any Dynatest program, please observe the following:
LINE LENGTH must be preserved (32 or 80 chrs per line), so TABulator OPTIMIZATION must be avoided/suppressed and INSert/DELete should be used with great care.
POINTERS within the "Header" area carry information about FILE SIZE, FILE CONTENTS etc. and must track.

E:
"R32   88 880919FileName36F10"

[1] "R" denotes Random
[2,5] 32 or 80 = File width (metric:32, English:80)
[6,7] Reserved
[8,13] Number of USED Records (excluding the "EOF" record)
[14,19] DATE (YYMMDD)
[20,27] File Name
[28,29] "36" Number of lines in HEADER
[30] "F" FWD DATA File Identifier
[31,32] "10" Current Edition
[33,80] Reserved

2.LINE:
"70001..080xx-xxx40000   .2112 8"

[1] No of active Deflectors.
[2] Deflector Range 0: 2000 mu, 1: 100mil (2540mu)
[3] Transport Lock Type 0:Manual, 1:Automated
[4] Hydraulic Ctrl type 0:PS1, 1:Flow Sw.
[5] DMI type 0: Two fase Wheel-targets (Obsolete)
1: Two fase Xmission (? Not available)
>1: One fase Xmission plus Direction (Backlight)
[6] 0:Direct (no choice) 1:Direct/120/60 2:Direct/120 3:Direct/60
4:FIXED 120 (no choice) 5:FIXED 60 (no choice)
[7] #0: Allow Choice of Peaks only / Peaks and History
[8] #0: Temperatures BLANKED (after store)

[9,16] FWD Serial Number.

```
[17,24]  Optional DMI Calibration figure (states per 10 km)
[25]     Filter Mode:  0:Direct  1:120 Hz        2:60 Hz
                                 5:120 w. Hist   6:60 w. History
[26]     Printer type  1:Microline 2:Epson 3:Think Jet
[27]     Print Style  1:Data Proc  2:Enhanced  3:Correspondence
[28,31]  Paper length (in)
[32]     Number of lines per inch (6 or 8).
[33,80]  Reserved
```

3.LINE:

```
"150 0   200 300 450 650 900 1200   5.9     0   7.9  etc....

[1,4]    RADIUS of PLATE (mm)
[5,8]    always ZERO
[9,12]   Distance from center Chnl.2 (mm)
[13,16]    -      -     -     -   3  -
[17,20]    -      -     -     -   4  -
[21,24]    -      -     -     -   5  -
[25,28]    -      -     -     -   6  -
[29,32]    -      -     -     -   7  -
[33,38]  Radius of plate (inches)
[39,44]  Zero
[45,50]  Distance from center Chnl.2 (inches)
[51,56]    -      -     -     -   3    -
[57,62]    -      -     -     -   4    -
[63,68]    -      -     -     -   5    -
[69,74]    -      -     -     -   6    -
[75,80]    -      -     -     -   7    -
```

```
 E:
"C:\FWD\DATA\                  .FWD"

[1,2]    Working Disc Drive
[3,28]   Working Directory (26 characters max.)
[29,32]  FWD Data file Extension (JLN=Julian date)
[33,80]  Reserved
```

5.LINE:

```
"123.5   Mileparken ....

[1,32 or 80]  Roadway Identification
```

6.LINE: Copy of last STATION ID (see line 38) stored in file, except for:

```
[27,32]  POINTER (Record number) to last Station ID record.
```

7.LINE: Next Expected STATION ID (see line 38), except for:

```
[27,32]  POINTER (Record number) to "EOF" record.
```

8.LINE:

```
"2730373027303730200.1   210.5   "

[1,4]    mV at 0'C       Pavement Sensor (Optional)
[5,8]    mV at 100'C
[9,12]   mV at 0'C       Air Temp Sensor (Optional)
[13,16]  mV at 100'C
[17,24]  Lowest Chainage/Mileage (km or Miles)
```

[25,32] Highest Chainage/Mileage
[33,80] Reserved

NE:
"8 15 3.5 5 2 15 2 8 "

[1,4]	Vibr/Drift Limit (mu)		
[5,8]	Lower Plate Time Limit		
[9,12]	Raise.Weight	-	(1.Stop)
[13,16]	Lower Catch	-	(NO Pres2)
[17,20]	Drop	-	(till TG)
[21,24]	Raise Plate	-	
[25,28]	Raise Weight	-	(til NO TG)
[29,32]	Raise Catch	-	
[33,80]	Reserved		

10.LINE:
"Ld 02029 1 83.5 "
[1,3] always "Ld "
[4,8] Load Cell Serial Number
[10,14] Relative Gain
[16,20] Initial Gain
[21,80] Reserved.

Lines 11 to 20 hold Deflector Serial Numbers and Gains similar to line 10.

21.LINE:
"Operator ID .....
[1,32 or 80] Operator

NE:
"00101011........................."

		0:	1:	2:	3:
[1]	Test Units	kPa,my,mm	lbs,mill,inch		
[2]	Temperature	Centigrade	Fahrenheit		
[3]	Stn. Request	OFF	ON		
[4]	Test Checks	Roll-Off	RollOff+Decr	NONE	Decrease
[5]	Rejection	OFF	ON		
[6]	Stationing	0:Km 1:Km.0xxx 2:meters 3:Miles 4:Ml.0xxx 5:Ml.feet 6:feet 7:yards 8:N.C. 9:Manual Step			
[7]	Tmp. Request	OFF	ON		
[8]	Cnd. Request	OFF	ON		

[9,32] Reserved
[33,80] Reserved.

23.LINE:
"5 2 5 2 ...."

[1,4]	Allowed LOAD Variation			(kPa)
[5,8]	-	-	-	(percent)
[9,12]	-	Deflection	-	(mu)
[13,16]	-	-	-	(percent)
[17,80]	Reserved			

24.LINE : Last used SUBSECTION ID (see line 37).

25.LINE:
"DtCty PxNnnnS 000+0.0 000+0.0 St ....

```
    [1,32 or 80] Roadway ID TEMPLATE

26.LINE:
    "  Cty P Nnnn
    [1,32 or 80] File name generation mask (Roadway ID chr. positions)

27.LINE:
    "*000+0.0 000+0.0 St ...
    [2,32 or 80] Roadway Subsection ID TEMPLATE

28.LINE:
    "................................"
    [1,80] Reserved

29.LINE:
    "                18  100 1Peak...64  3.9 .....
    [1,16]   Reserved.
    [17,20]  5-day Airtemperature ('C)   (Optional)
    [21,24]  Thickness of Asphalt. (mm)  (Optional)
    [25]     =1: CPS ON/OFF choice allowed
    [26,29]  Current CPS Choice: "CPS "  or  "Peak"
    [30,32]  Reserved
    [33,36]  5-day Airtemp ('F)         (Optional)
    [37,40]  Thickness of Asphalt (in)  (Optional)
    [41,80]  Reserved

30.LINE:
    "AA1111111PBB2222222PCC3333333PDD4444444S...................."
    [1,64]   Drop No's (Active Sequence flow columns)
    [65,80]  Reserved.

31.LINE:
    "AA1111111PBB2222222PCC3333333PDD4444444S4444444444444444444"
    [1,64]   Sequence Heights
    [65,80]  Reserved.

32.LINE:
    ".........*.........*.........*.........*...................."
    [1,64]   Sequence Test Plots
    [65,80]  Reserved.

33.LINE:
    "..********...********...********...********.*******************"
    [1,64]   Storage of Peaks
    [65,80]  Reserved.

34.LINE:
    "............................................................"
    [1,64]   Storage of Load Time History
    [65,80]  Reserved.

35.LINE:
    "............................................................"
    [1,64]   Storage of Whole Time History
    [65,80]  Reserved.

36.LINE:
    "................................"
    SETUP "Name" (Descriptive information)
```

37. LINE SUBSECTION ID (the first one):

```
"*010+1.0 015+0.0 .......
[1]  Always "*"
[2,32 or 80] User specified information (see line 27)
```

TEST data are stored chronologically from line 38 and up in groups of:
One STATION IDENTIFIER and
one or more Load and Deflection DATA SETS.

Comments, Subsection IDs and "Sensor History Blocks" may precede or follow any group of TEST data.

STATION IDENTIFIER (the first one):

38.LINE

```
"S205.3   0   25.5 0026 28   01200   78   79   82...................
  Station LaneTemp CAPvtAir SHrMnTemp Pvt Air
[1]       always "S"
[2,9]     Station
[10,13]   Lane Specification
[14,18]   Asphalt Temperature ('C)
[19,20]   Joint Code or CRACKs, Alligator Cracks Condition level
[21,23]   PAVEMENT Surface Temp ('C)    (Optional)
[24,26]   AIR Temperature ('C)          (Optional)
[27]      Station "Direction" : "I" or "D"
[28]      Current Stationing mode (see line 22)
[29,32]   Time of Day (HrMn)
[33,36]   Asphalt Temperature ('F)
[37,40]   PAVEMENT Surface Temp ('F)    (Optional)
[41,44]   AIR Temperature ('F)          (Optional)
[45,80]   Reserved
```

DATA SET: (the first one)

39.LINE:

```
"754 1280905 837 688 431 234 122  10730 50.39 35.63 32.95 27.09 etc..
[1,4]     LOAD (kPa)
[5,8]     CENTER Defl   (mu)
[9,12]    DEFLECTION 2
[13,16]       -      3
[17,20]       -      4
[21,24]       -      5
[25,28]       -      6
[29,32]       -      7
[33,38]   Force (lbf)
[39,44]   CENTER Defl   (mil)
[45,50]   DEFLECTION 2
[51,56]       -      3
[57,62]       -      4
[63,68]       -      5
[69,74]       -      6
 75,80]       -      7
```

COMMENTS:

```
"'This is a Comment
```

```
[1]             Apostrophe always
[2,32 or 80]    Comment Text.
```

OR HISTORY BLOCKS:

"Bxxxx 0 ....10.55   ...."

followed by xxxx records (lines).

Parenthesized figures are true for the WIDE file format.

```
[1]       B is Block identifier
[2,5]     Size of block in Records (lines)
[6,8]     Type     0: Load (kPa).
                      38 (15) lines,
                      8 (20) samples per line,
                      One sample occupies 4 characters,
                      Interval between samples is 0.2 mSec.

                   1: Load (kPa) and 7 deflections (mu).
                      300 (150) lines,
                      1 (2) Load and Deflection DATA SETs per line,
                      Interval between Sensors is 0.025 mSec,
                      Interval between Lines is 0.2 (0.4) mSec.

[9,16]    Reserved.
[17,24]   Station
[25,80]   Reserved
```

FWD _MDD Data Collection Procedures Control Trailer

1. Turn on power to both MDD boxes.

2. Insure that both MDD boxes have the switch at ½ mode

3. Click on the start button (Bottom left corner of computer screen).

4. Click on "Shut Down".

5. Click on circle next to "Restart in MSDOS mode".

6. Click on "Ok"

7. When the computer finishes rebooting you will see "C:\windows>" in the upper left corner of the screen.

8. Now type in "cd\QB45" and then press the enter key

9. This will take you to the subdirectory on C:\ drive of Quick Basic 45 (C:\QB45>).

10. Now type "MDD96TTI" and press the enter key. This will start the MDD program.

11. Input Site No.: Press the number 1 key and press the enter key.

12. Is this a truck test? (Y/N) Press the "N" key and then press the enter key.

13. Is automatic trigger required? (Y/N) Press the "Y" key and then press the return key.

14. Enter trigger channel number (1 – 10): Press "1" for left wheel path or "4" for right wheel path and press the enter key.

15. Enter the ABSOLUTE voltage difference: .1 (period key then "1") then press the enter key. NOTE: program provides: '*suggested range: From 0.85 volt to 0.38volt; Recommended Value: 0.15* volt'

16. Enter 'N' for Negative and 'P' for Positive pulse: Press the 'N' key and then the enter key.

17. Enter 'S' to start data acquistion: **NOTE**: At this time inform the FWD operator by radio that you are waiting for him to finish his setup. The FWD operator has to do his seating drops and inform you that he is ready before you can proceed. Should you proceed with out waiting for the FWD operator to do his setup and have to wait, then program will kick you out when you attempt the data collection. If this happens return to line # and start over.

18. When the FWD operator informs you that he is ready, then press the "S or s" key one time and **WAIT** (*DO NOT PRESS THE ENTER KEY AT THIS TIME.*)

19. Tell the FWD operator you are ready and he will give you a count down (i.e. 3,2,1), when he says 1 in his countdown, THEN PRESS THE ENTER KEY.

20. The program will now gather the data. When finished it will prompt you at the bottom of screen. Now press the ENTER key to continue.

21. Press the ENTER key to scroll through the graphs, this is to ensure that they look OK. NOTE: *should you notice a lot of static in the wave forms, then pass this on to Mike. You will only see a wave form on half of the screens you enter through, because you are only looking at on MDD.*

22. Q to plot? Press the ENTER key.

23. FWD load? Press the ENTER key.

24. Change filename? (Y/N) Press the "Y" key and enter file name (i.e. *wheelpath_series_drop#.prn).*

Filenames are as follows:

Left MDD	Right MDD
L_1_1.prn	R_1_1.prn
L_1_2.prn	R_1_2.prn
L_1_3.prn	R_1_3.prn
L_1_4.prn	R_1_4.prn

25. After typing in filename, then press the enter key.

26. At the options menu screen: press the number "2" key and press the enter key.

27. Press the "S" key. **DO NOT PRESS THE ENTER KEY**.

28. Inform the FWD operator know you are ready, he will need to have time to setup his program again. When both are ready he will begin the countdown again. Repeat this process until the series is finished for that wheel path.

29. When the series is completed and you are at the options menu screen, select "1" to run a new truck. NOTE: The only thing different to be entered is the trigger channel.

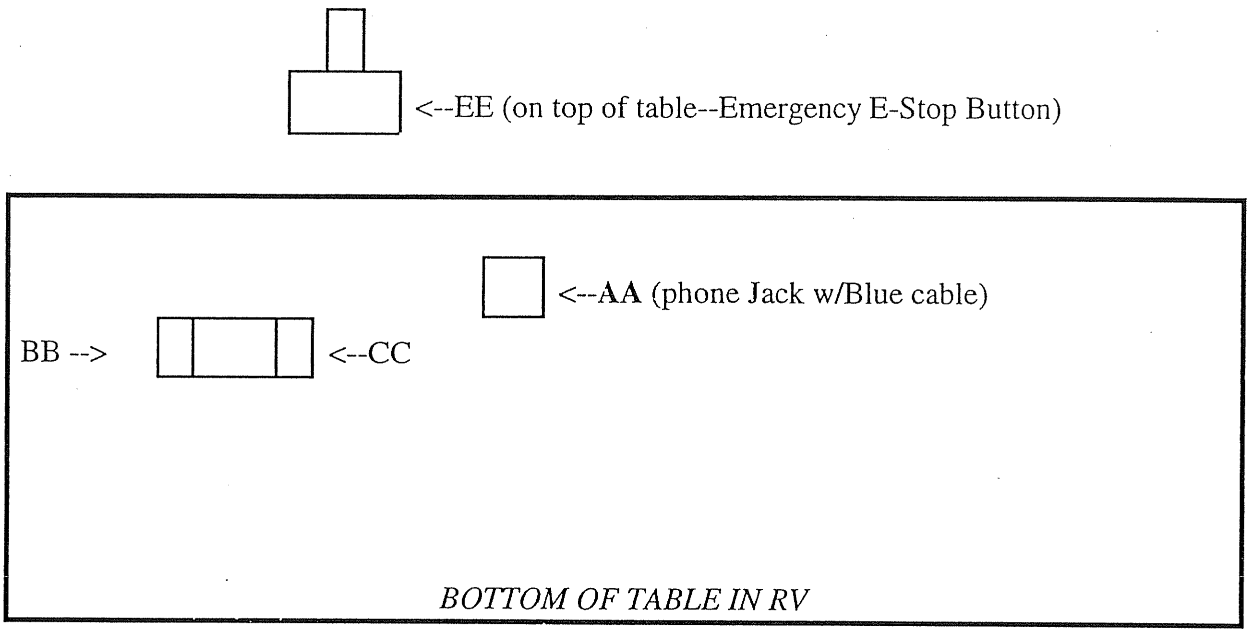
30. When finished with all drops, at the options menu screen choose exit system from the menu and press the enter key.

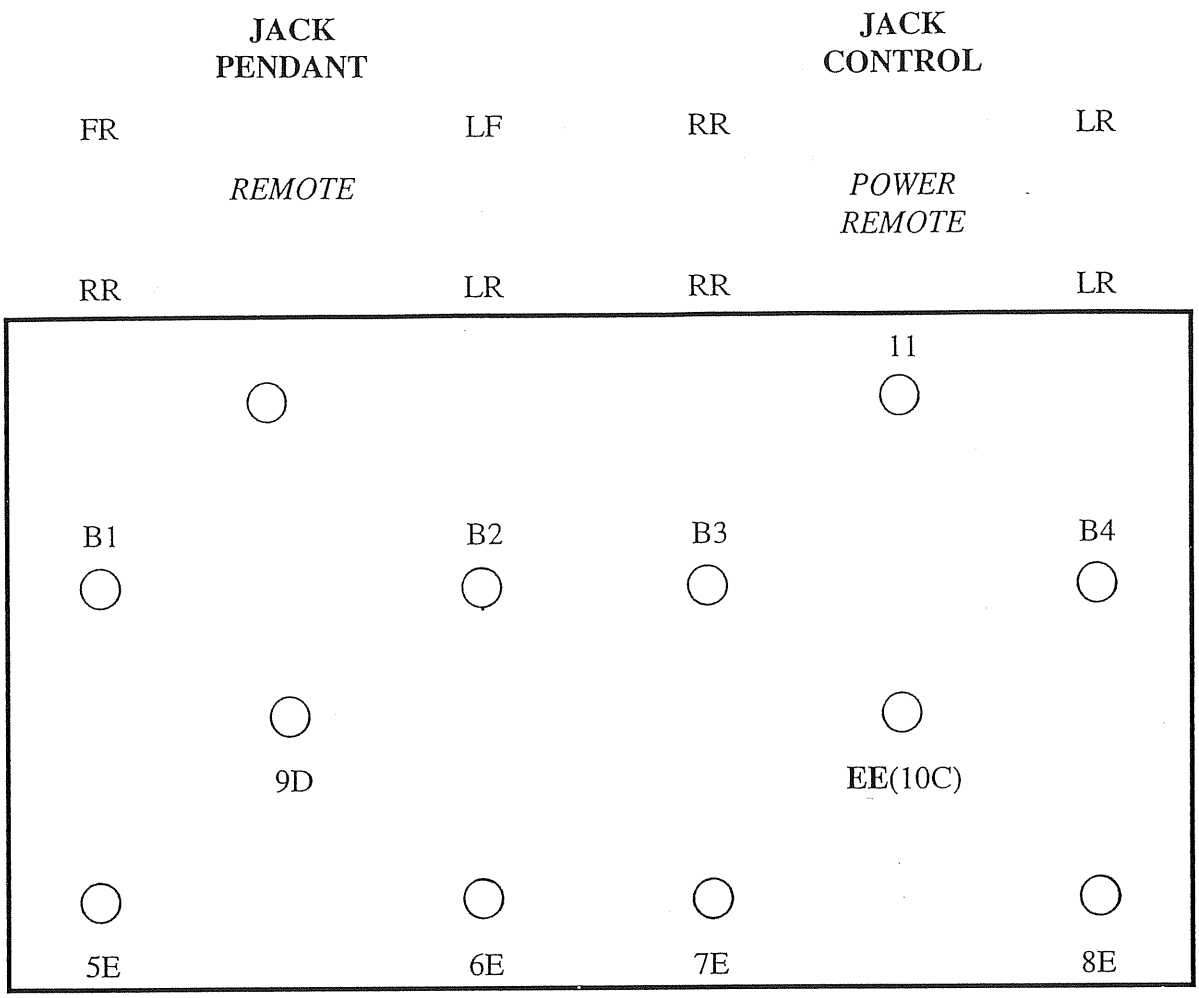
31. At the DOS prompt C:\>, type "exit" and press the enter key.

32. Using the Fluke meter set to dcv, you need to measure the voltage from all 3 channels on both MDD boxes, and record it in the log book.

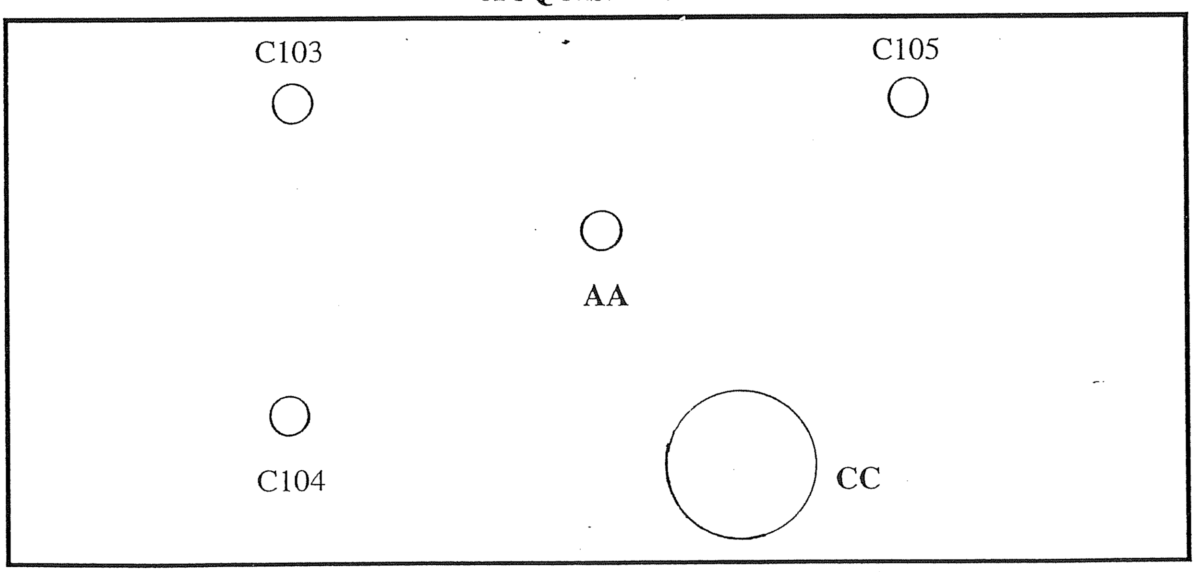
MISCELLANEOUS

AA -- *UNDER TABLE IN RV TO PHONE JACK(BLUE CORD)*
BB -- *TO GRAY BOX UNDER TABLE IN RV.*
CC -- *TO GRAY BOX UNDER TABLE IN RV.*
EE -- *ON TOP OF TABLE IN RV -- EMERGENCY (E-STOP) BUTTON*
MDD1 -- *MDD DATA LINE #1.*
MDD2 -- *MDD DATA LINE #2.*





ACQUISITION



HORNER ELECTRIC
ADVANCED PRODUCTS GROUP

Horner Electric's SNP to RS232 Adapter

Product Specifications and Installation Data

User's Manual

for the *HE693SNP232*, *HE693SNPCBL* and *HE693XTADP*

RS232 SERIAL PORT WIRING

The HE693SNP232 SNP to RS-232 Adapter is equipped with two ports. The 15-pin "SNP" port plugs directly into the PLC Programmer Port on the CPU rack power supply. Power to the SNP Adapter is supplied directly from the programming port (maximum 25mA@5VDC). The 9-pin RS-232 port connects to any RS-232 device. The "pinout" for the HE693SNP232 Adapter serial ports are defined below. The direction indicated is with respect to the adapter.

Pin Number	Signal Name	Direction
1, 3, 7	[0V] Ground	N/A
2, 5	[+5V] VCC	N/A
4	No Connection	N/A
6	[CTS-] Clear to Send	Input
8	[RTS+] Request to Send	Output
9,10	[TXD-] Transmit Data	Output
11	[TXD+] Transmit Data	Output
12	[RXD-] Receive Data	Input
13	[RXD+] Receive Data	Input
14	[CTS+] Clear to Send	Input
15	[RTS-] Request to Send	Output

Table 1. 15-pin Port

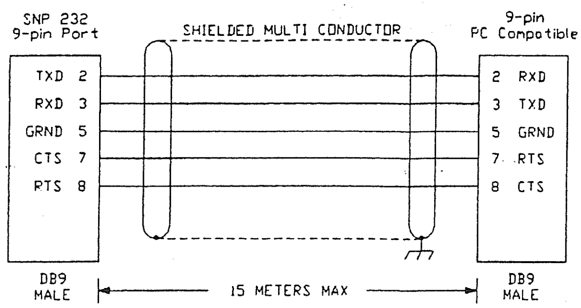
Pin Number	Signal Name	Direction
2	[TXD] Transmit Data	Output
3	[RXD] Receive Data	Input
5	[GND] Ground	N/A
7	[CTS] Clear to Send	Input
8	[RTS] Request to Send	Output

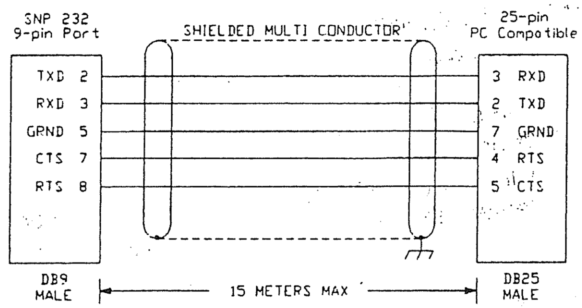
Table 2. 9-pin Port

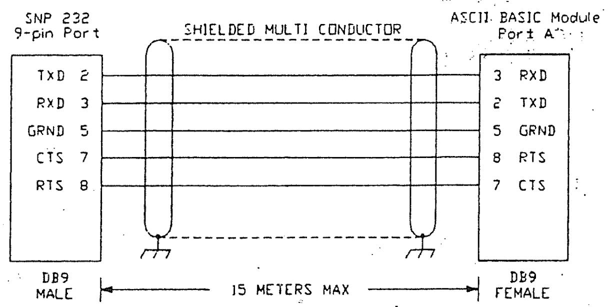
This pinout was chosen to allow direct connection (using a straight through, or 1 to 1 cable) to the IBM PC/AT. Nearly ALL of the IBM compatible computers equipped with a 9-pin RS232 port will provide a pinout compatible with that shown above.

Cable Diagrams

When connecting the SNP adapter to IBM compatible PCs with hardware handshaking, the following cable interface should be used.

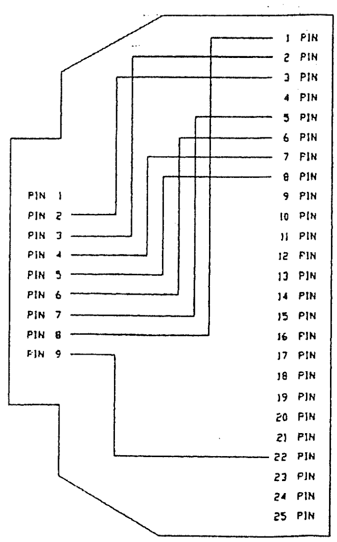






XT Adapter Pinout

The XT Adapter can be used on an IBM compatible PC which has a 25-pin RS232 port. The internal wiring of the XT Adapter is show below.



PLC-5 AND AXLE COUNTS

Reloading PLC-5 and Axle Counts

If you power up the PLC-5 and get a MLS graphic and statement in the upper left corner stating "PLC-5 COMMUNICATIONS LOST", perform the following procedure.

- Go to the RV, leave the PLC-5 on
- Shutdown all screens except Program Manager
- Open IPDS
- Open PLC-5, the screen that comes up is the MAIN SCREEN
- Press F5 (who)
- Press F5 (who active)
- At 04 you will see

  5/30 ???? (Program is lost)
- Press F1 (online program)

  You will hear a beep and "PROCESSOR RAM IS FAULTED" error
- Press enter to clear memory
- Press F6 (restore program)

  Select the newest date (currently 3-14-96) by arrowing down
- F1 (begin restore)
- Press a key to continue when prompted to

Program is installed, now return to main screen

Changing the Axle Count

- You will need to look in the doghouse to see the axle count, this will be helpful to make sure you are changing the right number
- Press F1 (online program)

  Arrow down to MLS_DC
- Press F8 (monitor file)
- Press F10 (no)
- On this screen, the red bar needs to be in the upper left hand corner, as far as possible. Imagine a ladder (this is a program ladder), the bar needs to be up and down on the vertical rung. Use the arrow keys to move the red bar.
- Press F8 (data monitor)
- Type in N7:110

Example Axle count: 1,350,024

***Make sure red bar is on column you are changing (use arrow key to move)

In the first column (0) enter 024 and press enter
In the second column (1) enter 1350 and press enter

PROFILER PROCEDURES

Profiler Procedures

1. Set up the profiler assembly on the MLS.

2. Connect the two silver cables on the profiler data box, these are on the bottom of the data cart, to their respective fittings.

3. Place indicator on the Zero mark on the cross bar and lower the data wheel.

4. Ensure that power is provided to the Data cart.

5. Set switch on black box to the "A" position (top of data cart).

6. Turn on computer.

7. Turn on profiler data box (2^{nd} shelf of Data cart).

8. When the computer has finished booting up, you will see the DOS prompt (C:\>), type in "LOGGER" and press the enter key.

9. The LOGGER program will now execute and prompt you for various inputs.

10. Type in your initials.

11. Select Transverse or Longitudinal. (Select Transverse by pressing the "T" key).

12. Select Location. (I.e. 0, 1. 5, 3, 4.5, 6, 7.5, 9, 10.5 or 12).

13. Now press the button with the three slashes once. (This will allow you to input the X and Y data).

14. To input the value for "Y", press the "Y" key once, then press the keys to input "1000" and press the Load key.

15. To input the value for "X", press the "X" key once, then press the keys to input "0" and press the Load key).

16. The computer screen should show "press any button to zero the logger". This is the small box just in front of the switch box.

17. Now press a key, you should hear a fast sounding tone, if you do not then press another key.

18. Move the slide to the left until it stops.

19. Check computer to see if it obtained the data point.

20. Now move the slide from the left to the right slowly to start gathering the data.

21. Watch the computer monitor to be sure that you are getting all the data points.

22. When you get to the right side of the cross bar the program will plot a graph to show you what has been collected.

23. If plot looks good then accept it.

24. Pick up the data wheel and move the slide back to the left to the "0" mark.

25. Move to the next Transverse line and continue this process until you have collected all the data for the test set.

Power on computer & X-Y box

Set selector box to A = profiler

Start C:\ loggers

put in initials, location

250 POINTS

12.7 mm INTERVAL

set profiler on 0

Press // on x-y box

Press Y 1000 load

Press X 0 load

Press "all" on other box

Profile !

P-SPA PROCEDURES

P-SPA Procedures:

1. Plug in Computer keyboard.
2. Remove panel on left side of computer and hook up the TAN cable from the lunch box to the top right connector of the computer.
3. Attach the power cable to the computer.
4. Turn the power on to the computer. Wait until the screen shows the DOS prompt: C:\>.
5. Then change to the directory PSPA (type: CD\PSPA and press enter key).
6. Run the program (type: PSPA and press enter key).
7. Use arrow keys to go to: Setup, then to Project Setup and then to Project Directory.
8. Type: N (for NEW).
9. Type: Projects\N10k and press enter key. (N = North, 1 = Pad, 0k = Run [ie. 20k, 40k etc.]).
10. Use arrow keys to go to: Acquisition. "DATA COLLECTION" should then come up.
11. Place lunch box in the correct position on a wheel path. (To take a *Longitudinal* reading point the button on the end of the lunch box towards the 12M line. To take a *Transverse* reading point the button towards the side lines).
12. Press ENTER key to collect data.
13. When DATA collection is completed a WAVEFORM screen will appear. The lines of the same COLOR should resemble each other and should be able to lay one on top of the other or as close as possible. If they do not see line 20.
14. Press Esc (Escape) button one time.
15. The PROJECT STATION screen will come up and at this time type in : N10k (see line 9), for the STATION TYPE input: 0L (0 = k Run, L = Left Wheel path, C = Center Line and R = Right Wheel Path) and for the COMMENT input LONG for Longitudinal or TRANS for Transverse.
16. Press ENTER button Two (2) times. Note some times an error screen will come up.
17. Press Esc (Escape) button if this occurs and the DATA COLLECTION screen should return.
18. Move the lunch box to the next location (either LONG or TRANS).
19. Go back to Line 12 and repeat the process until you have TWO (2) readings at each of the 27 data collection points (one LONG and one TRANS).
20. If the data is bad then continue with the labeling until finished. Then move the lunch box over one way or the other approximately ½ inch and repeat the test again. When you have obtained good data then label it as: LONG2 or TRANS2. (The number on the end indicates that it was the second, third or forth try at getting the data).

How to extract PSPA data

1. Go to the C:\PSPA\PROJECTS\N1XXk (XX = RUN COMPLETED i.e. 20k, 40k ETC.) directory that you created when you collected the data.
2. Then copy ALL the files from that directory to a floppy disk.
3. At this time you need to Edit the COMMENTS.TXT file. On the left hand side is a column of numbers, one number for every P-Spa "Drop". It is important that you write down the 1st number, then scroll down to the bottom of the file and write down the last number. At this time you can also fix any mislabeled points.
4. Now go to the C:\PSPA\RAWDATA directory and copy ALL of the *.ZIP files (each one is numbered) that were in the COMMENTS.TXT file. The PSPA computers have Windows 95 – at this point it's easier to plug in a mouse, restart the computer and use Windows 95 file manager to copy the files to floppy disks.

STRAIN GAUGE CALIBRATION FLOWCHART

Strain Gauge Calibration Flowchart

Step 1

For a specific bogie, input strain gauge and Captels readings at low and high loads over the anticipated range. Calculate tho differences

	Strain gauge	Captels	Delta
Low	5014	4500	514
High	10229	10160	69
	5215	5660	445

Step 2

Input the current strain gauge calibration factor (SF). Convert load to strain units and recalculate SF.

SF = 1.025

Strain units = 5087.805

New SF = 1.105587

Step 3

Input the new SF into software and update the program

Step 4

Resample and compare the strain gauge and Captels loads. Check the differences.
Calculate the error in pounds and convert to strain units.

	Strain gauge	Captels	Delta
Low	[illegible]	5170	[illegible]
High	11016	10000	1016

Error in lbs. = 1025

Error in strain units = 927

Step 5

Calculate the offset correction. Update the strain guage setting.

Old offset correction. 3100

New offset correction. -2173

Step 6

Repeat steps 1 - 5 until strain gauge load ≤ Captels load

Note: If polarity is opposite the strains will be negative. Reverse the signs

See Bogies: #2 LF and RF; #6 LF and LR (?)

	A	B	C	D	E
1	**Calcs Bogie #3 Front Left (FL)**				
2					
3	**Step 1**				
4					
5					
6					
7					
8		Strain gauge	Captels	Delta	
9	Low	5014	4500	=B9-C9	
10	High	10229	10180	=B10-C10	
11					
12		=B10-B9	=C10-C9	=D9-D10	
13					
14	**Step 2**				
15					
16					
17					
18	SF =		3025		
19					
20	Strain units =		=B12/C18		
21					
22	New SF =		=C18*(C12+D12)/C12		
23					
24	**Step 3**				
25					
26					
27					
28	**Step 4**				
29					
30					
31					
32					
33		Strain gauge	Captels	Delta	
34	Low	5204	5170	=B34-C34	
35	High	11016	10000	=B35-C35	
36					
37	Error in lbs.			=AVERAGE(D34:D35)	
38	Error in strain units			=D37/C22	
39					
40	**Step 5**				
41					
42					
43					
44	Old strain gauge settin			5100	
45	New strain guage setti			=D44+D38	
46					
47					
48	**Note:** Dark fields are	input fields			
49					
50					

SURVEYING INSTRUCTIONS

Surveying Instructions

- Set up Sokkia over PK nail

  Turn on and break horizontal and vertical planes

  Plug in cable from Husky into data out on Sokkia

  Site back site (BS)

  Zero the Sokkia by pressing *shft + 0 set*

  Press *7* to shoot first distance with Sokkia (The first shot must be taken with the Sokkia), S Dist will flash, a beep will sound when shot is complete. Pres *ce-ca* after S Dist appears at top.

- Powering up Husky

  If at cd:\> type *cd sdms*

  Then type *sdms*

  Husky will build help tables then go to the main screen

  At the main screen, select *F1* for project (proj)

  Enter the name of the new project (F510k)

  You will now be ready to start a new series of shots

  TK: type RTO (Radial Topography)

  AC: press enter

  ID: press enter

  HY: enter highway if wanted then press enter

  Date will automatically be placed in

  WE: press enter or enter weather

  TE: enter temperature or press enter

  BP: enter barometric pressure or press enter

IT: enter instrument press the up arrow and (V,?), select LEITZ_SET

SN: serial #

OB: observer

RE: recorder

AC: OS (occupied station)

PN: 2

FE: ASPH (asphalt) this must come off the CAiCE point description sheet

PD: PK (PK nail) this can be anything, but PK will show small when printing

IH: instrument height, measure to the side of the Sokkia where there is a small dot

YC: assume 10,000

XC: assume 10,000

ZC: assume 100

AC: BS

PN: 1

YC: enter nothing

XC: enter nothing

ZC: enter nothing

AZ: 0.000

HZ: shoot this point with the Sokkia by pressing *7*, then shoot with the Husky (*F1*). After shooting BS, change **AC:BS** to **AC:SS** (side shot), this is done by backspacing over the prompt letters (AC:, AZ:, ...) and typing what command you need to change. From this point on, you will only press *F1* to continue your shots, unless you want to change a feature (FE). Watch the Husky display to ensure the screen changes/rolls, this will let you know the shot was taken.

The Husky will prompt after the first side shot for SH:, which is the staff height. Measure from the ground to the center of the prism and enter. Remember, everything is being done in metric.

- When you have completed the survey

    Press escape, it will ask to *Close or Suspend*, always suspend by pressing *S*

    You can then power off the Husky and disconnect from the Sokkia

    Go into the RV and find the black cable under the control bench that has Husky label on it

    Plug this into the Husky

    Escape out of SDMS back to c:\>

    When back at c:\>, type hcom. This is the software that will transfer data from the Husky to the PC on the right.

    On the PC, at c:\ type cd hcom and press enter, then hcom and press enter

    The HCOM screen will come up, on the left will display the PC info, and the right will display the Husky data

    On the PC side, go to SDMS32\DATA

    On the Husky side, tag the files that have your project name by pressing enter

    Press T to transfer these files to the sdms\data directory

    Exit HCOM

    At c:\, type cd sdms32 and press enter, then type sdms and press enter

    When the sdms screen comes up, select f3 to compute

    Press f1 for directory to find your file

    Arrow down and press enter on your file

    Select yes to all questions except to print a report. This process is being done so the data can be moved into and viewed in CAiCE

WEATHER STATION-DATALOGGER

CC: MF

WEATHER STATION - DATALOGGER

SUMMARY:

To begin the weather station program, type the word 'WEATHER' at the DOS prompt. The following screen will then be displayed:

Please choose which you would like to do:

1. **MONITOR/GRAPH Data - Real Time**
2. **DOWNLOAD Data Directly from Station**
3. **DOWNLOAD Stored Module Data**
4. **REVIEW Data file - 15 Min. Intervals**
5. **SET Datalogger CLOCK to PC Clock**
6. **PRINT Report**
7. QUIT

Select one of the choices, type the number, and press 'ENTER.'

1. MONITOR/GRAPH Data - Real Time: Is pretty much self explanatory. You will first be placed in a mode that displays most of the significant weather station current sensor readings. In order to display different readings press 'L' for locations. The syntax used to specify sensors is each number followed by a comma, or in the case of a range type the first number, 2 periods, then the last number (Ex: 1,2,3, etc. ... or 1..24). The default setting should show at least 1 of each type of sensor. If you wish to view the graphic representation of the current sensor readings press 'G' for graph. The screen will change from the numerical readings to a graphic bar graph / strip chart type display.

2. DOWNLOAD Data Directly from Station: If you wish to download data to a PC directly from the weather station, use this command. You will create a data file named '10700XXX.DAT' that will contain all of the data since the last download or the last 27 (approx.) Days - whichever is least. The 'XXX's represent the sequential order of any other data files in the weather station root directory (C:\ENVIRO\) - i.e., the program will scan the database in the root directory, and name the new file on sequential increment higher than the highest one found.

3. DOWNLOAD Stored Module Data: If you are downloading data from the data canister. A special AC powered isolation module cable and 25-pin to 9-pin adapter will be required. This will create a data file in the same format as described in '2. DOWNLOAD Data Directly from Station' (above).

4. REVIEW Data - 15 Minute Intervals: Will display an entire data file - sorted into columns - by 15 minute intervals. After choosing this selection you will be prompted to enter a filename. If you know the filename, enter it at this time. If not, press 'F1' and all of the .DAT files in the root directory will be displayed. Select one of the files, and enter it at the prompt. In order to see the sorted display press 'F1', then press 'R' for run. For more detail or specific reports, various parameters of the sorted report may be manipulated. To do this, press 'F1' then 'E' for edit. As you go to each parameter you may then press 'F2' for help. You will get a listing, and some examples of proper syntax at the top of the screen.

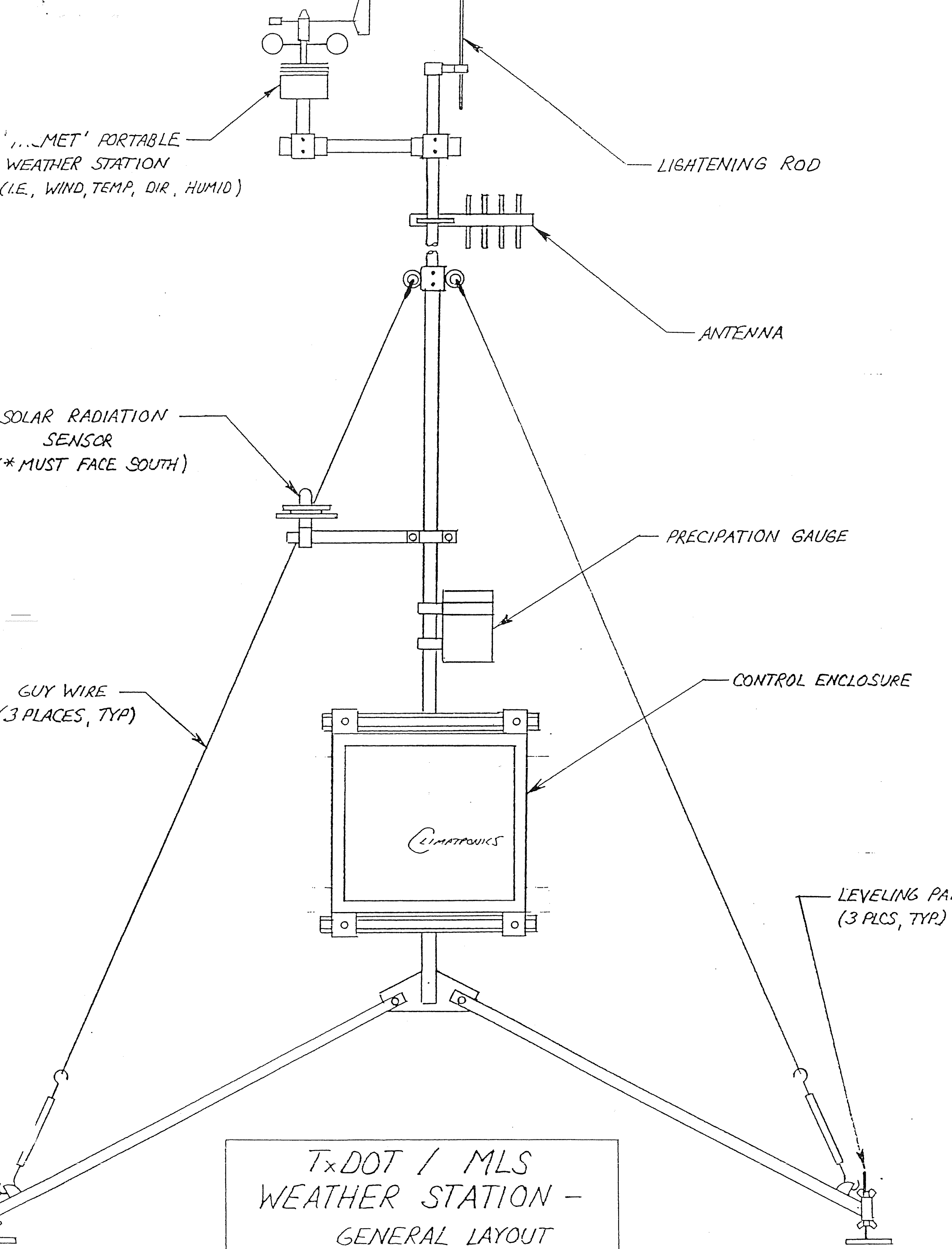
5. SET Datalogger CLOCK To PC Clock: Will reset the internal clock in the weather station to match that of the (attached) PC.

6. PRINT Report: Prints a copy of a program or data file. You will be prompted to enter a filename (preferably with a .PRN extension). A report will then be printed.

7. QUIT: Exits you from the Weather Station menu, and returns you to a standard DOS prompt.

Each of the modes you can enter into may be individually customized to sort, display, or report the data in a number of ways. It is highly recommend that prior to attempting to re configure a routine, you read through all of the datalogger manuals, and become familiar with both the hardware, and the software. As far as the software goes, it has been written in a somewhat complicated, yet simplistic way in order to allow a nearly infinite number of ways to individually configure the operating / recording / reporting parameters. You may find it is similar to a BASIC program, capable of 'AND', 'OR', 'GOTO', and Arithmetic functions. The simple batch files, and menu provided are simply intended to allow ease of operation until such time that a higher level of mastery is achieved.

The following page is a rough sketch of what the assembled Weather Station should look like. Again, there are not many specifics regarding the setup. After doing it, you will probably find that there are either not many alternatives as to the specific placement(s) of the devices, or that 'exact' placement just does not matter.


'...MET' PORTABLE
WEATHER STATION
(I.E., WIND, TEMP, DIR, HUMID)
LIGHTENING ROD
ANTENNA
SOLAR RADIATION
SENSOR
(* MUST FACE SOUTH)
PRECIPATION GAUGE
CONTROL ENCLOSURE
CLIMATRONICS
GUY WIRE
(3 PLACES, TYP)
LEVELING PA
(3 PLCS, TYP)
TxDOT / MLS
WEATHER STATION -
GENERAL LAYOUT

APPENDIX C

INSTRUMENTATION SUMMARY MEETINGS

INSTRUMENTATION - SUMMARY OF PRIOR MEETINGS

Meeting Minutes
07/01/2002

Attendees: Ronald Hudson, Dar-Hao Chen, Mike Murphy, Ron White
Subject: Instrumentation – Data collected on Previous MLD Test Sections

Dar-Hao gave a presentation on data taken at previous MLD test sites.

- At 10000 load reps, the collected data including FWD, Dipstick, seismic…
- Each time data is collected, unit is shutdown for 1 to 2 days
- 40 FWD drops – 10 X 4loads per location. Now they drop 3 time X 4 loads X 10 locations = 120 drops per data collection

MDD data

- Three inch limit between LVDTs

Wander programmed in bogies does not mimic real world conditions. Zone of influence under MLS is 1 meter. In real world, the zone of influence is 1.2 meters.

They measure profile 2 times before loading commences to establish basis.

The best MLS data they have is from the Jacksboro sites.

Load (several questions were raised pertaining to load measurements)

- How much variability is due to Captelss vs. dynamics of bogies?
- Hoe is load verified at other points of the test section other than at the Captelss scales?
- What is documented procedure for setting and verifying the loads applied by the MLS.

There is no cracking data because there were no discernable cracks.

Coring – Not contained in the Jacksboro data. Not collected with any set frequency.

Laboratory Test Data – is contained in a separate database.

October 28, 2002

Instrumentation:

A general discussion was held concerning the instrumentation that will be installed to collect test section data.

German indicated it will be up to CTR to provide the instrumentation test plan to carry out the pilot project. TxDOT will be responsible for having functional instrumentation available for installation. The instrumentation tool box available to CTR will include:

1. New moisture sensors from U of Houston, or existing TDR moisture sensors.
2. New I button temperature sensors or exiting thermocouple temperature sensors.
3. Load data from bogie mounted strain gauges or load data from existing Captelss WIM system.
4. MDD data
5. Weather data to include wind speed and direction, rainfall, and humidity.
6. FWD
7. SPA (DSPA, PSPA, SPA)
8. Longitudinal and transverse profile data from new profiler device, old profiler and dipstick
9. DCP
10. Laboratory materials testing
11. Coring
12. Crack detection camera or visual condition survey
13. Trenching

The condition of some of these instruments is unknown as is the availability. Existing Inter-agency Contracts (IAC) should be review and renewed as needed to insure the outside expertise is available as needed.

Existing and new instrumentation must be tested prior to installation in the test facility to insure proper function.

Followup:

Moisture sensors
Cy will get new moisture sensor data from LTPP sites and give to Jorge for evaluation.

Rich Rogers is in charge of moisture info from LTPP sites. Get from the SPS1 site.

CTR will meet with Richard Liu at RMC1 to get additional information about the moisture sensors.

MDDs

MDDs under contract with TTI to supply and install MDDs. John Ragsdale (IAC Contract). Cy will follow-up on status of IAC.

Need layout specs on number of LVDT per hole. Minimum spacing of LVDTs. Minimum distance from surface, etc.

Weather Station

Thermocouples – up to 25 thermocouples can be monitored. (Dr. Hudson will follow up on temperature buttons (I-buttons) with Terry Dorsey). It was suggested the whether station be moved to Pickle and tested on site. I is currently being operated by Cy Helms at his office.

Load Monitoring System:

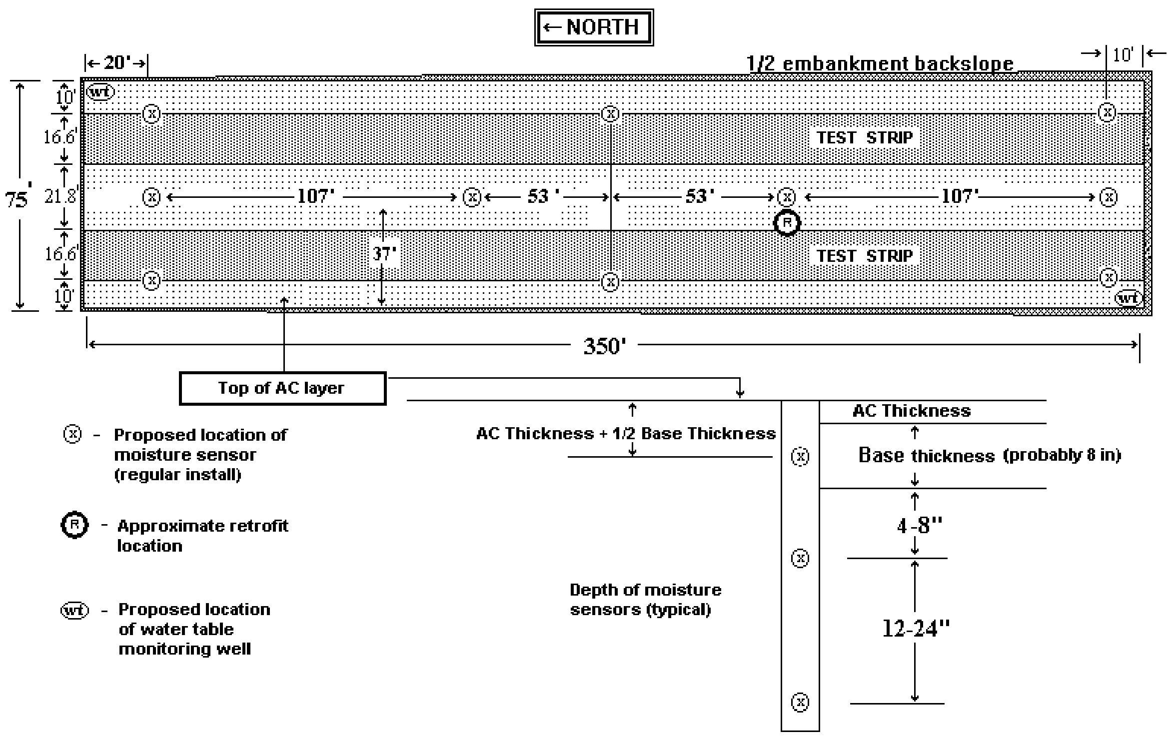
RGB is responsible. Mike Murphy will ask RGB how they plan to calibrate and validate the loads from the strain gauge system.

Profiler – The methods for data collection and processing should be documented and reviewed.

DSPA – TxDOT just bought a new DSPA. The date of delivery unknown. Could borrow one in the meantime as needed.

FWD
PSPA IACs are required for installation and/or data processing
SPA

Soils – Texas Triaxial testing to be done by TxDOT on subgrade, and base materials?
UTEP to perform Mod. of Resilience testing on subgrade.


←NORTH
←20'→
1/2 embankment backslope
→ 10' ←
75'
10'
16.6'
21.8'
16.6'
10'
wt
TEST STRIP
107'
53 '
53'
107'
37'
R
TEST STRIP
wt
350'
Top of AC layer
AC Thickness
AC Thickness + 1/2 Base Thickness
Base thickness (probably 8 in)
4-8"
12-24"
Depth of moisture sensors (typical)
- Proposed location of moisture sensor (regular install)
- Approximate retrofit location
- Proposed location of water table monitoring well

December 18th, 2002 Email

From: German Claros [mailto:GCLAROS@dot.state.tx.us]
Sent: Wednesday, December 18, 2002 8:42 AM
To: Mike Murphy; W. Ronald Hudson
Cc: Dar Hao Chen; Paul Krugler; Ron White
Subject: Re: Richard Liu Memo

Dear Dr Hudson:

I have made a quick review of the memo attached to this e-mail and have the following observations:

1. The memo includes a lot of questions that can be solved by a phone call to Richard Liu.
2. The possible layout is too tentative. You need to develop a more completed instrumentation layout. I do not think we need temperature sensors pair with the moisture sensors in the subgrade. You should investigate how other APT facilities instrument the subgrade.
3. You should coordinate with the RS of the pilot study to define the sensor required for the base and surface layer. I do not see a need to install moisture sensors in the surface layer.
4. Reading rate should be investigated by you and make a recommendation on that. reading rate will depend on data acquisition capabilities, storing, and real variation that needs to be capture. I do not see the need of more than 2 reading a day and even one may be enough.

I would like to see a more developed layout before any meeting is conveyed.

Hudson reply

German we have been working on this since 2 months before RMC meeting . several phone calls plus 2 hour meeting at RMC with Liu. Then Bileu and Dar Hao get involved because his work is with them. We cannot get real answers by phone. If you can do so Please do!!
Yesterday you seemed to agree that we needed to move on this meeting.,You could not attend the last meeting and gave your general OK to the plan, now you say it is not definitive, then you send a email "back to the drawing board". You asked me to tell you when you Micro-manage. THIS is micro-management'.WE have presented 2 plans. I am not going to play games and present more modified plans until we have a consensus.I could revise 19 plans and no one would accept them until we have consensus .

You said in our meeting with Paul that this project took too much of your time. It will if you second guess everything we do.

You can work out the Liu memo with Mike . The ball is is in his court, but we need a meeting with LIU to find out really what he can do and when .
This is just the first step to try to get real facts on Instrumentation. Next is weather station then MDD etc, etc, We always get" oh yeah, no problem", but no definitive facts, Cy Helms was helpful but now he tells up he cant deal with us ,only Dar hao.

As I mentioned on Tues, our approach is to try to work thru Moisture sensors as a trial, then move on others.

-----Original Message-----

January 8, 2003 Meeting Minutes

1. Limit the number of sensors to 20 as this number can be handled by one control box.
2. Put the top sensor in each hole very close to the base material for moisture information at this interface.
3. Move northern and southern 3 sensors 10 feet further into the embankment, closer to where the test sections could be located.
4. Install the sensors during the construction of the embankment but install one retrofit sensor for comparative study of the outputs with other sensors.
5. Incorporate 2 water table portholes into this drawing.
6. It was decided to have 2 control boxes and 40 sensors.
7. Output from moisture sensors will be downloaded directly to laptop or desktop computers and will not be interfaced with the weather station.
8. Pooling frequency will be 1 per hour per sensor. This allows for 4-years of data storage on the control boxes. The frequency of polling is programmable by the user.

Temperature sensors – general consensus was that temperature sensors were not required in conjunction with every moisture sensor. Additional discussions are required, but at this time, TxDOT plans install temperature sensors as they did at Jacksboro:

In MLS – 3 gauges: 2 in wheel path outside WP
Outside MLS – 1 gauge in pavement (no mention of ambient air temperature)

The question was asked should the back slope of the TxAPT embankment be sealed from moisture intrusion and evaporation.

WRH feels this could lead to abnormal conditions. The consensus was to not seal the back slope and to monitor moisture with the proposed gauges. If moisture variation becomes a problem in the future, then having the slope unsealed gives us more options to correct the problem.

Cy will work on a diagram to show how the moisture sensor leads will be run to the control box. Based on this, we will prepare a bill of materials that identifies the numbers of sensors to be built and required lead length for each.

The control box for moisture sensors needs 110 VAC. If power is lost, data is not lost but data collection is suspended. Should we consider running a UPS circuit to the box to insure uninterrupted data collection?

Optional phone line can be hooked up to the control box to download data remotely

Get 30-40 lbs of gray clay should be collected and used to calibrate the moisture sensors to the embankment soil.

WR Hudson will prepare revised embankment instrumentation plan.

Richard Liu will propose adding a temperature probe to moisture probe as a separate instrument.

March 3, 2003 Meeting Minutes

Action Items:

- Richard has researched the lead in wire for the moisture sensors and will send us several samples of wire to look at.
- Cy Helms will go to Houston on March 12th , arriving at 10:00 AM to pick up the camera/profiler instrument and bring the equipment to Austin. Richard will come to Austin on March 20 and meet with project staff to validate the operation of the systems.
- Cy will prepare an area in Building 41 where the device can be tested.
- Ron White will prepare a memorandum describing all the instrumentation the TxAPT Center wants to install for the "Shakedown" test.
- German will follow-up with Mark McDaniel for the TxDOT installation plans of geophone sensors.
- Cy Helm will coordinate with John Ragsdale (TTI) for the MDD installations.
- Jorge will provide a Tech Memo to define what he wants for instrumentation on the Pilot Project.
- Cy Helms will install the weather station at the TxAPT site, on the existing embankment prior to May 12th, 2003.

Meeting Notes:
The goal of this meeting was to establish a roadmap by which all proposed instrumentation would be organized and made ready for installation on the first MLS test site. The first test site will be the "Shakedown" test performed by the TxAPT Center staff.

The equipment supplied by Dr. Richard Liu (University of Houston) was discussed first.

Moisture sensors–
These sensors will be manufactured and shipped to TxDOT by April 15th. TxDOT will calibrate these sensors for the planned subgrade material.

Richard has researched the lead in wire for these sensors and he will send us several samples of wire to look at. The best candidate appears to be one with a thick plastic (polypropylene) jacket. All sensors will be equipped with the same cable.

Two electronic boxes are being assembled by Richard to record the output from the sensors. Each box will have 20 input channels.

Crack Detection and Profiler
This device is ready to be shipped. Cy Helms will go to Houston on March 12th at 10:00 AM to pick up the instrument and bring the equipment to Austin. Richard will come back to Austin on March 20 and meet with project staff to validate the operation of the systems.

Cy will prepare an area in Building 41 where the device can be tested. A special frame will be assembled on which the device can be hung for testing.

Richard Liu will send Users' Manuals for all three devices to Ron White.

Geophones
TxAPT staff is waiting for a plan from TxDOT for the installation of geophones. German will contact Mark McDaniel to follow-up.

MDD
The MDDs can take a maximum of three sensors per hole. Normally, each test will have two MDD instruments installed in the test section. Four MDD assemblies, but preferably 6, should be available to TxAPT for installation. Cy Helm will be responsible for MDD installations. He will coordinate with John Ragsdale (TTI) to get these units installed.

Load Cell
It is planned to install the Captelss load cell WIM system on the first "Shakedown" test to validate the function and calibration of the Strain Gauge load monitoring system.

AC Strain Gauges–
This was not discussed, but if the "Shakedown" section is constructed with 2" or more of asphalt, then we should consider installing an off-the-shelf strain gauge system for testing.

Cy Helms will install the weather station at the TxAPT site, on the existing embankment prior to May 12th, 2003.

Ron White will prepare a memorandum describing all the instrumentation the TxAPT Center wants to install for the "Shakedown" test.

Jorge will provide a Tech Memo to define what he wants for instrumentation on the Pilot Project.
Notes by Ron White

TxAPT/TxDOT Project Status Meeting
Meeting Minutes
April 8, 2003

Attendees:

John Bilyeu, TxDOT
Dar-Hao Chen, TxDOT
German Claros, TxDOT
Cy Helms, TxDOT
Ronald Hudson, TxAPT/CTR
Ron White, TxAPT/CTR
Tom Rioux, CTR
Yetkin Yildirim, CTR
André Smit, CTR
Sharon Campos, TxAPT/CTR

Absent:
Mike Murphy, TxDOT
Jorge Prozzi, CTR
Richard Liu, University of Houston

1. <u>Review Construction Contract</u>

Ron White gave an update on the status of the construction contract for the embankment. The 1st envelope for bids will be opened on Thursday April 10, with the 2nd envelope being opened on April 11 and the review committee will meet on April 15 at 3:00 to receive the bid packages. Construction should begin about mid-May and the selected contractor will have 75 days to complete the project. The utilities did get included in the bid package.

Yetkin asked who is responsible for the mix design. Ron said the contractor does the mix design as provided for in the second addenda. CTR and /or TxDOT will have the ability to verify the mix design provided by the contractor.

2. <u>Status of MLS</u>

Dar-Hao Chen gave a PowerPoint presentation to update all attendees on the status of the renovations on the MLS.

- The hydraulic changes to the MLS are 90% complete.
- The power rail installation is complete.
- The collector arm assembly and wire motors to the collectors assemblies are completed.
- Generator is repaired and running.

The following tasks remain to be completed:

- Install the drive shafts. There were some clips missing from the drive shaft assembly. The parts were suppose to have been shipped and should arrive at TxDOT on April 9. If they do not receive, TxDOTs legal department will get involved in the process. Cy Helms also stated that he would drive down to (**Houston???)** pick them up.
- Run the mechanical test under load. This can't be done until the drive shafts are installed and the MLS is running (approximately 30 to 90 days - depending on drive shaft delivery).
- Install strain gauges. Strain gauges need to be installed and calibrated.
- Install triggering system (to link axle number, axle count, load, MDD deflection). There is an outstanding IAC with University of Houston. Richard Liu will install the triggering systems under this IAC.
- Debug crack and profile systems.
- **Need to add to this list:**
    - Calibrate strain gauges
    - MLS Control Computers still need to be tested as new computer is being purchased.
    - Verify operation of the Captelss Load Cell system (Cy will do)

Comments:

German asked if there is enough money to fund another contract for another drive shaft if needed. Answer was yes.

Jorge Prozzi needs to be involved for the Pilot Study on the Captels load measuring devices and strain gauges.

3. Instrumentation – University of Houston

- Profiler – The new profiler/camera support is not operationally practical. John Bilyeu will give priority to simplifying it. U of H is sending manuals on how to operate the equipment.
- Camera - waiting on manuals to evaluate usefulness of digital camera.
- Moisture Sensors – Will be calibrate by Cy as soon as they are received. Cy will check 20 of the sensors for calibration in clay and base material. Not information was provided on the leading cable for the moisture sensors. We will wait and see what we get from U of H.

Ron White is performing simple experiment on the iButton moistures sensors. If the preliminary test checks out, Cy will incorporate a few iButton moisture sensors in his moisture sensor calibration plan.

U of H is working on a "next generation" moisture sensor we will consider for the future. Richard Rogers is project director on this project.

4. Weather Station.

The weather station is now set up at the TxAPT site and ready for use. It has a built in data logger that records the data. Usually the control trailer is near enough to it to download the data into a computer. The system is currently being powered by 110 VAC with battery and solar panel backup. We can periodically download data via laptop during the construction phase of the site or until the control trailer is moved on site. There are different channels that need to be set up for the data. Ron White will work with Cy to make the weather station operational.

5. **Captelss – WIM – Status -Quality Status of Existing Equipment**

Cy has three sets of frames for installing the WIM load cells and can have more fabricated as needed. This is enough to instrument three pads. He has 4 weight platforms. Two large platforms with 6 load cell elements in each and 2 small platforms with 4 load cell elements in each. If a load cell element fails, the plate can be repaired. If a plate splits in two, a new plate would need to be ordered from France.

Ronald Hudson asked for them to have at least 3-4 plates operational at all times in case one plate breaks. Cy said he has dummy plates and that seemed acceptable to all. If TxAPT needs to order, German asked for a memo from Ron White for approval to purchase and additional large plate.

A comment was made that if the strain gauges work, we would need less of the Captelss. The Captelss electronics are brand new and untested. Cy will setup the system and check its operational status.

6. Load Calibration of Strain Gauge

Discussed under the status of the MLS above. Need to add to the "tasks remaining" list that the strain gauges need to be calibrated.

7. MDD – availability and purchase

There is an existing IAC with John Ragsdale for installing the MDD. German would like to see TxAPT self-sufficient and have someone on staff to install the MDDs. CTL makes an MDD for about $5,000 per unit. John Bilyeu indicated that the installation of MDDs is pretty intricate. Dar-Hao indicated he wasn't willing to devote TxDOT manpower to learn the installation of the MDD since they are only installed only every once in awhile. Maybe TTI could be hired and paid under separate money to come and install the MDDs.

Some recommendations on how many to purchase:

1. How will it be funded?
2. Who will install?
3. Types of MDDs.

Ronald Hudson will look into the aspects of capabilities. He is hard to reach, but has a crew who could train TxAPT staff to put them in.

8. Existing profiler

Need to use the existing profiler on the Pilot Study. The new one will also be used so that it can be tested.

9. Dipstick

Dar-Hao doesn't want to use the dipstick; isn't sure it is needed. Ronald Hudson wants to use dipstick as a backup test. The dipstick doesn't have a computer for downloading data; data is taken manually and then entered.

10. Testing of MLS Control Computers and Data Collection

Incorporated in one computer. Getting a new computer, which still needs to be programmed. This item needs to be added to #2 above under "Tasks Remaining".

11. Temperature Devices

- Thermocouples. TxDOT has two spools of wire, which is plenty for the thermocouples.
- iButtons – Will be installed in conjunction with each moisture sensor. They will also be installed in conjunction with each thermocouple.
- DSPA. TxDOT is ordering four sets. This purchase in independent of the TxAPTC. If needed for construction, one can be borrowed from UTEP.
- RDD. Question about what this is used for? Used for uniformity. Going to be used for selection of test pads.
- FWD. Also used to check for uniformity of test pads.

12. Other

There needs to be a couple of meetings set up soon. One will be a meeting to determine who will read the data and will process the data and give to TxAPT for loading on the website and Access. Specific procedures need to be in place so all data can be read and downloaded easily. Have to do a dummy analysis first before putting final data collection procedures in place.

Geophones. There has been talk (Mark McDaniel, Soheil Nazarian) about putting geophones in the embankment (?) but no plan has been submitted for review. John Bilyeu will send email requesting the plans.

Fiber Optics. Ferguson labs have fiber optics. The UT ITS fiber optics is not normal TxDOT ones. Tom Rioux said that the ones that UT has would work for TxDOT.

Jorge Prozzi will contact John Bilyeu to set up meeting on the Pilot Study.

TxAPT Center
Materials Testing Meeting Minutes
May 27, 2003

Attendees:

Mike Arellano, TxDOT, CST
John Bilyeu, TxDOT/CST M&P
Sharon Campos, UT/TxAPT
German Claros, TxDOT/RTI
Greg Cleveland, TxDOT/CST M&P
Ronald Hudson, UT/TxAPT
Jorge Prozzi, UT/CTR
Tom Rioux, UT/TxAPT
Ron White, UT/TxAPT
Andrew Wimsatt, TxDOT/FTW
Yetkin Yildirim, UT/CTR

The purpose of the meeting was to discuss materials testing and the instrumentation status.

Action Items:

1. German Claros will talk with Mark McDaniel to discuss the geophone issue.
2. German Claros will send written approval to purchase two Kistler sensors.
3. Mike Arellano will establish the testing frequency for soils and base testing.
4. Ron White will call Mark Jones about a new schedule for the Pre-Construction meeting.
5. Jorge will write up the process for test section selection.
6. Tom Rioux will define some questions about the MLS data collection process and data cleansing.

Agenda and Discussion:

1. Finalize and assign persons responsible for the materials testing and site construction QA testing.

   a. M_r testing

   b. Sample quantities

Asphalt test strips will be laid on one day and the remainder of the TxAPT embankment will be paved the next day. This sequence will allow cores from the test strip to be collected and verified for percent air voids.

Greg Cleveland will oversee the paving operations, organize GPR, inspect paving laydown, A/C material testing, etc.

TxAPT will confirm who will perform the M_r test (Soheil or TTI). Mike will provide TxAPT with the required quantity of material for this test.

Mike Arellano will establish the testing frequency for soils and base testing so that the sample sizes can be established.

We have no power over the contractor to enforce the air voids specification (5 to 7%). We must use the Pre-Construction meeting to discuss these issues with the contractor. It was suggested that we also request a Pre-Paving meeting as well to define the paving process and the sampling requirements.

German Claros suggested we assign one person for each material to make sure all testing is covered. The following assignments are as follows:

- A/C – Greg Cleveland
- Base – Mike Arellano
- Subgrade – Jorge Prozzi

It was suggested we use stratified random sampling to select core locations for testing A/C air void content.

In addition to material samples, we also need an estimate of how many A/C cores will be needed for laboratory testing.

2. Discuss any progress made since the last meeting on instrumentation, specifically:

   a. Status of moisture sensors

John Bilyeu has a commitment from Richard Liu for delivery by end of June. They should be ready to go July 7.

   b. Status of weather station-is it collecting data - when can we start downloading data

      Weather station is on the TxAPT site, however it still is not collecting data. Dr. Hudson asked if they could please connect it and begin collecting data for TxAPT to look at.

   c. Status of the MLS repairs

      MLS was turned on and still had problems with drive shaft. They are ordering more parts and will attempt again soon.

   d. Status of the triggering system for recording data

      Richard Liu is developing it. Further information is pending

   e. Status of the new profiler/camera system

      No progress to date. They are converting it to a manual system.

   f. Geophone status

      German Claros will talk with Mark McDaniel to discuss the geophone issue.

g. Other instrumentation

a. Alternate WIM sensors

German Claros gave verbal approval to buy two Kistler sensors for testing on the shakedown section. He will follow up with written approval.

3. Status of the construction contractor

   UT Physical Plant was still waiting for some insurance and bond packages from Ranger.

4. Preparations for the pre-construction meeting (tentative date is still June 5)

   Ron White will call Mark Jones about a new schedule for the Pre-Construction meeting.

5. Discuss the Pilot Study and Shakedown Test Plans.

   Ron White did not have a test plan for the shakedown test. Jorge handed out a test plan for the Pilot Study. Jorge will write up the process for test section selection.

6. Discuss data cleansing/processing protocols

Tom Rioux will define some questions about the MLS data collection process and data cleansing. He will arrange for a meeting with Cy Helms, John Bilyeu, Jorge, to discuss this process and establish some basic guidelines. Once established, the basic guidelines will be tested during the shakedown test.

APPENDIX D

TXDOT PROPOSED MOISTURE SENSOR INSTALLATION PROCEDURES

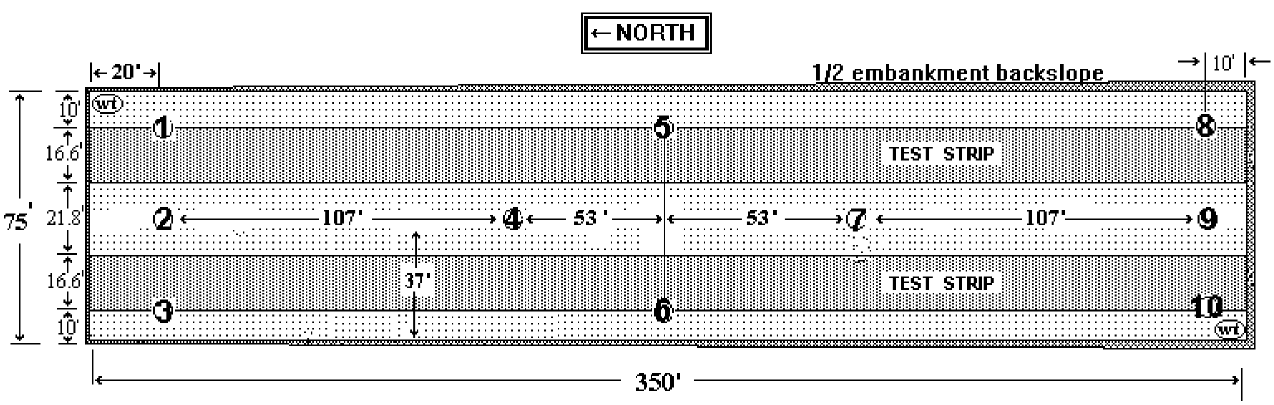
Moisture Sensor Installation Procedure

Gather some tools and supplies:

- Total-station to shoot locations
- Tape measure to measure depth
- 10-inch auger or at least a post-hole digger
- Pointy digging tool (for digging trenches in subgrade)
- Saw (for digging trenches in base)
- Plate compactor for repacking trenches
- Tamping rod to compact soil in sensor holes (4x4 lumber?)
- Shovels (full size and hand trowel)
- Screenings (to protect sensors in base layer)
- Spray paint
- Marking pens, tape

Preliminary work:

Label the sensors with their location. Suggested marking scheme:

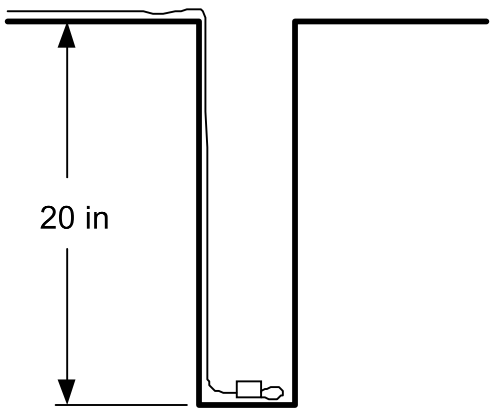


Then at location 3 for example, there can be a 3T (top) 3M (mid) and 3B (bottom). Label the sensors on both ends of the line so there's no confusion later.

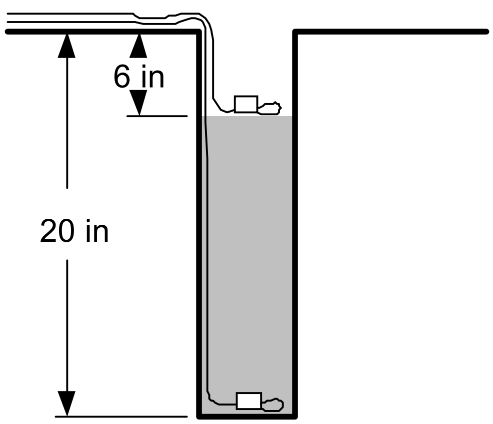
The M and B sensors will be installed after the embankment (subgrade) is constructed and before the base layer is constructed. The T sensors will be installed after the base layer is constructed.

Establish a reference point (and back-sight) somewhere off the embankment. These points must remain intact during base layer construction. Set up the total-station at the reference point and shoot in the locations of all the sensor holes. Mark them with spray paint.

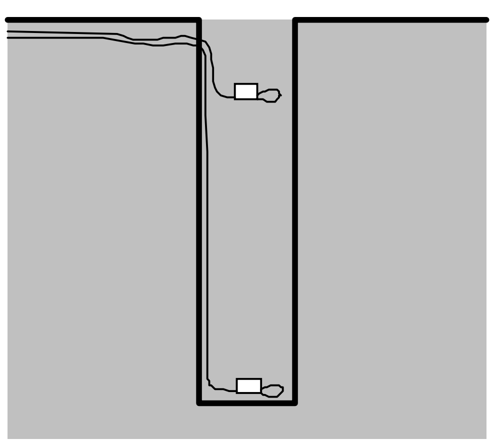
At each location, dig or augur 20 inches into the embankment and set the bottom sensor there:



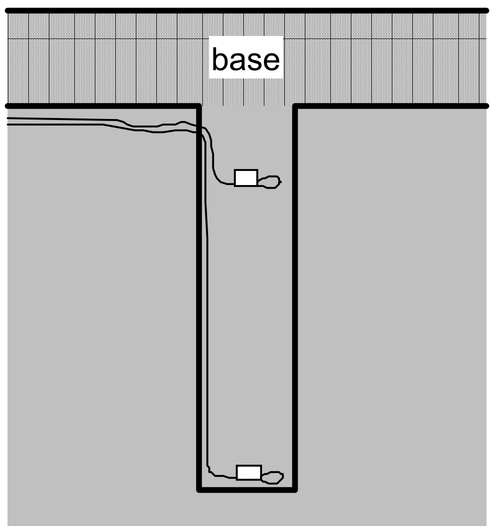
Carefully refill and repack the soil into the hole until it is 6 inches deep. Put the mid sensor at that depth:



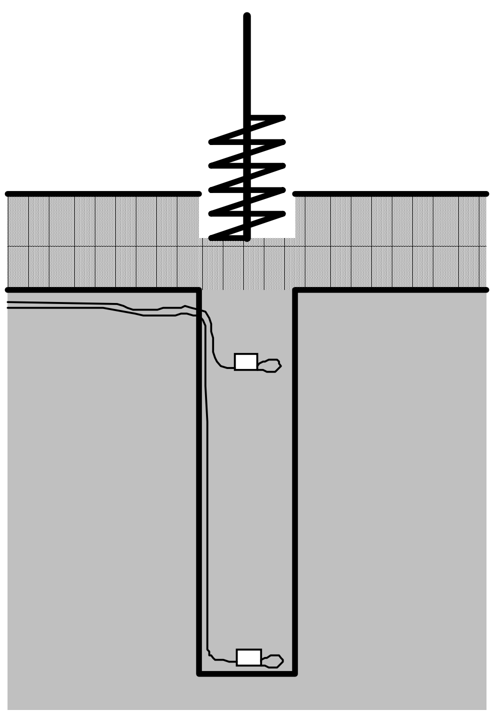
Dig a trench, about 2 or 3 inches deep, leading away from the hole. Bury the two wires in the trench and repack the original soil into the hole and trench. Use the plate compactor to smoothly compact the soil over the trench and hole:



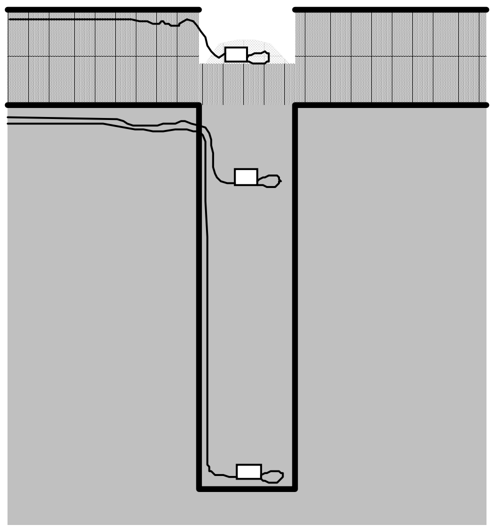
Wait until the base layer is put down. Then set up the total-station and re-shoot the locations, marking them with spray paint.



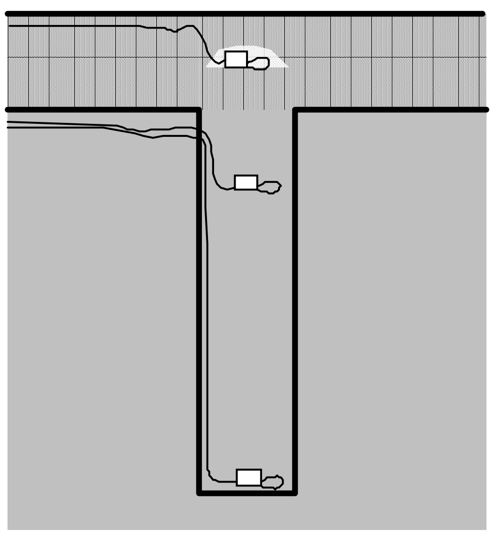
Dig or augur halfway (4 inches) into the base. Sawcut a small trench leading away from the hole, similar to the trenches in the subgrade. It may be necessary to make sawcuts.



Set the top sensor at a depth of 4 inches. Bury the wire 2 or 3 inches below the surface same as the previous wires. Put a shovel full of base screenings on the sensor to protect it from sharp pieces of base:

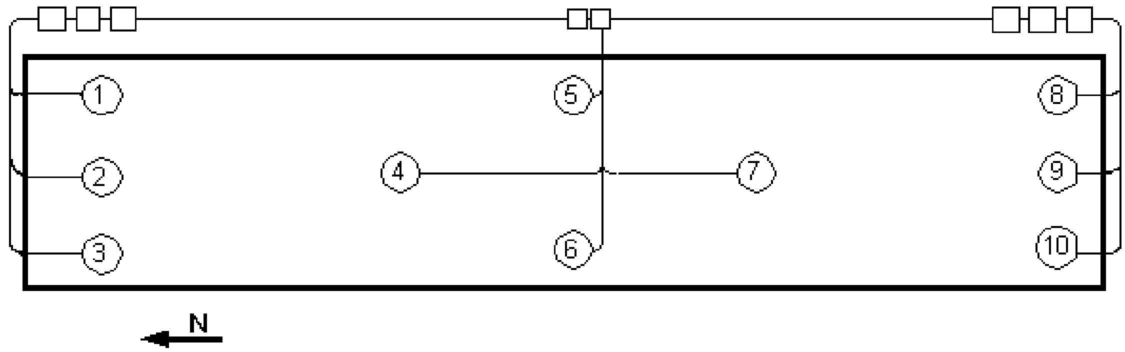


Replace the base material and use the plate compactor to smooth everything out:



That's it! We will probably want to check the sensors immediately after installation to see how many we broke.

Trench map:



Note: The exact location of the i-button collection boxes has not been pinned down yet. The two collection boxes for Richard's moisture sensors will most likely go on the east side of the embankment (directly east of location 5).

APPENDIX E

TEST PROCEDURES FOR US59 TEST PAD R3-1 (DRAFT)

Test Procedures for US59 Test Pad R3-1 (DRAFT)

Things to do or note Prior to Testing

We have not collected MLS data in a while, so we are bound to be rusty on all the procedures. On top of that, some things will be different from the procedures done in Jacksboro. New procedures related to crack monitoring, PSPA or strain gauges may come up during the Lufkin testing. Fortunately, the Lufkin tests will be SHORT, and mainly to debug the MLS and relearn our data collection procedures. The following is a tentative guide.

1. The top layer of section R3 (where the first MLS test will be run) is 3 inches of AC. This is the only layer where we will monitor temperatures. Keeping with the idea of Surface, Top, Middle and Bottom thermocouple depths, they should be installed at 0" (epoxied to the surface) 0.5", 1.5", and 3." The thermocouples can be set in the same location on the test pad as we had them in Jacksboro, along the centerline near 9~10.5m. If there is no Captel drain, the wires can be run through a sawcut or out the 12m end of the pad.
2. For now there are no changes to the transverse and longitudinal profiling. The transverse profiles are run twice for the initial Zero-k collection. Longitudinal profiles are still at 760mm left and right of centerline. All transverse and longitudinal gridlines should be drawn and labeled so that profiles are always taken in the same place. The regular FWD tests are on the same 27 points we have always done. The wheelpath locations are 925mm left and right of centerline. The transverse gridlines are still every 1.5m.
3. FWD whole history collection is at five points: 6L, 4.5C, 6C, 7.5C and 6R (this is the easiest order of points to move the FWD trailer around). We will run the Edition 20 whole history program which collects 60ms. See Cy's detailed Whole-History collection procedure.
4. MDD-FWD procedure: The left and right MDDs will probably be installed at the same locations on 4.5m. If the FWD-MDD distance (FWD plate to MDD cap) is marked out straight from the beginning, that eliminates having to measure and record the distance every time. Cy will come up with a plumb-bob or pointer system! Mark a spot 9" behind (toward line 0m) the MDD centers and let that be the center of the FWD plate. Make another mark 18" behind the center of the MDD cap. Line up the trailer carefully over the 9" point and do three (4-load) FWD drop series at that location. Then move to the 18" distance and do one 4-drop series.
5. Occasionally the anchor movement will need to be measured, using the 7th FWD geophone. This procedure will be typed up on another sheet.
6. Conduct PSPA and SPA tests at all grid points from 3 to 9m, Left, Center and Right (15 points). If we have strain gauges and they are able to measure MLS loads 0-3m and 9-12m, we should do PSPA and SPA tests there as well. The PSPA is done with the "lunchbox" oriented both longitudinally and transverse at each point. PSPA collection can be done by crew members using the procedure sheet. The SPA is done with the trailer oriented the

same at each point as the FWD trailer. The software that drives the PSPA and SPA will be changed soon, requiring another sheet.

7. Record the static Captel and/or strain gauge data as the loads are set. The strain gauges will need to be calibrated using Captels or portable DPS scales. As U of H develops new equipment such as the strain gauges and optical crack monitoring system, we will have to learn new procedures. Some of this may be as soon as the Lufkin testing. All new procedures will be simplified as much as possible and summarized on one sheet, which can be laminated and kept with the equipment. **more info to follow when we know what's going on**
8. Record the initial static MDD voltages, making sure any MLS tires are well clear of the MDDs. The readings should be around +7 ~ +8 volts initially, and will decrease gradually as the test pad is compressed.

During Testing (any interval)

Record rolling MDD and dynamic Captel and/or strain gauge data at three times: the beginning, middle and end of the run. More details will follow as we find out more about the strain gauges.

After 20K Repetitions

Before machine is raised:
1. Collect static Captel data or strain gauge readings.
2. Record the static MDD voltage readings, making sure the MLS tires are away from the MDDs.

After machine is raised:
1. Do transverse and longitudinal profiles once.
2. Collect dipstick data longitudinally on the same lines as longitudinal profiles, starting at 0m. There should be 40 readings out and 40 back. Make sure there is an even number of readings or you will confuse John (worse).
3. Collect SPA and PSPA data at the same locations (3-9m) as before.
4. Do regular FWD and whole history at the points mentioned above.
5. FWD-MDD in both wheelpaths, three series at 9" and one series at 18"

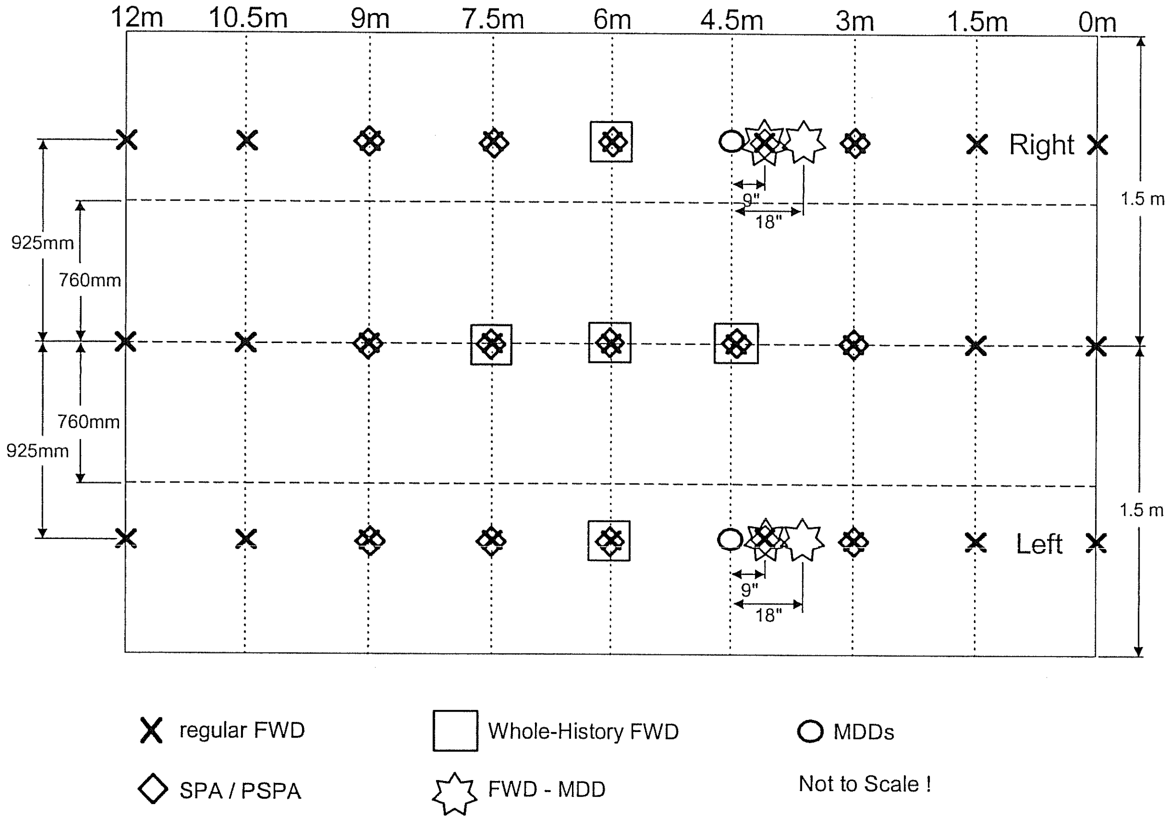
Follow the same procedure at 40k, 80k, 150k, 300k.

AT 300,000 Repetitions

Data collection as usual, except for the FWD-MDD:
Do the FWD-MDD tests while recording the anchor movement, as done prior to MLS testing.

Notices:

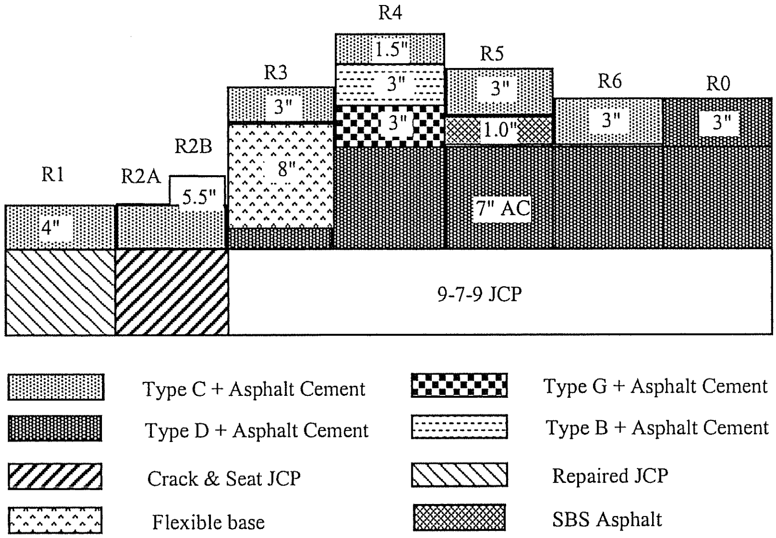
1. Check/set the dates and times in all the computers, especially the weather station's data logger. Make sure any Windows95 machines are set to adjust for daylight savings time and watch out for DST on the DOS machines.
2. The weather station has recently been revamped and should be more reliable than it has been, since it has new nonmoving parts. However, it is unproven when running on intermittent generator power. Its data should be downloaded every week while it is "on probation" *regardless of when the other data is collected.* This way, we can fix any weather station problems right away with no more than a week's data lost. The contract for instrumentation help from U of H is extended, so we can call on those guys for help if necessary.
3. Trailer rigs like the SPA and FWD should be pointed toward the 12m line for all testing except at 10.5m and 12m, in which case the trailer will not fit on the test pad and should be flipped around.
4. Filenaming convention:
   Filenames should indicate the pad being tested and the number of axles run. For example, regular FWD data collected on pad R3-1 after 40,000 axles would be named R3-1-40k.fwd. Other files such as MDD or transverse profiles where there are several files generated at the same time can be differentiated by the methods in Cy's handout. DO put those files in a folder that indicates the testpad and number of axles run.
5. See the map for a clear guide on where each test is run:



NOTES REGARDING TEST PERIODS AND TEMPERATURES

During any week of the year, at-depth pavement temperatures have a standard deviation of 8-10 degrees F. These short-term fluctuations are present year-round and cannot be avoided. Testing "prime time" is from the 2nd week of June to the 2nd week of September. This is when at-depth pavement temperatures are high and most consistent. On the rut-resistant sections of US59, the MLS will produce rutting most quickly during this time of year, shortening the test periods. There is no season when MLS testing is precluded by temperature variations. It should be noted that temperature drops an average of 2.7 degrees/week from the 2nd week of September to the 2nd week of December. From the 2nd week of December to the 2nd week of March, temperature rises an average of 0.8 degrees/week. From the 2nd week of March to 2nd week of June, the temperature rises about 2.2 degrees per week. MLS tests conducted during these periods should be shortened as to avoid a large temperature difference from the beginning to end of the test. The following table shows the pavement temperature variation (degrees F) that can be expected during 3, 4, or 5-week tests ending different weeks of the year:

		3-week test	4-week test	5-week test
Jan.	**1**			
	2			
	3	27.2		
	4	31.0	31.0	
Feb.	**1**	33.8	34.5	34.5
	2	39.5	39.5	39.5
	3	31.8	39.5	39.5
	4	34.7	40.3	42.7
Mar.	**1**	34.1	34.7	40.3
	2	36.7	37.0	37.6
	3	31.3	39.2	39.2
	4	29.4	31.3	39.2
Apr.	**1**	23.8	29.7	31.6
	2	27.0	27.4	33.4
	3	23.7	27.5	28.0
	4	31.1	32.2	36.0
May.	**1**	31.0	33.6	34.8
	2	28.0	33.8	36.5
	3	25.4	29.4	35.3
	4	31.7	32.4	33.6
Jun.	**1**	35.1	36.4	37.0
	2	35.1	35.1	36.4
	3	22.4	35.1	35.1
	4	26.0	27.7	35.6
Jul.	**1**	26.6	28.2	28.7
	2	26.2	26.6	28.2
	3	20.1	26.2	26.6
	4	19.1	20.9	26.9
Aug.	**1**	19.7	19.7	21.4
	2	18.6	19.8	19.8
	3	19.2	19.4	20.2
	4	18.7	19.2	19.5
Sept.	**1**	20.3	22.4	22.4
	2	23.0	23.6	25.7
	3	23.0	27.9	28.4
	4	21.1	23.0	27.9
Oct.	**1**	22.3	23.8	24.8
	2	24.9	26.2	27.3
	3	30.0	32.7	32.7
	4	39.6	39.6	40.6
Nov.	**1**	31.8	40.6	40.6
	2	31.7	34.3	43.2
	3	27.6	31.7	34.3
	4	26.6	28.7	32.0
Dec.	**1**	29.4	32.8	34.8
	2	26.4	29.4	32.8
	3	32.1	32.1	35.1
	4	32.1	32.1	32.1



The cross sections for the overlays on rigid pavement