DEMT - DISTRIBUTED ENERGY MANAGEMENT TOOLS IN CAMBODIA AND LAOS

IED | ELECTRICITE DU CAMBODGE | MIH Lao PDR | Power Dev

Supported by the ACE through the EC – ASEAN Energy Facility

ASEAN CENTRE FOR ENERGY · ACE ·

Distributed Energy Management Tools (DEMT Project) for Cambodia and Lao PDR

Specification of Stakeholder Requirements For REE Management Tool

Cambodia, August 2005

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1. Introduction

The Distributed Energy: Operational Management Tools in Cambodia and Laos (DEMT) Project is funded by the European-ASEAN Energy Facility (EAEF) and is being implemented by:

a) Innovation Energie Developpement (IED);
b) Ministry of Industry, Mines and Energy (MIME) in Cambodia
c) Electricite du Cambodge (EDC); and
d) Ministry of Industry and Handicrafts (MIH) in Lao PDR.

This project was launched in May 2005 and is scheduled to conclude in May 2006. The main objective of the project is to help improve access to quality and reliable energy services to rural populations, by:

a) providing Laos and Cambodia with tailor made software tools to ensure the sustainable operations of local mini grids and / or renewable energy systems.
b) ensuring the long term sustainable operation (technical and managerial) of distributed renewable energy systems outside the main grid in Laos and Cambodia – hence increasing their penetration rate and acceptance;
c) increasing the efficiency of distributed energy systems (technical and managerial) through loss reduction (technical and non technical), improved maintenance and operation thus improving the economic viability of these systems;
d) contributing to the emerging of professional and well trained local – private – operators capable of efficiently running distributed renewable energy systems; and
e) developing institutional capability at the Ministerial / regulators level to formulate, implement and monitor the performance of private rural SMEs involved in distributed - renewable energy electrification.

In the rural areas of Cambodia and Lao PDR the generation and distribution of electricity is mainly left to small private entrepreneurs because the governments need to focus limited resources on urban areas. Consequently this important rural service is usually provided by small family businesses with very limited technical and managerial capacity, with no access to support services or advice, and with very limited access to financial services needed to upgrade their operations. The environment in which these small businesses operate is increasingly difficult due to rising fuel prices (imported diesel fuel), and increasing pressure from government to improve standards and reduce prices.

The concept behind this project is that the profitability and quality of service provided by these REEs should be improved with the use of an appropriate software tool that simplifies and reduces the time and cost of standard REE functions; while also providing the REE with better information for business decision making.

The methodology and main activities of the project can be summarised in the following phases:

A. **Needs Assessment –** to determine the requirements of the target user groups, with activities including site visits, survey, stakeholder interviews and analysis of existing systems;
B. **Development of Improved Tools –** creating a tool to meet the specified requirements of the users;
C. **Pilot Installation and Testing –** providing the tool and training to a sample group of users, and monitoring their use and experience of it over a 3 month period; and
D. **Training and Dissemination –** selecting and training a group of around 20 trainers, suitably qualified and in an appropriate institution, then these new trainers will train groups of REEs in the use of the new tool.

In Cambodia this project will also conduct some activities with Electricite du Cambodge (EDC), the state-owned utility, with the aim of improving some of their management software tools already used for rural electricity services.

This project is being implemented simultaneously in Lao PDR where the partner is the Ministry of Industry and Handicrafts (MIH). The situation of rural electricity service provision in Lao PDR has some differences to that in Cambodia, most significantly the absence of a large number of privately owned diesel mini-grids. There are however a large number of rural communities that are supplied by individual solar home systems or village pico-hydro units. A new World Bank funded project will soon greatly expand the number of such communities, and the private operators that manage them.

Consequently for Lao PDR the partners have agreed to develop a management tool focussed on the needs of the small Provincial Energy Service Companies (PESCOs) that provide these services.

The lessons and experiences will be shared between the stakeholders in both countries, as will the final software tools once they are developed, in order to maximise the future shared benefits of this project.

2. Aim and Purpose of this Document

The aim of this document is to specify the requirements of the target stakeholders of this project with respect to the design of a tool that would help improve the management of Rural Electricity Enterprises (REEs).

The specific purpose of this document is to accurately convey these requirements to a software programmer who is tasked with designing an appropriate REE Management Tool to meet the users' needs as far as possible. This document plays an important role in the project by documenting the proposed and agreed outcomes of the first phase, and then steering the direction and outputs of the second phase.

These specifications will, as far as possible, be produced without consideration of any pre-determined design solutions or pre-existing software. However since in reality only

one tool will be developed, these specifications must represent the majority of potential users while making note of any known special needs or differences.

The draft version of this document was reviewed by the DEMT stakeholders at a Specification Review Workshop in Phnom Penh on July 25th and 26th, 2005.

All stakeholders were encouraged to provide relevant comments at the Review Workshop, or else in writing or over the telephone to the following contact. Following the workshop this specifications document was updated to incorporate the feedback provided during the workshop plus some comments received afterwards. Any further comments or queries should be directed to:

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3. Defining Target Users

In Cambodia target users of the REE Management Tool are Rural Electricity Enterprises (REEs), that can be defined as private businesses operating in rural areas of Cambodia whose main business activity is the generation and, or, distribution of electricity. There is a wide range of sizes amongst REEs, from small single proprietor businesses operating in small rural villages, up to relatively large commercial operations with thousands of customers and large modern generators. There is no accurate and current data on Cambodia's REEs, however some reports have estimated that there may be over 600 REEs in total.

The Electricity Authority of Cambodia (EAC) is responsible for licensing REEs and ensuring their compliance with various licence conditions. EAC reports that there are currently 120 REEs that hold a valid licence for generation, distribution, or both (a consolidated licence).

The primary target users for the REE Management Tool will be REEs that meet the following criteria:

a) Privately-owned businesses;
b) hold a valid Generation, Distribution or Consolidated licence from EAC;
c) have more than 100 customers and less than 2000 customers;
d) have a staff member available to learn and use the tool who can read and write in Khmer and is familiar with basic use of a computer; and
e) are interested to implement a new tool to try to improve the management of their business.

It is considered important for the target REEs to be already licensed because the tool is expected to provide them the most benefit. In addition the EAC tariff regulations should

help to ensure that the benefits of any efficiency improvements achieved through the use of the tool will be shared with rural electricity customers. There are 120 licensed REEs (in June 2005) and it is expected that at least one third of these meet the above criteria.

A group of secondary target users for the REE Management Tool consists of those REEs that met the same criteria as above, but are not licensed by EAC. These are considered an important user group because they represent the majority of REEs and are expected to become licensed in the near future. There is no accurate estimate available for the number of REEs in this group, but it is likely to be around 500.

4. REE Business Functions

The business functions common to all REE businesses can be summarised into the five main categories listed below. Note that this list assumes both generation and distribution activities, but is also partly relevant for REEs that only either generate or distribute power.

1. **Customer Registration –** adding a new customer to the REE business and recording their status (eg: some REEs register as soon as they express interest, and are placed on a waiting list until they are physically connected to the REE's distribution system.
2. **Power Generation –** operating the generators to supply the customer demand, optimising the design and condition of equipment to maximise efficiency and reliability, and performing maintenance as required;
3. **Power Distribution –** designing and installing the distribution system to deliver demanded electricity to households, performing routine and emergency maintenance in order to maximise safety, reliability and efficiency
4. **Customer Billing -** record customer use for each billing period, calculate bill, produce printed bill, deliver to customer, collect payment, and monitoring payment performance, take action if the account is not paid within a certain period
5. **Reporting –** provide regular business information to various stakeholders including EAC (it is one of the licence conditions)

The detailed REE activities required for each function are described in the following table. This table also classifies each activity as either essential, an EAC licensing requirement, or as non-essential with respect to the facilitation/management of the activity by the REE Management Tool. In other words, how important is it that each particular activity is covered by the new REE Management Tool in order for it to be useful.

Each activity is also classified as either 'universal', meaning that the majority of REE businesses currently perform this activity, or not.

Task and Activity	Description	Essential?	Universal?
1. Customer Registration			
Maintain waiting list of potential customers	▪ When a new potential customer asks to be connected to the network then an REE staff member adds their details to a waiting list (date, name, telephone number, code identifier*, location*, type of customer*)	Yes	No
Maintain a list of existing customers	▪ When a new customer is connected to the REE network then an REE staff member adds their details to the list of active customers, and removes them from waiting list (date, name, telephone number, code identifier*, location*, type of customer*, feeder connection*, power rating*, if 3 phase*)	Yes	Yes
Remove customers that are disconnected	▪ When a customer is disconnected from the REE network for any reason an REE staff member notes their change of status on the list of active customers (date, reason for disconnection*)	Yes	Yes
2. Power Generation			
Record operating hours of engines	▪ At the start and end of each supply period each day an REE operator records the actual daily operating hours for each engine and generator (date, time, engine identifier, engine hours, generator identifier, generator hours)	EAC	No
Record daily engine performance characteristics	▪ Each day during each supply period an REE operator records daily engine performance characteristics (date, time, engine identifier, fuel consumption, operating hours, exhaust temperature, cooling water temperature, air temperature, lubricating oil volume)	EAC	No
Record daily generator	▪ Each day during each supply period an REE operator records daily	EAC	No

performance characteristics	generator performance characteristics for each phase (date, time, phase number*, electrical power, current, voltage, frequency, power factor)		
Record details of breakdowns or problems with engines or generators	▪ When a breakdown or problem is identified in an engine or generator then an REE operator records the details of the problem (date and time of incident, description)	EAC	
Record details of repairs to engines or generators	▪ When a repair must be made to an engine or generator an REE operator records the details of the work (date and time of repair work, description, duration of work , duration of network outage, cost of spare parts and consumables, name of REE operator that does the work*)	EAC	No
Record details of any planned maintenance performed	▪ When any planned maintenance activities are performed on an engine or generator an REE operator records the details of the work (description, time+date, duration of work, duration of network outage, description and cost of spare parts, description and cost of consumables, name of REE operator that does the work*)	EAC	No
Record details of any fuel purchases	▪ When fuel is purchased for the engines an REE staff member records the details (date, fuel type, quantity, supplier, price)	EAC	No
Record details of any lubricating oil purchases	▪ When lubricating oil is purchased for the engines an REE staff member records the details (date, fuel type, quantity, supplier, price)	EAC	No
Record details of any purchases of other consumables	▪ When other consumable items are purchased for the engines an REE staff member records the details (date, description of consumable, quantity, supplier, price)	EAC	No
3. Power Distribution			

Record technical details of new connections	▪ When a customer is connected an REE operator records the details of the connection (customer name, customer identifier*, address*, meter box identifier*, transformer identifier*, feeder identifier*, maximum current rating, 3-phase or Single Phase*)	EAC	No
Record energy sent to the REE network	▪ At the start and end of each supply period each day an REE operator records the energy output to each phase and each feeder of the REE network (date, time, feeder identifier*, phase number*, energy output meter reading)	EAC	No
Record daily performance characteristics of the REE network	▪ Each day during each supply period an REE operator records daily performance characteristics of the REE network (date, time, feeder identifier*, phase number*, current, voltage, frequency, power factor)	EAC	No
Record any changes to the REE network	▪ When the REE network is changed an REE operator records the changes made (date, nature of the change, location of the change, length of conductor installed or removed, rating of conductor installed or removed, if conductor is bare or insulated)	EAC	No
Record performance characteristics throughout the network	▪ Regularly an REE operator measures and records performance characteristics at a number of locations throughout the REE network and preferable during peak the load period (date, time, location, feeder identifier*, phase number, voltage level, current, frequency, power factor)	EAC	No
Record incidents of network faults	▪ When there is a fault discovered in the REE network an REE staff member records the details (date, time, location, description)	EAC	No
Record any network repairs conducted	▪ When a fault in the REE network is repaired an REE operator records the details of the work (date, time, location, description of repairs, duration of work, duration of network outage, cost of spare parts and consumables, name of staff member that does work*)	EAC	No

4. Customer Billing			
Read customer's meters	▪ At the end of each billing period an REE staff member visits every consumption meter and records the reading (date, time, customer name or identifier*, location*, meter identifier*, reading, name of REE staff member)	Yes	Yes
Calculate customer consumption and fee	▪ After recording the customer meter readings the REE staff member returns to the REE office and calculates the consumption and cost for each customer (name of customer, customer identifier*, billing period start date, billing period end date, old meter reading, new meter reading, total consumption over the billing period, price per kWh, total bill for the billing period)	Yes	Yes
Produce customer bills	▪ After calculating the consumption and cost for each customer, an REE staff member produces a bill for each customer (name of customer, customer identifier*, number of bill*, billing period start date, billing period end date, payment due date, old meter reading, new meter reading, total consumption over the billing period, price per kWh, total bill for the billing period, outstanding balance*, total due*)	Yes	Yes
Record customer payment	▪ When a customer makes a bill payment the REE staff member records the details of the payment and issues the customer a receipt (date, time, customer name or identifier*, old total due*, total paid, new total due*, new payment due date*, receipt number, REE staff member name)	Yes	Yes
Remind customers with overdue payments	▪ When the payment due date lapses for any customer and the customer fails to make the defined minimum payment then an REE staff member will contact the customer to enquire about payment (date, time, customer name or identifier*, total due*, total paid, REE staff member name, comments) <if payment is made then links to previous activity>	No	No

Disconnect customer	▪ After a further defined grace period, if any customer fails to make the defined minimum payment or meet any conditions agreed in the follow-up phone call, then an REE staff member will physically disconnect the customer from the REE network by disconnecting the wires inside the meter box (date, time, customer name or identifier*, REE staff member name, customer status*, comments)	Yes	No
Re-connect customer	▪ When a previously disconnected customer pays an agreed minimum of the amount due and/or complies with agreed conditions then an REE staff member will physically re-connect the customer to the REE network by reconnecting the wires inside the meter box (date, time, customer name or identifier*, REE staff member name, customer status*, comments)	No	No
5. Reporting			
Internal REE management report	▪ Regularly the REE Manager will calculate and record general performance characteristics of the REE business (date, the period that the report refers to, total number of customers, number of customers of each type*, total new customers connected for the period, total number of customers disconnected during the period, total value of bills issues for period, total bill payments collected during period, name and details of customers with overdue bill payments, average energy losses for the period, total costs for the period, net revenue for the period)	EAC	No
EAC Licence application information	▪ When the REE first applies for an EAC licence and REE operator records the following general information and submits it to EAC (date, REE Business Name, REE Licensee Applicant, Type of license applied for, REE full location details, REE contact details, Technical specifications of each engine and generator, Full technical specifications of REE network, number of customers, average energy sold per year, proposed electricity tariff(s), capital cost and	EAC	No

	age of all equipment, running costs of business, …)		
Annual EAC licensee report	▪ Once per year the licensed REE must submit a full report to the EAC (Licensee Number, Licensee name, type of license, full location details; For Each Generator: full technical specifications, fuel and oil consumption, costs, repairs, and output characteristics ; For REE Network: full technical specifications for conductors, transformers and poles).	EAC	No
	▪		

Notes:

- ‘Essential’ denotes that either it is an essential element of majority of REE businesses today, OR it is an essential requirement of the relevant government regulator, such as EAC
- Two types of REE staff are defined here: REE Staff, who can be any person working in the business including the owner, technical staff and administrative staff; REE Operator refers to the technical staff only, REE Manager refers to either an on-site manager or the owner.
- The parameters marked with asterix are not common to all REE businesses

5. REE Stakeholders and Information Flows

The main stakeholders in most REE businesses can be summarised and classified as either internal to the business, or external, as follows:

A. Stakeholders within REE	
Owner(s)	owner of the business (an individual, or group of people)
Operator	the manager/operator employed by the owner to run the business
Technical Staff	employees who perform technical tasks relating to generation and distribution of power
Billing Staff	employees who visit each customer to read meters, issue bills and receive payments
Accountant	employee who performs all book keeping and financial reporting activities

B. Stakeholders outside REE	
Customers	customers of the REE
Fuel Supplier(s)	suppliers of fuel to the REE
Other Suppliers	suppliers of equipment, parts and other
EAC	electricity Authority of Cambodia
MIME and DIME	Ministry of Industry, Mines and Energy + provincial departments
Financier(s)	bank, micro-credit agency, family members, investors etc
MEF	the provincial taxation departments of the Ministry of Economy and Finance

Annexe 1

The flow of information between the external REE stakeholders is represented in the matrix below.

From \ To	REE	Customers	Fuel Suppliers	Other Suppliers	EAC	MIME	Financier
REE		Bills Receipts	Payment	Payment	Licence application Annual report	General reports on request	Repayments Dividends Financial reports
Customers	Regist. details Payment						
Fuel Suppliers	Invoice						
Other Suppliers	Invoices						
EAC	Licence Tariff rate Formats						
MIME	Operating Permission				Policy Regulations Law		
Financier	Funding						

6. Specific Design Considerations

During the needs assessment activities a number of specific requirements and design considerations have been identified that should be incorporated into the REE Management Tool if possible. These are described in the following table.

REE Management Tool Interface	
Language	Khmer language throughout (using Khmer script), but using suitable icons wherever possible to reduce the need for text
General Appearance	The appearance of forms and windows should be as simple and uncluttered as possible by minimising unnecessary text and hiding advanced features etc on additional windows
Complexity	The general logical flow and process should be as simple as possible and designed specifically for a typical REE that knows their business well but has very low computer skills and experience.
Help Functions	On-screen help should be available for every function in the form of brief descriptions of items that appear when the mouse is rolled over them, plus a single button on each page that takes the user to a more detailed description or help menu.
Error Checking	The tool should check all data as it is entered and compare it with pre-defined expected data ranges and types, and should prompt the user to confirm any unusual or non-compliant data values.
REE Management Tool Output	
EAC Requirements	The output forms shall comply with any relevant EAC licence requirements, such as contents and format of customer bills and reports to EAC.
Production Costs	All output forms, and especially the customer bills, shall be designed to minimise the amount of paper and ink required, while still clearly providing all the required information, in order to reduce the REE's operating costs.
Integrated Forms	Where possible relevant information will be combined onto a single form in order to further save production costs, eg: the customer bill should include a customer receipt section that can be completed by hand, torn-off and handed to the customer when a bill is paid.
Saving Forms for Printing Elsewhere	The user should be given the option with any output form to save to disk in a printer-ready format, rather than sending it directly to a printer. This will allow REEs to generate the forms on any computer, then take them on disk to a place with a suitable printer (eg internet café) for printing, without needing to take the entire database between computers.
Customising REE Management Tool	
Initial Set-up	The user should be clearly prompted to define standard parameters and preferences during the first use of the tool. Such parameters would include basic technical specifications such as number, type and capacities of gen-sets; and defining any grace period allowed prior to

	disconnecting a customer for not paying bills. The set-up process should be simple for standard users, but allow as much flexibility as possible for REEs with different management and reporting needs.
Changing Parameters	Once the initial set-up has been performed by the user, usually after the first session, the user will only be prompted for further set-up information if it is essential for a particular function, however the set-up functions will still be accessible by the user to confirm or modify the parameters at any time.
Customising Output Forms	Part of the initial set-up parameters will be the definition of standard text, logo, and any standard messages to appear on forms (eg: payment terms to appear on the customer bills). The user should also be provided an option to insert an additional customised message on customer bills at the time of bill production (eg: promotional information, or new instructions for bill payment etc).

7. Units, Abbreviations and Acronyms

This section defines the standard units of measurement, terms, acronyms and abbreviations that should be used throughout the REE Management Tool in order to avoid confusion and maintain consistency. Where there is more than one commonly used item then the user should be offered the option to choose which one they would prefer to use.

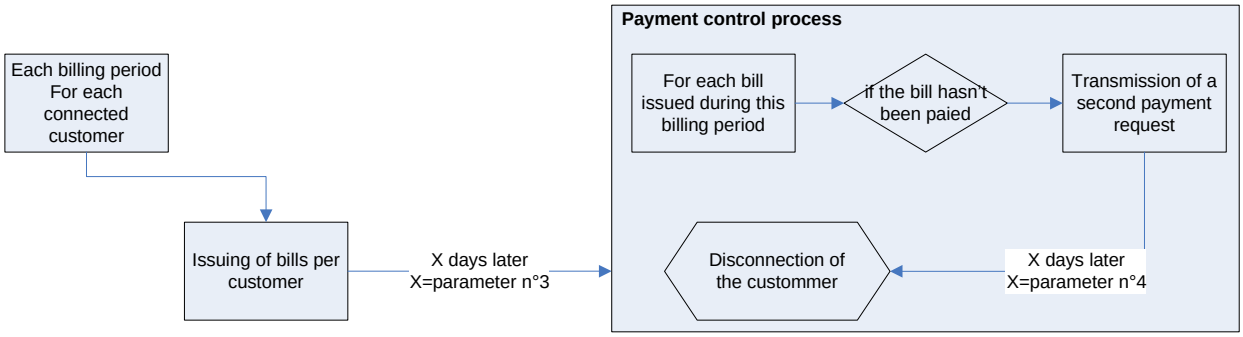
Units of Measurement	Unit	Abbreviation
Electrical Potential	Volts	V
Electrical Current	Amperes	A
Active Power	Watts	W
	Horsepower	HP
Apparent Power	Kilo-volt Amperes	kVA
Reactive Power	Kilo-volt Amperes Reactive	kVAr
Energy	Kilowatt-Hours	kWh
Electrical Power Phase	Phase	Φ
Power Factor	cosφ	<none>
Currency	Cambodian Riels	R
	US Dollars	$
Liquid Volume	Litres	l
	Gallons	G
Temperature	Degrees Celsius	°C
Distance	Metres	m

Acronym	Term
DEMT	Distributed Energy Management Tools
DIME	Department of Industry, Mines and Energy (provincial)
DO	Diesel Oil
EAC	Electricity Authority of Cambodia
EdC	Electricité du Cambodge
HFO	Heavy Fuel Oil
MEF	Ministry of Economy and Finance
MIME	Ministry of Industry, Mines and Energy
REE	Rural Electricity Enterprise

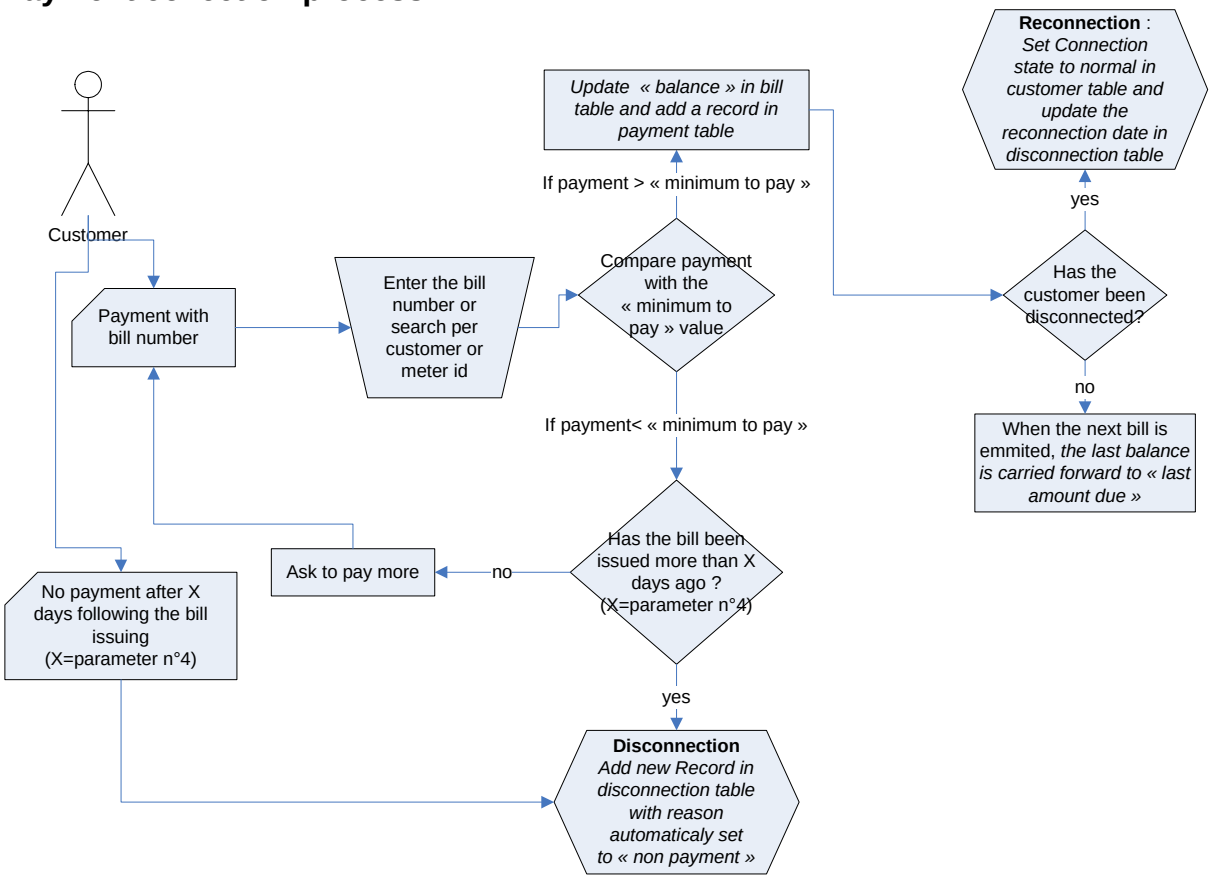
ANNEX A. PROCEDURES FOR BILLING AND PAYMENT

Here are some samples of the procedures requested by the REE business that will be assisted by the software tool.

Billing procedure



Payment collection process

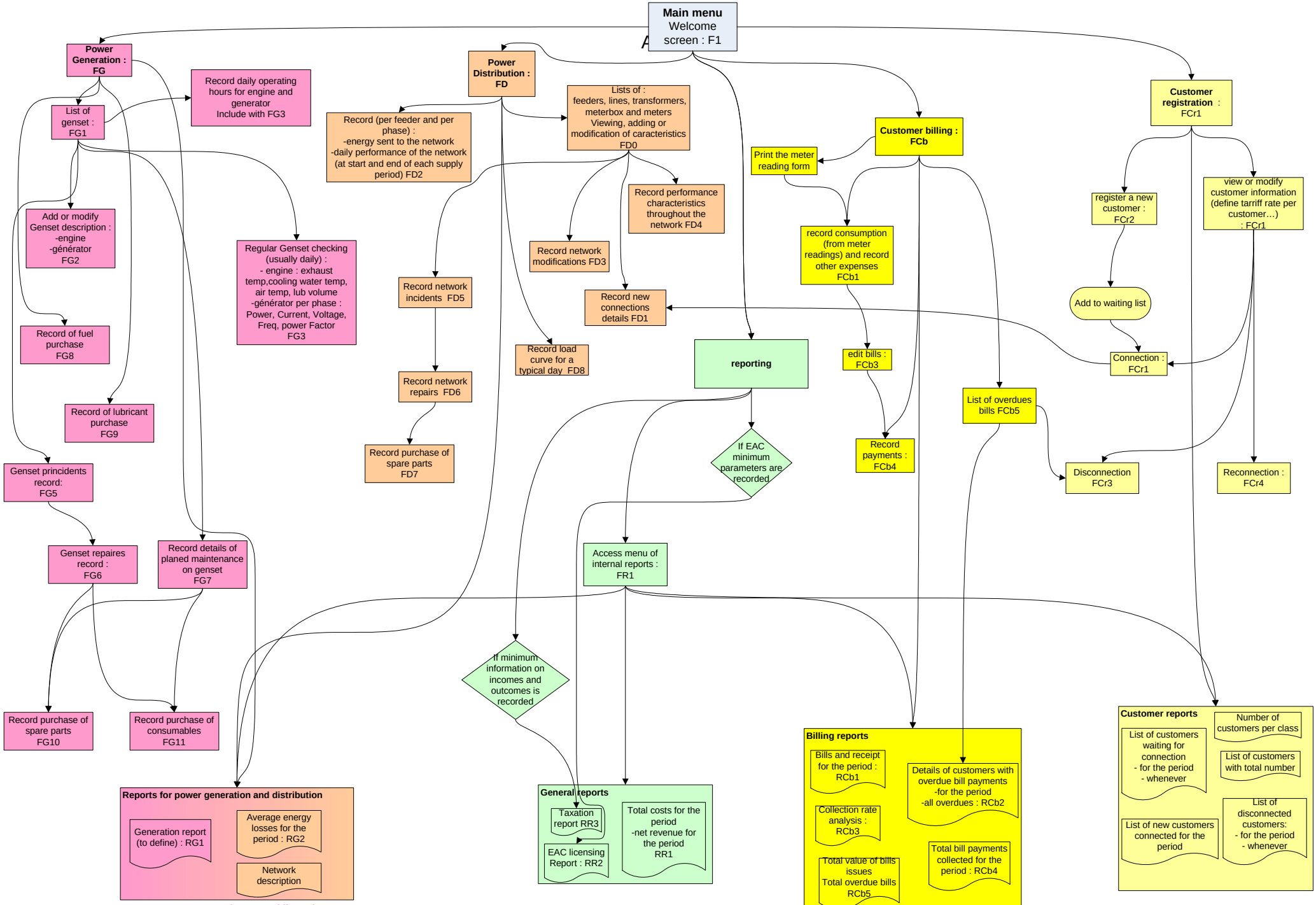


ANNEX B. GENERAL ORGANISATION OF INTERFACES WITHIN THE APPLICATION

(Next page) schematic organisation of the 5 main modules :

- **Customer registration**
- **Customer billing**
- **Power distribution**
- **Power generation**
- **Reports**

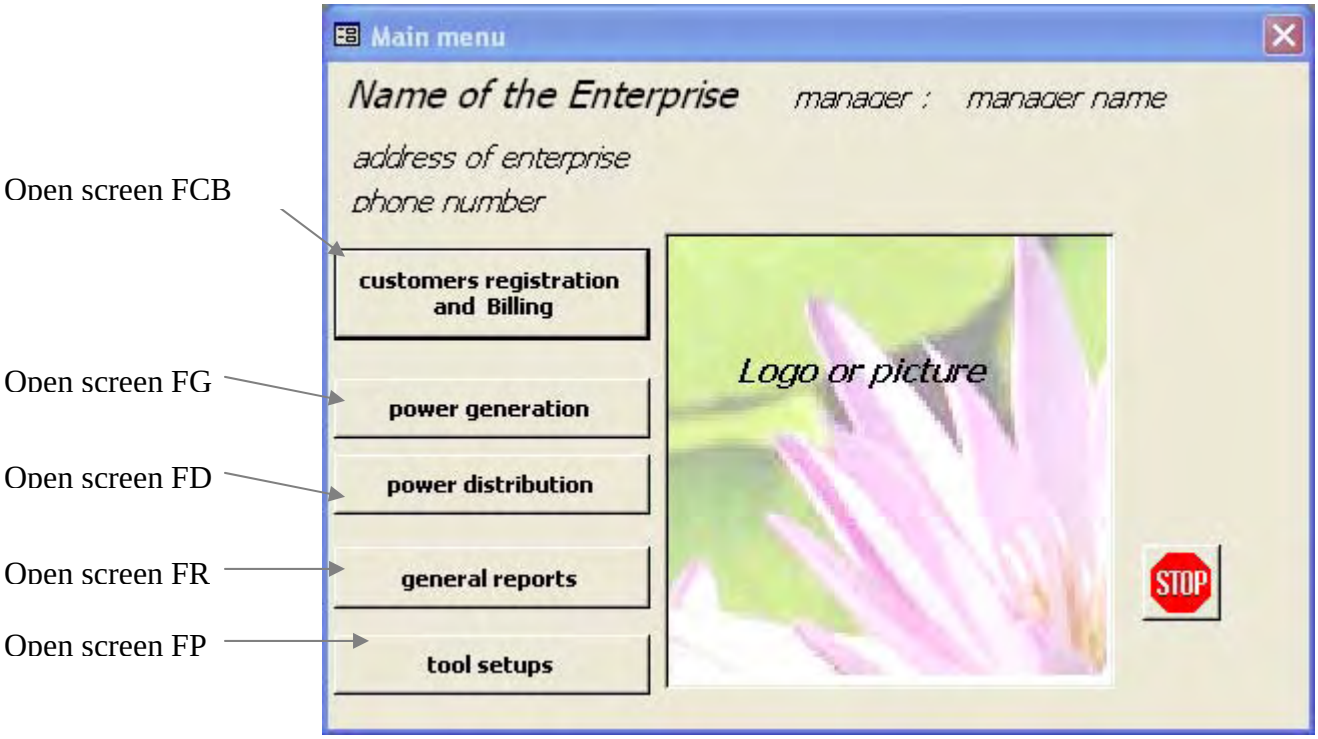
Nota: in the interfaces document, the modules customer registration and customer billing are mixed together.


Main menu
Welcome screen : F1
Power Generation : FG
List of genset : FG1
Record daily operating hours for engine and generator
Include with FG3
Add or modify Genset description : -engine -générator FG2
Regular Genset checking (usually daily) : - engine : exhaust temp,cooling water temp, air temp, lub volume -générator per phase : Power, Current, Voltage, Freq, power Factor FG3
Record of fuel purchase FG8
Record of lubricant purchase FG9
Genset princidents record: FG5
Genset repaires record : FG6
Record details of planed maintenance on genset FG7
Record purchase of spare parts FG10
Record purchase of consumables FG11
Reports for power generation and distribution
Generation report (to define) : RG1
Average energy losses for the period : RG2
Network description
Power Distribution : FD
Record (per feeder and per phase) : -energy sent to the network -daily performance of the network (at start and end of each supply period) FD2
Lists of : feeders, lines, transformers, meterbox and meters Viewing, adding or modification of caracteristics FD0
Record performance characteristics throughout the network FD4
Record network modifications FD3
Record network incidents FD5
Record new connections details FD1
Record load curve for a typical day FD8
Record network repairs FD6
Record purchase of spare parts FD7
reporting
If EAC minimum parameters are recorded
If minimum information on incomes and outcomes is recorded
Access menu of internal reports : FR1
General reports
Taxation report RR3
EAC licensing Report : RR2
Total costs for the period -net revenue for the period RR1
Customer billing : FCb
Print the meter reading form
record consumption (from meter readings) and record other expenses FCb1
edit bills : FCb3
Record payments : FCb4
List of overdues bills FCb5
Billing reports
Bills and receipt for the period : RCb1
Collection rate analysis : RCb3
Total value of bills issues Total overdue bills RCb5
Details of customers with overdue bill payments -for the period -all overdues : RCb2
Total bill payments collected for the period : RCb4
Customer registration : FCr1
register a new customer : FCr2
Add to waiting list
Connection : FCr1
view or modify customer information (define tariff rate per customer…) : FCr1
Disconnection FCr3
Reconnection : FCr4
Customer reports
List of customers waiting for connection - for the period - whenever
Number of customers per class
List of customers with total number
List of new customers connected for the period
List of disconnected customers: - for the period - whenever

ANNEX C. SOFTWARE INTERFACE DESIGN

C.1 Main screen

C.1.1 Screen F1 : main menu



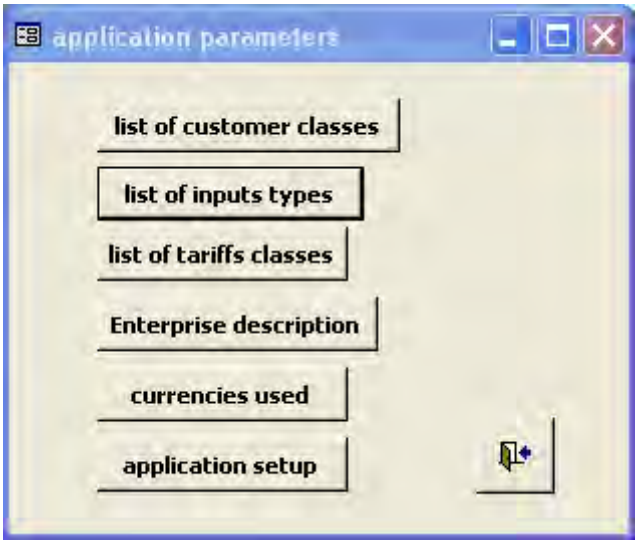
This screen is the main menu which leads to the 5 main screens.

On this screen, the enterprise name, phone number, manager name and logo or picture of the REE can be fully customised within the parameters menu.

C.2 Access to parameters and customization of the application.

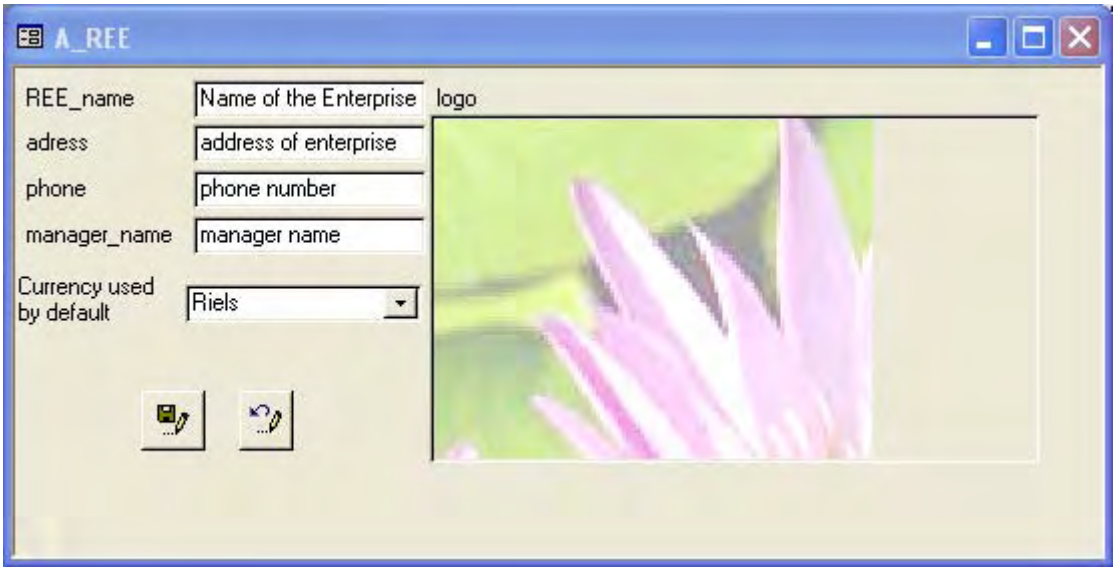
Different parameters are set by default in the delivered application but can be modified in the interfaces available in the “tool setup” option of the main menu.

C.2.1 Screen FP : Menu for parameters



C.2.2 Screen FP4 : Enterprise description

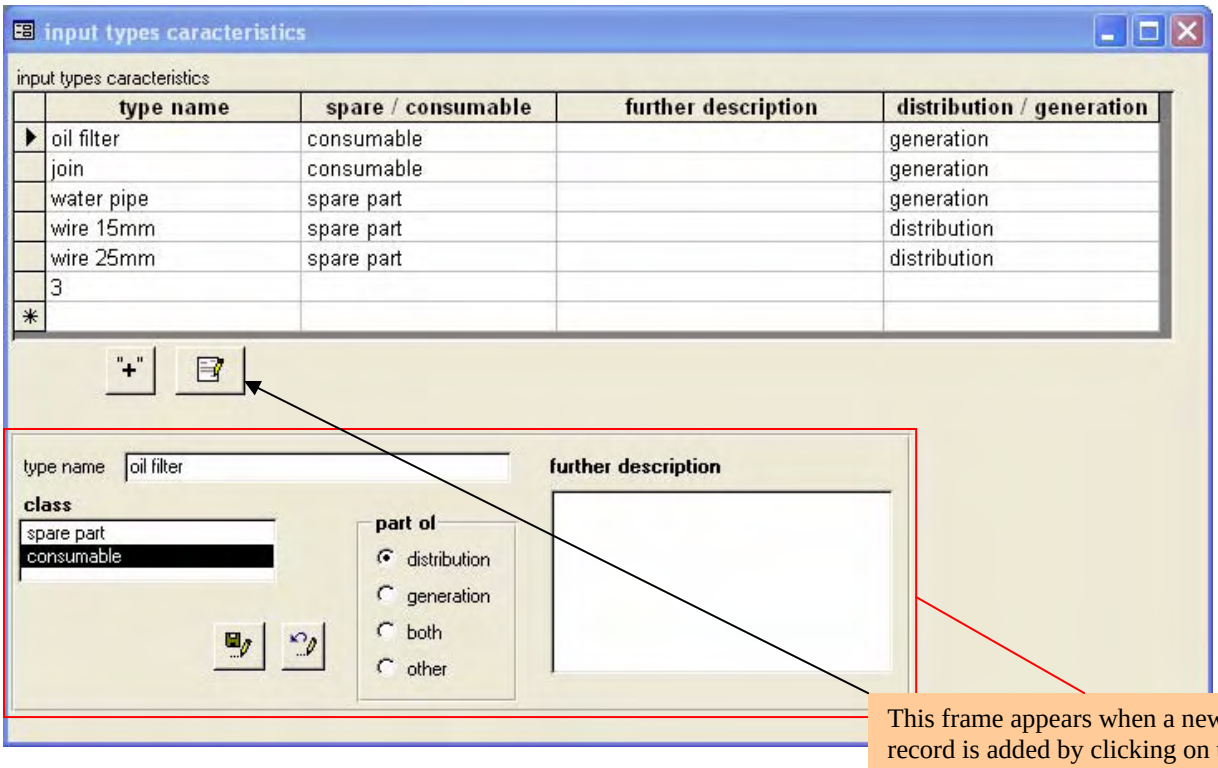
Allow to modify the description of enterprise and the currency used (from the currency list defined in the screen FP5). A new logo can be dragged in the picture box.



The currency used by default is selected from the currency list (screen FP5, cf C.2.5 p23) ; It is set only one time at the first setup as every money input will be stored in the database using this currency. This parameter is enabled while no input has been entered in the database.

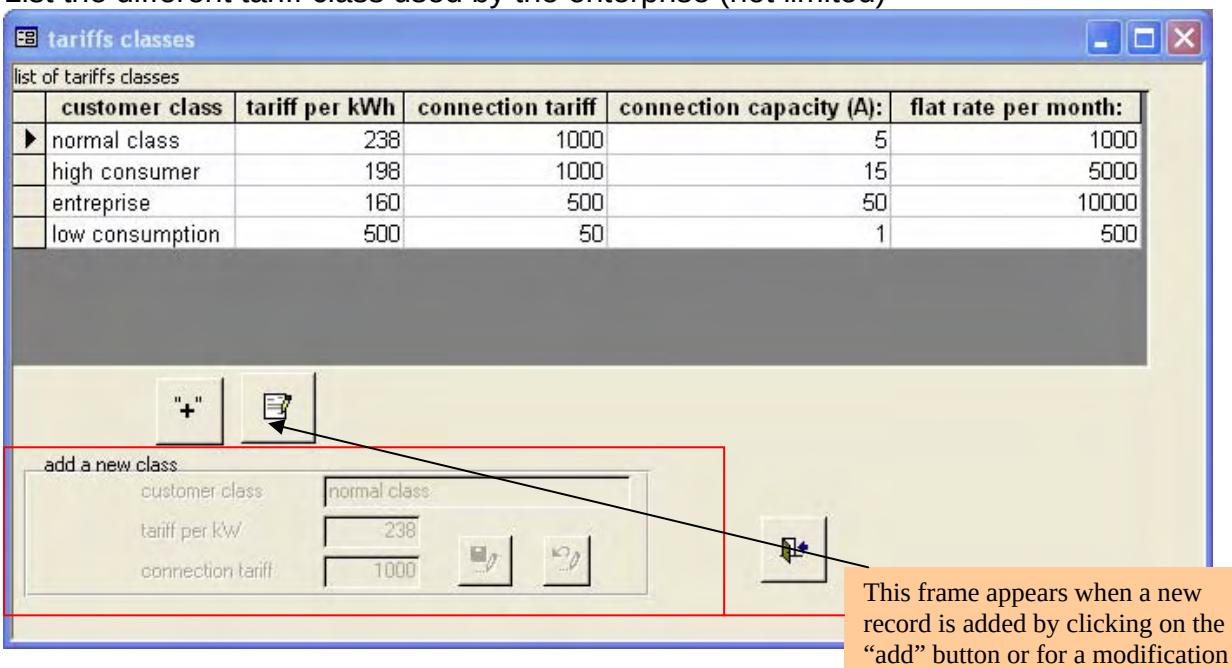
C.2.3 Screen FP2 : list of inputs types

List of the different type of inputs (spare parts or consumables) that can be bought for the REE business. These elements are provided as a pick-list to the user when recording items bought for a repair or maintenance purpose.



C.2.4 Screen FP3 : list of tariffs classes

List the different tariff class used by the enterprise (not limited)



C.2.5 Screen FP5 : currencies used

Currently only used for Riel and Dollars to record the conversion rate and allow some payments in the 2 currencies.

C.2.6 Screen FP6 : application setup

Automatically opens at the first use of the application to allow the user to select the desired options so that non-essential options are hidden and the application appearance is simplified.

This interface allow the user to choose among the following management options :

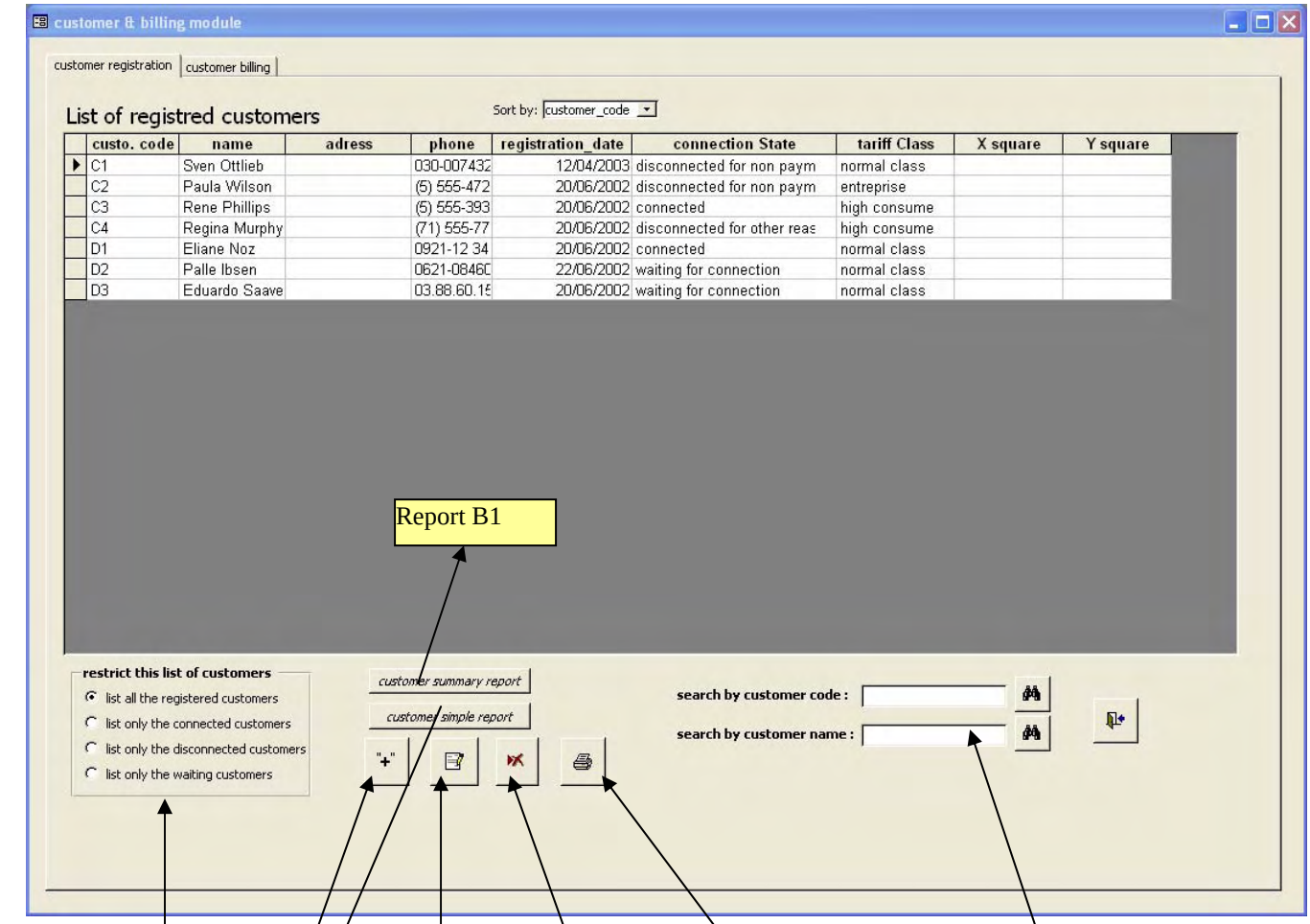
- Use of medium voltage devices? (if set to no, all the sections concerning the transformers MV/LV are hidden)
- Record the daily performance at the input of the network*? If this option is chosen, the tracking of Voltage and current is compulsory but another option to select is the tracking of current and power factor.
- Record the daily performance along the network* ? If this option is chosen, the tracking of Voltage and current is compulsory but another option to select is the tracking of current and power factor.
- Record the list of spare parts and consumables purchased during the maintenance and repairs operations for distribution and generation modules*? (if set to no, just a text description of the operation will be recorded on each operation)
- Record regular genset checking* (operating hours, temperatures…)*?
- Simple bill consultation (if set to yes: the frame with the buttons “for the selected customer for the billing period” is hidden, the payments record, bills and balance can only be checked for all the customers listed). Acceptable for small REEs.
- Allow to record extra expense for the customers (like extra electric appliances, wiring checking…)
- Location of customer: by X/Y square grid, by street address or both.
- Credit practical details :
    - Credit allowed or not? [default=Yes]
    - If allowed, for which items? (installation fee / monthly consumption charges / extra services) [default= installation fee and monthly consumption charges]
    - Maximum amount allowed (ie :the maximum negative balance before the REE refuses to provide more credit until payments are made, or disconnects customer) [default=no limit],
    - maximum number of payment periods with zero repayment allowed [default=no maximum],
    - interest rate per period (the rate at which the customer is charged for outstanding balances) [default=0%]

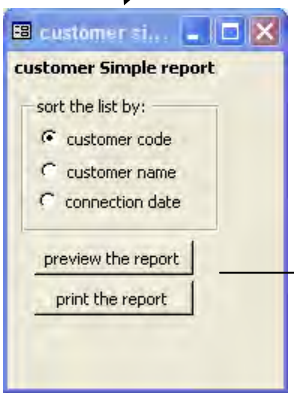
* if set to no, the application is not EAC compliant and the EAC report will be incomplete

* if set to no, the application is not EAC compliant and the EAC report will be incomplete

C.3 Customer Registration & Billing Module

C.3.1 Screen FCr1 : View or modify customers





Report B1

filter the above list (and the printed report)

Open Screen FCr2 in modification mode

Search a customer among the above list and select him in the list

Open Screen FCr2 in adding mode

Delete customer : Display full warning !
This button is disabled if the selected customer is normally connected to the network

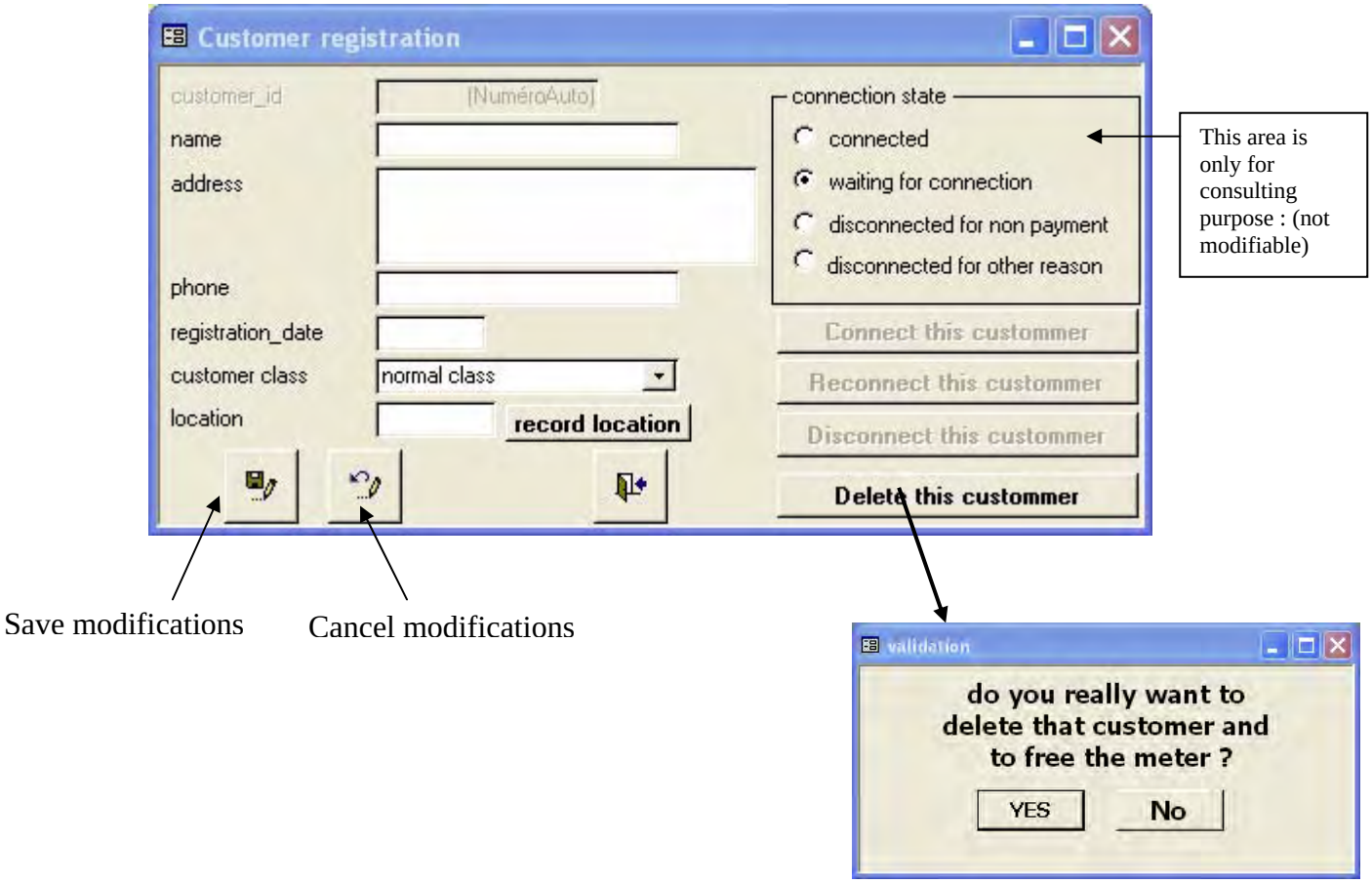
Print the list (by using the customer list report)

Report B3

C.3.1.1 screen FCr2 : Register a new Customer

this screen is available in 2 modes :

- Modification : the data of the selected customer appear in the text boxes and are modifiable
- Adding : the boxes are blank, the user enters the data for the new customer and when he cliks on “OK”, a new customer_id is generated automatically. As for all forms, A data entry check is performed for each textbox.



- the list control customer class lists all the value of the table “C_customerClass” that can be modified within the screen FP1
- in adding mode, the following radio buttons controls “connection state” are enabled (the others are disabled) :
  - connected
  - waiting for connection
- in modification mode, all the radio buttons controls are enable except when the customer has been connected : the state “waiting for connection” is disabled.

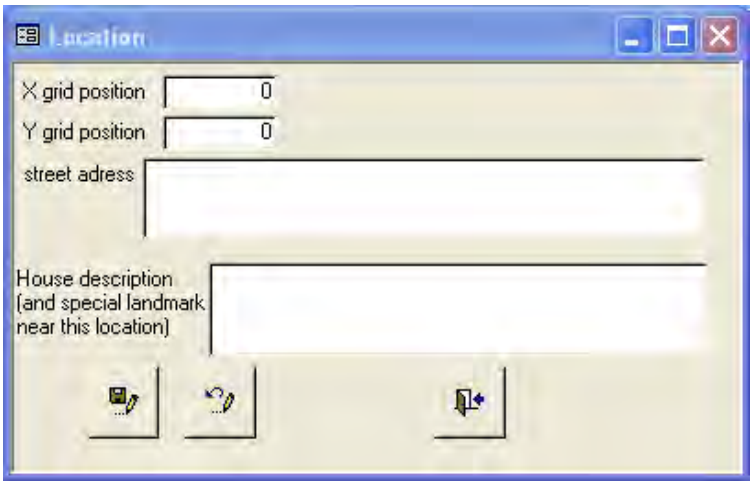
If the value of “connection state” is set to “waiting for connection” then the customer is added to the waiting list.

If the customer was waiting for connection and the radio button “connected” is pressed, then the screen FD1 opens to record the connection details when the modifications are saved for this customer.

If the customer was connected and the radio button “disconnected for non payment” is pressed, then the screen FCr3 with “disconnected for non payment” written in the textbox “reason for disconnection” opens when the modifications are saved for this

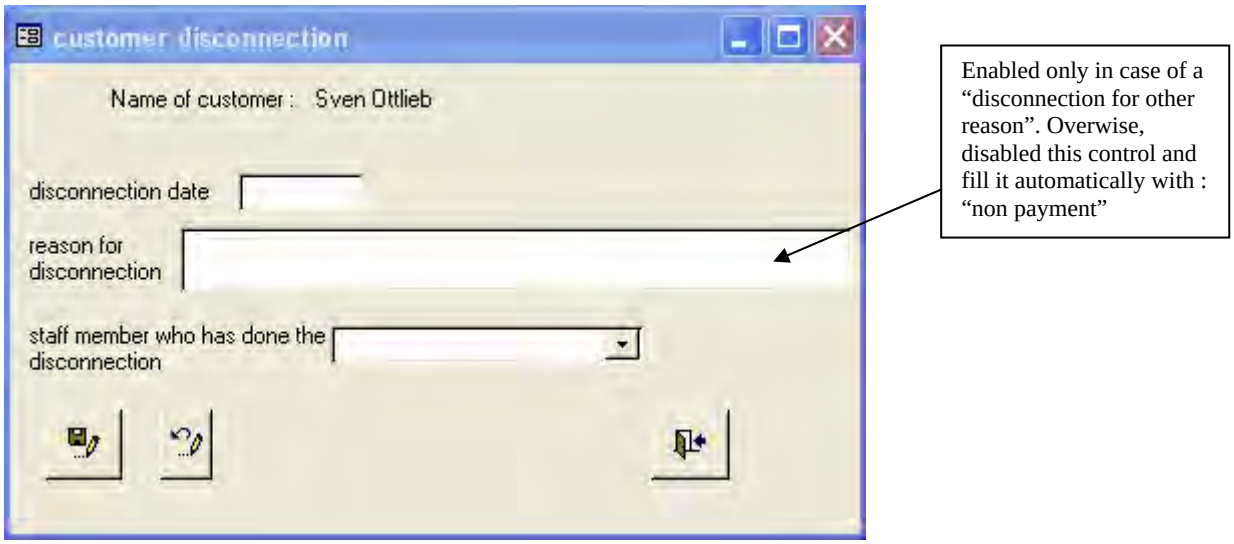
customer. Idem with the “disconnected for other reason” option but with a blank case in “reason for disconnection”.

The “record location” button open the following screen as a pop-up :



depending of the initial setup options, we can record the location of a particular customer either by his position on a square grid, by his street address and optionally by a description of a particular landmark close to his house.

C.3.1.2 Screen FCr3 : Customer disconnection



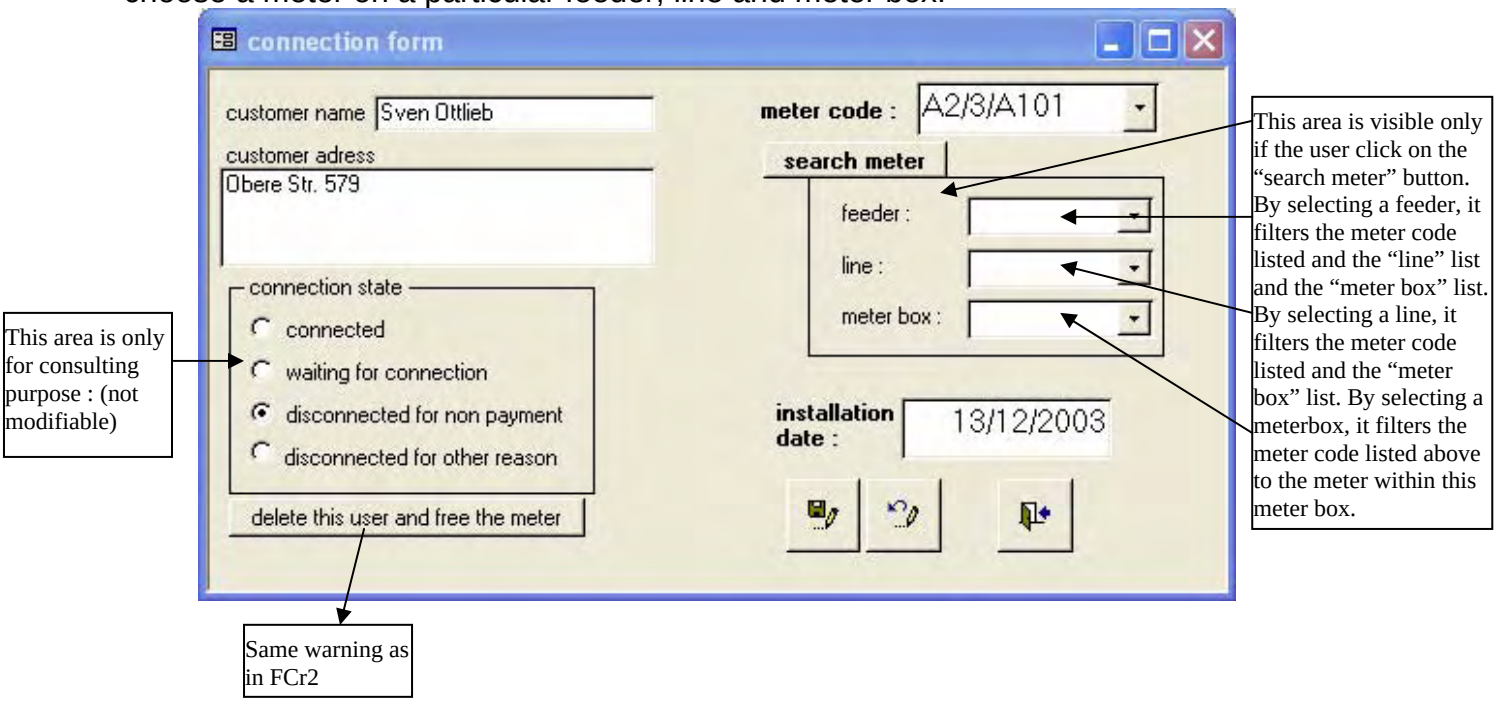
C.3.1.3 Screen FCr4 : Customer reconnection

C.3.1.4 Screen FD1 : connection details

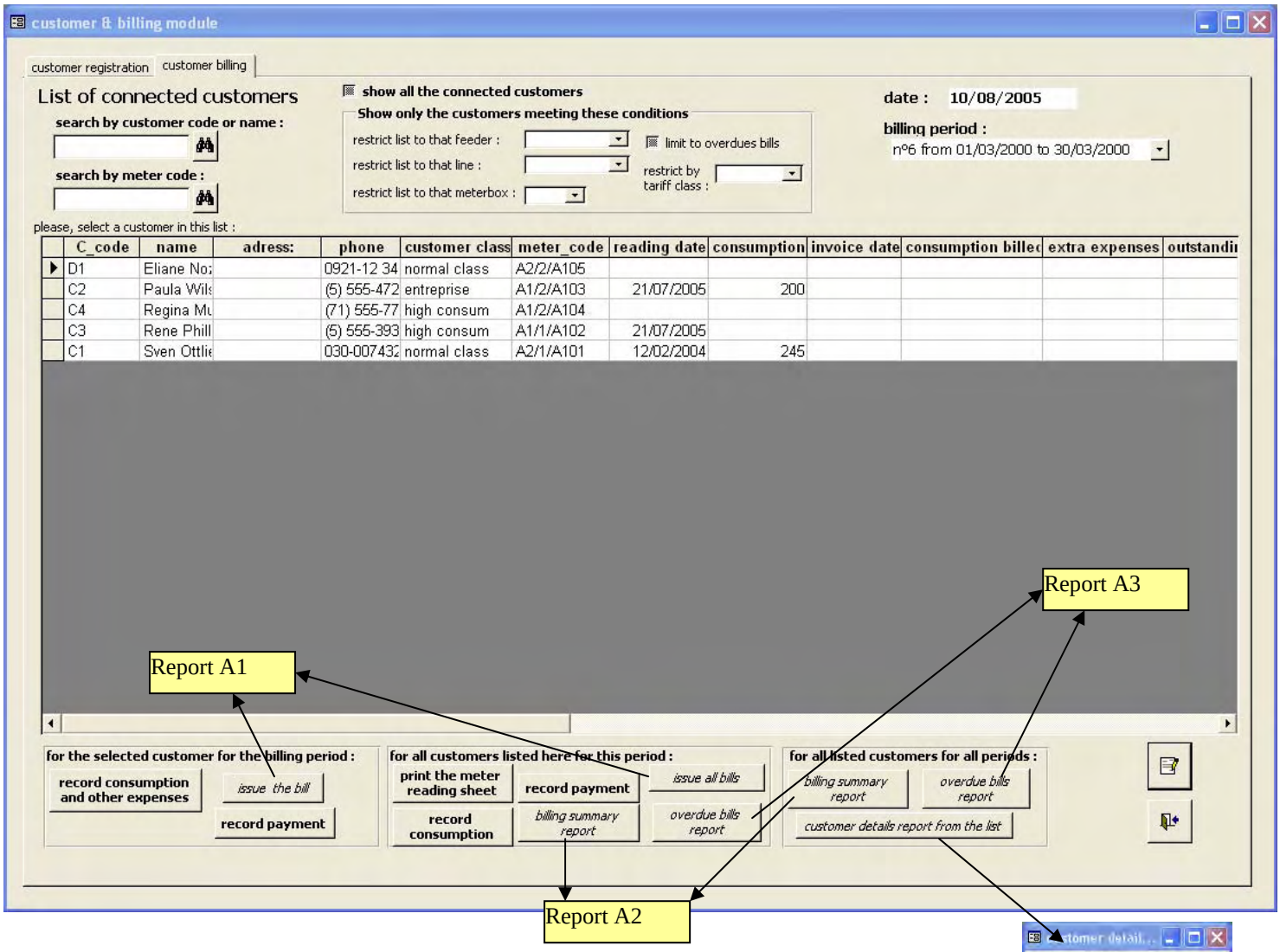
This screen allow to link a customer with a meter when the connection is done. The meters lists in the meter code are non connected meters. When a new meter is connected, the installation date can be entered (by default : it's set to the current date).

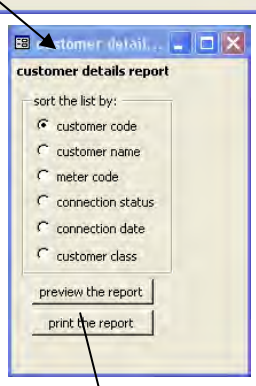
By clicking on "delete this user and free the meter", the connection with the meter and the customer is removed forever within the database and he customer is deleted (warning message before).

By clicking on search meter, the box under this button appears and let the user choose a meter on a particular feeder, line and meter box.



C.3.2 Screen FCb0 : Billing and payments





By default, when this form is open, the billing period is set to the current period (*the current billing period is recorded in the "currentPeriod" field from the A_REE table*). But the user can select another period to access to customer information for this particular period. Only the customers connected during the selected period will be listed here.

The list shown in the interface gives an overview of the customers billing status :

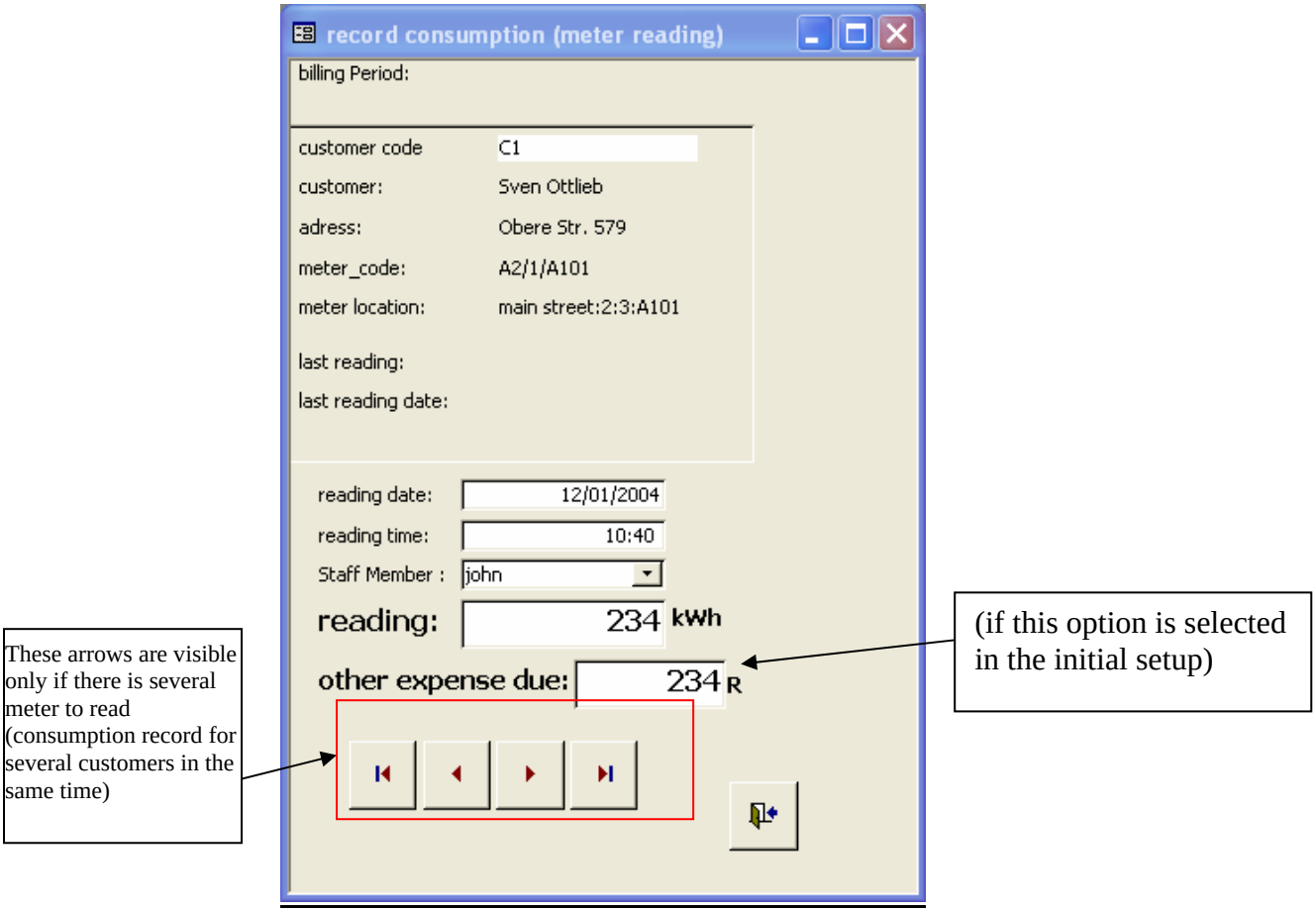
- Name, Address, phone
- Tariff class
- Meter code
- Reading date (if the reading as already been done for this period)
- Consumption (idem)
- Invoice date (if the bill has been issued for that customer)
- Consumption billed
- Extra expenses
- Last amount due
- Outstanding balance

- Total paid
- New balance

This list can be filtered by feeder, by a line (from lines deserved by the selected feeder) or by a meterbox (from the meterboxes deserved by a selected line) or even by tariffs classes. It's also possible to list only the overdue bills.

C.3.2.1 Screen FCb1 : Record consumption

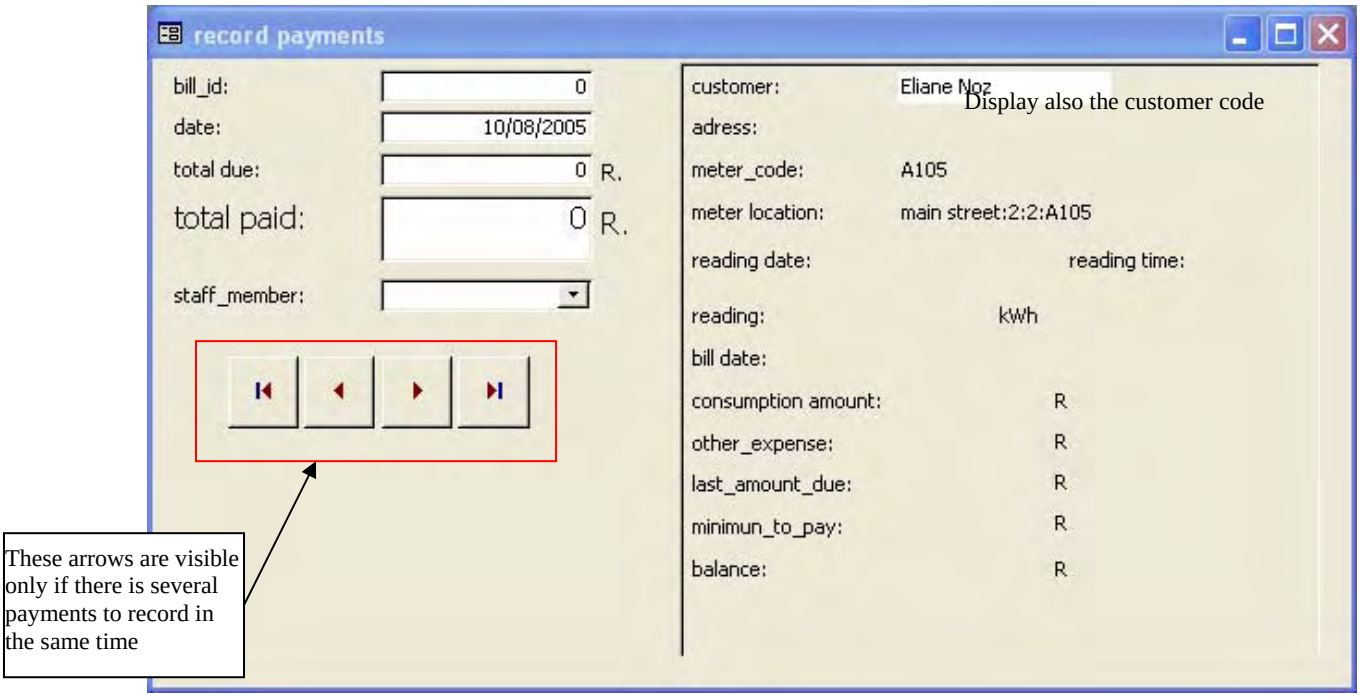
This screen is popped-up from the last screen either by using the record consumption for a selected customer (in that case, no navigations arrows appear) or for all customers (the red navigations arrows allow to go to the following customer in the same order as in the printed "meter reading sheet")



C.3.2.2 Screen FCb4 : Record payments

This screen is popped-up from the last screen either by using the record payments for a selected customer (in that case, no navigations arrows appear) or for all customers (the red navigations arrows allow to go to the following customer in the same order as in the printed "meter reading sheet").

Annexe 4



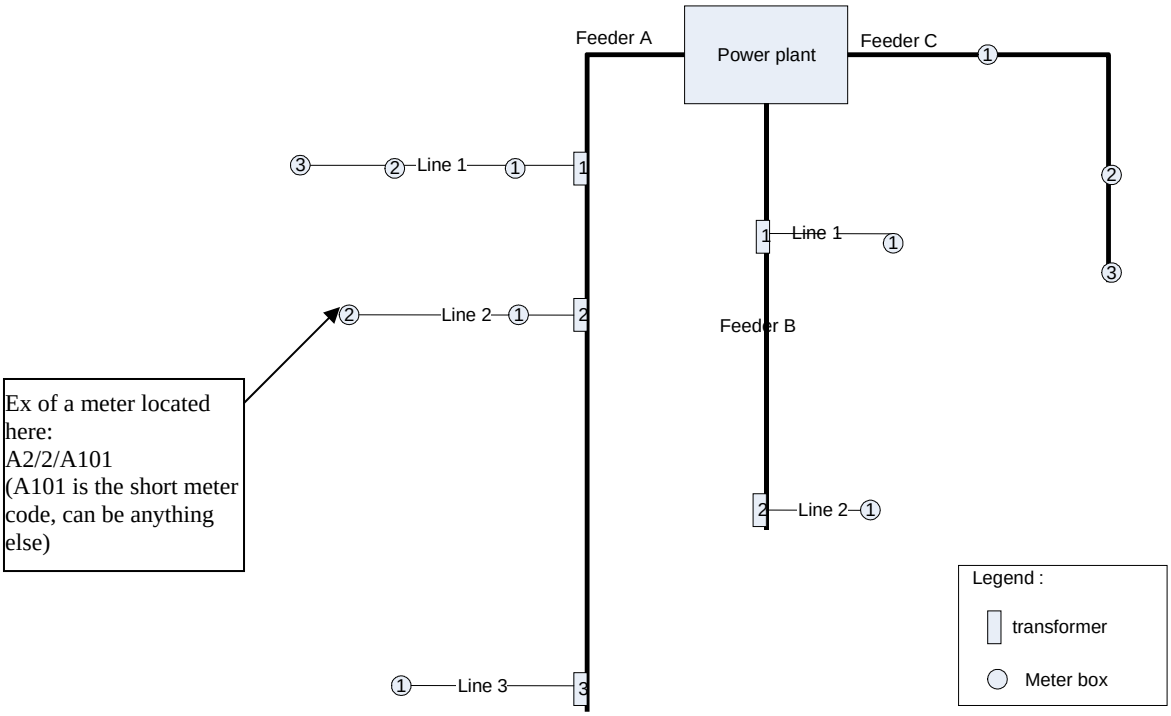
C.4 Power distribution module

Most of the features of this module can be accessed from the same interface using tabs controls :

- Network elements
  - Feeders
  - Lines
  - Transformers
  - Meter boxes
  - meters
- Daily records
  - Daily performance
  - Energy sent to the network
- Reports

The REE network is symbolize by the next convention :

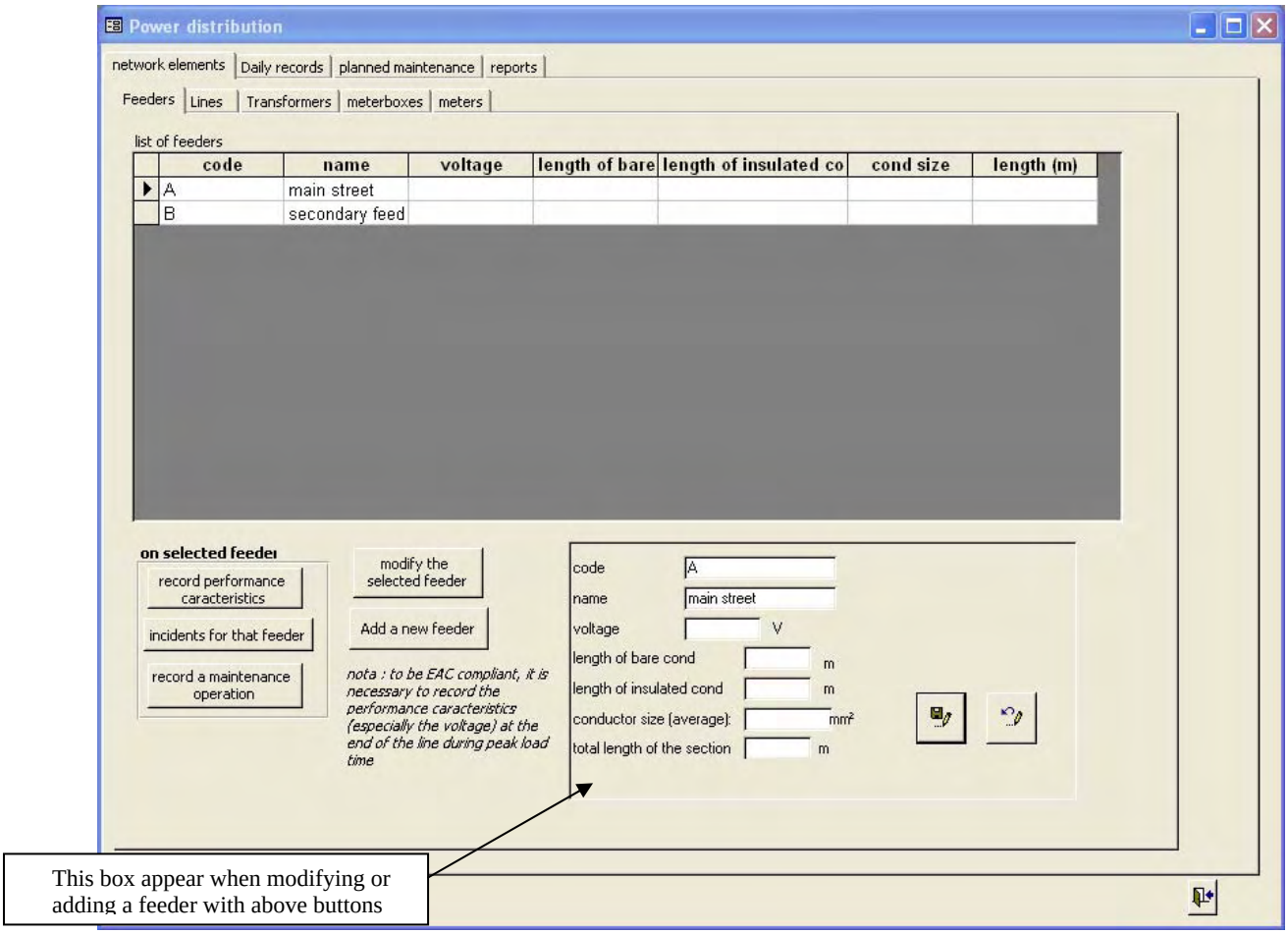
Annexe 4



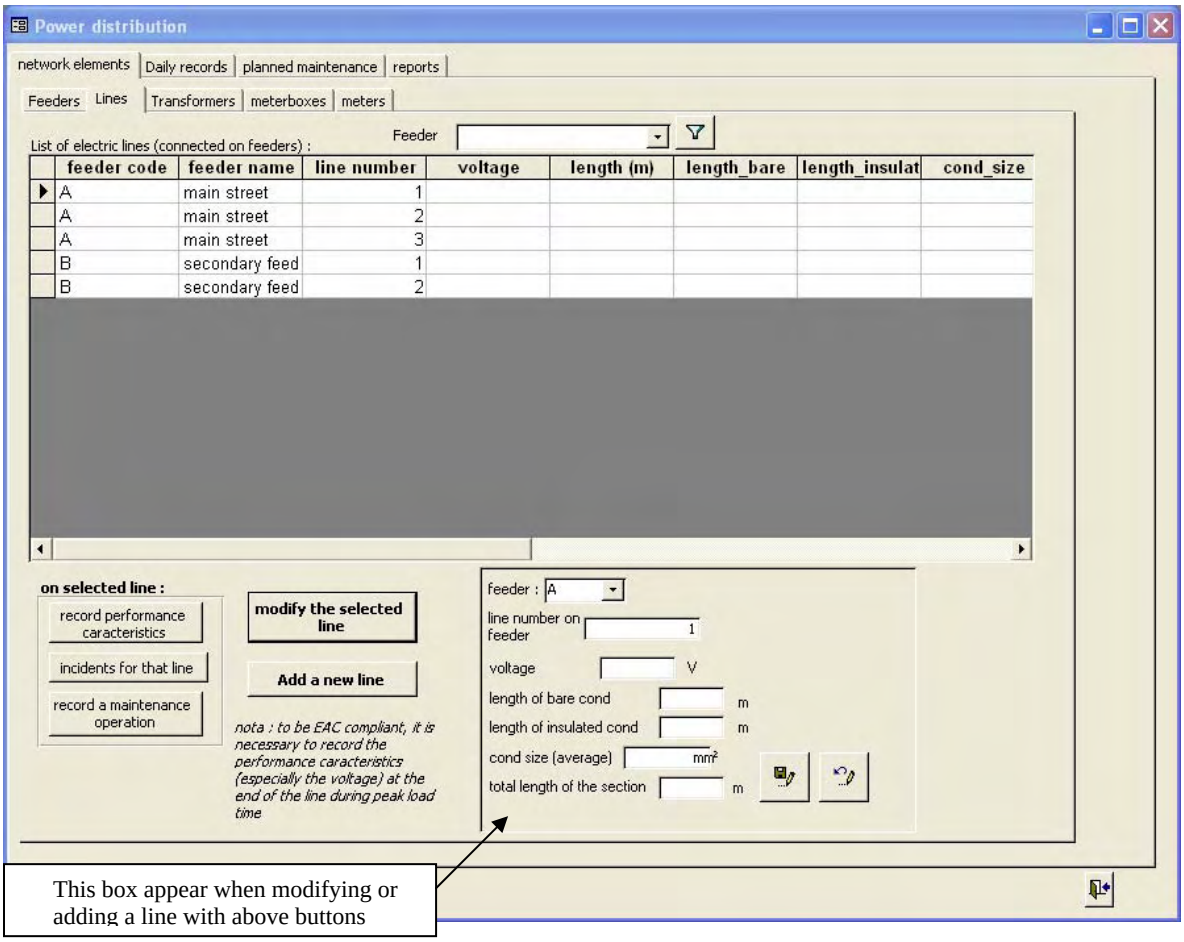
REE Network schema as recorded in the software

C.4.1 Series of Screens FD0 : Network elements

C.4.1.1 List of feeders

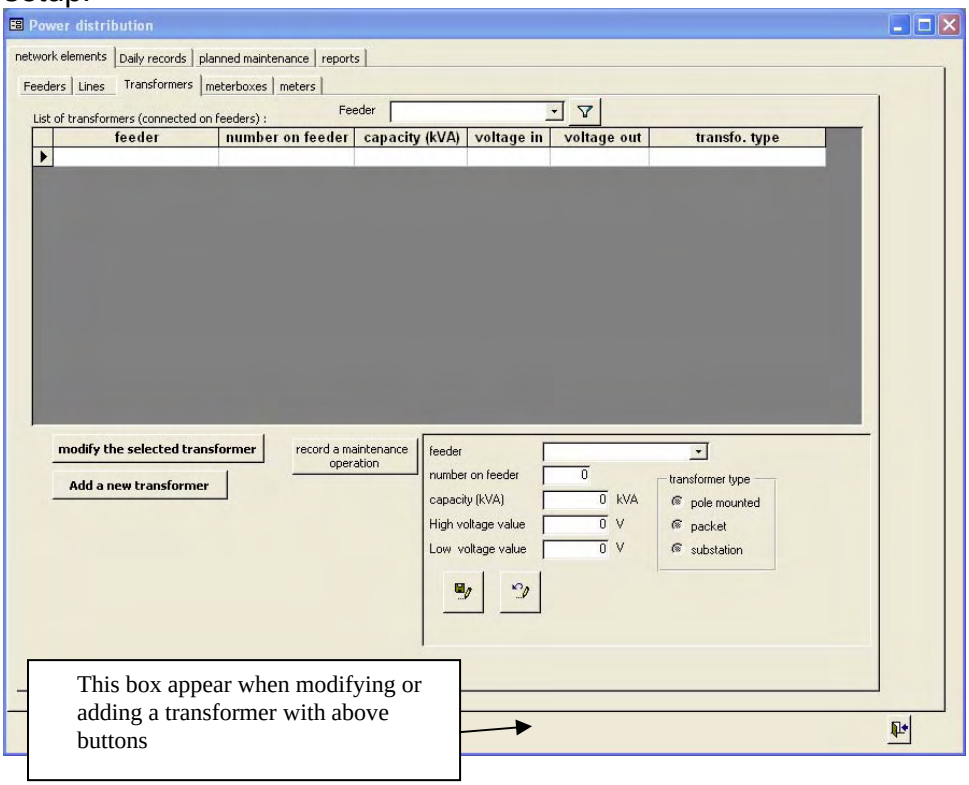


C.4.1.2 List of lines

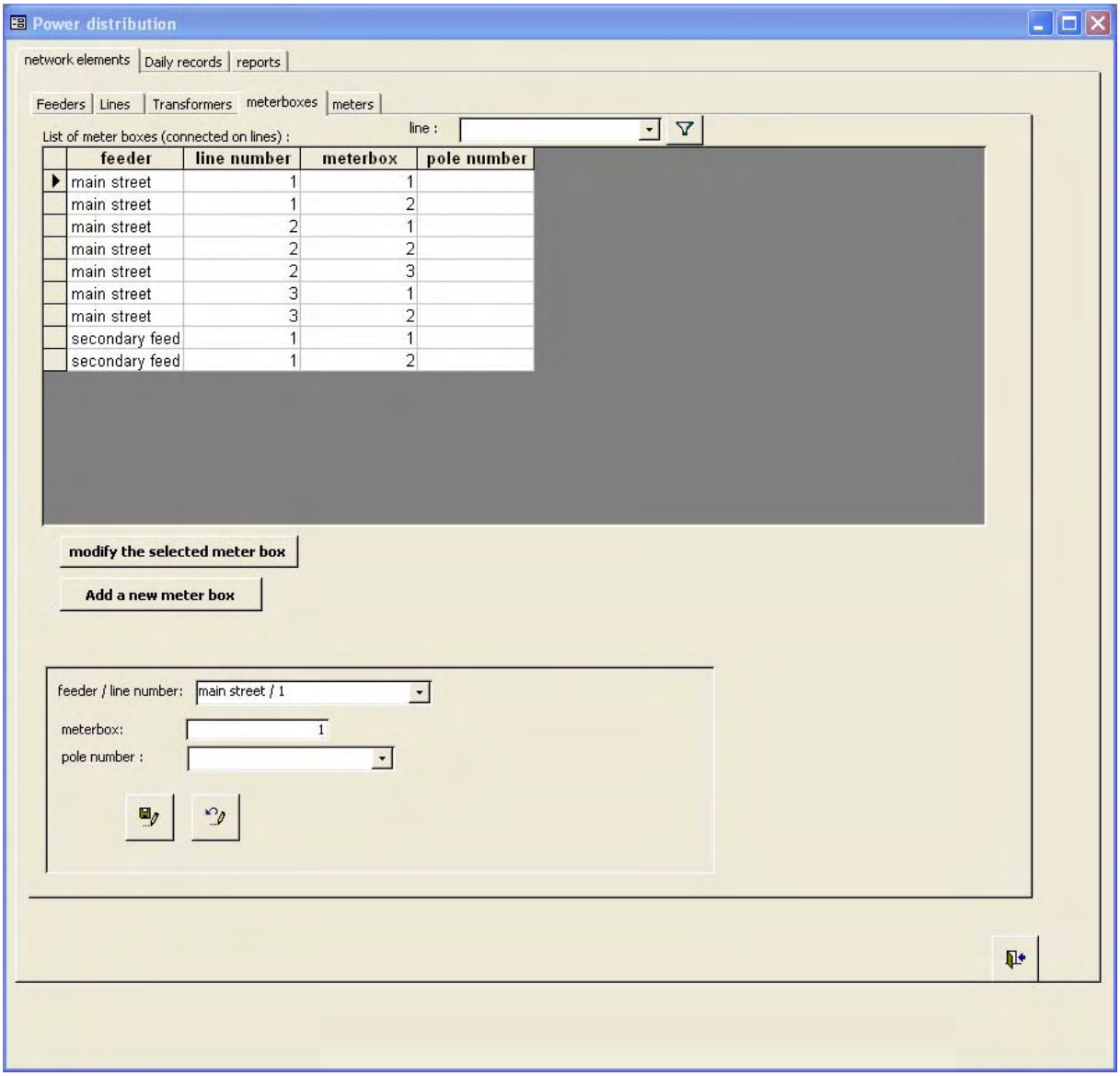


C.4.1.3 List of transformers

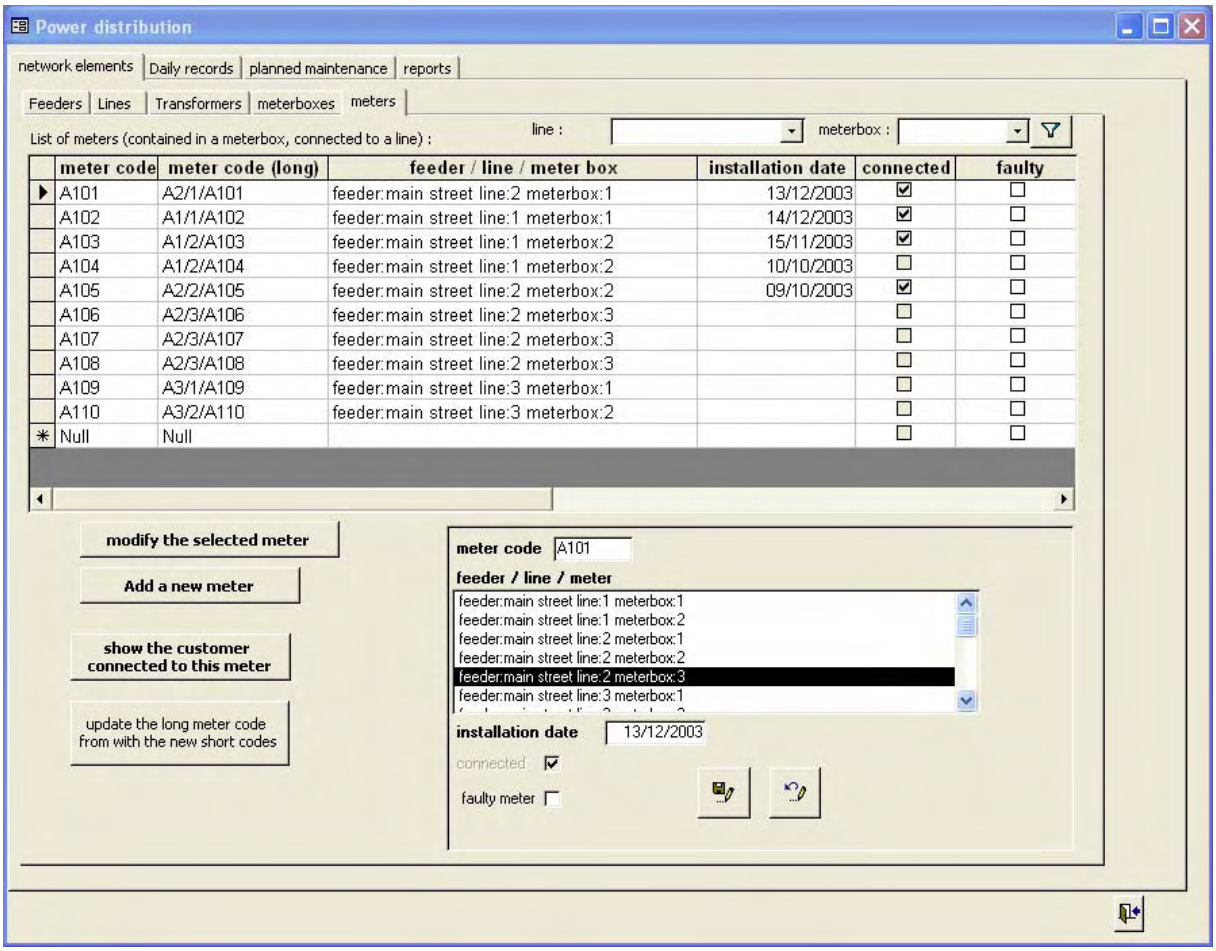
This screen is available only if the medium voltage option is set to yes in the initial setup.



C.4.1.4 List of meter boxes

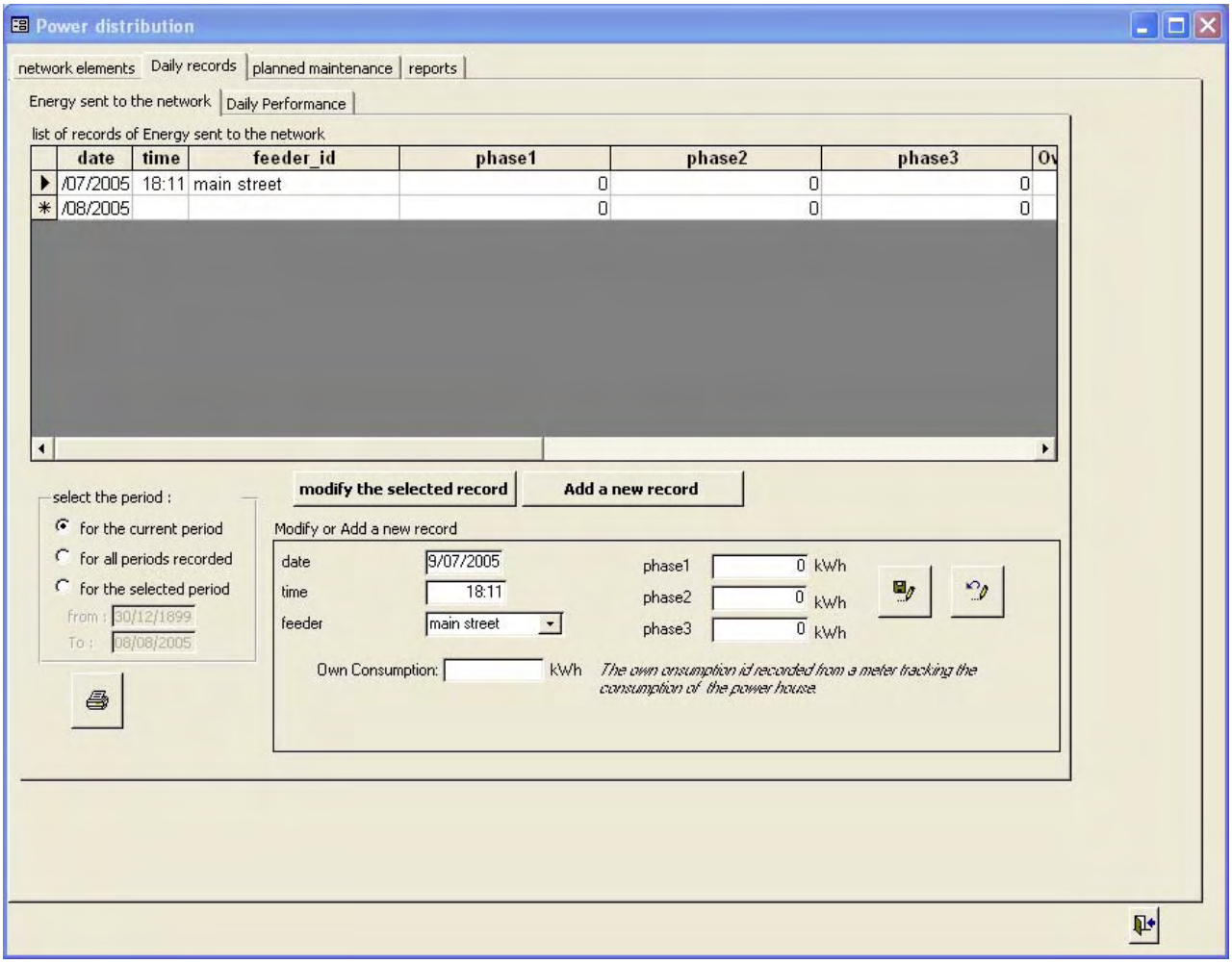


C.4.1.5 List of meters



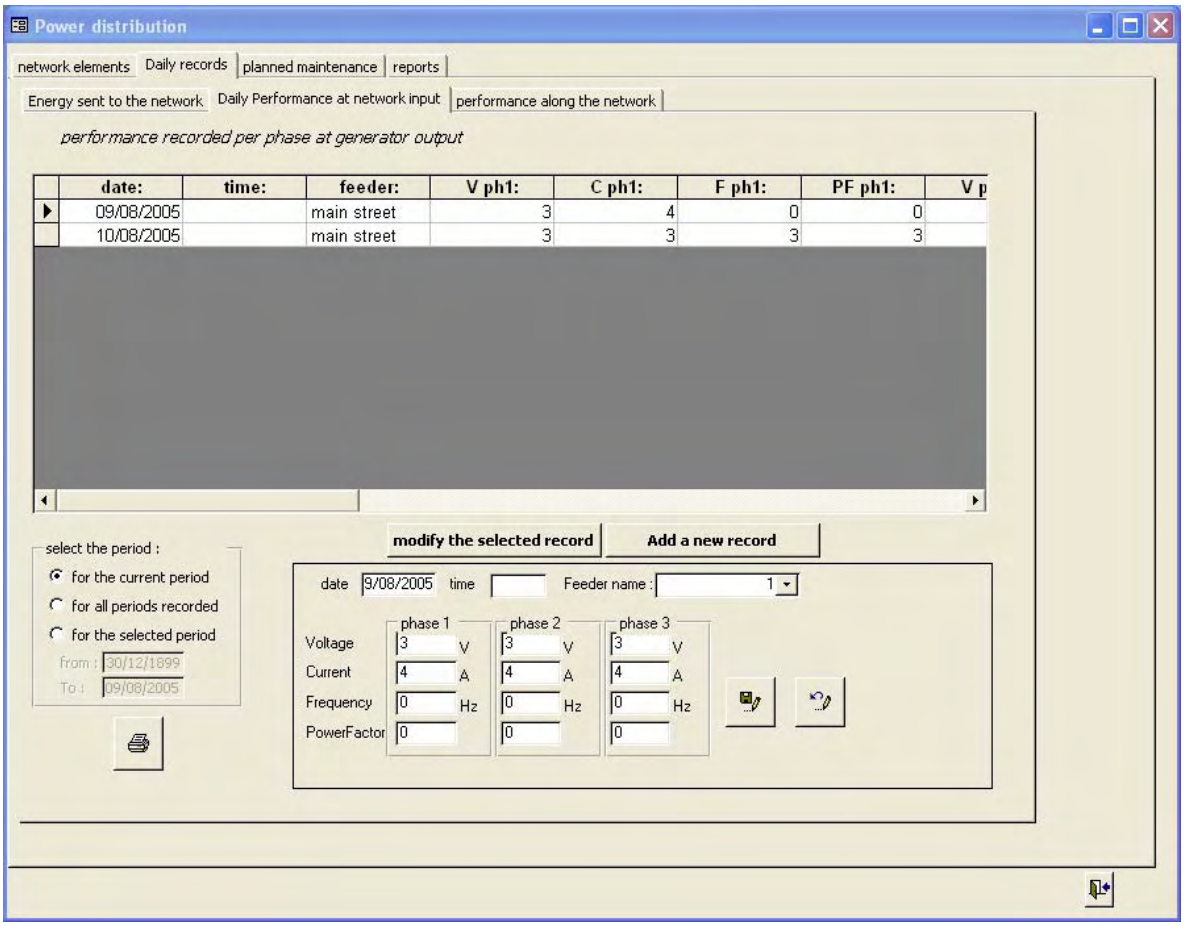
C.4.2 Screens FD2 : Daily Monitoring

C.4.2.1 Energy sent to the network per feeder and per phase



C.4.2.2 Daily performance of electricity sent to each feeder per phase

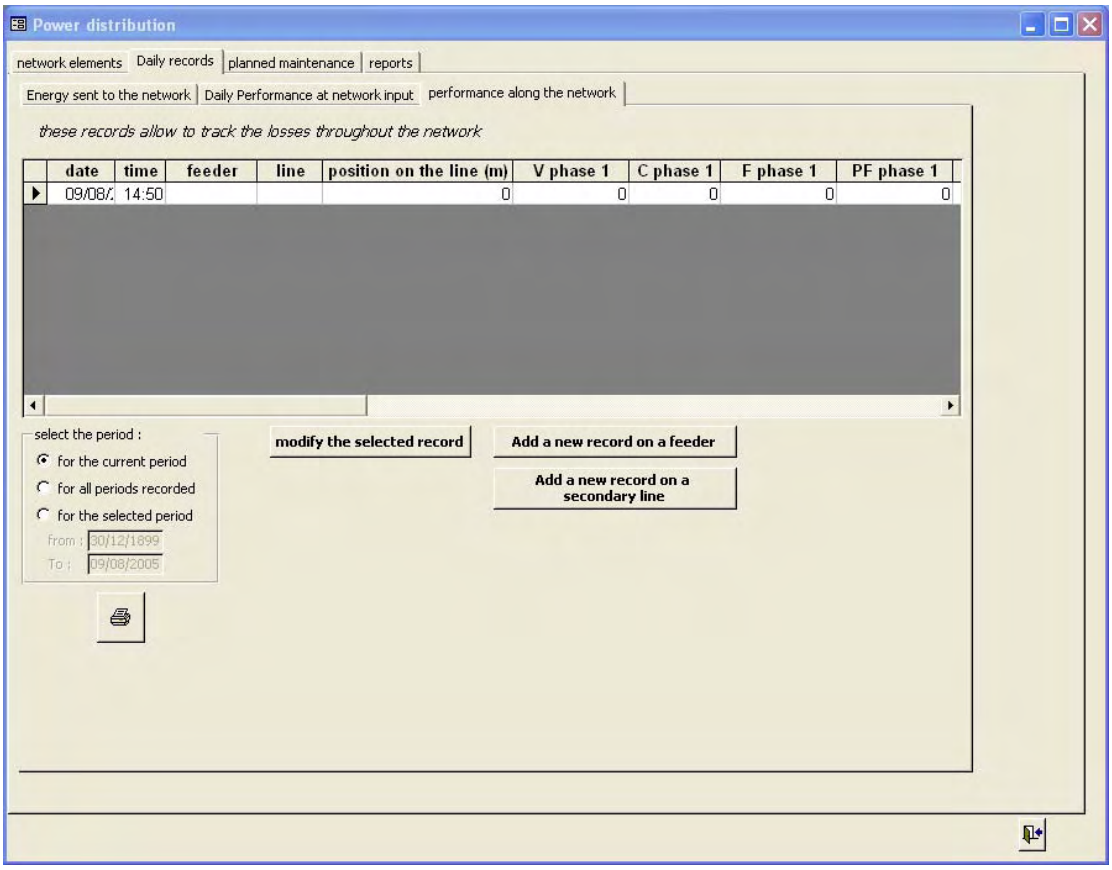
This screen is enabled only if this option is selected in the initial setup. If it is selected, another option allow to record only the voltage and current. In this case, the Frequency and power factor boxes will be hidden and not displayed in the consultation list neither.



C.4.2.3 Screen FD4 : Measure of the performance along the network

This screen is enabled only if this option is selected in the initial setup. If it is selected, another option allow to record only the voltage and current. In this case, the Frequency and power factor boxes will be hidden and not displayed in the consultation list neither.

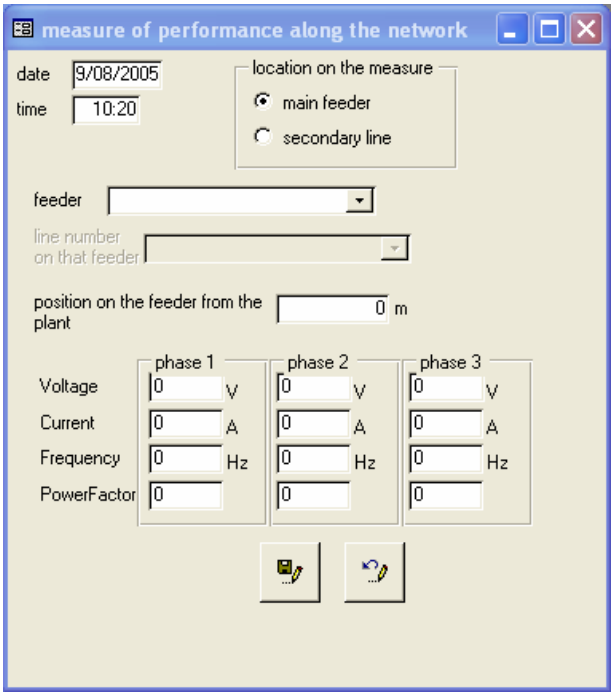
Annexe 4



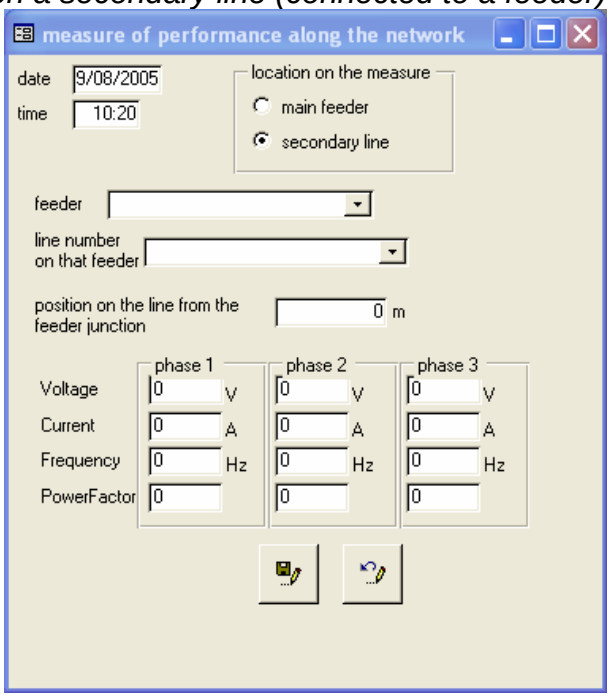
the buttons “add a new record on a feeder” and “add a new record on a secondary line” open a popup with one of the 2 following screens. These input screens can also be opened from the list of network elements for feeders (cf C.4.1.1) and lines (cf C.4.1.2) with the “record performance characteristics” button control.
These screens disappear when the save button or the cancel button are clicked.

The measurements can be done as frequently as desired (preferably at peak load time).

For a measurement on a feeder :

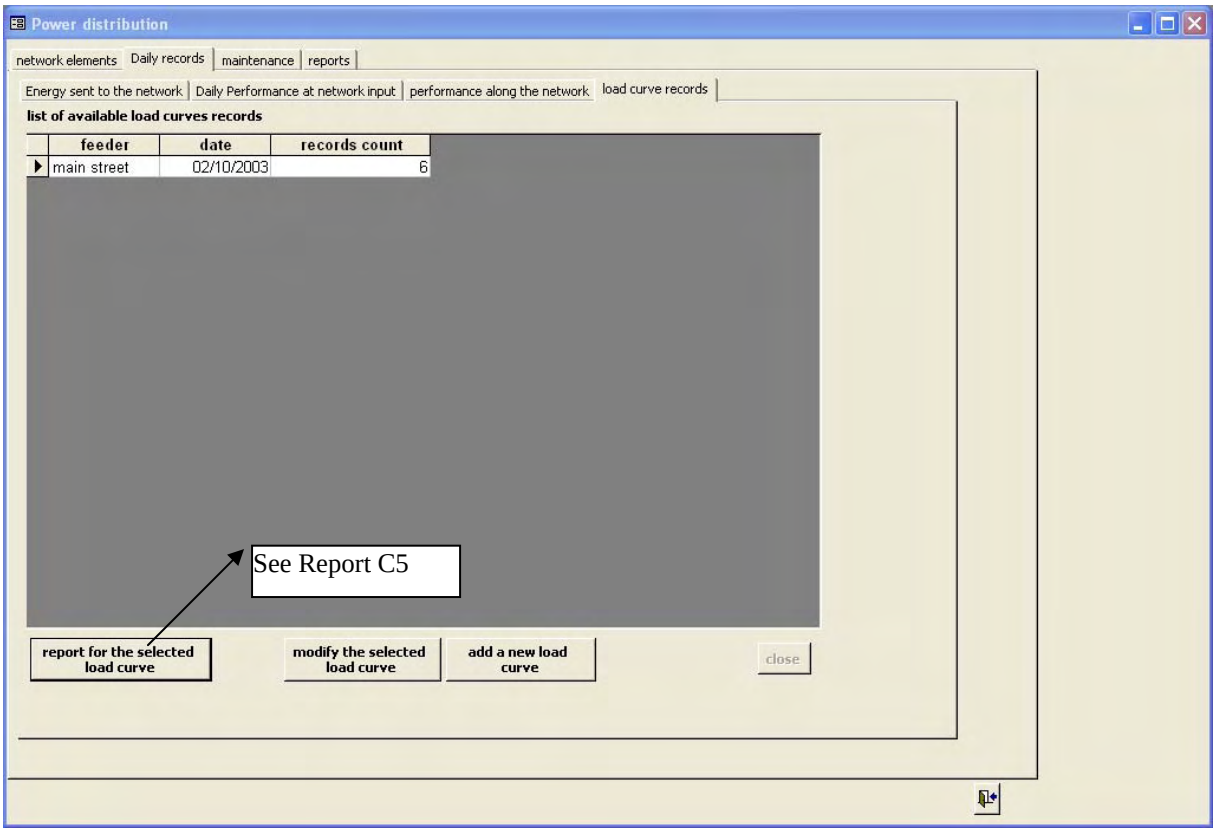


For a measurement on a secondary line (connected to a feeder) :

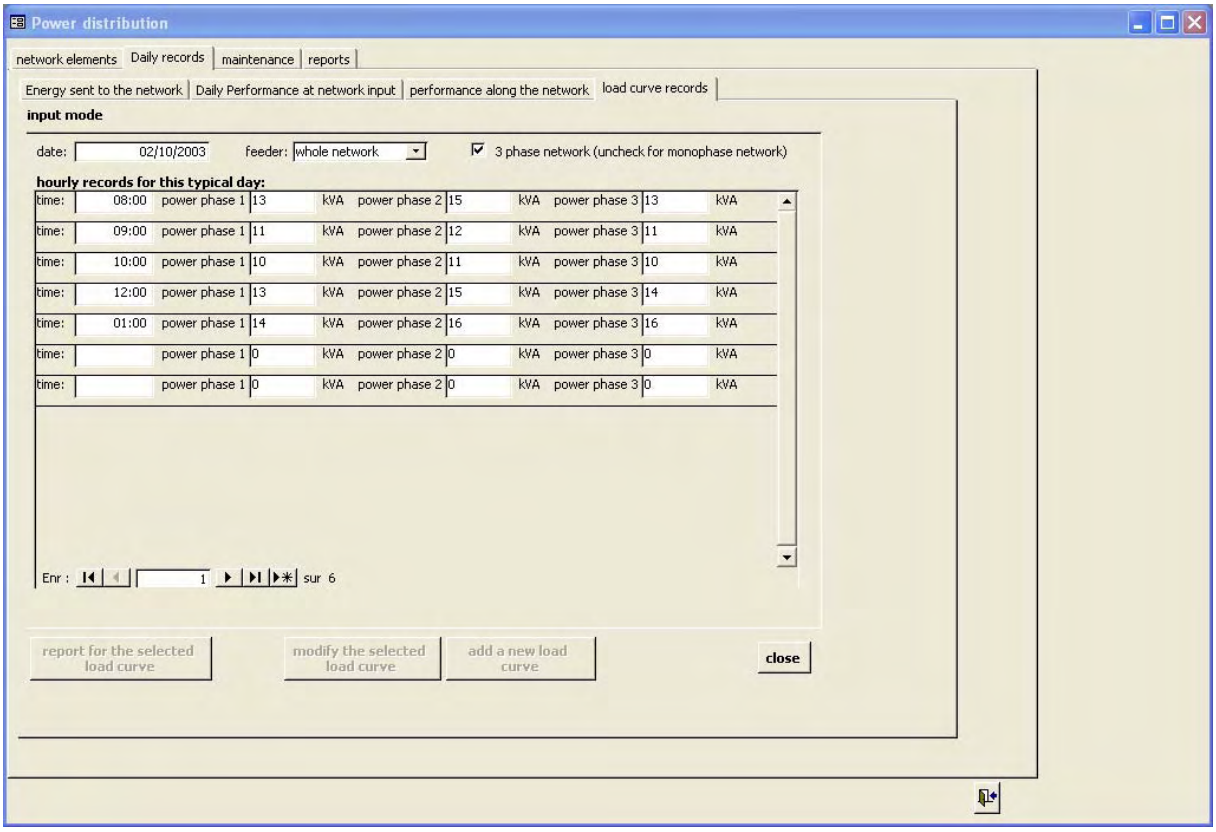


C.4.2.4 Screen FD8 : record load curve for a typical day

This screen appears first in readOnly mode : it lists all the record for load curve done per day and per feeder (or for the whole network if no feeder).



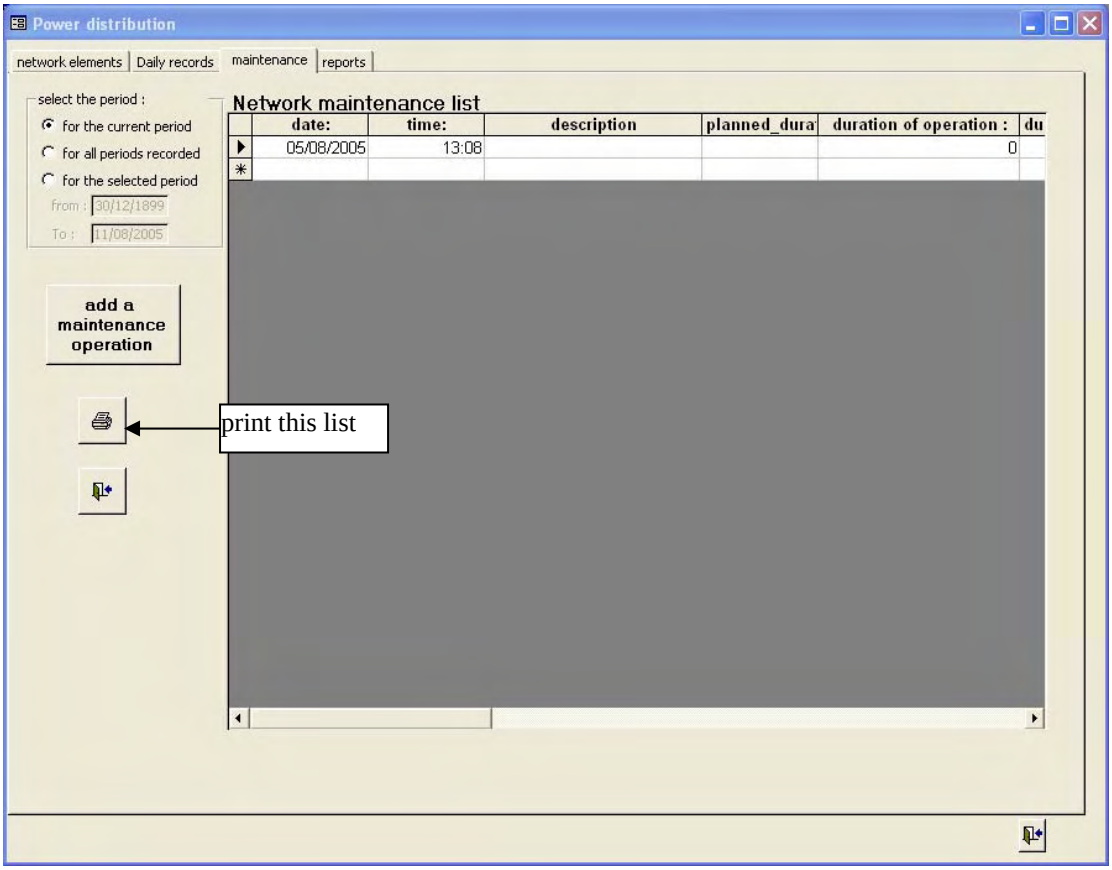
For each record in this list, it is possible to open the related report (drawing the load curve), modify the data for this record or add a new record. The modify and add buttons leads to the next screen :



on the “feeder” listbox, the first item selected by default is : “whole network”. If the 3 phase option is checked, 3 textboxes let record the power per phase, if it is unchecked, only one textbox for the power record.
It is better to have one record per hour but not compulsory, we can have as many record as we want, the more records we have, the more precise is the load curve.

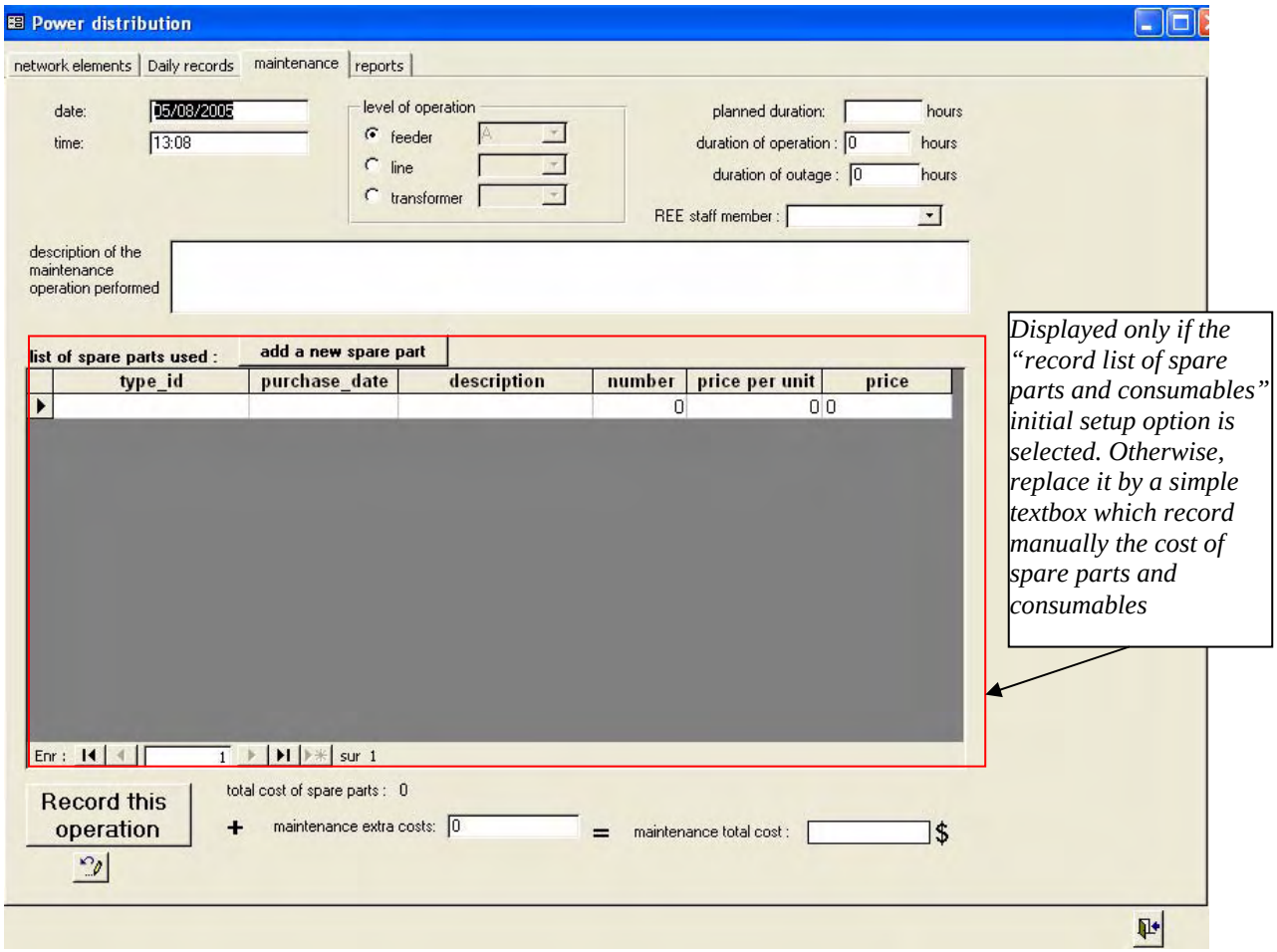
C.4.3 Screen FD3 : Recording Network Maintenance Operations

The list of all the maintenance operations can be accessed by using the "maintenance" tab :



The button "add a maintenance operation" allow to record a new maintenance operation.
It is also possible to enter a new maintenance operation directly from the list of network elements for feeders (cf C.4.1.1) and lines (cf C.4.1.2) and transformers with the "record a maintenance" button (in this case, the screen is accessed in modifying mode).

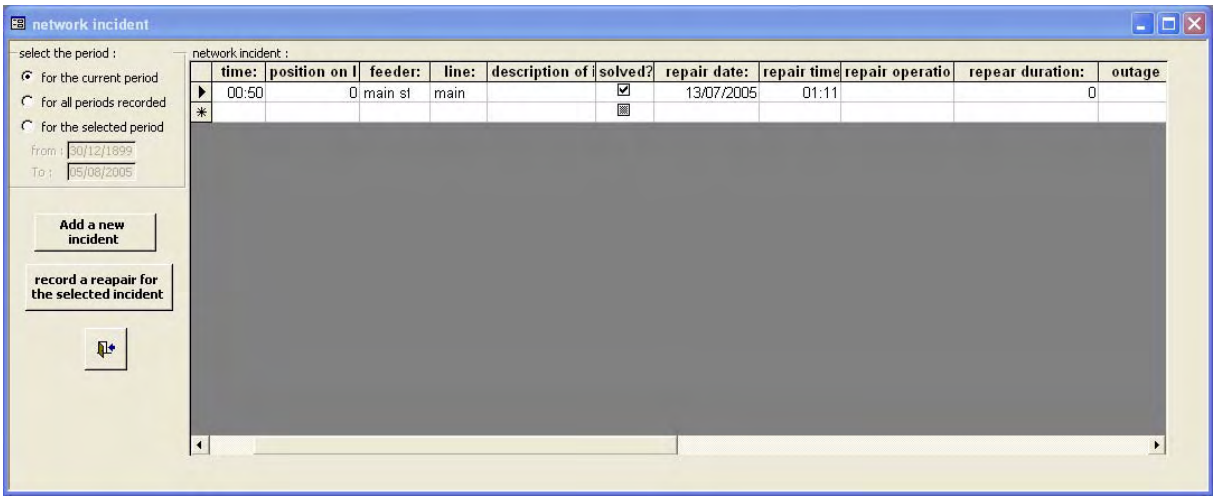
The input screen for the maintenance operations is as following :



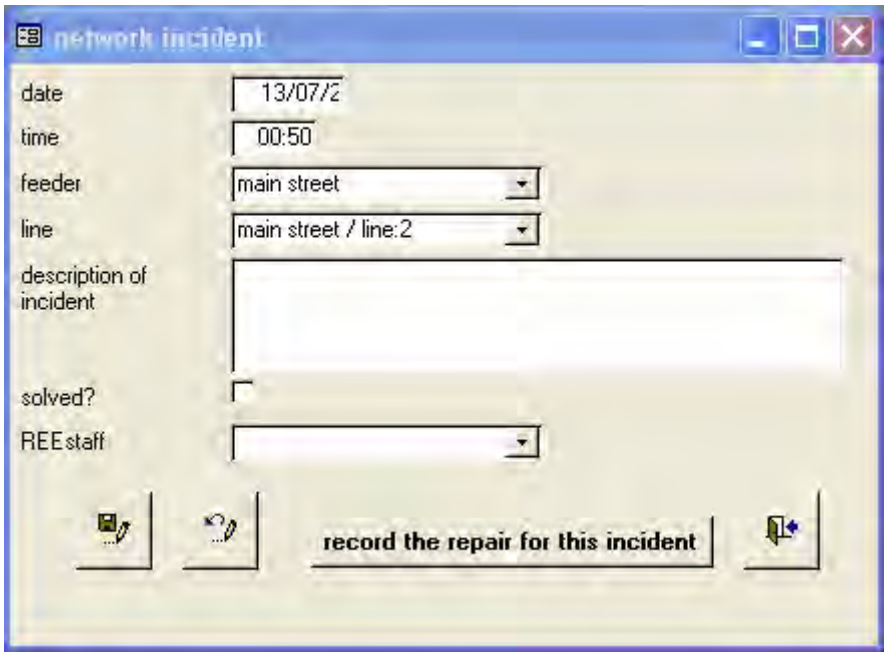
If the record list of spare parts and consumables initial setup option is not selected,

C.4.4 Screen FD5 : record a network incident

In the list of network elements for feeders (cf C.4.1.1) and lines (cf C.4.1.2), the "list of incidents" button control allow this screen to pop-up for the selected elements (either feeder or line).
This screen disappears when the save button or the cancel button are clicked.

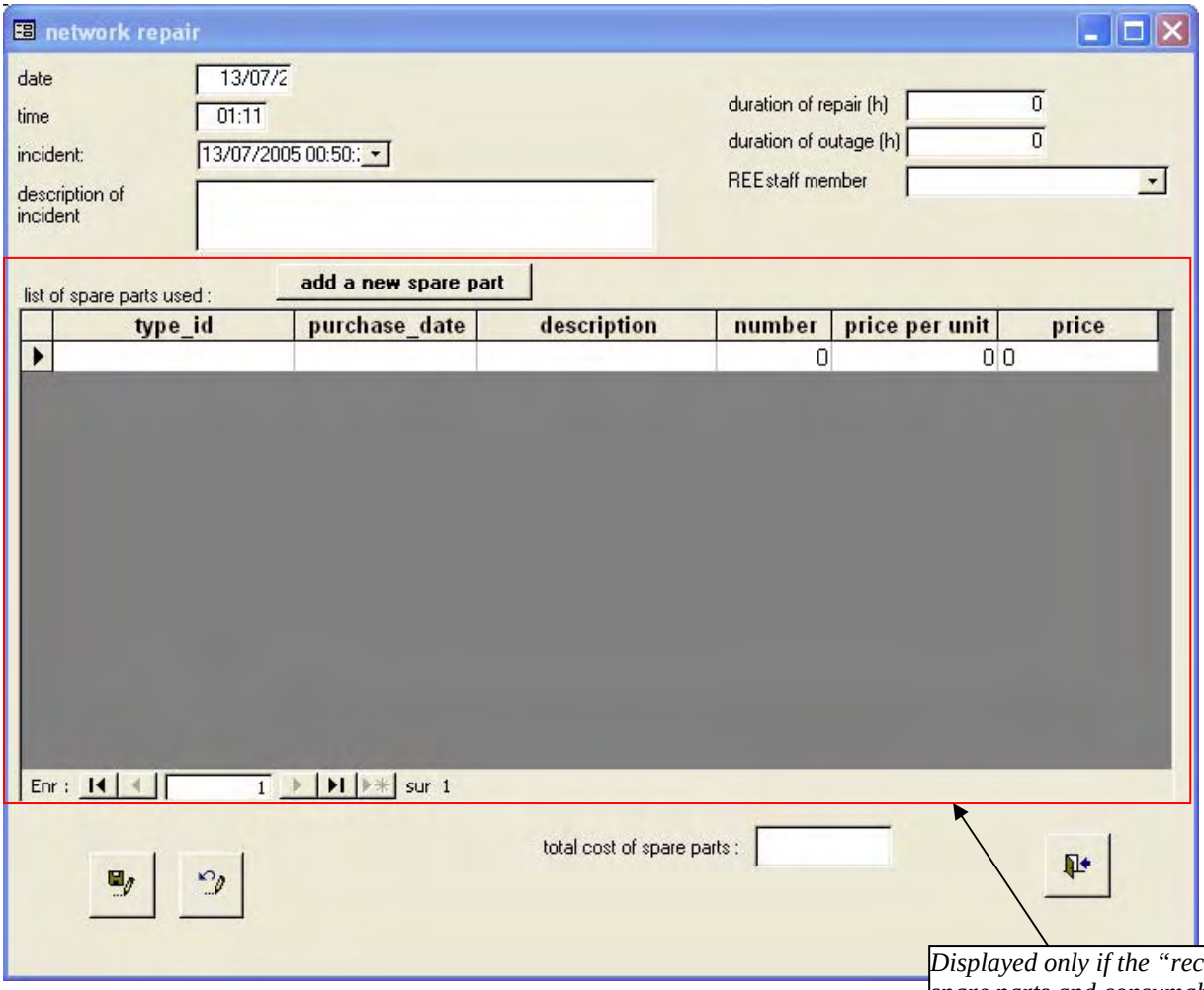


by clicking on "add a new incident" : he following input screen appear :



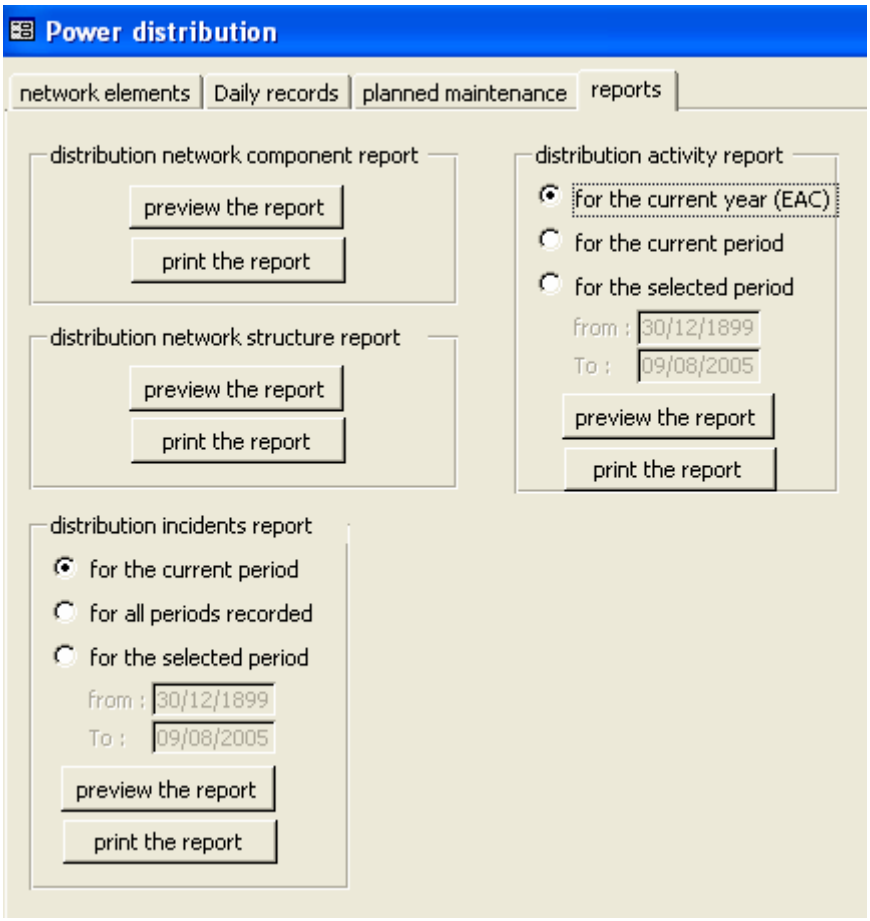
By clicking on the “record the repair for this incident” button, the next screen appears and allow to record the repair description relative to this incident.

C.4.5 Screen FD6 : Recording Repairs



Displayed only if the “record list of spare parts and consumables” initial setup option is selected. Otherwise, replace it by a simple textbox which record manually the cost of spare parts and consumables

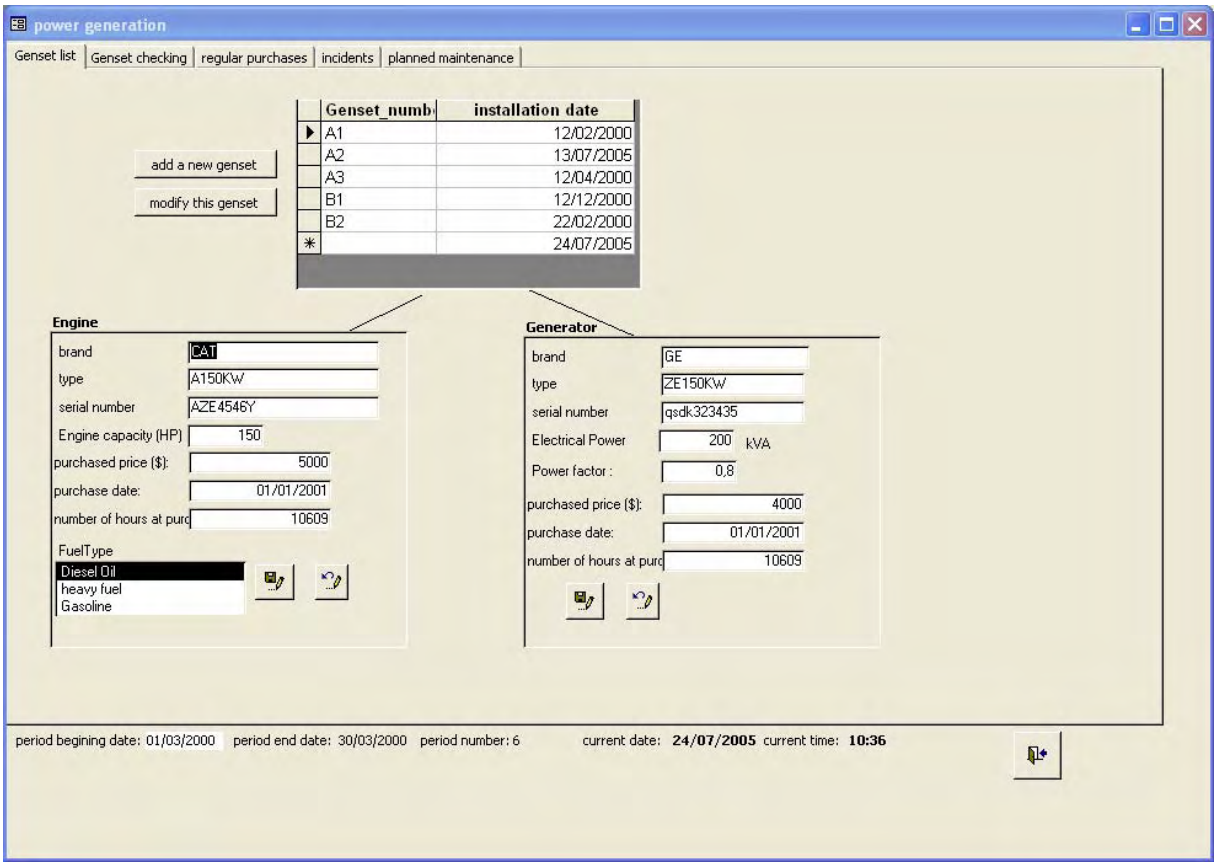
C.4.6 Reports on the Distribution Side



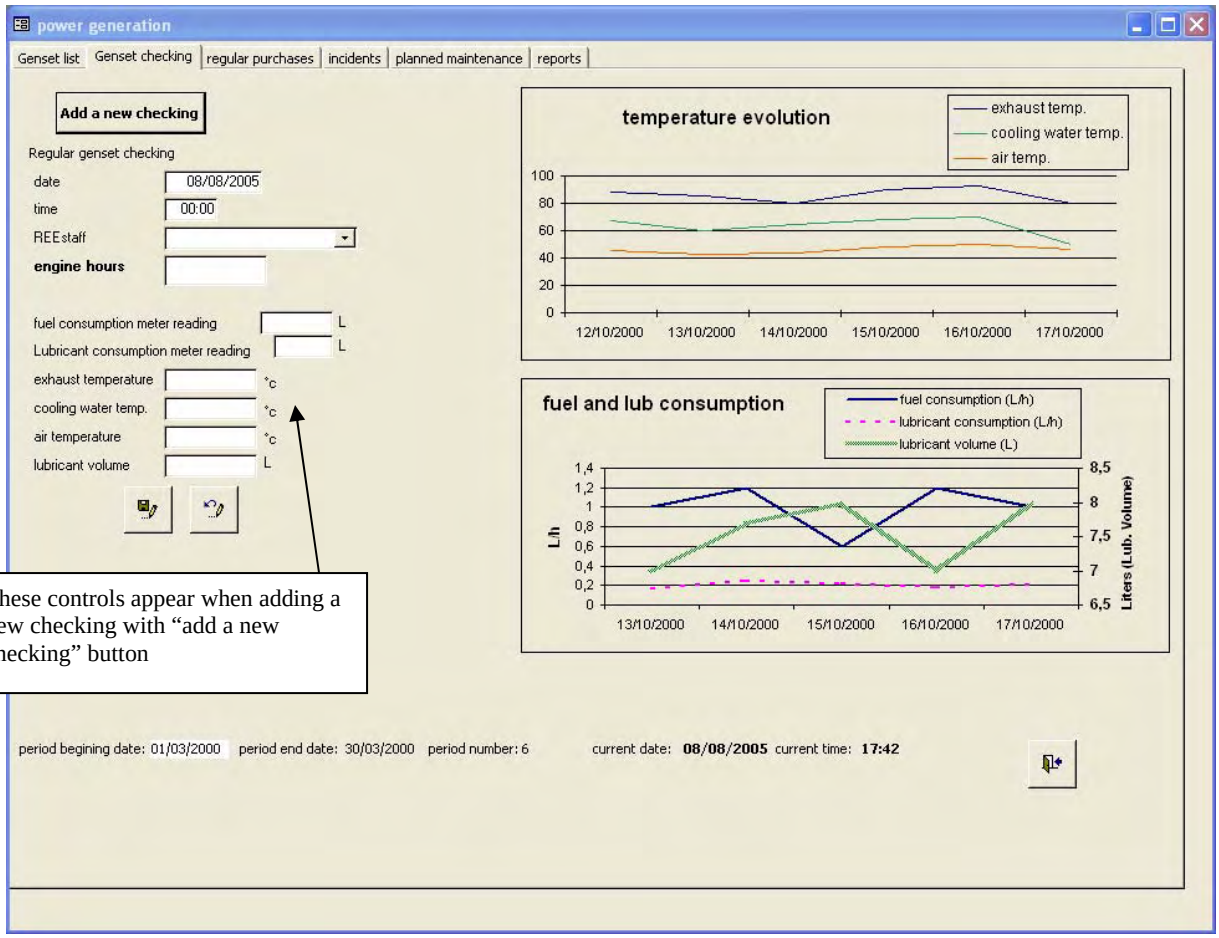
these reports can also be launched from the report menu (screen FR1 of 0). The different reports are described in this section.

C.5 Power Generation Module

C.5.1 Screen FG1 : List of Gen-sets



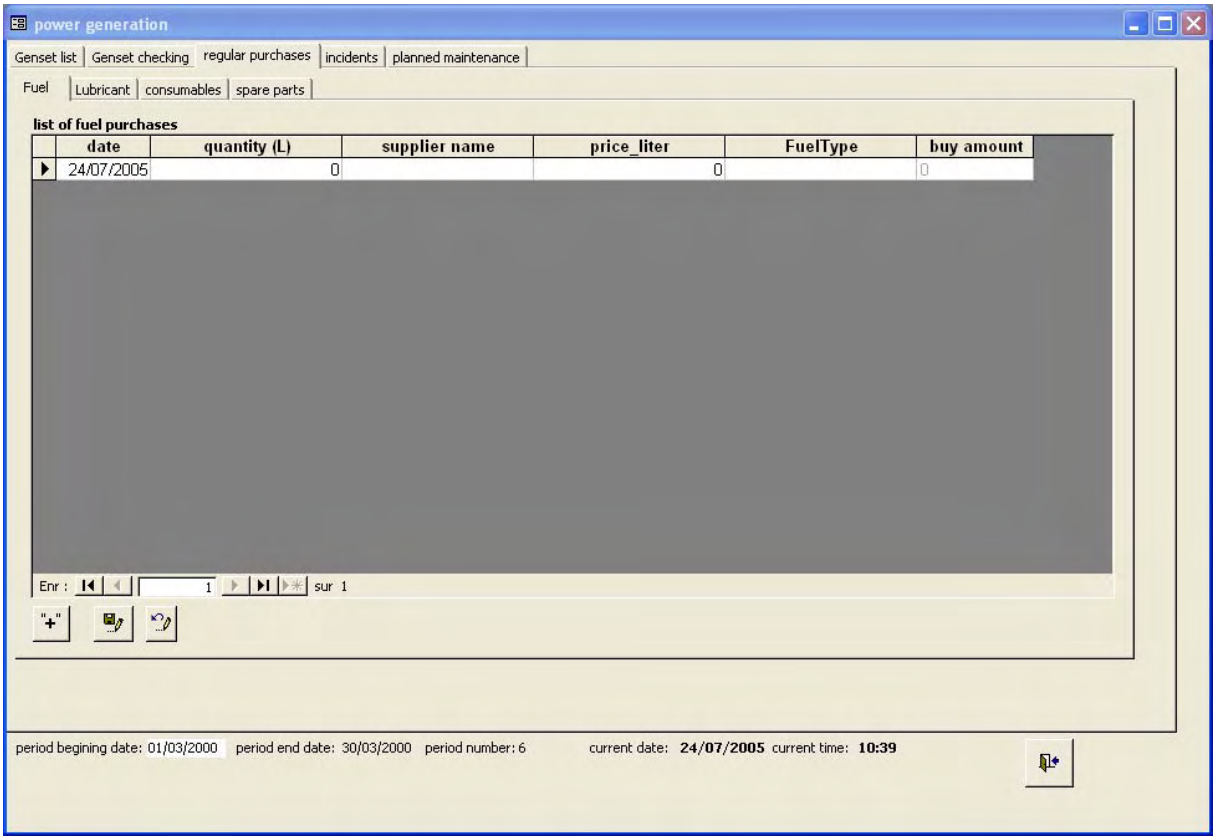
C.5.2 Screen FG1 : Monitoring Gen-Sets



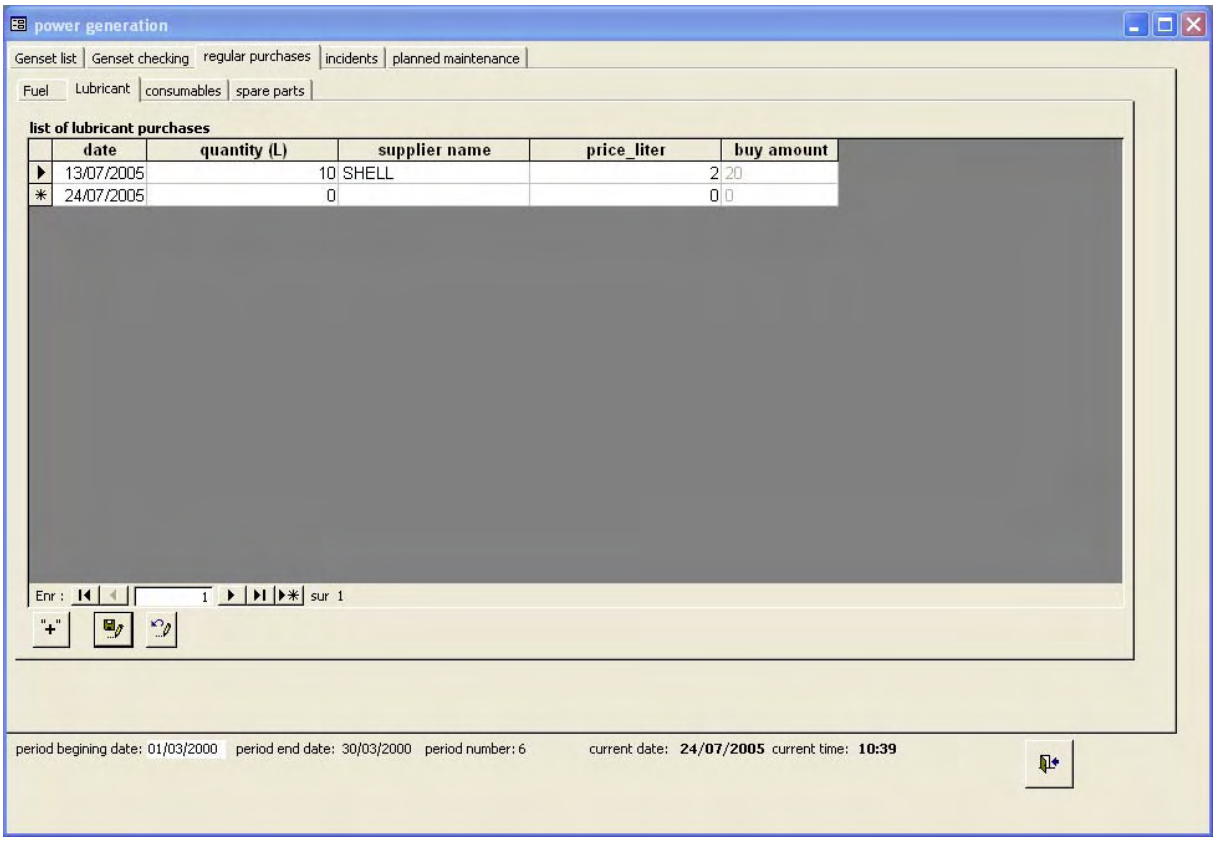
the fuel consumption is computed as this :
FC= (current fuel meter reading - last fuel meter reading) / (current engine hours – last engine hours)
Same for lubricant consumption.
The charts trend is over a range of 1 month.

C.5.3 Screen FG1 : regular purchases

C.5.3.1 Fuel purchases



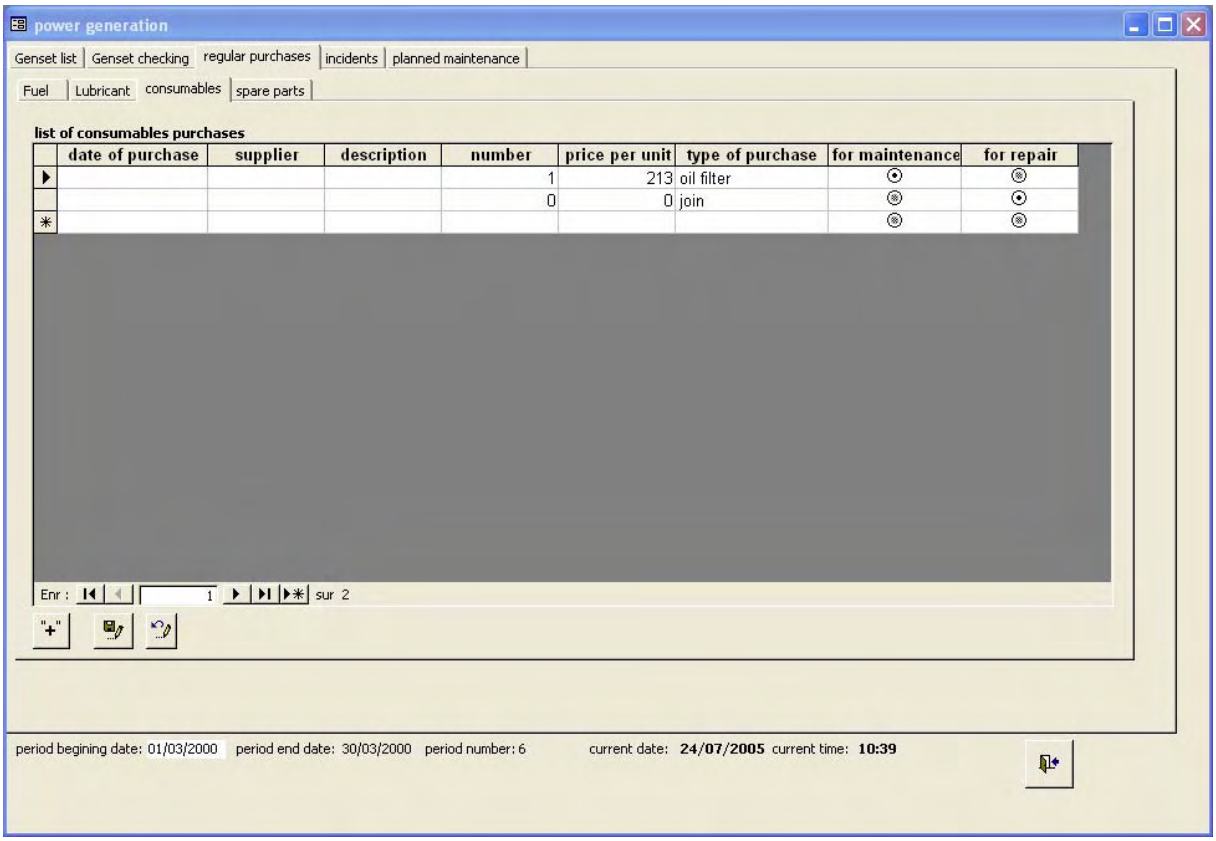
C.5.3.2 Lubricant Purchases



C.5.3.3 Consumables

Displayed only if the "record list of spare parts and consumables" initial setup option is selected.

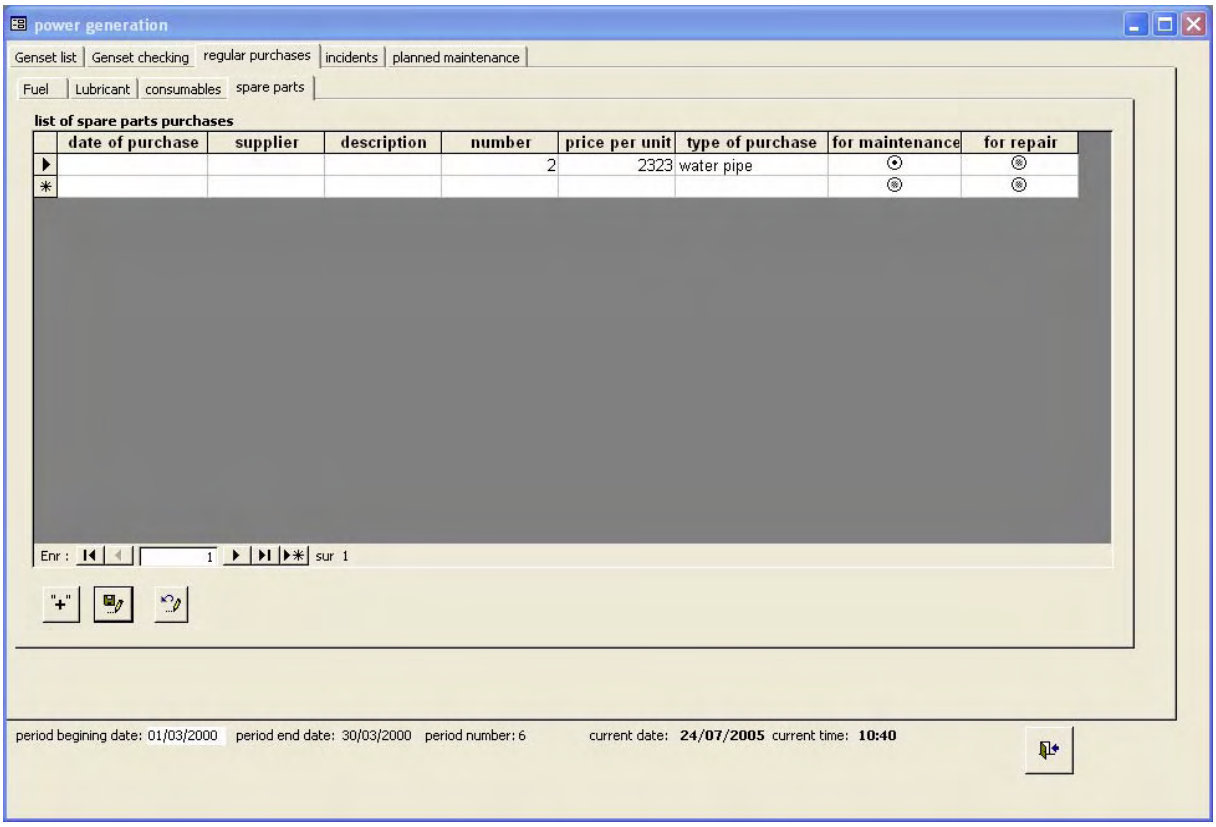
Some consumables can also be added from the "planned maintenance" windows and from the repair windows. Even if their different buy purpose is recorded, they all can be listed in this form.



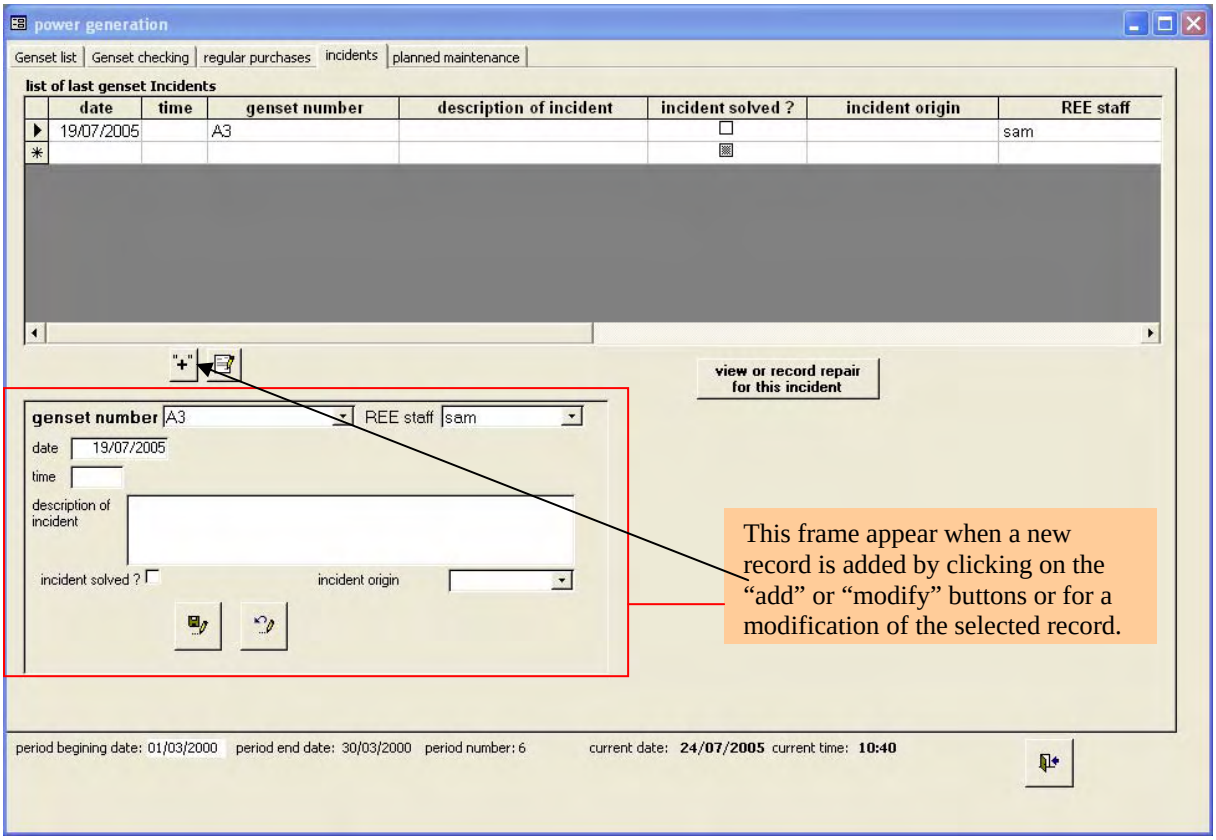
C.5.3.4 Spare parts

Displayed only if the "record list of spare parts and consumables" initial setup option is selected.

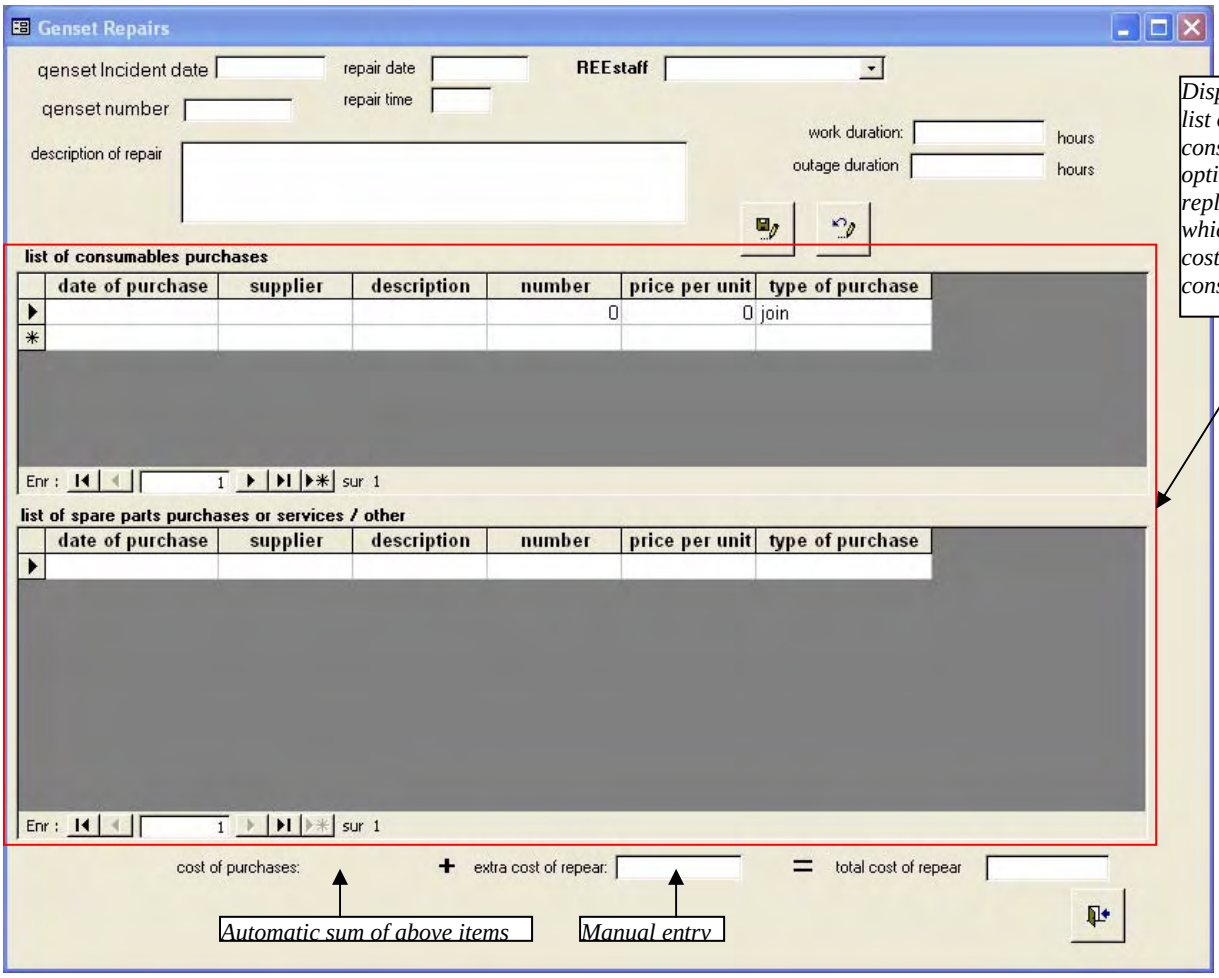
Same remark as for consumables



C.5.4 Screen FG1 : incidents



By clicking on "view or record repair for this incident", the following screen pops up and let record the repair operation for the particular incident :

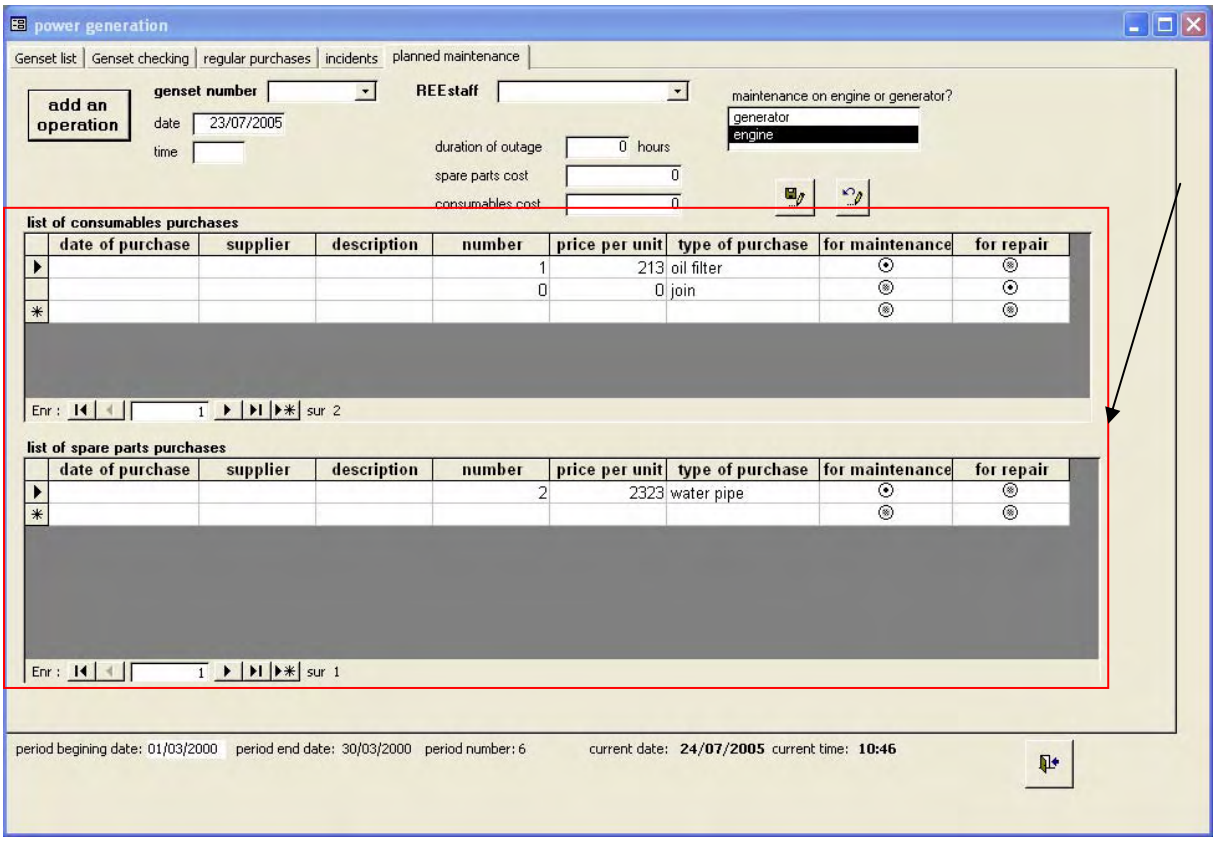


Displayed only if the "record list of spare parts and consumables" initial setup option is selected. Otherwise, replace it by a simple textbox which record manually the cost of spare parts and consumables

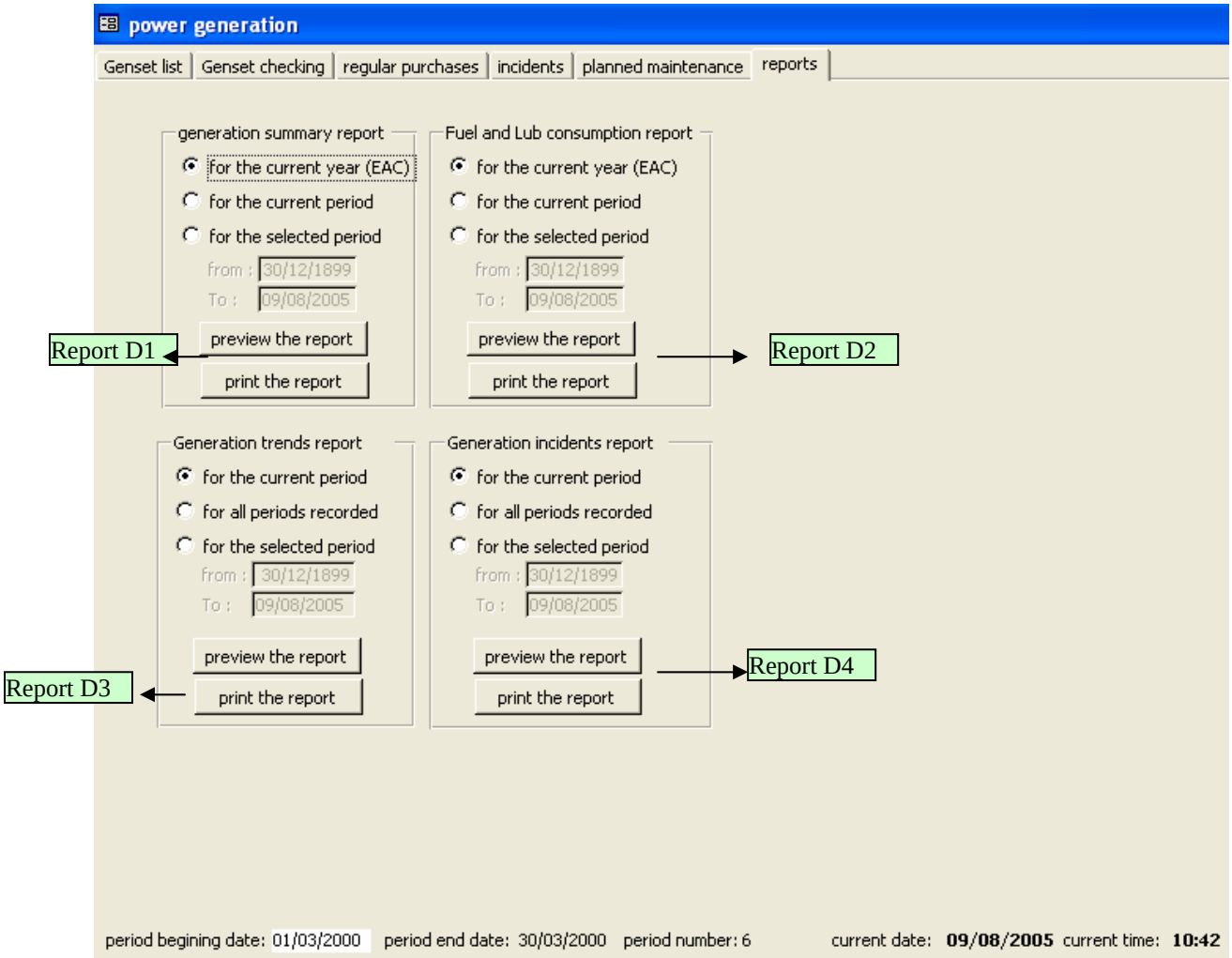
C.5.5 Screen FG1 : planned maintenance

On the opening, this screen is blank except the "add an operation" button. When clicking on it, a new record is added with the controls as follow :

Displayed only if the "record list of spare parts and consumables" initial setup option is selected. Otherwise, replace it by a simple textbox which record manually the cost of spare parts and consumables



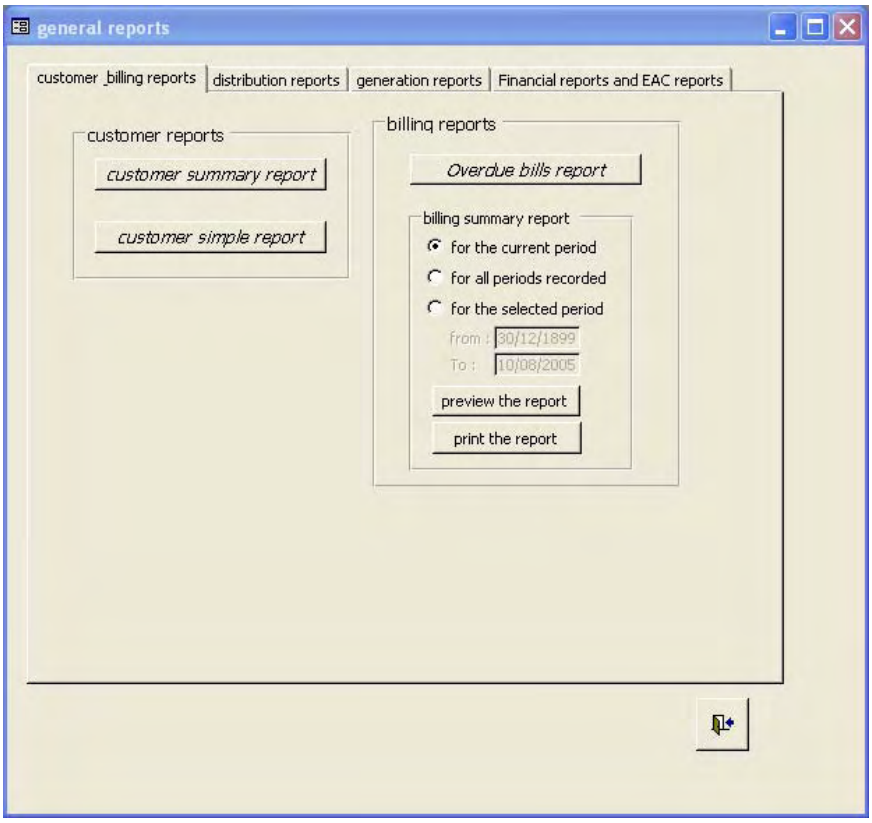
C.5.6 Screen FG10 : Generation reports



C.6 Reporting module

All the reports launch controls can be accessed from this module (as most of them can also be launched from their related module expert for the financial and EAC reports .

C.6.1 Screen FR1_C : menu for access for customer and billing reports



Access to reports : B1,B2,A3,A2.

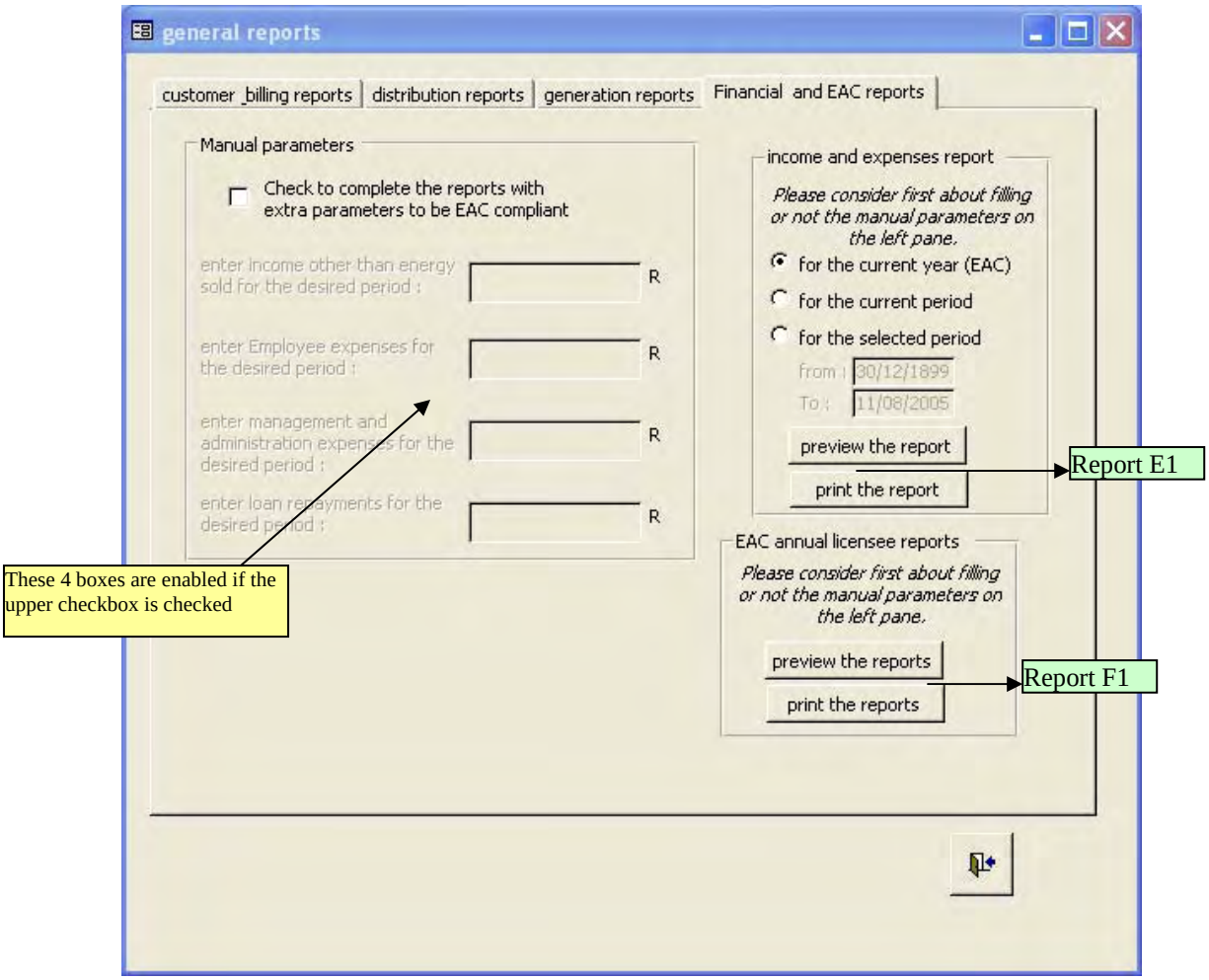
C.6.2 Screen FR1_D : menu for access for distribution reports

Same interface as in C.4.6
Access to reports : C1,C2,C3,C4.

C.6.3 Screen FR1_G : menu for access for generation reports

Same interface as in C.5.6
Access to reports : D1,D2,D3,D4.

C.6.4 Screen FR1_F : menu for access for financial and EAC reports



The income and expense report required by EAC needs some extra information not tracked by the software. Thus, it is necessary to fill manually this information before editing this report. This is done with the 4 boxes on the left pane of this interface.

ANNEX D. REPORT SPECIFICATIONS

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A. Billing Reports

A.1.	Individual Customer Bills
Format	▪ Standard EAC Format ▪ Main section plus a small tear-off receipt at bottom of form ▪ Fit to half A4 size to save paper.
Parameters	▪ Header: REE Business Name, Logo, EAC License Number and contact details, and "Customer Bill" ▪ Main section: Customer Number, Customer Name, Period of Bill, Previous Meter Reading, This Meter Reading, Energy Consumed, Tariff Rate, Total Bill ▪ *Plus if the REE allows credit, then also show the Carry-Over Balance and the Running Total.* ▪ *Plus if the REE allows additional expenses to be billed to customer, then also show the total of any Additional Expenses and add this to a Grand Total or to the Running Total (if credit is allowed)* ▪ Receipt section: Customer Number, Customer Name, Period of Bill, Total Bill
Options	▪ User can choose to print all bills, or select individual customers to print ▪ Bills can be printed directly, or saved to file for printing elsewhere

A.2.	Billing Summary Report
Format	▪ Header: "Billing Summary Report for: " <insert name of REE> ▪ 1 page with table or dot points for part 'a' at top, then chart for part 'b' underneath ▪ charts should have clear legend and also label point values ▪ Footer: page number
Parameters	a. <u>Current Period Summary</u> ▪ Dates of Report Period ▪ Date of report ▪ Total number of active customers (currently connected) ▪ Total kWh sold for all customers for the period ▪ Total value of bills issued for all customers for the period b. <u>Billing Performance Trends</u> Bar Chart with each period along x-axis, and with two y-axes: kWh on the left and the chosen currency for the REE on the other y-axis; and displaying the following series of data: ▪ Total kWh billed for all customers for each period ▪ Total value of bills issued for all customers for each period ▪ Total value of bills collected for all customers for each period
Options	▪ User chooses which periods to be shown for the trend charts

A.3. Overdue Bills Report	
Format	▪ Header: “Overdue Bills Report for “ <insert name of REE> ▪ Summary table at top of first page ▪ Then a single table listing all customers with outstanding payments due (as many pages as necessary) ▪ Footer: page number
Parameters	a. Summary (table) ▪ Total number of customers with outstanding payments this period ▪ Percentage of customers with outstanding payments this period, compared to total number of active customers this period ▪ Total value of outstanding payments this period ▪ Percentage of the total value of outstanding payments compared to the total value of bills issued. b. Listing of Overdue Bills (table) ▪ Customer Code ▪ Customer Name ▪ Total Amount Owed ▪ Date of Last Payment ▪ Amount of Last Payment
Options	▪

B. Customer Reports

B.1 Customer Summary Report	
Format	▪ Header: “Customer Summary Report for “ <insert name of REE> ▪ One main chart on a single page with a clear legend and labelled point values ▪ Footer: page number
Parameters	a. Customer Status Single bar chart displaying periods along x-axis, and numbers of customers on y-axis, and displaying the following data series for each period: ▪ Number of connected customers ▪ Total number of potential customers waiting for connection ▪ Number of new connections in the period ▪ Number of customers disconnected during period If the REE has multiple classes of customers or tariff rates, then the proportional numbers of these will be labelled on each of the above bars. So, eg: if an REE has two tariff classes then for each period in the chart there will be 4 bars, according to the series mentioned above, and each bar will be divided and labelled into the proportional type of tariff.
Options	None

B.2 Customer details Report	
Format	▪ Header: “Customer Details Report for “ <insert name of REE> ▪ Single table listing all customers that match the criteria selected by the user (as many pages as necessary) ▪ This report is produced for the current period ▪ Footer: page number
Parameters	a. Summary Table ▪ Entry Number (ie: row numbers to track how many are in report) ▪ Customer Code ▪ Customer Name ▪ Customer Address ▪ Customer Phone Number ▪ Customer Status ▪ Customer Class (if defined) ▪ Feeder connection ▪ Meter code ▪ Reading date ▪ Consumption ▪ Invoice date ▪ Consumption billed ▪ Extra expense ▪ Last amount due ▪ Outstanding balance ▪ Total paid ▪ Current Balance
Options	The user will be prompted to select a single search criteria from the following list and will also be prompted for which field to sort by: • Customer code • Customer name • Meter code • Customer class • Connection status • Connection date When accessed from the “list of connected customer” interface, the report includes only the connected customers with allow to apply a search criteria to restrict that list by : ▪ On Waiting List ▪ Currently Connected - by Class (if the REE has defined multiple classes then user will be prompted to choose which class, or all of them) ▪ Currently Connected – by Feeder (the user will be prompted to choose any of the feeders, or all of them) ▪ Currently Connected – by line ▪ Currently Connected – by meterbox ▪ Newly Connected (in current period) ▪ Newly Disconnected (in current period) ▪ Currently Disconnected

B.3 Basic Customer Report	
Format	▪ Header: “Customer Details Report for “ <insert name of REE> ▪ Single table listing all customers that match the criteria selected by the user (as many pages as necessary) ▪ This report is produced for the current period ▪ Footer: page number
Parameters	a. customer list ▪ Customer Code ▪ Customer Name ▪ Customer Address ▪ Customer phone ▪ Customer Status (is connected / is waiting / is disconnected) ▪ Customer Class (if defined) ▪ Meter code (if connected)
Options	The user will be prompted to select a search criteria from the following list • List all the customers • List only the connected customers • List only the waiting customers • List only the disconnected customers The user will be prompted for which field to sort by: • Customer code • Customer name • Connection date The user will be prompted if he wants to group the records by (a single or both options can be chosen together): • Customer class (if defined) • Connection status

C. Distribution Network

C.1 Distribution Network Structure Report	
Format	▪ Header: " Distribution Network Structure Report for " <insert name of REE> ▪ Single table formatted to indicate the hierarchy of network elements, printed over as many pages as needed ▪ This report is produced for the current period ▪ Footer: page number
Parameters	This table will print a full list of network elements and customer connections, sorted and formatted according to the 'network hierarchy' as follows: 1. Feeder Identifierfeeder code, feeder name, voltage, length of bare/insulated conductor, average conductor size, total length. 1.1. line identifier, voltage, length of bare/insulated conductor, average conductor size, total length and if medium voltage network : Transformer Identifier with capacity,voltage in/ voltage out, 1.1.1 Meter Box Identifier with pole number 1.1.1.1 Customer Meter with : short meter and long meter codes, installation date, connection status (connected or not)
Options	▪ None

C.2 Distribution Network Components Report	
Format	▪ Standard EAC Format ▪ Header: " Distribution Network Report for " <insert name of REE> ▪ Two summary tables as described below, running over as many pages as needed ▪ This report is produced for the current period ▪ Footer: page number
Parameters	a. Transformers (6 columns) ▪ Row number ▪ Transformer type (pole-mounted, packet or substation) ▪ Medium Voltage (showing input and output voltages, eg: "0.4/15 kV") ▪ Low Voltage (as above) ▪ Installed Capacity (in units of kVA) ▪ Number of transformers b. Conductors (8 columns) ▪ Row number ▪ Conductor type (Medium Voltage or Low Voltage, with phase 1, 2, 3 for LV) ▪ Rated capacity of conductor (in units of kV) ▪ Length of Insulated Conductor ▪ Length of Bare Conductor ▪ Voltage at the end of Conductor during peak load
Options	▪ None

C.3 Distribution Activity Report	
Format	▪ Standard EAC Format (except for the period – see below) ▪ Header: " Distribution Activity Report for " <insert name of REE> ▪ Two summary tables as described below, running over as many pages as needed ▪ Footer: page number
Parameters	a. Energy Distribution Activity (5 columns) ▪ Row number ▪ Description: ▪ Total Energy Distributed (kWh) ▪ Total Energy Sold (kWh) ▪ Energy Line Losses (kWh) ▪ Total time that the generators were not working (hours) ▪ Total time that the grid was not operating (hours) ▪ Total time for maintenance of the grid (hours) ▪ Total cost of maintenance of the grid (Riels) ▪ Total time for planned maintenance of the grid (hours) ▪ Total number of faulty customer meters ▪ Total number of customers ▪ Total number of working hours per day (hours) ▪ Units (as indicated above) ▪ Value for the period ▪ Notes b. Current Tariffs (4 columns) ▪ Tariff Description ▪ Unit of tariff (eg: Riels) ▪ Tariff Rate per kWh ▪ Note
Options	▪ The user will be given option to choose the reporting period as either Annual (the required EAC format, which gives the 12 months to date) or Current Period.

C.4 Distribution Incidents Report	
Format	▪ Header: " Distribution Incidents Report for " <insert name of REE> ▪ Summary table and then a single table with full listing of incidents as described below, running over as many pages as needed ▪ The user will be prompted to define the report period ▪ Footer: page number
Parameters	a. Summary of Distribution Network Incidents ▪ Total Number of Distribution Network Incidents in the period ▪ Total Number of Performed Distribution Network Repairs in the period ▪ Total Cost of Distribution Network Repairs in the period b. Single Table with an entry for each network incident during the period: ▪ Date of Incident ▪ Time of incident ▪ Location of incident (feeder code or line number) ▪ Description of incident ▪ Date of repairs (rest will be blank if not yet repaired) ▪ Description of repairs ▪ Duration of work ▪ Duration of network outage ▪ Total cost of spare parts and consumables ▪ Name of staff member that performs repairs
Options	▪ The user will be prompted to define the report period

C.5 Load Curve Report	
Format	▪ Header: " Load Curve Report for " <insert name of REE> ▪ Single plot of the load curve. ▪ The user will be prompted to define the report period ▪ Footer: page number
Parameters	<u>Load Curve</u> ▪ Plot of total demand throughout a 24 hour period. Time is on x-axis (actual time of day) and demand on y-axis (kVA). ▪ User selects which 24hr period to plot (chooses date) ▪ It is unlikely that the user will have recordings of power for every hour, and often will have no recordings. So if less than 3 recordings are available for the selected period then an error message should be displayed informing that the load curve is not meaningful due to lack of input data.
Options	▪ The user will be prompted to define the report period

D. Generation Reports

D.1 Generation Summary Report	
Format	▪ Standard EAC Format (except for the period – see below) ▪ Header: " Generation Summary Reports for " <insert name of REE> ▪ A single Summary table on a single page ▪ Footer: page number
Parameters	Summary Table (8 columns) ▪ Row number ▪ Description: ▪ Engine Manufacturer (name) ▪ Rated Engine Capacity (HP) ▪ Rated Power Output of Generator (kVA) ▪ Power Factor of Output (fraction between 0 and 1.0) ▪ Energy Produced per Week (kWh) ▪ Energy Produced for the period (kWh) ▪ Name of Fuel Supply Company ▪ Total Fuel Consumption for the period (Litres) ▪ Specific Fuel Consumption (Litres per kWh) ▪ Name of Lubricant Supply Company ▪ Total Lubricant Consumption in Period (Litres) ▪ Specific Lubricant Consumption for the period (Litres per kWh) ▪ Total Cost of Repairs in the period (Riels) ▪ Total Number of Repairs in the period ▪ Number of Breakdowns in the period ▪ Cost of Planned Maintenance Activities (Riels) ▪ Own Consumption (kWh) ▪ Total Energy Distributed in the period (kWh) <just total generated less the own consumption> ▪ Units (as indicated above) ▪ Total for all generators ▪ Generator 1 ▪ Generator 2 ▪ Generator 3 ▪ <expand as needed for the number of generators> ▪ Notes
Options	▪ The user will be given option to choose the reporting period as either Annual (the required EAC format, which gives the 12 months to date) or Current Period.

D.2 Fuel and Lubricant Consumption Report	
Format	▪ Standard EAC Format (except for the period – see below) ▪ Header: " Fuel and Lubricant Consumption Report for " <insert name of REE> ▪ A single Summary table on a single page (landscape orientation) ▪ Footer: page number
Parameters	Summary Table with one column for each **month** plus a column of field labels: ▪ "Diesel Fuel Data" ▪ Diesel Fuel Supplier (if many suppliers during the period, list all of them) ▪ Quantity Purchased (Litres) ▪ Price per Litre (Riels) ▪ Total cost (Riels) ▪ "Lubricant Data" ▪ Lubricant Supplier (if many suppliers during the period, list all of them) ▪ Quantity Purchased (Litres) ▪ Price per Litre (Riels) ▪ Total cost (Riels) ▪ "Generation" ▪ Total Generation Output (kWh) ▪ Own Consumption in Powerhouse (kWh) ▪ Total Energy Sold (kWh) ▪ Total Energy Equivalent of Flat-Rate Customers
Options	▪ The user will be given option to choose the reporting period as either Annual (the required EAC format, which gives the 12 months to date) or Current Period.

D.3 Generation Trends Report	
Format	▪ Header: "Generation Trends Report for: " <insert name of REE> ▪ 1 page with X charts , each with a clear legend and labelled point values ▪ Footer: page number
Parameters	a. Generation Output Trends Bar Chart with each period along x-axis, and energy (kWh) on y-axis, and the following series: ▪ Total kWh produced by each engine (on a single bar, showing contribution from each engine ▪ Total kWh distributed after subtracting own consumption b. Fuel Consumption Trends Bar Chart with each period along x-axis, and Litres of Fuel per kWh on y-axis, and the following series: ▪ Specific Fuel Consumption of each engine (three separate bars per period) ** The chart area will be divided into 3 areas indicating three classifications of engine efficiency as defined by EAC in the 2004 Annual Report:* ▪ *Good = Less than 0.32 L/kWh* ▪ *Medium = 0.32 to 0.36 L/kWh* ▪ *Low = More than 0.36 L/kWh*
Options	▪ User chooses which periods to be shown for the trend charts

D.4 Generation Incidents Report	
Format	▪ Header: " Generation Incidents Report for " <insert name of REE> ▪ Summary table and then a single table with full listing of incidents as described below, running over as many pages as needed ▪ The user will be prompted to define the report period ▪ Footer: page number
Parameters	a. Summary of Generation Incidents (table with a column for each individual gen-set, plus a totals column): ▪ Number of Generation Incidents in the period ▪ Number of Generation Incidents for each gen-set (separately) ▪ Number of Performed Generator Repairs in the period ▪ Cost of Generator Repairs in the period b. Separate Table for each Gen-Set, with an entry for each incident during the period: ▪ Date of Incident ▪ Time of incident ▪ Gen-Set Identifier ▪ Description of incident ▪ Date of repairs (rest will be blank if not yet repaired) ▪ Description of repairs ▪ Duration of work ▪ Duration of generation outage ▪ Total cost of spare parts and consumables ▪ Name of staff member that performs repairs
Options	▪ The user will be prompted to define the report period

E. Financial Reports

E.1 Income and Expenses Report	
Format	▪ Header: " Income and Expenses Report for " <insert name of REE> ▪ Standard EAC Format (except for the period – see below) ▪ A single summary table on a single page ▪ The user will be prompted to define the report period ▪ Footer: page number
Parameters	Summary Table (2 columns – Item Description and Total for the Period, all in Riels): ▪ Income from Energy Sold ▪ Other (entered manually by the user) ▪ Total Income ▪ Diesel Fuel Expenses ▪ Lubrication Expenses ▪ Consumables Expenses ▪ Employees Expenses (entered manually by the user) ▪ Maintenance and Spares Expenses ▪ Management and Administration Expenses(entered manually by the user) ▪ Depreciation ▪ Unusual Planned Maintenance Costs ▪ Loan Repayments (entered manually by the user) ▪ Total Expenses <if user does not enter manual employee costs, then leave blank with an explanatory note> ▪ Net Income <if user does not enter manual employee costs, then leave blank with an explanatory note>
Options	▪ The user will be given option to choose the reporting period as either Annual (the required EAC format, which gives the 12 months to date) or Current Period. ▪ The user will be prompted to directly enter the Employees Expense for the period (and for other icome, management and administration expenses and loan repayments), but if they choose not to then the report will default to a blank entry as indicated above.

F. EAC Licensee Reports

F.1 Annual Licensee Report	
Format	▪ Header: “EAC Annual Licensee Report“ Licensee Name: <insert name of REE> Licence Number: <insert licence number> Type of License: <insert type> Location: <insert full address> ▪ Standard EAC Format ▪ Combine the separate reports into one, as described below ▪ Footer: page number
Parameters	Combine the following reports to create single EAC Annual Report: ▪ Generation Summary Report – page 1 ▪ Distribution Network Components Report – page 2 ▪ Distribution Activity Report – page 3 ▪ Fuel and Lubricant Consumption Report – page 4 ▪ Income and Expenses Report – page 5
Options	▪

G. Data Entry Forms

G.1 Meter Reading Forms	
Format	▪ Header: “Meter Reading Form for: “ <insert name of REE>, ”Date”: <insert date> ”Meter Reader”: <leave space for employee to enter his/her name> ▪ Single table of customer details with blank space for data entry ▪ Footer: page number
Parameters	Table with 8 columns and entry for each customer: ▪ Customer Identifier ▪ Customer Name ▪ Customer Location ▪ Period of Bill ▪ Previous Meter Reading ▪ This Meter Reading (blank space for data entry) ▪ Date of reading ▪ Time of reading ▪ Comments (blank space for data entry)
Options	▪ User is prompted to choose which customers to print Meter Reading Forms for (should be sorted by the Meter and Meter Box identifiers) ▪ Forms can be printed directly, or saved to file for printing elsewhere

G.2 Engine Monitoring Form	
Format	▪ Header: “Engine Monitoring Form for: “ <insert name of REE>, ”Monitoring Period”: <insert period> ▪ Single table with columns for each parameter needed, and blank rows for staff to enter data each day. ▪ Footer: page number
Parameters	a. Table of Data to be recorded daily (or as often as practical) with labels and blank space for data entry: ▪ Date ▪ Time ▪ engine identifier ▪ fuel consumption ▪ operating hours shown on meter ▪ exhaust temperature ▪ cooling water temperature ▪ air temperature ▪ lubricating oil volume ▪ initials of staff member
Options	▪ The user will be prompted to specify the period for the report to be used

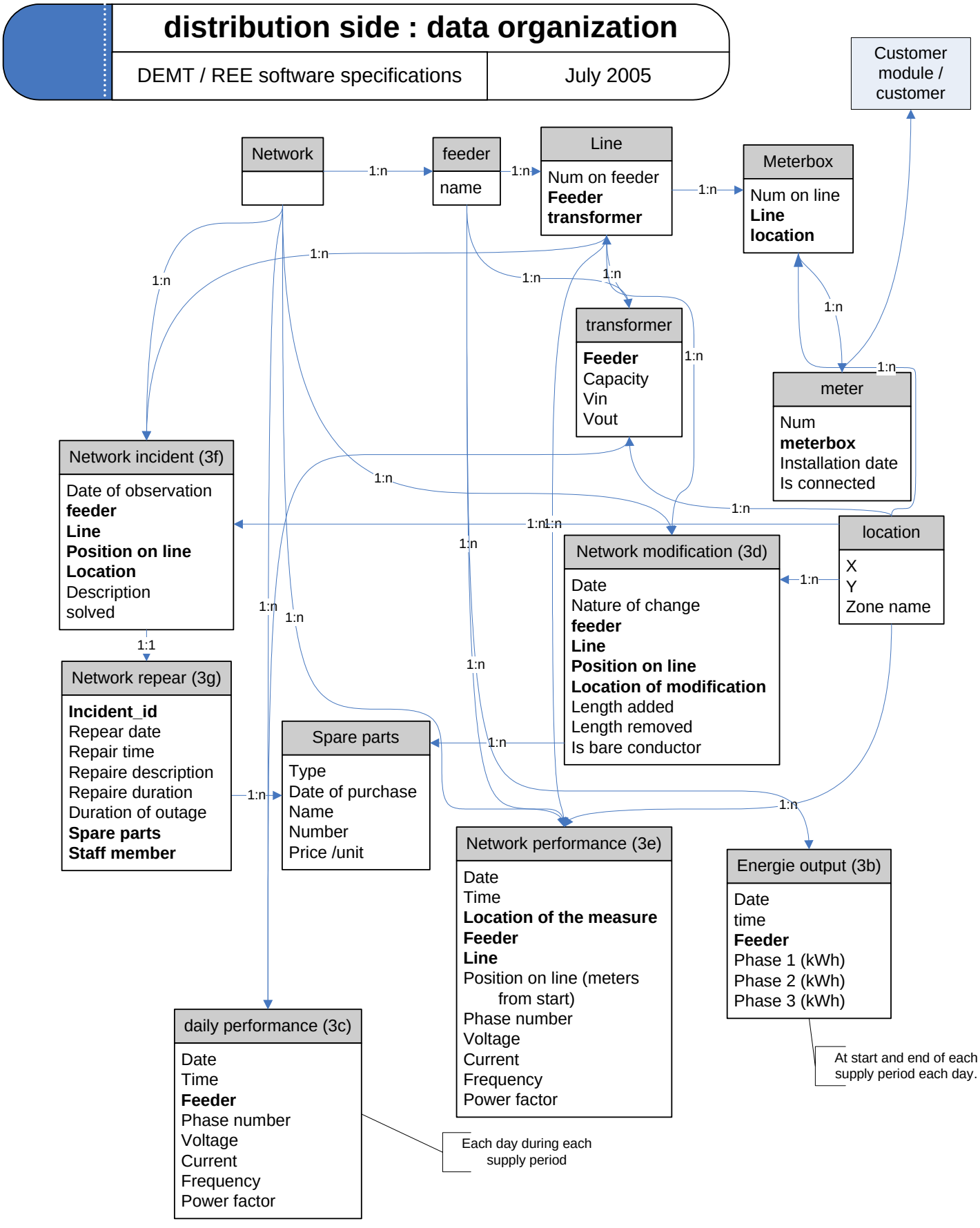
G.3 Generator Monitoring Form	
Format	▪ Header: “Generation Monitoring Form for: “ <insert name of REE>, ”Monitoring Period”: <insert period> ▪ Single table with columns for each parameter needed, and blank rows for staff to enter data each day. ▪ Footer: page number
Parameters	a. Table of Data to be recorded daily (or as often as practical) with labels and blank space for data entry: ▪ Date ▪ Time ▪ generator identifier ▪ phase number ▪ voltage ▪ frequency (if possible) ▪ power factor (if possible) ▪ Energy output meter reading (if meter is connected to more than one phase or generator then staff can indicate this on sheet) ▪ initials of staff member
Options	▪ The user will be prompted to specify the period for the report to be used

G.4 Generator Incidents and Repairs Monitoring Form	
Format	▪ Header: “Generator Incidents and Repairs Monitoring Form for: “ <insert name of REE>, ”Monitoring Period”: <insert period> ▪ Single table with columns for each parameter needed, and blank rows for staff to enter data as needed. ▪ Footer: page number
Parameters	a. A blank table to be filled-in when an incident occurs: ▪ Date of Incident ▪ Time of incident ▪ Gen-Set Identifier ▪ Description of incident ▪ Date of repairs (rest will be blank if not yet repaired) ▪ Description of repairs ▪ Duration of work ▪ Duration of generation outage ▪ Total cost of spare parts and consumables ▪ initials of staff member
Options	▪ The user will be prompted to specify the period for the report to be used

G.5 Distribution Monitoring Form	
Format	▪ Header: “Distribution Monitoring Form for: “ <insert name of REE>, ”Monitoring Period”: <insert period> ▪ Single table with columns for each parameter needed, and blank rows for staff to enter data each day. ▪ Footer: page number
Parameters	a. Table of Data to be recorded daily (or as often as practical) with label and blank space for data entry: ▪ Date ▪ Time ▪ feeder identifier ▪ if measure on a secondary line : line number on that feeder ▪ location of the measure from the plant if feeder measure or from the feeder junction if secondary line measure (in meters) ▪ phase number ▪ voltage ▪ frequency (if possible) ▪ power factor (if possible) ▪ initials of staff member
Options	▪ The user will be prompted to specify the period for the report to be used

G.6 Distribution Incidents and Repairs Monitoring Form	
Format	▪ Header: “Distribution Incidents and Repairs Monitoring Form for: “ <insert name of REE>, ”Monitoring Period”: <insert period> ▪ Single table with columns for each parameter needed, and blank rows for staff to enter data as needed. ▪ Footer: page number
Parameters	a. A blank table to be filled-in when an incident occurs: ▪ Date of Incident ▪ Time of incident ▪ Location of incident ▪ Description of incident ▪ Date of repairs (rest will be blank if not yet repaired) ▪ Description of repairs ▪ Duration of work ▪ Duration of network outage ▪ Total cost of spare parts and consumables ▪ initials of staff member
Options	▪ The user will be prompted to specify the period for the report to be used

ANNEX E. DATA TABLES STRUCTURE



production side : data organization

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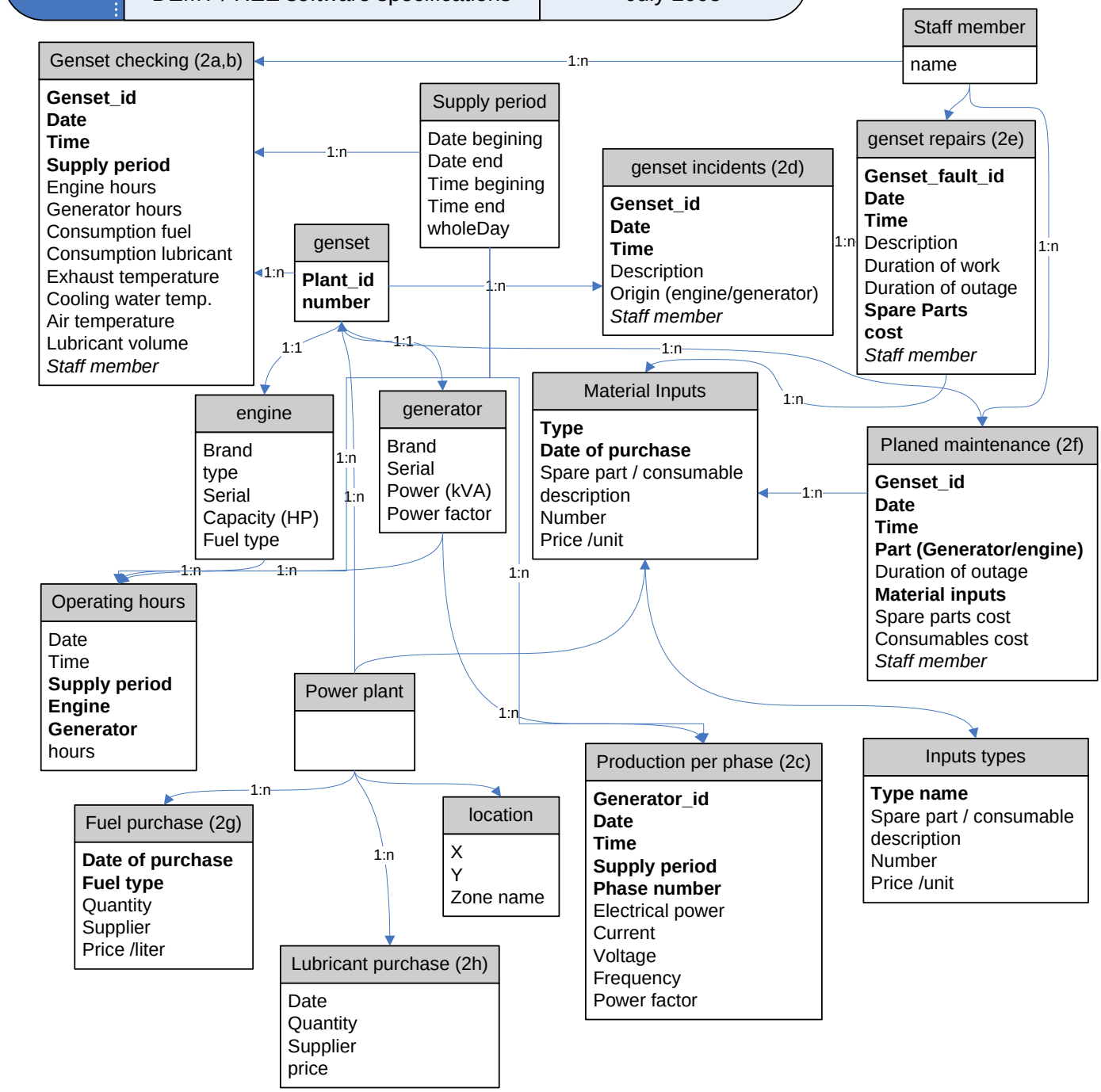
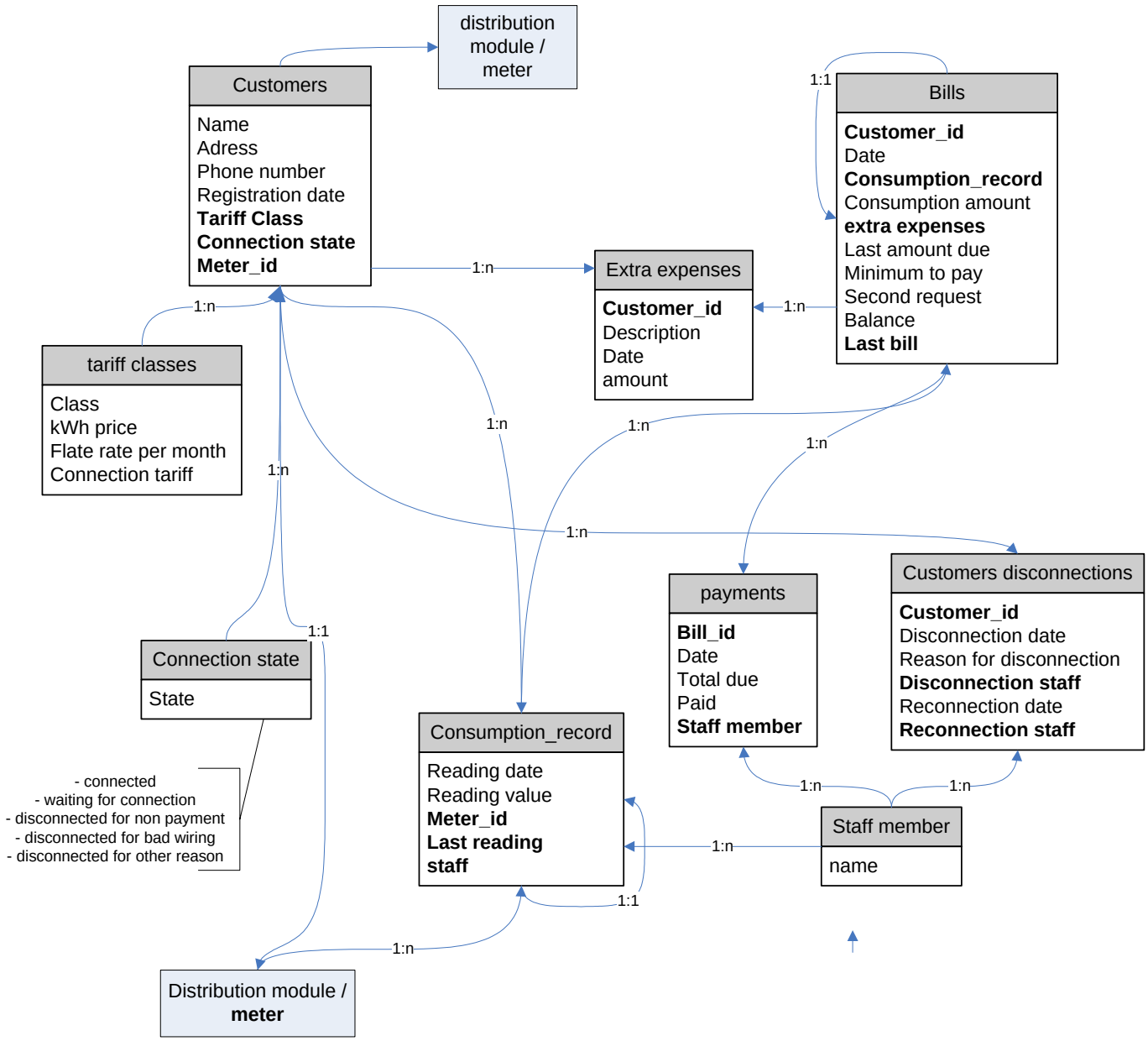


customer side : data organization

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