

**UNESCO**  
**Intergovernmental Oceanographic Commission (IOC)**  
**Global Sea Level Observing System (GLOSS)**

**Technical Survey and Assessment Report**  
**Aden, Republic of Yemen**  
**8-12th July 2006**

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<b>Table of Contents:</b>	<b>Page</b>
Summary	3
Mission Objectives	3
Additional Material	3
Brief History of Aden Tide Gauges	4
Civil Aviation and Meteorology Authority Tide / Wave Gauge	5
Breakwater at Steamer Point / Ras Marbut, Tawahi	6
Port Control Tower / Harbour Masters Office	6
Port Hydrographic Survey and Dredging Section	6
Tide Gauge Hut at Pilots Pier	7
Previous Tide Gauge at Post Office Pier.	7
Jetty at YPA Head Office Tawahi	7
Tide Gauge Status (Pilots Pier)	7
Future of the Pilots Pier.	8
Bench Marks	8
Historical Data	9
Tidal Range at Aden	9
Other Ports in Yemen suitable for GLOSS / IOTWS Tide Gauges	9
Al Mukalla Port (Hadramawt Governate)	9
Nishtun Port (Al Mahra Governate)	9
Socotra Island (Yemen)	9
Al Hudayda Port (Red Sea)	10
Recommendations	11
Port of Aden (Yemen Ports Authority) Head Office Senior Staff	12
Contacts	13
References	14
Abbreviations	14

## **Summary**

A technical survey of tide gauge systems in Aden, The Republic of Yemen was carried out from 8-12<sup>th</sup> July 2006.

This was combined with the UNESCO IOC assessment mission to Sanaa by an international team from IOC, ADRC, UN-ISDR and IOC GLOSS attending to identify needs and support requirements of Yemen in order to participate in the Indian Ocean Tsunami Warning and Mitigation System (IOTWS).

## **Mission Objectives**

The IOC GLOSS mission to Aden was to establish the following:

1. The status and history of existing tide gauge instrumentation.
2. Location of suitable sites for new IOC GLOSS -IOTWS tide gauges in Aden and Yemen.
3. Location of vertical survey datum benchmarks.
4. Photograph each location and collect relevant material.
5. Establish contact with relevant local staff.
6. Establish if power and telephone links are available on site.
7. Determine if tidal data exists after 1969 from Aden.

## **Additional Material**

Please also refer to:

CDROM Digital photographs for the Port of Aden and Socotra

Documentary film of Socotra - DVD.

Scanned charts of Yemen Ports.

[www.portofaden.com](http://www.portofaden.com)

## Brief History of Aden Tide Gauges

Tide gauges have operated at the Port of Aden from 1879-up to approximately 1986, and later from 2000 to present date. Data has only been submitted to IOC GLOSS / PSMSL (POL) for the period of 1879-1969. This represents one of the longest reliable records of sea level. Tide gauges have previously operated from the Post Office Pier, Tawahi at Aden and from the existing tide gauge hut at Pilots Pier, Tawahi.

From approximately 1974 up to around 1986 a Munro float tide gauge was located at the Pilots Pier tide gauge hut. This consisted of a float stilling well and a large format horizontal drum recorder. The support frame and cabinet exist but the instrument has been removed from the tide gauge hut. A similar unused Munro gauge is in the Port Hydrographic Survey Office.

The tide gauge hut at the Pilots Pier was used for the WS Ocean Systems SLM-2 Tide Monitor pressure gauge which operated from 2000 to 2005. The recording data logger and chart recorder are situated in a nearby small building. A similar gauge operated at Al Hudayda from 2001 to 2002. Both gauges were donated by PERSGA ([www.persga.org](http://www.persga.org)) and installed by an engineer from Sudan.

A Microstep MIS integrated weather station / sea level / wave gauge system was installed in 2004 and is presently fully operational at the Port Control Tower, Ras Marbut / Steamer Point at Tawahi (Fig.1, 2 & 3). The Civil Aviation and Meteorology Authority (CAMA) operate this system providing data to the WMO and WMO GTS (*but not tidal height*). (Note: The Microstep MIS system is from Slovakia <http://www.microstep-mis.com>). The CAMA Microstep MIS system is the only operational tide gauge in Aden and Yemen at present to the knowledge of Yemen Ports Authority, GLOSS and CAMA.



Fig 1. Ras Marbut Breakwater from the Port Control Tower. The CAMA tide gauge pressure sensor is next to the light tower at the end of the Breakwater.



Fig 2. Port Control Tower, Tide Gauge hut (centre) and data logger hut (left of photo) with Pilots Pier on the right at Tawahi.

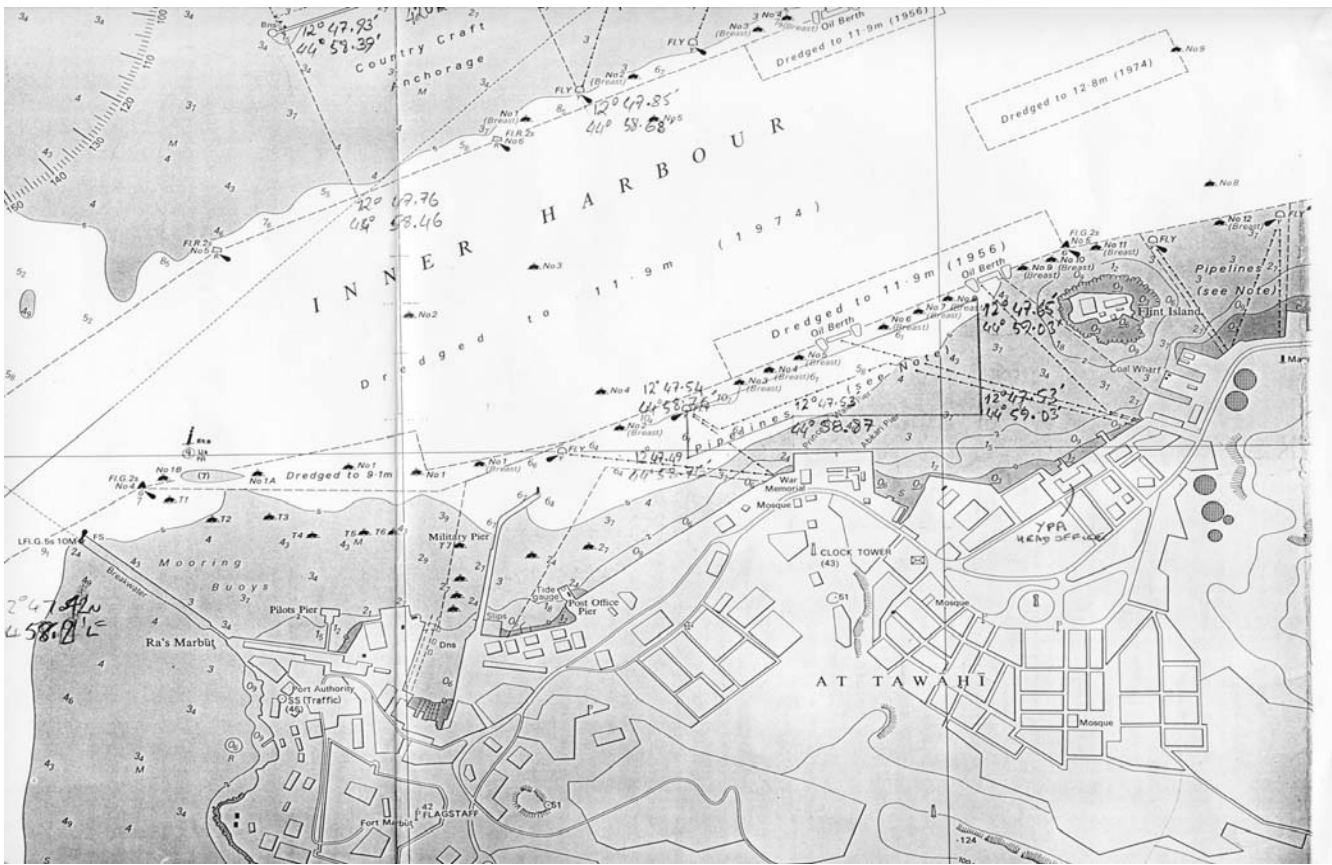


Fig 3. UK Admiralty Chart of the Port of Aden, Tawahi. Note the position of the Ras Marbut Breakwater, Pilots Pier, Post Office Pier and YPA Head Office with the small Jetty.

### Civil Aviation and Meteorology Authority Tide / Wave Gauge

The Civil Aviation and Meteorology Authority have a Meteorological Observation Station on the top floor of the Port Control Tower at Steamer Point / Ras Marbut / Tawahi (Fig.3). This Meteorological Office is manned 24 hours with the weather observers on 12-hour shifts.

The weather system used is a Microstep MIS with an Aanderaa WTR9 (Norwegian) wave and tide pressure sensor located at the end of the breakwater extending west from Ras Marbut / Steamer Point near the Port Control Tower. This was installed in April 2004 and is fully operational (<http://www.microstep-mis.com>).

The Microstep MIS weather sensors are situated on top of the Port Control Tower. Data from the Aanderaa WTR9 wave and tide gauge pressure sensor is transmitted by radio telemetry from the navigation light tower at the end of the breakwater (Fig 2, 3) over to the Port Control Tower a distance of 450 metres. The data is updated every half-hour from the system and displayed on the PC computer screen. Parameters are then logged by hand on the daily observation sheets, this data includes hourly:

- Tidal Height (logged incorrectly on sheets as HW- High Water)
- Tidal Slope (logged incorrectly on sheets as LW - Low Water)
- Sea surface temperature with significant / maximum / average wave height and period
- Wind direction / speed and full weather parameters i.e. visibility, air temp, air pressure etc.

**Note:** The automated system is displaying half-hourly data and the observer is logging hourly data as required by the WMO.

WMO Metar coded messages are transmitted automatically into the WMO GTS every 3 hours and include hourly observations of weather parameters, wave height, wave period and sea surface temperature but this does 'not include' sea level height.

The Aanderaa WTR9 pressure sensor is located on the sea bed and a armoured cable runs to the AGA starboard (green) navigation light tower with solar panel and radio telemetry mast on top. Unfortunately this sensor cable has broken away from the southwest facing side of the jetty and is likely to break as it is exposed to the dominant wave direction. This should be secured immediately to the sea wall protected by a metal (stainless steel) or heavy gauge (10mm) plastic PVC half-pipe bolted to the jetty. The Port Divers will be needed to do this task.

### **Breakwater at Steamer Point / Ras Marbut, Tawahi**

The Aanderaa WTR9 tide / wave pressure sensor for the Microstep MIS system is located at the end of the breakwater at Steamer Point /Ras Marbut, Tawahi (Fig 1). The depth of seabed below the surface of the concrete structure is 7m with sea level 2m below deck level (north side) on 10/7/2006 1200 am LT.

There is a security gate to the entrance of the breakwater but at the time this was not locked. The breakwater is protected on either side with large rocks. No electrical power is available on the breakwater. The navigation light tower is powered by solar panels. The Port Control Tower overlooks the breakwater and a manned coastguard boat is moored nearby each day for port security. However locals use the breakwater for fishing. Security needs improving at this site. This could be an ideal location for a GLOSS/IOTWS tide gauge but it lacks suitable security and has no electrical power links. Security could be improved by keeping the gate locked and preventing public access. Storm waves from the southwest could easily wash over the exposed end of the breakwater.

### **Port Control Tower / Harbour Masters Office**

Capt. Hussein Ahmed Assaedi is the Port of Aden Harbour Master. His office is situated in the Port Control Tower at Steamer Point, Tawahi (Fig 2). One floor of the tower is the Port operations room with radar and marine communications. The top floor is the Meteorological Observation room for the Civil Aviation and Meteorological Authority (CAMA). The Pilots Pier and tide gauge hut is visible from this control tower.

### **Port Hydrographic Survey and Dredging Section**

The Port of Aden (YPA) Technical Department has a Hydrographic Survey Section, which operates a small survey vessel and checks the depth of navigation channels. They previously operated the various tide gauges. The section has full survey charting capabilities with echo sounder, theodolites, total stations and survey levels but not GPS. A new purpose built hydrographic survey vessel is due to be delivered to the Port, which will expand the survey capabilities. Eng. Ahmed Abdul Kawi Saeed is the head of the Port Technical Department. Mahfood M Mohammed Kassim is the head of the Hydrographic Survey Office and Saleh Al Khaulaqi is the deputy Chief Surveyor.



Fig 4. Pilots Pier Tide Gauge Hut housing the WS Ocean System SLM-2 Tide Monitor pressure sensor /stilling well, with Ras Marbut breakwater and Pilots Pier



Fig 5. Adjacent watchmen's hut housing the WS Ocean-Systems data logger /printer/chart plotter, with Mahfood M Mohammed Kassim- Chief Hydrographic Surveyor

### **Tide Gauge Hut at Pilots Pier**

The structure of the hut is sound with no signs of subsidence or external cracks (Fig 4). The door needs replacing and the windows should be blocked up to increase security and prevent flooding in the event of a tsunami wave. The floor of the hut is 3.8m above the seabed, with a depth of water of 1.6m at low water on 10/7/06. Minor repairs to the floor of the cabin are needed and general maintenance to structure and surrounding security gate, walls and fences. The depth of seabed below the hut could easily be deepened by JCB / backhoe removing years of accumulation of silt, sand and rocks. The roof access hatch needs repairs. **Note:** Pilots Pier has previously been referred to as Pilots Bunder and Pilots Blunder (incorrectly).

### **Previous Tide Gauge at Post Office Pier**

The previous tide gauge at Post Office Pier was moved to Pilots Pier. No visit was made to this old site. The Admiralty Chart for Aden shows the tide gauge location at Post Office Pier and needs correcting according to the new location for the GLOSS tide gauge.

### **Jetty at YPA Head Office Tawahi**

The small jetty in front of the Yemen Port Authority (Port of Aden) Head office is another suitable location for a GLOSS tide gauge. No tide gauge hut would be necessary and a small stainless steel frame would need to be fabricated on site. The jetty is made of cut stone and dates back to 1910, there are no signs of subsidence. Power and electricity can easily be run from the office. The Port has offered this site as an alternative to Pilots Pier. It offers improved security and is overlooked by the YPA head office (Fig 6, 7).

The depth of water on the outer jetty is only about 1.5 m but it is proposed to dredge this site to allow small pilot boats alongside. The channel nearby has recently been dredged.



Fig 6. YPA Head Office Jetty (Jetty hand rails removed for repairs).



Fig 7. YPA Head Office / Jetty, Capt.Roy Facey (Port Development Advisor) and Saleh Al Khulaqui (Deputy Chief Hydrographic Surveyor).

### **Tide Gauge Status (Pilots Pier)**

There is a non-operational tide gauge at the Pilots Pier, Tawahi close to the Port Control Tower/Office of the Harbour Master (Fig. 4, 5, 8 & 9).

This tide gauge is a WS Ocean Systems SLM-2B Tidal Monitor system with a pressure transducer. This was donated to Aden Port along with a similar gauge at Al Hudayda (Hodeida) by PERSGA [www.persga.org](http://www.persga.org). It was installed in July 2000 by a PERSGA engineer and operated successfully up to 2005. Data is printed on a thermal printer and chart plotter. The similar tide gauge at Al Hudayda operated from 2001 to 2002. Attempts are now being made to make these gauges

operational - but they would not be suitable for the IOTWS as data is only printed on paper at hourly intervals. There is also no access to digital data from the system control unit or link to a telephone modem.



Fig 8. Tide gauge control unit in night watchman's hut.



Fig 9. Tide gauge chart plotter and printer in night watchman's hut.

### Future of the Pilots Pier.

There are plans to landfill / develop the port around the existing tide gauge hut at Pilots Pier. The engineering plans have been prepared but construction is not due for 3-4 years. However the existing Pilots Pier is considered very useful and provides shelter from any northerly - northwest wind / waves. If a GLOSS / IOTWS tide gauge were established here this may influence future options concerning developing this site. One mention was that the future port expansion at Tawahi could retain the Pilots Pier and existing tide gauge hut. For these reasons the alternative option of the small jetty in front of the YPA Head Office could be more secure and permanent.



Fig 10. Port Engineers Office Bench Mark and Chief Hydrographic Surveyor Mahfood M Mohammed Kassim.



Fig 11. Pilot's Pier Tide Gauge Hut Bench Mark. On vertical left wall above lower step (badly rusting).

### Bench Marks

The Great Triangulation Survey of India (GTS) provided various benchmarks around Tawahi Port of Aden. The primary benchmark at Fairway House / Post Office House next to Post Office Pier no longer exists and the other remaining vertical bench mark is at the North East corner of the Port Engineers Office (PEO). There is another bench mark at the Pilots Pier tide gauge hut, situated on the lower wall by the steps next to the tide staff. Both of these benchmarks are in poor condition and need urgent repairs or replacing (Fig 10, 11).



Re-establishing a new network of benchmarks should be a 'priority' and use the staff from the Hydrographic Survey and Dredging Section. Bronze benchmark plaques can be supplied from GLOSS or manufactured from bronze metal in the Port.

## Historical Data

The Hydrographic Survey Department of the Port are investigating the available paper tide gauge charts from the 1974-1986 Munro tide gauge observations at Pilots Pier. However the charts may have been moved since the tide gauge stopped working and there is some uncertainty as to their location. This is probably as a result of the wars in Aden during 1986 and 1994 and staff changes. Data is available for the WS Ocean SLM Tide Monitor at Pilots Pier from 2000-2004 on paper print rolls.

## Tidal Range at Aden

From the Admiralty Tide Tables (1983), the range between MHHW and MLLW (springs) is 1.5m and from MLHW and MHLW (neaps) is 0.6m. The Form Factor  $F=0.87$  so the tide is mixed mainly semidiurnal.

## Other Ports in Yemen suitable for GLOSS / IOTWS Tide Gauges

### Al Mukalla Port (Hadramawt Governate)

This is a busy YPA small Port in the middle of the Gulf of Aden. **Kamal Abdo Saeed Ghaleb** YPA Port Officer attended the 2000 Persga/IOC/GLOSS Jeddah workshop and is now based in Mukalla Port. It presently has no tide gauge but has a secure /safe jetty suitable for a GLOSS radar and pressure sensor gauge. Co-ordinates 14 32 07 N and 49 08 29 E.

### Nishtun Port (Al Mahra Governate)

This is a small YPA Port in the eastern Gulf of Aden with a suitable modern jetty for a GLOSS tide gauge. Co-ordinates 15 49 16 N and 52 11 31E. The town of Nishtun is very small and isolated in the Al Mahra Governate close to the border with Oman.



Fig. 12. Hawlaf Jetty, 7km NE from Hadibu Socotra. (Satellite image from google earth)



Fig 13. Socotra. Hadibu and Hawlaf Jetty. (Satellite image from google earth).

## Socotra Island (Yemen)

There is a small rock / rubble jetty at Hawlaf, 7 km north east of Hadibu (12 39 07 N, 54 01 23 E) which is the capital of Socotra on the north side of the island (Fig. 12, 13, 14, 15).

South-westerly and north-easterly winds/waves and variable southerly katabatic winds from the mountains at up to 50m/s affect this jetty. For these reasons YPA will build a new jetty further west near the airport in 3-4 years which will provide a safer jetty for berthing vessels. There is a YPA Port officer based at Hadibu.

The only jetty at present is at Hawlaf and provides the only access to unload small cargo vessels from Mukalla and Nishtun Ports. From inspection of the satellite images (Google Earth) and photographs available, the jetty is located in an isolated area 7km east of Hadibu at 12 40 48N and 54 04 55E with no security or buildings on the jetty. There appears to be a secure

fenced compound nearby for oil/petrol tanks and some isolated buildings. The end of the jetty has a small concrete landing stage used to berth vessels alongside and unload cargoes. I would expect storm waves to wash over the landing stage.

UNEP have a office at Habibu (Fig 14) with Yemen and Italian staff who presently help to maintain the YPA automatic weather station recording wind data in preparation for a new jetty. There are around 80,000 residents on the island. The south side of the island is vulnerable to 10 m swells and surf.

With lack of security at the jetty and the exposed location, I would recommend waiting until the new YPA jetty is built west of Hadibu near the airport in 3-4 years.

Furthermore the logistics of transporting equipment and materials to the island are not easy. Two flights a week from Mukalla are sometimes cancelled due to poor visibility on the island and strong winds in summer (May-September). The small cargo vessels can only berth if sea conditions allow and this would be unlikely May-September. All material would need to be transported to the island with lack of local supplies or resources. Fabrication of the support frame /stilling wells for the tide gauge will need to be done in Aden Port and transported by air /sea to Habibu.



Fig 14. View from UNDP office at Hadibu, Socotra.



Fig. 15. YPA Jetty at Hawlaf, 7 km NE from Hadibu, Socotra.

### **Al Hudayda Port (Red Sea)**

This is a sizeable Port on the Red Sea with a natural harbour protected by a headland / spit at 14 51 16 N, 42 56 12 E. Persga ([www.persga.org](http://www.persga.org)) provided a WS Ocean Systems SLM-2 Tide Monitor, which was installed in 2001 and operated until 2002. **Wadhah Abdullah Yahya Mugammal** one of the YPA staff that attended the 2000 Persga/IOC/GLOSS Jeddah workshop is based in Hudayda Port.

## Recommendations:

1. The Civil Aviation and Meteorology Authority (CAMA) and the Yemen Ports Authority (YPA) could pursue links in maintaining the existing CAMA Microstep MIS weather / wave / tide gauge at the Port Authority Control Tower at Ras Marbut / Tawahi, until a new IOC GLOSS tide gauge can be installed. This will require weekly calibration checks on tidal height linked to Port Authority benchmarks. To make this system useful for Tsunami detection for the IOTWS then data transmission to the WMO GTS needs upgrading to include tidal height observed every minute transmitted every 15 minutes as automatic Metar messages into the WMO GTS. YPA divers will be needed to clean and maintain the underwater sensors / cables. This will provide essential temporary input into the IOTWS. Microstep MIS in Slovakia could advise on system software changes (<http://www.microstep-mis.com>).

The CAMA Microstep MIS seabed mounted Aanderaa pressure sensor cable running to the Ras Marbut breakwater and light tower needs urgent attention to secure it to the sea wall.

No one presently carries out any calibrations of sea level to the Port Benchmarks. A Tide Gauge Bench Mark should be established at the Ras Marbut breakwater linked to the Port GTS PEO (Great Triangulation Survey of India - Port Engineers Office) benchmark and a suitable calibration stilling well installed.

2. A new radar / pressure gauge should be installed at the Port of Aden, Tawahi at either the old tide gauge hut (Pilots Pier) used up to 2005 or at the small jetty in front of the YPA (Port of Aden) head office at Tawahi. This second location has higher security, power and telephone links. However the depth (1.5m) may be an issue for a pressure sensor/stilling well - the YPA mentioned they could easily dredge around this jetty which would also allow Pilot boats to berth alongside. I suggest the north east side of the outer jetty as suitable.

3. Future locations for IOC GLOSS - IOTWS tide gauges are at Mukalla (Hadramawt Governate) and Nishtun (Al Mahra Governate) YPA ports. A tide gauge could be installed at Socotra YPA new jetty to be built in 3-4 years. The existing jetty lacks security and is exposed to south westerly and north easterly waves and strong 50m/s katabatic winds from the mountains.

4. Only two YPA survey vertical height reference /datum benchmarks survive at Tawahi. The main primary benchmark at the old Post Office-Fairway House has been destroyed in recent construction work. The benchmark at the Port Engineers Office (PEO) at Tawahi needs urgent attention to repair and reinforce cracks in the wall. The only other benchmark is the tide gauge bench mark (TGBM) just beside the steps at the Pilots Pier Tide gauge hut - this benchmark is rusting badly and needs painting to prevent further rusting. A priority is that new benchmarks should be established around the YPA Tawahi complex using bronze metal plaques supplied from GLOSS /POL or manufacturer locally from bronze metal in the Port.

5. If the old tide gauge hut at Pilots Pier is to be re- used I would suggest blocking up the windows with concrete blocks for security, leaving adequate ventilation holes. A new bronze TGBM needs to be established and levelled. Replace the old wooded door with a galvanised steel door and carry out repairs to the structure. The seabed below the hut stilling well needs excavating to remove accumulation of loose rocks and sand, to extend the depth below 1.5m at low tide. This could be done with a JCB / backhoe. The general area needs cleaning and painting as it has been neglected. Security should be improved with the surrounding perimeters walls, gate and fence repaired. The roof access panel needs repairing.

6. YPA advice is to ship all equipment from Europe to Port of Aden by sea freight, this will take around 15 days. The method of shipping is to use LCT (Less Than Container.)

7. The WS Ocean SLM-2B Tide Monitor pressure gauges installed at Aden and Hudayda by Persga are no longer worth while maintaining. The company WS Ocean Systems is no longer in business and the spare parts are likely to be obsolete. Further more the systems did not provide digital access to data and relied on paper printouts and charts which is not suitable to the extremes of heat, humidity and dust in Aden. WS Ocean Systems became WS Envirotech Inc in the USA.

8. The Port of Aden could make use of the old Munro Tide gauge as a museum exhibit in the Head Office, much like the old analogue tide prediction calculator at the Proudman Oceanographic Laboratory at Birkenhead. The Port expressed interest in such an exhibit, maintaining historical archives of sea level observations at Aden Port - for publication in the Port Journal.

Port of Aden (Yemen Ports Authority) Head Office Senior Staff



Fig 16. Abdulrab Al Khulaqui (Marketing Director) and Capt. Roy Facey (Port Development Advisor)



Fig 17. Eng Ahmed Abdul Kawi Saeed (Head of Technical Department) & Mahfood Kassim (Chief Hydrographic Surveyor).



Fig 18. Mayed Saeed Yafai (Deputy Marketing Director) & Capt Hussein Ahmed Assaedi (Port Harbour Master)



Fig. 19. Saleh Al Khulaqui (Deputy Chief Hydrographic Surveyor) and Captain Roy Facey on YPA Head Office Jetty.

## Contacts

**Note:** The Yemen Ports Authority and the Civil Aviation and Meteorology Authority are part of The Ministry of Transport and Maritime Affairs.

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### **YPA staff that attended the PERSGA, IOC, GLOSS Workshop in Jeddah, 2006.**

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### **The Regional Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden [www.persga.org](http://www.persga.org)**

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Yemen Meteorological Service [www.yms.gov.ye](http://www.yms.gov.ye)
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## Abbreviations

GTS	:	Global Telecommunications System
IOTWS	:	Indian Ocean Tsunami Warning and Mitigation System (IOTWS).
METAR	:	International standard code format for hourly surface weather observations.
WMO	:	World Meteorological Organisation
YPA	:	Yemen Ports Authority

*Disclaimer Note: Whilst every effort is made to be accurate in the report it is submitted with Errors and Omissions Excepted, E&OE.*