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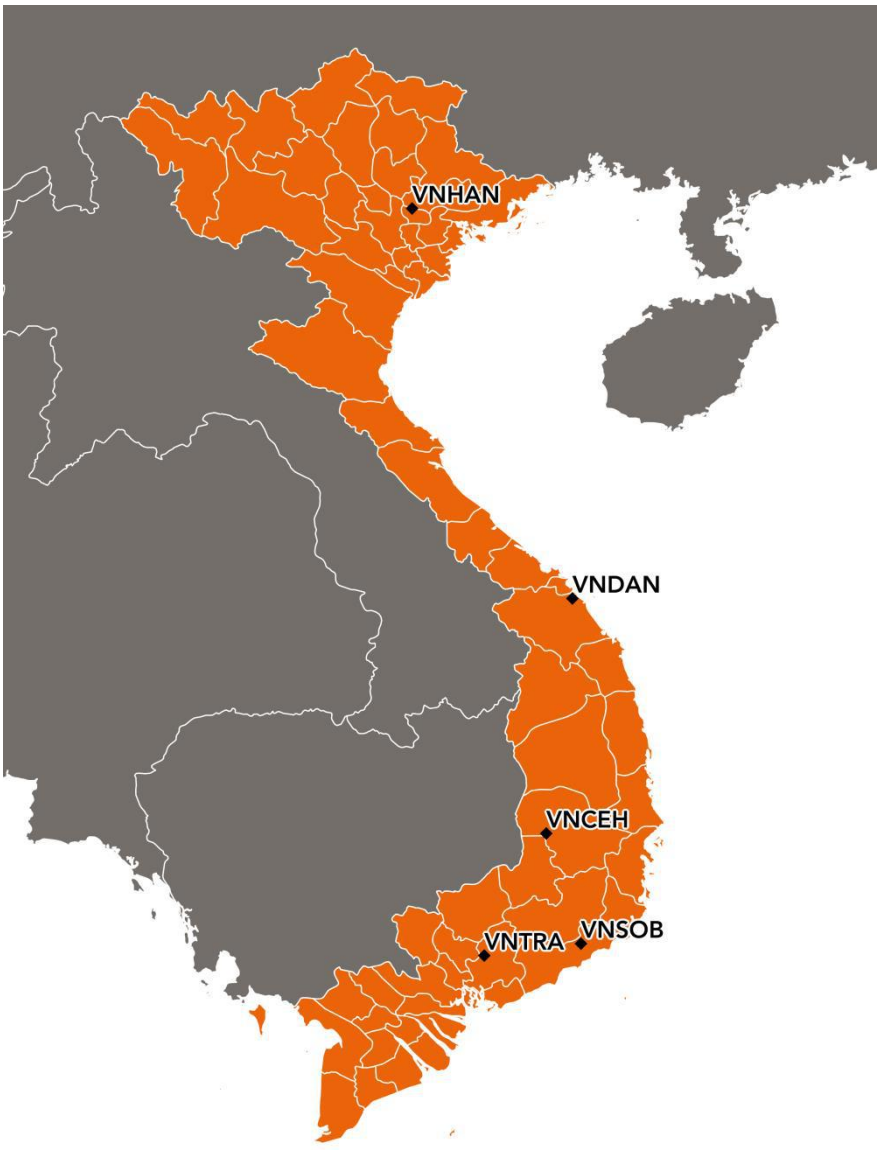
ESMAP
Energy Sector Management Assistance Program

Solar Resource Mapping in Vietnam

SITE INSTALLATION REPORT

SEPTEMBER 2017



This report was prepared by Suntrace, 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 – Vietnam" [Project ID: P145513]. 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.

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SOLAR MEASUREMENT CAMPAIGN IN VIETNAM

SELECTION #: 1231900

Installation Report: Central Highlands (VNCEH)

Suntrace Technical Documentation
21 September 2017

World Bank Group
ESMAP Renewable Energy Mapping Initiative

Authors:
Joana Zerbin, Marko Schwandt

Reviewed by:
Dr. Richard Meyer, Raul Granados

Authors Contact Information:
Suntrace GmbH
Grosse Elbstrasse 145c
22767 Hamburg
Germany
E: meteo@suntrace.de
W: www.suntrace.de

HRB Hamburg: 110819
VAT: DE266610323

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1. INTRODUCTION

The principal task of this installation project was the installation of six meteorological measurement stations at the selected sites including the training of the local staff from EVN (Vietnam Electricity, state-owned utility) on principle maintenance works of the meteorological measurement stations of Type HelioScale ω (Tier 1) and Type HelioScale φ (Tier 2). The selected sites are listed in Table 1, see also Implementation Plan for more details.

The first installation mission took place from 22nd of August to 1st of September 2017. During the first installation mission, the Tier 1 stations were installed at the sites VNCEH (Central Highlands), VNTRA (Tri An) and VNHAN (Bac Ninh near Hanoi). All Tier 2 stations (2x Tier 2 stations for sites VNDAN (Da Nang) and VNSOB (Song Binh) plus 1x Tier 2 spare station) were additionally installed at VNCEH for calibration of the RSP sensors for 2 ½ weeks until the second installation mission started. The second installation mission was undertaken from 12th to 19th of September 2017 and the Tier 2 stations at VNDAN and VNSOB were installed. The spare station will be stored at the Head office of VATEC in Nha Trang. The inauguration with the local government, EVN and World Bank representatives was held on 20th of September in Song Binh (VNSOB).

The International Experts Joana Zerbin and Marko Schwandt from Suntrace GmbH traveled from Germany / Spain to the sites in Vietnam. Vietnam Applied Technical Co. Ltd (VATEC) as local partner company in this project supported Suntrace during the installation.

Overview of Station Sites

Figure 1. Country map showing sites for solar measurement stations considered for the Vietnam ESMAP project.

Site name and description	Type	Site code	Elevation	Latitude	Longitude
Hanoi region: Bac Ninh on rooftop of new EVN bldg.	Tier1	VNHAN	60 m	21.2013°N	106.0629°E
Da Nang on rooftop of EVN/CPC bldg. within the city	Tier2	VNDAN	24 m	16.0125°N	108.1865°E
Central Highlands region on ground before EVN bldg. near hydro spillway	Tier1	VNCEH	290 m	12.7535°N	107.8761°E
Song Binh station location on private house's rooftop	Tier2	VNSOB	62 m	11.2641°N	108.3452°E
Tri An region near HCMC on top of EVN bldg. near water spillway	Tier1	VNTRA	57 m	11.1024°N	107.0378°E

Table 1. Selected sites for solar measurement stations in Vietnam within the WB ESMAP program

This report gives an overview of the on-site installation of the Tier 1 station close to the guardhouse at the water spillway of the Tan Hoa dam, in Dak Lak, Central Highlands region, which took place between 24th and 27th of August 2017. The site code for this site is VNCEH.

Tier 1 stations are equipped with a robust and highly reliable pyrheliometer, a shaded pyranometer (which measures DHI), a non-shaded pyranometer (which measures GHI), and a 2-axis sun tracker with a shadow-ball assembly. Besides, a barometer measures atmospheric pressure and a thermo-hygro sensor measures air temperature and relative humidity. Additionally, a wind mast with a cup anemometer and a wind vane assembly ensures measuring accurate wind speed and direction. Furthermore, a plug-and-play blueberry COMPACT data-logging system controls, stores and transmits the measured data of the stations. For power supply of the Tier 1 stations, a solar panel, batteries and charge controllers are installed. At this site, a soiling measurement system is also installed.

2. LOCATION CENTRAL HIGHLANDS – VNCEH

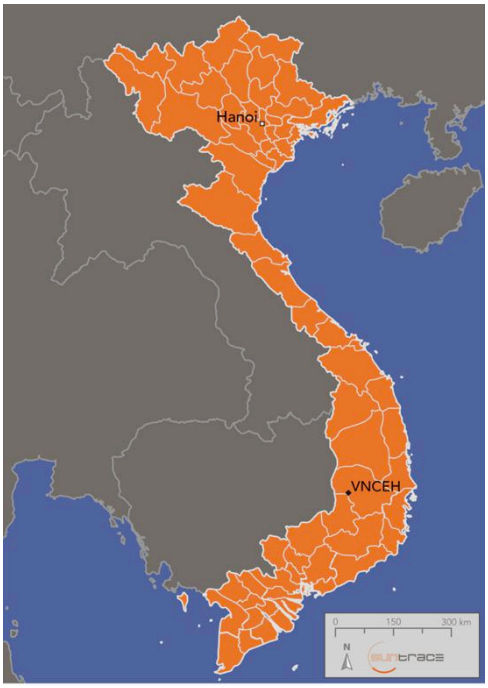


Figure 2. Country map showing the site VNCEH for solar measurements considered for the Vietnam ESMAP project.

Figure 3. Location of VNCEH relative to the extent of the region

3. DESCRIPTION OF STATION

Installation details	
Location	Central Highlands region on ground in front of EVN bldg. near hydro spillway.
Site ID	VNCEH
Station ID	1162
Longitude/Latitude	12.7535°N / 107.8761°E
Elevation	290 m
Date of commence-ment	26th of August 2017

Table 2. Overview of site parameters VNCEH

Solar Measurement Station Tier 1

Recorded meteorological parameters:

- global horizontal irradiance (GHI) in W/m²
- direct normal irradiance (DNI) in W/m²
- diffuse horizontal irradiance (DHI) in W/m²
- ambient temperature in °C
- relative humidity in %
- wind speed in m/s 10 m above ground
- wind direction at 10 m above ground
- barometric pressure in hPa
- soiling measurement via 3 reference cells measuring global tilted (10°) irradiance (GTI) in W/m²

Additional information:

- For Tier 1 stations, a 250 Wp photovoltaic panel, batteries and a charge controller are installed.

List of installed instruments and measurement sensors

No.	Instrument	Manufacturer	Model No.	Serial No.
1	Pyrheliometer	Hukseflux	DR02	9299
2	Pyranometer 1 (DHI)	Hukseflux	SR30-01	2118
3	Pyranometer 2 (GHI)	Hukseflux	SR30-01	2121
4	Reference Cell 1	IKS	ISET Cell	03081
5	Reference Cell 2	IKS	ISET Cell	03085
6	Reference Cell 3	IKS	ISET Cell	03087
7	Data logger Blueberry COMPACT	Wilmers Messtechnik	0141	1162
8	Thermo-hygro sensor	E+E	EE071	1711050002481361
9	Anemometer	Wilmers Messtechnik	0293	1289
10	Wind vane	Wilmers Messtechnik	0218	20003588
11	Sun tracker including shading assembly	EKO	STR-22G	S15136.06

Table 3. List of installed instruments and measurement sensors at VNCEH

Figure 4. Photo of Tier 1 Station of type HelioScale ω installed at VNCEH

4. HORIZON

Figure 5. Horizon at VNCEH

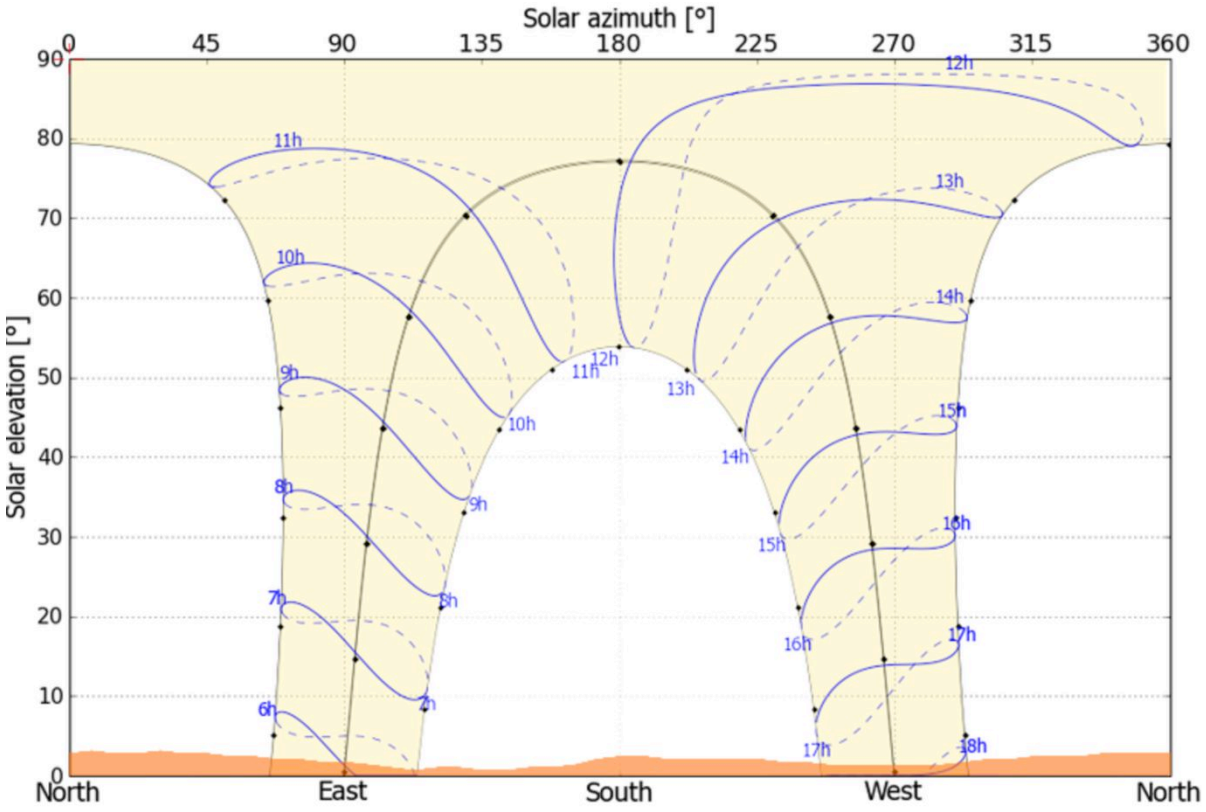


Figure 6. Sun path for VNCEH

5. STATION COMMISSIONING

Responsible staff for monitoring of the stations

Standby Station Keeper

Name: Duc Nguyen
Address: Srepok 3 HPP, Tan Hoa ward, Bum Don district, Dak Lak province, Vietnam
Mobile: +84 966009899
Mail: duc.ngd@gmail.com

Station Supervisor

Name: Tan Tien Nguyen
Address: 60A Cau Be, xa Vinh Thanh, Thanh pho Nha Trang, tinh Khanh Hoa
Mobile: +84 905707760
Mail: tiennt.vatec@gmail.com

Station Supplier

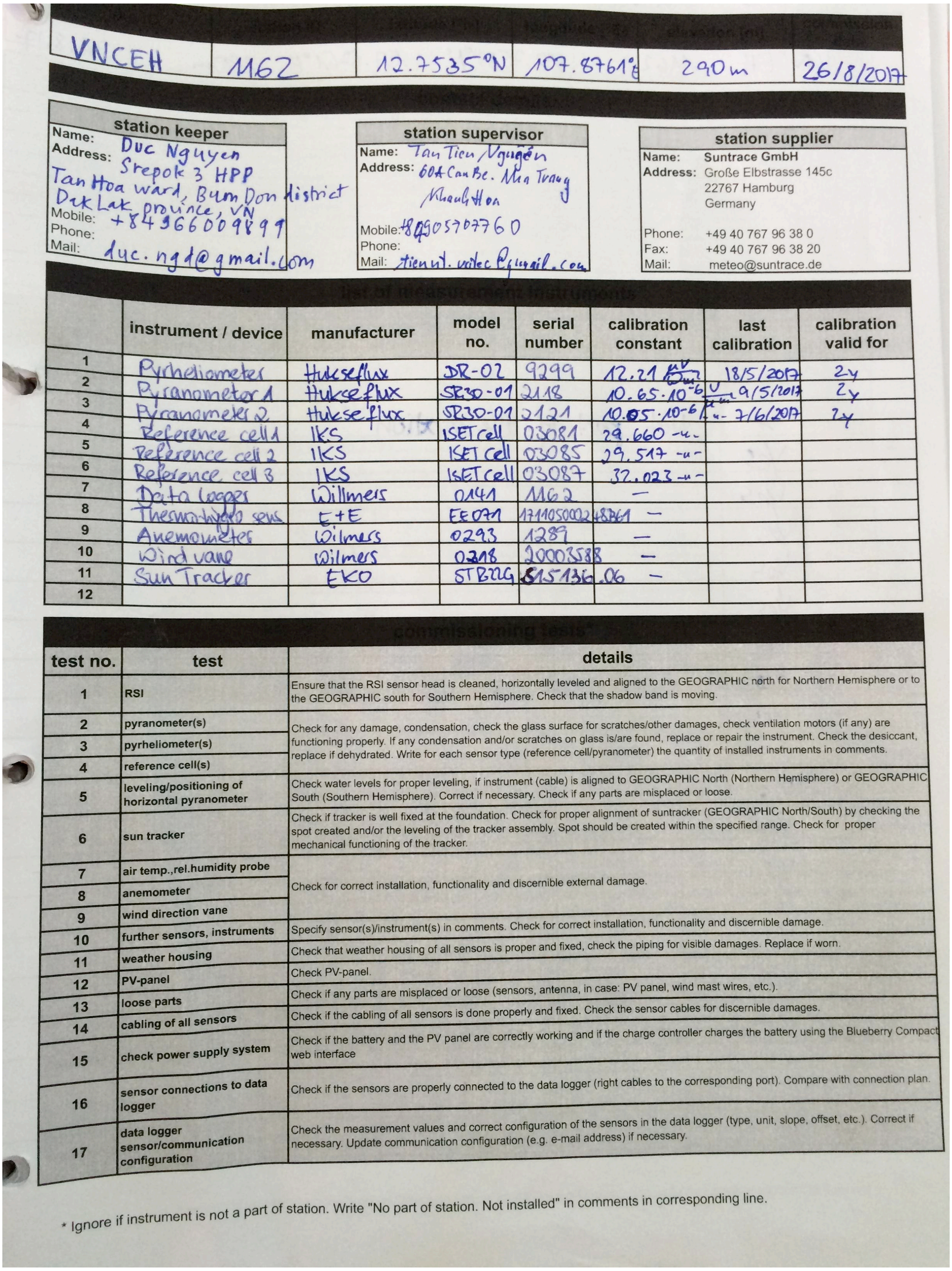
Suntrace GmbH
Address: Grosse Elbstrasse 145c, 22767 Hamburg, Germany
Phone: +4940-76796380
Fax: +4940-767963820
Mail: meteo@suntrace.de

	Applied test	Details	Approved Yes/No	Comments
1	RSI	-	-	No part of station
2	pyranometers	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	pyrheliometer	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	---

	Applied test	Details	Approved Yes/No	Comments
4	reference cells	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	---
5	leve- ve- ling/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.	Yes	---
6	sun tracker	Check if tracker is well fixed at the foundation. Check for proper alignment of sun tracker (GEOGRAPHIC North/South) by checking the spot created and/or the leveling of the tracker assembly. Spot should be created within a specific range. Check for proper mechanical functioning of the tracker.	Yes	---
7	thermohygro	Check for correct installation, functionality and discernible external damage.	Yes	---
8	anemometer	Check for correct installation, functionality and discernible external damage.	Yes	---
9	wind direction vane	Check for correct installation, functionality and discernible external damage.	Yes	---
10	further sensors	-	-	No further sensors
11	weather housing	Weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.	Yes	---
12	PV-panel	Properly fixed to tripod, facing south at northern hemisphere and vice versa, no visible damages (cracks, scratches).	Yes	---
13	loose parts	Check if any parts are misplaced or loose (sensors, antenna, PV panel, wind mas wires, etc.).	Yes	---
14	cabling of all sensors	Check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernable damages.	Yes	---
15	check power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.	Yes	---

	Applied test	Details	Approved Yes/No	Comments
16	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	---
17	data logger configuration	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	Internet provider: Viettel Mobile APN: e-connect
18	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	---
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your observation and document them.	Yes	---
20	tracker table, tripod & wind mast	Check if is steady and well fixed on the ground. Check bolts on the foundations.	Yes	---
21	fence, door, lock	Check the fence and door including its lock.	Yes	---
22	horizon pictures	360° panorama picture from the view point of radiation sensors should be taken.	Yes	---
23	station pictures	Take photos of all sensors and instruments and also of the whole station. The serial numbers should be seen.	Yes	---
24	general view	Anything unusual? If NO write "Yes" for approved	Yes	---
25	station keeper training and documentation	Training of Station Keeper. Check the station documentation such as: analogy of serial numbers, station logbook, etc.	Yes	---

Table 4. List of applied tests for commissioning of VNCEH



VNCEH	1162	12.7535°N	107.8761°E	290 m	26/8/2017

station keeper
Name: Duc Nguyen
Address: Srepok 3 HPP
Tan Hoa ward, Buon Don district
Dak Lak province, VN
Mobile: +84 366009899
Phone:
Mail: duc.ngd@gmail.com

station supervisor
Name: Tan Tieu Nguyễn
Address: 60A Cau Be. Nha Trang
Khanh Hoa
Mobile: +84 905707760
Phone:
Mail: tiennt.vntec@gmail.com

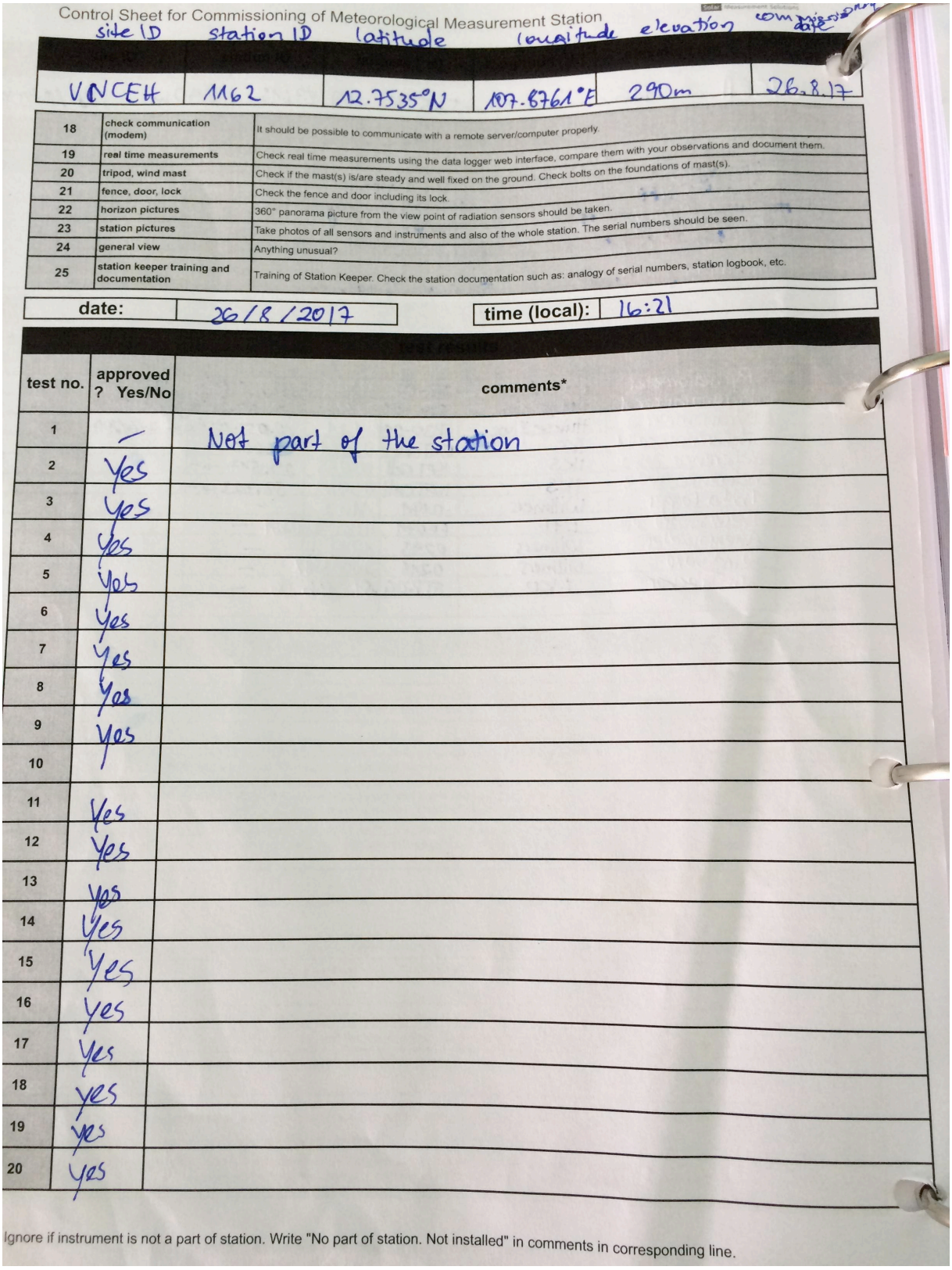
station supplier
Name: Suntrace GmbH
Address: Große Elbstrasse 145c
22767 Hamburg
Germany
Phone: +49 40 767 96 38 0
Fax: +49 40 767 96 38 20
Mail: meteo@suntrace.de

	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	Pyrheliometer	Hukseflux	DR-02	9299	12.21 µV/(W/m²)	18/5/2017	2y
2	Pyranometer 1	Hukseflux	SR30-01	2118	10.65·10⁻⁶ V/(W/m²)	9/5/2017	2y
3	Pyranometer 2	Hukseflux	SR30-01	2121	10.05·10⁻⁶ -"-	7/6/2017	2y
4	Reference cell 1	IKS	ISET cell	03081	29.660 -"-		
5	Reference cell 2	IKS	ISET cell	03085	29.517 -"-		
6	Reference cell 3	IKS	ISET cell	03087	32.023 -"-		
7	Data logger	Willmers	0141	1162	–		
8	Thermo-hygro sens.	E+E	EE071	171105000248B61	–		
9	Anemometer	Wilmers	0293	1289	–		
10	Wind vane	Wilmers	0318	20003588	–		
11	Sun Tracker	EKO	STR22G	S15136.06	–		
12							

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 using the Blueberry Compact web interface
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 configuration	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.

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

Figure 7. Commissioning Protocol page 1/3 VNCEH.



Control Sheet for Commissioning of Meteorological Measurement Station

site ID	station ID	latitude	longitude	elevation	commissioning date
VNCEH	1162	12.7535°N	107.6761°E	290m	26.8.17

18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your 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.

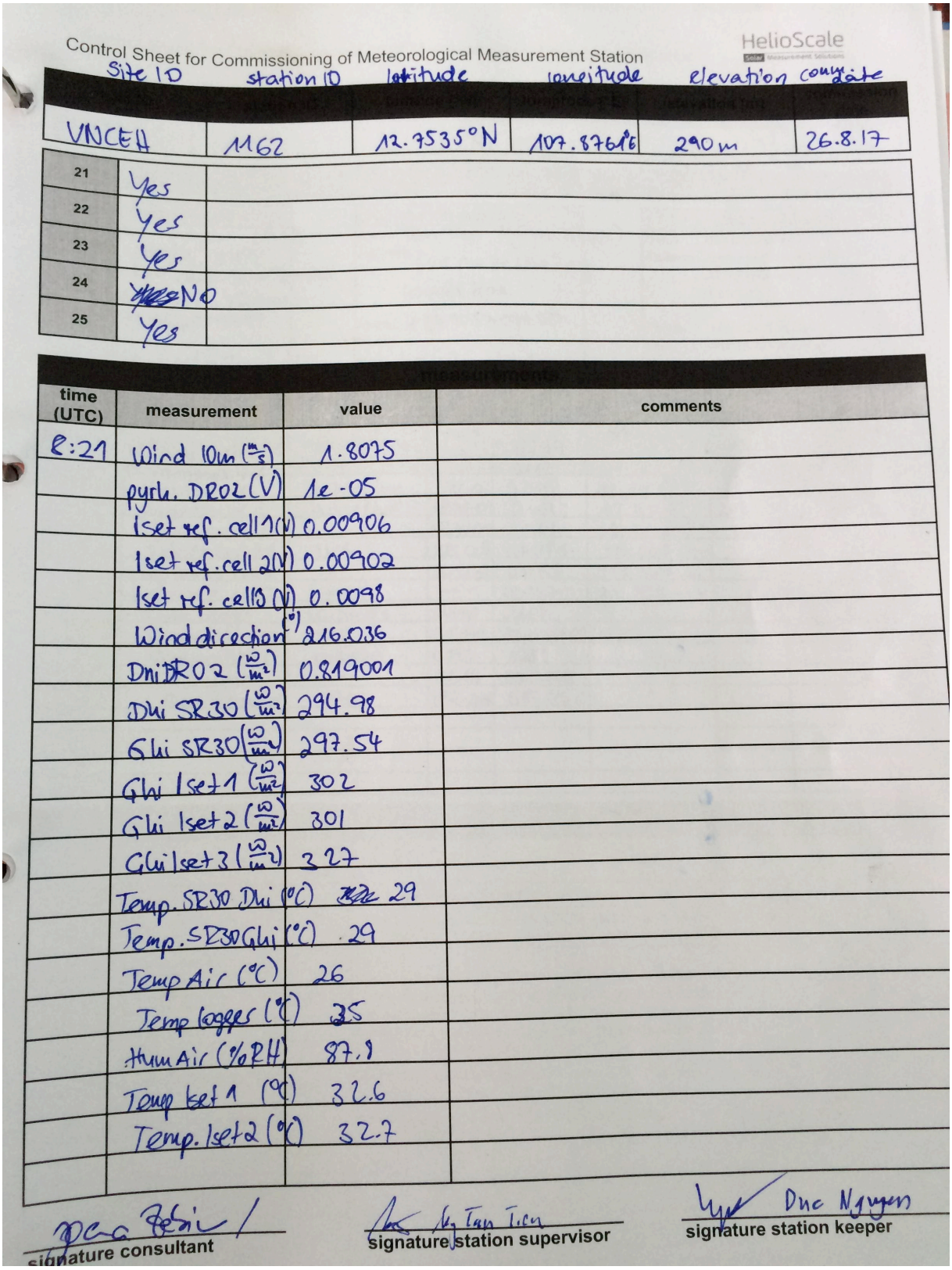
date: 26/8/2017 time (local): 16:21

test results

test no.	approved ? Yes/No	comments*
1	–	Not part of the station
2	Yes	
3	Yes	
4	Yes	
5	Yes	
6	Yes	
7	Yes	
8	Yes	
9	Yes	
10		
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	yes	
19	yes	
20	yes	

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

Figure 8. Commissioning Protocol page 2/3 VNCEH.



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

Site ID	station ID	latitude	longitude	elevation	commissioning date
VNCEH	1162	12.7535°N	107.8761°	290 m	26.8.17

21	Yes
22	Yes
23	Yes
24	~~Yes~~ NO
25	Yes

measurements

time (UTC)	measurement	value	comments
8:21	Wind 10m ($\frac{m}{s}$)	1.8075	
	pyrh. DR02 (V)	1e-05	
	Iset ref. cell 1 (V)	0.00906	
	Iset ref. cell 2 (V)	0.00902	
	Iset ref. cell 3 (V)	0.0098	
	Wind direction (°)	216.036	
	Dni DR02 ($\frac{W}{m^2}$)	0.819001	
	Dhi SR30 ($\frac{W}{m^2}$)	294.98	
	Ghi SR30 ($\frac{W}{m^2}$)	297.54	
	Ghi Iset 1 ($\frac{W}{m^2}$)	302	
	Ghi Iset 2 ($\frac{W}{m^2}$)	301	
	Ghi Iset 3 ($\frac{W}{m^2}$)	327	
	Temp. SR30 Dhi (°C)	~~32~~ 29	
	Temp. SR30 Ghi (°C)	29	
	Temp Air (°C)	26	
	Temp loggers (°C)	35	
	Hum Air (%RH)	87.9	
	Temp Iset 1 (°C)	32.6	
	Temp. Iset 2 (°C)	32.7	

signature consultant

signature station supervisor

Duc Nguyen

signature station keeper

Figure 9. Commissioning Protocol page 3/3 VNCEH.

6. SUMMARY OF COMPLETED TASK

- The installed station and spare parts have been tested prior to delivery for the project.
- The World Bank ESMAP Tier 1 solar measurement station at the location VNCEH is installed and commissioned successfully at the 26th of August 2017.
- For cross-calibration of the RSP-instruments of the 3x Tier 2 stations including the spare station were set up provisionally and pre-commissioned at the VNCEH site. The pre-commissioning protocols are attached as Annex to this report.
- 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. A daily automatic quality control procedure is applied to the unprocessed raw data, this additionally to the by contract committed monthly delivery of post processed data including a monthly summary report.
- FTP servers will be set up for data sharing with EVN companies at all sites of this measurement campaign.

7. PHOTO DOCUMENTATION

Figure 10. Sun tracker with shadow ball assembly and PV panel in the front at VNCEH. Soiling measurement on the right.

Figure 11. Sun tracker with shadow ball assembly, and Pyranometer 1 in the front closer to the shadow ball measuring DHI and Pyranometer 2 in the back

Figure 12. Calibration station (left), sun tracker with PV panel (middle), soiling measurement (right), wind mast (back)

Figure 13. Tier 1 station at VNCEH

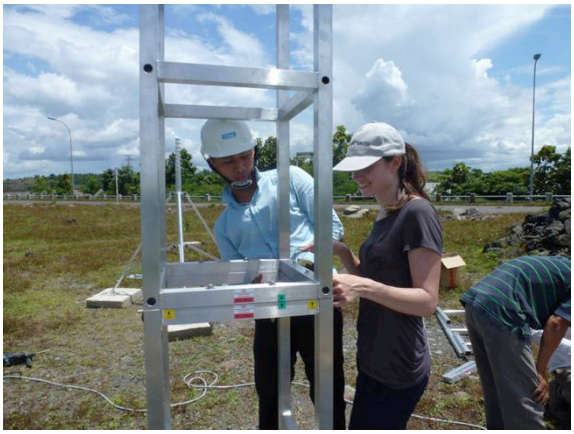


Figure 14. Mounting sun tracker table

Figure 15. Complete Tier 1 station with Tier 2 calibration station at VNCEH

Figure 16. Complete Tier 1 station with calibration station at VNCEH

Figure 17. Calibration station at VNCEH

Figure 18. Commissioning and station keeper training at VNCEH

Figure 19. Calibration station with rotating shadow bands

Figure 20. Commissioning and station keeper training at VNCEH

Figure 21. After commissioning with EVN staff at VNCEH

Figure 22. Special training on solar resources and HelioScale Stations for EVN staff at VNCEH

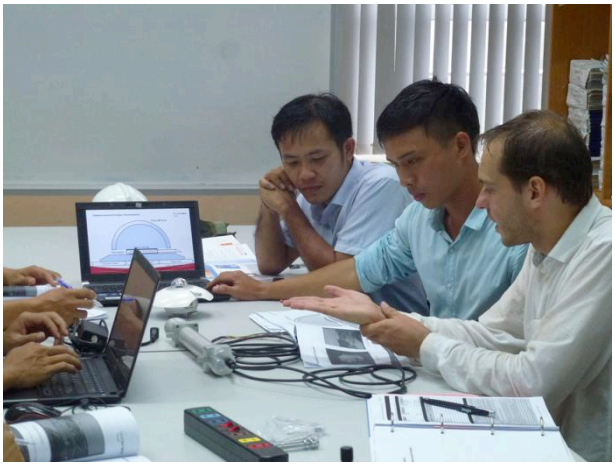


Figure 23. Special training on solar resources and HelioScale Stations for EVN staff at VNCEH

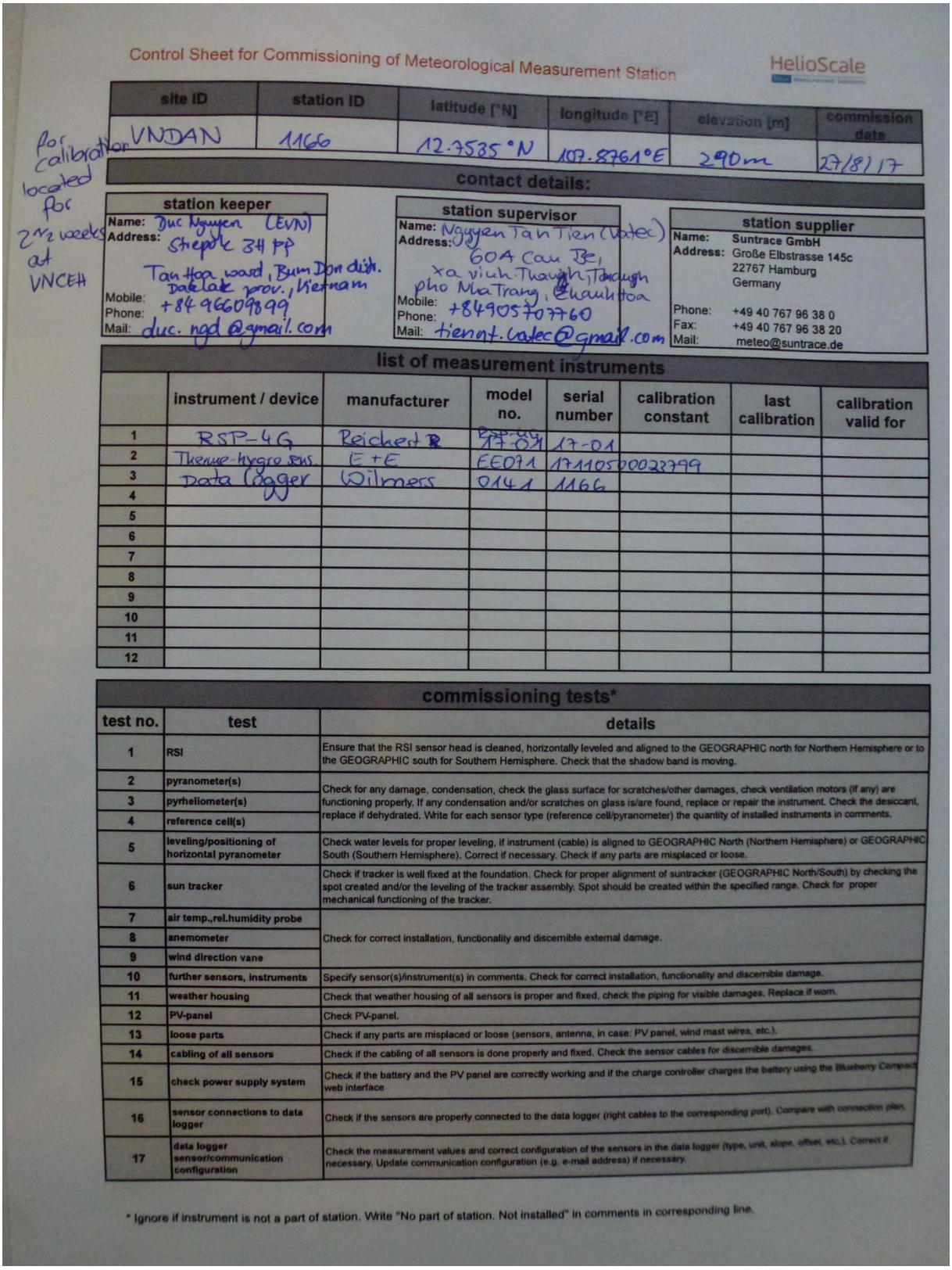
Figure 24. Station with fence at VNCEH

Figure 25. Figure 26. Station with fence at VNCEH

Figure 27. Tier 1 station with calibration station in VNCEH

Figure 28. Tier 1 station at VNCEH

8. ANNEX: COMMISSIONING PROTOCOLS OF TIER 2 STATIONS



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission date
VNDAN	1166	12.7535 °N	107.8761°E	290m	27/8/17

for calibration located for 2½ weeks at VNCEH

contact details:

station keeper	station supervisor	station supplier
Name: Duc Nguyen (EVN)	Name: Nguyen Tan Tien (Vatec)	Name: Suntrace GmbH
Address: Strepok 34 pp Tan Hoa ward, Buon Don distr. Daklak prov., Vietnam	Address: 604 Cau Bo, xa Vinh Thanh, Thanh pho Nha Trang, Khanh Hoa	Address: Große Elbstrasse 145c 22767 Hamburg Germany
Mobile: +84 966098 99	Mobile: +84905707760	Phone: +49 40 767 96 38 0
Phone:	Phone:	Fax: +49 40 767 96 38 20
Mail: duc.ngd@gmail.com	Mail: tiennt.vatec@gmail.com	Mail: meteo@suntrace.de

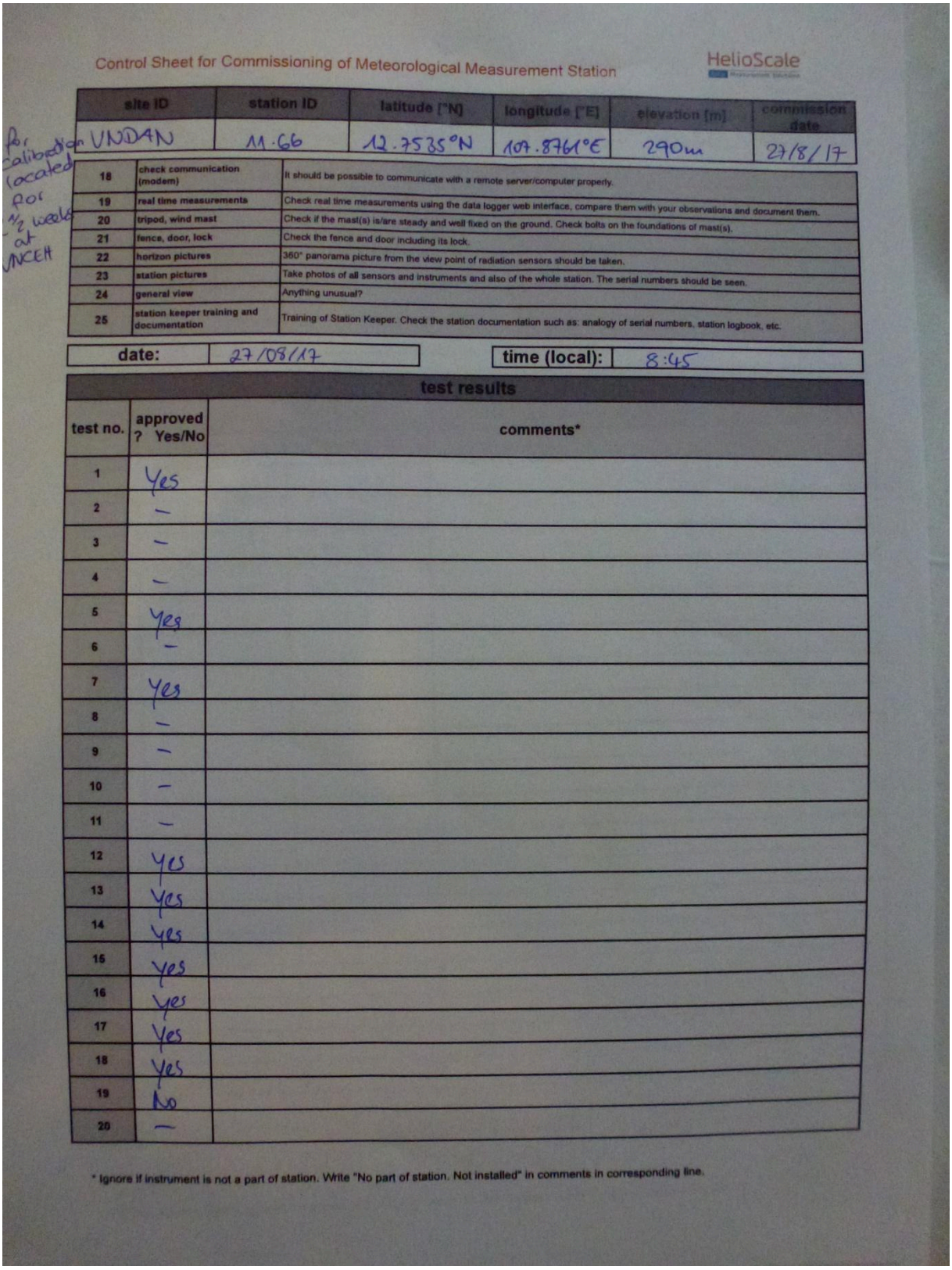
list of measurement instruments

	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	RSP-4G	Reichert	RSP-4G	17-01			
2	Thermo-hygro sens.	E+E	EE071	17110500023799			
3	Data Logger	Wilmers	0141	1166			
4							
5							
6							
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 using the Blueberry Compact web interface
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 configuration	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.

* 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 date
VNDAN	11.66	12.7535°N	107.8761°E	290m	27/8/17

for calibration located for ½ week at VNCEH

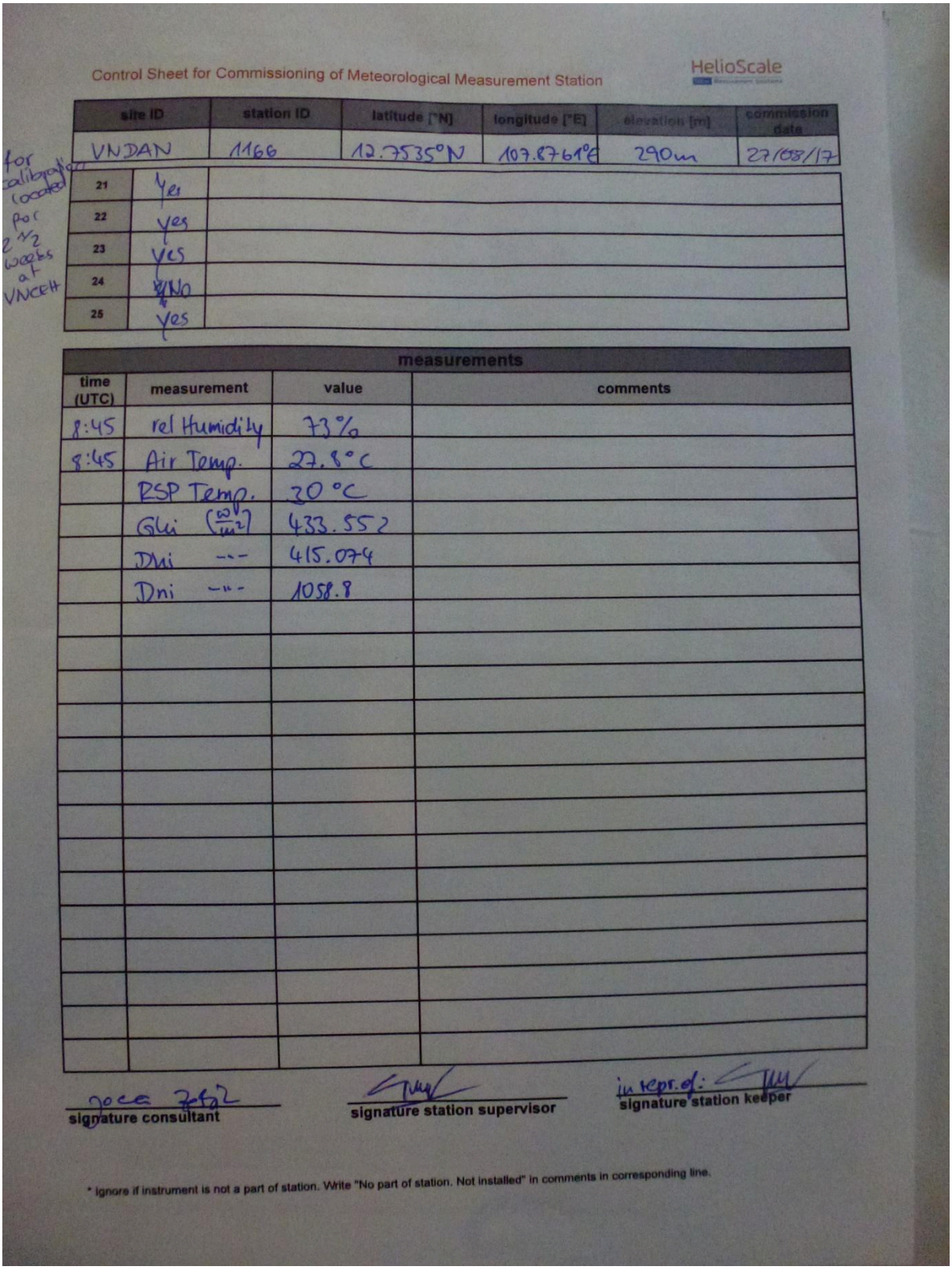
18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your observations and document them.
20	tripod, wind mast	Check if the mast(s) is/are 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.

date:	27/08/17	time (local):	8:45

test results

test no.	approved ? Yes/No	comments*
1	Yes	
2	–	
3	–	
4	–	
5	Yes	
6	–	
7	Yes	
8	–	
9	–	
10	–	
11	–	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	Yes	
19	No	
20	–	

* 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 date
VNDAN	1166	12.7535°N	107.8761°E	290m	27/08/17

for calibration located for 2 1/2 weeks at VNCEH

21	Yes
22	yes
23	Yes
24	~~No~~ Yes
25	yes

measurements

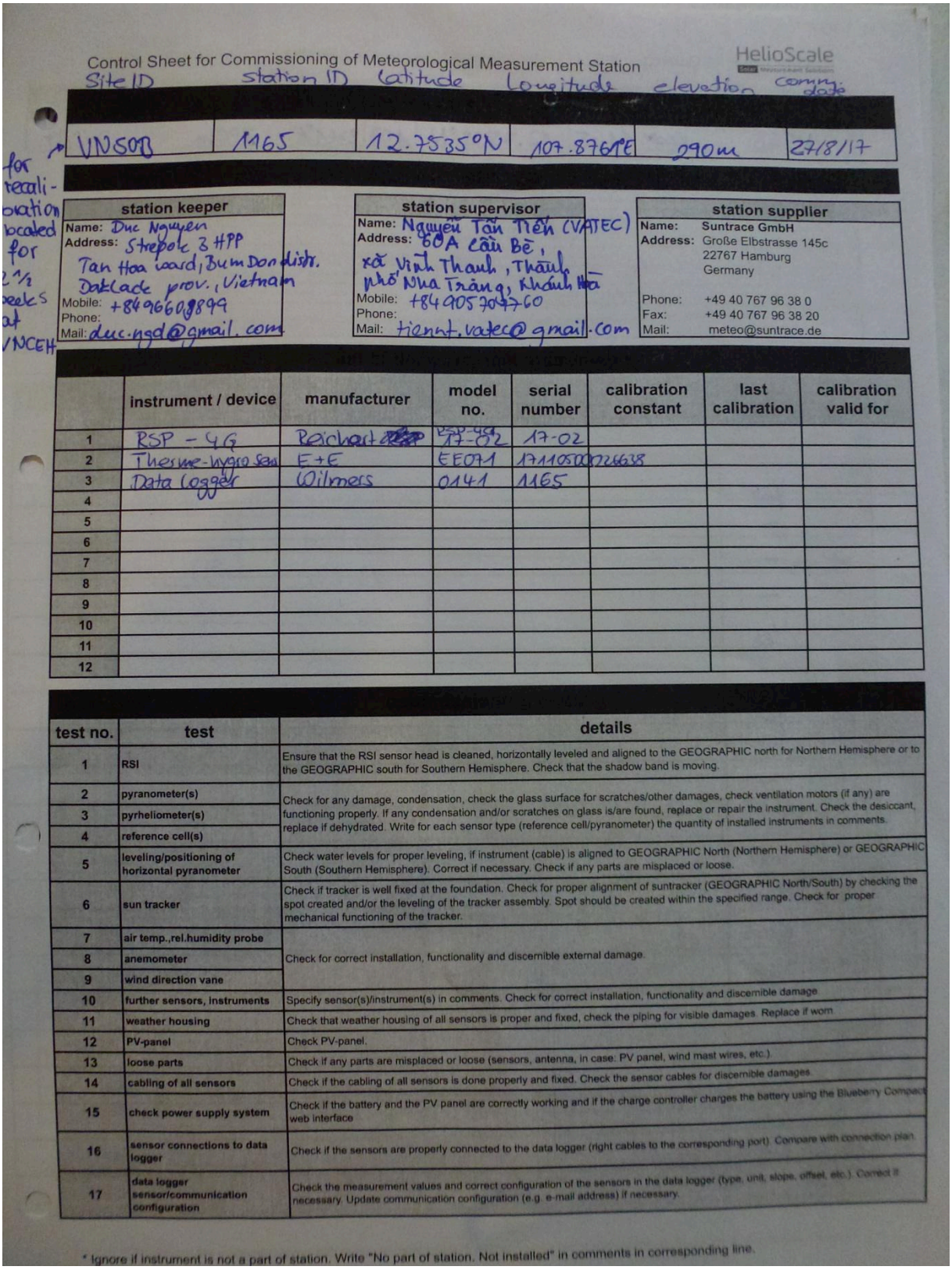
time (UTC)	measurement	value	comments
8:45	rel Humidity	73%	
8:45	Air Temp.	27.8°C	
	RSP Temp.	30°C	
	Ghi (W/m^2)	433.552	
	Dhi ---	415.074	
	Dni ---	1058.8	

joca Tata
signature consultant

signature station supervisor

in repr. of:
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	Longitude	elevation	comm. date
VN508	1165	12.7535°N	107.8761°E	290m	27/8/17

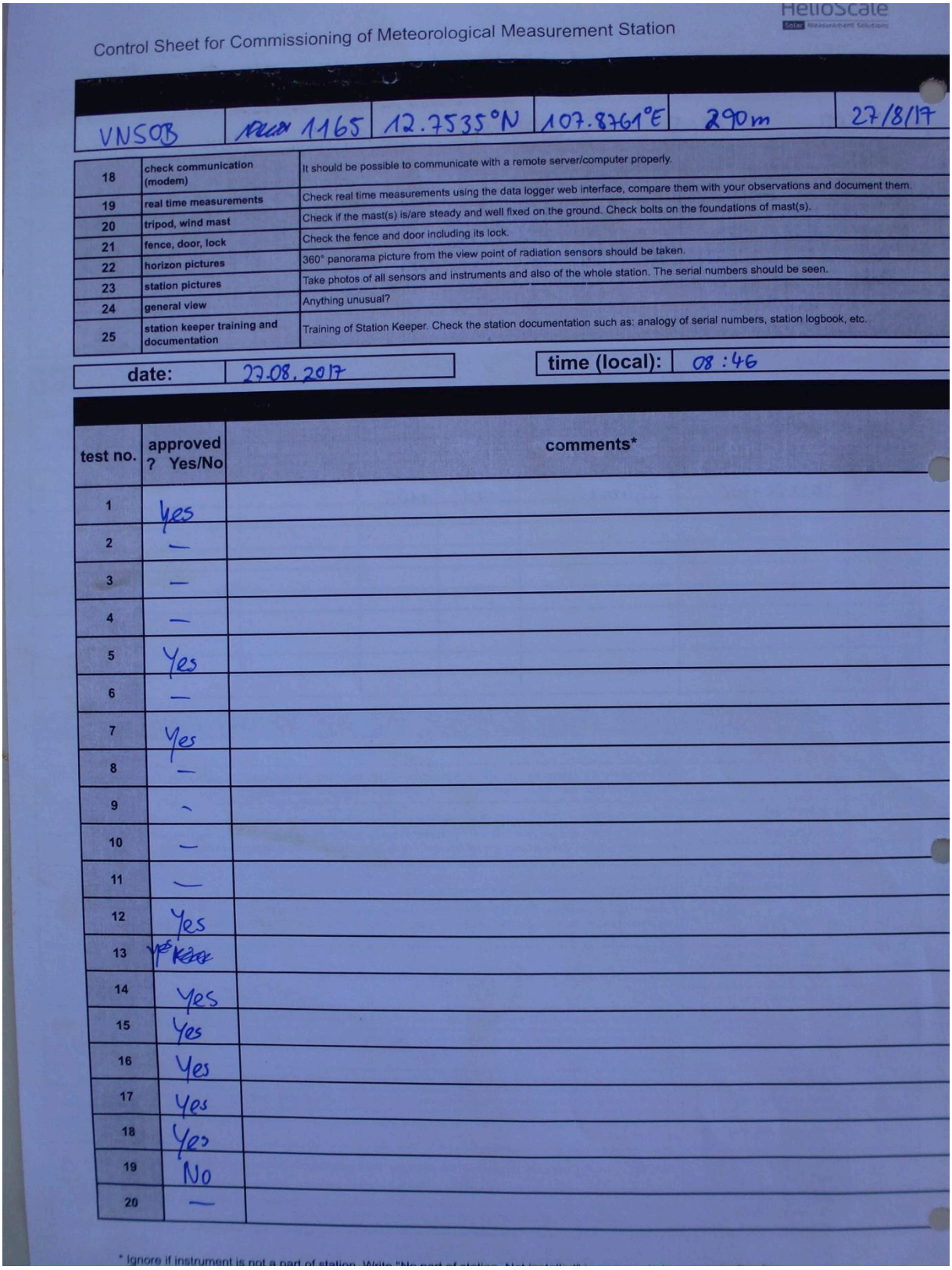
for recalibration located for 2½ weeks at VNCEH

station keeper	station supervisor	station supplier
Name: Duc Nguyen	Name: Nguyễn Tấn Tiến (VATEC)	Name: Suntrace GmbH
Address: Strepok 3 HPP Tan Hoa ward, Buon Don distr. Daklack prov., Vietnam	Address: 60A Cầu Bê, xã Vĩnh Thanh, Thành phố Nha Trang, Khánh Hòa	Address: Große Elbstrasse 145c 22767 Hamburg Germany
Mobile: +84966008899	Mobile: +84905704760	Phone: +49 40 767 96 38 0
Phone:	Phone:	Fax: +49 40 767 96 38 20
Mail: duc.ngd@gmail.com	Mail: tiennt.vatec@gmail.com	Mail: meteo@suntrace.de

	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	RSP - 4G	Reichart	RSP-4G 17-02	17-02			
2	Thermo-hygro sen	E+E	EE071	17110500026638			
3	Data Logger	Wilmers	0141	1165			
4							
5							
6							
7							
8							
9							
10							
11							
12							

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 using the Blueberry Compact web interface
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 configuration	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.

* 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 Solar Measurement Solutions

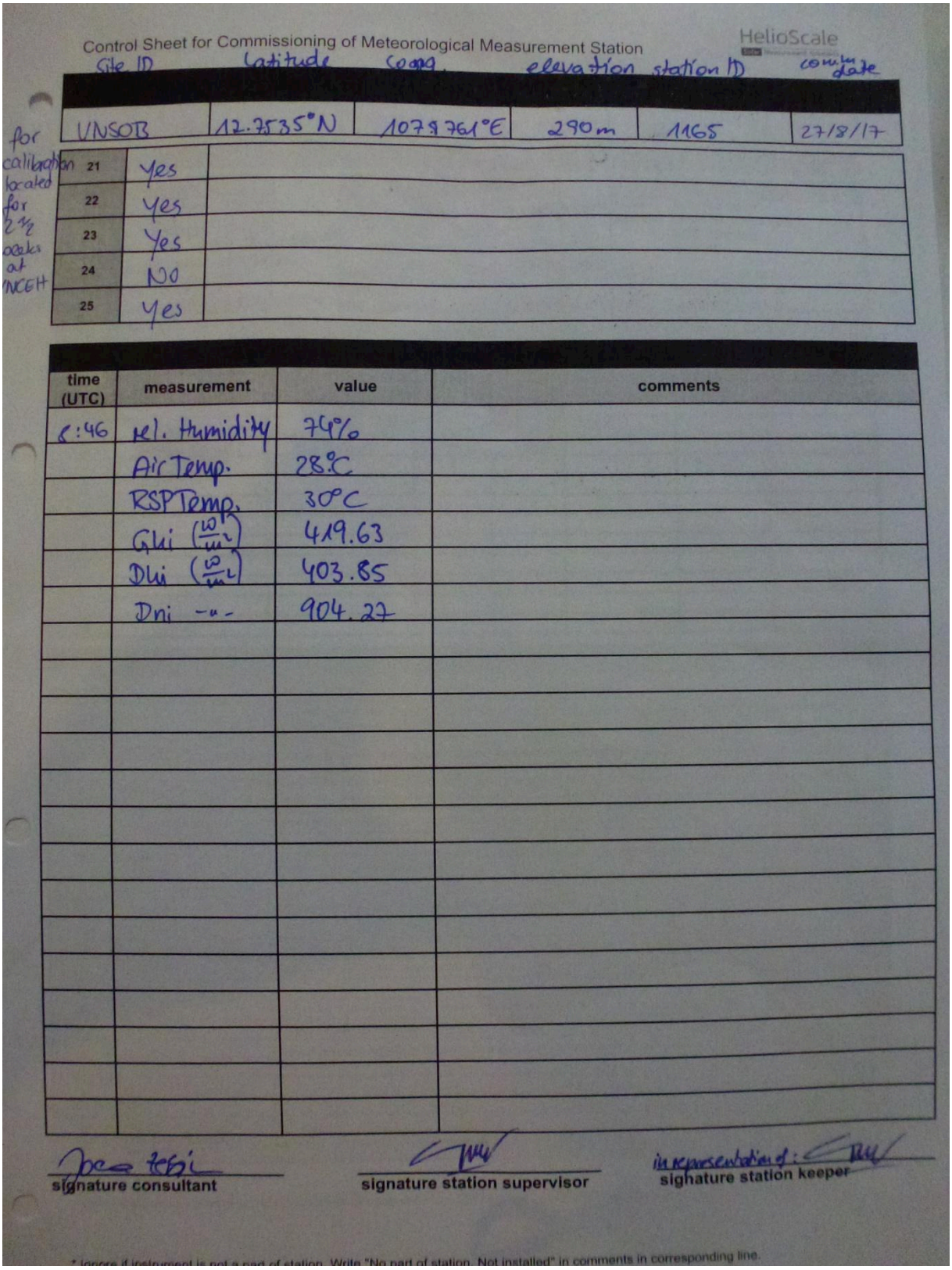
VNSOB	1165	12.7535°N	107.8761°E	290m	27/8/17

18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your 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.

date:	27.08.2017	time (local):	08:46

test no.	approved ? Yes/No	comments*
1	Yes	
2	—	
3	—	
4	—	
5	Yes	
6	—	
7	Yes	
8	—	
9	-	
10	—	
11	—	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	Yes	
19	No	
20	—	

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



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

Site ID	Latitude	Long.	elevation	station ID	comm. date
VNSOB	12.7535°N	107.9761°E	290m	1165	27/8/17

for calibration located for 2½ weeks at VNCEH

21	Yes
22	Yes
23	Yes
24	NO
25	Yes

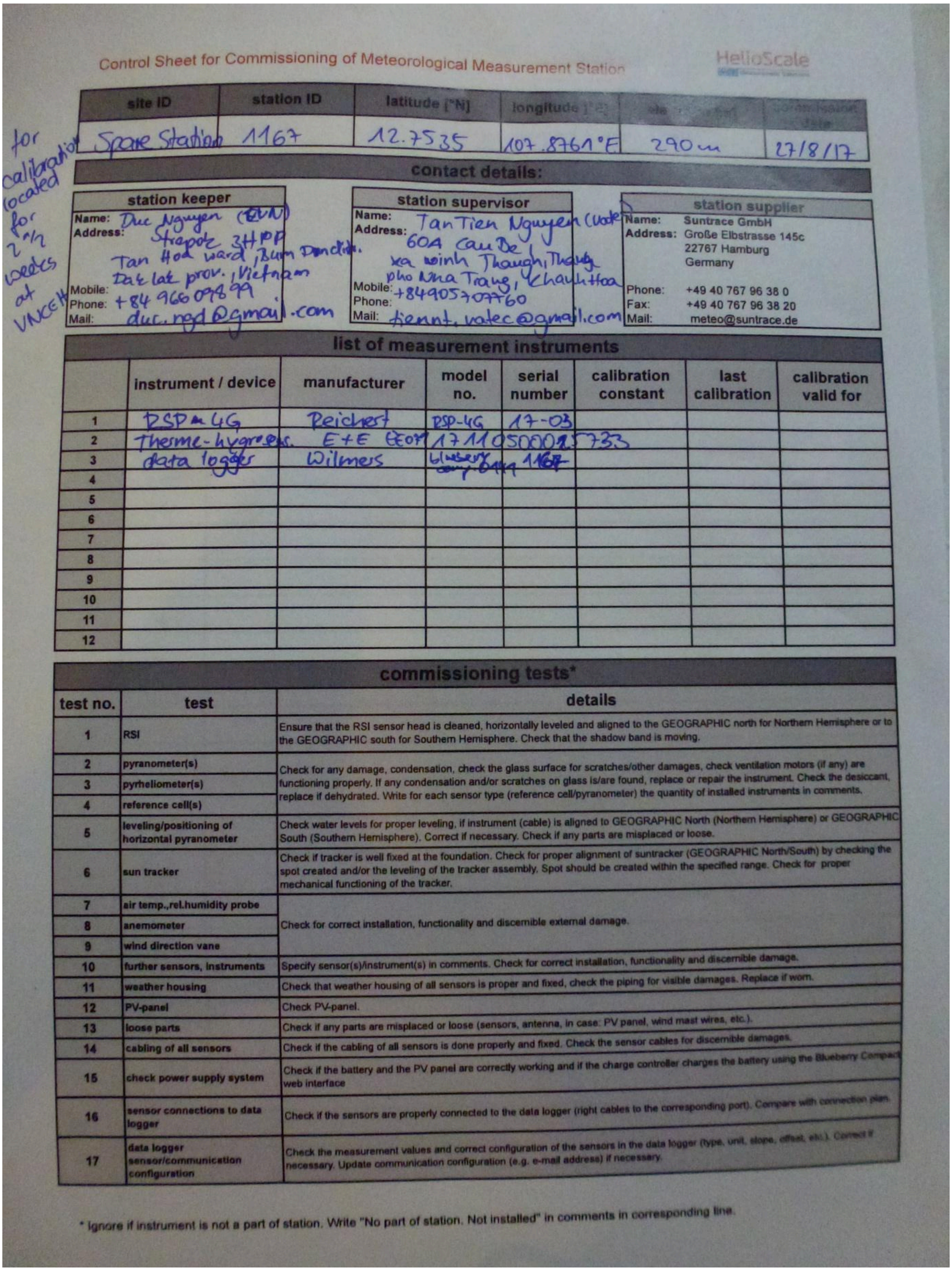
time (UTC)	measurement	value	comments
8:46	rel. Humidity	74%	
	Air Temp.	28°C	
	RSP Temp.	30°C	
	Ghi ($\frac{W}{m^2}$)	419.63	
	Dhi ($\frac{W}{m^2}$)	403.85	
	Dni -"-	904.27	

signature consultant

signature station supervisor

in representation of:
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]	site elevation	commissioning date
Spare Station	1167	12.7535	107.8761°E	290 m	27/8/17

for calibration located for 2 1/2 weeks at VNCEH

contact details:

station keeper
Name: Duc Nguyen (EVN)
Address: Sre pok 3HPP Tan Hoa ward, Buon Don dist. Dak Lak prov., Vietnam
Mobile:
Phone: +84 966 098 99
Mail: duc.npd@gmail.com

station supervisor
Name: Tan Tien Nguyen (Vatec)
Address: 60A Cau De xa Vinh Thanh, Thang pho Nha Trang, Khanh Hoa
Mobile: +84905707760
Phone:
Mail: tiennt.vatec@gmail.com

station supplier
Name: Suntrace GmbH
Address: Große Elbstrasse 145c 22767 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	Reichert	RSP-4G	17-03			
2	Thermo-hygrosens.	E+E	EE07	17110500025733			
3	data logger	Wilmers	blueberry comp. 6414	1167			
4							
5							
6							
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.
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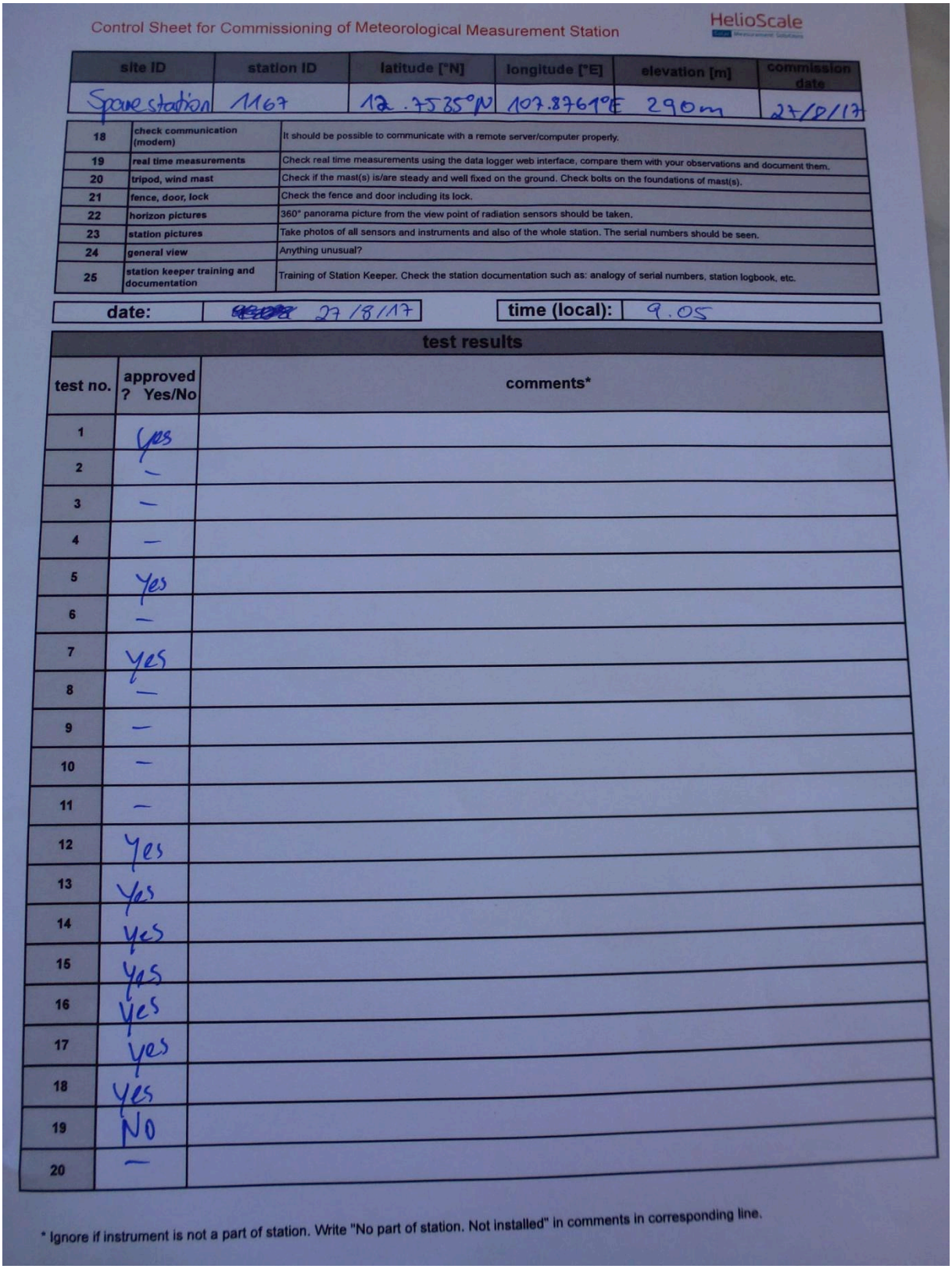
16	sensor connections to data logger	Check if the sensors are properly connected to the data logger (right cables to the corresponding port). Compare with connection plan.
17	data logger sensor/communication configuration	Check the measurement values and correct configuration of the sensors in the data logger (type, unit, slope, offset, etc.). Correct if necessary. Update communication configuration (e.g. e-mail address) if necessary.

* 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 date
Spare station	1167	12.7535°N	107.8761°E	290m	27/8/17

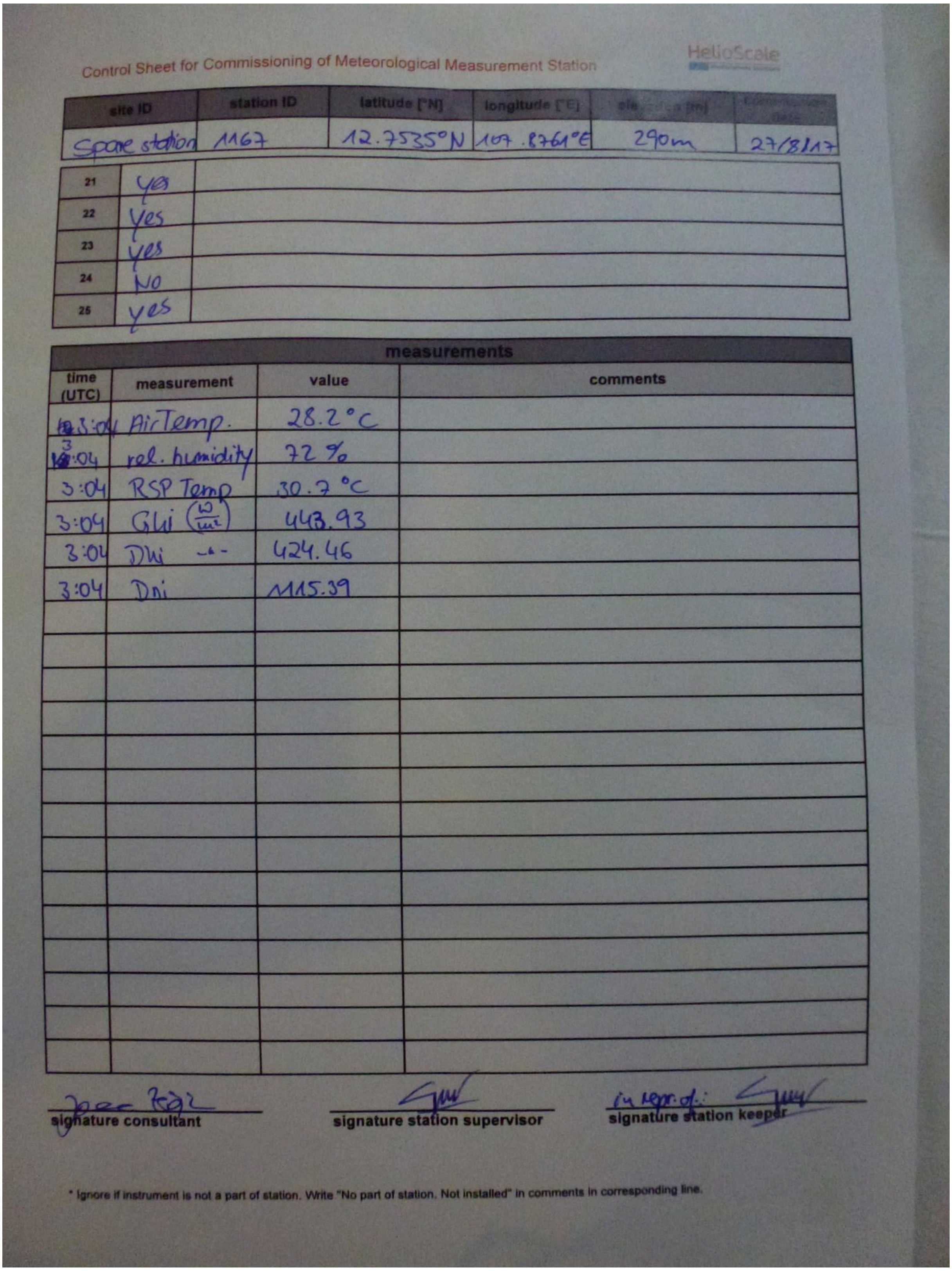
18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your observations and document them.
20	tripod, wind mast	Check if the mast(s) is/are 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.

date:	27/8/17	time (local):	9.05

test results

test no.	approved ? Yes/No	comments*
1	Yes	
2	–	
3	–	
4	–	
5	Yes	
6	–	
7	Yes	
8	–	
9	–	
10	–	
11	–	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	Yes	
19	No	
20	–	

* 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]	commissioning date
Spare station	1167	12.7535°N	107.8761°E	290m	27/8/17

21	yes	
22	yes	
23	yes	
24	No	
25	yes	

measurements

time (UTC)	measurement	value	comments
3:04	AirTemp.	28.2°C	
3:04	rel. humidity	72 %	
3:04	RSP Temp	30.7 °C	
3:04	Ghi (W/m²)	443.93	
3:04	Dhi -"-	424.46	
3:04	Dni	115.39	

signature consultant | signature station supervisor | i.A. signature station keeper

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

SOLAR MEASUREMENT CAMPAIGN IN VIETNAM

SELECTION #: 1231900

Installation Report: Da Nang (VNDAN)

Suntrace Technical Documentation
21 September 2017

World Bank Group
ESMAP Renewable Energy Mapping Initiative

Authors:
Joana Zerbin, Marko Schwandt

Reviewed by:
Dr. Richard Meyer, Raul Granados

Authors Contact Information:
Suntrace GmbH
Grosse Elbstrasse 145c
22767 Hamburg
Germany
E: meteo@suntrace.de
W: www.suntrace.de

HRB Hamburg: 110819
VAT: DE266610323

Table of content

1. INTRODUCTION

The principal task of this installation project was the installation of six meteorological measurement stations at the selected sites including the training of the local staff from EVN (Vietnam Electricity, state-owned utility) on principle maintenance works of the meteorological measurement stations of Type HelioScale ω (Tier 1) and Type HelioScale φ (Tier 2). The selected sites are listed in Table 1, see also Implementation Plan for more details.

The first installation mission took place from 22nd of August to 1st of September 2017. During the first installation mission, the Tier 1 stations were installed at the sites VNCEH (Central Highlands), VNTRA (Tri An) and VNHAN (Bac Ninh near Hanoi). All Tier 2 stations (2x Tier 2 stations for sites VNDAN (Da Nang) and VNSOB (Song Binh) plus 1x Tier 2 spare station) were additionally installed at VNCEH for calibration of the RSP sensors for 2 ½ weeks until the second installation mission started. The second installation mission was undertaken from 12th to 19th of September 2017 and the Tier 2 stations at VNDAN and VNSOB were installed. The spare station will be stored at the Head office of VATEC in Nha Trang. The inauguration with the local government, EVN and World Bank representatives was held on 20th of September in Song Binh (VNSOB).

The International Experts Joana Zerbin and Marko Schwandt from Suntrace GmbH traveled from Germany / Spain to the sites in Vietnam. Vietnam Applied Technical Co. Ltd (VATEC) as local partner company in this project supported Suntrace during the installation.

Overview of Station Sites

Figure 1. Country map showing sites for solar measurement stations considered for the Vietnam ESMAP project.

Site name and description	Type	Site code	Elevation	Latitude	Longitude
Hanoi region: Bac Ninh on rooftop of new EVN bldg.	Tier1	VNHAN	60 m	21.2013°N	106.0629°E
Da Nang on rooftop of EVN/CPC bldg. within the city	Tier2	VNDAN	24 m	16.0125°N	108.1865°E
Central Highlands region on ground before EVN bldg. near hydro spillway	Tier1	VNCEH	290 m	12.7535°N	107.8761°E
Song Binh station location on private house's rooftop	Tier2	VNSOB	62 m	11.2641°N	108.3452°E
Tri An region near HCMC on top of EVN bldg. near water spillway	Tier1	VNTRA	57 m	11.1024°N	107.0378°E

Table 1. Selected sites for solar measurement stations in Vietnam within the WB ESMAP program

This report gives an overview of the ground installation of the Tier 2 station in Da Nang on top of the EVN CPC company building. The installation took place between 13th and 15th of September 2017. The site code for this site is VNDAN.

Tier 2 stations are designed to be very robust and less sensitive to cleaning, as a Rotating Shadowband Irradiometer (RSI) measures GHI, DHI and DNI. In order to reach high quality data, the Tier 2 stations are equipped with a thermopile pyranometer, which complies with Secondary Standard requirements – highest quality Level of ISO 9060 (1990). Besides, a barometer measures atmospheric pressure and a thermo-hygro sensor measures air temperature and relative humidity. Furthermore, a plug-and-play blueberry COMPACT data-logging system controls, stores and transmits the measured data of the stations. For power supply of the Tier 2 stations, a solar panel, batteries and charge controllers are installed. Additionally, a wind mast with a cup anemometer assembly ensures measuring accurate wind speed. A soiling measurement system and a corrosion measurement kit were installed as additional equipment.

2. LOCATION DA NANG – VNDAN

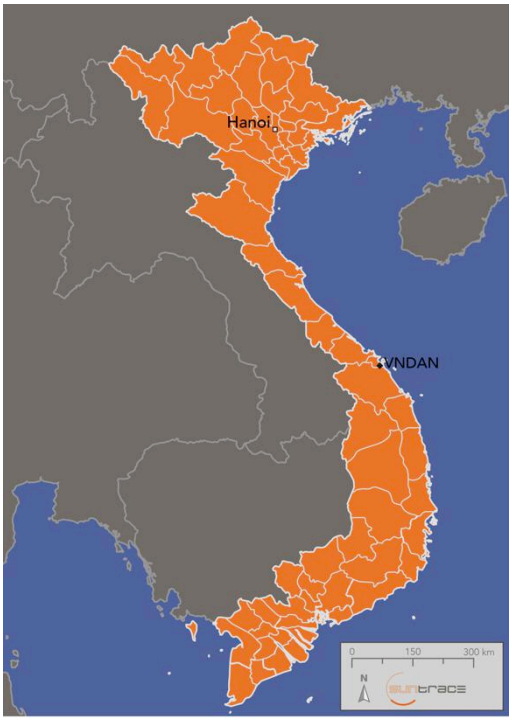


Figure 2. Country map showing the site VNDAN for solar measurements for Solar Measurements in Vietnam ESMAP project.

Figure 3. Location of VNDAN relative to the extent of the region

3. DESCRIPTION OF STATION

Installation details	
Location	Vietnam – Da Nang City, EVN CPC rooftop
Site ID	VNDAN
Station ID	1166
Longitude/Latitude	16.0125°N /108.1865°E
Elevation	24 m
Date of commencement	15th of September 2017

Table 2.Overview of site parameters VNDAN

Solar Measurement Station Tier 2

Recorded meteorological parameters:

- global horizontal irradiance (GHI) in W/m²
- direct normal irradiance (DNI) in W/m²
- diffuse horizontal irradiance (DHI) in W/m²
- ambient temperature in °C
- relative humidity in %
- wind speed in m/s 27 m above ground
- barometric pressure in hPa
- soiling measurement via 3 reference cells measuring global tilted (10°) irradiance (GTI) in W/m²

Additional information:

- The Reichert RSP4G (RSI), which is installed, is known to be a precise and robust instrument. Contrary to pyrheliometers, which are used in Tier 1 stations and require daily cleaning to reach its outstanding accuracy, it is sufficient to clean such RSI on a weekly basis.
- The Hukseflux SR20 is used in the RSI, which is equipped with dome heating system to reduce the influence of dew, but is not ventilated
- For Tier 2 stations, a 60 Wp photovoltaic panel, batteries and a charge controller are installed.
- As the roof of the EVN building in Da Nang is 24 m high, a wind mast measuring wind speed was installed at a height of 3 m.

List of installed instruments and measurement sensors

No.	Instrument	Manufacturer	Model No.	Serial No.
1	Rotating Shadow-band Irradiometer	Reichert	RSP-4G	17-01
2	Pyranometer 1	Hukseflux	SR20-D2	6998
3	Reference Cell 1	IKS	ISET Cell	03083
4	Reference Cell 2	IKS	ISET Cell	03082
5	Reference Cell 3	IKS	ISET Cell	02665
6	Data logger Blue-berry COMPACT	Wilmers Messtech-nik	0141	1166
7	Thermo-hygro Sen-sor	E+E	EE071	17110500023799
8	Anemometer	Wilmers Messtech-nik	0293	1294

Table 3.List of installed instruments and measurement sensors at VNDAN

Figure 4. Photo of Tier 2 Station of type HelioScale φ installed at VNDAN

4. HORIZON

Figure 5. Horizon at VNDAN

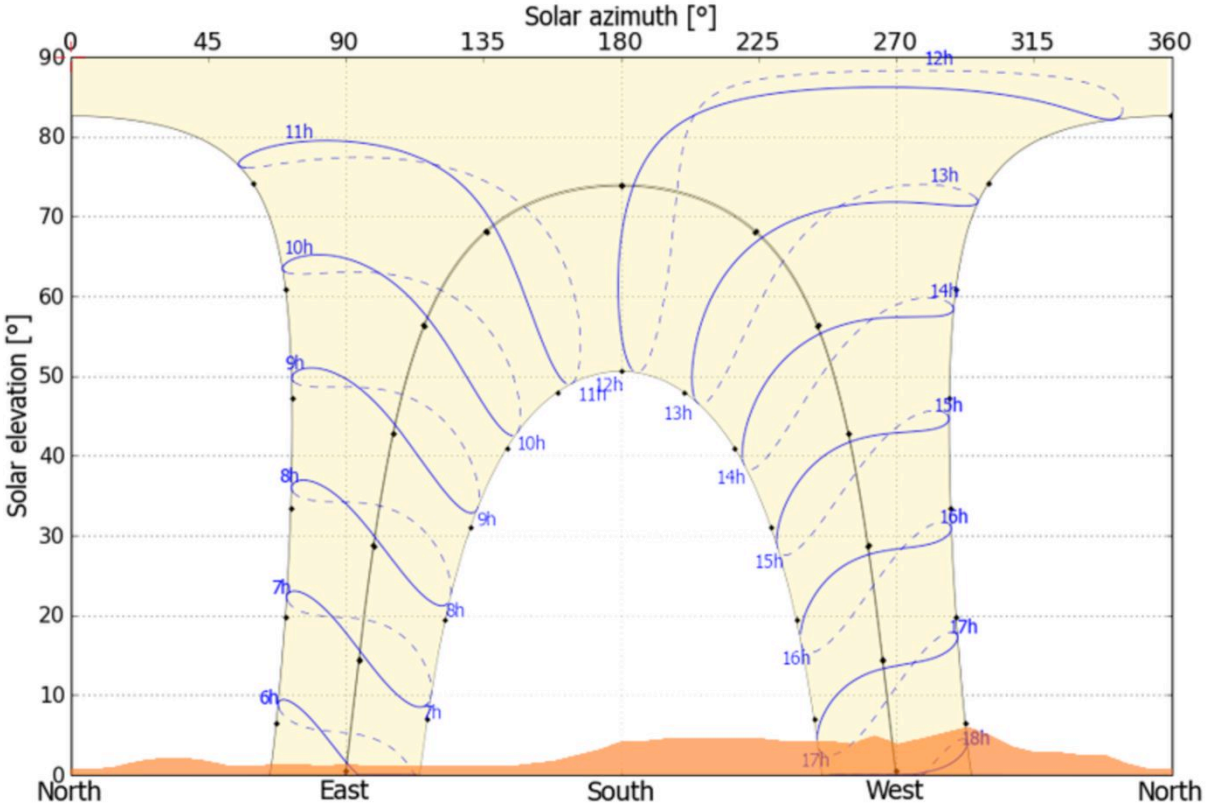


Figure 6. Sun path for VNDAN

5. STATION COMMISSIONING

Responsible staff for monitoring of the stations

Standby Station Keeper

Name: Dang Don Thach
Address: To 26 Phuong Hoa tho Tay, quan Cam Le, thanh pho Da Nang
Mobile: +84 979444093
Phone: +84 906560698
Mail: dangdonthach@gmail.com

Station Supervisor

Name: Tan Tien Nguyen
Address: 60A Cau Be, xa Vinh Thanh, Thanh pho Nha Trang, tinh Khanh Hoa
Mobile: +84 905707760
Mail: tiennt.vatec@gmail.com

Station Supplier

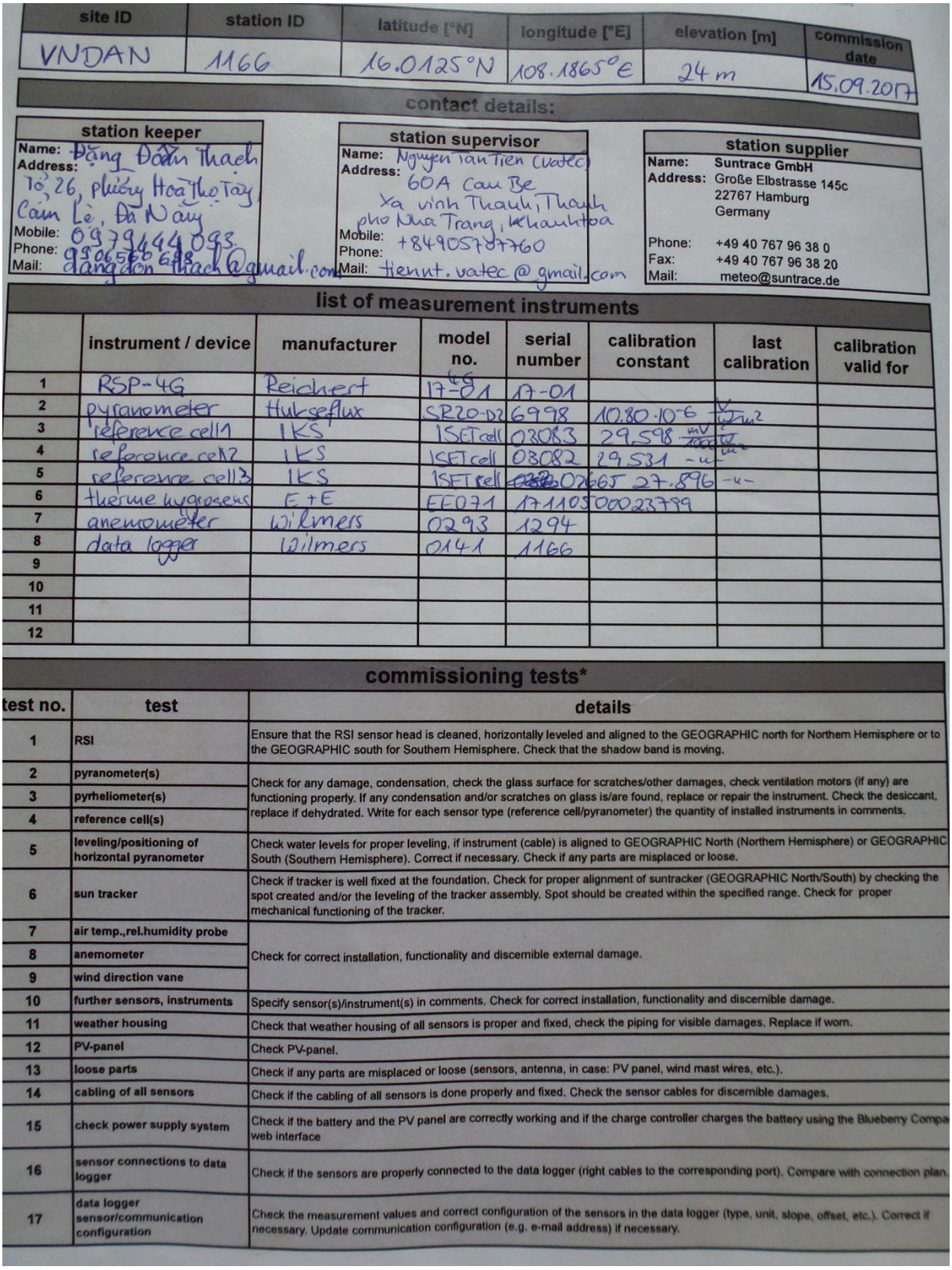
Suntrace GmbH
Address: Grosse Elbstrasse 145c, 22767 Hamburg, Germany
Phone: +49 40 767 96 38 0
Fax: +49 40 767 96 38 20
Mail: meteo@suntrace.de

	Applied test	Details	Approved Yes/No	Comments
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 of Southern Hemisphere. Check that the shadow band is moving.	Yes	---
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.	Yes	---

	Applied test	Details	Approved Yes/No	Comments
3	Pyrheliometer(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.	---	No part of this station. Not installed.
4	reference cell(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.	Yes	---
5	leve- ve- ling/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.	Yes	---
6	sun tracker	Check if tracker is well fixed at the foundation. Check for proper alignment of sun tracker (GEOGRAPHIC North/South) by checking the spot created and/or the leveling of the tracker assembly. Spot should be created within a specific range. Check for proper mechanical functioning of the tracker.	---	No part of this station. Not installed.
7	air temperature, rel. humidity probe (ther- mohygro)	Check for correct installation, functionality and discernible external damage.	Yes	---
8	anemometer	Check for correct installation, functionality and discernible external damage.	Yes	---
9	wind direction vane	Check for correct installation, functionality and discernible external damage.	---	No part of this station. Not installed.
10	further sensors, instruments	Specify sensor(s)/instrument(s) in comments. Check for correct installation, functionality and discemible damage	-	No further sensors installed.
11	weather housing	Weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.	Yes	---

	Applied test	Details	Approved Yes/No	Comments
12	PV-panel	Properly fixed to tripod, facing south at northern hemisphere and vice versa, no visible damages (cracks, scratches).	Yes	---
13	loose parts	Check if any parts are misplaced or loose (sensors, antenna, PV panel, wind mas wires, etc.).	Yes	---
14	cabling of all sensors	Check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernable damages.	Yes	---
15	check power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.	Yes	---
16	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	---
17	data logger sensor/communication configuration	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	Internet provider: Viettel Mobile APN: e-connect
18	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	---
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your observation and document them.	Yes	---
20	tracker table, tripod & wind mast	Check if is steady and well fixed on the ground. Check bolts on the foundations.	Yes	Tracker table not part of the station
21	fence, door, lock	Check the fence and door including its lock.	Yes	Station on roof top, building well locked
22	horizon pictures	360° panorama picture from the view point of radiation sensors should be taken.	Yes	---
23	station pictures	Take photos of all sensors and instruments and also of the whole station. The serial numbers should be seen.	Yes	---
24	general view	Anything unusual? If NO write "Yes" for approved	Yes	---
25	station keeper training and documentation	Training of Station Keeper. Check the station documentation such as: analogy of serial numbers, station logbook, etc.	Yes	---

Table 4. List of applied tests for commissioning at VNDAN



site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission date
VNDAN	1166	16.0125°N	108.1865°E	24 m	15.09.2017

contact details:

station keeper	station supervisor	station supplier
Name: Đặng Đoàn Thạch	Name: Nguyen Tan Tien (VATEC)	Name: Suntrace GmbH
Address: Tổ 26, phường Hoà Thọ Tây, Cẩm Lệ, Đà Nẵng	Address: 60A Cau Be Xa Vinh Thanh, Thanh pho Nha Trang, Khanhhoa	Address: Große Elbstrasse 145c 22767 Hamburg Germany
Mobile: 0979444093	Mobile: +84905787760	Phone: +49 40 767 96 38 0
Phone: 0905566648	Phone:	Fax: +49 40 767 96 38 20
Mail: dangdoanthach@gmail.com	Mail: tienvt.vatec@gmail.com	Mail: meteo@suntrace.de

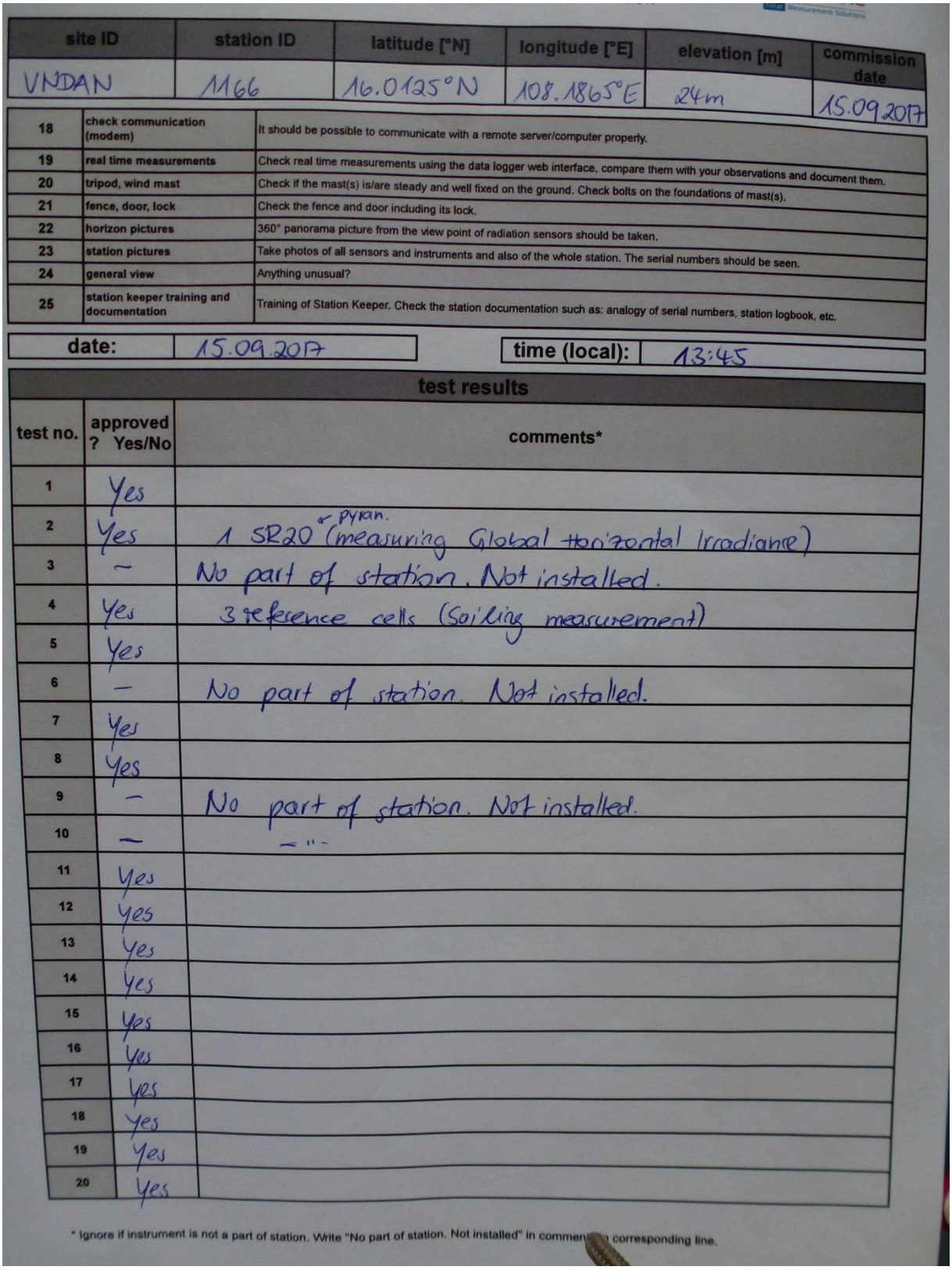
list of measurement instruments

	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	RSP-4G	Reichert	17-01	17-01			
2	pyranometer	Hukseflux	SR20-D2	6998	$10.80 \cdot 10^{-6}$		
3	reference cell1	IKS	ISET cell	03083	29.598		
4	reference cell2	IKS	ISET cell	03082	29.531		
5	reference cell3	IKS	ISET cell	03665	27.896		
6	therme hygrosens	E+E	EE071	17110500023799			
7	anemometer	Wilmers	0293	1294			
8	data logger	Wilmers	0141	1166			
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 using the Blueberry Compa web interface
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 configuration	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.

Figure 7. Commissioning Protocol page 1/3 VNDAN



site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission date
VNDAN	1166	16.0125°N	108.1865°E	24m	15.09.2017

18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your 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.

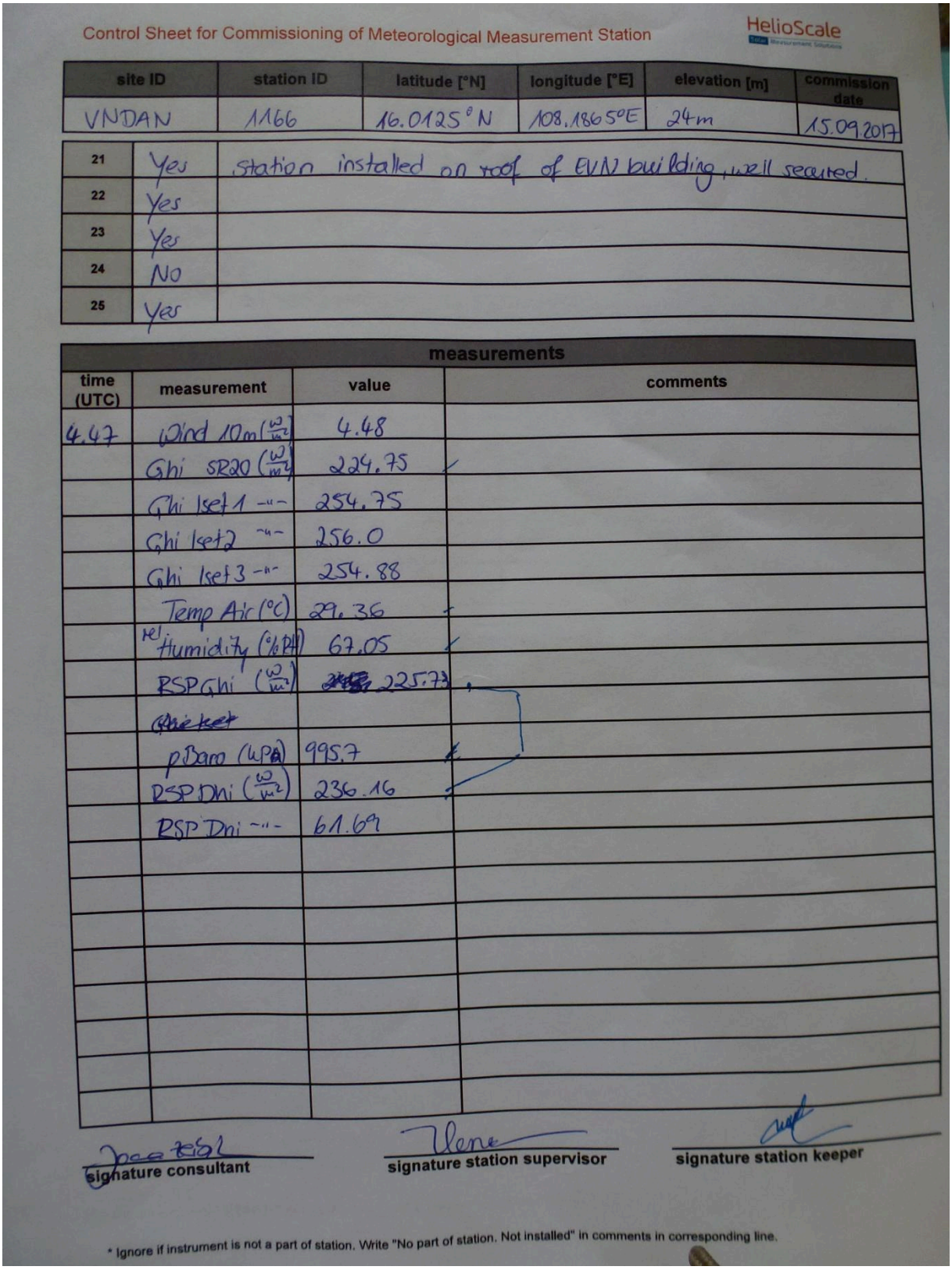
date:	15.09.2017	time (local):	13:45

test results

test no.	approved ? Yes/No	comments*
1	Yes	
2	Yes	1 SR20 (pyran. measuring Global horizontal Irradiance)
3	–	No part of station. Not installed.
4	Yes	3 reference cells (Soiling measurement)
5	Yes	
6	–	No part of station. Not installed.
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	

* Ignore if instrument is not a part of station. Write "No part of station. Not installed" in comme[illegible] corresponding line.

Figure 8. Commissioning Protocol page 2/3 VNDAN



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission date
VNDAN	1166	16.0125°N	108.1865°E	24m	15.09.2017

21	Yes	station installed on roof of EVN building, well secured.
22	Yes	
23	Yes	
24	No	
25	Yes	

measurements

time (UTC)	measurement	value	comments
4.47	Wind 10m (W/m²)	4.48	
	Ghi SR20 (W/m²)	224.75	
	Ghi Ref 1 -"-	254.75	
	Ghi Ref 2 -"-	256.0	
	Ghi Ref 3 -"-	254.88	
	Temp Air (°C)	29.36	
	Humidity (%RH)	67.05	
	RSP Ghi (W/m²)	225.73	
	~~Ghi ket~~		
	pBaro (hPa)	995.7	
	RSP Dhi (W/m²)	236.16	
	RSP Dni -"-	61.69	

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.

Figure 9. Commissioning Protocol page 3/3 VNDAN

6. SUMMARY OF COMPLETED TASK

- The installed equipment has been tested prior to delivery for the project.
- The World Bank ESMAP Tier 2 solar measurement station at the location VNDAN is installed and commissioned successfully at the 15th of September 2017
- 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. A daily automatic quality control procedure is applied to the unprocessed raw data, this additionally to the by contract committed monthly delivery of post processed data including a monthly summary report.
- FTP servers will be set up for data sharing with EVN companies at all sites of this measurement campaign.

7. PHOTO DOCUMENTATION

Figure 10. Tier 2 station with soiling measurement at VNDAN

Figure 11. Tier 2 station with soiling measurement at VNDAN

Figure 12. Tier 2 station with soiling measurement at VNDAN

Figure 13. Wind mast measuring wind speed at VNDAN

Figure 14. Sensors of Tier 2 station (RSP, SR20, Thermohygro & soiling sensor) at VNDAN

Figure 15. Commissioning & station keeper training with EVN staff at VNDAN

Figure 16. Commissioning & station keeper training with EVN staff at VNDAN

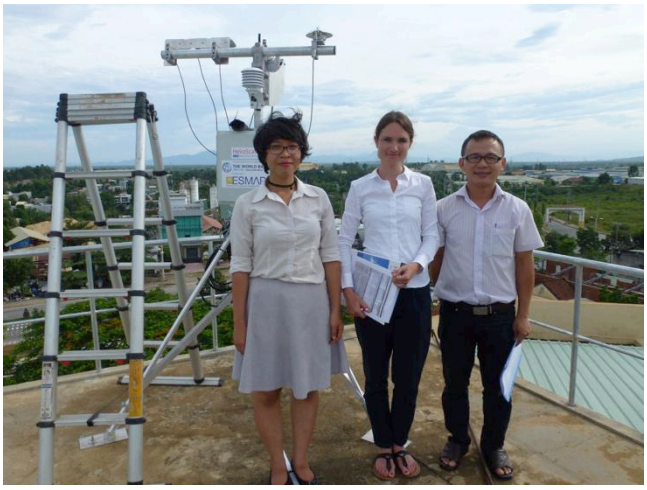


Figure 17. After commissioning with EVN staff at VNDAN

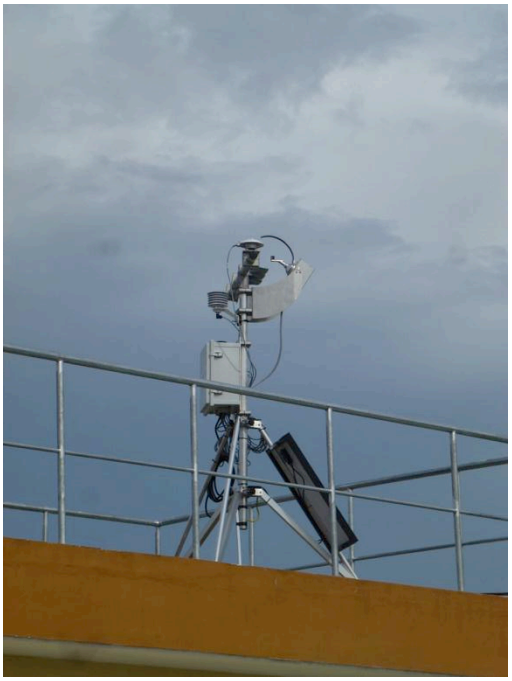


Figure 18. Tier 2 station at VNDAN

Figure 19. Tier 2 station with wind mast (left) and lightning protection (middle) on rooftop at VNDAN

Figure 20. Tier 2 station with wind mast on rooftop at VNDAN

Figure 21. After commissioning with EVN staff at VNHAN

Figure 22. After commissioning with EVN staff at VNHAN

SOLAR MEASUREMENT CAMPAIGN IN VIETNAM

SELECTION #: 1231900

Installation Report: Bac Ninh (VNHAN)

Suntrace Technical Documentation
21 September 2017

World Bank Group
ESMAP Renewable Energy Mapping Initiative

Authors:
Joana Zerbin, Marko Schwandt

Reviewed by:
Dr. Richard Meyer, Raul Granados

Authors Contact Information:
Suntrace GmbH
Grosse Elbstrasse 145c
22767 Hamburg
Germany
E: meteo@suntrace.de
W: www.suntrace.de

HRB Hamburg: 110819
VAT: DE266610323

Table of content

1. INTRODUCTION

The principal task of this installation project was the installation of six meteorological measurement stations at the selected sites including the training of the local staff from EVN (Vietnam Electricity, state-owned utility) on principle maintenance works of the meteorological measurement stations of Type HelioScale ω (Tier 1) and Type HelioScale φ (Tier 2). The selected sites are listed in Table 1, see also Implementation Plan for more details.

The first installation mission took place from 22nd of August to 1st of September 2017. During the first installation mission, the Tier 1 stations were installed at the sites VNCEH (Central Highlands), VNTRA (Tri An) and VNHAN (Bac Ninh near Hanoi). All Tier 2 stations (2x Tier 2 stations for sites VNDAN (Da Nang) and VNSOB (Song Binh) plus 1x Tier 2 spare station) were additionally installed at VNCEH for calibration of the RSP sensors for 2 ½ weeks until the second installation mission started. The second installation mission was undertaken from 12th to 19th of September 2017 and the Tier 2 stations at VNDAN and VNSOB were installed. The spare station will be stored at the Head office of VATEC in Nha Trang. The inauguration with the local government, EVN and World Bank representatives was held on 20th of September in Song Binh (VNSOB).

The International Experts Joana Zerbin and Marko Schwandt from Suntrace GmbH traveled from Germany / Spain to the sites in Vietnam. Vietnam Applied Technical Co. Ltd (VATEC) as local partner company in this project supported Suntrace during the installation.

Overview of Station Sites

Figure 1. Country map showing sites for solar measurement stations considered for the Vietnam ESMAP project.

Site name and description	Type	Site code	Elevation	Latitude	Longitude
Hanoi region: Bac Ninh on rooftop of new EVN bldg.	Tier1	VNHAN	60 m	21.2013°N	106.0629°E
Da Nang on rooftop of EVN/CPC bldg. within the city	Tier2	VNDAN	24 m	16.0125°N	108.1865°E
Central Highlands region on ground before EVN bldg. near hydro spillway	Tier1	VNCEH	290 m	12.7535°N	107.8761°E
Song Binh station location on private house's rooftop	Tier2	VNSOB	62 m	11.2641°N	108.3452°E
Tri An region near HCMC on top of EVN bldg. near water spillway	Tier1	VNTRA	57 m	11.1024°N	107.0378°E

Table 1. Selected sites for solar measurement stations in Vietnam within the WB ESMAP program

This report gives an overview of the ground installation of the Tier 1 station in Bac Ninh near Hanoi on top of the local head office of EVN in Bac Ninh province. The installation took place between 30th of August and 1st of September 2017. The site code for this site is VNHAN.

Tier 1 stations are equipped with a robust and highly reliable pyrheliometer, a shaded pyranometer (which measures DHI), a non-shaded pyranometer (which measures GHI), and a 2-axis sun tracker with a shadow-ball assembly. Besides, a barometer measures atmospheric pressure and a thermo-hygro sensor measures air temperature and relative humidity. Additionally, a wind mast with a cup anemometer and a wind vane assembly ensures measuring accurate wind speed and direction. Furthermore, a plug-and-play blueberry COMPACT data-logging system controls, stores and transmits the measured data of the stations. For power supply of the Tier 1 stations, a solar panel, batteries and charge controllers are installed. At this site, a soiling measurement system is also installed.

2. LOCATION BAC NINH NEAR HANOI – VNHAN

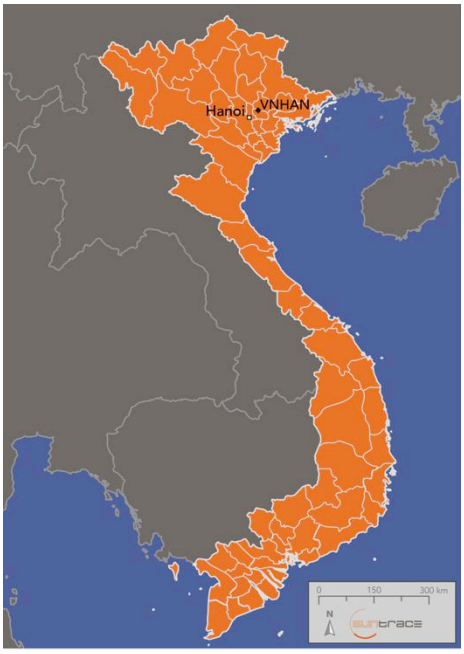


Figure 2. Country map showing the site VNHAN for solar measurements considered for the Vietnam ESMAP project.

Figure 3. Location of VNHAN relative to the extent of the region

3. DESCRIPTION OF STATION

Installation details	
Location	Vietnam – Hanoi region: Bac Ninh on rooftop of new EVN building
Site ID	VNHAN
Station ID	1163
Longitude/Latitude	21.2013°N /106.0629°E
Elevation	60 m
Date of commencement	1st of September 2017

Table 2. Overview of site parameters VNTRA

Solar Measurement Station Tier 1

Recorded meteorological parameters:

- global horizontal irradiance (GHI) in W/m²
- direct normal irradiance (DNI) in W/m²
- diffuse horizontal irradiance (DHI) in W/m²
- ambient temperature in °C
- relative humidity in %
- wind speed in m/s ca. 63 m above ground
- wind direction at ca. 63 m above ground
- barometric pressure in hPa
- soiling measurement via 3 reference cells measuring global tilted (10°) irradiance (GTI) in W/m²

Additional information:

- As the roof is 60 m high, the wind mast was installed at a height of 3 m above the rooftop.
- For Tier 1 stations, a 250 Wp photovoltaic panel, batteries and a charge controller are installed.

List of installed instruments and measurement sensors

No.	Instrument	Manufacturer	Model No.	Serial No.
1	Pyrheliometer	Hukseflux	DR-02	9298
2	Pyranometer 1 (DHI)	Hukseflux	SR30-01	2123
3	Pyranometer 2 (GHI)	Hukseflux	SR30-01	2125
4	Reference Cell 1	IKS	ISET Cell	03110
5	Reference Cell 2	IKS	ISET Cell	03091
6	Reference Cell 3	IKS	ISET Cell	02672
7	Data logger Blue-berry COMPACT	Wilmers Messtech-nik	0141	1163
8	Thermo-hygro Sen-sor	E+E	EE071	171105000265DA
9	Anemometer	Wilmers Messtech-nik	0293	1291
10	Wind vane	Wilmers Messtech-nik	0318	20003589

No.	Instrument	Manufacturer	Model No.	Serial No.
11	Sun tracker including shading assembly	EKO	STR-22G	S1513605

Table 3.List of installed instruments and measurement sensors at VNHAN

Figure 4. Photo of Tier 1 Station of type HelioScale ω installed at VNHAN

4. HORIZON

Figure 5. Horizon at VNHAN

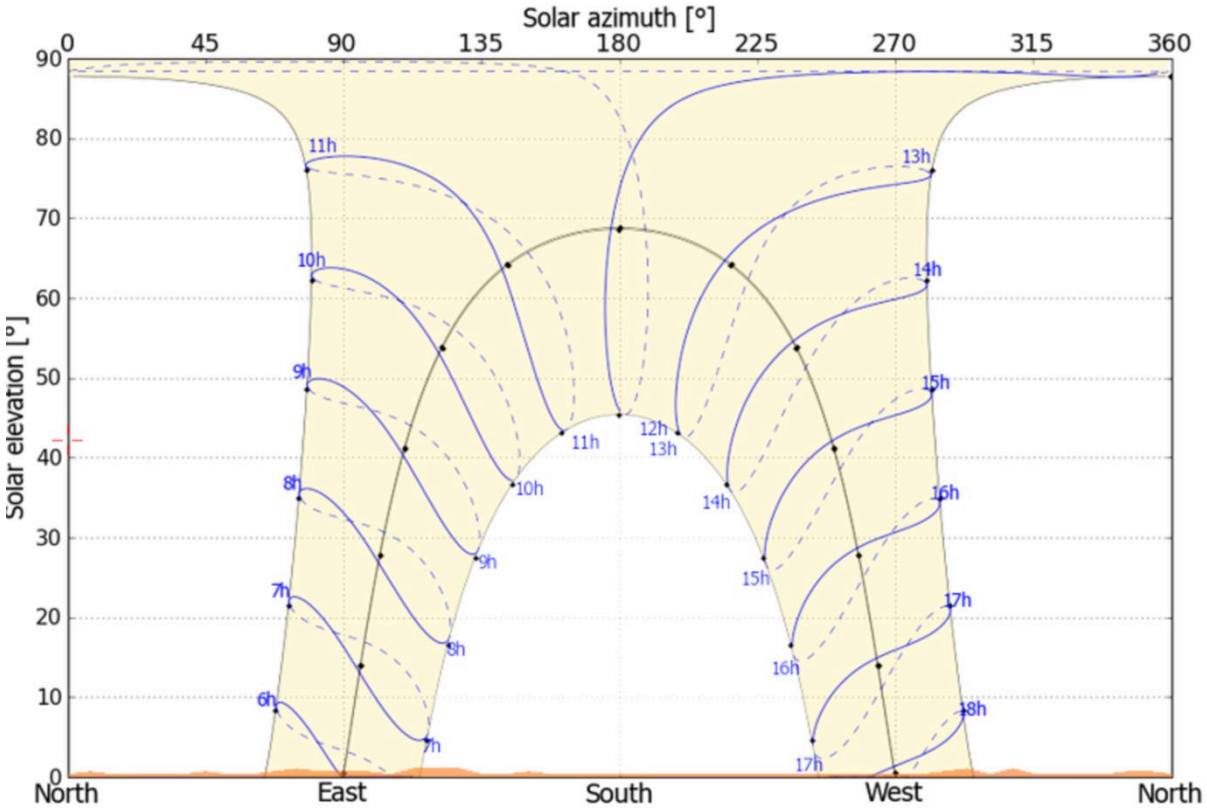


Figure 6. Sun path for VNHAN

5. STATION COMMISSIONING

Responsible staff for monitoring of the stations

Standby Station Keeper

Name: Ta Thauh Tuan
Address: Cong ty Dien luc tinh Bac Ninh, xa Hoa Long,thanh pho Bac Ninh, tinh Bac Ninh
Mobile: +84 963154985
Mail: tuanhan150485@gmail.com

Station Supervisor

Name: Tan Tien Nguyen
Address: 60A Cau Be, xa Vinh Thanh, Thanh pho Nha Trang, tinh Khanh Hoa
Mobile: +84 905707760
Mail: tiennt.vatec@gmail.com

Station Supplier

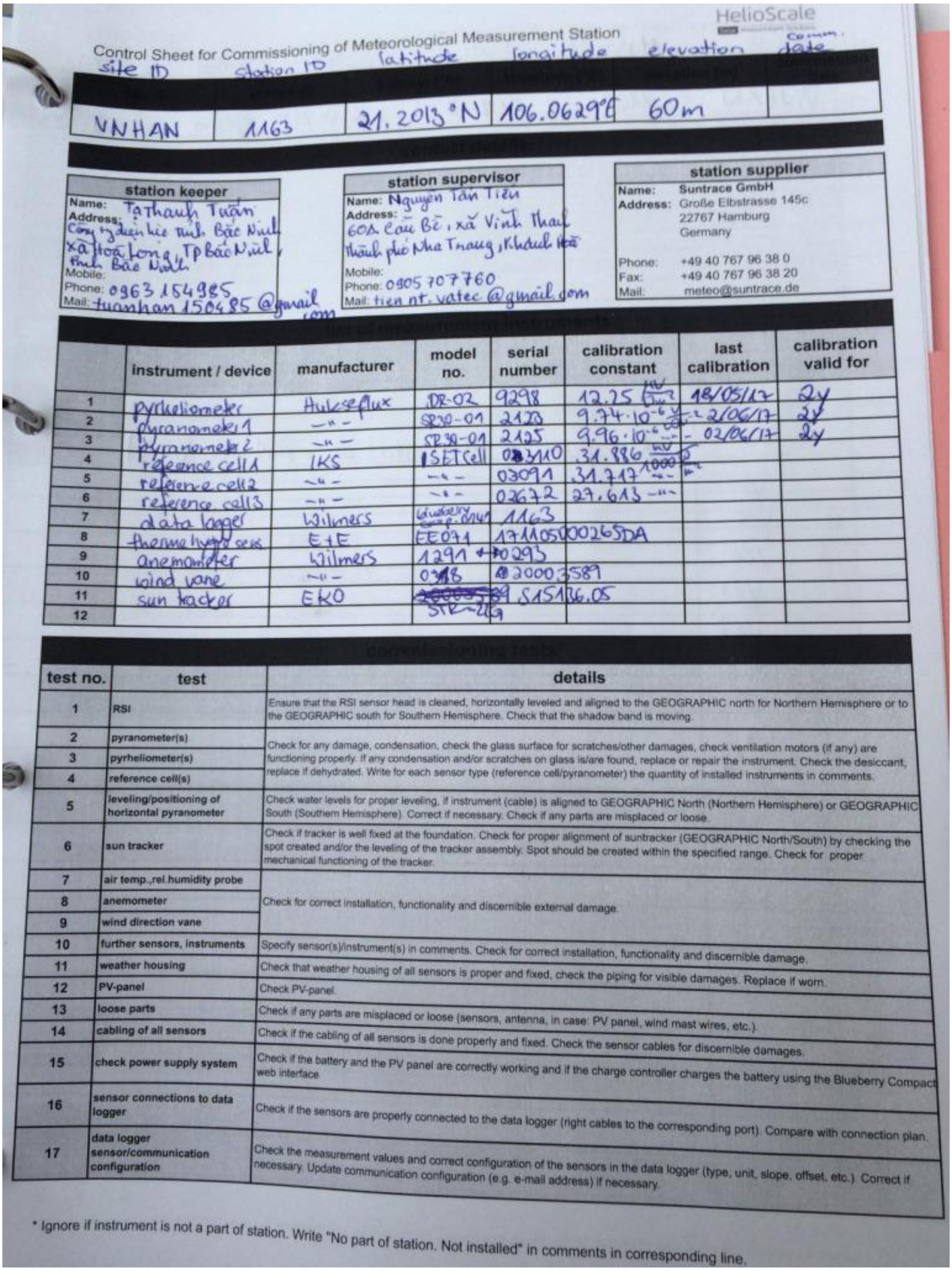
Suntrace GmbH
Address: Grosse Elbstrasse 145c, 22767 Hamburg, Germany
Phone: +49 40 767 96 38 0
Fax: +49 40 767 96 38 20
Mail: meteo@suntrace.de

	Applied test	Details	Approved Yes/No	Comments
1	RSI	-	-	No part of station – not installed
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.	Yes	---
3	Pyrheliometer(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.	Yes	---
4	reference cell(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	Yes	---

	Applied test	Details	Approved Yes/No	Comments
		scratches on glass is/are found, replace or repair the instrument. Check the desiccant, replace if dehydrated.		
5	leve-ve-ling/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.	Yes	---
6	sun tracker	Check if tracker is well fixed at the foundation. Check for proper alignment of sun tracker (GEOGRAPHIC North/South) by checking the spot created and/or the leveling of the tracker assembly. Spot should be created within a specific range. Check for proper mechanical functioning of the tracker.	Yes	---
7	air temperature, rel. humidity probe (thermohygro)	Check for correct installation, functionality and discernible external damage.	Yes	---
8	anemometer	Check for correct installation, functionality and discernible external damage.	Yes	---
9	wind direction vane	Check for correct installation, functionality and discernible external damage.	Yes	---
10	further sensors, instruments	Specify sensor(s)/instrument(s) in comments. Check for correct installation, functionality and discemible damage	-	No additional sensors were installed.
11	weather housing	Weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.	Yes	---
12	PV-panel	Properly fixed to tripod, facing south at northern hemisphere and vice versa, no visible damages (cracks, scratches).	Yes	---
13	loose parts	Check if any parts are misplaced or loose (sensors, antenna, PV panel, wind mas wires, etc.).	Yes	---
14	cabling of all sensors	Check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernable damages.	Yes	---
15	check power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.	Yes	---
16	sensor connections to data	Check if the sensors are properly connected to the data logger (fixing cables to the corre-	Yes	---

	Applied test	Details	Approved Yes/No	Comments
	logger	sponding port). Compare with connection plan.		
17	data logger sensor/communication configuration	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	Internet provider: Viettel Mobile APN: e-connect
18	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	---
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your observation and document them.	Yes	---
20	tracker table, tripod & wind mast	Check if is steady and well fixed on the ground. Check bolts on the foundations.	Yes	---
21	fence, door, lock	Check the fence and door including its lock.	Yes	Station on roof top, building well locked
22	horizon pictures	360° panorama picture from the view point of radiation sensors should be taken.	Yes	---
23	station pictures	Take photos of all sensors and instruments and also of the whole station. The serial numbers should be seen.	Yes	---
24	general view	Anything unusual? If NO write “Yes” for approved	No	---
25	station keeper training and documentation	Training of Station Keeper. Check the station documentation such as: analogy of serial numbers, station logbook, etc.	Yes	---

Table 4. List of applied tests for commissioning at VNTRA



HelioScale

Control Sheet for Commissioning of Meteorological Measurement Station

site ID	station ID	latitude	longitude	elevation	comm. date
VNHAN	1163	21.2013°N	106.0629°E	60m	

contact details

station keeper	station supervisor	station supplier
Name: Ta Thanh Tuấn	Name: Nguyễn Tấn Tiến	Name: Suntrace GmbH
Address: Công ty điện lực tỉnh Bắc Ninh, xã Hoà Long, TP Bắc Ninh, tỉnh Bắc Ninh	Address: 60A Cầu Bê, xã Vĩnh Thái, thành phố Nha Trang, Khánh Hoà	Address: Große Elbstrasse 145c, 22767 Hamburg, Germany
Mobile:	Mobile:	Phone: +49 40 767 96 38 0
Phone: 0963154985	Phone: 0905 707760	Fax: +49 40 767 96 38 20
Mail: tuanhan150485@gmail.com	Mail: tien.nt.vatec@gmail.com	Mail: meteo@suntrace.de

list of measurement instruments

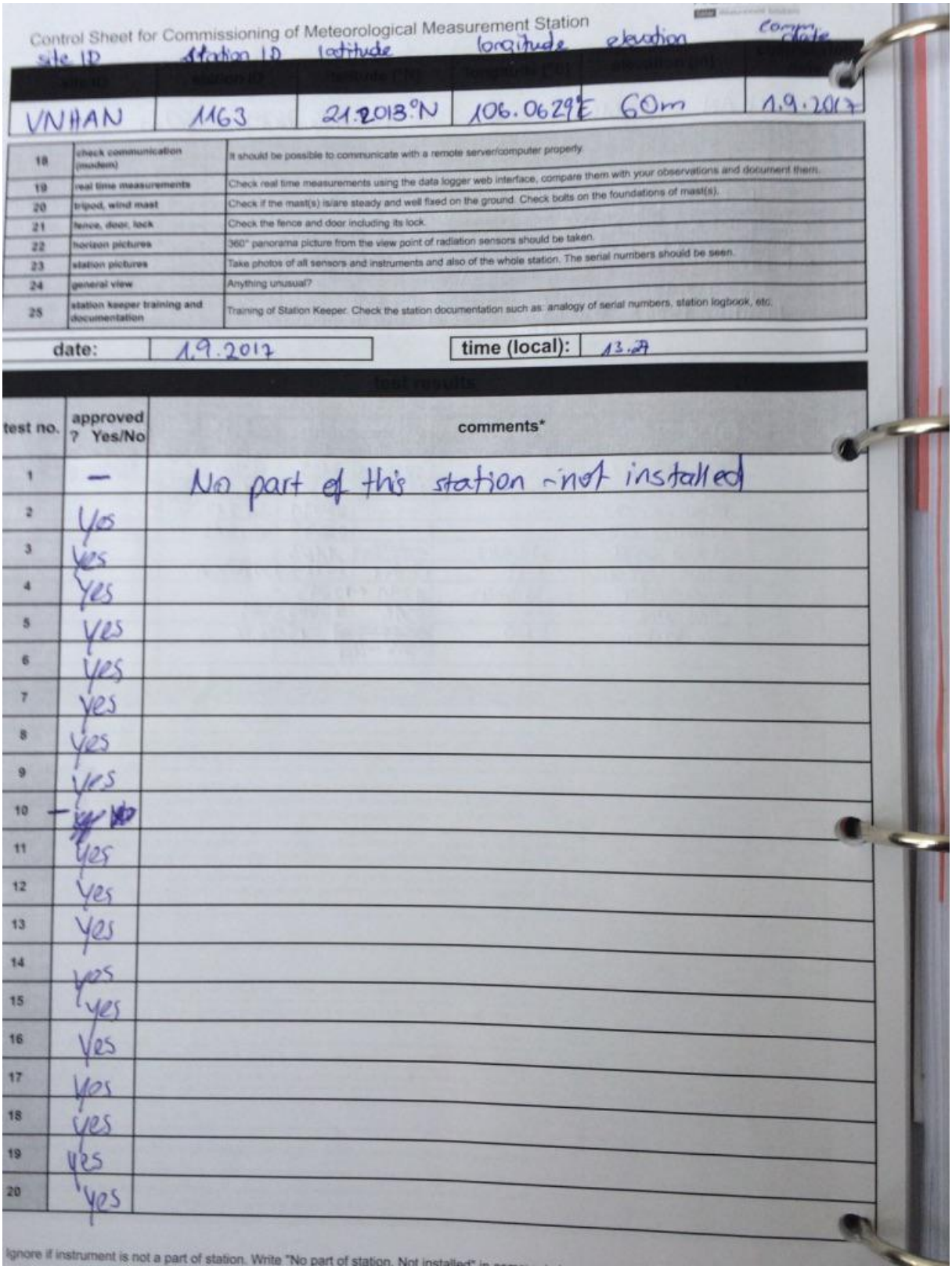
	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	pyrheliometer	Hukseflux	DR-02	9298	12.25 µV/(W/m²)	18/05/17	2y
2	pyranometer 1	–"–	SR30-01	2123	9.74·10⁻⁶ V/(W/m²)	2/06/17	2y
3	pyranometer 2	–"–	SR30-01	2125	9.96·10⁻⁶ –"–	02/06/17	2y
4	reference cell 1	IKS	ISET Cell	03110	31.886 mV/(1000 W/m²)		
5	reference cell 2	–"–	–"–	03091	31.717 –"–		
6	reference cell 3	–"–	–"–	02672	27.613 –"–		
7	data logger	Wilmers	blueberry comp. 0144	1163			
8	thermo hygro sens.	E+E	EE071	171105000265DA			
9	anemometer	Wilmers	1291	10293			
10	wind vane	–"–	0318	20003589			
11	sun tracker	EKO	~~20003589~~ STR-22G	S15136.05			
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 using the Blueberry Compact web interface
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 configuration	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.

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

Figure 7. Commissioning Protocol page 1/3 VNHAN



Control Sheet for Commissioning of Meteorological Measurement Station

site ID	station ID	latitude	longitude	elevation	comm. date
VNHAN	1163	21.2013°N	106.0629°E	60m	1.9.2017

18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your 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.

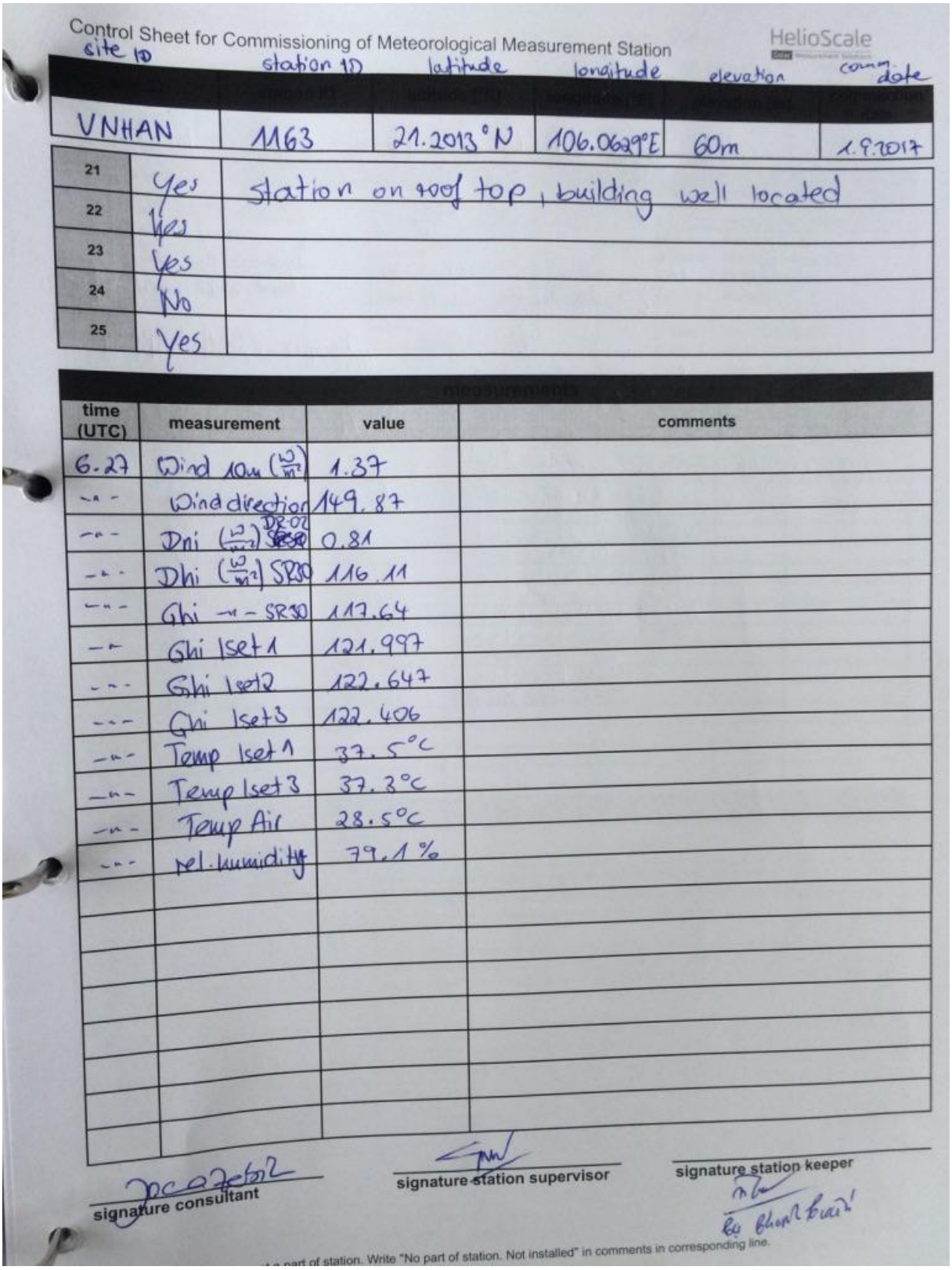
date: 1.9.2017 time (local): 13.27

test results

test no.	approved ? Yes/No	comments*
1	—	No part of this station - not installed
2	Yes	
3	Yes	
4	Yes	
5	Yes	
6	Yes	
7	Yes	
8	Yes	
9	Yes	
10	—	
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	Yes	
19	Yes	
20	Yes	

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

Figure 8. Commissioning Protocol page 2/3 VNHAN



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude	longitude	elevation	comm. date
VNHAN	1163	21.2013°N	106.0629°E	60m	1.9.2017

21	Yes	station on roof top, building well located
22	Yes	
23	Yes	
24	No	
25	Yes	

measurements

time (UTC)	measurement	value	comments
6.27	Wind 10m ($\frac{W}{m^2}$)	1.37	
-"-	Wind direction	149.87	
-"-	Dni ($\frac{W}{m^2}$) SR02	0.81	
-"-	Dhi ($\frac{W}{m^2}$) SR30	116.11	
-"-	Ghi -"- SR30	117.64	
-"-	Ghi Iset1	121.997	
-"-	Ghi Iset2	122.647	
-"-	Ghi Iset3	122.406	
-"-	Temp Iset1	37.5°C	
-"-	Temp Iset3	37.3°C	
-"-	Temp Air	28.5°C	
-"-	rel. humidity	79.1 %	

signature consultant

signature station supervisor

signature station keeper

part of station. Write "No part of station. Not installed" in comments in corresponding line.

Figure 9. Commissioning Protocol page 3/3 VNHAN

6. SUMMARY OF COMPLETED TASK

- The installed station and spare parts have been tested prior to delivery for the project.
- The World Bank ESMAP Tier 1 solar measurement station at the location VNHAN is installed and commissioned successfully at the 1st of September 2017
- 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. A daily automatic quality control procedure is applied to the unprocessed raw data, this additionally to the by contract committed monthly delivery of post processed data including a monthly summary report.
- FTP servers will be set up for data sharing with EVN companies at all sites of this measurement campaign.

7. PHOTO DOCUMENTATION

Figure 10. Tier 1 station at VNHAN at VNHAN

Figure 11. Tier 1 station with wind mast and soiling measurement at VNHAN

Figure 12. Wind mast measuring wind speed and direction at VNHAN

Figure 13. Soiling measurement system at sunset at VNHAN

Figure 14. EVN NPC building with Tier 1 station on roof top at VNHAN

Figure 15. Commissioning and station keeper training with EVN staff at VNHAN

Figure 16. After commissioning with EVN staff at VNHAN

Figure 17. After commissioning with EVN staff at VNHAN

SOLAR MEASUREMENT CAMPAIGN IN VIETNAM

SELECTION #: 1231900

Installation Report: Song Binh (VNSOB)

Suntrace Technical Documentation
21 September 2017

World Bank Group
ESMAP Renewable Energy Mapping Initiative

Authors:
Joana Zerbin, Marko Schwandt

Reviewed by:
Dr. Richard Meyer, Raúl Granados

Authors Contact Information:
Suntrace GmbH
Grosse Elbstrasse 145c
22767 Hamburg
Germany
E: meteo@suntrace.de
W: www.suntrace.de

HRB Hamburg: 110819
VAT: DE266610323

Table of content

1. INTRODUCTION

The principal task of this installation project was the installation of six meteorological measurement stations at the selected sites including the training of the local staff from EVN (Vietnam Electricity, state-owned utility) on principle maintenance works of the meteorological measurement stations of Type HelioScale ω (Tier 1) and Type HelioScale φ (Tier 2). The selected sites are listed in Table 1, see also Implementation Plan for more details.

The first installation mission took place from 22nd of August to 1st of September 2017. During the first installation mission, the Tier 1 stations were installed at the sites VNCEH (Central Highlands), VNTRA (Tri An) and VNHAN (Bac Ninh near Hanoi). All Tier 2 stations (2x Tier 2 stations for sites VNDAN (Da Nang) and VNSOB (Song Binh) plus 1x Tier 2 spare station) were additionally installed at VNCEH for calibration of the RSP sensors for 2 ½ weeks until the second installation mission started. The second installation mission was undertaken from 12th to 19th of September 2017 and the Tier 2 stations at VNDAN and VNSOB were installed. The spare station will be stored at the Head office of VATEC in Nha Trang. The inauguration with the local government, EVN and World Bank representatives was held on 20th of September in Song Binh (VNSOB).

The International Experts Joana Zerbin and Marko Schwandt from Suntrace GmbH traveled from Germany / Spain to the sites in Vietnam. Vietnam Applied Technical Co. Ltd (VATEC) as local partner company in this project supported Suntrace during the installation.

Overview of Station Sites

Figure 1. Country map showing sites for solar measurement stations considered for the Vietnam ESMAP project.

Site name and description	Type	Site code	Elevation	Latitude	Longitude
Hanoi region: Bac Ninh on rooftop of new EVN bldg.	Tier1	VNHAN	60 m	21.2013°N	106.0629°E
Da Nang on rooftop of EVN/CPC bldg. within the city	Tier2	VNDAN	24 m	16.0125°N	108.1865°E
Central Highlands region on ground before EVN bldg. near hydro spillway	Tier1	VNCEH	290 m	12.7535°N	107.8761°E
Song Binh station location on private house's rooftop	Tier2	VNSOB	62 m	11.2641°N	108.3452°E
Tri An region near HCMC on top of EVN bldg. near water spillway	Tier1	VNTRA	57 m	11.1024°N	107.0378°E

Table 1. Selected sites for solar measurement stations in Vietnam within the WB ESMAP program

This report gives an overview of the on-site installation of the Tier 2 station near Song Binh, on a private house rooftop. The installation took place between 17th and 19th of September 2017. The site code for this site is VNSOB.

Tier 2 stations are designed to be very robust and less sensitive to cleaning, as a Rotating Shadowband Irradiometer (RSI) measures GHI, DHI and DNI. In order to reach high quality data, the Tier 2 stations are equipped with a thermopile pyranometer, which complies with Secondary Standard requirements – highest quality Level of ISO 9060 (1990). Besides, a pluviometer measures rain precipitation, a barometer measures atmospheric pressure and a thermo-hygro sensor measures air temperature and relative humidity. Furthermore, a plug-and-play blueberry COMPACT data-logging system controls, stores and transmits the measured data of the stations. For power supply of the Tier 2 stations, a solar panel, batteries and charge controllers are installed. Additionally, a wind mast with a cup anemometer and a wind vane assembly ensures measuring accurate wind speed and direction. A soiling measurement system and a corrosion measurement kit were installed as additional equipment.

2. LOCATION SONG BINH – VNSOB

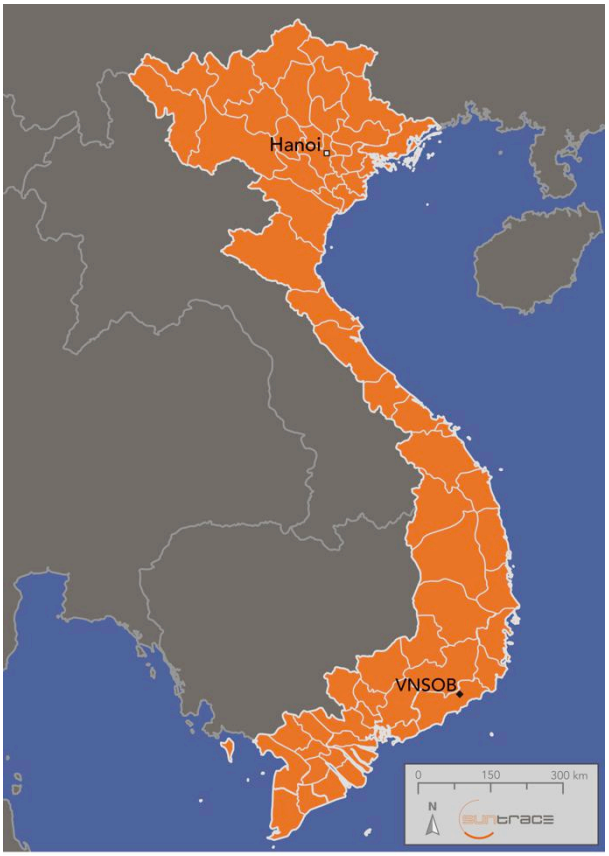


Figure 2. Country map showing the site VNSOB for solar measurements for Solar Measurements in Vietnam ESMAP project.

Figure 3. Location of VNSOB relative to the extent of the region

3. DESCRIPTION OF STATION

Installation details	
Location	Vietnam – Song Binh station location on private house's rooftop
Site ID	VNSOB
Station ID	1166
Longitude/Latitude	16.0125°N /108.1865°E
Elevation	24 m
Date of commencement	19th of September 2017

Table 2.Overview of site parameters VNSOB

Solar Measurement Station Tier 2

Recorded meteorological parameters:

- global horizontal irradiance (GHI) in W/m²
- direct normal irradiance (DNI) in W/m²
- diffuse horizontal irradiance (DHI) in W/m²
- ambient temperature in °C
- relative humidity in %
- wind speed in m/s 10 m above ground
- wind direction 10 m above ground
- barometric pressure in hPa
- soiling measurement via 3 reference cells measuring global tilted (10°) irradiance (GTI) in W/m²
- corrosion measurement kit measuring the corrosivity of metals i.e. oxidation of metal. 4 different samples are used_ aluminum (Al), copper (Cu), steel (Fe) and zinc (Zn).
- rain gauge (pluviometer) measuring rain precipitation in mm.

Additional information:

- The Reichert RSP4G (RSI), which is installed, is known to be a precise and robust instrument. Contrary to pyrheliometers, which are used in Tier 1 stations and require daily cleaning to reach its outstanding accuracy, it is sufficient to clean such RSI on a weekly basis.
- The Hukseflux SR20 is used in the RSI, which is equipped with dome heating system to reduce the influence of dew, but is not ventilated
- For Tier 2 stations, a 60 Wp photovoltaic panel, batteries and a charge controller are installed.
- As the roof of the private house near Song Binh is 4 m high, the wind mast was installed at a height of 6 m above rooftop.
- Signal deviations of the RSP sensor of the Tier 2 station for VNSOB were noticed during calibration. It was decided to replace it and re-checked.

List of installed instruments and measurement sensors

No.	Instrument	Manufacturer	Model No.	Serial No.
1	Rotating Shadow-band Irradiometer	Reichert	RSP-4G	17-03
2	Pyranometer 1	Hukseflux	SR20-D2	6997
3	Reference Cell 1	IKS	ISET Cell	02623
4	Reference Cell 2	IKS	ISET Cell	03089
5	Reference Cell 3	IKS	ISET Cell	02759
6	Data logger Blue-berry COMPACT	Wilmers Messtech-nik	0141	1167
7	Thermo-hygro Sen-sor	E+E	EE071	17110500025733
8	Anemometer	Wilmers Messtech-nik	0293	1290
9	Wind vane	Wilmers Messtech-nik	0318	20002437
10	Corrosion meas-urement kit	Fraunhofer ISE	Samples: S155-157, Z155-157, A155-157, C155-157	
11	Rain Gauge	Young	52203	TB13883

Table 3.List of installed instruments and measurement sensors at VNSOB

Figure 4. Photo of Tier 2 Station of type HelioScale φ installed at VNSOB

4. HORIZON

Figure 5. Horizon at VNSOB

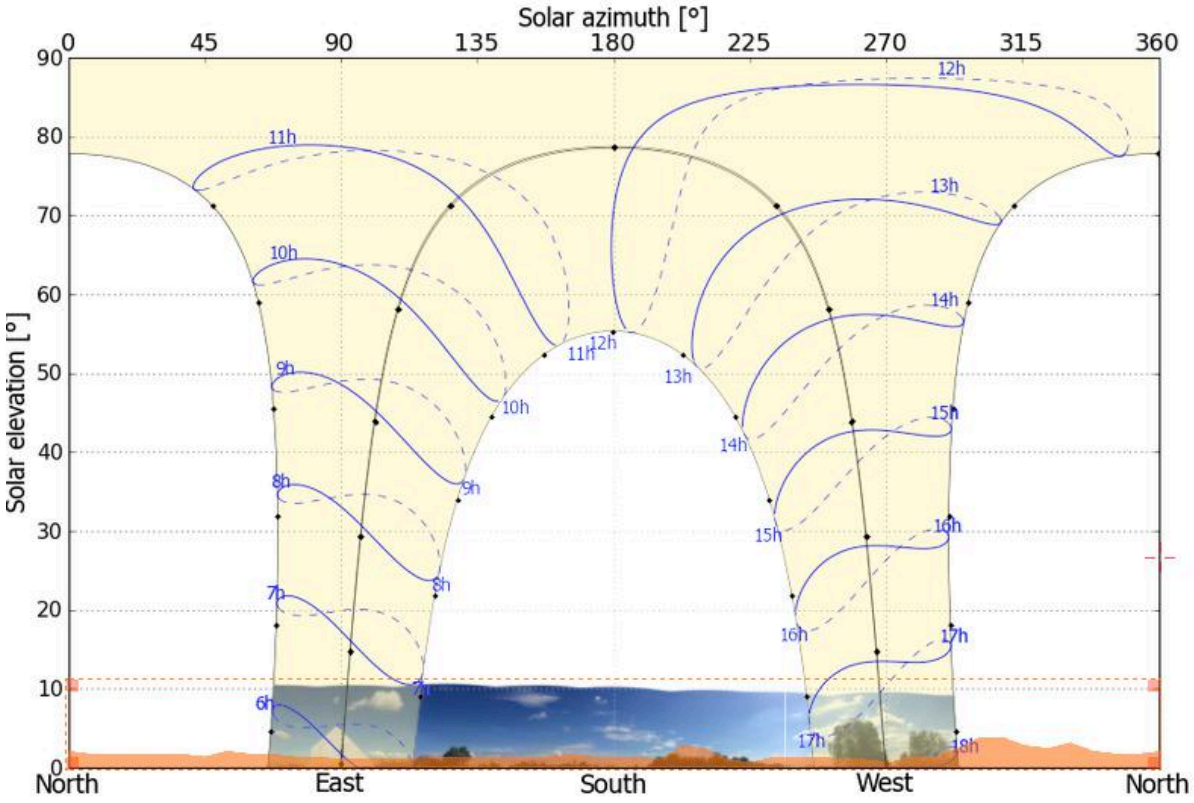


Figure 6. Sun path for VNSOB

5. STATION COMMISSIONING

Responsible staff for monitoring of the stations

Standby Station Keeper

Name: Le Sy Phu

Address: Ban quan ly du an thuy dien 5, khu pho 3, Phuong My Binh, thanh pho Phan Rang, Thuy Chau, Ninh Thuan

Mobile: +84 935612666

Mail: syphuqltd5@gmail.com

Station Supervisor

Name: Tan Tien Nguyen

Address: 60A Cau Be, xa Vinh Thanh, Thanh pho Nha Trang, tinh Khanh Hoa

Mobile: +84 905707760

Mail: tiennt.vatec@gmail.com

Station Supplier

Suntrace GmbH

Address: Grosse Elbstrasse 145c, 22767 Hamburg, Germany

Phone: +49 40 767 96 38 0

Fax: +49 40 767 96 38 20

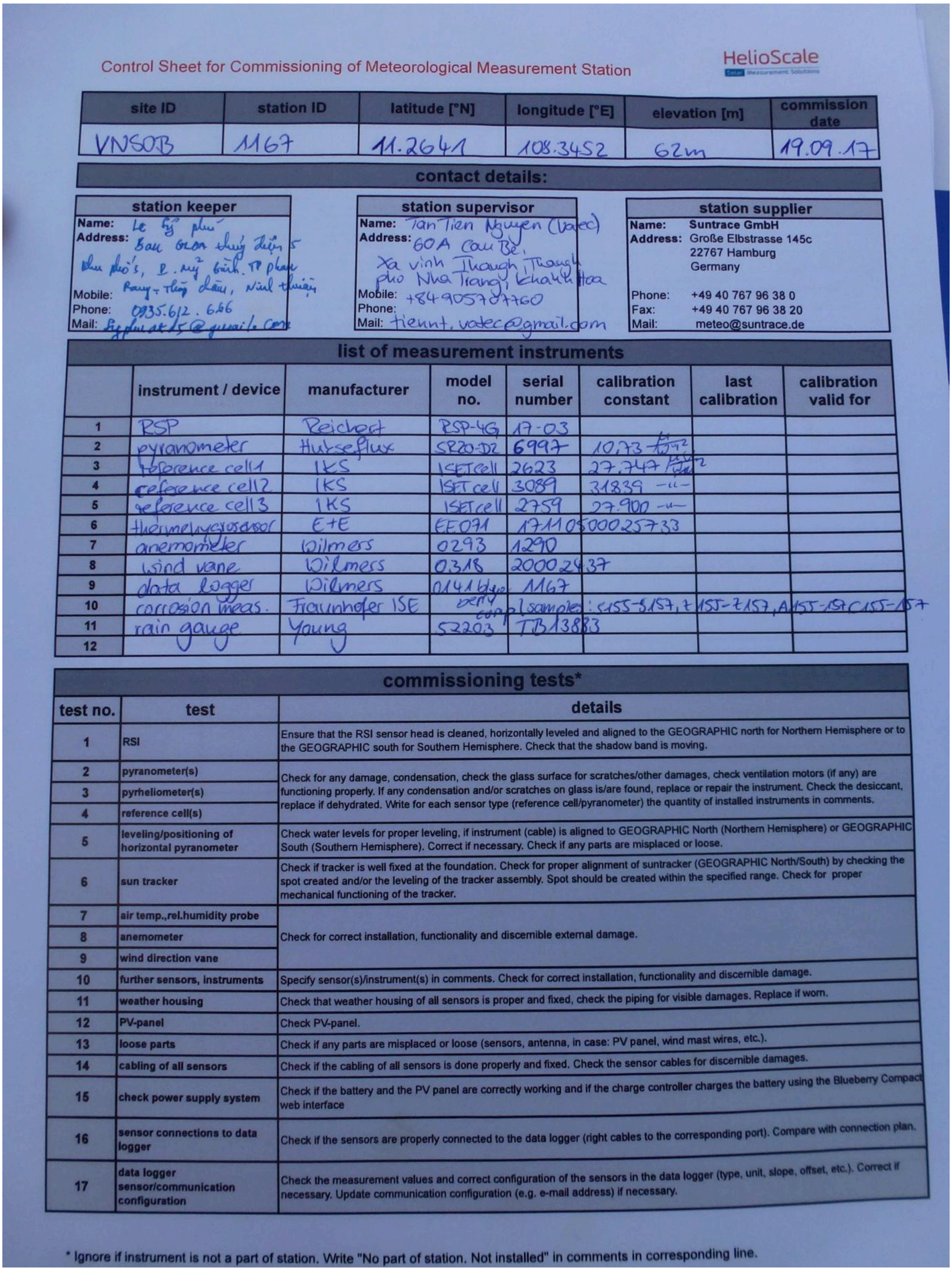
Mail: meteo@suntrace.de

	Applied test	Details	Approved Yes/No	Comments
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 of Southern Hemisphere. Check that the shadow band is moving.	Yes	---
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.	Yes	---

	Applied test	Details	Approved Yes/No	Comments
3	pyrheliometer(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.	---	No part of this station. Not installed.
4	reference cell(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.	Yes	---
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.	Yes	---
6	sun tracker	Check if tracker is well fixed at the foundation. Check for proper alignment of sun tracker (GEOGRAPHIC North/South) by checking the spot created and/or the leveling of the tracker assembly. Spot should be created within a specific range. Check for proper mechanical functioning of the tracker.	---	No part of this station. Not installed.
7	air temperature, rel. humidity probe (thermohygro)	Check for correct installation, functionality and discernible external damage.	Yes	---
8	anemometer	Check for correct installation, functionality and discernible external damage.	Yes	---
9	wind direction vane	Check for correct installation, functionality and discernible external damage.	Yes	---
10	further sensors, instruments	Specify sensor(s)/instrument(s) in comments. Check for correct installation, functionality and discemible damage	Yes	Rain gauge. Corrosion Measurement kit, this will be exposed after 1 year
11	weather housing	Weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.	Yes	---

	Applied test	Details	Approved Yes/No	Comments
12	PV-panel	Properly fixed to tripod, facing south at northern hemisphere and vice versa, no visible damages (cracks, scratches).	Yes	---
13	loose parts	Check if any parts are misplaced or loose (sensors, antenna, PV panel, wind mas wires, etc.).	Yes	---
14	cabling of all sensors	Check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernable damages.	Yes	---
15	check power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.	Yes	---
16	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	---
17	data logger sensor/communication configuration	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	Internet provider: Viettel Mobile APN: e-connect
18	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	---
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your observation and document them.	Yes	---
20	tracker table, tripod & wind mast	Check if is steady and well fixed on the ground. Check bolts on the foundations.	Yes	Tracker table not part of the station.
21	fence, door, lock	Check the fence and door including its lock.	Yes	Station on roof top, ladder locked
22	horizon pictures	360° panorama picture from the view point of radiation sensors should be taken.	Yes	---
23	station pictures	Take photos of all sensors and instruments and also of the whole station. The serial numbers should be seen.	Yes	---
24	general view	Anything unusual? If NO write "Yes" for approved	Yes	---
25	station keeper training and documentation	Training of Station Keeper. Check the station documentation such as: analogy of serial numbers, station logbook, etc.	Yes	---

Table 4. List of applied tests for commissioning at VNSOB



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission date
VNSOB	1167	11.2641	108.3452	62m	19.09.17

contact details:

station keeper	station supervisor	station supplier
Name: Le [illegible]	Name: Tan Tien Nguyen (Vatec)	Name: Suntrace GmbH
Address: [illegible]	Address: 60A Cau Be, Xa vinh Thaugh, Thaugh pho Nha Trang, Khanh Hoa	Address: Große Elbstrasse 145c, 22767 Hamburg, Germany
Mobile:	Mobile: +84905707760	Phone: +49 40 767 96 38 0
Phone: 0935.612.666	Phone:	Fax: +49 40 767 96 38 20
Mail: [illegible]@gmail.com	Mail: tiennt.vatec@gmail.com	Mail: meteo@suntrace.de

list of measurement instruments

	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	RSP	Reichert	RSP-4G	17-03			
2	pyranometer	Hukseflux	SR20-D2	6997	10,73 [illegible]		
3	reference cell1	IKS	ISETcell	2623	27,747 [illegible]		
4	reference cell2	IKS	ISETcell	3089	31839 -"-		
5	reference cell3	IKS	ISETcell	2759	27.900 -"-		
6	thermohygrosensor	E+E	EE071	17110500025733			
7	anemometer	Wilmers	0293	1290			
8	wind vane	Wilmers	0318	20002437			
9	data logger	Wilmers	0141 [illegible]	1167			
10	corrosion meas.	Fraunhofer ISE	very comp	1 samples: S155-S157, Z155-Z157, A155-157, C155-157			
11	rain gauge	Young	52203	TB13883			
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 using the Blueberry Compact web interface
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 configuration	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.

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

Figure 7. Commissioning Protocol page 1/3 VNSOB

Control Sheet for Commissioning of Meteorological Measurement Station

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission date
VNSOB	1167	11.2641	108.3452	62m	19.09.17

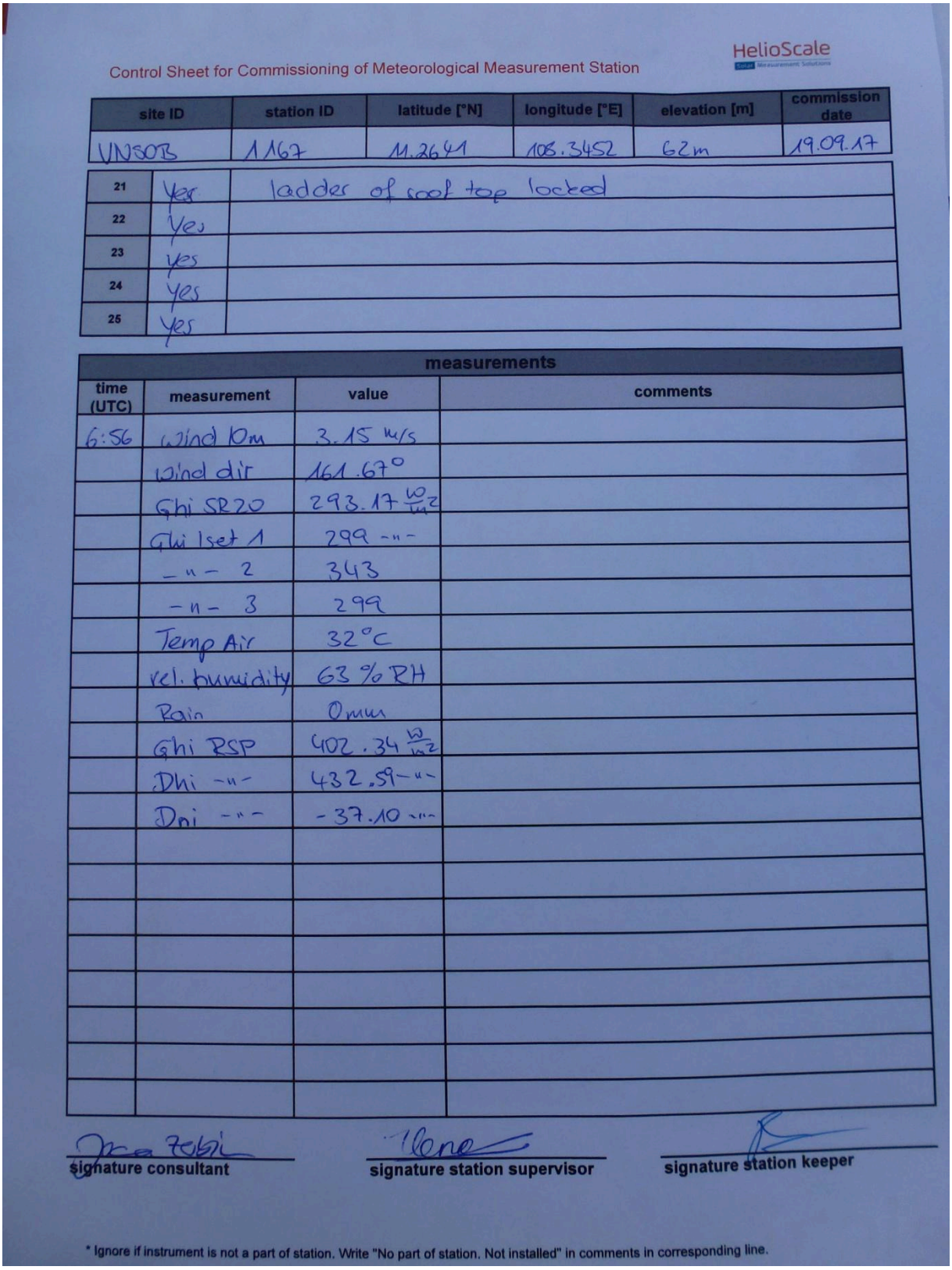
18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your observations and document them.
20	tripod, wind mast	Check if the mast(s) is/are 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.

date:	19.09.17	time (local):	14:15

test results

test no.	approved ? Yes/No	comments*
1	Yes	
2	Yes	
3	–	No part of this station. Not installed.
4	Yes	
5	Yes	
6	–	No part of station. Not installed.
7	Yes	
8	Yes	
9	Yes	
10	Yes	Rain Gauge, Corrosion Measurement System
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	Yes	
19	Yes	
20	Yes	

Figure 8. Commissioning Protocol page 2/3 VNSOB



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude [°N]	longitude [°E]	elevation [m]	commission date
VNSOB	1167	11.2641	108.3452	62m	19.09.17

21	Yes	ladder of roof top locked
22	Yes	
23	yes	
24	Yes	
25	Yes	

measurements

time (UTC)	measurement	value	comments
6:56	Wind 10m	3.15 m/s	
	Wind dir	161.67°	
	Ghi SR20	293.17 W/m²	
	Ghi Set 1	299 -"-	
	-"- 2	343	
	-"- 3	299	
	Temp Air	32°C	
	rel. humidity	63 % RH	
	Rain	0mm	
	Ghi RSP	402.34 W/m²	
	Dhi -"-	432.59 -"-	
	Dni -"-	-37.10 -"-	

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.

Figure 9. Commissioning Protocol page 3/3 VNSOB

6. SUMMARY OF COMPLETED TASK

- The installed equipment has been tested prior delivery for the project.
- The World Bank ESMAP Tier 2 solar measurement station at the location VNSOB is installed and commissioned successfully at the 19th of September 2017
- 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. A daily automatic quality control procedure is applied to the unprocessed raw data, this additionally to the by contract committed monthly delivery of post processed data including a monthly summary report.
- FTP servers will be set up for data sharing with EVN companies at all sites of this measurement campaign.

7. PHOTO DOCUMENTATION

Figure 10. Tier 2 station in VNSOB (northern view)

Figure 11. Tier 2 station in VNSOB (northwestern view)

Figure 12. Tier 2 station in VNSOB (western view)

Figure 13. Tier 2 station in VNSOB during installation

Figure 14. Rain gauge (pluviometer)

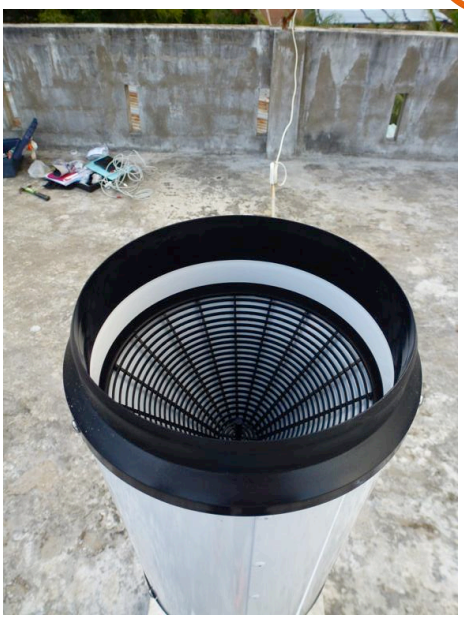


Figure 15. Rain gauge (pluviometer) from top

Figure 16. Corrosion measurement kit

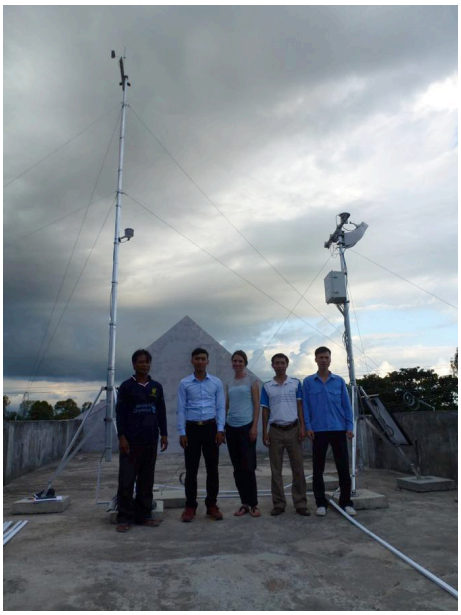


Figure 17. Foto group 1 after commissioning of VNSOB

Figure 18. Foto group 2 after commissioning of VNSOB

Figure 19. General view of VNSOB station: wind mast (far left), Tier 2 station and soiling system (far right), rain gauge (center) and corrosion kit (near right).

SOLAR MEASUREMENT CAMPAIGN IN VIETNAM

SELECTION #: 1231900

Installation Report: Tri An (VNTRA)

Suntrace Technical Documentation
21 September 2017

World Bank Group
ESMAP Renewable Energy Mapping Initiative

Authors:
Joana Zerbin, Marko Schwandt

Reviewed by:
Dr. Richard Meyer, Raúl Granados

Authors Contact Information:
Suntrace GmbH
Grosse Elbstrasse 145c
22767 Hamburg
Germany
E: meteo@suntrace.de
W: www.suntrace.de

HRB Hamburg: 110819
VAT: DE266610323

Table of content

1. INTRODUCTION

The principal task of this installation project was the installation of six meteorological measurement stations at the selected sites including the training of the local staff from EVN (Vietnam Electricity, state-owned utility) on principle maintenance works of the meteorological measurement stations of Type HelioScale ω (Tier 1) and Type HelioScale φ (Tier 2). The selected sites are listed in Table 1, see also Implementation Plan for more details.

The first installation mission took place from 22nd of August to 1st of September 2017. During the first installation mission, the Tier 1 stations were installed at the sites VNCEH (Central Highlands), VNTRA (Tri An) and VNHAN (Bac Ninh near Hanoi). All Tier 2 stations (2x Tier 2 stations for sites VNDAN (Da Nang) and VNSOB (Song Binh) plus 1x Tier 2 spare station) were additionally installed at VNCEH for calibration of the RSP sensors for 2 ½ weeks until the second installation mission started. The second installation mission was undertaken from 12th to 19th of September 2017 and the Tier 2 stations at VNDAN and VNSOB were installed. The spare station will be stored at the Head office of VATEC in Nha Trang. The inauguration with the local government, EVN and World Bank representatives was held on 20th of September in Song Binh (VNSOB).

The International Experts Joana Zerbin and Marko Schwandt from Suntrace GmbH traveled from Germany / Spain to the sites in Vietnam. Vietnam Applied Technical Co. Ltd (VATEC) as local partner company in this project supported Suntrace during the installation.

Overview of Station Sites

Figure 1. Country map showing sites for solar measurement stations considered for the Vietnam ESMAP project.

Site name and description	Type	Site code	Elevation	Latitude	Longitude
Hanoi region: Bac Ninh on rooftop of new EVN bldg.	Tier1	VNHAN	60 m	21.2013°N	106.0629°E
Da Nang on rooftop of EVN/CPC bldg. within the city	Tier2	VNDAN	24 m	16.0125°N	108.1865°E
Central Highlands region on ground before EVN bldg. near hydro spillway	Tier1	VNCEH	290 m	12.7535°N	107.8761°E
Song Binh station location on private house's rooftop	Tier2	VNSOB	62 m	11.2641°N	108.3452°E
Tri An region near HCMC on top of EVN bldg. near water spillway	Tier1	VNTRA	57 m	11.1024°N	107.0378°E

Table 1. Selected sites for solar measurement stations in Vietnam within the WB ESMAP program

This report gives an overview of the on-site installation of the Tier 1 station in Tri An region, near Ho Chi Minh City, on top of an EVN building close to the Tri An dam near the water spillway. The installation took place between 28th and 29th of August 2017. The site code for this site is VNTRA.

Tier 1 stations are equipped with a robust and highly reliable pyrheliometer, a shaded pyranometer (which measures DHI), a non-shaded pyranometer (which measures GHI), and a 2-axis sun tracker with a shadow-ball assembly. Besides, a barometer measures atmospheric pressure and a thermo-hygro sensor measures air temperature and relative humidity. Additionally, a wind mast with a cup anemometer and a wind vane assembly ensures measuring accurate wind speed and direction. Furthermore, a plug-and-play blueberry COMPACT data-logging system controls, stores and transmits the measured data of the stations. For power supply of the Tier 1 stations, a solar panel, batteries and charge controllers are installed. At this site, a soiling measurement system and a corrosion measurement kit are also installed.

2. LOCATION TRI AN – VNTRA

Figure 2. Country map showing the site VNTRA for solar measurements considered for the Vietnam ESMAP project.

Figure 3. Location of VNTRA relative to the extent of the region

3. DESCRIPTION OF STATION

Installation details	
Location	Vietnam – Tri An region near HCMC on top of EVN bldg. near water spillway, Tri An dam
Site ID	VNTRA
Station ID	1164
Longitude/Latitude	11.1024°N/107.0378°E
Elevation	57 m
Date of commencement	29th of August 2017

Table 2.Overview of site parameters VNTRA

Solar Measurement Station Tier 1

Recorded meteorological parameters:

- global horizontal irradiance (GHI) in W/m²
- direct normal irradiance (DNI) in W/m²
- diffuse horizontal irradiance (DHI) in W/m²
- ambient temperature in °C
- relative humidity in %
- wind speed in m/s ca. 13 m above ground
- wind direction at ca. 13 m above ground
- barometric pressure in hPa
- corrosion measurement kit measuring the corrosivity of metals i.e. oxidation of metal. 4 different samples are used_ aluminum (Al), copper (Cu), steel (Fe) and zinc (Zn).
- soiling measurement via 3 reference cells measuring global tilted (10°) irradiance (GTI) in W/m²

Additional observations:

- As the EVN building's roof is ca.10 m high, a 3 m high wind mast was installed above the rooftop.
- For Tier 1 stations, a 250 Wp photovoltaic panel, batteries and a charge controller are installed.

List of installed instruments and measurement sensors

No.	Instrument	Manufacturer	Model No.	Serial No.
1	Pyrheliometer	Hukseflux	DR-02	9312
2	Pyranometer 1 (DHI)	Hukseflux	SR30-01	2120
3	Pyranometer 2 (GHI)	Hukseflux	SR30-01	2124
4	Reference Cell 1	IKS	ISET Cell	02687
5	Reference Cell 2	IKS	ISET Cell	02691
6	Reference Cell 3	IKS	ISET Cell	02683
7	Data logger Blueberry COMPACT	Wilmers Messtechnik	0141	1164
8	Thermo-hygro Sensor	E+E	EE071	171105000249E8

No.	Instrument	Manufacturer	Model No.	Serial No.
9	Anemometer	Wilmers Messtechnik	0293	1292
10	Wind vane	Wilmers Messtechnik	0318	20003590
11	Sun tracker including shading assembly	EKO	STR-22G	S1510788
12	Corrosion measurement	Fraunhofer ISE		Samples: S152-154, Z152-154, A152-154, C152-154

Table 3.List of installed instruments and measurement sensors VNTRA

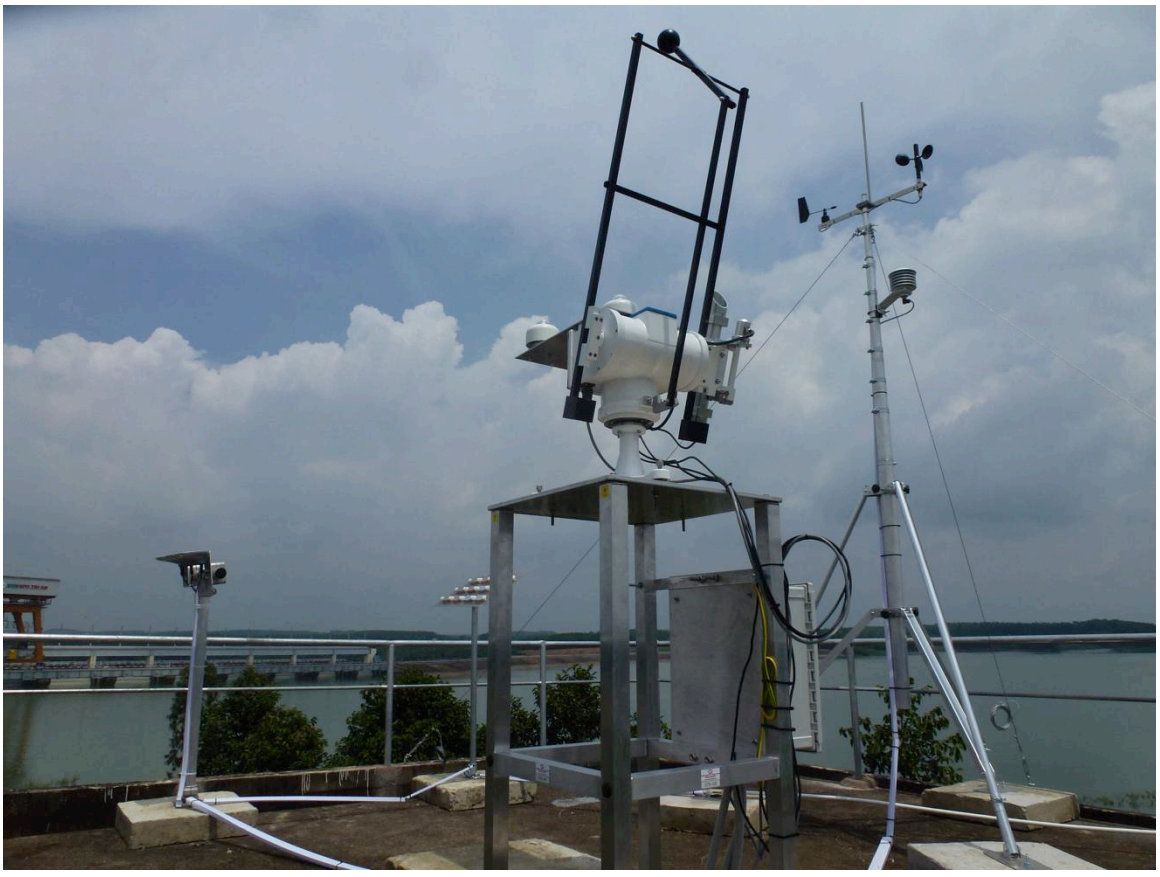


Figure 4. Photo of Tier 1 Station of type HelioScale ω installed at VNTRA

4. HORIZON

Figure 5. Horizon at VNTRA

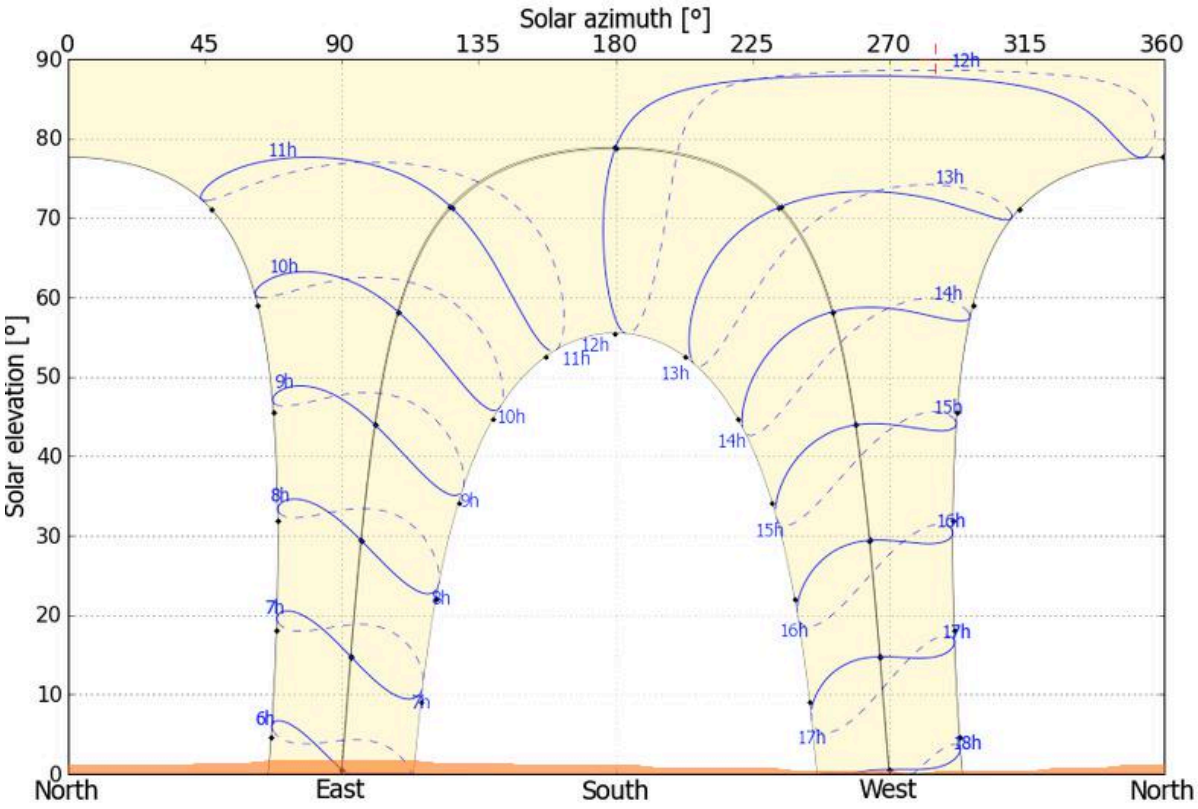


Figure 6. Sun path for VNTRA

5. STATION COMMISSIONING

Responsible staff for monitoring of the stations

Standby Station Keeper

Name: Huynh Ngoc Cuong
Address: Thi tran Vinh An, huyen Vinh Cuu, tinh Dong Nai
Mobile: +89 974426699
Mail: huynhngoccuong@yahoo.com

Station Supervisor

Name: Tan Tien Nguyen
Address: 60A Cau Be, xa Vinh Thanh, thanh pho Nha Trang, tinh Khanh Hoa
Mobile: +84 905707760
Mail: tiennt.vatec@gmail.com

Station Supplier

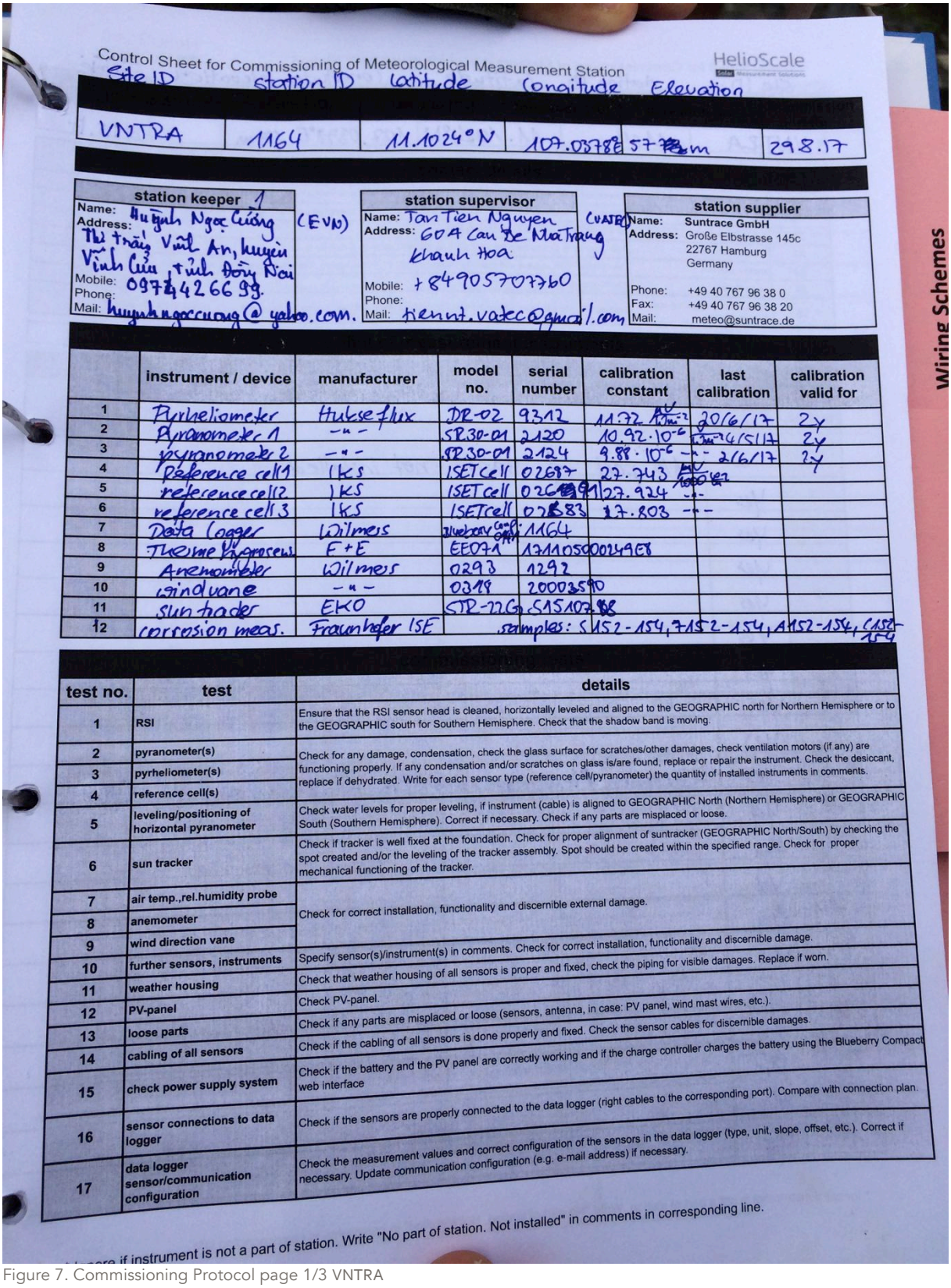
Suntrace GmbH
Address: Grosse Elbstrasse 145c, 22767 Hamburg, Germany
Phone: +49 40 767 96 38 0
Fax: +49 40 767 96 38 20
Mail: meteo@suntrace.de

	Applied test	Details	Approved Yes/No	Comments
1	RSI	-	-	No part of station – not installed
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.	Yes	---
3	pyrheliometer(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.	Yes	---

	Applied test	Details	Approved Yes/No	Comments
4	reference cell(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.	Yes	---
5	leve- ve- ling/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.	Yes	---
6	sun tracker	Check if tracker is well fixed at the foundation. Check for proper alignment of sun tracker (GEOGRAPHIC North/South) by checking the spot created and/or the leveling of the tracker assembly. Spot should be created within a specific range. Check for proper mechanical functioning of the tracker.	Yes	---
7	air temperature, rel. humidity probe (thermohygro)	Check for correct installation, functionality and discernible external damage.	Yes	---
8	anemometer	Check for correct installation, functionality and discernible external damage.	Yes	---
9	wind direction vane	Check for correct installation, functionality and discernible external damage.	Yes	---
10	further sensors, instruments	Specify sensor(s)/instrument(s) in comments. Check for correct installation, functionality and discemible damage	-	Corrosion Measurement kit, this will be exposed after 1 year
11	weather housing	Weather housing of all sensors is proper and fixed, check the piping for visible damages. Replace if worn.	Yes	---
12	PV-panel	Properly fixed to tripod, facing south at northern hemisphere and vice versa, no visible damages (cracks, scratches).	Yes	---
13	loose parts	Check if any parts are misplaced or loose (sensors, antenna, PV panel, wind mas wires, etc.).	Yes	---
14	cabling of all sensors	Check if the cabling of all sensors is done properly and fixed. Check the sensor cables for discernable damages.	Yes	---

	Applied test	Details	Approved Yes/No	Comments
15	check power supply system	Check if the battery and the PV panel are correctly working and if the charge controller charges the battery.	Yes	---
16	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	---
17	data logger sensor/communication configuration	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	Internet provider: Viettel Mobile APN: e-connect
18	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	---
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your observation and document them.	Yes	---
20	tracker table, tripod & wind mast	Check if is steady and well fixed on the ground. Check bolts on the foundations.	Yes	---
21	fence, door, lock	Check the fence and door including its lock.	Yes	Station on roof top, building well locked
22	horizon pictures	360° panorama picture from the view point of radiation sensors should be taken.	Yes	---
23	station pictures	Take photos of all sensors and instruments and also of the whole station. The serial numbers should be seen.	Yes	---
24	general view	Anything unusual? If NO write “Yes” for approved	No	---
25	station keeper training and documentation	Training of Station Keeper. Check the station documentation such as: analogy of serial numbers, station logbook, etc.	Yes	---

Table 4. List of applied tests for commissioning at VNTRA



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

Site ID	station ID	Latitude	Longitude	Elevation	
VNTRA	1164	11.1024° N	107.05788 E	57 m	298.17

station keeper 1
Name: Huỳnh Ngọc Cường (EVN)
Address: Thị trấn Vĩnh An, huyện Vĩnh Cửu, tỉnh Đồng Nai
Mobile: 0974426699
Phone:
Mail: huynhngoccuong@yahoo.com

station supervisor
Name: Tan Tien Nguyen (VATEC)
Address: 604 Cau De Nha Trang Khanh Hoa
Mobile: +84905707760
Phone:
Mail: tiennt.vatec@gmail.com

station supplier
Name: Suntrace GmbH
Address: Große Elbstrasse 145c
22767 Hamburg
Germany
Phone: +49 40 767 96 38 0
Fax: +49 40 767 96 38 20
Mail: meteo@suntrace.de

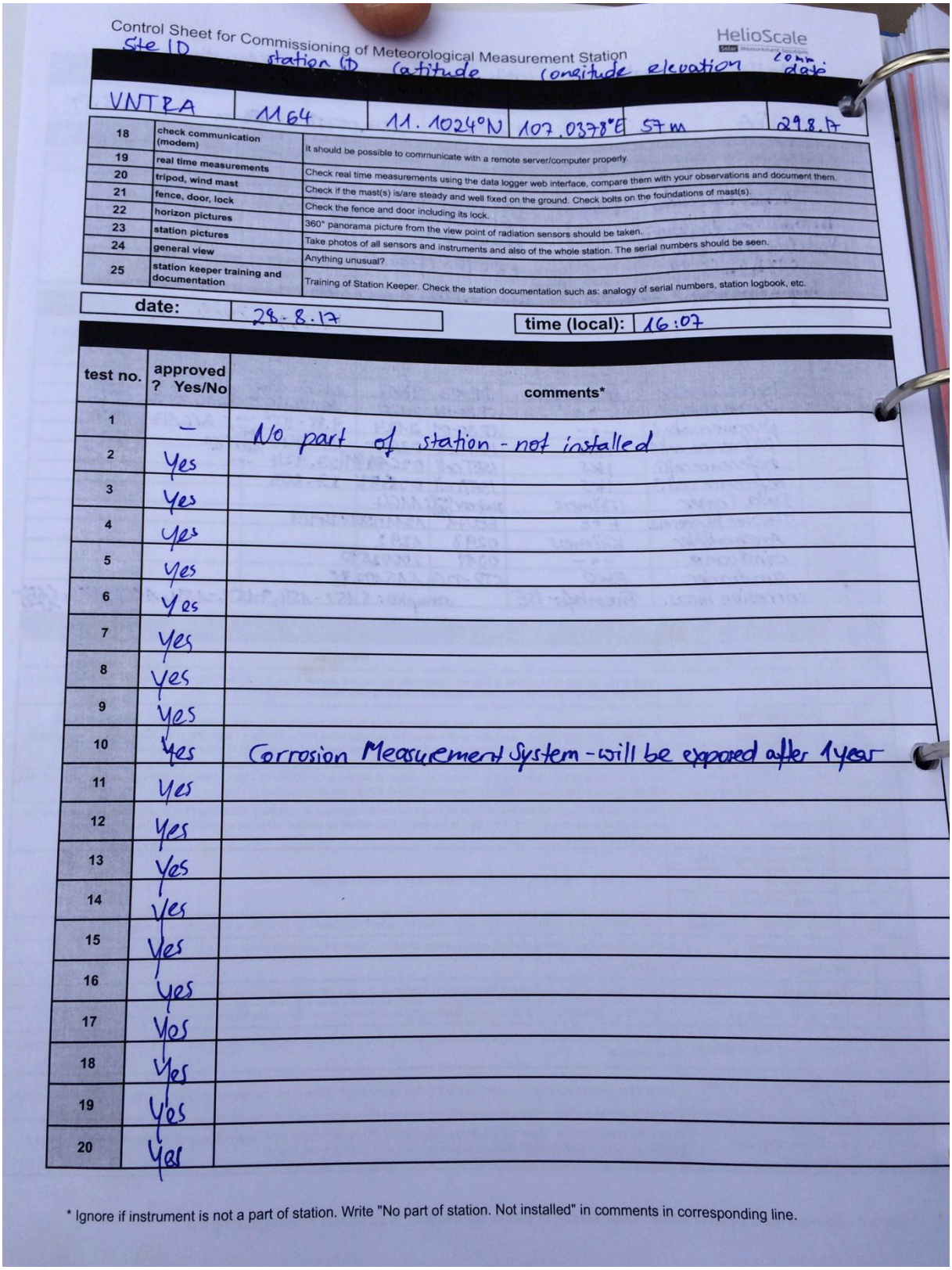
	instrument / device	manufacturer	model no.	serial number	calibration constant	last calibration	calibration valid for
1	Pyrheliometer	Hukseflux	DR-02	9312	11.72	2016/17	2y
2	Pyranometer 1	-"-	SR30-01	2120	$10.92 \cdot 10^{-6}$	24/5/17	2y
3	pyranometer 2	-"-	SR30-01	2124	$9.88 \cdot 10^{-6}$	-"- 2/6/17	2y
4	Reference cell 1	IKS	ISET cell	02687	27.743		
5	reference cell 2	IKS	ISET cell	02691	27.924	-"-	
6	reference cell 3	IKS	ISET cell	02683	27.803	-"-	
7	Data Logger	Wilmers	Blueberry	1164			
8	Thermo Pyranometer	E+E	EE071	17110500024968			
9	Anemometer	Wilmers	0293	1292			
10	windvane	-"-	0319	20003590			
11	sun tracker	EKO	STR-22G	S15107			
12	corrosion meas.	Fraunhofer ISE		samples: S1S2-154, T1S2-154, A1S2-154, C1S2-154			

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 using the Blueberry Compact web interface
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 configuration	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.

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

Wiring Schemes

Figure 7. Commissioning Protocol page 1/3 VNTRA



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

Site ID	station ID	Latitude	Longitude	elevation	zone	date
VNTRA	1164	11.1024°N	107.0378°E	57 m		29.8.17

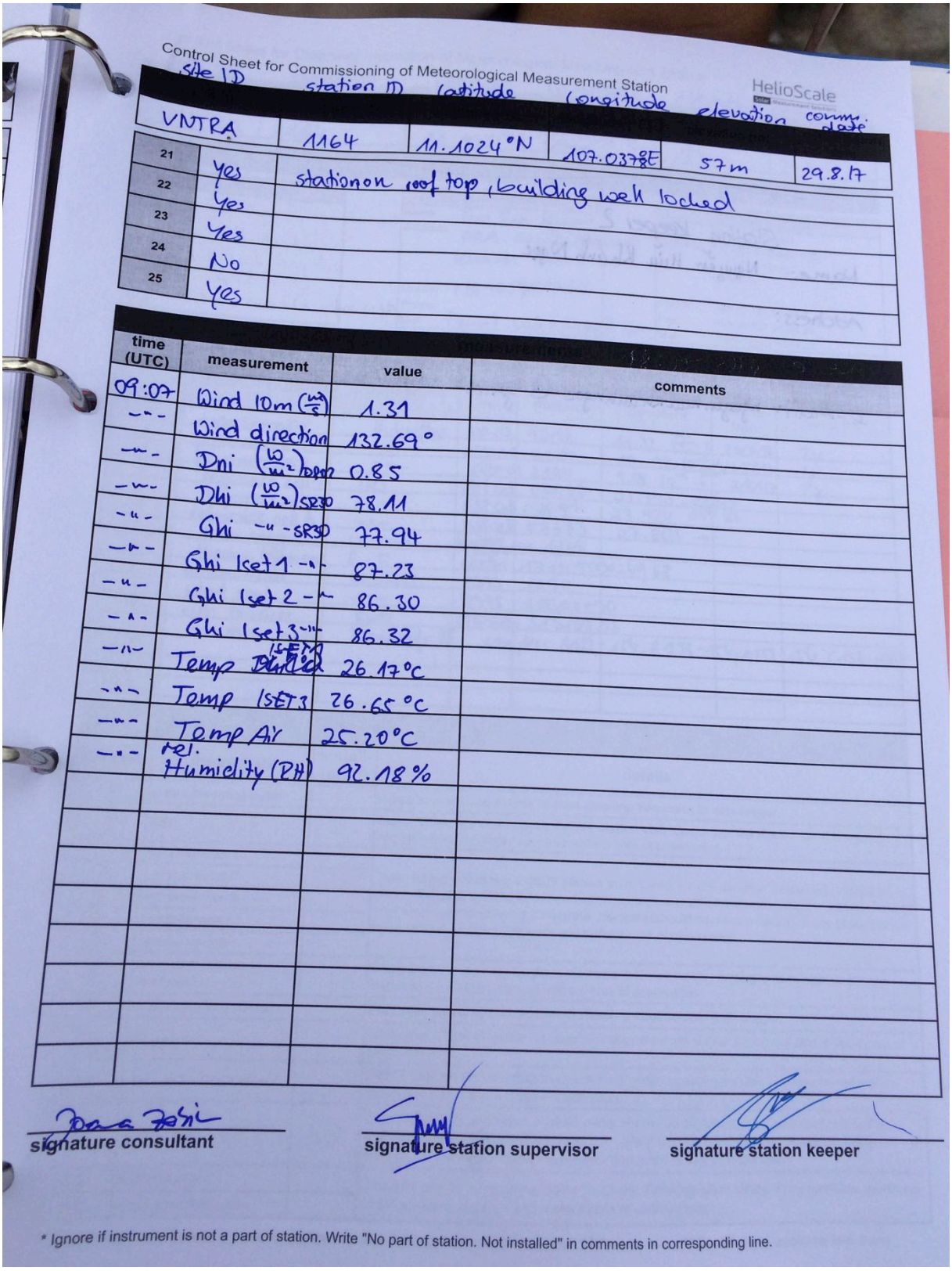
18	check communication (modem)	It should be possible to communicate with a remote server/computer properly.
19	real time measurements	Check real time measurements using the data logger web interface, compare them with your observations and document them.
20	tripod, wind mast	Check if the mast(s) is/are 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.

date: 28.8.17 time (local): 16:07

test no.	approved ? Yes/No	comments*
1	–	No part of station - not installed
2	Yes	
3	Yes	
4	Yes	
5	Yes	
6	Yes	
7	Yes	
8	Yes	
9	Yes	
10	Yes	Corrosion Measurement System - will be exposed after 1 year
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	Yes	
19	Yes	
20	Yes	

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

Figure 8. Commissioning Protocol page 2/3 VNTRA



Control Sheet for Commissioning of Meteorological Measurement Station

HelioScale

site ID	station ID	latitude	longitude	elevation	comm. date
VNTRA	1164	11.1024°N	107.0378E	57m	29.8.17

21	yes	station on roof top, building was locked
22	yes	
23	yes	
24	No	
25	yes	

time (UTC)	measurement	value	comments
09:07	Wind 10m ($\frac{m}{s}$)	1.31	
-"-	Wind direction	132.69°	
-"-	Dni ($\frac{W}{m^2}$) DR20	0.85	
-"-	Dhi ($\frac{W}{m^2}$) SR30	78.11	
-"-	Ghi -"- SR30	77.94	
-"-	Ghi Iset1 -"-	87.23	
-"-	Ghi Iset2 -"-	86.30	
-"-	Ghi Iset3 -"-	86.32	
-"-	Temp Dhi (SET2)	26.17°C	
-"-	Temp ISET3	26.65°C	
-"-	Temp Air	25.20°C	
-"-	rel. Humidity (RH)	92.18%	

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.

Figure 9. Commissioning Protocol page 3/3 VNTRA

6. SUMMARY OF COMPLETED TASK

- The installed station and spare parts have been tested prior to delivery for the project.
- The World Bank ESMAP Tier 1 solar measurement station at the location VNTRA is installed and commissioned successfully at the 29^{h} of August 2017
- 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. A daily automatic quality control procedure is applied to the unprocessed raw data, this additionally to the by contract committed monthly delivery of post processed data including a monthly summary report.
- FTP servers will be set up for data sharing with EVN companies at all sites of this measurement campaign.

7. PHOTO DOCUMENTATION

Figure 10. Tier 1 station at VNTRA

Figure 11. Wind mast measuring wind speed & direction and thermo-hygro sensor at VNTRA

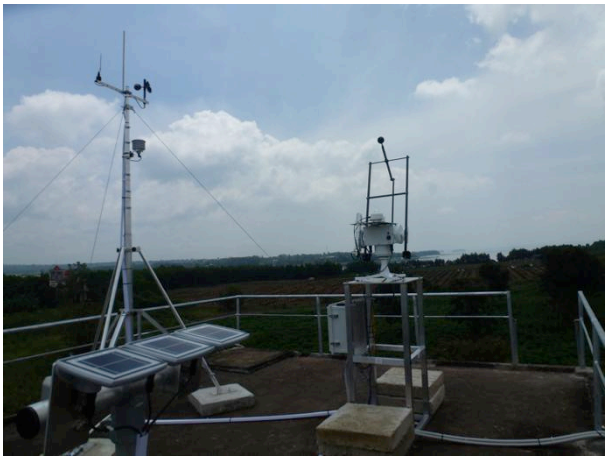


Figure 12. Tier 1 station with wind mast and soiling measurement at VNTRA

Figure 13. Tier 1 station at VNTRA

Figure 14. Tier 1 station at VNTRA with add. Equipment

Figure 15. Tier 1 station with data logger in the front at VNTRA

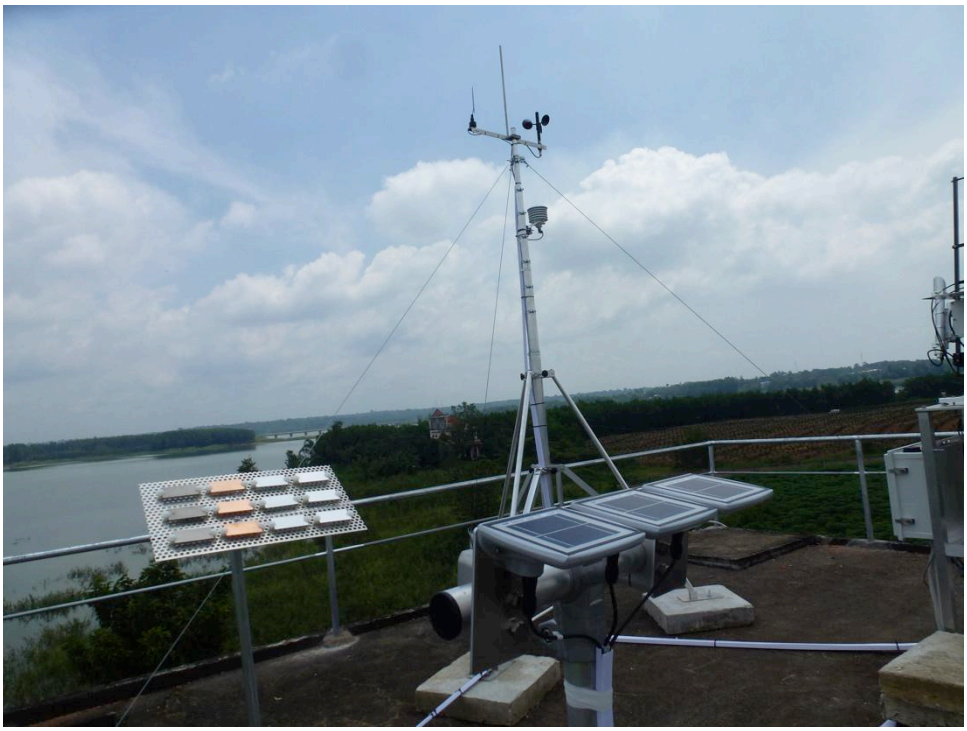


Figure 16. Corrosion measurement kit (left), soiling measurement system (front), wind mast (back) at VNTRA

Figure 17. Tier 1 station on the rooftop at VNTRA

Figure 18. Commissioning and station keeper training with EVN staff at VNTRA

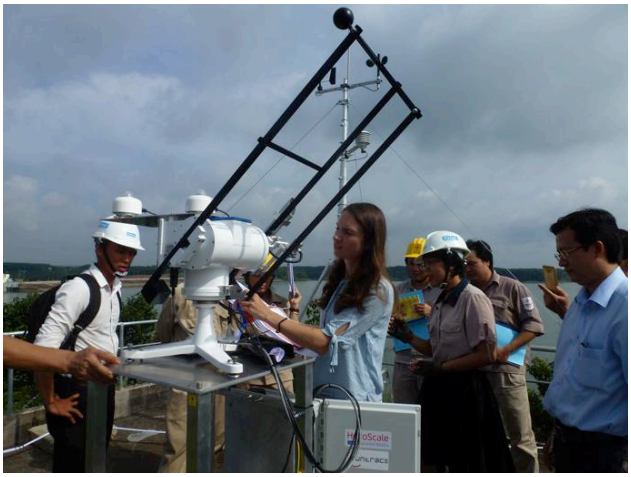


Figure 19. Commissioning and station keeper training with EVN staff at VNTRA

Figure 20. Commissioning and station keeper training with EVN staff at VNTRA

Figure 21. After commissioning with EVN staff at VNTRA