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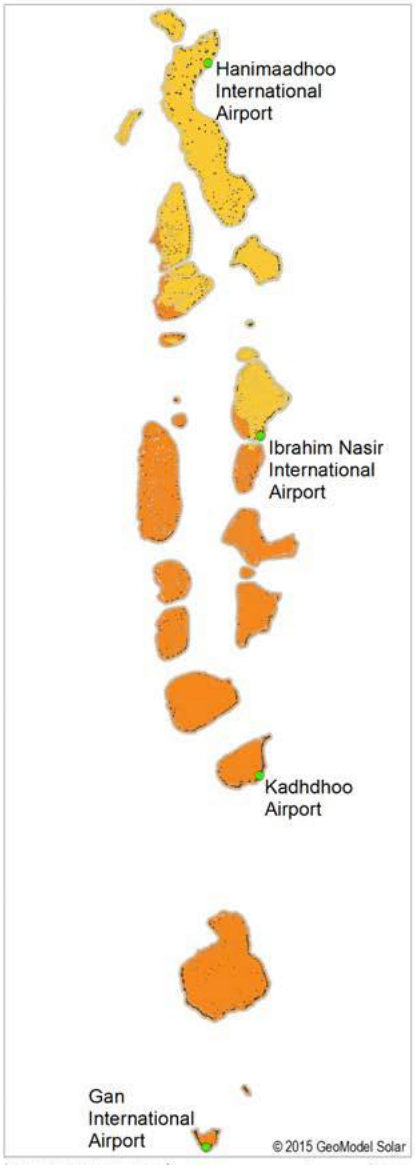
ESMAP
Energy Sector Management Assistance Program

Solar Resource Mapping in the Maldives

SITE INSTALLATION REPORTS

FEBRUARY 2017



This report was prepared by Solargis, under contract to The World Bank.

It is one of several outputs from the solar resource mapping component of the activity "Renewable Energy Resource Mapping and Geospatial Planning – Maldives" [Project ID: P146018]. This activity is funded and supported by the Energy Sector Management Assistance Program (ESMAP), a multi-donor trust fund administered by The World Bank, under a global initiative on Renewable Energy Resource Mapping. Further details on the initiative can be obtained from the ESMAP website.

This document is an **interim output** from the above-mentioned project, and the content is the sole responsibility of the consultant authors. Users are strongly advised to exercise caution when utilizing the information and data contained, as this may include preliminary data and/or findings, and the document has not been subject to full peer review. Final outputs from this project will be marked as such, and any improved or validated solar resource data will be incorporated into the Global Solar Atlas.

Contents:

1. Site Installation Report: Gan
2. Site Installation Report: Hanimaadhoo
3. Site Installation Report: Kadhdhoo
4. Site Installation Report: Maldives/Male

INSTALLATION REPORT – MALDIVES at GAN IINTERNATIONAL AIRPORT

ESMAP Maldives – Installation of meteorological measurement station of type TIER 2

Suntrace Technical Documentation
6 February 2017

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SECTION 1: INTRODUCTION

Between the 4th of December 2015 when the travel to Malé (Maldives) from Almería (Spain) / Hamburg (Germany) began and the 18th of December 2015 when Marko Schwandt returned to Almería four meteorological airport sites were installed.
This report summaries the tasks and results of the installation of the meteorological measurement station installed at International Airport Gan, in the following named as MVGAN, completed on 13th of December 2015.
The main task of the mission was the installation of a meteorological measurement station of Type TIER 2 at the selected airport site MVGAN including the training of the local staff from the Maldives Meteorological Service about principle maintenance works of the meteorological measurement stations of Type TIER 2. TIER 2 stations are equipped with a RSP 4G, a rotating shadowband irradiometer (RSI) based on a fast response photodiode sensor, one SR20-T1 pyranometer for redundant GHI measurement, one thermohygro-sensor, one barometric pressure sensor, one anemometer at 3 m height and a data logger.

SECTION 2: DESCRIPTION OF STATION

Recorded meteorological parameters:

- Global Horizontal Irradiance (GHI) in W/m^2
- Direct Normal Irradiance (DNI) in W/m^2
- Diffuse Horizontal Irradiance (DHI) in W/m^2
- Ambient Temperature in °C
- Relative Humidity in %
- Wind Speed (3m) in m/s
- Barometric Pressure in hPa

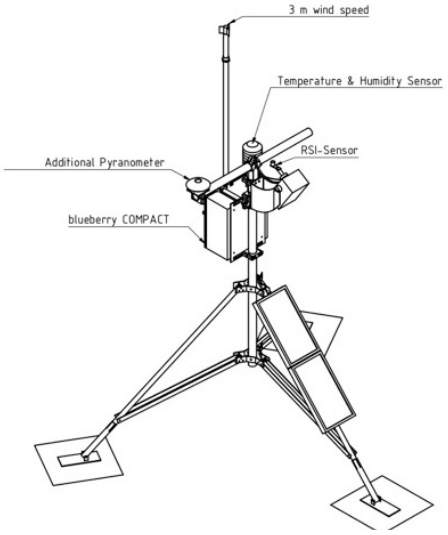


Figure 2-1: Design of installed TIER 2 station

Installation details:	
Location:	Maldives – Gan International Airport
Site ID:	MVGAN
Station ID:	1121
Longitude/Latitude	73.1500/0.6906
Date of commencement:	13 December 2015

List of installed measurement instruments:

	Instrument	**Manufacturer**	**Model No.**	**Serial No.**
1	RSI	Reichert GmbH	RSP 4G	14-03
2	Pyranometer	Hukseflux	SR20-T1	4384
3	Anemometer	Thies Clima	First Class	10159376
4	Thermohygro	Driesen und Kern	DKRF 400	K04497
5	Data logger	Wilmers GmbH	blueberry	1121
6	PV Panel	Solara	S-series 60W	888675

Figure 2-3: Location of the MVGAN station

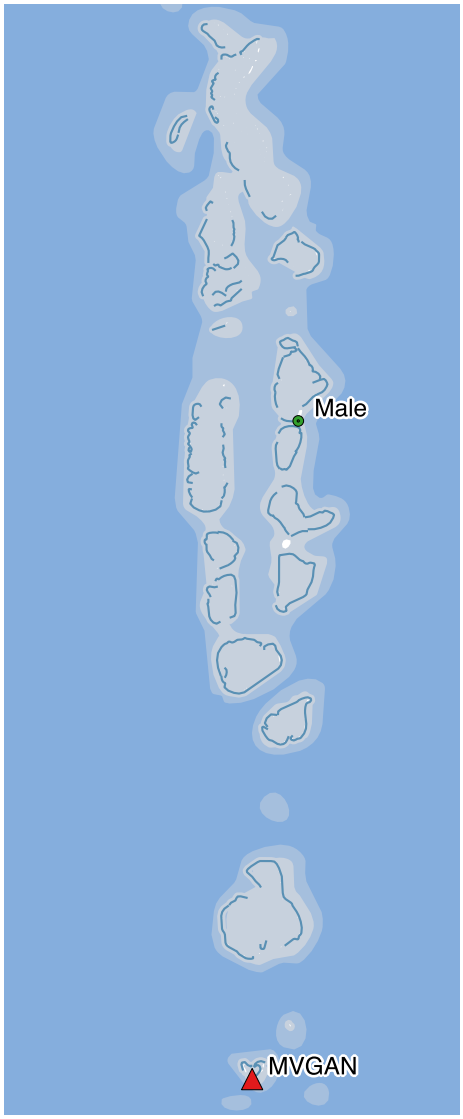


Figure 2-2:Location of station in Maldives

SECTION 3: STATION COMMISSIONING

Commissioning protocol:

	Applied test	Details	Approved Yes/No	Comments
1	Fencing	Fencing properly prepared and door closes and can be locked	Yes	Fencing is not required-station is located in high security area
2	RSI	Installed Licor sensor head is cleaned, horizontally leveled and aligned to the Geographic North for Northern Hemisphere or to the Geographic South for Southern Hemisphere. Shadow band is moving.	Yes	---
2	Pyranometer	Check for any damage, condensation, check the glass surface for scratches/other damages, check ventilation motors (if any) are functioning properly. If any condensation and/or scratches on glass is/are found, replace or repair the instrument. Check the desiccant, replace if dehydrated.	Yes	---
3	Pyranometer	Leveling/positioning of horizontal pyranometer	Yes	---
4	Thermohygro	Check for correct installation, functionality and discernible external damage.	Yes	---
5	Anemometer	Check for correct installation, functionality and discernible external damage.	Yes	---
6	Weather housing	Weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.	Yes	---
7	PV-panel	Properly fixed to tripod, facing south at northern hemisphere and vice versa , no visible damages (cracks, scratches)	Yes	---
8	Wires and cabling	Visually check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernible damages.	Yes	---
9	Power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.	Yes	---
10	Sensor connections to data logger	Check if the sensors are properly connected to the data logger (fixing cables to the corresponding port). Compare with connection plan.	Yes	---
11	Data logger	Check the measurement values and correct configuration of the sensors in the data logger (type, unit, slope, offset, etc.). Correct if necessary. Update communication configuration (e.g. e-mail address) if necessary.	Yes	Email addresses were adjusted
12	Modem	Check if SIMcard is inserted and modem registers to GSM network. It should be possible to communicate with a remote server/computer properly.	Yes	Internet provider: Dhiraagu via private IP-Address – public APN not available
13	Tripod and wind mast	Check if the mast(s) is/are steady and well fixed on the ground. Check bolts on the foundations of mast(s).	Yes	---

Comments:
All calibration certificates have been handed over to Maldives Meteorological Service, together with the station documentation, original and signed commissioning protocols and maintenance templates.

Photo documentation

Figure 3-1: Site Overview

Figure 3-2: Pyranometer

Figure 3-3: Rotating Schadowband Irradiometer

Figure 3-4: Anemometer

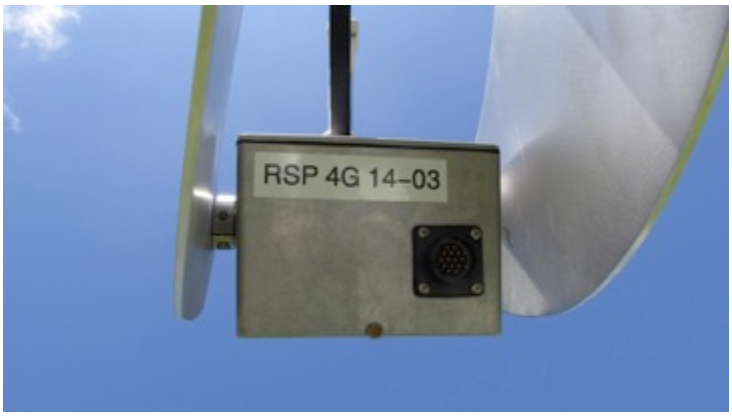


Figure 3-5: Rotating Shadowband Irradiometer

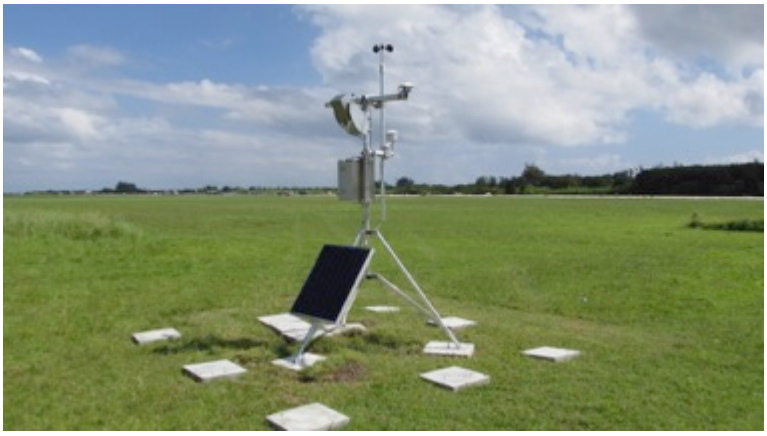


Figure 3-6: Station overview

Figure 3-7: Data Logger

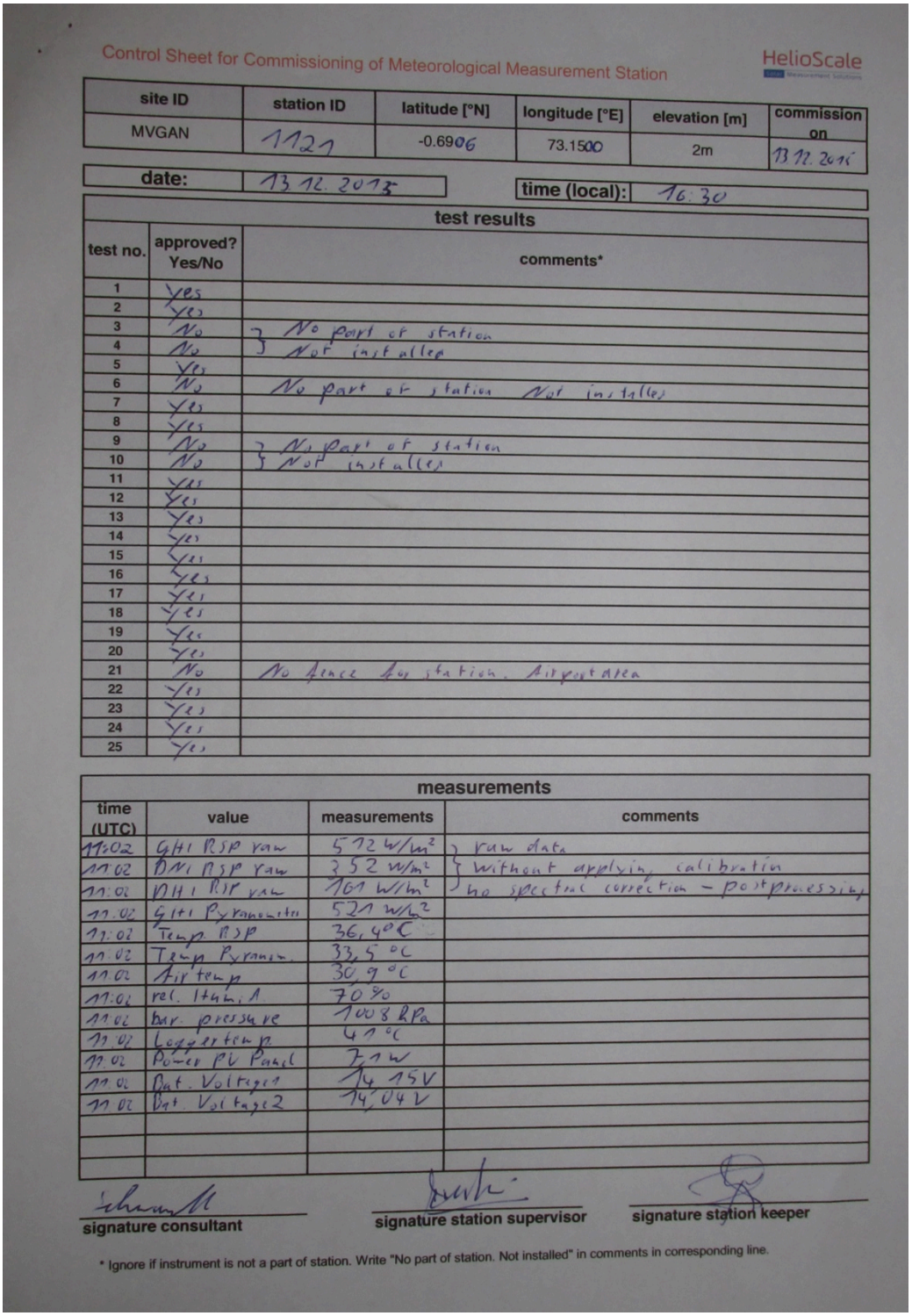
Figure 3-8: PV-Panel

Figure 3-9: 360° view

SECTION 4: SUMMARY OF COMPLETED TASKS

- The meteorological measurement station has been installed and commissioned successfully.
- The installed station and spare parts have been tested prior to delivery for the project.
- Renewable Energy Maldives (REM) provides local technical assistance. Local staff was trained extensively during the installation of all four stations to conduct all required maintenance checks, the replacement of sensors, etc. Local staff will perform station maintenance. The local staffs members from the Maldives Meteorological Service (MMS) have been trained in detail how to maintenance the stations and how to document the maintenance visits via the provided control sheets for cleaning and inspection. They are also instructed to realize smaller works like leveling, alignment etc. Detailed information about the various maintenance tasks as well as the control sheets can be found in the corresponding presentation hold on 6th December 2012 during the workshop at the headquarter of Maldives Meteorological Service, Malé. A detailed inspection and maintenance visit will be performed by the local partner Renewable Energy Maldives 6 month and 18 month after the installation. Field verification (optionally re-calibration) after 12 and 24 months will be performed by Renewable Energy Maldives and Suntrace.
- Recorded data will be downloaded daily via GPRS. Data will be provided on a monthly basis including a summary of the last recorded month. Data transfer works properly. Additionally to the by contract committed monthly delivery of post processed data including a monthly summary report, the unprocessed raw data is sent via a daily Email to the Headquarter of Maldives Meteorological Service (MMS), to the corresponding local offices of MMS, to REM, to GeoModel Solar and to Suntrace GmbH. A daily automatic quality control procedure is applied to the unprocessed raw data.
- The responsible station keeper will check leveling of RSI and Pyranometer once a month.

ANNEX: CONTROL SHEETS FOR COMMISSIONING AND CLEANING OF METEOROLOGICAL MEASUREMENT STATION



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission on
MVGAN	1121	-0.6906	73.1500	2m	13.12.2015

date: 13.12.2015 time (local): 16.30

test results

test no.	approved? Yes/No	comments*
1	Yes	
2	Yes	
3	No	} No part of station
4	No	} Not installed
5	Yes	
6	No	No part of station Not installed
7	Yes	
8	Yes	
9	No	} No part of station
10	No	} Not installed
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	Yes	
19	Yes	
20	Yes	
21	No	No fence for station. Airport area
22	Yes	
23	Yes	
24	Yes	
25	Yes	

measurements

time (UTC)	value	measurements	comments
11:02	GHI RSP raw	572 W/m²	} raw data
11:02	DNI RSP raw	252 W/m²	} without applying calibration
11:02	DHI RSP raw	161 W/m²	} no spectral correction – postprocessing
11:02	GHI Pyranometer	521 W/m²	
11:02	Temp. RSP	36,4 °C	
11:02	Temp. Pyranom.	33,5 °C	
11:02	Air temp.	30,9 °C	
11:02	rel. Humid.	70 %	
11:02	bar. pressure	1008 hPa	
11:02	Loggertemp.	41 °C	
11:02	Power PV Panel	71 W	
11:02	Bat. Voltage1	14,15 V	
11:02	Bat. Voltage2	14,04 V	

signature consultant | signature station supervisor | signature station keeper

* Ignore if instrument is not a part of station. Write "No part of station. Not installed" in comments in corresponding line.

Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission on
MVGAN	1121	-0.6906	73.1500	2m	13.11.2015

contact details:

station keeper
Name: Mohamed Nazmee
Address: Samazamanzil S. Muradhoo feydhoo
Mobile: 7941839
Phone:
Mail: Nazmee@meteorology.gov.mv

station supervisor
Name: AHMED MUSLIM
Address: REGIONAL WEATHER SERVICE
Mobile: 777 3407
Phone:
Mail: ahmed.muslim@meteo[illegible]

station supplier
Name: Suntrace GmbH
Address: Brandstwiete 46
20457 Hamburg
Germany
Phone: +49 40 767 96 38 0
Fax: +49 40 767 96 38 20
Mail: meteo@suntrace.de

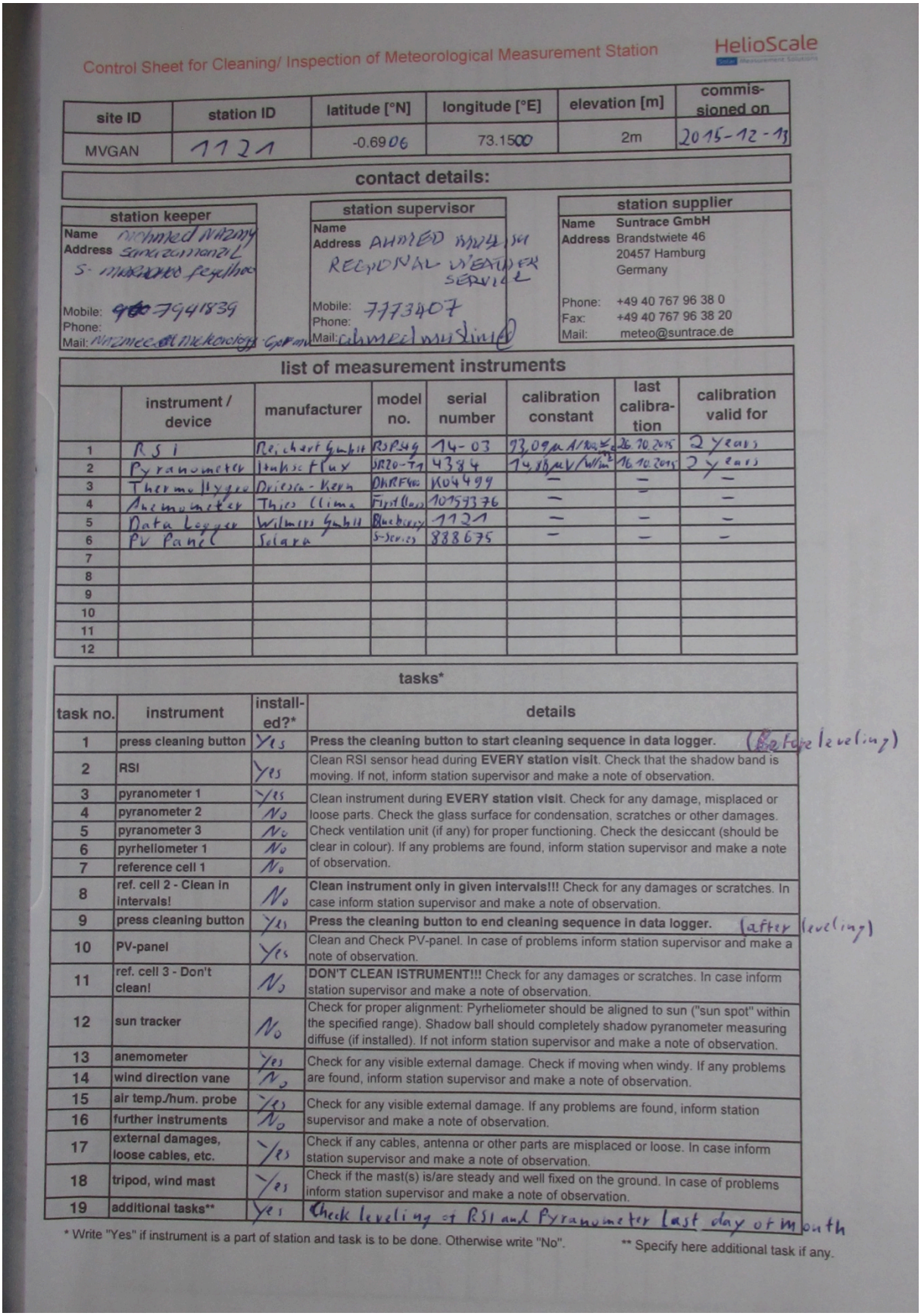
list of measurement instruments

	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	RSI	Reichert GmbH	RSP-4G	14-03	93,09 µA/1000W/m²	2015-10-26	2 years
2	Pyranometer	Hukseflux	SR20-T1	4384	14,88 µV/W/m²	2015-10-16	2 years
3	Thermo-Hygro	Driesen-Kern	DKRF400	K04499	–	–	–
4	Anemometer	Thies Clima	First Class	10159376	–	–	-
5	Data Logger	Wilmers GmbH	Blueberry	1121	–	–	-
6	PV Panel	Solara	S-Series	888075	–	–	-
7							
8							
9							
10							
11							
12							

commissioning tests*

test no.	test	details
1	RSI	Ensure that the RSI sensor head is cleaned, horizontally leveled and aligned to the GEOGRAPHIC north for Northern Hemisphere or to the GEOGRAPHIC south for Southern Hemisphere. Check that the shadow band is moving.
2	pyranometer(s)	Check for any damage, condensation, check the glass surface for scratches/other damages, check ventilation motors (if any) are functioning properly. If any condensation and/or scratches on glass is/are found, replace or repair the instrument. Check the desiccant, replace if dehydrated. Write for each sensor type (reference cell/pyranometer) the quantity of installed instruments in comments.
3	pyrheliometer(s)	
4	reference cell(s)	
5	leveling/positioning of horizontal pyranometer	Check water levels for proper leveling, if instrument (cable) is aligned to GEOGRAPHIC North (Northern Hemisphere) or GEOGRAPHIC South (Southern Hemisphere). Correct if necessary. Check if any parts are misplaced or loose.
6	sun tracker	Check if tracker is well fixed at the foundation. Check for proper alignment of suntracker (GEOGRAPHIC North/South) by checking the spot created and/or the leveling of the tracker assembly. Spot should be created within the specified range. Check for proper mechanical functioning of the tracker.
7	air temp.,rel.humidity probe	Check for correct installation, functionality and discernible external damage.
8	anemometer	
9	wind direction vane	
10	further sensors, instruments	Specify sensor(s)/instrument(s) in comments. Check for correct installation, functionality and discernible damage.
11	weather housing	Check that weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.
12	PV-panel	Check PV-panel.
13	loose parts	Check if any parts are misplaced or loose (sensors, antenna, in case: PV panel, wind mast wires, etc.).
14	cabling of all sensors	Check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernible damages.
15	check power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.
16	sensor connections to data logger	Check if the sensors are properly connected to the data logger (right cables to the corresponding port). Compare with connection plan.
17	data logger sensor/communication	Check the measurement values and correct configuration of the sensors in the data logger (type, unit, slope, offset, etc.). Correct if necessary. Update communication configuration (e.g. e-mail address) if necessary.
18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements, compare them with observations and document them.
20	tripod, wind mast	Check if the mast(s) is/are steady and well fixed on the ground. Check bolts on the foundations of mast(s).
21	fence, door, lock	Check the fence and door including its lock.
22	horizon pictures	360° panorama picture from the view point of radiation sensors should be taken.
23	station pictures	Take photos of all sensors and instruments and also of the whole station. The serial numbers should be seen.
24	general view	Anything unusual?
25	station keeper training and documentation	Training of Station Keeper. Check the station documentation such as: analogy of serial numbers, station logbook, etc.

* Ignore if instrument is not a part of station. Write "No part of station. Not installed" in comments in corresponding line.



Control Sheet for Cleaning/ Inspection of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commis-sioned on
MVGAN	1121	-0.6906	73.1500	2m	2015-12-13

contact details:

station keeper	station supervisor	station supplier
Name [illegible]	Name	Name Suntrace GmbH
Address [illegible]	Address AHMED [illegible] REGIONAL WEATHER SERVICE	Address Brandstwiete 46, 20457 Hamburg, Germany
Mobile: [illegible] 7941839	Mobile: 7773407	Phone: +49 40 767 96 38 0
Phone:	Phone:	Fax: +49 40 767 96 38 20
Mail: [illegible]	Mail: [illegible]	Mail: meteo@suntrace.de

list of measurement instruments

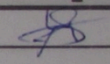
	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	RSI	Reichert GmbH	RSR4g	14-03	93,09 µA/kW/m²	26.10.2015	2 years
2	Pyranometer	Kipp&Zonen	SR20-T1	4384	14,18 µV/W/m²	16.10.2015	2 years
3	Thermohygro	Driesen-Kern	DKRF400	K04499	–	–	–
4	Anemometer	Thies Clima	First Class	10159376	–	–	–
5	Data Logger	Wilmers GmbH	Blueberry	1121	–	–	–
6	PV Panel	Selexa	S-Series	888675	–	–	–
7							
8							
9							
10							
11							
12							

tasks*

task no.	instrument	installed?*	details
1	press cleaning button	Yes	**Press the cleaning button to start cleaning sequence in data logger.** (Before leveling)
2	RSI	Yes	Clean RSI sensor head during **EVERY station visit**. Check that the shadow band is moving. If not, inform station supervisor and make a note of observation.
3	pyranometer 1	Yes	Clean instrument during **EVERY station visit**. Check for any damage, misplaced or loose parts. Check the glass surface for condensation, scratches or other damages. Check ventilation unit (if any) for proper functioning. Check the desiccant (should be clear in colour). If any problems are found, inform station supervisor and make a note of observation.
4	pyranometer 2	No	
5	pyranometer 3	No	
6	pyrheliometer 1	No	
7	reference cell 1	No	
8	ref. cell 2 - Clean in intervals!	No	**Clean instrument only in given intervals!!!** Check for any damages or scratches. In case inform station supervisor and make a note of observation.
9	press cleaning button	Yes	**Press the cleaning button to end cleaning sequence in data logger.** (after leveling)
10	PV-panel	Yes	Clean and Check PV-panel. In case of problems inform station supervisor and make a note of observation.
11	ref. cell 3 - Don't clean!	No	**DON'T CLEAN ISTRUMENT!!!** Check for any damages or scratches. In case inform station supervisor and make a note of observation.
12	sun tracker	No	Check for proper alignment: Pyrheliometer should be aligned to sun ("sun spot" within the specified range). Shadow ball should completely shadow pyranometer measuring diffuse (if installed). If not inform station supervisor and make a note of observation.
13	anemometer	Yes	Check for any visible external damage. Check if moving when windy. If any problems are found, inform station supervisor and make a note of observation.
14	wind direction vane	No	
15	air temp./hum. probe	Yes	Check for any visible external damage. If any problems are found, inform station supervisor and make a note of observation.
16	further instruments	No	
17	external damages, loose cables, etc.	Yes	Check if any cables, antenna or other parts are misplaced or loose. In case inform station supervisor and make a note of observation.
18	tripod, wind mast	Yes	Check if the mast(s) is/are steady and well fixed on the ground. In case of problems inform station supervisor and make a note of observation.
19	additional tasks**	Yes	Check leveling of RSI and Pyranometer last day of month

* Write "Yes" if instrument is a part of station and task is to be done. Otherwise write "No". ** Specify here additional task if any.

site ID	station ID	latitude [°N]	longitude [°E]	commissioned on
HVGAN	1121	-0.6906	73.1500	2015-12-13

task number		1.	2.	3.	4.	5.	6.	7.	8.	9	10.	11. - 19.		
		CLEANING										VISUAL INSPECTION		
frequency		check at each station visit							every 12 weeks*	each station visit		check each station visit		
task		press cleaning button	RSI	pyranometer 1	pyranometer 2	pyranometer 3	pyrheliometer 1	reference cell 1	ref. cell 2 - Clean in intervals!	press cleaning button	PV-panel	check for any visible damages, loose cables etc.	comments	name / signature
Is this sensor installed? Insert "✓" or "-"		✓	✓	✓	–	–	–	–	–	✓	✓			
Date	Local time													
13/12/15	15:00	✓	✓	✓	–	–	–	–	–	✓	–	✓	Day of commissioning	
					–	–	–	–	–					
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Don't leave any fields empty.
If no comments or instrument not installed insert "–".

Complete blue fields always with:
✓ task done or – task not done

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INSTALLATION REPORT – MALDIVES at HANIMAADHOO INTERNATIONAL AIRPORT

ESMAP Maldives – Installation of meteorological measurement station of type TIER 2

Suntrace Technical Documentation
6 February 2017

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VAT: DE266610323

SECTION 1: INTRODUCTION

Between the 4th of December 2015 when the travel to Malé (Maldives) from Almería (Spain) / Hamburg (Germany) began and the 18th of December 2015 when Marko Schwandt returned to Almería four meteorological airport sites were installed.
This report summaries the tasks and results of the installation of the meteorological measurement station installed at Hanimaadho Internationa Airport, in the following named as MVHAQ, completed on 10th of December 2015.
The main task was the installation of a meteorological measurement station of Type TIER 2 at the selected airport site MVHAQ including the training of the local staff from the Maldives Meteorological Service about principle maintenance works of the meteorological measurement stations of Type TIER 2. TIER 2 stations are equipped with a RSP 4G, a rotating shadowband irradiometer (RSI) based on a fast response photodiode sensor, one SR20-T1 pyranometer for redundant GHI measurement, one thermohygro-sensor, one barometric pressure sensor, one anemometer at 3 m height and a data logger.

SECTION 2: DESCRIPTION OF STATION

Recorded meteorological parameters:

- Global Horizontal Irradiance (GHI) in W/m^2
- Direct Normal Irradiance (DNI) in W/m^2
- Diffuse Horizontal Irradiance (DHI) in W/m^2
- Ambient Temperature in °C
- Relative Humidity in %
- Wind Speed (3m) in m/s
- Barometric Pressure in hPa

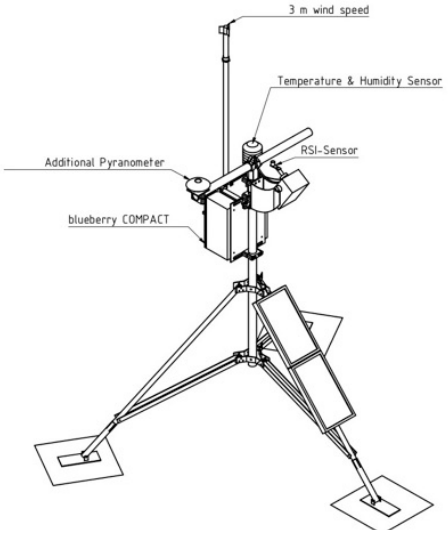

Figure 2-1: Design of installed TIER 2 station

Installation details:	
Location:	Maldives - Hanimaadhoo International Airport
Site ID:	MVHAQ
Station ID:	1124
Longitude/Latitude	73.169610°/6.748233°
Date of commencement:	10 December 2015

List of installed measurement instruments:

	Instrument	**Manufacturer**	**Model No.**	**Serial No.**
1	RSI	Reichert GmbH	RSP 4G	14-11
2	Pyranometer	Hukseflux	SR20-T1	4485
3	Anemometer	Thies Clima	First Class	10159375
4	Thermohygro	Driesen und Kern	DKRF 400	K04495
5	Data logger	Wilmers GmbH	blueberry	1124
6	PV Panel	Solara	S-series 60W	888668

Figure 2-2: Location of the MVHAQ station

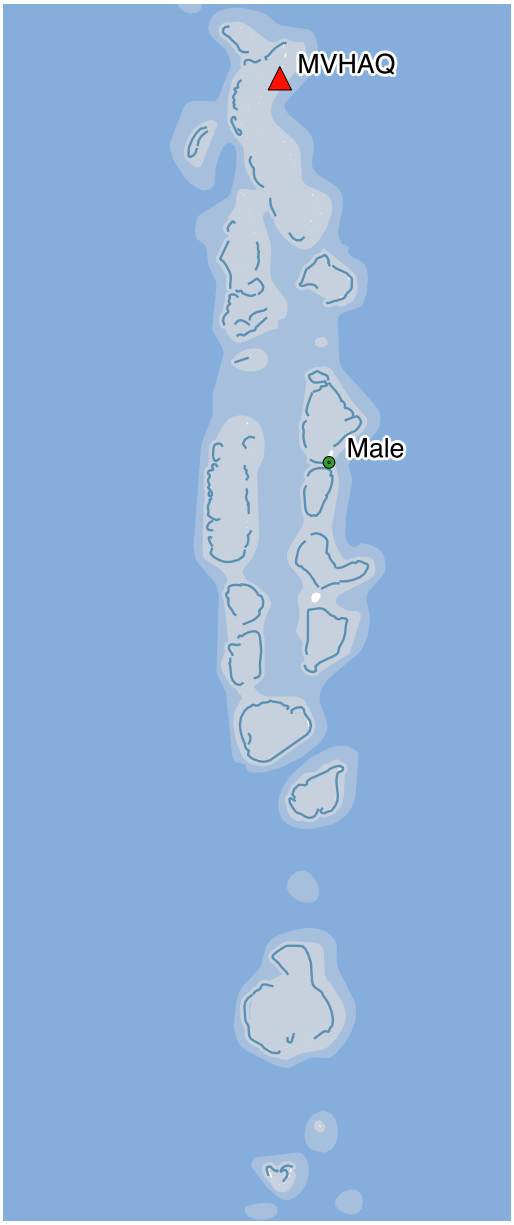

Figure 2-2:Location of the station in Maldives

SECTION 3: STATION COMMISSIONING

Commissioning protocol:

	Applied test	Details	Approved Yes/No	Comments
1	Fencing	Fencing properly prepared and door closes and can be locked	Yes	Fencing is not required-station is located in high security area
2	RSI	Installed Licor sensor head is cleaned, horizontally leveled and aligned to the Geographic North for Northern Hemisphere or to the Geographic South for Southern Hemisphere. Shadow band is moving.	Yes	---
2	Pyranometer	Check for any damage, condensation, check the glass surface for scratches/other damages, check ventilation motors (if any) are functioning properly. If any condensation and/or scratches on glass is/are found, replace or repair the instrument. Check the desiccant, replace if dehydrated.	Yes	---
3	Pyranometer	Leveling/positioning of horizontal pyranometer	Yes	---
4	Thermohygro	Check for correct installation, functionality and discernible external damage.	Yes	---
5	Anemometer	Check for correct installation, functionality and discernible external damage.	Yes	---
6	Weather housing	Weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.	Yes	---
7	PV-panel	Properly fixed to tripod, facing south at northern hemisphere and vice versa , no visible damages (cracks, scratches)	Yes	---
8	Wires and cabling	Visually check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernible damages.	Yes	---
9	Power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.	Yes	---
10	Sensor connections to data logger	Check if the sensors are properly connected to the data logger (fixing cables to the corresponding port). Compare with connection plan.	Yes	---
11	Data logger	Check the measurement values and correct configuration of the sensors in the data logger (type, unit, slope, offset, etc.). Correct if necessary. Update communication configuration (e.g. e-mail address) if necessary.	Yes	Email addresses were adjusted
12	Modem	Check if SIMcard is inserted and modem registers to GSM network. It should be possible to communicate with a remote server/computer properly.	Yes	Internet provider: Dhiraagu via private IP-Address – public APN not available
13	Tripod and wind mast	Check if the mast(s) is/are steady and well fixed on the ground. Check bolts on the foundations of mast(s).	Yes	---

Comments:
All calibration certificates have been handed over to Maldives Meteorological Service, together with the station documentation, original and signed commissioning protocols and maintenance templates.

Photo documentation

Figure 3-1: Station installation and training

Figure 3-2: Station overview

Figure 3-3: 360° view

Figure 3-4: Anemometer

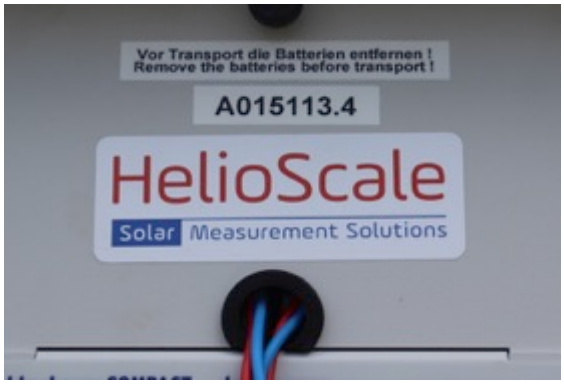

Figure 3-5: Serial Number- Datalogger

Figure 3-6: Rotating Shadowband Irradiometer

Figure 3-7: Thermohygrosensor

Figure 3-8: Datalogger

SECTION 4: SUMMARY OF COMPLETED TASKS

- The meteorological measurement station has been installed and commissioned successfully.
- The installed station and spare parts have been tested prior to delivery for the project.
- Renewable Energy Maldives (REM) provides local technical assistance. Local staff was trained extensively during the installation of all four stations to conduct all required maintenance checks, the replacement of sensors, etc. Local staff will perform station maintenance. The local staffs members from the Maldives Meteorological Service (MMS) have been trained in detail how to maintenance the stations and how to document the maintenance visits via the provided control sheets for cleaning and inspection. They are also instructed to realize smaller works like leveling, alignment etc. Detailed information about the various maintenance tasks as well as the control sheets can be found in the corresponding presentation hold on 6th December 2012 during the workshop at the headquarter of Maldives Meteorological Service, Malé. A detailed inspection and maintenance visit will be performed by the local partner Renewable Energy Maldives 6 month and 18 month after the installation. Field verification (optionally re-calibration) after 12 and 24 months will be performed by Renewable Energy Maldives and Suntrace.
- Recorded data will be downloaded daily via GPRS. Data will be provided on a monthly basis including a summary of the last recorded month. Data transfer works properly. Additionally to the by contract committed monthly delivery of post processed data including a monthly summary report, the unprocessed raw data is sent via a daily Email to the Headquarter of Maldives Meteorological Service (MMS), to the corresponding local offices of MMS, to REM, to GeoModel Solar and to Suntrace GmbH. A daily automatic quality control procedure is applied to the unprocessed raw data.
- The responsible station keeper will check leveling of RSI and Pyranometer once a month.

ANNEX: CONTROL SHEETS FOR COMMISSIONING AND CLEANING OF METEOROLOGICAL MEASUREMENT STATION

Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission on
MVHAQ	1124	6.7482	73.1696	2m	10.12.2015

date: 10.12.2015 **time (local):** 11:00

test results

test no.	approved? Yes/No	comments*
1	Yes	–
2	Yes	–
3	–	
4	–	No part of station Not installed
5	–	
6	–	
7	Yes	–
8	Yes	–
9	–	No part of station. Not installed
10	–	–
11	Yes	–
12	Yes	–
13	Yes	–
14	Yes	–
15	Yes	–
16	Yes	–
17	Yes	–
18	Yes	–
19	Yes	–
20	Yes	–
21	Yes	No fence, no door on site. –
22	Yes	–
23	Yes	–
24	Yes	–
25	Yes	–

measurements

time (UTC)	value	measurements	comments
05:56	GHI Pyranometer	192 W/m²	
05:56	GHI RSP raw	103 W/m²	raw data without calibration / correction
05:56	DHI RSP raw	100 W/m²	
05:56	DNI RSP raw	2 W/m²	
05:56	Temp. Pyran.	27.1 °C	
05:56	Temp. RSP	27.5 °C	
05:56	Wind speed	1.4 m/s	
05:56	Air temp	27.4 °C	
05:56	Rel. Humidity	89 %	
05:56	Bat. Press.	1013 hPa	
05:56	Bat. Voltage 1	12.66 V	
05:56	Bat. Voltage 2	12.69	

signature consultant

signature station supervisor Ahmed Samsor

signature station keeper Yaseef Qasim

* Ignore if instrument is not a part of station. Write "No part of station. Not installed" in comments in corresponding line.

HelioScale

Control Sheet for Commissioning of Meteorological Measurement Station

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission on
MVHAQ	1124	6.7482	73.1696	2m	10.12.2015

contact details:

station keeper	station supervisor	station supplier
Name: Yoosef Qasim	Name: AHMED SAMEER	Name: Suntrace GmbH
Address: Fahi / H.Dh. Hanimaadhoo (Hanimaadhoo met office)	Address: HIYAA / HANIMAADHOO HANIMAADHOO MET. OFFICE	Address: Brandstwiete 46, 20457 Hamburg, Germany
Mobile: +9607552765	Mobile: +9607934299	Phone: +49 40 767 96 38 0
Phone:	Phone:	Fax: +49 40 767 96 38 20
Mail: Yoosef_fahi@hotmail.com	Mail: sameer_met@hotmail.com	Mail: meteo@suntrace.de

list of measurement instruments

	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	RSI	Reichet GmbH	RSP-4G	14-11	93.76	16 Oct 15	2 YEARS
2	Pyranometer	Hukseflux	SR20-T1	43885	14.80	12 Oct 15	2 YEARS
3	Thermo-Hygro	Driesen-Kern	DKRF400	K04495	—	—	—
4	~~Driesen~~						
5	Anemometer	Thies Clima	First class	10159375	—	—	—
6	Data Logger	Vilmers GmbH	Blueberry	1124	—	—	—
7	PV-Panel	Solara	S-Series	888668	—	—	—
8							
9							
10							
11							
12							

commissioning tests*

test no.	test	details
1	RSI	Ensure that the RSI sensor head is cleaned, horizontally leveled and aligned to the GEOGRAPHIC north for Northern Hemisphere or to the GEOGRAPHIC south for Southern Hemisphere. Check that the shadow band is moving.
2	pyranometer(s)	Check for any damage, condensation, check the glass surface for scratches/other damages, check ventilation motors (if any) are functioning properly. If any condensation and/or scratches on glass is/are found, replace or repair the instrument. Check the desiccant, replace if dehydrated. Write for each sensor type (reference cell/pyranometer) the quantity of installed instruments in comments.
3	pyrheliometer(s)	
4	reference cell(s)	
5	leveling/positioning of horizontal pyranometer	Check water levels for proper leveling, if instrument (cable) is aligned to GEOGRAPHIC North (Northern Hemisphere) or GEOGRAPHIC South (Southern Hemisphere). Correct if necessary. Check if any parts are misplaced or loose.
6	sun tracker	Check if tracker is well fixed at the foundation. Check for proper alignment of suntracker (GEOGRAPHIC North/South) by checking the spot created and/or the leveling of the tracker assembly. Spot should be created within the specified range. Check for proper mechanical functioning of the tracker.
7	air temp.,rel.humidity probe	Check for correct installation, functionality and discernible external damage.
8	anemometer	
9	wind direction vane	
10	further sensors, instruments	Specify sensor(s)/instrument(s) in comments. Check for correct installation, functionality and discernible damage.
11	weather housing	Check that weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.
12	PV-panel	Check PV-panel.
13	loose parts	Check if any parts are misplaced or loose (sensors, antenna, in case: PV panel, wind mast wires, etc.).
14	cabling of all sensors	Check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernible damages.
15	check power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.
16	sensor connections to data logger	Check if the sensors are properly connected to the data logger (right cables to the corresponding port). Compare with connection plan.
17	data logger sensor/communication	Check the measurement values and correct configuration of the sensors in the data logger (type, unit, slope, offset, etc.). Correct if necessary. Update communication configuration (e.g. e-mail address) if necessary.
18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements, compare them with observations and document them.
20	tripod, wind mast	Check if the mast(s) is/are steady and well fixed on the ground. Check bolts on the foundations of mast(s).
21	fence, door, lock	Check the fence and door including its lock.
22	horizon pictures	360° panorama picture from the view point of radiation sensors should be taken.
23	station pictures	Take photos of all sensors and instruments and also of the whole station. The serial numbers should be seen.
24	general view	Anything unusual?
25	station keeper training and documentation	Training of Station Keeper. Check the station documentation such as: analogy of serial numbers, station logbook, etc.

* Ignore if instrument is not a part of station. Write "No part of station. Not installed" in comments in corresponding line.

Control Sheet for Cleaning/ Inspection of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commis-sioned on
MVHAQ	1124	6.7482	73.1696	2m	

contact details:

station keeper	station supervisor	station supplier
Name Address Mobile: Phone: Mail:	Name Address Mobile: Phone: Mail:	Name Suntrace GmbH Address Brandstwiete 46 20457 Hamburg Germany Phone: +49 40 767 96 38 0 Fax: +49 40 767 96 38 20 Mail: meteo@suntrace.de

list of measurement instruments

	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	RSI	Reichert GmbH	RSP46	RSP-46	93.76	16Oct15	2 YEARS
2	Pyranometer	Hukseflux	SR20-T1	4385	14.80	12-Oct15	2 YEARS
3	Thermo-Hygro	Driesen-Kern	DKRF400	K04495	—	—	—
4	Anemometer	Thies Clima	First Class	1015 9375	—	—	—
5	Data Logger	Wilmers GmbH	blueberry	1124	—	—	—
6	PV-Panel	Solara	S-Series	888668	—	—	—
7							
8							
9							
10							
11							
12							

tasks*

task no.	instrument	install-ed?*	details
1	press cleaning button	Yes	**Press the cleaning button to start cleaning sequence in data logger.**
2	RSI	Yes	Clean RSI sensor head during **EVERY station visit**. Check that the shadow band is moving. If not, inform station supervisor and make a note of observation.
3	pyranometer 1	Yes	Clean instrument during **EVERY station visit**. Check for any damage, misplaced or loose parts. Check the glass surface for condensation, scratches or other damages. Check ventilation unit (if any) for proper functioning. Check the desiccant (should be clear in colour). If any problems are found, inform station supervisor and make a note of observation.
4	pyranometer 2	No	
5	pyranometer 3	No	
6	pyrheliometer 1	No	
7	reference cell 1	No	
8	ref. cell 2 - Clean in intervals!	No	**Clean instrument only in given intervals!!!** Check for any damages or scratches. In case inform station supervisor and make a note of observation.
9	press cleaning button	Yes	**Press the cleaning button to end cleaning sequence in data logger.**
10	PV-panel	Yes	Clean and Check PV-panel. In case of problems inform station supervisor and make a note of observation.
11	ref. cell 3 - Don't clean!	No	**DON'T CLEAN ISTRUMENT!!!** Check for any damages or scratches. In case inform station supervisor and make a note of observation.
12	sun tracker	No	Check for proper alignment: Pyrheliometer should be aligned to sun ("sun spot" within the specified range). Shadow ball should completely shadow pyranometer measuring diffuse (if installed). If not inform station supervisor and make a note of observation.
13	anemometer	Yes	Check for any visible external damage. Check if moving when windy. If any problems are found, inform station supervisor and make a note of observation.
14	wind direction vane	No	
15	air temp./hum. probe	Yes	Check for any visible external damage. If any problems are found, inform station supervisor and make a note of observation.
16	further instruments	No	
17	external damages, loose cables, etc.	Yes	Check if any cables, antenna or other parts are misplaced or loose. In case inform station supervisor and make a note of observation.
18	tripod, wind mast	Yes	Check if the mast(s) is/are steady and well fixed on the ground. In case of problems inform station supervisor and make a note of observation.
19	additional tasks**	Yes	Check leveling of RSI + Pyranometer end of every month

* Write "Yes" if instrument is a part of station and task is to be done. Otherwise write "No".

** Specify here additional task if any.

site ID	station ID	latitude [°N]	longitude [°E]	commissioned on
HVHAQ	1124	6.7482	73.1696	

task number		1.	2.	3.	4.	5.	6.	7.	8.	9	10.	11. - 19.	
		CLEANING										VISUAL INSPECTION	
frequency		check at each station visit							every 12 weeks*	each station visit		check each station visit	comments
task		press cleaning button	RSI	pyranometer 1	pyranometer 2	pyranometer 3	pyrheliometer 1	reference cell 1	ref. cell 2 - Clean in intervals!	press cleaning button	PV-panel	check for any visible damages, loose cables etc.	
Is this sensor installed? Insert "✓" or "-"		✓	✓	✓	-	-	-	-	-	✓	✓		
Date	Local time												
10-12-15	0943	✓	✓	✓	-	-	-	-	-	✓	✓	✓	station starts running

Complete blue fields always with:
✓ task done or – task not done

Don't leave any fields empty.
If no comments or instrument not installed insert "–".

1 of 13

INSTALLATION REPORT – MALDIVES at KADHDHOO AIRPORT

ESMAP Maldives – Installation of meteorological measurement station of type TIER 2

Suntrace Technical Documentation
6 February 2017

Responsible Authors:

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SECTION 1: INTRODUCTION

Between the 4th of December 2015 when the travel to Malé (Maldives) from Almería (Spain) / Hamburg (Germany) began and the 18th of December 2015 when Marko Schwandt returned to Almería four meteorological airport sites were installed.
This report summaries the tasks and results of the installation of the meteorological measurement station installed at Kadhdoo airport, in the following named as MVKDO, completed on 14th of December 2015.
The main task was the installation of a meteorological measurement station of Type TIER 2 at the preselected airport site MVKDO including the training of the local staff from the Maldives Meteorological Service about principle maintenance works of the meteorological measurement stations of Type TIER 2. TIER 2 stations are equipped with a RSP 4G, a rotating shadowband irradiometer (RSI) based on a fast response photodiode sensor, one SR20-T1 pyranometer for redundant GHI measurement, one thermohygro-sensor, one barometric pressure sensor, one anemometer at 3 m height and a data logger.

SECTION 2: DESCRIPTION OF STATION

Recorded meteorological parameters:

- Global Horizontal Irradiance (GHI) in W/m^2
- Direct Normal Irradiance (DNI) in W/m^2
- Diffuse Horizontal Irradiance (DHI) in W/m^2
- Ambient Temperature in °C
- Relative Humidity in %
- Wind Speed (3m) in m/s
- Barometric Pressure in hPa

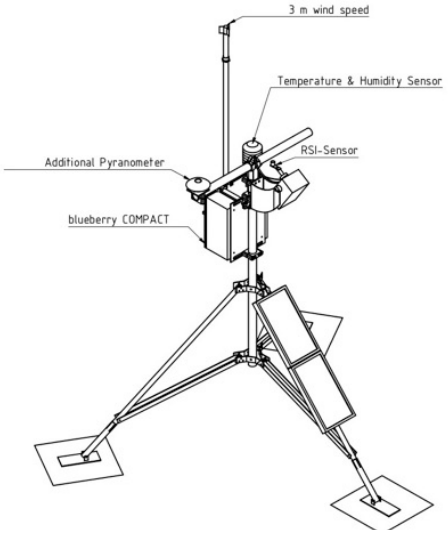


Figure 2-1: Design of installed TIER 2 station

Installation details:	
Location:	Maldives - Kadhdhoo Airport
Site ID:	MVKDO
Station ID:	1122
Longitude/Latitude	73.5203/1.8599
Date of commencement:	14 December 2015

List of installed measurement instruments:

	Instrument	**Manufacturer**	**Model No.**	**Serial No.**
1	RSI	Reichert GmbH	RSP 4G	14-07
2	Pyranometer	Hukseflux	SR20-T1	4383
3	Anemometer	Thies Clima	First Class	10159377
4	Thermohygro	Driesen und Kern	DKRF 400	K04498
5	Data logger	Wilmers GmbH	blueberry	1122
6	PV Panel	Solara	S-series 60W	888707

Figure 2-2: Location of the MVKDO station

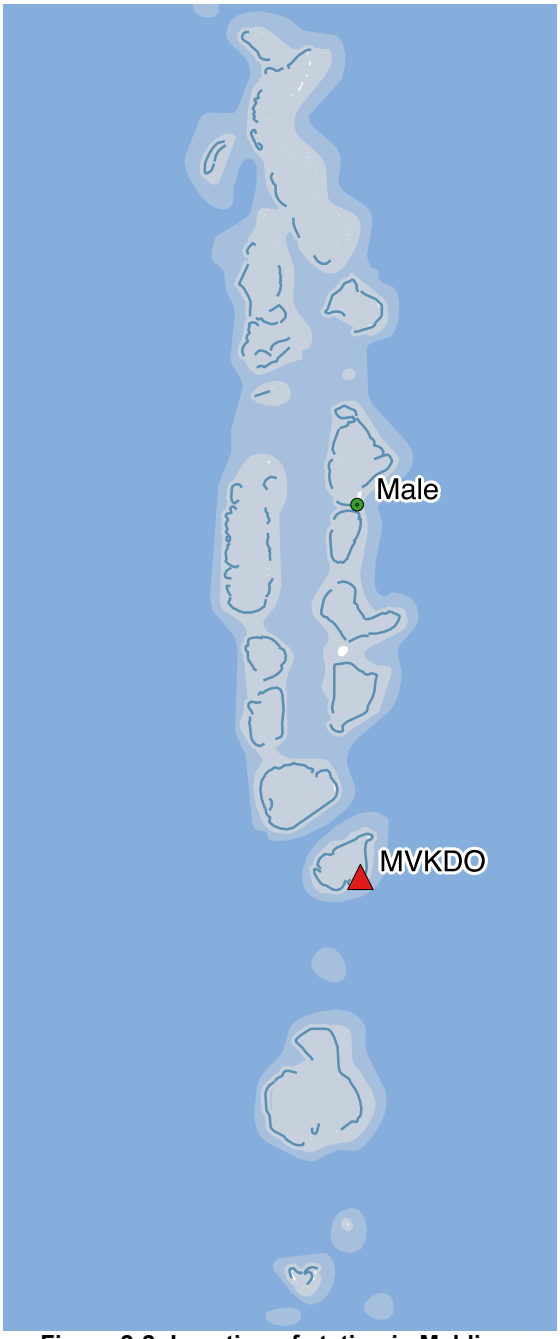


Figure 2-2: Location of station in Maldives

SECTION 3: STATION COMMISSIONING

Commissioning protocol:

	Applied test	Details	Approved Yes/No	Comments
1	Fencing	Fencing properly prepared and door closes and can be locked	Yes	Fencing is not required-station is located in high security area
2	RSI	Installed Licor sensor head is cleaned, horizontally leveled and aligned to the Geographic North for Northern Hemisphere or to the Geographic South for Southern Hemisphere. Shadow band is moving.	Yes	---
2	Pyranometer	Check for any damage, condensation, check the glass surface for scratches/other damages, check ventilation motors (if any) are functioning properly. If any condensation and/or scratches on glass is/are found, replace or repair the instrument. Check the desiccant, replace if dehydrated.	Yes	---
3	Pyranometer	Leveling/positioning of horizontal pyranometer	Yes	---
4	Thermohygro	Check for correct installation, functionality and discernible external damage.	Yes	---
5	Anemometer	Check for correct installation, functionality and discernible external damage.	Yes	---
6	Weather housing	Weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.	Yes	---
7	PV-panel	Properly fixed to tripod, facing south at northern hemisphere and vice versa , no visible damages (cracks, scratches)	Yes	---
8	Wires and cabling	Visually check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernible damages.	Yes	---
9	Power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.	Yes	---
10	Sensor connections to data logger	Check if the sensors are properly connected to the data logger (fixing cables to the corresponding port). Compare with connection plan.	Yes	---
11	Data logger	Check the measurement values and correct configuration of the sensors in the data logger (type, unit, slope, offset, etc.). Correct if necessary. Update communication configuration (e.g. e-mail address) if necessary.	Yes	Email addresses were adjusted
12	Modem	Check if SIMcard is inserted and modem registers to GSM network. It should be possible to communicate with a remote server/computer properly.	Yes	Internet provider: Dhiraagu via private IP-Address – public APN not available
13	Tripod and wind mast	Check if the mast(s) is/are steady and well fixed on the ground. Check bolts on the foundations of mast(s).	Yes	---

Comments:
All calibration certificates have been handed over to Maldives Meteorological Service, together with the station documentation, original and signed commissioning protocols and maintenance templates.

Photo documentation

Figure 3-1: Station installation

Figure 3-2: Anemometer

Figure 3-3: Station overview

Figure 3-4: PV-Panel

Figure 3-5:Pyranometer

Figure 3-6: Data Logger

Figure 3-7:Rotating Shadowband Irradiometer

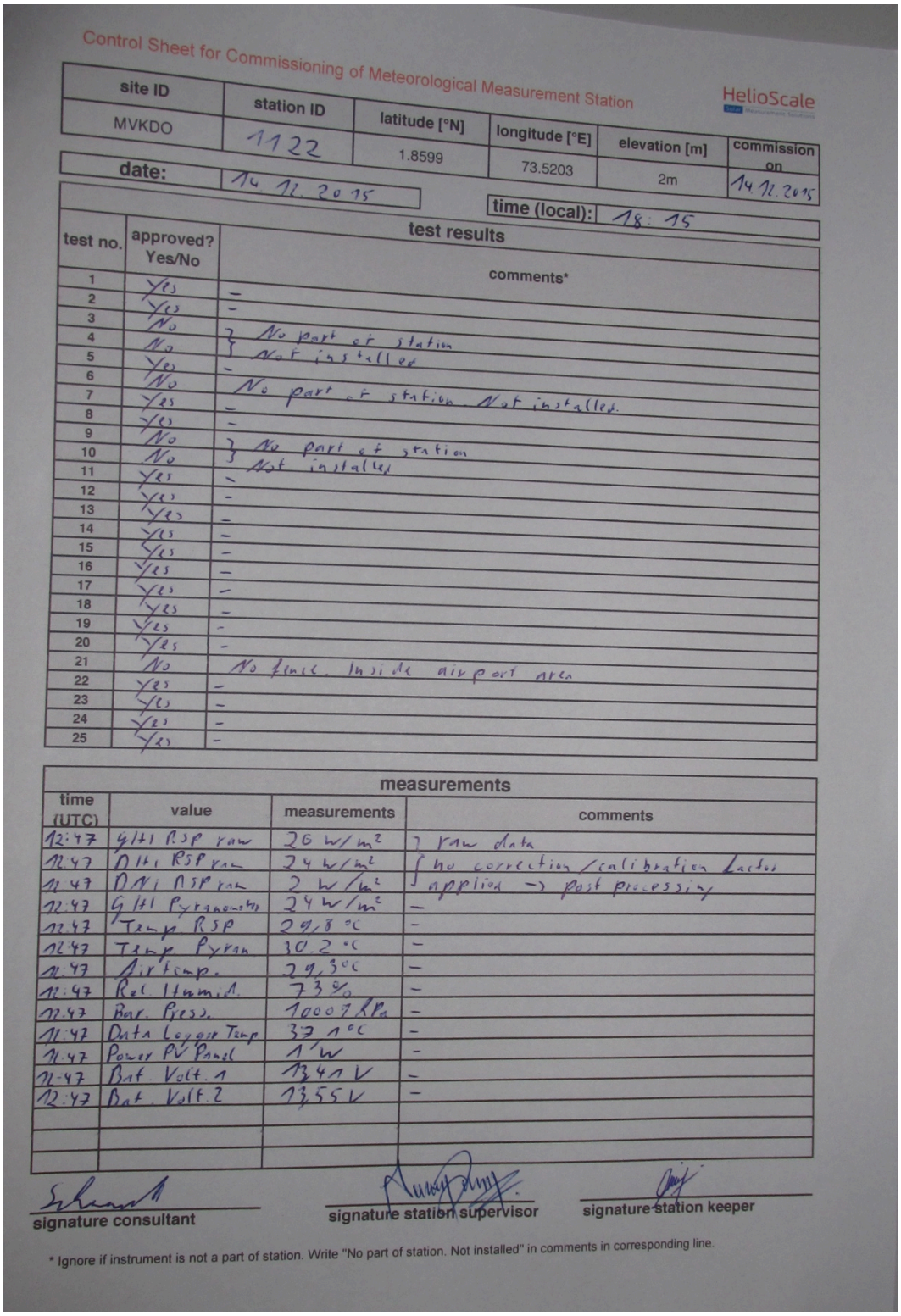
Figure 3-8: Site overview

Figure 3-9 :360° overview

SECTION 4: SUMMARY OF COMPLETED TASKS

- The meteorological measurement station has been installed and commissioned successfully.
- The installed station and spare parts have been tested prior to delivery for the project.
- Renewable Energy Maldives (REM) provides local technical assistance. Local staff was trained extensively during the installation of all four stations to conduct all required maintenance checks, the replacement of sensors, etc. Local staff will perform station maintenance. The local staffs members from the Maldives Meteorological Service (MMS) have been trained in detail how to maintenance the stations and how to document the maintenance visits via the provided control sheets for cleaning and inspection. They are also instructed to realize smaller works like leveling, alignment etc. Detailed information about the various maintenance tasks as well as the control sheets can be found in the corresponding presentation hold on 6th December 2012 during the workshop at the headquarter of Maldives Meteorological Service, Malé. A detailed inspection and maintenance visit will be performed by the local partner Renewable Energy Maldives 6 month and 18 month after the installation. Field verification (optionally re-calibration) after 12 and 24 months will be performed by Renewable Energy Maldives and Suntrace.
- Recorded data will be downloaded daily via GPRS. Data will be provided on a monthly basis including a summary of the last recorded month. Data transfer works properly. Additionally to the by contract committed monthly delivery of post processed data including a monthly summary report, the unprocessed raw data is sent via a daily Email to the Headquarter of Maldives Meteorological Service (MMS), to the corresponding local offices of MMS, to REM, to GeoModel Solar and to Suntrace GmbH. A daily automatic quality control procedure is applied to the unprocessed raw data.
- The responsible station keeper will check leveling of RSI and Pyranometer once a month.

ANNEX: CONTROL SHEETS FOR COMMISSIONING AND CLEANING OF METEOROLOGICAL MEASUREMENT STATION



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission on
MVKDO	1122	1.8599	73.5203	2m	14.12.2015

date: 14.12.2015 time (local): 18:15

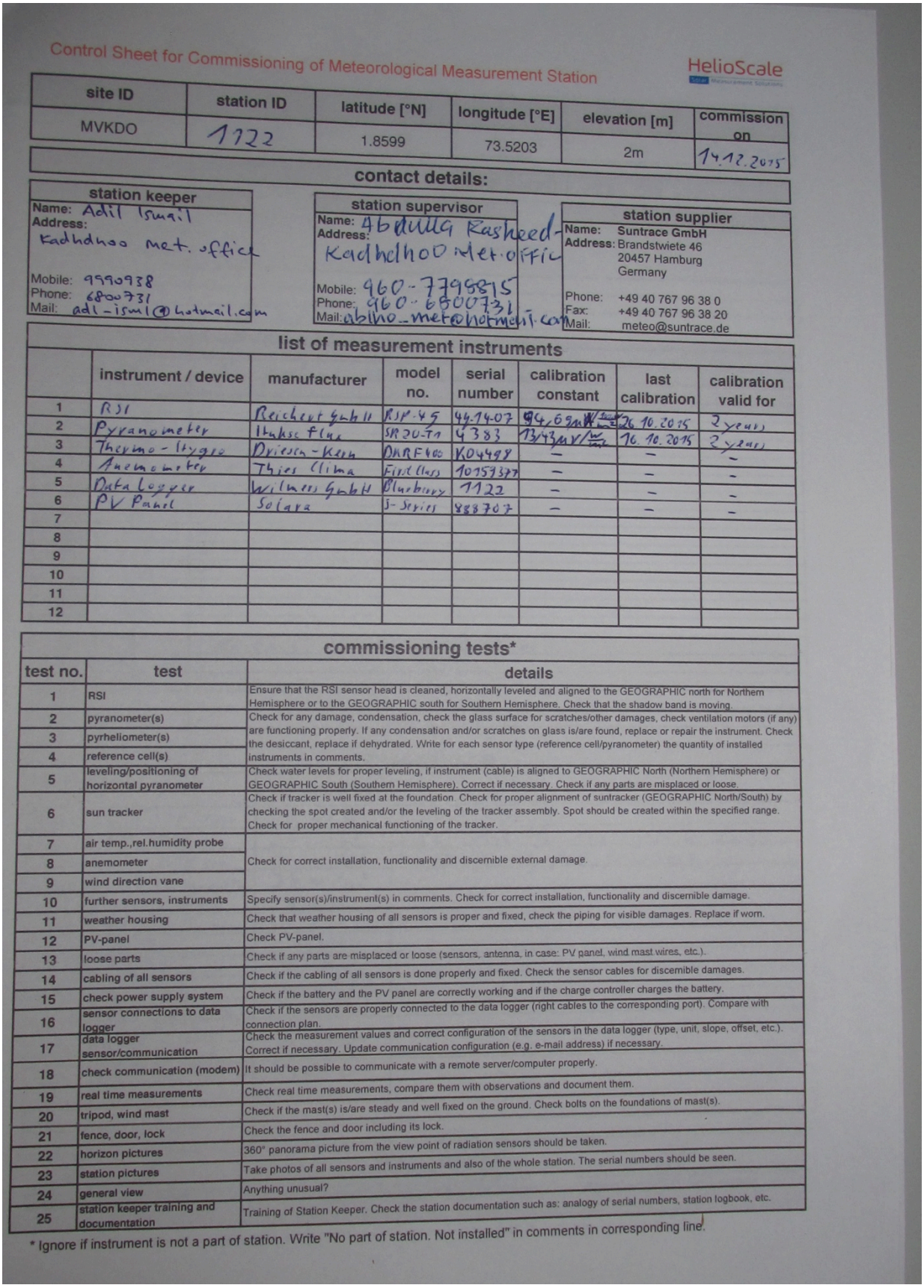
test no.	approved? Yes/No	test results comments*
1	Yes	-
2	Yes	-
3	No	No part of station Not installed
4	No	
5	Yes	-
6	No	No part of station Not installed.
7	Yes	-
8	Yes	-
9	No	No part of station
10	No	Not installed
11	Yes	-
12	Yes	-
13	Yes	-
14	Yes	-
15	Yes	-
16	Yes	-
17	Yes	-
18	Yes	-
19	Yes	-
20	Yes	-
21	No	No fence. Inside airport area
22	Yes	-
23	Yes	-
24	Yes	-
25	Yes	-

measurements

time (UTC)	value	measurements	comments
12:47	GHI RSP raw	26 W/m²	raw data
12:47	DHI RSP raw	24 W/m²	no correction/calibration factor
12:47	DNI RSP raw	2 W/m²	applied -> post processing
12:47	GHI Pyranometer	24 W/m²	-
12:47	Temp. RSP	29,8 °C	-
12:47	Temp. Pyran	30.2 °C	-
12:47	Air temp.	29,3°C	-
12:47	Rel. Humid.	73 %	-
12:47	Bar. Press.	1000,7 hPa	-
12:47	Data Logger Temp	37,1°C	-
12:47	Power PV Panel	1 W	-
12:47	Bat. Volt. 1	13,41 V	-
12:47	Bat. Volt. 2	13,55 V	-

signature consultant | signature station supervisor | signature station keeper

* Ignore if instrument is not a part of station. Write "No part of station. Not installed" in comments in corresponding line.



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission on
MVKDO	1122	1.8599	73.5203	2m	14.12.2015

contact details:

station keeper
Name: Adil Ismail
Address: Kadhdhoo met. office
Mobile: 9990938
Phone: 6800731
Mail: adl-ism1@hotmail.com

station supervisor
Name: Abdulla Rasheed
Address: Kadhdhoo Met.office
Mobile: 960-7795815
Phone: 960-6800731
Mail: ablho_meteo@hotmail.com

station supplier
Name: Suntrace GmbH
Address: Brandstwiete 46
20457 Hamburg
Germany
Phone: +49 40 767 96 38 0
Fax: +49 40 767 96 38 20
Mail: meteo@suntrace.de

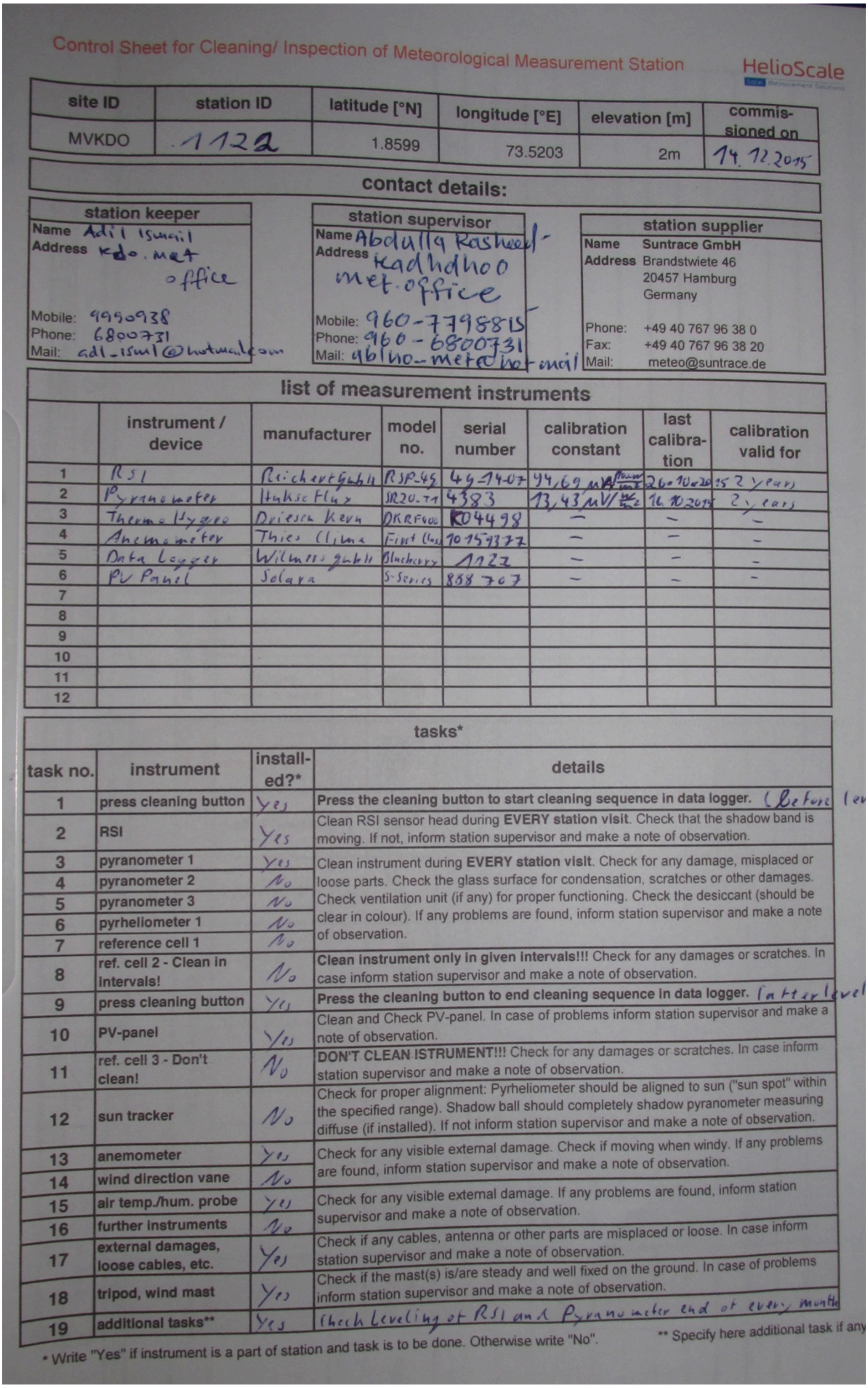
list of measurement instruments

	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	RSI	Reichert GmbH	RSP-45	44-14-07	94,69 W/m²	26.10.2015	2 years
2	Pyranometer	Ithase Flux	SR20-T1	4383	13,43 µV/W/m²	16.10.2015	2 years
3	Thermo-Hygro	Driesen-Kern	DKRF400	K04498	–	–	–
4	Anemometer	Thies Clima	First Class	10757327	–	–	–
5	Data Logger	Wilmers GmbH	Blueberry	1122	–	–	–
6	PV Panel	Solara	S-Series	888707	–	–	–
7							
8							
9							
10							
11							
12							

commissioning tests*

test no.	test	details
1	RSI	Ensure that the RSI sensor head is cleaned, horizontally leveled and aligned to the GEOGRAPHIC north for Northern Hemisphere or to the GEOGRAPHIC south for Southern Hemisphere. Check that the shadow band is moving.
2	pyranometer(s)	Check for any damage, condensation, check the glass surface for scratches/other damages, check ventilation motors (if any) are functioning properly. If any condensation and/or scratches on glass is/are found, replace or repair the instrument. Check the desiccant, replace if dehydrated. Write for each sensor type (reference cell/pyranometer) the quantity of installed instruments in comments.
3	pyrheliometer(s)	
4	reference cell(s)	
5	leveling/positioning of horizontal pyranometer	Check water levels for proper leveling, if instrument (cable) is aligned to GEOGRAPHIC North (Northern Hemisphere) or GEOGRAPHIC South (Southern Hemisphere). Correct if necessary. Check if any parts are misplaced or loose.
6	sun tracker	Check if tracker is well fixed at the foundation. Check for proper alignment of suntracker (GEOGRAPHIC North/South) by checking the spot created and/or the leveling of the tracker assembly. Spot should be created within the specified range. Check for proper mechanical functioning of the tracker.
7	air temp.,rel.humidity probe	Check for correct installation, functionality and discernible external damage.
8	anemometer	
9	wind direction vane	
10	further sensors, instruments	Specify sensor(s)/instrument(s) in comments. Check for correct installation, functionality and discernible damage.
11	weather housing	Check that weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.
12	PV-panel	Check PV-panel.
13	loose parts	Check if any parts are misplaced or loose (sensors, antenna, in case: PV panel, wind mast wires, etc.).
14	cabling of all sensors	Check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernible damages.
15	check power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.
16	sensor connections to data logger	Check if the sensors are properly connected to the data logger (right cables to the corresponding port). Compare with connection plan.
17	data logger sensor/communication	Check the measurement values and correct configuration of the sensors in the data logger (type, unit, slope, offset, etc.). Correct if necessary. Update communication configuration (e.g. e-mail address) if necessary.
18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements, compare them with observations and document them.
20	tripod, wind mast	Check if the mast(s) is/are steady and well fixed on the ground. Check bolts on the foundations of mast(s).
21	fence, door, lock	Check the fence and door including its lock.
22	horizon pictures	360° panorama picture from the view point of radiation sensors should be taken.
23	station pictures	Take photos of all sensors and instruments and also of the whole station. The serial numbers should be seen.
24	general view	Anything unusual?
25	station keeper training and documentation	Training of Station Keeper. Check the station documentation such as: analogy of serial numbers, station logbook, etc.

* Ignore if instrument is not a part of station. Write "No part of station. Not installed" in comments in corresponding line.



Control Sheet for Cleaning/ Inspection of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commis-sioned on
MVKDO	1122	1.8599	73.5203	2m	14.12.2015

contact details:

station keeper	station supervisor	station supplier
Name Adil Ismail	Name Abdulla Rasheed	Name Suntrace GmbH
Address kdo. met office	Address Kadhdhoo met. office	Address Brandstwiete 46, 20457 Hamburg, Germany
Mobile: 9990938	Mobile: 960-7798815	Phone: +49 40 767 96 38 0
Phone: 6800731	Phone: 960-6800731	Fax: +49 40 767 96 38 20
Mail: adl_isml@hotmail.com	Mail: gblno-met@hotmail	Mail: meteo@suntrace.de

list of measurement instruments

	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibra-tion	calibration valid for
1	RSI	Reichert GmbH	RSP-4G	4G-14-07	94,69 mA/(kW/m²)	26.10.2015	2 years
2	Pyranometer	Hukseflux	SR20-T1	4383	13,43 μV/(W/m²)	16.10.2014	2 years
3	Thermo Hygro	Driesen Kern	DKRF400	K04498	–	–	–
4	Anemometer	Thies Clima	First Class	10159377	–	–	–
5	Data Logger	Wilmers GmbH	Blackberry	1122	–	–	–
6	PV Panel	Solara	S-Series	888 707	–	–	–
7							
8							
9							
10							
11							
12							

tasks*

task no.	instrument	install-ed?*	details
1	press cleaning button	Yes	Press the cleaning button to start cleaning sequence in data logger. (Before lev…
2	RSI	Yes	Clean RSI sensor head during EVERY station visit. Check that the shadow band is moving. If not, inform station supervisor and make a note of observation.
3	pyranometer 1	Yes	Clean instrument during EVERY station visit. Check for any damage, misplaced or loose parts. Check the glass surface for condensation, scratches or other damages. Check ventilation unit (if any) for proper functioning. Check the desiccant (should be clear in colour). If any problems are found, inform station supervisor and make a note of observation.
4	pyranometer 2	No	
5	pyranometer 3	No	
6	pyrheliometer 1	No	
7	reference cell 1	No	
8	ref. cell 2 - Clean in intervals!	No	Clean instrument only in given intervals!!! Check for any damages or scratches. In case inform station supervisor and make a note of observation.
9	press cleaning button	Yes	Press the cleaning button to end cleaning sequence in data logger. (after level)
10	PV-panel	Yes	Clean and Check PV-panel. In case of problems inform station supervisor and make a note of observation.
11	ref. cell 3 - Don't clean!	No	DON'T CLEAN ISTRUMENT!!! Check for any damages or scratches. In case inform station supervisor and make a note of observation.
12	sun tracker	No	Check for proper alignment: Pyrheliometer should be aligned to sun ("sun spot" within the specified range). Shadow ball should completely shadow pyranometer measuring diffuse (if installed). If not inform station supervisor and make a note of observation.
13	anemometer	Yes	Check for any visible external damage. Check if moving when windy. If any problems are found, inform station supervisor and make a note of observation.
14	wind direction vane	No	
15	air temp./hum. probe	Yes	Check for any visible external damage. If any problems are found, inform station supervisor and make a note of observation.
16	further instruments	No	
17	external damages, loose cables, etc.	Yes	Check if any cables, antenna or other parts are misplaced or loose. In case inform station supervisor and make a note of observation.
18	tripod, wind mast	Yes	Check if the mast(s) is/are steady and well fixed on the ground. In case of problems inform station supervisor and make a note of observation.
19	additional tasks**	Yes	Check Leveling of RSI and Pyranometer end of every month

* Write "Yes" if instrument is a part of station and task is to be done. Otherwise write "No".

** Specify here additional task if any

task number		1.	2.	3.	4.	5.	6.	7.	8.	9	10.	11. - 19.		
frequency		CLEANING										VISUAL INSPECTION		
task		check at each station visit							every 12 weeks*	each station visit		check each station visit	comments	name / signature
		press cleaning button	RSI	pyranometer 1	pyranometer 2	pyranometer 3	pyrheliometer 1	reference cell 1	ref. cell 2 - Clean in intervals!	press cleaning button	PV-panel	check for any visible damages, loose cables etc.		
Is this sensor installed? Insert "✓" or "-".		✓	✓	✓	-	-	-	-	-	✓	✓	✓		
Date	Local time													
14.12.2015	13:47	✓	✓	✓	-	-	-	-	-	✓	-	✓	Day of commitioning	

Don't leave any fields empty.
If no comments or instrument not installed insert "–".

Complete blue fields always with:
✓ task done or – task not done

1 of 13

INSTALLATION REPORT – MALDIVES at MALE INTERNATIONAL AIRPORT

ESMAP Maldives – Installation of meteorological measurement station of type TIER 2

Suntrace Technical Documentation
6 February 2017

Responsible Authors:

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W: http://www.suntrace.de

HRB Hamburg: 110819
VAT: DE266610323

SECTION 1: INTRODUCTION

Between the 4th of December 2015 when the travel to Malé (Maldives) from Almería (Spain) / Hamburg (Germany) began and the 18th of December 2015 when Marko Schwandt returned to Almería four meteorological airport sites were installed.
This report summaries the tasks and results of the installation of the meteorological measurement station installed in Malé, in the following named as MVMLE, which has been completed on 8th of December 2015.
The main task was the installation of a meteorological measurement station of Type TIER 2 at the preselected airport site MVMLE including the training of the local staff from the Maldives Meteorological Service about principle maintenance works of the meteorological measurement stations of Type TIER 2. TIER 2 stations are equipped with a RSP 4G, a rotating shadowband irradiometer (RSI) based on a fast response photodiode sensor, one SR20-T1 pyranometer for redundant GHI measurement, one thermohygro-sensor, one barometric pressure sensor, one anemometer at 3 m height and a data logger.

SECTION 2: DESCRIPTION OF STATION

Recorded meteorological parameters:

- Global Horizontal Irradiance (GHI) in W/m^2
- Direct Normal Irradiance (DNI) in W/m^2
- Diffuse Horizontal Irradiance (DHI) in W/m^2
- Ambient Temperature in °C
- Relative Humidity in %
- Wind Speed (3m) in m/s
- Barometric Pressure in hPa

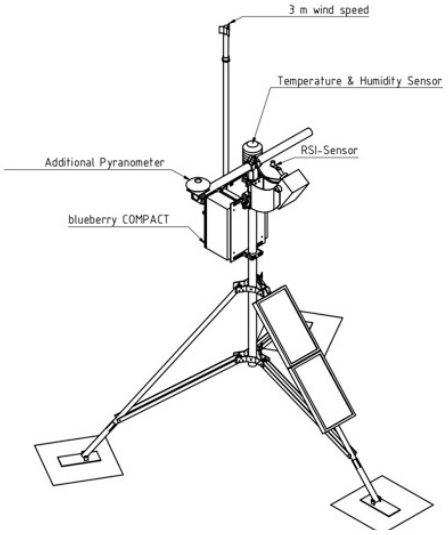


Figure 2-1: Design of installed TIER 2 station

Installation details:	
Location:	Maldives – Male Internatioanl Airport
Site ID:	MVMLE
Station ID:	1125
Longitude/Latitude	73.528112/4.192742
Date of commencement:	08 December 2015

List of installed measurement instruments:

	Instrument	**Manufacturer**	**Model No.**	**Serial No.**
1	RSI	Reichert GmbH	RSP 4G	14-08
2	Pyranometer	Hukseflux	SR20-T1	4318
3	Anemometer	Thies Clima	First Class	10159378
4	Thermohygro	Driesen und Kern	DKRF 400	K04496
5	Data logger	Wilmers GmbH	blueberry	1125
6	PV Panel	Solara	S-series 60W	888709

Figure 2-2: Location of the MVMLE station

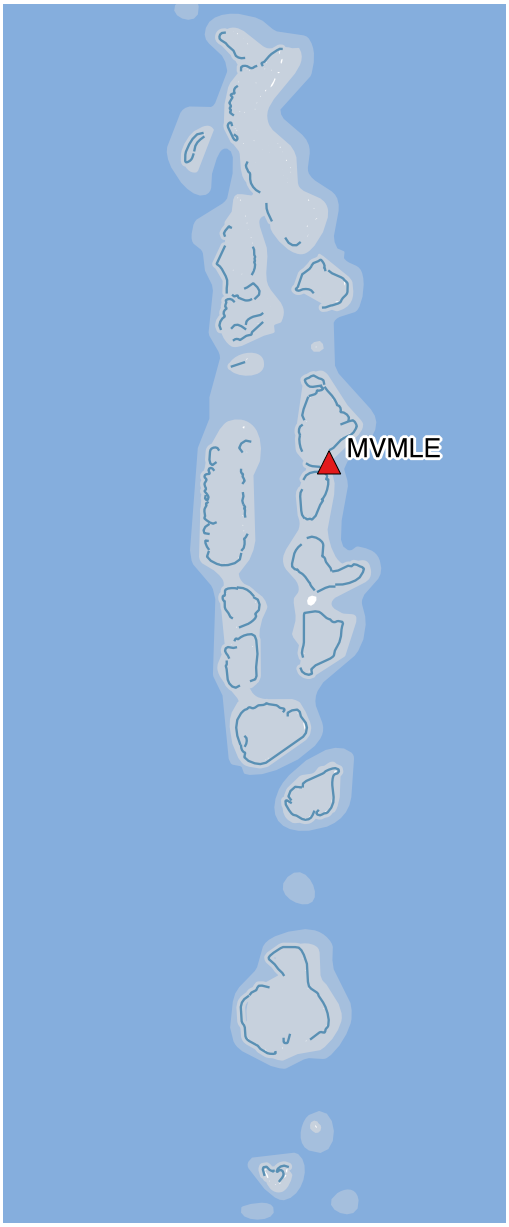


Figure 2-3: Location of station In Maldives

SECTION 3: STATION COMMISSIONING

Commissioning protocol:

	Applied test	Details	Approved Yes/No	Comments
1	Fencing	Fencing properly prepared and door closes and can be locked	Yes	Fencing is not required-station is located in high security area
2	RSI	Installed Licor sensor head is cleaned, horizontally leveled and aligned to the Geographic North for Northern Hemisphere or to the Geographic South for Southern Hemisphere. Shadow band is moving.	Yes	---
2	Pyranometer	Check for any damage, condensation, check the glass surface for scratches/other damages, check ventilation motors (if any) are functioning properly. If any condensation and/or scratches on glass is/are found, replace or repair the instrument. Check the desiccant, replace if dehydrated.	Yes	---
3	Pyranometer	Leveling/positioning of horizontal pyranometer	Yes	---
4	Thermohygro	Check for correct installation, functionality and discernible external damage.	Yes	---
5	Anemometer	Check for correct installation, functionality and discernible external damage.	Yes	---
6	Weather housing	Weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.	Yes	---
7	PV-panel	Properly fixed to tripod, facing south at northern hemisphere and vice versa , no visible damages (cracks, scratches)	Yes	---
8	Wires and cabling	Visually check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernible damages.	Yes	---
9	Power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.	Yes	---
10	Sensor connections to data logger	Check if the sensors are properly connected to the data logger (fixing cables to the corresponding port). Compare with connection plan.	Yes	---
11	Data logger	Check the measurement values and correct configuration of the sensors in the data logger (type, unit, slope, offset, etc.). Correct if necessary. Update communication configuration (e.g. e-mail address) if necessary.	Yes	Email addresses were adjusted
12	Modem	Check if SIMcard is inserted and modem registers to GSM network. It should be possible to communicate with a remote server/computer properly.	Yes	Internet provider: Dhiraagu via private IP-Address – public APN not available
13	Tripod and wind mast	Check if the mast(s) is/are steady and well fixed on the ground. Check bolts on the foundations of mast(s).	Yes	---

Comments:
All calibration certificates have been handed over to Maldives Meteorological Service, together with the station documentation, original and signed commissioning protocols and maintenance templates.

Photo documentation

Figure 3-1: Station Overview

Figure 3-2: Station installation

Figure 3-3:Pyranometer

Figure 3-4:Rotating Shadowband Irradiometer

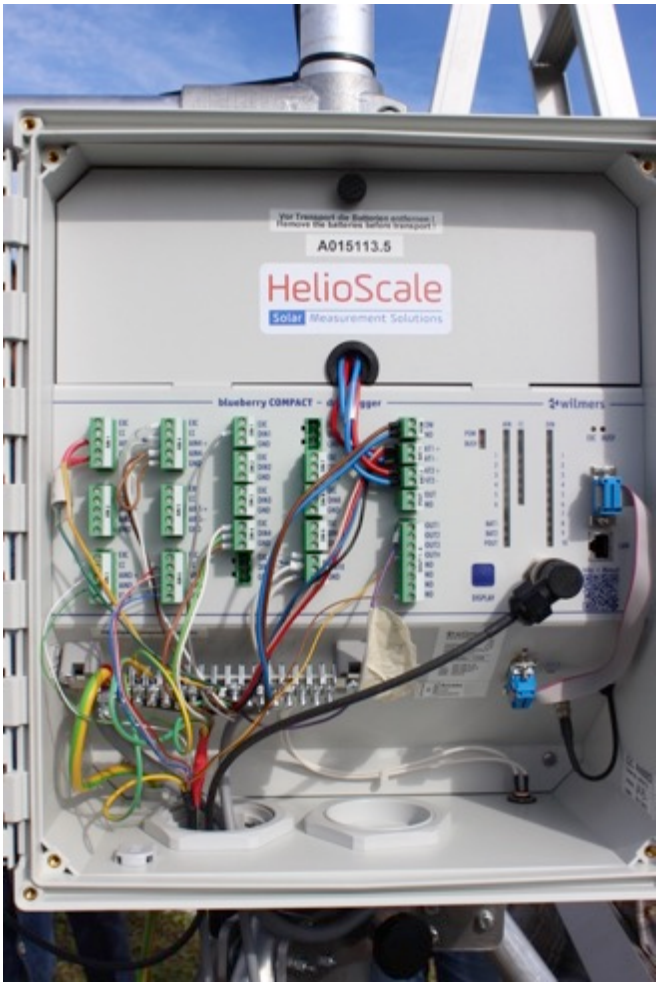


Figure 3-5: Datalogger

Figure 3-6: Rotating Shadowband Irradiometer - View from top

Figure 3-7: Thermohygro-Sensor

Figure 3-8: Datalogger - Serial Number

Figure 3-9: Anemometer

Figure 3-10:Serial Number Anemometer

Figure 3-11: 360 ° view

SECTION 4: SUMMARY OF COMPLETED TASKS

- The meteorological measurement station has been installed and commissioned successfully.
- The installed station and spare parts have been tested prior to delivery for the project.
- Renewable Energy Maldives (REM) provides local technical assistance. Local staff was trained extensively during the installation of all four stations to conduct all required maintenance checks, the replacement of sensors, etc. Local staff will perform station maintenance. The local staffs members from the Maldives Meteorological Service (MMS) have been trained in detail how to maintenance the stations and how to document the maintenance visits via the provided control sheets for cleaning and inspection. They are also instructed to realize smaller works like leveling, alignment etc. Detailed information about the various maintenance tasks as well as the control sheets can be found in the corresponding presentation hold on 6th December 2012 during the workshop at the headquarter of Maldives Meteorological Service, Malé. A detailed inspection and maintenance visit will be performed by the local partner Renewable Energy Maldives 6 month and 18 month after the installation. Field verification (optionally re-calibration) after 12 and 24 months will be performed by Renewable Energy Maldives and Suntrace.
- Recorded data will be downloaded daily via GPRS. Data will be provided on a monthly basis including a summary of the last recorded month. Data transfer works properly. Additionally to the by contract committed monthly delivery of post processed data including a monthly summary report, the unprocessed raw data is sent via a daily Email to the Headquarter of Maldives Meteorological Service (MMS), to the corresponding local offices of MMS, to REM, to GeoModel Solar and to Suntrace GmbH. A daily automatic quality control procedure is applied to the unprocessed raw data.
- The responsible station keeper will check leveling of RSI and Pyranometer once a month.

ANNEX: CONTROL SHEETS FOR COMMISSIONING AND CLEANING OF METEOROLOGICAL MEASUREMENT STATION

HelioScale

Control Sheet for Commissioning of Meteorological Measurement Station

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission on
MVALE	AØ15113.5	4,1927	73,5289	2m	2015-12-08

date:	2015-12-08	time (local):	

test results

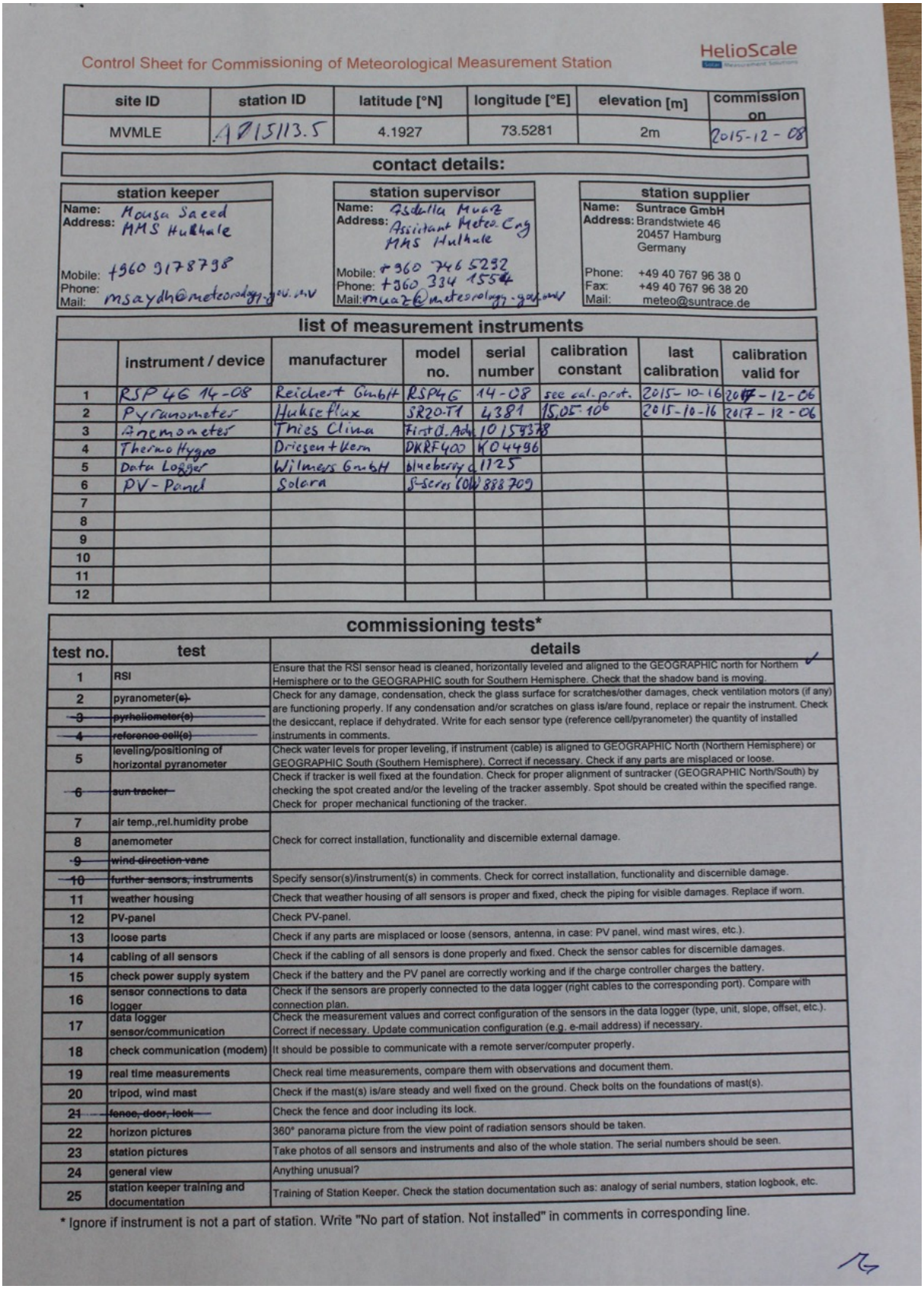
test no.	approved? Yes/No	comments*
1	yes	
2	Yes	
3	NA	
4	NA	
5	Yes	
6	NA	
7	Yes	
8	Yes	
9	NA	
10	NA	
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	Yes	
19	Yes	
20	Yes	
21	NA	
22	Yes	
23	Yes	
24	Yes	
25	yes	

measurements

time (UTC)	value	measurements	comments
07:19	Wind speed	2,3 m/s	
07:21	service button	1	
07:21	RSP temp.	33.6 °C	
07:21	Pyr temp	33.3 °C	
07:22	RSP GHI	968 W/m²	} raw val.
07:22	" DNI	848 W/m²	
07:22	" DHI	190 W/m²	
07:23	Pyr GHI	1014 W/m²	
07:24	Rel. Humidity	31.2 °C	
07:24	Rel. Hum	71 %	
07:24	barometric	1010 hPa	
07:24	T Logger	46 °C	
07:25	PV Power	20.5 W	
07:25	batt. volt 1	14.0 V	
07:25	" " 2	14.1 V	
09:21	PV voltage	18.2 V	

signature consultant | signature station supervisor | signature station keeper

* Ignore if instrument is not a part of station. Write "No part of station. Not installed" in comments in corresponding line.



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission on
MVMLE	A215113.5	4.1927	73.5281	2m	2015-12-08

contact details:

station keeper
Name: Mousa Saeed
Address: MMS Hulhule
Mobile: +960 9178798
Phone:
Mail: msaydh@meteorology.gov.mv

station supervisor
Name: Abdulla Muaz
Address: Assistant Meteo. Eng MMS Hulhule
Mobile: +960 746 5232
Phone: +960 334 1554
Mail: muaz@meteorology.gov.mv

station supplier
Name: Suntrace GmbH
Address: Brandstwiete 46
20457 Hamburg
Germany
Phone: +49 40 767 96 38 0
Fax: +49 40 767 96 38 20
Mail: meteo@suntrace.de

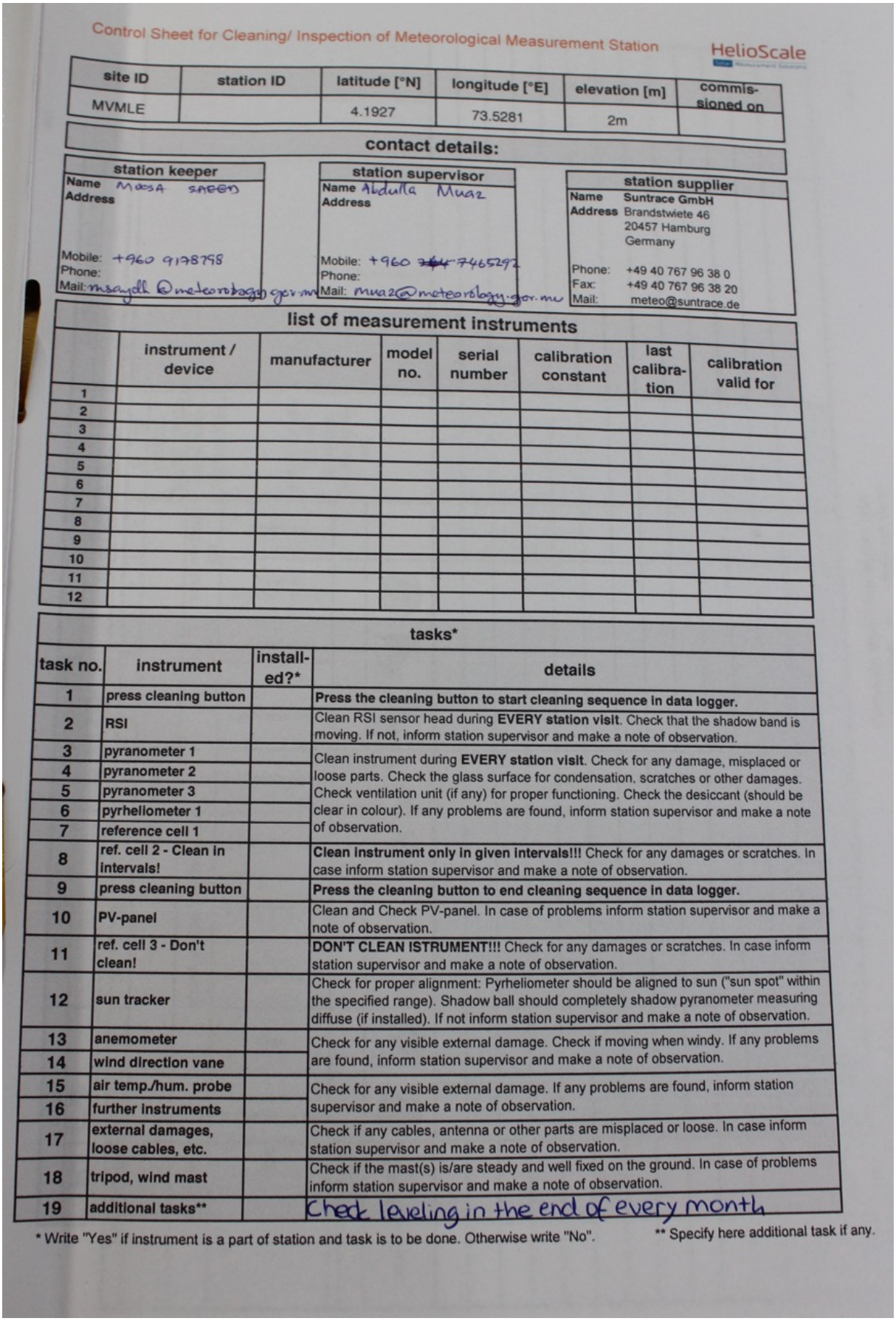
list of measurement instruments

	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	RSP 4G 14-08	Reichert GmbH	RSP4G	14-08	see cal. prot.	2015-10-16	2017-12-06
2	Pyranometer	Hukseflux	SR20-T1	4381	15,05·10⁶	2015-10-16	2017-12-06
3	Anemometer	Thies Clima	First.Adv.	10154378			
4	ThermoHygro	Driesen+Kern	DKRF400	K04496			
5	Data Logger	Wilmers GmbH	blueberry	1125			
6	PV-Panel	Solara	S-series (0W)	888709			
7							
8							
9							
10							
11							
12							

commissioning tests*

test no.	test	details
1	RSI	Ensure that the RSI sensor head is cleaned, horizontally leveled and aligned to the GEOGRAPHIC north for Northern Hemisphere or to the GEOGRAPHIC south for Southern Hemisphere. Check that the shadow band is moving.
2	pyranometer(s)	Check for any damage, condensation, check the glass surface for scratches/other damages, check ventilation motors (if any) are functioning properly. If any condensation and/or scratches on glass is/are found, replace or repair the instrument. Check the desiccant, replace if dehydrated. Write for each sensor type (reference cell/pyranometer) the quantity of installed instruments in comments.
~~3~~	~~pyrheliometer(s)~~	
~~4~~	~~reference cell(s)~~	
5	leveling/positioning of horizontal pyranometer	Check water levels for proper leveling, if instrument (cable) is aligned to GEOGRAPHIC North (Northern Hemisphere) or GEOGRAPHIC South (Southern Hemisphere). Correct if necessary. Check if any parts are misplaced or loose.
~~6~~	~~sun tracker~~	Check if tracker is well fixed at the foundation. Check for proper alignment of suntracker (GEOGRAPHIC North/South) by checking the spot created and/or the leveling of the tracker assembly. Spot should be created within the specified range. Check for proper mechanical functioning of the tracker.
7	air temp.,rel.humidity probe	Check for correct installation, functionality and discernible external damage.
8	anemometer	
~~9~~	~~wind direction vane~~	
~~10~~	~~further sensors, instruments~~	Specify sensor(s)/instrument(s) in comments. Check for correct installation, functionality and discernible damage.
11	weather housing	Check that weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.
12	PV-panel	Check PV-panel.
13	loose parts	Check if any parts are misplaced or loose (sensors, antenna, in case: PV panel, wind mast wires, etc.).
14	cabling of all sensors	Check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernible damages.
15	check power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.
16	sensor connections to data logger	Check if the sensors are properly connected to the data logger (right cables to the corresponding port). Compare with connection plan.
17	data logger sensor/communication	Check the measurement values and correct configuration of the sensors in the data logger (type, unit, slope, offset, etc.). Correct if necessary. Update communication configuration (e.g. e-mail address) if necessary.
18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements, compare them with observations and document them.
20	tripod, wind mast	Check if the mast(s) is/are steady and well fixed on the ground. Check bolts on the foundations of mast(s).
~~21~~	~~fence, door, lock~~	Check the fence and door including its lock.
22	horizon pictures	360° panorama picture from the view point of radiation sensors should be taken.
23	station pictures	Take photos of all sensors and instruments and also of the whole station. The serial numbers should be seen.
24	general view	Anything unusual?
25	station keeper training and documentation	Training of Station Keeper. Check the station documentation such as: analogy of serial numbers, station logbook, etc.

* Ignore if instrument is not a part of station. Write "No part of station. Not installed" in comments in corresponding line.



Control Sheet for Cleaning/ Inspection of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commis-sioned on
MVMLE		4.1927	73.5281	2m	

contact details:

station keeper
Name MOOSA SAEED
Address
Mobile: +960 9178798
Phone:
Mail: msayd@meteorology.gov.mv

station supervisor
Name Abdulla Muaz
Address
Mobile: +960 7465292
Phone:
Mail: mua2@meteorology.gov.mv

station supplier
Name Suntrace GmbH
Address Brandstwiete 46
20457 Hamburg
Germany
Phone: +49 40 767 96 38 0
Fax: +49 40 767 96 38 20
Mail: meteo@suntrace.de

list of measurement instruments

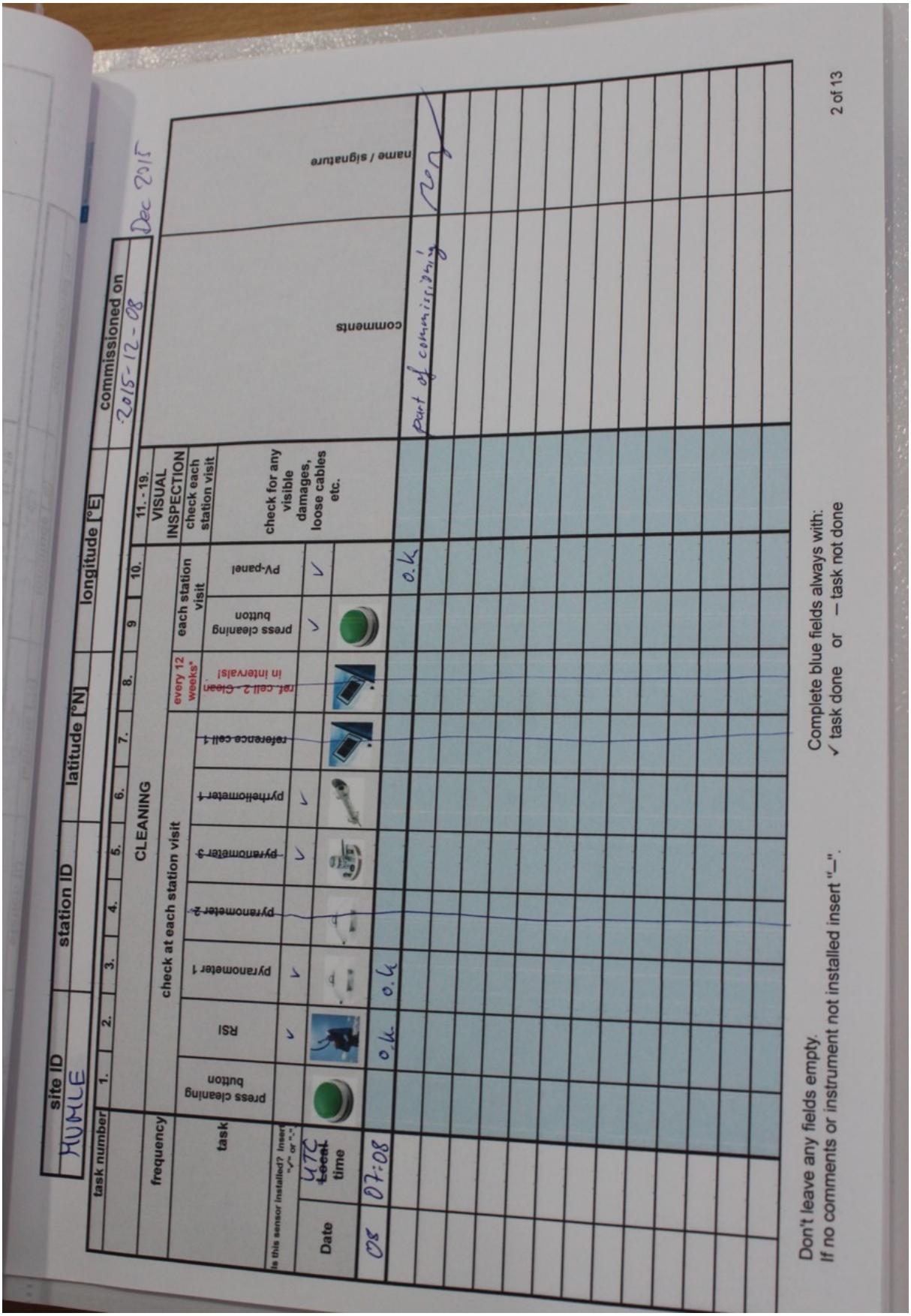
	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibra-tion	calibration valid for
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

tasks*

task no.	instrument	install-ed?*	details
1	press cleaning button		**Press the cleaning button to start cleaning sequence in data logger.**
2	RSI		Clean RSI sensor head during **EVERY station visit**. Check that the shadow band is moving. If not, inform station supervisor and make a note of observation.
3	pyranometer 1		Clean instrument during **EVERY station visit**. Check for any damage, misplaced or loose parts. Check the glass surface for condensation, scratches or other damages. Check ventilation unit (if any) for proper functioning. Check the desiccant (should be clear in colour). If any problems are found, inform station supervisor and make a note of observation.
4	pyranometer 2		
5	pyranometer 3		
6	pyrheliometer 1		
7	reference cell 1		
8	ref. cell 2 - Clean in intervals!		**Clean instrument only in given intervals!!!** Check for any damages or scratches. In case inform station supervisor and make a note of observation.
9	press cleaning button		**Press the cleaning button to end cleaning sequence in data logger.**
10	PV-panel		Clean and Check PV-panel. In case of problems inform station supervisor and make a note of observation.
11	ref. cell 3 - Don't clean!		**DON'T CLEAN ISTRUMENT!!!** Check for any damages or scratches. In case inform station supervisor and make a note of observation.
12	sun tracker		Check for proper alignment: Pyrheliometer should be aligned to sun ("sun spot" within the specified range). Shadow ball should completely shadow pyranometer measuring diffuse (if installed). If not inform station supervisor and make a note of observation.
13	anemometer		Check for any visible external damage. Check if moving when windy. If any problems are found, inform station supervisor and make a note of observation.
14	wind direction vane		
15	air temp./hum. probe		Check for any visible external damage. If any problems are found, inform station supervisor and make a note of observation.
16	further instruments		
17	external damages, loose cables, etc.		Check if any cables, antenna or other parts are misplaced or loose. In case inform station supervisor and make a note of observation.
18	tripod, wind mast		Check if the mast(s) is/are steady and well fixed on the ground. In case of problems inform station supervisor and make a note of observation.
19	additional tasks**		Check leveling in the end of every month

* Write "Yes" if instrument is a part of station and task is to be done. Otherwise write "No".

** Specify here additional task if any.


site ID
station ID
latitude [°N]
longitude [°E]
commissioned on
RUMLE
2015-12-08
Dec 2015
task number
frequency
task
CLEANING
check at each station visit
every 12 weeks*
each station visit
11. - 19.
VISUAL INSPECTION
check each station visit
press cleaning button
RSI
pyranometer 1
pyranometer 2
pyranometer 3
pyrheliometer 1
reference cell 1
ref. cell 2 - Clean in intervals!
press cleaning button
PV-panel
check for any visible damages, loose cables etc.
comments
name / signature
Is this sensor installed? Insert "✓" or "-".
Date
UTC
Local time
08
07:08
O.K.
O.K.
O.K.
part of commissioning
Don't leave any fields empty.
If no comments or instrument not installed insert "–".
Complete blue fields always with:
✓ task done or – task not done
2 of 13