Global Atmosphere Watch
World Calibration Centre for Surface Ozone
Carbon Monoxide and Methane

Swiss Federal Laboratories for Materials Testing
and Research (EMPA)

DRAFT

EMPA-WCC REPORT 00/1

Submitted to the

World Meteorological Organization

SYSTEM AUDIT OF SURFACE OZONE MEASUREMENTS

AT GAW GLOBAL MOUNTAIN STATION MT. KENYA

INCLUDING OZONE SOUNDING, NAIROBI

KENYA, JANUARY 2000

Submitted by

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WMO World Calibration Centre for Surface Ozone, Carbon Monoxide and Methane

EMPA Dübendorf, Switzerland

Contents:

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S SCHWEIZERISCHER KALIBRIERDIENSTDIENST
SERVICE SUISSE D'ETALONAGE
C SERVIZIO SVIZZERA DI TARURA
S SWISS CALIBRATION SERVICE

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Figures:

Tables:

1. Abstract

The World Calibration Centre at EMPA conducted a system audit of the surface ozone measurements at the global GAW station Mt. Kenya. It was the first audit since the start of the ozone measurements in December 1999 at the mountain site. The planned performance audit at the site had to be postponed for the next audit because the power line had broken at the time of the audit. Thus we were limited to intercomparison measurements between the WCC transfer standard and the ozonesond calibrator in Nairobi. This ozone calibrator is used for the confirmation of the calibration of the ozonesonds which are launched weekly from Nairobi., The results of the three multipoint runs demonstrated good agreement. The recorded differences (ozonesond calibrator vs. WCC) lie in the range of 1.5 % lower with a negative offset of 0.5 ppb (figures 5 and 6). For the application (ozonesond check), the determined deviation to the WCC transfer standard is considered as low and has no practical implications on the ozonesond data acquired up to now.

The system audit (mountain station and ozonesond launch site) was focused on the instrument and station maintenance. It consisted of developing a documentation regime and giving theoretical and practical training on the ozone instruments.

To date, huge efforts have been made by the KMD, the WMO and the SMI to install electrical power at the mountain site. The experience shows that the project is not completed yet, but ongoing efforts have to be made. However, the key role in the future success of the station might play accessibility to the site at any time of the year within a day or two. Beside the problems with the electrical power line to the site, this must be of highest priority to be solved.

On the other hand, it should be also noted that the set-up and installation of the new mountain site is a great success. The station is well equipped and ready to fill the gap of air measurement data of the tropics. Especially mentioned should be Dr. W. Junkermann of the IFU, Germany, who has contributed an important part to this success.

All persons associated directly or indirectly with the operation of the station are highly motivated and co-operative and have remarkable team spirit. Finally, we should acknowledge the KMD, in particular Mr W. Kimani for helping us in every possible way to overcome of time-consuming custom procedures.

Recommendations

1) It must be of first priority to find an adequate solution to make the station accessible any time of the year within a day or two. The experts recommend that WMO and the other interested institutions remain strongly supportive of KMD's efforts in overcoming this difficult issue.
2) The huge problem with the power line to the site is not solved yet. Already shortly after the opening, the line needs a major maintenance works to become functional again. Thus, all sides are called upon to keep up with support to make the power line more reliable and stable.
3) It is important that the whole team becomes familiar with the measurement technique and the data processing. To ensure the adequate quality contacts should be sought to persons experienced in measurements at remote sites (such as Cape Point or Zugspitze) Such contacts may avoid years of learning by "try and error" and provide other suggestions how to operate a similar site.

4) It is recommended that the agreement of filling in the control form (questionnaire), any time the site is visited, be implemented as worked out during the audit.
5) Influence of expected daily temperature variation (20°C down to 5 to10°C) on the measurement instruments should be followed.
6) The mountain station should be meteorologically characterised to make data interpretation more meaningful.

Dübendorf, 15. September, 2000 EMPA, World Calibration Centre

Project engineer Project manager

A. Herzog B. Buchmann

2. Introduction

In establishing a co-ordinated quality assurance programme for the WMO Global Atmosphere Watch programme, the air pollution and environmental technology department of the Swiss Federal Laboratories for Materials Testing and Research (EMPA) was assigned by the WMO to operate the WMO-GAW World Calibration Centre (WCC) for Surface Ozone, Carbon Monoxide and Methane. At the beginning of 1996 our work had started within the GAW programme with the parameter surface ozone. The activities were extended for carbon monoxide and methane, in the middle of the year 1997 and 2000, respectively. The detailed goals and tasks of the WCC concerning surface ozone are described in the WMO-GAW report No. 104.

In agreement with the responsible persons of the Kenya Meteorological Department in Nairobi, it was planned to conduct a system and performance audit at the global GAW station Mt. Kenya. However, due to power problems during the audit, the tasks had to be limited to a system audit at the mountain site.

The station was established within the framework of GEF and is designated for long-term measurements of several chemical compounds and physical and meteorological parameters in the free troposphere over the African continent. The set-up of the site was coordinated by the Institute for Atmospheric Environmental Research (IFU), Germany, in particular Dr. W. Junkermann, who has been on site during the audit to upgrade and improve the actual site configuration.

The scope of the audit was confined to the tropospheric ozone measurement system including data processing, documentation and any supporting measures of quality assurance. The audit procedure was performed according to the "Standard Operating Procedure (SOP) for performance auditing ozone analysers at global and regional WMO-GAW sites", WMO-GAW Report No. 97. The assessment criteria for the ozone intercomparison have been developed by EMPA-WCC and are based on WMO-GAW Report No. 97 (EMPA-WCC report 98/5 "Traceability, Uncertainty and Assessment Criteria of ground based Ozone Measurements" by P. Hofer, B. Buchmann and A. Herzog, September 1998, available on request from the authors at: EMPA, 134, Ueberlandstr. 129, CH-8600 Dübendorf).

Additionally to the system audit performed at Mt. Kenya site, the ozone calibrator of the GAW team at KMD, Nairobi, was checked and intercompared with the transfer standard of EMPA. The ozone calibrator has been used for checking the ozonesonds which are launched weekly since 1998 by the KMD, Nairobi. The ozone soundings are operated in a close twinning with the Swiss Meteorological Institute (SMI). In the future, the instrument can also be used for periodical calibration of the ozone analyser of the Mt. Kenya site.

The present audit report is submitted to the station manager of the KMD, the IFU in Germany, the SMI in Payerne and the World Meteorological Organization in Geneva.

Previous audits:

- none

System and performance audits at global GAW stations will be regularly conducted on mutual arrangement.

3. Global GAW Site Mt. Kenya

3.1. Site Characteristics

The mountain site of the global GAW station Kenya is located on the north-western side of the Mount Kenya within the national park (GPS coordinates: 00° 03' 40" S – 37° 17' 50" E) at an approximate altitude of approximate 3650 m a.s.l.. The nearest town is Nanyuki, a small village due west in the lower high plateau hosting a bigger farmer community. The surrounding terrain of the station is gently sloping moorland with low bushes and several smaller streams nearby. The station itself is exposed in all directions on a 10 m high rock outcrop. Access to the site requires a two hour drive from Nanyuki by a 4WD vehicle up to "Old Moses" camp at 3300 m a.s.l. and a 30 to 40 minutes uphill walk. The national park is entered at the Sirimon Gate following a steep small, unpaved road, which is closed to the public. The road is in very poor condition and maintenance would be extremely important to keep the station accessible in the wet season within a day or two.

The facilities at the site consist of two 2.5 m x 6 m cabins attached to each other, which provide space for an office and measurement racks. On the flat roof of the laboratory cabin (walk on), the air inlet and several radiation and meteorological equipment are mounted (see schematic).

Assessments about the microclimate e.g. prevailing winds, temperatures, etc, can not be made yet.

Figure 1: Picture of Mt. Kenya station

From the beginning, the installation of the power line had been a big issue for the station responsibles. Today a more than 20 km long power line leads up to station. It branches off from the road between Nanyuki and Meru and follows a pathway through the Sirimon gate, through the national park (see picture). Already shortly after the opening, the line has needed a major maintenance works to become functional again. At the date of printing, the line was still dead.

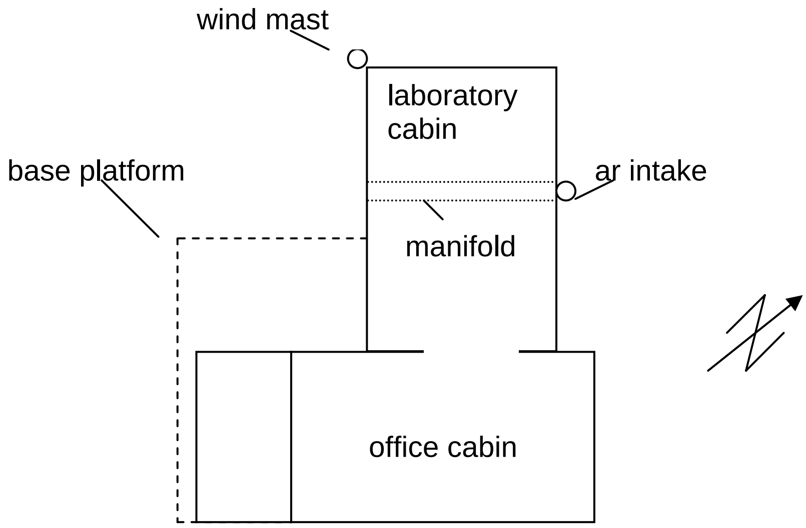

Figure 2: Schematic of the station Mt. Kenya

3.2. Measurement Programme

Table 1: Measurement programme as end of January 2000

Parameter	Measurement Typ

Meteo sensors

total radiation	CM 11, Kipp&Zonen
diffuse radiation	CM 11 (shadowband), Kipp&Zonen
temperature, humidity	DTR 13, VAISALA
wind (direction, velocity)	VAISALA
precipitation (wet only)	M.I.C. company

Chemical measurements

ozone	TEI 49-003
aerosols (not in operation yet)	Aethalometer, GIV

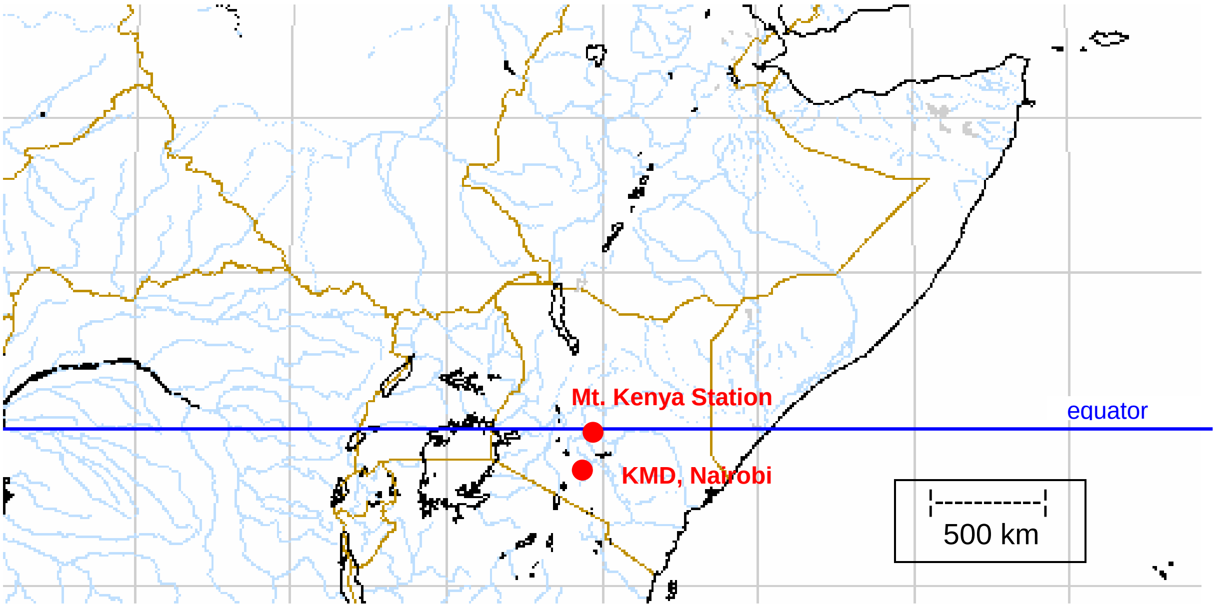

Figure 3: Map of East Africa

3.3. Operators

The mountain station has started its operation on 3. December 1999 with a start-up measurement programme listed in section 3.2. The leading office for operation and maintenance is the Kenya Meteorological Department (KMD) in Nairobi. On behalf of the WMO, the Institute for Atmospheric Environmental Research (IFU), Germany has set up the station at the mountain site on Mt. Kenya, in co-operation with the KMD. IFU has further provided its expertise in the form of trainings and infrastructural support. The structure of the station management is shown in Table 2.

Table 2: Operators

Mr Wilson Kimani, Officer-in-charge of the station, Meteorologist
Operators Mr John Rotich, Meteorologist Mr Josiah Kariuki, Meteorologist Mr Dominic Mutungi, Technical engineer Mr John Aseyo, Technical engineer
External Expert Dr Wolfgang Junkermann, IFU, Germany

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3.4. Surface Ozone Level

The site characteristics and the relevant concentration range can be well defined by the frequency distribution. The surface ozone measurements started a month ago, having acquired a week of data. Thus, a representative frequency distribution could not be calculated, yet. However, the relevant ozone concentration range at Mt. Kenya station is estimated to be between 10 and 35 ppb. But during periods of air masses from forest fires reaching the station, ozone values up to 100 ppb could be possible.

4. Measurement Technique, Mt. Kenya

4.1. Air Inlet System

The air intake part is mounted on the northern side of the laboratory cabin 1.7 m above the platform and about 4.5 m above the ground. It consists of a small, inverse aluminium-bucket, which shields the manifold from rain. The manifold consists of a glass tube (id 5 cm, 2m long) which lies inside a covering aluminium tube. The glass tube enters the cabin under the ceiling. It passes the room and leaves it on the opposite side. The manifold is flushed with a high volume pump. From the manifold a 1.5 m, ¼ " Teflon tube branches off through which the instrument pump sucks ambient air with 2 l/min through the ozone analyser. The residence time of the ambient air in the inlet line lies around 10 seconds.

Comment

The Teflon tube and the rain protection at the inlet were clean and free of dust. The inlet system, concerning construction materials as well as residence time, is adequate for gas analysis.

4.2. Instrumentation

The monitoring system at the global GAW station Mt. Kenya consists of an ozone analyser including an internal ozone generator, plus an external zero air unit consisting of a pump and a charcoal cartridge. The ozone instrument is installed in a 19" rack in a 6m x 2.5m cabin unit. The room has no heating but can be ventilated if temperature exceeds a set limit. However, temperatures below 10°C, during nights, going up to 20°C at daytime can be expected with the actual start measurement programme. The analyser is not exposed to direct sunlight. Instrumental details for the ozone instrument on the mountain site are listed in table 3.

Table 3: ozone analyser

	ozone analyser
type	TEI 49-003 #51959-290
method	UV absorption
In operation	since December 1999
range	0-1000 ppb; 0-10 analog output
settings	span: 509; offset: 49
specials	Internal ozone generator
signal output	analog: 0-10 V, serial: none

The instrumentation and a valve control box to perform regular zero point and span checks is installed at the site but could not taken in operation. However, the staff is instructed on how to use it and should be able to use it as soon there is power back at the site.
The station had been equipped with a DCP (data collection platform) to send an hourly data string to the KMD in Nairobi.

Comment

The ozone measurement system (UV method) at Mt. Kenya station represents a complete ozone measurement unit with the possibility to perform regular zero and span checks. Influence of expected daily temperature variation on the measurement instruments should be followed.

4.3. Operation and Maintenance

The operator team of the site had been trained on the ozone analyser, besides from the other measurement equipment. The training was held by Dr W. Junkermann (IFU) at the mountain site in October 1999. It was focused on maintenance under real conditions, including cleaning of the cells and the solenoid valves, adjusting the pressure sensor and performing other regular service checks. In addition to this audit it was planned to continue and repeat this training in order to intensify the first part. Because of a circuit break in the power line to the station it was only possible to perform a dry run.

Due to frequent and long power failures from the beginning on (December 1999) up to the time of the audit the operator team had no possibility to gain first-hand experience on how to maintain the instruments and the station. Thus, the audit was used to discuss the future maintenance works and to develop maintenance documents, i.e. checklists, and logbooks, together with the station team. The produced documents are listed in the Appendix III

Comment

The appearance inside the station is clean and functional.
Assuming that a highly motivated team is able to scope with a challenging task one thinks that the station staff is sufficiently trained to start with the measurements, once the power is back up at the mountain. However, it is regarded as eminently important to integrate the people in the exchange of technical know-how and to continue with support in the form of training.

4.4. Data Handling

Only a few days of data had been acquired, thus, the methods of data treatment was discussed only in brief. Therefore, it is recommended that the KMD staff finds a twinning partner to discuss associated issues. First contacts to the global GAW site of Cape Point, South Africa exist.

4.5. Documentation

As mentioned in the section "operation and maintenance", the operators have laid a basis with the created document forms and checklists (see Appendix III).

4.6. Competence

All persons associated directly or indirectly with the operation of the station are highly motivated and co-operative and have a remarkable team spirit.
The present state of the site was achieved only due to extraordinarily effort of the staff and the helping partners, especially that of the SMI and that of the IFU, namely Dr. W. Junkermann.

5. Intercomparison of Ozone Sounding Calibrator, KMD, Nairobi

5.1. Experimental Procedure

The Kenya Meteorological Department, Nairobi, successfully launches ozonesonds weekly since several years. For the ozone sounding project within the GAW programme, an ozone calibrator of the type TEI 49-PS had been purchased by the WMO. It is used for the confirmation of the ozonesond calibration. In the course of the system audit at Mt Kenya station, an intercomparison of this ozone calibrator was performed at the ozone launch site at the KMD in Nairobi.
At the KMD, the WCC transfer standard (detailed description see Appendix II) and the ozonesond calibrator were hooked up to power for warming up over night (deviation to the GAW report No. 97 in which only one hour of warm-up time is required). Before the intercomparison was started the transfer standard, the PFA tubing connections to the instrument and the instrument itself were conditioned with about 200 ppb ozone for 20 min. On the 31. January, two comparisons runs between the ozonesond calibrator and the WCC transfer standard were performed. A third run was carried out on the next day. Table 4 shows the experimental details and figure 4 the experimental set up of the intercomparison measurement. In general, no modification of the ozone calibrator was made which could have influenced the measurements. Beside the intercomparison procedure, the measurement cells of the ozonesond calibrator have been inspected for dust and particles. The cells and tubing were in proper, clean condition.

Finally, the observed results were discussed in an informal review with the involved personnel.

The audit procedure included a direct intercomparison of the WCC transfer standard TEI 49C-PS with the Standard Reference Photometer SRP (NIST UV photometer) in Switzerland before and after the audit. The results are shown in the Appendix II.

Table 4: Experimental details

auditor WCC:	A. Herzog
reference :	WCC: TEI 49C-PS #54509-300 transfer standard
ozone sounding calibrator (KMD, Nairobi):	TEI 49PS #53677-297 (calibrator), UV absorption Gain: 6; Ozone level: 000
ozone source:	WCC: TEI 49C-PS, internal generator
zero air supply:	WCC: silicagel – inlet filter 5 μm – metal bellow pump – Purafil (potassium permanganate) – activated charcoal – outlet filter 5 μm
data acquisition system:	WCC: 16 channel ADC circuit board, software
surrounding conditions:	p: 825 hPa ± 2 hPa and T_{indoor}: approx. 25°C
pressure transducers reading:	TEI 49C-PS: 825 hPa TEI 49PS: 823 hPa
concentration range:	0 - 1000 ppb
number of concentrations:	5 + zero air at beginning and end
approx. concentration levels:	50 / 100 / 150 / 200 / 245 ppb

sequence of concentration:	random
averaging interval per concentration:	runs 1 – 3: 5 minutes
number of runs:	2 x on 31. January 1 x on 1. February
connection between instruments:	1 meter of 1/4" PFA tubing

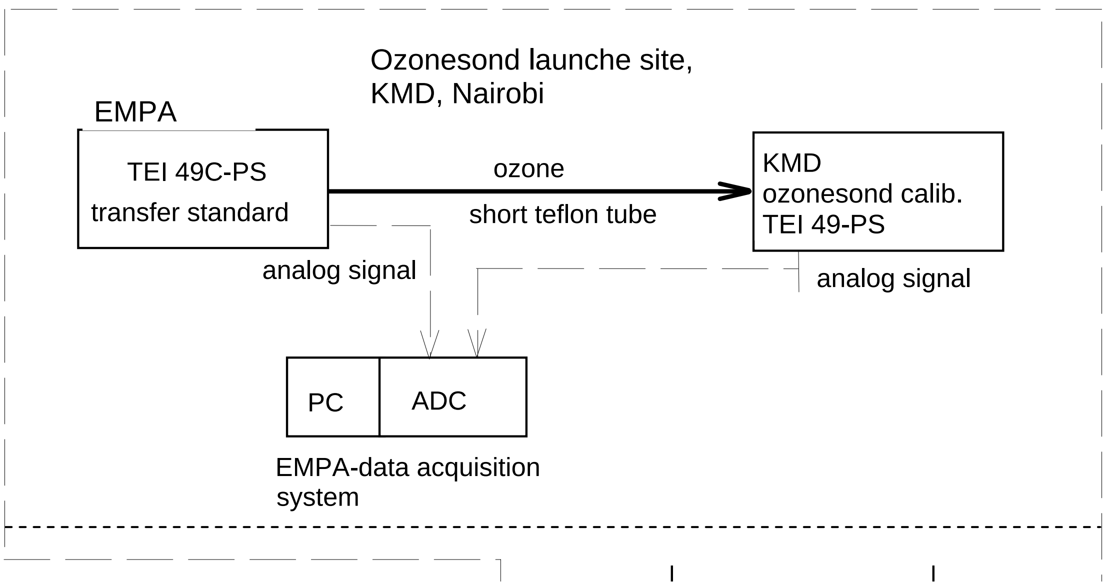

Figure 4: Experimental set up

C circuit board and a PC with the corresponding software. Hooked up to the analog output of all the involved instruments, the data was collected by the data acquisition system of the WCC.

5.2. Results

The results comprise three intercomparisons between the ozonesond calibrator TEI 49-PS against the WCC transfer standard TEI 49C-PS, carried out on 31. January and 1. February, 2000.

In the following tables the resulting mean values of each ozone concentration and the standard deviations (s_d) of twenty 30-second-means are presented. For each mean value the differences between the tested instruments and the transfer standard are calculated in ppb and in %.

Furthermore, the diagrams show the results of the linear regression analysis of the ozonesond calibrator TEI 49PS compared to the WCC transfer standard (TEI 49C-PS). The results of the three runs are then summarised to a mean regression (Figure 5 and 6).

Table 5: 1. Intercomparison

No.	**transfer standard**		**TE 49PS**			
	TE 49C-PS conc.	s_d	conc.	s_d	deviation from reference	
	ppb	ppb	ppb	ppb	ppb	%
1	0.4	0.32	0.3	0.39	0.0	
2	244.8	0.31	241.8	0.59	-3.1	-1.3%
3	99.8	0.40	97.9	0.54	-1.8	-1.8%
4	199.8	0.95	196.6	0.78	-3.2	-1.6%
5	49.9	0.45	48.6	0.49	-1.3	-2.6%
6	149.8	0.74	147.5	0.78	-2.3	-1.6%
7	0.4	1.12	0.2	0.27	-0.2	

Table 6: 2. Intercomparison

No.	**transfer standard**		**TE 49PS**			
	TE 49C-PS conc.	s_d	conc.	s_d	deviation from reference	
	ppb	ppb	ppb	ppb	ppb	%
1	0.4	1.12	0.2	0.27	-0.2	
2	99.9	0.47	97.7	0.57	-2.2	-2.2%
3	245.2	0.36	241.5	0.56	-3.6	-1.5%
4	49.9	0.54	48.5	0.57	-1.4	-2.8%
5	149.9	0.91	147.5	0.72	-2.4	-1.6%
6	200.0	0.57	197.0	0.65	-3.0	-1.5%
7	0.5	0.25	0.1	0.32	-0.4	

Table 7: 3. Intercomparison

No.	**transfer standard**		**TE 49PS**			
	TE 49C-PS conc.	s_d	conc.	s_d	deviation from reference	
	ppb	ppb	ppb	ppb	ppb	%
1	0.5	0.25	0.3	0.38	-0.2	
2	199.9	0.92	196.5	0.80	-3.4	-1.7%
3	50.1	0.43	48.4	0.50	-1.6	-3.3%
4	150.0	0.29	146.8	0.38	-3.2	-2.1%
5	100.1	0.32	97.7	0.45	-2.4	-2.4%
6	245.0	0.39	240.6	0.62	-4.4	-1.8%
7	0.6	0.27	0.1	0.32	-0.6	

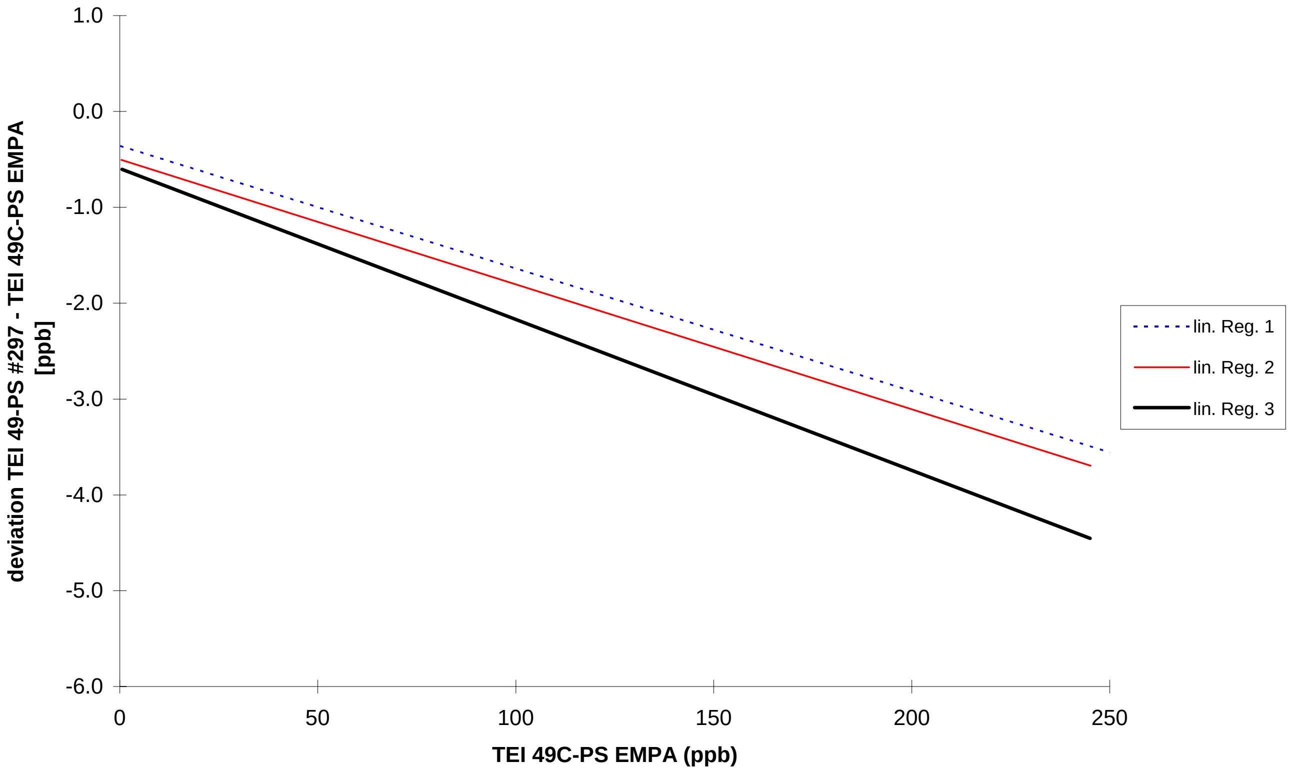

Figure 5: Individual linear regressions of intercomparison runs with TEI 49PS

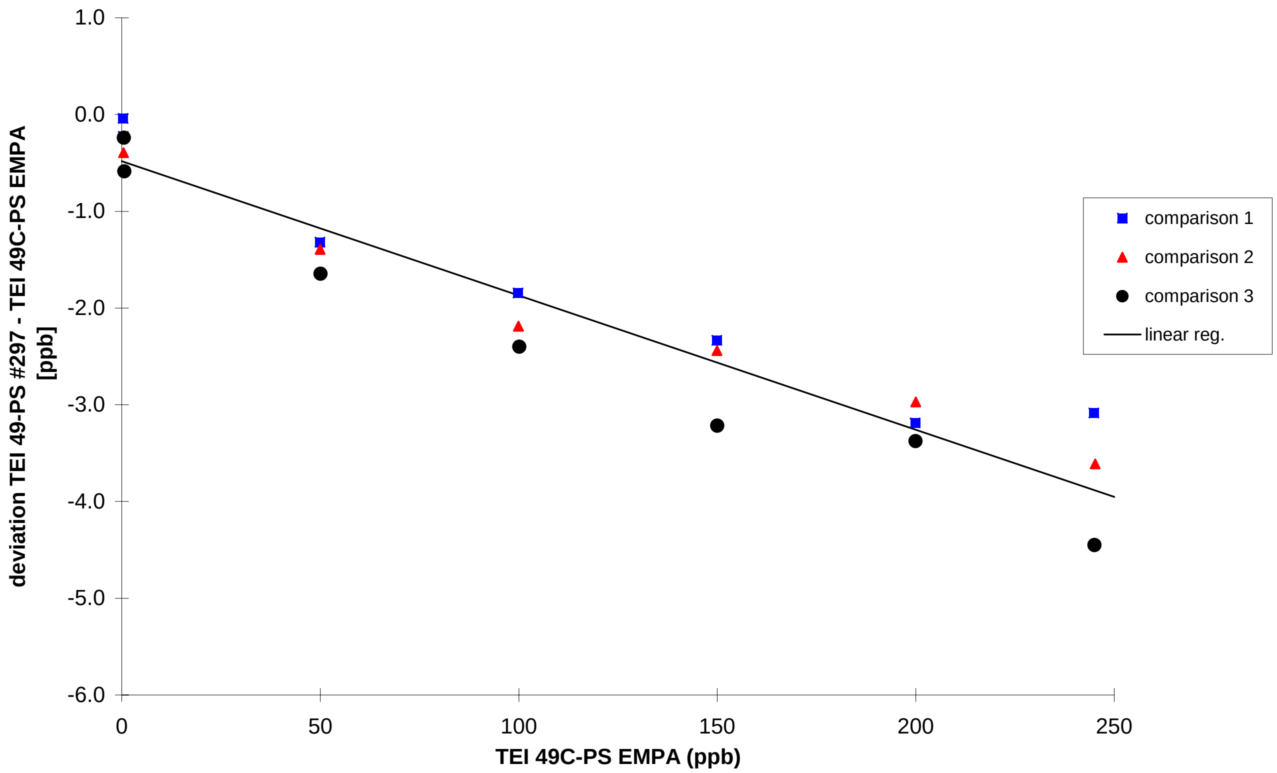

Figure 6: Mean linear regression of ozonesond calibrator, TEI 49PS

From the three comparisons we have calculated the linear regression equation. The equation is valid for the range of 0-250 ppb ozone.

TEI 49PS (ozonesond calibrator, Nairobi):

TEI 49PS = 0.986 x TEI 49C-PS - 0.5 ppb

TEI 49PS = O_3 mixing ratio in ppb, determined for TEI 49 #53677-297
TEI 49C-PS = O_3 mixing ratio in ppb, related to TEI 49C-PS #54509-300

Standard deviation of:	- slope s_m	0.0009	(f = 3) f=degree of freedom
	- offset S_b in ppb	0.12	(f = 3)
	- residuals in ppb	0.20	(f = 19)

Comment

The ozonesond calibrator had been used for several years without being calibrated in the meantime. Considering this aspect, the results of the intercomparison look very good, implying that the instrument was handled correctly and thoughtful.

For the application (ozonesond check), the determined deviation of about 1.5 % to the WCC transfer standard is considered as low and has no practical implications. Thus, the internal calibration factors of the ozonesond calibrator were not adjusted.

Appendix

I WCC Transfer Standard TEI 49C-PS

The Model 49C-PS is based on the principle that ozone molecules absorb UV light at a wavelength of 254 nm. The degree to which the UV light is absorbed is directly related to the concentration as described by the Lambert-Beer Law.

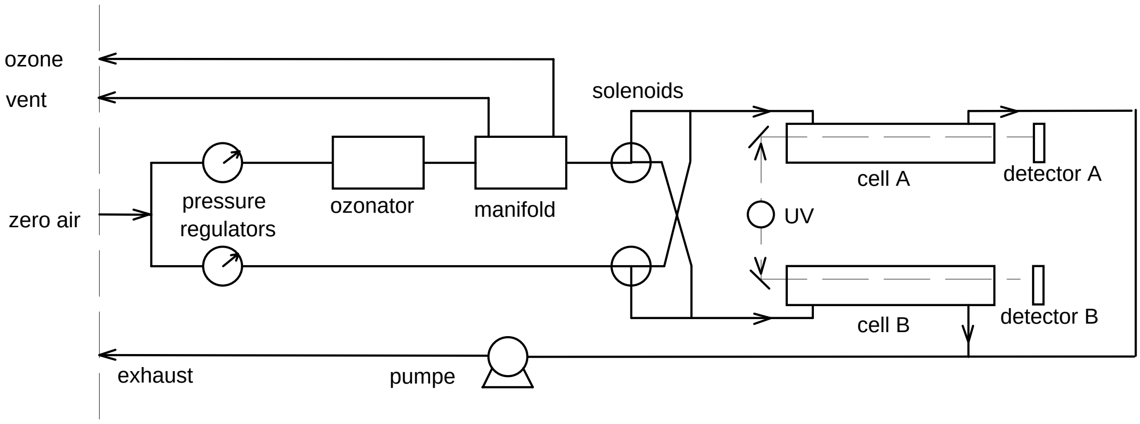

Figure 7: Flow schematic of WCC transfer standard TEI 49C-PS

Zero air is supplied to the Model 49C-PS through the zero air bulkhead and is split into two gas streams, as shown in Figure 7. One gas stream flows through a pressure regulator to the reference solenoid valve to become the reference gas. The second zero air stream flows through a pressure regulator, ozonator and manifold the sample solenoid valve to become the sample gas. Ozone from the manifold is delivered to the ozone bulkhead. The solenoid valves alternate the reference and sample gas streams between cells A and B every 10 seconds. When cell A contains reference gas, cell B contains sample gas and vice versa.

The UV light intensities of each cell are measured by detectors A and B. When the solenoid valves switch the reference and sample gas streams to opposite cells, the light intensities are ignored for several seconds to allow the cells to be flushed. The Model 49C-PS calculates the ozone concentration for each cell and outputs the average concentration.

II Stability of the Transfer Standard TEI 49C-PS

To exclude errors which might occur through transportation of the transfer standard, the TEI 49C-PS #54509-300 has to be compared with the SRP#15 before and after the field audit.

The procedure and the instruments set up of this intercomparison in the calibration laboratory at the EMPA-WCC are summarised in Table 8 and Figure 8.

Table 8: Intercomparison procedure TEI 49C-PS - SRP

pressure transducer:	span check (calibrated barometer)
concentration range:	0 - 200 ppb
number of concentrations:	5 + zero air at start and end
approx. concentration levels:	30 / 60 / 90 / 125 / 185 ppb
sequence of concentration:	random
averaging interval per concentration:	5 minutes
number of runs:	2 before and 3 after audit
zero air supply:	Pressurised air - zero air generator (CO catalyst, Purafil, charcoal)
ozone generator:	SRP's internal generator
data acquisition system:	SRP's ADC and acquisition

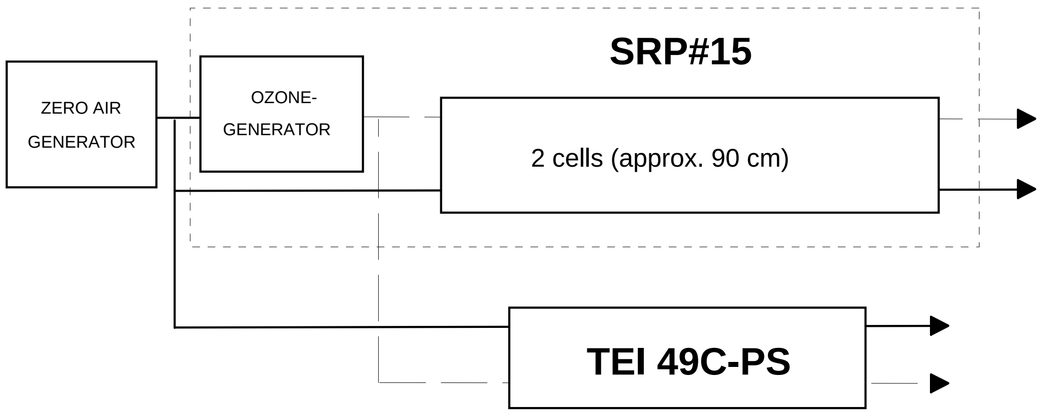

Figure 8: Instruments set up TEI 49C-PS - SRP

The stability of the transfer standard is thoroughly examined with respect to the uncertainties of the different components (systematic error and precision). The assessment criteria for the transfer standard of the WCC-O_3 (TEI 49C-PS) are defined to ± (1 ppb + 0.6%), taking the uncertainty of the SRP into account.
Figures 9 and 10 show the resulting linear regression and the corresponding 95% prediction interval for the comparisons of TEI 49C-PS vs. SRP#15.

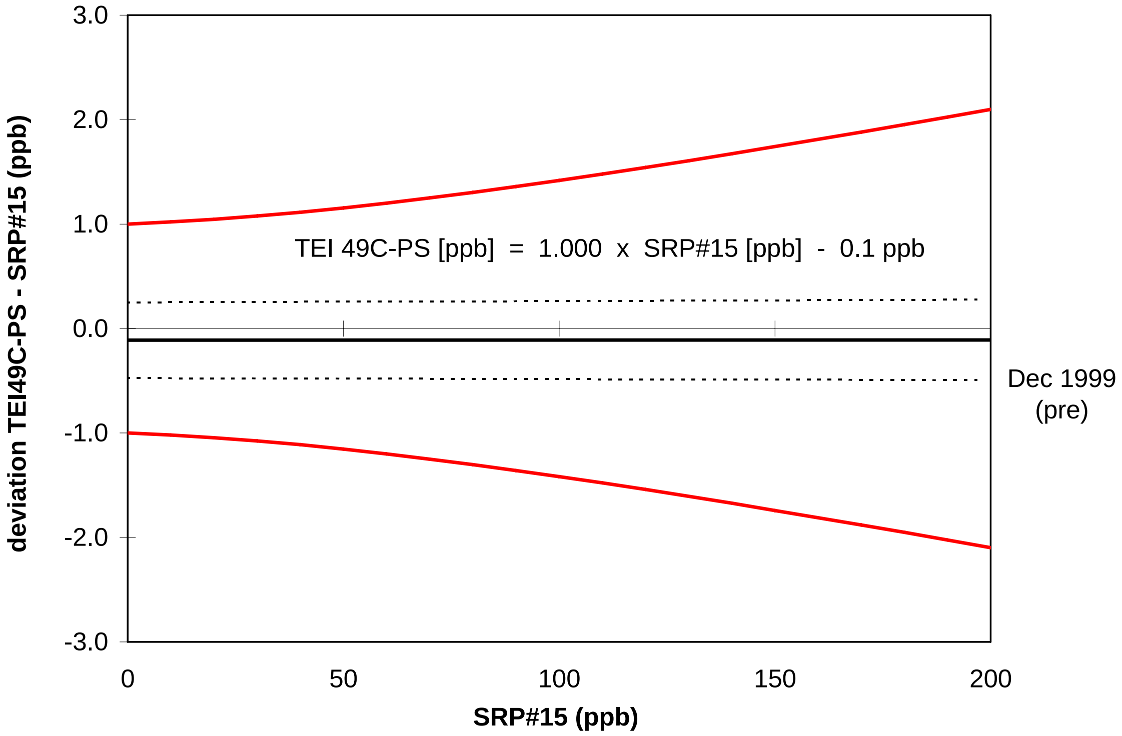

Figure 9: Transfer standard WCC, before audit

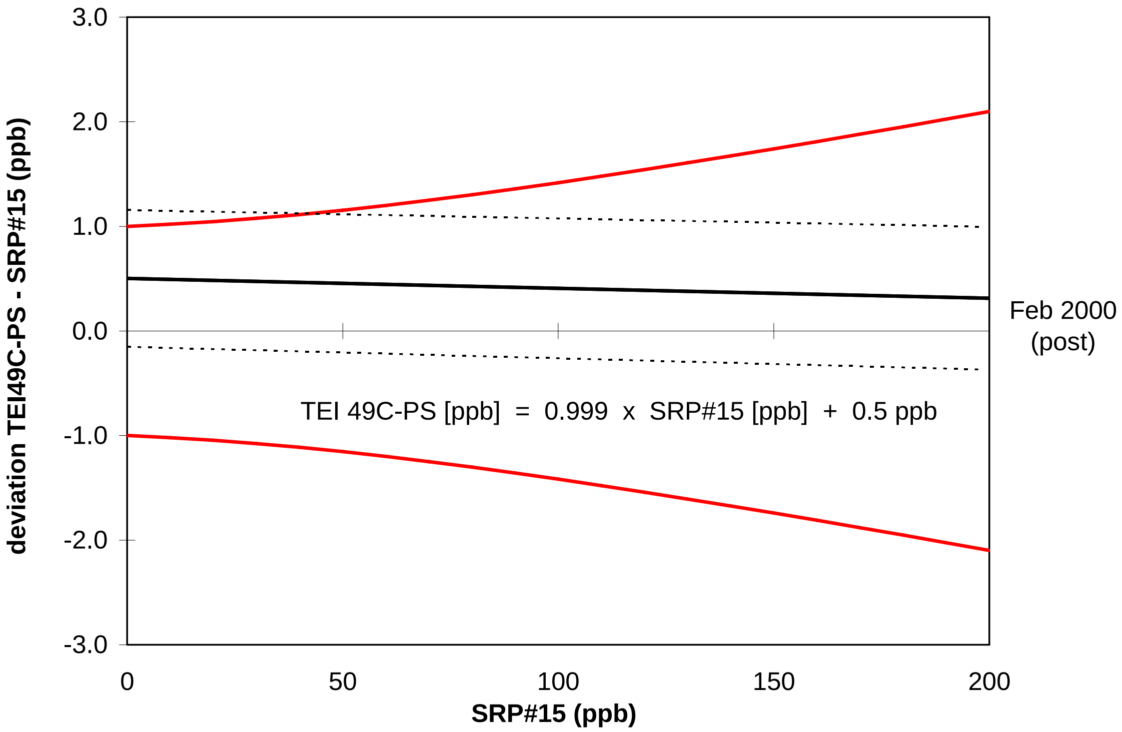

Figure 10: Transfer standard WCC, after audit

III Maintenance Documents

In the following, one shows the different checklists and preventive maintenance sheets that have been developed together with the operator team. The lists are working papers and will be subject to change.

Maintenance checklist: global GAW Station Mt KENYA

Operator(s) : .... Date :..

General Checks		**Final Checks**	
Manifold pump working	Y / N	Windows closed	Y / N
Milos-Time adjusted	Y / N	Draw the blinds	Y / N
Empty checklists at site	Y / N	Ladder back in the shelter	Y / N
Empty diskette at site	Y / N	Lights switched off	Y / N
		Lock both doors	Y / N

General remarks and observations concerning the station and its environment : ....
....
....
....

Special tasks: ....
....
....
....

Things to take with up to the site for the next visite: ....
....
....
....

Data

Check *.log files	Y / N
Download data to c:\data*.*	Y / N
Download data to a:*.*	Y / N
Export *.log files to LOTOS	Y / N
Print out graphs	Y / N

comments : ....
....
....

Wind Speed / Direction (....)

Cross bar oriented Y / N

Are sensors rotating Y / N

comments : ....

....

....

Single Radiometer (CM 11 , Kipp&Zonen)

Glass dome cleaned Y / N

Leveled out Y / N

Checked silicagel colour replaced Y / N

comments : ....

....

....

Shadowband Radiometer (CM 11 , Kipp&Zonen)

Shadowband adjusted Y / N

Left .... / right .... scale (equal)

Glass dome cleaned Y / N

Leveled out Y / N

Checked silicagel colour replaced Y / N

comments : ....

....

....

WET ONLY PRECIPITATION COLLECTOR (M.I.C. company)

cleaning wet sensors Y / N

check shut / open function Y / N

water inside bucket Y / N

weight: total .... g (bucket: x.x kg) net .... g

comments : ....

....

....

TEMPERATURE / HUMIDITY (DTR 13, VAISALA)

Visually checked Y / N

comments : ....

....

DATA ACQUISITION SYSTEM (MILOS 500)

LED error off Y / N

LED status blinking (1x / second) Y / N

comments : ....

....

....

OZONE ANALYSER (Thermo Environmental Instruments Model 49)

Instrument operating OK	(or any alarm message: ....)		Y / N
Temperatures:	Temp. (A / B): 15 - 45°C (appr. 5°C above room temp.)(.................... °C)		Y / N
Pressure:	a few mmHg below ambient pressure	(.................... mm Hg)	Y / N
Flows:	each 0.5 - 1.0 l/min	(Cell A: .... l/min. / Cell B: .... l/Min.)	Y / N
Frequencies:	65 - 120kHz	(Cell A: .... kHz / Cell B: .... kHz)	Y / N
Noise:	< 4 kHz	(Cell A: .... Hz / Cell B: .... Hz)	Y / N

Manual checks :	former	actual		
zero :	.... ppb O_3	.... ppb O_3	Span setting:	.... (509)
span :	.... ppb O_3	.... ppb O_3	Offset:	...................(49)

Instrument filter changed (date last change: ....) Y / N

comments : ....

....

....

....

Preventive Instrument Maintenance

Periodical Maintenance Sheet:
LOG Book: TEI Ozone Analyser 49 #

3-MONTHLY:

P-Sensor	Target-date		Operator		Operator		Operator		Operator
	done at: comment :								
	Target-date		Operator		Operator		Operator		Operator
analog output	Target-date		Operator		Operator		Operator		Operator
	done at: comment :								
	Target-date		Operator		Operator		Operator		Operator

ANNUALLY

optical part	Target-date		Operator		Operator		Operator		Operator
cleaning cells	done at: comment :								
T-Sensor	Target-date		Operator		Operator		Operator		Operator
check Temp.	done at: comment :								
Connections	Target-date		Operator		Operator		Operator		Operator
check loose connections	done at: comment :								
valve leak check	done at: comment :								

BI-ANNUALLY:

Adsorb. 0-air:	Target-date		Operator		Operator
replace charcoal	Done at :				

Preventive Station Maintenance

Periodical Maintenance Sheet:
global GAW Site Mt. KENYA

ANNUALLY

manifold	Target-date		Operator		Operator		Operator		Operator
cleaning	done at: comment :								
floor	Target-date		Operator		Operator		Operator		Operator
cleaning	done at: comment :								

TRI-ANNUALLY

ozone scrubber	Target-date		Operator		Operator		Operator		Operator
replace	done at: comment :								

Preventive Ozone Calibrator Maintenance

Periodical Maintenance Sheet:
LOG Book: TEI Ozone Calibrator 49-PS #53677-297

ANNUALLY

optical part	Target-date		Operator		Operator		Operator		Operator
cleaning cells	done at: comment :								
T-Sensor	Target-date		Operator		Operator		Operator		Operator
check Temp.	done at: comment :								
Connections	Target-date		Operator		Operator		Operator		Operator
check loose connections	done at: comment :								
valve leak check	done at: comment :								

6-MONTHLY:

P-Sensor	Target-date		Operator		Operator		Operator		Operator
	done at: comment :	amb. : mbar sensor: mbar		amb. : mbar sensor: mbar		amb. : mbar sensor: mbar		amb. : mbar sensor: mbar	
	Target-date		Operator		Operator		Operator		Operator
		amb. : mbar sensor: mbar		amb. : mbar sensor: mbar		amb. : mbar sensor: mbar		amb. : mbar sensor: mbar	
pressure gauges	Target-date		Operator		Operator		Operator		Operator
readings (psi / l/min)	done at: comment :	psi / l/ min psi / l/min		psi / l/ min psi / l/min		psi / l/ min psi / l/min		psi / l/ min psi / l/min	
	Target-date		Operator		Operator		Operator		Operator
(zero: 6psi / 0.5 l/min ozone: 4.5psi / >2 l/min)		psi / l/ min psi / l/min		psi / l/ min psi / l/min		psi / l/ min psi / l/min		psi / l/ min psi / l/min	

BI-ANNUALLY:

Pumpe Zero Air	Target-date		Operator		Operator
diaphragma function check	Done at :				
Adsorb. 0-air:	Target-date		Operator		Operator
replace charcoal / purafil	Done at :				