



Sensors

DGNSS Position Quality Information for DP Applications

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Subsea 7/Veripos**

October 9-10, 2007

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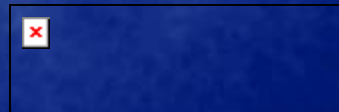


DGNSS Position Quality Information for DP Applications

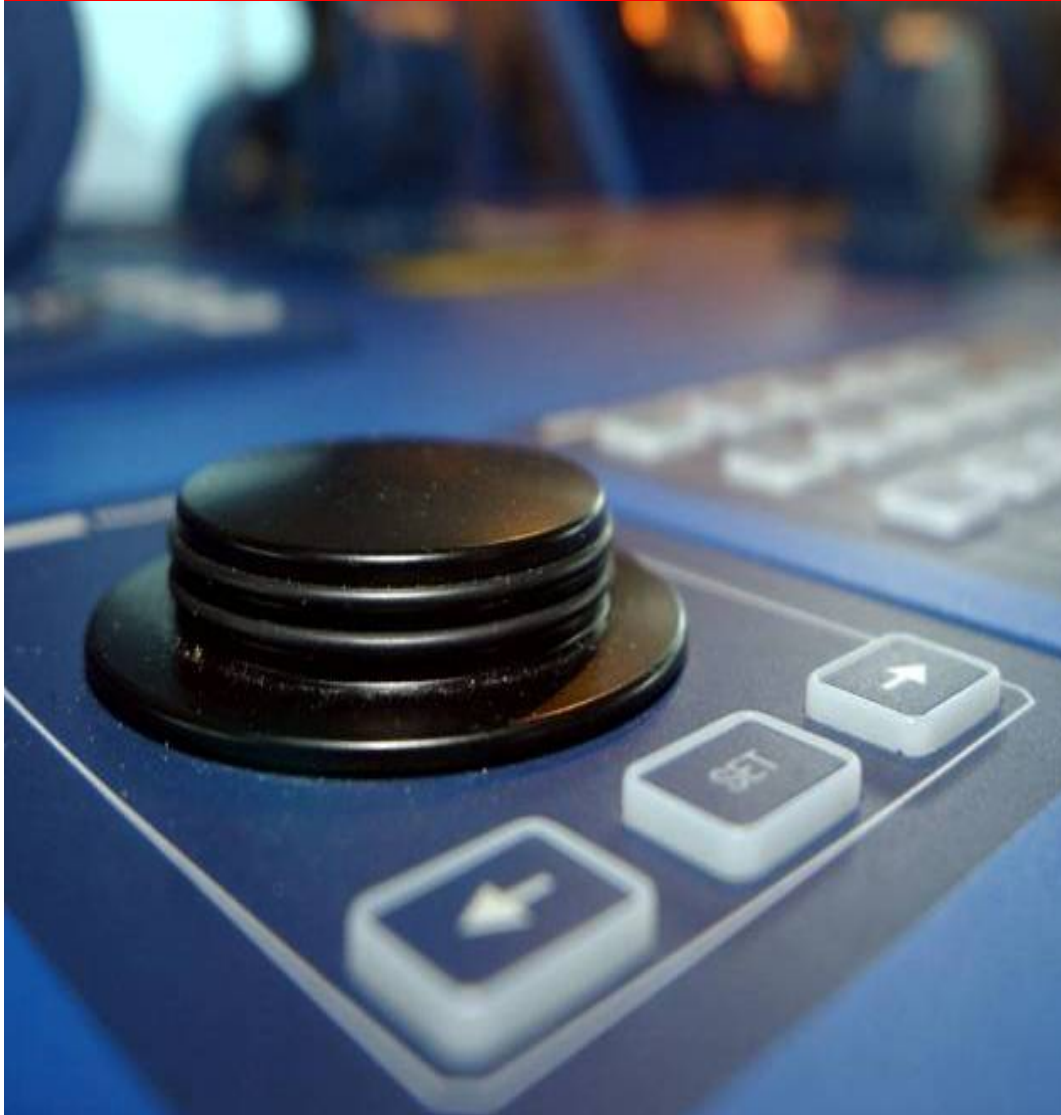
David Russell

MTS-DP Conference

9th-10th October 2007



Overview



- **Introduction**
- **Advances in Positioning Technologies**
- **Position Quality Standards**
 - NMEA
 - UKOOA
 - IMCA
- **Considerations for DP Applications**
- **Conclusions**
- **Recommendations**

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- **Positioning techniques can now deliver position solutions at the decimetre level**

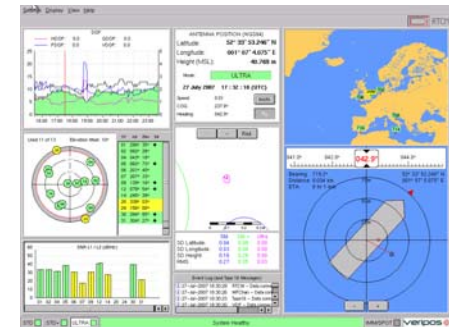
- Future enhancements will see new satellite constellations and modernization of the current systems
- Will see developments with new position solutions
 - Different levels of accuracy
 - Different combinations of satellite signals
- Differing solutions require to be weighted differently in the DP system
 - Therefore, not only is a position required but associated quality information to allow proper solution weighting



Importance of GNSS to DP



- Positioning is critical to all DP Operations
- Requirements for DP Operations
 - Both precision and accuracy are important for DP operations
 - DP position reference must provide a reliable & stable position solution
 - Validity and quality of instantaneous position solution has to be assessed immediately so action can be taken
 - Other reference systems such as acoustics, taut-wire – mean less dependence on DGNSS



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The Potential Consequences of a Loss of Position

An Operator's Perspective

- Harm to personnel: >1,040 people
- Harm to environment: Irrevocable
- Damage to assets: \$50 Million - \$1 Billion
- Loss of revenue: \$ 15 Million/day
- Delays in revenue: Day(s) - year(s)
- Loss of reputation: Intangible



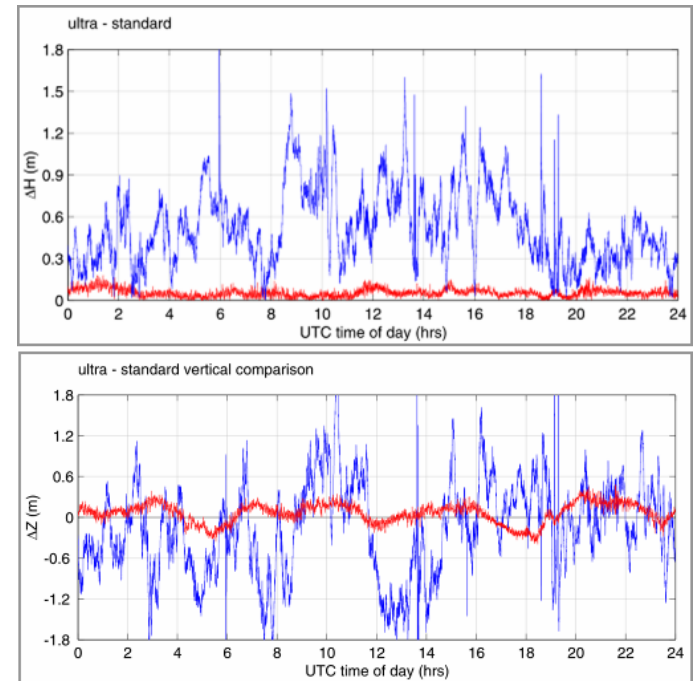
Source:

Managing Dynamically Positioned (DP) Operations - A Practical Approach - An Operator's Perspective
Suman Muddusetti & Tracy Harris - Shell International Exploration and Production Inc.

Advances in Positioning Technologies



- **Positioning is essential technology for the oil and gas industry**
 - Satellite Navigation technology can now be considered a mature and accepted technology
- **Augmentation data from service providers allows a higher level of accuracy & precision over standalone GPS**
 - Services offered range in accuracy from the metre level to the decimetre level
 - Implications when position references of different accuracy levels are used in DP system
- **Satellite navigation will remain a key technology for offshore operations**



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Position Quality Standards



- **Within the offshore industry a number of position quality recommendations and guidelines exist**

- Provide quality information on the calculated position
- Allow user to accept or reject position

- **Most commonly used standards/guidelines**

- NMEA
- UKOOA
- IMCA

- **Guidelines are not intended to be used as a specifications**

- left to the discretion of the supplier/operator/user whether or not to follow the guideline





- **NMEA standards designed to**
 - Facilitate public interest in interconnection & interchange ability of equipment
 - Minimize the misunderstanding & confusion between manufacturers
 - Assist purchasers in selecting compatible equipment
- **The main standards used for positioning**
 - NMEA 0183
 - Including High Speed (HS) standard
 - NMEA 2000®



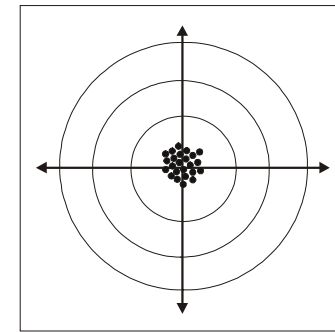


- **GPS receiver communication is defined within the specification**
 - NMEA 0183 commonly used within DP equipment and sensors that connect to the DP system
- **NMEA 0183 Standard**
 - Single talker and multi-listener
 - Universal method for data exchange between 2 devices
 - Recommends a physical layer
 - Open to miss-interpretation
- **Latest version is 3.01 (released Jan. 2002)**

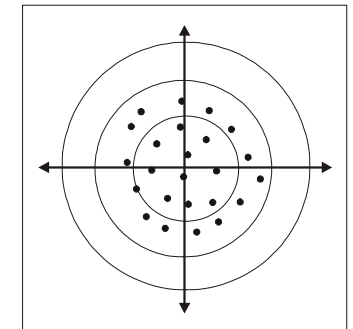


- UKOOA issued guidelines for the use of DGPS in offshore surveying in 1994

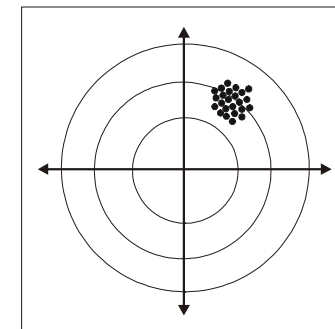
- sets out what is generally regarded as good practice but are not mandatory and operators are free to adopt different standards
- recommendations aimed at survey users but could equally be applied to DP applications
- particularly when high accuracy positioning systems are used
- provide the user with confidence that the position calculated is accurate & reliable



Precise & Accurate



Low Precision



Precise & Inaccurate



- **Guidelines presents a set of test statistics and quality measures**
 - essential to assess the precision and reliability of each position in order to ensure the quality of the calculated position
- **Following test statistics are recommended**
 - w-test used to detect outliers
 - F-test to verify the model which is being used to account for 'errors' in the DGPS observations
- **Following quality measures are recommended**
 - Error Ellipse an approximate graphical representation of the positional standard deviation in two dimensions
 - External Reliability the effect of the maximum MDE (marginally detectable error) on the computed position



- **IMCA guidelines on using DGPS as a position reference in DP control systems issued 1997**
- **The main objectives of the were:**
 - to assist optimum DGPS use and improved reliability
 - to make some realistic proposals for improved DGPS use in DP i.e.
 - to propose standard DGPS interface to DP control systems
 - to improve the use of DGPS Quality Control (QC) indicators in DP activities
 - to provide a basis on which DP classification authorities may formally approve (not merely accept) DGPS as a DP position reference
 - distil current best practices into guidance on the optimum use of DGPS in DP activities, and therefore further improve DP users' confidence in DGPS



- Definition of new message format to provide a consistent approach for interfacing DP systems
 - Proposed message format based on NMEA GGA message including a DGPS Quality Indicator (DQI) to indicate whether the position was acceptable

DQI	Status of Solution <small>(see note 1)</small>	Precision <small>(see note 2)</small>	Comments <small>(see note 3)</small>
0	Failed Solution	N/A	-
1	Uncorrected	N/A	Solution obtained but no differential
2	Corrected position but no redundancy	N/A	Minimum DGPS solution
3	Corrected position; Redundancy of 1	Poor	Poor Dilution of Precision (DOP)/geometry
4	Corrected position; Redundancy of 1	<10m	Adequate DOP/geometry
5	Corrected position; Redundancy of >1	<10m	Ability to reject outlier; Poor DOP/geometry
6	Corrected position; Redundancy of >1	<10m	Ability to reject outlier; Gradual improvement in geometry/DOP
7	Corrected position; Redundancy of >1	<4m	Ability to reject outlier; Gradual improvement in geometry/DOP
8	Corrected position; Redundancy of >1	<2m	Ability to reject outlier; Gradual improvement in geometry/DOP
9	Corrected position; Redundancy of >1	<0.5m	Ability to reject outlier; Gradual improvement in geometry/DOP

Notes: 1. Prerequisite is a successful solution with a valid statistical test
 2. Confidence regions are 95%
 3. Assumes improving DQI; if DQI value is worsening, read gradual deterioration

Considerations for DP Applications



- **The NMEA standard provides a good interface standard for DP systems and is commonly used**
 - Typically utilise the GGA sentence which provides a position to the DP which has limited quality information about the calculated position
 - Position references of different accuracies can be used within a DP system so it is important that quality information is available so that the DP can process and weight the position solution correctly
- **Presently there is no standard or message format that has been universally adopted by the DP community**
 - Message types vary between DP manufacturers
 - Legacy DP systems require old format message types e.g. Syledis format.

Position Output Strings - GGA



Veripos Standard (L1 DGPS ~1-2m accuracy)

```
$GPGGA,213137.00,5707.7189993,N,00204.7508917,W,2,08,1.0,25.46,M,50.28,M,9.2,1003*6E
```

Veripos Ultra (L1/L2 PPP ~0.1-02m accuracy)

```
$GPGGA,213137.00,5707.7189758,N,00204.7509600,W,2,08,1.0,25.62,M,50.28,M,22.0,0069*5F
```

Position Output Strings - GLL



Veripos Standard (L1 DGPS ~1-2m accuracy)

```
$GPGLL,5707.7189993,N,00204.7508917,W,213137.00,A,D*79
```

Veripos Ultra (L1/L2 PPP ~0.1-02m accuracy)

```
$GPGLL,5707.7189758,N,00204.7509600,W,213137.00,A,D*78
```

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Position Output Strings

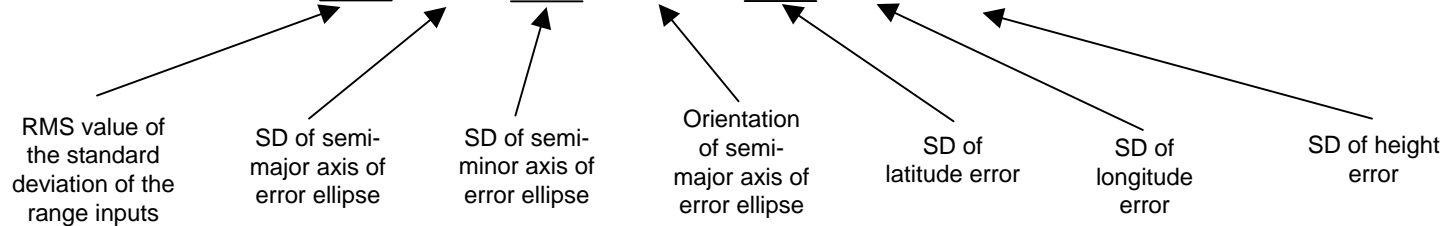


Veripos Standard (L1 DGPS ~1-2m accuracy)

```
$GPGGA,213137.00,5707.7189993,N,00204.7508917,W,2,08,1.0,25.46,M,50.28,M,9.2,1003*6E
```

```
$GPGLL,5707.7189993,N,00204.7508917,W,213137.00,A,D*79
```

```
$GPGST,213137.00,1.37,0.63,0.32,165.25,0.35,0.62,1.12*66
```



Veripos Ultra (L1/L2 PPP ~0.1-02m accuracy)

```
$GPGGA,213137.00,5707.7189758,N,00204.7509600,W,2,08,1.0,25.62,M,50.28,M,22.0,0069*5F
```

```
$GPGLL,5707.7189758,N,00204.7509600,W,213137.00,A,D*78
```

```
$GPGST,213137.00,0.28,0.03,0.02,0.42,0.02,0.03,0.05*6F
```

Position Output Strings – Veripos UKOOA



Veripos Standard (L1 DGPS ~1-2m accuracy)

PDOP	HDOP	VDOP	Fix Status	Internal Reliability	External Reliability	Unit Variance	Variance Lat	Co-Variance Lat/Long	Variance Long	Variance Height	95% Error Ellipse semi-major axis (m)	95% Error Ellipse semi-minor axis (m)	Orientation of Semi-major axis of error	
228	1.06	Verify	2	1349	423108.0	+0.2	+7.2	57	07.718999N	002	04.750893W	25.467	+50.28	
1.977	0.981	1.717	3	10.414	0.862	0.20	1.210	-0.344	0.680	2.188	1.55	0.78	165.3	

[P 8{01 07 11 14 19 20 24 28} 3{0777 0701 0702}]

F Test (P=Pass, F=Fail) No of SV's and PRN Nos Reference Statios Used

Veripos Ultra (L1/L2 PPP ~0.1-02m accuracy)

```

[ 218 1.06Verify 1 1349 423108.0 +0.2 +20.0 57 07.718977N 002 04.750959W 25.623 +50.28
 1.977 0.981 1.717 7 4.182 0.100 0.49 0.052 -0.002 0.041 0.100 0.06 0.05 179.8
P 8{01 07 11 14 19 20 24 28} 1{0069}]
  
```

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Conclusions



- **It is evident that there is a multitude of different output strings available for use in DP systems and no consistent approach or standard**
- **With the advances in positioning technology it is becoming clear that there is a lack of status and quality information being made available to the DP control systems to allow better modelling and weighting of the position solutions**
- **GNSS is important for DP operations and with the advances in positioning technology it is always a reference that is going to be used so more information on the generated position will be beneficial**
- **The standards that exist need to be updated to reflect recent recent improvements in satellite navigation performance**

Conclusions



- **It seems sensible to define a new standard which is universally adopted**
 - provide the necessary GNSS system status and quality information to permit better modelling
- **The current IMCA and UKOOA documents are only guidelines and are not intended to be used as a specifications**
- **With such a safety critical aspect then perhaps the guidelines should be reviewed or re-written in consultation with the key players in the DP industry so that they become specifications for both the DGNSS supplier and DP system manufacturers**
- **Sat Nav advances will see new positioning solutions using up to 4-6 satellite constellations**
 - so knowing the quality of the solution will be ever more important

Thank you for your attention

QUESTIONS



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