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Energy Auditor Training Curriculum

October 1979

Prepared for
U.S. Department of Energy
Assistant Secretary for Conservation
and Solar Energy
Office of State Energy Conservation Programs

DISCLAIMER

DOE/CS/5226-1

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October 1979

Prepared by
American Institute of Industrial Engineers
Norcross, Ga. 30092

Prepared for
U.S. Department of Energy
Assistant Secretary for Conservation
and Solar Energy
Office of State Energy Conservation Programs
Washington, D.C. 20585

Under Contract No. EM-78-C-01-5226

ENERGY AUDITOR TRAINING

CURRICULUM

CONTENTS

ENERGY AUDITOR TRAINING CURRICULUM

I. INTRODUCTION

The Federal Guidelines for Energy Audit Procedures require that energy audits be performed by energy professionals. However, the guidelines define the qualifications of the energy professional in a general sense. Certification of the energy professional as an energy auditor is presently left to the individual states. This job becomes monumental when one considers that certification by the states encompasses a number of different tasks including such things as:

1) identifying requirements to be met by potential energy auditors;

2) development of an energy auditor training curriculum;

3) implementation of the curriculum in an ongoing energy auditor training program;

4) recommendation of trained auditors to perform energy audits;

5) state registration of the energy auditor;

6) etc.

The curriculum presented herein is designed to be used by States in training energy auditors. The curriculum has been prepared to insure that participating individuals are technically competent to plan, implement and follow-up energy audits. Successful completion of the program satisfies general qualification requirements for an energy auditor. If the auditor is to perform Preliminary Energy Audits (PEA) or Energy Audits (EA) for schools, hospitals, local government or public care institutions covered in the National Energy Conservation Act (NECPA), he must have the qualifications described in the Federal Register (Energy Measures and Energy Audits Grants Program for Schools and Hospitals and Buildings Owned by Units of Local Government and Public Care Institutions, Vol. 44, No. 64, April 2, 1979, p. 19354). Definitions of Preliminary Energy Audits and Energy Audits (PEA/EA) are contained in that reference. If the auditor is to perform Class A energy audits in commercial or industrial buildings, then a technical background equivalent to a B.S. degree in a technical field or experience to do comprehensive audits for their own plants or buildings is needed. Class A audit definition and associated auditor qualifications are found in the Federal Register, Energy Audit Procedures, Vol. 42, No. 125, June 29, 1977, p. 33163.

The core of the training curriculum is the logical sequence of steps that the energy auditor will be experiencing in conducting energy audits and the implementation and monitoring of a comprehensive energy management program. The curriculum is organized for the auditor trainer to effectively educate the energy auditor for the auditor's primary responsibility—to

identify energy saving opportunities. Management's role is also presented since without it recommended O & M options may never be followed up. Briefing management on safety problems identified during the audit is also stressed as part of the overall audit process.

Persons conducting the auditor training curriculum must, by necessity, satisfy all requirements expected of persons taking the course. In addition, these trainers must have actual experience in planning for, implementing and following-up energy audits for schools, hospitals, local government buildings and public care institutions.

The following curriculum is set up to be run by individual states for a minimum time period of two days. An actual walk-through audit for a building should be added to the curriculum to demonstrate the many tasks in the energy audit process. In addition to adding a day to the curriculum for the walk-through audit, many auditor trainers may want to expand parts of the curriculum to meet specific needs of their states.

The curriculum was structured around the overall contents of the DOE reference source *Instructions for Energy Auditors*. Complementing this overall outline are a series of suggested transparencies that can be used by the auditor trainers. Many of the suggested transparencies for use were drawn from this reference source. Transparencies for the training sessions can be prepared from the camera ready material included herein. However, the exact transparency to be used for each section of the curriculum can be specifically designed and prepared around the needs of the individual states. Extensive field testing of the curriculum has demonstrated the need for at least those suggested herein.

For training intended for those participating in the grant program for schools, hospitals, units of local government and public care institutions, States may want to incorporate into the curriculum reference sources and transparencies drawn from other DOE documents such as:

(1) Making Cents of Your Energy Dollar (A Guide to Identifying Energy and Cost Saving Opportunities in Institutional Buildings), Vol. 1, Energy Audit.

(2) Making Cents of Your Energy Dollar (A Guide to Assessing Energy and Cost Saving Opportunities in Institutional Buildings), Vol. 2, Technical Materials and References.

Basically, additions to the curriculum require the auditor trainers to prepare handouts, transparencies, reference sources, specific examples, etc. for appropriate sections of the curriculum. Since the requirements of the grant program for schools, hospitals, units of local government and public care institutions vary from those of the Class A audit program, users of this manual should select those elements which address the requirements of the program for which training is being offered.

Slides may also be used very effectively by the auditor trainers to complement the curriculum. Specific points covered with the slides could be directed at problem areas an auditor would see as a walk-through audit was performed. Lighting, doors, windows, insulation (roof and walls), controls, HVAC (heating, ventilating, air-conditioning) systems and equipment are typical areas where slides can be effectively used to simulate a walk-through audit for the persons being trained. As before the value of the auditor training curriculum can be enhanced by using well planned, informative slides. These slides can be used very effectively to set the stage for the walk-through audit.

CURRICULUM

I. INTRODUCTION

A. OUTLINE OF COURSE OBJECTIVES —

identifies the objectives of the training curriculum which insure the trained auditor:

1. Can systematically discover and evaluate NO-COST and LOW-COST energy saving opportunities
2. Understands basic principles of industrial energy utilization
3. Can compare project alternatives using sound economic evaluation techniques
4. Understands energy use modeling and data collection
5. Can recommend the kind of management policies necessary for a sustained energy management program

B. FORMAT/AGENDA FOR THE TRAINING SESSION -

discussion centered on the agenda for the training session

C. ENERGY AUDIT CONTACTS/REFERENCE SOURCES -

outlines in detail personal contacts and reference sources for energy auditors

D. DEFINITIONS OF CLASS A, B, AND C AUDITS *AND* PRELIMINARY ENERGY AUDITS (PEA's) AND ENERGY AUDITS (EA's) —

summarizes the types of audits that are available (direct reference to Federal Registers)

E. REQUIREMENTS FOR CONDUCTING CLASS A, B, AND C AUDITS *AND* PEA's/ EA's—

identifies regulations that must be satisfied by the auditor such as on-site visits; evaluation of energy systems; analysis of energy and cost savings; and general recommendations

F. RESPONSIBILITIES AND LIABILITIES OF THE CLIENT AND AUDITOR -

identifies the need to fully document in writing (such as job descriptions) what both parties should expect to provide to each other, what both are expected to do for each other, types of reports/results expected, types of analysis to be conducted, etc.

G. NEED FOR THE CLIENT TO DESIGNATE A PERSON IN CHARGE -

summarizes the advantages/necessity of having a designated person within the company in charge of audit programs

H. ESTIMATE OF COST FOR THE AUDIT —

summarizes through field records and case studies (from at least several building/ industry audits) time and cost estimates for the audit

II. THE ENERGY AUDIT

A. NEED FOR A SYSTEMS APPROACH TO THE ENERGY AUDIT —

impresses upon the auditor the importance of examining the building shell and its function in performing the energy audit

B. FLOW CHART DEPICTING ELEMENTS OF AN ENERGY AUDIT -

uses a flow diagram to show relationships of tasks involved in conducting an energy audit

C. PROCEDURE FOR CONDUCTING AN ENERGY AUDIT -

refers to the flow diagram above in organizing the tasks to be followed to insure a successful energy audit

D. DESIRED OUTPUT FROM THE AUDIT -

identifies the type of material to be included in and possible format for the audit report to be submitted to the client

E. ORGANIZATIONAL STRUCTURE NEEDED IN THE AUDIT FUNCTION -

identifies, through an organizational chart (along with job descriptions) for the auditor's office, the person(s) responsible for each of the tasks discussed in "Procedure for Conducting an Energy Audit"

F. APPROACHING THE AUDIT -

identifies what to look for in performing a walk-thru-audit and use of checklists that direct attention to possible problem areas

G. CASE STUDY - INTRODUCTION —

using a series of slides and transparencies that identify numerous example problem areas in various classes of buildings, an on-site audit will be simulated

III. DATA COLLECTION

A. SOURCES OF INFORMATION -

designed to provide publications, data bases, key words, abstracts, indexes, services and persons (within the client's office) that have access to needed information

B. USEFUL FORMS -

discusses the forms for collecting building information and energy usage and cost data that are necessary for conducting audits

C. NEED FOR AN EQUIPMENT INVENTORY IN THE BUILDING -

describes in conjunction with the "Useful Forms" section above how to insure a total systems approach to the energy audit

D. INTERVIEWS -

stresses the importance of using other means (than completing forms) for collecting information necessary for conducting audits

E. INSTRUMENTATION NEEDED FOR DATA COLLECTION -

describes the basic instruments (portable, durable, easy to operate and relatively inexpensive) used in conducting energy audits

IV. ANALYSIS LEADING TO ENERGY CONSERVATION OPPORTUNITIES

A. WALK-THRU-AUDITS - O & M OPPORTUNITIES —

identifies the many O & M changes within a building/industry requiring no cost but can reduce energy consumption by 20%

B. COMBUSTION OF FOSSIL FUELS AND INDUSTRIAL WASTES —

discusses the fundamentals of heat recovery and combustion of fossil fuels to assess overall energy consumption within a building/industry

C. BOILER PLANTS —

examines energy saving possibilities in boiler plants

D. STEAM DISTRIBUTION —

discusses such things as the relationship between temperature and pressure, and regulation and control

E. ELECTRIC POWER —

includes a discussion on tariff structures, and uses and economizing techniques for electric consumption

F. ENVIRONMENTAL CONTROL AND SPACE CONDITIONING —

addresses the function of environmental control and space conditioning of a building as the provision of conditions of comfort for the occupants (i.e., temperature and humidity)

G. SPECIAL BUILDING AND PLANT FUNCTIONS —

points out the need for the auditor to have a broad background in energy consuming functions as well as having access to solid resource material

H. WASTE HEAT RECOVERY —

shows how to identify possible opportunities for recovery of heat or cold otherwise discharged to the atmosphere

I. AUTOMATIC CONTROL EQUIPMENT —

identifies the possibilities for utilizing computer control of equipment for energy management

J. EVALUATION OF POTENTIAL FOR ENERGY CONSERVATION MEASURES —

shows how to evaluate overall potential for energy conservation measures (retrofits) by use of broad scale figures of merit

K. EVALUATION OF POTENTIAL FOR SOLAR AND RENEWABLE RESOURCE MEASURES —

evaluation procedure is the same as that used for energy conservation measures

V. ECONOMIC ANALYSIS AND PRIORITIZATION

A. TECHNIQUES FOR ECONOMIC ANALYSIS -
discusses, through examples, net present values, annual costs, minimum acceptable rate of return, salvage value, cost trade offs, "pay back" periods, etc

B. ANALYSIS OF ECO's -

using techniques discussed above actual case studies will be examined to identify energy conservation opportunities and at the same prioritizing the opportunities will be discussed

VI. ACTION PLAN FOR AN ENERGY CONSERVATION PROGRAM

A. FOLLOW-UP AND MONITORING -

included to stress the importance of "auditing the audit" to insure long range benefits from the implementation work

B. MANAGEMENT OF THE ENERGY CONSERVATION PLAN -

designed to identify persons responsible to get and keep management interested, for the energy conservation plan as well as measures of effectiveness that can be used to keep a building/industry from "back sliding"

C. PREVENTIVE MAINTENANCE -

presents cost and energy trade-offs within a building/industry related to preventive maintenance

TRANSPARENCIES

I. INTRODUCTION

TRANSPARENCY I. A. (1)

USE A TRANSPARENCY THAT IDENTIFIES THE NAME OF THE TRAINING SESSION AND LEADERS OF THE SESSION.

ENERGY AUDITOR TRAINING
CURRICULUM/SESSION

PRESENTED BY

NAME

NAME

CITY, STATE

TRANSPARENCY I. A. (2)

USE A TRANSPARENCY (AND INCLUDE A HANDOUT) THAT OUTLINES THE COURSE OBJECTIVES FOR THE TRAINING SESSION.

OBJECTIVES
ENERGY AUDITOR TRAINING SESSION

To insure that the trained auditor:

FOR CLASS A AUDITS

1. Can systematically discover and evaluate NO-COST and LOW-COST energy saving opportunities.

2. Understands basic principles of industrial energy utilization.

3. Can compare project alternatives using sound economic evaluation techniques.

4. Understands energy use modeling and data collection.

5. Can recommend the kind of management policies necessary for a sustained energy management program.

FOR NECPA ENERGY AUDITS

1. Can systematically discover and evaluate NO-COST and LOW-COST energy saving opportunities.

2. Understands basic principles of building energy utilization.

3. Can perform comparisons of project alternatives using "rule of thumb indicators"; or provide "ball park" estimates for the potential of retrofit and renewable resource applications.

4. Understands data collection.

5. Can assist in identifying the kind of management policies necessary for a sustained energy management program.

TRANSPARENCY I. B. (1)

USE A TRANSPARENCY THAT IDENTIFIES THE AGENDA FOR THE TRAINING SESSION AND BRIEFLY DISCUSS EACH SECTION OF THE SESSION.

FORMAT/AGENDA
ENERGY AUDITOR TRAINING
SESSION

I. INTRODUCTION

A. OUTLINE OF COURSE OBJECTIVES
B. FORMAT/AGENDA FOR THE TRAINING SESSION
C. ENERGY AUDIT CONTACTS/REFERENCE SOURCES
D. DEFINITIONS OF CLASS A, B, AND C AUDITS AND PEA's/EA's
E. REQUIREMENTS FOR CONDUCTING CLASS A, B, AND C AUDITS AND PEA's/EA's
F. RESPONSIBILITIES AND LIABILITIES OF THE CLIENT AND AUDITOR
G. NEED FOR THE CLIENT TO DESIGNATE A PERSON IN CHARGE
H. ESTIMATE OF COST OF THE AUDIT

II. THE ENERGY AUDIT

A. NEED FOR A SYSTEMS APPROACH TO THE ENERGY AUDIT
B. FLOW CHART DEPICTED ELEMENTS OF AN ENERGY AUDIT
C. PROCEDURE FOR CONDUCTING AN ENERGY AUDIT
D. DESIRED OUTPUT FROM THE AUDIT
E. ORGANIZATIONAL STRUCTURE NEEDED IN THE AUDIT FUNCTION
F. APPROACHING THE AUDIT

FORMAT/AGENDA
ENERGY AUDITOR TRAINING
SESSION
(CONT'D)

G. CASE STUDY - INTRODUCTION —

III. DATA COLLECTION

A. SOURCES OF INFORMATION
B. USEFUL FORMS
C. NEED FOR AN EQUIPMENT INVENTORY IN THE BUILDING
D. INTERVIEWS
E. INSTRUMENTATION NEEDED FOR DATA COLLECTION

IV. ANALYSIS LEADING TO ENERGY CONSERVATION OPPORTUNITIES

A. WALK THRU AUDITS - O & M OPPORTUNITIES
B. COMBUSTION OF FOSSIL FUELS AND INDUSTRIAL WASTES
C. BOILER PLANTS
D. STEAM DISTRIBUTION
E. ELECTRIC POWER
F. ENVIRONMENTAL CONTROL AND SPACE CONDITIONING
G. SPECIAL BUILDING AND PLANT FUNCTIONS
H. WASTE HEAT RECOVERY
I. AUTOMATIC CONTROL EQUIPMENT

V. ECONOMIC ANALYSIS AND PRIORITIZATION

A. TECHNIQUES FOR ECONOMIC ANALYSIS
B. ANALYSIS OF ECO's

FORMAT/AGENDA
ENERGY AUDITOR TRAINING
SESSION
(CONT'D)

VI. ACTION PLAN FOR AN ENERGY CONSERVATION PROGRAM

A. FOLLOW-UP AND MONITORING
B. MANAGEMENT OF THE ENERGY CONSERVATION PLAN
C. PREVENTIVE MAINTENANCE

TRANSPARENCY I. B. (2)

USE A TRANSPARENCY (AND INCLUDE A HANDOUT) THAT SUMMARIZES TIME REQUIREMENTS TO PRESENT EACH SECTION OF THE TRAINING SESSION.

TIME REQUIREMENTS
ENERGY AUDITOR
TRAINING SESSION

TOPIC AREA	TIME
I. INTRODUCTION	1 HOUR
II. THE ENERGY AUDIT	3 HOURS
III. DATA COLLECTION	4 HOURS
IV. ANALYSIS LEADING TO ENERGY CONSERVATION OPPORTUNITIES	1 HOUR (brief introduction only)
V. ECONOMIC ANALYSIS AND PRIORITIZATION	4 HOURS
VI. ACTION PLAN FOR AN ENERGY CONSERVATION PROGRAM	3 HOURS
	16 HOURS

TRANSPARENCY I. B. (3)

USE A TRANSPARENCY (OR SERIES OF TRANSPARENCIES) TO PROVIDE A LISTING OF REFERENCES (I.E., AUDITOR TRAINING MANUALS) THAT WILL BE USED IN THE TRAINING SESSION; CONTENTS OF THE ACTUAL REFERENCE SOURCES SHOULD BE BRIEFLY REVIEWED WITH THE PARTICIPANTS (SESSION LEADER MUST POINT OUT THAT NOT EVERY REFERENCE IS USED HEREIN BUT HE/SHE MUST POINT THE PARTICIPANT TO WHERE ADDITIONAL SOURCES CAN BE FOUND).

REFERENCES
ENERGY AUDIT TRAINING CURRICULUM

1. Federal Register: FEA, Energy Audit Procedures, Vol. 42, No. 125, Wednesday, June 29, 1977

2. Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978

   A) Extensive definition of terms included in Volume 2
   B) Extensive bibliography in Volume 2
   C) Detailed list of conversion factors in Volume 2

3. Waste Heat Management Guidebook, NBS Handbook 121, U.S. Department of Commerce/NBS and Federal Energy Administration/ Conservation and Environment, February, 1977

4. New HVAC Energy Saving Development, Air Distribution Associates, Inc., 1977

5. Making Cents of Your Energy Dollar (A Guide to Identifying Energy and Cost Saving Opportunities in Institutional Buildings) Vol 1, Energy Audit, Developed by ECAC for DOE, 1979

6. Making Cents of Your Energy Dollar (A Guide to Assessing Energy and Cost Saving Opportunities in Institutional Buildings) Vol 2, Technical Materials and Reference, Developed by ECAC for DOE, 1979

TRANSPARENCY I. C.

USE A TRANSPARENCY (AND INCLUDE A HANDOUT) THAT DOCUMENTS CONTACTS AND REFERENCE SOURCES - NAMES, ADDRESSES, PHONE NUMBERS - THAT CAN BE USED BY ENERGY AUDITORS FOR THE STATE THE TRAINING SESSION IS BEING GIVEN IN.

ENERGY AUDITOR
CONTACTS AND REFERENCE SOURCES

A. DOE, WASHINGTON OFFICE

B. DOE, REGIONAL OFFICE

C. STATE ENERGY OFFICE

D. ELECTRIC UTILITY COMPANIES

E. NATURAL GAS
   COAL
   FUEL OIL
   ETC.
   } COMPANIES

TRANSPARENCY I. E.

USE A TRANSPARENCY (AND INCLUDE A HANDOUT) THAT IDENTIFIES ALL REQUIREMENTS FOR CLASS A, B, AND C AUDITS; PARTICULAR ATTENTION TO BE DIRECTED TO CLASS A AUDIT REQUIREMENTS.

REQUIREMENTS
CLASS A, B, AND C AUDITS

CLASS A INFORMATION AUDIT

I. Consists of
   A. On-site visit by a state-qualified auditor
   B. Evaluation of energy consumption and systems
      1. Analysis of savings (energy and cost) from one or more state-selected modifications
      2. A workbook or manual enabling the owner to do 1.

   C. Energy consumption description
      1. Actual energy use by fuel type, each month for the last year
      2. Cost of energy by fuel type, each month for the last year
      3. Building profile
         a. Location and site conditions
         b. Construction and condition of building
         c. Descriptions of HVAC, hot water, and lighting systems

Class A information audits (CONT'D)

D. For an industrial plant, add
   1. Description of production processes: layout, material handling, and waste handling systems
   2. Consumption of energy of these systems

II. COSTS —
guidelines have been set forth in the Federal Register (6/29/77) without enforcement mechanisms

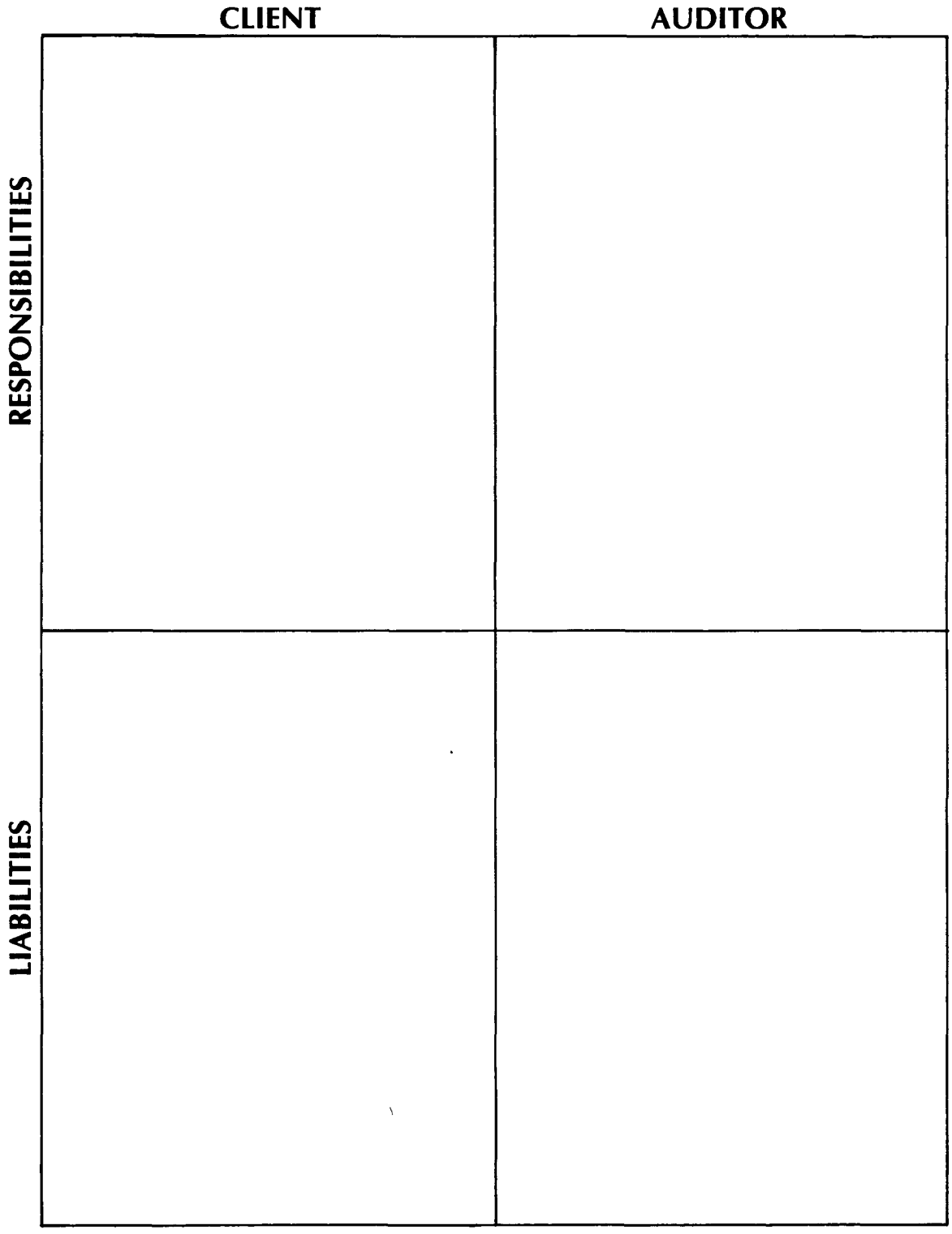
III. Class B audits —
   A. Completed questionnaire to analysis center
   B. Analysis and evaluation of the modifications returned to owner.

IV. Class C audits
   A. Pamphlet sent to business
   B. Business fills out and implements

TRANSPARENCY I. F.

USE A TRANSPARENCY THAT THE SESSION LEADER CAN LIST ITEMS ON THAT THE PARTICIPANTS COLLECTIVELY IDENTIFY AS RESPONSIBILITIES, EXPECTATIONS, AND LIABILITIES FOR BOTH PARTIES.

RESPONSIBILITIES AND LIABILITIES OF CLIENT AND AUDITOR



TRANSPARENCY I. G.

USE A TRANSPARENCY TO SUMMARIZE POINTS THE PARTICIPANTS COLLECTIVELY IDENTIFY AS TO WHY A DESIGNATED COMPANY "PERSON IN CHARGE" WILL HELP INSURE A SUCCESSFUL AUDIT PROGRAM.

NEED FOR MANAGEMENT COMMITMENT

TRANSPARENCY I. H.

USE A TRANSPARENCY THAT OUTLINES COSTS COMPONENTS (THAT REQUIRE TIME AND MANPOWER COMMITMENTS) THAT MUST BE CONSIDERED DURING THE ENTIRE AUDITING PROCESS; TRAINING SESSION LEADERS MUST PROVIDE FIRST HAND EXPERIENCE OR DOCUMENTED EVIDENCE (FROM CONSULT AUDITING GROUPS, ETC.) AS TO WHAT TO EXPECT THE AUDIT TO COST - TIME AND MANPOWER.

ESTIMATES OF COSTS FOR PERFORMING AN AUDIT

COST COMPONENTS (tasks to be completed)	EXPECTED COST (time/manpower requirements)
1. PLANNING FOR THE AUDIT	
2. PRELIMINARY DATA ANALYSIS	
3. ON-SITE VISITS	
4. PREPARATION OF RECOMMENDATIONS	

TRANSPARENCIES

II. THE ENERGY AUDIT

TRANSPARENCY II. A.

USE A TRANSPARENCY THAT SUMMARIZES SEVERAL REASONS FOR APPROACHING THE ENERGY AUDIT FROM A SYSTEMS POINT OF VIEW; SESSION LEADER SHOULD THEN SOLICIT INPUT FROM THE PARTICIPANTS AND LIST THESE IDEAS ON THE TRANSPARENCY.

ENERGY AUDITS
USE THE SYSTEMS APPROACH

1. **Where is the energy being used? (Your time is too valuable to waste. Spend it on the BIG savings.)**

2. **Will improving one part of the system hurt another?**

TRANSPARENCY II. B.

USE A TRANSPARENCY (AND INCLUDE HANDOUTS) TO SHOW, AND DISCUSS THROUGH A FLOW DIAGRAM, THE TASKS INVOLVED IN CONDUCTING AN ENERGY AUDIT.

GENERAL CONTENTS OF AN ENERGY AUDIT

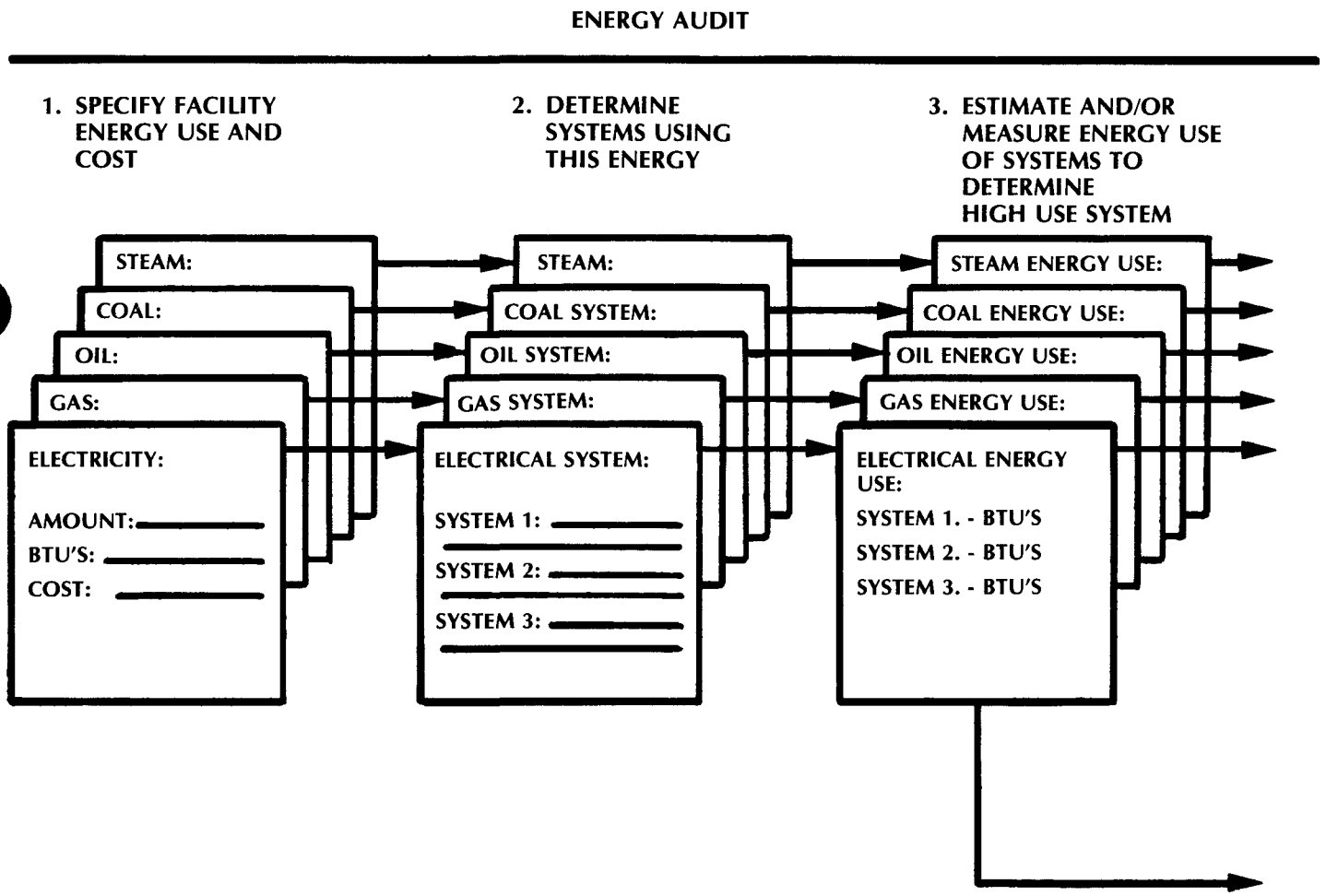
I. Energy Audit
   A. Specify Facility Energy Use and Costs
   B. Determine Systems Using This Energy
   C. Estimate and/or Measure Energy Use of Systems to Determine High Use System

II. Identification (O & M)
   A. Examine Opportunities to Reduce Energy Use Through operational Changes to Each System

III. Identification (Retrofit)
   A. Identify Retrofit Options for Each System
   B. Screen Options Based on Complexity and Energy Savings. Select Those for Detailed Analysis
   C. Screen for Future Facility Use and Fuel Availability

IV. Retrofit Design and Evaluation
   A. Engineering Analysis: Specification of Retrofits and Cost Estimates
   B. Financial Analysis: Estimate Energy and Dollar Savings for Each Option
   C. Rank Options and Select Retrofit Projects

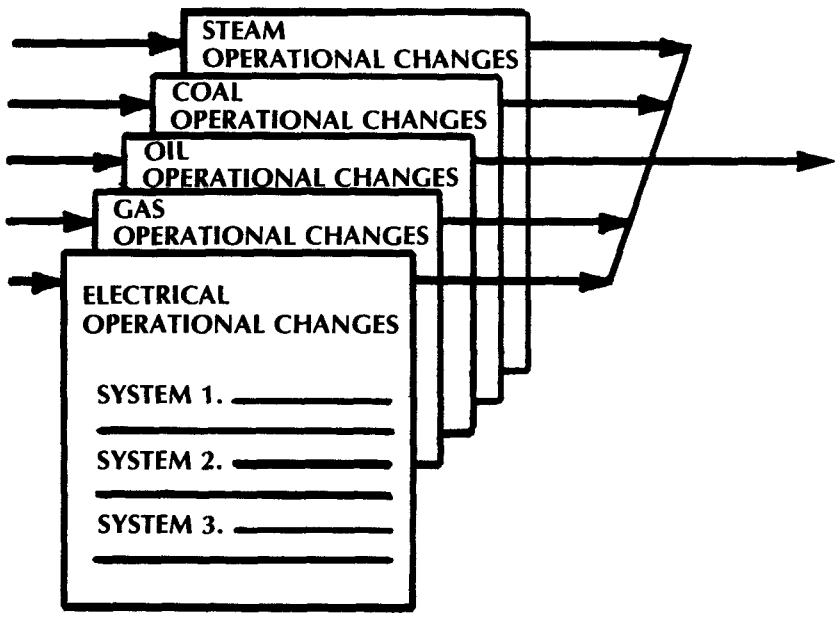
SCHEMATIC OF AN ENERGY AUDIT



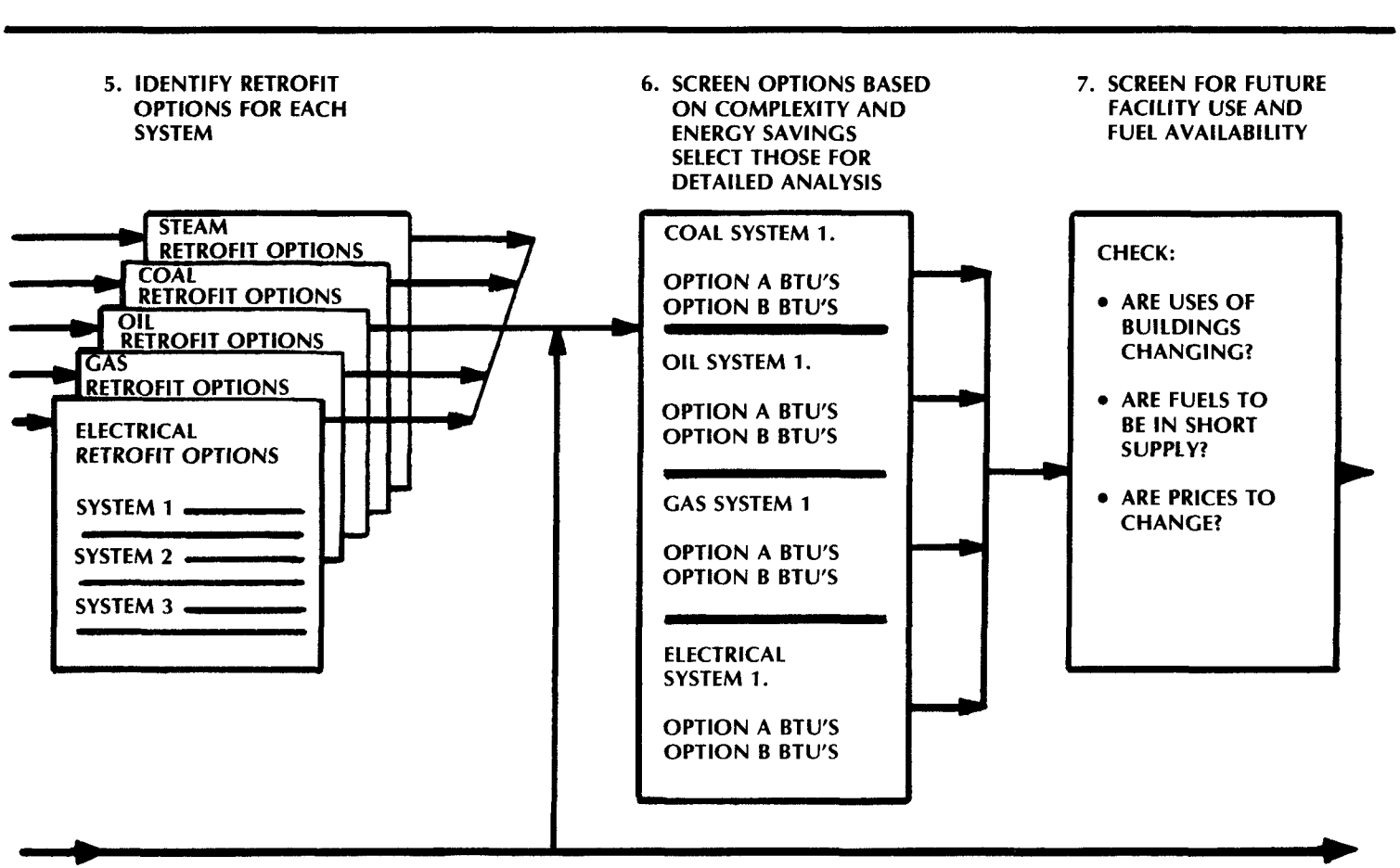
SCHEMATIC OF AN ENERGY AUDIT (CONT'D)

IDENTIFICATION

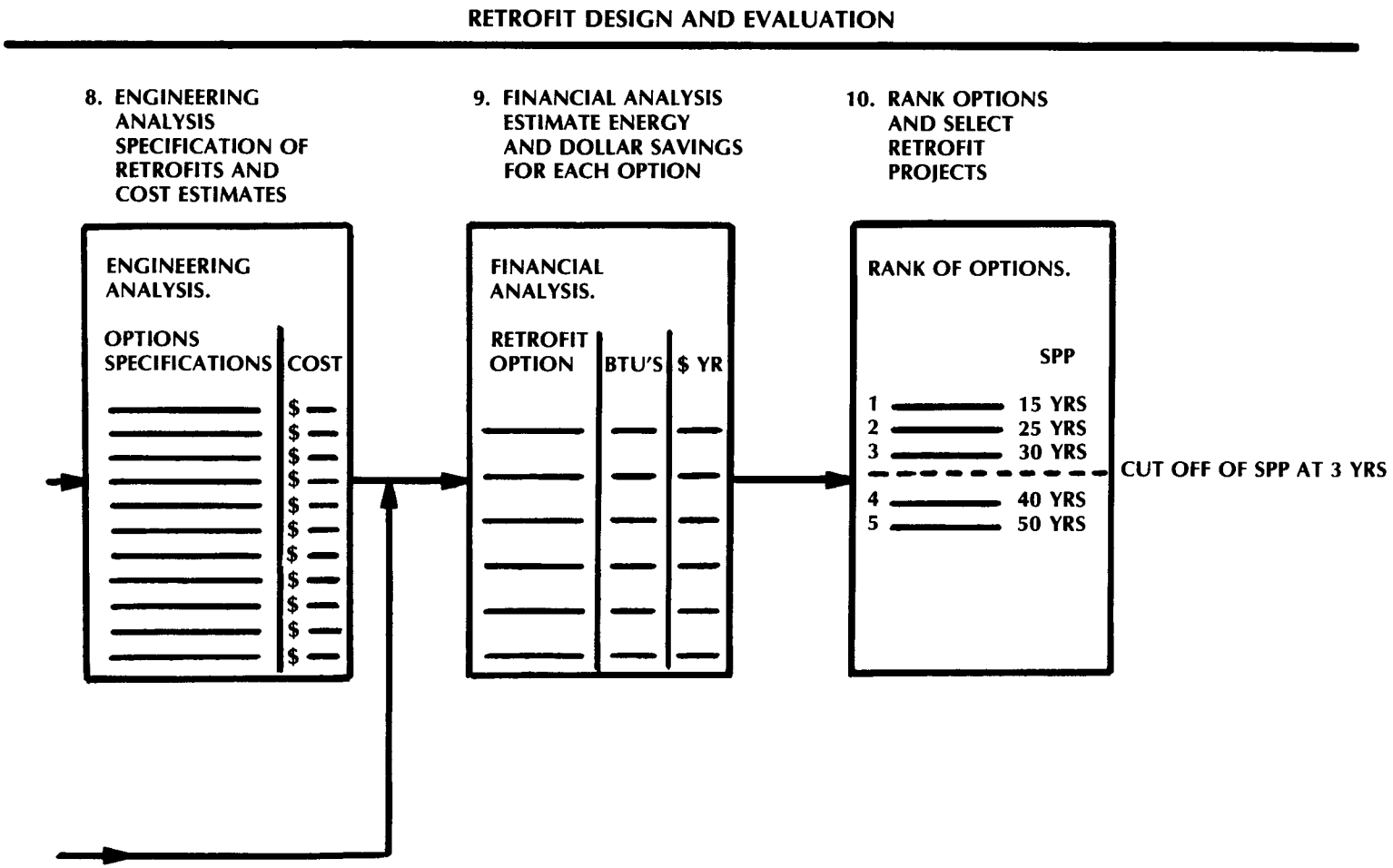
4. EXAMINE OPPORTUNITIES TO REDUCE ENERGY USE THROUGH OPERATIONAL CHANGES TO EACH SYSTEM



SCHEMATIC OF AN ENERGY AUDIT (CONT'D)



SCHEMATIC OF AN ENERGY AUDIT (CONT'D)



TRANSPARENCY II. C.

USE A TRANSPARENCY (AND PROVIDE AS A HANDOUT) TO SUMMARIZE THE TASKS TO BE COMPLETED IN CONDUCTING AN ENERGY AUDIT; DISCUSS EACH TASK TO REINFORCE OR LAY THE GROUND WORK FOR OTHER ITEMS BEING COVERED IN THE TRAINING PROGRAM.

ENERGY AUDIT PROCEDURE

1. Planning the Audit

2. Describe the System
   A. General Information
   B. Building profile
   C. Historical Utility Data
   D. Equipment Use Profile

3. Perform Walk-Through Audit (Three)

4. Perform Analysis

5. Submit Reports

6. Monitor Results

TRANSPARENCY II. D.

USE A TRANSPARENCY SO THAT THE DISCUSSION LEADER CAN LIST SUGGESTIONS/IDEAS THAT ARE GENERATED BY THE PARTICIPANTS: DISCUSSION LEADER SHOULD REFER TO THE FEDERAL REGISTER AND THE STATE ENERGY OFFICE TO INSURE THAT FEDERAL AND STATE "OUTPUTS" ARE OBTAINED; DISCUSSION LEADER SHOULD TIE THIS MATERIAL IN WITH THE MATERIAL "LIABILITIES AND RESPONSIBILITIES OF THE CLIENT AND AUDITOR" TO INSURE ADEQUATE PLANNING IS DONE.

DESIRED OUTPUT FROM AN ENERGY AUDIT

REQUIRED OUTPUT FROM	DESIRED OUTPUT FROM
FEDERAL REGISTER	NA
STATE ENERGY OFFICE	NA
CLIENT	

TRANSPARENCY II. E.

USE A TRANSPARENCY TO SUMMARIZE (SUGGESTIONS FROM THE PARTICIPANTS) WHO WILL BE RESPONSIBLE IN THE AUDITORS OFFICE FOR INSURING COMPLETION OF EACH OF THE TASKS IN "PROCEDURES FOR CONDUCTING AN ENERGY AUDIT"; DISCUSSION SHOULD INCLUDE SUGGESTED TIMES TO COMPLETE EACH TASK AND THE OVERALL TOTAL TIME TO COMPLETE THE AUDIT (BY A LARGE/SMALL AUDITING GROUP).

ORGANIZATIONAL STRUCTURE NEEDED IN THE AUDIT FUNCTION

PROCEDURE FOR CONDUCTING AN ENERGY AUDIT	PERSON(S) RESPONSIBLE (IN THE AUDITOR'S OFFICE)
1. Planning the Audit	
2. Describe the System A. General Information B. Building Profile C. Historical Utility Data D. Equipment Use Profile	
3. Perform Walk-Through Audit	
5. Submit Reports	
4. Perform Analysis	
6. Monitor Results	

TRANSPARENCY II. F.

USE A TRANSPARENCY TO LIST "RECOMMENDED TIME" TO PERFORM WALK-THRU-AUDITS; DISCUSSION LEADER SHOULD ALSO, BUT BRIEFLY, IDENTIFY AREAS THE AUDITOR MIGHT DIRECT ATTENTION TO IN ORDER TO REDUCE ENERGY COSTS.

SUGGESTED TIMES FOR WALK-THROUGH AUDITS AND WHAT TO LOOK FOR DURING THE WALK-THROUGH AUDIT

TIMES FOR WALK-THROUGH AUDITS:

1. During Working Hours - With a member of energy management team

2. During Working Hours - Alone

3. At 2:00 a.m. - Alone

WHAT TO LOOK FOR:

1. Refer to checklist on pages 338-494 in Instructions for Energy Auditors, Vol. 2

2. Lighting

3. Heating, Ventilation, Air Conditioning (HVAC)

4. Insulation

5. Leaks

6. Preventive Maintenance

SUGGESTED TIMES FOR WALK-THROUGH AUDITS AND WHAT TO LOOK FOR DURING THE WALK-THROUGH AUDIT (CONT'D)

BASIC QUESTIONS:

1. Does this project need this much heat (or this much refrigeration)?

2. Do we need to heat (or cool) this area?

3. Do we need all this light?

4. Do we need this equipment on

   A. During the peak?

   B. Anytime?

SLIDES/TRANSPARENCIES II. G.

USE MANY SLIDES/TRANSPARENCIES THAT ALLOW THE PARTICIPANTS IN THE TRAINING SESSION TO "SEE" PROBLEM AREAS THAT MIGHT BE ENCOUNTERED DURING AN ON-SITE VISIT TO A BUILDING; SUGGESTED BUILDINGS TO BE INCLUDED IN THIS WOULD BE SCHOOLS, CHURCHES, OFFICE BUILDINGS, INDUSTRIAL ESTABLISHMENTS AND EVEN RESIDENTIAL BUILDINGS; SLIDES/TRANSPARENCIES SHOULD REINFORCE THAT MANY PROBLEM AREAS ARE SIMILIAR AND INCLUDE SUCH THINGS AS:

A. LEAKS AROUND DOORS AND WINDOWS
B. BROKEN WINDOW PANES
C. WINDOWS OPEN WITH HEAT/AIR CONDITIONING ON
D. THERMOSTATS SET TOO HIGH
E. THERMOSTAT SETTINGS CONSTANTLY CHANGED
F. PIPES NOT INSULATED
G. LEAKS IN STEAM LINES
H. HVAC SYSTEM DIRTY
I. HVAC SYSTEM NOT RUNNING EFFICIENTLY
J. AIR DUCTS NOT CLOSED
K. LIGHTS ON WHEN NOT NEEDED

INCLUDE ENOUGH SLIDES/TRANSPARENCIES TO ACCOMPLISH OBJECTIVES OF THIS SESSION AREA

TRANSPARENCIES

III. DATA COLLECTION

TRANSPARENCY III. A.

USE A TRANSPARENCY TO OUTLINE SOURCES OF INFORMATION FOR DATA NEEDED TO CONDUCT THE ENERGY AUDIT; SPECIFIC NAMES AND ADDRESSES MAY BE PROVIDED AHEAD OF TIME BUT PARTICIPANTS CAN BE USED TO ASSIST IN IDENTIFYING DATA SOURCES.

SOURCES OF INFORMATION
ENERGY AUDIT DATA

1. Weather Bureau

2. Electric Utility Company

3. Natural Gas
   Coal
   Fuel Oil
   Etc.
   } Fuel Companies

4. Example. contacts for Public Schools
   A. State Superintendent
   B. State Energy Conservation Coordinator
   C. District Superintendents
   D. School Principals
   E. Teachers
   F. Students
   G. Custodians
   H. Maintenance Personnel

5. Other Sources

TRANSPARENCY III. B.

USE A SERIES OF TRANSPARENCIES TO DEMONSTRATE THE TYPES OF FORMS AVAILABLE TO THE AUDITOR; DISCUSSION LEADER SHOULD POINT OUT THE REFERENCE SOURCE INSTRUCTIONS FOR ENERGY AUDITORS, VOLUME 1 CONTAINS 27 DIFFERENT FORMS; FORMS TO INCLUDE AT LEAST THOSE RELATED TO THE GENERAL INFORMATION, BUILDING PROFILE, UTILITY DATA, AND EQUIPMENT USE PROFILE (ALL FROM THE TRAINING SESSION TOPIC AREA "ENERGY AUDIT PROCEDURE").

GENERAL INFORMATION

Date _____

Audit Period _____

Name of Facility _____

Address _____

_____

Type of Facility _____

Manager _____

Energy Coordinator _____

Energy Sources and Utilities	Utility or Supplier	Rate Schedule or Present Cost
Electricity		
Natural Gas		
No. 2 Fuel Oil		
No. 4 Fuel Oil		
No. 6 Fuel Oil		
Propane		
Bituminous Coal		
Anthracite Coal		
Purchased Steam		
Wood		
Waste Fuel		

Location of nearest U.S. Weather Bureau Station: _____

_____

Normal Annual Heating Degree Days: _____

Normal Annual Cooling Degree Days: _____

BUILDING ENVELOPE AND CONSTRUCTION - INSTRUCTIONS

Use additional forms if more than one building is involved

Item	Answer Guide
Date Constructed	- Nearest year, approximately.
Date Modernized	- Nearest year, approximately.
Number of Floors	- Above ground.
Floor Area	- From plans or tape measures.
Roof Area	- Use floor area for the covered floor.
Skylight Area	- From plans or estimate.
Building Frame	- Steel? Concrete? Wood? Brick? Other?
Exterior Walls	- Brick? Block? Clapboard? Metal? Other?
Windows	- Number of fixed sash, double hung, swing, other?
Doors	- Number of single, double, revolving overhead, other?
Glazing	- Number of sq. ft. facing north, south, east, west.
% Glass/Exterior Wall Area	- Estimate or divide area of glass × 100 by area of walls.
Exterior Glass Shading	- Any or some. If some, how much?
Interior Glass Shading	- Number of windows w/shading and how much?
Ceiling/Roof Insulation	- Data from plans - R value from insulation contractor.
Floor Insulation	- Data from plans - R value from insulation contractor.
Wall Insulation	- Data from plans - R value from insulation contractor.
Building Envelope Condition	- List defective conditions.
Ventilation/Exhaust	- Number of and area of openings. Cracks around doors and windows sealed or not.
Other Major Air Leaks	- Discuss area and orientation.
General Condition of Building	- List problem area.
Has a Roof Survey . . .?	- When.
Special Requirements	- List.
Comments	- List.

BUILDING ENVELOPE AND CONSTRUCTION

Show sketch of building location and Orientation

Date Constructed _____

Date Modernized _____
Unit Plan Type _____
No. of Floors _____

Total Enclosed Floor Area
  Square Feet _____
Total Roof Area
  Square Feet _____

Skylight Area
  Square Feet _____
Building Frame _____
Exterior Walls - Masonry, Curtain, Frame _____

Windows
  Fixed Sash, Double Hung _____

Doors
  Single _____
  Double _____
  Revolving _____

Glazing (NSEW)
  Single _____
  Double _____
  Reflective _____

% Glass/Exterior Wall Area
  North _____
  South _____
  East _____
  West _____

Exterior Glass Shading
  Fins _____
  Overhead _____
  Trees _____
  Other _____

Interior Glass Shading _____
  Shades _____
  Blinds _____
  Drapes, open mesh _____
  Drapes, opaque _____
  Other _____

BUILDING ENVELOPE AND CONSTRUCTION (CONT'D)

Ceiling/Roof Insulation
- Thickness, inches _____
- Type (R Value) _____
- Approx. Area, Sq. Ft. _____

Floor Insulation
- Thickness, inches _____
- Type (R value) _____
- Approx. Area, Sq. Ft. _____

Wall Insulation
- Thickness, inches _____
- Type (R Value) _____
- Approx. Area, Sq. Ft. _____

Building Envelope Condition
- Structural Damage _____
- Broken or Defective Windows _____

Ventilation/Exhaust
- Openings that remain open _____
- Tightness around windows & doors _____

Other Major Air Leaks

_____ _____
_____ _____
_____ _____

General Condition of Building _____

Has a roof survey been done within the last few years? When? _____

Special Requirements, not listed _____

Comments: _____

_____

_____

_____

BUILDING PLAN AND FUNCTION

Attach sketch of building or set of building plans (including diagrams of individual function areas if possible)

FUNCTION	AREA SQ. FT.	DAY OF WEEK	ESTIMATED NO. OCCUPANTS	PERIOD OF OCCUPANCY
Office and administration	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Corridors and stairways	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Living	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Dining	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Food preparation	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Instructional	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Manufacturing	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Warehouse or raw material storage	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____

BUILDING PLAN AND FUNCTION

(CONT'D)

FUNCTION	AREA SQ. FT.	DAY OF WEEK	ESTIMATED NO. OCCUPANTS	PERIOD OF OCCUPANCY
Garage	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Public Areas (Waiting rooms, etc.)	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Hospital Patient rooms	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Operating or Treatment rooms	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Laboratories	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Other	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____
Other	_____	Mon to Fri	_____	_____
		Saturday	_____	_____
		Sunday	_____	_____

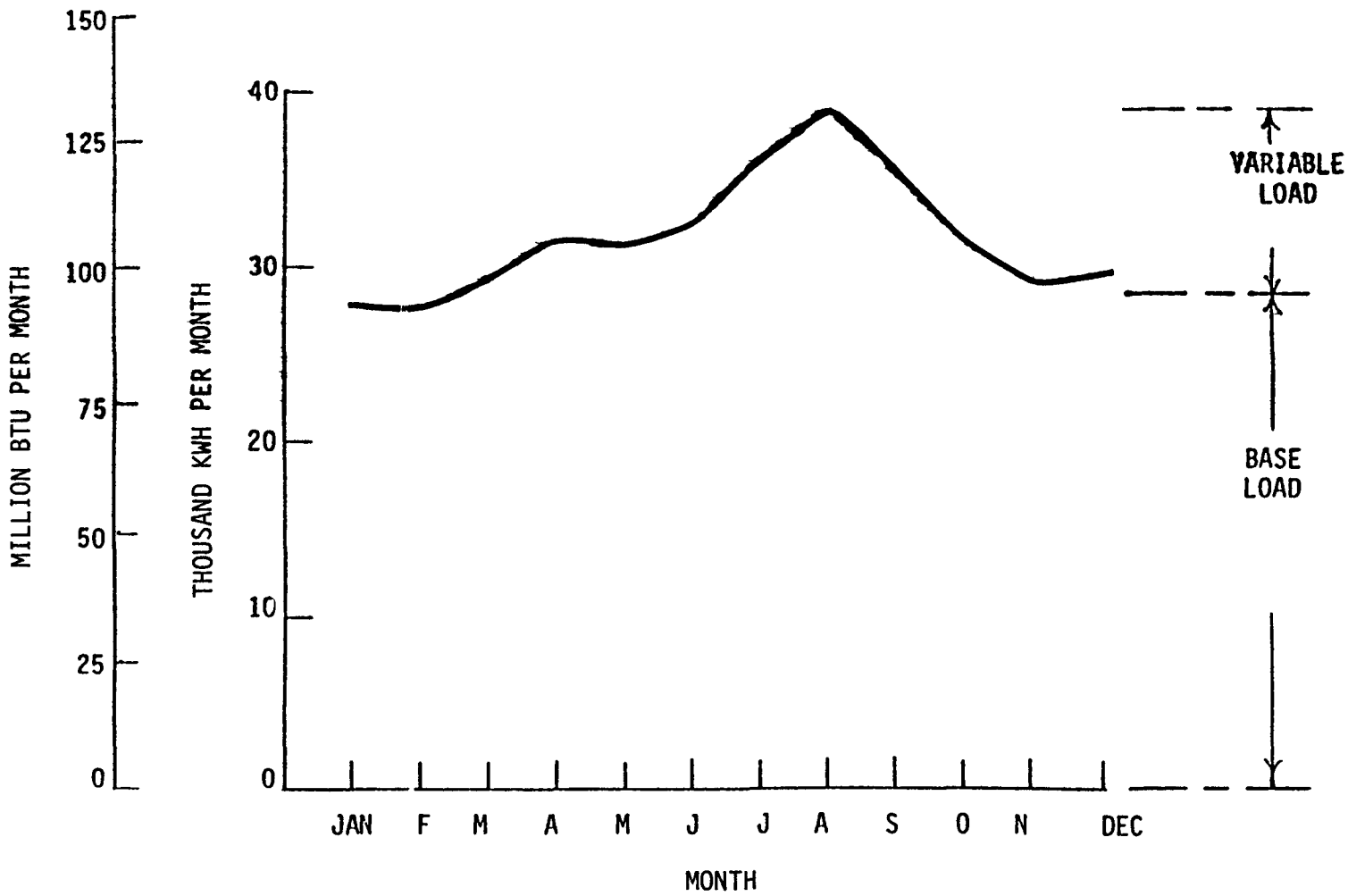
Total Area [_____] sq ft

HISTORICAL QUANTITY AND COST DATA FOR ELECTRICITY

BUILDING _____ UTILITY _____
METER SERIAL NO. _____ RATE SCHEDULE _____
LOCATION _____

BILLING PERIOD (1)	MAXIMUM DEMAND KW(2)	POWER FACTOR (3)	CONSUMPTION KWH (4)	TOTAL COST $ (5)	COST $/KWH (6)	CONSUMPTION MILLION BTU (7)	COST $/MILLION BTU (8)
ANNUAL							

PROFILE OF ELECTRIC ENERGY USAGE FOR A SAMPLE BUILDING

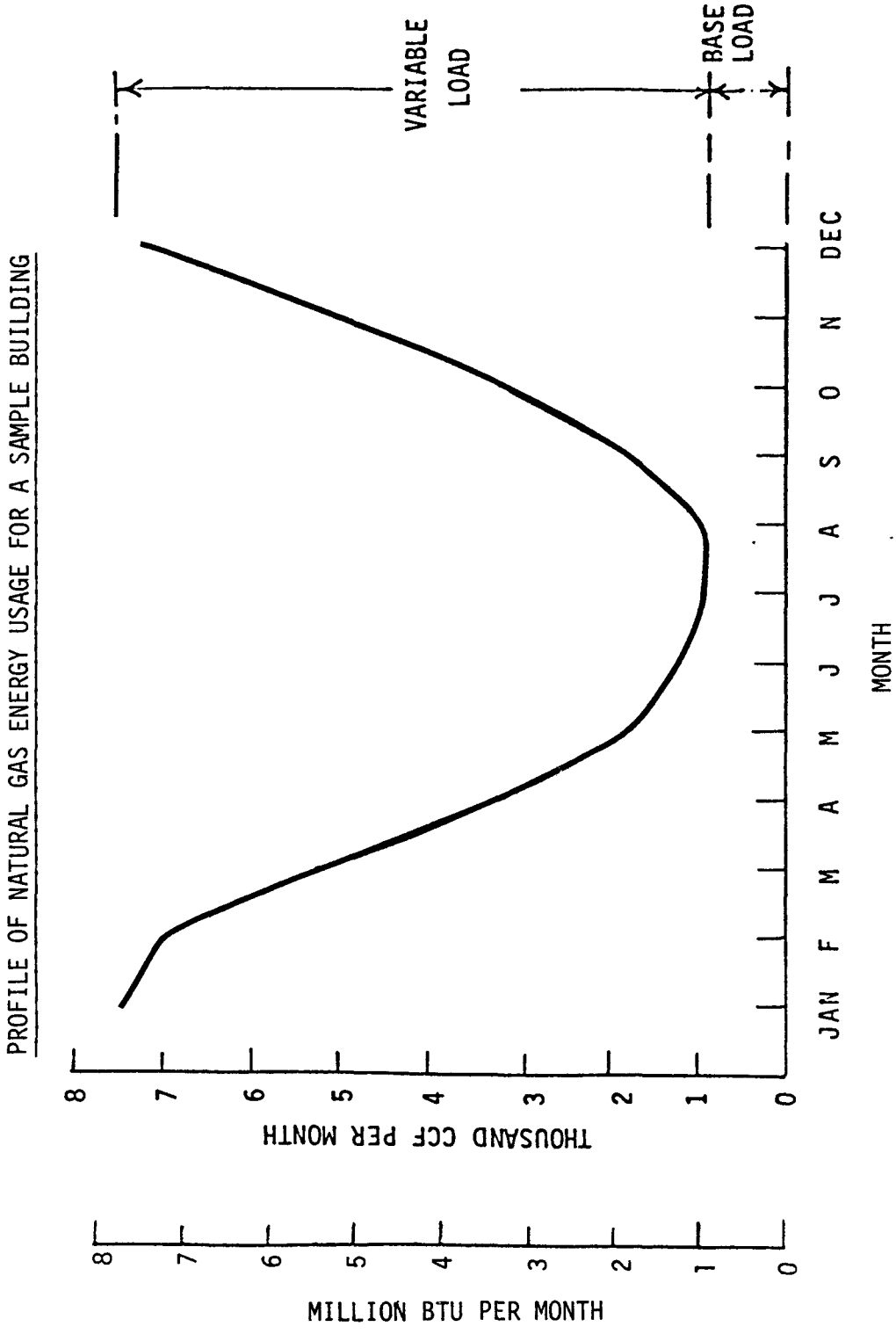


FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978.

HISTORICAL QUANTITY AND COST DATA FOR NATURAL GAS

BUILDING _____ UTILITY _____
METER SERIAL NO. _____ RATE SCHEDULE _____
LOCATION _____

BILLING PERIOD (1)	MAXIMUM DEMAND (2)	CONSUMPTION ☐ CCF ☐ THERMS (3)	HHV (4)	TOTAL COST $ (5)	$ COST PER ☐ CCF ☐ THERMS (6)	CONSUMPTION MILLION BTUS (7)	COST $/MILLION BTU (8)
ANNUAL							



FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978.

DEGREE DATA AND OTHER FACTORS AFFECTING ENERGY USE

BUILDING _____

AUDIT PERIOD _____

LOCATION OF U.S. WEATHER STATION _____

SOURCE OF WEATHER DATA _____

	MONTH	HEATING DEGREE DAYS	COOLING DEGREE DAYS	OPERATING DAYS	BUILDING USE HOURS	MONTHLY PRODUCTION POUNDS
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
Annual						
Normal Degrees Days						

CONNECTED LOAD, ELECTRIC ENERGY

BUILDING(S): _____ **Surveyed by:** _____

AUDIT PERIOD: _____ _____

Price per kwh: $ _____

	A	B	C	D	E	F	G	H
Energy Type	Equipment Description	Elec. use per Device (kilowatts)	No. of Devices	Total Elec. Use (kilowatts)	Elec. Cost per Hour (dollars)	Operating Hours per Year	Elec. Cost per Year (dollars)	Total Elec. Yearly used KWH
ELEC.								
						TOTAL ANNUAL:		
							Energy Cost	Fuel Used

Column D = B × C
Column G = E × F

Column E = D × Price per KWH
Column H = D × F

HOT WATER SYSTEMS

HEATER TYPE	FUEL TYPE OIL, GAS, OTHER	RATED INPUT, KWH, GAL PER HR, OTHER	*ENERGY RATING	AQUASTAT TEMPERATURE °F	UNIT OR AREA SERVED

*In millions of Btu per hour.

LIGHTING SYSTEMS

UNIT OR AREA SERVED	TYPE LUMINAIRE (FIXTURE)	WATTS PER LUMINAIRE	QUANTITY	TOTAL WATTS	METHOD OF CONTROL
Interior Lighting					
Exterior Lighting					

TRANSPARENCY III. E.

USE A TRANSPARENCY TO SUMMARIZE THE EQUIPMENT THAT CAN BE USED BY THE AUDITOR IN CONDUCTING THE ENERGY AUDIT; ALSO FROM THE REFERENCE SOURCE INSTRUCTIONS FOR ENERGY AUDITORS, VOLUME 1 POINT OUT EQUIPMENT MANUFACTURERS.

INSTRUMENTS FOR USE IN CONDUCTING ENERGY AUDITS

THERMOMETERS

AMMETER

VOLTMETER

POWER FACTOR METER

COMBUSTION TESTER

LIGHT METER

VELOMETER

USE SAFELY, OR GET HELP FROM AN EXPERT!

TRANSPARENCIES

IV. ANALYSIS LEADING TO ENERGY CONSERVATION OPPORTUNITIES

TRANSPARENCY IV, A THROUGH I

USE A SERIES OF TRANSPARENCIES THAT PRESENT (THROUGH CHARTS/GRAPHS) THE EFFECT OF PERFORMING A DETAILED ENERGY AUDIT ANALYSIS IN BUILDINGS; DISCUSSION LEADER SHOULD MAKE USE OF MATERIAL IN THE REFERENCE SOURCE INSTRUCTIONS FOR ENERGY AUDITORS, VOLUME 1 AND 2*; DISCUSSION LEADER SHOULD DRAW CASE STUDIES/ACTUAL EXAMPLES FROM SESSION PARTICIPANTS TO INSURE POSITIVE INTERACTION OF EVERYONE.

*TERMINOLOGY USED IN THE FOLLOWING TRANSPARENCIES, WHILE CONSISTENT WITH VOLUMES 1 AND 2, MAY BE DIFFERENT FROM STANDARD ELECTRICAL ENGINEERING TERMINOLOGY FOR THESE TYPES OF PROBLEMS.

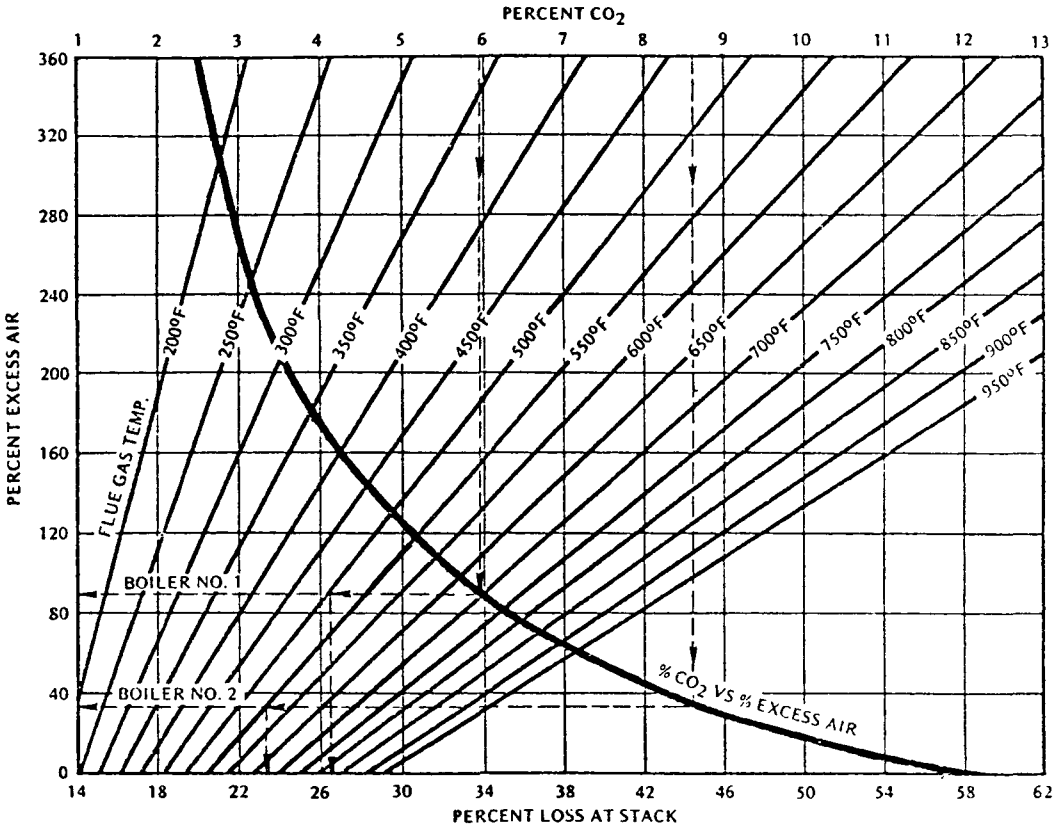
OPERATION AND MAINTENANCE OPPORTUNITIES

MANY O & M OPPORTUNITIES LISTED IN INSTRUCTIONS FOR ENERGY AUDITORS, VOLUME 2

OTHER AREAS FOR REDUCING ENERGY COSTS

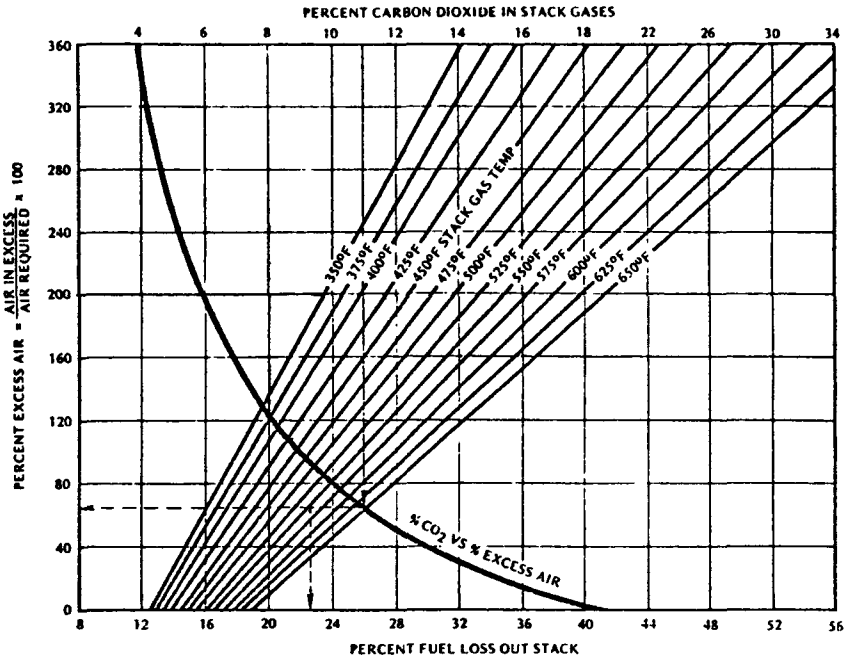
1. Stack Gas Analysis
2. Waste Heat Analysis
3. Use Industrial Wastes for Fuel
4. Improve Boiler Efficiency
5. Stop Leaks
6. Insulate Pipes
7. Examine Lighting
8. Consider Power Factor Correction (Improvement)

STACK GAS LOSS CURVES



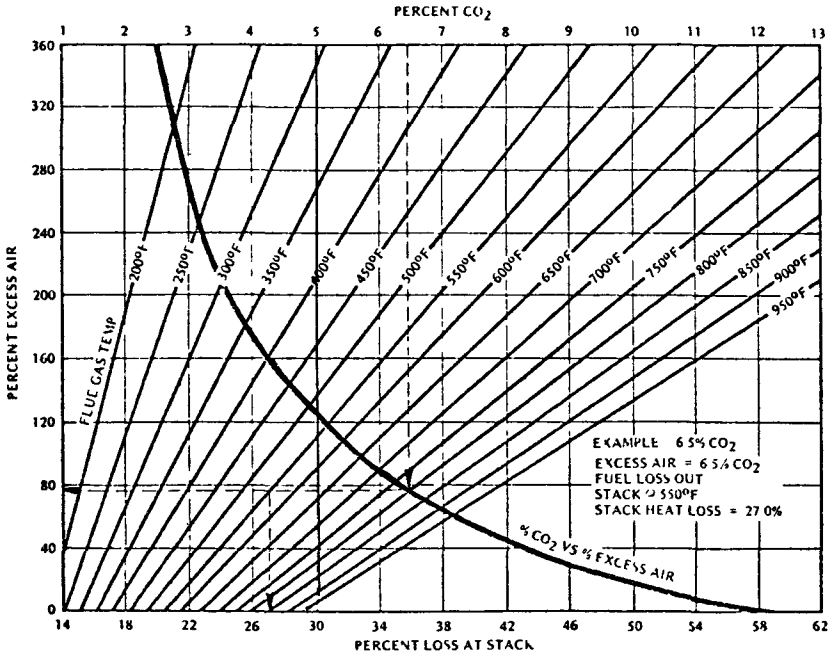
FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978.

HEAT LOSS CURVES - BITUMINOUS COAL



FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978.

STACK GAS LOSS CURVES - NATURAL GAS



FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978.

WASTE HEAT RECOVERY INFORMATION

TEMPERATURE OF WASTE HEAT FLUID

FLOW RATE OF WASTE HEAT FLUID

CHEMICAL COMPOSITION OF WASTE HEAT FLUID

MINIMUM ALLOWABLE TEMPERATURE OF WASTE HEAT FLUID

TEMPERATURE OF HEATED FLUID

CHEMICAL COMPOSITION OF HEATED FLUID

MAXIMUM ALLOWABLE TEMPERATURE OF HEATED FLUID

CONTROL TEMPERATURE, IF CONTROL REQUIRED

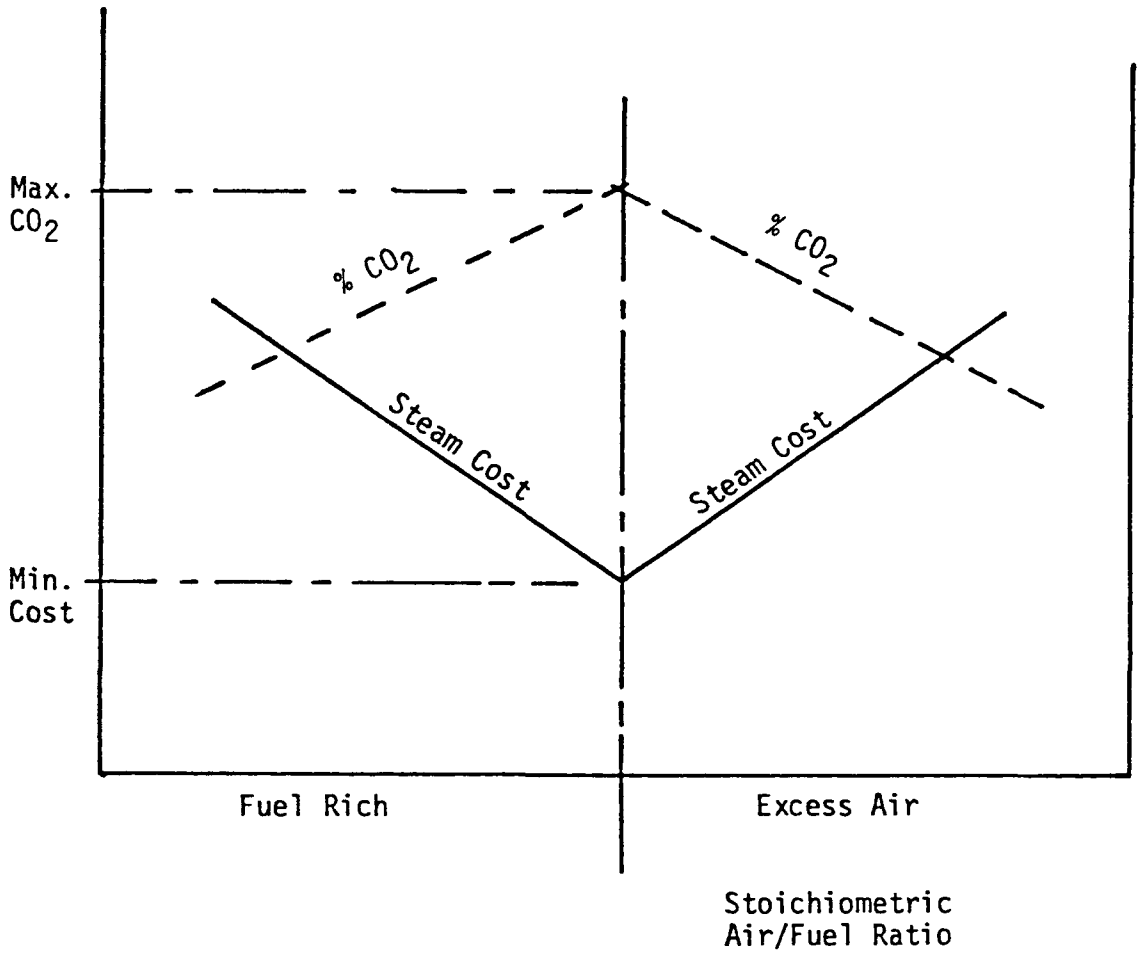
SOURCE: WASTE HEAT MANAGEMENT GUIDEBOOK: NBS HANDBOOK 121 (U.S. DEPARTMENT OF COMMERCE, 1977, $2.75)

HEATING VALUES OF INDUSTRIAL WASTE FUELS

FUEL	HEATING VALUE	
	BTU/LB	BTU/CU FT
Solid Fuels		
Bagasse	3,600 - 6,500	
Bark	4,500 - 5,200	
Wood Waste	4,500 - 6,500	
Sawdust	4,500 - 7,500	
Coffee Grounds	4,900 - 6,500	
Rice Hulls	5,200 - 6,500	
Corn Cobs	8,000 - 8,300	
Municipal Refuse	4,500 - 6,500	
Industrial Refuse	6,600 - 7,300	
Coal	8,000 - 24,000	
Liquid Fuels		
Black Liquor (Pulp Mills)	4,000	
Dirty Solvents	10,000 - 16,000	
Gasoline	20,700	
Industrial Sludge	3,700 - 4,200	
Naphtha	20,250	
Naphthalene	18,500	
Oil Waste	18,000	
Paints & Resins	6,000 - 10,000	
Spent Lubricant	10,000 - 14,000	
Sulfite Liquor	4,200	
Oil	18,500	
Gas Fuels		
Coke - Oven Gas		500 - 600
Refinery Gas		1,200 - 1,800
Natural Gas		1,000

FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978. p. 139

RELATIONSHIP BETWEEN STEAM COST AND AIR/FUEL RATIO



FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978.

BOILERS

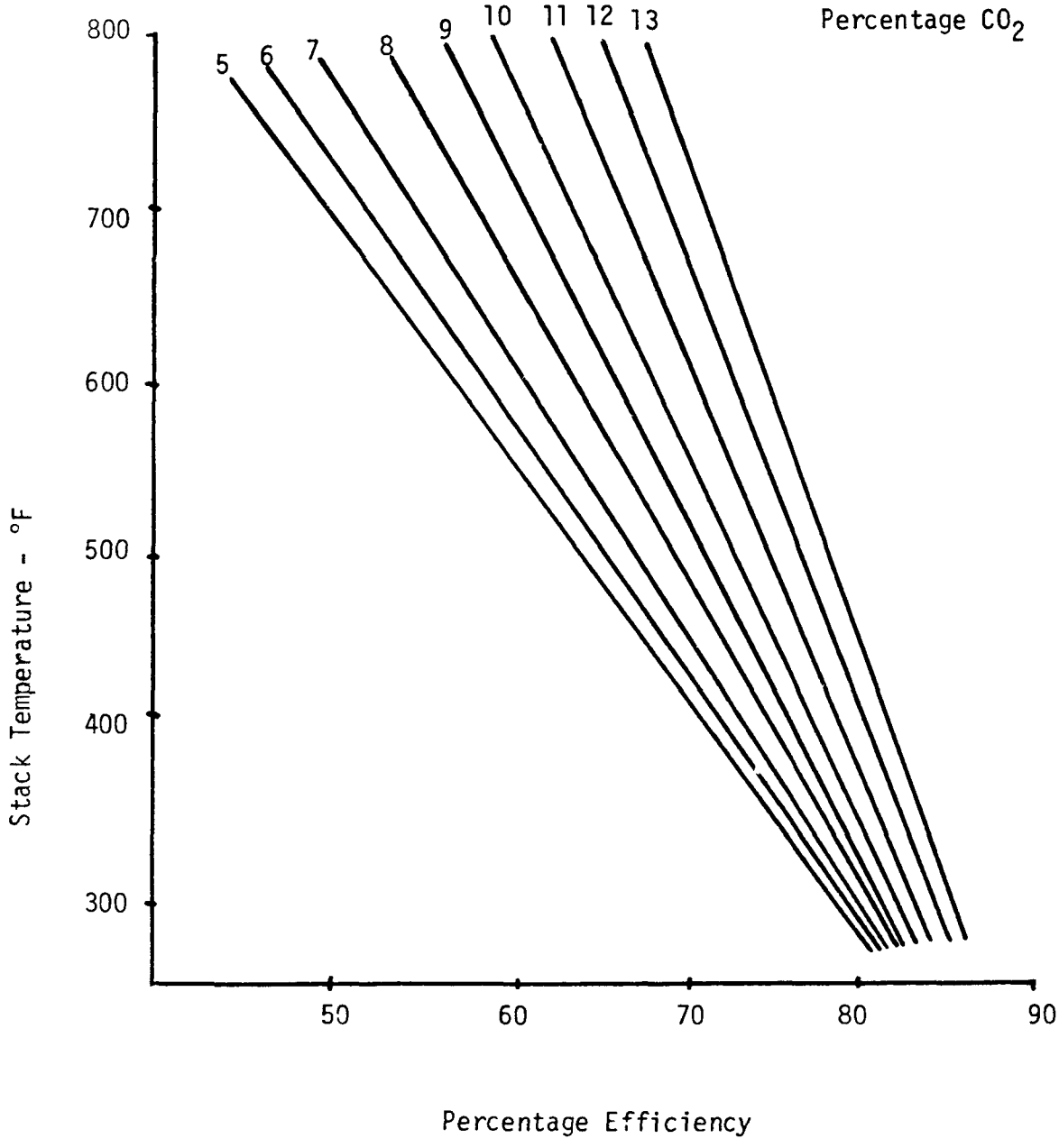
GET AN EXPERT

1. Local Fuel Company
2. Consulting Engineer
3. Vendors

THE SAVINGS POTENTIAL IS GREAT, BUT EXPERT ADVICE IS ESSENTIAL.

TYPICAL EFFICIENCY OF AN OIL-FIRED BOILER

(based on stack temperature & CO_2 content of gas)



FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978.

EXAMPLES OF FLUID LOSS THROUGH SMALL HOLES:

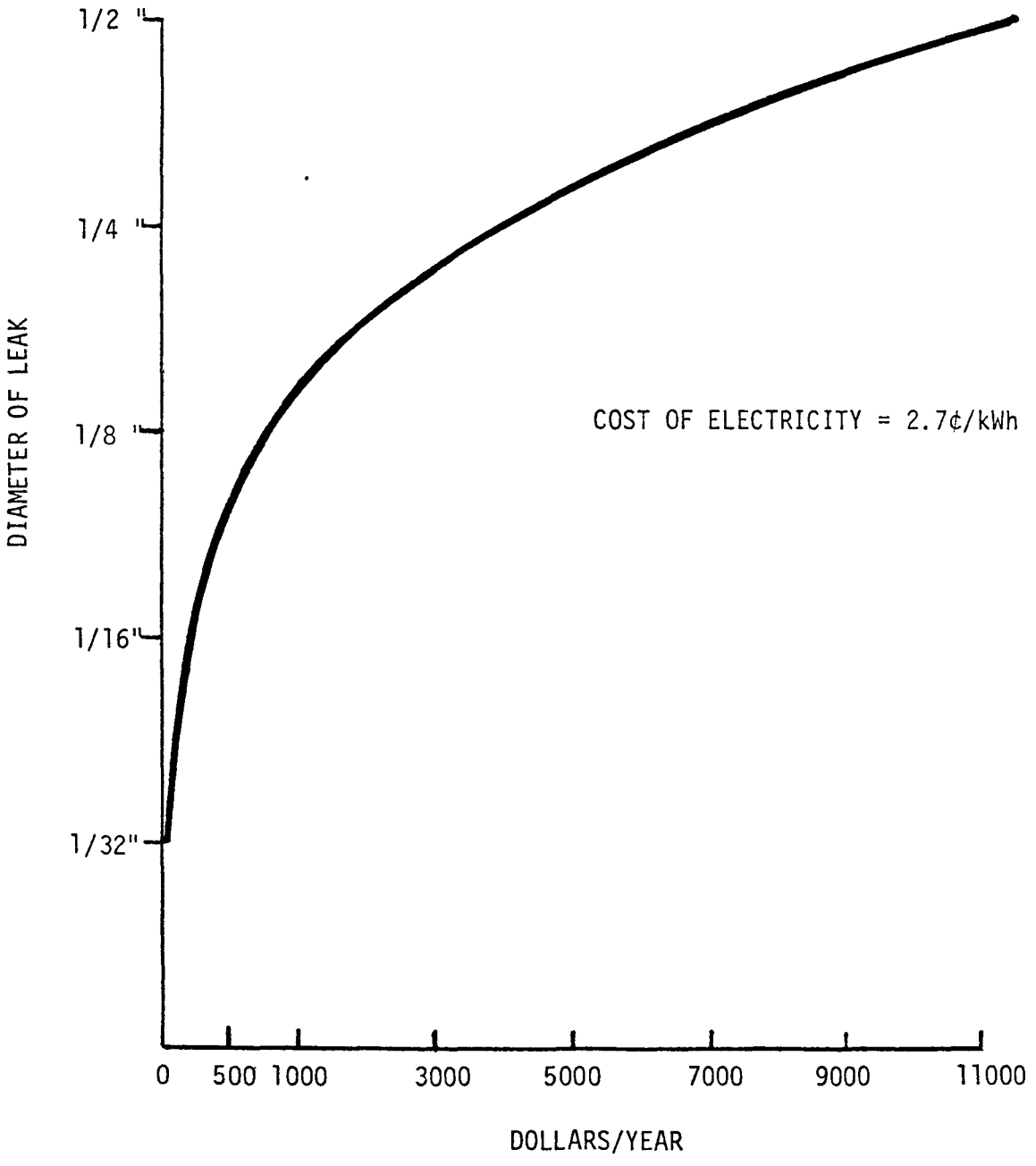
DIAMETER OF HOLE	STEAM - LB/HOUR 100 PSIG	300 PSIG	WATER - GALS/HOUR 20 PSIG	100 PSIG	AIR S.C.F.M. 80 PSIG
1/16"	14	33	20	45	4
1/8"	56	132	80	180	16
3/16"	126	297	180	405	36
1/4"	224	528	320	720	64

PIPE HEAT LOSSES

PIPE DIA. INCHES	SURFACE TEMP.°F	INSULATION THICKNESS	HEAT LOSS(BTUS/FT/HR.) UNINSULATED	INSULATED	INSULATION EFFICIENCY
4	200	1½"	300	70	76.7
	300	2"	800	120	85.0
	400	2½"	1500	150	90.0
6	200	1½"	425	95	78.7
	300	2"	1300	180	85.8
	400	2½"	2000	195	90.25
8	200	1½"	550	115	79.1
	300	2"	1500	200	86.7
	400	2½"	2750	250	91.0

FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978.

COST OF AIR LEAKS AT 100 PSI



FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978.

LIGHTING

1. Turn it off if you don't need it on

2. Reduce wattages where possible

3. Consider changing light types or luminaires

4. To save labor dollars, consider group relamping

RECOMMENDED LIGHT INTENSITIES

Notes: Source Code: F4 = 4 Foot, 2-Tube Fluorescent Luminaire
F8 = 8 Foot, 2-Tube Fluorescent Luminaire
H = 400 Watt, Multi-Vapor H.I.D. Luminaire
I = 100, Watt, 120 Volt Incandescent Lamp

TYPE, OCCUPANCY & AREA	FOOTCANDLES (MIN. - MAX.)	SOURCE	HEAT LIBERATED W/Ft²	Btu/Ft²
PROCESSING AND MANUFACTURING				
Bulk Unloading	30	H	.56	1.9
General Process Equipment Areas	50	H	.93	3.16
Mixing, Weighing, & Blending, Processing Bins & Tanks, Equipment Rooms	30	H	.56	1.9
Refrigeration Compressors, Fans, Pumps & Air Compressors, Freezer Tunnels	5	—	—	—
Palletizing Equipment Area	30	H	.56	1.9
Cleaning, Grading & Inspection of Raw Materials	70	H	1.3	4.42
Preliminary Sorting, Cutting Final Sorting, Inspection	100	H	1.85	6.29
Color Inspection & Appraisal	100-200	I	8.2-16.4	27.88-55.76
Machine Composition, Composing Room & Presses	100	F8	2.04	6.94
Loading, Rail & Truck	20	H	.41	1.39
Inside Truck Bodies & Freight Cars	10	I	.82	2.79
PACKAGING				
Filling, Labeling, Packing, Wrapping	50	F8	1.02	3.47

FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978. p. 309

RECOMMENDED LIGHT INTENSITIES

(CONT'D)

TYPE, OCCUPANCY & AREA	FOOTCANDLES (MIN. - MAX.)	SOURCE	HEAT LIBERATED W/Ft²	Btu/Ft²
STORAGE				
Rough Bulky (spare equipment)	10	F8	.20	.68
Medium (spare parts)	20	F8	.41	1.39
Fine (bins & racks)	50	F8	1.02	3.47
Picking Stock, Classifying	30	F8	.61	2.07
WAREHOUSES				
DSSD Warehouse Cold Storage Warehouse	15-25	H	.28-.46	.95-1.56
UTILITY				
Boiler Plants, Compressors, Pump Rooms, Auxiliary Condensers, Deaeator, Evaporator, Heater, Floors	30	H	.56	1.9
Control Panels	50	F8	1.02	3.47
Utility Tunnels	5	F8	.10	.34
Cooling Tower	5	F8	.10	.34
MAINTENANCE SHOP				
All Work Areas	50	F8	1.02	3.47
LABORATORIES				
All Work Areas	100	F4	2.27	7.72
ELECTRICAL EQUIPMENT & INSTRUMENT				
Switchgear, Indoor, Unit Substations	20	F8	.41	1.39
Motor Control Center, Central Control Room				
Aisle Lighting	50	F8	1.02	3.47
Instrument & Repair Shop	100	F8	2.04	6.94

FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978. p. 310

RECOMMENDED LIGHT INTENSITIES

(CONT'D)

TYPE, OCCUPANCY & AREA	FOOTCANDLES (MIN. - MAX.)	SOURCE	HEAT LIBERATED W/Ft²	Btu/Ft²
OFFICE				
General Office	70-100	F4	1.3-2.27	4.42-7.72
Private Office, Conference Room	70	F4	1.59	5.41
Data Processing & Teletype	150	F4	3.41	11.59
Drafting Rooms	150	F4	3.41	11.59
Telephone Switchboard	50	F4	1.14	3.88
Reception	30	F4	.68	2.31
Library - General	30	F4	.68	2.31
Reading Rooms	70	F4	1.59	5.41
Rest, Toilet & Locker Rooms	30	F4	.68	2.31
Aisles, Corridors & Stairways	20	F4	.45	1.53
Product Display Area	100	F4	2.27	7.72
Night Lighting (Security)	1	F4	.02	.07
LUNCH ROOMS				
Dining Areas - Service Type	30	F4	.68	2.31
CAFETERIAS				
Cafeteria	50	F4	1.14	3.88
Food Displays - Twice the General Levels, but not less than	50	F4	1.14	3.88
Kitchen	70	F4	1.59	5.41
MEDICAL FACILITIES				
Reception Area	50	F4	1.14	3.88
General Examination	50	F4	1.14	3.88
Examination Table	100	F4	2.27	7.72

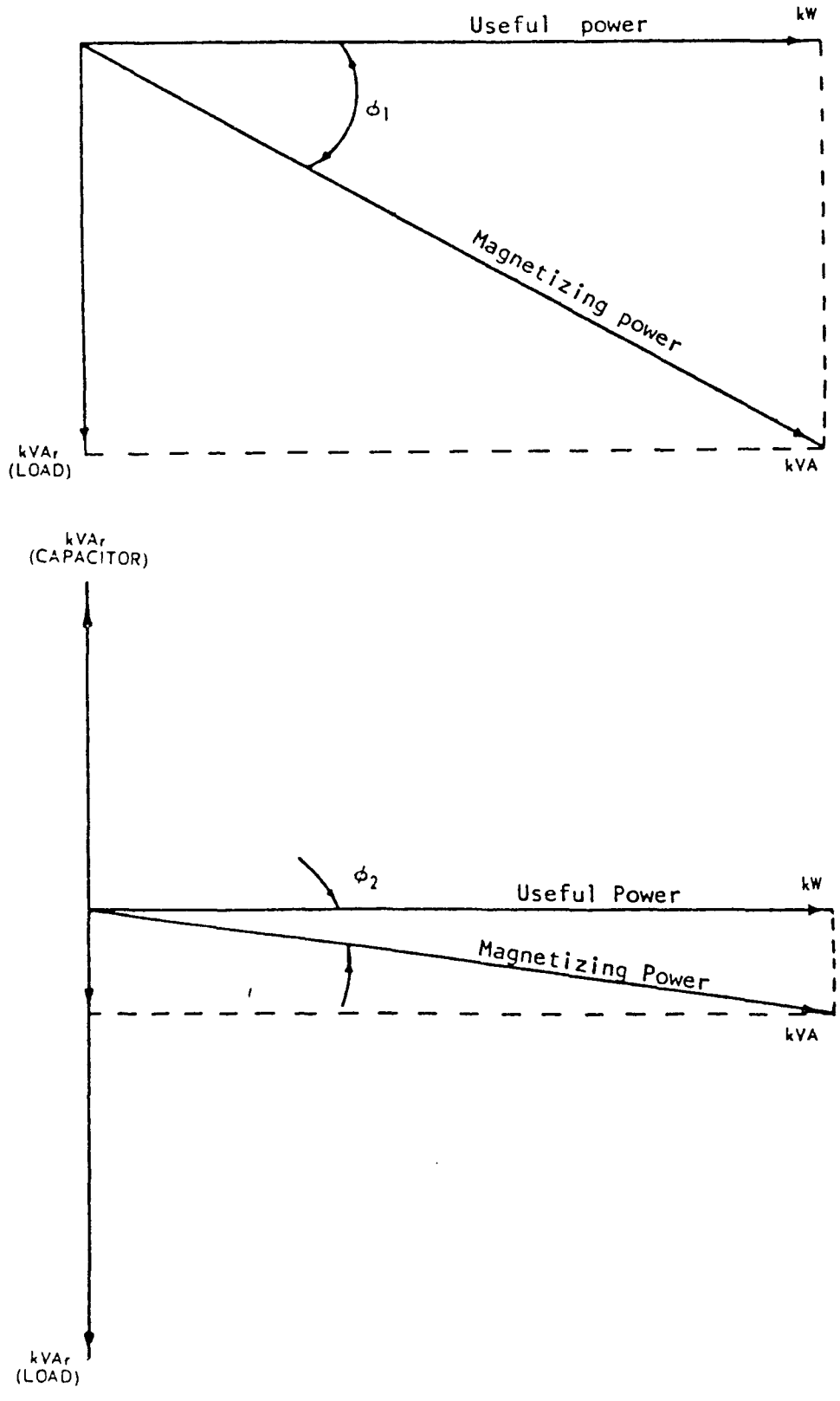
FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978. p. 311.

HOW ELECTRICITY IS BILLED

DEMAND CHARGE = CHARGE TO PAY FOR INSTALLED CAPACITY

USAGE CHARGE = CHARGE TO PAY FOR ENERGY CONSUMED

VECTOR RELATIONSHIPS IN AC POWER SYSTEMS



FROM: Instructions for Energy Auditors, DOE/CS - 0041/12 or 13 (two volume set) September, 1978.

TRANSPARENCY IV. J.

PROVIDE THE ATTACHED NARRATIVE MATERIAL IN THE FORM OF A HANDOUT. DISCUSSION SHOULD BE DIRECTED TO THE EVALUATION OF POTENTIAL FOR ENERGY CONSERVATION MEASURES. INCLUDE A TRANSPARENCY OF THE TABLE SHOWING HOW TO DETERMINE THE ENERGY CONSERVATION MEASURES POTENTIAL INDEX. INSTRUCTOR SHOULD COMPLETE THE TABLE WITH THE PARTICIPANTS BY WORKING THROUGH AN EXAMPLE.

(SEE ATTACHED SHEETS)

EVALUATION OF POTENTIAL FOR ENERGY CONSERVATION MEASURES

This evaluation is patterned on the 1976 ASHRAE Systems Handbook, Chapter 1, and the Energy Audit Procedures published by the Ohio Board of Regents in June 1978. A Relative Importance Factor (RIF), ranging from 15 to 35 is assigned to each of the five items listed. Within each, conditions are described and a Weighting Factor (WF) assigned to each condition. The evaluation of the potential of the building for energy conservation measures is based on the sum of the product of the RIF and WF. The higher this value, the greater the potential for energy savings. Since energy audits are intended to make relative comparisons, it is essential that conformity be maintained. Therefore, neither the RIF not the WF are to be altered. Determine the Weighting Factor as follows:

a. Building Envelope (RIF:15)—

Percentage of glass area can be estimated by dividing the glass area in a typical wall by the wall area. Large or low infiltration can be determined by noting fit of outside doors and windows in their frames. Tight fitting doors and windows denote low infiltration and loose fit-up denotes high infiltration.

	WF
Bldgs over 40 percent glass and large infiltration	1.0
Bldgs over 40 percent glass	.9
Bldgs with large infiltration	.8
Bldgs under 40 percent glass	.7
Bldgs with low infiltration	.6
Bldgs under 15 percent glass	.5

b. Lighting (RIF:15)—

To determine power usage for lighting in watts/square foot, total the wattage of all lamps in the building and divide by the gross floor area of the building.

	WF
Lighting over 3 w/sq. ft.	1.0
Lighting 2 to 3 w/sq. ft.	.9
Lighting 1 to 2 w/sq. ft.	.8
Lighting reduced by changes in switching	.7
Lighting that cannot be reduced	.6

c. HVAC System Type (RIF:35)—

Check the type of HVAC system found in your building. If knowledge of the system is not available, obtain the information from a qualified engineer, blueprints, specifications, name plates, your local HVAC contractor, or refer to HVAC systems exhibit in the appendix of the ASHRAE Systems Handbook.

	WF
Reheat of Dual Duct	1.0
Multizone or Induction Unit	.9
Rooftop Units, Wall Units, or Unit Ventilators	.8
Fancoil, VAV, or Heat and Vent System	.7
Radiation, Unit Heaters (no fan systems)	.6

d. Outside Air (RIF:20)—

Check the ventilation system for outside air percentage. If knowledge of the system is not available, obtain the information from a qualified engineer, blueprints, specifications, name plates, or contact your local HVAC contractor.

	WF
75 to 100 percent Outside Air	1.0
50 to 75 percent Outside Air	.9
25 to 50 percent Outside Air	.8
10 to 25 percent Outside Air	.7
Infiltration, toilet exhaust only	.6

e. Fan Energy (RIF:15)—

To determine square feet per fan horsepower (HP), divide building gross floor area by total HP of all HVAC and ventilating fans in the building. HP rating can be found on nameplates of pumps and motors in your air handling systems.

	WF
Under 200 sq. ft. per fan HP	1.0
200-600 sq. ft. per fan HP	.9
600-1000 sq. ft. per fan HP	.8
1000-1500 sq. ft. per fan HP	.7
1500-2000 sq. ft. per fan HP	.6
Over 2000 sq. ft. per fan HP	.5

Complete the following table to determine the energy conservation measure potential index.

		RIF	X	WF	= EVALUATION
a.	Bldg Envelope - % Glass and Infiltration	15			
b.	Lighting Levels	15			
c.	HVAC System Type	35			
d.	Ratio Outside Air	20			
e.	Fan Energy	15			
Energy conservation measure potential index					

CALCULATION OF ENERGY CONSERVATION MEASURES POTENTIAL INDEX

	RIF	X	WF	= EVALUATION
A. BLDG ENVELOP - % AND INFILTRATION	15			
B. LIGHTING LEVELS	15			
C. HVAC SYSTEM TYPE	35			
D. RATIO OUTSIDE AIR	20			
E. FAN ENERGY	15			
ENERGY CONSERVATION MEASURE POTENTIAL INDEX				

TRANSPARENCY IV. K.

PROVIDE THE ATTACHED NARRATIVE MATERIAL IN THE FORM OF A HANDOUT. DISCUSSION SHOULD BE DIRECTED TO THE EVALUATION OF POTENTIAL FOR SOLAR AND RENEWABLE RESOURCE MEASURES. INCLUDE A TRANSPARENCY OF A TABLE TO DETERMINE THE SOLAR AND RENEWABLE RESOURCE MEASURE POTENTIAL INDEX. INSTRUCTOR SHOULD COMPLETE THE TABLE WITH THE PARTICIPANTS BY WORKING THROUGH AN EXAMPLE.

(SEE ATTACHED SHEETS)

EVALUATION OF POTENTIAL FOR SOLAR AND RENEWABLE RESOURCE MEASURES

This evaluation procedure operates in the same manner as that for energy conservation measures.

a. Insolation available (RIF:30)—

Available insolation is a function of geographic location and site characteristics. Determine average annual horizontal insolation from information provided by the State or from National Weather Service data, as appropriate for the location. Determine by observation whether the building is shaded or unshaded (a building whose roof and south-facing wall are (approximately) more than half-shaded for (approximately) more than four hours per day, should be considered "shaded"). If the building itself is shaded, note whether there is open, unshaded land available adjacent to the building site.

	WF
Unshaded and 1300 BTU/sq. ft. or more	1.0
Unshaded, less than 1300 BTU/sq. ft.	.5
Open land and 1300 BTU/sq. ft. or more	1.0
Open land, less than 1300 BTU/sq. ft.	.5
Shaded, 1300 BTU/sq. ft. or more	.2
Shaded, less than 1300 BTU/sq. ft.	.1

b. Fuel (RIF:20)—

Note the fuel used for heating, air-conditioning, and hot water.

	WF
All electric	1.0
Oil or gas heat, otherwise electric	.8
Coal heat, otherwise electric	.4
Oil or gas heat, hot water	.4
Coal heat, hot water	.2

c. Building Characteristics (RIF:10)—

Refer to the description of building size and shape and the location of heating, air-conditioning, and hot water equipment. A "favorable" building is one in which the equipment is in one location on the roof or adjacent to the south-facing wall. One which is "fair" would be other than compact (i.e., E-shaped, L-shaped, etc.) but in which the equipment is in one location on the roof or adjacent to the southfacing wall, or compact but in which the equipment is within five floors of the roof or 50 feet

of the south-facing wall. A building which is not compact and in which the equipment is located beyond five floors of the roof and 50 feet of the south-facing wall is to be characterized as "moderate." A highly irregular building or one in which equipment is in scattered locations, most of which are more than five floors from the roof or 50 feet from the south-facing wall are "poor."

	WF
Favorable	1.0
Fair	.8
Moderate	.5
Poor	.2

d. Roof Characteristics (RIF:10)—

Refer to the description of the roof pitch, materials, structural members, and obstructions. Characterize the building as "favorable" if:

1) the roof is flat or pitched nearly to the South

2) the roof is built-up, shingled, or otherwise sufficiently durable to withstand mounting and maintaining solar collectors

3) the structural members are strong enough to support additional weight

4) roof area is free of obstructions

A "fair" rating would be given a building meeting the above conditions except that the roof pitch is only approximately in the direction of South *or* where there are roof obstructions. Describe a building as "moderate" if the roof pitch is only approximately toward the South *and* there are roof obstructions. A building which meets none of these conditions is characterized as "poor."

	WF
Favorable	1.0
Fair	.8
Moderate	.5
Poor	.2

e. Wall Characteristics (RIF:20)—

Determine the glass area of the South-facing walls as a percentage of the total and the construction material.

	WF
Over 75 percent glass, masonry	1.0
Over 75 percent aluminum or metal	.7
Over 75 percent wood or other	.6
25 percent - 75 percent masonry	.7
25 percent - 75 percent aluminum or metal	.6
25 percent - 75 percent wood or other	.4
Under 25 percent masonry	.5
Under 25 percent aluminum or metal	.3
Under 25 percent wood or other	.2

f. Wind Speed (RIF:30)—

Determine average monthly wind speed using data supplied by the State, obtained from the National Weather Service or local records. Note whether there are natural or man-made barriers in the direction of the prevailing winds.

	WF
Greater than 15 mph, no barriers	1.0
Between 10-15 mph, no barriers	.5
Greater than 15 mph, some obstructions	.7
Between 10-15 mph, some obstructions	.3
Less than 10 mph	.2

CALCULATION OF SOLAR AND RENEWABLE RESOURCES MEASURES POTENTIAL INDEX

	RIF	X	WF	= EVALUATION
A. INSOLATION AVAILABLE	30			
B. FUEL	20			
C. BUILDING CHARACTERISTICS	10			
D. ROOF CHARACTERISTICS	10			
E. WALL CHARACTERISTICS	20			
F. WIND SPEED	30			
SOLAR/RENEWABLE RESOURCES MEASURE POTENTIAL INDEX				

TRANSPARENCIES

V. ECONOMIC ANALYSIS AND PRIORITIZATION

TRANSPARENCY V. A. AND B.

USE A SERIES OF TRANSPARENCIES THAT BRIEFLY DESCRIBE FOR THE SESSION PARTICIPANTS HOW TO USE ENGINEERING ECONOMY TECHNIQUES FOR ANALYZING ALTERNATIVES FOR CONSERVING ENERGY.

ENGINEERING ECONOMY TECHNIQUES

POINTS TO BE COVERED

1. CASH FLOW DIAGRAMS
2. TERMINOLOGY
3. COMPOUNDING
4. DEPRECIATION
5. TAXES (BRIEFLY)
6. INFLATION

COSTS TO CONSIDER

CAPITAL - INITIAL OUTLAY

ANNUAL UPKEEP

MAINTENANCE CONTRACT

MAINTAINING YOURSELF

- TRAINING
- PARTS
- EQUIPMENT
- SPECIAL TOOLS
- LABOR (BURDENED)

SPARE PARTS

TECHNICAL MANUALS

DOWNTIME

COST OF SPACE

CHANGE IN INSURANCE RATES

INSTALLATION CHARGES

REBUILDING COSTS

CONTINGENCY FACTOR

ESCALATION

DESIGN & ENGINEERING

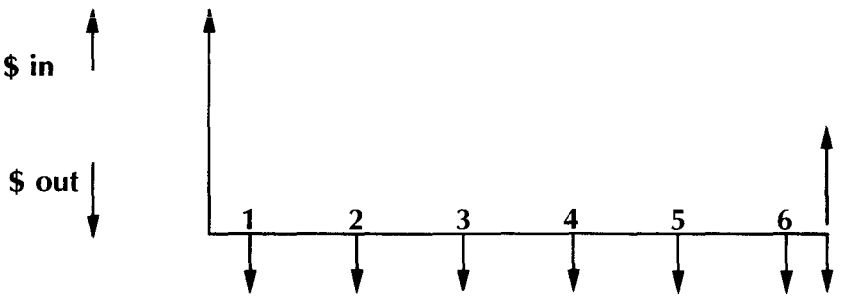
USE ENOUGH TRANSPARENCIES TO COVER THE BASIC MATERIAL PRESENTED IN THE FOLLOWING ENGINEERING ECONOMY MATERIAL; THE SESSION LEADER SHOULD PRESENT AND SOLVE THE EXAMPLES DURING THE SESSION, SOLICITING THE ASSISTANCE OF THE PARTICIPANTS (TO GET "TABLE LOOK UPS" AND "CALCULATED VALUES") TO INSURE UNDERSTANDING OF THE MATERIAL.

ENGINEERING ECONOMY

INTRODUCTION:

Cash Flow Diagrams
Terminology
Compounding
Depreciation
Taxes (briefly)

A. CASH FLOW DIAGRAMS



Shows amounts of cash flow and timing. $ are not to scale. A communication tool.

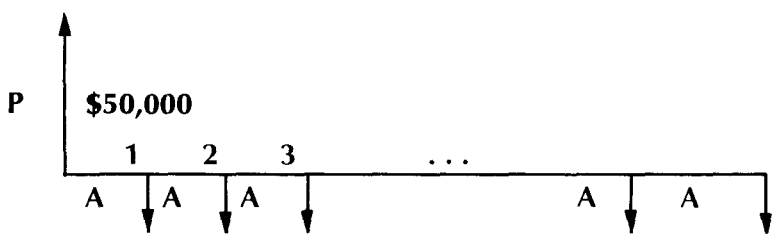
B. TERMINOLOGY

P - a present amount
A - an annual sum
I - interest rate per period
N - number of periods
F - a future amount

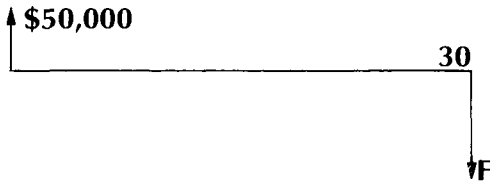
Example: House:

Pay now $50,000 - current value. Pay the bank in yearly installments for the next 30 years.

i - 10%.



Question - how much is A?



P = PRESENT VALUE OF INVESTMENT

C. COMPOUNDING AND USE OF TABLES

At end of year 1, $50,000 is worth $50,000 (1.10) = 55,000 at end of year 2

$55,000 (1 + .10) = 60,500

= 50,000 (1.10) (1.10)

= 50,000 $(1.10)^2$

end of year 3: 50,000 $(1.10)^3$

end of year 30: 50,000 $(1.10)^{30}$

$F = 50{,}000\ (1 + i)^n$

$= P(1 + i)^n$

$P = \dfrac{F}{(1+i)^n}$ $\qquad P = F \times P/F$

$P = F \times (P/F, i,n)$

$F = P \times (F/P, i,n)$

Here: $F = 50{,}000 \times (F/P, 10\%, 30)$

$= 50{,}000 \times 17.449$

$= 872{,}450$

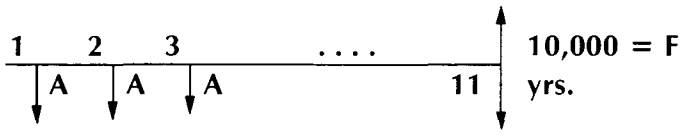
In the first problem,

P = 50,000, and A is unknown

$A = P \times (A/P, 10\%, 30)$

$= 50{,}000 \times .1061$

= $5305



i = 10%

Want A.

$$A = F(A/F, 10\%, 11)$$
$$= 10{,}000 \times .0540$$
$$= 540$$

Non-yearly compounding:

$1000, i = 20%, compounded semi-annually. Interest is computed twice each year.

$$\text{Interest + Capital} = 1000\left(1 + \frac{.20}{2}\right)^2$$
$$= 1000\,(1.10)^2$$
$$= 1000 \times (F/P, 10,2)$$
$$= 1000 \times 1.210$$

21% is effective interest rate
20% is nominal interest rate

D. DEPRECIATION

1. why use it - pay back capital.
2. methods

S = salvage value

Example: D-7 Cat:
Present cost $80,000
Salvage value in 5 years: $40,000.

Straight line:

Year	Depreciation	Book Value
1	8000	80000 − 8000 = 72,000
2	8000	72K − 8K = 64K
3	8000	64K − 8K = 56K
4	8K	48K
5	8K	40K

each year: $\frac{\text{cost} - \text{salvage}}{\text{no. years}} = \frac{80{,}000 - 40{,}000}{5}$

$$= 8000$$

SYD − Sum of Years Digits

$$\text{Year 1 depreciation rate} = \frac{5}{1+2+3+4+5} = \frac{1}{3}$$

Year 1 depreciation

$$= (80{,}000 - 40{,}000) \times \frac{1}{3} = \frac{40{,}000}{3} = 13K \quad \$Book = 67K$$

ENGINEERING ECONOMY
(CONT'D)

Year 2: $(80K - 40K) \times \frac{4}{15} = 10{,}666$

Book value = 56K

Year 3: $(80K - 40K) \times \frac{3}{15} = 8000$

Book value = 48K = 56K−8K etc. for year 4 and year 5.

Declining Balance: Suppose

rate $= \frac{200}{5} = 40\%$.

Depreciation = book value × .40, each year
Salvage is not included.
Year 1 depreciation = 80,000 × .40 = 32,000
Year 2 depreciation = (80K − 32K) × .40 = 19,200
= 48K × .40
Year 3 depreciation (48K − 19.2K) × .40 = $11,520
= 28.8K × .40
Year 4 depreciation (28.8K − 11.52K) × .40 = $6,910

ENGINEERING ECONOMY
(CONT'D)

EXAMPLE:

D-7 Cat:

Present cost $80,000
Salvage value in 5 years: $40,000

STRAIGHT LINE:

Year	Depreciation	Book Value
1	8000	80,000 − 8000 = 72,000
2	8000	72K−8K = 64K
3	8000	64K−8K = 56K
4	8K	48K
5	8K	40K

Each year: $\frac{\text{Cost} - \text{Salvage}}{\text{No. years}} = \frac{80{,}000 - 40{,}000}{5}$

$= 8000$

SYD − Sum of the Years Digits

Year 1 Depreciation rate $= \frac{5}{1+2+3+4+5} = \frac{1}{3}$

Year 1 Depreciation $= (80{,}000 - 40{,}000) \times \frac{1}{3} = \frac{40{,}000}{3} = 13K$

Year 2 $(80K - 40K) \times \frac{4}{15} = 10{,}666$ $ Book = 67K

Book value = 56K

Year 3 $(80K - 40K) \times \frac{3}{15} = 8000$

Book value = 48K = 56K − 8K

etc. for year 4 and year 5

DECLINING BALANCE: Suppose rate $= \frac{200}{5} = 50\%$.

Depreciation = book value × .40, each year.
Salvage is not included.

Year 1 Depreciation = 80,000 × .40 = 32,000
Year 2 Depreciation = (80K−32K) × .40 = 19,200
= 48K × .40
Year 3 Depreciation = (48K−19.2K) × .40 = $11,520
= 28.8K × .40
Year 4 Depreciation = (28.8K−11.52K) × .40 = $6,910

ENGINEERING ECONOMY
—EXAMPLES—

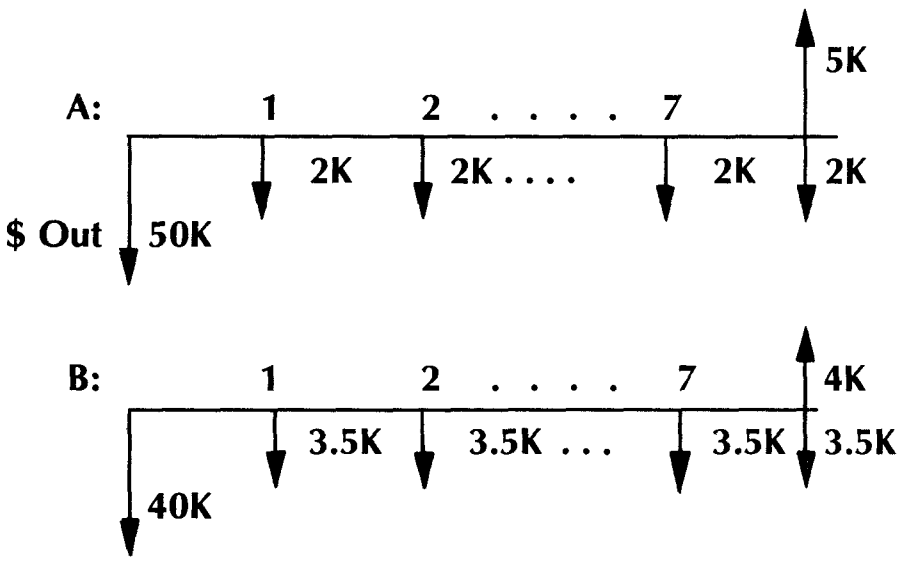
I. INTRODUCTION

A. Equal service lives
B. Unequal service lives
C. Computing RoR
D. Depreciation

A. EQUAL SERVICE LIVES EXAMPLE.

Alt A: First cost $50,000
Annual O&M 2,000
Salvage, i = 10%

Alt B: First cost $40,000
Annual O&M 3,500
Salvage 4,000



ENGINEERING ECONOMY
—EXAMPLES—
(CONT'D)

CHOOSE A BASIS FOR COMPARISON:

1. Present worth (equivalent PW) compare alternatives in terms of today's $.

2. Equivalent annual cost basis:

PW_A = Present Worth of A
= 50,000 + 2000 × (P/A, 10%, 8)
−5000 × (P/F, 10%, 8)
F
= 50,000 + 2000 × 5.3349 − 5000 × .4665
= 58,337.30

AC_A = Equivalent Annual Cost of A
= 50,000 × (A/P, 10%, 8)
−5000 × (A/F, 10%, 8)
= 50,000 × .1875 + 2000 − 5000 × .0375
= 10,937.50

PW_B = 40,000 + 3500 × (P/A, 10, 8) − 4000 × (P/F, 10%, 8)
= 40,000 + 3500 × 5.3349-4000 × .4665
= 56,806.15

AC_B = 40,000 × (A/P, 10, 8) + 3500 − 4000 × (A/F, 10, 8)
= 40,000 × .1875 + 3500 − 4000 × .0875
= 10,650 = PW_B × (A/P, 10, 8) = 56,806 × .1875

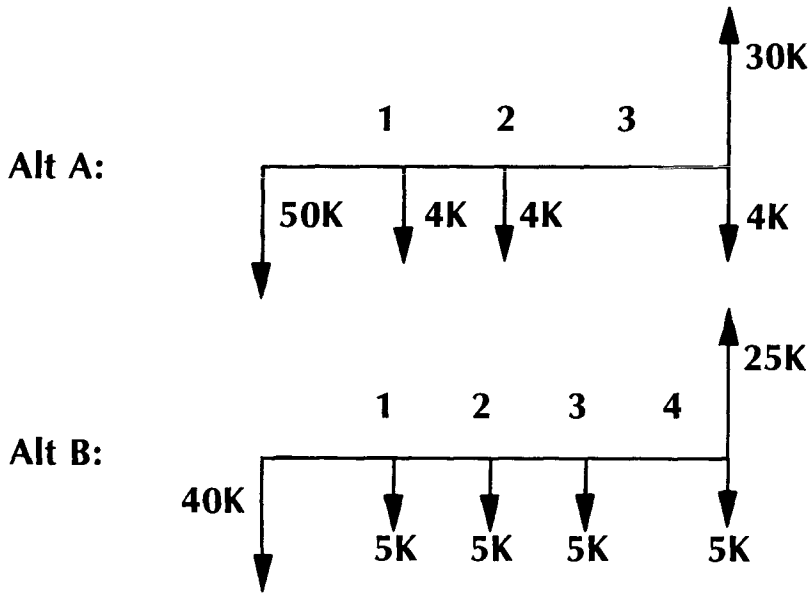
Either PW method of AC method works for equal service lives.

OTHER CONSIDERATIONS:

1. Taxes
2. Different capabilities and problems with the different machines
3. Cash availability

ENGINEERING ECONOMY
—EXAMPLES—
(CONT'D)

B. Unequal Service Lives



Methods: (10% interest)

1. Choose some multiple of both service lives, and compare using previous methods. (12 years).
2. Use annual cost comparison.

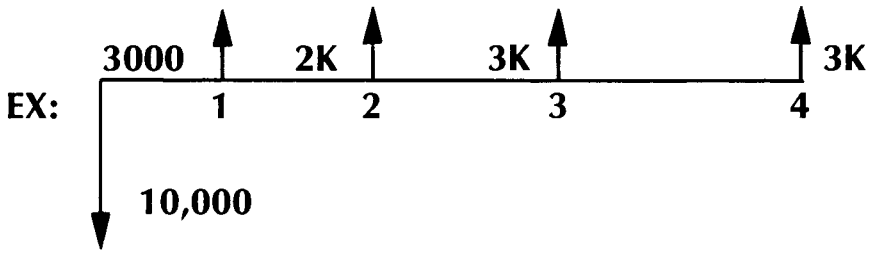
$$AC_A = 50{,}000 \times (A/P,10,3) + 4000 - 30{,}000 \times (A/F,10,3)$$

$$AC_A = 50{,}000 \times .4021 + 4000 - 30{,}000 \times .3021$$
$$= 15{,}042.$$

$$AC_B = 40{,}000 \times (A/P,10,4) + 5000 - 25{,}000 \times (A/F,10,4)$$
$$= 40{,}000 \times .3155 + 5000 - 25K \times .2155$$
$$= 12{,}232.50$$

C. Computing Rate of Return

Two situations: Before and after taxes used in estimating value of cost reduction projects and many others.



$10{,}000 = P \qquad 3K = A$

$$(P/A,i,4) = \frac{10{,}000}{3000} = 3.333$$

Problem: what is i?

$i = 10\% = (P/A,i,4) = 3.1699$

$i = 20\% \quad (P/A,i,4) = 2.5887$

$i = 5\% \quad (P/A,i,4) = 3.5460$

$$\frac{1 - 5\%}{10\% - 5\%} = \frac{3.333 - 3.5460}{3.1699 - 3.5460} = .566$$

$i = 5\% + 5 \times .566 = 7.83\%$

TRANSPARENCIES

VI. ACTION PLAN FOR AN ENERGY CONSERVATION PROGRAM

TRANSPARENCY VI. A.

USE A TRANSPARENCY TO SUMMARIZE THE IMPORTANCE OF "MONITORING" THE ENERGY CONSERVATION PROGRAM.

MONITORING
(THE ENERGY CONSERVATION PROGRAM)

WHY

1. KEEP UP MOTIVATION OF EMPLOYEES AND MANAGEMENT

2. KEEP TRACK OF PROGRESS TOWARD GOALS

3. FIND WHAT WORKS, AND COPY IT

4. FIND WHAT DOESN'T WORK, AND AVOID IT

HOW

1. SELECT MEANINGFUL MEASURES OF EFFECTIVENESS - - - EX:

   $/FT^2, BTU/SQ FT, BTU/TON,

   BTU/MANHOUR, BTU/(PROFIT DOLLAR)

2. DETERMINE EFFECTIVE MEANS OF DISPLAYING PROGRESS TO EMPLOYEES

3. KEEP PROGRAM UP TO DATE

TRANSPARENCY VI. B.

USE A TRANSPARENCY WHICH THE SESSION LEADER CAN LIST/SUMMARIZE, FROM THE PARTICIPANTS, TYPES OF PERSONS (IN THE CLIENT'S OFFICE) WHO SHOULD BE INVOLVED IN THE ENERGY CONSERVATION PROGRAM TO INSURE AN ON-GOING PROGRAM; SESSION LEADER SHOULD TIE THIS MATERIAL IN WITH THE DISCUSSION RELATED TO THE TRAINING SESSION AREA "RESPONSIBILITIES AND LIABILITIES OF THE CLIENT AND AUDITOR".

PERSONS RESPONSIBLE FOR INSURING AN ON-GOING ENERGY CONSERVATION PROGRAM

TRANSPARENCY VI. C.

USE A SERIES OF TRANSPARENCIES THAT PROVIDE A CHECKLIST (SUCH AS FROM AIR DISTRIBUTION ASSOCIATES, INC.) FOR PREVENTIVE MAINTENANCE; SESSION LEADER SHOULD PROVIDE A DETAILED DISCUSSION TO COMPLEMENT THE CHECKLISTS.