**USNWG on Taximeters, GPS Subcommittee**

July 24, 2015

Philadelphia, PA.

Draft Meeting Summary

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1. **Background**

A meeting of the U.S. National Work Group on Taximeters (USNWG) was held on September 24-26, 2012, in Gaithersburg, MD. One of the topics that were discussed was GPS technology as a commercial measurement and its growing use in cell phone apps to acquire vehicles for hire for transport of passenger.

 Mr. Michael Lombardi (NIST) gave a presentation on GPS technology and a group discussion on the topic followed. The USNWG work group agreed that the topic needed to be discussed further and it was suggested that a smaller subcommittee be formed to specifically address this issue. Interested members were asked to participate in this subcommittee, and 9 members of the USNWG agreed to participate. The GPS subcommittee’s mission was to address the use of GPS as a source for commercial measurements as used in association with GPS cell phone Apps, taximeters and other devices.

Subsequent discussions would consider the potential of distance measurements obtained through GPS as becoming a viable alternative to the more traditional methods of measurement. At that time, traceability of GPS measurements and their reliability was not clearly understood within the weights and measures community.

To initiate the work of the subcommittee, to the members elected to establish limits for the scope of this work. The following questions address some of the core issues that the subcommittee will need to consider.

Questions and considerations for subcommittee:

1. There seem to be two distinct applications of GPS used in determining a charge for transportation service.
	1. One application functions by the entry of a point of origin and a point of destination, then through the use of mapping-type software (e.g., Google maps, MapQuest); the distance between these two points is calculated. This calculation is based on and dependent on a pre-selected route which may or may not be the actual route followed by the hired vehicle. The charge for the trip is pre-determined and made available to the customer, up front.
	2. The second type of application is where a receiver located in the vehicle for hire serves to provide positioning information to the GPS system, and then based on successive signal transmissions and frequent updates of that receiver’s position, a course of travel is plotted for that vehicle which represents the actual route traveled.

The subcommittee will need to determine if either or both of these applications will need to be considered when developing weights and measures (legal metrology) regulation.

1. Devices that employ GPS can then be categorized into 3 classes, as listed below, is it prudent to develop regulation based on the particular characteristics of each of the following categories?
2. A taximeter that operates using features and functions found on traditional-type of taximeters. The only exception being that this taximeter uses GPS as a measurement source rather than a vehicle’s speed sensor, or input through the On Board Diagnostic (OBD) data-port, both of which are integral parts of the vehicle.
3. A software based device, installed on hardware permanently installed in a vehicle which calculates fare based on GPS measurements. Other features and functions may or may not be those of a traditional taximeter (e.g., initial drop, time-only fare calculation, cross-over speed calculations, use of multiple rates, extras charges, flat and negotiated flat rates) may or may not be present.
4. Apps (software application) that may be downloaded and function on various types of hardware devices (smart phone, tablets, computers, etc.).  The hardware used to calculate passenger charges would not be permanently installed or linked to the vehicle. The device’s software would then be used to determine the fare for hire of that vehicle.
5. **Subcommittee efforts**

In the three years that the GPS Subcommittee has been established there has been a dedicated effort to initiate and establish an ongoing dialog between the manufactures of cell phone applications and the weights and measures community. This effort has had little success although there has been some recent progress towards that goal. During the three year period however, the use of GPS and cell phone apps has been established in many cities in the U.S. and the effort to recognize and regulate these systems has grown in importance.

* 1. **General**

At the July 24, 2015 meeting of the GPS Subcommittee, Mr. John Barton (NIST technical advisor) called the meeting to order and gave a brief history of the subcommittee’s formation and its specific goals and objectives. Participating members of the GPS Subcommittee and observers in the meeting were told that although the roster of the subcommittee was maintained at a small number to maximize the efficiency of communication and discussion on specific topics, all participants at this meeting would be given a chance to voice their opinion.

Mr. Barton then turned the meeting over to Mr. William Fishman, acting chairman of the GPS Subcommittee, who would conduct the remainder of the meeting. Mr. Fishman introduced himself and reviewed the guidelines for the meeting. Introductions were made by the participating members of the subcommittee and observers in the meeting.

During the July 2015 meeting of the GPS Subcommittee, Mr. Fishman presented some general information on GPS technology to the members. The subcommittee was informed that GPS is a free service provided and maintained by the U.S. government. The Global Positioning System (GPS), is a radio navigational system that allows land, sea and airborne users to determine their exact location, it is available 24 hours a day under all weather conditions anywhere in the world. It consists of a network of 28 operational satellites orbiting the earth. All that is necessary to use this system is a receiver unit that is capable of receiving signals from the satellites and software to process and display the information.

Mr. Fishman informed the group that the processes use to determine the accuracy of the measurement produced by this system are complicated and there are a number scientific-based publications that have documented analysis of the GPS system and its accuracy. For the purpose of measuring distance which can then be used as input for taximeters and cell phone apps, the accuracy of GPS would reportedly meet or exceed technologies currently in use today.

Mr. Fishman stated that in general, there are two main topics that the subcommittee needs to discuss.

* GPS used as a commercial measurement.
* GPS mobile telephone apps and GPS based taximeters.

Mr. Mike Sikula questioned what is being considered as the measuring device in the GPS system and asked the group if it will be the satellite, the GPS receiver, or the computer involved in calculation of charges that will be subject to weights and measures regulation. Mr. Fishman responded by stating that the “device” that must be considered is actually the process by which the GPS measurement is translated into passenger charges. He further added that the receiver captures a GPS satellite signal and that this is followed by the signal being processed by the system software resulting in specific location data. A repetition of this process many times over the course of travel will be performed to plot the course of the vehicle’s traveled route.

Mr. Fishman stated that the process can involve many elements such as: satellite-based support; operational software; and mapping software all of which are used to determine a GPS coordinate. The accuracy of this system can depend somewhat on how intelligent the software is.

An example of the use of GPS technology was given by referencing the practice in New York City where “geo-fencing” is used to determined when a taxi crosses from an area where “fare A” is applied to an area where “fare B” is applied. This technology also provides a method to automatically charge for tolls on bridges that are used. The subcommittee was informed that that this type of measurement is a point-to-point measurement that determines the distance between those points along a straight line. These measurements may be made numerous times between the points of origin and destination and therefore, the more frequently the information is updated, the more accurate the result of the measurement.

Mr. Fishman made reference to a document which states the possible calculations used and the possible errors that may occur in the measurement. It is believed that for use in the transportation-for-hire service, GPS and cell phone apps can prove to be as good as or better than the technology currently in use.

The point was made that the subcommittee’s concern is primarily when the use of a GPS measurement is used for distance and time measurements in commercial transactions. Because the GPS based taximeters and cellular telephone “apps” are now being used in commerce they are expected to be regulated and addressed in NIST Handbook 44 (HB44) requirements. This subcommittee will be addressing the accuracy of time and distance measurements, the reliability and vulnerability of the software which is used in this type of system. The subcommittee will also be concerned with the presentation of information to the passenger. This work will also involve a review of requirements in Handbook 44 and modification as necessary of the existing HB44 wording to address these types of transactions.

Mr. Fishman, provided the subcommittee members information regarding the process by which HB44 is amended and stated that the subcommittee will be developing proposals for changes in HB44 to enable the regulation of GPS/cellular telephone apps through the Taximeters Code.

Mr. Fishman also expressed the need for additional input from the providers of transportation-for-hire services that use these technologies, developers of cell phone apps, and the weights and measures community to determine what is necessary to establish guidelines and modifications which would facilitate their use in commercial transactions. He then pointed out that there are different ways cellular telephone apps are currently being used in the vehicle-for-hire industry. One example is when the app will provide the customer a predetermined price for the hiring of a vehicle and process the dispatch of the vehicle. Another example is when the app will update the charges for fare using distance and time data obtained from the GPS system.

The subcommittee’s work will involve analyzing the problems that are reported to occur when using GPS for distance measurement and location. Another issue that the subcommittee will be addressing is how to test the performance of these systems and provide a means to seal the device. Mr. Fishman stated that it is important to make sure that whatever calibration settings are used to make a measurement, once the device is inspected and tested by a weights and measures, it will remain accurate. If there no means to apply a physical security seal, then there must be other means of making sure is the measurement is secure. Ms. Kristin Macey stated that it is also important to make sure that there is no facilitation of fraud in any newer technology put into use.

Mr. Barton provided an explanation of the subcommittee’s mission by stating that the group’s aim is to protect the consumer and to provide equity in the marketplace. Furthermore, there are now companies participating in this subcommittee that have introduced the use of GPS and cellular telephone app technology in the transportation industry and the subcommittee will need to determine how to apply appropriate regulations to this relatively new-type of service. This work could possibly involve the development of a different HB44 Code that applies to software-based systems or instead, amend the existing Taximeters Code so that this newer technology is covered within that existing code.

 Mr. James Cassidy agreed and added that it is also important to develop appropriate regulations to make sure that the playing field is level for vehicle-for-hire services no matter what method of measurement is used.

Mr. Fishman stated to the group that there is also an NTEP (National Type Evaluation Program) process where the evaluation of the design and performance of the device is performed. It is important that since those services using cellular telephone apps companies are presenting competitive business models to the traditional taxi services, the GPS/cellular telephone app companies must be compelled to submit their device to go through the process before it is granted approval for commercial use. It is in the interest of the weights and measures community to ensure that any technology used as the means to determine a measurement is sufficiently accurate.

* 1. **GPS Measurement Accuracy**

Mr. Fishman informed the subcommittee that it is his belief that a pure GPS signal will provide distance measurements that are very accurate. What should be recognized however, is that the signal is subject to manipulation and depending on how often you sample it, and how that signal is applied to software to calculate a fare can ultimately affect the calculation of a passenger’s total charges. Mr. Fishman added that GPS based devices should be held to equivalent or better standards than what is being applied to traditional-type taximeters.

Mr. Davis stated that it is really the software that uses the signals from the GPS system to determine a measurement and then can apply that measurement to determine a distance. The effectiveness of the system depends on the accuracy and intelligence of the software in use.

* 1. **Security Sealing Provision**

During the July 2015 meeting, the subcommittee was asked to consider the sealing requirements that currently exist in HB44. This requirement is drafted for traditional-type meters that can be sealed using a wire security seal, which can be placed on the device and served to secure all of the metrological functions. The subcommittee will now need to consider how to seal a GPS/cellular telephone device. This will likely involve providing some type of security for the software being used because there is no dedicated “device” in this type of system that would allow you to seal the calibration mechanism. Mr. Fishman stated his belief that it may be possible to effectively secure some features such as the values of the rates being applied but there is no obvious means to secure all metrological functions of the “taximeter.”

Mr. Barton stated that the intent behind any of the sealing requirements is that the metrological functions and features used by the device be effectively sealed to ensure that measurement capability remains accurate. Sealing these new types of devices which use software will require major modifications of the existing sealing requirements in the Taximeters Code so that they would apply to the software used in these newer devices.

If the existing requirements in the Taximeters Code contain some basic fundamentals that we can apply to GPS, but when addressing GPS based devices, the group should recognize that to develop appropriate standards for these types of devices may involve creating a separate HB44 Code.

* 1. **Testing Procedures**

Ms. Macey provided suggestions regarding the testing of devices that use GPS as a measurement source and stated that a road test is the only viable option. In addition, the “measured mile” road test that is currently prescribed for testing taximeters will need to be more robust than simply having the vehicle travel through a 1 mile road test. This is because the purpose of the road test is to evaluate the device as it will be used and the current criteria may not be sufficient to adequately evaluate the GPS/cellular telephone app systems. She explained further that her experience has been that the city of San Francisco, CA. is an ideal location to perform the testing due to the travel routes that will involve the vehicle going up and down hills, through the downtown area surrounded by large buildings and through tunnels that may affect the reception of the GPS signal.

Mr. Fishman agreed and stated that previously it has been possible to test customary taximeters using a variety of methods such as a dynamometer, a fifth wheel as a transfer standard, or by connecting a taximeter to a simulator (pulse generator) in a laboratory (see HB44 N.1.2. below). However, none of these methods of testing will be suitable for testing a GPS based device.

**N.1.2. Test Procedures.** ‑ The distance test of a taximeter, whether a road test, a simulated‑road test, or a fifth‑wheel test

Mr. Fishman went on to state that New York City has 21,000 taxicabs and they use a stationary dynamometer system which is the only practical way they can test given the number of taximeters and the number of trained staff capable of performing as test. Ms. Macey pointed out that another immediate question that this subcommittee should address is what would be the appropriate tolerance used when testing. Our agency (CA Division of Measurement Standards) will continue to test these new devices using the measured road course and apply the tolerances that are now used for traditional-type taximeters.

Ms. Macey asked the members of the subcommittee for their opinions if they believed that GPS can meet the tolerance requirements in the taximeter code. Also adding that she did not believe the existing prescribed tests are descriptive enough to resolve the actual cases where GPS might fail a test due to certain external influences.

Mr. Davis noted that a GPS signal from a satellite provides the position and time with an equation that performs accurately but added that the frequency of the individual readings/signals also affect the accuracy of the total distance measurement. Mr. Davis further stated that if the GPS-based devices are used when traveling down a crowded city with tall buildings, the GPS signal might bounce off the buildings giving you erroneous results. It is presumed however that this problem could be corrected with software. Mr. Davis stated his belief that existing tolerances can be used but added that when tests are performed, a route should be selected which could produce the erroneous signals that might result in calculation errors in a GPS-based device.

Mr. Sikula stated that perhaps for devices that use GPS technology there is a need to add a new element in the requirement that addresses test conditions that could include an increase in the number of miles under test and add that environmental conditions that are detrimental to the GPS signal must be present.

* 1. **Discussion on Definitions and Scope**

Ms. Macey pointed out that the subcommittee has not fully discussed the addition of needed definitions. If the existing code is modified to support the evaluation of GPS-based systems, it will need to be broadened in scope and vocabulary. If this is not done, then a separate new code is needed. Considering that a taximeter is defined as a device that calculates charges a fare by time or distance, it is questionable whether that definition can be also applied to a cellular telephone app. Explaining further that an app is not a device and it is the cellular telephone that uses software to determine the fare.

Mr. Davis stated that the existing Taximeters Code already supports the regulation needed for application to GPS/cellular telephone apps, but the definitions are generally being overlooked. He believes that if the basic definitions are expanded to accommodate the newer technology, then subcommittee can move forward with further development of the Taximeters Code.

Mr. Davis added that the current definition of a taximeter does not adequately encompass the GPS-based devices. Because the operation of these types of systems is based in the app software used (located perhaps in the “cloud” or a remotely located server), the current definition of “taximeter” does not adequately address those systems. This can create “loophole” that could possibly be used evade any significant regulation of this technology by declaring that the HB44 Taximeters Code is not relevant to the GPS/cellular telephone based systems. In other words, the devices that are being used are not being considered to be taximeters by some and therefore they would not be subject to any existing weights and measures regulation.

Ms. Macey pointed out that the use of that loophole is not valid because those types of devices can be evaluated and tested by weights and measures through the application of the HB44 General Code requirement G-A.3. “Special and Unclassified Equipment.”Ms. Macey acknowledged however, that the scope of the current Taximeters Code should be broadened along with the relevant definitions so that the GPS-based devices will fall under Weights and Measures jurisdiction without any reservations.

She acknowledged that if the software application or “app” is what is replacing the taximeter in these systems, the argument can be made that there really isn’t a device. Adding that there is cellular telephone that the software is loaded onto but it is not possible to take the software out of the phone and have it work. Ms. Macey then raised the question of whether it is more appropriate to rename the existing code as the “time and distance measuring device code” or should a new code for the GPS enabled devices be created.

Mr. Barton agreed that a Weights and Measures official can use the General Code of HB44 to look at a device not specifically covered in HB44. General Code requirement G-A.3. “Special and Unclassified Equipment” gives the weights and measures official a means to evaluate devices that are not specifically covered in HB44. That requirement gives the official a very broad brush to apply sensible and suitable requirements and specifications to evaluate a device and is shown below.

**G-A.3. Special and Unclassified Equipment.** – Insofar as they are clearly appropriate, the requirements and provisions of the General Code and of specific codes apply to equipment failing, by reason of special design or otherwise, to fall clearly within one of the particular equipment classes for which separate codes have been established. With respect to such equipment, code requirements and provisions shall be applied with due regard to the design, intended purpose, and conditions of use of the equipment.

* 1. **Time and/or Distance Calculations of Fare**

Ms. Macey asked the subcommittee members to consider a specific requirement that she recommends be modified. This requirement, S.4. “Interference,” states that the fare can be calculated using time or distance but not both at the same time and is shown below.

**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)

It was explained to the subcommittee that this requirement states that a taximeter is permitted to calculate charges using time or distance but is prohibited of using both of those factors at the same time to calculate passenger charges. The process of switching from one input (time/distance) to another is called the “cross-over.” This cross-over will take place when the vehicle reaches a speed where the calculation of fare charges will be optimized by switching from one factor (distance or time) to the other. If the vehicle’s speed falls below the cross-over, fare will be calculated using time elapsed and likewise, if the vehicle’s speed climbs above the cross-over, the fare will be calculated using distance traveled.

Ms. Macey pointed out that this requirement is not aligned with the corresponding international OIML standard (OIML R21) that allows a taximeter to charge for time and distance at the same time. The U.S. requirement was originally established to account for the fact that mechanical taximeters used various gears and mechanisms to calculate their fare and this was a limitation of the system used. It is being reported that some GPS/app services being used are not in compliance with the U.S. standard in that they calculate charges using time and distance factors simultaneously.

Ms. Macey recommended that the subcommittee work to modify S.4. and any other relevant requirement in the Taximeters Code to allow a taximeter to charge for time and distance at the same time. This requirement could be made optional and enforced at the discretion of each jurisdiction that would permit this manner of calculation for a fare.

Mr. Byron Corcoran stated that modifying this requirement and eliminating the crossover would likely be favored by fleet (taxicab) owners because it would result in an increase of fare unless the rate structures are adjusted accordingly. Ms. Joanne Rausen agreed stating that if this change is made, it could be left up to the jurisdiction if they permit both time and distance measurements for fare calculation to be used simultaneously.

Mr. Sikula, asked the subcommittee members if permitting the calculation of fare by both time and distance would lead to an increase of the fare amount. Ms. Macey stated that if this modification is made to the existing Taximeters Code technology, there would likely be an evolution of rate structures to adjust for the new method allowed for calculation of fare charges. She believes that is will be a process that occurs gradually over time and that it will be up to each jurisdiction to make any adjustments to their rate structures.

Mr. Davis added that the whole purpose of using time or distance from the regulatory point of view is to guarantee a driver a predictable fare charge so they can earn a consistent wage. The cross-over ensured that if the taxi is stuck in heavy traffic the loss in the distance portion of the fare would be compensated by the gain of the time portion of the fare.

Mr. Barton asked the group if S.4. Interference was eliminated, would it be possible to adjust rate structures to ensure that the cost of hired transportation would not be irreparably transformed and cause significant disruption in this industry. Mr. Fishman stated that this change will require that rates be modified to account for this new method of calculating the fares and that hopefully the end result will be the pricing for this service will remain the same overall. The subcommittee members generally agreed that this change could be accomplished without any great deal of harm to either the industry or its customers.

Mr. Barton stated that this specific change of deleting one requirement will have an impact in other sections of the code. If the subcommittee would agree, Mr. Barton has volunteered to review the entire Taximeter Code to determine if this change will influence other requirements. He also agreed to develop a draft for wording that would allow the simultaneous use of time and distance throughout the code.

Ms. Angela Godwin stated that since this change will alter the accepted method of calculation of a fare, it should be done carefully to make the customers and operators aware of what will be permitted. Ms. Macey stated that we could modify this requirement to allow both methods of calculating a fare and thereby permitting the evolution in technology used in this industry over time. This would still allow the use of existing devices and it would be up to the jurisdiction on how this change is enforced. Ms. Macey stated that the only difference in testing would then be that the evaluator will not do the interference test with those devices that calculate a fare using a simultaneous time and distance calculation.

* 1. **Identifying Additional Areas of Non-Compliance**

Mr. Fishman asked the subcommittee to consider a traditional-type taximeter where the only change would involve the source of distance measurement and whether by changing that input from a source in the vehicle’s transmission to an input from a GPS system would exclude that device from being appropriately covered under the HB44 Taximeters Code? Believing that the Taximeters Code would not require significant change to accommodate this type of device, Mr. Fishman explained that it will be the types of systems that operate through the use of a cellular telephone app that will require significant changes to the Taximeters Code. The distinction between these types of systems must be recognized.

As a representative of taximeter manufacturers, Mr. Corcoran was asked if he is aware of other areas in the existing HB44 Taximeters Code that a GPS-based taximeter might have problems complying with. Mr. Corcoran responded that it is possible to use GPS as the input for any existing model of taximeter and it will generally meet all existing requirements. The one area that may be problematic would be when the GPS signal is lost. This most likely could be compensated for by using a time only mode when the GPS signal is lost. Mr. Corcoran added that there is a requirement in the handbook (S.6. Power Interruption, Electronic Taximeters) that addresses power loss to the device and it may be possible that the subcommittee could expand on that requirement to recognize GPS communications loss.

The subcommittee acknowledged that a system could employ multiple distance inputs that would include the vehicle’s transmission or from the GPS system. This may be another means to address the loss of a GPS signal. Mr. Corcoran added that the features of a cellular telephone used as a taximeter that he believes would be in conflict with current requirement involve the size and appearance of the displayed indications.

Ms. Macey stated that there may be a significant problem with using time only if a GPS signal is lost. She stated that there is no assurance that equity will be maintained in a transaction that would allow the calculation of a passenger’s fare to be switched to strictly a time basis when GPS signal is lost. She further stated that it is her belief that allowing the fare to be calculated by time and distance simultaneously will produce greater equity and clarity in the transaction.

Mr. Fishman identified the next agenda item regarding a HB44 Taximeters Code requirement S.1.4. “Actuation of Fare-Indicating Mechanism” which states the fare-indicating element shall be activated by the fare indicating mechanism whenever the vehicle is in motion. There was some general discussion among the subcommittee about the fact that the GPS receiver is not likely a permanent fixture in the vehicle and what factor would activate the fare-indicating mechanism. This requirement is shown below.

**S.1.4. Actuation of Fare‑Indicating Mechanism.** – When a taximeter designed to calculate fares upon the basis of a combination of distance traveled and time elapsed 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)

Mr. Fishman acknowledged that the GPS system is not in the vehicle and that there needs to be some discussion about the impact of this section if it were to apply to GPS devices. There was then a general discussion on the subject with many differing views.

Mr. James Cassidy stated that the ultimate goal is that the standards encourage the most precise and accurate measurement available and if the international standards can be used it will be appropriate to use the most accurate method. Whatever technology is used, the standards for accuracy should not be reduced.

Mr. Seth Schreiberg was asked for his opinion concerning the visibility of displays available on cellular telephones in regard to the transparency of the transaction. Mr. Schreiberg responded that whether this is necessary may depend on the type of service offered. He explained to the subcommittee that there are different levels of service offered by his company. One of those services is simply the ability to request a taxicab (equipped with a traditional-type taximeter) through their app. Mr. Schreiberg further stated that with the other types of services offered, which do not use a traditional taximeter, the passenger can request an estimate for the ride prior to requesting the service, and then track the ride on their phone.

* 1. **Closing remarks**

Mr. Barton stated that he plans to review the taximeter code closely and determine what effect it would have on the rest of the Taximeters Code if the interference requirement (S.4.) is eliminated. He stated also that he will review the code in its entirety and identify those sections that that the subcommittee will need to address. The next meeting will be two days in duration and take place as a face-to-face meeting in California tentatively planned for late October or early November. The subcommittee will be notified as soon as the dates are confirmed.

Mr. Fishman stated that we are still trying to keep the GPS Subcommittee membership small, about 12 members, and we will be reporting to the larger USNWG Committee on Taximeters, which has an open membership. If anyone has any additional comments or would like to address any other subjects, please send them to me or Mr. Barton. Mr. Fishman acknowledged the assets in the subcommittee by recognizing the technical nature of the subjects that are being discussed and the knowledge and experience that the subcommittee members are willing to share with the group.

1. **Attendance:**

 **Name Company Email**

|  |  |  |
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