

**POLICY RECOMMENDATIONS FOR  
ESTABLISHING THE LoanSTAR  
MONITORING AND ANALYSIS PROGRAM**

Submitted to:

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Office of the Governor  
State of Texas

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#### **DISCLAIMER**

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## EXECUTIVE SUMMARY

The major objectives of the Monitoring and Analysis Program (MAP) should be to:

- Verify energy and dollar savings of the retrofits
- Reduce energy costs by identifying operational and maintenance improvements at facilities receiving retrofits
- Improve retrofit selection in future rounds of the LoanSTAR Program
- Provide a detailed data base of energy use in commercial/institutional buildings located in Texas

The Monitoring and Analysis Program should be conducted by:

- A Monitoring and Analysis Contractor (MAC)
- Data Acquisition Subcontractors (DAS)
- A Monitoring Advisory and Review Committee (MARC)

Monitoring and data analysis should be conducted at three primary levels:

- Facility/whole building(s) utility data
- Facility/whole building(s) short-term demand and consumption data
- Sub-metered retrofit data

Monitoring and Analysis Program cost is expected to be approximately:

- Three percent of retrofit cost for hardware purchase and installation
- Two percent of retrofit cost for first-year analysis and operator feedback to retrofit buildings
- 0.5-1.0 percent of the retrofit cost will be required for each subsequent year in which tracking and feedback services are provided to a building.

The cost of the Monitoring and Analysis Program should be included in the loans provided to the agencies since it provides an engineering service which will enhance retrofit savings.

Major tasks of the Monitoring and Analysis Contractor (MAC) should be to:

- Develop a Comprehensive Implementation Plan for the Monitoring and Analysis Program.
- Coordinate a workshop at which the Monitoring Advisory and Review Committee outlines modifications to the Comprehensive Implementation Plan to be implemented by the MAC.
- Specify data reporting format.

- Develop an approved list of monitoring equipment for use in the MAP and negotiate (with assistance of GEMC) quantity discounts for same.
- Qualify three to six firms as Data Acquisition Subcontractors and supervise their performance.
- Design and implement a system to archive data collected.
- Analyze data to determine savings realized by retrofits.
- Analyze data and examine facilities to determine whether further retrofits and/or operational savings are practical.
- Conduct training for facility operators to implement findings of MAC which will improve efficiency of building operation.

The Data Acquisition Subcontractors should:

- Assist the MAC in design of the instrumentation plan for each monitored site.
- Install the hardware and calibrate sensors.
- Provide data/guarantee data to MAC.
- Maintain hardware for the duration of the monitoring in each building.
- Periodically recalibrate sensors and report on hardware condition.

The Monitoring Advisory and Review Committee should:

- Provide input and expertise from national monitoring and analysis efforts to preclude costly MAP errors and needless duplication of effort.
- Participate in workshop to outline refinements and improvements to the Comprehensive Implementation Plan for the MAP.
- Meet at six- to twelve-month intervals to review progress of the Monitoring and Analysis Program, ensure that it fully integrates appropriate input from other monitoring projects, and recommend future directions of the program.

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## CHAPTER 1

### INTRODUCTION AND BACKGROUND

In 1988, the Governor's Energy Management Center (GEMC) of Texas received approval from the U.S. Department of Energy to establish a \$98.6 million statewide retrofit demonstration program, the LoanSTAR (Loan to Save Taxes and Resources) Program. The LoanSTAR Program is designed to demonstrate commercially available, energy efficient, retrofit technologies and techniques. The program will utilize a revolving loan financing mechanism to fund energy conserving retrofits in state agencies and institutions, public schools, and local governments. Retrofits are identified by engineering audits conducted according to the guidelines of the Texas State Energy Conservation Program (SECP). Each retrofit will compete for funds on the basis of the estimated payback period, ability to repay the loan through energy savings, engineering assessment of the viability of the retrofit, and the ability of the GEMC to monitor the project effectively. The projects will include the latest cost-effective energy saving technologies for commercial and institutional buildings.

The LoanSTAR Program will be implemented in three phases. Phase I includes state agencies and institutions that received energy audits conducted by engineering firms for the GEMC through the state of Texas Energy Cost Containment Program (TECCP). Capital intensive energy conserving improvements recommended by the auditors in TECCP are the retrofit projects targeted for funding in this phase. Loan recipients will repay the loan from energy savings projected from the retrofit projects.

Public schools and local governments are targeted for Phase II of LoanSTAR. Previous engineering audits of these facilities conducted under the Institutional Conservation Program (ICP) revealed potential energy savings similar to those in state buildings.

The projects funded by LoanSTAR will primarily include retrofits to lighting, HVAC systems, building shell, electric motors, energy management control systems (EMCS), boilers, and energy recovery systems. Other retrofits using alternative or renewable energy systems and load management will also be considered.

The LoanSTAR Program will establish a monitoring and analysis project to measure energy and cost savings at a large number of selected sites and increase the effectiveness and savings from the program. Because the

program is expected to eventually involve hundreds of retrofits (and monitoring installations) in buildings throughout the state, it is extremely important that a document be prepared that provides overall direction to the monitoring and analysis component of the LoanSTAR Program. Failure to do so could result in unnecessary metering and added program cost.

This report serves that purpose. It is intended primarily to guide policymakers in developing a comprehensive monitoring program that will serve the purposes of the GEMC, the institutions receiving the retrofits, building researchers, and others involved in the program. Chapter 2 describes the overall purpose of the monitoring and analysis program and the benefits expected by each of the major participants in the program. Chapter 3 discusses the organization of the program, which includes developing the metering specifications and establishing an advisory committee. Chapter 4 discusses the major monitoring and analysis tasks necessary for a successful program.

## CHAPTER 2

### OBJECTIVES OF THE MONITORING PROGRAM

The monitoring program is an innovative, but essential, feature of the LoanSTAR Program that will serve differing purposes to the many parties interested in its results. The **primary purposes** of the monitoring program will be to:

- 1) Verify energy and dollar savings of the retrofits
- 2) Reduce energy costs by identifying operational and maintenance improvements at facilities receiving retrofits
- 3) Improve retrofit selection in future rounds of the LoanSTAR Program
- 4) Provide a detailed data base of energy use in commercial\* buildings located in Texas

The money for each retrofit financed from the LoanSTAR Program must be repayed to the GEMC in accordance with the energy savings estimated during the energy audits of the building/facility. Thus, the first purpose of the monitoring program will be to determine whether the savings from the retrofit are as large as those estimated in the audits of the building/facility. To satisfy this purpose, a monitoring plan must be developed for each building/facility retrofit to provide adequate data to verify the savings from the retrofit. Verification of savings will include measurement of consumption data before and after the retrofit, and analysis of the data to account for weather, changes in operation of the building, etc. The verification is a quality assurance program to ensure that the program provides operating savings to the agencies purchasing retrofits.

The second objective of the program is to reduce the energy costs in a building/facility by monitoring its energy-using characteristics. Experience at the University of Colorado, Princeton University and the U.S. DOE demonstrates how monitoring helps identify specific energy use patterns of equipment (lights, HVAC, etc.) and changes in operation that can substantially reduce the energy use of a building. Monitoring specific equipment can provide a precise breakdown of how much energy is used for cooling, lighting,

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\* "Commercial" buildings as used in this document refers to any of the state-owned buildings, schools, or local government buildings participating in the LoanSTAR Program. No distinction is made between "institutional" buildings and other "commercial" buildings.



heating and other uses in a building. These data enable identification of retrofits that are not performing as expected and why, and "non-performers" can be dropped from future phases of the program. The data (with interpretation) from the monitoring will also be made available to the building operator to help identify ways to improve the daily operation of the facility. Data from monitoring can also show how changes in occupancy, weather, equipment, etc. have affected the energy use of a building/facility. It is expected that the savings realized from this activity will pay for the entire monitoring program.

The data and subsequent analysis will measure the cost effectiveness of a number of different types of retrofits in Texas buildings. Some retrofits will prove more effective and others less effective than expected. This knowledge will enable engineers who perform future audits to make more cost-effective recommendations. Hence the third objective is to increase the cost-effectiveness of future rounds of the LoanSTAR Program by reducing the number of relatively ineffective retrofits installed.

The final major objective of the program is establishment of a detailed, commercial building, end-use data base for buildings in Texas. Several large data collection programs in the U.S., including one at the Pacific Northwest Laboratory and another at the Lawrence Berkeley Laboratory, provide building scientists with data bases for analysis of how buildings use energy and development of better analytical tools for predicting energy use. None include a large number of buildings in hot and humid climates, and none have been established for evaluation of the effectiveness of retrofits. Thus, the data base for the LoanSTAR Program will be unique and provide building scientists with invaluable data for future analyses.

#### **CHAPTER POLICY RECOMMENDATIONS**

The major objectives of the Monitoring and Analysis Program should be to:

- 1) Verify energy and dollar savings of the retrofits
- 2) Reduce energy costs by identifying operational and maintenance improvements at facilities receiving retrofits
- 3) Improve retrofit selection in future rounds of the LoanSTAR Program
- 4) Provide a detailed data base of energy use in commercial buildings located in Texas

## CHAPTER 3

### ORGANIZATION

It is recommended that the Monitoring and Analysis Program (LoanSTAR MAP) be conducted by a Monitoring and Analysis Contractor (MAC), Data Acquisition Subcontractors (DAS) and a Monitoring Advisory and Review Committee (MARC) with other subcontractors as needed. The MAC will oversee monitoring, design the data base and write software, conduct analyses, interface with building operators, and conduct educational programs for building operators. It is recommended that this contractor develop a comprehensive plan for achieving the objectives described in Chapter 2 in conjunction with the Governor's Energy Management Center and the MARC. The Monitoring Advisory and Review Committee will also provide ongoing contact with other monitoring and analysis efforts to ensure incorporation of applicable techniques and results from those monitoring and analysis efforts. The Data Acquisition Subcontractors will install and maintain the monitoring equipment under the supervision of the MAC. Other subcontracts will be let to supplement the expertise of the MAC as appropriate.

#### **Monitoring and Analysis Contractor (MAC)**

The Monitoring and Analysis Contractor should be responsible for carrying out the overall monitoring and analysis program. Major duties will include:

- Prepare a draft plan for the metering and analysis needed to achieve program objectives.
- Select and supervise performance of Data Acquisition Subcontractors.
- Prepare a list of approved hardware (after testing for compatibility) and update periodically.
- Design and implement a system to archive data collected.
- Analyze data to determine savings realized by retrofits.
- Report results to the GEMC and building owners.
- Analyze data and examine facilities to determine whether further retrofits and/or operational savings are practical.

- Conduct training for facility operators to implement operational procedures identified which will improve efficiency of building operation.

#### **Data Acquisition Subcontractors (DAS)**

Data Acquisition Subcontractors will be required to install and maintain the data acquisition equipment in the buildings monitored. The DAS will prepare the metering installation plan for each monitored building, with the cooperation of and subject to approval of the MAC (and the agency); select hardware from the approved list; and install the system. The DAS will also calibrate the system (including periodic recalibration) and provide maintenance as necessary to ensure that at least 90 percent of the data collected is usable while the building is being monitored as part of the LoanSTAR Program. Calibration procedures must be approved by the MAC.

#### **Monitoring Advisory and Review Committee (MARC)**

The Monitoring Advisory and Review Committee should be composed of representatives from 6-8 organizations with experience in monitoring and analyzing data from buildings. The MARC will meet initially to develop recommendations for the Comprehensive Monitoring and Analysis Plan, using the draft plan developed by the MAC as a "straw-man" document. It will meet thereafter at six- to twelve-month intervals to review progress of the program, ensure that the monitoring and analysis fully integrates appropriate input from other monitoring projects, and recommend future directions of the program. Members of the MARC will come from organizations such as national laboratories, universities, and Federal agencies.

#### **Levels of Monitoring**

The monitoring program is intended to verify the savings obtained, ensure that retrofits operate properly, and identify additional measures reducing energy costs. Sufficient data must be collected to achieve these objectives, but monitoring and analysis expense must not undermine the cost-effectiveness of the LoanSTAR Program.

Evidence from Princeton and elsewhere shows the cost effectiveness of sub-metering large buildings with major retrofits. Savings to be achieved in smaller buildings, however, will not generally justify the expense of sub-metering. Such buildings will have whole-building energy consumption analyzed--sometimes with monthly data and sometimes with 15-minute or hourly demand data.

The levels of monitoring and analysis recommended can be grouped in three categories:

1) *Facility/whole building(s) utility data:* These data will vary from monthly consumption data, based on utility bills, to weekly or daily data collected by utility meters. It is useful for separating consumption into heating, cooling, water heating, and other non-weather related consumption. This facilitates comparison of these end-uses with those of similar buildings and separation of buildings into categories such as high, average and low use. The PRISM program developed at Princeton is the most sophisticated program available for analyzing monthly or daily whole-building data. Weekly or daily data from whole building meters at the University of Colorado, the U.S. Department of Energy, and elsewhere have helped identify additional end-use values and operational improvements. Analysis of this type is particularly appropriate for smaller buildings where the expense of separate monitoring equipment cannot be justified. A substantial portion of retrofits in the schools and local governments are expected to fall within this category.

2) *Whole-building short-term demand data:* An increasing number of utilities are using meters which record 15-minute demand data for medium-sized buildings. Ongoing work at Texas A&M, Princeton, and LBL shows that use of 15-minute data permits a much more detailed analysis of end-use patterns and identification of major individual operating parameters within buildings; for example, whether lights or air conditioners are being turned off as scheduled. This is a viable option for buildings of intermediate size. Portable meters will sometimes be used to collect such data for a one- to two-month period.

3) *Sub-metered data:* This level of monitoring has all the capabilities of the first two levels and also enables more detailed analysis for identifying the savings associated with specific retrofits and pin-pointing operational problems. Sub-metered data acquisition systems range from simple two- to six-channel "stick-on" systems to the larger 15+ channel systems. Sub-metering in some of the smaller all-electric buildings can be done with the smaller systems to obtain a maximum of data at minimum cost. The 15+ channel systems are expected to be cost-effective in the larger buildings and some of the groups of smaller buildings with more expensive retrofits (costing more than \$500,000 in aggregate). These larger buildings constitute about half of the expenditures expected in Phase I of the LoanSTAR Program. The 15+ channel systems will also be required in selected smaller installations (such as schools and local government buildings) to "calibrate" the simpler levels of monitoring for different building types in Texas. Portable

systems will be used for one- to two-month periods in some of these buildings as well.

### **Determining Levels of Monitoring**

Retrofits that cost more than \$200,000 will typically be submetered, with the number of channels varying with the size and complexity of the building and retrofit. (Typical systems cost \$1,000 per channel.) Demand meters should be utilized in installations where the retrofit cost is above \$50,000 with utility meters used for smaller installations.

Another group of buildings for which submetering is recommended are selected smaller buildings that are individually typical of a larger group of buildings such as common school buildings and municipal office buildings. Selected buildings need to be monitored to clearly indicate the meaning of characteristics identified in daily, weekly, and monthly utility meter readings.

A general guideline for hardware cost consistent with the monitoring levels indicated above would provide 3% of the retrofit cost for monitoring hardware and installation. The analysis component of the Monitoring and Analysis Program is expected to have an additional first year cost of approximately two percent of the retrofit cost for typical buildings. It will be larger when applied to large buildings with minimal retrofits. This covers the cost of learning a building and its characteristics well enough to model the building and compare measured performance of retrofits with expected performance. Once installed and calibrated, the ongoing performance tracking, analysis and feedback to building operators for a particular building is expected to be 0.5-1.0 percent of the retrofit cost (or energy cost, if the retrofit is small) on an annual basis.

**It is recommended that the cost of the metering installation and the analysis be included in the loan amount that must be repaid by the agency since the MAP is expected to contribute to more efficient operation and lower energy bills.**

Experience at several sites in different parts of the country shows a thorough metering and analysis program will save five to fifteen percent of the total energy cost of buildings. Once the MAP demonstrates similar savings in LoanSTAR Program buildings, a comprehensive metering and analysis program should be considered for all state-owned buildings in Texas. Savings of \$10,000,000 to \$25,000,000 per year would be expected from a fully-implemented program of this type.

## CHAPTER POLICY RECOMMENDATIONS

1. The Monitoring and Analysis Program (LoanSTAR MAP) should be conducted by
  - A Monitoring and Analysis Contractor (MAC)
  - Data Acquisition Subcontractors (DAS)
  - A Monitoring Advisory and Review Committee (MARC)
2. Monitoring and data analysis should be conducted at three levels:
  - Facility/whole building(s) utility data
  - Facility/whole building(s) short-term demand data
  - Sub-metered data
3. Program cost should be approximately:
  - Three percent of retrofit cost for hardware purchase and installation
  - Two percent of retrofit cost for first-year analysis and operator feedback to retrofit buildings
  - 0.5-1.0 percent of the retrofit cost will be required for each subsequent year that tracking and feedback services are provided to a building

These costs should be included in the initial loan given to the agencies.

## CHAPTER 4

### MAJOR MONITORING AND ANALYSIS PROGRAM TASKS

The Monitoring and Analysis Program (MAP) requires a large number of tasks and subtasks to achieve the program objectives outlined in Chapter 2. This chapter delineates the following major tasks:

- 1) Develop comprehensive draft plan for the MAP
- 2) Conduct MARC workshop to refine MAP Plan
- 3) Install data monitoring systems
- 4) Acquire and archive data
- 5) Analyze data
- 6) Report findings

The role of each major group within the MAP organization in performing these tasks is also defined. The chapter is organized to follow the project time line, but recognizes significant time overlap in these tasks.

#### **Develop a Comprehensive Draft Plan for Implementing the Monitoring and Analysis Program**

A comprehensive implementation plan for the MAP should be drafted by the MAC to provide the detail necessary to implement the plan outlined in this "Policy Recommendations" document. The draft can then be used by the GEMC and the MARC as the basis for a two- or three-day workshop to refine the implementation plan. This plan should be designed to achieve the program objectives cost-effectively.

The plan should emphasize program specifications and guidelines that need to be determined before the program is implemented. The plan should specify the following items:

- Approach to experimental design
- Data acquisition hardware and software
- Field data monitoring points
- Data products including data collection interval and monitoring duration
- Data analysis procedures
- Verification and quality control procedures
- Format for archiving data

The plan will also describe mechanisms to communicate program findings to agencies that own buildings and their building operators, utilities, engineers, building scientists, and other interested parties.

### **Conduct MARC Workshop to Refine MAP Plan**

The first meeting of the Monitoring Advisory and Review Committee should be held within two months of program startup to modify and refine the preliminary draft of the Comprehensive Monitoring and Analysis Plan. This mechanism will enable the MAC to utilize the experience of the other major monitoring programs to minimize mistakes and duplication of effort. Most of these programs required two to five years from inception until significant data was acquired. Initial retrofits in the LoanSTAR Program are planned for late 1989, so the MAP must be implemented quickly.

The two- to three-day workshop should be structured to use the draft plan as a starting point--not as a definitive statement of how the program will be conducted. The workshop should produce a refined and detailed outline of changes needed in the plan, to be implemented by the MAC immediately following the workshop.

### **Install Data Monitoring Systems**

Installing the data monitoring systems requires three distinct steps: (1) selecting the hardware and subcontractors; (2) developing metering and analysis plans for each site; and (3) purchasing, installing, calibrating and testing the equipment.

### *Selection of Data Acquisition Subcontractors*

For long-term, reliable operation of the monitoring equipment, it is important that quality equipment be purchased and that it be installed by professionals in installation of such equipment in commercial and institutional buildings. Thus an important task of the of MAC will be developing the criteria for selecting the hardware and the data acquisition subcontractors (DASs) who will install and maintain the monitoring equipment.

The MAC should develop a list of monitoring equipment that is appropriate for each level of monitoring discussed. Equipment should be tested to ensure compatibility with data transmission protocols and any other equipment with which it must interface before being listed. This list should serve as the approved list of hardware for any application. The MAC should seek quantity discounts from the hardware vendors through an open contract, placement on the state contract list, or other suitable procedure, which could reduce the hardware cost 10 to 25% over normal retail prices.



The MAC should qualify three to six engineering firms as DASS who can install and maintain the monitoring equipment at each site. The qualifying of the DASS should be through a competitive bidding process. Once a DAS list is approved by the MAC and GEMC, it should be sent to each agency applying for a loan. The GEMC should require the agency to use only firms from this list for installation of equipment. In upgrading the technology base in Texas, it would be desirable to encourage out-of-state bidders to establish a working relationship with a Texas firm while some in-state firms may find it advantageous work with out-of-state firms experienced at installation of building monitoring systems. Another criteria for selection of firms is geographical distribution. When monitoring installation work is allocated to firms, it could then be done geographically; for example, a firm operating out of San Antonio could be assigned agencies in that part of the state. This action will reduce travel costs and enable quick response if a monitoring system has problems.

#### *Develop Site Metering and Analysis Plan (SMAP)*

As a loan is approved by the GEMC, it will be necessary for the MAC to conduct a preliminary survey to determine information such as building(s) description, utility billing data, existing metering on EMS system, type of retrofit, estimated savings, local climatological data, and photographic record. Some of this information will come from the audit report and loan application. With these data, the MAC should develop a Conceptual Monitoring Plan (CMP) with an initial estimate on the level of metering required for the facility, noting quantities to be submetered.

The MAC should then contract with a DAS to conduct a one- to two-day site visit to develop a Preliminary Site Monitoring and Analysis Plan (PSMAP) analogous to the Preliminary On-Site Screening Report (POSSR) of the audit program. The PSMAP should include options for hardware to be installed, its locations, data it will provide and its format, as well as estimates of the hardware and installation costs to provide the energy data specified by the MAC.

This PSMAP should then be used by the MAC to develop a Site Monitoring and Analysis Plan (SMAP) that contains the final recommendations for the type of monitoring system installed, locations, etc. Agency concurrence on the SMAP is important to ensure that the proposed installation does not interfere with an existing system and is installed in an accessible and safe location. The agency's concurrence is also important because the money for the monitoring system is being paid by the agency out of its retrofit loan.

### *Purchase, Installation and Maintenance of Monitoring Equipment*

Once a SMAP is approved, the monitoring equipment for that site can be purchased and installed. The subcontract to the DAS from the agency should include hardware purchase, installation, calibration, and maintenance. The MAC should oversee the installation, verifying that the equipment works to specifications and that the data being collected is in the proper format and passes a specified battery of data quality control tests.

Following installation and initial calibration and checkout of equipment at an installation, the DAS should provide periodic inspection, recalibration and verification of data accuracy according to a prescribed schedule. Continuing maintenance of the equipment must be provided in a timely manner to assure that usable data is delivered to the MAC at least 90 percent of the time.

### **Acquire and Archive Data**

One of the objectives of this program is to provide a data base on energy use for commercial buildings in Texas. This database will be an important resource to the state and to the nation. Because of the potential large number of users of the data, it must be formatted to be accessed by other building databases such as Lawrence Berkeley Laboratory's BECA database or Pacific Northwest Laboratory's ELCAP database. Software must be written that can arrange the data in a transfer format. Specific must be written that can arrange the data in a transfer format. Specific uses of the data (outside of the retrofit program) envisioned include:

- 1) Periodic preparation of detailed end-use energy characteristics of state-owned buildings in Texas
- 2) Estimation of retrofit conservation potentials in commercial buildings in Texas
- 3) Comparison of energy use indices of buildings in Texas with those in other parts of the country

Some of the users of the data from this program will be the GEMC, electric utilities, the Texas Public Utility Commission, national laboratories, energy auditors, and building scientists.

## Analyze Data

Data analyses will be performed in several phases for each monitored site. These include:

- Data verification
- Pre-retrofit analysis
- Preliminary post-retrofit analysis
- Detailed analyses

### *Data Verification*

Data verification is performed immediately after the monitoring equipment is installed. The data will be compared with past utility data, auditor estimates of consumption and any other information available to verify that the data acquisition system and sensors are providing reasonable values. This is followed by independent checks of most sensor outputs using portable instrumentation. Such checks must be performed periodically for data quality assurance.

### *Pre-retrofit Analysis*

Pre-retrofit analysis utilizes data collected from the building before retrofit measures are installed to determine existing conditions (e.g. indoor temperatures), the energy use patterns of the building and the influence of weather, occupancy, etc. on energy use. These data will be compared with audit data, and building operators will be interviewed when possible to obtain building operating procedures. These data will be analyzed to determine whether the submetering installed can accurately measure the response of the building and particular end-uses to the planned retrofits. In some cases, the analysis might indicate the need for changes in the monitoring systems installed.

### *Preliminary Post-Retrofit Analysis*

Preliminary post-retrofit analysis is conducted to determine whether the retrofit measures are performing as planned. If retrofit measures do not perform to design expectations, analysis (sometimes in conjunction with site visits) will determine whether there is an installation error or an incorrect audit estimate of savings. Installation errors can be corrected to increase the savings from the retrofit. Such cases may necessitate development of a procedure to resolve conflicts between retrofit contractors and the MAC/DAS. This analysis will also compare the energy use characteristics of the building with pre-retrofit values to estimate the retrofit energy and dollar savings. These

preliminary estimates will be the first indication of how well the retrofit is performing.

#### *Detailed Analyses*

Detailed analyses will be included in the final reports provided to the GEMC and the agencies. Methods for determining retrofit savings are undergoing considerable improvement. Most techniques used for estimating retrofit savings are not sophisticated. The preliminary estimates will be based on the best analysis procedures available, but this project is expected to develop improved analysis procedures to be described in the final reports. This analysis will also identify the savings attributable to specific retrofit measures when practical. This information will go to the GEMC to improve the measures selected for future loans. All three phases of analysis following verification will seek to identify cost-effective operational improvements.

#### **Report Findings**

The findings from this program will be reported in three ways:

- Regular written summaries
- Technology transfer workshops
- Feedback (written and oral) to building owners and operators

#### *Regular Written Summaries*

Regular summaries from this program should take several forms. For the GEMC and the agency involved, both of which are interested in monitoring the success of a retrofit, the summaries should be as frequent as four times a year. These summaries will include details of energy use and dollar savings by end-use (if monitored). Additional reports will be required for buildings/facilities which perform below expectations. There should also be an annual report that summarizes major advances in analysis techniques, data acquisition methods, etc. produced by the program. This might incorporate the fourth summary report.

#### *Technology Transfer Workshops*

As the data from this program are analyzed and new techniques developed for estimating retrofit energy savings, the MAC should organize workshops to transfer this technology to engineering auditing firms, building operators, etc. The first of these workshops will probably

be during the second year of the MAP. Some of these workshops could be incorporated into the annual building symposium that the GEMC currently sponsors.

#### *Feedback to Building Owners and Operators*

The MAP will differ from all large scale monitoring programs conducted to date by its emphasis on interaction with the building operators to better understand operating practices and provide subsequent suggestions for improving operating practices. The evaluation of current operating practices will be based on an examination of whole building and submetered consumption data as well as discussions with building operators. Experience shows an interactive process to be most effective: some features of the operation are obvious from the consumption data, but others require observation of the data and discussion with building operators.

An initial meeting with the building operators will show some of the preliminary data collected, familiarize them with system capabilities, and solicit their input on specific items to look for in the data. It will emphasize that operators and MAC personnel will both benefit from the process. The program is intended to make them look better as operating personnel and enable them to learn more about their building(s). Subsequent meetings will be held when analysis shows a need for operator input or leads to recommendations for operational changes. Written recommendations will be sent to the agency.

#### **CHAPTER POLICY RECOMMENDATIONS**

1. A Comprehensive Draft Plan for the Monitoring and Analysis Program should be developed by the Monitoring and Analysis Contractor.
2. A workshop should be held at which the Monitoring Advisory and Review Committee outlines modifications to the Comprehensive Draft Plan.
3. The MAC should develop an approved list of monitoring equipment for use in the MAP and negotiate (with assistance of GEMC) quantity discounts for same.
4. The MAC should qualify three to six firms as Data Acquisition Subcontractors.
5. The MAC should provide feedback to building owners and operators and conduct technology transfer workshops.