Department of Natural Resources and Environment (DONRE) Ho Chi Minh City

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Ho Chi Minh City Environmental Improvement Project
Air Quality Monitoring and Reference Laboratory

MR-3, Mission 7, Oct-Nov 2005; Reference and calibration laboratory, installations and training

NILU
Norwegian Institute for Air Research

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Ho Chi Minh City
Environmental Improvement Project
Air Quality Monitoring Component

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Ho Chi Minh City Environmental Improvement Project
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MR-3, Mission 7, Oct-Nov 2005; Reference and calibration laboratory, installations and training

Bjarne Sivertsen, Rolf Dreiem, Leif Marsteen,
Rune Ødegaard and The N. Thanh

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List of Abbreviations

ADACS	Automatic Data Acquisition System
AQI	Air Quality Index
CO	Carbon monoxide
CEN	European Committee for Standardisation
CLRTAP	Convention on Long Range Transport of Air Pollutants
DANIDA	Danish International Development Assistance
DONRE	Department of Natural Resources and Environment
DOSTE	Department of Science, Technology and Environment.
EDC	Environmental Data Centre at DONRE
EPU	Environmental Protection Unit
EQMA	Division of Environmental Quality, Monitoring and Assessment
GIS	Geographical Information System
HCMC	Ho Chi Minh City
HEIA	HCMC **E**nvironmental **I**mprovement Project **A**ir Quality Monitoring component
HEIP	HCMC **E**nvironmental **I**mprovement Project
ISO	International Organization for Standardization
NEA	National Environmental Agency
NILU	Norwegian Institute for Air Research
NO_2	Nitrogen dioxide
NORAD	Norwegian Agency for Development Cooperation
MPI	Ministry of Planning and Investment
PM_{10}	Particulate matter with diameter Less than 10 micrometer
$PM_{2,5}$	Particulate matter with diameter Less than 2,5 micrometer
PIU	Project Implementing Unit (PIU)
QA	Quality Assurance
QC	Quality Control
SO_2	Sulphur dioxide
SOP	Standard Operating Procedures
SVN	Schmidt Vietnam Co. Ltd

1 Air Quality Monitoring and Reference Laboratory

1.1 Introduction

On 16 November 2004 an extension of the project **H**o Chi Minh City **E**nvironmental **I**mprovement Project **A**ir Quality Monitoring component (HEIA) was signed between DONRE and NILU. The new project is named the Ho Chi Minh City Environmental Improvement Project; Air Quality Monitoring Component, Reference Laboratory and Training (HEIA-R). NORAD shall make payment for supplies and services provided under the new Contract.

This report was prepared after the third Mission of the HEIA-R project, which also represented Mission 7 of the total HEIA project. A first mission during the new phase of the NORAD project was paid to HCMC during 28 January to 4 February 2005. The second visit, which was Mission number 6 of the total project, took place from 1 May 2005 to 14 May 2005.

The tasks, which have been planned for Mission 7, are:

1. Install instruments and equipment in the new calibration and reference laboratory at HEPA.
2. Install new meteorological station for HEPA at DOSTE (Dien Bien Phu Str.)
3. Perform training in calibration and repair
4. Start the repair and maintenance procedures
5. Verify the quality of the collected data
6. Present and discuss 24-h average data
7. Update QA/QC procedures
8. Present new SOP procedures
9. Perform gap analysis of the existing data regarding improvement of the quality of data, data checking procedures at HEPA computer centre
10. Prepare and discuss reporting procedures of the air quality data together with the HEPA team
11. Upgrade the existing AirQUIS version, merge two versions
12. Check and upgrade AQI procedures
13. Improve emission data (point sources (positions), line sources (traffic count) and area sources (wards and population data)
14. Run model tests
15. Work shops and seminars

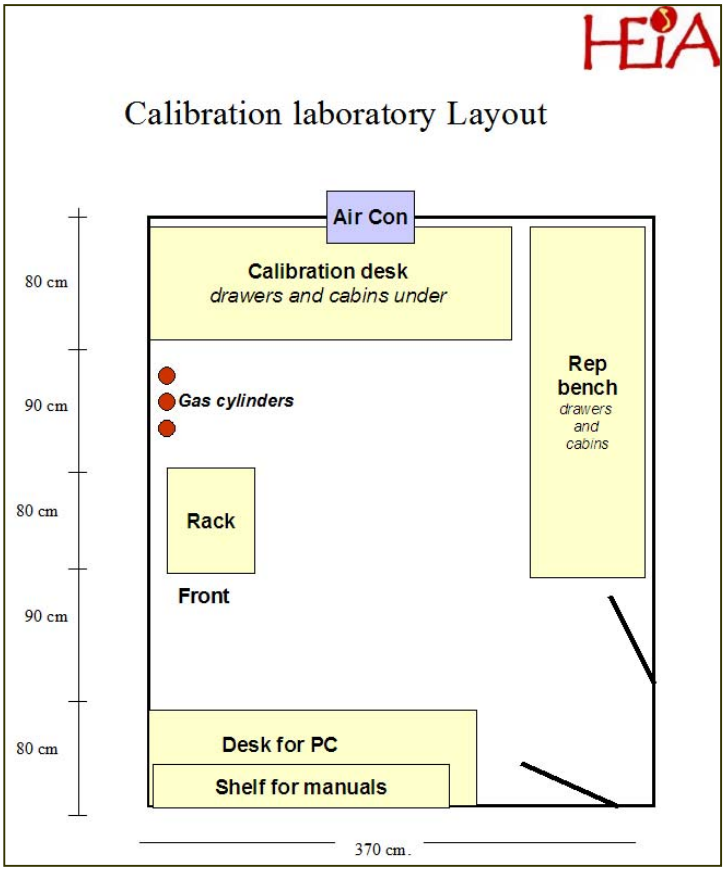
Several meeting with DONRE were held. The schedule for the Mission is presented in Appendix A.

2 Reference Laboratory design and update

2.1 Reference laboratory

The reference and calibration laboratory had been designed prior to the Mission in October 2005 (See NILU OR 58/2005). The first design was based upon information collected during visits to HCMC in January and in May 2005.

Specifications for instruments to be purchased for the reference laboratory had also been discussed. Specifications for the laboratory itself included originally the room size, which should be at least 3,2 x 6 m.
Also the instruments, shelves, place for instrument rack and calibration gases were included.



During September 2005 the final layout of the laboratory was finalized and agreed upon. The final drawing is presented on the figure above.

3 Procure and install Reference Laboratory

3.1 Procurement

The procurement of instruments for the reference laboratory was finalised in April 2005. NILU evaluated the content as well as prices and placed a new request at Industriell Måleteknikk in Norway. They also delivered all the instruments for the NORAD financed part of the monitoring system in HCMC.

NILU has obtained a compatible price from the Norwegian company and the order was placed at the end of April 2005. A complete list of the deliveries to DONRE/HEPA is presented in Appendix B.

3.2 Installations of instruments at Reference Laboratory

The laboratory room and facilities was finalised the day when we arrived in HCMC, on 25 October 2005. The next day the rack for calibration instruments was mounted on the floor. Further installations of the Zero Air compressor, Calibrator and NOx, SO_2, CO and ozone analysers in Rack were performed during the next day.

The gas regulators were installed on the primary gas cylinders even if the installations of furniture and air condition system in the same room made it difficult to concentrate on the instrumentation.

On 27 October the stainless steel tubing on primary gas cylinders were connected. After lunch the first calibration tests could start.

A quick test of the NOx, SO_2 and CO monitors were performed and the very first results of a multi point calibration performed at the reference laboratory at HEPA can be seen in Appendix F2.

3.3 A new meteorological station

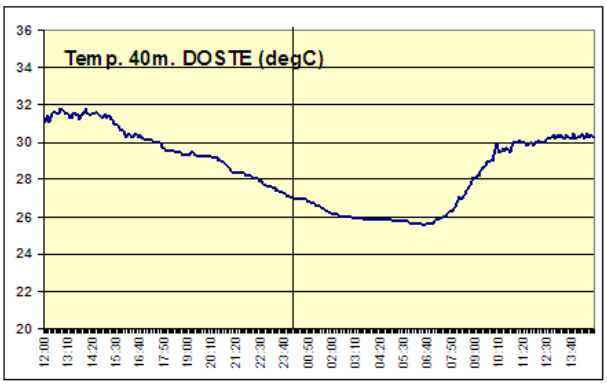
As part of the deliveries from NILU/NORAD a new meteorological station had been developed for installations in the mast at DOSTE.

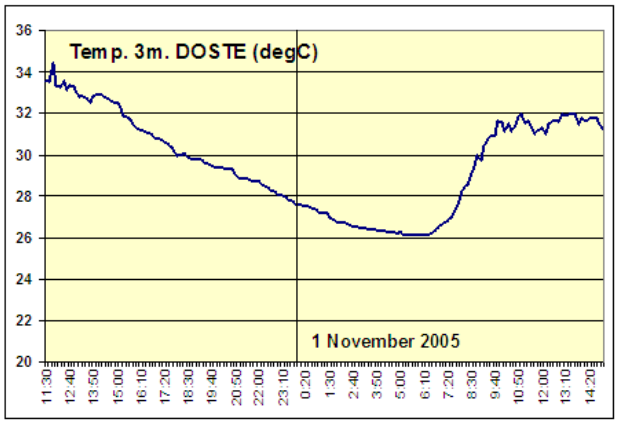
The existing weather station at DOSTE, installed during the DANIDA project, has never been operated adequately as stated in several Mission reports. Good quality meteorological data are necessary for performing air pollution modelling. HEPA and

NILU have thus agreed to use money from the budget to procure and install a new weather station at DOSTE.

The instrumentation of this station has been based on the new automatic weather station produced by Vaisala. It has been tested and prepared at NILU with the new NILU data logger and one additional temperature sensor for ground level measurements. NILU had made it complete with solar panel driven battery pack and blue tooth wireless connections.

Mast climbers took down the old meteorological sensors and cables on 2 November 2005. The new sensors were tested on the ground prior to the installation of the meteorological sensors, solar panel and data logger.





After installation the system was tested again and all sensors were working well. The lower temperature sensor was mounted on the shelter.

The first data were collected on a laptop computer. The temperature data were checked and the upper and lower temperatures compared. The data available from the new station is shown in the table below.

```
DATA    LOGGED  FROM    DATE:20050808   TIME:1355
        TO      DATE:20051101   TIME:1445
LIST    DATA    FROM    DATE:20051031   TIME:1200
        TO      DATE:20051101   TIME:1445

STOP    ON      FULL    PAGE    ?       N

SITE    :       VAISALA MET     HCMC
                        WS      WD      TU      RH      PP      Prec
2005.10.31      12:00   5       297     31.1    52.8    1005.4  0       100
2005.10.31      12:05   4.2     300     31.3    54.5    1005.4  0       100
2005.10.31      12:10   4.5     312     31.4    54.5    1005.3  0       100
2005.10.31      12:15   4       309     31.1    56      1005.3  0       100
2005.10.31      12:20   4       300     31.5    54.6    1005.2  0       100
2005.10.31      12:25   3.4     290     31.6    56.2    1005.1  0       100
2005.10.31      12:30   3.1     302     31.6    56.7    1005    0       100
2005.10.31      12:35   3.9     297     31.6    57.2    1004.9  0       100
2005.10.31      12:40   3.7     281     31.5    56.8    1004.8  0       100
2005.10.31      12:45   4.1     272     31.8    55.8    1004.8  0       100
2005.10.31      12:50   4.1     303     31.7    54.3    1004.7  0       100
2005.10.31      12:55   4.8     277     31.7    52.5    1004.7  0       100
2005.10.31      13:00   4       293     31.6    53.5    1004.6  0       100
2005.10.31      13:05   5.1     276     31.5    52.9    1004.5  0       100
2005.10.31      13:10   4.8     274     31.5    53      1004.4  0       100
```

4 Quality Assurance (QA/QC)

4.1 Design QA/QC and documentation materials

The establishment of the reference and maintenance/repair laboratory will ensure that the programme will sustain good quality. A detailed evaluation of the available data in the HEPA database, as well as the results of the Audit undertaken during Mission 6 clearly demonstrated the needs for a thorough evaluation and upgrading of the QA/QC system at HEPA.

4.2 Review of the existing system

Prior to the mission the quality system was reviewed and updated based on experience from operations so far and the introduction of the calibration laboratory. A structured quality system was developed and implemented including the following elements:

- A description of the quality organisation and responsibilities
- A description of the new reference laboratory and traceability in calibrations
- Detailed task schedules for each type of instrument
- Standard Operations Procedures (SOPs) on
    - Quality Control at stations
    - Quality Control at EDC
    - Operation of SO2 analysers
    - Operation of NOx analysers
    - Operation of CO analysers
    - Operation of O3 analysers
    - Operation of PM analysers
    - Calibration of instruments
    - How to perform a station audit

4.3 Quality control at data retrieval

All data are automatically entered into the AirQUIS database, where some automatic data control will delete obvious errors in the data. This will immediately improve the database that e.g. is being used to estimate the daily Air Quality Index.

Using the AirQUIS database time series should be printed every week. From these print outs data should be evaluated and controlled by going over them manually (“control by finger”) It is in some cases necessary to print some simple statistics in order to control the data.

The QC procedures using the AirQUIS measurement database are shown in Figure 4.3 below.

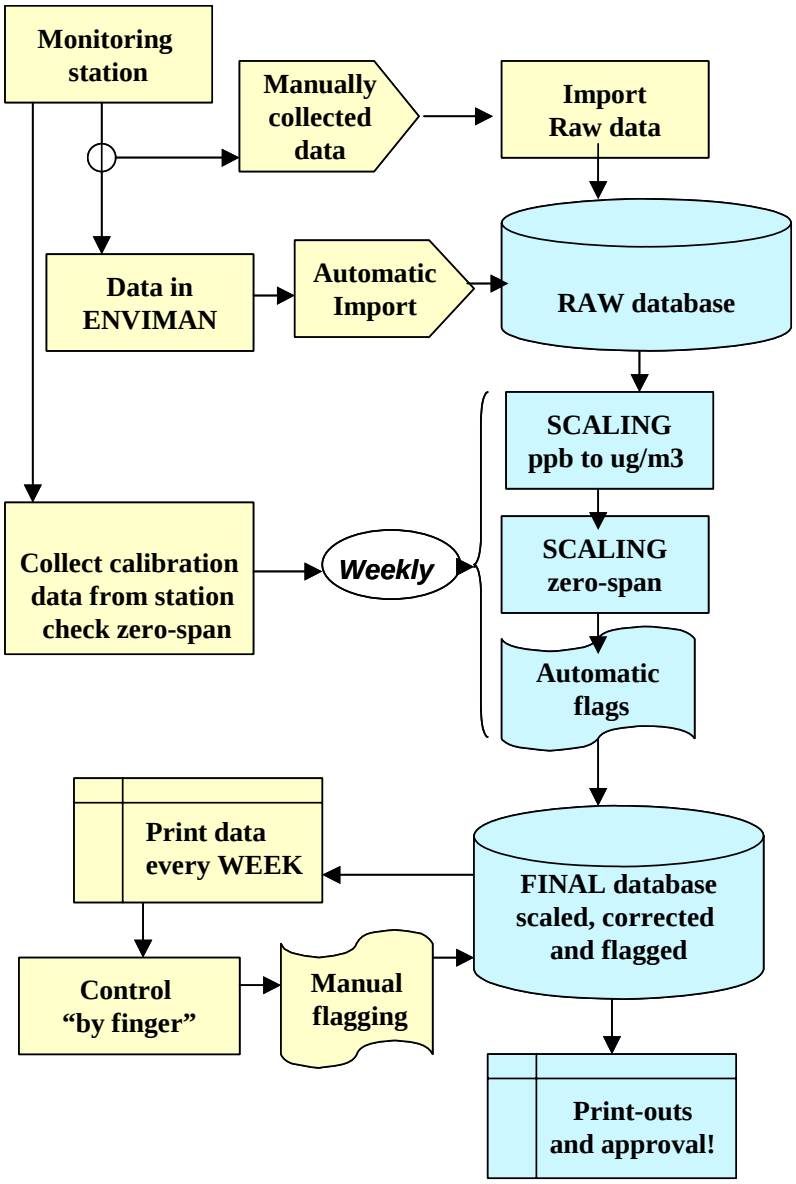


Figure 4.3: Procedures for quality control of data in AirQUIS.

Whenever errors or strange data are identified from the database, the field operators will have to be notified, so that errors in calibrations or in instrument performance can be checked and corrected as soon as possible.

4.4 Logbooks and manuals

The station manuals were distributed in the measurement network. The logbooks were established and will be kept in the reference lab. A binder including the complete quality system (The Quality Manual / Standard Operating Procedures) was handed over to HEPA together with an electronic copy of the same.

The following documents were prepared as part of these manuals:

- Log books on
    - Each measurement station
    - Each instrument in the network
    - Each instrument in the reference lab
    - Gas cylinders in the reference lab
- Station manuals for each station including SOPs and forms

The electronic copy was installed on the calibration lab computer. In addition to describing the quality system the Quality Manual is regarded as a template document from which copies are made for use in the network as necessary

Below is the table of contents of the Quality Manual:

4.5 The QA/QC system installed

During the mission the quality system was installed, made operable and ready for use. The QA/QC manual introduction is shown in Appendix C1.

There is one logbook for each of the analysers. The logbook for the NOx monitor is titled “API200” and on the inside covers the DOSTE identification number is marked (API-x) together with the instrument’s serial number. In this way, the logbook can always be tracked back to the right instrument. This is particularly important when instruments are returned from repair and/or when they are moved from one station to another.

The system consists of the following documents:

Documentation	**# docs.**	**Location**
The Quality Manual / Standard Operating Procedures Manual	1	Reference laboratory, EDC
SOPs on Data control	1	Reference laboratory, EDC
SOPs on reference laboratory	1	Reference laboratory, EDC
Equipment history log book, covering 31 field analyzers 4 RefLab analyzers 1 RefLab calibrator 3 RefLab gas cylinders	1	Reference laboratory, EDC
Station history log book, covering 9 stations	1	Reference laboratory, EDC
Station manuals, covering 9 stations	9	At measurement stations: DOSTE Hong Bang Thu duc Tan Son Hoa Thong Nhat Binh Chanh Zoo, District 2 Quang Trung

A yearly external audit of the air quality monitoring operation should be considered. The audit will evaluate the operations against international standards and help DOSTE in keeping a high level of data quality. NILU as The National reference laboratory for Air Quality in Norway has long experience in performing audits and does several audits in measurement networks in Norway every year. NILU is prepared to be the external auditor for the DOSTE network.

5 AirQUIS performance

AirQUIS was again updated and verified at HEPA during Mission 7. NILU is continuing to improve AirQUIS regarding stability, performance and features, and new releases of AirQUIS have been made available for HEPA during the whole HEIA project period.

5.1 Further development and testing

Air quality data will have to be corrected according to tests and corrections that have been undertaken at NILU.

The following subjects was carried-out during the Mission in November:

- Database management
- AirQUIS upgrade
- On the job training
    - Scaling and quality control of measurement data
    - Emission inventory and air quality dispersion modelling

5.2 Database Management:

One of the main purposes for the visit was to merge the Ho Chi Minh City air quality measurement database updated at NILU with HEPA's measurement database. This was undertaken by creating a new Oracle user and import the new “NILUs Oracle dump” file.

The new database did not include data from 1 of October to 7 of November 2005; therefore a manual import of this data was done, including scaling and unit conversion from ppb to ug/m3 and ppm to mg/m3.

The threshold values for Vietnam have been changed for 2005. Therefore the values in the database were updated as well. These values are applied in calculation of the air quality index.

Additional to this a clean up of the database was carried-out by deleting the existing table space and creating a new table space.

Procedures for how to create an AirQUIS database in Oracle were prepared prior to Mission 7. The procedures are presented in Appendix D1.

5.3 AirQUIS upgrade:

An upgraded and tailor made AirQUIS system for HCMC was installed on the server and 2 workstations. Scaling of measurement data as well as import and quality control of emission inventory data, including traffic and industry data, was done.

5.4 Automatic AQI generator in AirQUIS

The **daily reporting** of air quality in HCMC is done through the generating of an air quality index (AQI). The AQI procedures were re-evaluated and some slight changes and improvements were included in November 2005. The AQI procedures were then programmed into the AirQUIS system for automatic generation every day.

A more detailed description of the system is presented in Appendix D2.

6 Air Quality Modelling

6.1 Prepare input data

The input data to the model module of AirQUIS is still being collected and prepared. Emissions can be stored as field data sets for area sources, line and field data sets for road links and point data sets for point sources.

During Mission 7 in November 2005 all available sources were tested and installed into the new version of AirQUIS. As of 20 November there were:

- 118 Line sources and roads
- 125 stacks with a total of 70 industries
- An almost complete set of area sources for traffic emissions based on information on population distributions in the Wards of HCMC

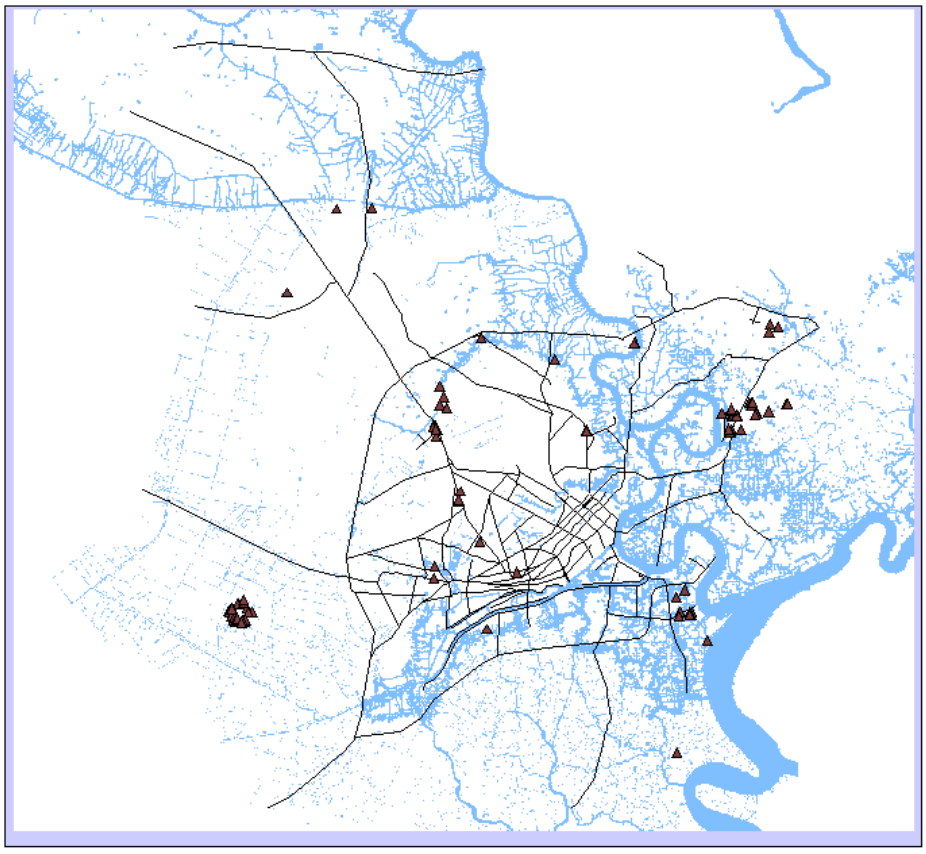


Figure 6.1: The emission inventory sources as of 20 November 2005.

6.1.1 Point sources

At the end of Mission 7 a total of 125 point sources had been installed in AirQUIS. These sources represented about 70 different industries in HCMC.

The co-ordinates and correct positions had been updated and correct positions are now available in AirQUIS.

6.1.2 Population distribution, area sources

Area source emissions have been estimated based on the population distribution in each of the Wards of HCMC. Estimated emissions of NOx is presented in the Figure 6.2 below based on an average emission factor for NOx from motor bikes of 0.3 g/km. Further studies are necessary to reach at a relevant emission factor for the motor bike park of HCMC.

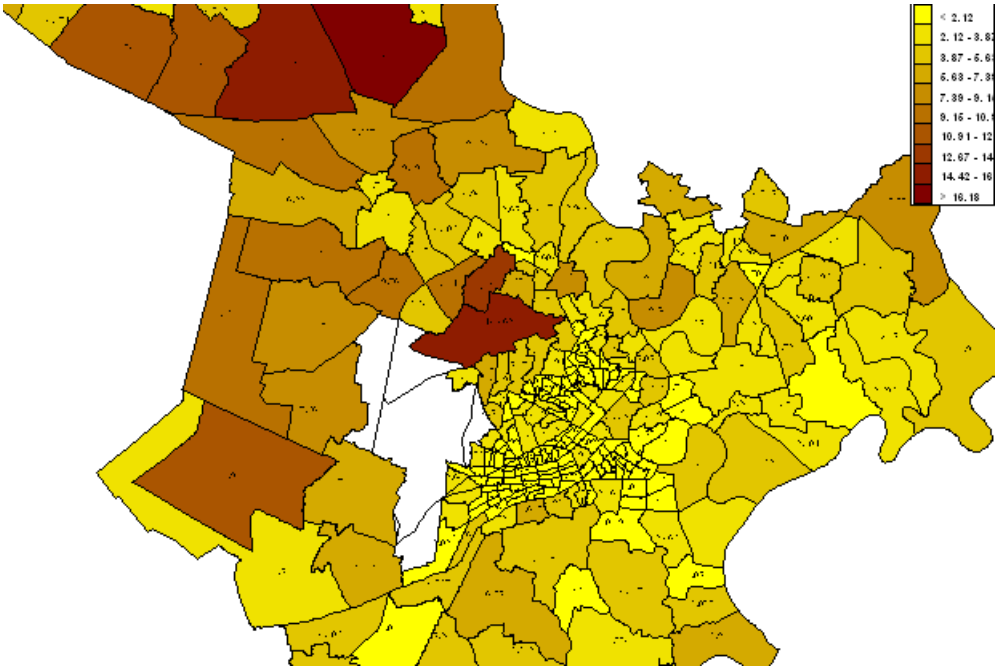


Figure 6.2: Total emissions of NOx from motorbikes in each Ward of HCMC. The numbers represents the rest emissions in the areas when the main streets have already been included as line sources.

6.1.3 Line sources and traffic emission data

All main line sources (major roads in HCMC) have been imported into AirQUIS. This represents a total of 118 line sources (main roads) distributed over the city as shown in Figure 6.1.

6.2 Meteorological data input

Meteorological data as input for the model test runs have been tested and selected. As a test period data for January 2005 was imported into AirQUIS models.

However, it seems that the stability parameter did not reflect the atmospheric conditions of HCMC well enough. Further studies will therefore have to be undertaken. More tests and verifications of the model performance will critically depend upon the input data.

6.3 Dispersion modelling

Some test runs have been performed using the AirQUIS models. Even if the input data have not been completed it has been interesting to evaluate the model performance in HCMC.

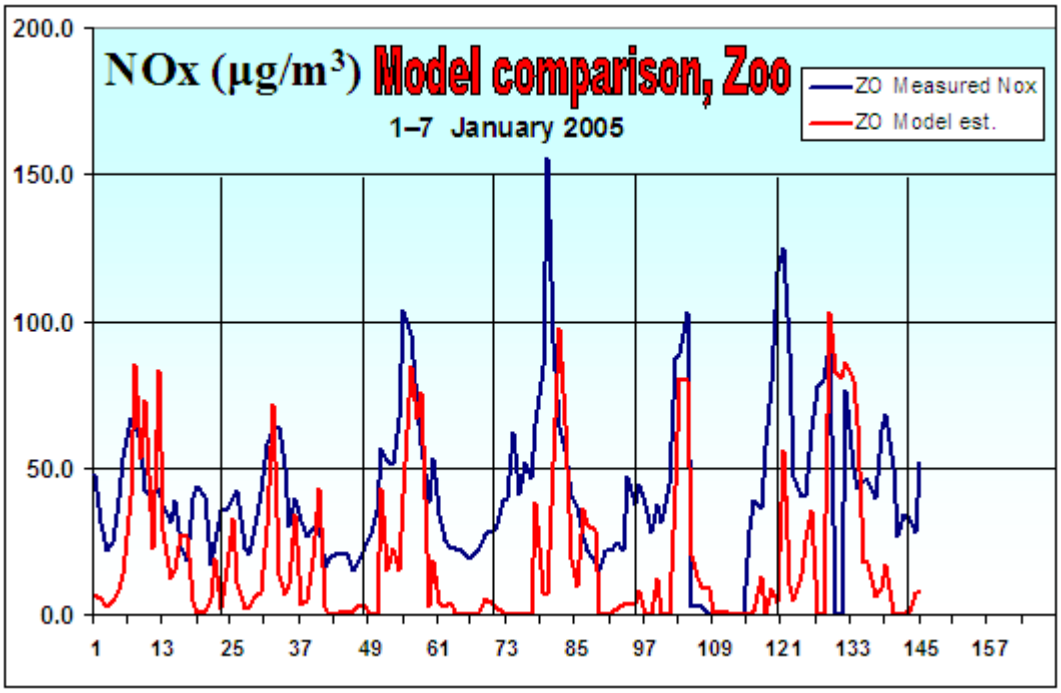


Figure 6.3: Comparisons between model estimates and measured NO_2 concentrations at the station Zoo in District 1, assuming that only the sources close to the site influence on the concentrations.

The model test run presented in Figure 6.3 is promising. However, we have excluded all sources more than about 3 km away from the receptor point. This means that the model still overestimate the ground level concentrations.

The models need considerable testing and modification before it may be called operational. We are still not satisfied with the situation regarding this issue, but we are working together with HEPA to solve the problem.

A memo on model verification work performed at NILU during the summer 2005 is presented in Appendix E.

7 Field Operations

7.1 Operational phase

Trained monitoring experts at HEPA have been undertaken field operations for several years now. Still there are details in the quality assurance programme and in the procedures that was improved during Mission 7.

7.2 Maintenance and service

As part of the establishment of the reference laboratory it is expected that the possibilities for instrument follow-ups, repairs and maintenance will be improved. Some instruments (from Danida) have now been operated for more than 5 years. The lifetime of some of these monitors are between 5 and 10 years. To keep up good quality data they need to be checked and maintained properly.

NILU normally recommends a yearly overhaul of the instruments. This will in the future be one of the tasks of the reference and calibration laboratory. The new laboratory installed in October-November 2005 will also act as a repair workshop. It will thus be important that the local experts follow up and keep track of available spare parts and of the status of the instruments.

7.3 Reference laboratory functions

The new reference laboratory will have to undertake advanced quality assurance and maintenance routines. Once every year the monitors should undergo a dynamic calibration and overhaul at the reference laboratory. Before the Mission a memo was presented to indicate some tasks and the NILU personnel used in the last phase of the project (See Appendix F1).

The field operations require that trained monitoring experts are visiting the stations every week. Other experts are being trained for using the data retrieval systems and the databases. QA/QC at all levels is an important issue that should be kept alive through regular Auditing of the system.

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.

The first tests of the instruments in the new calibration laboratory were performed at the end of October. The results are presented in Appendix F2.

7.4 Consumables and spare parts

As mentioned several times it will in the future be important to keep track of the spare parts and keep the storage updated. This may reduce the downtime of the instruments. Several spare part lists have been produced during the HEIA project. The last one presented to NILU before Mission 7 was dated August 2005. This list is shown in Appendix F3.

8 Seminars and workshops

Seminars and workshops had been prepared to improve the operational capacity and the Quality Assurance part of the air quality monitoring programme and also improve the capacity concerning air quality management and abatement strategy planning.

The following seminars and workshops were prepared during Mission 7:

- 17 November 2005: QA/QC seminar
- 18 November 2005; QA/QC work shop and hands-on training
- 23 November 2005; Final HEIA seminar with presentation of results
- 24 November 2005; Workshop and hands-on training using the AirQUIS system

In addition hand-on training was given to the staff at HEPA concerning the use of the calibration system. This training also included some maintenance and repair of instruments in addition to the procedures for dynamical calibrations of the monitors.

8.1 The QA/QC seminar, 17 November 2005

Training is a key issue in the development of the reference laboratory. This training included one seminar and a workshop in addition to hands-on training.

New procedures as well as updated Standard Operations Procedures (SOP) were developed during the Mission in November. The seminar presented the general background and the content of a complete quality assurance program. The programme for this seminar is presented in Appendix G1. Nine local experts participated in the seminar.

8.2 The final seminar on 23 November 2005

The large seminar held at DONRE on 23 November 2005 presented a summary of the air quality monitoring and management programme in Ho Chi Minh City. Dr Tuan at HEPA/DONRE introduced the programme, which has been developed, based on DANIDA and NORAD funds. The presentations were mainly based on the development and training performed by NILU and included background, monitoring system, calibration laboratory and air quality results.

The schedule for this seminar is presented in Appendix G2. Forty representatives from various institutions and governmental bodies participated in the seminar. A number of documents have been prepared as a result of these presentations. See; Sivertsen, 2005 b-d (NILU F59/2005, NILU F60/2005 and NILU F 61/2005).

8.3 Assessment and understanding air pollution

One part of the Seminar was dealing with air quality assessment and the understanding of atmospheric processes.

As part of the process it will be possible to evaluate the relative importance of the impact from selected sources or categories of sources. Also the comparisons between measured air pollution levels and the air quality limit values as presented by the Vietnamese authorities have been important.

The proposed limit values as given in TCVN-2005 is presented in the table below and compared with the Guidelines issued by the World Health Organisation.

Table 8.3: The WHO air quality guideline values as compared to the Vietnamese air quality standards proposed in 2005 (TCVN-2005)

llutant	Averaging Time	WHO (μg/m^3)	TCVN-2005 (μg/m^3)
SO_2	Annual Avg.	50	50
	24 Hours	125	125
	1 Hour	500 (10min)	-
CO	8 Hours	10 000	10 000
	1 Hour	30 000	30 000
NO_2	Annual Avg.	40	40
	24 Hours	-	-
	1 Hour	200	200
O_3	8 Hours	120	80 *(24 h)*
	1 Hour	-	120
PM10	Annual Avg.	20	50
	24 Hours	50	150
Pb	Annual	0.5	

The findings based on the measurements performed by HEPA can be briefly summarised as follows:

PM_{10} concentrations
Suspended particulate matter represents the largest problem in HCMC. The annual average PM_{10} limit values are exceeded at all measurement sites.
Daily average concentrations are also exceeded. The daily limit value given for Vietnam is relatively high. Even so we see that the 24-hour average concentrations are exceeded by more than 1 % of the time at the urban background stations.

NO_2 concentrations
Annual average NO_2 concentrations were only exceeded at the roadside stations in HCMC. The measurements performed by passive samplers indicated that the NO_2 concentrations sharply decrease with the distance from the street or road. Only about 50 m away from the street the concentrations are half the level measured at the street.

There is also a clear diurnal variation in NO_2 concentrations with peak values in the morning and late afternoon rush hour. It is also evident that the highly turbulent daytime boundary layer in HCMC efficiently dilutes the NOx emitted from cars at the surface.

Ozone concentrations
Ozone in the lower part of the atmosphere (in the troposphere) is one of the most wide spread global air pollution problem today. In and around urban areas, relatively large gradients of ozone can be observed. Near strong emission sources of NOx, where there is an abundance of NO, ozone is "scavenged" as it reacts with NO. As a result the ozone concentrations are often low in busy urban centres and higher in suburban and adjacent rural areas.

The highest ozone concentrations measured in the HCMC network is thus found at the regional background stations. Daytime hourly concentrations may easily exceed 200 µg/m^3 in the dry season. The daytime hourly concentrations inside the city and close to roads seldom exceeded 120 µg/m^3. The limit value of 120 µg/m^3 was exceeded about 4 % of the time from 1 January to 1 September 2005 at the sites District 2 and Zoo station.

CO concentrations
CO concentrations measured near roads and streets also show a clear diurnal variation with maxima during rush hours. The highest average CO concentration at BinhChanh, located near one of the main roads running out of HCMC, was 12.6 mg/m^3 in October 2005.
The eight hour average limit values were exceeded during a few days in 2004.

SO_2 concentrations
SO_2 is not a major air pollution problem in HCMC. None of the limit values have been exceeded for SO_2. Typical annual average concentrations are between 20 and 30 µg/m^3.

Air Quality Index (AQI) generated daily
Daily values of the Air Quality Index (AQI) have been established in AirQUIS based on the present and proposed air quality standards for Vietnam (TCVN 5937 – 1995 and TCVN 5937 – 2005).

The generated AQI values are being transferred every day to the information board near Binh Thanh marked in the city centre of HCMC.

The AQI estimated for the preceding day has also been prepared to present on an Internet page for HEPA. A test site was developed by NILU based on the measurement programme. This site was based on the AirOnline development at NILU and was shown to HEPA in September 2004.

The final evaluation of the automatic AQI generator in AirQUIS has been tested and evaluated and is now being presented on the HEPA web page:
www.hepa.gov.vn

8.4 AirQUIS and the use of models

Additional training was given in air pollution modelling and the use of AirQUIS for this purpose. To make the users able to fully understand the input data as well as the results from these model estimates, practical on-the job training was undertaken during Mission 7.

The method for scaling of measured data was carried-out by using the weekly updated span and zero values.

Import and quality control of emission inventory data, including traffic and industry data, was done.

Model calculations were carried out. The results from these calculation resulted in that more quality control of the emission data is required, additional to tuning of the dispersion model in AirQUIS.

A presentation of AirQUIS as the IT solution for HCMC was presented during the final seminar at DONRE. See NILU F 65/2005.

9 Meetings

Several meetings have been organised during the final phase of the HEIA and HEIA-R project. Project meetings have been part of the planning of the installations of the reference laboratory, meetings with DONRE concerned the cost specifications and planning of the seminars and other meeting were connected to visits and clarifications of various kinds.

9.1 Project meetings

Project meetings have been held at NILU to follow-up the project. Minutes of these meetings have been sent to HEPA/DONRE immediately after each meeting.

As part of Project Meeting number 12 held on 16 August 2005 tasks and time schedules for the further work in HCMC was presented (See Appendix H1). This included both the work needed to continue the second part of the HEIA project as well as some preparations needed to meet the requirements of the APPH project.

A considerable amount of time has been spent on data quality controls and corrections. To further improve this part of the data quality assessment it was decided that data would be forwarded to NILU every month. NILU experts have spent a considerable amount of time to evaluate the data and report back to the QA/QC officer at HEPA.

9.2 Meetings at DONRE

Several meetings were held at DONRE to discuss the status and cost specifications for approval of invoices. The payment schedule for the total 2005 budget of **2 044 463.- NOK** is linked to major milestones described in plans and Mission reports, until 10 November 2005. Payments, invoices and reports are indicated in the table below.

No	Indicator	Report	Invoice	Date	1000 NOK
1	Planning, design and training	MR1	25053	29 Apr 2005	134 549,08
2	Audit and training	MR2	25314	17Aug 2005	481 706,88
3	Equipment and field study	SR1	25643	25 Nov2005	857 009,00
4	Installation and training	MR3	25676	1 Dec 2005	413 537.08
5	Final seminars and reporting	MR4		31 Dec ?	157 197,96
	Total budget				**2044 000**

A cost specification presented for the invoice dated 17 August 2005 is presented as an example in Appendix H2.

The cost specifications follow the project contract cost estimate and are divided into fees, reimbursable and equipment included transport etc.

At the end of the year 2005 there will still be 157 197,- NOK remaining from the original budget. It was proposed from DONRE to use these remaining funds for additional training and a study tout to Norway.

It has not yet been decided whether NORAD will accept this proposal.

9.3 NORAD visits the laboratory

Mr Leif Landro from the NORAD office in Hanoi visited the reference and calibration laboratory on 9 November 2005. Dr Tuan of HEPA expressed thanks to NORAD that HEAP/DONRE has received the air quality monitoring and management system, including the nice laboratory, which had been installed during the last few weeks. He also mentioned the close co-operation with NILU, which had made the development a success.

A handout prepared for the NORAD visit is presented in Appendix H3. Mr Dam, head of the laboratory, presented the handout and told Mr Landro about the operations of the network and the support given to HEPA by NILU.

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Appendix A

Time schedules and personnel

Mission 7, October-November 2005

The NILU Mission to HCMC from 24 October to 25 November 2005 will mainly concentrate on establishing the Calibration and Reference laboratory at HEPA, upgrading the QA/QC systems, verify and finalise the AirQUIS database and give several seminars and workshops.

The tasks, which have been planned for Mission 7, are:

1. Install instruments and equipment in the new calibration and reference laboratory at HEPA.
2. Install new meteorological station for HEPA at DOSTE (Dien Bien Phu Str.)
3. Perform training in calibration and repair
4. Start the repair and maintenance procedures
5. Verify the quality of the collected data
6. Present and discuss 24-h average data
7. Update QA/QC procedures
8. Present new SOP procedures
9. Perform gap analysis of the existing data regarding improvement of the quality of data, data checking procedures at HEPA computer centre
10. Prepare and discuss reporting procedures of the air quality data together with the HEPA team
11. Upgrade the existing AirQUIS version, merge two versions
12. Check and upgrade AQI procedures
13. Improve emission data (point sources (positions), line sources (traffic count) and area sources (wards and population data)
14. Run model tests
15. Work shops and seminars
16. Meeting with DONRE

Daily schedules

Day	Hr.	Assignment	NILU	HEPA/ DONRE	Done
Mon 24Oct					
Tue 25	10:20	BS & RD arrive in HCMC	BS, RD		Ok
Wed 26	0900	Meeting at HEPA Start installation RefLab	BS, RD, RD	Dr. Tuan,VTD, NTH, LSQT, NTHD	ok
Thu 27	0900 1400	Install Ref lab Meeting with DONRE	RD BS	Air Group Dr. Tuan	ok
Fri 28		Install Ref lab Training at reflab	RD RD, BS	 EQMS	
Mon 31	0900	Install met sensors at DOSTE	RD, BS	NBQ, NTH	Ok
Tue 1 Nov		Install met sensors DOSTE	RD	Air Group	Ok
Wed 2		Check met data Training at maintenance lab	BS RD	Air Group	Ok
Thu 3		Data quality control and reporting	BS	VTD, DTMH	Ok
Fri 4		Air Quality and Health	BS	VTD, Dr. Tuan	Ok
	1655	Rune arriving HCMC			
Mon 7	0900	RuO arriving in HCMC Prepare AirQUIS work	RuO	VTD	Ok
Tue 8	0900	AirQUIS work Prepare data for reporting, Mission report	RuO BS	VTD, DTMH NTH	Ok

Appendix A1

Day	Hr.	Assignment	NILU	HEPA/ DONRE	Done
Wed 9		AirQUIS merging and training Met data analyses and tests	RuO, BS	VTD, DTMH NTH,	Ok
Thu 10		AirQUIS upgrade, merging and AQI	RuO	VTD, DTMH, NTH	Ok
Fri 11		Finalise AirQUIS and AQI work	RuO	VTD, DTMH, NTH	Ok
Mon 14		Leif arriving in HCMC	LM, BS		Ok
Tue 15		QA/QC work – upgrade SOP	LM, BS	VTD, AirGroup	Ok
Wed 16		**Seminar QA/QC meeting room?**	LM, BS	All +	Ok
Thu 17		**Work shop** and training HEPA personnel	LM	Dr. Tuan, VTD, HEPA exp	Ok
Fri 18		Ref lab procedures QA/QC, procedures	LM, BS	Air Group	Ok
Mon 21		TNT arriving in HCMC			
Tue 22		Prepare final reporting	BS, TNT	VTD ++	Ok
Wed 23		**Final seminar**; understanding Air Quality	BS, TNT	all	Ok
Thu 24		Work shops, according to needs Meeting DONRE	BS, TNT BS	Dr. Tuan, AirGroup	Ok
Fri 25		Final meetings Planning for future	BS, TNT	Dr. Tuan, AirGroup	Ok

The staff

DONRE/HEPA	
Nguyen Dinh Tuan (NDT)	Director of HEPA
Le Van Khoa (LVK),	Project Manager HEPA/DONRE
Vo Thanh Dam (VTD),	Division of Environmental Quality, Monitoring and Assessment (EQMA) at HEPA, data expert
Nguyen Bao Quoc (NBQ),	Instrument expert, field operations
Nguyen Thanh Huy (NTH)	QA/QC, field operations, instruments
Nguyen Toan Hung Dung (NTHD)	Instruments and monitors, repair
Miss Duong Thi Minh Hang (DTMH)	Emission data, modelling
DONRE	
Nguyen Van Chien	Deputy Director of DONRE
Nguyen Thi Tuyet Hoa (NTTH)	DONRE Secretary
NILU	
Bjarne Sivertsen (BS)	Project Manager
The Nguyen Thanh (TNT)	IT Manager, Computer expert
Rolf Dreiem (RD)	Instrument expert
Leif Marsteen (LM)	QA/QC expert
Rune Odegaard (RuO)	Computer and AirQUIS expert

Work notes from Rolf Dreiem
October - November 2005.

25 October 2005
Arrived HCMC at 10 am. Had a meeting at HEPA in the afternoon. Made plans for installation of Ref. Lab. We were assured that the Ref. Lab. room would be finished by the morning next day.

26 October 2005
Mounted Rack on the floor. Mounted Zero Air compressor, Calibrator and NOx, SO2, CO and O3 analysers in Rack.
Gas Regulators put on primary gas cylinders.
Furniture and air condition was mounted this day and made it difficult to work.

27 October 2005.
Connected stainless steel tubing on primary gas cylinders. Connected Teflon tubing from zero air generators to calibrator and from calibrator to all analysers. Started Ref. Lab Rack at lunchtime.
Started to generate calibration gases from calibrator. The system did not work at first. Had to open up tubing and flush with primary standard gas. Made a quick test of NOx, SO2 and CO monitors.
The results was 3-5 % more than generated from calibrator. Last calibration was at API factory. The result is according to expected performance. Did not find time to test the ozone generator and analyser.
Unpacked meteorological station and demonstrated the functionality.

28 October 2005
Started to test the O3 analyser. Generated 100 and 500 ppb of O3. The result was better than 8 % of expected value.

Calibrated the NOx analyser and made a multipoint calibration. Made a GPT (Gas Phase Titration) to calculate the efficiency of NO_2 converter. The multipoint calibration made a nice straight line and the converter efficiency is better than 99 %.

Summarised the function of the Ref. Lab. instruments to HEPA staff.
The mast climber came to inspect the new meteorological station. I explained in details how to mount the station on top of the mast. The plans were to install the Met. Station the following Monday morning.

31 October 2005.
Installed new excel work sheet on the Ref. Lab. computer. Brought Meteorological Station to DOSTE, including temperature on measurement on the shelter. The mast climbers took down the old meteorological sensors and cables. Tested the new sensors on the ground and explained to mast climbers how to assemble the station on top of the mast. The climbers mounted the meteorological sensors, solar panel and data

logger. The system was tested and worked well. Time was corrected to Vietnamese time. The lower temperature sensor was mounted on the shelter and worked well.

November 2005.
Instructed the staff how to use the new Excel sheet to calculate calibrations curves from the results we obtained from the meterological sensors on 28 Ox\ctober 2005.

This system is new and the local HEPA staffs were trained to perform the calculations. Training is also needed in the operations of the new met station.

I also started the CO multipoint calibrations and prepared the Excel calibration sheet. The result was good.

Installed Ecologg software on my computer and went to DOSTE to collect more data from the new station.
Downloaded data from meteorological tower and temperature sensor on the shelter.

5 November 2005.
Meteorological data from tower and shelter was given to B. Sivertsen.
Started NOx monitor. PMT is too high but is being reduced very slowly. Cannot wait so we started the SO_2 analyser to get more training in real multipoint calibration. The staff at Ref. Lab did all the work and needed just a few hints from me. This work was performing well.

Performed detailed inspections on an unstable SO_2 monitor. I performed factory calibration and this worked well but after a few minutes the analyser started to drift again. As a beginning I advised the team to try a new power supply to see if the drift goes away.
My mission to HCMC ended on 11 November 2005.

Rolf

Appendix B

Procure Reference laboratory equipment

AppB1

Ho Chi Minh City Environmental Improvement Project;
Air Quality Monitoring Component; Reference lab

Department of Natural Resources an d Environment (DONRE)
HCMC Environmental Protection Agency (HEPA)
The Norwegian Institute for Air Research (NILU)

Delivery list for HEIA-R project

Delivery list for HEIA-R project

Monitors	Unit price USD	Price USD	Price NOK		
API M100E, UV fluoresence SO2 monitor	9700	9700	63 050.0		
API M200E, chemiluminisence NO-NO2-NOx monitor	10250	10250	66 625.0		
API M400E, UV abs O3 monitor without ozone generator	7020	7020	45 630.0		
API M300E, Gas filter correlation CO monitor	9750	9750	63 375.0		
API M701 zero air generator with catalytic CO scrubber	4200	4200	27 300.0		
API M 700 multigas calibrator UV Photometer module	14950	14950	97 175.0		
RS232 Cable, 1,8 m	10	50	325.0		
RS232 Multi-Drop OK- 4 for E-series, 1 for A-series	200	1000	6 500.0		
Cable for 230 V, 50 Hz, 2 m, Norwegian type connector	6	36	234.0		
Rack mount for one unit with 26" or 24 " Chassis slides	200	200	1 300.0		
Rack mount for one unit, no slides, ears only	80	480	3 120.0		
Internal Ethernet Connection (only E series instruments)	250	250	1 625.0		
Ethernet Cable, 2 m (only E series instruments)	14	14	91.0		
Remote and local automatic leak check for M700	100	100	650.0		
Additional Manual	100	100	650.0		
		0	0.0		
Monitors total				58100	377 650.0
Rack	1100	1100	7 150.00		
Additional instruments	4710	4710	30 615.00		
3 xGas regulators (3x550)	550	1650	3 575.00		
Ultrasonic bath	1255	1255	8 157.50		
Gas sylinder CO	2198	2198	14 287.00		
Gas sylinder NO	2198	2198	14 287.00		
Gas sylinder SO2	2198	2198	14 287.00		
Toolbox	315	315	2 047.50		
Connectors cables	315	315	2 047.50		
Aircon + furnitures	3095	3095	20 117.50		
AirOnline licences	3000	3000	19 500.00		
Test and equipment produced at NILU			65 410.00		
Various equipment					201 481.00
HCMC Ref Lab - Equipment Costs					
Air Con	1 006.94	1 006.94	6 545.1		
PC, OS and 17" LCD	1 432.30	1 432.30	9 310.0		
Furniture	630.52	630.52	4 098.4		
Computer CD memory	25.25	25.25	164.1		
Total HCMC Ref Lab - Equipment Costs				3 095.0	20 117.6
				Total	*kr 599 248.57*

HoChoMinhCity
25 November 2005

Bjarne Sivertsen

Vo Thanh Dam

Tran Nguyen Hien

BS\HEIA\Delivery list

Appendix C

Quality Assurance (QA/QC)

AppC1

QA/QC manual introduction

Introduction

This manual has been written to serve as a general introduction to DONRE/HEPA's Air Quality Monitoring and Management 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.

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.

Objectives of the HCMC AQM network

The main objective of the HCMC AQM network is to provide reliable information to People's Committee and to the public about the air quality in Ho Chi Minh City. The data provided by the network will advise the preparation of an air quality management strategy to be implemented in HCMC in the future.

As a part of the air quality monitoring strategy, several objectives can be achieved, including:

- Establish source/receptor relationships;
- Identify which pollutants are of greatest concern and their current status;
- Show how widespread air pollution problems are and indicate the general extent of the public exposure;
- Provide benchmarks against which trends in overall air quality can be compared and devise performance indicators for assessing the impact of an air quality management plan or strategy;
- Provide a data base for evaluation of effects; of urban, land use, and transportation planning; of development and evaluation of abatement strategies; and of development and validation of atmospheric processes and models.

Another main objective in the monitoring and management programme is to provide input data for modelling. These data will serve as a background for performing air

quality planning and abatement studies in the future. Model results may also serve as input to other studies such as health related investigations and exposure assessments.

Data quality control objectives

Good data quality and high data capture are essential if the monitoring network is to achieve its objectives. To ensure that data are sufficiently accurate, reliable and comparable, consistent data quality control procedures are to be applied throughout the network in HCMC.

Good QC practice covers most aspects of network operation, including equipment evaluation, site operation, maintenance and calibration, data review and ratification. The successful implementation of each component of the QC scheme is essential for the success of the programme.

The fundamental aims of a quality control programme are as follows:

a. The data obtained from measurement systems should be representative of ambient concentrations existing in each urban area.
b. Measurements must be accurate, precise and traceable.
c. Data must be comparable and reproducible. Results from this geographically extended network must be internally consistent and comparable with international and other accepted standards.
d. Results must be consistent over time.
e. In order for seasonally or annually averaged measurements to be meaningful, an appropriate level of data capture is required throughout the year.

Essential requirements for conformity are the following quality assurance (QA) aspects -

- Measurement methods used must be of known performance and defined scope of application;
- All calibrations must be traceable through an unbroken chain to international standards (the SI system);
- On a long term, measurements should be made within a documented quality system.

The Air Quality Monitoring programme fulfils the QA aspects regarding the measurement methods, as the instrument principles used are all in accordance with ISO, EN and US standards. Trace ability is ensured through the use of traceable gas calibration standards. For particulate matter, regular inter comparison between the PM10 measured by means of beta ray absorption and PM10 measured by means of gravimetrical analysis can ensure a high data quality and comparability.

A documented quality system is an essential part of quality assurance. Documenting procedures is, in itself, insufficient to ensure good practice. Training should be given to the local site operators in QC procedures. This training must ensure that the site operators are experienced with the monitoring techniques involved and with the network procedures required to maintain a high standard of performance.

Furthermore, audits should be performed from at least annually to ensure that QC procedures are followed in practice.

Scope of the operating manual

In any air quality monitoring network, particularly one with devolved functions, it is vital that the responsibilities of all participants are well known. Documentation should describe specific operating and maintenance procedures, which are designed to ensure high data quality and network efficiency.

Specific issues addressed in this operating manual include trace ability, maintenance and calibration schedules, routine quality control procedures at the monitoring stations and at the EDC. The procedures for the individual monitoring instruments are described in separate SOP's. These SOP's describes how to handle the instruments under the conditions given, and they are to be seen as a supplement to the manuals delivered by the manufacturer of the instruments. It is recommended that the procedures are evaluated and supplemented continuously as more experience is gained.

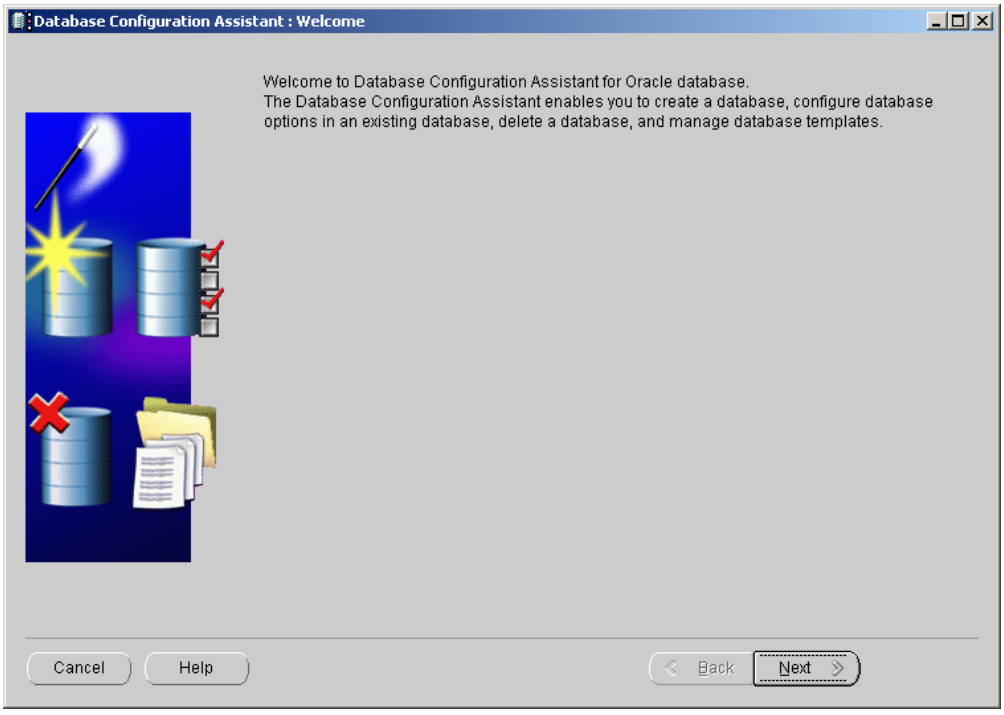
Appendix D

AirQUIS Performance

Project Name	
Project No	
Customer	HEPA
Title	How to create AirQUIS database on Oracle database
Creator	The Nguyen Thanh & Rune Ødegård
Date	13 July 2005

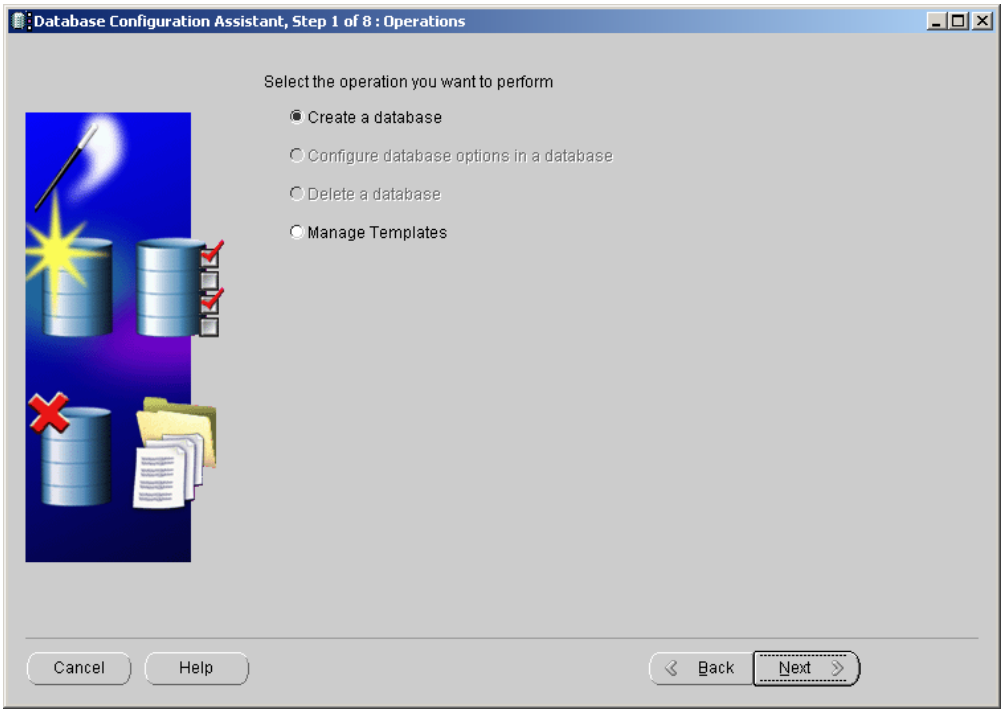
Start the program ’Database Configuration Assistant’.

Start -> Programs -> ORACLE-OraHome92 -> Configuration And Migration Tool ->
’Database Configuration Assistant’

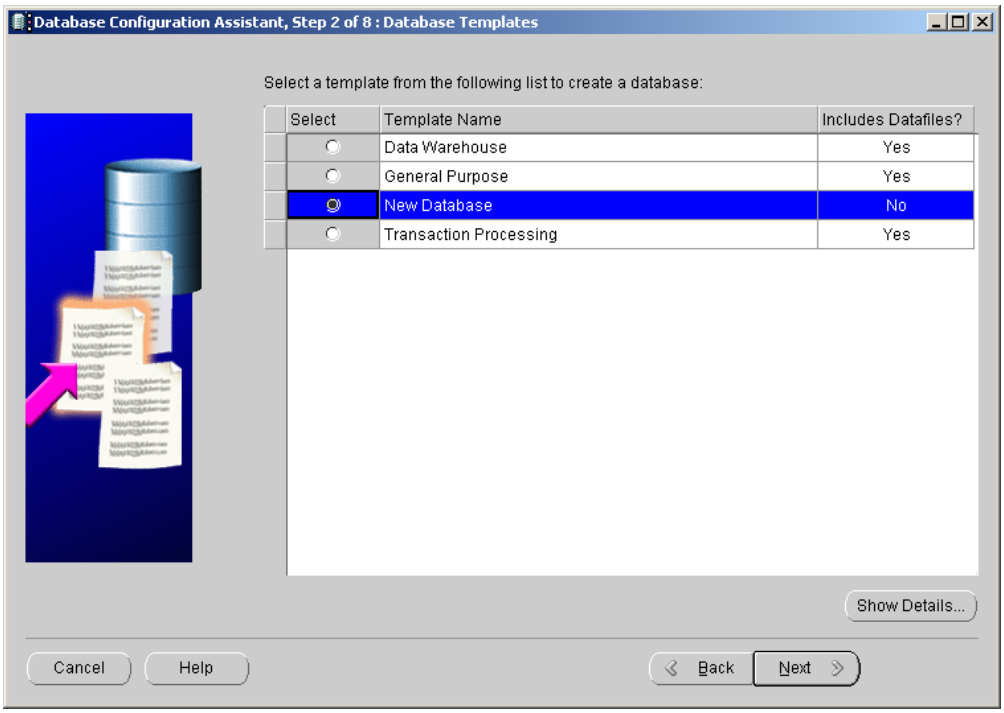


Push ‘Next’ button.

NILU
PO Box 100
2027 Kjeller
Telephone: 63 89 80 00
Fax: 63 89 80 50
E-mail: airquis@nilu.no
Internet: www.nilu.no

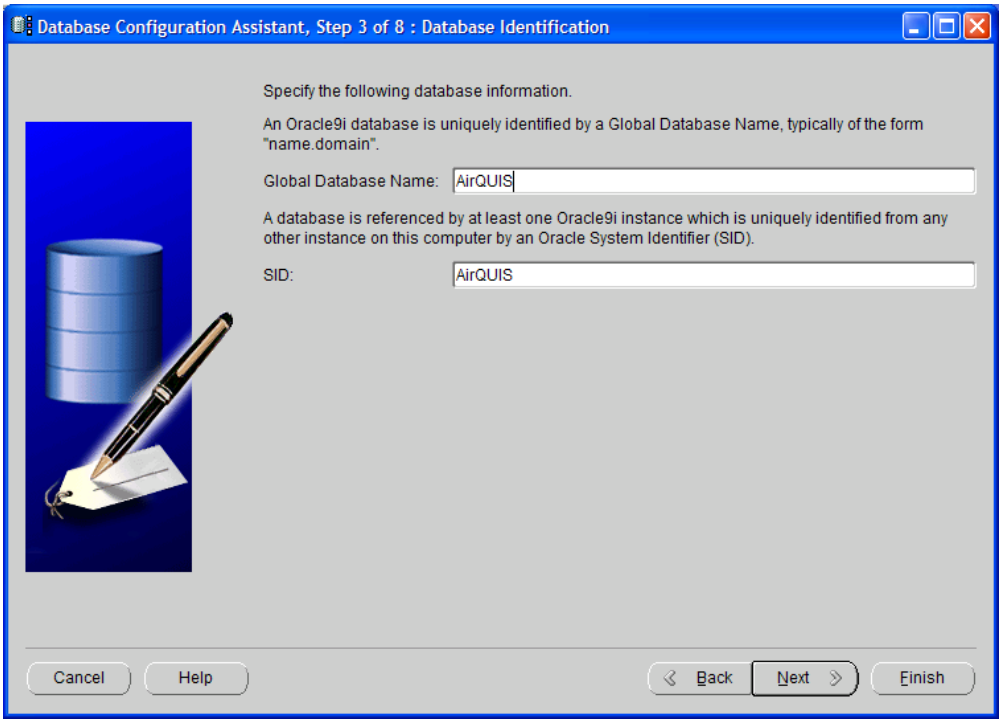


Choose ‘Create a database’, and push ‘Next’ button.

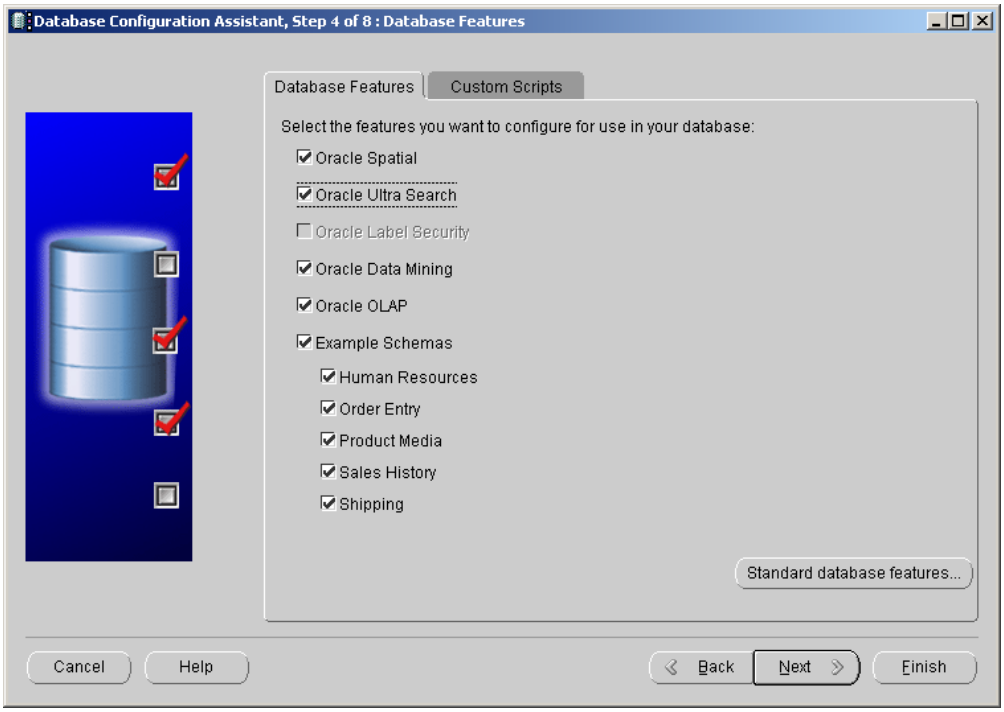


Choose ‘New Database’, and push ‘Next’ button.

NILU
PO Box 100
2027 Kjeller
Telephone: 63 89 80 00
Fax: 63 89 80 50
E-mail: airquis@nilu.no
Internet: www.nilu.no



Fill in the name for 'Global Database Name', AIRQUIS. We normally use AIRQUIS as the database name, and AIRQUIS for the SID. Push 'Next' button.



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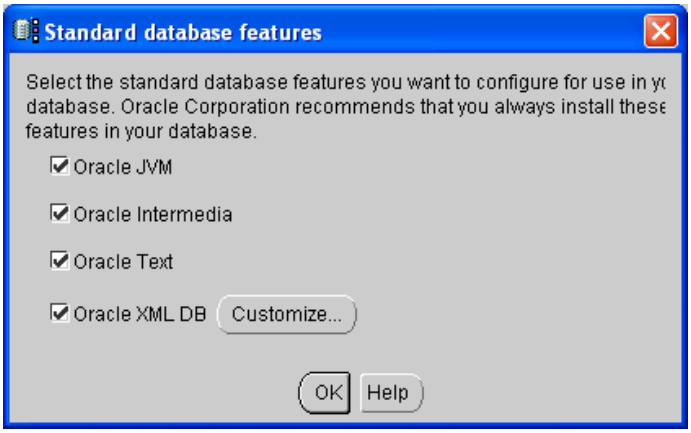
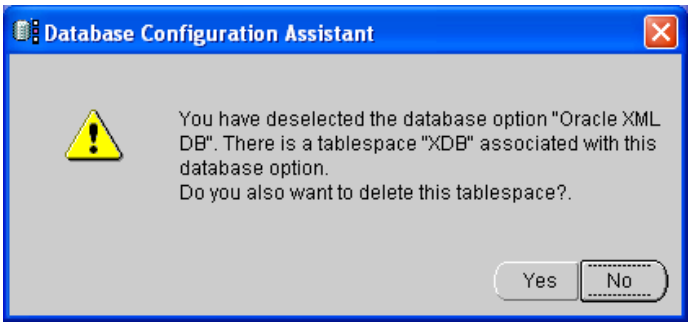
Internet: www.nilu.no

Select ‘Standard database features…’



Deselect ‘Oracle XML DB’ and push ‘OK’ button.



Answer ‘Yes’ to delete tablespace “XDB”.

NILU
PO Box 100
2027 Kjeller
Telephone: 63 89 80 00
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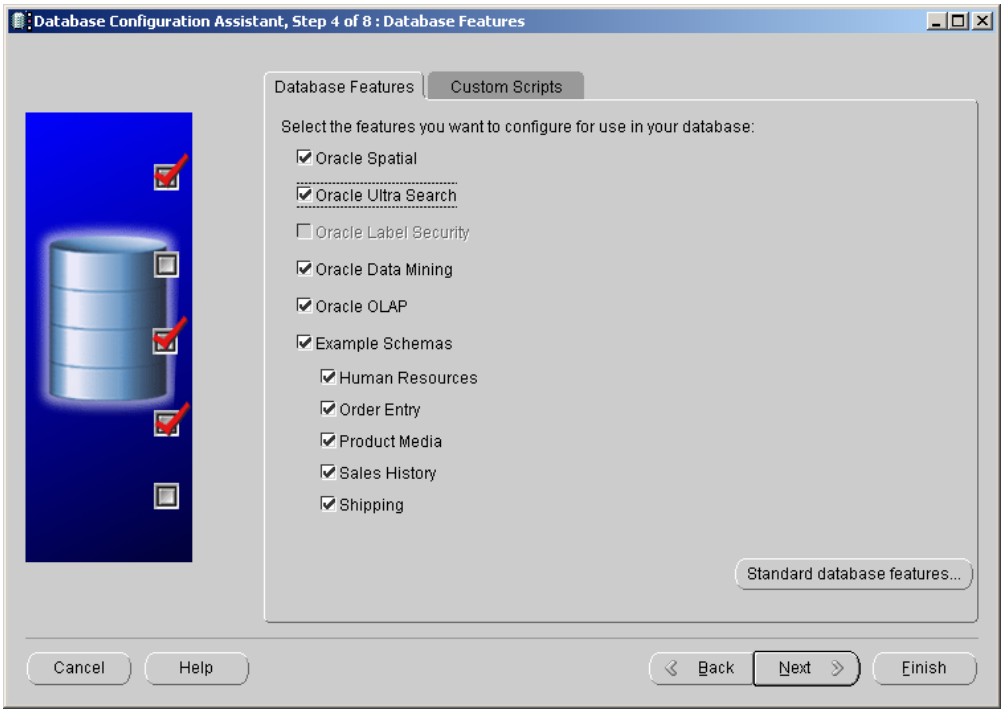

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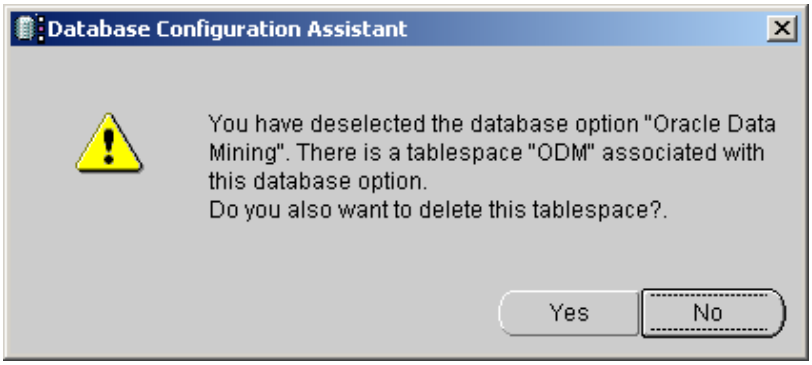

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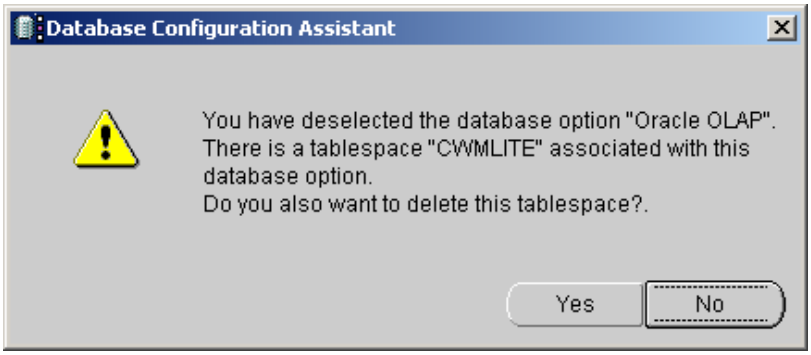

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Fax: 63 89 80 50
E-mail: airquis@nilu.no
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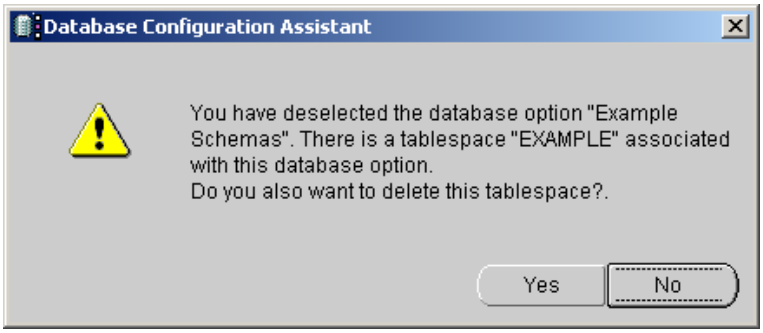
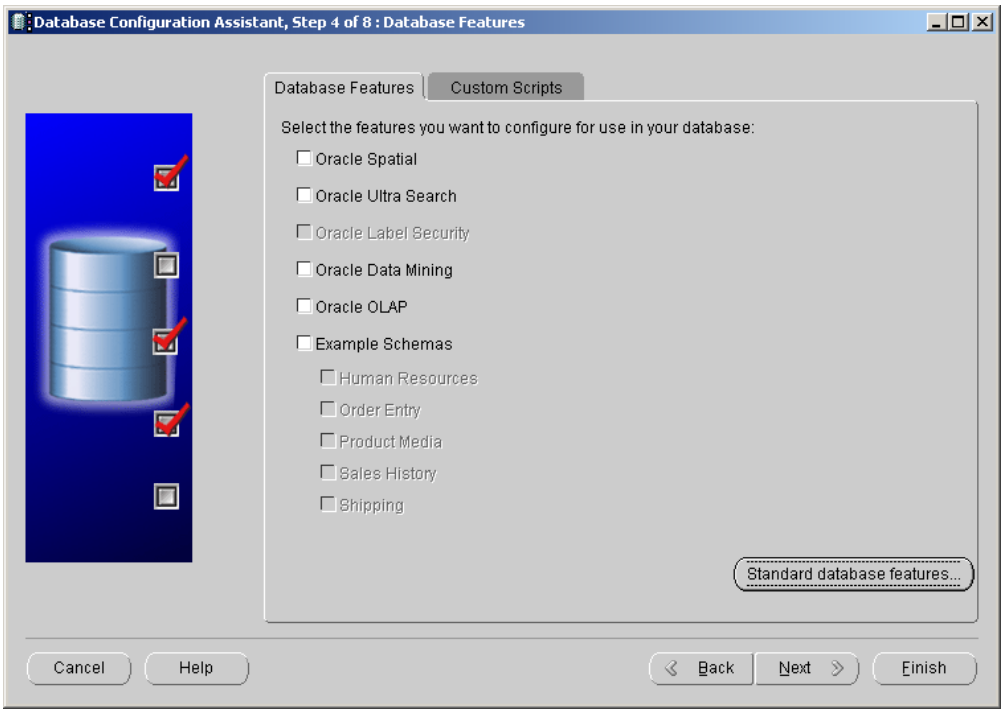
Answer ‘Yes’.



Answer ‘Yes’.



Push ‘Next’ button.

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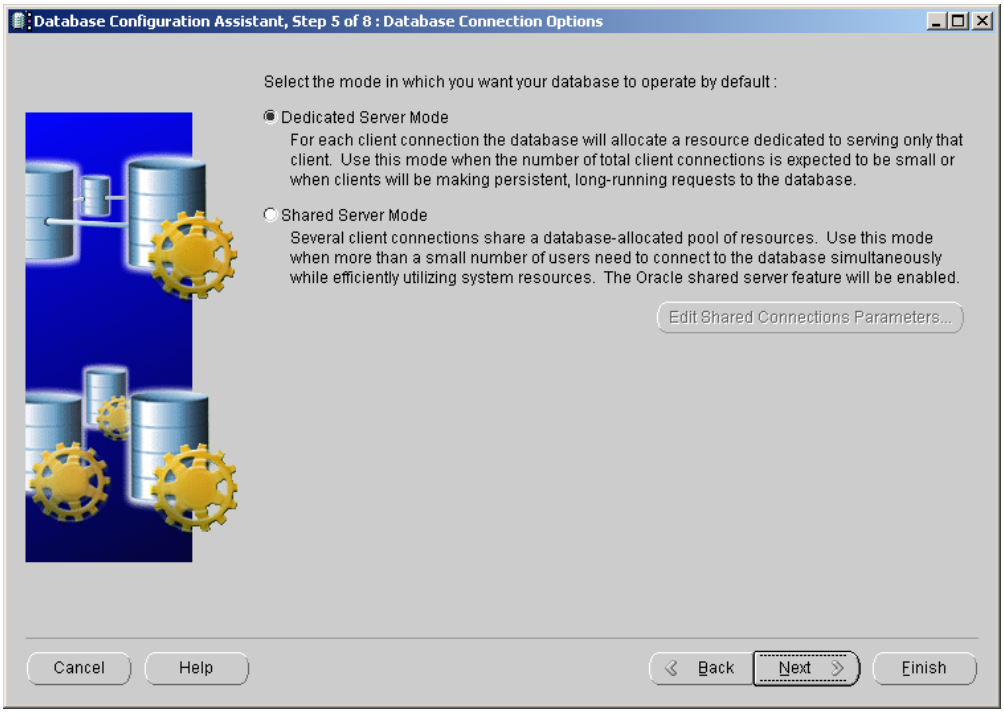
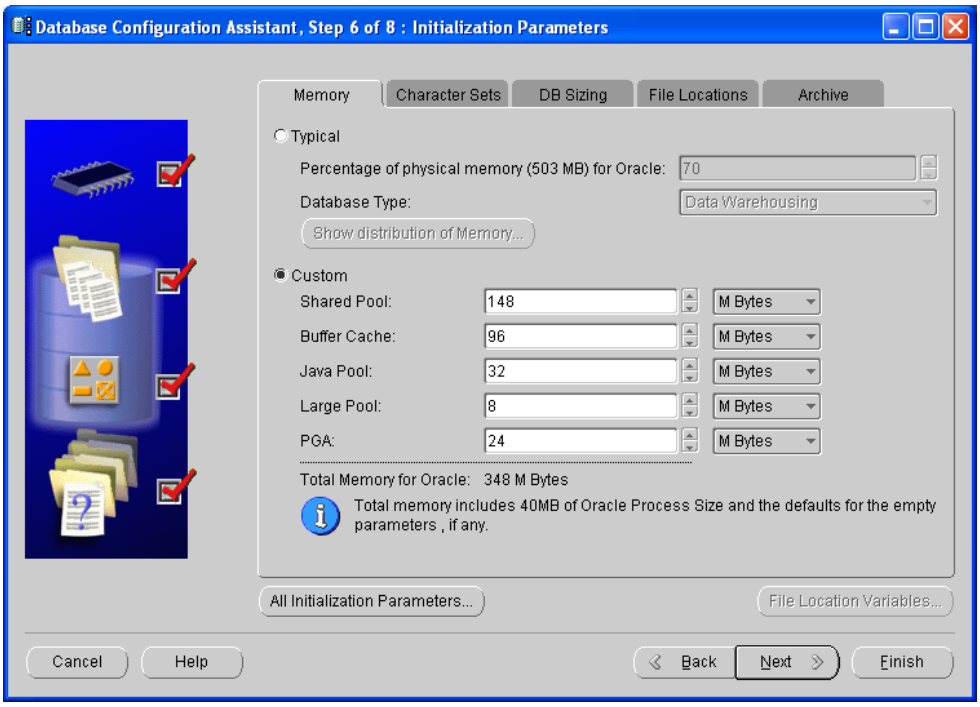
Internet: www.nilu.no



Select 'Dedicated Server Mode', and push 'Next' button.



Adjust memory for the new database, depending on server memory and number of databases on the server.

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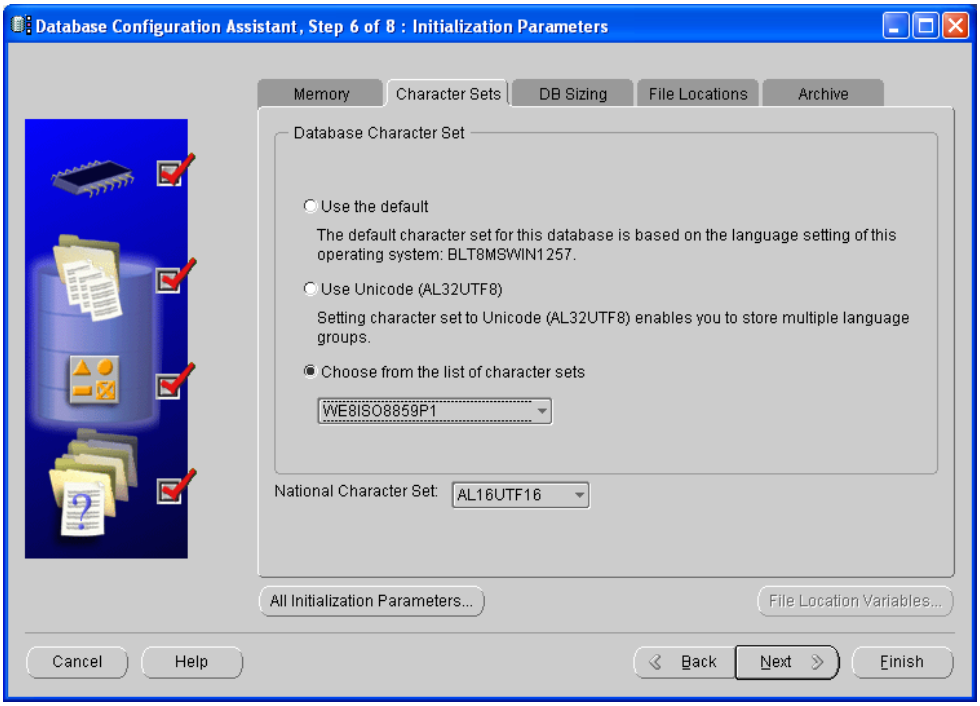

Select ‘Character Sets’ tab, and ‘Choose from the list of character sets’ to WE8ISO8859P1’.
Push ‘Next’ button.

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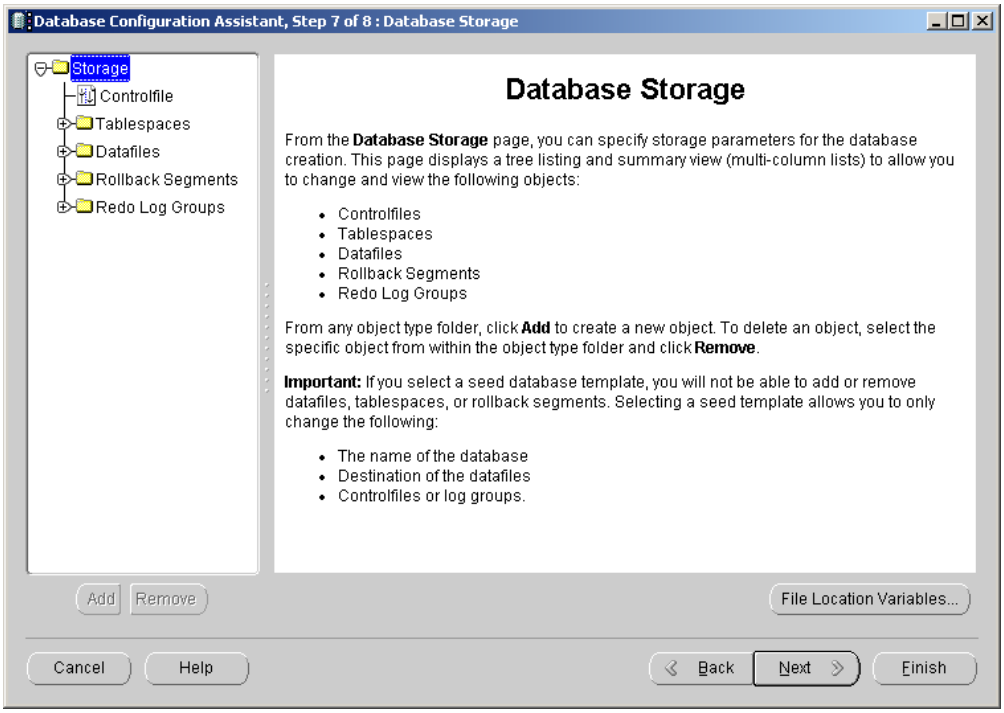

Choose ‘Tablespaces’ tab.

The installation scripts for AirQUIS use AIRQUISDATA and TEMP tablespaces. Usually we use to store AirQUIS projects on the tablespace AirQUISDATA.

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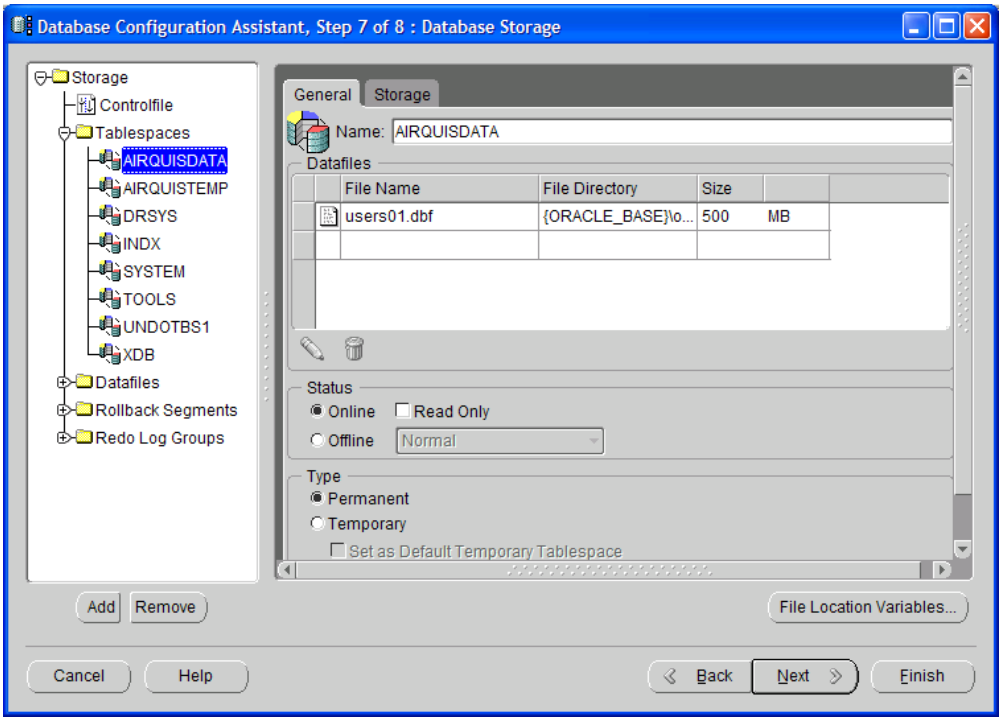

Change the name of the USER tablespace to AIRQUISDATA. Adjust the size of the tablespace to a suitable size for your use. (5 –25 GB?)

Adjust the size of the tablespace TEMP to at least 400- 500 MB.

Push ‘Next’ button.

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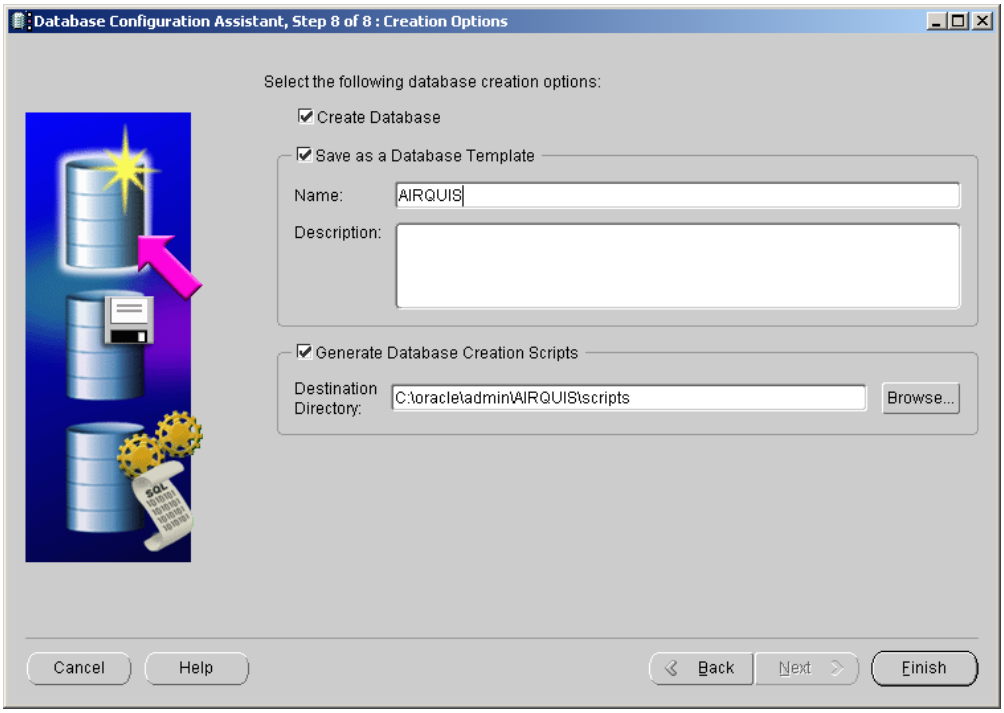

Select ‘Create Database’ and ‘Generate Database Creation Scripts’. You can also save it as a Database Template.

Push ‘Finish’ button to create the database.

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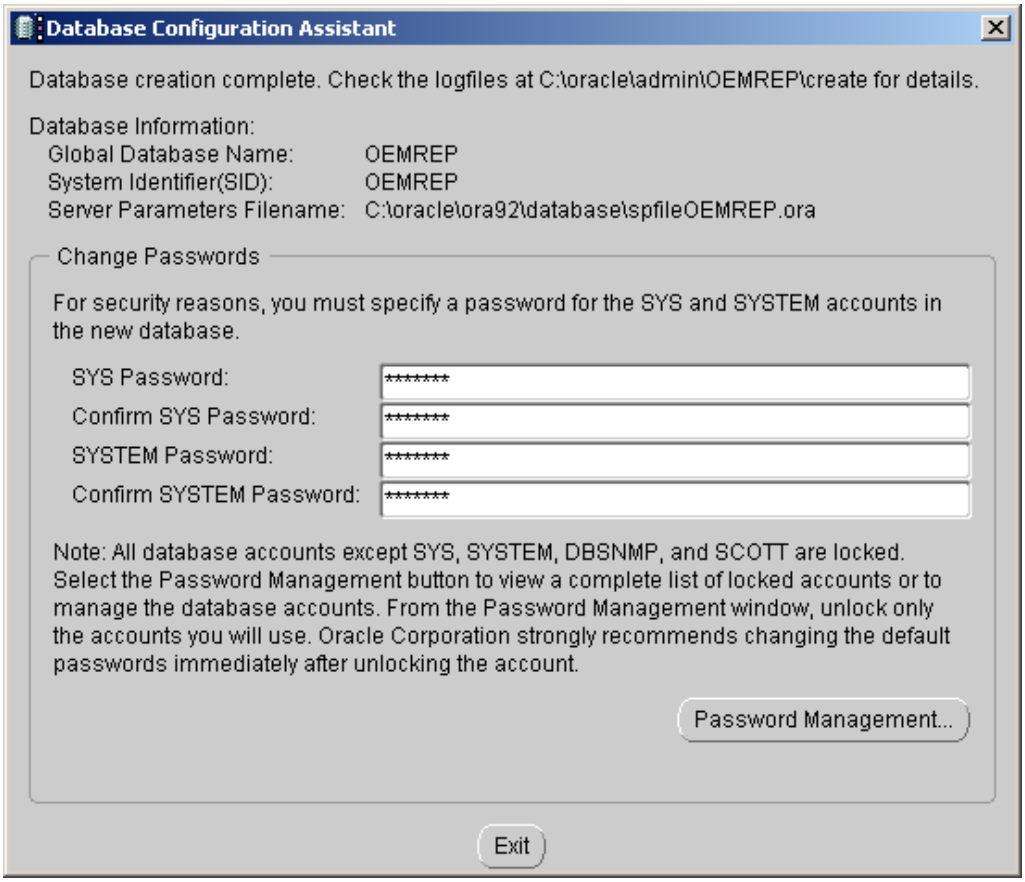

Give passwords for the ORACLE users SYS and SYSTEM, and REMEMBER the passwords!
Push 'Exit' button to finish creating the database.

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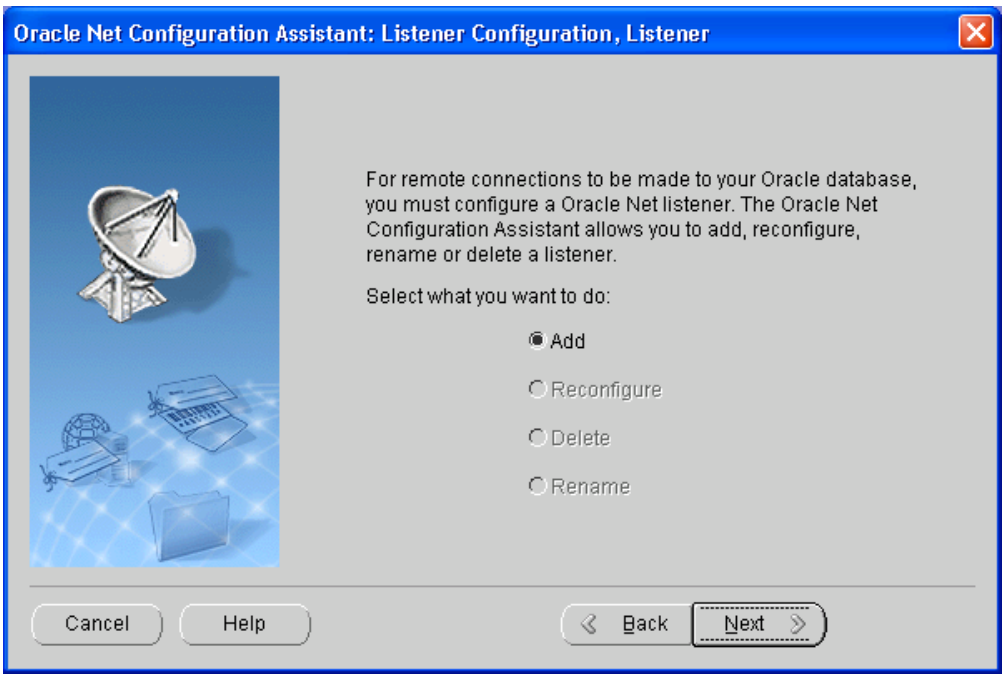
The first time you create a database, you may have to configure the LISTENER service for The Oracle database server.

Start the program:
Start -> All Programs -> Oracle – OraHome92 -> Configuration and Migration Tools -> Net Configuration Assistant .



Push ‘Next’ button.

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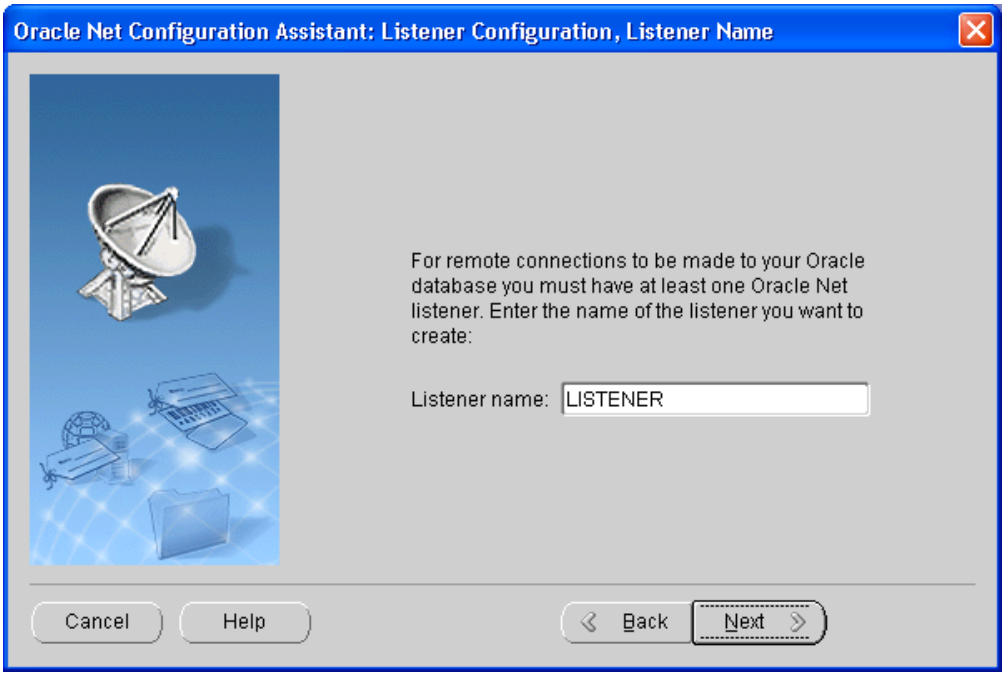
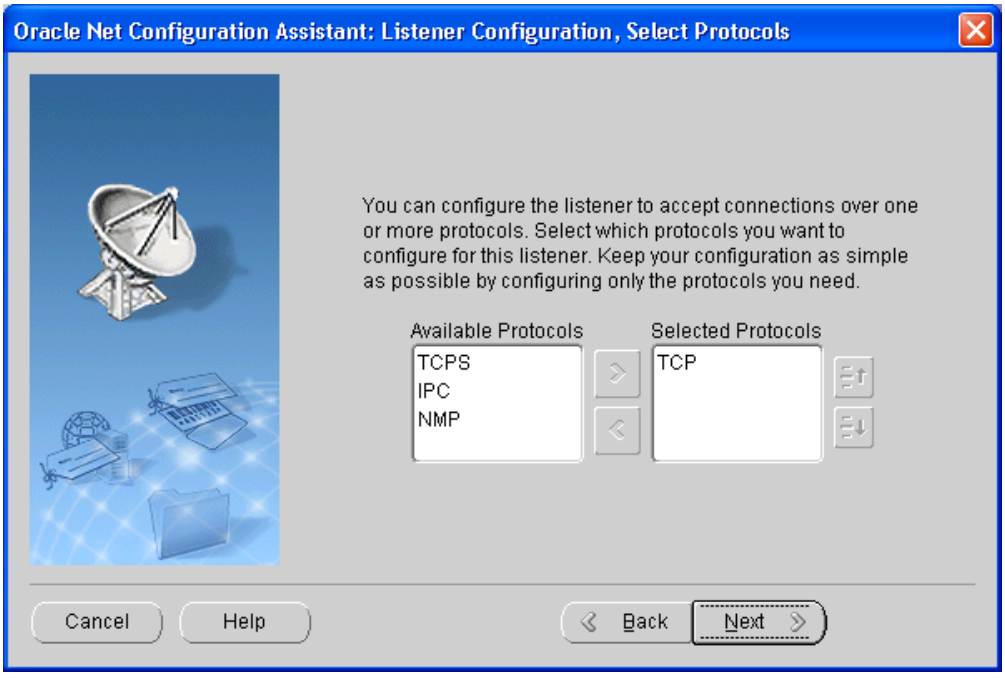


Push ‘Next’ button.



Push ‘Next’ button.

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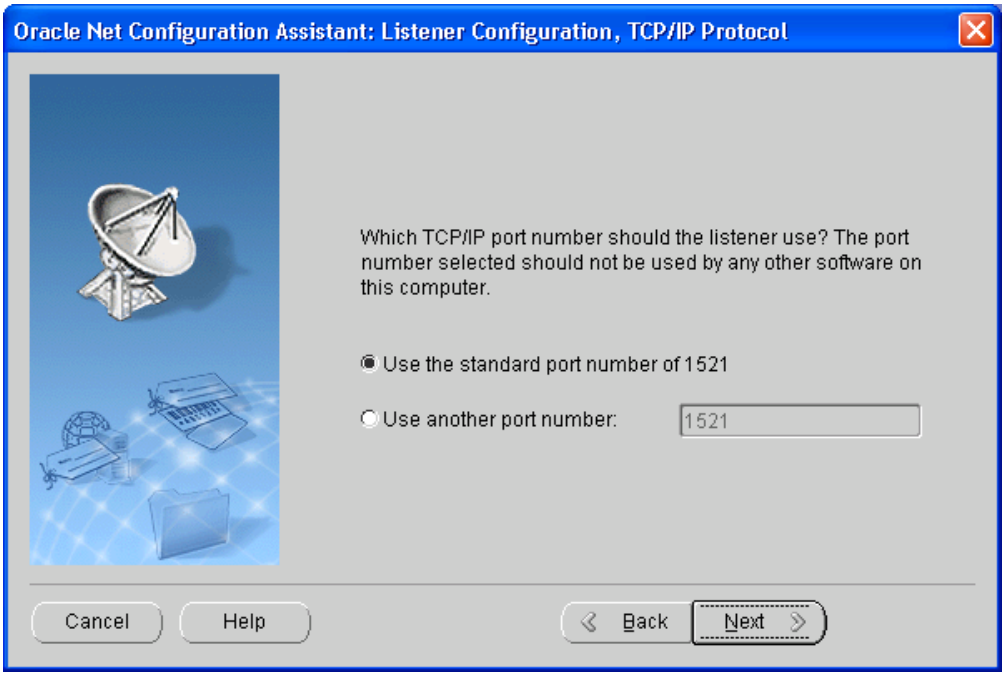
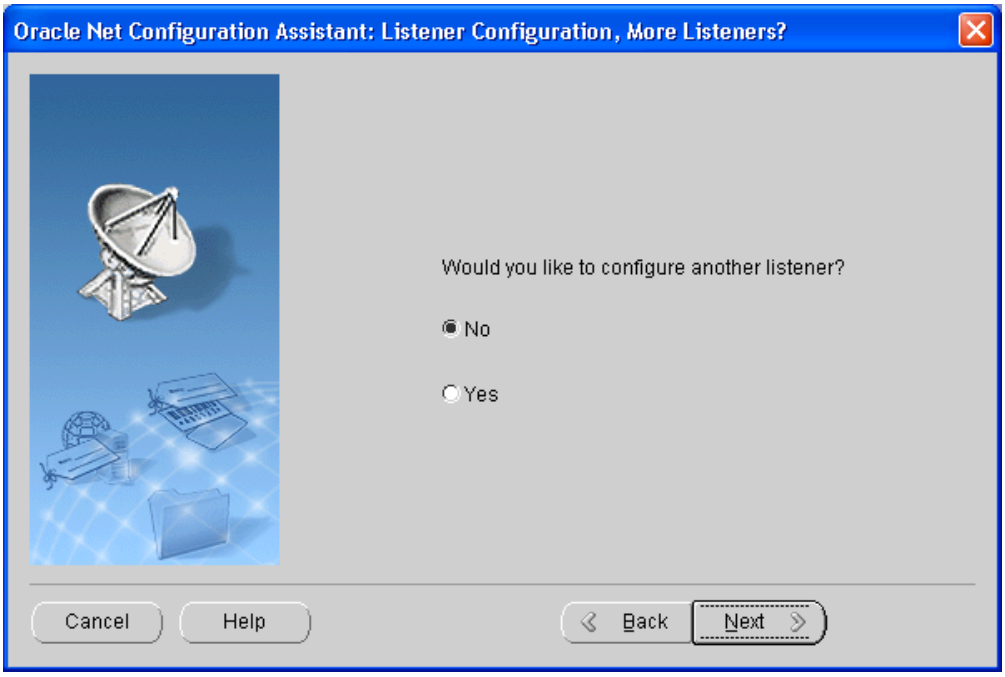


Push ‘Next’ button.



Push ‘Next’ button.

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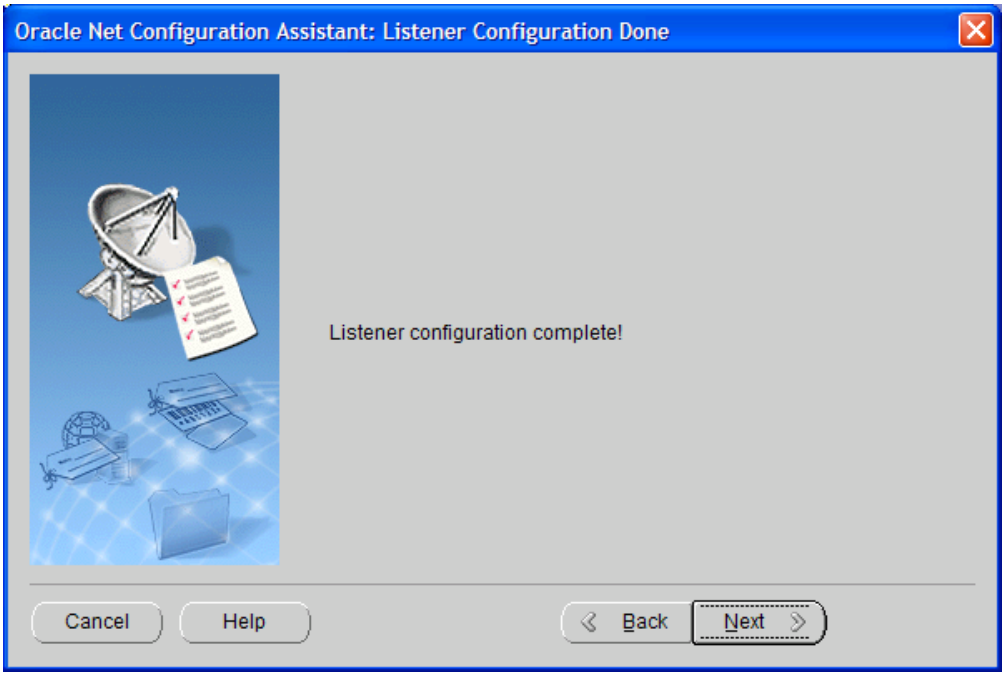

Push ‘Next’ button.

Listener configuration is finished.

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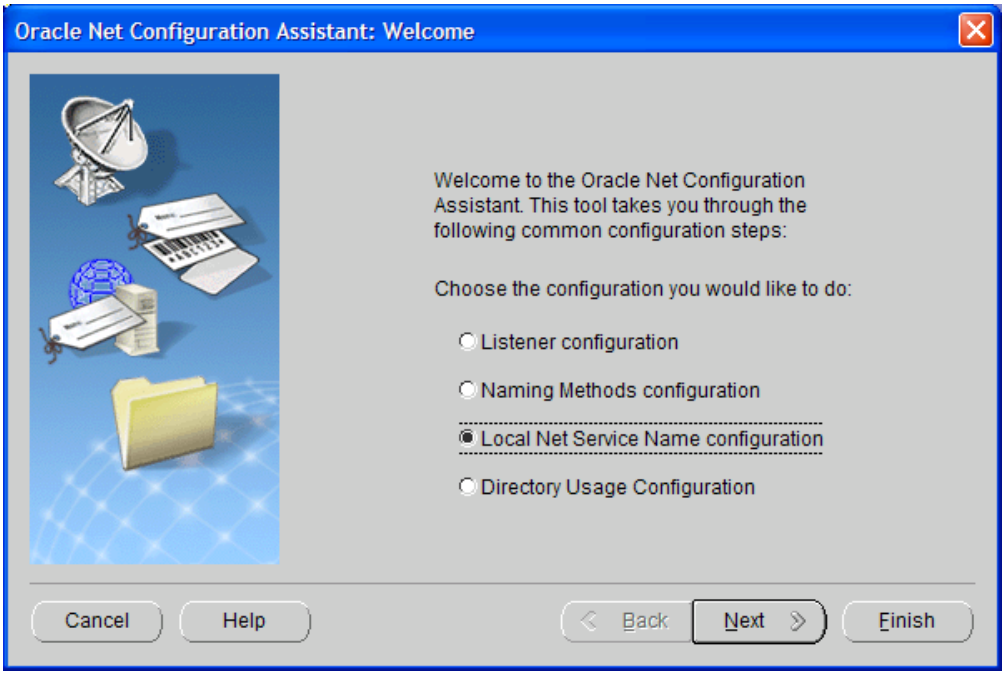
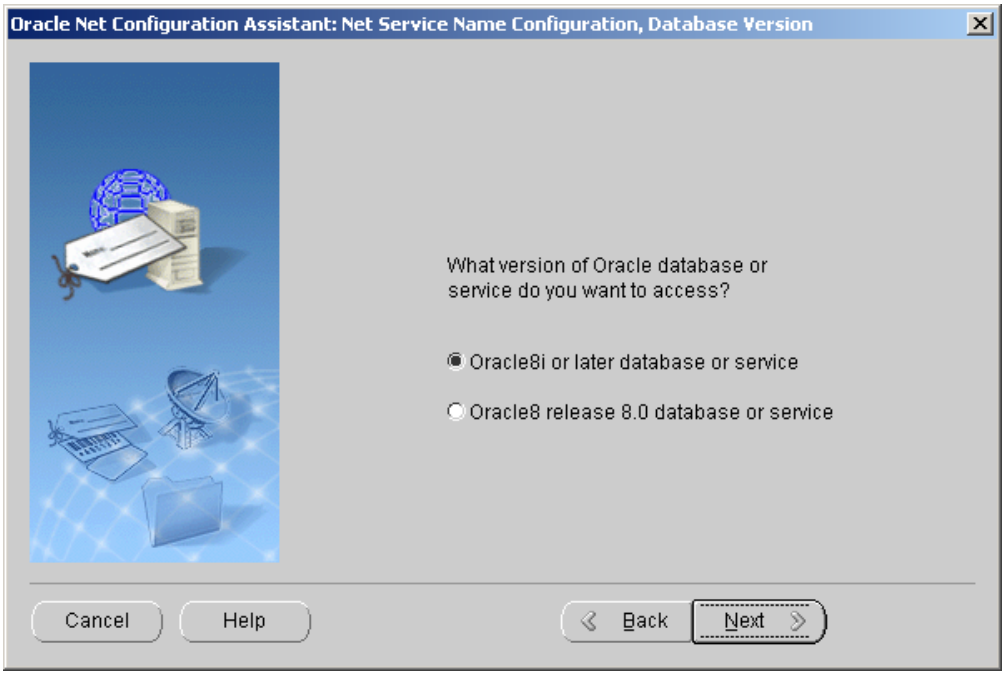
Add a ‘Net service Name’ for the Oracle database.



Select ‘Local Net Service Name configuration’.
Push ‘Next’ button.



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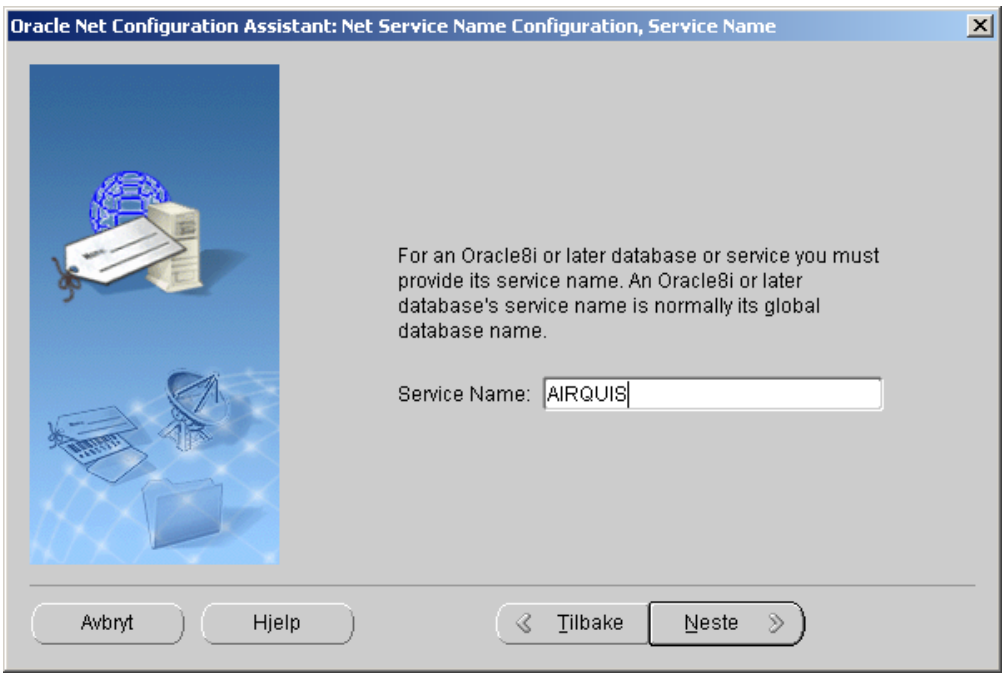
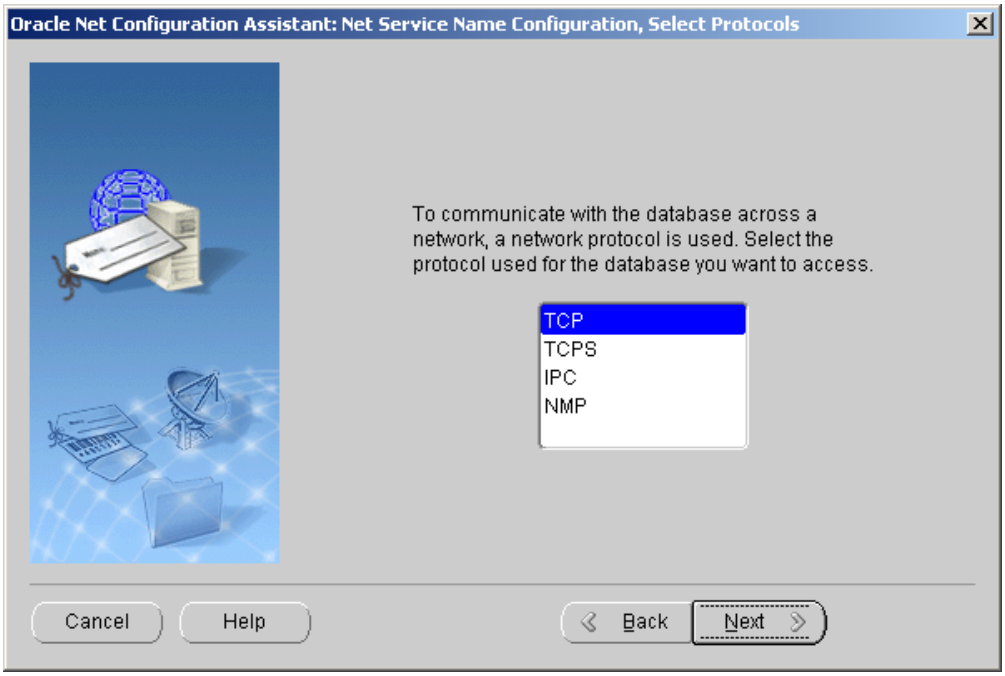
Select the version of the ORACLE database, ‘ORACLE8i or later database or service’ for
ORACLE 8i and ORACLE 9i database. Push ‘Next’ button.



Fill in the name of the ORACLE Service, we normally use the same name as the database, AIRQUIS, and push ‘Next’ button.



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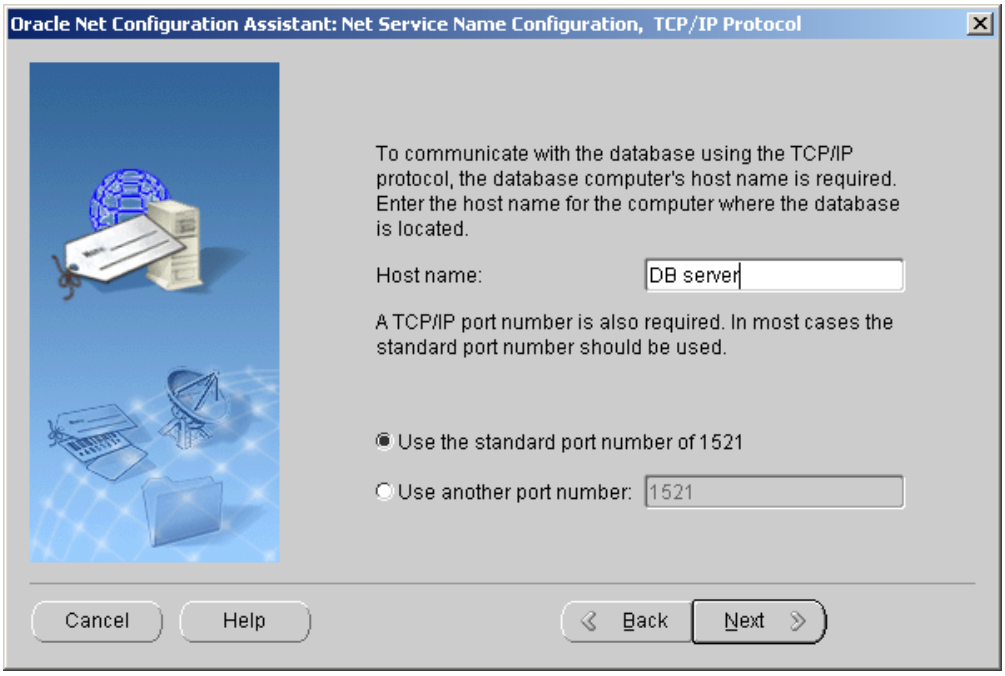
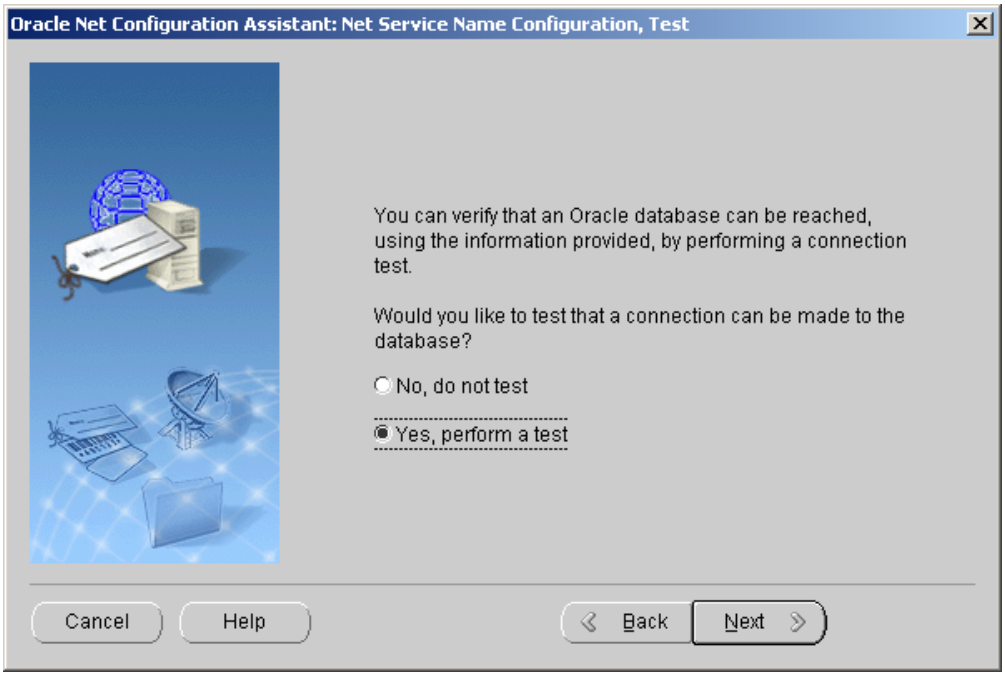
Select the type of your network, and push ‘Next’ button.



Fill in the Host name, or the IP-address of the database server, and push ‘Next’ button.



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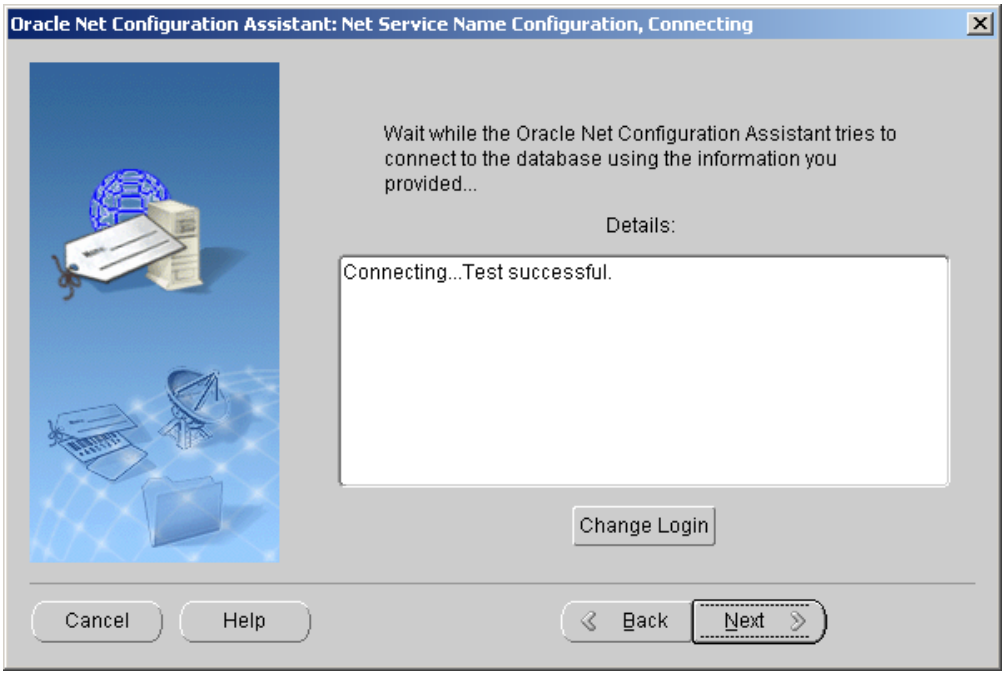
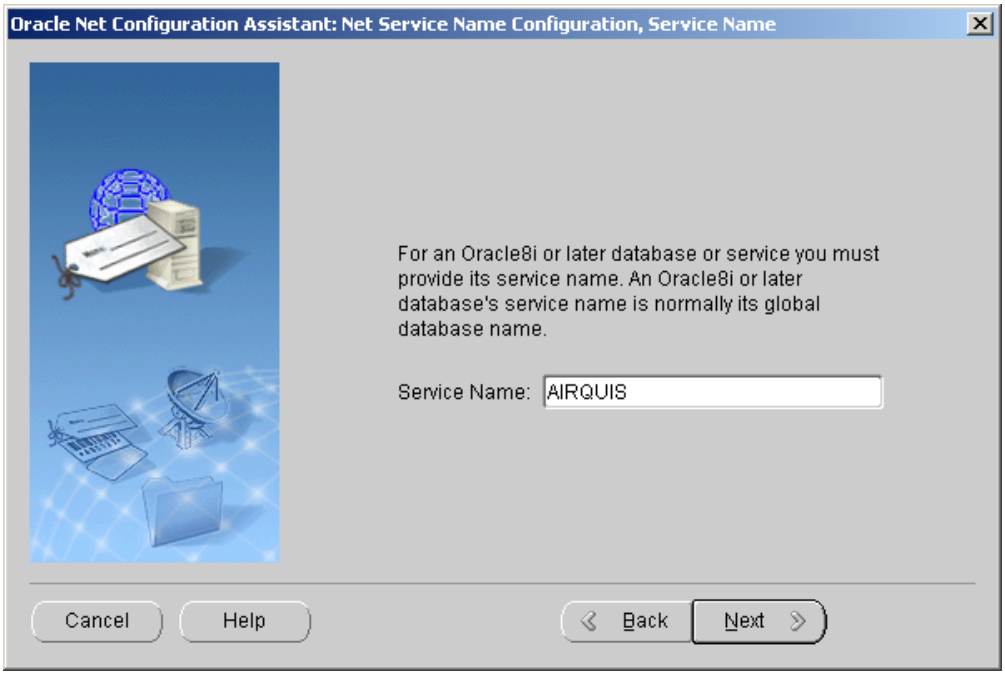
Select ‘Yes, perform a test’, and push ‘Next’ button.



If the test is successful, the ORACLE client can connect to the database. Push ‘Next’ button.



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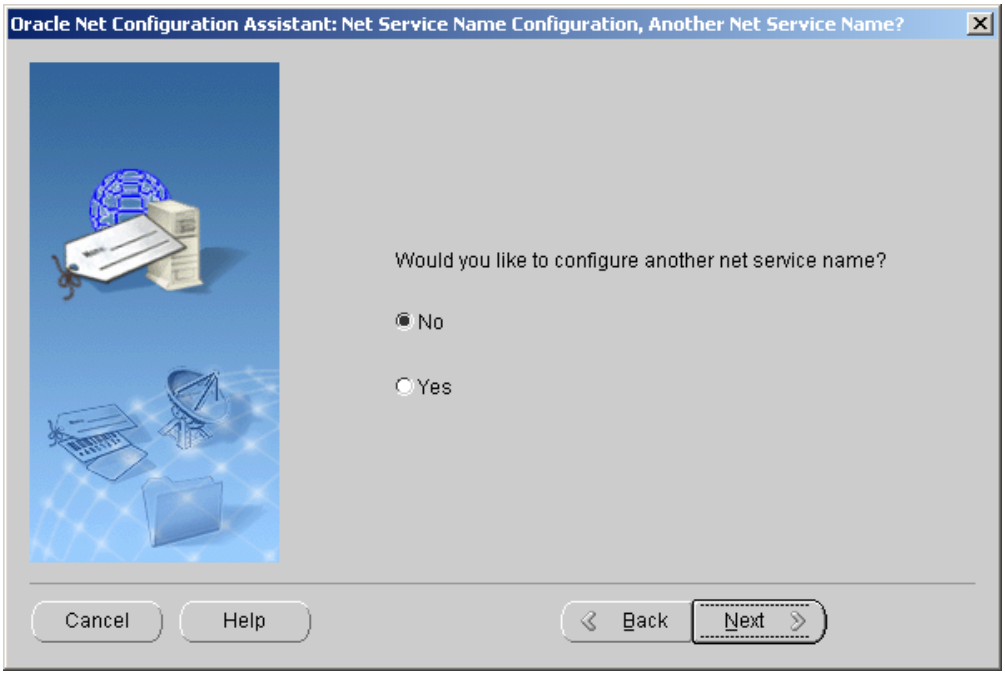
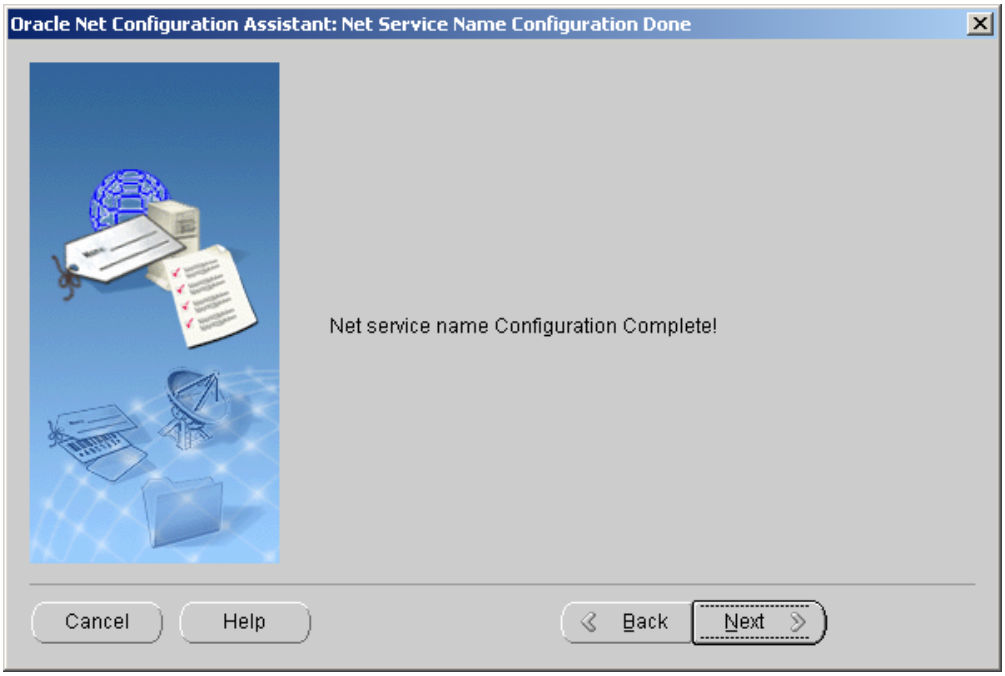
We normally use AIRQUIS as Service Name in the ORACLE client configuration.
Push 'Next' button.



Select 'No', and push 'Next' button.



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Push ‘Next’ button.

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The first time to start the 'Enterprise Manager Console'

Start -> All Programs -> Oracle – OraHome92 -> Enterprise Manager Console

Use 'Launch Standalone', and push 'Next' button.

You have to add database(s) to Enterprise Manager Console.

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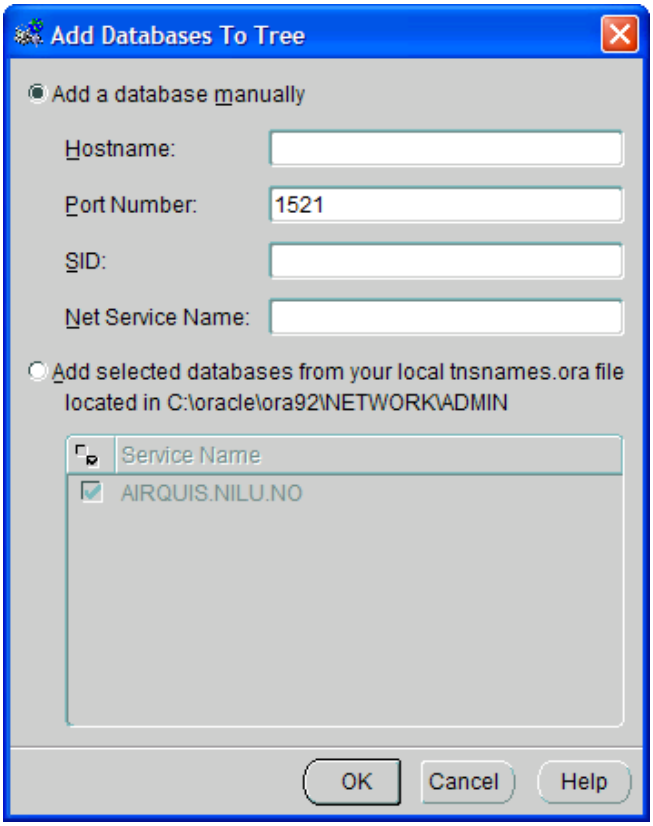

Choose ‘ Add selected databases …’ .

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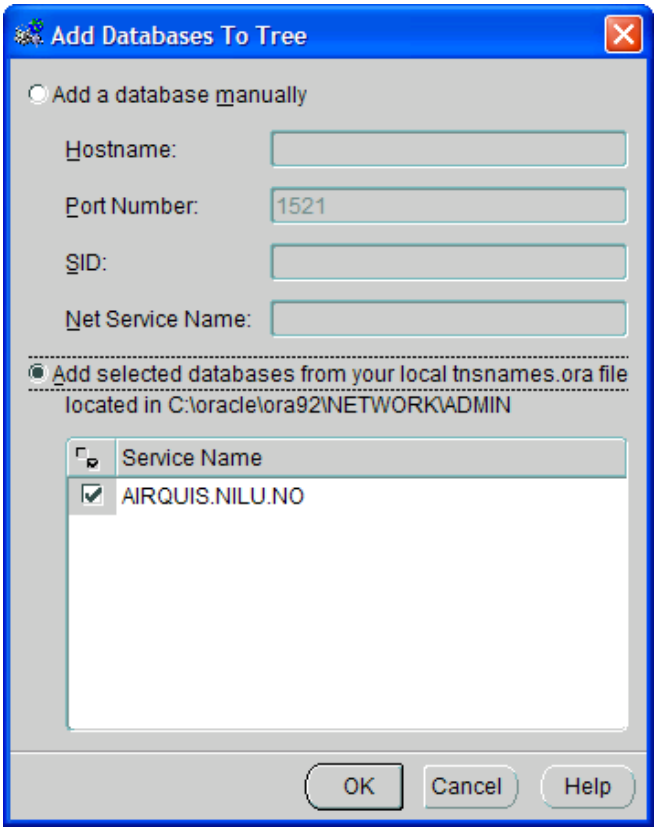

Push 'OK' button.

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You can now log on to Enterprise manager with an Oracle user.

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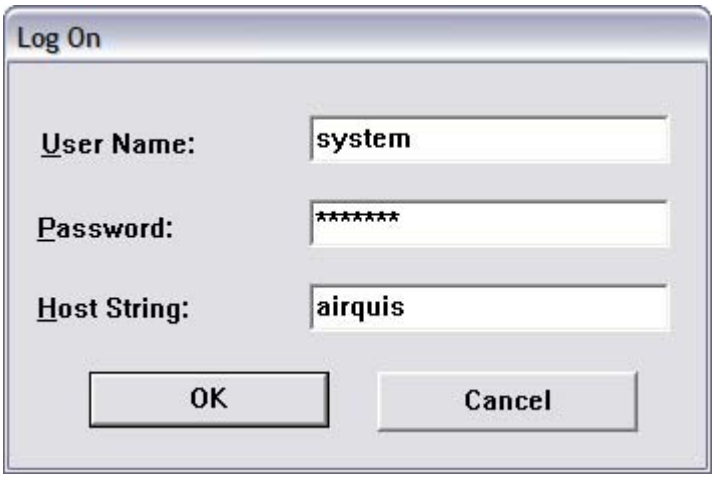
Run KERNEL Script (creates necessary AirQUIS kernel user and its required tables, triggers, etc.)

Start -> All Programs -> Oracle – OraHome92 -> Application Development -> SQL Plus



Login with:

- **User Name: system**
- **Password: ******
- **Host string: airquis**

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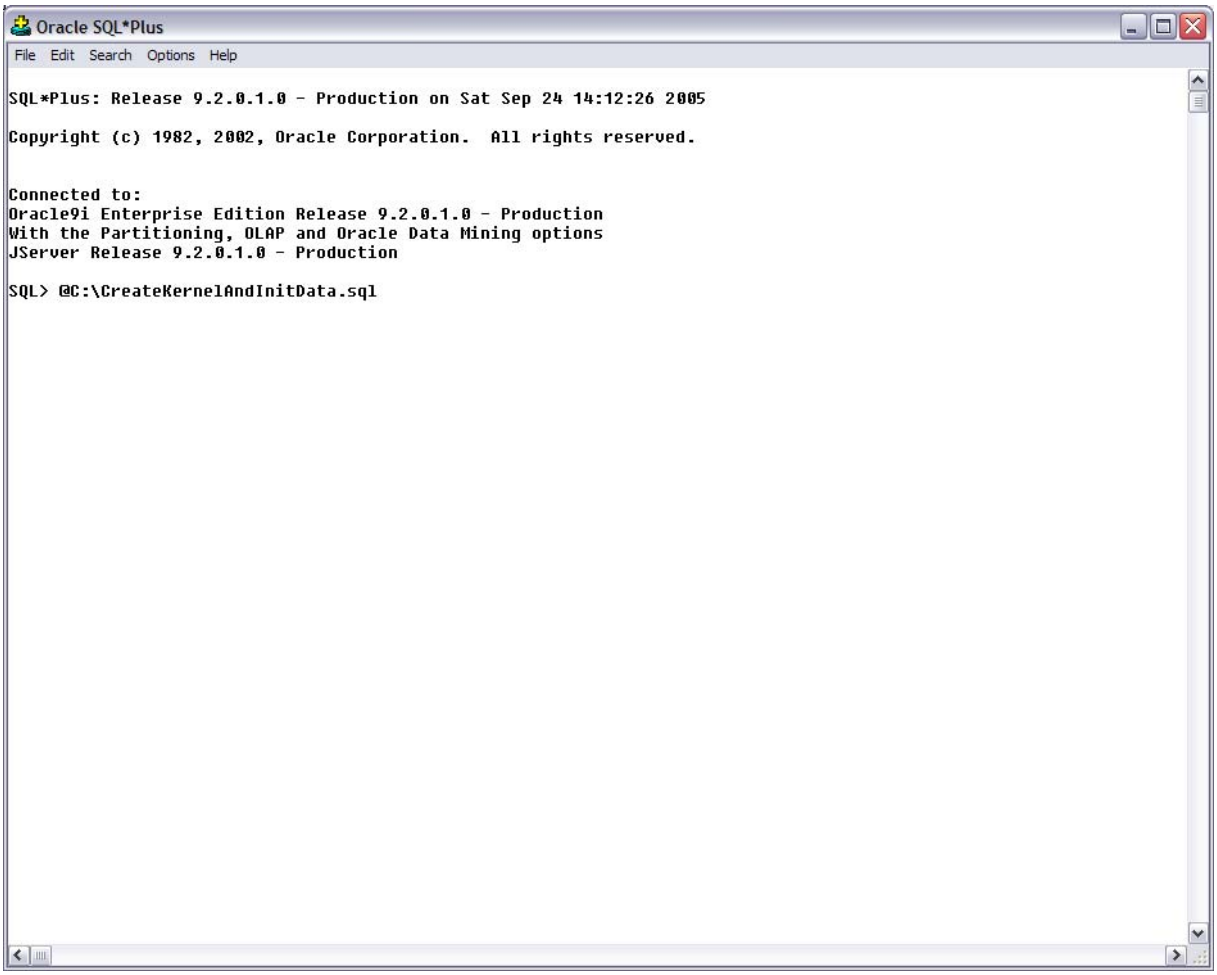
Find the SQL script file "CreateKernelAndInitData.sql" and copy it to C:

In the Oracle SQL* Plus form (illustrated below) write:
"@C:\ CreateKernelAndInitData.sql" and press <enter>.



Close the Oracle SQL* Plus application.

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Memo

The Air Quality Index (AQI) generator

The **daily reporting** of air quality in HCMC is done through the generating of an air quality index (AQI). The AQI procedures were re-evaluated and some slight changes and improvements were included in November 2005. The AQI procedures were then programmed into the AirQUIS system for automatic generation every day.

The measured results for the potential harmful species PM_{10}, NO_2, CO, SO_2, and O_3 are included for determination of the AQI. All parameters may not be measured at a given station. In this case only the measured parameters are included. Further both hourly and daily averages are included to take into account that the health deterioration may be initiated both of short time exposure to high concentrations and long time exposure to lower levels. This fact is also reflected in the Air Quality Standards.

The Air Quality Index (AQI) has been established in AirQUIS based on the present and proposed air quality standards for Vietnam (TCVN 5937 – 1995 and TCVN 5937 – 2005). The selected values used for generating the AQI values have also been compared with the World Health Organisation's new proposed guideline values for air quality.

Based on the information above we have selected the following values for generating the AQI.

	Concentration level (µg/m^3)	
Parameter	**1 hr average**	**24 hr average**
PM_{10}	150	100
NO_2	200	100
SO_2	300	125
Ozone	120	60
CO	30 000	5 000

The simplest way to estimate the AQI for HCMC is dividing the procedures into hourly AQI(h) based on hourly concentrations and 1-hr average standards, and daily AQI(d) based on daily average concentrations and 24-hr average standards. The final AQI for each day will be the highest value of the hourly maximum AQI value and the daily AQI.

In the analyses below we have used the following nomenclatures:

h = hour j = site i = compound d = daily (24 hour) C = concentration S = standard (hourly, daily, annual)

Sites:
1 = DOSTE
2 = Hong Bang
3 = Tan Son Hoa
4 = Thu Duc
7 = Zoo, District 1
9 = Quang Trung
8 = District 2 PC
5 = Thong Nhat Hospital
6 = Binh Chanh Educ Centre

Hourly Index, AQI(h)

The highest ratio of concentration to standard for any site and compound during this hour is being estimated from:

$AQI(h,j) = Max_h\ (C(h,i,j)/S(h,i))*100$

The compound giving the highest ratio will give one index for each site for a given hour.

Daily Index, AQI(d)

A daily index is also established for the compounds available at each station, such a SO_2, NO_2, CO, O3 and PM_{10}. The procedure is similar to the hourly giving:

$AQI(d,j) = Max\ (C(d,i,j)/S(d,i,))*100$

The daily air quality index will be selected as the higher of the two indexes:

Max((AQI(h,j),AQI(d,j))

The index for one site will thus be related to the compound that gives the highest ratio of the highest hourly and the 24-hour average concentration to standard.

Site type relevant hourly index

Based on a total of 9 stations in operation in HCMC, the index will be divided in two categories;

1. Traffic represented by:
   DOSTE, Hong Bang, Thong Nat Hospital and Binh Chanh
2. Urban background stations represented by:
   Tan San Hoa, Zoo-District 1 and Quang Trung.

The remaining stations at Thu Duc and District 2 PC are located in residential areas occasionally highly impacted by industrial sources. These data will be presented in the monthly reports by different type of statistics.

The two types of Air Quality Indexes (AQI) is therefore:

- Traffic:
  AQI(traffic) = (AQI(1)+AQI(2)+AQI(5)+AQI(6))/4
- Urban/residential:
  AQI(urban/residential) = (AQI(4)+AQI(7)+AQI(9))/3

A third AQI (residential/industrial) may be generated from (AQI(4)+AQI(7))/2

Data quality assumptions:
To assure that adequate data quality has been taken into account in the generation of an AQI, the following quality assurance has been considered:

- Data with *warning and exclude flags* will not be part of the AQI estimate.
- Negative concentrations are not included.
- At least 6 one-hour average concentrations are needed to produce a daily AQI.

Exclude flags include:

- Missing data
- Too many equal values after each other (presently set at 3 values)

Warning flags:

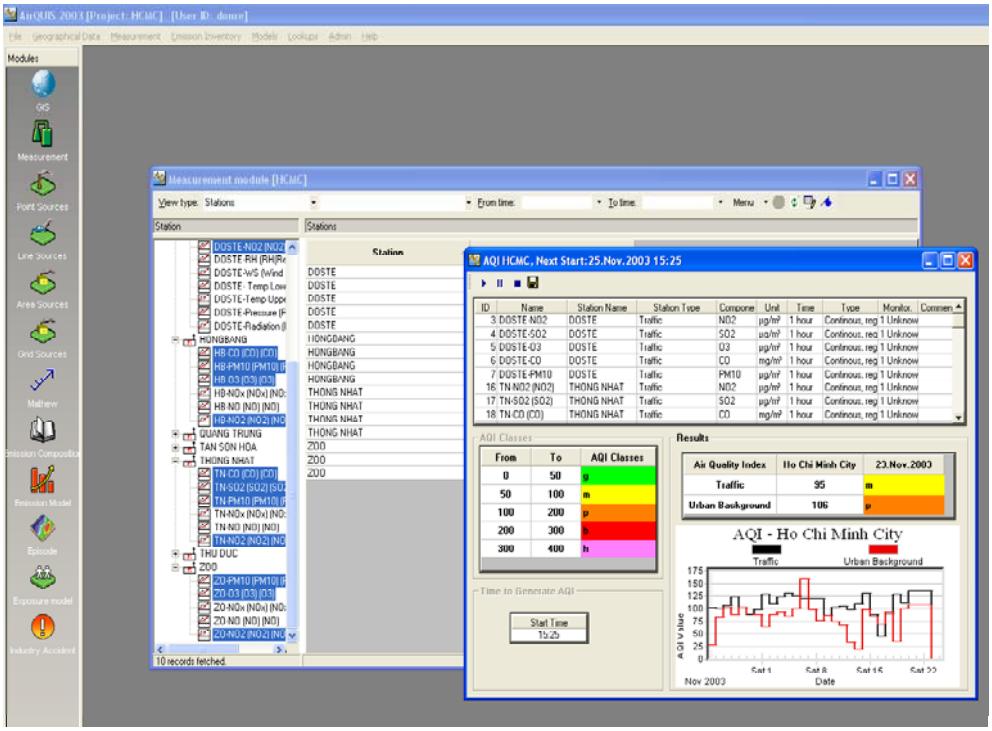
- Related to expected minimum and maximum values

Categorised air quality
The air quality is categorized in five classes, based on the guidelines given in the US Federal Register Part III, Environmental Protection Agency, 40 CFR Part 58, according to the following table:

Classification of index	
0 to 50	Good
51 to 100	Moderate
101 to 200	Poor
201 to 300	Unhealthy
301 and above	Hazardous

AQI automatically generated by AirQUIS
AQI is generated from AirQUIS entered through the measurement menu. Every day at 07:00 hrs (time may be specified) the daily AQI will be updated. The air Quality will be classified according to AQI classes presented above. The classification may be altered if necessary. New sites and components may also be changed in the AQI generation.

The AirQUIS screen during the AQI processing is presented in the Figure below:



AQI on Internet

The generated AQI values are being transferred every day to the information board near Binh Thanh marked in the city centre of HCMC.

The AQI estimated for the preceding day has also been prepared to present on an Internet page for HEPA. A test site was developed by NILU based on the measurement programme. This site was based on the AirOnline development at NILU and was shown to HEPA in September 2004.

The final evaluation of the automatic AQI generator in AirQUIS has been tested and evaluated and is now being presented on the HEPA web page:
www.hepa.gov.vn

Appendix E

Air Quality Modelling

App E1

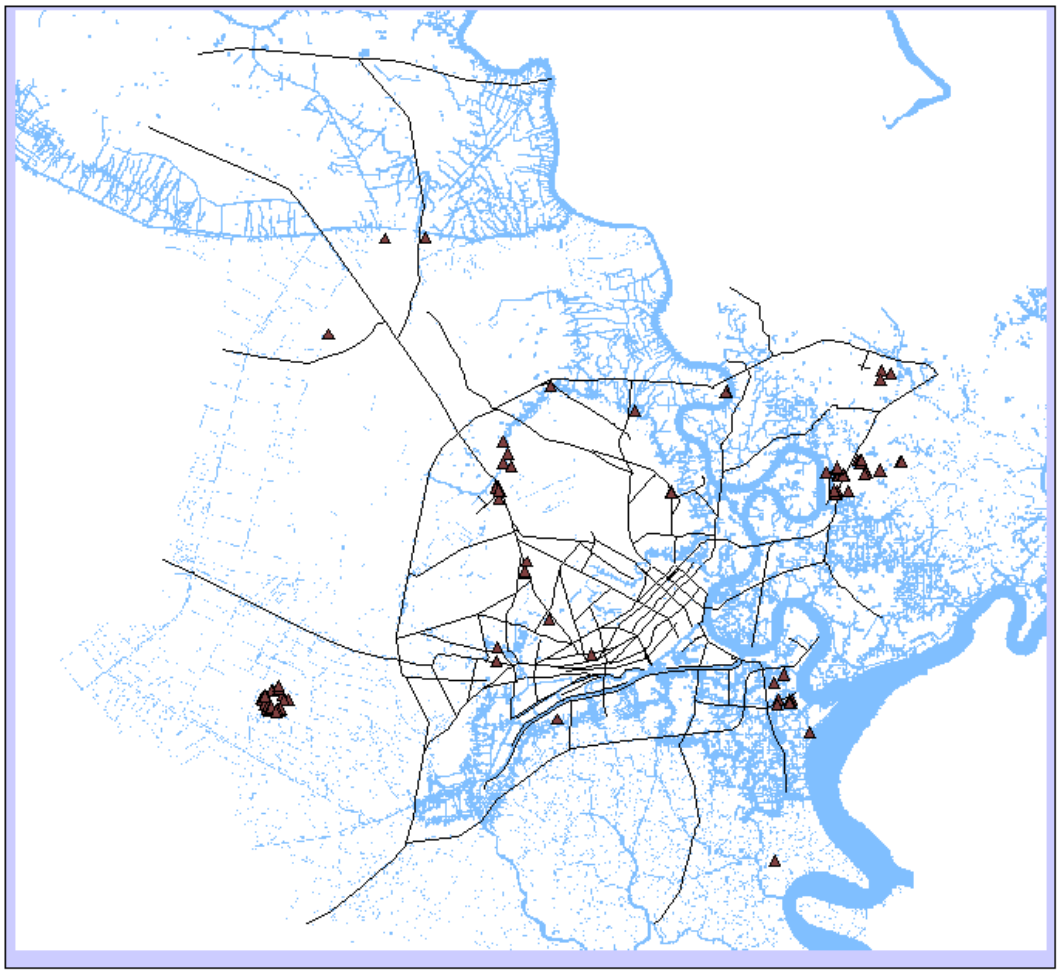
Emission inventories

The collection of emission sources continued during 2005.

During Mission 7 in November 2005 all available sources were tested and installed into the new version of AirQUIS. As of 20 November there were:

- 118 Line sources and roads
- 125 stacks with a total of 70 industries
- An almost complete set of area sources for traffic emissions based on information on population distributions in the Wards of HCMC

Another 80 point sources may be installed in the near future.



HoChiMinhCity Ennvironmental Protection Agency
(HEPA/DONRE)
The Norwegian Institute for Air Research (NILU)

Minutes

Title:	Line source model result verification
Date	02 August 2005
Participants:	Rune Ødegård (RuO), The Nguyen Thanh (TNT)
Prepared by:	TNT
Distribution:	Bjarne Sivertsen (BS), Rune Ødegaard (RuO), Le Van Khoa (LVK), Vo Thanh Dam (VTD), Nguyen Thanh Huy (NTH), Nguyen Boa Quoc (NBQ), Nguyen Toan Hung Dung (NTHD), Duong Thi Minh Hang (DTMH)

NILU has received a dump from DTMH for verification regarding too high model results comparing to measurement data, confer e-mail from DTMH of 26 July 2005.

There are several elements that may affect the model result. The most relevant elements for this case are:

Meteorology

- The quality of the data period for meteorological data used for this model run
  - No variation in the lower temperature data
  - No variation in the wind direction data

Emission (line sources)

As we all know, it's a great challenge to establish a complete and updated emission inventory for model run. Main elements such as

- The lines to be included according to traffic pattern and impact
- Traffic counting
- "Correct" Traffic Emission Factors Set

will influence to model run.

Verification of the model results

Receptor points e.g. near background stations are used for verifying the model results. The measurement data must also be of good quality.

The elements mentioned above are the first thing that should be looked into for this case.

NILU's proposal

NILU propose the following for **Line Sources:**

Identify a good and representative meteorological and air quality data for modelling purpose. We propose to start with the following components and time period

DOSTE station	
Component	**Time Period**
Wind Direction	01 Jan 2005 to 01 Feb 2005
Wind Speed	01 Jan 2005 to 01 Feb 2005
Upper Temperature	01 Jan 2005 to 01 Feb 2005
Lower Temperature	01 Jan 2005 to 01 Feb 2005
O3	01 Jan 2005 to 25 Jan 2005

Zoo station	
Component	**Time Period**
NO2	01 Jan 2005 to 01 Feb 2005

Thong Nhat station	
Component	**Time Period**
PM10	01 Jan 2005 to 01 Feb 2005

Mr. Bjarne will try to identify more relevant data.

Traffic Emission Factor Set

We have extended the Emission Calculation Vehicle Classes (ECVC) to be compatible with EURO I. The proposed ECVC is:

Heavy trucks

DHLH unregulated (heavy trucks)	1 - Xe tai nang, xe tren 25 cho - Heavy trucks
DHLH regulated (heavy trucks)	1 - Xe tai nang, xe tren 25 cho - Heavy trucks

Light trucks

PreCat (light cars)	2 - Xe tai nhe, xe 4-16 cho - Light trucks
US 83/87/90 (light cars)	2 - Xe tai nhe, xe 4-16 cho - Light trucks
EURO 1 G (light cars)	2 - Xe tai nhe, xe 4-16 cho - Light trucks
EURO 1 D (light cars)	2 - Xe tai nhe, xe 4-16 cho - Light trucks
DHLL unregulated (light trucks)	2 - Xe tai nhe, xe 4-16 cho - Light trucks
DHLM unregulated (light trucks)	2 - Xe tai nhe, xe 4-16 cho - Light trucks
Tractors unregulated	2 - Xe tai nhe, xe 4-16 cho - Light trucks
DHLL regulated (light trucks)	2 - Xe tai nhe, xe 4-16 cho - Light trucks
DHLM regulated (light trucks)	2 - Xe tai nhe, xe 4-16 cho - Light trucks
Tractors regulated	2 - Xe tai nhe, xe 4-16 cho - Light trucks

Bus

DHB unregulated (bus)	3 - Xe buyt – Bus
DHB regulated (bus)	3 - Xe buyt – Bus

Motorbikes

Motorcycles unregulated	4 - Xe gan may - Motorbikes
Motorcycles regulated	4 - Xe gan may - Motorbikes

There are sub classes within the main classes.

Please verify the following data in the Traffic Emission Factor Set

- Traffic Emission Factor Set
- ECVC – RVC Distribution
- ECVC Basic and Ageing Factors
- Speed and Dependency Factors

We propose that HEPA use the same Traffic Emission Factor Set (EURO I) as in China.

Point Sources

Please verify the stack data once again eg. the Gas Flow rate should be product of Gas Velocity times π (3.14) times square of the stack radius.

Further work

We recommend you to verify all the Traffic Emission Factor Set above and update the line source with more data (roads).

Please verify and add more data for the point sources.

We have uploaded a modified AirQUIS project dump for you to download: ftp://ftp.nilu.no/pub/AirQUIS/Ho_Chi_Minh/HCMC_Modelling.DMP, including new emission factors and approximately one months of air quality and meteorology data mention above.

Have you started collection of the area sources?

It's important that the new meteorological and air quality data must be of good quality.

Appendix F

Field operations

App F1-Memo

Title	**Tasks and schedules for HEIA-R project**
Purpose	To specify and describe the actual Missions and tasks undertaken and to be undertaken as part of the second phase of the HEIA project..
Distribution	Mr. Hien, Mme Hoa, Mr. Khoa, Mr Dam, The Nguyen Thanh (TNT)
Author	Bjarne Sivertsen
Date	October 2005
Reference No	O-101143

Introduction
An extension of the NORAD financed Air Quality Monitoring Project (HEIA) was signed between Department of Natural Resources and Environment (DONRE) and NILU on 16 November 2004. The new project is named the Ho Chi Minh City Environmental Improvement Project; Air Quality Monitoring Component, Reference Laboratory and Training (HEIA-R).

The project has been performed according to the plans. Only minor changes in personnel and Missions (time schedules) have been necessary due to personnel and facilities available. We have adjusted to the actual situation in order to undertake the project in the best possible and most practical manner. The missions and personnel used are described in the following.

Missions and reports
A first mission during the new phase of the NORAD project was paid to HCMC during 28 January to 4 February 2005. The second and a major Mission took place from 1 May 2005 to 14 May 2005.
The numbering of the Mission reports have been referring to the new HEIA-R phase; MR1 to MR4 (**M**ission **R**eference laboratory project reports). The two main Missions to HCMC during this project phase have also been numbered following the numbering from he first phase, which has been presented as Mission 6 (May 2005) and Mission 7 (Oct-Nov 2005) reports. We also issued one status report (SR1) after procurement of equipment, which was undertaken from Norway. This report also included a summary of an additional field study undertaken in May 2005.

Report	Old nr.	Indicator	Work during month
MR1	Memo 1	Planning, design and training	Jan- Apr 2005
MR2	Miss6	Audit and training	May – July 2005
SR1	Memo 2	Equipment, field study	July- Sep 2005
MR3	Miss7	Installation and training	Oct-Nov 2005
MR4	Final rep	Final seminars and reporting	Nov Dec 2005

A short Mission was paid to HCMC in July 2005 in connection with meetings related to the ADB Air Pollution Poverty and Health project. Only the project manager participated in meetings and discussions related to the HEIA-R project. Several

meetings with the HEPA staff was arranged to discuss data quality control, prepare status and monthly reports as well as discuss the procedures for the establishment of the calibration and reference laboratory.

The next main mission to HCMC was in October- November 2005. This included:

- The installation of the reference and calibration laboratory at HEPA
- Installation of a new meteorological station in HCMC
- Upgrading the GIS based database and modelling system, AirQUIS
- Data quality assurance (QA/QC) included training and workshops
- Training in understanding air quality data and reporting
- A final seminar and workshop to summarise the results of the HEIA projects

We assume that the Mission in October – November 2005 will be the final one of the NORAD financed HEIA projects. There is an opening for a final check of the equipment and reporting procedures early next year (2006) approved by NORAD. However, the funds made available have been used long time before the end of this year, and NILU will probably have to support the project from the institute's own budget to finalise the tasks as described in the proposal.

Personnel

There has been a slight change in personnel during the HEIA-R project compared to the experts presented in the proposal. These changes have been discussed before and are again presented in the following table.

Init	Name	Functions
BS	Bjarne Sivertsen	Project Manager, Air Quality monitoring design and presentations (*as plan*)
TNT	The Nguyen Thanh	Data base systems, data transmission, system, GIS and AirQUIS manager (*as plan*)
RuO	Rune Odegaard	AirQUIS expert. Replaced H Laupsa to improve the AirQUIS development and training (*replacement)*.
RD	Rolf Dreiem	Instrument expert, reference laboratory establishment (*as plan, but on leave for 6 months due to illness*)
HW	Harald Willoch	Replacement for RD during illness. Responsible for Audits to all stations performed in May 2005. (*Temporary replacement*)
LM	Leif Marsteen	Quality assurance (QA/QC) expert, instrument procurement and QA/QC training (*as plan)*
MW	Mona Waagsboe	Supporting the Project Manager in air quality data quality controls and reporting.(*additional support expert*)

AppF2

Dynamic calibration sheet for NOx monitors

The first dynamic calibration was performed at the new calibration and reference laboratory at HEPA on 1 November 2005.

The results the calibration of the NOx monitor is presented below:

Dynamic calibration - NOx-monitor

Guest

Owner:	Ref Lab			
Monitor:	200E			
Serial no:	814			
Date:	10/28/2005			
Comment:				
		NO	NOx	NO2
Range:		1500	1500	1500
Offset:				
Gain:				

Reference

Cal. lab:	Ref Lab	Purpose:	First callibration
Calibrator:	API 700	Ser. no:	1282
Gas std:	NIST	Ser. no:	CAL013261
NO:	48.74 ppm	NOx:	49 ppm

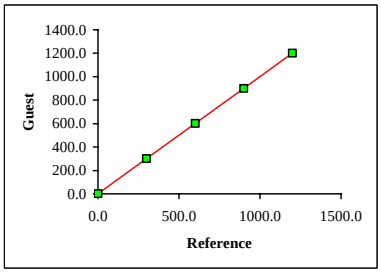
	a	b	
Gas flow:	1	0	GF = a * Gas + b
Dil. flow:	1	0	DF = a * ZeroAir + b

Parameter NO

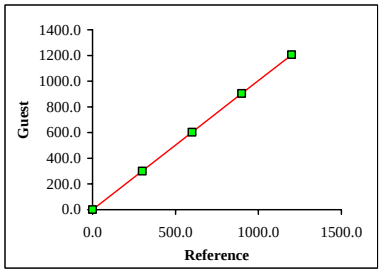
Zero air [LPM]	Gas [SCCM]	Ref. man. [ppb]	Ref. [ppb]	Guest [ppb]	Rel. dev. [%]	Statstics, y=ax+b	a	b
	0.0	0.0	0.0	1.0	1.0	Scale fact.:	1.001	-1.001 1)
		300.0	300.0	300.4	0.1	Regression (G vs. R):		
		600.0	600.0	601.4	0.2	Scale fact.:	0.999	1.040 2)
		900.0	900.0	900.0	0.0	Std. error:	0.001	0.442
		1200.0	1200.0	1200.0	0.0	Std. error y estimate:		0.570
						r2:	1.00000	

Parameter NOx

Ref [ppb]	Guest [ppb]	Rel. dev [%]	Statstics, y=ax+b	a	b
0.0	0.7	0.7	Scale fact.:	0.996	-0.697
300.0	299.6	-0.1	Regression (G vs. R):		
600.0	602.4	0.4	Scale fact.:	1.005	-0.460
900.0	904.0	0.4	Std. error:	0.001	0.855
1200.0	1206.0	0.5	Std. error y estimate:		1.103
			r2:	1.00000	



1) Ref = a * Guest + b [ppb]
2) Guest = a * Ref + b [ppb]



Converter check

	Without O3 [ppb]		With O3 [ppb]	
NO:	600.0	599.5	207.0	206.2
NOx:	600.0	596.7	599.0	595.7
NO2:		-2.8	NOx-NO	389.5
Eff. (%):		99.7	**>= 96% OK**	

Laboratory environment

Temp:	26.3	°C
Pressure:		mBar
Rel. hum.:	66.0	%

Comments

Init: Huy

AppF3

In stock spare parts at HEPA as of August 2005

Air Pollution Monitoring - Instrument

Part number	Item	Quantity
005960000	Activated chaircoal	24
005970000	Purafil	22
FL0000003	Filter, DFU (036-040180)	15
KIT000002	Retrofit, O3 Gen Brick, M200A	1
FL0000001	Sintered Filter (002 - 024900)	30
015090000	UV lamp supply	2
015062200	Permeation tube	3
011390200	Power supply module M100A	1
011390200	Power supply module M200A	1
011390300	Power supply module M400A	1
PU0000022	Pump Rebuild Kit, KNF Model #N05ATI	22
KIT000058	Leak checker with gauge	1
014340000	Valve, Shuttle, Drier	2
005260200	UV Lamp Assembly, Source	4
015810000	Source Assembly (with Adapter)	2
002730000	Window 665 NM (002-013100)	3
003290000	Thermistor Assembly 885-071600	3
002620100	UV Lamp Assembly	1
005140300	V/F card assembly	1
KIT000124	CPU card assembly	1
014080100	Assembley, High Voltage Power Supply	1
KIT000093	214 nM UV filer	1
021070000	PMT Pream Card	1
002680000	CD, PMT, SO2, Low noise	2
002670000	CD, PMT, NOx, Low noise	1

Appendix G

Seminars and workshops

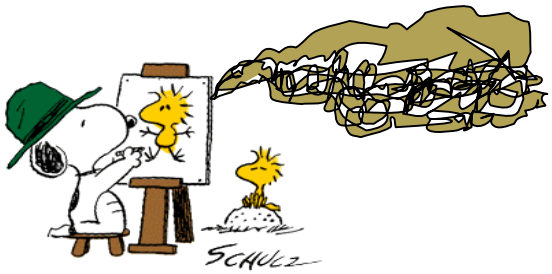
App. G1

Seminar HEPA 16 November 2005

QA/QC in air quality monitoring and assessment

Time (hr)	Topic	Lecturer
09:00	Welcome, presentations, introduction	BS, VTD
09:15	Introduction to the Measurement Network Operations • Instruments • Calibrations • Data quality	L Marsteen
09:45	Quality Assurance programme • Background for introducing a quality system • The three Qs: Quality assurance, Quality control, Quality assessment • Tasks and responsibilities in the quality organisation • Traceability in calibrations • Quality system outline, the Quality Handbook data quality objectives	L Marsteen
10:30	Coffee break	
10:45	Air quality data and errors • Why correct data • Procedures for correcting data • Presentation of data, examples and reports	BS
11:45	Lunch break	
13:30	The HEPA quality assurance system • The Quality Control Manual • SOPs, log books and other reports • How to use the system	L Marsteen
14:30	The HEPA experience	VTD, HEPA experts
	Coffee break	
15:00	The importance of quality in all parts Examples, discussions and presentations from HEPA	all
15:45	Questions and Summary	all

AppG2-



HCMC Air Quality Monitoring and Management Programme

Final seminar 23 November 2005

Contents and Agenda

Introduction

The seminar will present a summary of the air quality monitoring and management programme, which has been developed, based on Danida and NORAD funds in Ho Chi Minh City. The presentations will mainly be based on the development and training performed by NILU and will include background, monitoring system, calibration laboratory and air quality results.

The basic platform established for the air quality databases, emission inventories as well as the air pollution modelling has been based on the Norwegian developed AirQUIS system. This system may also be used for air quality assessment and planning. To ensure the best possible quality in the programme NORAD added support for the development of a reference and calibration laboratory. Results and status concerning the air pollution situation in HCMC will be presented in the seminar.

A total of 9 measurement sites using automatic monitors have been established in Ho Chi Minh City (HCMC). Four of the sites were supported by Danida and installed in 2000, while the remaining five sites have been supported by NORAD and were installed with the support from Norwegian Institute for Air Research (NILU) in 2002. The stations, site characteristics and locations are given in the Table below.

Table1: Air pollution measurement sites in HCMC, site characteristics and positions.

Stations				Indicators					UTM 84 N	
ID	Code	Name	Charact.	PM10	NO2	SO2	O3	CO	X coordin (m)	Y coordin (m)
1	DO	DOSTE	Traffic		X	X	X	X	684,430	1,192,220
2	HB	Hong Bang	Traffic		X		X	X	681,620	1,189,460
3	TD	Thu duc	Res/Ind		X	X			693,640	1,199,790
4	TS	Tan Son Hoa	Urb Bkg		X	X	X	X	682,830	1,193,930
5	TN	Thong Nhat	Traffic	X	X	X		X	680,690	1,193,530
6	BC	Binh Chanh	Traffic	X	X			X	674,500	1,183,000
7	ZO	Zoo	Urb Bkg	X	X		X		686,420	1,193,370
8	D2	District 2	Res/ind	X	X	X	X		691,160	1,193,510
9	QT	Quang Trung	Urb Bkg	X	X	X	X		677,940	1,200,080

Hourly air quality data are being collected through the automatic monitoring and telemetric network every day. The data are quality controlled and transferred for storage in the integrated relational databases. Statistical programmes for control of quality and representativeness are used to check the validity of the data. Results can be then presented using user-friendly graphical tools.

The key features of the system is the integrated approach that enables the user 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. At present Air Quality Index (AQI) values are generated automatically and presented on an information board in the city centre of HCMC as well as on an Internet page developed for DONRE/HEPA.

Air pollution dispersion models have also been 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. For this purpose the HEPA experts are in the process of completing an emission inventory for HCMC.

During the last few months NILU has, with the financial support from NORAD, established a reference and calibration laboratory at HEPA. This will assure that calibrations and controls of the data will give quality assured air pollution information for HCMC.

Proposed Agenda for the seminar

To be held in HCMC,
Wednesday 23 November 2005

Time (hr)	Topic	Lecturer
09:00	Welcome, presentations, introduction	Dr Chien, B Sivertsen
09:15	The air quality monitoring and management programme for HCMC a) Installations, content and schedules b) Background and indicators	 Dr. Tuan Bjarne Sivertsen
10:00	***Coffee break***	
10:15	The GIS based AirQUIS platform; data transfer and data bases	The Nguyen Thanh
11:45	Modelling air quality (introduction) Impact assessment, planning and forecasts	B Sivertsen
12:00	***Lunch break***	
13:30	Emission inventories and modelling in HCMC, (Input- output – examples) The use of models in air quality management programmes	B Sivertsen Ms Minh Hang
14:15	***Coffee break***	
14:30	Air Quality assessment, Air pollution levels (comparisons to standards) Reporting procedures	B Sivertsen
15:15	Using the system and data dissemination systems Understanding air pollution, future applications, Air Quality Management and abatement strategies	T N Thanh B Sivertsen
16:00	Questions, discussions and summaries	all

Appendix H

Minutes of meetings

Minutes

Title: **Project meeting no. 12**
Date 16 August 2005
Participants: Bjarne Sivertsen (BS), The Nguyen Thanh, (TNT), Harald Willoch (HW), Rolf Dreiem (RD), Leif Marsteen (LM), Mona Waagsbø (MoW), Tore Nilsen TIN),
Prepared by: B Sivertsen
Distribution: Participants, Rune Ødegaard (RuO), Gunnar Jordfald (GJ), Paal Berg (PB), Le Van Khoa (LVK), Vo Thanh Dam (VTD), NORAD, SFT

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1 Agenda

An Agenda for the meeting had been distributed before the meeting:

- Project status just now, Mission report 6 (BS)
- Instruments and spare parts; field instruments (HW/TNT)
- Status Reflab rooms (BS)
- Instruments and equipment for Reflab + Vaisala weather station!(LM/HW)
- AirQUIS status, air quality data and input data (TNT)
- Data controls and corrections (MOW/BS)
- Training needs assessment; prepare for seminars in October. (BS/LM)
- NILU/HEPA input to the new ADB Health project (BS)
- Time schedules and further work.
- Other matters

2 Summary of the meeting

2.1 Project status just now, Mission report 6 (BS)

Mission report 6 was distributed to the Division of Environmental Quality, Monitoring and Assessment (EQMA) at HEPA on 1 August 2005, and will also be sent to NORAD and SFT after this meeting. The invoice no. 25314 has been prepared together with a status report (see attached) to be sent to NORAD with copy to DONRE on 17 August 2005. Questions from Mr Dam received on 12 August will also be addressed and answered in this document.

Other matters concerning the project status are being discussed below.

2.2 Instruments and spare parts; field instruments (HW/RD/TNT)

We received a list containing the status of instruments during Mission 6, in May 2005. Mr Quoc sent an additional list of spare parts available at HEPA to NILU on 16 August 2005. RD and HW will check these lists and try to identify the total needs for spare parts to be added to enable repair and maintenance at the new reference laboratory. RD will also add the instrument serial numbers to be sure that we know which instrument belong where.

HEPA has reported errors on the data loggers provided by OPSIS. TNT will check prices and communicate with HEPA to try to have all instruments WITH data loggers in operation. Instruments like the PM_{10} monitor at Zoo station does not seem to log data at all. The error will have to be identified and repaired.

2.3 Status reference laboratory and repair rooms (BS/TNT)

The layout of the reference laboratory was discussed during our visit to HEPA in May 2005 (See Mission 6 report). During the last few days we have been informed that the space available on the ground floor has been reduced, and that the size of the reflab + data retrieval room is totally 3.5 m x 7 m. This will not be sufficient to house the reference and repair laboratory and the data retrieval room. We are still discussing with HEPA alternative solutions, and Mr Dam provided a third alternative on 17 August (See Attachment 2).

Furniture, benches and shelves as well as air condition system and computer will be purchased locally in HCMC. NILU will specify these objects to be bought locally.

2.4 Instruments and equipment for Reference laboratory (LM/RD)

Instruments for the reference laboratory have been arrived in Oslo at the Norwegian dealer; Industriell måleteknikk. The instruments will be checked and sent directly on to HEPA in HCMC to arrive there well in time before installations. Packing list and specifications will be sent to HEPA when these are available at NILU.

The reference laboratory will also be equipped with reference gases. These gases will be provided from NILU. LM will check that gases are available and see that these will be sent to HCMC to arrive in time before installations at the end of September.

2.5 Vaisala weather station (LM/TIN/HW)

HEPA and NILU have agreed to use money from the budget to procure and install a new weather station at DOST. The new meteorological station has been delivered by Vaisala OY in Finland and has been tested at NILU.

NILU has prepared a new transfer of these data to the HEPA data centre. Meteorological data will thus be transferred from the NILU data logger mounted in the tower via blue tooth technology to the shelter at DOST. From here the data will be transferred to the computer centre via a new normal telephone line or via a mobile telephone in the shelter. The operator at the computer center will initiate this retrieval every morning or whenever needed.

HW will check the dimensions of the tower to prepare installations. The old sensors will be taken down and new sensors mounted. We will need the dimensions of the different parts of the tower as soon as possible. HEPA will see that there are people available locally to climb the tower during installations.

2.6 AirQUIS status, air quality data and input data (TNT/RuO)

NILU has received a dump from Ms. Duong Thi Minh Hang at HEPA for verification regarding the models in AirQUIS. The results of modelling have given too high concentrations compared to the measurements undertaken in HCMC.

There are several elements that may affect the model result. The most relevant parameters to evaluate has been:

- Meteorological input data
  The quality of the data period for meteorological data used for this model run
  No variation in the lower temperature data
  No variation in the wind direction data
- Emission data (line sources, area sources and point sources)

It has been a great challenge to establish a complete and updated emission inventory for traffic input to the model run. Only a few of the main roads have been counted. Emission factors have been taken from international studies not necessarily representative for HCMC. Also the point sources have not been adequately imported to AirQUIS.

We have changed and corrected the emission factors for traffic sources. The vehicle classification has been improved, and new runs have indicated that the results have been improved.

We have uploaded a modified AirQUIS project dump for download at: ftp://ftp.nilu.no/pub/AirQUIS/Ho_Chi_Minh/HCMC_Modelling.DMP, including new emission factors and approximately one months of air quality and meteorology data mention above.
Further work has to include:

- Collect and import more point sources
- Import new meteorological data sets
- Import area sources as estimated by each Ward of HCMC
- Continue test runs and compare with good quality air pollution data.

2.7 Data controls and corrections (MOW/BS)

A considerable amount of time has been spent on data quality controls and corrections. To further improve this part of the data quality assessment it was decided during Mission 6 that printouts of all data, which is supposed to be collected in a special designed Word file, would be E-mailed to NILU. NILU experts will then evaluate the data and report back to the QA/QC officer at HEPA.

QA/QC procedures will have to be upgraded. As part of reporting these data we will have to describe the automatic quality controls (LM/TNT) as well as the manual checking of data (BS). Scaling factors taken from the sites every week does not seem to be applied when data are transferred to the AirQUIS database. This will have to be verified by Mr Dam.

Printouts of raw data in AirQUIS have been presented for all data. Data for 2005 are being corrected and a new updated database will be presented to HEPA. An example of printouts is shown in Attachment 3. We see relatively good correlation between the stations operated, but there are a lot of data totally missing. Also the behavior of the AQI does not seem correct all the time. This is dependent upon which stations and which parameters are working at any time.

2.8 Training needs assessment; prepare for seminars in November (BS/LM/TNT)

Training workshops and training seminars will be prepared and will be held in November 2005. A main part of these workshops will contain quality assurance procedures. We see that as part of the establishment of the reference laboratory there is still a fundamental lack in understanding the importance of quality assurance.

Another part of the seminars will be (again) on understanding air pollution and in the application of AirQUIS. Especially the modelling part of the AirQUIS applications will be repeated and given more attention.

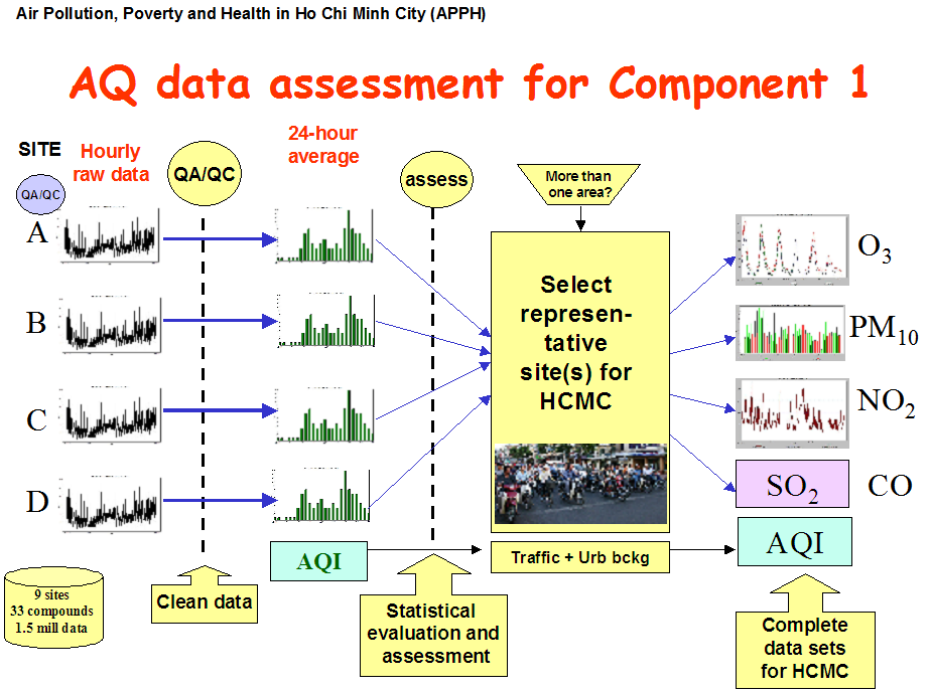
2.9 NILU/HEPA input to the new ADB Health project (BS)

Another meeting concerning the new air pollution, poverty and health (APPH) project was held in HCMC in July 2005. HEPA, in collaboration with NILU, will provide exposure estimates for each patient in this study.

From the air quality measurement programme as well as from model estimates it will be possible to produce concentrations in receptor points as well as in specified areas of the following pollutants:

- Suspended particles (PM_{10} as an indicator)
- Ozone
- Nitrogen dioxide (NO_2)
- Carbon monoxide in selected streets (CO)
- Sulphur dioxide (SO_2)

The procedures and techniques to be used for obtaining the necessary input of air quality information will depend on the detailed design of the programme. HEPA is presently trying to identify sources of pollution that need to be focused on or accounted for as confounders.



The figure above indicates a procedure for air quality data assessment to obtain input data for the first component of the health project.

For the second component of the APPH project we may need to perform exposure estimation. There are at least three different exposure models that will be utilized:

1. Daily exposure estimate at the city level: individual pollutants
2. Daily exposure estimate at the city level: Air Quality Index
3. Total exposure of individuals in micro environments

Daily exposure estimate at the ward level may be available. This would involve combining data from air pollution monitors with other information currently being collected, such as traffic density and emission inventories. Each patient's residence would then be assigned the ward-level ambient concentration for each day.

2.10Time schedules and further work

Two Missions are being planned for the Autumn 2005. The first mission includes installations of the reference laboratory and weather station, while the second is divided in 3 parts.

The four parts of the two missions are thus:

1. Install Reference laboratory and new weather station.
   Period: 25 September to 4 October 2005
   NILU experts: BS and RD
2. AirQUIS, data quality, plus on the job training
   Period: 6 - 11 November
   NILU: BS and TNT
3. QA/QC, understanding data, workshops and seminars
   Period: 14 –18 November 2005
   NILU: BS and LM
4. Summary, conclusions last update of AirQUIS
   Period: 21.25 November 2005
   NILU: BS and TNT

Depending upon infrastructure availability and other matters there still may be small changes in the proposed schedules.

2.11 Other matters

RD is back at NILU from a period of illness from 22 August 2005. He will thus take over the responsibility for instruments and reference laboratory installations.

HoChiMinhCity Ennvironmental Protection Agency
(HEPA/DONRE)
The Norwegian Institute for Air Research (NILU)

Attachment 1:
Memo

Title	**Tasks undertaken 1 April-31 July 2005**
Purpose	A description of tasks performed from 1 April to 31 July 2005, related to invoice to NORAD nr. 25314, dated 17 August 2005.
Distribution	Mme Nguyen Thi Tuyet Hoa (NTTH), Mr. Khoa, Mr Dam, The Nguyen Thanh (TNT)
Author	Bjarne Sivertsen
Date	15 August 2005
Reference No	O-101143

Referring to the Invoice nr. 25314 addressed to NORAD dated 17 August 2005 and the Mission 6 Status report (MR1-2) (NILU OR 38/2005) the following tasks have been undertaken during this period of the project:

1 Missions to HCMC

Two Missions have been paid to HCMC during the Invoice period. The official project Mission was totally number 6 during the NORAD financed HEIA and HEIA-R projects and took place from 1 May 2005 to 14 May 2005.

Another Mission took place 14 to 22 July 2005 and was mainly aimed at planning the Asian Development Bank project on Air Pollution, Poverty and Health. However, meetings were also held at HEPA concerning modelling and data quality.

2 Preparing the reference laboratory at HEPA

The Reference Laboratory is being prepared and will include maintenance and repair capacity building, plus additional training for the application of the AirQUIS system for air quality planning in HCMC is all part of the HEIA-R project.

Specifications and discussions of the layout of the Reference Laboratory was discussed in meetings with HEPA, and a layout and plans for reconstructions were presented at HEPA. See Mission report 6.
It was agreed that a room for the Reference laboratory would have to be identified at HEPA before September 2005. The complete reference laboratory should then be equipped with gas monitors in addition to the multipoint calibration units, to enable calibrations of gas standards.

3 Instruments for the reference laboratory

Instruments for the reference laboratory have been specified and ordered by NILU. NILU has obtained a compatible price from the Norwegian company and the order was placed at the end of April 2005. The further plan is to have all equipment available in HCMC before the end of August 2005 for installations in the Reference laboratory in September, when also testing will start. The NILU instrument experts will prepare installations. Some training will be given to the HEPA experts during the installations.

NILU also plan to install a new meteorological station for HEPA during the same period. This station will be located at the tower at DOST near Dien Bin Phu street in District 3. The plan is to install the station at DOST in September 2005 as a "gift" from the NORAD/NILU project. Work has been undertaken to prepare and test this new weather station.

4 Data quality assurance and training (HCMC)

A considerable amount of time has been spent on data quality controls and corrections. To further improve this part of the data quality assessment it was decided during Mission 6 that printouts of all data, which is supposed to be collected in a special designed file, would be E-mailed to NILU. NILU experts will then evaluate the data and report back to the QA/QC officer at HEPA.

In HCMC we analysed air quality data, performed corrected actions and did some training on the data assessment at the computer centre. Procedures for data quality controls after imported to the database were also developed.

5 Station audits

The NILU instrument expert performed a complete station audit between 7 May and 12 May 2005 (See Appendix C, Mission report 6). This work was originally planned as part of the first phase of the HEIA project, but due to illness it had to be postponed. The NILU procedures for system evaluation audits have been followed.
The station audit included several controls including:

- The station itself (infrastructures)
- Instrument performance including
  - Performance evaluation audit - gas monitors
  - Performance evaluation audit - PM_{10} monitors
  - Evaluation of Meteorological equipment
- Documents and operational reporting procedures

A non-compliance report has also been prepared after the completion of the audits. A separate report has been prepared as a result of t he audit

6 Instrument status and spare parts

Some instruments (from Danida) have now been operated for more than 5 years. The lifetime of some of these monitors are between 5 and 10 years. To keep up good quality data they need to be checked and maintained properly. NILU normally recommends a yearly overhaul of the instruments. This will in the future be one of the tasks of the reference and maintenance laboratory.

NILU has spent time during this period to check spare part lists and available instruments at HEPA.

7 AirQUIS status and upgrades

A new updated version of AirQUIS was installed and verified at HEPA during Mission 6. The shape files for Wards in HCMC have been prepared and installed in AirQUIS.

The modelling area in AirQUIS has been identified and the grid system for modelling was decided before Mission 6. The grid consists of 43 EW and 35 NS points with 1 km resolution. Also stack coordinates for the large point sources have been re-inspected and new co-ordinates introduced in AirQUIS.

The work concerning the use of AirQUIS for monitoring data as well as for modelling and air quality planning is a continuous process. To update the system the following challenges have been solved:

1. Reinstall the latest update and workable AirQUIS (Appendix D2, Mission 6).
2. Import HCMC's Wards shape file into GIS of AirQUIS (Appendix D3, M6)
3. Revise and input traffic counting data into AirQUIS
4. Import correct locations of point sources

Also air quality data will have to be corrected according to tests and corrections that have been undertaken at NILU.

8 Modelling data input

As indicated under the AirQUIS status above, NILU and HEPA have been working on preparing input to the dispersion models. New traffic counting data and the specification of wards has been prepared

During Mission 6 we also verified new point sources and industrial emissions. These data will be prepared for AirQUIS.

Wind and temperature data from the HEPA tower have been corrected and verified. Also meteorological data based on large-scale weather forecast data have been collected.

9 Passive sampling of NO_2 and SO_2, May 2005

Concentrations of NO_2 and SO_2 were measured along selected roads and streets in HCMC using passive samplers. The sampling period for most of the samplers were from 4 to 12 May 2005. The purpose was to verify the measurements undertaken by the continuous programme, and to study the concentrations as functions of the distance from major roads.

Concentrations of SO_2 ranged between 16 and 53 µg/m^3 as an average over 8 days of sampling. Similarly the NO_2 concentrations varied from 24 µg/m^3 at the urban background site at Ton Son Hoa to 84 µg/m^3 in Ly Tuong Kiet Street near Thong Nhat hospital

10Internet pages

NILU supported HEPA in establishing an Internet presentation of air quality data online. Establishing of this web site was not a part of this project. However, HEPA asked assistance from NILU and the data can be found at www.hepa.gov.vn and www.luftkvalitet.info for more information about NILU as Air Quality Service Provider.

11Further institutional building

It is in everybody's interest that the HEPA experts will be able to communicate and use the tools provided by the NORAD funds in the best possible manner. As part of the continued NORAD funded project NILU will do its best to update and to assure that the new Division of Environmental Quality, Monitoring and Assessment (EQMA) at HEPA have the best tools available and that adequate training is being given to the staff. These EQMA experts need to have updated knowledge of methods and data to represent the key personnel in the future.

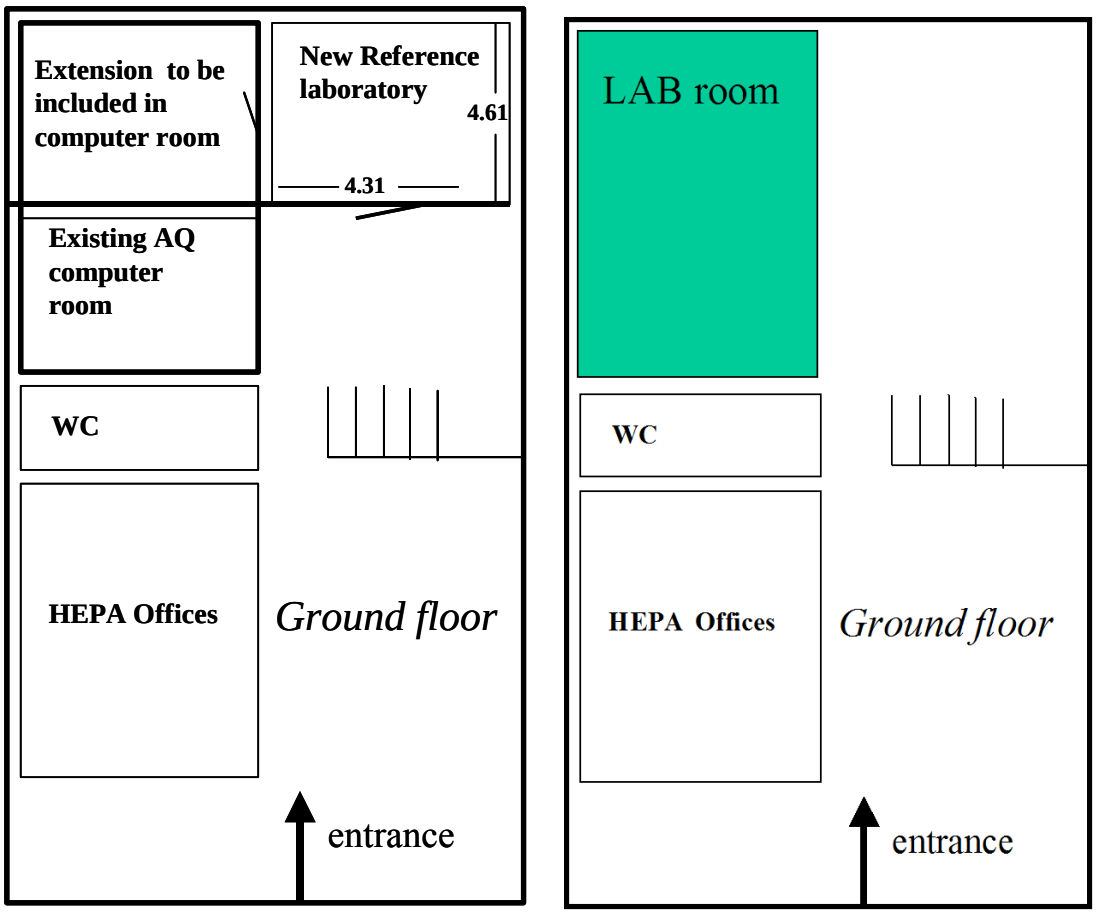
12Meetings

A number of meetings have been held at NILU and at HEPA during the Invoice period. Minutes from these meetings can be found in the Mission report.

Attachment 2

Reference laboratory options

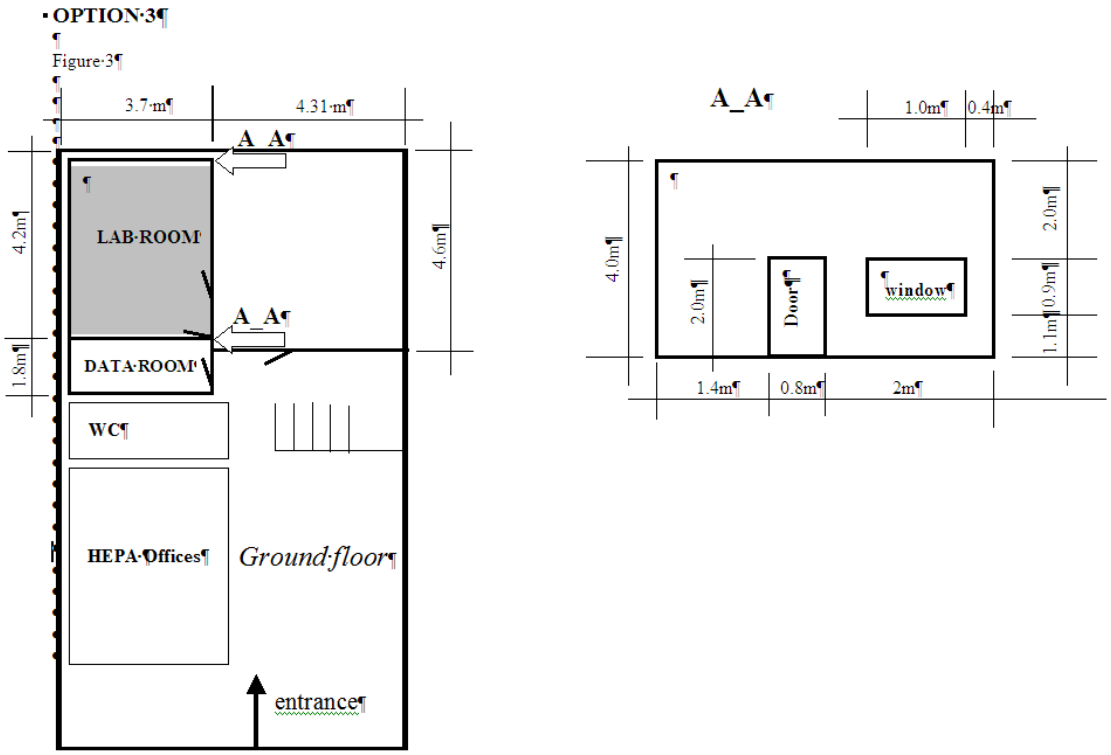
We still propose to go for the original proposal from NILU, because this is the best solution. The figure to the left is our original proposal. The figure to the right is prepared based on information from Mr Dam concerning the solution accepted by HEPA as of 16 August 2005.



Alternative 2 (right figure) can not fulfil our purpose. This room (green) could be used as reference and repair laboratory alone! The data collection equipment must thus be moved to another location.

Another possibility is to divide the green alternative into two rooms: 3.5x 4.5 m (lab) and 3.5 x 2.5 m. We will also propose to move the modelling and assessment computers to the space beside these rooms and give the existing room in the first floor to other HEPA activities.

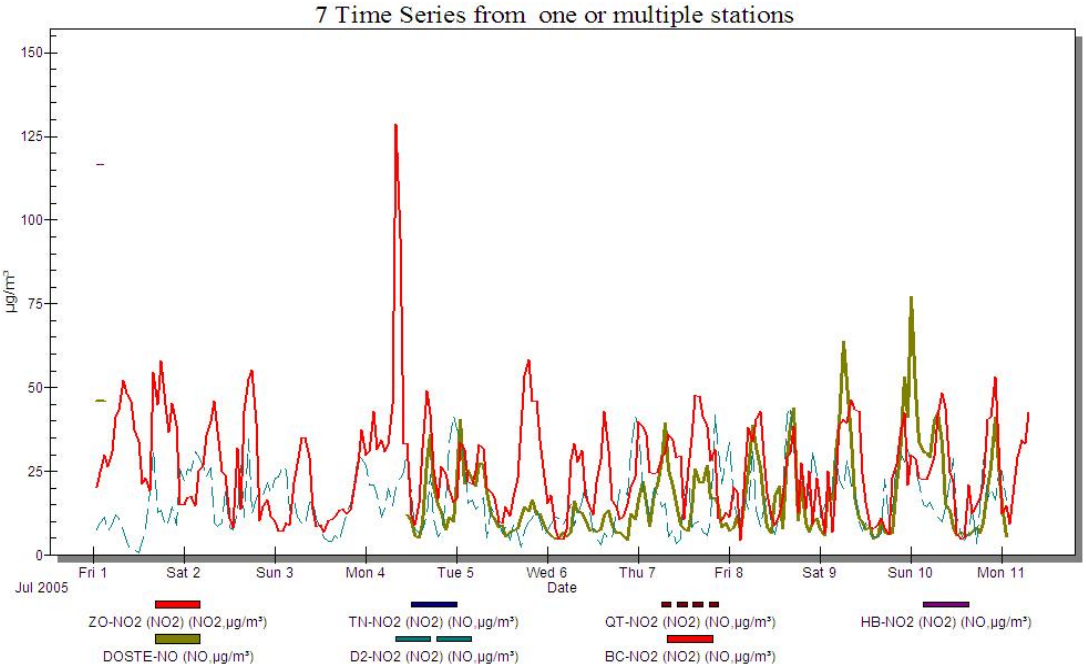
An option 3 was received from Mr Dam on 17 August. The total layout is shown below.



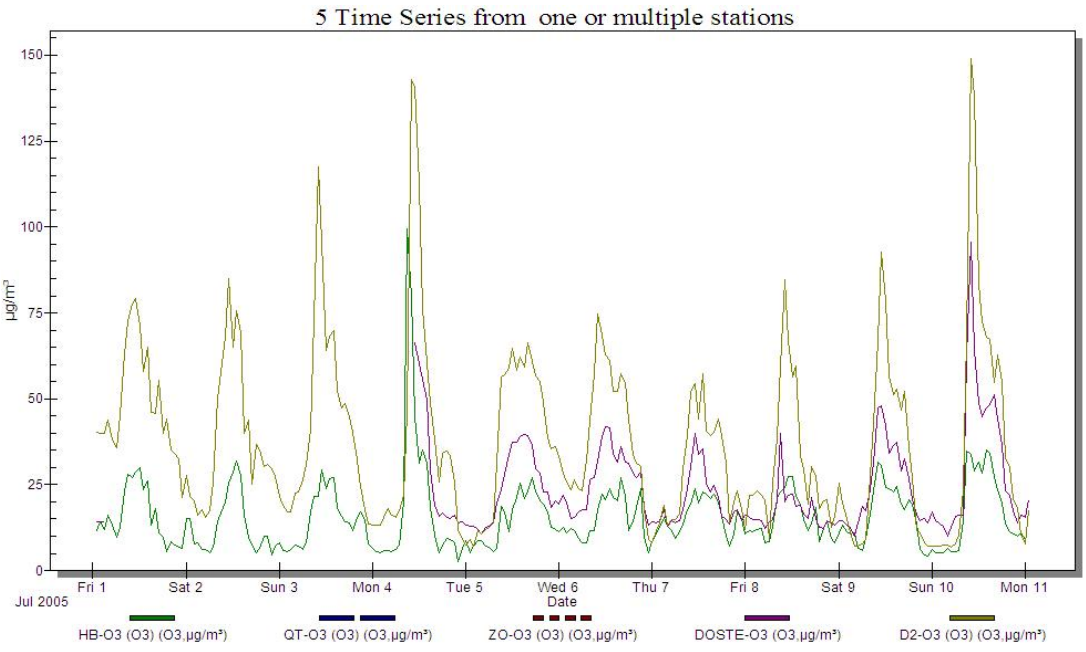
Attachment 3

Raw Data 1 – 11 July 2005

NO_2 at Binh Chanh, District 2 and Doste

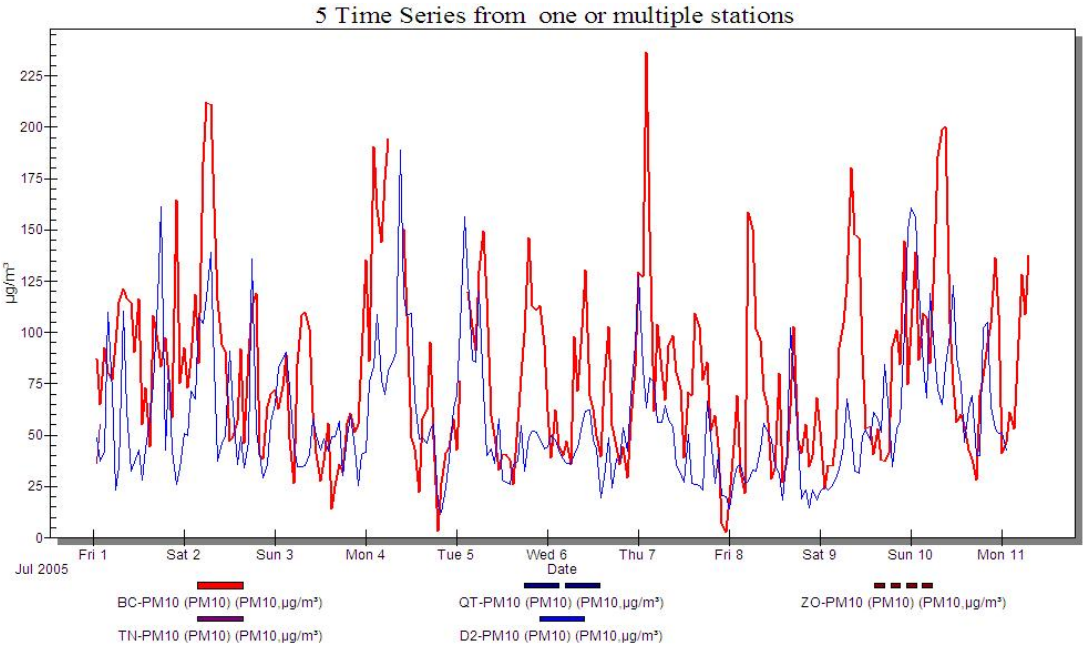


Ozone at District 2, Doste and Hong Bang



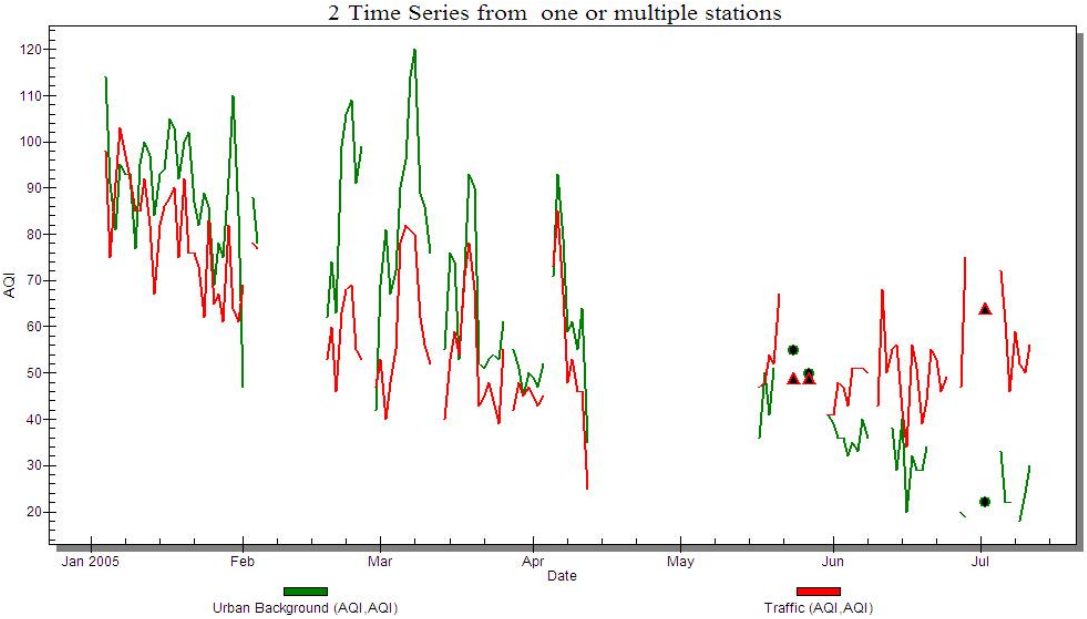
Hourly raw data July 2005

PM_{10} at Binh Chanh and District 2.



3 AQI data

AQI for traffic (red) and urban background stations (green) for the year 2005.



App. H2

Cost specifications, HEIA project Phase 1 and 2

Introduction

The total budget for 2005 and beyond is composed of the remaining work from the first phase of the project, which had to be postponed due to hospitalisation of the instrument expert Mr R Dreiem, and the additional funds made available through the Reference lab project. The health problems of Mr Dreiem also caused a delay in some of the training component, which has been undertaken during the first 6 months of 2005.
The total budget for the new Reference lab component is according to the new contract **1 732 000 NOK**. The remaining budget from the first phase of the HEIA programme is **312 463 NOK** (see table below).

Total budget and payments HEIA project

Invoice date	Number	Costs NOK
21.06.2002		2747130.83
06.02.2003		934226.24
12.06.2003		285221.77
28.11.2003		1101883.17
04.06.2004		478247.84
20.12.2004		514328.72
Credit		-127000
30.12.2004	24676	153498.15
Total payd		**6087536.72**
Budget		6400000
Remaining work Jan05		**312463.28**

The payment schedule for the total remaining budget of **2 044 463.- NOK** is linked to major milestones described in plans and Mission reports. An updated payment schedule will look as follows:

Payment	Indicator	Report	Old nr.	Month	1000 NOK
1	Planning, design and training	MR1	Memo 1	1-4	135
2	Audit and training	MR2	Miss6	5-7	482
3	Equipment procured, field study	SR1	Memo 2	11	800
4	Installation and training	MR3	Miss7	10-11	500
5	Final seminars and reporting	MR4	Final rep	11-12	127
	Total budget				**2044**

NORAD will make the payments for services directly to NILU in accordance with terms of the Contract upon receipt of invoices issued by NILU and certified by DONRE.

Payment of tasks related to Phase 1

The final tasks remaining from the first phase of the project has been finalised as of the end of July 2005. The costs for these tasks have been included in two invoices issued by NILU; Invoice 25053 dated 29 April 2005 and invoice 25314 dated 17 August 2005.

The tasks and persons involved as well as hours used and total costs is presented below.

First phase of HEIA - from Invoice 25053

Fees		Manhrs				
Function	Persons	Norway	HCMC	Tot. (hrs)	hr rate	Total (NOK)
Proj. manager	BS	12	60	72	826	59392.00
AirQUIS	TNT, RuO	7	0	7	826	5466.00
AQ data support	MW, +	20.7		20.7	572	11856.00
Ref lab, QA/QC	RD, LM +	22.3		22.3	592	13214.00
				122		**89928.00**

Travel and subsistence						
Person	period	Allowances	Ticket			Total
BS	January 2005	22016.00	21000.00			**43016.00**

Direct costs						
DHL freight						651.40
Visa						953.68

Total Invoice no. 25053, 29 April 2005				**134549.08**

First phase of HEIA - from Invoice 25314 -17 Aug 2005

Fees		Manhrs				
Function	Persons	Norway	HCMC	Tot. (hrs)	Hr rate	Total (NOK)
Proj. manager	BS	4	30	34	826	28084.00
AirQUIS	TNT, RuO			0	826	
AQ data support	MW, +	1		1	571	571.00
Audit, QA/QC	HW, LM +	29	108	137	772	105728.81
						134383.81

Travel and subsistence						
Person	period	Allowances	Ticket			Total
HW	May 2005	22530.39	21000.00			**43530.39**

Total First Phase work from Invoice no. 25314, 17 Aug 2005			**177914.20**

Total work performed as part of Phase 1	**312463.28**

Payment of tasks related to Phase 2

The tasks performed as part of the second phase of the HEIA project, also referred to as the Reference Laboratory and training project (HEIA-R), has been invoiced as part of the invoice 25314 dated 17 August 2005. The remaining part of this project will be invoiced in November and December 2005.

The tasks and persons involved in the work of the Reference Laboratory and training project until the end of July 2005 is presented below

Hours spent for Phase 2 (HEIA-R) related work

Manhours		Jan 2005						Feb 2005							hr. rate	hours	NOK
Name		24	25	26	27	28		31	J	1	2	3	4	5	F		
BS	HCMC	2	2	2	2	2		2		2	8	8	8	8		840	46	38640.00
	NILU								10						6	840	16	13440.00

		May 2005																
Name		1	2	3	4	5	6	9	10	11	12	13	14	18	19	M	hr.rate	hours	NOK
BS	HCMC		8	8	8	8	8	8	8	8	8	8	8				840	88	73920.00
	NILU															6	840	6	5040.00
TNT	HCMC					8	8	8	8	8	8	8	8	8	8		840	80	67200.00
	NILU															38	840	38	31920.00
MW	HCMC																620		0.00
	NILU															38	620	38	23560.00
																	Total	**312**	**253720.00**

2.0 Reimbursables

Travel expences

Person	**Period**	**dayrate**	**days**	**allowance**	**airfair**	**Total**
		NOK	**n**	**NOK**	**NOK**	**NOK**
T N Thanh	4-20 may 2005	1440	12	17280	21000	**38280.00**
Visa TNT+HW	(Receipts Att. 1)					**2332.80**
Additional travel costs (Att. 2)						**656.00**
Total travels						**41268.80**

2.5 Equipment and transport

Item						**NOK**
Reflab software						2194.36
Chemical analyses for field studies (Attacment 3)						6240.00
Shipping DHL (Attachment 4)						369.52
Total equipment and transport						**8803.88**

Total second phase (HEIA-R) work from invoice no 25314, 17 Aug 2005	**303792.68**

Total invoice 25314	**481706.88**

Persons involved

Init	Name	Functions
BS	Bjarne Sivertsen	Project Manager, Air Quality monitoring design and presentations
TNT	The Nguyen Thanh	Data base systems, data transmission, system, GIS and AirQUIS manager
RuO	Rune Odegaard	AirQUIS expert. Replaced H Laupsa to improve the AirQUIS development and training.
RD	Rolf Dreiem	Instrument expert, reference laboratory establishment
HW	Harald Willoch	Replacement for RD during illness. Responsible for Audits to all stations performed in May 2005.
LM	Leif Marsteen	Quality assurance (QA/QC) expert, instrument procurement and QA/QC training
MW	Mona Waagsboe	Supporting the Project Manager in air quality data quality controls and reporting.

Conditions

The invoices have been sent in original form to PIU DONRE with a copy to NORAD. Approvals are supposed to be forwarded to NORAD after 10 calendar days. The payments are due forty five (45) days from the date of the invoice included 10 calendar days for the certification process at PIU DONRE. The prices for continual services shall not be changed during the Contract period. The price may be changed only upon renewal of the Contract. NILU may also claim price additions to cover documented increases in Norwegian customs or taxes, which are levied during the term of the Contract.

Norwegian Institute for Air Research (NILU)
P.O. Box 100, N-2027 Kjeller, Norway

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AUTHOR(S) Bjarne Sivertsen, Rolf Dreiem, Leif Marsteen, Rune Ødegaard and The N. Thanh	CLASSIFICATION * A CONTRACT REF.

REPORT PREPARED FOR
NORAD
Postboks 8034 Dep.
0030 OSLO, Norway

Ho Chi Minh City, Env. Improv. Project Implement Unit
Departement of Natural Resources and Environment (DONRE)
63 Ly Tu Trong Street,
District 1
Ho Chi Minh City

ABSTRACT
This report contains the conclusions from the third Mission of the HEIA-R project. This Mission was also the last one of the HEIA project. Nine air quality monitoring stations are now operated by HEPA in HCMC, and an air quality management system, AirQUIS, which has been installed and training was finalised.

Tasks undertaken during this last mission included the installations of instruments and equipment in the new calibration and reference laboratory at HEPA. The installation of a new meteorological station, further training in calibration and repair, a complete update of the QA/QC procedures, an upgrade of the existing AirQUIS version, improvement of the modelling capacity as well as the preparation and of workshops and a final seminar at DONRE were parts of this last mission.

NORWEGIAN TITLE

KEYWORDS		
Air quality monitoring	Air quality assessment	Vietnam

ABSTRACT (in Norwegian)

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