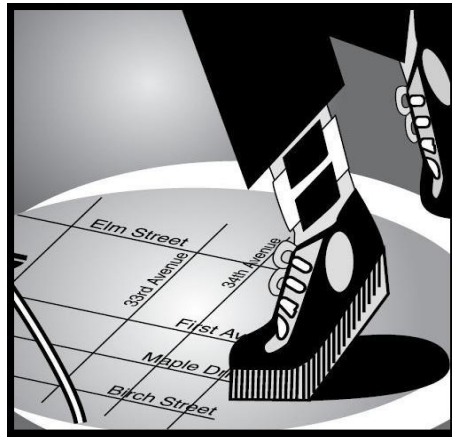


Testing Protocols for Offender Tracking Technologies



An agency's guide for measuring the effectiveness of equipment used to track offenders

June 2011

*These testing protocols were established by **George Drake**, President of Correct Tech, LLC on behalf of the National Institute of Justice's Corrections Technology Center of Excellence
June 2011*

Table of Contents

Why test offender tracking equipment?	4
Initial preparation	5
GPS Acquisition Time Test	6
Baseline Test	8
Residential Building Test	10
Commercial Building Test	12
Urban Canyon Test	14
Rural Test	16
Vehicle Tracking/Breadcrumb Trial Tests	18
Exclusion Zone Test	20
Inclusion Zone Test	22
Zones within a Zone Test	24
Intentional Shielding Test	26
Bracelet Strap Cutting Test	28
Bracelet Water Tightness Test	30
Tracking Device Battery Drain Test	32
Communication Failure Test	34
Alarm Response Time Test	36
Tether Battery Drain Test	38
Nuisance and False Alarms	39
Appendix 1: Summary of Test Results	40

Why test offender tracking equipment?

When selecting offender tracking equipment, an agency should consider a number of factors. Cost, the reputation of the vendors, customer support, software functionality, and product performance are all factors that should be carefully weighed. This document is designed to assist agencies with evaluating just one of these factors – product performance. By following the steps provided on the following pages, your agency can objectively evaluate how offender tracking equipment performs in your local environments.

The offender tracking equipment offered by the many vendors in today's marketplace has a wide variety of features and capabilities. Many of these features may be important to your agency while others may be nice to have, but are not essential. It is important to understand the capabilities of the equipment so you can make selections that will meet your agency needs.

It is also important to recognize that the same equipment may perform much differently in varying environments. Equipment designed to work well in urban environments could perform poorly in predominately rural areas of the country. In fact, some equipment will not work at all in these environments.

Among the factors that contribute to performance variations in differing environments include:

- Cellular service availability
- Cellular carriers used
- Land line options
- Antenna orientation
- Power conservation strategies
- Topography
- Heavy foliage
- Presence of "urban canyons"
- Building materials used in the area

An agency will also want to try many of the new product features, which can vary widely from vendor to vendor. The design of the software can play a significant factor in user satisfaction. Notification options may be an important feature to an agency while the elimination of nuisance alarms (unnecessary alerts) could be another's priority. Additionally, the professionalism of the monitoring center staff and the support provided by the account managers may be a deciding factor.

Whatever priorities your agency has, it is difficult to know whether a vendor's equipment is right for you unless you take it for a test drive. This guide is designed to assist your agency in performing a variety of testing protocols which will allow you to objectively compare the performance of different equipment. Realizing that most agencies do not have sophisticated equipment that can be found in product testings laboratories, these protocols were developed for non-technical evaluators to be completed in environments where supervising officers work every day. No expensive equipment is needed and most tests can be completed with only a moderate investment of time.

Initial Preparation

In order to maximize the effectiveness of your testing process, it is recommended that you take a few preparatory steps and consider a few factors before beginning.

- Determine which cellular service provider(s) the equipment utilizes.
- Go to the service provider's homepage on the internet and review updated coverage maps. Keep in mind that the accuracy of coverage maps may vary widely. You may need to consult with the cellular service provider in order to obtain the most up-to-date maps.
- Be sure the testing sites selected are well within the coverage areas to assure that location data recorded by the equipment can be communicated to the monitoring center.
- If one purpose of the testing is to determine how data is collected and stored outside of the cellular coverage area, use the maps to locate areas not covered by the cellular service.
- Be sure all batteries are fully charged at the beginning of the testing period.
- Synchronize your watch to the clock used by the vendor's software.

GPS Acquisition Time Test

Part of the enrollment process with all offender tracking devices is orienting the tracking device. Often referred to as a “cold start”, the tracking device must be powered up and taken outside where it has an unobstructed view of the sky. Some equipment can acquire GPS data within a minute or two while other devices take much longer. Officers who have used equipment with slow acquisition times will tell you how frustrating it is to be standing outside with the equipment for lengthy periods. Devices using *Assisted GPS* are more likely to become oriented quickly, although other factors such as weather, foliage, nearby buildings and antenna orientation can also play a factor in acquisition speeds.

This test is designed to demonstrate the GPS acquisition speed of the equipment being tested.

Procedure:

- Read the manufacturer’s instructions on how to allow the device to acquire GPS on its first use.
- Record the time.
- Perform the GPS acquisition procedure.
- Each manufacturer’s equipment will provide a method of notifying the user when GPS has been acquired. In order to make this test more standardized, the acquisition will be considered complete when the first location point is calculated.
- After acquisition has been completed, review the mapping portion of the vendor software, locate the first plotted point, and record the time associated with that point.
- Calculate the time difference between the time recorded at the beginning of the test with the time of the first recorded location point.

GPS Acquisition Time Worksheet

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

Time to Acquire GPS			
---------------------	--	--	--

Notes: _____

Baseline Test

The purpose of this procedure is to determine how accurate the tracking equipment is under ideal conditions. This information can be used to compare the accuracy of location data when the equipment is used in more challenging conditions.

Procedure:

- Select a site that is outside, in an open area (such as a meadow, park or a parking lot) and at least 300 feet away from any commercial structures that are taller than 50 feet in height.
- The site should be away from nearby mountains, cliffs, heavily forested areas or any other obstruction that blocks a clear view of the sky beyond a 15 degree angle to the horizon.
- Select a site that has a landmark (or intersection) that can be easily recognized from the satellite view of the mapping software that the vendor utilizes (i.e. Google Earth or Microsoft Earth). The selected site should be in an area the mapping software displays in high resolution.
- Set the activated tracking device on a table (or other stand) so it is approximately 2.5 to 3.5 feet (two-piece unit) or six inches above the ground (one-piece unit) above the ground and oriented in a manner that is consistent with how the equipment will be worn or carried by the offender.
- Record the starting time of the test.
- Let the device collect data points for at least 45 minutes.
- Note: Some devices will not collect GPS points while they are at rest. If this is the case, the tracking device should be worn by an evaluator while walking along a carefully planned route in an environment described above.
- Record the time the test is concluded.
- Retrieve the location data points with the vendor's software, using the satellite view, if available. Estimate and record the distance of each location data point from the actual location of the tracking device using the landmark that was selected. As an alternative to plotting every point, you may evaluate every 5th point or every 10th point. You should have no less than 20 points to evaluate.
- Add all of the distances together and divide by the number of data points evaluated to establish an average.
- A "thrown point", for this purpose, will be defined as a data point that is beyond 100 times the average distance of the other points to the actual location. Thrown points should not be used when calculating the average. However, they should be documented, as excessive thrown points can be very problematic when tracking offenders.
- It is recommended that you repeat this procedure one hour later. The changing locations of the satellites in the sky can occasionally cause differing results.
- Average the findings of the two results to arrive at the tracking device's optimal accuracy expectation.

Baseline Test Worksheet

Trial 1

Trial 2

	Vendor 1	Vendor 2	Vendor3
Test Date			
Test Start Time			
Test End Time			

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

	Distance From Target		
Point 1	3		
Point 2	3		
Point 3	4		
Point 4	5		
Point 5	8		
Point 6	6		
Point 7	6		
Point 8	3		
Point 9	3		
Point 10	5		
Point 11	7		
Point 12	5		
Point 13	8		
Point 14	5		
Point 15			
Point 16			
Point 17			
Point 18			
Point 19			
Point 20			

	Distance From Target		
Point 1			
Point 2			
Point 3			
Point 4			
Point 5			
Point 6			
Point 7			
Point 8			
Point 9			
Point 10			
Point 11			
Point 12			
Point 13			
Point 14			
Point 15			
Point 16			
Point 17			
Point 18			
Point 19			
Point 20			

Total			
Tr. Avg.			

Total			
Tr. Avg.			

	Vendor 1	Vendor 2	Vendor 3
Test Avg.			

Make additional copies as needed.

Residential Building Test

Because an offender will typically be at home twelve or more hours each day, it is important that the equipment that your agency selects works well in this environment. While performing this testing, you may discover that GPS signals are often unable to penetrate the shielding caused by the building materials. Mobile homes, high-rise apartment buildings and adobe structures are especially problematic. While performing this test, monitor how many GPS interruptions occur and for how long these interruptions last.

- Select a residence that is made of materials that is the most typical for your area. For example, if most residences are one story structures with 2"x 6" wood framing with a bricked exterior, locate a residence with these characteristics.
- The selected residence should not be in a high rise, a mountainous area, a heavily wooded area or in a canyon unless a majority of the residences in the community are so situated.
- Set the tracking device on a table 2.5 to 3.5 feet above the floor in a bedroom that has at least one window within 10 feet of the device. Choose a bedroom on the top floor of multiple story residences.
- Record the starting time of the test.
- Let the device collect data points for at least 45 minutes. A longer test period (i.e., 8-10 hours) will produce more definitive results. To get results the most representative results, allow as much time for this evaluation as possible.
- Note: Some two-piece devices will not collect GPS points while they are at rest. If this is the case, the tracking device should be worn by an evaluator and the evaluator should remain in motion without moving far from the designated location.
- Record the time the test is concluded.
- Retrieve the location data points with the vendor's software, using the satellite view (aerial imagery) if available. Estimate and record the distance of each location data point from the actual location of the tracking device. Add all of the distances together and divide by the number of data points retrieved to establish an average. As an alternative to plotting every point, you may evaluate every 5th point or every 10th point. You should have no less than 20 points to evaluate.
- A "thrown point", for this purpose, will be defined as a data point that is beyond 100 times the average distance of the other points to the actual location. Thrown points should not be used when calculating the average. However, they should be documented, as excessive thrown points can be very problematic when tracking offenders.
- Repeat this procedure one hour later. The changing locations of the satellites in the sky can cause differing results.
- Average the findings of the two results to arrive at the tracking device's expected accuracy in a typical residential setting for the community in which the device was tested.
- You may repeat this procedure for other types of structures, such as mobile homes, high rises or adobe residences.

Residential Building Test Worksheet

Trial 1

Trial 2

	Vendor 1	Vendor 2	Vendor3
Test Date			
Test Start Time			
Test End Time			

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

	Distance From Target		
Point 1			
Point 2			
Point 3			
Point 4			
Point 5			
Point 6			
Point 7			
Point 8			
Point 9			
Point 10			
Point 11			
Point 12			
Point 13			
Point 14			
Point 15			
Point 16			
Point 17			
Point 18			
Point 19			
Point 20			

	Distance From Target		
Point 1			
Point 2			
Point 3			
Point 4			
Point 5			
Point 6			
Point 7			
Point 8			
Point 9			
Point 10			
Point 11			
Point 12			
Point 13			
Point 14			
Point 15			
Point 16			
Point 17			
Point 18			
Point 19			
Point 20			

Total			
Tr. Avg.			

Total			
Tr. Avg.			

	Vendor 1	Vendor 2	Vendor 3
Test Avg.			

Make additional copies as needed.

Commercial Building Test

All offenders will spend time inside commercial structures. Conditions of supervision may require schooling, counseling, employment and frequent visits to your agency's office. Many of these locations are in commercial structures where GPS signals may not penetrate. If your agency has plans to monitor an offender's presence at these required locations, this testing is very important.

- Follow the same procedure as in the Indoor Residential Test, but place the tracking device in one of the middle floors of a high rise office building with no direct line of sight to a window.
- Average the error distances as was done in the previous tests. Do not be surprised if some devices fail to produce any location data points in this environment.
- You may repeat this procedure in other commercial structures that are typical within the community that the equipment will be used.

Commercial Building Test Worksheet

Trial 1

Trial 2

	Vendor 1	Vendor 2	Vendor3
Test Date			
Test Start Time			
Test End Time			

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

	Distance From Target		
Point 1			
Point 2			
Point 3			
Point 4			
Point 5			
Point 6			
Point 7			
Point 8			
Point 9			
Point 10			
Point 11			
Point 12			
Point 13			
Point 14			
Point 15			
Point 16			
Point 17			
Point 18			
Point 19			
Point 20			

	Distance From Target		
Point 1			
Point 2			
Point 3			
Point 4			
Point 5			
Point 6			
Point 7			
Point 8			
Point 9			
Point 10			
Point 11			
Point 12			
Point 13			
Point 14			
Point 15			
Point 16			
Point 17			
Point 18			
Point 19			
Point 20			

Total			
Tr. Avg.			

Total			
Tr. Avg.			

	Vendor 1	Vendor 2	Vendor 3
Test Avg.			

Make additional copies as needed.

Urban Canyon Testing

If your agency will be utilizing offender tracking equipment in major metropolitan areas that have clusters of tall buildings, this testing is especially important. Sometimes GPS signals bounce off the sides of buildings before being received by the tracking device. Other signals arrive to the tracking device following a direct path. This can create location inaccuracy and is known as the multipath effect. The signal following the indirect route arrives at the tracking device later causing the error. The multipath affect can create location errors as minor as a few feet or as large as a mile or more, depending on how far the reflected signal travelled before arriving at the tracking device. Some GPS chips have incorporated clever algorithms to minimize this problem. This testing will help you determine to what extent, if any, multipathing will have on your ability to accurately track offenders in urban and commercial environments.

- Set the tracking device to record location data points as frequently as possible.
- Wear the equipment as recommended by the manufacturer.
- Record the time your testing begins.
- Walk up and down city streets for at least 30 minutes, selecting a route that contains many of the tallest buildings and large structures with reflective exteriors. Keep a record of your path and on which side of the street you walked.
- Record the time your testing was completed.
- While comparing the recorded path as generated by the tracking software, compare the accuracy against the device's optimal accuracy as measured in the Baseline Test.
- Count the number of "thrown points" (if any) and compare that with the number that occurred during the Baseline Test.

Urban Canyon Worksheet

Trial 1

Trial 2

	Vendor 1	Vendor 2	Vendor3
Test Date			
Test Start Time			
Test End Time			

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

	Distance From Target		
Point 1			
Point 2			
Point 3			
Point 4			
Point 5			
Point 6			
Point 7			
Point 8			
Point 9			
Point 10			
Point 11			
Point 12			
Point 13			
Point 14			
Point 15			
Point 16			
Point 17			
Point 18			
Point 19			
Point 20			

	Distance From Target		
Point 1			
Point 2			
Point 3			
Point 4			
Point 5			
Point 6			
Point 7			
Point 8			
Point 9			
Point 10			
Point 11			
Point 12			
Point 13			
Point 14			
Point 15			
Point 16			
Point 17			
Point 18			
Point 19			
Point 20			

Total			
Tr. Avg.			

Total			
Tr. Avg.			

	Vendor 1	Vendor 2	Vendor 3
Test Avg.			
Thrown Pts.			

Make additional copies as needed.

Rural Test

Most agencies have at least part of their jurisdiction in rural areas. If you expect to track offenders actively in these environments, it is important to determine which vendors' equipment work best in these conditions. Some vendors claim that their equipment will work in locations even where cellular voice communications are not possible, citing that data communication uses less bandwidth than does voice. If you find that active tracking cannot be done in the locations you have selected, consider choosing a passive tracking system that can periodically upload data using landline telephone connections.

- Ask the vendor which cellular service(s) the tracking device uses.
- Refer to the cellular coverage maps of the service used by the vendor. Make sure the maps are current.
- Select a rural location where cellular service is not provided.
- Drive to that location and remain for at least one hour.
- If you have a cell phone that utilizes the same cellular service as the tracking device being tested, check the signal strength on your phone to confirm that service is unavailable.
- If possible, access the vendor's monitoring website while in the rural area to determine if your presence in the rural area has been recorded.
- Return and access the website and determine whether the location points have been saved and recorded upon returning to an area having cellular coverage.
- Repeat this test in an area that has weak signal strength.

Rural Testing Worksheet

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

What cell service is utilized?

--	--	--

Are coverage maps available?

Y / N	Y / N	Y / N
-------	-------	-------

Is a cell phone available using this service?

Y / N	Y / N	Y / N
-------	-------	-------

If yes, does the phone show service availability?

Y / N	Y / N	Y / N
-------	-------	-------

Comments: _____

When checking the vendor's software, **while still in the rural testing area**, were there any tracking points recorded?

Y / N	Y / N	Y / N
-------	-------	-------

When checking the vendor's software, **after returning to your office site**, were there any tracking points recorded?

Y / N	Y / N	Y / N
-------	-------	-------

Comments: _____

Were there any "thrown" or missed tracking points?

Y / N	Y / N	Y / N
-------	-------	-------

Comments: _____

Vehicle Tracking Test / Breadcrumb Trail Test

Offenders spend many hours driving and riding in vehicles. A vehicle can sometimes cause shielding that prevents GPS signals from arriving at the tracking device. One-piece units that are worn on the ankle (and subsequently are often placed under the dashboard not far from the engine block when an offender is in the front seat) are more susceptible to this type of shielding. This testing protocol will not only help you determine how well tracking can take place while an offender is in the vehicle, but it is also an ideal time to evaluate the tightness of the system's tracking pattern. Devices on the market today plot tracking points as frequently as once every 10 seconds to as infrequently as once every several minutes. If it is important to know the paths that offenders take, especially when their velocity increases (i.e. while driving in a vehicle), you will want to select a device that will plot tracking points more frequently.

- Set the tracking device to record location data points as frequently as possible.
- Record the starting time of the test.
- Wearing the equipment as recommended by the vendor, drive a typical motor vehicle for at least 20 minutes in an area that does not have significant RF barriers (avoid mountain roads, heavily forested areas and urban canyons). Note: if the manufacturer's user guide does not provide information as to where a two-piece device should be positioned while in a vehicle, place the tracking device on the car seat.
- Record the completion time of the test.
- Compare the route as it was recorded by the vendor's software. Accuracy can be measured by how far left or right the recorded point is indicated relative to its actual path. If you are able to maintain a steady speed, check to see if the tracking points are evenly spaced. This will also provide a good indication of accuracy.
- Take note of any significant errors in the recorded data points, including missing or thrown points.
- Measure the quality of the breadcrumb trail by counting the number of location data points recorded and divide that by the number of minutes the equipment was tested. This will determine the maximum points per minute the equipment will record.

Vehicle Tracking Test/Breadcrumb Trail Worksheet

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

On average, how many feet to the left or right were the points plotted from the actual route taken?

Notes: _____

Were you able to drive at a constant speed for at least part of the trial?

Notes: _____

If so, were the points evenly spaced along this portion of the route taken?

Notes: _____

What is the time interval between plotted points?

Notes: _____

Were there any tracking points not plotted?

Notes: _____

How frequently were points plotted? Vendor 1 _____ Vendor 2 _____ Vendor 3 _____

Notes: _____

Exclusion Zone Test

At the heart of offender tracking is the objective of keeping supervisees away for certain locations. Whether those places are bars, playgrounds, the victim's residence or some other "hot spot" that an offender must avoid, it is imperative that the equipment your agency selects performs exceptionally well when monitoring these zones. This testing protocol will show you how well the equipment performs this important function.

- Using the vendor provided software, create an exclusion zone that will be the target of this test.
- If applicable, set the tolerance (the time a tracking device can remain in a restricted area without generating an alert) to zero minutes.
- Print a copy of the map showing the precise borders of the restricted area. Note whether the zone can be defined by an oval, circle, rectangle, square or polygon.
- Select a method of alert notification, (such as a page to be received by the evaluator).
- On the first trial, blatantly violate the restricted area by entering the center of the zone and staying there for at least five minutes.
- Record the start and finish time of this trial.
- On the second trial, attempt to avoid detection by driving a vehicle or walking through the outskirts of the zone without stopping. Stay in the zone less than one minute.
- Keeping in mind the data point collection rate as determined in the Breadcrumb Trail Test, see how long you can loiter within a zone without detection. **Note: Some systems download zone and schedule data into the tracking unit. These devices should send an alert to the monitoring station as soon as a zone is breached because the device will instantly know it is in a restricted area. Equipment that does not download data into the tracking device makes periodic location calculations and sends the data to the the monitoring center where a computer checks the location data against the offender's zone and schedule information. These systems can be more vulnerable to missing brief exclusion zone violations.**

Exclusion Zone Worksheet

Trial 1

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

When blatantly violating the zone, did the system record the violation and alert the officer as expected?

Notes: _____

Trial 2

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

When briefly violating the zone, did the system record the violation and alert the officer as expected?

Notes: _____

Inclusion Zone Test

Another important objective of an offender tracking program is the monitoring of an offender's presence at required locations. Monitoring the offender's home to enforce a curfew is the most common use for an inclusion zone. However, inclusion zones can also be created to monitor an offender's attendance at work, school, counseling, or adherence to day reporting requirements. Use this protocol to test the accuracy and reliability a system's ability to monitor these zones.

- Using the vendor provided software, create an inclusion zone that will be the target of this test.
- If applicable, set the tolerance (the time a tracking device can remain outside an inclusion area without generating an alert) to zero minutes.
- Print a copy of the map showing the precise borders of the inclusion area. Note: the zone may be defined by an oval, circle, rectangle, square or polygon.
- Select a method of alert notification, (such as a page to be received by the evaluator).
- On the first trial, blatantly violate the inclusion area by leaving the area and staying away for at least fifteen minutes.
- Record the start and finish time of this trial.
- Repeat the procedure, but only remain outside of the inclusion zone for one minute.
- Keeping in mind the datapoint collection rate as determined in the Breadcrumb Trail Test, see how long you can loiter outside the zone without detection. **Note: Some systems download zone and schedule data into the tracking unit. These devices should send an alert to the monitoring station as soon as a zone is breached because the device will instantly know it is outside an inclusion area. Equipment that does not download data into the tracking device makes periodic location calculations and sends the data to the the monitoring center where a computer checks the location data against the offender's zone and schedule information. These systems can be more vulnerable to missing zone violations.**

Inclusion Zone Worksheet

Trial 1

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

When blatantly violating the zone, did the system record the violation and alert the officer as expected?

Notes: _____

Trial 2

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

When briefly violating the zone, did the system record the violation and alert the officer as expected?

Notes: _____

Zones within a Zone Test

Most supervision conditions require an offender to stay inside of jurisdictional boundaries (i.e. city or county limits) unless a travel permit is granted. To monitor compliance with this activity using offender tracking equipment, the jurisdiction (i.e. city or county) needs to be a large inclusion zone. The offender is also assigned exclusion and inclusion zones that are inside of this large jurisdictional inclusion zone. Some vendor's software cannot monitor zones within zones. This protocol is designed to determine if the company's software is capable of doing this.

- Set a jurisdictional inclusion zone around a large portion of a city.
- Create an inclusion zone inside of the jurisdictional zone.
- Create an exclusion zone inside of the jurisdictional zone.
- Leave the smaller inclusion zone at a time that the schedule requires your presence there.
- Arrive at the exclusion zone and remain for ten minutes.
- Leave the large jurisdictional zone and return after ten minutes.
- Review the alarms generated by the software to determine if they were properly generated.

Zone within a Zone Worksheet

Trial 1

Inclusion Zone within an Inclusion Zone

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

Did the software allow you to create these zones?

Y / N

Did software generate an alarm when the internal zone was violated?

Y / N

Notes: _____

Trial 2

Exclusion Zone within an Inclusion Zone

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

Did the software allow you to create these zones?

Y / N

Did software generate an alarm when the internal zone was violated?

Y / N

Notes: _____

Trial 3

Leaving the jurisdictional zone

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Violation Time			
Did alarm occur?			

Intentional Shielding Test

Some offenders will attempt to circumvent zone and schedule requirements by intentionally shielding their assigned tracking device. Blocking the weak GPS signals from reaching a tracking device can be easily accomplished with aluminum foil or some other readily available shielding material. Some vendors have developed counter measures to warn that GPS is lost and the device's whereabouts are unknown. Offender tracking equipment is of little value if offenders, with little effort, can circumvent the system and violate zones and schedules without detection. In fact, an offender could exploit a system's vulnerabilities and create an alibi by using the tracking history to suggest he was not at the location of a crime that he or she committed. Obviously, this testing protocol is important, and the results should be evaluated carefully before deciding which equipment your agency will ultimately use.

- **Note: The optimal amount of shielding will block the relatively weak GPS signals from reaching the tracking device while allowing cellular communications and the RF link to the tether (of two-piece units) to continue to work. You may increase or decrease the amount of foil used to obtain this level of shielding.**
- Attempt to shield the tracking device's ability to receive GPS signals by placing two layers of aluminum foil completely around the tracking device. Make sure there are no tears or openings in the foil.
- Repeat the Exclusion and Inclusion Zone Testing protocols.
- Check the tracking points on the vendor software to determine how the shielding effected the systems ability to track the device.
- If you are testing a two-piece unit, note whether this shielding generated a "Bracelet Gone", "Communication Failure" or "Motion, No GPS" or alerts.
- If you are testing a one-piece device, note whether this shielding generated a "Communication Failure" and/or "No GPS" alerts. This test should be done while wearing the device.
- Equipment that produces only a "No GPS" alert may not be providing sufficient protection against intentional shielding. Typically, "No GPS" alerts happen many times each day as an offender legitimately enters and leaves buildings. You will not be able to differentiate between intentional and unintentional GPS shielding.
- After assessing how vulnerable your selected equipment is to intentional shielding, you should consider which applications may not be appropriate for your program (i.e. victim protection).

Intentional Shielding Worksheet

Trial 1 One foil layer

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

Did one layer block GPS?
 Did one layer block cell communication?
 Did one layer cause a "Bracelet Gone" alert (2-piece)?

Vendor 1	Vendor 2	Vendor 3

Trial 2 Two foil layers

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

Did two layers block GPS?
 Did two layers block cell communication?
 Did two layers cause a "Bracelet Gone" alert (2-piece)?

Vendor 1	Vendor 2	Vendor 3

Trial 3 Three foil layers

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

Did three layers block GPS?
 Did three layers block cell communication?
 Did three layers cause a "Bracelet Gone" alert (2-piece)?

Vendor 1	Vendor 2	Vendor 3

Bracelet Strap Cutting Test

Vendors that offer bracelets with only conduction or continuity tamper technology may be susceptible to tampering without producing an immediate alert. These bracelets detect a weak current that constantly passes through the conductive material of the strap. If the strap is cut, the current is interrupted and the bracelet goes into a tamper mode. Try to defeat this technology with this test.

- Using 12 or 14 gauge wire and four alligator clips, make 2 six inch jumpers with an alligator clip at each end.
- While wearing a bracelet in a non-tamper state, attach an alligator clip of the first jumper to the top portion of bracelet strap approximately one inch from where the strap fastens to the transmitter. Make sure the teeth of the alligator clip have a tight grip on the strap. In a similar fashion attach the second alligator clip of the first jumper to the strap approximately one inch from the other side of the transmitter, also on the top portion of the bracelet strap.
- Repeat the process with the second jumper, but place the alligator clips on the bottom portion of the bracelet strap directly below the first set.
- Using a pair of scissors, cut the strap slowly, looking for any metal wires embedded within the strap. If a wire is found, remove one of the jumper wires and place both alligator clips on the exposed wire and cut the strap between the clips. If there is no embedded wire, cut the strap completely through.
- Carefully, pull the cut strap apart using caution not to disturb the alligator clips and then remove the bracelet from your ankle.
- Check the vendor provided software to determine whether an alert was generated.
- **Note: Although this type of tamper will be obvious to a supervising officer upon visual inspection, the officer will not know when the tamper occurred. An offender could, for example, call the supervising officer well after the fact (but before a visual inspection) asking permission to remove the bracelet for a bogus medical emergency.**

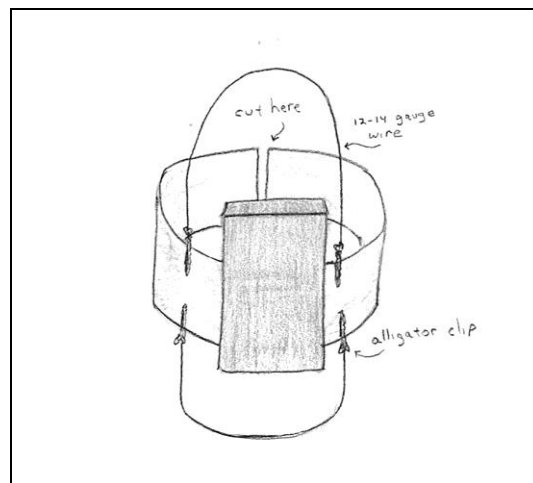


Diagram showing how to install jumpers

Bracelet Spoofing Test Worksheet

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

What type of tamper detection technology is present?

	Vendor 1	Vendor 2	Vendor 3
Conductive Strap	Y / N	Y / N	Y / N
Fiber Optics	Y / N	Y / N	Y / N
Proximity Sensor	Y / N	Y / N	Y / N
Temperature	Y / N	Y / N	Y / N
Other	Y / N	Y / N	Y / N

Comments _____

	Vendor 1	Vendor 2	Vendor 3
Did the jumper wire defeat the design?	Y / N	Y / N	Y / N

Comments _____

Bracelet Water Tightness Test

Although it is reasonable to prohibit an offender from participating in water sports such as snorkeling or scuba diving, it is not reasonable to require an offender to alter their bathing and hygiene routines significantly. This test is designed to measure the water tightness of the bracelet when submerged in water, such as may occur when an offender takes a bath.

- This test is to be performed only with the consent of the vendor, as some vendors do not claim their bracelets (especially one-piece devices) are watertight.
- If a swimming pool is available, submerge the bracelet in eight feet of water for one hour.
- As an alternative, place the bracelet into a large plastic trash bin filled with water for three hours. The depth of the water should be at least 2 ½ to 3 feet. This is a much less demanding test than submerging the device in a swimming pool, but it does expose the bracelet to more water pressure than it encounters with typical bathing in a bathtub.
- Remove the bracelet from the water.
- Thoroughly dry the external surfaces of the bracelet with a towel.
- If the bracelet is designed to be opened by field staff, inspect the interior of the bracelet for moisture. Specifically, look for moisture near battery connection points, fiber optic windows, or other tamper detection devices. Prolonged exposure to moisture may cause damage resulting in malfunctions occurring over time.
- Continue with normal use and monitor whether the device is working properly.

Water Tightness Test Worksheet

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			
Depth of water			
Duration of submersion			
Can the bracelet be opened?	Y / N	Y / N	Y / N
Was water visible inside?	Y / N	Y / N	Y / N

Comments: _____

Did the device work after testing?

Y / N	Y / N	Y / N
-------	-------	-------

Comments: _____

Tracking Device Battery Drain Test

A common complaint made by supervising officers relates to the insufficient battery life of some tracking devices. Many offenders maintain busy schedules that require lengthy absences from their homes (where the charging equipment is stored). It is frustrating for all parties when a tracking device becomes discharged prematurely and that schedule needs to be interrupted in order to recharge a tracking device. This test will measure the battery life of the tracking device in ideal conditions. Keep in mind that the batteries that you are provided with during this evaluation are probably new. The average battery life may be significantly shorter when placed in real life tracking situations, especially when an offender is moving constantly and/or when there are numerous alerts and notifications to be processed.

- Fully charge the tracking device.
- If the time to report a “Communication Failure” is a programmable, set it to send an alert one hour after communication is lost.
- If there is an adjustable setting for sending an alert for overdue communication, it should be set at one hour.
- Conduct this test where cellular coverage is good.
- Do not have any scheduled inclusion events and be sure the place of the testing is not in an exclusion zone.
- Record the time of day when the fully charged tracking device is taken off the charger.
- Record the time you (acting as the offender) received a warning for a low battery alert.
- Record the time you (acting as the supervising officer) received an alert that the tracking device has a low battery.
- Compare these two notification times. Does the offender have sufficient time to correct the situation so the supervising officer does not have to be notified if the offender rectifies the problem in a timely manner? Note: The software should have time stamped reports indicating when the warning alarms were sent to the offender wearing tracking device and to the supervising officer.
- Record the time the device shuts down completely due to lack of power. The device may send a final notification to the monitoring center that indicates the time the device was shut down due to low power.
- Compute the hours the device was operational before shutting down. Also, compute the length of time after the low battery alert was sent to the time of the final shut down.
- The number of hours of battery operation should be at least 18 hours under these conditions. In normal operation, battery life will usually be shorter because the device will be reporting zone violations and other events that require additional battery power. Also, batteries that have been in service for an extended period often will have a shorter operational life between charges. Some batteries that are repeatedly discharged and recharged (especially if the battery is never allowed to fully discharge) may develop “battery memory” problems that could significantly shorten the operational life of a battery.
- It may be convenient to perform the Communication Failure Alert Test in conjunction with this testing protocol

Tracking Device Drain Test Worksheet

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

Time of low battery warning			
Time officer alerted -warning			
Time of device shutdown			
Time officer alerted - final			
Hours to low battery warning			
Hours to device shutdown			

Did the warning provide sufficient time for an offender to take corrective action?

Y / N	Y / N	Y / N
-------	-------	-------

Comments: _____

Did the alert to the officer occur a sufficient time after the offender was warned to avoid an unnecessary alert to the officer (if the offender took prompt corrective action)?

Y / N	Y / N	Y / N
-------	-------	-------

Comments: _____

Communication Failure Alert Test

When an active tracking device ceases to operate, it is imperative that the supervising officer is alerted promptly to the fact that an offender is no longer being tracked. The device may stop communicating with the monitoring center for a number of reasons, including; a malfunctioning or damaged device, a discharged battery, or being out of cell coverage for an extended time. Regardless of the reason, a quick response by the supervising officer is needed. This test is designed to determine if the tested system provides a communication failure alert, and if so, how timely is that alert generated.

- Perform this test in conjunction with the Tracking Device Battery Drain Test
- One circumstance which should generate a Communication Failure Alert is neglecting to charge a battery and allowing the tracking device to become nonfunctional.
- After completing the Tracking Device Battery Drain Test, allow the device to remain off the charger in a completely discharged state for at least four hours.
- During this time, the system should send an alert to the supervising officer that communication with the device is overdue
- This may be the last alert an officer receives when an offender has disabled or abandoned his tracking equipment.

Communication Failure Alert Test Worksheet

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

After the tracking device battery was completely drained, was a communication failure alert eventually generated?

Y / N	Y / N	Y / N
-------	-------	-------

If so, how much time elapsed from the device shutdown to the generation of the alert?

--	--	--

Comments: _____

Alarm Response Time Test

Obviously, when a violation occurs, the supervising officer needs to be notified as soon as practically possible. As you will notice when performing this test, there may be many steps that occur before an officer is made aware of a violation. This test measures how quickly the system processes a violation and how effectively it interfaces with other communication services to deliver an alert notification to an officer in the field.

- Conduct this test in an area with good cellular coverage for both the tracking device and the supervising officer's portable communication device (they may utilize different cellular services).
- While wearing a bracelet in a non-tamper state, cut the bracelet with a pair of scissors.
- Record the time.
- Record the time the tracking device warns the offender of the violation (if so designed).
- Record the time the software indicates the tamper status was reported to the monitoring center.
- Record the time the alert was received by the supervising officer's e-mail server.
- Record the time the alert was received by the supervising officer's portable communication device (pager, phone text message, or e-mail).
- Measure the time differential between the violation occurrence and the time the alert ultimately arrived at the officer's portable communication device.
- Repeat this test with exclusion and inclusion zone violations, keeping in mind that the system may have adjustable tolerances that create a delay before reporting these alerts.

Alarm Response Worksheet

Trial 1

Tamper Alert

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

Time of bracelet tamper			
Time offender warned			
Time software is alerted			
Time in Officer's e-mail			
Time to portable device			
Total to notify officer			

Trial 2

Exclusion Zone Alert

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

Time of bracelet tamper			
Time offender warned			
Time software is alerted			
Time in Officer's e-mail			
Time to portable device			
Total to notify officer			

Trial 3

Inclusion Zone Alert

	Vendor 1	Vendor 2	Vendor 3
Test Date			
Test Start Time			
Test End Time			

Time of bracelet tamper			
Time offender warned			
Time software is alerted			
Time in Officer's e-mail			
Time to portable device			
Total to notify officer			

Tether Battery Drain Test

This is not a practical test for most agencies to conduct during a trial period because most of these batteries are designed to remain operational for several months. It is recommended that the experience of other agencies using the specific equipment in question be obtained.

Comments from other agencies concerning the tether battery life:

Nuisance Alarms

During the entire evaluation period, take note of any alarms that were not necessary or sent in error. Keep in mind, when actually tracking offenders, every false alarm or nuisance alarm will need to be addressed by the supervising officers. Excessive nuisance and false alarms will undermine the program's integrity and cause officers to question the legitimacy of all alarms received.

Observations about unnecessary alarms:

Appendix 1: Summary of Test Results

In order to evaluate which piece tracking equipment performed best overall in your local environment, provide a numeric rating that represents your level of satisfaction for each test performed. Since each criterion measured has a different relative importance to your agency, it is important to assign each a weight value.

If the test results were extremely impressive, a rating of 10 can be given while a device that completely failed a test can receive a rating of zero. Similarly, weights for each criterion will be assigned a factor with 1.0 being the most important and a weight of 0.0 given to criterion with no importance. The rating is then multiplied by the weight factor to arrive at a weighted score for that criterion. By adding up all of the scores, the relative performance of each vendor's equipment can be compared.

The Weighted Score Results Worksheet will assist you with this exercise.

Weighted Score Results Worksheet

<u>Test</u>	Vendor 1			Vendor 2			Vendor 3		
	<u>Rating</u>	<u>Weight</u>	<u>Score</u>	<u>Rating</u>	<u>Weight</u>	<u>Score</u>	<u>Rating</u>	<u>Weight</u>	<u>Score</u>
Baseline Test									
Indoor Residential									
Indoor Commercial									
Urban Canyon									
Rural Testing									
Vehicle Tracking Test									
Breadcrumb Trail Test									
Exclusion Zone Test									
Inclusion Zone Test									
Zones within a Zone									
Intentional Shielding Test									
Bracelet Spoofing									
Bracelet Water Tightness									
Battery Drain Test									
Communication Failure									
Alarm Response Time									
Other Testing Performed									
Totals									