



**Sentinel Peak Resources  
Inglewood Oil Field**

**METEOROLOGICAL STATION ANNUAL DATA REPORT - 2021**

***Baldwin Hills CSD Condition 22.310.050.B.10***

Prepared: February 2022

Prepared for:

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## **1.0 INTRODUCTION**

### **1.1 BACKGROUND, CSD CONDITIONS**

Sentinel Peak Resources (SPR) operates a Meteorological Station at the Inglewood Oil Field in Los Angeles County, the installation and operation of which is a requirement of the Baldwin Hills Community Standards District (CSD). The station design was approved by the South Coast Air Quality Management District (SCAQMD) when it was first put into operation in 2010. The SCAQMD approval was provided to the Los Angeles County Regional Planning Division, who oversees implementation of the CSD.

The CSD Section 22.310.050.B.10 states:

“Meteorological Station. The operator shall maintain and operate a meteorological station at the oil field in good operating condition and in compliance with all applicable Environmental Protection Agency ("EPA") and SCAQMD rules, regulations, and guidelines, and to the satisfaction of the director. The operator shall conduct an audit of the meteorological station on an annual basis and submit the results of the audit to the SCAQMD and the director. The operator shall maintain the data files for the meteorological station for a period of not less than 10 years. All such data shall be available upon request to the SCAQMD and the director.”

The CSD Section 22.310.050.B.4 further defines the schedule for the project:

“Meteorological Station. Within 120 days following the effective date, or at such later date as may be approved by the director for good cause shown, the operator shall submit to the SCAQMD a design for the installation of a meteorological station at the oil field that shall meet all the requirements of the United States Environmental Protection Agency ("EPA") guidelines on meteorological data as outlined in EPA Publication "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (EPA-454/R-99-005) as published in February 2000. The operator shall take such actions as may be necessary to promptly secure SCAQMD approval of such design. The meteorological station shall be installed and fully operational within 180 days of receipt of approval of the design from the SCAQMD, or at such later date as may be approved by the director for good cause shown.”

### **1.2 PURPOSE OF THE METEOROLOGICAL STATION**

Meteorological data is collected for general use in air quality modeling applications and consists of wind direction, wind speed, temperature and temperature differential, and solar radiation. A decade ago, meteorological data from the West Los Angeles station for 1981 was used in the preparation of the health risk assessment for the Baldwin Hills CSD Environmental Impact Report (EIR), in conjunction with the five-year (1985-1989) meteorological dataset from Los Angeles International Airport inherent to the Hotspots Analysis and Reporting Program Model. These regional meteorological stations remain in service today such that longer-term data is available from these sources.

The Inglewood Oil Field meteorological station collects data representative of the local conditions at the oil field, so that after a five-year period a determination can be made if the oil field meteorological conditions are significantly different warranting a rerun of the health risk assessment, per the CSD Condition 22.310.050.B.11:

“Updated Health Risk Assessment. After every five years of operation of the meteorological station, the operator shall provide the previous five years of meteorological data to the SCAQMD and the director. If the SCAQMD or the director determines that the previous five years of meteorological data from the oil field could result in significant changes to the health risk assessment that was conducted as part of the Baldwin Hills Community Standards District Environmental Impact Report, then the county may elect to

re-run the health risk assessment using the previous five years of meteorological data from the meteorological station.”

Further, the approved Odor Minimization Plan dated February 2009 states that odor complaints “will be compared with the wind direction identified during the time of reported complaint, using the oil field map. Wind direction will be obtained from the data recorded at the PXP meteorological station”. Thus, meteorological data is referenced in our odor complaint investigations.

The purpose of the Meteorological Station is therefore two-fold:

1. As a reference in investigating odor complaints; and,
2. To determine whether the previous five years of meteorological data from the oil field could result in significant changes to the health risk assessment.

Meteorological station data recorded at the Inglewood Oil Field was also reviewed in 2016; no “significant changes” were evident, such that no update to the health risk assessment was recommended based on this consideration.<sup>1</sup>

### **1.3 COMPLIANCE**

The required Meteorological Station design was submitted to the County and the SCAQMD on March 25, 2009 and was approved by the County and the SCAQMD on July 21, 2009. The design of the station is compliant with the United States Environmental Protection Agency (EPA) guidelines on meteorological data as outlined in EPA Publication "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (EPA-454/R-99-005, February 2000). Fully compliant operations and data collection for the Inglewood Oil Field meteorological station started on January 15, 2010.

The primary meteorological parameters that are measured at the Inglewood Oil Field meteorological station, per the EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV (2008), are as follows:

- Wind speed (horizontal), measured in miles per hour (mph);
- Wind direction, measured in degrees;
- Temperature, measured in degrees F (°F)
- Temperature difference (delta temperature), measured in °F; and,
- Solar radiation, measured in Watts per meter squared (W/m<sup>2</sup>).

Annual reports for previous years beginning in 2010 have been prepared. This report presents the required annual audit and data analysis per the CSD Section 22.310.050.B.10 requirements, for the data collected during calendar year 2021, the eleventh (11<sup>th</sup>) year of the station operation.

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<sup>1</sup> See 2016 Environmental Quality Assurance Plan by MRS, “MRS determined Met data not significantly different, no recommendation for updated health risk assessment. SCAQMD did not comment”.

## 2.0 METEOROLOGICAL STATION INSTALLATION & OPERATION

### 2.1 METEOROLOGICAL STATION LOCATION AND INSTRUMENTATION

The station is comprised of a 10-meter (33 feet) tall tower, with meteorological sensors mounted on the tower, and a data logger at the base. Figure 1 and Figure 2 show images of the meteorological station as configured during calendar year 2020.

The meteorological station is located on the well pad of well #129 on Vickers Lease (see the maps on **Figure 3** "Field view" and **Figure 4** "Close-up view"). Geographic Coordinates of the station are 34° 00' 32.00"N, 118° 22' 43.30" W. The location is at an elevation of 122 meters (400 ft) above sea level, is free from vegetation, and is over 100 m (330 feet) away from the closest obstruction. The distance from the nearest obstruction meets the EPA requirement that the station is at least 10 times the height of the closest obstruction.



**Figure 1.** Meteorological Station at Inglewood Oil Field

The station tower is mounted on a secure foundation and equipped with a lightning rod grounding system and is specifically designed to support meteorological instruments. The station is powered from the oil field's power grid. The sensors are secured to the station tower with mounting arms specifically designed to support meteorological instruments.

In 2021, the five sensors mounted on the station tower were as follows:

- one wind direction sensor,
- one wind speed sensor,
- two temperature sensors to measure ambient temperature and temperature difference (delta temperature) at 2 meters and 10 meters, and
- one solar radiation sensor.

The two temperature sensors are shielded from direct sun with air-aspirated shields. These shields prevent heating of the temperature sensors by direct sun exposure and thus distorting the actual temperature measurement.

On September 17, 2019, SPR initiated installation of a new, more updated datalogger and cellular modem communications (Campbell Scientific CR1000 datalogger and CELL210 cellular modem). Prior to the upgrade, an "as found" calibration was performed on the instrumentation as measured by the Met One Automet datalogger. Following the installation of the new Campbell Scientific CR1000 datalogger, an "as left" calibration was performed through the new data system to verify the sensor and overall system accuracy.



**Figure 2.** Upgraded datalogger and cellular modem from 2019

## 2.2 METEOROLOGICAL STATION OPERATION AND MAINTENANCE

SPR assumed ownership of the oilfield and meteorological station on December 30, 2016, and assumed responsibility for the operations and maintenance of the station. In early months of our responsibility for this station, we experienced some data anomalies associated with failure to manually download data within an overwrite timeframe. That data retrieval was corrected before and throughout calendar year 2018. Sentinel Peak Resources upgraded the station in 2018, working closely with Met One Instruments Inc. (Met One) to determine the best available options for upgrades to the datalogger and sensors. Consequently, older sensors were retired so that we began 2018 with newer replacement sensors. Beginning in May 2019, Sentinel Peak Resources retained T&B Systems to provide quarterly onsite performance audits of the meteorological instrumentation. Based upon some of the initial audit findings in May 2019 and noted issues with data loss and difficulties accessing data through the Met One interface, it was decided in mid-2019 to upgrade the Met One datalogger to a Campbell Scientific CR1000 datalogger and cellular modem for remote data polling. This equipment upgrade was performed in September 2019. Quarterly, independent audits in 2021 were performed by T&B Systems on March 2, 2021, June 9, 2021, September 13, 2021 and on December 9, 2021. The summary reports for each of the audits can be found in **Attachment 5**.

SPR personnel also conducted regular visual inspections for the following parameters:

- proper rotation (no noise or off-center rotation) of the wind anemometer and wind direction vane,
- that there are no obstructions to the sensors, and
- overall cleanliness and orderly appearance of the instruments, tower, and data logger.

Identical sensors are kept on inventory for each of the sensors installed on the station so that when time came for the scheduled calibration, an identical calibrated sensor could be installed quickly, while the one

that needs to be calibrated is sent to the vendor facility. Refer to **Attachment 3** for relevant sensor calibration records.

SPR maintains logs of the 2021 meteorological station events, which are summarized and provided in **Attachment 4**.

## **2.3 DATA COLLECTION, ANALYSIS AND ARCHIVING**

During 2021, data from the sensors was transmitted to a datalogger mounted at the base of the tower. The datalogger computed and recorded hourly averages from all the station sensors per the EPA Publication "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (EPA-454/R-99-005). Following the installation of the new CR1000 datalogger, T&B Systems setup routine, remote polling of the datalogger via cellular modem and are currently ingesting the data into their data management and visual software system. Data were reviewed monthly for anomalies with assistance from an independent contractor (T&B Systems). Any missing or anomalous data was flagged and is noted in the preceding table. The wind speed and seasonal wind direction data was also plotted as wind roses (see **Attachment 2**).

## **3.0 ANALYSIS OF DATA COLLECTED IN 2021**

Meteorological data was collected and reviewed throughout 2021. The hourly data that were flagged monthly were reviewed in more detail. At the end of the year, the data were analyzed for errors and inconsistencies per the EPA specifications on meteorological data validation.

### **3.1 DATA VALIDATION TECHNIQUES**

The data collected at the Inglewood Oil Field meteorological station was compared to the AQMD's meteorological station located at the Los Angeles Airport (LAX); this set of data was checked for quality control and recommended for use in the Sentinel Peak Resources data validation effort by Kevin Durkee of the SCAQMD.

Data validation was performed per the EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements (2008). The method included

- evaluating minimum, maximum and average for the whole data set for each meteorological parameter
- plotting the data versus time and looking for anomalies, data outliers such as too high or too low values, "no-activity", zero data, unusual spikes, unusual inactivity or repeated data for prolonged time periods, etc.
- comparisons with the upper and/or lower limit on the allowed data ranges, normal changes/variations in parameters, see **Attachment 1** for the details on the various data validation techniques
- plotting wind roses and comparing with wind roses to the nearby AQMD LAX PAMS meteorological station, see **Attachment 2**

### 3.2 DATA GAPS AND ANOMALIES

Using the techniques described above, data anomalies and other notable events for missing or invalid data in 2021 are identified in **Table 1**. Data during these periods were removed from the validated dataset.

**Table 1 Summary of SPR Notable Events in 2021 Affecting Data Capture.**

Date/Hours Affected	Parameter(s) Invalidated	Reason for Invalidation
February 12 - 19, 2021 (12:00 - 12:00)	Wind Direction	Wind Vane blew off of the WD sensor
March 2, 2021 (08:00 & 09:00)	All parameters	Quarterly Audit
June 9, 2021 (07:00, 08:00 & 09:00)	All parameters	Quarterly Audit
August 17 – 20, 2021 (15:00 – 05:00)	All parameters	Data Server Malfunction
September 13, 2021 (07:00 & 08:00)	All parameters	Quarterly Audit
October 30, 2021 (0:00)	All parameters	Data Polling Error
December 9, 2021 (08:00 & 09:00)	All parameters	Quarterly Audit

**Table 2 SPR 2021 Data Summary**

Parameter	Statistic	SPR 2021
Wind Speed (mph)	Avg	7.1
	Min	0.0
	Max Gust	47.5
Wind Direction. (degrees)	Avg	191.4
	Min	0.1
	Max	359.8
Temp (2m) (°F)	Avg	62.1
	Min	41.5
	Max	89.6
Delta Temp. (°F)	Avg	-0.53
	Min	-4.15
	Max	6.61
Solar Radiation (w/m <sup>2</sup> )	Avg	220.0
	Min	0.0
	Max	1049



The 2021 wind speed and direction data were plotted as wind roses (see **Attachment 2**) and compared to the AQMD LAX meteorological station wind roses. **Attachment 2** presents the resulting graphs. It can be seen that the winds have similar patterns. The wind patterns were also compared to previous years and found to correlate well.

To consider the data valid for further studies the EPA requires a data capture of  $\geq 90\%$  of valid data. **Table 3** summarizes the data capture for the 2021 SPR data.

**Table 3          SPR 2021 Data Capture Statistics**

SPR 60-Min Variable	2021 Data Capture	2021 Total Hours	2021 Valid Hours	2021 Invalid/Missing Hours
2-Meter Ambient Temperature (Avg)	99.2%	8760	8688	72
10-Meter Ambient Temperature (Avg)	99.2%	8760	8688	72
Temperature Difference (delta-T) (Avg)	99.2%	8760	8688	72
Wind Speed (Avg)	99.2%	8760	8688	72
Wind Direction (Avg)	97.2%	8760	8519	241
Solar Radiation (Avg)	99.2%	8760	8688	72

## **4.0 CONCLUSIONS**

The Inglewood Oil Field meteorological station was fully operational throughout calendar year 2021, with all measured parameters meeting the data capture goal of  $\geq 90\%$ .

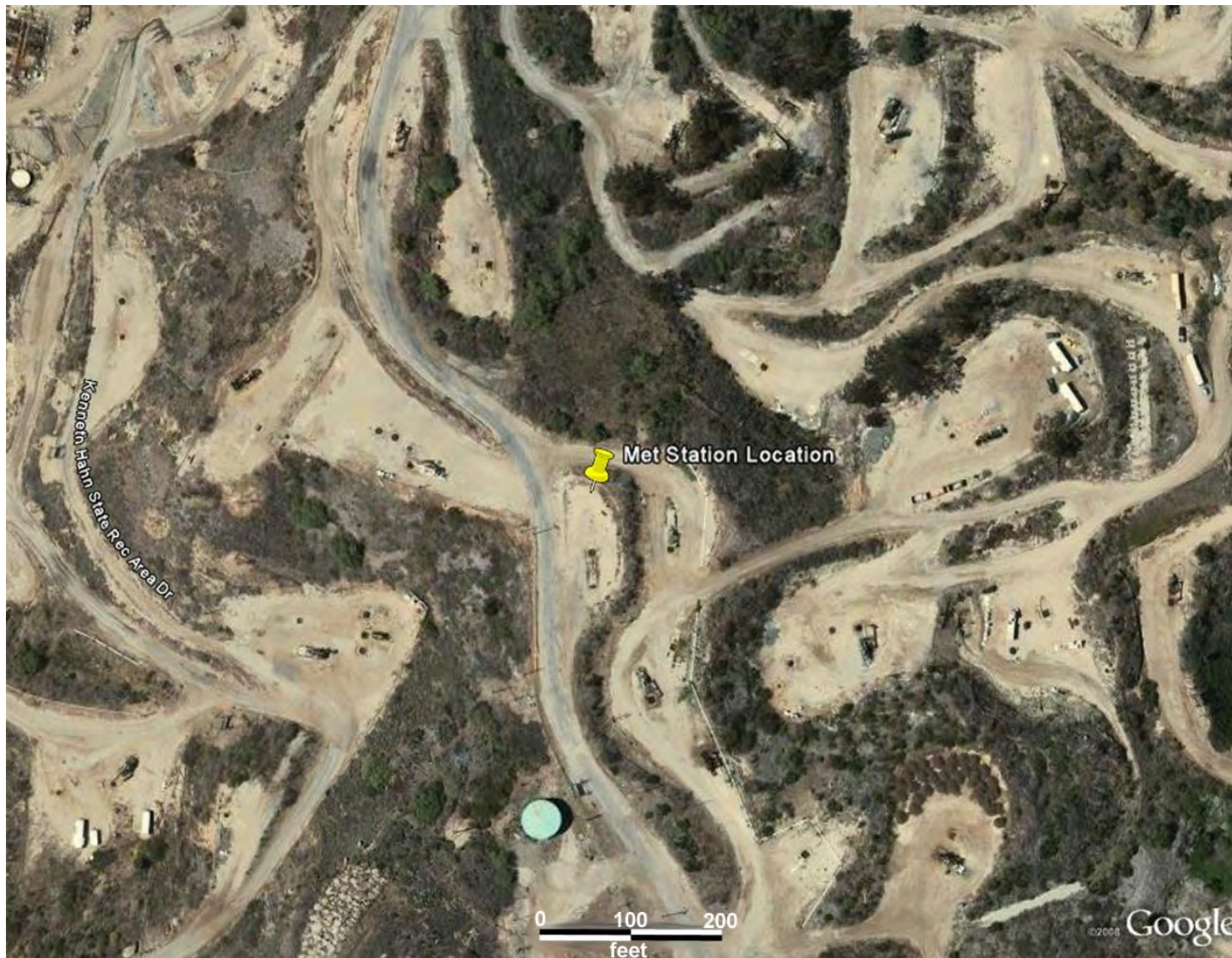
## **5.0 REFERENCES**

1. EPA. 2008. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements.
2. EPA. 2000. Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-005.



**Figure 3** Sentinel Peak Resources Meteorological Station Location – Field View





**Figure 4** Sentinel Peak Resources Meteorological Station Location – Close-up View

## ATTACHMENT 1, DATA VALIDATION TECHNIQUES

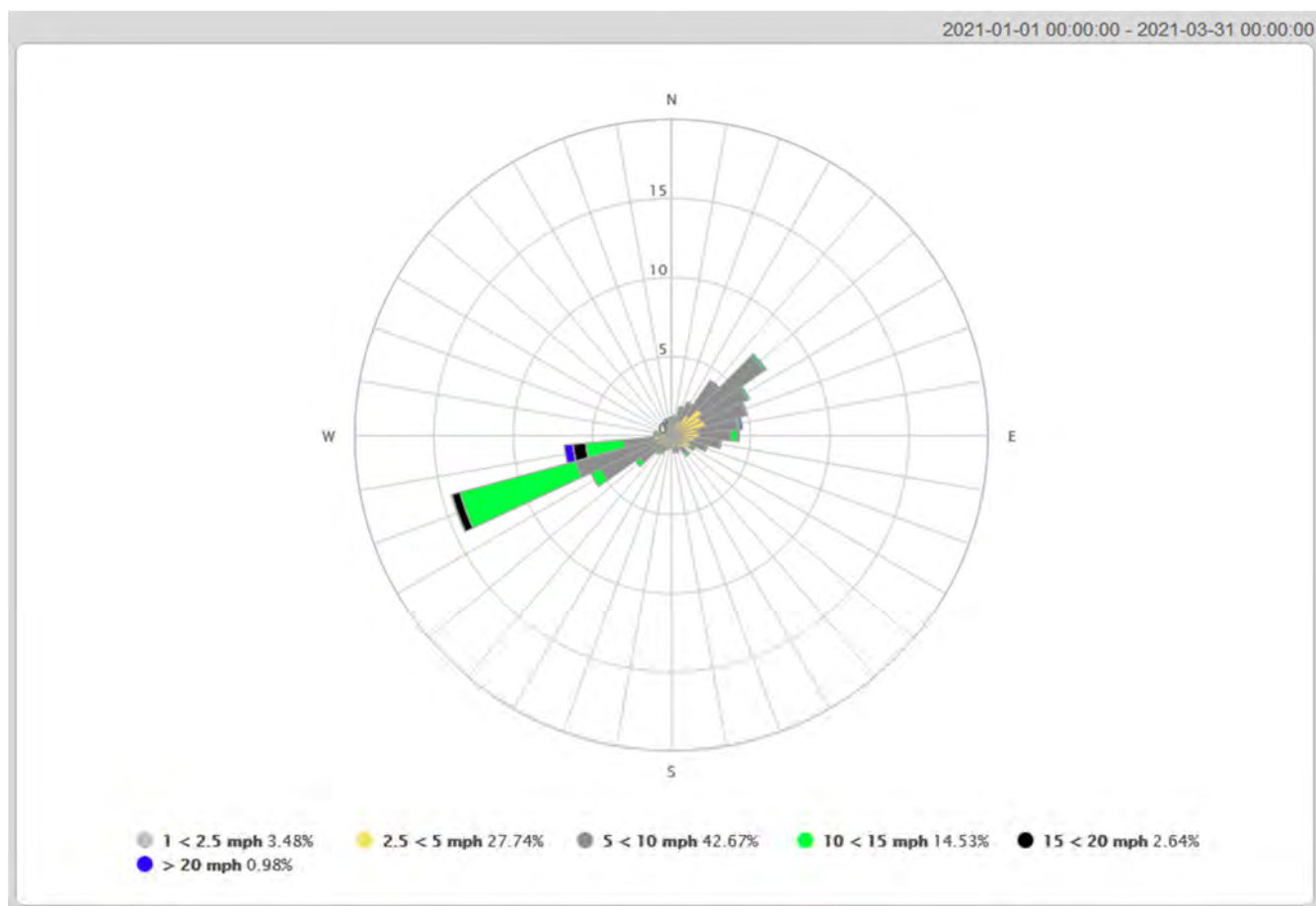
Variable	Criteria: flag data if the value
Wind Speed	<ul style="list-style-type: none"> <li>- is less than zero or greater than 25 m/s (56 mph)</li> <li>- does not vary by more than 0.1 m/s (0.22 mph) for 3 consecutive hours</li> <li>- does not vary by more than 0.5 m/s (1.1 mph) for 12 consecutive hours</li> <li>- correlates well with data from other stations in the same area</li> </ul>
Wind Direction	<ul style="list-style-type: none"> <li>- is less than zero or greater than 360°</li> <li>- does not vary by more than 1 degree for more than 3 consecutive hours</li> <li>- does not vary by more than 10 degrees for 18 consecutive hours</li> <li>- correlates well with data from other stations in the same area</li> </ul>
Temperature	<ul style="list-style-type: none"> <li>- is greater than the local record high</li> <li>- is less than the local record low</li> <li>- is greater than a 5 °C (9 °F) change from the previous hour</li> <li>- does not vary by more than 0.5 °C (0.8 °F) for 12 consecutive hours</li> <li>- correlates well with data from other stations in the same area</li> </ul>
Temperature Difference – Delta T	<ul style="list-style-type: none"> <li>- is <b>greater than</b> 0.1 °C/m (<b>1.8 °F for 10 m</b> or 5.4 °F for 30 m) during <b>daytime</b></li> <li>- is <b>less than</b> –0.1 °C/m (<b>–1.8 °F for 10 m</b> or –5.4 °F for 30 m) during <b>nighttime</b></li> <li>- is <b>greater than</b> 5.0 °C (<b>9.0 °F</b>) or <b>less than</b> –3.0 °C (<b>–5.4 °F</b>)</li> </ul>
Radiation	<ul style="list-style-type: none"> <li>- is greater than zero at night</li> <li>- is greater than the maximum possible for the season and latitude</li> <li>- correlates well with data from other stations in the same area</li> </ul>

Source: [http://www.webmet.com/met\\_monitoring/863.html](http://www.webmet.com/met_monitoring/863.html)

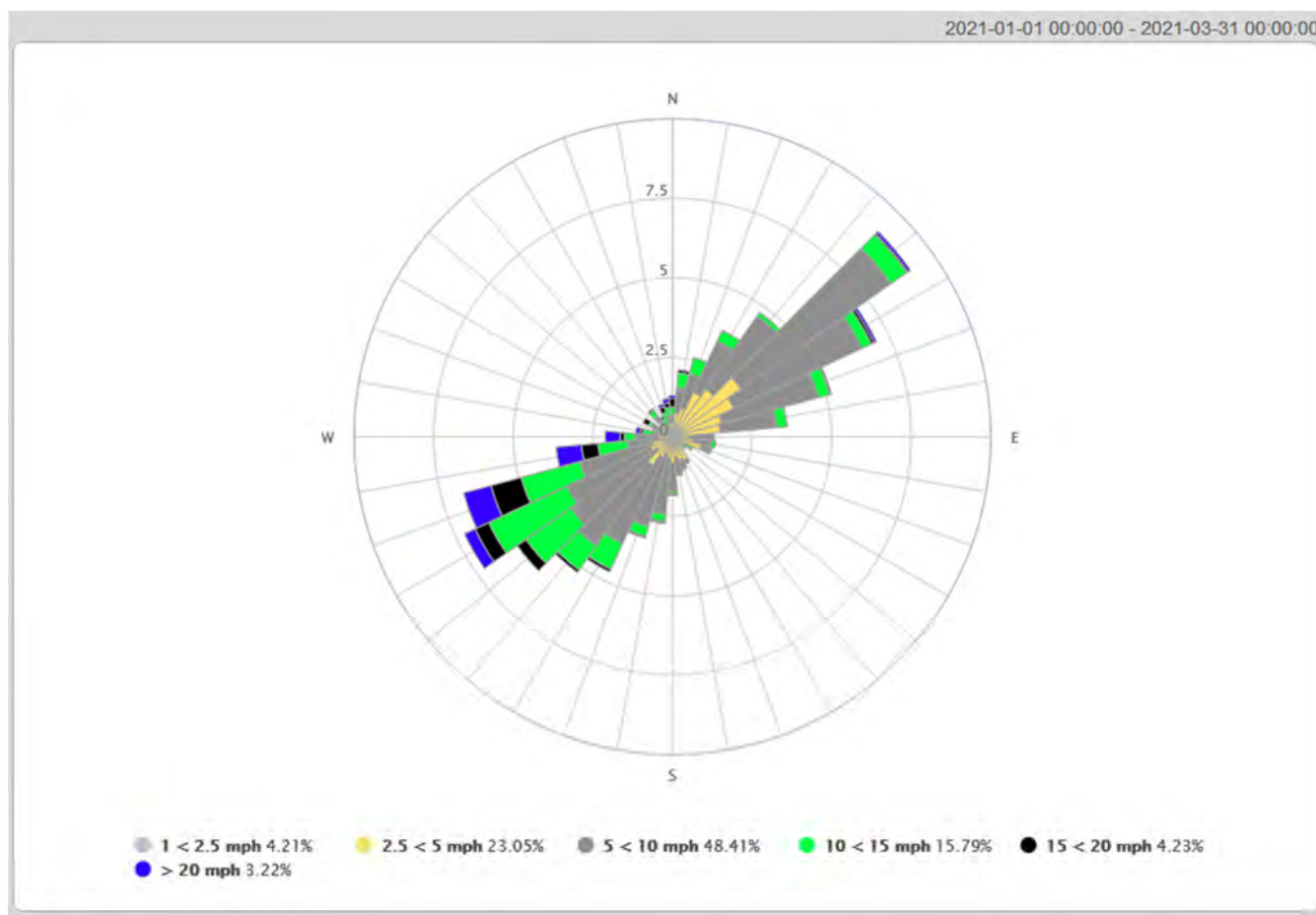
## **ATTACHMENT 2, WIND ROSES**

### **AQMD LAX PAMS Monitoring Station Surface Wind Data, 2021 as compared with Sentinel Peak Resources Wind Data, 2021**

**IMPORTANT NOTE** on reading the wind roses: The graphs' colored segments show the winds as **BLOWING FROM** that direction.

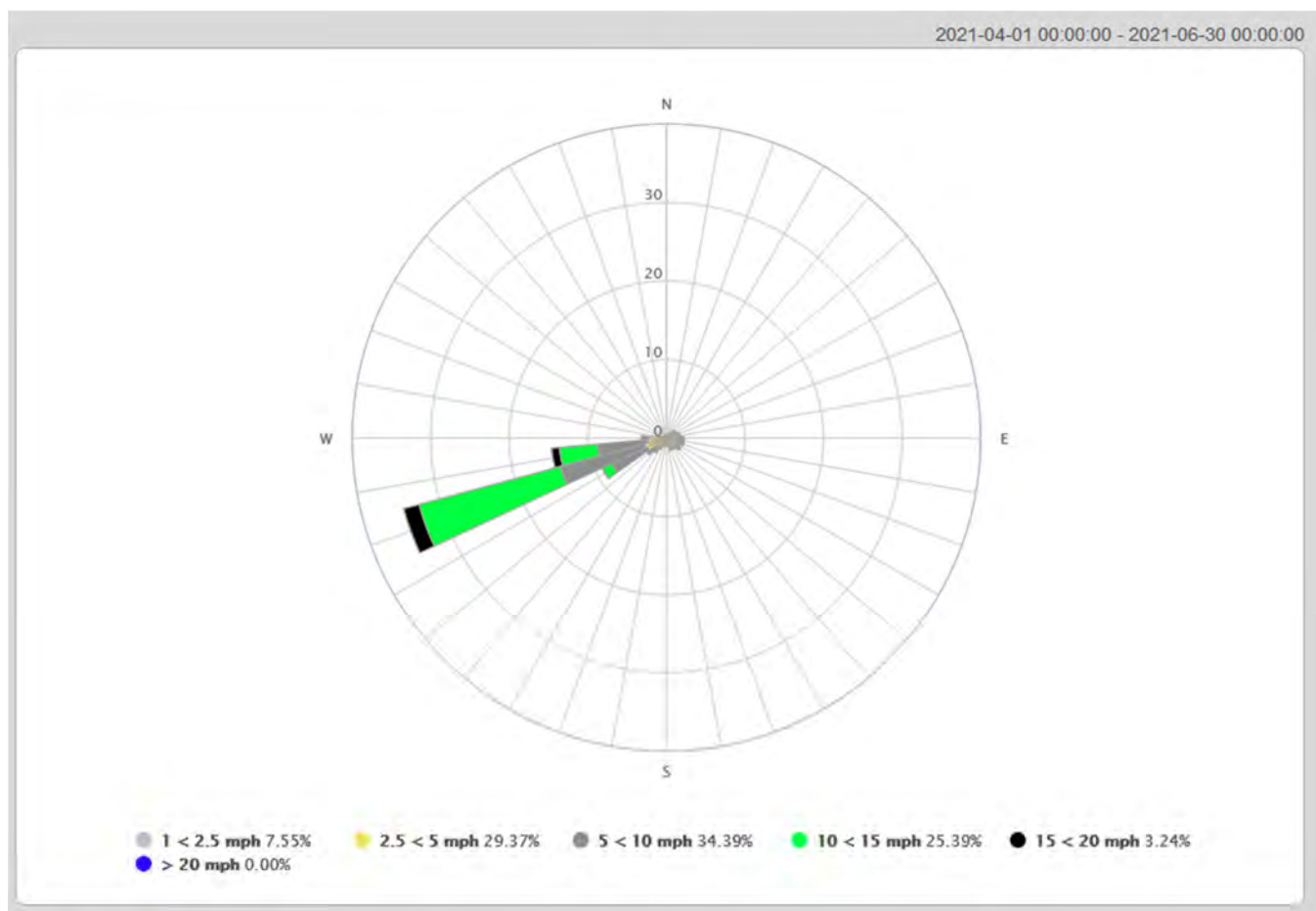


SPR (January - March 2021)

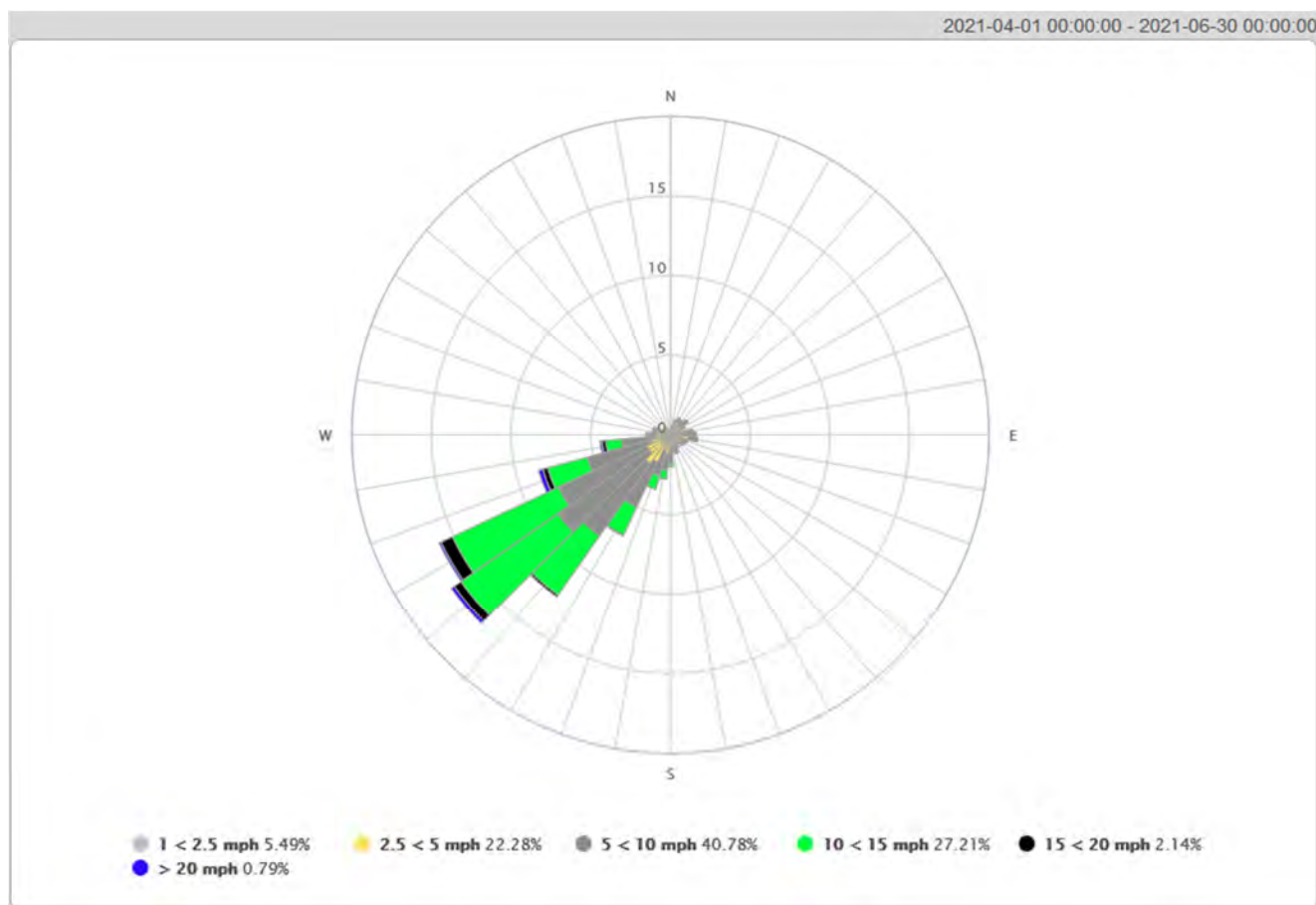


LAX (January - March 2021)

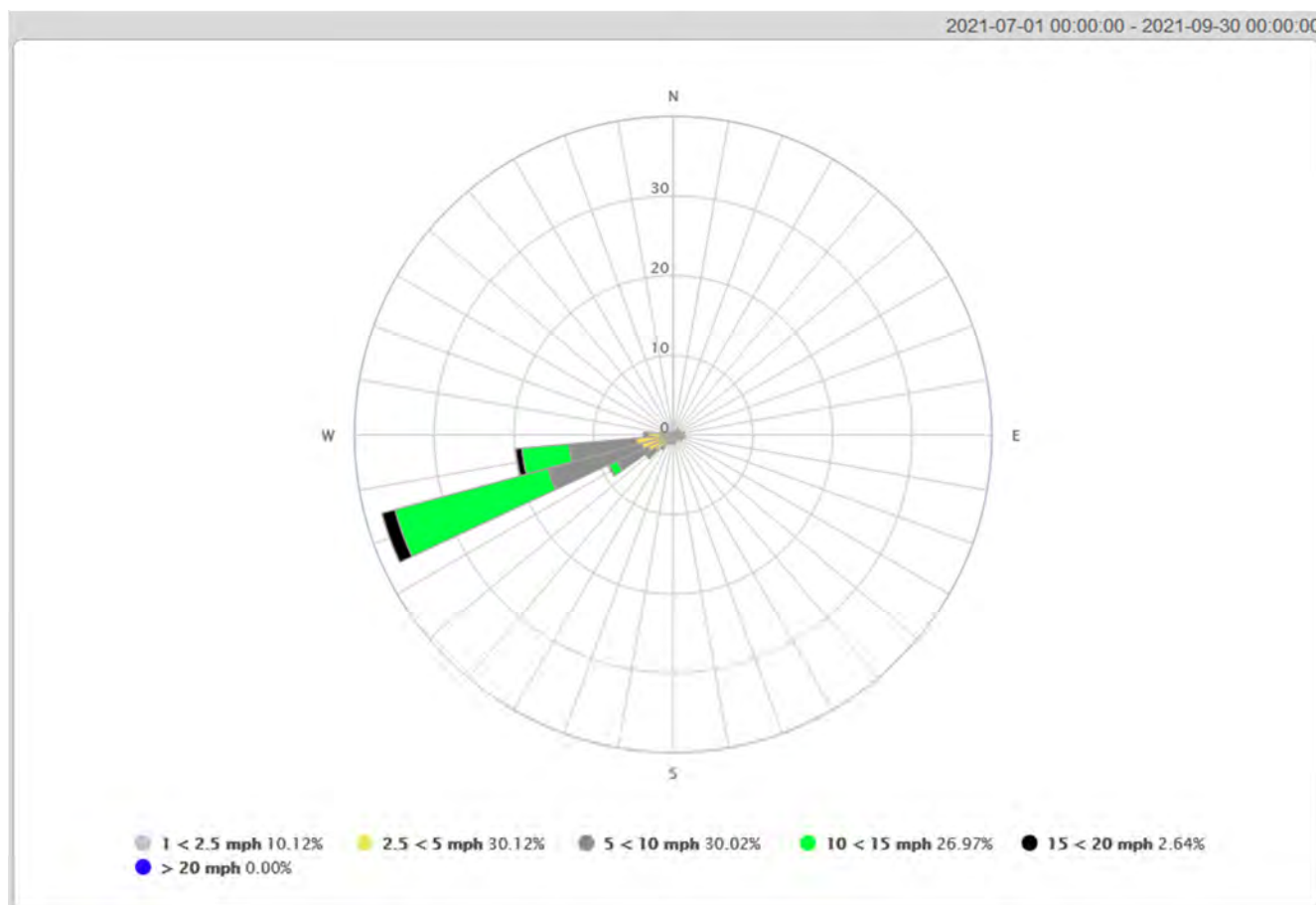




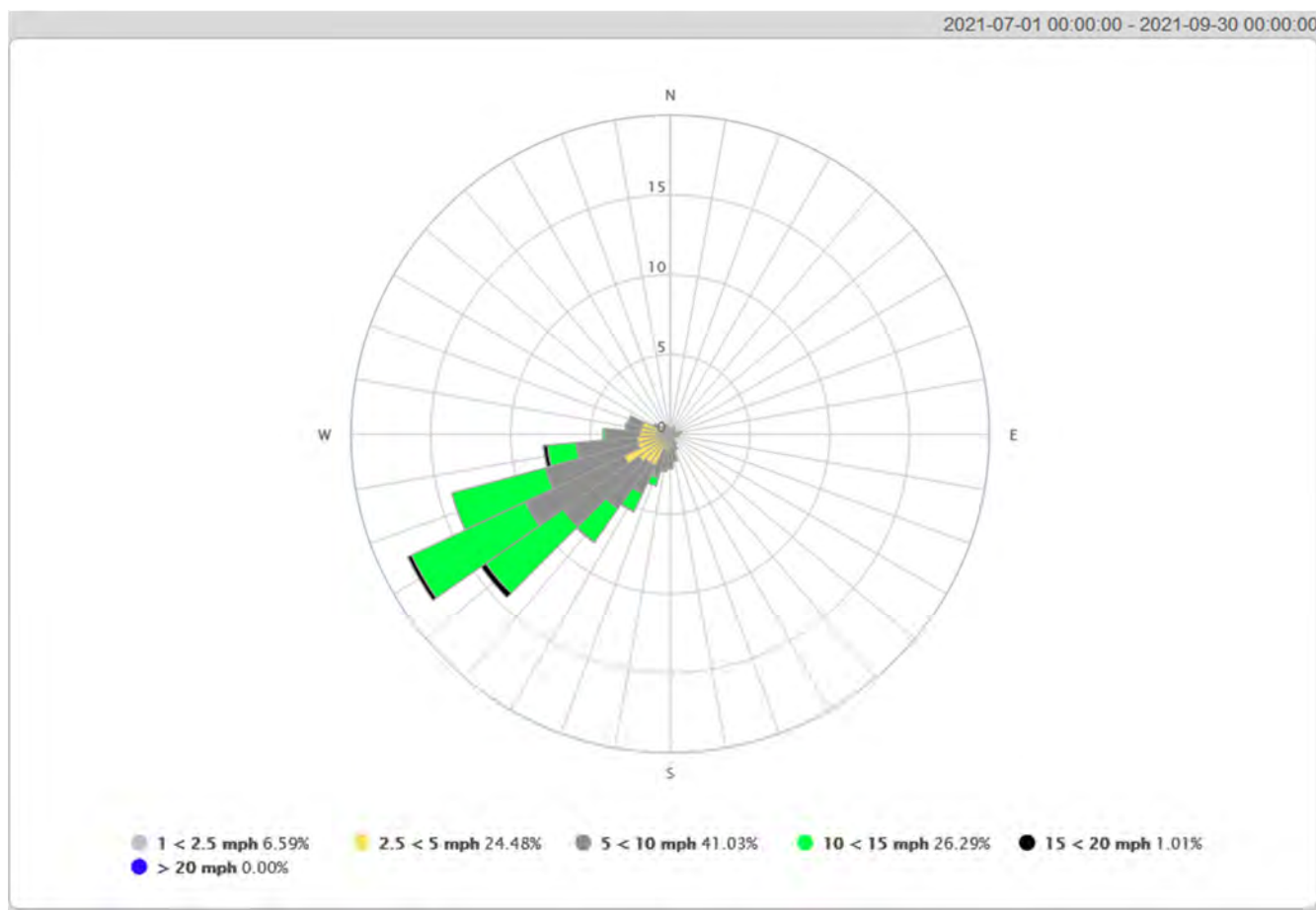
SPR (April - June 2021)



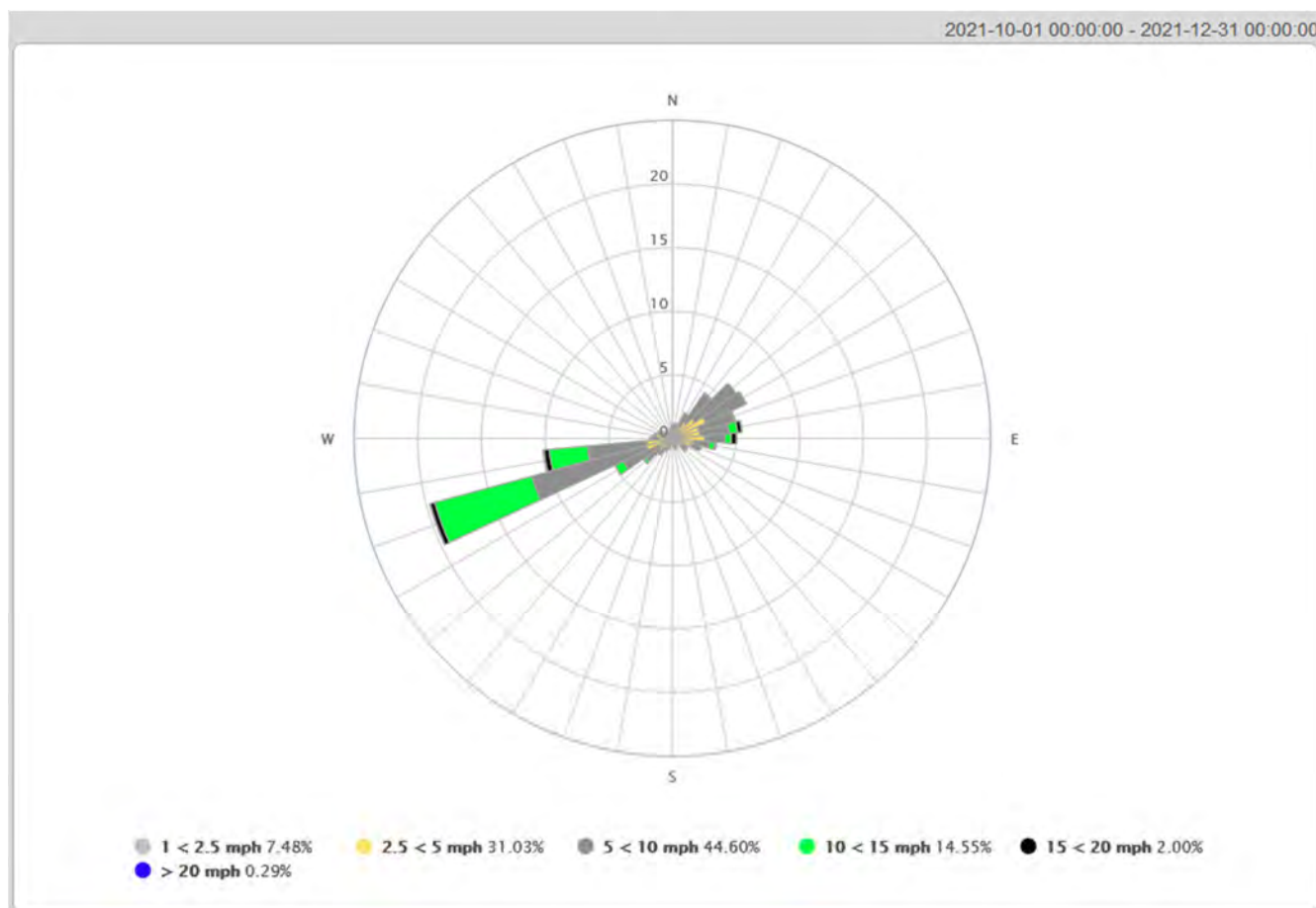
LAX (April - June 2021)



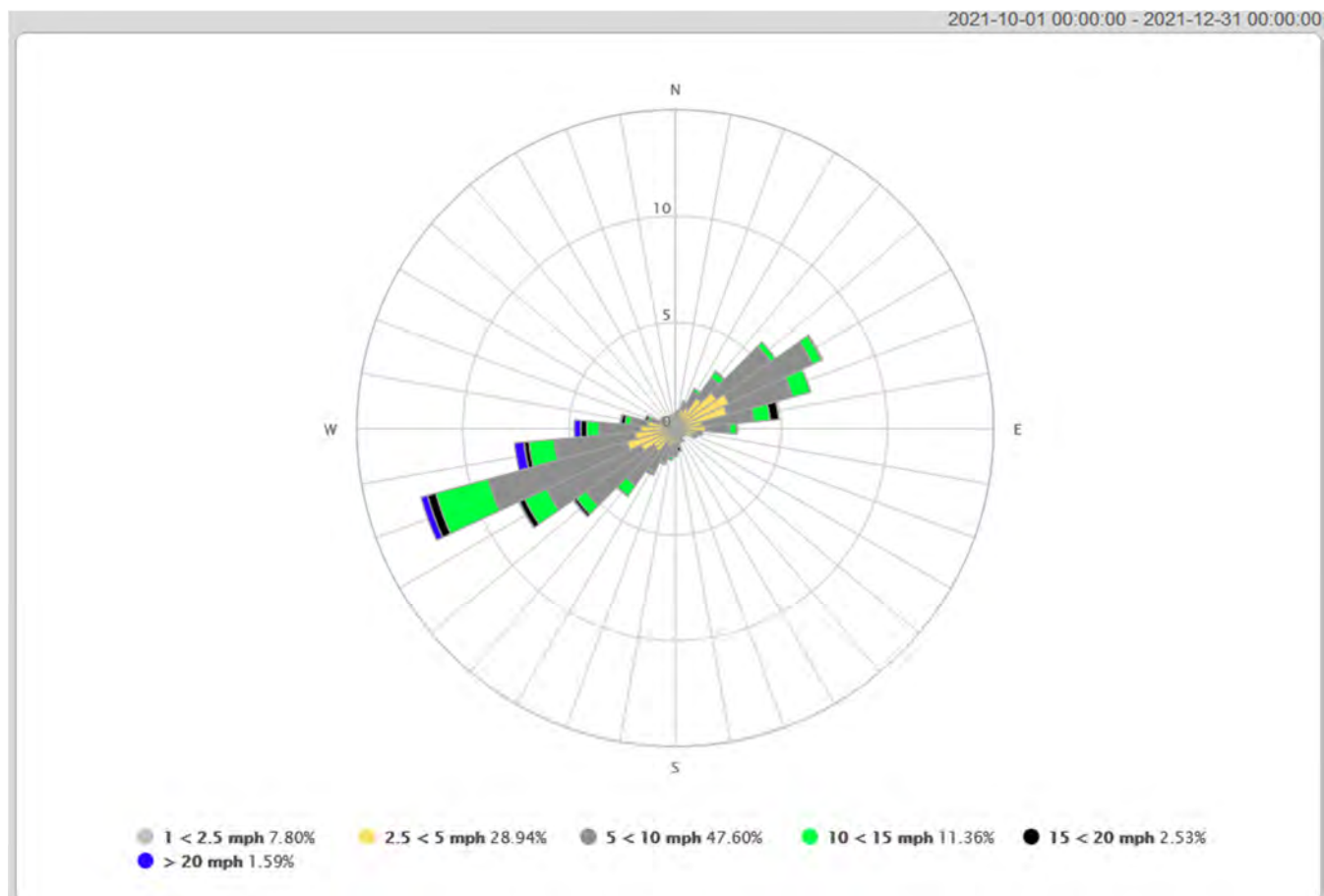
SPR (July - September 2021)



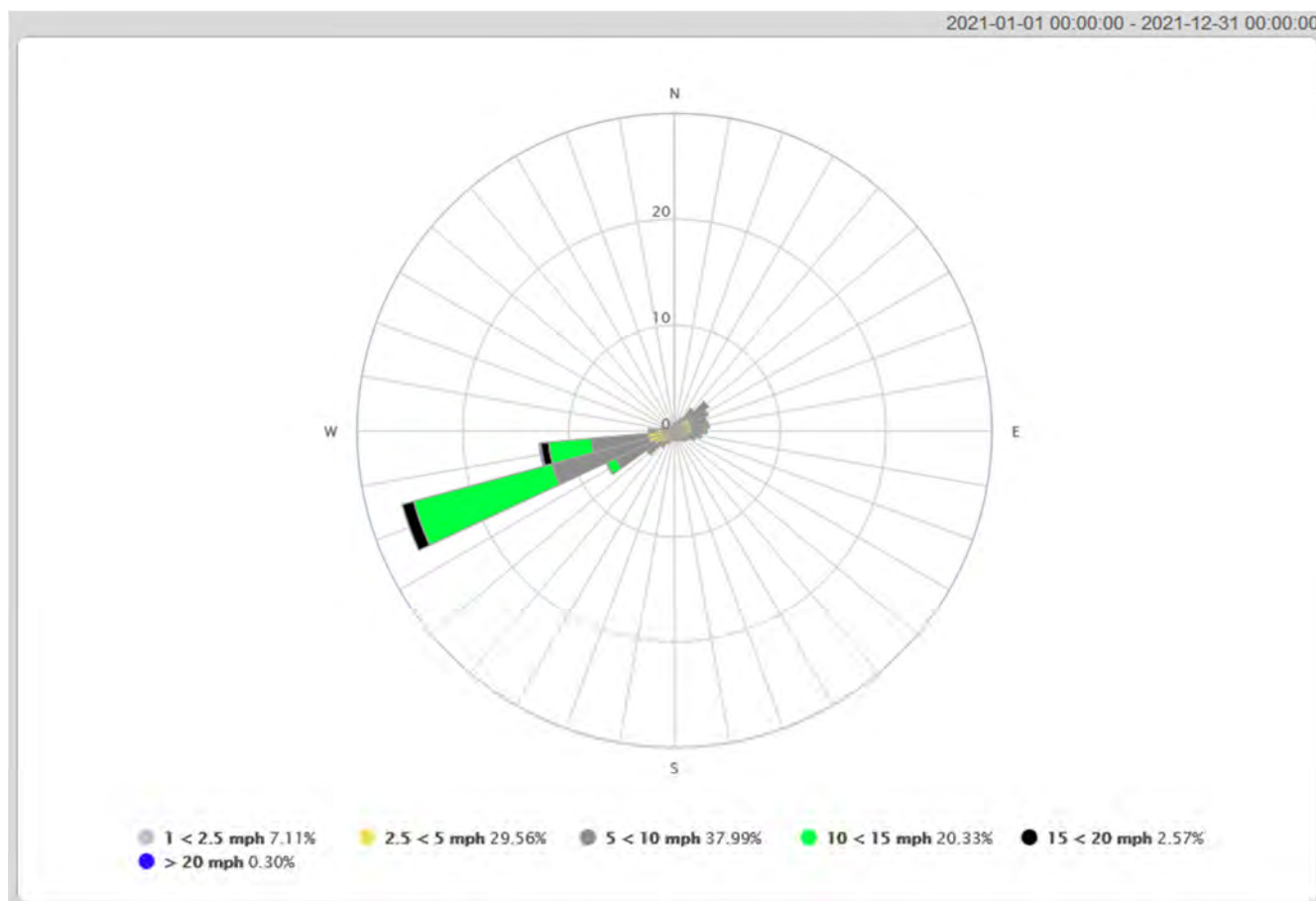
LAX (July - September 2021)



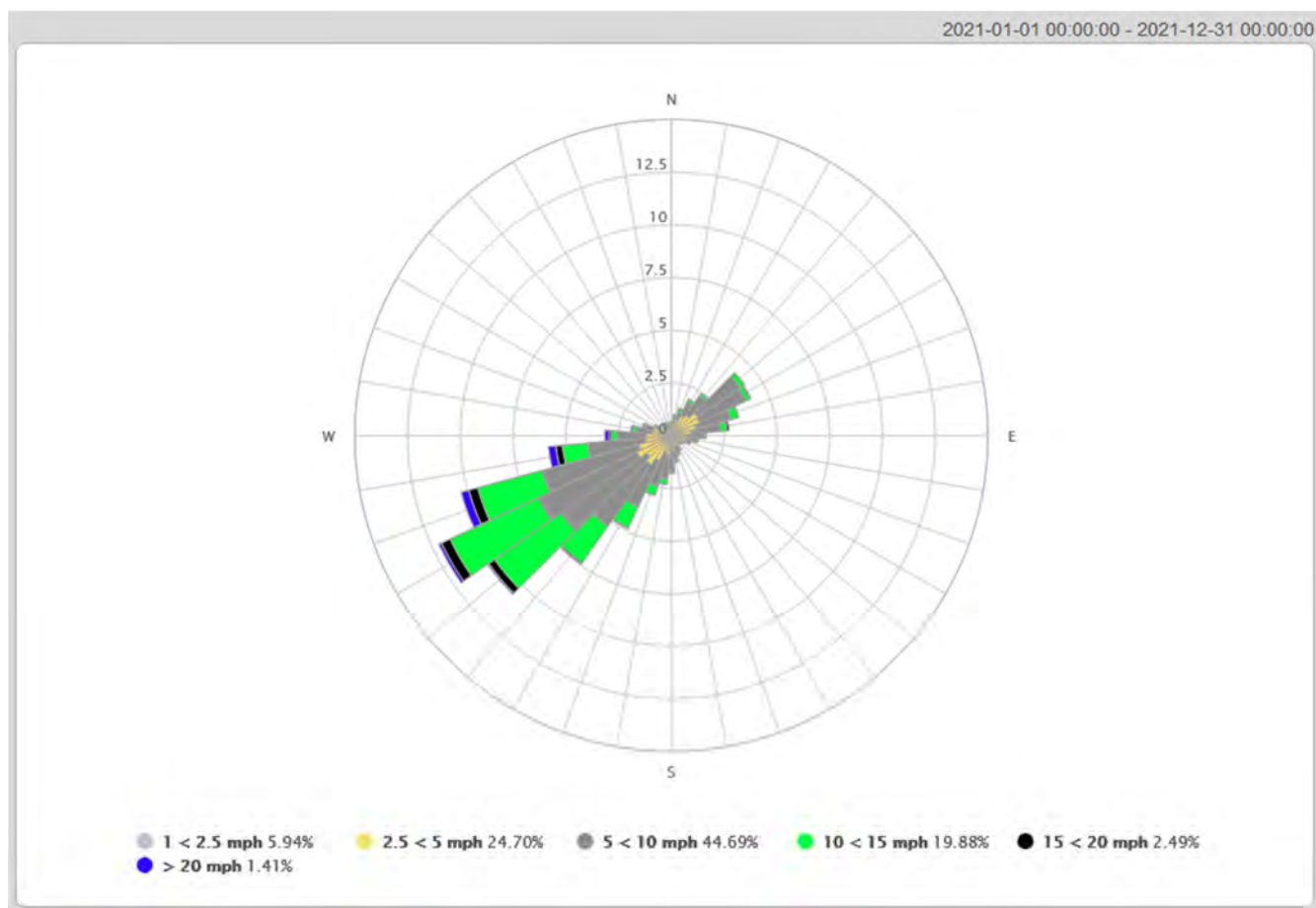
SPR (October - December 2021)



LAX (October - December 2021)



SPR (2021)



LAX (2021)



## **ATTACHMENT 3, 2021 CALIBRATION DOCUMENTATION**

**Met One Instruments, Inc.  
Inglewood Station Calibration Certificates**

## **ATTACHMENT 4, 2021 MAINTENANCE AND REVIEW LOG**

## MET STATION INSPECTION / MAINTENANCE LOG

DATE	TIME	Personnel	INSPECTION / MAINTENANCE ITEMS	NOTES / COMMENTS
1/3/2021	10:15 AM	J Walters, SPR	Visual Assessment and check with phone app.	The anemometer appears to have stopped spinning. Had Patty Cook check online. Looks like it's registering exactly 1 mph. Contacted D Yoho with T&B Systems to check into and address.
1/4/2021	7:56 AM	J Walters, SPR	Visual Assessment and check with phone app.	Looked at the hourly data from 6 AM to 12 PM yesterday, anemometer was flat lined at 1 mph for all those hours. Looks to be working fine now. T&B Systems informed that they may swap out the sensor for the Q1 2022 audit/calibration.
2/4/2021	11:35 AM	J Walters, SPR	Visual Assessment and check with phone app.	The wind sensors appear to be working accurately; temperature sensor as well.
2/18/2021	10:55 AM	J Walters, SPR	Wind vane was identified as missing..	Found wind vane on the downhill side immediately SE of the MET Station. Contacted subcontractor M&A to re-install and verify wind direction after re-installed.
2/19/2021	9:45 AM	J Walters, SPR	Wind vane was re-installed and wind direction verified.	There was no damage to wind vane. Have scheduled to audit / calibrate sensors with T&B Systems on 3/2/2021.
2/19/2021	7:24 AM	J Walters, SPR	T&B Systems' David Yoho assessed data to determine when the wind vane / wind direction became invalidated.	Based on D Yoho's email notes: The actual time to start the invalidation is at 12:00 PST on 2/12/21. This period also corresponds to wind gusts of ~ 30 mph.
3/2/2021	10:20 AM	J Walters, SPR	T&B Systems conducted Q1 Calibration/Audit. Passed.	There were no comments noted at the time of the audit. There were no issues observed at the time of the audit.
3/4/2021	11:05 AM	J Walters, SPR	Visual Assessment and check with phone app.	The wind sensors appear to be working accurately; temperature sensor as well.
3/25/2021	10:21 AM	J Walters, SPR	Visual Assessment and check with phone app.	The wind sensors appear to be working accurately; temperature sensor as well.
6/9/2021	7:00 AM	J Walters, SPR	T&B Systems conducted Q4 Calibration/Audit. Passed.	Everything checked out fine. No adjustments needed.
6/10/2021	11:10 AM	J Walters, SPR	Visual Assessment and check with phone app.	The wind sensors appear to be working accurately; temperature sensor as well.
7/1/2021	10:25 AM	J Walters, SPR	Visual Assessment and check with phone app.	The wind sensors appear to be working accurately; temperature sensor as well.
8/19/2021	9:52 AM	J Walters, SPR	Visual Assessment and check with phone app.	The wind sensors appear to be working accurately; temperature sensor as well.
9/7/2021	9:45 AM	J Walters, SPR	Visual Assessment and check with phone app. Checked with Dean Dusette, LACDRP Insp.	The wind sensors appear to be working accurately; temperature sensor as well.
9/13/2021	7:10 AM	J Walters, SPR	T&B Systems conducted Q3 Calibration/Audit. Passed.	Everything checked out fine. T&B just had to make an adjustment to the barometric pressure sensor.
9/28/2021	10:15 AM	J Walters, SPR	Visual Assessment and check with phone app.	The wind sensors appear to be working accurately; temperature sensor as well.
10/13/2021	11:01 AM	J Walters, SPR	Visual Assessment and check with phone app.	The wind sensors appear to be working accurately; temperature sensor as well.
11/11/2021	11:25 AM	J Walters, SPR	Visual Assessment and check with phone app. Checked with Dean Dusette, LACDRP Insp.	The wind sensors appear to be working accurately; temperature sensor as well.
12/9/2021	7:00 AM	J Walters, SPR	T&B Systems conducted Q4 Calibration/Audit. Passed.	With exception of the barometric pressure sensor, the system calibration was good overall. T&B adjusted the BP to get back within criteria.

## **ATTACHMENT 5, QUARTERLY AUDIT SUMAMRY REPORTS**



Site: Sentinel Peak Resources – Los Angeles

Audit Date: March 2, 2021 (First Quarter 2021)

Instrumentation Audited: Surface Meteorology

Key Person(s): Joseph Walters

Auditor: David Yoho  
Technical & Business Systems, Inc.  
25570 Rye Canyon Rd., Unit J  
Valencia, CA 91355

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The purpose of this summary is to provide a report of significant audit findings at the Sentinel Peak Resources facility in Los Angeles, CA. Key elements of the audit are identified below. Results of the performance audit comparisons are included.

#### **GENERAL COMMENTS**

There were no comments noted at the time of the audit.

#### **KEY METEOROLOGICAL AUDIT FINDINGS**

There were no issues observed at the time of the audit.

**AUDIT RECORD***T&B Systems*

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**HORIZONTAL WIND SPEED**Date: **03/02/21**Start: **7:10 PST**Finish: **9:30 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **W24360**K factor: **1.4**Range: **0 - 100** mphLast calibrated: **20-Nov**Model: **014A**Sensor Ht.: **10 meters**Starting torque: **0.1** gm cmStarting threshold: **0.6** mphStarting threshold criteria: **1.0** mph

<i>Audit Point</i>	<i>Input MPH</i>			<i>DAS MPH</i>	<i>DAS Diff. MPH</i>
1	1.0			1.0	0.0
2	9.9			10.0	0.0

*Audit Criteria:  $\pm 5.6$  MPH;  $ws \leq 11.2$  MPH*

<i>Audit Point</i>	<i>Input MPH</i>			<i>DAS MPH</i>	<i>DAS Diff. %</i>
3	18.9			18.9	0.0
4	36.8			36.8	0.0
5	54.7			54.7	0.0

*Audit Criteria:  $\pm 5\%$ ;  $ws > 11.2$  MPH*

Comments: There were no problems noted.

**AUDIT RECORD***T&B Systems*

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

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**HORIZONTAL WIND DIRECTION**Date: **03/02/21**Start: **7:10 PST**Finish: **9:30 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **J10229**K factor: **30**Range: **360°**Crossarm: **94°**Last calibrated: **20-Nov**Model: **024A**Sensor Ht.: **10 meters**Starting torque: **NA gm cm**Starting threshold: **mph**Starting threshold criteria: **1.0 mph**

<i>Audit Point</i>	<i>Degrees Reference</i>			<i>Degrees DAS</i>	<i>DAS Diff. Degrees</i>
1	94			97	3
2	184			185	1
3	274			277	3
4	4			6	2

*Audit Criteria: ±5 degrees*

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**AMBIENT TEMPERATURE (2 METERS)**Date: **03/02/21**Start: **7:10 PST**Finish: **9:30 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **T20201 - 1**Lower Range: **-58** Deg FUpper Range: **122** Deg FLast calibrated: **20-Nov**Model: **062MP**Sensor Ht.: **2 meters**

<i>Audit Point</i>	<i>Input Deg F</i>			<i>DAS Deg F</i>	<i>DAS Diff. Deg F</i>
1	32.1			32.2	0.1
2	70.9			70.6	-0.3
3	103.6			103.5	-0.1

*Audit Criteria:  $\pm 0.9^{\circ}\text{F}$* 

Comments: There were no problems noted.



**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**TEMPERATURE DIFFERENCE (DELTA-T)**Date: **03/02/21**Start: **7:10 PST**Finish: **9:30 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **T20201-1 / T20201-2**Lower Range: **-58** Deg FUpper Range: **122** Deg FLast Calibrated: **20-Nov**Model: **062MP**Sensor Ht.: **2 m / 9 m**

<i>Audit Point</i>	<i>Input Deg F</i>	<i>2-9 Temp Diff Deg F</i>
1	32.1	0.01
2	70.9	0.02
3	103.6	-0.09

*Audit Criteria:  $\pm 0.18^{\circ}\text{F}$* 

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**SOLAR RADIATION**Date: **3/2/21**Start: **7:10 PST**Finish: **9:30 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Sensor Mfg: **LICOR**Serial No.: **PY104697**Range: **0 - 1500 W/m2**Last Calibrated: **20-Nov**Model: **200X**Sensor Ht.: **~ 3 meters**

<i>Audit Point</i>	<i>Input W/m2</i>	<i>DAS W/m2</i>	<i>Diff %</i>
1	205	190	-7.3
2	215	207	-3.7
3	277	265	-4.3
4	334	320	-4.2
5	332	315	-5.1
6	376	361	-4.0
7	534	515	-3.6

*Audit Criteria:  $\pm 10\%$* 

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**BAROMETRIC PRESSURE**Date: **3/2/21**Start: **7:10 PST**Finish: **9:30 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Sensor Mfg: **MetOne**Serial No.: **NA**Range: **NA**Last Calibrated: **20-Nov**Model: **090**Sensor Ht.: **1 meter**

<i>Audit Point</i>	<i>Input in hg</i>	<i>DAS in hg</i>	<i>Diff in hg</i>
1	29.55	29.53	-0.07

*Audit Criteria:  $\pm 0.09$ "*

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**PRECIPITATION**Date: **03/02/21**Start: **7:10 PST**Finish: **9:30 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Model: **070D**Serial No.: **X10024**Sensor Ht.: **1 meter**Units: **Inches**Funnel Diam.: **8 inch**Last Calibrated: **20-Nov**

<i>Audit Point</i>	<i>Input Inches</i>	<i>DAS Inches</i>	<i>Diff. %</i>
1	0.61	0.62	2.1

*Audit Criteria: ±10% of input*

Comments: There were no problems noted.

**T&B SYSTEMS PERFORMANCE EVALUATION EQUIPMENT CERTIFICATION DATA**



OTT Hydromet Corp. 20400 Lewis Drive, Suite 100, Sterling, VA 20154, USA • Tel: (703) 436-2800 • info@otthydromet.com • www.otthydromet.com

## CALIBRATION CERTIFICATE

<b>CERTIFICATE NUMBER</b>	012021123339
<b>PYRANOMETER MODEL</b>	CMP 6
<b>SERIAL NUMBER</b>	123339
<b>SENSITIVITY</b>	15.62 $\mu\text{V/W/m}^2$ at normal incidence on horizontal pyranometer
<b>IMPEDANCE</b>	40 $\Omega$
<b>REFERENCE PYRANOMETER</b>	Kipp & Zonen CMP 6 sn 090860 active from 01 January 2021
<b>CALIBRATION DATE</b>	09 January 2021
<b>CLASSIFICATION</b>	ISO 9060, Class B (First Class)*

### Calibration procedure

The indoor calibration procedure is based on a side-by-side comparison with a reference pyranometer under an artificial sun fed by an AC voltage stabiliser. It embodies a 150 W Metal-Halide high-pressure gas discharge lamp. Behind the lamp is a reflector with a diameter of 16.2 cm. The reflector is 1 m above the pyranometers producing a vertical beam. The reference and test pyranometers are mounted horizontally on a table, which can rotate. The irradiance at the pyranometers is approximately 500  $\text{W/m}^2$ . During the calibration preceding the reference and test pyranometer are interchanged to correct for any non-homogeneity of the beam. Temperature during calibration:  $22.2 \pm 0.1^\circ\text{C}$ .

### Hierarchy of traceability

The reference pyranometer was compared with the sun and sky radiation as source under clear sky conditions using the 'alternating sun-and-shade method' (ISO 9846 paragraph 5). The measurements were performed in Delft, The Netherlands (latitude:  $51.9569^\circ$ , longitude:  $4.1863^\circ$ , altitude: 10m above sea level). Dates of measurements: 22-24 June 2020.  
The receiver surface was pointed directly at the sun using a solar tracker. During the comparisons, the instrument received tilted global radiation intensities from 834 to 1089 with a mean of 959  $\text{W/m}^2$  and tilted diffuse radiation intensities from 96 to 274 with a mean of 158  $\text{W/m}^2$ . The ambient temperature ranged from  $+19.0$  to  $+29.9$  with a mean of  $+23.9^\circ\text{C}$ .  
The direct radiation on the reference pyranometer as obtained with the alternating sun-and-shade method was compared to the DNI measured by the absolute cavity pyrheliometer PMO6 SN 103. The PMO6 is calibrated against the World Standard Group (WSG), maintained at the WRC Davos every International Pyrheliometer Comparison (IPC). The PMO6 participated in the NPC 2019 hosted by NREL in Golden, Colorado to verify its stability. WRR factor of PMO6: 0.99789.

This calibration proved that the reference pyranometer has been stable and that the original sensitivity  $14.08 \pm 0.35 \mu\text{V/W/m}^2$  valid until will be applied (see PMOD calibration details). Observed sensitivity differences between the consecutive years are well within the calibration uncertainty.

PMOD calibration details: The reference pyranometer was compared with the sun and sky radiation as source under mainly clear sky conditions using the 'continuous sun-and-shade method'. The pyranometer was installed horizontally. During the comparisons, the global radiation ranged from 573 to 1033 with a mean of 897  $\text{W/m}^2$ . The solar zenith angle varied from  $24.6$  to  $49.6$  with a mean of  $32.6$  degrees. The ambient temperature ranged from  $+18.6$  to  $+24.9$  with a mean of  $+21.9^\circ\text{C}$ . The sensitivity calculation is based on 530 individual measurements. The readings of the WSG are referred to the World Radiometric Reference (WRR). The estimated uncertainty of the WRR relative to SI is  $\pm 0.3\%$ . The obtained sensitivity value and its expanded uncertainty (95% level of confidence) are valid for similar conditions and are  $14.08 \pm 0.35 \mu\text{V/W/m}^2$ . The measurements were performed in Davos (latitude:  $46.8143^\circ$ , longitude:  $-7.8458^\circ$ , altitude: 1558m above sea level). Dates of measurements: 10, 12, 15, 20, 21 July 2015.  
Global radiation data were calculated from the direct solar radiation as measured with the absolute cavity pyrheliometer PMO4 (member of the WSG, WRR-Factor: 0.998625, based on IPC-2010) and from the diffuse radiation as measured with a continuous disk shaded pyranometer Kipp & Zonen CM22 SN 020059 (ventilated with heated air).

### Justification of total instrument calibration uncertainty

The combined uncertainty of the result of the calibration is the 'root sum square' of the following components.

1. The expanded uncertainty due to random effects and instrumental errors during the calibration of the reference CMP 6 is  $\pm 0.35/14.08 = \pm 2.49\%$  (see traceability text).
2. Based on experience, the expanded uncertainty of the transfer procedure (calibration by comparison) is estimated to be  $\pm 0.5\%$ .
3. The estimated uncertainty of the WRR relative to SI is  $\pm 0.3\%$ .

The expanded uncertainty is:  $\pm 2.49\% + 0.5\% + 0.3\% = \pm 2.55\%$  (k=2).

### Notice

The calibration certificate supplied with the instrument is valid at the date of first use. Even though the calibration certificate is dated, calibration, manufacture, or recalibration, the instrument does not undergo any sensitivity changes when kept in the original packaging.

\* From October 2018 the classification conforms to ISO 9060:2018. Instruments issued before that date conform to ISO 9060:1990.

### Calibration by Kipp & Zonen Authorised Calibration Partner

This calibration was performed by a Kipp & Zonen Authorised Calibration Partner, with all required facilities, procedures and training provided by Kipp & Zonen, and audited by Kipp & Zonen bi-annually.

Sterling, VA, USA, 09 January 2021

*Paul Delisi*  
Paul Delisi  
(in charge of calibration facility)

*Khôi Tran*  
Khôi Tran  
(in charge of test)

Chinook Engineering

innovative measurements

*Certificate of Accuracy***Transfer Standard Type: Electronic Thermometer**

Certificate No: T 071620. 01

Transfer standard, model/type: Cooper Instrument Corporation Model SH66A Temperature Instrument

Serial number: T&amp;B SH66A #2

Probe S/N: 1075

submitted by/owner: T &amp; B Systems

25570 Rye Canyon Road

Unit J

Valencia, CA 91355

Was compared to:

NIST Traceable Hg-in-glass thermometer serial number 3L9452 and ice point. Miller & Weber Hg-in-glass thermometer sn 3L9452 is traceable to NIST Thermometer 40350, through Transfer Standards 3C4465 & 1Y9716.

Date: 07/16/20

Lab temperature: 23.9 °C  
Barometric Pressure: 660.7 mmHG

Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.0	0.0	0.0	0.0
10.2	10.2	0.0	0.0
22.0	22.0	0.0	0.0
42.0	42.0	0.0	0.0

**Note:**

If no sign is given on the correction, the true temperature is higher than the indicated temperature. If the sign is negative, the true temperature is lower than the indicated temperature.

Transfer Standard adjustments made? YES ☐ NO ☒

Pre-calibration measurements:

Reference Thermistor (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)

Certified By: MK

Date: July 16, 2020

Marty Kjorstad

*Chinook Engineering*

a division of Pace Analytical Services, LLC

555 Absaraka Street

Sheridan, Wyoming 82801 USA

(307) 674-7506

[chinook@imlinc.com](mailto:chinook@imlinc.com)



7641 N. Business Park Dr., Tucson, AZ 85743 U.S.A., 1.888.290.6060

# Certificate of Calibration

Serial No. 207787 - 17-Jun-2020

## Device Under Test

Customer:	Technical and Business Systems (T&B Systems)	Calibration Procedure/Rev. #:	DOC-AUTOCAL-GASFLOW/Rev. 94
Return Number:	R42254	Calibrated By:	Jonathan Petersen
Serial Number:	207787	Calibration Date:	17-Jun-2020
Model Number:	FP-25	Certification Number:	274260
Software Version:	7v21.9-N02/FP	Full Scale Pressure (internal):	30,000 PSIA
Process Gas:	RH Air	Pressure Accuracy (internal):	+/-0.5% of Full Scale
Calibration Gas:	Air	Temperature Accuracy (internal):	+/-1.5°C
Range:	25,000 SLPM	Relative Humidity Accuracy:	+/-3.5% RH
Gas Temperature:	25.78°C	Standard Temp. & Pressure:	25.00°C, 14.69595 PSIA
Ambient Humidity:	34.64%	Normal Temp. & Pressure:	0.00°C, 14.69595 PSIA
		Calibration due 1 yr. after receipt:	

## Equipment Used

Temperature:	TOOL-TEMP15	Flow:	TOOL-FLOW73
Tool Due Date:	13-Nov-2020	Tool Due Date:	05-Aug-2020
Manufacturer/Model:	ASL / F200-A-2+Probe	Manufacturer/Model:	Alicat / MCM-30SLPM-D
Device Uncertainty:	+/- 0.02°C	Device Uncertainty:	±0.32% Reading or ±0.02% F.S.

All test equipment used for calibration is NIST traceable.

## Calibration

Uncertainty: +/- (1% of Reading + 0% of Full Scale)  
Units of measure: SLPM

Calibration Pressure: N/A

### Flow Calibration

#### As Found

D.U.T.	Actual	In Tolerance
0.000	0.000	Yes
1.677	1.668	Yes
6.258	6.248	Yes
6.680	6.667	Yes
12.526	12.489	Yes
16.683	16.658	Yes
18.778	18.737	Yes
22.030	21.976	Yes
25.006	24.961	Yes

#### As Left

D.U.T.	Actual	In Tolerance
0.000	0.000	Yes
1.665	1.669	Yes
6.244	6.248	Yes
6.665	6.666	Yes
12.479	12.488	Yes
16.649	16.658	Yes
18.730	18.738	Yes
21.981	21.977	Yes
24.978	24.984	Yes

### Temperature Probe

Uncertainty: +/- 0.2°C

D.U.T.	Actual
24.23	24.19

### Barometer

Uncertainty: +/- 1 mmHg

D.U.T.	Actual
699.90	700.00

Calibrated By:  
QC Signature:

Jonathan Petersen  
6/17/2020 4:12:00 PM

Alicat Scientific, Inc. is an ISO 9001 certified company.

CS1 Rev 17 Last Modified 15-May-2017

\*Alicat was used for the barometric pressure verification





**R.M. Young Company**  
2801 Aero Park Drive  
Traverse City, Michigan 49686 USA

### CERTIFICATE OF CALIBRATION AND TESTING

Model: 18802/18811  
Serial Number: CA04380

Description: Anemometer Drive - 2 motors, 20 to 15,000 RPM  
(18802 comprised of 18820A Control Unit and 18830A Motor Assembly)  
(18811 comprised of 18820A Control Unit and 18831A Motor Assembly)

R. M. Young Company certifies that the above equipment was inspected and calibrated prior to shipment in accordance with established manufacturing and testing procedures. Standards established by R.M. Young Company for calibrating the measuring and test equipment used in controlling product quality are traceable to the National Institute of Standards and Technology.

Nominal Motor RPM	27106D Output Frequency Hz (1)	Calculated RPM (2)	Indicated RPM (3)
18802 <input checked="" type="checkbox"/> Clockwise and Counterclockwise rotation verified.			
300	50	300	300
2700	450	2700	2700
5100	850	5100	5100
7500	1250	7500	7500
10200	1700	10200	10200
12600	2100	12600	12600
15000	2500	15000	15000
18811 <input checked="" type="checkbox"/> Clockwise and Counterclockwise rotation verified.			
30.0	5	30.0	30.0
150.0	25	150.0	150.0
300.0	50	300.0	300.0
450.0	75	450.0	450.0
600.0	100	600.0	600.0
750.0	125	750.0	750.0
990.0	165	990.0	990.0

- (1) Measured output frequency of YOUNG model 27106D standard anemometer attached to motor shaft.
- (2) YOUNG model 27106D produces 10 pulsed per revolution of the anemometer shaft.
- (3) Indicated on the Control Unit LCD.

\* Indicates out of tolerance.

☐ New Unit

☒ Service / Repair Unit

☐ As found

☒ No calibration adjustments required

☐ As left

Traceable frequency meter used for calibration:  
Model: 34405A

Serial Number: TW46290020

Date: 23 July 2020  
Calibration Interval: One year

Tested By : EC

M E T E O R O L O G I C A L I N S T R U M E N T S

Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com Website: youngusa.com  
ISO 9001:2008 CERTIFIED



Site: Sentinel Peak Resources – Los Angeles

Audit Date: June 9, 2021 (Second Quarter 2021)

Instrumentation Audited: Surface Meteorology

Key Person(s): Joseph Walters

Auditor: David Yoho  
Technical & Business Systems, Inc.  
25570 Rye Canyon Rd., Unit J  
Valencia, CA 91355

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The purpose of this summary is to provide a report of significant audit findings at the Sentinel Peak Resources facility in Los Angeles, CA. Key elements of the audit are identified below. Results of the performance audit comparisons are included.

#### **GENERAL COMMENTS**

There were no comments noted at the time of the audit.

#### **KEY METEOROLOGICAL AUDIT FINDINGS**

There were no issues observed at the time of the audit.

**AUDIT RECORD***T&B Systems*

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**HORIZONTAL WIND SPEED**Date: **06/09/21**Start: **6:15 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **W24360**K factor: **1.4**Range: **0 - 100** mphLast calibrated: **03/02/21**Model: **014A**Sensor Ht.: **10 meters**Starting torque: **0.1** gm cmStarting threshold: **0.6** mphStarting threshold criteria: **1.0** mph

<i>Audit Point</i>	<i>Input MPH</i>			<i>DAS MPH</i>	<i>DAS Diff. MPH</i>
1	1.0			1.0	0.0
2	9.9			10.0	0.0

*Audit Criteria:  $\pm 0.56$  MPH;  $ws \leq 11.2$  MPH*

<i>Audit Point</i>	<i>Input MPH</i>			<i>DAS MPH</i>	<i>DAS Diff. %</i>
3	18.9			18.9	0.0
4	36.8			36.8	0.0
5	54.7			54.7	0.0

*Audit Criteria:  $\pm 5\%$ ;  $ws > 11.2$  MPH*

Comments: There were no problems noted.

**AUDIT RECORD***T&B Systems*

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**HORIZONTAL WIND DIRECTION**Date: **06/09/21**Start: **6:15 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **J10229**K factor: **30**Range: **360°**Crossarm: **94°**Last calibrated: **03/02/21**Model: **024A**Sensor Ht.: **10 meters**Starting torque: **NA gm cm**Starting threshold: **mph**Starting threshold criteria: **1.0 mph**

<i>Audit Point</i>	<i>Degrees Reference</i>			<i>Degrees DAS</i>	<i>DAS Diff. Degrees</i>
1	94			96	2
2	184			186	2
3	274			276	2
4	4			6	2

*Audit Criteria: ±5 degrees*

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**AMBIENT TEMPERATURE (2 METERS)**Date: **06/09/21**Start: **6:15 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **T20201 - 1**Lower Range: **-58** Deg FUpper Range: **122** Deg FLast calibrated: **03/02/21**Model: **062MP**Sensor Ht.: **2 meters**

<i>Audit Point</i>	<i>Input Deg F</i>			<i>DAS Deg F</i>	<i>DAS Diff. Deg F</i>
1	32.6			32.5	-0.1
2	67.5			67.3	-0.2
3	99.9			100.0	0.1

*Audit Criteria:  $\pm 0.9^{\circ}\text{F}$* 

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**TEMPERATURE DIFFERENCE (DELTA-T)**Date: **06/09/21**Start: **6:15 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **T20201-1 / T20201-2**Lower Range: **-58** Deg FUpper Range: **122** Deg FLast Calibrated: **03/02/21**Model: **062MP**Sensor Ht.: **2 m / 9 m**

<i>Audit Point</i>	<i>Input Deg F</i>	<i>2-9 Temp Diff Deg F</i>
1	32.6	0.10
2	67.5	0.01
3	99.9	0.01

*Audit Criteria:  $\pm 0.18^{\circ}\text{F}$* 

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**SOLAR RADIATION**Date: **6/9/21**Start: **6:15 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Sensor Mfg: **LICOR**Serial No.: **PY104697**Range: **0 - 1500 W/m2**Last Calibrated: **03/02/21**Model: **200X**Sensor Ht.: **~ 3 meters**

<i>Audit Point</i>	<i>Input W/m2</i>	<i>DAS W/m2</i>	<i>Diff %</i>
1	108	111	2.8
2	199	204	2.5
3	518	522	0.8
4	204	208	2.0
5	566	573	1.2
6	587	595	1.4
7	630	624	-1.0

*Audit Criteria:  $\pm 10\%$* 

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**BAROMETRIC PRESSURE**Date: **6/9/21**Start: **6:15 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Sensor Mfg: **MetOne**Serial No.: **NA**Range: **NA**Last Calibrated: **03/02/21**Model: **090**Sensor Ht.: **1 meter**

<i>Audit Point</i>	<i>Input in hg</i>	<i>DAS in hg</i>	<i>Diff in hg</i>
1	29.67	29.69	0.07

*Audit Criteria:  $\pm 0.09$ "*

Comments: There were no problems noted.



**AUDIT RECORD****PRECIPITATION**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

Date: **06/09/21**Start: **6:15 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **X10024**Units: **Inches**Last Calibrated: **03/02/21**Model: **070D**Sensor Ht.: **1 meter**Funnel Diam.: **8** inch

<i>Audit Point</i>	<i>Input Inches</i>	<i>DAS Inches</i>	<i>Diff. %</i>
1	0.61	0.63	3.8

*Audit Criteria: ±10% of input*

Comments: There were no problems noted.

**T&B SYSTEMS PERFORMANCE EVALUATION EQUIPMENT CERTIFICATION DATA**



OTT Hydromet Corp. 20400 Lewis Drive, Suite 100, Sterling, VA 20154, USA • Tel: (703) 436-2800 • info@otthydromet.com • www.otthydromet.com

## CALIBRATION CERTIFICATE

<b>CERTIFICATE NUMBER</b>	012021123339
<b>PYRANOMETER MODEL</b>	CMP 6
<b>SERIAL NUMBER</b>	123339
<b>SENSITIVITY</b>	15.62 $\mu\text{V/W/m}^2$ at normal incidence on horizontal pyranometer
<b>IMPEDANCE</b>	40 $\Omega$
<b>REFERENCE PYRANOMETER</b>	Kipp & Zonen CMP 6 sn 090860 active from 01 January 2021
<b>CALIBRATION DATE</b>	09 January 2021
<b>CLASSIFICATION</b>	ISO 9060, Class B (First Class)*

### Calibration procedure

The indoor calibration procedure is based on a side-by-side comparison with a reference pyranometer under an artificial sun fed by an AC voltage stabiliser. It embodies a 150 W Metal-Halide high-pressure gas discharge lamp. Behind the lamp is a reflector with a diameter of 16.2 cm. The reflector is 1 m above the pyranometers producing a vertical beam. The reference and test pyranometers are mounted horizontally on a table, which can rotate. The irradiance at the pyranometers is approximately 500  $\text{W/m}^2$ . During the calibration procedure the reference and test pyranometers are interchanged to correct for any non-homogeneity of the beam. Temperature during calibration:  $22.2 \pm 0.1^\circ\text{C}$ .

### Hierarchy of traceability

The reference pyranometer was compared with the sun and sky radiation as source under clear sky conditions using the 'alternating sun-and-shade method' (ISO 9846 paragraph 5). The measurements were performed in Delft, The Netherlands (latitude:  $51.9569^\circ$ , longitude:  $4.1863^\circ$ , altitude: 10m above sea level). Dates of measurements: 22-24 June 2020.  
The receiver surface was pointed directly at the sun using a solar tracker. During the comparisons, the instrument received tilted global radiation intensities from 834 to 1089 with a mean of 959  $\text{W/m}^2$  and tilted diffuse radiation intensities from 96 to 274 with a mean of 158  $\text{W/m}^2$ . The ambient temperature ranged from  $+19.0$  to  $+29.9$  with a mean of  $+23.9^\circ\text{C}$ .  
The direct radiation on the reference pyranometer as obtained with the alternating sun-and-shade method was compared to the DNI measured by the absolute cavity pyrheliometer PMO6 SN 103. The PMO6 is calibrated against the World Standard Group (WSG), maintained at the WRC Davos every International Pyrheliometer Comparison (IPC). The PMO6 participated in the NPC 2019 hosted by NREL in Golden, Colorado to verify its stability. WRR factor of PMO6: 0.99789.

This calibration proved that the reference pyranometer has been stable and that the original sensitivity  $14.08 \pm 0.35 \mu\text{V/W/m}^2$  valid until will be applied (see PMOD calibration details). Observed sensitivity differences between the consecutive years are well within the calibration uncertainty.

PMOD calibration details: The reference pyranometer was compared with the sun and sky radiation as source under mainly clear sky conditions using the 'continuous sun-and-shade method'. The pyranometer was installed horizontally. During the comparisons, the global radiation ranged from 573 to 1033 with a mean of 897  $\text{W/m}^2$ . The solar zenith angle varied from  $24.6$  to  $49.6$  with a mean of  $32.6$  degrees. The ambient temperature ranged from  $+18.6$  to  $+24.9$  with a mean of  $+21.9^\circ\text{C}$ . The sensitivity calculation is based on 530 individual measurements. The readings of the WSG are referred to the World Radiometric Reference (WRR). The estimated uncertainty of the WRR relative to SI is  $\pm 0.3\%$ . The obtained sensitivity value and its expanded uncertainty (95% level of confidence) are valid for similar conditions and are  $14.08 \pm 0.35 \mu\text{V/W/m}^2$ . The measurements were performed in Davos (latitude:  $46.8143^\circ$ , longitude:  $-7.8458^\circ$ , altitude: 1558m above sea level). Dates of measurements: 10, 12, 15, 20, 21 July 2015.  
Global radiation data were calculated from the direct solar radiation as measured with the absolute cavity pyrheliometer PMO4 (member of the WSG, WRR-Factor: 0.998625, based on IPC-2010) and from the diffuse radiation as measured with a continuous disk shaded pyranometer Kipp & Zonen CM22 SN 020059 (ventilated with heated air).

### Justification of total instrument calibration uncertainty

The combined uncertainty of the result of the calibration is the 'root sum square' of the following components.

1. The expanded uncertainty due to random effects and instrumental errors during the calibration of the reference CMP 6 is  $\pm 0.35/14.08 = \pm 2.49\%$  (see traceability text).
2. Based on experience, the expanded uncertainty of the transfer procedure (calibration by comparison) is estimated to be  $\pm 0.5\%$ .
3. The estimated uncertainty of the WRR relative to SI,  $\pm 0.3\%$ .

The expanded uncertainty is:  $\pm 2.49\% + 0.5\% + 0.3\% = \pm 2.55\%$  (k=2).

### Notice

The calibration certificate supplied with the instrument is valid at the date of first use. Even though the calibration certificate is dated, calibration, manufacture, or recalibration, the instrument does not undergo any sensitivity changes when kept in the original packaging.

\* From October 2018 the classification conforms to ISO 9060:2018. Instruments issued before that date conform to ISO 9060:1990.

### Calibration by Kipp & Zonen Authorised Calibration Partner

This calibration was performed by a Kipp & Zonen Authorised Calibration Partner, with all required facilities, procedures and training provided by Kipp & Zonen, and audited by Kipp & Zonen bi-annually.

Sterling, VA, USA, 09 January 2021

*Paul Delisi*  
Paul Delisi  
(in charge of calibration facility)

*Khôi Tran*  
Khôi Tran  
(in charge of test)

Chinook Engineering

innovative measurements

*Certificate of Accuracy***Transfer Standard Type: Electronic Thermometer**

Certificate No: T 071620. 01

Transfer standard, model/type: Cooper Instrument Corporation Model SH66A Temperature Instrument

Serial number: T&amp;B SH66A #2

Probe S/N: 1075

submitted by/owner: T &amp; B Systems

25570 Rye Canyon Road

Unit J

Valencia, CA 91355

Was compared to:

NIST Traceable Hg-in-glass thermometer serial number 3L9452 and ice point. Miller & Weber Hg-in-glass thermometer sn 3L9452 is traceable to NIST Thermometer 40350, through Transfer Standards 3C4465 & 1Y9716.

Date: 07/16/20

Lab temperature: 23.9 °C  
Barometric Pressure: 660.7 mmHG

Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.0	0.0	0.0	0.0
10.2	10.2	0.0	0.0
22.0	22.0	0.0	0.0
42.0	42.0	0.0	0.0

**Note:**

If no sign is given on the correction, the true temperature is higher than the indicated temperature. If the sign is negative, the true temperature is lower than the indicated temperature.

Transfer Standard adjustments made? YES ☐ NO ☒

Pre-calibration measurements:

Reference Thermistor (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)

Certified By: MK

Date: July 16, 2020

Marty Kjorstad

*Chinook Engineering*

a division of Pace Analytical Services, LLC

555 Absaraka Street

Sheridan, Wyoming 82801 USA

(307) 674-7506

[chinook@imlinc.com](mailto:chinook@imlinc.com)

Chinook Engineering

innovative measurements

*Certificate of Accuracy***Transfer Standard Type: Barometric Pressure/Altimeter**

Certificate No: B 121319. 01

Transfer standard model: Druck DPI 705 Digital Pressure Indicator

Serial number: 1478/98-12

submitted by/owner: T &amp; B Systems

25570 Rye Canyon Road, Unit J  
Valencia, CA 91355

Was compared to Precision Absolute Reference Barometer:

Model No. 355-AI0900

Serial number: 913930-M1

Certified accuracy of  $\pm 0.007$ "Hg

NIST traceable to Ruska Deadweight Tester SN 38342/C-85

Date: December 13, 2019

Lab temperature: 23.2 °C

Lab pressure: 657.9 mm Hg

Reference barometer (hPa)	Transfer Standard (hPa)	Difference from Reference (hPa)	Transfer Standard Correction* (hPa)	
725.0	736.2	11.2	-11.2	ambient
800.0	811.4	11.4	-11.4	
877.2	888.4	11.3	-11.3	
950.0	962.0	12.0	-12.0	
1050.0	1062.0	12.0	-12.0	

**Note:**

If no sign is given on the correction, the true pressure  
is higher than the indicated pressure. If the sign is negative,  
the true pressure is lower than the indicated pressure.

Transfer Standard adjustments made? YES ☐ NO ☒

Reference barometer (hPa)	Transfer Standard (hPa)	Difference from Reference (hPa)	Transfer Standard Correction* (hPa)

Certified By: RLS

Date: December 13, 2019

Roger L. Sanders

*Chinook Engineering*

a division of Pace Analytical Services, LLC

555 Absaraka Street

Sheridan, Wyoming 82801 USA

(307) 674-7506

chinook@imlinc.com



**R.M. Young Company**  
2801 Aero Park Drive  
Traverse City, Michigan 49686 USA

### CERTIFICATE OF CALIBRATION AND TESTING

Model: 18802/18811  
Serial Number: CA04380

Description: Anemometer Drive - 2 motors, 20 to 15,000 RPM  
(18802 comprised of 18820A Control Unit and 18830A Motor Assembly)  
(18811 comprised of 18820A Control Unit and 18831A Motor Assembly)

R. M. Young Company certifies that the above equipment was inspected and calibrated prior to shipment in accordance with established manufacturing and testing procedures. Standards established by R.M. Young Company for calibrating the measuring and test equipment used in controlling product quality are traceable to the National Institute of Standards and Technology.

Nominal Motor RPM	27106D Output Frequency Hz (1)	Calculated RPM (2)	Indicated RPM (3)
18802 <input checked="" type="checkbox"/> Clockwise and Counterclockwise rotation verified.			
300	50	300	300
2700	450	2700	2700
5100	850	5100	5100
7500	1250	7500	7500
10200	1700	10200	10200
12600	2100	12600	12600
15000	2500	15000	15000
18811 <input checked="" type="checkbox"/> Clockwise and Counterclockwise rotation verified.			
30.0	5	30.0	30.0
150.0	25	150.0	150.0
300.0	50	300.0	300.0
450.0	75	450.0	450.0
600.0	100	600.0	600.0
750.0	125	750.0	750.0
990.0	165	990.0	990.0

- (1) Measured output frequency of YOUNG model 27106D standard anemometer attached to motor shaft.
- (2) YOUNG model 27106D produces 10 pulsed per revolution of the anemometer shaft.
- (3) Indicated on the Control Unit LCD.

\* Indicates out of tolerance.

☐ New Unit

☒ Service / Repair Unit

☐ As found

☒ No calibration adjustments required

☐ As left

Traceable frequency meter used for calibration:  
Model: 34405A

Serial Number: TW46290020

Date: 23 July 2020  
Calibration Interval: One year

Tested By : EC

M E T E O R O L O G I C A L I N S T R U M E N T S

Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com Website: youngusa.com  
ISO 9001:2008 CERTIFIED



Site: Sentinel Peak Resources – Los Angeles  
Audit Date: September 13, 2021 (Third Quarter 2021)  
Instrumentation Audited: Surface Meteorology  
Key Person(s): Joseph Walters  
Auditor: David Yoho  
Technical & Business Systems, Inc.  
25570 Rye Canyon Rd., Unit J  
Valencia, CA 91355

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The purpose of this summary is to provide a report of significant audit findings at the Sentinel Peak Resources facility in Los Angeles, CA. Key elements of the audit are identified below. Results of the performance audit comparisons are included.

#### **GENERAL COMMENTS**

There were no comments noted at the time of the audit.

#### **KEY METEOROLOGICAL AUDIT FINDINGS**

1. The barometric pressure audit results did not meet the recommended audit criteria of  $\pm 0.09$ " Hg. The datalogger factor was adjusted bringing the sensor response back within criteria.

**AUDIT RECORD***T&B Systems*

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**HORIZONTAL WIND SPEED**Date: **09/13/21**Start: **6:30 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **W24360**K factor: **1.4**Range: **0 - 100** mphLast calibrated: **06/09/21**Model: **014A**Sensor Ht.: **10 meters**Starting torque: **0.1 gm cm**Starting threshold: **0.6 mph**Starting threshold criteria: **1.0 mph**

<i>Audit Point</i>	<i>Input MPH</i>			<i>DAS MPH</i>	<i>DAS Diff. MPH</i>
1	1.0			1.0	0.0
2	9.9			10.0	0.0

*Audit Criteria:  $\pm 5.6$  MPH;  $ws \leq 11.2$  MPH*

<i>Audit Point</i>	<i>Input MPH</i>			<i>DAS MPH</i>	<i>DAS Diff. %</i>
3	18.9			18.9	0.0
4	36.8			36.8	0.0
5	54.7			54.7	0.0

*Audit Criteria:  $\pm 5\%$ ;  $ws > 11.2$  MPH*

Comments: There were no problems noted.



**AUDIT RECORD***T&B Systems*

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**HORIZONTAL WIND DIRECTION**Date: **09/13/21**Start: **6:30 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **J10229**K factor: **30**Range: **360°**Crossarm: **95°**Last calibrated: **06/09/21**Model: **024A**Sensor Ht.: **10 meters**Starting torque: **NA gm cm**Starting threshold: **mph**Starting threshold criteria: **1.0 mph**

<i>Audit Point</i>	<i>Degrees Reference</i>			<i>Degrees DAS</i>	<i>DAS Diff. Degrees</i>
1	95			96	1
2	185			186	1
3	275			277	2
4	5			6	1

*Audit Criteria: ±5 degrees*

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**AMBIENT TEMPERATURE (2 METERS)**Date: **09/13/21**Start: **6:30 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **T20201 - 1**Lower Range: **-58** Deg FUpper Range: **122** Deg FLast calibrated: **06/09/21**Model: **062MP**Sensor Ht.: **2 meters**

<i>Audit Point</i>	<i>Input Deg F</i>			<i>DAS Deg F</i>	<i>DAS Diff. Deg F</i>
1	32.3			32.6	0.3
2	70.3			70.2	-0.1
3	102.6			102.6	0.0

*Audit Criteria:  $\pm 0.9^{\circ}\text{F}$* 

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**TEMPERATURE DIFFERENCE (DELTA-T)**Date: **09/13/21**Start: **6:30 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **T20201-1 / T20201-2**Lower Range: **-58** Deg FUpper Range: **122** Deg FLast Calibrated: **06/09/21**Model: **062MP**Sensor Ht.: **2 m / 9 m**

<i>Audit Point</i>	<i>Input Deg F</i>	<i>2-9 Temp Diff Deg F</i>
1	32.3	0.15
2	70.3	0.11
3	102.6	0.00

*Audit Criteria:  $\pm 0.18^{\circ}\text{F}$* 

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**SOLAR RADIATION**Date: **9/13/21**Start: **6:30 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Sensor Mfg: **LICOR**Serial No.: **PY104697**Range: **0 - 1500 W/m2**Last Calibrated: **06/09/21**Model: **200X**Sensor Ht.: **~ 3 meters**

<i>Audit Point</i>	<i>Input W/m2</i>	<i>DAS W/m2</i>	<i>Diff %</i>
1	73	73	0.0
2	128	135	5.5
3	167	174	4.2
4	253	255	0.8
5	252	255	1.2
6	477	476	-0.2

*Audit Criteria:  $\pm 10\%$* 

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**BAROMETRIC PRESSURE**Date: **9/13/21**Start: **6:30 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Sensor Mfg: **MetOne**Serial No.: **NA**Range: **NA**Last Calibrated: **06/09/21**Model: **090**Sensor Ht.: **1 meter**

<i>Audit Point</i>	<i>Input in hg</i>	<i>DAS in hg</i>	<i>Diff in hg</i>
As Found	29.52	29.45	<b>-0.24</b>
As Left	29.52	29.52	<b>0.00</b>

*Audit Criteria:  $\pm 0.09$ " Hg*

Comments: The audit results did not meet criteria. The datalogger factor was adjusted.

**AUDIT RECORD****PRECIPITATION**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

Date: **09/13/21**Start: **6:30 PST**Finish: **8:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **X10024**Units: **Inches**Last Calibrated: **06/09/21**Model: **070D**Sensor Ht.: **1 meter**Funnel Diam.: **8** inch

<i>Audit Point</i>	<i>Input Inches</i>	<i>DAS Inches</i>	<i>Diff. %</i>
1	0.61	0.63	3.8

*Audit Criteria: ±10% of input*

Comments: There were no problems noted.

**T&B SYSTEMS PERFORMANCE EVALUATION EQUIPMENT CERTIFICATION DATA**



OTT Hydromet Corp. 20400 Lewis Drive, Suite 100, Sterling, VA 20154, USA • Tel: (703) 436-2800 • info@otthydromet.com • www.otthydromet.com

## CALIBRATION CERTIFICATE

<b>CERTIFICATE NUMBER</b>	012021123339
<b>PYRANOMETER MODEL</b>	CMP 6
<b>SERIAL NUMBER</b>	123339
<b>SENSITIVITY</b>	15.62 $\mu\text{V/W/m}^2$ at normal incidence on horizontal pyranometer
<b>IMPEDANCE</b>	40 $\Omega$
<b>REFERENCE PYRANOMETER</b>	Kipp & Zonen CMP 6 sn 090860 active from 01 January 2021
<b>CALIBRATION DATE</b>	09 January 2021
<b>CLASSIFICATION</b>	ISO 9060, Class B (First Class)*

### Calibration procedure

The indoor calibration procedure is based on a side-by-side comparison with a reference pyranometer under an artificial sun fed by an AC voltage stabiliser. It embodies a 150 W Metal-Halide high-pressure gas discharge lamp. Behind the lamp is a reflector with a diameter of 16.2 cm. The reflector is 1 m above the pyranometers producing a vertical beam. The reference and test pyranometers are mounted horizontally on a table, which can rotate. The irradiance at the pyranometers is approximately 500  $\text{W/m}^2$ . During the calibration procedure the reference and test pyranometers are interchanged to correct for any non-homogeneity of the beam. Temperature during calibration:  $22.2 \pm 0.1^\circ\text{C}$ .

### Hierarchy of traceability

The reference pyranometer was compared with the sun and sky radiation as source under clear sky conditions using the 'alternating sun-and-shade method' (ISO 9846 paragraph 5). The measurements were performed in Delft, The Netherlands (latitude:  $51.9569^\circ$ , longitude:  $4.1863^\circ$ , altitude: 10m above sea level). Dates of measurements: 22-24 June 2020.  
The receiver surface was pointed directly at the sun using a solar tracker. During the comparisons, the instrument received tilted global radiation intensities from 834 to 1089 with a mean of 959  $\text{W/m}^2$  and tilted diffuse radiation intensities from 96 to 274 with a mean of 158  $\text{W/m}^2$ . The ambient temperature ranged from  $+19.0$  to  $+29.9$  with a mean of  $+23.9^\circ\text{C}$ .  
The direct radiation on the reference pyranometer as obtained with the alternating sun-and-shade method was compared to the DNI measured by the absolute cavity pyrheliometer PMO6 SN 103. The PMO6 is calibrated against the World Standard Group (WSG), maintained at the WRC Davos every International Pyrheliometer Comparison (IPC). The PMO6 participated in the NPC 2019 hosted by NREL in Golden, Colorado to verify its stability. WRR factor of PMO6: 0.99789.

This calibration proved that the reference pyranometer has been stable and that the original sensitivity  $14.08 \pm 0.35 \mu\text{V/W/m}^2$  valid until will be applied (see PMOD calibration details). Observed sensitivity differences between the consecutive years are well within the calibration uncertainty.

PMOD calibration details: The reference pyranometer was compared with the sun and sky radiation as source under mainly clear sky conditions using the 'continuous sun-and-shade method'. The pyranometer was installed horizontally. During the comparisons, the global radiation ranged from 573 to 1033 with a mean of 897  $\text{W/m}^2$ . The solar zenith angle varied from  $24.6$  to  $49.6$  with a mean of  $32.6$  degrees. The ambient temperature ranged from  $+18.6$  to  $+24.9$  with a mean of  $+21.9^\circ\text{C}$ . The sensitivity calculation is based on 530 individual measurements. The readings of the WSG are referred to the World Radiometric Reference (WRR). The estimated uncertainty of the WRR relative to SI is  $\pm 0.3\%$ . The obtained sensitivity value and its expanded uncertainty (95% level of confidence) are valid for similar conditions and are  $14.08 \pm 0.35 \mu\text{V/W/m}^2$ . The measurements were performed in Davos (latitude:  $46.8143^\circ$ , longitude:  $-7.8458^\circ$ , altitude: 1558m above sea level). Dates of measurements: 10, 12, 15, 20, 21 July 2015.  
Global radiation data were calculated from the direct solar radiation as measured with the absolute cavity pyrheliometer PMO4 (member of the WSG, WRR-Factor: 0.998625, based on IPC-2010) and from the diffuse radiation as measured with a continuous disk shaded pyranometer Kipp & Zonen CM22 SN 020059 (ventilated with heated air).

### Justification of total instrument calibration uncertainty

The combined uncertainty of the result of the calibration is the 'root sum square' of the following components.

1. The expanded uncertainty due to random effects and instrumental errors during the calibration of the reference CMP 6 is  $\pm 0.35/14.08 = \pm 2.49\%$  (see traceability text).
2. Based on experience, the expanded uncertainty of the transfer procedure (calibration by comparison) is estimated to be  $\pm 0.5\%$ .
3. The estimated uncertainty of the WRR relative to SI is  $\pm 0.3\%$ .

The expanded uncertainty is:  $\pm 2.49\% + 0.5\% + 0.3\% = \pm 2.55\%$  (k=2).

### Notice

The calibration certificate supplied with the instrument is valid at the date of first use. Even though the calibration certificate is dated, calibration, manufacture, or recalibration, the instrument does not undergo any sensitivity changes when kept in the original packaging.

\* From October 2018 the classification conforms to ISO 9060:2018. Instruments issued before that date conform to ISO 9060:1990.

### Calibration by Kipp & Zonen Authorised Calibration Partner

This calibration was performed by a Kipp & Zonen Authorised Calibration Partner, with all required facilities, procedures and training provided by Kipp & Zonen, and audited by Kipp & Zonen bi-annually.

Sterling, VA, USA, 09 January 2021

*Paul Delisi*  
Paul Delisi  
(in charge of calibration facility)

*Khôi Tran*  
Khôi Tran  
(in charge of test)



Chinook Engineering

innovative measurements

*Certificate of Accuracy***Transfer Standard Type: Electronic Thermometer**

Certificate No: T 070621. 01

Transfer standard, model/type: Cooper Instrument Corporation Model SH66A Temperature Instrument

Serial number: T&amp;B SH66A #2

Probe S/N: 1075

submitted by/owner: T &amp; B Systems

25570 Rye Canyon Road

Unit J

Valencia, CA 91355

Was compared to:

NIST Traceable Hg-in-glass thermometer serial number 3L9452 and ice point. Miller & Weber Hg-in-glass thermometer sn 3L9452 is traceable to NIST Thermometer 40350, through Transfer Standards 3C4465 & 1Y9716.

Date: 07/06/21

 Lab temperature: 22.1 °C  
 Barometric Pressure: 662.2 mmHG

Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.0	0.0	0.0	0.0
21.6	21.6	0.0	0.0
42.1	42.1	0.0	0.0

**Note:**

If no sign is given on the correction, the true temperature is higher than the indicated temperature. If the sign is negative, the true temperature is lower than the indicated temperature.

Transfer Standard adjustments made? YES ☐ NO ☒

Pre-calibration measurements:

Reference Thermistor (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)

Certified By: MK

Date: July 6, 2021

Marty Kjorstad

*Chinook Engineering*

a division of Pace Analytical Services, LLC

555 Absaraka Street

Sheridan, Wyoming 82801 USA

(307) 674-7506

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Chinook Engineering

innovative measurements

*Certificate of Accuracy***Transfer Standard Type: Barometric Pressure/Altimeter**

Certificate No: B 120320. 01

Transfer standard model: Druck DPI 705 Digital Pressure Indicator

Serial number: 1478/98-12

submitted by/owner: T &amp; B Systems

25570 Rye Canyon Road, Unit J  
Valencia, CA 91355

Was compared to Precision Absolute Reference Barometer:

Model No. 355-AI0900

Serial number: 913930-M1

Certified accuracy of  $\pm 0.007''\text{Hg}$ 

NIST traceable to Ruska Deadweight Tester SN 38342/C-85

Date: December 3, 2020

Lab temperature: 22.0

°C

Lab pressure: 665.0

mm Hg

Reference barometer (hPa)	Transfer Standard (hPa)	Difference from Reference (hPa)	Transfer Standard Correction*
725.0	736.2	11.2	-11.2
800.0	811.4	11.4	-11.4
885.8	897.4	11.6	-11.6
950.0	961.4	11.4	-11.4
1050.0	1062.4	12.4	-12.4

ambient

**Note:**

If no sign is given on the correction, the true pressure  
is higher than the indicated pressure. If the sign is negative,  
the true pressure is lower than the indicated pressure.

Transfer Standard adjustments made? YES ☐ NO ☒

Reference barometer (hPa)	Transfer Standard (hPa)	Difference from Reference (hPa)	Transfer Standard Correction*

Certified By:

Date: December 3, 2020

Marty Kjorstad

*Chinook Engineering*

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(307) 674-7506

chinook@pacelabs.com



**R.M. Young Company**  
2801 Aero Park Drive  
Traverse City, Michigan 49686 USA

### CERTIFICATE OF CALIBRATION AND TESTING

Model: 18802  
Serial Number: CA04380

Description: Anemometer Drive - 200 to 15000 RPM  
(Comprised of 18820A Control Unit and 18830A Motor Assembly)

R. M. Young Company certifies that the above equipment was inspected and calibrated prior to shipment in accordance with established manufacturing and testing procedures. Standards established by R.M. Young Company for calibrating the measuring and test equipment used in controlling product quality are traceable to the National Institute of Standards and Technology.

Nominal Motor RPM RPM	27106D Output Frequency Hz (1)	Calculated RPM (2)	Indicated RPM (3)
300	50	300	300
2700	450	2700	2700
5100	850	5100	5100
7500	1250	7500	7500
10200	1700	10200	10200
12600	2100	12600	12600
15000	2500	15000	15000

☒ Clockwise and Counterclockwise rotation verified.

- (1) Measured output frequency of YOUNG model 27106D standard anemometer attached to motor shaft.
- (2) YOUNG model 27106D produces 10 pulsed per revolution of the anemometer shaft.
- (3) Indicated on the Control Unit LCD.

\* Indicates out of tolerance.

☐ New Unit

☒ Service / Repair Unit

☐ As found

☒ No calibration adjustments required

☐ As left

Traceable frequency meter used for calibration:  
Model: 34405A

Serial Number: MY53020093

Date: 26 July 2021  
Calibration Interval: One year

Tested By : DO

M E T E O R O L O G I C A L I N S T R U M E N T S  
Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com Website: youngusa.com  
ISO 9001:2008 CERTIFIED



Site: Sentinel Peak Resources – Los Angeles

Audit Date: December 9, 2021 (Fourth Quarter 2021)

Instrumentation Audited: Surface Meteorology

Key Person(s): Joseph Walters

Auditor: David Yoho  
Technical & Business Systems, Inc.  
25570 Rye Canyon Rd., Unit J  
Valencia, CA 91355

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The purpose of this summary is to provide a report of significant audit findings at the Sentinel Peak Resources facility in Los Angeles, CA. Key elements of the audit are identified below. Results of the performance audit comparisons are included.

#### **GENERAL COMMENTS**

There were no comments noted at the time of the audit.

#### **KEY METEOROLOGICAL AUDIT FINDINGS**

1. The barometric pressure audit results did not meet the recommended audit criteria of  $\pm 0.09$ " Hg. The datalogger factor was adjusted bringing the sensor response back within criteria.

**AUDIT RECORD***T&B Systems*

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**HORIZONTAL WIND SPEED**Date: **12/09/21**Start: **7:30 PST**Finish: **9:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **W24360**K factor: **1.4**Range: **0 - 100** mphLast calibrated: **09/13/21**Model: **014A**Sensor Ht.: **10 meters**Starting torque: **0.1 gm cm**Starting threshold: **0.6 mph**Starting threshold criteria: **1.0 mph**

<i>Audit Point</i>	<i>Input MPH</i>			<i>DAS MPH</i>	<i>DAS Diff. MPH</i>
1	1.0			1.0	0.0
2	9.9			10.0	0.0

*Audit Criteria:  $\pm 5.6$  MPH;  $ws \leq 11.2$  MPH*

<i>Audit Point</i>	<i>Input MPH</i>			<i>DAS MPH</i>	<i>DAS Diff. %</i>
3	18.9			18.9	0.0
4	36.8			36.8	0.0
5	54.7			54.7	0.0

*Audit Criteria:  $\pm 5\%$ ;  $ws > 11.2$  MPH*

Comments: There were no problems noted.

**AUDIT RECORD***T&B Systems*

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**HORIZONTAL WIND DIRECTION**Date: **12/09/21**Start: **7:30 PST**Finish: **9:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **J10229**K factor: **30**Range: **360°**Crossarm: **95°**Last calibrated: **09/13/21**Model: **024A**Sensor Ht.: **10 meters**Starting torque: **NA gm cm**Starting threshold: **mph**Starting threshold criteria: **1.0 mph**

<i>Audit Point</i>	<i>Degrees Reference</i>			<i>Degrees DAS</i>	<i>DAS Diff. Degrees</i>
1	95			95	0
2	185			184	-1
3	275			274	-1
4	5			2	-3

*Audit Criteria: ±5 degrees*

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**AMBIENT TEMPERATURE (2 METERS)**Date: **12/09/21**Start: **7:30 PST**Finish: **9:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **T20201 - 1**Lower Range: **-58** Deg FUpper Range: **122** Deg FLast calibrated: **09/13/21**Model: **062MP**Sensor Ht.: **2 meters**

<i>Audit Point</i>	<i>Input Deg F</i>			<i>DAS Deg F</i>	<i>DAS Diff. Deg F</i>
1	32.2			32.8	0.6
2	68.9			68.6	-0.3
3	102.0			102.0	0.0

*Audit Criteria:  $\pm 0.9^{\circ}\text{F}$* 

Comments: There were no problems noted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**TEMPERATURE DIFFERENCE (DELTA-T)**Date: **12/09/21**Start: **7:30 PST**Finish: **9:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site Name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Serial No.: **T20201-1 / T20201-2**Lower Range: **-58** Deg FUpper Range: **122** Deg FLast Calibrated: **09/13/21**Model: **062MP**Sensor Ht.: **2 m / 9 m**

<i>Audit Point</i>	<i>Input Deg F</i>	<i>2-9 Temp Diff Deg F</i>
1	32.2	0.01
2	68.9	0.02
3	102.0	0.00

*Audit Criteria:  $\pm 0.18^{\circ}\text{F}$* 

Comments: There were no problems noted.



**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**SOLAR RADIATION**Date: **12/9/21**Start: **7:30 PST**Finish: **9:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Sensor Mfg: **LICOR**Serial No.: **PY104697**Range: **0 - 1500 W/m2**Last Calibrated: **09/13/21**Model: **200X**Sensor Ht.: **~ 3 meters**

<i>Audit Point</i>	<i>Input W/m2</i>	<i>DAS W/m2</i>	<i>Diff %</i>
1	20	20	0.0
2	41	43	4.9
3	25	26	4.0
4	24	26	8.3
5	20	21	5.0

*Audit Criteria: ±10%*

Comments: There were no problems noted. Clouds and rain kept the readings low.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**BAROMETRIC PRESSURE**Date: **12/9/21**Start: **7:30 PST**Finish: **9:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Sensor Mfg: **MetOne**Serial No.: **NA**Range: **NA**Last Calibrated: **09/13/21**Model: **090**Sensor Ht.: **1 meter**

<i>Audit Point</i>	<i>Input in hg</i>	<i>DAS in hg</i>	<i>Diff in hg</i>
As Found	29.53	29.60	<b>0.24</b>
As Left	29.54	29.54	0.00

*Audit Criteria:  $\pm 0.09$ " Hg*

Comments: The audit results did not meet criteria. The datalogger factor was adjusted.

**AUDIT RECORD**

25570 Rye Cyn. Rd, Unit J

Valencia, CA 91355

(661) 294-1103

**PRECIPITATION**Date: **12/09/21**Start: **7:30 PST**Finish: **9:00 PST**Auditor: **David Yoho**Witness: **Joseph Walters**Site name: **Sentinel Peak**Operator: **Sentinel Peak**Project: **QA**Manufacturer: **Met One**Model: **070D**Serial No.: **X10024**Sensor Ht.: **1 meter**Units: **Inches**Funnel Diam.: **8 inch**Last Calibrated: **09/13/21**

<i>Audit Point</i>	<i>Input Inches</i>	<i>DAS Inches</i>	<i>Diff. %</i>
1	0.61	0.64	5.4

*Audit Criteria: ±10% of input*

Comments: There were no problems noted.

**T&B SYSTEMS PERFORMANCE EVALUATION EQUIPMENT CERTIFICATION DATA**



OTT Hydromet Corp. 20400 Lewis Drive, Suite 100, Sterling, VA 20154, USA • Tel: (703) 436-2800 • info@otthydromet.com • www.otthydromet.com

## CALIBRATION CERTIFICATE

<b>CERTIFICATE NUMBER</b>	012021123339
<b>PYRANOMETER MODEL</b>	CMP 6
<b>SERIAL NUMBER</b>	123339
<b>SENSITIVITY</b>	15.62 $\mu\text{V/W/m}^2$ at normal incidence on horizontal pyranometer
<b>IMPEDANCE</b>	40 $\Omega$
<b>REFERENCE PYRANOMETER</b>	Kipp & Zonen CMP 6 sn 090860 active from 01 January 2021
<b>CALIBRATION DATE</b>	09 January 2021
<b>CLASSIFICATION</b>	ISO 9060, Class B (First Class)*

### Calibration procedure

The indoor calibration procedure is based on a side-by-side comparison with a reference pyranometer under an artificial sun fed by an AC voltage stabiliser. It embodies a 150 W Metal-Halide high-pressure gas discharge lamp. Behind the lamp is a reflector with a diameter of 16.2 cm. The reflector is 1 m above the pyranometers producing a vertical beam. The reference and test pyranometers are mounted horizontally on a table, which can rotate. The irradiance at the pyranometers is approximately 500  $\text{W/m}^2$ . During the calibration procedure the reference and test pyranometers are interchanged to correct for any non-homogeneity of the beam. Temperature during calibration:  $22.2 \pm 0.1^\circ\text{C}$ .

### Hierarchy of traceability

The reference pyranometer was compared with the sun and sky radiation as source under clear sky conditions using the 'alternating sun-and-shade method' (ISO 9846 paragraph 5). The measurements were performed in Delft, The Netherlands (latitude:  $51.9569^\circ$ , longitude:  $4.1863^\circ$ , altitude: 10m above sea level). Dates of measurements: 22-24 June 2020.  
The receiver surface was pointed directly at the sun using a solar tracker. During the comparisons, the instrument received tilted global radiation intensities from 834 to 1089 with a mean of 959  $\text{W/m}^2$  and tilted diffuse radiation intensities from 96 to 274 with a mean of 158  $\text{W/m}^2$ . The ambient temperature ranged from  $+19.0$  to  $+29.9$  with a mean of  $+23.9^\circ\text{C}$ .  
The direct radiation on the reference pyranometer as obtained with the alternating sun-and-shade method was compared to the DNI measured by the absolute cavity pyrheliometer PMO6 SN 103. The PMO6 is calibrated against the World Standard Group (WSG), maintained at the WRC Davos every International Pyrheliometer Comparison (IPC). The PMO6 participated in the NPC 2019 hosted by NREL in Golden, Colorado to verify its stability. WRR factor of PMO6: 0.99789.

This calibration proved that the reference pyranometer has been stable and that the original sensitivity  $14.08 \pm 0.35 \mu\text{V/W/m}^2$  valid until will be applied (see PMOD calibration details). Observed sensitivity differences between the consecutive years are well within the calibration uncertainty.

PMOD calibration details: The reference pyranometer was compared with the sun and sky radiation as source under mainly clear sky conditions using the 'continuous sun-and-shade method'. The pyranometer was installed horizontally. During the comparisons, the global radiation ranged from 573 to 1033 with a mean of 897  $\text{W/m}^2$ . The solar zenith angle varied from  $24.6$  to  $49.6$  with a mean of  $32.6$  degrees. The ambient temperature ranged from  $+18.6$  to  $+24.9$  with a mean of  $+21.9^\circ\text{C}$ . The sensitivity calculation is based on 530 individual measurements. The readings of the WSG are referred to the World Radiometric Reference (WRR). The estimated uncertainty of the WRR relative to SI is  $\pm 0.3\%$ . The obtained sensitivity value and its expanded uncertainty (95% level of confidence) are valid for similar conditions and are  $14.08 \pm 0.35 \mu\text{V/W/m}^2$ . The measurements were performed in Davos (latitude:  $46.8143^\circ$ , longitude:  $-7.8458^\circ$ , altitude: 1558m above sea level). Dates of measurements: 10, 12, 15, 20, 21 July 2015.  
Global radiation data were calculated from the direct solar radiation as measured with the absolute cavity pyrheliometer PMO4 (member of the WSG, WRR-Factor: 0.998625, based on IPC-2010) and from the diffuse radiation as measured with a continuous disk shaded pyranometer Kipp & Zonen CM22 SN 020059 (ventilated with heated air).

### Justification of total instrument calibration uncertainty

The combined uncertainty of the result of the calibration is the 'root sum square' of the following components.

1. The expanded uncertainty due to random effects and instrumental errors during the calibration of the reference CMP 6 is  $\pm 0.35/14.08 = \pm 2.49\%$  (see traceability text).
  2. Based on experience, the expanded uncertainty of the transfer procedure (calibration by comparison) is estimated to be  $\pm 0.5\%$ .
  3. The estimated uncertainty of the WRR relative to SI is  $\pm 0.3\%$ .
- The expanded uncertainty is:  $\pm 2.49\% + 0.5\% + 0.3\% = \pm 2.55\%$  (k=2).

### Notice

The calibration certificate supplied with the instrument is valid at the date of first use. Even though the calibration certificate is dated, calibration, manufacture, or recalibration, the instrument does not undergo any sensitivity changes when kept in the original packaging.

\* From October 2018 the classification conforms to ISO 9060:2018. Instruments issued before that date conform to ISO 9060:1990.

### Calibration by Kipp & Zonen Authorised Calibration Partner

This calibration was performed by a Kipp & Zonen Authorised Calibration Partner, with all required facilities, procedures and training provided by Kipp & Zonen, and audited by Kipp & Zonen bi-annually.

Sterling, VA, USA, 09 January 2021

*Paul Delisi*  
Paul Delisi  
(in charge of calibration facility)

*Khôi Tran*  
Khôi Tran  
(in charge of test)

Chinook Engineering

innovative measurements

*Certificate of Accuracy***Transfer Standard Type: Electronic Thermometer**

Certificate No: T 070621. 01

Transfer standard, model/type: Cooper Instrument Corporation Model SH66A Temperature Instrument

Serial number: T&amp;B SH66A #2

Probe S/N: 1075

submitted by/owner: T &amp; B Systems

25570 Rye Canyon Road

Unit J

Valencia, CA 91355

Was compared to:

NIST Traceable Hg-in-glass thermometer serial number 3L9452 and ice point. Miller & Weber Hg-in-glass thermometer sn 3L9452 is traceable to NIST Thermometer 40350, through Transfer Standards 3C4465 & 1Y9716.

Date: 07/06/21

Lab temperature: 22.1 °C  
Barometric Pressure: 662.2 mmHG

Reference Standard (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)
0.0	0.0	0.0	0.0
21.6	21.6	0.0	0.0
42.1	42.1	0.0	0.0

**Note:**

If no sign is given on the correction, the true temperature is higher than the indicated temperature. If the sign is negative, the true temperature is lower than the indicated temperature.

Transfer Standard adjustments made? YES ☐ NO ☒

Pre-calibration measurements:

Reference Thermistor (°C)	Transfer Standard (°C)	Difference from Reference (°C)	Transfer Standard Correction* (°C)

Certified By: MK

Date: July 6, 2021

Marty Kjorstad

*Chinook Engineering*

a division of Pace Analytical Services, LLC

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Sheridan, Wyoming 82801 USA

(307) 674-7506

[chinook@pacelabs.com](mailto:chinook@pacelabs.com)

Chinook Engineering

innovative measurements

*Certificate of Accuracy***Transfer Standard Type: Barometric Pressure/Altimeter**

Certificate No: B 120320. 01

Transfer standard model: Druck DPI 705 Digital Pressure Indicator

Serial number: 1478/98-12

submitted by/owner: T &amp; B Systems

25570 Rye Canyon Road, Unit J  
Valencia, CA 91355

Was compared to Precision Absolute Reference Barometer:

Model No. 355-AI0900

Serial number: 913930-M1

Certified accuracy of  $\pm 0.007$ "Hg

NIST traceable to Ruska Deadweight Tester SN 38342/C-85

Date: December 3, 2020

Lab temperature: 22.0

°C

Lab pressure: 665.0

mm Hg

Reference barometer (hPa)	Transfer Standard (hPa)	Difference from Reference (hPa)	Transfer Standard Correction*
725.0	736.2	11.2	-11.2
800.0	811.4	11.4	-11.4
885.8	897.4	11.6	-11.6
950.0	961.4	11.4	-11.4
1050.0	1062.4	12.4	-12.4

ambient

**Note:**

If no sign is given on the correction, the true pressure  
is higher than the indicated pressure. If the sign is negative,  
the true pressure is lower than the indicated pressure.

Transfer Standard adjustments made? YES ☐ NO ☒

Reference barometer (hPa)	Transfer Standard (hPa)	Difference from Reference (hPa)	Transfer Standard Correction*

Certified By:

Date: December 3, 2020

Marty Kjorstad

*Chinook Engineering*

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chinook@pacelabs.com



**R.M. Young Company**  
2801 Aero Park Drive  
Traverse City, Michigan 49686 USA

### CERTIFICATE OF CALIBRATION AND TESTING

Model: 18802  
Serial Number: CA04380

Description: Anemometer Drive - 200 to 15000 RPM  
(Comprised of 18820A Control Unit and 18830A Motor Assembly)

R. M. Young Company certifies that the above equipment was inspected and calibrated prior to shipment in accordance with established manufacturing and testing procedures. Standards established by R.M. Young Company for calibrating the measuring and test equipment used in controlling product quality are traceable to the National Institute of Standards and Technology.

Nominal Motor RPM RPM	27106D Output Frequency Hz (1)	Calculated RPM (2)	Indicated RPM (3)
300	50	300	300
2700	450	2700	2700
5100	850	5100	5100
7500	1250	7500	7500
10200	1700	10200	10200
12600	2100	12600	12600
15000	2500	15000	15000

☒ Clockwise and Counterclockwise rotation verified.

- (1) Measured output frequency of YOUNG model 27106D standard anemometer attached to motor shaft.
- (2) YOUNG model 27106D produces 10 pulsed per revolution of the anemometer shaft.
- (3) Indicated on the Control Unit LCD.

\* Indicates out of tolerance.

☐ New Unit

☒ Service / Repair Unit

☐ As found

☒ No calibration adjustments required

☐ As left

Traceable frequency meter used for calibration:  
Model: 34405A

Serial Number: MY53020093

Date: 26 July 2021  
Calibration Interval: One year

Tested By : DO

METEOROLOGICAL INSTRUMENTS  
Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com Website: youngusa.com  
ISO 9001:2008 CERTIFIED