**AMERICAN PILOTS' ASSOCIATION**

**Portable Pilot Units:
A Best Practices Summary**


October 27, 2016



## 1. Introduction

This summary provides the basis for the development and implementation of Best Practices for Portable Pilot Units (PPUs). These Best Practices cover philosophy, operation, technology, training, and other subjects that enhance the development and use of PPUs by pilots. The summary is intended to serve as a generally agreed statement by the U.S. piloting profession of Best Practices for PPUs. As such, it is subject to change.

This summary was prepared by a PPU Best Practices Working Group of the American Pilots' Association's Navigation and Technology Committee (NAVTECH)[1]. The concepts and recommendations outlined in the summary are based upon extensive experience of APA-member pilots using PPUs, general engineering principles, ongoing engagement with various technology providers, and advice of legal counsel. The summary was originally approved by NAVTECH and adopted by the Trustees of the American Pilots' Association on October 24, 2008. It has been updated by NAVTECH since that time, with the latest update in May 2016. This version was adopted by the APA Trustees on October 27, 2016.


## 2. Definitions

PPU             Portable Pilot Unit can be generally described as a portable, computer-based system that pilots bring aboard a vessel to use as a decision-support tool for navigating in confined waters.

GPS             The U.S. Global Positioning System comprised of a constellation of satellites orbiting the earth at a very high altitude. The signal-in-space is accurate to +/- 7.8 meters 95% of the time.

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[1] The members of the Working Group are: Captain Jorge J. Viso, pilot/member of the Tampa Bay Pilots, chairman, APA Navigation and Technology Committee; Captain Wayne E. Bailey, pilot/member of the Pilots' Association for the Bay and River Delaware, member, APA Navigation and Technology Committee; Paul G. Kirchner, Executive Director-General Counsel, APA, and William R. Cairns, Navigation Technology Advisor, APA.

GNSS                Global Navigation Satellite System refers to any of the global positioning satellite systems such as GPS, GLONASS, Galileo, Beidou, and others in development.

GBAS                Ground Based Augmentation System is a terrestrial-based differential correction system.  The typical GBAS in use in the U.S. is the U.S. Coast Guard (USCG) beacon system.

USCG Beacon         Ground-based, elevated-accuracy Medium Frequency radio system developed by the USCG, also known as Differential GPS (DGPS). Typically, the positional error of a DGPS position is 1 to 3 meters. In addition, this USCG maritime service provides 10-meter (2 dRMS) navigation accuracy and integrity alarms for GPS and DGPS out-of-tolerance conditions within ten seconds of detection. This form of GPS correction was the initial method of enhancing GPS accuracy in PPUs.

DGPS                Differential GPS uses a surveyed position and compares it with the GPS position.   The difference indicates the GPS error (i.e., differential correction), which is then broadcast to capable receivers.

SBAS                Satellite Based Augmentation System is a satellite based differential correction system.  The system used in the U.S. is the Federal Aviation Administration (FAA) operated Wide Area Augmentation System (WAAS).

WAAS                Wide Area Augmentation System is a satellite based, elevated-accuracy system that was initially developed for commercial aviation.  The WAAS specification requires a position accuracy of 7.6 meters 95% of the time.  WAAS provides satellite based integrity monitoring of the GPS constellation.

AIS                 Automatic Identification System is a VHF-based time division multiple Access (TDMA) radio system used by vessels and Vessel Traffic Services and other shoreside facilities primarily for identifying and locating vessels.  It also provides a means for vessels to electronically exchange data. GPS, without correction, is typically used to supply AIS positions.

Integrity Monitoring A utility within the hardware and / or software to alert the operator that the threshold for position integrity has been exceeded. Current examples include RAIM (Receiver Autonomous Integrity Monitoring) and the RTCM message disseminated through the USCG differential beacon system.

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| Pilot Plug | IMO-specified data port installed in a vessel that provides a pilot with access to data received and transmitted from the vessel's AIS. |
| WiFi | A wireless communications technology that enables equipped devices to exchange data.  For the purposes of this paper, WiFi generally refers to the 2.4 GHz 802.11b/g/n standard. |
| Bluetooth | A wireless communications technology that shares the same frequency as WiFi. It is more flexible than WiFi but provides lesser throughput of data at generally shorter distances. |
| PC/Tablet | The most common user interface used for PPUs. |
| Charting Programs | Software used to display Own Ship and Target Vessel positions on a nautical chart.  The 3 most common types of Charting Programs are:  Raster Navigational Chart, Electronic Navigational Chart (Vector), and Custom or Proprietary Vector Display. |

## 3. Overview

Pilotage is, and always has been, a local matter.  What works well for one district may be impractical or cumbersome for a geographically different area.  There is no single PPU or solution that can meet the needs of all pilotage districts.  And, in some cases, use of a PPU may not be appropriate. It is crucial to note, however, that, when used, the PPU is a navigation and decision-support tool for the pilot alone.  While members of the piloted vessel's bridge team can always ask to see the PPU display, the PPU should not be considered as a source of information for transmission to the piloted vessel, other vessels, or shore. It is not designed for that purpose.

The general goal of this summary is to encourage marine pilots to continue to strive for the highest level of proficiency associated with the development and use of a PPU. This entails not only ongoing pilot education on the limitations of PPUs and on the safe operation and integration of PPUs into their working practices, but also assisting pilots in the adoption of safe practices and key principles associated with the development of their PPUs.

Deviations from the Best Practices or recommendations of this paper may be appropriate in some circumstances.  Pilots and their associations are encouraged to develop an explanation for a decision not to follow a Best Practice.

## 4. History of PPU Development

The development of a portable, pilot-carried navigation system in the United States started in 1980, well before the implementation of the GPS/DGPS service and portable

laptop computers. Working with engineers of the USCG Research & Development Center and the Johns Hopkins Applied Physics Laboratory, Capt. Joseph F. Bradley of the Pilots' Association for the Bay and River Delaware assisted with the development of a Differential LORAN-C navigation system that was intended to be a self-contained, pilot-carried waypoint navigation system that required only a power source from the vessel for its operation. This early system weighed about 30 pounds and eventually provided position accuracies of approximately 10 meters. The navigation information provided was: Cross Track Distance in feet, Speed Over the Ground in knots, Distance to the next waypoint, and Rate of Divergence from the centerline in feet per second.

In 1991, with the emergence of GPS and the USCG's Differential Service, work with the portable system was shifted from the LORAN-C based system to one based on DGPS. USCG R&D Center and Johns Hopkins participation in the project ended at this time. Starlink Inc. and Raytheon Service Company joined Capt. Bradley in the project with the goal of turning the portable pilot navigation system (to be eventually described as a PPU) into a commercially viable product. Starlink engineers wrote a custom navigation program for use on a laptop computer and integrated it with a DGPS receiver–antenna to create a self-contained system that weighed 13 pounds and required only a power source from the ship to operate. Using waypoints provided by the U. S. Army Corps of Engineers and the USCG supplied Differential signal, consistent position accuracies of less than 2 meters were seen.

In 1994, the Pilots' Association for the Bay & River Delaware became the first U. S. based pilotage group to equip all of its pilots with a PPU. In the ensuing years, a vast majority of U. S. pilot groups have equipped their pilots with PPUs. In the small number of remaining pilot groups, after considerable trial and consideration, determinations have been made that PPUs are not always necessary or even appropriate given the particular characteristics of the pilotage district. Pilot groups continuously reevaluate the application and design of PPUs for the unique needs and requirements of their pilotage operations.


## 5. Portable Pilot Unit Configurations

The following are the most common configurations available and employed by pilots:

- [D]GPS/Charting Program: This basic configuration provides a representation of Own Ship position on a chart display of varying detail. Position accuracy may be enhanced by the use of differential corrections.

- [D]GPS/Charting Program/Self-contained AIS receiver: A proprietary transponder system added to the basic GPS/Charting configuration provides positions of other AIS-equipped vessels in addition to Own Ship position. Another variation utilizes an internet based server operating as a Virtual Private Network (VPN).

- [D]GPS/Charting Program/AIS Input via Pilot Plug:  Other vessel positions are added to the display of Own Ship Position on a chart.  Target Vessel location and data is received from the Own Ship's AIS through a connection to the Pilot Plug.  Own Ship Gyro Heading may also be obtained through the Pilot Plug.

- Charting Program/AIS Input via Pilot Plug:  The display of Own Ship Position on the chart is totally dependent on the ship's GPS and AIS equipment.

The priority of own-ship positioning display over AIS target display, or vice-versa, will greatly influence the hardware and software choices made within these general configurations.  Similarly, the need for, and availability of, detailed hydrographic information or other area-specific information will drive the selection and configuration of many components.  Charting programs, whether supplied by the system integrator or commercially obtained, should be tailored to the specific needs of the pilot group and area of operation.


## 6. Development

The successful development of a PPU starts with identifying the navigation needs and issues for a given pilotage area.  Where PPUs have been most successfully incorporated into piloting practices, the pilots took the lead in selecting the units and tailoring them to their particular requirements.  Development of any system, however, should involve other partners outside of the pilotage organization who are capable of providing the required technical expertise and advice.

There are many policy and system configuration choices that need to be made during the development of a system.  While not all-inclusive, consideration should be given to the following:

- A committee of veteran pilots with varying levels of computer experience should be formed to determine the pilot group's priorities in developing the system.  When addressing the complexity of the system to be developed, the committee should consider the operational experience of the intended users.

- A manufacturer or system integrator with the resources and expertise to provide a reliable system that is capable of attaining the required accuracy should be selected to work with the committee.

- The system's computer, components, and programming should be dedicated to navigation-related activities.  Limited User Accounts, as opposed to Administrative Accounts, should be employed to prevent users from having the ability to load or change software, or access and change

configuration settings. Software and hardware controls should be put in place to prevent unauthorized parties from accessing any part of the system. Distribution of passwords for administrative control of the system should be kept to a minimum.

- Data sources for waypoints, soundings, aids to navigation, etc:
    - Government: USACOE / USCG / NOAA / Local Port Authority.
    - Corporate: System vendor, component manufacturer, or programmer.
    - Private: pilot or pilots' association.

    Official government sources should be used whenever possible. There may be times when a corporate source may be acceptable, providing the supplier of the data can establish the credibility of the source. Pilots and pilot associations should avoid supplying data, but may assist with locating reliable sources.

- Standardization: It is essential that all systems in a given pilotage area contain and display the same base waypoints, general routes, and aids to navigation. It is also essential that individual pilots not have the ability to alter or add to the waypoints, routes, and aids to navigation in their system. It is acceptable for a program to allow individual notations on a display provided the notations do not impair or impact the normal viewing and operation of the system. In many pilotage districts, several routes may be appropriate.

- Required standard of accuracy: The pilot group or association should determine the position accuracy required for the area and type of work performed, and select the positioning device(s) and display type or mode that will most reliably meet the standard.

- Systems that are capable of displaying Own Ship position from more than one positioning source should have a means of displaying and or comparing multiple Own Ship positions at the same time, with the most accurate positioning source being clearly identified.

- Rate of Turn display in a PPU can be derived from several sources, with varying degrees of accuracy depending on the method employed. Any pilot district that chooses to display ROT in their PPU should confirm that the accuracy they require is provided by the method selected.

- Warnings or alerts to advise the user of positioning errors or problems in the system (i.e., Integrity Monitoring) should be incorporated, where practicable. Visual warnings should be accompanied by an audible alarm.

- Recording of trips: In the absence of mandated recording and archiving of trips, the pilot group's legal advisors should be consulted for guidance.

- Connection methods between components will vary depending on manufacturer and components selected.  The method(s) selected should reflect due regard for optimal reliability and ease of setup.  In cases where a WiFi or Bluetooth connection is employed for the link between the primary navigation sensor and the system display, it may be advisable to have available a cabled backup.

- Extensive, real-time, in-the-field tests of the proposed system should be conducted prior to general deployment.

## 7. Training

The common maritime industry practice of supplying a mariner with a piece of equipment and an instruction manual, but no formal training on the equipment, cannot be regarded as a proper or safe procedure for a PPU.  Even in the absence of a specific regulatory requirement that a pilot be trained in the use of a particular piece of equipment, the inability to competently use an available resource, particularly one brought aboard by the pilot, may under some circumstances constitute negligence.  Pilots should be trained prior to their first use of a PPU, and they should receive supplemental instruction any time their hardware or software configuration has an appreciable change.

The amount and type of training required prior to using a PPU will vary depending on many factors.  Typically, systems that display more information and that require more interaction from the user will need greater amounts and higher levels of training.

Some of the factors to be considered in determining the type and amount of training are:

- Type of positioning or navigation tool – GNSS / GBAS / SBAS

- Type display device – PC / Tablet / Hand-held or portable GNSS /etc.

- User interface – Windows / MAC / Manufacturer's Proprietary System.

- Type of display format – Text / Graphical / Charts (RNC, ENC) / Manufacturer's Custom System.

- Connectivity method(s) of equipment – Wired / WiFi / Bluetooth.

- Intended area or environment of use.

- Other tools combined with the navigation system – AIS / Pilot Plug / internet connectivity

Training topics should cover the theory behind the selected positioning device(s), an extensive hardware and software orientation, principles and use of Electronic Navigational Charts and AIS (when equipped), and integration of the equipment into the pilot's Bridge Resource Management practices.

It should not be assumed that because a component of a PPU may be commonly used in another facet of everyday life, training on that item or area can be eliminated.


## 8. Deploying a PPU in a Pilotage Area

Pilot organizations generally deploy their PPUs in one of two manners:

- Acquire a system for each pilot in the organization and issue each pilot a unit for his or her exclusive use, or

- Acquire a number of systems sufficient to cover the anticipated vessel movements at a given moment, and provide each pilot assigned to a vessel a means of taking a system to the vessel.

Most Associations that start with systems that are shared among pilots (Library System) tend eventually to acquire additional systems in order to provide each pilot with his or her own system. Logistical difficulties with pooling of the systems is the reason commonly cited for acquiring additional systems.

Regardless of how the systems are assigned, a number of spare systems should be kept on hand to provide for backup when systems are unavailable, damaged, or in need of service.


## 9. Maintaining a PPU

Absent official guidance from a regulatory source, pilot organizations deploying a PPU should work with the supplier of their system to enact measures that ensure the systems their pilots carry are maintained in good working order.

As a practical matter, a system for diagnosing and correcting any day-to-day problems with systems should be established. Likewise, a system for periodic maintenance checks and software or hardware updates should be established. It is recommended that as much of the maintenance as possible is done either by the manufacturer / supplier or by qualified IT servicing providers.

If equipped with Wireless Broadband Internet Service, technicians can remotely access and service systems through a Virtual Private Network. VPN access for administrative or service purposes during actual piloting operations requires extreme caution and is not recommended when such action can be avoided.

A pilot group should maintain a supply of spare parts so that pilots can easily replace lost or damaged components such as carry bags, antenna cables, or power supply adapters.  It may also be advisable for pilots to carry spare batteries, power cords, or other ancillary equipment as needed.

Up-to-date equipment assignment records, maintenance logs, and records of software and hardware updates should be kept.


## 10.    Summary

Marine pilots are encouraged to consider these best practices in the light of their local conditions. These best practices offer guidance in the areas of design, development, configuration, deployment, operation and training to pilot groups that choose to employ PPUs.

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