OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

RESTRICTED

15159

DP/ID/SER.A/665
30 December 1985
ENGLISH

ENERGY CONSERVATION IN INDUSTRY

DP/EGY/83/001

EGYPT

Technical report: Energy Management Systems (Auditing)*

Prepared for the Government of Egypt
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of F.J. Feltoe
Expert in Industrial Energy Management

United Nations Industrial Development Organization
Vienna

252

* This document has been reproduced without formal editing.

V.85-37842

TABLE OF CONTENTS.

Table of contents	1.
Explanatory notes and preface	2.
Abstract	3.
Introduction	4.
Recommendations	4.
Main Report	
Suggested audit procedure	5.
The next step:- monitoring and targeting	13.

EXPLANATORY NOTES.

The following abbreviations are used

TIMS	:TABBIN INSTITUTE FOR METALLURGICAL STUDIES
IECC.	:INDUSTRIAL ENERGY CONSERVATION CENTRE
M. and T.	:MONITORING AND TARGETING SYSTEM OF ENERGY MANAGEMENT

PREFACE.

The "auditing" of the energy situation in any industry, is only part of Energy Management. To be effective it must be accompanied by measures to ensure the participation, support and accountability of line managers as well as the specialists in energy - beginning at the most senior level.

Given this context, auditing sorts out where energy is used; what types of energy are used; the overall energy consumption and cost; the relationship of this performance to some acceptable standard; the relationship of energy cost to other controllable costs within the plant, and finally it produces and analyses energy and cost-saving opportunities.

The audit procedure should only be of size and complexity relevant to the scale of the industry and which can be digested comfortably by the plant management.

- It should be part of an internal, organically growing situation, rather than a massive externally imposed exercise. - This situation, is successfully achieved when, for instance, the audit, is part of a "monitoring and targeting system" of energy management.

ABSTRACT.

This four-week mission had, as its main objectives, assisting the staff of the Tabbin Institute for Metallurgical Studies to analyse data already collected from several steelworks and to proceed towards a structured audit on a common basis.

Plant visits were made to:-

Delta Steel Company. Cairo.
National Metals Industries. Cairo.
The "Copper" Works. Alexandria. (Iron and Steel Plant).

Data was also considered from:-

The Egyptian Iron and Steel Company. Helwan.

The following staff were principally involved

Dr. Mohammed Fouad:-	Rolling Mills
Dr. Atia Saad:-	Steelmaking
Dr. Moussa Touni:-	Foundries.

After much discussion the document was produced which forms the main body of this report:-

"Suggested Audit Procedure for Metallurgical Industries".

In order to instruct as many as possible, the results were presented to the whole staff of the Tabbin Institute at a final seminar, and some additional work was done with Dr. Said Al-Wahab on the glass industry.

INTRODUCTION.

This is sufficiently covered in the "Abstract", but it can be said that the four week visit provided sufficient time to instruct the staff in auditing, and that, deliberately, the subject matter was confined to this aspect of energy management.

The outcome should be that the small but competent group will be able to move on from data collection and analysis to audit studies and recommendations. This will contribute to the central objective for TIMS:- to develop a "core" of trained engineers to help in the total energy conservation programme in Egypt.

RECOMMENDATIONS.

1. Each of the staff should now re-cast the presentation and tabulation of data in accordance with the procedure which we agreed.

2. The management of TIMS should consider concentrating the whole team on a single steel plant until they are skilled at auditing and working to a common format.

3. The management of TIMS, and also UNDP senior staff, should ensure the involvement (a) of very senior executives in the plant(s) being examined (b) of line managers at works and departmental level.

4. TIMS can effectively deploy only one full team, and it is essential that each study should be "held down" to a scale which can be managed both by TIMS and the various plants.

Suggested procedure for an energy audit suitable for the steel plants being considered in Egypt.

INDEX.

A. Audit procedure
B. Check-Lists for improving energy efficiency.
a) No Cost/Low Cost Items b) Higher Cost Items requiring investment.
C. Effect of domestic and international fuel prices.
D. The next step - monitoring and targeting.

A. Audit procedure.

1.0 Line, or block diagrams required for
.1 Main process flow (whole works) and plant configuration
1.2 Departmental process flows where justified.

The above should indicate the main energy users.

1.3 Corresponding diagrams showing the main energy services (oil, electricity, steam etc.) including the metering points.

1.4 Management family tree indicating persons who have responsibility for energy-using plant. The latter should also be marked on block diagrams 1.1 and 1.2.

2.0 If possible, decide what essential extra metering is required, and initiate action to purchase it.
Early decisions are needed to avoid delay in obtaining meters, at a later stage in the audit.

3.0 Confirm the total annual energy and production and cost, figures already obtained, and if at all possible obtain corresponding figures for each of the twelve months in the selected year (1983/84)

3.1 Tabulate the total annual energy usage in common units (e.g. GJ) and cost, as follows

Table 3.11. Energy Purchased (Cost per Year)

Type of Energy	Unit	Quantity	Price	Annual Cost	% Cost
Electricity	KWh		-LE/kWh	LE	
Mazout	tonnes		-LE/tonne	LE	
Sular	tonnes		-LE/tonne	LE	
Coke	tonnes		-LE/tonne	LE	
TOTAL					100

Table 3.12. Energy Purchasers in common units (GJ Per Year)

Type of Energy	Annual Quantity	Annual Quantity GJ	%
Electricity	kWh	GJ	
Mazout	tonnes	GJ	
Sular	tonnes	GJ	
Coke	tonnes	GJ	
TOTAL			100

3.2 If possible, obtain and tabulate the energy used, per department. This may have to wait until some additional metering is provided.

Table 3.2.1 Energy Used per Department, per Year.

Department.	Electricity GJ	Mazout GJ	Sular GJ	Coke GJ	Total GJ	%	Cost LE	Cost %
1.								
2.								
3. etc								
TOTAL						100		100

3.3 Note:- the above tables provide management with the basic information on where energy is used and what it costs and where action is most urgently required.

3.4 Tabulate energy usage per tonne of output from each department "i.e. Specific energy consumption".

Table 3.4.1 Energy per tonne of "departmental"output.

Department	Output tonnes	Energy GJ	Energy Cost LE	Energy GJ/tonne	Energy Cost LE/tonne
1.					
2.					
3. etc					
TOTAL					

3.5 In order to be able to add up the departmental specific energies, (in order to obtain a total works figure, which can be then compared with other works), it is necessary to select a common unit of production, usually either tonnes of liquid steel; tonnes of ingot; or tonnes of finished output. The most common is tonnes of liquid steel(t.l.s), which also facilitates international comparisons. It is assumed that this is adopted.

Table 3.5.1 Energy per tonne of liquid steel.

Department	Output liquid steel tonnes	Energy GJ/tls	Energy Cost LE/tls	
1.				
2. etc.				
TOTAL				(Works Total)

3.6 An essential figure for management is, however, energy cost per tonne of output sold. This is a vital figure which can be used to relate energy cost to other production costs. In Egypt, the subsidised, low cost of energy, makes energy look unimportant in relation to other production costs whereas in fact, in typical steel works, the real cost is very high (between 20% and 40% of total production cost,) compared with 2% to 4% in Egypt.
This is outside the scope of these audit notes, but see Section C

3.7 At this stage it is possible, but not essential, to show the distribution of energy diagrammatically e.g. by a Sankey diagram.

4.0 Carry out efficiency tests on major items of plant such as furnaces and boilers to identify losses and take early steps to minimise them. The "energy bus" becomes very effective at this stage, and can be used early in the audit to check the big users, where savings are likely to be made.

This may also give "early warning" to management of changes which may need capital investment, or action to eliminate poor operational practices.

5.0 General Energy Survey (for opportunities to economise)

Having established figures which show where energy is used, it is necessary to carry out a practical survey to spot plant and services which could be improved (also operating practice), and an experienced energy manager can quite quickly establish a list of actions needed.

A detailed check list is given in Section B, but actions come under the categories of:-

Zero Cost - better housekeeping and following correct procedure for operating plant and eliminating waste (the term "housekeeping" is much too weak)

Low Cost - Items such as improved control equipment and improved plant maintenance.

"High Cost - This is a relative term but includes plant modifications or replacement with new equipment where capital will need to be authorised. The list produced should include estimates of cost and "pay-back" time.

THE FIRST PRIORITIES MUST BE (a) STEADY PLANT LOADING. (b) A PRODUCTION PLAN WHICH CONSIDERS ENERGY (c) GOOD MAINTENANCE.

B. Check list for improving energy efficiency (practical survey).

a) No cost/low cost items (normal pay-back less than 6 months based on world energy prices).

1.0 Furnaces and Boilers.

In addition to carrying out efficiency trials (E.G. with use of the energy bus) the following are necessary. Others will be found.

1.1 Set fuel/air ratio control in accordance with manufactures instructions - e.g. mechanical linkages and cams, dampers and controllers.

1.2 Burners to be cleaned, properly maintained, and nozzles repaired, if worn. Avoid overheating at the burner.

1.3 Stop air inleakage in brickwork, flues and dampers

1.4 Set properly for balanced draught in furnace/boiler.

1.5 Clean and maintain fans, pumps and compressors.

1.6 Check flue gas for correct combustion e.g. O2 content.

1.7 Ensure correct balance of burners in multi-burner furnaces.

1.8 Check that furnaces are neither under-loaded nor overloaded.

1.9 Furnace doors to be a good fit and to be kept shut except when loading and unloading. No overheating around door.

1.10 Inspect and repair refractory brick lining. Use ceramic fibre,

where applicable.

1.11 Check the heating cycles for any product. Keep time to a minimum. Similarly for temperature.
1.12 Minimise weight of non-productive hardwear such as carriers, trays, etc.
1.13 Aim for steady operation and production scheduling.
1.14 Close down unwanted furnaces.
1.15 Do not light up the furnace too early.
1.16 Boiler surfaces to be kept clean.
1.17 External insulation kept in good repair.
1.18 Heat recovery to be considered, where appropriate.

2.0 Electrical Equipment.

2.1 Switch off equipment not in use.
2.2 Optimise the power factor by plant loading, capacitors etc.
2.3 Take advantage of cheap night-time tariff, when available.
2.4 Control maximum demand by production-planning - and automatic controllers where suitable.
2.5 Avoid under-loading of motors.
2.6 Consider speed control as an alternative to damper or valve throttling in fans and pumps.

3.0 Compressed Air and Steam Services.

3.1 Check for leaks and repair.
3.2 Check traps on a routine basis.
3.3 Keep insulation in good repair.
3.4 Isolate and dismantle unused parts of the system.
3.5 Consider all users of steam and compressed air - some users are quite unsatisfactory (e.g. live steam for heating; compressed air for blowing off swarf.
3.6 Ensure that compressor unloading valves are working.
3.7 Renew compressor rings, glands, valves etc.
3.8 Clean air filters and check dryers, drains etc.

4.0 Ventilation.

4.1 Fan power to be minimised by reducing ventilation to correct level. Oversized fans to be avoided.

5.0 Plant Operations and Maintenance.

5.1 Turn off all intermittent plant when not in use. Also applies to services (gas, steam, oxygen etc.).
5.2 Plan production for minimum demand by Staggered start-up times and running.
5.3 Systematic maintenance is a "must" for energy efficiency.
5.4 Smooth plant loading is also vital.

Check List for improving energy efficiency (Contd.).

b) Higher Cost Items requiring investment (Typical Examples only).

		Cost(LE)	Saving(LE)/yr	Pay-Back.
1.0	**Furnaces and Boilers**			
	1.1 Recuperators. Install if not existing.	80,000	16[illegible],000	0.5/1.5
	1.2 Fuel/Air Ratio. Automatic Control System.	50,000	25,000	2.0
	1.3 Brickwork. Major Repair or Replacement.	100,000	100,000	1.0
	1.4 Waste Heat Boilers. Consider installation on furnaces.	800,000	400,000	2.0
	1.5 Boilers. Consider replacement	600,000	200,000	3.0
2.0	**Electrical Equipment.**			
	1.0 Maximum Demand. Fit Controller	120,000	80,000	1.5
	2.0 Power Factor. Install Capacitors.	1m	400,000	2.5
	3.0 Variable Speed Motors. Install on fans, pumps and underloaded drives.	150,000	30,000	5.0
3.0	**Services.**			
	1.0 Steam System. Major insulation repairs.	40,000	20,000	2.0
	2.0 Steam System. Condensate Recovery.	100,000	33,000	3.0
	3.0 Compressed Air. Study and replace pipework.	100,000	40,000	2.5
	4.0 Compressed Air. Replace compressors.	200,000	80,000	5.0
	5.0 Oil Tanks & System. Insulate	300,000	100,000	3.0

4.0 **Ventilation.** Air Conditioning.

5.0 **Plant Operation - Major Changes**

"Hot Connecting" - Avoid cooling between processes.

Heat Loss-Rolling - Optimise rolling route & cooling.

C. Domestic/International Energy Prices.

The audit report should be based on international energy prices on the basis that Egypt will be able to export energy saved at ruling world prices.

A very approximate comparison of present prices is given below, but individual works expect to meet a step-by step rise from the present, subsidised level, to something approaching international energy prices, over five years. This process has already begun - the figures below are already out of date.

	Approximate Present Prices	
	Domestic (LE)	International
Mazout LE/Metric Tonne	7.5	242
" LE/litre	0.0064	0.206
Sular LE/Metric Tonne	35	320
" LE/litre	0.025	0.232
Electricity LE/kwh	0.010	0.092
Steam (Typical) LE/Metric Tonne	0.454	14.636

D. The Next Step:- "Monitoring and Targeting"

After the audit, which will probably have illustrated the plant energy position, on the basis of a whole year, efforts should be made to collect the energy, production and cost information for each month of the year, and, if possible, for each major department. In U.K., this is often done weekly, but the frequency should correspond with that of the plant management reports.

For each major department, and for the total plant it is suggested that the following is graphed, initially, for the audit year chosen.

a) Energy Consumption (GJ/Month) against Production (Tonnes/Month).
b) Specific Energy Consumption (GJ/Tonne against Production (Tonnes/Month).

These graphs will show the pattern of past-performance, and will enable a "standard" to be selected against which the departmental and plant manager can gauge his performance each month.

This is an important step towards "monitoring and targeting", my recommended system of energy management.

Having established the energy and energy cost standards for overall and departmental performance, and having the full agreement to these standards by the works and departmental management, it is necessary

a) to set up a routine of management meetings which will consider energy performance against standards. Both line management and energy specialists to be involved.
b) to produce the on-going results regularly e.g each month
c) to ensure that action is initiated to inform senior management of the results, particularly in cost terms.
d) to take steps through line management, to rectify unnacceptable performance.

e) to recommend investment in proposals requiring capital.
f) to specify and implement developments, when authorised.

Finally, when a clear picture of present, and possible future levels of energy performance has emerged, targets can be set for the longer term results to aim at.