USNWG on Taximeters, GPS Subcommittee

October 20-21, 2015

Sacramento, CA.

Draft Summary

# Preface:

At the October 20-21st meeting, the GPS Subcommittee of the USNWG on Taximeters was informed of a change in the Subcommittee’s chair position during that meeting’s opening remarks. This change involved replacing Mr. Bill Fishman with Mr. John Barton (NIST OWM) as chair. Mr. Barton will now serve as chair and technical advisor to the Subcommittee.

The participants were introduced and the California Division of Measurement Standards (CADMS) was recognized for hosting this meeting. The subcommittee was given an overview of the purpose and scope of the GPS Subcommittee and the urgent nature of that work was emphasized.

The members were also informed that the CADMS had recently submitted a proposal for a new, separate NIST Handbook 44 (HB44) Code that would be applicable to Transportation Network Systems or TNS. Transportation Network Systems is the phrase that is being used to refer to the type of technology used in the vehicle-for-hire industry that is characterized by the use global positioning system (GPS) (and/or other location services) along with proprietary software applications or “apps” to provide vehicle-for-hire services to their customers. This proposal was submitted to the regional weights and measures associations for consideration as a developing item. It is expected that this proposal will appear on the National Conference on Weights and Measures (NCWM) agenda during its upcoming Interim Meeting in January 2016.

Ms. Kristin Macey explained to the group that the development of the proposal for a new HB44 code for TNS was to some extent motivated by specific needs in the state of California where a number of Transportation Network Companies (TNCs) have established operations. Ms. Macey explained that the necessity for a new code for TNS (rather than including them in the existing Taximeters Code) was based primarily on the differences in the technologies used in TNS as compared to traditional-type of meter-based services.

The participants were also informed that the U.S. National Working Group (USNWG) on Taximeters has been developing proposed changes to the existing HB44 Taximeters Code that would enable that code to be appropriately applied to TNS. Mr. Barton explained that while this approach did not align with approach taken in the CADMS proposal, the work involved to develop either set of proposed changes would not be mutually exclusive. The changes necessary to the existing HB44 Taximeters Code could also be applied in the development of a new separate code for TNS. The details of those changes that could amend the existing HB44 Taximeters Code can be found in this summary under the discussion portion of item IIIA of this meeting summary.

During the October 20, 2015 GPS Subcommittee meeting, some members requested an explanation of the reasoning behind the submission of a proposal to the National Conference on Weights and Measures (NCWM) to establish a separate NIST Handbook 44 (HB44) Code that would serve to apply to TNS. Ms. Macey responded by stating that when California regulators began to evaluate the TNS services, it was apparent that there were significant differences between TNS and more traditional-type taxi services. Those differences encountered by the regulatory officials involved in the testing were found to pose significant challenges in applying requirements and test procedures already established. The regulatory officials considered the established standards inappropriate for application to TNS. Not only were the HB44 requirements considered to be less than adequate but also the evaluation checklist contained in the National Conference on Weights and Measures, National Type Evaluation Program’s (NTEP) Publication 14 did not lend itself to be used in an appropriate manner for the evaluation of TNS.

A number of significant differences between traditional-type taxi services and TNS were noted during the testing performed by California officials including an estimate for the total fare charges provided to the potential customer prior to accepting the service. Another difference cited was that those TNS evaluated provided a detailed receipt to the passenger (via email or text message) that included the statement of fare charges based on time and distance values and a map of the route taken by the vehicle.

Ms. Macey informed the subcommittee members that the proposal submitted by CADMS for a separate HB44 code for TNS is intended to become a tentative code that could serve as a model for other regulatory officials to use on a trial basis. This tentative code could presumably then be used as a framework for the further development of a permanent TNS code. She also informed the subcommittee that it was not expected that that every necessary detail of the regulation of TNS would be sufficiently addressed in the initial drafting of the proposal.

# General Considerations

Mr. Barton asked the participants of the meeting to consider that, the TNC systems can be viewed as being comprised primarily of three main components that are used to produce a measurement of time and/or distance and then to calculate the total charge to the passenger. The three components are: the global positioning system; the cellular telephone (or similar device); and the software application or “app.”

In the subcommittee’s work towards the development of standards and regulations for these types of systems, it may be helpful to segregate the important issues in relation to those individual components. By doing so, the many important issues involved in the use of these type of systems could be partitioned and addressed with a more focused perspective and in simpler terms and thus (hopefully), resolved more easily. Following this approach, the following classifications will apply.

**Discussion:**

Mr. Barton stated his belief that since the GPS is managed by the military branches in the U.S. Government, it would be unlikely that any verification by civilian regulatory officials would be possible and he asked the subcommittee whether they felt if that type of verification would be absolutely necessary. The subcommittee generally agreed with this premise and did not believe that it is practical (or even possible) for a regulatory official to perform a certification specifically of measurement data provided by locator services that would be used in the calculation of passenger fares.

The subcommittee was provided with some details regarding the testing of a TNS by California Department of Food and Agriculture regulatory official that highlighted some of the unconventional methods used to assess these systems. Mr. Robert Takemori informed the subcommittee that the test courses selected for these evaluations were chosen due to the environment and conditions likely to be encountered on the courses. These factors included changes in elevation, tunnels, excessively crooked streets, high-rise buildings, poor atmospheric conditions, etc. It was observed during these tests that occasional (GPS) signal loss did occur and in some cases this loss affected the measurement of distance. This testing took place in part on a “measured-mile” course and in other instances the results of the fare calculation done by the TNS was compared to a traditional-type taximeter whose performance had been previously verified.

Mr. David Paul noted that GPS would not likely be the only source of identifying the vehicle’s position used in the business model of a TNS. He pointed out that there are other global positioning services and a number of auxiliary services that can be used together to obtain a more accurate and reliable positioning of the vehicle. The USNWG acknowledged this and agreed to use the more generic “location services” terminology instead of “GPS.”

In addition to global positioning services, a variety of technologies are available for use to augment and/or improve the performance of the positioning services. The GPS Subcommittee agreed that the term “location services” would encompass GPS and other global positioning services as well as any type of system or network used to augment those services and improve on their performance. All of these technologies working in concert may be used to produce an input as a source for measurement data used in the calculation of a passenger’s fare in the TNS.

It was suggested that since GPS or other types of locator systems provide a measurement used by the TNS providers, perhaps the responsibility of assuring that this measurement is accurate and correct would be appropriately placed on the service provider. A verification of the system as a whole via of comparison with a traceable measurement may be sufficient for the purposes of regulation of TNS.

The subcommittee members addressed a second component of the TNS that is a software-based device which would be used in place of a dedicated indicating element in a traditional-type taxi service. Typically, the potential customer will contact the service provider through the use of a personally-owned device such as a cellular telephone or tablet. These devices would have a software application installed on them to facilitate a request for a vehicle and to later provide a receipt once the service has been completed.

One concern discussed by the subcommittee was that it would be highly impractical if not impossible to apply regulatory standards to personally-owned devices such as cellular telephones or tablets. It was noted by the members that even though this type of device would perform as a component in a TNS, this would be a temporary status and would change with virtually every transaction. Another concern was the possibility that another software program running on a cellular telephone could interfere with the performance of the TNS’s service if both features were operating on the device at the same time.

Mr. Phillip Steiner questioned the subcommittee about the impact that an update of the operating software on a personal device (cell phone or tablet) would have on any certification given to the TNS whose functionality is dependent on that operating software. Specifically, the members were asked if there would be a need to re-certify a TNS after any update of operating software (e.g., IOS, or Android systems) was downloaded onto the device. Mr. Barton responded that it was his belief that if the operating system had any metrological effect on the TNS application installed on the device, then any revision of that software would be a reason for re-certification. He added that on other weighing and measuring devices that employ software, it is required to be identified with a version number. That version number can then be used by the regulatory official to verify that the software installed on the device is the same as that which had been tested under type evaluation.

Mr. Barton suggested to the subcommittee that there may be an alternative to involving software experts or analysts in the routine examination of TNS. Referring to procedures that are followed by many weights and measures field officials, it may be more reasonable and practical to require that software version numbers be made readily accessible to regulatory officials as a means to verify that the software installed on the device is certified. The subcommittee was also provided with copies of the NTEP’s Software Sector meeting agenda for the meeting of that group in September 2015. This document provided the subcommittee with examples of the issues being considered by the Software Sector and how those issues were being considered in a broad spectrum of various types of devices that are software-based. Mr. Barton suggested that resolutions from the Software Sector could possibly be considered as the basis for establishing the validity and the security of the software used for the operating systems installed on those personal devices.

It was pointed out to the members of the subcommittee that there are very few instances where specific requirements that address aspects pertaining to the software used can be found in other HB44 specific device codes. The subcommittee was informed that most requirements pertaining to software are found in the HB44 General Code and relate to the identification of software. Mr. Barton noted an exception to this would be requirements developed that address the security of metrological components in the software (i.e., the use of electronic sealing).

Mr. Seth Schreiberg stated that in his view, HB44 requirements should not be drafted so that they are excessively prescriptive by dictating software design but should instead be more results oriented (i.e., concerned with the final calculation of fare).

A significant point made during the October, 2015 meeting was that while the passenger/customer’s device is generally replacing an indicating element in a more traditional-type of system, in the TNS models that have been evaluated, there is no running total of indications of measurement or charges. Since there is no indication of measurement data or accruing charges displayed to the customer, the argument can be made that these personal devices should not be considered as indicating elements. It is noted however, that in the TNS models that were evaluated by California officials, a record in the form of a final statement/invoice is provided to the customer and that this receipt does include a statement of distance/time measured and the total of all charges assessed.

Mr. Jesse Davis pointed out to the subcommittee that this is the basis for his belief that the TNS can not be considered as a “taximeter.” The fact that the TNS is not a device and there is no indication of fare provided to the passenger (prior to a receipt being issued) makes it inappropriate to classify these systems as taximeters. Mr. Davis also made the claim that the National Type Evaluation Program (NTEP) does not certify software therefore, the TNS can not be type certified. Ms. Macey points out that there are instances where software has been certified under NTEP by citing fuel dispensing controllers and point-of-sale systems. She further explained that after that software has received NTEP approval, there is a required means to readily identify the version of software being used on any device/system. This allows for a field official to verify that a device/system in service is operating on software that has been evalulated.

Mr. Schreiberg stated that in his company’s business model, the customer’s personal device (typically a cellular telephone) would be the nearest equivalent to an indicating element in other weighing and measuring devices/systems. Mr. Barton noted that the passenger’s cellular telephone is a transitional device in the sense that with every transaction, a different cellular telephone becomes a component in the TNS.

Mr. Phil Steiner also pointed out that the driver’s cellular telephone may not be a permanent fixture in the TNS service in that there is no assurance that this device will not be interchanged with another. Mr. Steiner also stated that there may not be any need to require an indicating device in a TNS because it is his understanding that there is no customer information available until the trip has concluded, at which time a receipt is provided with the necessary information.

Mr. Schreiberg and Ms. Andrea Lobato (representing Transportation Network Companies or TNCs) were asked if their services would be able to provide a running total of measurement data and passenger charges. Each responded that to the best of their knowledge, this would not be feasible. Some other subcommittee members noted however, that traditional-type taximeters do not provide a continuous running total but instead provide only the display of updated fare charges at each interval (money drop). This generated more discussion among the subcommittee about what can actually be considered as a “running total.” Some members drew an analogy to the display of incrementing fare amounts displayed by a taximeter during intermittent intervals to the resolution of other types of weighing or measuring devices. Mr. Steiner pointed out that a “real-time” display is a relative concept. This prompted others in the group to question the value and benefit provided by an intermittent update of fare charges when considering that the update of that display will typically reflect relatively large increases in the total fare amount. With this notion in mind some subcommittee members also questioned whether it is necessary to develop requirements for application to TNSs that would mandate a “running total” on those systems.

Ms. Macey made a comparison of the TNS operation to the operation of dispensers being used to refuel hydrogen powered vehicles. She informed the subcommittee that the current design of (presumably) all hydrogen dispenser makes and models will not allow the fueling to be stopped during a refueling process until it is completed. This would not allow the customer to view a total accumulated charge until the vehicle has been completely filled. Ms. Macey questioned however, whether TNS would be able to be designed in the future in such a way that would allow the passenger to view fare charges as they are accumulating during the trip.

Mr. Bill Fishman asked those TNS representatives in the subcommittee if their services included the registration of customers by way of the customer’s acceptance of the terms of service for that TNS. The answer provided was that in both cases, the only means to use the service is for the customer to register with personal and financial data (primarily a credit card to be used for payment) and to acknowledge an acceptance of the terms of service for that provider. Mr. Fishman suggested that since the passenger must enter into an agreement with the service provider this might be considered to be a contractual transaction. Based on that suggestion, it was noted that there are specific exclusions of certain requirements found in other device codes in HB44. Such is the case in the Liquid Measuring Devices Code regarding the display of unit pricing to the customer for motor fuel sales occurring under the terms of fleet or other contractual sales. In those situations it is acknowledged that the pricing of the fuel is presented to the customer in the terms of a contract so the fuel dispenser is given an exclusion to the requirement of a unit price display.

Mr. David Paul stated his objection to the notion of providing an exemption to the TNS that would allow those systems to operate without requiring them to display customer information that traditional-type taximeters are required to display. He noted that both traditional taxis and TNS provide an equivalent service (i.e., transporting a passenger from point of origin to their destination) and calculate the fare for that service using time elapsed and/or distance traveled during the trip. It is his belief that to provide an exemption to TNS from providing a display of information that is of interest to the passenger represents an inequity of the regulatory standards. Mr. Paul also voiced his belief that allowing TNS companies to operate without requiring them to provide an indication of fare charges during a trip, represents an unfair advantage over their competition (taxis) who have made the investment of installing the necessary equipment to perform that function.

Mr. Steiner noted that a taximeter would remain in service for a period of several years after being installed and that the investment is minimal. This is in comparison to the cost of any licensing, insurance, medallions, etc. is far more expensive.

Mr. Schreiberg and Ms. Lobato both pointed out that traditional taximeters do not provide an estimate of the fare prior to the service being accepted by the passenger. They also pointed out that the receipt supplied to the customer at the conclusion of the service is very detailed (possibly more so than any receipt issued by a taximeter) and should be sufficient enough for the passenger to determine if they had been treated fairly. The detail of the additional features provided by the TNS (estimate of total fare and map of route taken) was considered by some subcommittee members to be advantageous to the customer in making a value comparison of the services.

Ms. Joanne Rausen raised the question to the subcommittee if there is any consideration to accept that the TNS will not provide an updated or running total of customer charges during the service. There was a general recognition among most subcommittee members that the presence of a contract between the service provider and the customer would make it possible for the TNS to operate without providing a running display of customer charges. Mr. David Paul noted however, that a running display is important to avoid any situations where the customer’s available funds would not be sufficient to cover the total charges accrued for a complete trip.

Some subcommittee members cited advantages of being able to observe a display of running charges in that the customer is able to use that information to make a value judgement of the service provided. Ms. Lobato made the point that if the consumer values that feature in a for-hire vehicle, they are free to use a traditional taxi service that would include a taximeter. Mr. Schreiberg added that the TNS services provide a good faith estimate of the total fare before the service is accepted by the customer allows them to make a value comparison of the for-hire services available. He added that in his view, both traditional type taxi service and the TNS have means to provide the customer with information to make value comparisons but just in a different manner.

Mr. Barton suggested that if the subcommittee is considering to recommend a proposal that would allow the TNS to operate and not to require a dedicated indicating element or a display of updated passenger information, it would seem prudent to draft a requirement in HB44 that specifies a clear and succinct terms of service. The proposal should require that important details about the service are presented to the potential customer in such a way that the customer is made readily aware of how the service operates and those terms of service should not be excessively complex.

Ms. Macey stated that the perceived disparity between the existing standards traditional-type taximeters and the proposed requirements for TNS may be a difference that would be reconciled in the future. Explaining that allowing the TNS to not display a running total of fare indications could be extended to taximeters at some point, or that TNS may be required to include such a display to the passenger at some future date. This is something that could be administered through the development of requirements that are non-retroactive and would not be enforceable until a designated effective date. Ms. Macey noted the relatively fast-paced evolution of the equipment used in the vehicle for-hire industry and suggested that at some point in the future both types of systems could be encompassed in a single HB44 code. Ms. Macey pointed out however, that at present there is a dire urgency to provide a standard to apply to TNS.

The subcommittee was asked to consider a third component in the TNS model. The members discussed the lack of a dedicated indicating element in the TNS.

The subcommittee addressed the question of what a for-hire vehicle system would be classified as if it consisted of a taximeter that was software-based and received distance measurement data from location services such as GPS. Mr. Jesse Davis informed the members that there are systems already in service and which have been granted type approval through the National Type Evaluation Program (NTEP) that include a completely software-based indicating element. It is his belief that this type of system should be correctly classified as a taximeter in spite of some differences in design of the system. He added that although this type of system consists of a taximeter that is completely software-based, a display of incrementing fare charges is provided.

Mr. Gaurav Nukala stated that his company’s (Flywheel) system incorporates an indicating element that is mounted in the vehicle. This indicating element is software-based and could be a generic type of device including a cellular telephone, tablet or other (Not Built for Purpose Device) and it does have the same display capability as a traditional type taximeter. The indicating element is somehow mounted in the vehicle however, it can easily be removed. It differs from a taximeter however, by receiving its measurement data from GPS. Mr. Barton noted that this type of device, unlike a traditional taximeter that receives pulses from the vehicle’s components, could be used in any vehicle since there is physical connection to the vehicle that must be factored into the calculation of distance traveled.

Ms. Macey informed the subcommittee that it is her understanding that the NTEP policy is to not perform any evaluations of systems that receive measurement data from GPS (or other location services) before the USNWG on Taximeters completes its task of the development of appropriate standards. Furthermore, she added that unless an appropriate HB44 code is developed, there is no means for systems that wish to use the measurement data from locations services to receive a NTEP certification. She informed the subcommittee members that until there are standards applicable to GPS (or similar location services) in HB44, NTEP does not have a foundation to use to perform evaluations of a system that makes use of that measurement data.

Mr. Barton stated his belief that a vehicle for-hire service that includes a taximeter that is software-based and receives measurement data from location services would appropriately be classified as a taximeter and that there should be amendments proposed to the existing HB44 Taximeters Code that would accommodate the use of location services.

The subcommittee also considered a variety of issues regarding the software used in TNS services, and primarily the security of that software. It was noted that this concern is multiplied due to the use of different software programs involved in the functioning of these systems. This would include (as a minimum) the software element in a location service such as GPS, the software application (app) provided by the TNS, and the software used in the operating system on the device where the TNS app has been loaded onto.

Mr. Barton shared copies of the NTEP Software Sector’s September 2015 meeting agenda containing the issues that that group addressed at that time. This agenda was provided to the GPS Subcommittee to demonstrate that there are others who are considering the issue of software security however, the Software Sector is dealing with software concerns in general and not as it is associated with any particular device. Included within this document is a draft for an evaluation checklist that itemizes particular criteria that an evaluator would examine.

Mr. Barton suggested to the subcommittee that based on the ongoing work (seen in meeting agenda) of the Software Sector, perhaps it is prudent to allow that group to continue the development of policies to verify/certify software and then incorporate those policies within the requirements to be developed by the subcommittee for TNS and other systems using software that is metrologically significant. Ms. Macey suggested that the subcommittee be expanded to include experts in the area of software and programming. Mr. Barton pointed out that there is likely no one in attendance that would qualify as a software expert, and that it may be counterproductive to turn this subcommittee into a software committee. As an alternative, if the subcommittee could develop a list of specific concerns and questions regarding the use of software in these systems, those concerns and questions could be given to appropriate subject matter experts and it be requested that those experts provide input for the subcommittee to consider.

Mr. Pere Tomas stated his belief that the subcommittee’s apparent acceptance of the accuracy and validity of data from GPS or other location services will circumvent a need for verification of these systems and would signify a leap of faith by regulators that everyone associated with these systems will abide by fair practices. Ms. Macey acknowledged that there will be some level of uncertainty involving the security of devices/systems but noted that the duty of weights and measures regulatory agents is to uncover this type of practice and to take appropriate action.

Mr. Fishman expressed concerns regarding the software program in the TNS service that performs the calculation of fare based on location services input by asking the subcommittee what is the potential effect that other features on an operating system (IOS or Android system) could have if they were to run at the same time that an TNS app was running. For example, could a telephone call received by a cellular telephone interfere with the functioning of a TNS app when both functions occur at the same time. Regarding the security of the software application or “app,” Mr. Nukala stated that when residing on an operating system such as I-phone operating systems (IOS) or Android operating systems, apps are located in a “sandbox” (i.e., they are isolated) so that interference from any other app on the device can affect their app.

Mr. Barton presented the subcommittee with a draft of a proposed new requirement for the HB44 Taximeters that intended to address this concern. This draft of a new paragraph S.1.3.3.3. would require that a software operating system that is running on a personal device would need to have the means to prevent any interruption of a transportation-for-hire app by any other feature or function on that device. Mr. Davis suggested that this is not needed however, he suggests that it be required that software performing the functions of a taximeter would need to be installed only on a “built for purpose” device (i.e., device dedicated to a single function). Others in the subcommittee disagreed stating that this is too restrictive and is not in-line with the technologies that are evolving and becoming a staple in the marketplace.

Mr. Jesse Davis pointed, that application software can be “spoofed” or replicated with similar software. This “spoofing” technique can be used to give the appearance that the original software is being used when that is not the case. Mr. Davis also stated that he believes that a cellular telephone used to access a TNS should not be permitted to have any other software programs running on it at the same time. Mr. Nukala responded saying that even though software can be “spoofed,” the authentic software is identified and this positive identification may easily be verified

Mr. Takemori informed the subcommittee that during the testing performed by CADMS, the software application used by the TNS was identified via a version number. He added however, that the software being used to calculate passenger fare was located on a network server in an unknown location and that there was no means available to verify the identification of the software or to assess its security. Mr. Davis expressed the notion that unless there is some means to verify the software used in the TNS systems (or any other systems) and be confident that it is secure, it may be pointless to worry about any other design features in the system.

Noting that many other devices that are covered under specific HB44 device codes which use software components in their operation, and that in those codes it is required that the software used must be identified with a version or revision number. This allows for the relatively easy means to verify that the software that the device was type approved with is the software that is currently being used during normal operation.

**Conclusions:**

While most GPS Subcommittee members in attendance at the October 2015 meeting supported the development of a separate HB44 code for TNS, there were still some members that held the belief that to evaluate TNS under a different set of standards would violate a principle of equal treatment for equivalent services. The principal objection of those not supporting the development of a separate code for TNS was that the subcommittee was seen as moving in a direction that would allow the TNS to avoid being required to display a running indication of passenger charges during the trip.

The GPS Subcommittee acknowledged that the overall goal is to provide standards that will allow regulatory officials to perform evaluations of any type of device of system that would calculate charges for the service of for-hire vehicles. The subcommittee recognized that there should be no unfair advantage given to one type of device/system over any other by establishing a different set of standards for either based on a business model rather than the design and operation of that device/system. With these principles in mind, the majority of the subcommittee agreed to proceed with a work plan that would further develop a tentative HB44 code for TNS, and to develop proposed changes to the existing HB44 Taximeters Code that would allow devices that can be defined as taximeters to use alternative sources of measurement data to determine time elapsed and distance traveled. This will include the use of GPS or other types of location services.

The subcommittee recognized that in some ways, the lines of distinction between TNS and traditional-type taximeters are beginning to blur and these different technologies are evolving in a direction where they may begin to resemble each other. By considering each of these approaches to establish standards for the newer technologies being used in the transportation for hire industry, the subcommittee did acknowledge a possibility that at some point it may become evident that a merger of these two sets of standards would be appropriate. Should that occur, all remaining efforts of the subcommittee would be focused in an appropriate manner.

Other conclusions of the October 2015 meeting included that the subcommittee members agreed that systems using global positioning services will in many cases use augmentation mechanisms/systems to enhance the performance of the positioning service(s) or to mitigate any loss of those services. In view of this, the members agreed that the terminology applied to the aggregate of mechanisms used to determine distance and/or time should be “location services.” The subcommittee therefore recognized the need to draft a definition for this term intended to be included in HB44 Appendix D.

The members also agreed that there would be little if any opportunity (or possibility) for a weights and measures official to independently assess the performance of location services that could be used to measure distance traveled and/or time elapsed. This is particularly the case with the GPS that is in the custody of the U.S. military. With this in mind, the subcommittee agreed that rather than evaluating the validity of signal input from these various sources, the overall performance of the system would be the basis for certifying a TNS. That is, the end result of the measurement used for calculation of a fare would be evaluated for accuracy and consistency.

Additionally, the subcommittee agreed that there is a need to establish additional testing procedures that would more effectively evaluate the location services systems and presumably detect any possible malfunctions. The testing that was described by Mr. Takemori included a number of important criteria which the subcommittee agreed would be crucial to establish as protocol for proper testing of TNS.

During the October 2015 GPS Subcommittee meeting, the members did not reach any consensus regarding the security of the various software programs involved in the operation of location services, software applications, personal digital devices, or other components in the system or networks used to provide transportation services. While there was general agreement that it would be impractical and unreasonable to place the responsibility of validating/certifying software function and security on weights and measures field officials, the subcommittee members acknowledged that this should be accomplished more appropriately at a type approval level. Once software is certified, the members believed that regulatory field officials would be able to verify its use on devices via a version or revision identifier/number.

## Title of Existing HB44 Code

The services that utilize GPS, cellular telephones, and software applications have noticeable differences from the existing, traditional-type taximeters in a number of areas. One primary distinction is that the traditional taximeters consist of hardware and possibly some software component(s) that are housed in a “black box” unit. In contrast, the functional components of those systems based on GPS and software apps will likely reside on remote computer servers and are will not be housed in a single unit. If the GPS/app-types of systems are to be addressed within the existing Taximeters Code, it may be beneficial to consider a change in the title of the code.

In a number of publications and documented references to the GPS/app-type of systems, the title of Transportation Network Companies or Transportation Network Systems has been used. Remaining consistent with the use of this terminology could offer a possible alternative to the current title of the Taximeters Code and would basically consist of changing that title to “Transportation Service Devices” or similar terminology. A change would then be necessary to the applications requirement; A.1. General.

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| **A.1. General.** – This code applies to taximeters; that is, to devices that automatically calculates at a predetermined rate or rates and indicate the charge for hire of a vehicle. |

The changes needed would consist of rewording the paragraph to be inclusive of Transportation Network Systems.

**Discussion/Conclusion:**

Due to time constraints this item was given a lower priority and was not considered during the October 2015 meeting.

*Note: As disclosed in the discussions and conclusions in the following item, the consensus of the subcommittee is not to support including TNS under the existing Taximeters Code. This item is therefore not likely to appear on the agenda for subsequent meetings.*

# Existing Taximeter Code Requirements

## Inclusion of Transportation Network Systems Under HB44 Section 5.54

As mentioned previously in this summary, two separate approaches to provide an appropriate set of standards for the TNS were being considered at the onset of the October 2015 GPS Subcommittee meeting. CADMS has submitted a proposal to the NCWM for a new tentative code that would apply to TNS. The alternate approach would be to amend portions of the existing Taximeter Code so that code could be inclusive of TNS. The subcommittee was informed that at this time neither approach is being considered as the only possible solution and that during the October 2015 GPS Subcommittee meeting, both approaches should be considered on their merits. It is expected that at some point during the further development of these drafts, it will become clear if one approach has any advantage over the other. It may also be determined that the modification of the HB44 existing code and the development of a new TNS code each have value and should be pursued. It may also be realized that much of the work in either one of these projects may be of value in both efforts.

The GPS Subcommittee was presented with a revision of the HB44 Taximeters Code that contained a number of amendments shown which were made with the intent that TNS would be evaluated using that existing code. Based on the belief that TNS could not be accurately described as “taximeters,” the subcommittee members suggested the use of a different terminology to identify those systems.

Subcommittee members were asked to consider a number of locations in the existing HB44 Taximeters Code where the current use of the term “taximeter(s)” could possibly impede the inclusion of TNS within that code. In order to have the existing section 5.54. also apply to TNS, a replacement of the term “taximeters” with the term “distance and time-based transportation devices” was suggested.

Sections of the existing Taximeters Code including paragraphs: A.3; S.1.1.; S.1.1.1.; S.1.2.; S.1.5.1.; S.1.5.2.; S.1.9.; S.2.; S.2.1.; S.4.; S.6.; S.7.; N.1.1.; N.1.2.; N.2.; T.1.1.; UR.2.; and UR.3. were all included as part of this proposed change.

**Discussion/Conclusion:**

The subcommittee’s discussions regarding the decision to either make appropriate changes to the existing HB44 Taximeters Code or to develop a new separate code for TNS, disclosed that the majority of the subcommittee favored the approach of developing a new separate code. The subcommittee members therefore agreed that the change suggested to replace the term “taximeter” with another more generic term and which would affect the numerous paragraphs listed above would not be necessary.

## Paragraph S.4. Interference

The possible elimination of paragraph S.4. was discussed to some extent during the July 2015 GPS Subcommittee meeting. Reportedly, some services using cell phone apps are calculating fare charges based on time and distance measurements made simultaneously. This would be in conflict with existing HB44 Taximeters Code requirements. It has been suggested that this requirement be eliminated so that “taxi” services may be calculated by time & distance simultaneously.

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| **S.4. Interference.** – The design of a taximeter shall be such that there will be no interference between the time and the distance portions of the mechanism device at any speed of operation.(Amended 1977 and 1988) |

The elimination of S.4. would then allow the calculation of charges based on time elapsed and on distance travelled to take place simultaneously. It was noted during the July 2015 meeting that this would, in effect increase the fare amount by approximately twice the amount if only one parameter (time or distance) is used to calculate the fare. For that reason, the subcommittee concluded that any regulatory jurisdiction that would allow the use of time *and* distance would likely also need to consider changes in the rate structure used.

Another important point consideration that was pointed out is that it is not known if the TNCs, through their use of GPS are capable of accurately measuring the speed of the vehicle. This accuracy is necessary to ensure that the “cross-over” function performs as it should to determine when the fare is determined on the basis of time or on distance.

It was also important to recognize that other paragraphs in the Taximeters Code may be affected by the deletion of paragraph S.4. Paragraphs: S.1.4.; S.1.5.2.; S.2.1.; N.3.; and T.1.3. could also be affected by the change considered for S.4.

**Discussion:**

Mr. Barton asked the members for their thoughts on the proposed deletion of paragraph S.4. Most members agreed that if a separate HB44 code is developed for TNS, there would be less incentive to delete the current S.4. This was based on the reasoning that under the current Taximeters Code, traditional-type taximeters are held to the existing HB44 requirement and would be required to be programmed to calculate fares using time or distance. In contrast, the TNCs represented in the GPS Subcommittee informed the group that their systems typically use both time and distance simultaneously in the calculation of fare charges. Further consideration by the subcommittee led to a discussion regarding the potential for traditional-type taximeters to operate in a similar fashion. This included some members to question the reasoning behind the initial requirement.

The subcommittee was informed by Mr. Steiner that there are no technical barriers that he is aware of that prevent modern taximeters from using time and distance concurrently to calculate fares. The subcommittee did acknowledge that if taximeters were to be allowed to use both time and distance, the rate structure in many jurisdictions will need to be reexamined to avoid excessive charges to the passengers. Mr. Davis noted that while taximeters could presumably calculate fare by time and distance simultaneously just as TNS technology is doing, the reverse may not be true. He explained that TNS through their use of GPS or other location services may, or may not be capable to precisely calculate the actual speed that the vehicle is traveling. This may be a more critical problem when the vehicle is traveling at slower speeds – when crossover from a distance-based calculation to a time-based calculation is more likely to occur.

Ms. Joanne Rausen informed the members of the subcommittee that in New York City there are different rate structures for TNS and for taximeters due to the difference in the use of time and distance factors. Ms. Macey noted that it would be a decision to be made by every jurisdiction whether the existing rate structure is suitable or not. Mr. Fishman shared his thoughts that if traditional taximeters are allowed to use time and distance, there should be a means on the device to indicate and inform the operator/passenger what is being used (i.e., time, distance, or time *and* distance) to calculate the fare charges. He also raised the question about how the international standard under OIML (International Organization of Legal Metrology) addresses this issue. Ms. Rausen agreed with the proposed amendment that would add a statement to clarify that this requirement (shown below) applies only to those devices/systems that use time and distance for the calculation of passenger’s fare but never simultaneously. This would be permissive of those systems that would use time *and* distance.

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| **S.4. Interference.** – The design of a taximeter shall be such that **when a fare is calculated by using time or by using distance (but not both at the same time)** there will be no interference between the time and the distance portions of the mechanism device at any speed of operation.(Amended 1977 and 1988) |

Mr. Tomas informed the subcommittee that the OIML standard that addresses taximeters (OIML R21) allows two methods for fare calculation. The first method is to calculate fares using time below the cross-over speed and distance above the cross-over speed (same as the current HB44 Taximeters Code). The second method allows for fares to be calculated using time and distance simultaneously. The subcommittee members expressed their support for this approach and indicated that this wording may be easier to interpret and less confusing than the wording used in the current HB44 equivalent – paragraph S.2. Basis of Fare Calculations.

Mr. Fishman pointed out that traditional-type taximeters had not previously be capable of recording the amount of fare charges attributed to time elapsed and fare charges attributed to distance traveled. He questioned the subcommittee members if it would now (since it is being proposed that fares can be based on time and distance simultaneously) be required that distance traveled as well a time elapsed during a trip be included on the passenger’s receipt. The subcommittee generally agreed that time elapsed (which is included as a factor in fare charges) should be required to be added to the list (in requirement S.1.9.) of information to be included on the passenger’s receipt.

Mr. Barton requested that the subcommittee also consider the following requirements that he had identified as those which could be impacted by the deletion/revision of paragraph S.4.

**Paragraph S.1.4. Actuation of Fare-Indicating Mechanism:**

An existing paragraph that would be affected by a change in the manner in which fares are allowed to be calculated (i.e., allowing time and distance to be used simultaneously) would be S.1.4. Actuation of Fare-Indicating Mechanism. This paragraph is worded in a manner so that it will only apply to taximeters that will operate using either time *or* distance in the calculation of fare. It was recommended that if the subcommittee is considering changes to the Taximeters Code that would permit taximeters to operate using both time *and* distance simultaneously, it is presumed that additional language will need to be added to qualify this requirement’s application to only those meters that operate by using one or the other but not both simultaneously.

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| **S.1.4. Actuation of Fare‑Indicating Mechanism.** –When a taximeteris operative with respect to fare indication, the fare‑indicating mechanism shall be actuated by the distance mechanism whenever the vehicle is in motion at such a speed that the rate of distance revenue equals or exceeds the time rate, and may be actuated by the time mechanism whenever the vehicle speed is less than this and when the vehicle is not in motion. Means shall be provided for the vehicle operator to render the time mechanism either operative or inoperative with respect to the fare‑indicating mechanism.(Amended 1977) |

The subcommittee members generally supported the notion that any vehicle-for-hire service should not be prohibited from calculating fare charges by time *and* by distance concurrently. Mr. Davis again stated his concern about whether systems that use GPS or other location services could precisely determine the vehicle speed. For those systems that would continue to use time *or* distance, this is critical to identify the crossover speed and thereby determine when the fare should be calculated by time or when it should be calculated using distance.

Others in the subcommittee noted that each jurisdiction will need to reexamine the rate structure that is used to determine if using time *and* distance to calculate fare would be reasonable, practical, and if it should be permitted in that locale.

**Paragraph S.1.5.2. Time not Recording:**

This paragraph is written under the presumption that all taximeters will use time or distance but not both simultaneously. And, similar to S.1.4. this paragraph is predicated on the notion that there is a means to toggle the time mechanism on/off and requires that when the time mechanism is not in use, there be a clear indication that time is not being used.

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| **S.1.5.2. Time not Recording.** – When a taximeter is set for fare registration with the time mechanism inoperative, it shall indicate “Time Not Recording” or an equivalent expression.(Amended 1988) |

The subcommittee expressed the notion that there are no changes necessary to this requirement. The existing language does not prohibit a device from calculating fare using time and distance concurrently.

**Paragraph S.2.1. Initial Time and Distance Intervals:**

The subcommittee recognized that this requirement would not be relevant if the system uses time and distance simultaneously to calculate fares. While it would seem that there would be no justification to require a means to toggle the time mechanism on/off as is required in the last sentence in this existing requirement, the members did not believe this requirement should be deleted. However, the members noted that if taximeters would be permitted to operate using both factors simultaneously, language will need to be added to S.2.1. specifying that this requirement applies to only those taximeters that operate by using time *or* distance.

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| **S.2.1. Initial Time and Distance Intervals.** – The time and distance intervals of a taximeter shall be directly proportional as expressed in the following formula:(Added 1990) |

The subcommittee also noted that whether or not a TNS using GPS and cellular telephone apps would be capable of measuring the speed of the vehicle precisely enough to determine when fares are to be calculated by either time or distance becomes relevant again when considering this paragraph.

**Paragraph N.3. Interference Test:**

This test note providing test procedures to evaluate the taximeter’s ability to switch from calculation of fare on the basis of time to the calculation of fare on the basis of distance (or vice versa) would only be relevant on devices using time or distance but not both simultaneously. Additional language would need to be drafted to specify that N.3. is only applicable to those traditional-type taximeters that function in that manner.

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| **N.3. Interference Test.** –**when a fare is calculated by using time or by using distance (but not simultaneously)**and the **taximeter** is equipped with a timing device through which charges are made for time intervals, a test shall be conducted to determine whether there is interference between the time and distance elements. During the interference test, the vehicle’s operating speed shall be 3 km/h or 4 km/h, or 2 mi/h or 3 mi/h faster than the speed at which the basic distance rate equals the basic time rate. The basic rate per hour divided by the basic rate per mile is the speed (km/h or mi/h) at which the basic time rate and basic distance rate are equal.(Amended 1988) |

**Paragraph T.1.3. On Interference Tests:**

Similar to the previous paragraph (N.3.), paragraphs T.1.3. (and T.1.3.1.) was identified as another requirement that would only be relevant to those taximeters that requires the calculation of fare by the time mechanism does not occur at the same time as any calculation of fare by the distance traveled. The members of the subcommittee indicated that T.1.3. and T.1.3.1. should be amended in the same fashion as the previously identified requirements that will be impacted by allowing time and distance to be used concurrently in the calculation of passenger’s fare charges.

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| **T.1.3. On Interference Tests.****T.1.3.1.** The registration of a taximeter in the “time on” position shall agree within 1 % of its performance in the “time off” position.(Added 1988) |

**Conclusions:**

Based on the views expressed by the subcommittee members, Mr. Barton agreed to draft a proposed amendment of S.2. to align the language in that HB44 requirement with the corresponding requirement in OIML R21. The members believe that this change would also aid in the interpretation and the clarity of the existing requirement.

The Subcommittee agreed that fare calculation should not be restricted to one factor (time /distance) or the other. The members agreed that the existing HB44 requirement S.1.4. should be revised so that it will be understood that taximeters would then be permitted to calculate fares using time *and* distance at the same time. The subcommittee members indicated that they supported the changes shown in the draft below.

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| **S.1.4. Actuation of Fare‑Indicating Mechanism.** – **Applicable when a fare is calculated by using time or by using distance (but not simultaneously).** When a taximeter is operative with respect to fare indication, the fare‑indicating mechanism shall be actuated by the distance mechanism whenever the vehicle is in motion at such a speed that the rate of distance revenue equals or exceeds the time rate, and may be actuated by the time mechanism whenever the vehicle speed is less than this and when the vehicle is not in motion. Means shall be provided for the vehicle operator to render the time mechanism either operative or inoperative with respect to the fare‑indicating mechanism.(Amended 1977) |

The subcommittee members agreed that there are no changes needed to paragraph S.1.5.2.

The subcommittee agreed that paragraphs S.4. and S.2.1. should be retained however, these requirements should be amended through the addition of the same wording used to modify paragraph S.1.4. (i.e., …“when a fare is calculated by using time or by using distance - but not both time and distance simultaneously…”). Similarly, the subcommittee agreed that the necessary changes needed to paragraph N.3. Interference Test, and paragraph T.1.3. On Interference Tests would be to add the same wording limiting the application of those requirements to only taximeters that calculate fares using time *or* distance but not those that use time *and* distance at the same time.

The changes supported by the subcommittee are as follows.

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| **S.4. Interference.** – The design of a taximeter shall be such that **when a fare is calculated by using time or by using distance (but not simultaneously)** there will be no interference between the time and the distance portions of the mechanism device at any speed of operation.(Amended 1977 **~~and~~** 1988**, and 201X**) |

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| **S.2.1. Initial Time and Distance Intervals.** – **When a fare is calculated by using time or by using distance (but not simultaneously),** **~~T~~**the time and distance intervals of a taximeter shall be directly proportional as expressed in the following formula:(Added 1990)**(Amended 201X)** |

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| **N.3. Interference Test.** – If a taximeter is equipped with a timing device through which charges are made for time intervals **and** **when fare is calculated by using time or by using distance (but not both time and distance simultaneously)**, a test shall be conducted to determine whether there is interference between the time and distance elements. During the interference test, the vehicle’s operating speed shall be 3 km/h or 4 km/h, or 2 mi/h or 3 mi/h faster than the speed at which the basic distance rate equals the basic time rate. The basic rate per hour divided by the basic rate per mile is the speed (km/h or mi/h) at which the basic time rate and basic distance rate are equal.(Amended 1988**, and 201X**) |

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| **T.1.3. On Interference Tests. – For distance and time-based taximeters designed to calculate fares upon the basis of a combination of distance traveled and time elapsed, but not using both simultaneously.****(Amended 201X)** |

The subcommittee also agreed that just as the distance traveled is required to be included on the passenger’s receipt under paragraph S.1.9., the time elapsed (when it is a contributing factor in the calculation of fare charges) should also be included on that receipt. It was agreed that paragraph S.1.9. Recorded Representation should be amended to reflect this as in the following draft.

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| ***S.1.9. Recorded Representation.***– *A printed receipt issued from a taximeter, whether through an integral or separate recording element, shall include as a minimum, the following information when processed through the taximeter system:**(a) date;**(b) unique vehicle identification number, such as the medallion number, taxi number, vehicle identification number (VIN), permit number, or other identifying information as specified by the statutory authority;\***(c) start and end time of the trip;\***(d) distance traveled, maximum increment of 0.1 km (0.1 mi);\***(e) fare in $;**(f) each rate at which the fare was computed and the associated fare at that rate;\***(g) additional charges (in $) where permitted such as extras, any surcharges, telecommunication charges, and taxes shall be identified and itemized;\***(h) total charge for service in $ (inclusive of fare, extras, and all additional charges);\**1. *trip number, if available;\*\**

*(j) telephone number (or other contract information) for customer assistance;* ***and****\*\*****(k) when taximeters charge by time and distance simultaneously, a statement of chargeable time*****Note:** When processed through the taximeter or taximeter system, any adjustments (in $) to the total charge for service including discounts, credits, and tips shall also be included on the receipt.\*\**[Nonretroactive as of January 1, 1989] \*[Nonretroactive as of January 1, 2000]* *\*\*[Nonretroactive as of January 1, 2016]*(Added 1988) (Amended 1999**,**~~and~~ 2015**, and 201X**) |

## Paragraph S.5. Provision for Security Seals

This requirement has been discussed at length during meetings of the USNWG on Taximeter and the GPS Subcommittee. There is a contingent of members in these groups that are reluctant to permit the use of electronic type of security seals to replace a physical type of seal. In the deliberations on this topic within the GPS Subcommittee meetings, it was noted that the typical equipment (hardware) being used in the TNC-type of systems would not easily be sealed with cumbersome physical seals used on more traditional equipment. The size and the design of cellular telephones would not easily facilitate the use of a physical seal and furthermore, the metrological functions of these systems is controlled mainly through software that may not reside in the telephone.

There are a number of device manufacturers and operators of traditional-type taximeters that have expressed support in amending the sealing requirement in the existing HB44 Taximeters Code. They have stated that changes in the rate structure for some jurisdictions occur on somewhat of a routine basis and this must be addressed by changing the rate selection on each taximeter operating in that jurisdiction. If a physical seal must be broken to access the configuration parameters of each device, this can result in a very time-consuming and laborious effort (particularly when there are large fleets of taxis operating in that jurisdiction). By allowing remote configuration of parameters (such as the rate selections available) and an electronic type of sealing after those configuration changes have been made, processes such as this could be accomplished in a fraction of the time and reduce the cost immeasurably.

One of the questions brought up during the July 2015 GPS Subcommittee meeting was what component(s) within the TNC-type of systems would need to be sealed? More specifically, the question asks if it reasonable to expect that some form of security seal could be applied to: the GPS (or other location service) transmission network; the location service’s receiver; the cellular telephone; or the software used (including that in the provider’s application)?

While most of the HB44 specific device codes do include requirements related to sealing access to the metrological features, the security of the software component itself is evaluated at the type evaluation level and is generally not part of a field examination. In those cases where a device does have a software component, it has typically been considered sufficient that the official performing the examination be provided with means to observe the software version or revision number and match that number to version identified on the NTEP Certificate of Conformance issued after a successful type approval process.

**Discussion:**

During the October 2015 GPS Subcommittee meeting, the members considered the merits of deliberating on the issue of security seals in the context of modifying the existing HB44 Taximeters Code. Another option was to table the discussion of this item until the subcommittee addressed the further development of a proposed separate code for TNS as submitted by CADMS. The subcommittee recognized that there is at least one company that has designed a software-based product which would most likely be classified as a taximeter (and therefore would presumably be regulated under HB44 Section 5.54.). While this company’s product closely resembles traditional-type taximeters in most aspects, the source of measurement data used in calculating passenger fare is GPS and the device has no mechanism for applying a physical security seal. The members felt that it was therefore important to address at this time, the issue of provisions for sealing of devices as required in the existing HB44 Taximeters Code.

Mr. Paul expressed his regrets that there is a contingent of stakeholders (primarily regulatory officials) who are reluctant to permit taximeters to provide security by means of an electronic-type of sealing. Many of the subcommittee members also shared the notion that electronic sealing would be a reasonable and practical manner in which to provide security for taximeters and the newer generation of devices being introduced to the marketplace.

It was noted that by allowing electronic sealing, remote access of the taximeters to change rates is a viable option that the programmers could offer to the end users. Recognizing the considerable time and effort involved in changing the rate structure in a large fleet of taxis, adds to the appeal of permitting remote access to taximeters which would greatly expedite this process. This however, would involve changing the current requirements that do not allow anything but a physical type of security seal.

Mr. Steiner cited the example of his company (Centrodyne) that had manufactured a taximeter which was equipped with a means to be sealed electronically however, this was not permitted to be used in the U.S. due to sealing requirements that allow only a physical seal. He added that when Centrodyne submitted a proposal to amend the existing requirement in HB44 Taximeters Code, the proposal was rejected by the National Conference on Weights and Measures (NCWM). Furthermore, Centrodyne revised their proposal so that the recommended changes would allow remote access and electronic sealing for *configuration* parameters of taximeters but the *calibration* of those devices would still be sealed with a physical type security seal. This amended version of Centrodyne’s proposal was not supported by NCWM either.

Mr. Fishman agreed with the majority of the subcommittee in that he supports the revision of the HB44 Taximeters Code to allow for use of remote access and electronic sealing – at least for configuration parameters. He suggested to the subcommittee that many more types of devices are now being sealed using audit trails and other types of electronic sealing and that perhaps it would be appropriate to submit a proposal to change the current requirements again.

Ms. Rausen suggested that this type of proposal may meet with more favor if taximeters were to be required to display additional customer information, such as the actual rate that the fare is being calculated at. By providing a display of the monetary value for each unit of distance traveled or unit of time elapsed, the passenger is provided with additional information to verify that the appropriate rate is being applied.

There was a general discussion in the subcommittee where the various classifications of sealing methods used in HB44 device codes were explained. The subcommittee members were given information regarding the features required under other specific device codes in HB44 and how they are identified using the terminology of “Category 1,” “Category 2,” “Category 3,” etc. These classifications are typical and used to represent different mechanisms required for sealing that are associated with the device’s ability to be accessed for configuration/calibration purposes. The subcommittee expressed a particular interest in what is described as a Category 3 method of sealing in a number of HB44 specific device codes. It was explained to the subcommittee that the details pertaining to how changes to the devices can occur and how the devices must be sealed can vary for different types of devices. The “typical” Category 3 method of sealing would allow remote access of the device but would require that an event logger be used to record events (individual changes made) occurring through the remote access.

Mr. Davis suggested to the subcommittee that when provisions for sealing is considered in the context of TNS, it would be preferable to require that the computing capability or “intelligence” used in the calculation of passenger’s fare must reside on the device (cellular telephone, tablet, etc.) that is providing the transaction related indications and that is located in the vehicle. This makes any access to verify the security of this function readily available. Mr. Schreiberg disagreed, stating that containing this function in a central location (i.e., a central or cloud-based server) makes providing security much easier to manage and to access.

Some subcommittee members suggested that a draft proposal could be developed that would amend the existing HB44 Taximeters Code to allow remote access to parameters related to *configuration*, but not *calibration* of a device/system. In addition, the draft proposal could limit this ability to only devices or systems that provide a display of the active rate for time elapsed and distance traveled. The subcommittee generally agreed that this approach would most likely garner the necessary support from NCWM members and recognized the value of this same effort if applied in the further development of the proposed separate TNS code.

**Conclusions:**

The subcommittee agreed that to develop requirements for the provision for sealing and providing a means to verify the security of software-based systems and components will be one of the greatest challenges for this group. Most of the members also agreed that the details involved in the development of appropriate requirements applicable to security of software-based systems and the sealing of the metrological features of those systems should involve expertise that is not present in this subcommittee.

In view of the complex nature of this issue, the subcommittee agreed that a task group should be formed that will continue to develop a proposal to initiate changes in the existing Taximeters Code and for the further development of the TNS code. This task group would most likely include experts (from outside this GPS Subcommittee) that will be invited to participate in the development of appropriate requirements.

## Paragraph S.6. Power Interruption, Electronic Taximeters

This requirement addressing the loss of power to a taximeter has prompted some concern about systems using GPS and software applications and whether or not a loss of power to a cellular telephone (or other elements in a vehicle-for-hire system) could have similar detrimental effects on systems that receive measurement data from GPS-type location systems. The subcommittee will be asked to comment on whether the requirement as currently worded will suffice if applied to the newer generation of transportation devices/systems.

Additionally, the subcommittee was asked to consider if there can be an analogy made comparing the loss of power to a taximeter to the loss of GPS signal to a system using GPS for commercial measurement? The subcommittee members were also asked to consider if this requirement can be modified to draft a requirement that would cover the loss of GPS signal.

**Discussion:**

Mr. Barton presented the subcommittee with a draft for a new requirement that would address the loss of GPS (location service) signal in a system that receives its measurement data from that source. The draft (shown below) is proposed to follow the current Taximeters Code requirement S.6. Power Interruption, Electronic Taximeters and therefore be numbered as S.7. If developed into a proposed changed and submitted to NCWM, this would result in the renumbering of the current paragraph S.7. Anti-Fraud Provisions, Electronic Taximeters to be renumbered as S.8.

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| **S.7. Signal Loss for Systems Using GPS as a Measurement Source****For systems using the Global Positioning System (GPS) as an input for time and/or distance measurements, the following requirements apply:**1. **any loss of GPS signal that will result in inaccurate time and or distance measurement for a completed trip shall either be compensated for by appropriate auxialiary means or shall result in the conclusion of the accumulation of passenger charges. The conclusion of the transaction at the moment the GPS signal is lost shall include a totalization of accrued passenger charges and the generation of a passenger receipt.**
2. **any auxialiary means used to compensate for the loss or degradation of GPS signal shall produce accurate measurement of time and/or distance for that period of a transaction extending through the signal’s loss.**
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Mr. Davis noted that for TNS, a cellular telephone (used as an indicating element) is generally powered by a battery and not a direct power supply like a taximeter connected to the power supply in the vehicle. Also a number of the most recently manufactured devices will be designed with a back-up battery to avoid a complete power loss.

Mr. Fishman, considering the effects of a power loss on software-based systems stated that consideration must be given to the time needed for that type of system to “boot-up” or to power on and reach the point where normal operation can begin. Mr. Nukala agreed and stated that the 3 second time period as a threshold for power loss (power loss exceeding that threshold must result in a cessation of accumulated charges and a return to the previous indications) that is currently established does not account for the additional time needed for a software based device to “boot up.”

Mr. Schreiberg pointed out that an analogy can not be made in comparing a loss of power to the loss of GPS signal because when a loss of power occurs, all data for a transaction is lost however, if a loss of GPS signal occurs, it is only a temporary situation where the fare, distance, and time data that has accumulated thus far is retained. When the GPS signal is lost, it will be picked back up at a point when the receiver regains contact with the satellite network and the missing data for time and distance can be obtained through auxiliary means. When power is lost (for an extended time period), the accumulation and advancement of data for a transaction is halted.

Other subcommittee members noted that if the signal is lost from GPS or other location services, the fare can be calculated using time during the signal loss. Mr. Steiner questioned what would be the recommended threshold for use in determining what is an acceptable length of time for GPS signal loss. Mr. Schreiberg proposed that 3 seconds would most probably be negligible in maintaining an accurate depiction of the vehicle’s travel route and that he suspects it would have minimal if any effect on the end results.

*Note: Three seconds is the time period established as the threshold for power loss in a taximeter after which time the taximeter is required to display the indicated charges prior to the power loss and is prohibited from further advancement.*

Mr. Steiner also asked the subcommittee to consider that if a taximeter receiving measurement data from pulses generated from a vehicle’s components (wheels, transmission, OBD, etc.) lost that pulse signal, could there be any allowance for compensating means for that type of “signal” loss? Mr. Ron Hasemeyer recommended that any requirement proposed for inclusion in HB44 should not be so prescriptive that certain technologies would be unnecessarily excluded. Referring to the proposed new requirement S.7. (Signal Loss for Systems Using GPS as a Measurement Source) the term “GPS” could be replaced with “input to the taximeter” throughout the new language.

Because there is no “dedicated device” to serve as an indicating element in a TNS, some members of the subcommittee noted that a proposal addressing signal loss that would apply to systems that included a dedicated component (i.e., a taximeter, or software-taximeter) in the vehicle but would not be applicable to a TNS would be providing an unfair advantage to the TNS business model.

Recognizing the importance to ensure that a requirement addressing the loss of signal from any type of measurement source is applied uniformly, Mr. Hasemeyer suggested that the wording be generic and refer to the input signal in a non-specific manner. Mr. Steiner also suggested that such a requirement should have a provision included so that if a system is equipped with a means to compensate for any signal loss, it would not be required to cease the advance of accruing passenger charges. Mr. Hasemeyer added that if and when any compensation means was used, the end result must remain within the applicable tolerances.

The subcommittee considered if any compensation that would be used to account for a loss of signal would need to be independently tested to determine if its use would be capable of maintaining a final result within applicable tolerances. Some suggested that any compensation used should be capable of maintaining the accuracy of distance determined during that portion of the trip to within a given limit. Other subcommittee members supported simply basing an approval on the system by the final determination of trip indications but would insist on test procedures being developed so that compensation mechanisms (if present) would be certain to be used.

Mr. Barton presented a revised draft of the proposed new requirement S.7. Signal Loss for Systems Using Location Services and asked the subcommittee to review the changes. The subcommittee generally agreed with the revisions although, it was recognized that the intent of this requirement could not appropriately be applied to taximeters that received measurement data from vehicle components that produce a pulse signal.

**Conclusions:**

The subcommittee agreed that there should be an amendment to the HB44 Taximeters Code that would add a requirement stating the criteria for provisions during a loss of location services signal for those systems using those services for measurement data. The members also agreed that during type evaluation of a system using GPS or other location services, testing must be performed to evaluate the effect of signal loss due to any anticipated conditions that would prevent the signal from being received.

The members agreed to the changes shown in the following draft. This paragraph would be proposed to be placed in the Taximeters Code following the existing S.6. and be numbered S.7. as shown. This would necessitate the renumbering of the subsequent paragraph. In addition the subcommittee also agreed that some of the terminology used in this proposal (i.e., “location services”) should be appropriately defined in HB44 Appendix D. The definition for the term “location services” and other wording used in the revision of the Taximeters Code will be developed as part of the work assigned to a task-group led by Ms. Macey.

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| **S.7. Signal Loss for Systems Using Location Services. - If signal loss is not compensated for, a signal loss that will result in an inaccurate calculation of fare shall result in the indications not being susceptible to further advancement until the taximeter is cleared. Any auxiliary means used to compensate for the loss or degradation of location services signal shall produce measurement of time and/or distance that does not exceed the applicable tolerance for that period of a transaction extending through the signal’s loss.(Added 201X)** |

## S.7. Anti-Fraud Provisions, Electronic Taximeters

This existing HB44 Taximeters Code requirement was adopted previously to address an issue that involved the fraudulent use of an external device that when installed in a vehicle could introduce false pulses into the signal transmitted from the distance measuring device. These false signals would result in an increase in the distance measurement and therefore an increase in the fare charges.

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| **S.7. Anti‑Fraud Provisions, Electronic Taximeters. –** An electronic taximeter may have provisions to detect and eliminate distance input that is inconsistent with output of the vehicle’s distance sensor. When a taximeter equipped with this feature detects input inconsistent with the distance sensor:(a) The meter shall either filter out the inconsistent distance input signals or cease to increment fare based on distance until the distance input signal returns to normal. If the meter ceases to increment fare based on distance, the taximeter may continue to increment fare based on elapsed time;(b) The taximeter shall provide a visible or audible signal that inconsistent input signals are being detected; and(c) The taximeter shall record the occurrence in an event logger. The event logger shall include an event counter (000 to 999), the date, and the time of at least the last 1000 occurrences.(Added 2001) |

The GPS Subcommittee was asked to consider whether there be a similar requirement that would apply to any interference that could be anticipated from the input of GPS distance measurements. If this is needed, then the approach on how to draft the requirement will need to be determined (i.e., will S.7. be modified or will a new requirement be developed?).

**Discussion:**

Mr. Barton explained to the subcommittee that the majority of the changes being proposed in the draft for a revised S.7. Anti-Fraud Provisions, Electronic Taximeters were to reflect an initial intent to incorporate TNS within the existing Taximeters Code. Since the subcommittee has favored the approach that would develop a separate code for TNS, many of the changes suggested in this revision would not be necessary. There is a change being suggested however, that would revise this requirement in such a way that it would be appropriate for more traditional-type taximeters that would receive distance traveled information from alternative sources such as GPS or other location services. This recommended change would add a statement under bullet “(a)” that indicates if a taximeter losses distance input signals, the fare could still increment based on time data input as long as the distance input and time input did not originate from the same source. That one proposed change is shown in the following draft.

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| **S.~~7~~8. Anti‑Fraud Provisions, Electronic Taximeters. –** An electronic taximeter may have provisions to detect and eliminate distance input that is inconsistent with output of the distance sensor. When a taximeter equipped with this feature detects input inconsistent with the distance sensor:(a) The meter shall either filter out the inconsistent distance input signals or cease to increment fare based on distance until the distance input signal returns to normal. If the meter ceases to increment fare based on distance, the meter may continue to increment fare based on elapsed time **provided that the input source for time measurement is not the same as the source for distance measurement**;(b) The taximeter shall provide a visible or audible signal that inconsistent input signals are being detected; and(c) The taximeter shall record the occurrence in an event logger. The event logger shall include an event counter (000 to 999), the date, and the time of at least the last 1000 occurrences.(Added 2001) |

The subcommittee did not agree with the need for the change noted above however, most indicated they would support a requirement to be added to HB44 that would require means to detect signal that is not consistent with the input distance measuring input during the normal operation of the device.

Many in the subcommittee questioned the ability of a device or system to accurately discern between valid location service signals and those that are created to falsify location/distance data. This would be particularly difficult to perform in a field examination although the subcommittee generally agreed that this determination could probably be performed in a laboratory under controlled conditions. Therefore is was suggested that these proposed amendments to S.8. be included in HB44 as a basis for type evaluation procedures.

Mr. Schreiberg informed the subcommittee that his company uses methods to identify “false” GPS signals and when these are detected, there are means to mitigate the effects that these signal will have on an accurate calculation of distance.

**Conclusion:**

The subcommittee members agreed that there should be a requirement in the HB44 Taximeters Code to serve as a basis for testing a device/system under type evaluation. This requirement would specify that a device/system must detect and “filter-out” fraudulent location services distance measurement input signals. After further discussion, the members generally agreed on the wording shown in the following proposed revision of existing paragraph S.7. (to be renumbered as S.8.)

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| **S.~~7~~8. Anti-Fraud Provisions, Electronic Taximeters. –** An electronic taximeter **~~may~~shall** have provisions to detect and eliminate **inconsistent** distance input that **does not represent the** vehicle’s **normal operation**. When a taximeter **~~equipped with this feature~~** detects input inconsistent with the distance sensor:(a) The meter shall either filter out the inconsistent distance input signals or cease to increment fare based on distance until the distance input signal returns to normal. If the meter ceases to increment fare based on distance, the taximeter may continue to increment fare based on elapsed time;(b) The taximeter shall provide a visible or audible signal that inconsistent input signals are being detected; and(c) The taximeter shall record the occurrence in an event logger. The event logger shall include an event counter (000 to 999), the date, and the time of at least the last 1000 occurrences.(Added 2001) |

## N.1.1. Test Methods.

This existing requirement specifies the methods that are to be used in the testing of taximeters. With the possibility of taximeters incorporating the use of GPS or other location services, are changes needed?

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| **N.1.1. Test Methods.** – To determine compliance with distance tolerances, a distance test of a taximeter shall be conducted utilizing one or more of the following test methods:(a) **Road Test.** – A road test consists of driving the vehicle over a precisely measured road course.(b) **Fifth‑Wheel Test.** – A fifth‑wheel test consists of driving the vehicle over any reasonable road course and determining the distance actually traveled through the use of a mechanism known as a “fifth wheel” that is attached to the vehicle and that independently measures and indicates the distance.(c) **Simulated‑Road Test.** – A simulated road test consists of determining the distance traveled by use of a roller device, or by computation from rolling circumference and wheel‑turn data.(Amended 1977) |

Is it necessary to add a note under N.1.1.(c) stating that the simulated-road test (dynamometer) is not acceptable for taximeters whose measurement source is GPS or is this so obvious that a note is not necessary? Subcommittee members will be asked for comment.

**Discussion:**

The subcommittee was asked to provide comments that will determine whether or not specific language is needed to be added to the existing N.1.1. to clarify that for those systems using distance/time measurement data from sources outside of the vehicle (i.e., GPS or other location services), the only acceptable method to test the accuracy of that measurement data is noted under bullet point “(a)” – the performance of a road test.

Mr. Davis informed the subcommittee members that there is technology that has been developed which will produce a simulated GPS signal and could therefore possibly be used to test these systems in a laboratory setting (for type evaluation). Mr. Michael Lombardi agreed but added that this technology is very expensive and therefore is not widely available. Others in the subcommittee asked if this technology can be used to simulate location services input other than from GPS. The answer provided was that this particular technology will only produce GPS signal.

Mr. Steiner expressed the belief that there is no additional language necessary here, it is obvious that a simulated test (such as performed on a dynamometer) would not be appropriate. Mr. Barton asked the subcommittee if an added note (as shown in the following draft) is beneficial or if it is unnecessary and would only serve to confuse officials.

Mr. Davis reiterated his belief that appropriate testing must be developed for devices/systems that receive measurement data from location services. This testing must include any known sources of interference with the location services signal and could include: variation in altitude, poor atmospheric conditions, blockage of signal by tall buildings, mountains, other obstructions, etc. The Subcommittee acknowledged this to be critical and agreed to support efforts to develop adequate testing procedures.

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| **N.1. Distance Tests.****N.1.1. Test Methods.** – To determine compliance with distance tolerances, a distance test of a taximeter shall be conducted utilizing one or more of the following test methods:(a) **Road Test.** – A road test consists of driving the vehicle over a precisely measured road course.(b) **Fifth‑Wheel Test.** – A fifth‑wheel test consists of driving the vehicle over any reasonable road course and determining the distance actually traveled through the use of a mechanism known as a “fifth wheel” that is attached to the vehicle and that independently measures and indicates the distance.(c) **Simulated‑Road Test.** – A simulated road test consists of determining the distance traveled by use of a roller device, or by computation from rolling circumference and wheel‑turn data.**Note: A simulated-road test may not be appropriate for taximeters that receive measurement input from sources apart from the vehicle (e.g. location services).** |

**Conclusions:**

The subcommittee generally agreed that the proposed addition of a note to bullet point “(c)” as shown may be stating the obvious however, it does not confuse the issue and to insert this statement will not detract from the requirement.

## N.1.3. Test Conditions & UR.1. Inflation of Vehicle Tires

During the October 2015 meeting, the subcommittee was asked to consider the relevance of the following existing test notes requirements in the context of devices or systems that use location services as the input for distance measurement. Also to be included in that consideration was the existing user’s requirement UR.1. Inflation of Vehicle Tires. This user’s requirement addresses the same issue as does the notes requirement; N.1.3.2. Tire Pressure.

Mr. Barton asked the subcommittee members if there should be exemptions added to these requirements for systems that use location services noting that these factors would presumably have no effect on the accuracy of distance measurement in those types of systems.

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| **N.1.3. Test Conditions.****N.1.3.1. Vehicle Lading.** – During the distance test of a taximeter, the vehicle shall carry two persons, or in the case of a simulated‑road test, 70 kg or 150 lb of test weights may be substituted in lieu of the second person.**N.1.3.2. Tire Pressure.** – At the completion of test run or runs, the tires of the vehicle under test shall be checked to determine that the tire pressure is that operating tire pressure posted in the vehicle. If not, the tire pressure should be adjusted to the posted tire pressure and further tests may be conducted to determine the operating characteristics of the odometer.(Amended 1977) |
| **UR.1. Inflation of Vehicle Tires.** – The operational tire pressure of passenger vehicles and truck tires shall be posted in the vehicle and shall be maintained at the posted pressure.(Amended 1977) |

**Discussion:**

The subcommittee noted that in their discussions regarding any distinctions made between devices/systems using location services and those traditional-type devices/systems that use pulses generated from within components in the vehicle there is a lack of proper terminology to describe these different systems. Previously it was agreed that the subcommittee would use “location services” to refer to systems such as GPS, other satellite-based positioning systems, as well as auxiliary systems that may be used in conjunction with those positioning systems. The subcommittee members agreed that wording was needed to describe the more traditional measurement data sources and proposed that “pulse-based” systems be used for that purpose.

Mr. Davis noted that the existing HB44 Taximeters Code contains a number of requirements that will be applicable to one type of system according to the source of measurement data or the other (as described above). He suggested that it may be useful if those types of requirements could be separated according to the measurement sources within the existing requirements. Explaining further, he recommended that N.1.3. Test Conditions be given two sub-paragraphs (N.1.3.1. and N.1.3.2.) where each would contain the requirement pertaining to the different systems according to their measurement sources.

The following draft was developed and presented to the subcommittee based on this suggestion.

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| **N.1.3. Test Conditions.****N.1.3.1. For Pulse-Based Systems****N.1.3.1.1 Vehicle Lading.** – During the distance test of a taximeter, the vehicle shall carry two persons, or in the case of a simulated‑road test, 70 kg or 150 lb of test weights may be substituted in lieu of the second person.**N.1.3.1.2. Tire Pressure.** – At the completion of test run or runs, the tires of the vehicle under test shall be checked to determine that the tire pressure is that operating tire pressure posted in the vehicle. If not, the tire pressure should be adjusted to the posted tire pressure and further tests may be conducted to determine the operating characteristics of the taximeter.(Amended 1977)**N.1.3.2. For Systems Using Location Services*****[Subcommittee to develop bulleted list of appropriate criteria]*** |

**Conclusion:**

The subcommittee agreed to the formatting and wording of the above proposed changes and also agreed that additional specific test procedures would need to be developed and included under N.1.3.2. that are appropriate to evaluate devices and systems using location services as measurement data input. The further development of those additional test procedures will take place in subsequent meeting of the GPS Subcommittee.

In addition, the members agreed that the task group formed to (in part) develop proposals to add necessary definitions to HB44 Appendix D that are intended to provide adequate descriptions of specific terms used in the Taximeters Code and a proposed TNS Code will include a proposed definition for the term “pulse-based” systems.

## Subcommittee Title (“GPS Subcommittee”)

In view of the nature of the subcommittee’s work, the current title of this subcommittee’s name may not fully and accurately reflect the scope of that work. Since the main focus of this subcommittee is the use of the systems comprised of GPS and software applications it may be more appropriate to name the subcommittee after the type of system that utilizes these components to provide a service. The subcommittee will therefore be presented the suggestion that the name of the group be changed to Transportation Network Systems (TNS) Subcommittee. Comments will be solicited from the subcommittee.

**Discussion/Conclusions:**

Due to a lack of time during the October 2015 GPS Subcommittee meeting and the perception of the subcommittee members that this item is not a priority issue, it was not considered at this time.

## Additional Agenda Items:

The following items were listed as issues to be considered by the GPS Subcommittee during its October 2015 meeting however, based on the discussions of the earlier items, the agenda was shortened/modified. This modification of the agenda was done due to the general agreement among the subcommittee that Transportation Network Systems could be regulated through the development of a separate HB44 code and that this would be preferable to amending many of the requirements in the existing Taximeters Code. The following listing of additional requirements (originally included on the agenda) are considered to be those that could be impacted only if TNS were to be incorporated within the HB44 Taximeters Code and were therefore not considered during this meeting.

## S.1.5.1. General

## S.1.3. Visibility of Indications, S.1.3.1. Minimum Height of Figures, Words, and Symbols, and UR.2. Position and Illumination of Taximeter

## S.1.6. Fare Identification and S.1.7. Extras

## S.1.10. Non fare Information

## S.3.1. Positions of Control

## S.3.3. Control for Extras Mechanism

## Additional Considerations

Other discussions during the October 2015 of the GPS Subcommittee included:

Marking requirements applicable to TNS systems – will the existing marking requirements apply? No conclusions at this time.

Proposal of a new user’s requirement that specifies that the operator/user of any location services for commercial applications would be identified as being responsible for those service’s accuracy and reliability. The subcommittee did not support this believing that it is unnecessary.

The Subcommittee considered options that may be present to allow for the development and submission of any proposed changes to HB44. Noted was the typical procedure taken in formally submitting proposed changes in which the proposals are forwarded to one or more of the four regional weights and measures associations where they can be reviewed and considered. Discussed was the possibility that any proposals agreed to within this subcommittee meeting could be submitted for consideration by the NCWM at it interim meeting in January 2016. Noted was that according to protocol, proposals and conclusions from this subcommittee are to be further considered and vetted by the USNWG on Taximeters before being forwarded as proposed changes. Also noted was that all but one of the four regional weights and measures associations have already met and that the remaining (Southern Weights and Measures Association or SWMA) will meet during the week following this GPS Subcommittee meeting. This would not allow for sufficient time for any propose changes to be reviewed by the USNWG and then forwarded to the SWMA before their meeting.

The subcommittee agreed that no proposed changes should be forwarded to the NCWM without being properly vetted through others first. To do so would be considered risking inadequate development of the proposals.

**General Conclusions:**

The subcommittee agreed to the formation of two tasks groups to address specific issues identified during this meeting that require additional effort. Those issues included the consideration of methods of sealing and changes that can be proposed which will allow for the use of electronic means of sealing of specific devices/systems. This task group will also consider what components will be required to be sealed and will draw on expertise from within the subcommittee members and/or from outside experts to develop useful and appropriate requirements relating to sealing and providing security for software-based systems.

The other task group will address the terms of service that are included in the “contracts” which are agreed to by provider and customer using TNS. HB44 requirement(s) will be proposed that will identify the necessary elements to be included in the contracts that will provide an equitable alternative for those TNS services that operate without supplying a display of accumulating charges.

Ms. Macey agreed to lead both task groups and to schedule necessary meetings for those groups. Ms. Macey also noted that the task groups would develop definitions for several terms being used to describe the newer technologies and these definitions could be proposed to be added to HB44 Appendix D.

Mr. Barton agreed to revise the draft proposals for changes in the HB44 requirements that were agreed upon during this meeting and to present those “clean” revisions to the members of the subcommittee for a final review. Following this review and any additional changes identified, the proposals will be presented to the USNWG for their review and comment.

## Attendance

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| **Name** | **Affiliation** | **Email** |
| John Barton | NIST | john.barton@nist.gov |
| Jesse Davis | Creative Mobile Technologies, LLC | jdavis@cmtnyc.com |
| Bill Fishman | Retired - New York State Weights & Measures Metrology/NTEP Lab | bfishman@nycap.rr.com |
| Andrea Lobato | Lyft, Inc. | alobato@lyft.com |
| Michael Lombardi | NIST Time & Frequency Division | michael.lombardi@nist.gov |
| Kristin Macey | Director, CA Division of Measurement Standards | kristin.macey@cdfa.ca.gov |
| Gaurav Nukala | Flywheel |  |
| David Paul | Curb | dmp@gocurb.com |
| Joann Rausen | NYC Taxi and Limousine Commission- Policy & External Affairs | joanne.rausen@tlc.nyc.gov |
| Seth Schreiberg | Uber Technologies, Inc. | seths@uber.com |
| Phil Steiner | Centrodyne, Inc. | psteiner@centrodyne.com |
| Pere Tomàs | Taxitronic | ptomas@taxitronic.com |

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| **Attended via teleconference** |
| Angela Godwin | County of Ventura, CA | angela.godwin@ventura.org |

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| **Oberservers** |
| Andrei Brezoica | CA Division of Measurement Standards | andrei.brezoica@cdfa.ca.gov |
| Ron Hasemeyer  | Alameda County, CA |  |
| Bob O’Leary | Uber Technologies | bob.oleary@uber.com |
| Robert Takemori | Senior IT Systems Analyst, California Department of Food and Agriculture | robert.takemori@cdfa.ca.gov |