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Technology and
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Ho Chi Minh City

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Ho Chi Minh City Environmental Improvement Project
Air Quality Monitoring Component

Mission 1, April 2002; Inception phase

NILU
Norwegian Institute for Air Research

HEIA
Ho Chi Minh City
Environmental Improvement Project
Air Quality Monitoring Component

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1 Task 1. Review existing system

1.1 Introduction

The Norwegian Institute for Air Research, NILU, has been appointed to undertake the NORAD funded part of the air quality monitoring component of the Ho Chi Minh City Environmental Improvement Project (HEIP). The NORAD supported part of the project (phase 2) is based on a DANIDA funded (phase 1) project, and it is a component of the ADB funded Ho Chi Minh City Environmental Improvement Project. The UNDP through the "Environmental Management Ho Chi Minh City, Air Quality Monitoring Project" was responsible for phase 1 of the project,

The Executing Agency for the **H**o Chi Minh City **E**nvironmental **I**mprovement Project **A**ir Quality Monitoring component (HEIA) will be Department of Science, Technology and Environment (DOSTE). Project Implementing Unit (PIU) has been established in DOSTE, and this will co-ordinate and manage all activities required for the daily implementation and management of the components, while reporting and maintaining continuous contact with the PMU. The PIU will be responsible for the administration and supervision of the implementation of the Air Quality Monitoring component.

The Air Quality Monitoring component (HEIA) to be supported by NORAD, will add to the system developed in HCMC by Danish institutions funded by Danida. To meet one of the main objectives described in the Project Documents, which is to give information on source/receptor relationships and identify the pollutants of greatest concern, NILU will build on the existing developments to further develop and improve the monitoring programme as well as establish tools for perform air quality planning.

NILU will adapt to and build on the Danish systems chosen. NILU will inspect, review and evaluate the Danish network and operations as part of the final design. The evaluation and assessment will form the basis for further stations, instrumentation and the development of a total air quality planning system. Training assessments and the need for further training will be reported to UNOPS in Copenhagen.

The project will be undertaken in a number of tasks and subtasks. To meet the objectives as well as the requirements described in the Terms of Reference the following tasks will have to be undertaken:

1. Review existing monitoring programme
2. Design the updated monitoring programme
3. Procure and install new monitoring stations
4. Assure system integration
5. Establish Quality Assurance and Quality Control (QA/QC)
6. Install the GIS based Air Quality Management System
7. Establish emission and modelling functionality
8. Data interpretation and reporting
9. Air Quality planning and abatement strategy planning
10. Design and undertake capacity building and institutional strengthening

As part of Mission 1 NILU experts have undertaken a study and an assessment of the existing stations and evaluate the location of stations. This was undertaken before the site studies for new stations were performed. In addition the training needs have been discussed and is being reported in the Inception report. (Sivertsen et al. 2002).

1.2 Introductory meeting

An introductory meeting was held at DOSTE on 8 April 2002. The air pollution team at DOSTE participated. The agenda included:

- Project objectives,
- Presentation of the staff
- Presentation of Mission agenda
- The kick off seminar programme
- A short introduction to the monitoring system delivered by Danida

Minutes from the meeting is presented in Appendix A1

1.3 Site visits

The DANIDA supported programme has developed 4 monitoring station. These stations have been installed during the year 2000 and training of personnel at DOSTE has been undertaken. The location and type of the sites are indicated in the following table:

	Name	***Type***	***District***	***Address***
1	DOSTE in HCMC	Road side	3	244 Dien Bien Phu Street
2	Hong Bang Sec. School	Road side	5	132 Hung Wung , Ward 12
3	Tan San Hoa, Met. Inst.	Urban background	PhuNuan	236 B Le Van Sy
4	Thu Duc, District Dept. Urban Management	Industrial	Thu Duc	184 Tagore Street, Thu Duc University Village

Site visits to the existing air quality monitoring stations were paid on 9 and 10 April 2002. Reports from these site visits are presented in Appendix A2.

A brief evaluation of the sites can be summarised as follows:

- Thu Duc (Industrial station/residential) is located surrounded by industries and is occasionally impacted by plumes. The site is also located close to a small incinerator, which cause micro scale and local pollution impact. A building has been built close to the station after the measurements started and tall trees surround the site. The station is not perfectly exposed.
- Tan Son Hoa (Urban background) is nicely located in an urban background area surrounded by tall buildings. The shelter is located surrounded by tall buildings, which may influence the airflow near to the site. The activities at the Omni hotel may also influence the pollution.
- Hong Bang (Road Side station) is located 5 metres from a traffic-loaded road running out of the city towards west. The site is very well located and represents the air pollution that people living and moving along the streets will be exposed to.
- DOSTE (Road Side station) is also representative for the exposure to pollution at the road. The site is more open than Hong Bang and the intake is about 5 m from Dien Pien Phu Street.

In general the 4 sites instrumented in Phase 1 of the project seem to be well distributed. Some questions concerning representativeness have been raised, but the limitation given by permissions and security we will have to accept the best possible locations.

In the site studies for finding locations for the NILU stations, we will search for a “better” background site. Considering that so many people spend such a large amount of their time on and along the streets, we believe that road side stations are important to get a relevant picture of the air pollution population exposure. See Chapter 2.

The measurements of meteorological data undertaken along a 30 m tower at DOSTE was investigated, and found inadequate. DOSTE experts have not received any training in controlling, applying or improving the quality of these data. Errors were identified on the wind direction records and on the radiation data. Data from the sonic anemometer was not adequately handled. The meteorological data have to be upgraded, and this is an additional task for the NILU team in the next phase of the project. See also Chapter 9.2.

As part of the site visits we were given a specification of the existing shelters. The document is presented in Appendix A2b.

2 Task 2. Design and update

2.1 Site studies

Field studies were performed to find new sites for air pollution measurements in HCMC. The studies were based on the location of sites decided from the first phase of the project, supported by DANIDA. In the process of identifying new sites NILU has consider the following input:

1. The air pollution network should be designed to support an evaluation of the exposure of pollution to people (health related).
2. The spatial density, site distribution and site locations in HCMC should reflect the typical air pollution situations and enable a health impact analyses.
3. The locations should take into account the sites already available from the first phase of the project supported by DANIDA.
4. The indicators to be measured at each site should be considered relative to the site characteristics.
5. The necessary meteorological data sufficient for air quality assessment and modelling should be assured.

Evaluating the main source of pollution as well as the way of living in HCMC, we believe that a major part of air pollution exposure in the city is caused by air pollution emissions from vehicles and motorbikes. People are living, moving, staying, eating and sleeping on and along the street and roads. We have therefore concentrated more of the measurements to roadside stations than originally proposed. (See below).

The site studies were performed on 17 to 19 April 2002. DOSTE experts participated in all site studies. Reports from each of the sites are presented in Appendix B 1. Final recommendations concerning location of new monitoring sites has been based on site visits and discussions with DOSTE experts.

2.2 Design new monitoring sites

Five sites have been presented as priority sites to be developed as an addition to the Danida funded Phase 1 project. Individual site reports are presented in Appendix B2a. These sites are:

Truong Thanh, District 9 (Background)
The site is representative for a typical background station located outside the busy city and away from local sources. The area around is mainly farmland with scattered villages and towns within a few kilometres. The most important indicators here will be background measurements of ozone and NOx.

District 12, IT park, (Residential/Urban background)
This site is one of the better suited for open area residential location. The site is located downwind from the urban area of HCMC. The site could also be classified an urban background station.

District 2 People Committee building (Residential to urban background)
The site is to day a representative residential site. A small road is passing by the station. This road may be widened and experience increased traffic in the near future. There may also be large changes in the development of this area and the measurement here may in the future reflect these changes. This site is important to establish today and to keep as a permanent location in able to evaluate future trends in air pollution as the new city develops.

Thong Nhat Hospital (Roadside)
The location is well suited to reflect some of the most heavily traffic-loaded streets leading out of the city. The site will serve as a roadside station and will be representative for the exposure of pollution to people living and moving along the streets.

Binh Chanh Educational Office, (Roadside)
This location was the third one we considered in this general area of Binh Chanh. The educational centre is located at Hung Vuong road. An alternative for measurements in this district could be the People Committee building. Both sites are suites as road site stations in the western part of HCMC. They are both close to highway 1, which is the main road out of the city towards southwest.

A summary of selected sites is presented in the Table below. The site characteristics as well as the indicators to be measured at each site are presented in Table 1.

Table 1: The new proposed sites for air quality measurements in HCMC.

Site	NO_X	SO_2	O_3	CO	PM_{10}	VOC	Shelter	Site
Truong Thanh	1		1		1		1	Background.
IT park	1	1	1		1		1	Res/urban bg.
District 2 PC	1	1	1		1		1	Res/urban bg.
Thong Nhat hospital	1	1		1	1	1	1	Road side
Binh Chanh Educ.	1			1	1	1	1	Road side
Total instruments	5	3	3	2	5	2	5	

We have moved one of the SO_2 instrument from the background station to one of the road side stations to identify the impact of diesel trucks. Background SO_2 concentrations may be measured by using passive samplers.

3 Task 3. Procure and install

3.1 Specifications

Specifications for new instruments and a complete list of instruments as well as instrument descriptions were presented in a special section of the Technical Project proposal "Equipment and Supplies". (Sivertsen, 2002). See also the summary in Appendix C1.

The procurement phase started at NILU in February 2002. Industriell Måleteknikk (IM) has presented their last bid after discussions with NILU experts. The final agreements with IM have been verified. API provides spare parts for the first year. API will run a training course for DOSTE and Schmidt Vietnam on maintenance and repair. Our instrument expert will also be prepared to train DOSTE in repair operations.

3.2 Requests and evaluation

The evaluation of the procurement specification was undertaken and the instrument supplier has already been requested to deliver a bid. The necessary equipment, instruments, hardware and software, has also been ordered and will be delivered during the next 3 months from March 2002. After arrival and check at NILU they will be installed in the shelters.

NILU has evaluated two bids for shelters; from Instrumatic A/S and from a Norwegian deliverer. The Norwegian shelters have been built on specifications from NILU, and seem to be more flexible and more adjusted to our needs. It includes air-condition, power set-up and UPS. Air intake will be additional in both bids. The instrument experts prepared a written evaluation before final decision was taken. Decisions were taken on 6 February 2002.)

The intake for the PM_{10} monitor has been discussed. The European intake has several advantages:

- Easy maintenance, the collection plate can be easily removed and changed,
- "Ematal" protection reduces corrosion problems,
- Lighter and smaller, works better in windy conditions,

- Easily changed to PM $_{2,5}$ or PM1 by changing the nozzle plate.

The final decision was to use the European intake. The different bids were finally evaluated and an evaluation report was presented at NILU on 31 January 2002. Following this the orders were prepared and presented.

3.3 Prepare shelters at NILU

The monitoring stations will be assembled and tested completely in Norway before being shipped to Vietnam. The main reasons are that bits and pieces, small spare parts, wires and connections may be difficult to obtain locally.

The installation will include:

1. Establish the site infrastructures and prepare shelters.
2. Install the ambient air quality instruments in the monitoring shelters.
3. Adapt all instruments to the logging and data retrieval system.
4. Check and start the instruments.

The shelters have been ordered and will arrive at NILU during May 2002 according to schedule. The shelter design is presented in Appendix C3.

3.4 Test instrument set-up

Following the installation at NILU, a complete test programme will be operated at NILU to see that the instruments are working perfectly and that the data acquisition system will operate with the OPSIS retrieval system. Another purpose is to assure that the integration between the OPSIS system and the NILU AirQUIS air quality management system will work satisfactory.

3.5 Transport to Vietnam

When all instruments including spare parts for one year have been prepared and packed a list of specifications will be sent to DOSTE. DOSTE will be responsible for obtaining all necessary papers for custom clearance etc. According to schedules the shipment will be prepared around September-October, dependent upon site clearances in HCMC.

3.6 Field installations

NILU personnel together with DOSTE personnel will perform the installation in Ho Chi Minh City as on-the-job training. They will be involved in all phases of the installation, such as set up, calibration and field-testing of the whole monitoring programme.

4 Task4. Assure system integration

4.1 Identify existing data collection system

The new stations will be integrated in the existing data collection system Enviman ComVisioner to obtain one consistent monitoring system to be operated by DOSTE.

We will use the data retrieval and data collection system already installed and adapted by DOSTE. The data exchange interface with AirQUIS is seamless to the user. Information concerning the presently used system at DOSTE was collected, and the necessary interfaces will be prepared by NILU as indicated in the following.

4.2 Evaluate OPSIS system

The existing system was investigated and a report from the NILU IT manager is presented in Appendix D2.

DOSTE experts clearly expressed needs for EC training session covering installation and configuration. The reason being that the existing system was preinstalled and delivered by Instrumatic AS without any detailed hand-on training. DOSTE experts added that the existing documentations are not enough.

We were also informed that the EC-PC is 2 years old and they are afraid that hard ware failure may occur soon. This PC will also be extended with 5 EC licenses for the new stations.

4.3 Prepare interface

As part of the preparation of the interface between the OPSIS system and AirQUIS NILU will need monitoring data from 2001. This data will be imported into the AirQUIS system. A memo was prepared to identify the formats and files needed. (See Appendix F3).

For the future NILU installations new computers will be necessary. The NILU IT manager visited together with DOSTE experts a local IT-supplier recommend by DOSTE. The prices and the IT-equipment seemed to be acceptable. The well-known international PC-brands such as Compaq, IBM, HP etc. are approximately 5 – 10% more expensive than the local brand ones. We also received a quotation for the equipment needed for AirQUIS operations.

As part of the development of an interface between OPSIS and AirQUIS it is proposed that OPSIS and NILU experts participate in a common mission to DOSTE in August-September 2002. (See Appendix K1).

A new PC will be purchased for the additional monitoring system. The Enviman data retrieval system will be re-installed on the new computers and interfaces between Enviman ComVisioner and AirQUIS will be prepared. AirQUIS will then in the future be the basis for the air quality management system. As part of the installation of this new PC a joint training mission of NILU experts and OPSIS will be adequate.

5 Task5. Quality Assurance (QA/QC)

5.1 Design QA/QC

The existing Quality Assurance system was evaluated. Presentations and discussions at the DOSTE EDC Centre gave valuable input to the final design of the future QA/QC system. Meetings with Schmidt Vietnam revealed the functions concerning calibrations and reference lab functions.

5.1.1 Discussion at DOSTE, EDC

During the site visits and in meetings with the DOSTE team calibration procedures, standard operations procedures (SOP) and station/historical logbooks were controlled and verified. One of the objectives going through the routines that are already available is to see whether changes or improvements have to be made.

The first impression was good. Comments were made to the sites and to the calibration routines as presented in the site memo in Appendix A2. Logbooks and check lists are completed daily, and the NILU team approved the forms and commented that the routines at DOSTE seem to work adequately. (Appendix E1a).

A typical daily checklist used at the data retrieval at EDC is presented in Appendix E2a. The different levels of quality assurance were discussed with DOSTE. The use of flags and identification of errors was described. NILU stressed the need for “Quality assurance by finger” (visual control), e.g. on weekly plots of all data. In this way drift in the instruments will be more easily recognised.

The quality of the meteorological data collected at the 30 m tower at DOSTE is, however, not good as discussed in a Minute from the meeting on 12 April 2002. (See Appendix F1)

5.1.2 Meetings with Schmidt Vietnam

Routine checklists have been prepared for the operation of the measurements. Schmidt Vietnam (SV) is undertaking the controls and

calibrations for DOSTE. As part of the NILU evaluation, the QA/QC system was discussed with Schmidt Vietnam on 11 April 2002. (See Appendix E1b). SV does not presently have the experience and expert team that was foreseen to become the reference laboratory for air pollution monitoring in Vietnam. They are presently serving 6 sites in the country, and a rather small staff only have two year of experience.

On the other hand SV is the supplier for API instruments in Vietnam. SV is undertaking installations and warranty performance. For the project in HCMC SV shall carry out service and maintenance for the equipment supplied under the contact Project INT/95/R11 UNOPS. For this purpose an agreement has been made between SV and Instrumatic A/S (the Danish instrument supplier). SV also confirmed one year of warranty service for repair of API instruments (see Warranty Form, Appendix E1c).

One conclusion from the meeting with SV as well as discussions with DOSTE is that the Quality Assurance (QA/QC) systems may have to be changed or upgraded during the NORAD supported development. See also Chapter 11 about training needs.

5.2 Prepare SOP

The Danish experts had already prepared several SOPs during Phase 1, and these are presently being used by DOSTE (see Appendix E2). A copy of the SOP manual was taken to NILU to be discussed with NILU experts on QA/QC. This will form the basis for further improvement of the SOPs.

As part of the NILU routines we will assure that some typical SOPs are available. In field operations the following routines should be established:

- Station Manuals including Standard Operational Procedures (SOP) for instrument installations, maintenance, controls etc.,
- Zero span checks and calibration routines,
- Station history logbook available.

At the “Monitoring Laboratory” at DOSTE data are controlled following quality assurance routines as described i.e. in ISO 45001 from the International Standardisation Organisation

- At daily retrieval of data (Appendix E2a),
- with weekly paper plots, to be commented and stored as records,
- through simple statistical and graphical evaluations to check validity and representativeness of data,

Some final quality controls should also be part of the reporting of data.

5.2.1 Dynamic calibration

During the meetings with Schmidt Vietnam and DOSTE the discussion often was raised what was the best way of undertaking dynamic calibrations of the monitors; in the field or in the laboratory.

Dynamic calibration of a monitor should be performed periodically once a year to document the linearity of the monitor response.

A dynamic calibration may very well be performed at the station provided:

- There is enough room for the calibrator and gas standards
- Time is given for the calibrator and gas standards to equilibrate before use
- No major maintenance or repairs are necessary.

Usually there is not enough space at the station for this. It is, however, often more practical to perform the dynamic calibration in the laboratory. It can be combined with major maintenance, which is also performed once year. Due to lack of space you would not perform major maintenance at the station. During major maintenance parts that influence the response may be replaced and the instrument is usually adjusted. After such maintenance a dynamic calibration is usually necessary to check the linearity of the response.

5.3 QA presentation and training

Data retrieval and QA/QC presentations and training will be performed in HCMC as part of the operations. An appointed QA/QC responsible person at DOSTE will have to participate, together with experts operating the data retrieval and database systems.

The QA/QC officer has been appointed by DOSTE. Mr. Vo Thanh Dam will in the future be responsible for the Quality Assurance programme developed for the air quality monitoring programme in HCMC.

6 Task6. Install AirQUIS

6.1 Prepare AirQUIS platform and GIS

NILU will procure one PC server and one PC client with Windows operative system locally based on the evaluation together with DOSTE experts.

NILU will install Oracle database and configure AirQUIS database on the PC server. The PC client will be installed with one AirQUIS client licence. The PC server and the client PC will be connected on the existing network in the EDC. DOSTE experts have a backup routine by burning backup data on CD. This is not an optimal solution for AirQUIS due to the amount of data in the future. An alternative backup solution should be discussed during the project period.

Maps from HCMC are presently being digitised at the DOSTE Environmental Data Centre. These maps will represent a good basis for establishing the GIS functionality in AirQUIS for HCMC.

We have received copies of the maps on CD, and will bring these back to NILU for implementation and preparation to the HCMC AirQUIS database. (Example in Appendix F1). DOSTE experts informed also that the PC at the Data Centre is 2 years old and they are afraid that hardware failure may occur soon. This PC will also be extended with 5 EC licenses for the new stations. (See Appendix D2).

6.2 Establish final GIS

Shape Themes

To finalise the GIS database in AirQUIS we will have to define:

- Shape themes
- AirQUIS themes and
- Datasets

The Shape Themes are themes that are not connected to data in the AirQUIS database. Examples of shape themes may be coastlines, lakes, parks,

borders, or anything that will make the map look better and be easier to understand. The user decides which shape themes to include.

The AirQUIS Themes are the GIS representation of the data in the AirQUIS database, for example administrative regions, air pollution sources, road links, stations, building points. The user decides which themes to include. To display these later the user can select from a list of all AirQUIS themes.

All Datasets in the database can be viewed on the map. This may be data distributed on administrative or user defined regions (region data set), data distributed in grids (field data set), data distributed on lines (line data set) or data distributed in points (point data set). The data set may have been entered into the database manually or by import, or the data set may be results of model calculations.

Data such as population distributions, register of building materials and other parameters, which need to be linked to the GIS functionality, could be entered by districts, city sub quarters or by grid squares.

6.3 Develop and test interface

The interface between the OPSIS data retrieval system and AirQUIS will have to be developed and tested. As a initial study of the existing operations the NILU IT manager went through the system with DOSTE experts. See also Chapter 4.3 and Appendix F3.

To prepare and test the AirQUIS application NILU has collected air quality data from the four monitoring sites for 2001. These data will be imported into the AirQUIS system. The data are brought back from Mission one on CD. Appendix F3 describes a standard ascii input data format to AirQUIS.

6.4 Hand-on-training

Hand-on training will be given to the DOSTE experts during the installation of the AirQUIS platform, and later during the operations of the air quality management system. The actual work performed at DOSTE during the emission inventorying, data retrieval, transfer of data into the databases, data treatment and presentation as well as dispersion and exposure modelling will be part of this training.

7 Task7. Air Quality Modelling

7.1 Emission inventorying

7.1.1 The city and sources

HCMC is the largest city in Viet Nam with more than 5 million people (official statistics year 2000: 5.2 million) living on an area of 2,056 km^2. The city is also the main industrial and commercial centre in the country. Air pollution is a serious problem in HCMC. Emissions from vehicles, cars, trucks etc., and a large number of motorbikes is the most obvious source of air pollution. Even relatively new vehicles do not have modern technology. No pollution control and poor maintenance as well as low quality fuels are factors that result in high emission levels.

Emissions from industry are also a problem, since very few have installed pollution abatement measures such as filters. The efficiency in production is also low, so the waste and emissions from the processes are high per unit product produced.

The main exposure and human health impact seem to stem from millions of motorbikes filling the streets from early morning to late night. Simple countings have indicated that several streets have more than hundred thousand motorbikes passing through the street every day. Many people are spending a considerable time of the day along the streets and roads. It will thus be important to map the pollution and the exposure along these roads.

7.2 Prepare input data

To operate the AirQUIS air quality management system different type of input data have to be prepared:

- Maps and GIS system
- Emission data and emission inventories,
- Air Quality data,
- Meteorological data,
- Population distribution data,
- Area use and topographical data.

In addition to the data described above it will necessary to collect information on air quality limit values and regulations. A summary of the Vietnam standard TCVN 5937 – 1995 is presented in Appendix I4a.

It may also be necessary to prepare an inventory of buildings and building materials if cost estimates of air pollution impact in the city are to be performed in the future.

7.2.1 Population distribution

Data for the population distribution in HCMC was collected during the Mission. In the inner part of the city there is a population density of between 40 000 and 50 000 inhabitants per square kilometre.

Table 2: Population distributions and population densities for the Districts of HCMC (2001).

District No	Name	Population	Area (km2)	Population density (km-2)
1	District 1	257 776	7.50	34 370
2	District 2	85 937	50.20	1 712
3	District 3	228 764	4.86	47 071
4	District 4	168 527	4.18	40 317
5	District 5	205 592	4.27	48 148
6	District 6	278 580	6.93	40 199
7	District 7	82 022	32.45	2 528
8	District 8	309 907	19.25	16 099
9	District 9	126 200	113.70	1 110
10	District 10	230 633	5.71	40 391
11	District 11	248 139	5.31	46 731
12	District 12	113 229	52.25	2 167
13	Binh Thanh	375 268	20.61	18 208
14	Go Vap	241 662	19.98	12 095
15	Phu Nhuan	180 068	4.85	37 127
16	Tan Binh	512 754	29.51	17 376
17	Thu Duc	163 504	47.26	3 460
18	Binh Chanh	252 993	293.20	863
19	Can Gio	56 404	713.60	79
20	Cu Chi	260 438	428.48	608
21	Hoc Mon	193 752	109.53	1 769
22	Nha Be	61 480	97.00	634
Total:		**4 633 629**	**2 070.63**	**2 238**

7.2.2 Traffic density

Some preliminary data on traffic density and the development of traffic in HCMC has been obtained. A memo was prepared based on a paper presented on the Regional workshop on "Transport Planning, Demand Management and Air Quality" 26-26 February 2002, in Manila, Philippines. (Appendix G2).

The objective of this study has been to review traffic information prepared for HCMC. The ETAP project (Energy-Transport-Air-Pollution) has been a co-operation between ADEME France and DOSTE. The main conclusion of the report is that HCMC will meet severe traffic problems in the near future if the authority does not take measures towards changing the populations transport preference from individually based transport to public transport

A summary of the projections of motorcycles, cars and person trips per day until the year 2020 is presented in the table below.

Year	*HCMC – Forecasts of growth in motorcycle stock Trend scenario (x1000)*	*Car ownership forecasts for HCMC-Trend scenario. Cars per 1000 pop*	*Trend projection of the number of mechanised person trips in HCMC Per day (x1000)*	*From text: Average speed of cars in downtown area (km/h)*
1996	1400	8	8250	14.8
2000	2400	10		
2005	3100	17	13650	8.7
2010	3750	20	16600	6.6
2020	4500	140	22150	4.7

By 2010 already the projected number of motorcycles in HCMC will be more than 3,7 million. There will be more than 16 million person trips in the city per day. This will lead to a considerable growth in pollution along the streets and roads, if strict regulations on the vehicles and the bikes are not implemented. To perform an adequate emission inventory will be another challenge for the HEIA project.

7.3 Dispersion modelling

One module of the AirQUIS system consists of atmospheric dispersion models. The EPISODE model is a mass-consistent, 3-layer (in the vertical) model solving the basic transport-diffusion equations. Based upon spatially distributed and time dependent input data of emissions, wind and turbulence, the model gives time-dependent concentrations in any receptor point within the modelling area. (Walker, 1997)

Area-distributed sources (domestic, small industry, etc.) are treated within a grid system of typically 0.5-1 km. Superimposed on this, road traffic and point sources are treated in separate sub-grid models (Gaussian line-source dispersion of traffic emissions, and puff-trajectory model for point sources). Simple NO-NO_2-O_3 chemistry is included, and summer-type photo-chemistry calculation schemes are being introduced into the model.

DOSTE experts will have an introduction to the models and will be trained to operate the model in the AirQUIS system. One selected expert is

proposed to receive additional training at NILU, provided UNOPS will support this. (See Appendix K1).

8 Task8. Field Operations

8.1 Start-up phase

NILU experts together with the Danish instrument experts handling the DANIDA instrumentations, Instrumatic AS, will prepare the installations of monitors in shelters. All preparations and testing of instruments will be carried out at NILU in Norway before the ready-made stations are shipped to Vietnam. The instruments will also be adapted to the existing logging and data retrieval system and tested.

NILU instrument experts together with the DOSTE field operators will undertake installations in field in HCMC. Installations and start-up will also act as a hand-on training programme for local operators.

8.1.1 Screening with passive samplers

In the planning phase passive samplers have often been used to identify the spatial concentration distribution. Finn Palmgren Jensen in HCMC performed such study in August and December 2000. The results have not been assessed, but the analytical results have been provided to the HEIA project.

Concentrations of Benzene, Toluene and Xylene as weekly averages were measured. Benzene ranged between 26 and 96 $\mu g/m^3$ except near two gas stations where the concentrations measured were 100 to 130 $\mu g/m^3$. The European proposed limit value given in the European Union Directives is 5 $\mu g/m^3$ as an annual average. At the same sites Toluene was between 180 and 226 $\mu g/m^3$.

The Xylene concentrations ranged between 20 and 190 $\mu g/m^3$. We do not have the exact positions of the samplers available, so it would be difficult to verify spatial distributions. However it seems, from reading the names of the sites, that there is a clear gradient from the streets and out.

The NO_2 concentrations in August ranged between 4 and 14 $\mu g/m^3$, which seem to be very low. The typical monthly average NO_2 concentration at the DOSTE site is about 70 $\mu g/m^3$. In the December measurements the NO_2

concentrations ranged between 17 and 40 μg/m^3 .BTX was at about the same level as in August.

8.2 Operational phase

DOSTE field operators will, in addition to training received from the instrument producer, be trained by NILU to undertake all operations, calibrations and maintenance. Standard operations procedures have been prepared by Dk-Teknik in the first phase of the project (See Chapter 5). NILU experts will evaluate these procedures further. If necessary they will be upgraded, and new instruments delivered by NILU will have their own SOP, station logbooks as well as instrument logbooks.

Routines for daily data retrieval and quality controls are available, and will be followed up in the future. Daily and weekly data checks, and feedback to the operators will be recommended. NILU instrument experts together with the DOSTE field operators will also follow up calibration procedures and maintenance. Hand-on training in instrument maintenance, field calibrations and some simple repairs will be undertaken by NILU experts during the three year of operation in the project period. For further information of QA/QC, maintenance, multipoint calibrations of instruments see also Chapter 5 and Appendix K1.

There has also been prepared a routine maintenance checklist for DOSTE as well as a task list for Schmidt Vietnam. The last list seem to be more in the direction of a station audit where the following tasks have to be undertaken:

- Check Air Condition Units
- Check complete station and verify damages to containers,
- Every 6 month calibrate monitors,
- Validate zero span sources,
- Perform maintenance,
- Perform linearity test,
- Check and clean PM_{10} inlet,
- Check air intake and tubing (clean or replace),

8.3 First audits

Audits to the monitoring sites should be performed on an annual or a half-year basis. At similar national monitoring systems designed and installed by NILU, a national reference laboratory normally undertakes these audits.

In HCMC we had planned to use Schmidt Vietnam as this reference laboratory. However, after meetings and discussions (See Appendix E1b) we have realised that SV does not have the experience and the laboratory to undertake these functions in HCMC. During the warranty period, however, SV will serve as the instrument supplier for API monitors, which they actually are.

Audits to the monitoring stations from NILU experts have been scheduled to take place after one year of operations and after the second year of operations. This will assure that operations are following the prescribed operational procedures, and that the monitoring system is operated according to international standards while NILU is conducting the 3-year NORAD funded project.

8.4 Maintenance and service

Regular maintenance of the instruments is usually performed at the station during routine service visits. In addition to the regular maintenance NILU recommends a yearly overhaul where the instrument is examined, cleaned and adjusted more thoroughly. The overhaul will typically take two to three days.

Due to limited space at the station and to prevent the overhaul activities from disturbing the other instruments at the station the overhaul should be performed in the laboratory. In addition the overhaul usually requires spare parts, consumables and tools that is easier accessible in the laboratory then at the station. Before and after the yearly overhaul the monitor should undergo a linearity check to document the response after the last measurement period and before the next period respectively.

We will thus recommend that the multipoint calibrator system obtained by DOSTE will be permanently installed in a repair office at DOSTE

8.5 Dynamic calibrations

The yearly linearity check as recommended by CEN and the yearly overhaul as recommended by NILU should be combined and performed at the same time in the laboratory. The linearity check requires a complete dilution/calibration unit.

The three-monthly calibration of the monitor requires only two gas concentrations, zero and a fixed span level and should be performed at the station. The two-point calibration requires a zero air generator and a span gas cylinder containing a fixed certified “outdoor” concentration

Since DOSTE has a calibrator (Model 700 API) they should do their own dynamic calibrations. The calibrator must have the possibility of letting the operator specify the mixing ratio (output concentration). In addition calibration gases (about 100 ppm NO/ SO2, 5000 ppm CO) and a zero air generator is necessary.

8.6 Sites re-visited

After the second year of operation NILU experts will again visit all the monitoring stations, to check the performance and to verify adequate operations. NILU may also support DOSTE in any maintenance operation or simple repairs.

9 Task9. Data interpretations

9.1 Understanding AQ

Air quality assessment includes the use of air quality data, knowledge about sources and source distributions as well as meteorological data.

As part of the training one of the workshops will be dedicated to "Understanding air pollution". Data interpretation by use of combined air quality, meteorology and source information will be the basis for the information to be prepared. From statistical analyses and use of simple models it may be possible to establish the basis for improving air quality when necessary.

9.2 Use of Meteorological data

High quality Meteorological data are of uttermost importance for explaining the air quality data measured and for input to models in the future.

Meteorological data collected from the 30 m tower at DOSTE was discussed and evaluated. Meteorological instruments were installed here by Instrumatic AS in June 2000 and the meteorological sensors are now providing 5 minute data of wind speed, wind direction, air pressure, relative humidity, total incoming radiation, relative humidity and air temperature (the latter two are sampled approximately 3 m above ground at the AQ station at DOSTE).

These data have not been quality checked before. Wind direction data are probably shifted 180 degrees. Radiation data presented are erroneous (wrong order of magnitude). There are no measurements of the vertical temperature gradient as a measure for thermal stability in the lower atmosphere. The difference between air temperature at the mast top and at the ground ("deltaT") should be measured.

There is a need for training of the DOSTE team on analysis and quality control as well as for interpretations and application of meteorological data as part of the air quality analyses.

Wind direction frequency distributions and radiation data are presented as examples in Appendix I2a. There are documented errors in both theses datasets, which have to be checked and corrected. We have suggested that this could be performed at the same time as meteorological training is given to DOSTE in August- September 2002.

9.3 Statistical evaluation

The AirQUIS system offers several options for statistical and graphical presentations. Time series data can be presented and updated e.g. every hour included one or several indicator. One indicator may be plotted as a function of another parameter. Presentations can be prepared for screen presentations, for printouts or for automatic web presentations.

Other presentations that can be displayed directly are frequency distributions, exceedances of limit values, Breuer diagram (pollution roses), and air pollution as functions of meteorological variables.

9.4 Reporting Air Quality

As part of the reporting of air quality and the assessment of air quality it will be necessary to compare measured concentrations with air quality standards and limit values.
A summary of the Vietnam standard TCVN 5937 – 1995 is presented in Appendix I4a.

From the first evaluation of measured concentrations it may seem that surface ozone and NO_2 concentrations are most often exceeding the standards of 60 and 100 $\mu g/m^3$ respectively. PM_{10} concentrations are also high compared to international standards and guidelines. The Vietnamese standards are, however, given for TSP at 200 $\mu g/m^3$.

An example of a monthly report produced by DOSTE based on input from the first phase of the project is presented in Appendix I4b. The monthly average concentrations for January 2002 are summarized in the following table (in $\mu g/m^3$):

Site	*NO_2*	*SO_2*	*O3*	*PM_{10}*	*CO*
DOSTE	71	59	34	94	5.5
Hong Bang	55	-na-	29	121	7.3
Tan Son Hoa	18	46	56	89	1.5
Thu Duc	28	38	na	133	na

For compounds where we may compare with the air quality standards (Appendix I4a) the 24 hour average limits are exceeded for NO_2 , Ozone and CO. The exceedances are found at one site for NO_2 and Ozone and for both roadside stations for CO.

9.5 Internet presentations

Different objectives may be identified for the development of a Web site for the HCMC air quality management project. This web site may be used by the Authorities and by air quality planners and in the future also for the public. If of interest all layout, functions and content will be presented to local users for approval. There will be close contact between developers and users for comments and discussion

NILU has participated in the European Web application development; IRENIE, which demonstrated and evaluated the telematics options for increasing the efficiency of flows of data and information at the local, national and international levels.

10 Task10. Air Quality Assessment

10.1 Use of AirQUIS

The GIS based AirQUIS system will be the main platform for the Air Quality Assessment and Management system to be used for HCMC. AirQUIS consists of six components and makes use of an Oracle database. The system has integrated forms and maps; it was developed in Visual Basic and Map Object (GIS) and works well on an ordinary PC-server. The different components consist of:

- A manual data entering application,
- An on line monitoring system,
- A module for online data acquisition and quality control,
- A measurement data base for meteorology and air quality,
- A modern emission inventory data base with emission models,
- Numerical models for transport and dispersion of air pollutants,
- A module for exposure estimates and population exposure assessment,
- Statistical treatment and graphical presentation of measurements and modelling results,

All objects described above are integrated in a map and menu oriented user-friendly interface with direct link to the databases for measurements, emissions, modelling results and presentation tools. It is user friendly, it operates on a server and PC based clients and can serve as a total air quality planning tool for the area. The AirQUIS platform will be integrated with the OPSIS data retrieval system delivered by Danish funded Phase 1 project. Measurement data, emission inventories and modelling for planning purposes may be operated on the same platform.

DOSTE experts will be trained to use the system for air quality management. First during the installation at DOSTE and then during an intensive course offered at NILU for 2 selected experts. The basis for the air quality assessment and planning system is an integrated air quality monitoring system including both monitoring and modelling. (Clench-Aas et al. 1999)

10.2 Emission inventories

The development of a complete emission database as well as continuous update of this will be part of the AirQUIS platform. The sources of air pollution are divided in three categories. Emissions from single activities of some size, like industries, energy production etc., that are linked to single stacks, are treated as point sources. Emissions from home heating, public and private services, diffusive ground level emissions at large industrial complexes, agricultural activities etc. are treated as area sources. Emissions from road traffic are treated as line sources in the emission database.

During Mission 1 we were informed that questionnaires have been sent to the industries as part of a project undertaken by the People Committee for HCMC. The project is part of the Environmental Surveillance Project. The data collected from the industries are stored in the computer at the EDC Centre ay DOSTE. It seems like the system does not include stack positions and co-ordinates. This kind of information will have to be added to the database if we are going to use the data for Air Quality Assessment purposes.

10.3 Model exposure estimates

Exposure related to environmental and health damage can be assessed in different ways. Often, direct air quality measurements are used to characterize large areas and long time periods, and for some types of effects, this may be appropriate. Short-term locally varying changes in air quality, often related to human health and well being, can seldom be properly described using data from a monitoring network alone, and from monitoring data alone, options can not be assessed and predictions made. Here, the atmospheric dispersion models can be used with success.

The dispersion models ("EPISODE") (Walker, 1997) available in AirQUIS will enable quantification of changes in exposure and population responses to changes in source composition and emissions, which in turn is necessary for an evaluation of impacts of e.g. road traffic system changes on urban scale.

Over the past years, an air pollution exposure model EPISODE was developed to aid such assessments (Walker et al., 1999). The model, available for SO_2, NO_x, NO_2 and particulate matter (fine and coarse fraction), can provide several kinds of exposure estimates (Guerrero et al. 1999):

- Hourly estimates of concentrations in receptor points;
- Hourly estimates of average concentrations in grid squares;

- Temporarily and spatially aggregated estimates: period averages, period maxima and estimates of variability, estimates of accumulated time above air quality guidelines.

In addition to the results of the dispersion model, exposure estimation utilizes information about location of receptor points (absolute and relative to emission sources such as traffic), and in case of human exposure, location-specific information about whereabouts of the studied subjects such as geographic position.

10.4 Abatement and planning

The use of AirQUIS for abatement strategy planning will be part of the capacity building and training programme. Emission reduction scenarios, a plan for action and measures to improve the air quality in HCMC has to be developed by local experts in co-operation with Norwegian experts.

In addition to the emission-, meteorological-, air quality data described above it will necessary to collect more information to enable air quality impact assessment and planning to be undertaken.

Some of the databases that should be considered are:

- Population distribution,
- Air Quality Guidelines, limit values and standards,
- Area use and topographical features,
- Farming areas subject to agricultural waste burning,
- A register of buildings and building materials,

If abatement strategy planning procedures will be undertaken based on the AirQUIS development for HCMC, the specifications for source modifications will have to be given by the local Authorities and local experts. More comprehensive studies of this kind will have to be cost estimated in advance, for each scenario in question. The tool and other data will then be available as part of the AirQUIS system development and the application presented in this proposal.

11 Task11. Capacity building

A training needs assessment document has been prepared on request from UNOPS. This document is presented in Appendix K1. In summary training needs have been identified both for operations and maintenance of instruments, for data retrieval and controls as well as for understanding air pollution and performing air quality assessment and planning.

11.1 Kick-off seminar

A kick-off seminar was prepared and held at DOSTE during Mission 1. The seminar represented an introduction to the air quality monitoring and management programme that will be established for DOSTE in Ho Chi Minh City. The presentations were based on the AirQUIS platform and represented a modern air quality monitoring and management system. All the different elements included in the development prepared by NILU and funded by NORAD were covered in the seminar. The programme schedules and list of participants are presented in Appendix K 1a-b.

A separate presentation of the seminar slides has been prepared as a NILU document (Sivertsen, 2002)

11.2 Instruments and monitors

Training in the operations of monitors and instruments as well as the data retrieval system will be given. Training needs have been identified as specified in Appendix K1.

The instrument supplier has already offered some training, as presented in Appendix K2.
We have also received an offer from ESM Andersen who is the PM_{10} monitor manufacturer. The offer contains 2 days of training in the operations of the FH62 dust monitors. The training will take place in Erlangen, Germany (near Nürnberg) and will be conducted in English. The participants will have to pay travel and accommodation. We are looking into the possibility of accepting this training as part of the DOSTE visit to NILU, as Erlangen is only 2,5 hours from Frankfurt airport with train. Final decision will be taken later.

11.3 Data retrieval and QA/QC

The training in data retrieval and routine operations of the monitoring system will be mainly hand-on training, while QA/QC procedures and data statistics and understanding air pollution will be combined workshops and on-the job training. After the 3-year operation period it is expected that local experts in DOSTE will be able to completely take over the operations and undertake air quality measurements and reporting according to international standards.

We have identified a need for further training in the operation of the OPSIS retrieval system. The DOSTE experts expressed a need for training sessions covering installation and configuration of the OPSIS system. The existing system was preinstalled and delivered by Instrumatic AS without any detailed training. The existing documentations are not enough to undertake necessary re-installations and modifications. A proposal for further training is presented in Appendix K1.

11.4 AirQUIS training

The AirQUIS platform will be installed as a basis for the planning system in the HCMC. A comprehensive workshop based and on-the-job training programme will thus have to be undertaken to train local experts in using and taking over the system. The introduction to the system will be held as part of the "kick-off seminar". A few experts will be invited to NILU for further training and hand-on training will be given in HCMC as part of the operations. The system used for emission inventorying, data retrieval, databases, data treatment and presentation as well as dispersion and exposure modelling will be part of this training. The output will enable DOSTE experts to operate and use the planning tool in the future.

11.5 Use of models

Modelling and data interpretation skills will have to be evaluated. Air quality data statistics including the use of meteorological data in air quality interpretation and presentation will have to be prepared. Procedures for air quality impact assessments as well as preparation of abatement options and scenarios have to be presented. Cost-benefit analyses can be used to evaluate the best possible options to reduce the air pollution load seen from an economic point of view. The results of such analyses again may lead to the development of Action plans.

DOSTE experts will have to be directly involved in the collection of input data, they will have to evaluate the data and perform analyses and model estimates. They have already requested to have one expert specifically assigned for modelling to participate in the training at NILU.

11.6 Statistics and reporting

As part of the AirQUIS training both hand-on at DOSTE in HCMC and at NILU, statistical programmes available in AirQUIS and a report generator will be part of the training. We will also through workshops at the end of 2003 go through "Understanding air quality", which also will include the interpretation and reporting of air quality statistics.

11.7 AQ assessment and planning

The air quality assessment work, which will be performed at the end of the project, will start with training at NILU in March 2003. The input data for this assessment will be prepared together with NILU experts in HCMC. See training needs assessment in Appendix K1.

11.8 Abatement strategies

The abatement strategy planning will be a continuation of the assessment work. For optimal abatement strategies data on abatement costs as well as cost estimates for air quality impacts will have to be estimated. This is the last phase of the 3-year project.

Mr Steinar Larssen at NILU who developed the technology for the World Bank and has performed several studies in China (Guangzhou and Shanxi province) will be responsible for the introduction to optimal abatement strategy planning for HCMC.

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Appendix A

Task 1. Review existing system

Appendix A1: Minutes from introductory meeting

Minutes of Meeting #1

Title	Introductory meeting at DOSTE
Participants	Doan Thi Toi (DTT), Le Van Khoa (LVK), Nguyen Khac Thanh (NKT), Ngo Thanh Duc (NTD), Tran Ngoc Thanh (TrNT), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ), Nguyen Thanh Lam (NTL), Nguyen Thi Tuyet Hoa (NTTH), Bjarne Sivertsen (BS) and The Nguyen Thanh (TNT)
Distribution	Participants
Author	BS and TNT
Date	8 April 2002
Reference No	O-101143

Issue No **Issue**

1. A working agenda proposal during the NILU Mission 1 to HCMC and a draft of the main issues for the coming seminar 15 – 16 April 2002 were handed out by NILU.
2. LVK presented the DOSTE staff and gave a short introduction regarding positions and responsibilities.
3. The HEIA logo was presented and BS asked if there were comments to the project logo. The logo was accepted as it is. The logo will be used from now on for all future documentation.
4. The DOSTE staff proposed a few changes to the proposed working agenda. These changes will be implemented and a new agenda will be distributed.
5. The proposed seminar programme was presented. Questions from the DOSTE staff were discussed, and a list of participants will be prepared within a few days. The number of participants will be about 20 included some invited experts.
6. DOSTE expressed again some dissatisfaction with the tasks undertaken by Schmidt Vietnam. The meeting with Schmidt Vietnam proposed for Wednesday was changed till Thursday 11 April from 10:00 hrs. The meeting has been confirmed.
7. LVK presented DOSTE. He presented also the former and present situation of the air quality network in HCMC.
8. The DOSTE air quality experts at the Environmental Data Centre (EDC) had a short presentation of the ENVIMAN Commissioner for data retrieval purpose. The established SOP for instrument operations and the QA/QC system was briefly presented.
9. DOSTE has also started to prepare digitalised maps of HCMC using MapInfo Software. NILU will get a copy of the maps for preparing the GIS module in the AirQUIS system.

Appendix A2: Site visit reports

Site visits

Title	**Visits to the air quality monitoring sites in HCMC**
Participants	Le Van Khoa (LVK), Ngo Thanh Duc (NTD), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ), Bjarne Sivertsen (BS) and The Nguyen Thanh (TNT)
Distribution	Doan Thi Toi (DTT) and the participants
Author	BS and TNT
Date	10 April 2002
Reference No	O-101143

Topics	Comments
Sites	The 4 existing air quality measurement stations in HCMC were visited. These are Thu Duc (Background), Tan Son Hoa (Residential), Hong Bang (Road Side) and DOSTE (Road Side)
Characteristics	A short summary of the impressions from the stations visited is presented below: • The weekly stations site visits and maintenance performed by the DOSTE experts seemed to be satisfactory. • The DOSTE experts use on an average one-hour to fulfil the weekly maintenance. • Each month they collect 7 filters from the SM200 to be analysed by the DOSTE Centre of Analytical Service and Experimentation (CASE). • The DOSTE experts have expressed that they are not satisfied with the SM200, because this instrument is very often malfunctioning. • The follow-up and updates to be undertaken by Schmidt VN seem to be inadequate and incomplete. The station service logbooks also documented this. • The UPS for each shelter lasts approximately 20 minutes in case of power breakdown. • Thu Duc station: Only 5 metres from the air intake an open-air waste burner is occasionally used. This will create high concentrations of PM_{10} not representative for the average air pollution level of the area. There are also some tall trees growing

Topics	Comments
	close to the shelter. These may affect the air pollution level causing filtering effects on some of the air pollutants. A building has been constructed on the western side of the stations, after the installation of the instruments. • Tan Son Hoa station: The Omni Saigon Hotel nearby may influence the airflow and create some additional impact of pollution to the measurements intake. A small industry was placed about 20 m from the intake. • Hong Bang station: Located close to Hong Bang street with heavy traffic. Intake and shelter between fence and bicycle shelter. However it seems representative for the road-side location. • DOSTE station: The shelter is located inside the DOSTE property, only 5 m from the street. In addition to the monitors located in the shelter DOSTE is also operating an Andersen High Volume Sampler with PM_{10} hood. The filters are collected every six day and sent to DOSTE Centre of Analytical Service and Experimentation (CASE) for analyses (gravimetric and lead). The California Research Board (CARB) has recommended the procedures.
Operational costs	• The operational costs for each of the monitoring stations are 15 USD monthly for Security Guard and approximately 150 USD for Telephone and Electricity expenses.
Voltage stabilizers	• All stations were equipped with Voltage Stabilizers. DOSTE has already bought 5 extra for the stations to be installed by NILU in the HEIA project.
Data logger capacity	• VTD asked if the new data logger DL Pro 256 could be delivered with hard disk capacity larger than 2 GB. He needs also to know the possibility of changing the other kind of standard hard disk when the existing hard disk fails. TNT will prepare answers to these questions.
API instruments	• VTD asked the possibility of updating the model A to E. The model E is the newest release. TNT indicated that this inquiry is too late, but he will verify this with NILU in Norway.
Shelter	• Specifications of the shelters including technical specifications and dimensions were provided to NILU.

Topics	Comments
Met station	• Specifications of the Meteorological station located at DOSTE were provided to the NILU expert team.
Gas standards	• As a result of the discussions of calibration routines and the possible use of standard gases in the future we were informed that DOSTE has a certificate to procure such gas standards.
Spare parts	• It was confirmed (by VTD) that the Environmental Data Centre would be responsible for storing spare parts for the new measurement stations. DOSTE has a routine for the spare part inventory. VTD and TNT will verify this routine.

Appendix A2b: Shelter specification

MLU

A. TECHNICAL BUILDING MANNUAL

dimension:

outside dimensions: length 3100 mm, width 2200 mm, hight 2390 mm;
inside dimensions: length 2390 mm, width 2030 mm, hight 1995 mm;

ground construction:

4 pieces of panel to fix the lifting jacks 0,5 to.

ground construction:

0,55 mm galvanized sheet metal, 12 mm chipboard V100,
bar of wood 20 mm with polystryrene isolation, 16 mm chipboard V100,
PVC – ground Alpin 3000, gray, anti statically.

wall construction:

80 mm sandwich panel,
panels are without FCKW, isolation factor K = 0,35 W/m^2K,
according to DIN 4102 and ÖNORM 3800 fire resistant and classified in building material group B1.

roof construction:

80 mm sandwich panel (also like wall construction), over that 0,8 mm aluminium – sheet metal as roof coating.

door:

1 piece of entrance, dimension 1850 mm x 800 mm,
built in the middle of the container , chipped on the right side,

air condition:

1 piece air condition with 3,5 kW cooling power, with defrosting thermostat; built in the fixation for air conditioning.

Appendix B

Task 2. Design and update

Appendix B1a: Site reports

Site report

To select new sites in HCMC site visits were paid to a number of possible new visits on 17 to 19 April 2002. Site reports from each of these sites have been prepared.

Background

In HCMC we had to rely on studies performed during the first phase of the project, supported by DANIDA. In the process of identifying new sites NILU has consider the following input:

6. The air pollution network should be designed to support an evaluation of the exposure of pollution to people (health related).
7. The spatial density, site distribution and site locations in HCMC should reflect the typical air pollution situations and enable a health impact analyses.
8. The locations should take into account the sites already available from the first phase of the project supported by DANIDA.
9. The indicators to be measured at each site should be considered relative to the site characteristics.
10. The necessary meteorological data sufficient for air quality assessment and modelling should be assured.

Final recommendations concerning location of new monitoring sites has been based on site visits and discussions with DOSTE experts.

Evaluating the main source of pollution as well as the way of living in HCMC, we believe that a major part of air pollution exposure in the city is caused by air pollution emissions from vehicles and motorbikes. People are living, moving, staying, eating and sleeping on and along the street and roads. We have therefore concentrated more of the measurements to roadside stations than originally proposed. (See below).

Air pollution indicators

The major air pollution indicators have already been selected for the Ho Chi Minh City area. Indicators to be used at each individual monitoring site have to be considered relative to the type of sources and pollutants impacting the specific area.

The following (first priority) indicators should be considered:

- Sulphur dioxide (SO_2)

- Nitrogen oxides and nitrogen dioxide (NOx, NO_2)
- Particles with aerodynamic diameter less than 10 µm (PM_{10})
- Ozone (O3).
- Volatile organic compounds (VOC)

The need for measurements of other indicators may be evaluated, and simple screening studies may for some indicators be undertaken with inexpensive passive or sequential samplers.

Meteorological data needed for assessment of air quality has also been evaluated and improvements will have to undertaken to upgrade the meteorological data collected at the tower at DOSTE. Additional meteorological data taken from weather pres\dictions will be evaluated later as part of the modelling efforts.

Instrumentation

Instruments to be used at each of the sites are normally dependent upon objectives and site characteristics. In the original project documents (Terms of Reference) this had already been decided, and NILU experts had no influence on the selection.

The Table below indicates the parameters and instruments selected for the sites.

Complete list of ambient air quality instrumentation

Site No.	***NO_X*** *mon.*	***SO_2*** *mon.*	***O_3*** *mon.*	***CO*** *mon.*	***PM_{10}*** *mon.*	***VOC*** *sampl.*	***Air*** *intake*	***Data*** *acq.*	***Z/S*** *unit*	***Rack***	***Shelter***	***Site type***
1	1	1	1		1		1	1	1	1	1	Urban bg.
2	1	1	1		1		1	1	1	1	1	Urban bg.
3	1	1	1		1		1	1	1	1	1	Urban bg.
4	1			1	1	1	1	1	1	1	1	Road side
5	1			1	1	1	1	1	1	1	1	Road side
Total	5	3	3	2	5	2	5	5	5	5	5	

As will be seen from the report presented below concerning the final selection of sites, the type of sites as well as the needed instrumentation has been slightly changed. We believe that these changes will improve the total monitoring network and give adequate information to the air quality assessment of HCMC.

New sites

The discussions about the different sites visited as well as detailed descriptions can be found in Chapter 2.2. of the Mission report and in Appendix B2a "Site description report".

A summary of selected sites is presented in the Table below. The site characteristics as well as the indicators to be measured at each site are presented in the Table below.

The new proposed sites for air quality measurements in HCMC.

Site	NO_x	SO_2	O_3	CO	PM_{10}	VOC	Shelter	Site
Truong Thanh	1		1		1		1	Background.
IT park	1	1	1		1		1	Res/urban bg.
District 2 PC	1	1	1		1		1	Res/urban bg.
Thong Nhat hospital	1	1		1	1	1	1	Road side
Binh Chanh Educ.	1			1	1	1	1	Road side
Total instruments	5	3	3	2	5	2	5	

We have moved one of the SO_2 instrument from the background station to one of the road side stations to identify the impact of diesel trucks. Background SO_2 concentrations may be measured by using passive samplers

Appendix B2a - Design new monitoring sites

Site description reports

Site	**Cu Chi**
Site type	Regional background station
Area/Location	People Committee (PC) building Cu Chi District. The area is located about 35 km north-west of the city centre of HCMC
Access/ availability	Site inside the properties of PC, 600 m away from main road
Area description	"Park like" area, trees and green areas with low buildings surrounding the site. Remote from any local sources.
Local sources	No major local sources of air pollution. Industrial area located some kilometres northwest of the site with small enterprises including; plastic factories, food, textile and mechanical workshops. The site is surrounded by farmland. Agricultural waste burning was observed some kilometres south-east of the site.
Parameters	The most important parameters to measure here are: Ozone, PM_{10} , NO_2 , SO_2
Equipment	API monitors, betagauge PM_{10}
Air intake	Located at top of the shelter, placed on the ground.
Infrastructure	Shelter located 20 m from and in front of one administration office building will have telephone lines and power available.
Responsible expert	Ngo Thanh Duc (NTD), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ).
Comments	It was difficult to find the perfect location inside the People Committee properties, due to the many buildings and tall trees. The final location is a compromise, but is not a perfect location for a background station.

Cu Chi site, shelter at small hill.

Site in front of office building.

Site	**Hoc Mon PC**
Site type	Residential station
Area/Location	People Committee (PC) building Hoc Mon District. The area is located about 25 km north-west of the city centre of HCMC.
Access/ availability	Site inside the properties of PC, inside the town of Hoc Mon and surrounded by the town.
Area description	Inside the properties of PC there are tall buildings with trees and green areas. A rather complex setting for a good air quality monitoring site.
Local sources	The town with all its activities surrounds the site; traffic, markets etc. No major sources like industries were identified. There is a landfill about 10 km east of the town.
Parameters	The most important parameters to measure here are: PM_{10} , NO_2 , SO_2 , and ozone.
Equipment	API monitors, betagauge PM_{10}.
Air intake	Located at top of the shelter, placed on the ground surrounded by large buildings and trees.
Shelter location and infrastructure	Shelter located on a small triangle “park” in the middle of buildings located only 30 to 50 away from the shelter. Telephone lines and power will be available
Responsible expert	Ngo Thanh Duc (NTD), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ).
Comments	It was difficult to find a location inside the People Committee properties, due to the many buildings and trees. The final location is a compromise, but is not a perfect location for a background station.

The shelter may be placed on the green area to the right.

Site	**Hoc Mon Hospital**
Site type	Residential station
Area/Location	Hospital in the Hoc Mon District. The area is located about 25 km north-west of the city centre of HCMC, about 1 km from the PC building.
Access/ availability	Site inside the properties of the hospital. Two possible locations of the shelter was identified.
Area description	Inside the properties of PC there are tall buildings with trees and green areas. A rather complex setting for a good air quality monitoring site.
Local sources	The town of Hoc Mon is located around the site. No major sources like industries were identified in the vicinity. A hospital waste treatment plant is located within 50 m from the sites. (not in operation) There is a landfill about 10 km east of the town.
Parameters	The most important parameters to measure here are: PM_{10} , NO_2 , SO_2 , and ozone.
Equipment	API monitors, betagauge PM_{10}.
Shelter location and infrastructure	Two locations for shelter was discussed: 1. Shelter located on an open area south of the hospital 2. Shelter on top of a 4 m high corridor running between buildings Telephone lines and power will be available.
Air intake	Located at top of the shelter. On the open ground position tall trees will be somewhat away from the intake. In the roof trees will be close to the air intake. On the other side this location will be more representative for residential areas.
Responsible operators	Ngo Thanh Duc (NTD), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ).
Comments	It was difficult to identify a good location in the area. The final location is a compromise, but is not a perfect location for a background station.

Site	**District 12, IT park**
Site type	Residential
Area/Location	The site is inside a large technology park with open areas. It is located in District 12. The area is located about 12 km north-north-west of the city centre of HCMC, about 5 km north of the international airport.
Access/ availability	The site is inside the properties of the software park in District 12.
Area description	The area is open with trees and park like arrangements. The buildings are low; one and two stories, and far apart.
Local sources	The international airport is located about 3 km south and south-east of the site. A cement factory is located about 2 km west of the site. Otherwise the area is mostly residential.
Parameters	The most important parameters to measure here are: Ozone, NO_2 , PM_{10} and SO_2.
Equipment	API monitors, beta gauge PM_{10}.
Shelter location and infrastructure	The shelter location identified is about 200 m north of the main gate, in front of the APT Office building. Telephone lines and power will be available.
Air intake	Located at top of the shelter, which will be placed on an open area, on grass surface.
Responsible operators	Ngo Thanh Duc (NTD), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ).
Comments	This site is one of the better suited for open area residential location. The general area will be downwind (in the prevailing wind direction) from HCMC city.

The IT park site from west

The site seen towards the main gate (south)

Site	**Thong Nhat Hospital**
Coordinates	N: 10 deg 47,550 min, E 106 deg 39,215 min
Site type	Road side station
Area/Location	Hospital in the Tan Binh District. The area is located in the north-western part of the city centre of HCMC, about 2 km south of the airport.
Access/ availability	The site will be located inside the properties of the hospital. Two possible locations of the shelter was identified
Area description	Inside the properties of Thong Nhat hospital, next to the fence with some trees close to the shelter.
Local sources	The main sources are the traffic on two main roads crossing within 10 m from the site. Both roads are coming from the city centre, one to the airport the other is north and northwest bound. No major sources like industries were identified in the vicinity. We counted 160 motorbikes, 30 cars and 10 trucks per minute in each direction on one of the roads
Parameters	The most important parameters to measure here are: PM_{10} , NO_2 , SO_2 , CO and VOC
Equipment	API monitors, beta gauge PM_{10}, passive sampler for VOC
Shelter location and infrastructure	Two locations for shelter was discussed: 1. Shelter located at northern corner inside fence (close to crossing) 2. Shelter located at southern entrance close to security shelter Telephone lines and power will be available.
Air intake	Located at top of the shelter placed on the surface inside the fence.
Responsible operators	Ngo Thanh Duc (NTD), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ).
Comments	The location is well suited to reflect some of the most heavily trafficated streets leading out of the city. The site will serve as a road side station.

Site	**District 11** N: 10 deg 45,833 min, E 106 deg 38,623 min
Site type	Road side residential station.
Area/Location	Near or on the PC building of District 11.
Access/ availability	The site has to be located inside the properties of the District 11 PC. Three possible locations of the shelter was identified.
Area description	Inside the properties of PC there are tall buildings with trees and green areas in the back of the building and tall trees in the front facing the road/street. A rather complex setting for a good air quality monitoring site.
Local sources	Small industries including a food-processing factory 200 m east of the site and mechanical industries north of site 1. The main sources may be the traffic along Binh Thoi road.
Parameters	The most important parameters to measure here are: PM_{10} , NO_2 , and SO_2.
Equipment	API monitors, betagauge PM_{10}.
Shelter location and infrastructure	Three locations for shelter was discussed: 1. Shelter located behind the building on a small open area surrounded by building and trees (not a good location) 2. Shelter on top of a 4 m high balcony about 20 m from the street. Some trees between site and the street. 3. Shelter on the ground in the eastern corner of the area, placed behind the fence between café and the security house. Telephone lines and power will be available.
Air intake	Intake from top of the shelter.
Responsible operators	Ngo Thanh Duc (NTD), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ).
Comments	It was difficult to identify a good location in the area. The best location of the three may be near the fence, and we will again have a roadside station.



Site	**Binh Chanh PC** N: 10 deg 44,228 min, E 106 deg 36,923 min
Site type	Road side station.
Area/Location	The area is located about 15 km south-west of the city centre of HCMC, on the main road leading out of the city to My Tho, and close to National Road no. 1.
Access/ availability	Site is located inside the properties of the Binh Chanh People Committee building. It will be easily access to the shelter placed just behind the security house at the entrance.
Area description	The area is relatively open with few tall trees. Some local activities close to the shelter may influence the measurements.
Local sources	The main sources in this area are traffic. One main road is passing only 8 m from the intake. There are also some smaller industries within 2-3 km north of the site, including wood, textile and paper industries.
Parameters	The most important parameters to measure here are: PM_{10}, NO_2, SO_2, CO (VOC and ozone?).
Equipment	API monitors, beta gauge PM_{10}.
Shelter location and infrastructure	The shelter may be placed inside the fence behind the security house. Telephone lines and power will be available.
Air intake	Located at top of the shelter.
Responsible operators	Ngo Thanh Duc (NTD), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ).
Comments	This location was the third one we considered in this general area of Binh Chanh. An alternative for measurements in this district could be the educational centre at Hung Vuong road.

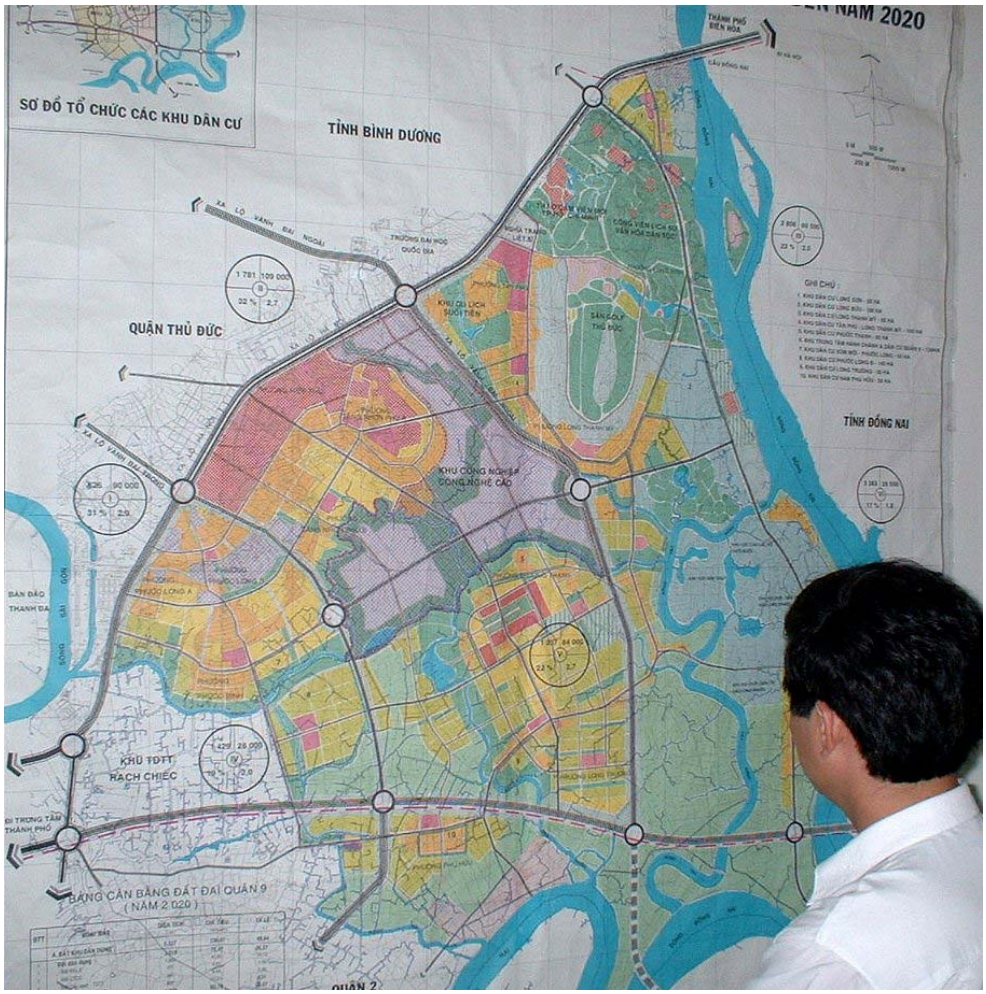
Site	**Binh Chanh Educational Office** N: 10 deg 43,711 min, E 106 deg 36,442 min
Site type	Road side station
Area/Location	The area is located about 15 km south-west of the city centre of HCMC, on 462 Hung Vuong road leading out of the city to My Tho, and close to National Road no. 1.
Access/ availability	Two possible sites were identified inside the properties of the Educational office building.
Area description	The area is relatively open with few tall trees. The space at the surface is limited due to tall buildings only 10-15 m from the fence at the road. The site is located north of the road.
Local sources	The main sources of pollution in this area are traffic. One main road is passing only 8 m from the intake. There are also some smaller industries within 2-3 km north of the site, including wood, textile and paper industries.
Parameters	The most important parameters to measure here are: PM_{10}, NO_2, CO, and VOC.
Equipment	API monitors, beta gauge PM_{10} , VOC with passive sample.
Shelter location and infrastructure	The two location for the shelter was found just inside the fence: 1. In the corner on the left side of the entrance (seen from the road). 2. In the corner on the right side of the entrance. Telephone lines and power will be available.
Air intake	Located at top of the shelter.
Responsible operators	Ngo Thanh Duc (NTD), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ).
Comments	This location was the second one we considered in this general area of Binh Chanh. The may be the first priority site, even if the two described the PC building and this does not seem very different from each other.

Site	**District 2 PC**
Site type	Residential / urban background station.
Area/Location	At the People Committee building of district 2. The site is located about 6 km east of the city centre of HCMC. The area is under development and the PC building may be moved within some years. Open areas surround the area. The main road to Hanoi passes less than 2 km north of the site and small industries are located about 3 km to the south. A future railroad station is planned only 500 m south from the site.
Access/ availability	The measurement site is proposed inside the properties of PC about 10 m from the fence.
Area description	Inside the properties of PC there are two and three story buildings with some low trees in front.
Local sources	The only pollution felt is smell from the production of animal food. The heavily traffic loaded main road to Hanoi may pollute the site at winds from north.
Parameters	The most important parameters to measure here are: PM_{10} , NO_2 , SO_2 , and ozone
Equipment	API monitors, beta gauge PM_{10}
Shelter location and infrastructure	Two locations for shelter was discussed: 1. Shelter located on grass in the eastern corner of the front area about 10 m from the fence. 2. Shelter on the surface close to the motorbike parking area close to the western corner of the building Telephone lines and power will be available.
Air intake	Air intake from top of the shelter, will not be heavily influenced by vegetation. On the first priority position (eastern corner) it may be close to a second building.
Responsible operators	Ngo Thanh Duc (NTD), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ).
Comments	The site is to day a reasonable representative residential site. There may be large changes in the development of this area and the measurement here may in the future reflect hence changes. An important site to keep permanent to evaluate future trends.

District 2 photos:

First priority location of shelter.

District 9 map



Site	**Truong Thanh, District 9**
Site type	Background station
Area/Location	The site will be placed at the Truong Thanh Ward building. The area is an open farmland about 15 km east of the city centre. There are residential areas (small villages) west and north of the site.
Access/ availability	The measurement site is proposed inside the properties of Truong Thanh Ward.
Area description	Close to the shelter there will be a fence and two-storey building. As a background site this will not have any influence on the measurements. There is no vegetation close to the intake.
Local sources	No local sources were identified in the area. There is a small footwear industry and other activities, but they are not supposed to be major sources of air pollution.
Parameters	The most important parameters to measure here are: Ozone, PM_{10}, NO_2 and SO_2 (passive).
Equipment	API monitors, beta gauge PM_{10} , SO_2 by passive samplers
Shelter location and infrastructure	The shelter will be placed at the ground behind the building close to the fence. The location is about 50 m away from a small road. Telephone lines and power will be available
Air intake	Air intake from top of the shelter close to the fence. It will be free of any obstacles and away from vegetation.
Responsible operators	Ngo Thanh Duc (NTD), Vo Thanh Dam (VTD), Nguyen Bao Quoc (NBQ).
Comments	The site is representative for a typical background station and will first of all serve as a background station for ozone and NO_x .

Appendix C

Task 3. Procure and install

Appendix C1: Specifications

Complete table of ambient air quality instrumentation

The table below lists the instrumentation for each measurement site. The column header texts refer to the following sections:

NO_x mon.	Equipment:	NO_x monitor
SO_2 mon.	Equipment:	SO_2 monitor
O_3 mon.	Equipment:	O_3 monitor
CO mon.	Equipment:	CO monitor
PM_{10} mon.	Equipment:	Particulate (PM_{10}) monitor
VOC sampl.	Equipment:	Volatile organic compound (VOC) sampler
Air intake	Equipment:	Air intake with manifold
Data acq.	Equipment:	Shelter data acquisition system
Z/S unit	Equipment:	Two point calibration unit
Accessories	Equipment:	Accessories
Shelter	Equipment:	shelter/ Container

Table 1. Complete list of ambient air quality instrumentation

Site	NO_X	SO_2	O_3	CO	PM_{10}	VOC	Shelter	Site
Truong Thanh	1		1		1		1	Background.
IT park	1	1	1		1		1	Res/urban bg.
District 2 PC	1	1	1		1		1	Res/urban bg.
Thong Nhat hospital	1	1		1	1	1	1	Road side
Binh Chanh Educ.	1			1	1	1	1	Road side
Total instruments	5	3	3	2	5	2	5	

General requirements

The following general requirements apply to all equipment specified in this procurement document.

Instructions

The supplier shall provide concise and clearly written documentation in English language (or other language accepted by the costumer), which provides the following data:

a) Clearly written instructions for routine use and maintenance.
b) A specification of equipment performance characteristics and productivity.
c) Full health and safety information.

Accessory and spare parts

The delivery shall include accessory and spare parts kit for 3 years' operation, according to supplier's experience. Budget for accessories and spare parts must be clearly specified.

The supplier must have spare parts in stock for at least five years after delivery of the instrumentation.

Packing and delivery

Delivery of equipment to NILU, Norway, including insurance, packing and transportation should be provided by the supplier.

The delivery shall take place less then two months after acceptance of the contract. If otherwise the time of delivery shall be specified by the supplier.

After sales facilities/incidental services

Name and location of nearest organization for incidental services shall be specified.

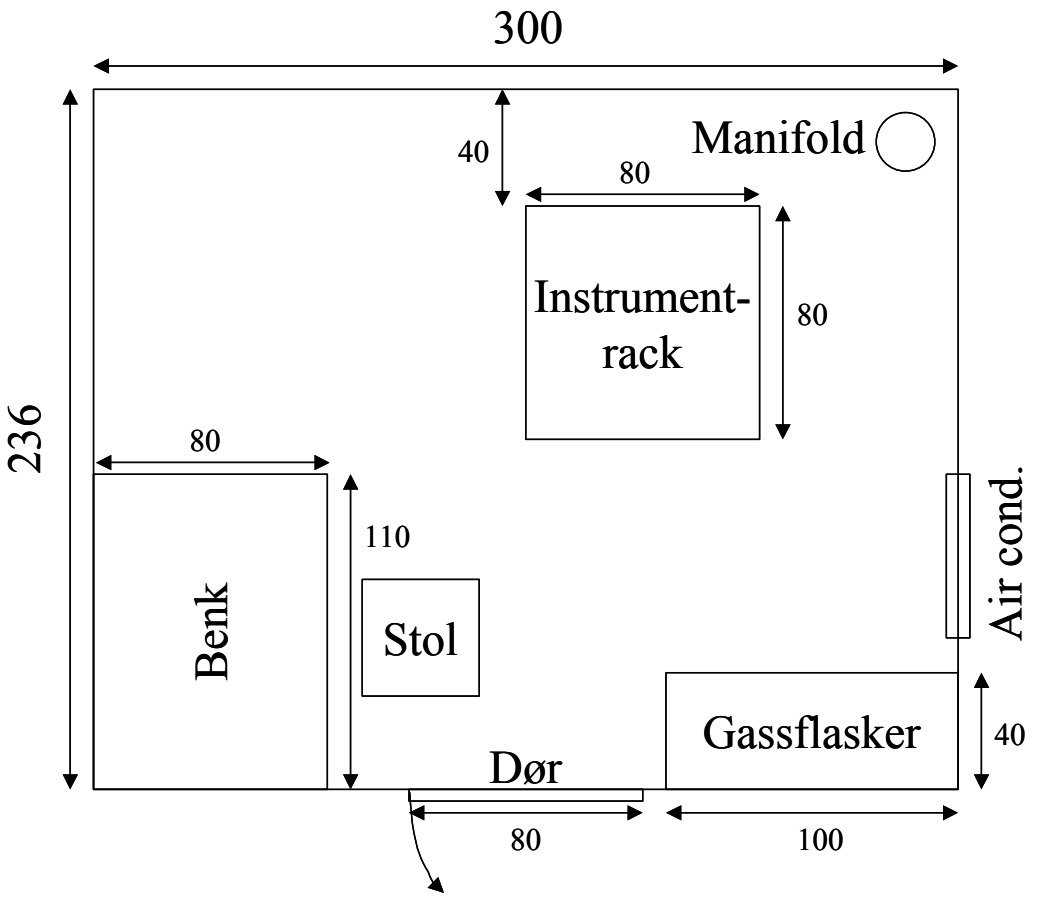
Warranty

Warranty of a minimum of 1 year for overall equipment is required. The warranty period shall be specified.

Appendix C3: Prepare shelters at NILU

NILU shelters

Specifications of NILU shelter
Lengths in cm. Inside measures



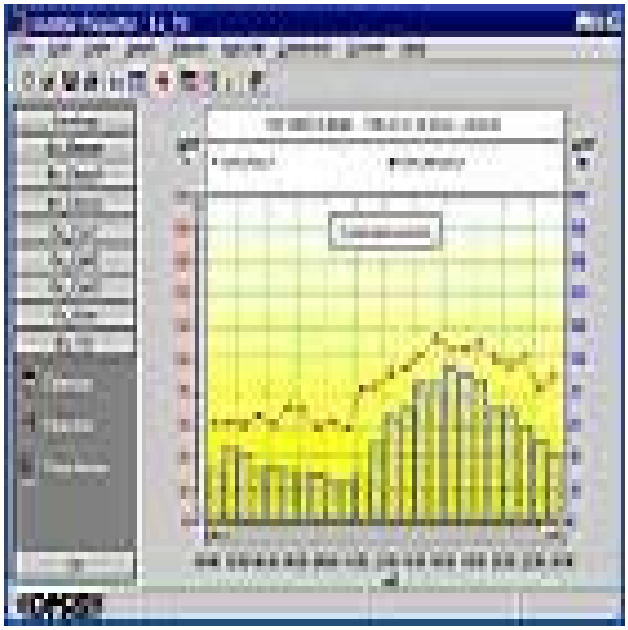
NILU målebu, målestokk 1:20, innvendige mål, 4/1-2001, LM

Appendix D

Task4. Assure system integration

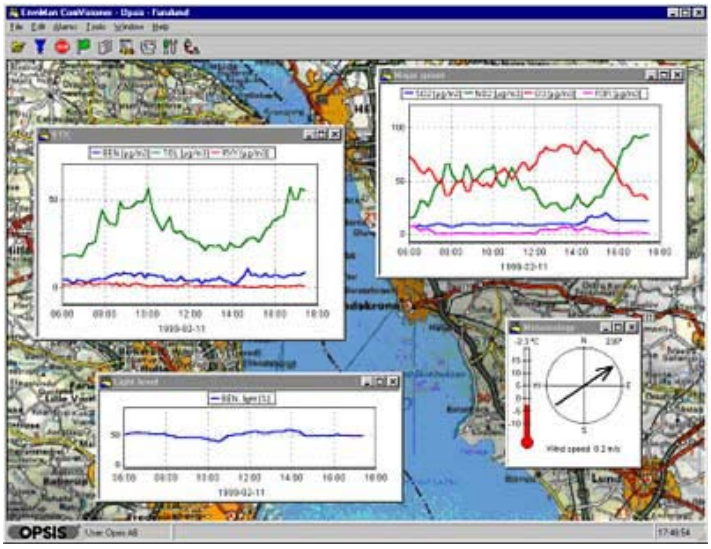
Appendix D1: Identify existing data collection system

EnviMan Software



The Opsis systems generate high levels of data and a range of software packages are available to allow maximum value to be extracted from this information. The full Opsis software range – EnviMan – provides a wide choice of data collection, reporting, display and other statistical functions, as well as local or remote communications with external computer systems.

ComVisioner



The EnviMan ComVisioner software is the core of the real-time data management functions in the EnviMan software suite. ComVisioner accesses monitoring stations, extracts data from them and puts this data in the EnviMan databases. Often, this data is used by EnviMan Reporter, Sitebuilder and Forecaster. It may also be used by e.g. EnviMan Planner and Finder.

ComVisioner also provides the possibility of automatic data validation, advanced data processing and calculations, report generation and many other features. Any data, real-time as well as historical, can be made available for displaying in charts or as numeric values. Together with IOManager, ComVisioner can provide input and output of data to and from external devices connected to the ComVisioner computer.

The software is based on a true client/server design using OLE Automation (COM, DCOM). The Server is responsible for carrying out all routine tasks like communication with stations, data storage, calculations etc. The Client serves as the user interface towards the Server, providing data displaying functionality, alarm management, configuration menus and other features.

ComVisioner can be licensed for one or more clients and for one or more stations. As a standard, ComVisioner can communicate with Opsis gas analysers and data loggers. Communication protocols for other types of data sources are available.

Appendix D2: Evaluate OPSIS system

Memo

Title	Status IT
Participants	Mr. Vo Thanh Dam (VTD), Mr. Tran Ngoc Thanh (TrNT) and Mr. The Nguyen Thanh (TNT)
Distribution	Mrs. Doan Thi Toi (DTT), Mr. Le Van Khoa (LVK), Mr. Bjarne Sivertsen and the participants
Author	TNT
Date	12 April 2002
Reference No	O-101143

Topics	Comments
ENVIMAN	
Data access	DOSTE experts informed that it is not possible to access the ENVIMAN ComVisioner (EC) database with ODBC. There is also no specific technical information available describing how to access to the database with external 3rd party products such as MS office query using ODBC. Instrumatics AS has developed for DOSTE experts a manual Excel routine for copying data from the measurement database for reporting purpose.
Training	DOSTE experts expressed also the very need for an EC training session covering installation and configuration, because the existing system was preinstalled and delivered by Instrumatic AS. DOSTE experts added that the existing documentations are not enough. TNT has been informed that support from Schmidt was very poor.
EC-PC	DOSTE experts informed also that the EC-PC is 2 years old and they are afraid that HW failure may occur soon. This PC will also be extended with 5 EC licenses for the new stations.
IT-equipment for AirQUIS	
IT-equipment	A server-PC and a client-PC will be delivered for the AirQUIS installation.
Network	The network consists of 1 file and print server with NT 4.0 5 clients 24 ports hub and TP cables. There are enough ports for the AirQUIS server and the AirQUIS client TCP-IP protocol 1 Colour Laser Printer 1 Scanner

Topics	Comments
	They do backup by burning CD-ROM.
IT-supplier	We had a discussion regarding how the IT-equipment should be purchased regarding prices, brand, availability, delivery, warranty and support. DOSTE experts informed that the price and availability of updated IT-equipments are fairly good here in Viet Nam.
Local IT-supplier	We visited a local IT-supplier recommend by DOSTE experts. The prices and the IT-equipment seemed to be acceptable. The well-known international PC-brands such as Compaq, IBM, HP etc. are approximately 5 – 10% more expensive than the local brand ones. We evaluated some equipment and got a quotation specified for AirQUIS. The DOSTE experts have good experiences regarding the maintenance and repair service on local manufactured PC (non well-known international PC-brand). Our common conclusion for the moment is to purchase local IT-equipment locally based on the good feedback form DOSTE experts regarding maintenance and repair service, but the local PCs must apply to the well-known international PCs.
Geographical Information System (GIS)	
	TrNT has produced for TNT the HCMC maps in ArcView format as GIS data for AirQUIS. There are 22 districts in HCMC.
Other - Monitoring data	
	VTD has produced for TNT 1 year of measurement data for all the stations. The data covers the whole year 2001 and will be used as test data for AirQUIS.

Appendix E

Task5. Quality Assurance (QA/QC)

Appendix E1a: Data collection at EDC

Minutes of Meeting #2

Title	Update on data collection at the Environmental Data Centre (EDC) DOSTE
Participants	Le Van Khoa (LVK), Tran Ngoc Thanh (TrNT), Vo Thanh Dam (VTD), Bjarne Sivertsen (BS), The Nguyen Thanh (TNT) and Lars Robert Hole (LRH)
Distribution	Participants
Author	BS, TNT and LRH
Date	12 April 2002
Reference No	O-101143

Item **Topics**

1. LVK and VTD gave an overview on data retrieving routines at DOSTE. The data are collected automatically every morning at 02:00 hrs for the preceding day. Telephone lines in HCMC are now functioning well, but earlier it has been more unstable. There is no problem with people tapping the line. If the station cannot be connected it will be controlled physically the same day. Logbooks and check lists are completed daily, and the NILU team approved the forms and commented that the routines at DOSTE seem to work adequately.

2. BS: The SO_2 monitors, especially at Ton Son Hoa station, should be upgraded. The daily zero-span calibration does not seem to work properly. The concentrations retrieved is clearly too low (even negative values). The permeation tube is malfunctioning and must be replaced.

   NOx measurements from the Thu Duc station are unstable.

   The different levels of quality assurance were discussed. VTD described how the erroneous data are flagged and removed. BS stressed the need for "Quality assurance by finger" (visual control), e.g. on weekly plots of all data. In this way drift in the instruments will be more easily recognised.

   Data are now stored in Excel-sheets.

3. BS & LRH: High quality Meteorological data are of uttermost importance for explaining the air quality data measured and for input to models in the future.
   VTD presented the data from the 30 m tower at DOSTE. Meteorological instruments were installed here by Instrumatic AS in June 2000 and the meteorological sensors are now

Item	Topics
	providing 5 minute data of wind speed, wind direction, air pressure, relative humidity, total incoming radiation, relative humidity and air temperature (the latter two are sampled approximately 3 m above ground at the AQ station at DOSTE). These data have not been quality checked before. Wind direction data are probably shifted 180 degrees. Radiation data presented are erroneous (wrong order of magnitude). There are no measurements of the vertical temperature gradient as a measure for thermal stability in the lower atmosphere. The difference between air temperature at the mast top and at the ground ("deltaT") should be measured. There is a need for training of the DOSTE team on analysis and quality control as well as for interpretations and application of meteorological data as part of the air quality analyses.

E1b: Meetings with Schmidt Vietnam

Minutes of Meeting with Schmidt Vietnam

Title	**Meeting with Schmidt Vietnam Co. Ltd**.
Participants	Mrs Hoang Bach Duong (Chief representative in HCMC), Mr. Phan Truong Son, (Hanoi office), Mr. Dinh Ngoc Hung, Mr. Dang Ngoc Khang, Mr. Bjarne Sivertsen (BS) and Mr. The Nguyen Thanh (TNT).
Distribution	TNT, LV Khoa
Author	BS
Date	11 April 2002
Reference No	O-101143

ITEM	Comments
Company	Schmidt Vietnam (SV) has its head office in Hanoi. They have all together 150 employees. Their main laboratory is in Hanoi.
Air experts	In HCMC SV has a calibrator unit and standard gases. Two air quality experts are located in the HCMC office. SV is presently servicing 6 air quality monitoring stations in Vietnam; 2 in Hanoi and 4 in HCMC. They have a very short experience in these operations, and it was pointed out that this is the first time they undertake air quality measurements.
Supplier	SV is performing installations and warranty performance. They are instrument supplier for API in Vietnam. For the project in HCMC SV shall carry out service and maintenance for the equipment supplied under the contact Project INT/95/R11 UNOPS. For this purpose an agreement has been made between SV and Instrumatic A/S (the instrument supplier).
Training	The air monitoring experts at SV have received training by API in Kuala Lumpur and in Hanoi.
Spare parts	SV can support DOSTE in obtaining spare parts when needed. They claim that after request from DOSTE it will take only two weeks to receive art such as filters etc. SV have their own custom office who are experts in the paper work needed. They also have a small stock of spare parts in their office in HCMC.

ITEM	Comments
	The spare parts most often used are: UV-lamps, filters, IR source for CO monitor, equipment for rebuilding pumps, flow meters?
SOP	The standard operations procedures (SOP) prepared by the Danish expert Mr. K Fuglesang of Dk-Teknik has not been followed up by SV (Statement from DOSTE). SV has primarily been assigned as instrument suppler on contract with Instrumatic A/S in Denmark. They have not received a sufficient supply of spare parts.
Repair	SV indicated that they would repair instruments no later that 2 days after a request has been received from DOSTE. If spare parts are needed it may take an extra 2 weeks.
Zero-span	Permeation tubes for two point calibrations every day have not been changed since the instruments were started two years ago. Some of the SO_2 permeation tubes have also been verified to be empty. Changes have to be undertaken immediately!
SM 200 problems	The SM 200 instrument has been proven to be unsteady. Some of the instruments show problems, sometimes. One instrument is very hot (Hong Bang). These problems have not been reported to Instrumatic A/S.
Enviman	The Enviman system installed at DOSTE is not known to SV. They cannot support DOSTE on this data retrieval system. They are trained to re-install Enviman, but they are not sure whether they can re-configure the system.
Warranty	The warranty period for the 4 stations installed in HCMC by the Danish experts in phase 1 run out in April 2003. For the NORAD supported system to be installed by NILU, we have signed an agreement (Confirmation form) for a warranty period of one year including spare parts and work free of charge from SV.
From NILU	SV requested from NILU : A complete list of configuration (instruments etc.) of each of the shelters to be delivered to the project in HCMC. NILU should prepare SOP and maintenance documents for the beta-gauge PM_{10} monitor.

E1c: Warranty form

Norsk institutt for luftforskning
Norwegian Institute for Air Research

Confirmation Form

Project Information	Page 83 of 136
Project Name	HCMC Environmental Improvement Project
Project start	21 December 2002
Duration	3 years
Equipment to be delivered	5 pcs API M200A 3 pcs API M100A 3 pcs API M400A 2 pcs API M300 5 pcs API M701 5 pcs ESM Andersen FH 62-1 dust monitors 5 pcs Opsis DL 256 PRO data loggers
Delivered by	NILU
Terms of Warranty	
Duration	1-year service on API instruments free of charge.
Valid from	The date of delivery to the Customer
Customer Information	
Name	DOSTE
Address	244 Dien Bien Phu, District 3, HCMC
Telephone	9326709
Telefax	9325711
Contact Person	Le Van Khoa
Distributor Information	
Name	API US
Address	
Telephone	
Telefax	
Contact Person	
Supplier Information	
Name	Industriell Maaleteknikk
Address	Box 158, Skårersletta 60, 1471 Lørenskog, Norway
Telephone	+4767972262
Telefax	+4767972264
Contact Person	Martin Furevik

Local Supplier Information	
Name	Schmidt Viet Nam Co
Address	65 Le Loi Boulevard, District 1
Telephone	8228228
Telefax	8230239
Contact Person	Dang Ngoc Khang

Date 15/4/02 Local Supplier Signature

HOÀNG BẠCH DƯƠNG

Appendix E2: Prepare SOP

DOSTE Standard Operating Procedures Manual

AQM Network Ho Chi Minh City dk-TEKNIK ENERGY & ENVIRONMENT

UNOPS project no. INT/95/R11 *Ver. 1-0*

Training course 4.2.2.B

1. AQM MONITORING NETWORK IN HCMC- INTRODUCTION AND OVERVIEW

1.1 INTRODUCTION

This manual has been written to serve as a general introduction to DOSTE's Air Quality Monitoring Network in Ho Chi Minh City and define the standard operating procedures and practices by the network operators. Section 1 and 2 are descriptive and contain general background information on the objectives, structure and management of the network. Section 3 describes the procedures for routine quality control performed at the monitoring stations. Section 4 describes the procedures for daily and weekly QC of the measured data transmitted to the Environmental Data Centre, and section 5 describes the general data reporting procedures to be employed.

Section 6-10 are reserved for the detailed Standard Operating Procedures (SOP's) to be used for the individual analysers used in the network.

The monitoring stations in HCMC have been in operation since May 2000. Because of the limited time (6 months at this time) that DOSTE has had to gain experience with the operation of the instruments, not all of the SOP's are yet defined in detail for the individual instruments.

Draft sections of this manual have been written by Mr. Le Van Khoa, who is the responsible manager for the AQM network at DOSTE, in collaboration with Mr. Karsten Fuglsang of dk-TEKNIK ENERGY & ENVIRONMENT, who has performed the training in operation and maintenance of the AQM network during the UNOPS project (INT/95/R11).

The manual does in no way provides a full documentation of the quality control system to be used for the network. QA/QC is an ongoing process, in which revised or more sophisticated methodologies may be introduced as circumstances change, new needs arise or additional resources become available. Corresponding operating manuals must therefore also be evolving documents. This manual is therefore modular structured, with loose-leaf binding allowing ready updating of individual sections of the text. It is the intention that the contents of the manual should be revised and expanded according to the experiences gained from the operation of the network.

A draft SOP's were prepared for NO_x (section 7) and PM10 (section 10) during the training course in November 2000. It is the intention that this SOP should form a foundation for the elaboration of SOP's for SO_2 , CO, and O_3.

Presently, the basic operation of the network is performed by DOSTE. However the calibration and maintenance is performed by Schmidt Vietnam Ltd. (SVN) on the basis of a 2 year contract. This manual focuses on the procedures employed by DOSTE. SVN procedures are described through SVN's internal operating procedures.

It should be stressed that an essential part of the QC is the trace ability of the measurements, and therefore, the calibration procedures employed by SVN are crucial for the data quality. Procedures for calibration have been included in the SOP's for the individual instruments. These procedures have been discussed with SVN's Service Manager Mr. Frank Otto and are in accordance with the procedures followed by SVN.

Appendix E2a: Daily check list at EDC

Check list for daily control of data at the data retrieval EDC

KIỂM TRA NGÀY TRONG TUẦN LỄ từ: 4/04/02 đến 05/04/02

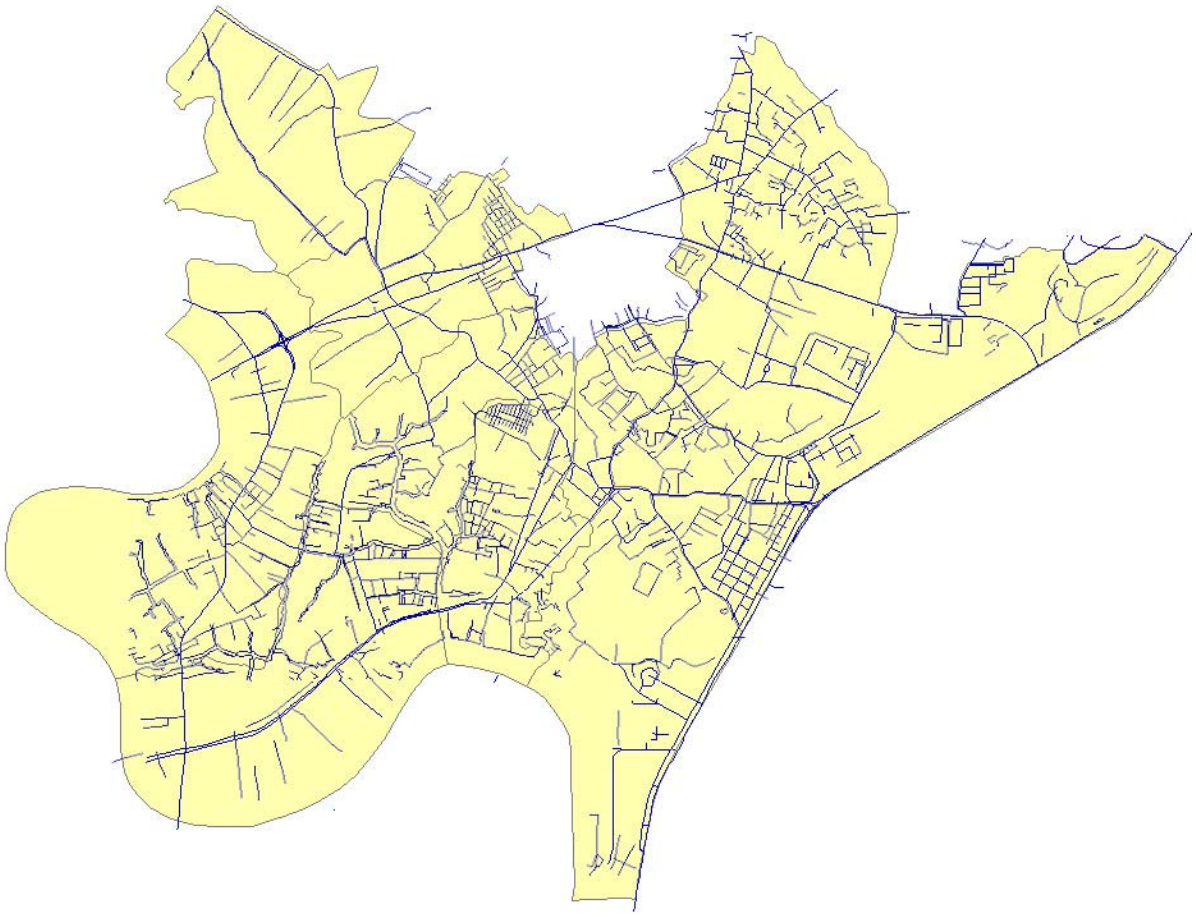
Nội dung kiểm tra	Thứ hai Ngày: 1/04	Thứ ba 2/04	Thứ tư 3/04	Thứ năm 4/04	Thứ sáu 5/0
Trạm Sở KH,CN&MT (DOSTE)					
K/tra, thu thập số liệu (data collection)	cannot connect	Same	O_3 lost some (-) values OK	Same	OK
K/tra tín hiệu báo động (alarm), nguồn điện (power), nhiệt độ phòng (room temperature),...	/	/	OK	OK	OK
K/tra việc chuẩn độ (ze/span calibration)	/	/	NO_x = 686 SO_2 = 14 O_3 = 427 ω = 31	Same	Same
Trạm Thủ Đức (TD)					
K/tra, thu thập số liệu (data collection)	OK	OK	PM10 = const NO_x has too high value ≈ 2 14ppb	OK	OK
K/tra tín hiệu báo động (alarm), nguồn điện (power), nhiệt độ phòng (room temperature),...	OK	OK	OK	OK	OK
K/tra việc chuẩn độ (ze/span calibration)	NO_x = 532 SO_2 = 533	Same	Same	Same	Same

Appendix F

Task6. Install AirQUIS

Appendix F1: Prepare GIS and database

As an example of the GIS maps retrieved from DOSTE, the Thu Duc District is presented below indicating ward borders, main roads and streets.



Appendix F3: Develop and test interface

Memo

Title	Monitoring Data from DOSTE to AirQUIS
Purpose	NILU needs monitoring data from 2001. This data will be imported into the AirQUIS system. This document will describe a standard ascii input data format to AirQUIS.
Distribution	Mrs. Doan Thi Toi (DTT), Dr. Le Van Khoa (LVK), Mr. Vo Thanh Dam (VTD), Mr. Nguyen Bao Quoc (NBQ), Miss Nguyen Thi Tuyet Hoa, Mr. Bjarne Sivertsen (BS) and Mr. The Nguyen Thanh (TNT),
Author	TNT
Date	10 April 2002
Reference No	O-101143

Description of the Standard ASCII data format to AirQUIS

Station ID	Component	From Date	From Time	To Date	To Time	Value	Unit	QA	QC
1098	pm10	2001/10/08	10:00	2001/10/08	11:00	19.3	ug/m3	1	102
1098	pm10	2001/10/08	11:00	2001/10/08	12:00	16.7	ug/m3	1	102
1098	pm10	2001/10/08	12:00	2001/10/08	13:00	11.5	ug/m3	1	102
1098	pm10	2001/10/08	13:00	2001/10/08	14:00	16.3	ug/m3	1	102
1098	pm10	2001/10/08	14:00	2001/10/08	15:00	15.6	ug/m3	1	102
1098	pm10	2001/10/08	15:00	2001/10/08	16:00	20.2	ug/m3	1	102
1098	pm10	2001/10/08	16:00	2001/10/08	17:00	18.9	ug/m3	1	102
1098	pm10	2001/10/08	17:00	2001/10/08	18:00	18.8	ug/m3	1	102
1098	pm10	2001/10/08	18:00	2001/10/08	19:00	16.1	ug/m3	1	102

Please note

- The heading is only for your information. The content of the file should look like this:
  1098 pm10 2001/10/08 10:00 2001/10/08 11:00 19.3 ug/m3 1 102
  1098 pm10 2001/10/08 11:00 2001/10/08 12:00 11.5 ug/m3 1 102
  1098 pm10 2001/10/08 12:00 2001/10/08 13:00 16.3 ug/m3 1 102
  etc.

- The filename should consist of <StationID_Component_yyyy> . The extension is <ens> e.g. **1098_pm10_2001.ens**.

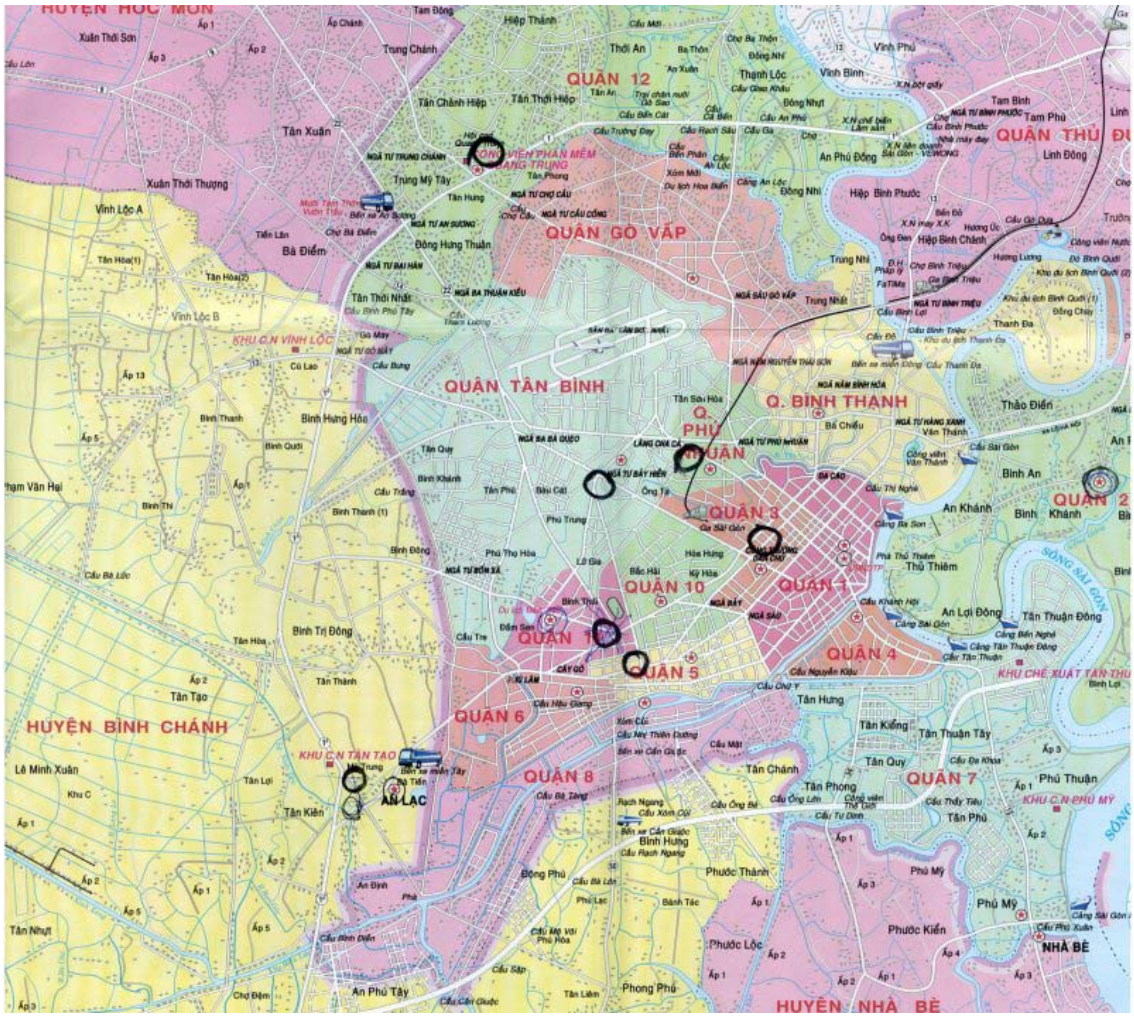
- The columns no. 9 (QA) and 10 (QC) may be left empty.

- The date format for the column no. 3 (From Date) and 5 (To Date) is yyyymmdd.
- The column no. 7 (Value) contains 1 hour average values.
- One file must only contain 1 station and 1 component.

Appendix G

Task7. Air Quality Modelling

Appendix G1: The city and sources



HCMC map with proposed air quality monitoring sites.

Appendix G2: Prepare input data – Traffic data

Memo

Title	**Air pollution and traffic in HCMC** -The ETAP approach
Purpose	To review traffic information prepared for HCMC, based on a Paper presented on the Regional workshop on "Transport Planning, Demand Management and Air Quality" 36-26 February 2002, Manila, Philippines
Distribution	BS, TNT, HEL
Author	Lars R Hole (review)
Date	16 April 2002
Reference No	O-101143

The paper upon which this memo is written was prepared by:
Fouzi Benkhelifa (Explicit-ADEME / France), Tran Quang Cu & Nguyen Le Truong (Enerteam – DOSTE of HCMC)

The report shows the transportation trends in HCMC and forecasts and several scenarios up to 2020. The two scenarios are basically the following:

1. "Business as usual" -No steps taken to improve the transportation situation.

2. "Improved public transport" –The government takes steps towards replacing much of the now individually based transport.

The main conclusion of the report is that HCMC will meet severe traffic problems in the near future if the authority does not take measures towards changing the populations transport preference from individually based transport to public transport.

Below, some of the most relevant numbers from the report are summarised.

Table 1:Characteristics of the public transport in HCMC and Hong Kong

	HCMC	Hong Kong
Population	5 millions	6 millions
Public transport trips/day	0.1 million	10 million
Individual cars / 1 000 persons	8	50
Massive rapid transit	Non-existent	Subway + suburban Network train

Table 2: Numbers from the reports on traffic forecasts in HCMC.

Year	Chart 15: HCMC – Forecasts of growth in motorcycle stock Trend scenario (x1000)	Chart 16: Car ownership forecasts for HCMC-Trend scenario. Cars per 1000 pop	Chart 17: Trend projection of the number of mechanised person trips in HCMC Per day (x1000)	From text: Average speed of cars in downtown area (km/h)
1996	1400	8	8250	14.8
2000	2400	10		
2005	3100	17	13650	8.7
2010	3750	20	16600	6.6
2020	4500	140	22150	4.7

Table 3: Vehicle distribution for two scenarios 2010 and 2020.

	Table 6: Projection of modal split trips (Minimum network). %		Table 7: Projection of modal split trips (Improved public transport). %.	
	2010	**2020**	**2010**	**2020**
Individual cars	3	6	3	4
Motorcycle	71	60	63	47
Bicycle	20	23	15	13
Public Transport	6	8	19	36
Total	100	100	100	100

Appendix H

Task8. Field Operations

Field operations

DOSTE field operators will be trained by NILU to undertake all operations, calibrations and maintenance. Standard operations procedures will be prepared; station logbooks as well as instrument logbooks will be developed and given to the operators.

Calibration and Maintenance

The supplier of instruments has been asked to provide concise and clearly written documentation in English language (or other language accepted by the costumer), which provides the following data:

a) Clearly written instructions for routine use and maintenance.
b) A specification of equipment performance characteristics and productivity.
c) Full health and safety information.

NILU instrument experts together with the DOSTE field operators will also follow up calibration procedures and maintenance. Hand-on training in instrument maintenance, field calibrations and some simple repairs will be undertaken by NILU experts during the three year of operation in the project period.

Multi point calibration

Equipment for calibration should be included in the deliveries. One proposal from DOSTE indicated that multipoint calibrators should be placed at each of the sites. This is NOT the way calibration and control of the monitoring programme is usually undertaken internationally..

A Reference Laboratory should be established in an early phase of the development of air quality monitoring systems. In HCMC it seems like this Reference Laboratory will have to be located at DOSTE and equipped with gas monitors to enable calibrations of gas standards. Expert personnel have to be trained to operate the monitors for calibration reasons. Personnel have to be prepared and trained to carry out systematic audits of the monitoring programmes."

Two point calibration units will be required at the shelters for performing weekly manual Zero/Span checks. The zero check shall be based on a zero air generator. The span check shall be based on a gas cylinder with "normal outdoor" concentration connected directly to the monitor without any dilution and without pressurising the monitor inlet. These two-point calibrators will be part of the delivery and installed in the shelters.

Multipoint calibrations and audits to the stations should be undertaken on an annual basis. In the original plan it was indicated that this function would be undertaken for DOSTE by Schmidt Vietnam. After discussions with SV and

DOSTE it has been agreed that NILU will establish the necessary expertise to operate the whole system at DOSTE. If necessary NILU could be contracted to perform Audits once a year in the future.

The Quality Assurance/Quality Control (QA/QC) systems may have to be upgraded as part of the NORAD development. Once every year the monitors should undergo a dynamic calibration and overhaul at the DOSTE Laboratory.

Checks and calibrations

There is an ongoing work in several working groups within the European standardisation organisation CEN that aims at standardising measurement methods. Working group 12 of Technical committee 264 is preparing standards for the measurement of NO_2, CO, SO_2 and O_3 respectively. The table below is an extract from the draft standard EN 14212, ambient air quality - Measurement method for the determination of the concentration of sulphur dioxide by ultraviolet fluorescence. Similar recommendations exist for the other measurement methods as well.

Recommended frequency of checks and calibrations

Checks and calibrations	Frequency	Action criteria
Regular maintenance of components of the analyser	As required by manufacturer	As required
Linearity	At least every year and after repair of the instrument	As required and when linearity ≥ 1 % of the measured value
Calibration and adjustment of the monitor	At least every 3 months	Zero : ≥ 5 ppb span : ± 3 % of span value

As can be seen from the table CEN recommends a calibration and adjustment of the monitor every three months and linearity check once a year. Calibration and adjustment includes only a two-point calibration where the monitor is adjusted at zero level and at a fixed span level. This is most easily done using a zero air generator and a span gas cylinder with "outdoor" concentration. The zero and span gas is fed directly to the monitor at ambient pressure. On the other hand to determine the linearity of the monitor's response gas concentrations at multiple levels including the zero level are required (a dynamic calibration). This is achieved by mixing zero air from a zero air generator with high concentration gas from a gas cylinder to the required level. The mixing ratio is controlled by a calibrator/dilution unit.

Regular maintenance of the instruments is usually performed at the station during routine service visits. In addition to the regular maintenance NILU recommends a yearly overhaul where the instrument is examined, cleaned

and adjusted more thoroughly. The overhaul will typically take two to three days. Due to limited space at the station and to prevent the overhaul activities from disturbing the other instruments at the station the overhaul should be performed in the laboratory. In addition the overhaul usually requires spare parts, consumables and tools that is easier accessible in the laboratory then at the station. Before and after the yearly overhaul the monitor should undergo a linearity check to document the response after the last measurement period and before the next period respectively.

The yearly linearity check as recommended by CEN and the yearly overhaul as recommended by NILU should be combined and performed at the same time in the laboratory. The linearity check requires a complete dilution/calibration unit. The three-monthly calibration of the monitor requires only two gas concentrations, zero and a fixed span level and should be performed at the station. The two point calibration requires a zero air generator and a span gas cylinder containing a fixed “outdoor” concentration.

Appendix I

Task9. Data interpretations

Appendix I2a: Use of Meteorological data

Memo

Title	**Evaluation of Meteorological data**
Purpose	To inspect the quality of the measurements and to produce wind frequency distributions.
Distribution	Dr. Le Van Khoa (LVK), Mr. Vo Thanh Dam (VTD), Thamh Nguyen The TNT, Leif Marsteen (LM), Rolf Dreiem (RD), LRH
Author	Bjarne Sivertsen and Lars R Hole
Date	23 April 2002
Reference No	O-101143

Introduction

The meteorological data collected at the 30 m tower at Doste are not correct. Lacking of training in the interpretation of data as well as malfunctions in the sensors or in the calibration factors has lead to a database that at present not can be used.

The sensors have to be checked again and the data retrieval and quality control of these data will have to be upgraded. We also believe that there are parameters collected especially by the Gill sonic anemometer that are not recorded and entered into the database. One example is turbulence, or st. d. in wind speeds in three dimensions, which are important input parameters for modelling. Also net radiation data can be used for this purpose, as input data to a met. preprocessor. These data experience fatal errors from about October 2001.

Wind data

We were told that the wind direction sensors were installed 180 degree out of alignment. This should have been corrected, but we could not find any evidence for this.

By looking at the raw data and performing a simple analysis of the wind direction frequency distribution (the wind rose) we see that there are major errors in the wind direction recordings. Figure 1 indicates that almost all recordings show wind direction less than 50 degrees (from north east), and there are no data above 120 degrees. This is of course impossible. If we compare these data with the expected annual wind direction distribution in Figure 1, taken from measurements at Tan Son Hoa, we see that the expected prevailing wind should be from around south-southeast.

It does not seem to be a simple correction factor in the data either. The conclusions are therefore that the wind sensors and the data transmission from the meteorological tower will have to be adjusted and corrected again.

As part of the training needs evaluated in Appendix K1, it is proposed that these corrections will be undertaken in the same mission as meteorological training is given at DOSTE.

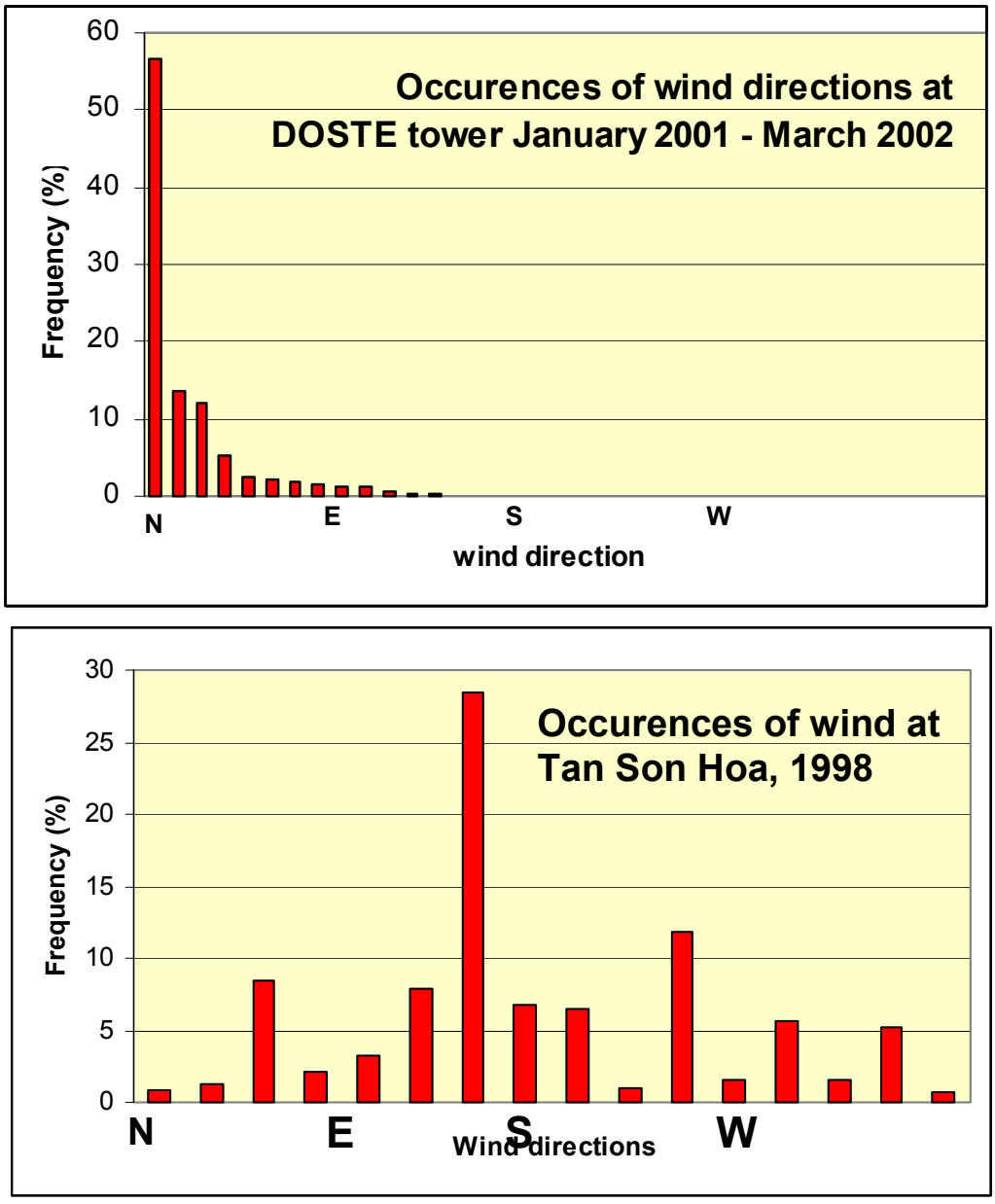
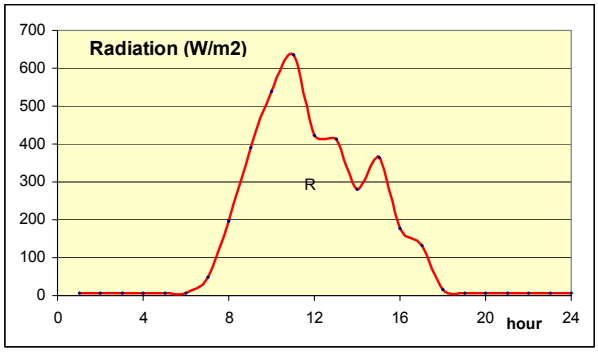


Figure 1: Wind direction frequency distribution based on measurements at DOSTE and at Tan Son Hoa.

Radiation data

a)



b)

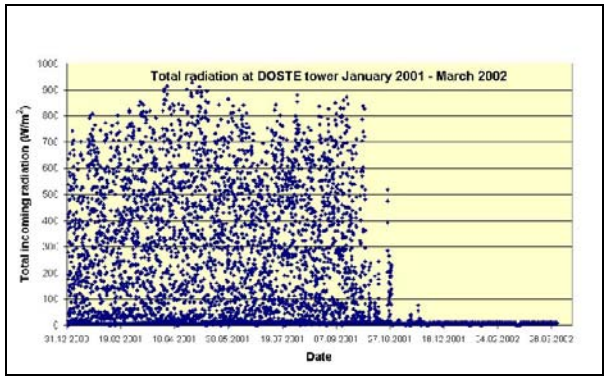


Figure 2: Global radiation measurements. a) Typical diurnal variation .b) Hourly records of global radiation from 1 January 2002 till March 2002.

The analyses of measurements of global radiation at the DOSTE tower reveals that something happened with the data at the end of October 2002. Figure 2 a show the expected range of radiation measurements throughout one day. The example is from January 2002.

These data will also have to be checked and corrected when the meteorological station is being serviced in August-September 2002.

Appendix I4a: Reporting AQ

Air Quality
Ambient Air Quality Standards

A summary of the Vietnam standard TCVN 5937 – 1995 is presented below:

1. Scope

1.1 This standard specifies concentration of main constituents in ambient air (carbon monoxide, nitrogen dioxide, sulphur dioxide, lead particulate, suspended particles).
1.2 This standard applies to evaluation of ambient air quality and to monitoring of air pollution status.

2. Limitation values

The limits of main parameters in ambient air are shown in Table 1.

Table 1 – Ambient air quality standards (all values are mg/m^3)

No	Parameter	1 hr average	8 hr average	24 hr average
1	CO	40	10	5
2	NO_2	0.4	-	0.1
3	SO_2	0.5	-	0.3
4	Lead (particulate)	-	-	0.005
5	O_3	0.2	-	0.06
6	Suspended particulate matter	0.3	-	0.2

Note:
Standard methods of analysis of ambient air quality parameters are specified in available current TCVNs

I4b:

Monthly report from the AQ network in HCMC

January 2002

The network consists of four measuring stations.

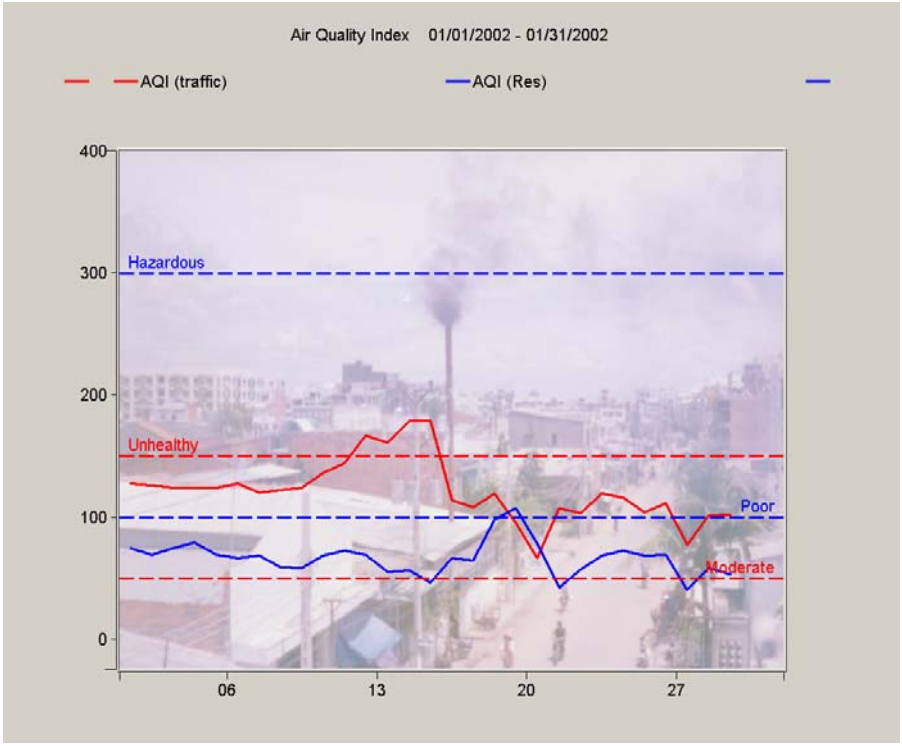
Station	Address	Type	Parameters	Remarks
DOSTE	244 Dien Bien Phu, District 3	Traffic	NO, NO_2, SO_2, CO, O_3, PM_{10}	
Hong Bang	132 ,Hung Vuong, District 5	Traffic	NO, NO_2, CO, O_3, PM_{10}	
Tan Son Hoa	56 Truong Quoc Dung, Phu Nhuan	Residential	NO, NO_2, SO_2, CO, O_3, PM_{10}	
Thu Duc	184 Tagore, Lang Dai Hoc, Thu Duc	Industrial	NO, NO_2, SO_2, PM_{10}	

Statistical parameters compared to VN standards.

Parameter	Stat.	DOSTE	Hong Bang	Tan Son Hoa	Thu Duc	VN Standard
NO ($\mu g/m^3$)	Average	**52.22**	**21.61**	**5.44**	**15.54**	
	98-percentile	117.43	59.71	31.89	61.84	
	Max. hour	133.91	85.44	458.80	158.30	
	Max. day	70.3	31.4	82.6	35.8	
NO_2 ($\mu g/m^3$)	Average	**71.26**	**55.26**	**18.22**	**27.73**	100
	98-percentile	162.68	109.95	57.99	58.68	
	Max. hour	425.91	145.75	141.29	73.33	400
	Max. day	102.2	73	38.7	42	100
SO_2 ($\mu g/m^3$)	Average	**59.34**	**N/A**	**45.63**	**38.27**	300
	98-percentile	148.54	N/A	130.73	105.03	
	Max. hour	226.01	N/A	203.25	159.84	500
	Max. day	81.1	N/A	99.0	58	300
O3 ($\mu g/m^3$)	Average	**34.38**	**29.09**	**56.31**	**N/A**	60
	98-percentile	122.73	104.12	163.73	N/A	
	Max. hour	158.78	131.96	205.41	N/A	200
	Max. day	53.9	48	77.6	N/A	60
CO (mg/m^3)	Average	**5.45**	**7.26**	**1.48**	**N/A**	5
	98-percentile	14.69	12.86	3.61	N/A	
	Max. hour	21.48	14.40	4.70	N/A	40
	Max. day	7.5	12.9	2.7	N/A	5
PM_{10} ($\mu g/m^3$)	Average	**94.29**	**121.17**	**88.64**	**133.34**	160
	Max. day	223.40	122.50	121.50	231.70	160 *)

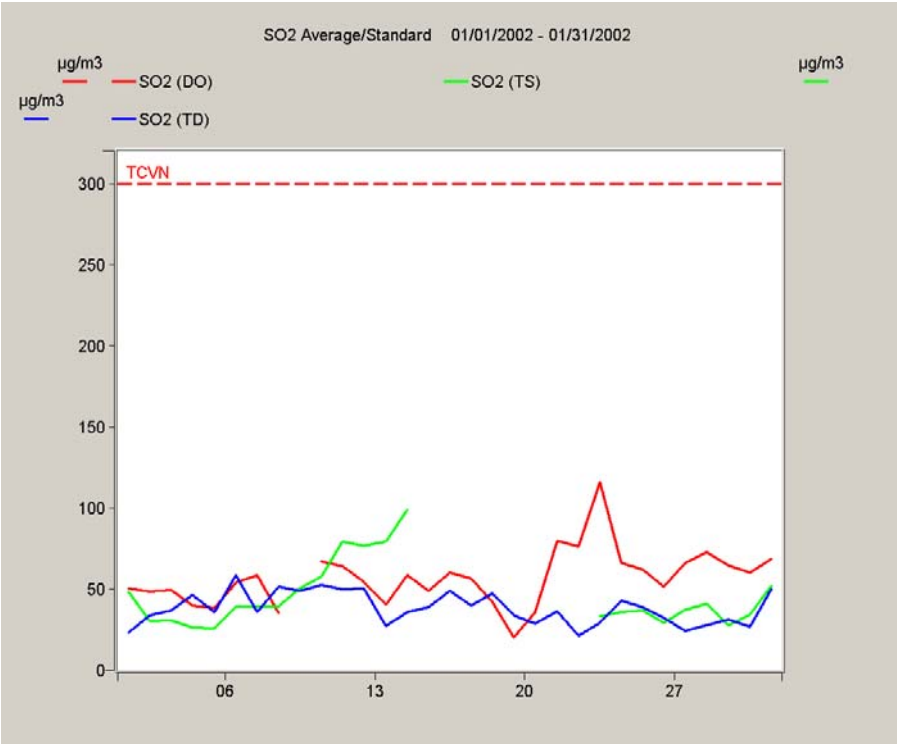
*) The value is derived by multiplying the standard for SPM with 0.8.
Values collected from the PM10 analysers for this period were not valid due to technical difficulties.
Graphs to be included.

1. Daily AQI for January 2002

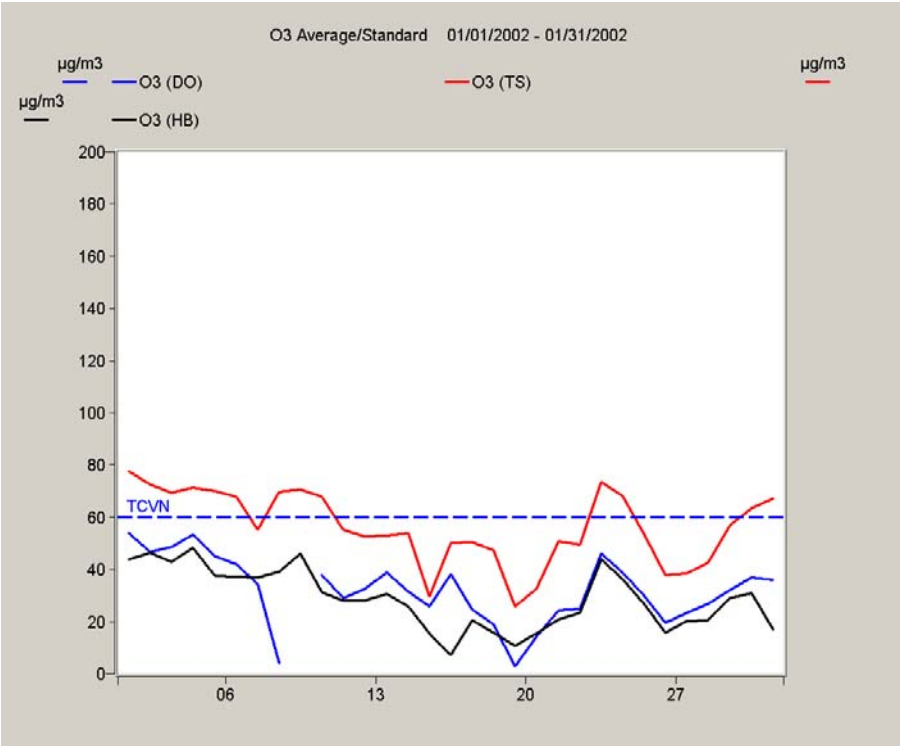


2. NO_2 Average / Standards for January 2002

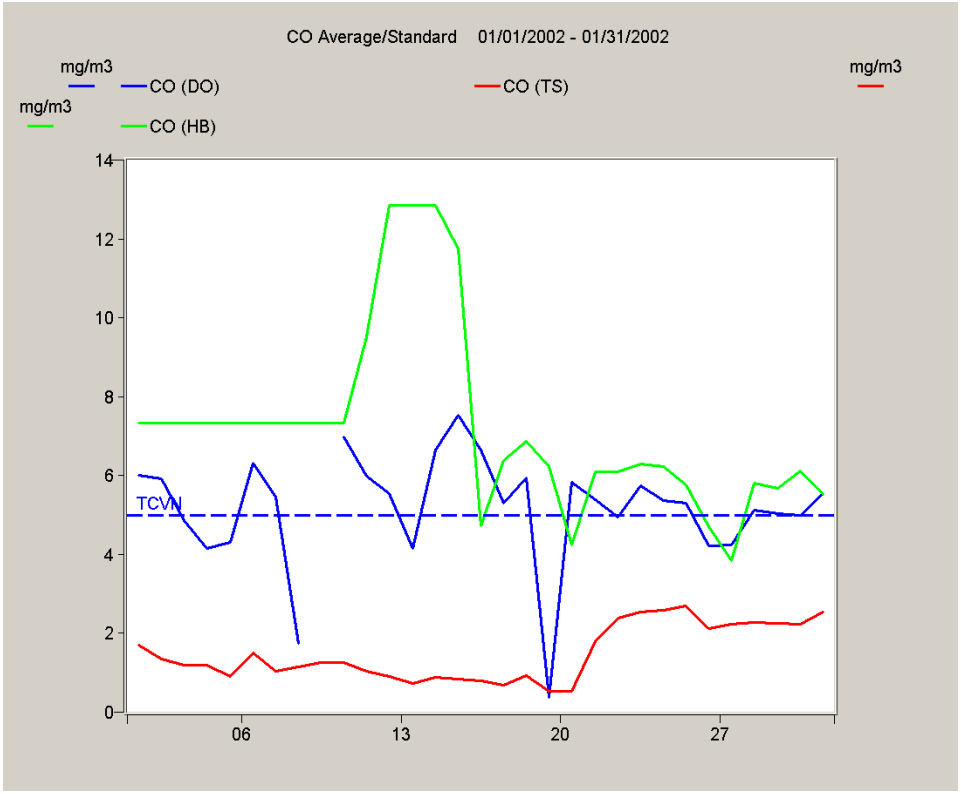
3. SO_2 Average/ Standards for January 2002



4. O_3 Average/ Standards for January 2002



5. CO Average/ Standards for January 2002



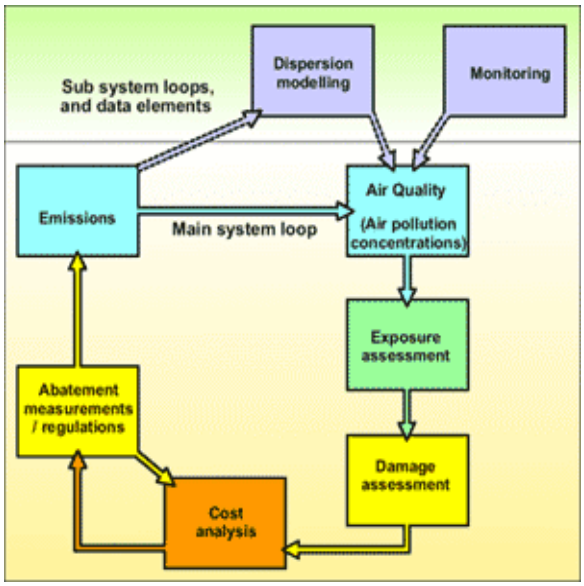
Appendix J

Task10. Air Quality Assessment

The basic concept for an Air Quality Management Strategy (AQMS) contains the following main components:

- Air Quality Assessment
- Environmental Damage Assessment
- Abatement Options Assessment*
- Cost Benefit Analysis or Cost Effectiveness Analysis
- Abatement Measures
- Optimum Control Strategy

The Air Quality Assessment, Environmental Damage Assessment and Abatement Options Assessment provide input to the Cost Benefit or Cost Effectiveness Analysis, which is also based on established Air Quality Objectives (i.e. guidelines, standards) and Economic Objectives (i.e. reduction of damage costs). The final result of this analysis is Optimum Control Strategy.



The modelling concept of an Air Quality Management Strategy system

NILU has performed several AQMS studies. One major effort was the World Bank supported investigation for Djakarta, Bombay, Manila and Kathmandu. The air quality management programme of this kind requires continuing activities on the urban scale in the following fields:

- Inventorying of air pollution activities and emissions
- Monitoring of air pollution and dispersion parameters
- Calculation of air pollution concentrations, by dispersion models
- Inventorying of population, materials and urban development
- Calculation of the effect of abatement/control measures
- Establishing/improving air pollution regulations
- The software system ENSIS/AirQUIS has been designed to support the necessary data and modelling needed as a basis for performing a modern AQMS.

Appendix K

Task11. Capacity building

Memo

INT/99/R11 Fund for Danish Consultancy Services, Equipment and Supplies, UNOPS Case file 98 Vie 1196

Air Quality Training Follow up

Introduction

The aims for project VIE 96/023 are to improve the institutional capacity of Ho Chi Minh City based agencies to manage the impacts of urban growth, and to gather, store and analyse the environmental data for management purposes by establishment of the air monitoring system. In addition to this, many other projects are being executed in the city to also support the broad aim of improving urban environmental quality.

NILU was requested by UNOPS as part of Mission 1 to HCMC to evaluate and assess the training needs by the institutions involved in air pollution monitoring and air quality management. This report briefly answers to the questions raised in the Terms of Reference given by UNOPS.

Objective

The aim of the training programme given as part of the establishment of an air quality monitoring and management system for HCMC is to enable DOSTE's staff to properly operate and maintain the instruments and equipment for air monitoring in HCMC, making the air quality monitoring sustainable and to perform an adequate air quality assessment as well as to undertake air quality management and planning.

Activities and output:

The following outputs has been described by UNOPS:

a) Review and assess the procedures for operation and maintenance of the air monitoring stations and the OPSIS equipment.
b) Review and assess the actual routines of DOSTE and Schmidt Vietnam (SV) for operation and maintenance of the air monitoring stations and the OPSIS equipment.
c) Identify discrepancies between a) and b) if any, and suggest changes to DOSTE/SV routines if necessary.
d) Identify the skills needed for properly operating and maintaining the equipment from DOSTE.
e) Identify the skills gap between the skills of DOSTE staff and the necessary skills identified in d).
f) Deliver training course with hands-on session according to the findings in d) and e).
g) Recommend further training needs for DOSTE's staff

h) Identify defects and faults concerning the instruments and equipment, if any, and report on these to DOSTE.

The analyses performed by the NILU expert team has been divided into three phases of the project:

- Operation and maintenance of instruments
- Data retrieval and databases,
- Air Quality Management

In all of these phases training needs have been identified based on a survey of present operations and on discussions and meeting with the teams involved in the present air quality monitoring programme.

For each of the phases recommendations have been presented to deliver adequate training to meet the requirement of the air quality monitoring and management programme developed in HCMC. Details concerning the review and assessment of the procedures applied presently can be found in the Mission 1 report from NILU.

Operation and maintenance of instruments

The Danida supported Phase 1 project has prepared Standard Operational Procedures (SOP) for the operations of the air quality instruments in HCMC. Mr Karsten Fuglesang at DK Teknik in Denmark prepared the QA/QC and SOP. These procedures seem relevant and are followed up by the DOSTE experts.

The day-by-day operations of the system seem to work adequately. A review of the operations including quality assurance and calibrations can be found in Mission 1 report. The main problem in the operational mode is the limited amount of training received at DOSTE in instrument maintenance, repair and calibrations. To improve on this part of the operations we have proposed a change in the system as presented below.

It was stressed in the discussions with DOSTE that the shared responsibilities between DOSTE and Schmidt Vietnam (SV) did NOT function properly. In the meetings with Schmidt Vietnam we were presented to a small group of experts, who did not have any long experience in operating air monitors. We have found out that SV is NOT the expert reference laboratory that we thought. They are merely an instrument provider trained by the instrument producer to perform simple maintenance during the warranty period and to undertake dynamic calibrations of the instruments. They are also supplier of spare parts.

During our project period SV has signed a letter of agreement to continue to undertake, as an instrument provider, repair and maintenance including spare parts free of charge during the warranty period. After and during installations of the instruments provided by NILU, supported by NORAD,

we will train DOSTE to undertake maintenance and repair. They will also receive training from API (the instrument manufacturer) in HCMC. They will receive training on the PM_{10} monitor at NILU and we also have received an offer from Andersen (Instrument manufacturer) for a 2-day course in Germany (this will be considered later).

To meet the future requirements of quality assured air quality data in the future our proposal will be:
DOSTE experts will receive training in operations, maintenance and repair. DOSTE further wants to strengthen their capability in operating the air quality monitoring system. They will also have to undertake dynamic calibrations. They have a calibrator that has not been used. So far SV have done the dynamic calibration with a calibrator, which belongs to SV, with inadequate and delayed feedback to DOSTE. This is not acceptable.

A reference laboratory, which has been indicated in the project documents, might have to be found in the future. We do not believe that SV presently is the right institution for this. We have thus proposed that the calibrator that DOSTE have received will be placed in a repair and calibration room at DOSTE. Annual instrument maintenance and calibrations will thus be undertaken by DOSTE from this laboratory. This will require training, which will be given by the instrument suppliers and by NILU experts.

The meteorological tower measurements do not function. The malfunctions have to be corrected, re-calibrations of the parameters have to be undertaken by the providers of these instruments, and the DOSTE team need training in the operation and presentation as well as application of the meteorological data, which are important for explaining air quality.

We suggest that a mission is planned in August/September with a joint effort from OPSIS/Instrumatic AS and NILU. The mission may combine meteorological data corrections and training and at the same time data retrieval training on the OPSIS system (see below).

Data retrieval and databases

We have identified a need for further training in the operation of the OPSIS retrieval system. The DOSTE experts expressed a need for training sessions covering installation and configuration of the OPSIS EnviMan ComVisioner system. The existing system was pre-installed and delivered by Instrumatic AS without any detailed training. The existing documentations are not enough to undertake necessary re-installations and modifications

DOSTE experts informed also that the PC at the computer centre is 2 years old and they are afraid that hard ware failures may occur soon. This PC will also be extended with 5 new licenses for the new stations. We have thus proposed that a new PC is purchased as soon as possible as part of the

NORAD funded project. The new computers will serve as a server and clients for the AirQUIS air quality management system.

As part of the installation of this new PC a joint training mission of NILU experts and OPSIS will be adequate. Presently this is proposed for August/September 2002.

Air quality management

The DOSTE project manager presented the following request for training linked to air quality management:

- Evaluate air quality and meteorological data,
- Report data and disseminate info to the public,
- Air Quality Management and strategy planning,
- Air quality forecast ability.

A large part of this training is part of NILU tasks in the NORAD funded project. However, it has been stressed several times from DOSTE that they believe the time set aside for from NILU experts is far too short. NILU also agrees in this statement and the matter was an important part of the contract negotiations in December 2001.

A presentation of the AirQUIS system and its applications will be given at NILU in February-March 2003. An intensive two-week training session will be given in the application of the GIS based planning tool. The use of AirQUIS as an air quality management system including abatement strategy planning and optimal abatement are important elements in the training in Norway. A selected small group of experts from DOSTE (2 persons paid by the project) will be invited to NILU.

DOSTE requested during Mission 1 that they wanted to send one additional expert to NILU for the purpose of training in the use of air pollution dispersion models. DOSTE have no experience in this field and again we have to stress that the original time for air quality data assessment and planning has been far too modest.

We will on request propose that the training period for DOSTE in the use of air quality data for planning purposes is extended by five man-weeks in HCMC. The training will be hand-on working together with the DOSTE experts in collecting input data, preparing meteorological data and performing modelling for planning purposes. The hand-on training will be undertaken over two separate periods. This work will start after March 2003.

Training schedules

Based on the analyses above we will propose the following training schedules:

No	Phase	Description	How	Where	When	Length days	Who
1	Operation and maintenance	Maintenance and repair of API monitors	Course	HCMC	June 2002	5	API (1)
2		Installation and dynamic calibrations	Hand-on	HCMC	Nov-Des 2002	5	NILU
3		Operation of PM_{10} monitors	Course	Germany	Mar 2003	2	Ander-sen (2)
4		Meteorological tower instruments checked and corrected		HCMC	Aug 2002	10	OPSIS? and NILU
5		Training in the use of meteorological data	Hand-on	HCMC	Aug 2002	5	OPSIS and NILU
6	Data retrieval and databases	OPSIS Enviman system	Course	HCMC	Aug 2002	2	OPSIS
7		OPSIS/AirQUIS interface training	Hand-on	HCMC	Aug 2002	2	NILU and OPSIS
8	Air Quality Management	Training course on dispersion models	Course	NILU	Mar 2003	14	NILU
9		Air quality management	Hand-on	HCMC	2003	40	NILU

(1) Five day course offered by API free of charge
(2) Two day course offered by Andersen free but travel and accommodation have to be paid

Cost estimate

A preliminary cost estimate is indicate in the following table:

Item	Description		Man-	Accomod	Fees	Reimburs
			hours	days	USD	USD
1	Maintenance and repair of API monitors				free	
2	Installation and dynamic calibrations	a)	40	7	4000	1120
3	Operation of PM_{10} monitors	b)		4	0	1440
4	Met tower checked and corrected		60	10	6000	1600
5	Training in the use of meteorlogical data		32	5	3200	800
6	OPSIS Enviman system		16	4	1600	640
7	OPSIS/AirQUIS interface training		16	4	1600	640
8	Training course on dispersion models	c)	40	14	4000	6040
9	Air quality management		200	35	20000	7500
	Total budget for additional training			**US$**	**40400**	**19780**

a) travel paid by NORAD

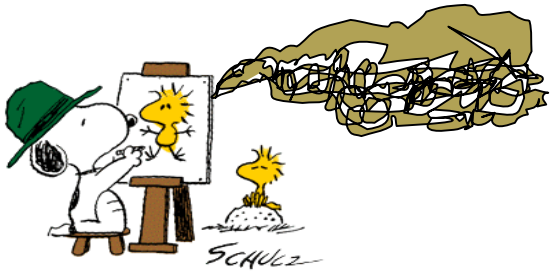
b) travel to Germany assumed from NILU

c) travel and accommodation for one DOSTE expert+ training fee for NILU

The total cost for the additional training identified in this report will thus amount to

US$ 60 180,-

Appendix K1a
Kick-off seminar Agenda and Schedules



Introduction to HCMC Air Quality Monitoring Component, NILU
Seminar 15 – 16 April 2002

Introduction

The seminar will represent an introduction to the air quality monitoring and management programme that will be established for DOSTE in Ho Ch iMinh City. The presentations will be based on a modern air quality monitoring and management system, which will form the basis for the developments, prepared by NILU and funded by NORAD. The basic platform to be used for air quality assessment and planning will be based on the Norwegian developed AirQUIS system.

The continuation of the development of an on-line monitoring programme for the most important air pollutants (Indicators) will be added to a model based air quality planning system.

The key features of the system is the integrated approach that enables the user in a user friendly way to not only access measured data quickly, but also use the data directly in the assessment and in the planning of actions. The demand of the integrated system to enable monitoring, forecasting and warning of pollution situations has been and will be increasing in the future. NILU has an extensive experience in the application of AirQUIS in several large urban areas worldwide.

Environmental data collected through the automatic monitoring and telemetric network will be quality controlled and transferred for storage in the integrated relational databases. Statistical programmes for control of

quality and representativeness will be used, and the first results can within one hour after field collection be presented using user-friendly graphical tools.

Air pollution dispersion models will be added to the system in HCMC to enable concentration estimates, evaluation of different source's relative importance to the total exposure, impact assessment and to perform optimal abatement planning.

Contents of the seminar

Below please find a list of some of the topics that will be presented during the seminar.

About NILU

AQMS Introduction

Monitoring Programme design

- Objectives
- Design the programme
- Site selection
- Indicators
- Selected Air Quality Indicators (AQI)
- Different instruments different prices

The Management platform

- AirQUIS system
- Introduction
- Demonstrations

Monitoring operations

- Data retrieval and QA/QC
- Data Quality Objectives
- Data retrieval and storage
- Data retrieval via telephone lines

Dispersion and meteorology

- Wind
- Turbulence
- Atmospheric stability

Dispersion models

- Different types of models
- Gaussian type models
- The EPISODE model
- Model applications

AirQUIS applications

- Presenting data
- Data dissemination
- Impacts assessment
- Abatement strategy planning

Schedule

Day 1

0900 Welcome address and opening of the seminar
0915 Presentation of NILU
0930 Introduction to the Air Quality Management System (AQMS)
1000 -Coffee break
1020 The complete air pollution management system
The platform-monitoring- models – exposure – databases – presentations
1130 Lunch
1330 Monitoring Programme Design
Objectives - Site studies – Indicators – Site characteristics - instruments
1430 The Air Quality Management platform
AirQUIS system - Demonstrations
1600 Comments and questions
End of day one

Day 2

0900 Monitoring operations
Data retrieval - QA/QC requirements
0945 Dispersion and meteorology
Wind – Turbulence –Stability
1000 Coffee break
1020 Dispersion models
Different- Gaussian models – EPISODE model – model applications
1130 Lunch
1330 AirQUIS applications
Presenting data – Impact assessment – Abatement planning - Forecasts
1530 Comments and questions
1600 Summary and end of seminar

The seminar has been designed for a maximum of 20 participants.

Appendix K1b: Seminar participants

PARTICIPATION LIST FOR SEMINAR
ON INTRODUCTION TO THE AIR QUALITY MONITORING AND MANAGEMENT PROGRAM
April 15 - 16, 2002

No.	Organization	Name of participant	Note
1	DOSTE	Dao Van Luong	
2	DOSTE	Le Van Khoa	
3	DOSTE	Ngo Thanh Duc	
4	DOSTE	Tran Ngoc Thanh	
5	DOSTE	Doan Thi Toi	
6	DOSTE	Nguyen Thi Tuyet Hoa	
7	DOSTE	Vo Thanh Dam	
8	DOSTE	Nguyen Bao Quoc	
9	DOSTE	Le Sanh Quoc Tuan	
10	DOSTE	Le Quang Dao	
11	DOSTE	Huynh Kim Tuoc	
12	UNDP Project Management Unit	Nguyen Khac Thanh	
13	UNDP Project Management Unit	Nguyen Thi Anh Nguyet	
14	Electrical Engineering School No. 2	Hoang Thien Kim	
15	Environmental Protection Center	Nguyen Quoc Binh	
16	Institute of Environment and Resources	Ho Minh Dung	
17	HCMC Environmental Improvement Unit	Nguyen Van Hien	
18	Chromatographic Development & Training Center	Nguyen Quoc Thai	
19	Energy Conservation Development & Research Center	Do Hoang Oanh	
20	Energy Conservation Development & Research Center	Tran Quang Cu	

Front page of NILU report (F 13/2002)

Ho Chi Minh City Environmental Improvement Project Air Quality Monitoring Component

Presentations at the kick-off seminar at DOSTE, HCMC 15-16 April 2002

Bjarne Sivertsen and Thanh Nguyen The

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ABSTRACT
A second phase of the Ho Chi Minh City Environmental Improvement Project, Air Quality Monitoring component (HEIA) is being supported by NORAD and will be undertaken by NILU. NILU will build on the existing system developed in HCMC by Danish institutions funded by Danida and will further develop and improve the monitoring programme as well as establish tools for performing air quality planning.

Mission 1 to HCMC aimed at performing an assessment of the existing stations prior to site studies for new stations. In addition the training needs have been discussed and is being reported in the Inception report. A kick off seminar was held, and tasks and responsibilities were discussed with our DOSTE counterparts.

NORWEGIAN TITLE

KEYWORDS		
Air quality monitoring	Air quality assessment	Vietnam

ABSTRACT (in Norwegian)

** Classification*
A Unclassified (can be ordered from NILU)
B Restricted distribution
C Classified (not to be distributed)