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Coordinating Preventive Maintenance With ENERGY MANAGEMENT

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Energy Task Force
of the Urban Consortium
for Technology Initiatives

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CITY OF CLEVELAND
George V. Voinovich, Mayor
George L. Forbes, Council President

Energy Office
Department of Parks, Recreation, and Properties

PREFACE

The Urban Consortium for Technology Initiatives was formed to pursue technological solutions to pressing urban problems. The Urban Consortium conducts its work program under the guidance of Task Forces structured according to the functions and concerns of local governments. The Energy Task Force, with a membership of municipal managers and technical professionals from nineteen Consortium jurisdictions, has sponsored over ninety energy management and technology projects in thirty-two Consortium member jurisdictions since 1978.

To develop in-house energy expertise, individual projects sponsored by the Task Force are managed and conducted by the staff of participating city and county governments. Projects with similar subjects are organized into "units" of four to five projects each, with each unit managed by a selected Task Force member. A description of the units and projects included in the Fifth Year (1983-1984) Energy Task Force Program follows:

UNIT -- MUNICIPAL OPERATIONS

Energy used to support public facilities and services by the nation's local governments in 1983 totaled approximately 1.4 quadrillion BTU's. By focusing on applied research to improve energy efficiency in municipal operations, the Energy Task Force helps reduce operating costs without increasing tax burdens on residents and commercial establishments. This Fifth Year unit consisted of five projects:

- Albuquerque, New Mexico - "Analysis of Municipal Bus Operations for the Advancement of Fuel Cell Technology"
- Baltimore, Maryland - "The Hydrate Process for Sewage Sludge Dewatering: Commercialization Assessment"
- Memphis, Tennessee - "Application of Mini-van Technology to Van Pool Services"
- Phoenix, Arizona - "Capacity Optimization of Hydronic Flows: Energy Savings in HVAC Systems"
- Washington, DC - "Facilities Energy Monitoring System: Application in a Large Municipal Government"

UNIT -- MUNICIPAL AND COMMUNITY ENERGY MANAGEMENT

Of the nation's estimated population of 232 million, approximately 60 percent reside or work in urbanized areas. The 543 cities and counties that contain populations greater than 100,000 consumed a total of 49 quadrillion BTU's in 1983. Applied research sponsored by the Energy Task Force helps improve the economic vitality of this urban community by aiding energy efficiency and reducing energy costs for public services and the community as a whole. This Fifth Year unit consisted of five projects:

- Boston, Massachusetts - "Computer-based Preventive Maintenance"
- Cleveland, Ohio - "Coordinating Preventive Maintenance with Energy Management"
- Columbus, Ohio - "Budgetary Incentives for Municipal Energy Management"

- Denver, Colorado - "Municipal Recycling Programs: Potential for Waste Management and Energy Savings"

- Philadelphia, Pennsylvania - "Energy Assistance Program Information System (EAPIS): Coordinating Residential Assistance Programs"

UNIT -- ALTERNATE/INTEGRATED SYSTEMS

Effective use of advanced energy technology and integrated energy systems in urban areas could save from 4 to 8 quadrillion BTU's during the next two decades. Urban governments can aid the realization of these savings and improve capabilities for the use of alternative energy resources by serving as test beds for the practical application of new and integrated technologies. This Fifth Year unit consisted of five projects:

- Chicago, Illinois - "Implementation Methods for an Integrated Energy System"

- Houston, Texas - "Pricing, Regulation and Competition in Cogeneration: A Method for Comprehensive Risk Analysis"

- New York, New York - "Feasibility of Water-based District Heating and Cooling"

- San Antonio, Texas - "Central Energy Systems Application to Economic Development"

- San Francisco, California - "On-site Cogeneration for Office Buildings"

UNIT -- PUBLIC/PRIVATE FINACING AND IMPLEMENTATION

City and county governments often have difficulty in carrying out otherwise sound energy efficiency or alternative energy projects due to constraints in the acquisition of initial investment capital. Many of these investment constraints can be overcome by providing means for private sector participation in innovative financing and financial management strategies. This Fifth Year unit consisted of five projects:

- Hennepin County, Minnesota - "Shared Savings in the Residential Market: Financing Single Family Energy Conservation"

- Kansas City, Missouri - "Street Light Inventory and Maintenance System"

- Pittsburgh, Pennsylvania - "Shared Savings for Energy Conservation: A Model Process for Local Governmets"

- Saint Louis, Missouri - "A Development Strategy for Superinsulated Housing"

- San Diego County, California - "Innovative Financing for a Privately Owned Waste-to-Energy Facility"

Reports from each of these projects are specifically designed to aid the transfer of proven experience to other local governments. Readers interested in obtaining any of these reports or further information about the Energy Task Force and the Urban Consortium should contact:

Energy Program
Public Technology, Inc.
1301 Pennsylvania Avenue, NW
Washington, DC 20004

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This project was undertaken by the City of Cleveland's Energy Office. Mary R. Niebling, Energy Planning Coordinator in the Energy Office, designed and developed all aspects of this project of coordinating preventive maintenance with energy management. Leonard Reitz, Energy Office Director, served as Project Director.

Without the assistance of Gene Keaveny, Manager of Preventive Maintenance, the daily operation of the city's PM program would not have occurred. Gene's technical skills complemented the efforts of the Energy Office in ensuring the project's success. Joe Hudak and Ed Looby provided the necessary support and cooperation of the Division of Maintenance; Mr. Looby is Commissioner of the division. In addition, cooperation was attributable to W. Laurence Bicking, Director of the Department of Parks, Recreation, and Properties, of which both the Division of Maintenance and the Energy Office are components.

The Cleveland chapter of the Building Owners and Managers Association (BOMA) provided significant direction in the design of a preventive maintenance program. Jack Kafer, Executive Vice President, directed BOMA's volunteer effort.

Dale Scott and Jon Mikolay of the City of Cleveland's Data Center assisted in the completion of this project by consulting on the design of the computer files in the preventive maintenance data system.

Mary Niebling is the author of this report. Leonard Reitz provided useful editorial advice and managed its final production. This report also could not have been completed without the assistance of Ceasar Moss and Mathile Saad of the PRP Department's Division of Administrative Services.

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ABSTRACT

A comprehensive preventive maintenance program is an essential ingredient in any energy management program for municipal buildings. In fact, as stated in Building Operating Management, "Preventive maintenance offers one of the highest rates of return for any energy management project." Ongoing maintenance of heating, ventilating, and air conditioning (HVAC) and lighting systems and equipment saves not only on energy/operating costs in the short run, but also on capital expenses for system and equipment replacement in the long run.

The City of Cleveland's project, Energy Planning and Management: Developing In-house Capabilities, for the Urban Consortium's Energy Task Force third year (1982) program identified the lack of adequate preventive maintenance as a problem area "which has resulted in both major deterioration of its (Cleveland's) physical plant and skyrocketing energy usage and costs". This lack of preventive maintenance has been a chronic problem which has stemmed from a lack of sufficient numbers of maintenance personnel; underutilization of existing personnel; inadequate up-to-date training of personnel; non-existing preventive

maintenance guidelines and schedules; and an inadequately organized division of work tasks.

During this past year, Cleveland's Energy Office, working with the city's Division of Maintenance, has investigated ways of solving these problems--particularly in the areas of personnel training and the adoption of preventive maintenance guidelines and schedules. This tack was followed to encourage the city's adoption of a substantially improved maintenance program with a preventive focus. A logical extension of Cleveland's energy management efforts to date, this year's project has

- o Improved coordination between the building maintenance function and the energy management function;
- o Developed a training program for those chiefly responsible for preventive maintenance;
- o Generated preventive maintenance guidelines and schedules for a selected group of city facilities;
- o Ensured the continuation of energy efficiency and cost/usage reductions resulting from improvements financed by the city's Energy Office and capital improvements program.

This project has led the way toward developing a coordinated program involving both preventive maintenance and energy management. Not only have energy usage reductions been stabilized as a result of this effort, but the city has also begun to benefit from the heightened expertise of its maintenance personnel and a more efficient use of their skills.

In the larger arena, this project has also served as a pilot for proving the case for preventive maintenance. Currently, management is considering the expansion of the program to city facilities beyond the initially selected group of recreation centers. These activities represent one of the first steps in a city-wide move toward an effective and comprehensive property management program for municipal facilities.

PROJECT PURPOSE

The purpose of this project was to develop on a pilot basis the tools and techniques necessary for the implementation of a preventive maintenance program for city facilities. In order to accomplish this, a coordinated effort had to be undertaken with the city's energy management and building maintenance programs.

Many cities have begun to recognize the value of preventive maintenance to the long term viability of their capital plants. The City of Cleveland came to this realization largely through the efforts of its energy management program. The city's Energy Office discovered that, generally, installed energy conservation improvements had not been realizing their anticipated reductions. This occurred largely because HVAC equipment and systems were not receiving adequate, regularly scheduled maintenance. In fact, in most cases the only maintenance received was accomplished on an emergency repair basis. This inadequate attention, as many cities have discovered, results in widely

fluctuating and generally high energy use; much too frequent replacement of equipment which needlessly burdens capital budgets; and buildings and equipment which are operationally out of control.

By developing the tools and techniques to initiate a preventive maintenance program for city facilities on a pilot basis, this project has demonstrated the viability and potential energy and dollar savings of a preventive maintenance program. This new knowledge will be instrumental in the expansion of the pilot program to all city facilities and in the eventual reorganization of the city's maintenance function.

The maintenance related problems in Cleveland are similar to those experienced by other local governments. Similarly, the tools developed in this project are transferable to other jurisdictions looking for ways to gain additional control over their facilities while stabilizing energy usage reductions. As Cleveland determined through its project, this is best done by coordinating energy management with preventive maintenance.

REPORT ORGANIZATION

This report presents Cleveland's experiences in developing and implementing, on a pilot basis, an energy-focused preventive maintenance program for its buildings. The effort was carried out with close coordination between the city's Energy Office and Division of Maintenance because of the common interest recognized to exist for both entities in the

successful development of the program. The following chapters present the substance of the effort.

CHAPTER 2 highlights how Cleveland's Energy Office and others in the city government came to the realization that preventive maintenance was an issue which needed to be addressed.

CHAPTER 3 defines preventive maintenance and identifies the elements necessary to the successful development and implementation of a preventive maintenance program.

CHAPTER 4 discusses how these necessary elements were developed in Cleveland and how successfully and completely they were applied during the project. The city's future plans with regard to preventive maintenance and energy management are also discussed as outcomes of the project.

CHAPTER 5 outlines the lessons learned through the project and provides a guide for other local governments considering the need for a preventive maintenance program to complement their energy management effort.

Readers desiring additional copies of this report or more information about the project will find a listing of report and information sources on the final page of this publication.

CHAPTER 2:

Energy Management and Maintenance in Cleveland

INTRODUCTION

This chapter outlines the past course of Cleveland's energy management effort and details how the Energy Office and others in the city realized that an extensive preventive maintenance (PM) program was sorely needed for city buildings. The affected parties in this effort are introduced as is the concept of property management, into which preventive maintenance should fit as a coordinated effort between energy management and building maintenance.

Following this historical background, Chapter 3 defines preventive maintenance and identifies the elements which are essential to the successful application of a PM program. This identification is done first on a generic basis, then used with more specificity in Chapter 4 to discuss the results of Cleveland's project.

ENERGY MANAGEMENT TO DATE

When Cleveland's Energy Office was officially formed in October, 1981, as a part of the Mayor's Office, it was as the result of a number of efforts which had identified energy management as an important issue to city government and its operations.

Two public-private cooperative efforts, developed during Mayor George V. Voinovich's first term, had indicated areas in which the city could become more efficient. The first of these efforts, the Operations Improvement Task Force--a group of volunteers representing the Cleveland business community--analyzed city operations and management. The result of the Operations Improvement Task Force's analysis was a report detailing a series of recommended actions for each department. Many of these recommendations related to energy use and, therefore, aided in the establishment of the city's energy planning and management effort.

As the second effort, in the spring of 1981, the local chapter of a private sector organization--the Building Owners and Managers Association (BOMA)--volunteered to conduct energy audits of a representative sample of city buildings. BOMA's findings indicated that potential energy savings in the range of 25 to 40 percent could be achieved and clearly showed that the city's energy expenditures were well above where they should be. Additionally, BOMA's findings showed that these expenditures would increase rapidly if an aggressive conservation program was not implemented immediately.

Thus, the Energy Office was born with two major thrusts: (1) an energy planning and management effort; and (2) an energy auditing and improvement effort. These two efforts, initially administered under separate management sections, have been, nonetheless, interdependent from the start. The energy planning and management section has

defined the extent of Cleveland's energy expenditures, developed energy data resources, designed auditing strategies, determined strategies for financing improvements, monitored the effectiveness of the installed improvements, and carried out liaison work with city departments. The auditing section has, of course, conducted energy audits of city facilities, made recommendations for energy efficiency improvements, overseen the installation of these improvements, and conducted periodic inspections to monitor the performance of the improvements.

Administrative Involvement

The Energy Office has, throughout its three year history, discovered that many components of city government indirectly affect the city's overall use of energy. The Energy Office has sought to reduce energy use through its involvement in these areas and through increasing the city administration's awareness of the implications of energy use throughout city operations. Areas of involvement have included components of management services such as energy accounting, budget information development and dissemination, energy usage monitoring, space utilization, design reviews, building operations and maintenance, and employee awareness.

Before the Energy Office came into being, the city had paid little attention to its operations and expenditures from an energy perspective. Today, while there is much yet to be done, the city's use of energy is recognized as a significant issue affecting its operations. Thus, while the

Energy Office also audits, finances, and installs energy savings improvements; it advises on the full range of local government activities from an energy perspective. These types of changes are, of course, difficult if not impossible to quantify in terms of dollar and energy savings.

Throughout the Energy Office's history it has gone through a number of administrative changes. Originally a special project and part of the Mayor's Office, in mid 1983 the Energy Office came under the authority of the Director of the Department of Parks, Recreation, and Properties (PRP) as part of this line department. Currently, as part of the department's long range plan of building property management capabilities within PRP for all General Fund supported city facilities, the Energy Office is attached to the department's Division of Administrative Services.

Financing Energy Improvements

The audits done by the local chapter of the Building Owners and Managers Association had indicated that energy savings were readily available within city facilities. Yet, one of the major shortcomings identified during the Energy Office's first year planning effort was the lack of capital dollars available to finance the energy improvements necessary to realize these savings. The city had been out of the bond market since 1977 and had been "cash short" resulting in a "freeze" on what previous bond funds remained unexpended.

The city's overall capital improvement program, needless to say, had been sparsely funded for several years, with many capital projects deferred because of these

financial problems. As the city began to recover its financial health, it was unlikely that newly recommended energy projects, no matter how cost-effective they were, would be financed in great quantity. Too many other priority projects were ahead in line.

Early in 1981, however, Cleveland voters passed an increase in the city income tax on the condition that a percentage of the revenue raised would be set aside for capital improvements and the repayment of past debts. The city reestablished its capital improvements program out of this "restricted income tax", a step in a deserving direction, but a step of very limited scope.

Recognizing the problems the Energy Office faced in finding capital available for energy improvements projects, Mayor Voinovich instructed the Office of Budget and Management (OBM) to reserve $100,000 out of this "restricted income tax" to create a fund to finance energy improvements. The fund was designed to revolve through an internal shared savings arrangement and provided the seed monies for the office to start making energy improvements of relatively low cost and quick payback. The fund attracted additional financial support from the Standard Oil Company of Ohio through a grant of $180,000 made in July, 1982. These monies formed the initial pool for Cleveland's innovative Energy Savings Payback Fund (ESPF).

The development and application of the ESPF was extensive and involved many parties within city government. This developmental process and its results were detailed in Cleveland's 1983 project report, The Energy Savings Payback

Fund (ESPF): A Municipally Financed Shared Savings Program. It is sufficient for this discussion to say that the fund was designed to create energy savings and to use such savings to repay the costs of the improvements (lent out of the fund) which generated them; thereafter a year's savings were shared equally between the fund and the division operating the building in which the improvements were made. This arrangement has allowed the fund not only to recover the costs of improvements but also to increase in size over time.

Indeed, during the fund's first full year of operation in 1983, over $150,000 was invested in energy savings improvements. The Energy Office was able to negotiate the return of $102,765 into the ESPF during that same year. From this same set of initial improvements another $85,000 was due back during the first half of 1984.

All told, the city has realized an annual energy cost avoidance of over a quarter million dollars since 1982 as a result of the Energy Office's auditing and improvement program. This cost avoidance translates into annual energy savings of over 37 billion BTU's (British Thermal Units). In keeping with its growing program, the office has proposed for the 1985 capital improvements program almost one million dollars worth of energy savings projects in city facilities, with over $300,000 projected in additional annual savings.

Learning a Lesson

The ESPF has helped to solve the problem of financing energy improvements in city facilities, but the experience also

taught another lesson. This lesson was that energy savings improvements could not just be installed and then be expected to yield continuing results. Due to both the nature of the improvements themselves and the paucity of clear energy savings during the fund's first operating year, it became apparent that much more was needed to obtain the desired results. The city needed a more comprehensive energy management program.

Many of the energy audits of city facilities had indicated that before any major energy savings improvements could be made, the first efforts had to be in correcting the effects of years of deferred maintenance. Boiler and HVAC systems controls were often inoperable; thermostats needed calibration; steam traps needed replacement; boilers needed to be acid cleaned; and filters had not been replaced for some time. All of these types of conservation measures had to be accomplished before more sophisticated measures could be installed. The Energy Office accordingly concentrated on those types of improvements which were related more to maintenance than to energy conservation per se. This became the city's first recognition of the relationship between energy management and maintenance.

But given the past history of building maintenance in Cleveland, how could anyone expect that the same situation would not eventually reoccur? And, in fact, after many of the Energy Office's improvements were installed, the anticipated energy reductions were not as clearly defined as expected. Upon follow-up visits, the Energy Office auditor determined that while energy improvements were installed

correctly, other maintenance related items remained uncorrected. It became readily apparent that something needed to be done with the maintenance of city facilities if the expected energy savings were to result and continue.

Upon numerous discussions it seemed that the best way to handle this problem was to provide better coordination between the building maintenance and energy management functions. The purviews of both maintenance and energy management were so closely aligned, yet, it was obvious under current operations that the Division of Maintenance could neither respond adequately to the multitude of its own tasks nor handle the energy related items emanating from the Energy Office.

BUILDING MAINTENANCE

Corrective maintenance and the general upkeep of building structures and equipment in all General Fund- supported departments in Cleveland are the responsibility of the Division of Maintenance. This division of the Department of Parks, Recreation, and Properties consists of a labor pool of skilled craftspeople such as carpenters, pipefitters, electricians, and plumbers. This labor pool performs all maintenance activities and some minor renovation jobs in city facilities. Very little of such work is contracted out; most is done in-house.

Since the mid-1970's the city charter has required (and been affirmed by the courts) that skilled craftspeople be paid the "prevailing wage" of their trade. This requirement

raised the cost of maintaining city facilities dramatically. Coupled with the division of work tasks required by trade unions, this high cost of maintenance has made the division and its trades personnel particularly susceptible to layoffs when operating budget deficits were experienced in the early 1980's. In fact, between 1980 and 1984 the division had its workforce cut in half due to layoffs. The workforce was reduced from over one hundred in 1980 to barely 50 in 1984. This factor plus the continued deterioration of facilities and the lack of new capital improvements caused a backlog of a year and a half's work orders to accumulate. Obviously, something had to be done to remedy the situation and bring city facilities back to safe, efficient operating condition.

The Operations Improvement Task Force, mentioned previously, also took a hard look at the problems experienced by the Division of Maintenance. The Task Force determined through its evaluation that it was impossible to analyze the operational efficiency and technical performance of the division because of a lack of an adequate information reporting system; most work requests were transmitted verbally, and adequate records of work performed and the time and materials it took to perform the work were not kept. It was agreed, however, that equipment and manpower utilization were well below private industry standards.

The Task Force recommended six avenues for the division to pursue in order to better allocate its resources and attack its backlog. Four of the six recommendations are germane to this project: first, implementing a maintenance planning, scheduling, and control system; second, requiring

user departments to budget and pay for all maintenance services; third, upgrading the managerial and technical skills of maintenance personnel; and fourth, implementing a preventive maintenance program.

In addressing each of these recommendations, the Task Force recognized that the first recommendation had to be accomplished prior to any of the others. Without a system in which to evaluate work requests, emergency repairs (clearly more expensive than preventive or corrective maintenance) would continue to be the rule rather than the exception. Additionally, without such a system it would be impossible to determine the division's cost of providing maintenance services and, therefore, the city would be unable to indicate the rationale for continuing to offer these services. The establishment of a PM program also demanded a scheduling and management control system and will, in turn, necessitate a determination of the cost of providing maintenance services.

The Task Force saw a preventive maintenance program as having the following benefits:

- o Improved utilization of city owned facilities
- o Improved services to the public
- o Substantial avoidance of repair and reconstruction costs
- o Improved public safety
- o Reduced energy costs.

The program would generate, according to the Task Force, annual savings to the city of about $500,000 based on industry experiences.

These experiences and recommendations led the city to recognize the need for preventive maintenance in its municipal facilities. The energy auditor--a building stationary engineer--was transferred from the Energy Office to the Division of Maintenance in late 1983 and was put in charge of all the building stationary engineers and boiler room operators working out of the division and instructed to start a preventive maintenance program. Preventive maintenance became in many people's eyes the solution to many of the city's problems. When it became apparent that the operating budget would not balance by the end of 1983, these positions were not affected at layoffs although the crafts positions in the division were cut substantially. Again in February, 1984 when an income tax increase was defeated by the voters, these positions were not affected although other crafts in the division were reduced. It appeared that the newly formed preventive maintenance team had been protected.

With the need for preventive maintenance well established but with its operations still not well designed, the Energy Office submitted a grant proposal to the Urban Consortium's Energy Task Force with the specific objective of coordinating preventive maintenance and energy management. Previous efforts had set the stage for combining the technical skills of the Maintenance Division with the planning and management capabilities of the Energy Office. The support from the Energy Task Force allowed very effective work toward this combination of skills.

The project's workplan used a standard "program development" outline for tackling the design of a preventive maintenance program in Cleveland. The six major tasks are outlined below and expanded in the fourth chapter to show how the project developed in Cleveland and to describe the city's future plans to implement and further apply the program.

Identify and Research Problem Areas

This task was felt to be necessary in first grounding the concept of preventive maintenance in Cleveland city government and looking at and learning from what other research and programs had been developed elsewhere--both in other cities and in private industry. Additionally, this task was needed to begin the process of identifying common interests between maintenance and energy management and in building support for new preventive approaches to maintenance of the city's facilities.

Selection of Target Facilities and Equipment

Even though all General Fund supported city facilities needed service through a comprehensive PM program, the substance of the program needed development on a targeted basis. Facilities and equipment were selected on the basis of criteria which were central to the interest of both the Division of Maintenance and the Energy Office.

Systems Development

Practice and research indicates that an effective PM program is crucially dependent upon the development of a system based on an inventory of the equipment to be maintained and on the schedules and guidelines to maintain said equipment. PM is a highly precise practice based on the specific assignment and routine treatment of a number of tasks. Because the number and volume of tasks are usually greater than the capacity of a human mind to remember, systems of task assignment and monitoring needed to be developed.

Training

The Task Force had identified training of maintenance personnel as a recommended action. The Energy Office also realized that training was needed to bring the preventive maintenance team's skills in line with the tasks they needed to perform. Additionally, training was seen as a way to re-orient the team's skills and focus towards the necessity and application of a PM program. Community resources were researched to identify where training opportunities could be found.

Monitoring the Program's Effectiveness

The project also had to look at the tools needed to monitor the program's effectiveness. Energy usage reductions were expected as well as a decrease in the number of emergency repairs, among other changes. While some of these changes could be expected to occur within the short term, others could only be expected in the long term. In either case, the

project looked toward institutionalizing these monitoring devices for long term proof of the program's effectiveness.

Results and Expansion of the PM Program

Since the initial project focus was on a limited scale, the results of the test were important in seeking the expansion of the program to other departments and finally to all General Fund supported city facilities. Additionally, the results and the application process were important in outlining and justifying PM for transfer to other local governments.

SUMMARY: MOVING TOWARDS PROPERTY MANAGEMENT

Property Management

Property management has been referred to several times already in this report as an objective sought by the City of Cleveland. While rather amorphous, this concept was used quite frequently by the Operations Improvement Task Force. Property management was used to signify the collection of all functions related to the management of city properties, both improved and unimproved, under one authority.

Over the years, these management fuctions (such as leasing, planning, space utilization, design and development, operations, budgeting for improvements, maintenance, and general information resources) had become decentralized among various operating divisions. Since these divisions were primarily and politically responsible for delivering of services rather than caring for their

property, facilities had deteriorated through neglect and a lack of expertise and resources. Efforts to correct this situation on a decentralized basis had yielded sporadic and inadequate results.

The concept of bringing these functions together under one authority became one of the objectives of the city's reorganization effort. The city administration felt that a centralized structure could more efficiently and cost effectively deliver property management services. By reorganizing in this manner, operating divisions such as police and fire could concentrate more thoroughly on providing charter-mandated services to the public.

The Department of Parks, Recreation, and Properties was seen as the department which would eventually house the property management functions. But before the department could be expected to coordinate this effort, it needed to strengthen its own capabilities (such as maintenance services). Evidence was needed to show that the department had the capability to offer effective services before other city divisions would be willing to relinquish control over their property.

In several respects, the preventive maintenance program became a building block in this effort. By building preventive maintenance capabilities, maintenance services would improve considerably. In addition, since the energy management and building maintenance functions were both considered integral to a comprehensive property management program, efforts to coordinate their activities and build

alliances were viewed by the administration as well directed.

Moving On

This chapter has shown how the Energy Office and the Division of Maintenance independently came to the conclusion that preventive maintenance was a necessary direction for both to pursue in coordinated fashion.

Before outlining further how Cleveland has begun to apply the concept of preventive maintenance to its own operations as a result of this project, a step needs to be taken in defining PM and outlining the components necessary for its successful application. This is done in the next chapter. This discussion is presented first in the generic and then in the specific to aid other local governments in setting up their own preventive maintenance programs and then benefitting from the results.

CHAPTER 3:
What is Preventive Maintenance ?

INTRODUCTION

From the research done in connection with this project, it seems that preventive maintenance (PM) is a practice which has been reemphasized during the last few years. Deterioration in many local government buildings through a lack of systematic upkeep has prompted a new look at how local governments maintain their buildings. Many cities have come to this awareness through their energy management activities. Energy management may represent the first time that a city has looked at building operations and performance from an efficiency standpoint. From this perspective, the lack of systematic maintenance often appears as as glaring deficiency.

Like improved energy management activities, improved maintenance operations require investments of time and money to design and implement a well functioning program. In time, however, a well designed and operated maintenance program, with a preventive maintenance program as its centerpiece, will save dollars, energy, and staff time. Also, like energy management efforts, a preventive maintenance program must be designed so as to demonstrate cost effectiveness. Of particular importance is the need to plan the program

carefully because by its very nature preventive maintenance demands precision and specificity.

Preventive maintenance, therefore, is defined in this chapter and distinguished from other types of maintenance. Also discussed are the components which must be considered in the planning and application of a PM program. This information is presented as guide for other local governments to follow in considering and implementing an improved PM program.

WHAT IS PREVENTIVE MAINTENANCE?

John W. Criswell in his book, Planned Maintenance for Productivity and Energy Conservation, defines preventive maintenance as "minor work done on a regular schedule to prevent trouble or deterioration to facilities or equipment. This includes such work as monitoring, recording indicator readings or settings, changing filters, draining condensate, minor lubrication, adjustments, and the like."

A number of key words and phrases in this quote lead to the distinction between preventive maintenance and other types of maintenance and repair. Following a discussion of these phrases, the other maintenance types will be mentioned briefly and distinguished as a review.

Preventive maintenance concerns itself with minor work. The examples of tasks in the last part of the quote are "minor" items, ones that can be accomplished quickly and routinely. These tasks take a predictable amount of time and, therefore, can be easily and tightly scheduled. The key

to preventive maintenance is to go from one piece of equipment to another quickly; to notice whether anything is not working correctly; to make minor adjustments and perform set tasks; and to report anything major or abnormal to a central clearinghouse. Further decisions concerning needed repairs and their priority are made and then the work is scheduled by this central clearinghouse. PM staff persons are then not only the performers of minor tasks but also as, Criswell calls them, the "eyes and ears" of the entire maintenance organization.

Preventive maintenance is done on a regular schedule. PM tasks are ones which need to be accomplished at set intervals, and, thus, fit neatly into a schedule. Scheduling intervals can range from days to years. Since most schedules are determined on an annual basis, work otherwise defined as PM which needs to be done less frequently than annually can still be done through a PM program; scheduling would have to be accomplished some other way.

In some instances, a regular schedule might override the previously specified PM attribute, that of minor work. For example, a major piece of equipment such as a steam boiler needs a variety of PM tasks performed anywhere from daily to annually. In this example, the annual preventive maintenance task might be considerably larger than " minor work" such as opening the boiler and punching the tubes in the autumn before the heating season begins. Since this task should be accomplished on a regular schedule (once a year), it is justified as part of the PM program.

The objective of PM tasks is to prevent trouble or deterioration to facilties and equipment. While all maintenance is preventive in nature in the long run, the definition of PM should take into consideration those tasks which are relatively inexpensive to accomplish initially and those which prevent major expenditures of labor and equipment and loss of service later on.

Other types of maintenance activities can be characterized as emergency repairs and follow-up maintenance. Criswell defines emergency repairs as "work done on a facility or on equipment that involves personnel safety, material loss or deterioration, or operational delay of equipment. This is unplanned work requiring an immediate response." Follow-up maintenance would be items which are less than emergency in nature or those tasks which can be scheduled but demand a greater expenditure of effort, materials, and labor.

Preventive maintenance is the first or basic stage of any maintenance program. Without it maintenance becomes mostly emergency in nature and, as a result, more expensive. Changing the focus of a program from deferral to prevention and from sole reliance on emergency repairs will not, however, mean that the need for emergency repairs will totally vanish. Such a change will mean that the incidence of emergency repairs will become much less frequent and that most maintenance activities can be anticipated.

This change will mean that the program will become more cost effective. Additional benefits will include a longer life expectancy for buildings and equipment, greater

efficiency of operation, savings in energy, and the increased reliability and service of facilities and equipment.

HOW IS PREVENTIVE MAINTENANCE ACCOMPLISHED?

Introduction

It is not by intentional action that maintenance programs have found themselves facing emergency repairs on a daily basis and an overwhelming backlog overall. Such outcomes tend to result from conditions which have built up over time. A focus on preventive maintenance demands strong management and a clear-cut system of priorities. Either maintenance programs have had neither of these attributes or political realities have stepped in and undermined the program. Whatever the reason, when PM has not been in place, conditions eventually deteriorate to such an extent that it becomes nearly impossible to catch up with all the corrective actions and emergency repairs which must be done. In fact, emergency repairs become, in many cases, the norm rather than the exception. Finally, maintenance management reaches the point where decisions such as which emergency is more of an emergency become commonplace.

Cities have also reached this point due to two other factors. First, over the last two decades local governments have come to rely on federal dollars to construct or renovate facilities. While these monies were indeed sorely needed, many local governments did not have the foresight or

wherewithal to make similar dollar commitments for operation and maintenance of these additional facilities. As a result, many local governments have had monies to build or renovate facilities (maybe even to the excess of what the population needed) and have chosen to do so because new construction and renovation were politically expedient. Then, when the choice came to allocate scarce local operating dollars between program operations and building and equipment maintenance, again maintenance lost out. After all, maintenance could always be put off until another day, could it not?

The reliance on emergency repairs and the growth of a backlog also came about in local governments because their management decisions were often made with inadequate emphasis on objective, systematic decision criteria. Preventive maintenance, as mentioned above, demands a logical system in assigning priorities to work tasks. So too ought a maintenance program in general rely on a priority system based on projecting the "cost" or outcome of deferral. When decisions about work priorities, assignment to personnel, and supervision are not made under this guideline, the program begins to deteriorate and lose ground. It then becomes a cycle which is more and more difficult to break as time continues.

How then does a local government break this cycle of an increasing number of emergency repairs and backlog? The first step, of course, is a recognition of the problem and a commitment on the part of management which is felt throughout the administrative structure that a new direction

will be taken. Next, a series of well thought out and practiced procedures must be put into operation. As the new program with its revised focus gains in coverage, sufficient changes will be noted which will begin to reverse the tide. These procedures and steps are discussed below and should be considered integral to any PM program.

Management Backing

A new program has the best chance for success when it has the visible support from those in top management positions. This is particularly true with regard to a preventive maintenance program which can be substantial departure from the existing situation and which demands at the outset a substantial commitment of time, money, and enthusiasm. This top management backing can be measured in the amount of resources--money, budget allocations, personnel, equipment, parts, and so on--which are made available to the program.

Not only must the management commitment exist at the upper level, but this commitment and the rationale for changing the focus of maintenance activities must be felt and understood throughout the organization. Maintenance personnel who will be performing the tasks must be convinced of the importance of their newly assigned duties. Additionally, program operations people working in the buildings affected must be aware of the new attitude with respect to maintenance and repair. By notifying employees about the program, they are alerted not only to its importance but also to those steps necessary to assure their cooperation with the new focus of PM.

Upper management, however, must set the tone and signify by its actions the importance attached to the new program. Commitment to the program is necessary not only in ensuring cooperation from a programmatic perspective but also in negotiating for a redirection of materials and budgets to support the program. As will be seen below, the program will need support from various sections of the administrative structure starting with the Budget Office and including the Purchasing Department.

Definition of Responsibilities

With the institution of the PM program, program planners must make the distinction between PM and the other types of maintenance to assign the proper place for the PM activities within the maintenance structure. Personnel assigned to the new program must be assigned only to PM and understand their job and responsibilities. The structure under which PM will operate must also be made apparent. A centralized structure for the program will usually yield the best results given the need to have specific, assigned tasks. PM is a controlled type of program without much leeway from the assigned tasks. Thus, of particular importance to the success and structure of a PM program is a supervisor or manager responsible for seeing that the PM tasks are accomplished as assigned. Also, the PM manager must ensure that priority is given to follow-up repairs specified as a result of the PM program.

In that connection, management must assign priority to those repairs which come out of the PM program. Those who

visit the buildings on a regular basis must be recognized for their contribution by having these repairs followed through with concrete, corrective action.

Equipment Inventory

One of the first steps in the establishment of a PM program is an inventory of the involved buildings and equipment. An inventory is an essential step for several reasons. First, the actual exercise of gathering the information makes the collectors more aware of what and where buildings are, what is in the buildings, where the equipment is located, and what its condition is. Upon completion, the inventory can be used to identify and order parts more quickly, to outline a plan for standardizing equipment, to schedule maintenance and replacement, and to help plan capital improvement programs.

The inventory must include information such as the following and should be developed on stardard forms to make data collection easier:

- o Building name and address
- o Name of equipment and an identifying code
- o Equipment location within the building
- o Equipment specifications such as manufacturer, model and serial number; horsepower, etc. of motors; filter and belt sizes; and oil weight.

While those involved in the program need to come to some common understanding of the range of information to be collected and included in the inventory, information should be limited to what is absolutely essential to the

performance of the PM tasks and what the program's capabilities are for keeping track of and updating the inventory. As guides, many of the PM programs listed in the Reference section of this report have samples of inventory forms used.

Initially, the inventory of equipment can be kept in a manual form. But, given the number of facilities operated and maintained by large local governments, it will probably be necessary eventually to automate the inventory. As more facilities are involved, the amount of information to be collected and manipulated quickly becomes very cumbersome.

Several private companies offer equipment inventorying software packages in connection with their larger preventive maintenance task scheduling systems. Several local governments also have developed systems ranging from the fairly simple to the complex. Again, the Reference section provides sources in this area.

The last stage of a building inventory should be identification. During this stage the inventory is reviewed in the building and all the equipment is tagged or labeled with an identifying number or term. From then on this identifier should be used to pinpoint the piece of equipment.

Equipment standardization. As mentioned above, one of the main issues in the equipment inventory will probably be that the city purchases too many different brands and types of equipment for basically similar purposes. This situation results in the need to stock a wide variety of PM

related materials and replacement parts and makes routine replacement unnecessarily complicated.

Additionally, the equipment inventory might uncover the fact that current equipment and parts suppliers do not have local offices. While on the surface this may not appear a significant issue, in the middle of an emergency breakdown having to wait weeks for repair parts might be disastrous. While the frequency of this problem can be avoided partially by scheduling replacement before failure and by ordering parts in advance, working with the city's purchasing division to standardize equipment purchases and to specify equipment with local suppliers should be a consideration in any PM program.

PM Scheduling

John Criswell defines scheduling in his book as "the means of bringing together all the known information and causing work to be done in an orderly manner to assure that all items receive the maintenance necessary for continued reliable operation." Task scheduling is an important part of a PM program because PM tasks, by their very nature, are so repetitive. Preventive maintenance tasks can cover a wide variety of equipment and systems. While preventive maintenance programs commonly concentrate on boilers and heating, ventilating, and air conditioning (HVAC) equipment and systems, other items included might be lighting systems and roofs. Basically, scheduling is done where any task which needs to be performed on a routine basis is involved in the PM program.

The equipment inventory provides a starting place for scheduling PM tasks. Manufacturers' specifications and common practice will have to be considered in connection with each type (and brand) of equipment when selecting when and what items of preventive maintenance are to be done. Evanston, Illinois' PM program relied on the following to determine scheduling intervals and the range of work: "Intervals were developed mostly from employee experience. Some newer equipment had manufacturer fact sheets attached and information was taken from them. Equipment that had a high rate of emergency repair was put at frequent intervals." Evanston's PM work "consists of lubrication, filter replacement, realignment if necessary, proper operation, fluid inspection, amperage readings if a motor is running hot, refrigerant pressure, cleaning and adjusting belts, clean and adjust burners, and similar operations."

PM work schedules will then have to be formulated according to available personnel; geographical distribution of work sites (so that unnecessary time is not spent on travel between facilities); and the availability of parts, materials, and equipment.

As with the equipment inventory, a start toward scheduling can probably be done on a manual basis. But as the scope of tasks grows and the number of facilities increases, it will most likely become too difficult to keep track of all the tasks, facilities, and personnel manually.

Task scheduling is usually included in most PM software packages. These programs easily can recall all tasks which need to be done in a certain period of time and flag work

which is not completed on schedule. They can also issue work orders and keep track of work performed. Again, these packages can be developed to meet a local government's specific needs or obtained as standard packages from private vendors.

Personnel

At the core of the preventive maintenance program are the personnel who will carry out the PM tasks on a daily basis. But what types of skills or specialities should these employees have?

Much of the answer to this question depends on the resources of the organization responsible for PM. PM necessitates at the field level that staff persons be generalists and how quite a bit about many different trade areas so that they can recognize potential problems, assess what needs to be done, and then notify the department about follow-up work. These employees must understand the basics of how the equipment operates and should have at least a preliminary idea of problem troubleshooting. These employees should be backed up with tradespeople who are specialists in particular crafts and who can also perform more extensive repairs which are noticed through the PM program.

Because many maintenance organizations have evolved distinct trade specialities over the years, this redirection of staff may be rather difficult to address. Negotiations with trade unions may be necessary to define workable and beneficial divisions of responsibility.

Supervision

An essential component of any practical, goal-oriented program is supervision. As stated earlier, the routine nature of PM tasks requires that a PM program be centrally managed and operated. For this reason the manager must assign workers first on the basis of tasks to be done rather than by building or building location. In this manner, individuals are responsible for the completion of a specific set of tasks rather than the whole of a building's HVAC system. This arrangement has the added bonus on having a number of inherent checks. The first check, of course, is the PM manager or supervisor spot checking work. The second level of checks will have the different crews visiting each building to perform their own tasks and catching and reporting on problems before they multiply. Other checks in the program, such as the scheduling system itself and the achievement of reduced energy usage, will ensure the program's successful operation.

Personnel Training

Program planners need to assess the current skill levels of personnel presently involved in the program against the requirements of the preventive maintenance tasks and the inventory of building equipment. After completing this skills inventory it will be possible to assess the training necessary to bring current staff up to the level required for a comprehensive PM program.

Chances are that the PM staff will not be sufficiently well acquainted with all the different types of equipment

and tasks required in the program. They will need, therefore, some type of supplementary training. At the very minimum, staff will need to be reoriented to the importance of preventive maintenance and how it is expected to work. Beyond that, staff will need to become familiar with the types of problems which they might encounter on their checks of equipment and systems and know how to proceed. They should also be aware of many different types of equipment and systems in the city's buildings so as to be able to specify and initiate work orders for more extensive corrective action.

Upon a determination of the range of training necessary, program planners should work with staff on what types of incentives might be needed to assure their participation in training. Additionally, resources already available in the community should be sought out and used. Resources might include local suppliers and distributors of commonly used materials and equipment or a local vocational school. Some states also have sponsored training workshops for personnel in connection with the Institutional Conservation Program available for schools and hospitals. These resources might be tapped to train a local government's PM staff.

Materials, Parts, Equipment, and Charges for Services

A preventive maintenance program must have an adequate supply of materials, parts, and equipment available to carry out its responsibilities. Without these supplies, the PM

staff will be unable to accomplish its tasks and work will not be followed-up.

Initially, given the number and range of tasks included in the program, estimates of the amount of supplies needed will have to be made. The equipment inventory will help to identify the types of needed filters, belts, lubricants, and other supplies. After a year's experience in the program, more precise supply numbers and amounts should be available.

The experience gained through the program should also be used to approximate how much it costs to provide preventive maintenance services on a measurable basis. In order to arrive at these costs, records of the amount of service provided, the cost of materials, equipment, and parts, and the labor time committed will have to be kept. Maintenance programs have frequently failed because benefitting departments have not had to pay for the provided maintenence services. Cost records will provide the first basis for charging for maintenance services. These charges will also serve to ensure that maintenance personnel are no longer laid off because there was no evidence to justify their retention and to demonstrate the worth of their contribution to the operation of city facilities.

Of all the local government programs examined in connection with this project, Oakland, California appears to have the most advanced system of charging for maintenance services. For further information, consult the sources shown in the References section at the end of this report.

Effectiveness Monitoring

PM can reduce operating and capital costs and alter the type of maintenance work required. By utilizing the information sources mentioned below, these reductions and alterations can be specified and the case made for continued, adequate budgetary support for PM.

The first source of information necessary to monitor is the number and type of work orders generated by the maintenance organization. The number of emergency repairs and the backlog of work orders should decrease as a result of the preventive maintenance program. By examining the volume and type of work orders, this aspect of the program's effectiveness can be monitored.

An energy usage information and monitoring system can be used to monitor energy use in the buildings involved in the program. As discussed earlier, preventive maintenance and energy efficiency bear a direct relationship to each other. Thus, an energy information system can be used to monitor this aspect of the program's effectiveness. Additionally, this information system can be used to pinpoint maintenance trouble spots (shown through higher than anticipated energy use) and as a check on the implementation of the program. Costs avoided can be derived from the energy savings and can be used, once again, to prove the existing need and benefits of the program.

Additional resources should be used to monitor the effectiveness of the program. Records such as dates when equipment was installed and the frequency of replacement will give an idea of how the PM program has increased

equipment reliability and extended service life. Also of use will be other less technical data. Building occupants should be able to see their comfort levels increased through the more consistent operation of their building environment. Discussion with these employees will give another indication of the benefits of the program.

SUMMARY

This chapter has considered and outlined the steps and tools needed to set up a preventive maintenance program for city buildings. These steps and tools were identified to provide a guide to other local governments for instituting their own preventive maintenance programs. The barriers which have created the deterioration existing in many cities' buildings were discussed also because the path to the development of a new program always lies in understanding how and why the new program is necessary.

Next, the report turns to a discussion of Cleveland's project and its results and plans for further development and expansion. These experiences and results are presented for other local governments to learn from Cleveland's efforts toward developing a preventive maintenance program.

CHAPTER 4:
Results and Expansion of PM

INTRODUCTION

Chapter 2 outlined the recent history of the City of Cleveland's energy management and maintenance activities and detailed how both the energy and maintenance programs came to see the institution of a preventive maintenance program as a mutually beneficial idea. The next step was to discover ways in which the city could best develop its PM program.

The Energy Office carried out the research into the development of a PM program, as discussed in the last chapter, under the auspices of the Urban Consortium's Energy Task Force. This research was transmitted to the Division of Maintenance and the Director of the Department of Parks, Recreation, and Properties (PRP) with suggestions for how a PM program might be developed in Cleveland to meet specified local needs.

By researching and then outlining the application of PM to the Maintenance Division's activities, the Energy Office filled a need. The PRP Director had been working with the Division for some time on the development of a reorganization plan for the division. This was, of course, precipitated by the Operations Improvement Task Force's recommendations. As referred to earlier, the recommendations from the Task Force centered a reorganization of the

division based on an information control and scheduling system and a preventive maintenance program. The end of 1983 found the division with its information control and scheduling system in place, but with no systematic plan for putting together a preventive maintenance program. Thus, the Energy Office's input was particularly timely and the office was able to contribute substantially to the development of the actual preventive maintenance program. Additionally, because the Energy Office had the resources to conceptualize and research the program and the new manager of preventive maintenance in the division had come from the Energy Office, the new program developed from an energy management perspective.

In the sections below, the program as developed is outlined. The format used in this outline integrates the original workplan tasks as described in Chapter 2 and the elements integral to a preventive maintenance program which were defined in Chapter 3. Following that discussion, the subject then turns to what Cleveland's future plans for expanding the PM program and achieving increased operational control of its buildings through additional energy management activities.

PUTTING PM INTO OPERATION--COORDINATION

As outlined above, the Energy Office's research into experiences elsewhere filled a need of the Maintenance Division for defining a plan for the implementation of PM in Cleveland's municipal facilities. In this way the project

conveniently divided itself: The Energy Office did the research, planning, and analysis; and the Division of Maintenance attended to the day-to- day application of the program.

The Energy Office researched not only the experiences of other local governments, but also worked with members of the Cleveland chapter of the Building Owners and Managers Association (BOMA). BOMA members met with Energy Office staff and described their PM programs and their inventory and scheduling systems. Visits to a number of facilities operated and managed by BOMA members provided opportunities to see these systems in operation.

A summary of the research findings, a detailed analysis of the costs of deferred maintenance in one recreation center, and an outline of the areas needing attention through a PM program were prepared by the Energy Office during the first quarter of the project. This report caused quite a stir because for the first time the costs and implications of deferred maintenance were detailed. In a five-year period, these costs had amounted to over $100,000 which could have been avoided in the one example recreation center through regularly scheduled maintenance and repair. Potentially avoidable annual energy costs were estimated between $5,000 and $10,000.

The report forced the discussion of the problems inherent with the division continuing upon its existing course. The report's findings also encouraged the division to cooperate with the Energy Office. And, while it was not

initially received with open arms, the report showed that the office had insights and ideas which could be helpful to the division in its reorganization efforts.

Following the presentation of the first report, the Energy Office was asked to rework the document. The new report was included in a Maintenance Division Reorganization Plan submitted to the PRP Director at mid-year; the Energy Office's write-up was incorporated as the section defining the direction of the new preventive maintenance program.

From this report and through the discussions which took place during its preparation, specific tasks to be accomplished in setting up the PM program were divided between the Energy Office and the Division of Maintenance. Activities assigned the Energy Office and the PM Manager were an equipment inventory and the formulation of PM tasks and schedules as well as the identification of training resources for the PM staff. In the meantime, other issues such as charging for maintenance services, equipment standardization, and winning management support were left with the Commissioner of the Division of Maintenance for resolution with others in the city's administrative structure.

THE INITIAL EFFORT

Personnel and Assignment

At the beginning of the project, the Maintenance Division had on staff a number of stationary engineers in addition to

the specific tradespeople such as plumbers, pipefitters, and electricians referred to earlier. The engineers had been assigned over the years to look after the boilers in the city's fifteen recreation centers. Most recently, each had been assigned two recreation centers.

Due to a lack of supervision, an unclear delineation of tasks and responsibilities, and a wide diversity of skills and commitment; conditions within the recreation centers had varied widely, with the great majority of the buildings and equipment deteriorating rapidly. When the PM manager came on board in late 1983, he quickly saw that the system was not working well and over a couple of months restructured responsibilities to serve the buildings and the equipment in consistent fashion. Three teams of the boiler operators and engineers were formed. One team performed daily boiler water treatment, another team changed belts and filters, and the third team checked and maintained HVAC equipment. Tasks were divided up according to skill level and interest; and results (such as stabilized energy use) began to be seen even though this assignment of tasks was done on a manual, ad hoc basis without following a systematic schedule.

Selecting Facilities for the Program

In determining which facilities and equipment to include in its emerging preventive maintenance program, program planners defined criteria to identify those facilities for the pilot program. These criteria were selected to show the benefits of the program. It was hoped, of course, that a

successful pilot program would gather support for the program and lead to its expansion.

The following are the criteria which were developed from the research effort. The adoption of these criteria should be obvious from the preceding discussions.

Facilities with high energy use and costs. The literature and experiences in preventive maintenance strongly support the contention that substantial energy savings can be achieved through a PM program. This is true because well maintained equipment is more likely to operate on a high level of efficiency than is equipment which is either not maintained or only repaired after it has broken down. Facilities can be looked at in this connection as systems of individual pieces of equipment; and, since pieces of equipment are rarely monitored individually, facility energy use and costs are the smallest scale at which this type of information can be disaggregated. Thus, in order to show the effectiveness of a PM program, it makes good sense to start with facilities which offer the greatest potential for energy savings.

Equipment with high energy use and costs. It also makes sense to provide routine maintenance for those pieces of equipment or systems which use the most energy and cost the most to operate. But, this criterion should not exclude from a PM program smaller, more energy efficient pieces of equipment which are part of a larger building system. Rather, a PM program should recognize the interrelated nature of various pieces of equipment in a building's HVAC

system. Boilers, for example, should be considered a focal point for PM since the efficiency and operation of many other pieces of equipment are dependent on the boiler's efficiency.

Facilities which are recipients of energy savings improvements. Facilities which do not have a PM program in place commonly experience wide fluctuations in energy use; i.e., as equipment breaks down it is replaced with new equipment which in turn deteriorates and decreases in energy efficiency once again. Because this relationship between preventive maintenance and energy savings exists, it makes sense to coordinate the institution of a PM program with recently financed energy improvements. Such coordination prolongs the useful life of an investment. If the institution of a PM program can go hand in hand with an energy improvement financing program, energy usage reductions can be achieved and energy use can then be stabilized.

Facilities which are recipients of capital improvements. Equipment and HVAC systems in facilities that do not receive routine preventive maintenance deteriorate more rapidly and need replacement sooner. Accordingly, in order for PM to be effective (most particularly, to be maximally effective), equipment and systems must first be restored to good operating condition. Thus, a PM program must be supported with capital funds. In reverse fashion, commitment to a PM program probably should be a prerequisite for the investment of capital dollars. Cities can no longer

afford premature replacement of equipment and systems just because PM has not been performed.

Facilities which are representative of others in the city. In the development of a program which will be extended to a larger system, the pilot program must be representative of the whole. By proceeding in this fashion, the full range of potential problems can be addressed and solved on a small rather than on a global scale.

Facilities managed by cooperative department staff. One of the keys to the success of a new program is the cooperation of local management. With prior and continuing cooperation, the more technical and structural aspects of the PM program can be tested and proven.

Selected Target Facilities: City Recreation Centers

Early in the project, Cleveland's fifteen recreation centers were chosen as target facilities for the institution of the city's preventive maintenance program. The reasons for this choice were based on the criteria discussed above and are covered below.

- In 1983, the Recreation Division spent more for natural gas in its facilities than any other division supported out of the city's General Fund. These expenditures translated into 23 percent of the General Fund's natural gas expenditures. Similarly, expenditures for electricity were relatively high, with the Division accounting for eleven percent of the General Fund's electricity expenditures.

Considering that the Recreation Division ranked fifth among all city divisions in 1983 in terms of total expenditures, accountintg for only 2.5% of all General Fund expenses, it seemed that its energy costs were disproportionately high.

- On the facility level, total energy costs for the fifteen recreation centers amounted to over $679,500 in 1983. Area energy costs by building ranged from $.60 per square foot as a low to $3.59 per square foot as a high for electricity and natural gas together.
- It should be noted that on a case-by-case basis, facilities in other city divisions have used more energy and cost more to operate. Cleveland's experience to date has shown that facilities with the very highest energy use and costs frequently have complicated operational or functional problems associated with them. In the face of the high energy expenses which they incur, the relative simplicity of recreation centers as energy-consuming facilities was a point which favored adopting them as the subject of this study.
- Almost all the recreation centers are heated by steam boilers. Because most of these centers heat swimming pool and domestic hot water with boiler-supplied heat exchangers, energy use and costs remain high all year long. Additionally, because of this arrangement, HVAC equipment must be treated as whole systems rather than as individual pieces of equipment.

- Through its experience, Cleveland's Energy Office had become convinced of the close relationship between preventive maintenance and energy conservation. This belief came about because many of the office's initial investments in energy improvements did not immediately generate the anticipated energy usage reductions. Upon examining these cases, the non-achievement of expected reductions appeared to be a consequence of a lack of routine maintenance. Additionally, many of the Energy Office's projects were directed at the effects of deferred maintenance. We felt that the only way to ensure and stabilize energy usage reductions at anticipated levels was to institute a PM program. As a result, the Energy Office has made improvements in more buildings in the Recreation Division than in any other division in the city. During 1983, these improvements amounted to over $52,000 invested. Cost avoided through these improvements came to $37,273 during the first six months of 1984 alone.
- Recreation centers had recently been evaluated in a division-wide study aimed at determining priorities for capital improvements. It was a matter of record in Recreation that boilers need to be replaced four times faster than normal experience would indicate, steam traps many times malfunction within a year of repair/replacement, and component pumps and motors have been removed from equipment and building systems

and not replaced. The primary reasons for these conditions was a lack of regular maintenance and inspection.

- In regard to their purposes and function, recreation centers are unique among city facilities. Their operating problems are, however, similar to those experienced by other buildings in other city divisions and departments.
- The recreation centers are operated by the Division of Recreation which is a component of the Department of Parks, Recreation, and Properties (PRP) as are the Energy Office and the Division of Maintenance. The Director of the PRP Department has supported the institution of a PM program as a part of the reorganization of the Maintenance Division.
- A final reason for selecting the recreation centers was that the stationary engineers and boiler room operators in the Maintenance Division (the persons who form the core of any PM program) had been employed in the recreation centers for several years. They have had complete access to the buildings during this time and are thoroughly familiar with the HVAC equipment and systems. PM has had a headstart in the recreation centers because the involved personnel did not have to be introduced to new buildings and equipment. The only required change was in restructuring and reorganizing tasks to best suit the design of the new PM program.

Thus, the initial preventive maintenance program was to take place in the city`s fifteen recreation centers. Next, we had to address the integral components of the PM program--the equipment inventory and task scheduling system.

SYSTEMS DEVELOPMENT

As pointed out in the last chapter, certain tools are essential to the success and effectiveness of a PM program. These tools include a building and equipment inventory, equipment specifications, and preventive mantenance tasks and schedules. The developed program took examples of what the research into the experiences of others had indicated were reasonable ways to proceed and refined them for application in Cleveland.

As a result of the Operations Improvement Task Force´s recommendation that a maintenance planning and control system be implemented, the Division of Maintenance with assistance from the Task Force purchased and put into operation a computer-based Work Management System. This system was designed with the capability to generate work orders for both corrective maintenance and recurring jobs. In its first effort the division developed this system to handle its backlog through the issuance of work orders for corrective maintenance. The recurring jobs file was not used initially as its use for preventive maintenance was seen as an action for later development.

The Energy Office, however, looked at the Work Management System from the perspective of its use for

preventive maintenance scheduling and work order generation. We determined that these tasks could eventually run through the system's recurring job file. But because the system was designed with buildings as its basic unit and because PM uses equipment as its base, we needed to build another earlier step into the system. This step started with an inventory of building HVAC equipment and systems. From there we could determine PM tasks and their schedules. This basic information could then be built into the Work Management System's recurring job file to issue work orders on a pre-determined schedule. This was the perspective; the system's design is detailed below.

Equipment Inventory

Through its research, the Energy Office discovered numerous examples of how an inventory of building equipment and systems could be compiled. While these examples all included the same types of basic information, the ways in which that inventory could be manipulated varied considerably from manually maintained, card-based systems to sophisticated, computer-based systems.

The preventive maintenance program in its initial effort needed a staged development. While the eventual aim of this development was to computerize the system, it was set up initially from information obtained from only a few municipal facilities. This direction took account of building and equipment complexities as they were encountered rather than attempting to identify all possibilities

beforehand and then designing the system to accommodate them.

Energy Office staff and the PM manager together spelled out the objectives of the inventory and its uses in scheduling PM tasks. The engineers under the control of the PM Manager were instructed to go to the city's fifteen recreation centers and inventory the HVAC equipment and systems. While a specific form was not used at this point in the process, the types of information which the PM staff was instructed to collect included the equipment name, its location in the building, and size and operation specifications. From this initial inventory, forms were developed and the initial inventory information was transposed onto them. The buildings were then revisited by the Energy Office staff person, the PM staff person who had collected the information, and the PM manager. The initial inventory was checked for accuracy and completeness and supplemented as necessary.

From this inventory information, an initial equipment identifier file was built on the Energy Office's computer system. A sample entry record for this file is shown as Figure 1. An individual record in the file identifies the building, the piece of equipment, and the location of the item within the building. To provide a link between the Energy Office's utility records and the Division of Maintenance's Work Management System, individual records in this file show both the site name used as the identifier in the Work Management System and the three-letter coded identifier used in the Energy Office's utility record

ENERGY OFFICE

PREVENTIVE MAINTENANCE SITE FORM

SITE: STR

SITE NAME: STERLING REC

EQUIPMENT#: EF-#1

TYPE (HVC): V

EQUIPMENT: EXHAUST FAN SO D RM

LOCATION: SOUTH DAY ROOM

FIGURE 1 Sample Entry Record for Equipment Inventory File

system. Additionally, the piece of equipment is specified in two fields. The first field is partially a generic code ("EF" for "exhaust fan" in this case) which specifies the equipment sufficiently for subsequent construction of the PM task and scheduling files. The second field contains a more complete name ("#1" here) allowing for field identification.

Equipment Specifications

As mentioned earlier, one of the uses of the equipment inventory is to lead to standardization of building equipment. This was one of the reasons for developing a file of equipment specifications. The file also can be used in determining replacement parts and the parts needed on a job.

The Equipment Specifications file was built from the information collected during the inventory and the forms

developed during the exercise. A sample entry form is shown as Figure 2 and includes information such as the part of the building served by the equipment (for air handlers, e.g.), the manufacturer, model and serial number, specifications for motors (horsepower, amperage, phase, and so on), the number and size of belts, and the number and size of filters. There is also a space to include specific notes about the particular piece of equipment.

Preventive Maintenance Tasks and Schedules

Next, we sat down with a list of all the different types of equipment in the inventoried buildings and developed a list of the PM tasks for each piece of equipment. Work tasks were coded and the frequency of the conduct of each task during a year was assigned. It had been recommended that each building's operations and maintenance manuals be used in this process, but these records were so incomplete that this recommendation was discarded as one too difficult to justify.

Two files were built from this information. For the first file, Preventive Maintenance Work Tasks and Frequencies, each record (as shown as Figure 3) includes a Work Task Code unique to a particular PM task and a particular frequency, a description of the task, and the number of times per year the task must be accomplished.

The second file was built as a bridge between the PM Work Tasks and Frequencies file and all other files--the Equipment Inventory (PM site form) file and the Equipment Specifications file--by cross-listing all items described by

FIGURE 2 Sample Entry Record for Equipment Specifications File

ENERGY OFFICE

PM EQUIPMENT SPECIFICATIONS

SITE:STR EQUIP:EF-#1 EQUIPMENT TYPE:V

EQUIPMENT: EXHAUST FAN SO D RM
LOCATION:SOUTH DAY ROOM
AREA SERVED:SAME

MANUFACTURER:REZNOR
PART/MODEL#:XL-105
SERIAL#:XA3018N-2
MISC.INFO:

MOTOR INFORMATION:

FRAME:	TYPE:	VOLTS:230
AMPS:	HP:0.5	PHASE:
BELTS 1		FILTERS
SIZE:4L-400		SIZE:

NOTES:

FIGURE 3 Sample Entry Record for PM Work Tasks and Frequencies File

ENERGY OFFICE

PREVENTIVE MAINTENANCE

WORK TASKS AND FREQUENCIES

WORK TASK CODE: 020

TASK DESCRIPTION: LUBRICATE BEARINGS

TASK FREQUENCY: 1 TIME(S) PER YEAR

the same generic part of the equipment code. This arrangement allows the files to be utilized both separately and in conjunction with one another. A sample record is shown as Figure 4.

Summary

The development of the PM inventory and scheduling system was successful relative to the program's objectives. But the components of this development--equipment inventory and data collection, transposition onto forms, checking the accuracy of the inventory, and entering the information into the computer--formed a massive undertaking even though we had initially limited the scope to fifteen recreation centers. Information relative to only seven of the centers was entered into the initial inventory file during the project. Even in some of these cases, time constraints did not allow return visits with the inventory information to check its completeness. The equipment specifications file was designed from the collected inventory information, but time did not allow for more than the specifications of a few pieces of equipment to be entered into the system. The PM Work Tasks and Frequencies file was fully developed, but again time did not allow sufficient checking and matching of tasks to equipment. More attention will be required to further enter these facilities.

In addition, the final step of combining the PM files with the Division of Maintenance's Work Management System still must be accomplished. This step will require completion prior to further development and expansion of the

ENERGY OFFICE

PREVENTIVE MAINTENANCE

EQUIPMENT TO TASK FORM

EQUIPMENT #: EF

WORK TASK CODE: 020

FIGURE 4 Sample Entry Record for Equipment to Task File

PM program. Time and staff resources prevented this avenue from progressing any further during the initial project.

In spite of these limitations, the development of the PM inventory and task scheduling system achieved the objectives of building coordination, laying groundwork, and winning support for continued development of the program. It was through the collection and development of the inventory information that frequent interaction occurred between the Energy Office and the Division of Maintenance and that alliances were forged. The Energy Office managed and directed the inventory effort and designed the computer files and system. The Division of Maintenance learned to rely on the Energy Office's skills in these areas just as the Energy Office learned to rely on the PM Manager's expertise with HVAC equipment and its operation and the PM staff's familiarity with the buildings and equipment. In addition, the Division of Maintenance was involved throughout the design and development of computer files. During the last stages of the project when the Energy Office

demonstrated the system to all project participants, all were impressed and understood the need for further development of the system and its integral part in the operation of a fully functioning PM program.

TRAINING

Background

The Operation Improvement Task Force in its analysis of city operations had also recommended the institution of training programs as a major thrust at all levels of the city's administrative structure. Particular areas for training included training for middle management and first line supervisors. A new division in the Personnel Department was formed to coordinate and administer city-wide training programs. The Mid-Management Training Program was the first training offered and by the end of 1984, 450 mid-level managers had gone through the program. The first line supervisor training program is currently in development and will be geared towards people like trades foremen and the PM manager in the Maintenance Division.

This discussion, while not specifically related to the development and application of the PM program, indicates the new focus on training prevalent in the City of Cleveland. As was building maintenance, training had often been cut in the budget process during the early 1980's, and as a result employee skills had in many cases not been upgraded.

Training became an administrative part of the program of the Department of Parks, Recreation, and Properties with

the formation of the Training and Productivity Committee within the department in late 1983. This committee was assigned the tasks of reviewing departmental training policies, developing training plans and budgets, and coordinating the dissemination of training information. Members were recruited from each division in the department and included a representative from both the Maintenance Division and the Energy Office.

Training for the PM Staff

Training of the personnel involved in the PM program had been identified from the inception of the project as an area requiring significant attention. The program's focus was new for all those involved and, thus, instruction was needed to define PM tasks and how they were to be accomplished. Additionally, program participants needed a general upgrade of their skills to bring them to an acceptable level of competence.

Specific focus was needed in the areas of the repair of electrical equipment, refrigeration, pneumatic controls, and boiler care and troubleshooting. Since the plan was also to have the PM staff assume some of the PM responsibilities currently being neglected by the trades because of the tremendous backlog, training also had to be geared towards introducing the participants to these trade areas.

Models of training programs used by other jurisdictions and private concerns as well as training resources within the immediate vicinity were researched. It was discovered that no one central clearinghouse for this information was

available and that the development of training programs was far behind the need for the programs. Some states were found to have identified the need for operations and maintenance training programs, but unfortunately the State of Ohio had not developed a program that was available for local government participants. In connection with the Institutional Conservation Program, the Ohio Department of Education had developed a program for schools and hospital personnel. But the needs of these institutions greatly exceeded the resources given the department. The State Office of Energy Conservation periodically offered training programs, but the cost and the limited coverage of the programs prohibited the city from considering that as a reasonable avenue to pursue.

As a result of findings and given the timing needed to institute training, project staff decided to pursue two other options: first, using the expertise of vendors of services and equipment; and second, developing a program specifically suited to the city's needs through a private concern. In the first option training classes have been offered during the year in the areas of boiler operation, boiler water treatment, and pneumatic controls. Each workshop was put together and offered at no cost by vendors doing business with the city.

The second option has yielded the most benefits to the PM program. Cleveland is fortunate to have within its borders one of the premier vocational schools in the State of Ohio. The West Side Institute of Technology (WSIT) is active in all trade areas and also has developed a

considerable reputation in training the disadvantaged in various areas of building operations and maintenance. With this expertise in mind, WSIT was approached by the Energy Office and the Division of Maintenance to design and offer a training program for the PM staff. Out of this effort evolved a program geared towards upgrading the participants' skills in the various trade areas and focusing the participants' attention on PM tasks. The course was designed to run for twelve weeks and to offer 96 hours of classroom and hands-on experience. A course outline is shown as Table 1.

The PM staff has wholeheartedly endorsed the program. Classes were offered at night and participants did not receive compensatory time or pay. Tuition, however, was paid by the city, but no incentives were offered other than inclusion in an important new program and a chance to upgrade personal skills. The response was, however, strongly enthusiastic and to date twelve city staff have participated in the program. At the end of the twelve-week session each successful participant received a certificate of completion for the course.

Further Development

WSIT has viewed this training program as a new area of involvement as it combines two focuses of their program: trades and building maintenance. The school has used this program as a pilot for developing this same kind of training to offer to others. Additionally, the city intends to

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PREVENTIVE MAINTENANCE AND ENERGY
CONSERVATION SEMINAR

WEEKS 1-4: TUESDAY & THURSDAY EVENINGS FROM 6:00pm to 10:00pm
Rm. 208 Ron Auvil - Instructor

Week #1
Day -1: Troubleshooting Air Supply Systems & Calibrating Pneumatic Thermostats
Day -2: Pneumatic Thermostats, Honeywell, Powers
Week #2
Day -3: Pneumatic Thermostats and Transmitters
Day -4: 1 Input Receiver Controllers
Week #3
Day -5: Dual Input Receiver Controllers
Day -6: Systems and Schematics
Week #4
Day -7: Systems and Schematics
Day -8: Review of all Material presented to date

WEEKS 5-12: MONDAY AND TUESDAY EVENINGS FROM 6:00pm to 10:00pm
Annex Up Classroom and others as required. Ron Clark - Instructor

Week #5
Day -9: Basic Electricity-Theory
Day-10: Basic Electricity-Wiring
Week #6
Day-11: Basic Electricity-Meters
Day-12: Motors
Week #7
Day-13: Motors
Day-14: Electrical Controls
Week #8
Day-15: Basic Refrigeration
Day-16: Basic Regrigeration
Week #9
Day-17: Air-Conditioning Systems
Day-18: Air-Conditioning Systems
Week #10
Day-19: Unit Heaters, Gas Fired Hot Water Heaters
Day-20: Basic Boiler Theory
Week #11
Day-21: Boiler Operation
Day-22: Boiler Controls
Week #12
Day-23: Combustion Controls and Testing
Day-24: Review of Program

Table 1 Course Outline for PM Training Program

continue its use for training additional employees as the PM program is expanded.

PROJECT RESULTS

The results of this project fell into several general categories which are discussed below. The first three types of results (improved coordination, PM guidelines and schedules, and the PM training program) are reviewed only briefly because the discussion of their development and application was covered in the main body of this chapter. Energy usage reductions and their resulting avoided costs are covered, however, in some detail. The last category of results, covered in the next section, concerns the program's further application in the recreation centers and the expansion of PM to the buildings in other city departments.

Improved Coordination

This project set out to build improved coordination between the city's building maintenance and energy management functions. By identifying areas of common interest and utilizing each organization's areas of expertise, this project achieved this objective and built a common recognition of each program's need for the other. The alliances formed during the project have become an important building block in the city's efforts to create a centralized property management capability within the Department of Parks, Recreation, and Properties.

PM Guidelines and Schedules

It was during the efforts to inventory the HVAC equipment in the city's recreation centers and to develop PM guidelines and schedules that the aforementioned coordination was built. These efforts resulted also in a data system on the Energy Office's computer which is integral to any further expansion of the PM program. Due to project time constraints, however, this work was not completed. But the basic design of the system and the road to completing this portion of the project was outlined for project participants. Staff must be assigned to take over the completion of the PM guidelines and schedules and to assume responsibility for updating the files.

PM Training Program

The project staff developed a comprehensive training course for the PM staff with West Side Institute of Technology, a local vocational school. The course was designed to re-orient the city engineers to preventive maintenance and to strengthen their technical skills in a variety of craft areas. Twelve engineers completed the course in late 1984. Subsequently, the Energy Office, the Division of Maintenance, and the vocational school will evaluate the course concerning its demonstrated worth and whether it should be offered again.

Energy Usage Reductions

Clearly, one significant result of the project should be the achievement of energy usage and cost reductions. Again, due

to the time limitations of the project along with the initial condition of the building equipment, results of this type are not yet readily apparent. It can be said, however, that energy use in the recreation centers has become less erratic at reduced levels during the course of this project. Prior to the project, energy use in the recreation centers tended to fluctuate widely between billing periods. Staff can expect to spend considerable time at the beginning of a PM program improving equipment operation techniques and bringing equipment up to efficient operating condition. Thus, the energy use in the recreation centers can be expected to fluctuate even less in the future as the program progresses.

Overall, the recreation centers have experienced reduced levels of energy use. Since many of these centers had also received energy efficiency improvements prior to the institution of the PM program, it is difficult to pinpoint the portion of those reductions due specifically to the emerging preventive maintenance program. As stated earlier, costs avoided through a combination of the PM program and the energy improvements amounted to over $37,000 during the first six months of 1984.

The 1984-85 heating season will be the first major test of the effectiveness of the PM program. If industry estimates are any indication, the program should be expected to generate avoided costs from energy usage reductions in the range of $20,000 to $30,000 over and above the effects of prior improvements. In time, additional savings in equipment replacement and labor costs should also be seen.

The Intention

Staff realized early in the program that the tools designed and developed during this project would not be fully implemented during the course of this ten-month project. In terms of the project's application, the most that we could have hoped for at the beginning was that a PM staff would be assigned and that the tools developed in the project would be developed to the point where management would be convinced that the program should be continued and expanded. In large measure this objective depended on the Energy Office's efforts to work effectively with the Division of Maintenance toward common interests and on the case being made for the program's expansion.

Clearly, additional measures of the project's success became management's continued and expanded application of the PM program in the recreation centers and the expansion of the program to other city divisions and departments. These areas are discussed below.

The Future of PM in the Recreation Centers

There is no question that preventive maintenance has become an integral part of the maintenance of the city's recreation centers. The question which remains is whether the tools developed during this project (in particular, the building inventory and the PM guidelines and schedules) will be used to their fullest extent or will the program continue to operate based on a manual and less than systematic

scheduling system. The long term success of the program demands the commitment of resources by management to pursue full development of the program; that is, the completion of the equipment inventories and PM guidelines. It is unfortunate for the future of the PM program that the Energy Office is no longer sufficiently staffed to complete, operate, and maintain the PM data system. These tasks should be turned over to the Maintenance Division for completion and continued operation.

Other questions remain concerning the complete implementation of the preventive maintenance program in the recreation centers. Resolution of the larger issues of charging for maintenance services, redefining the civil service classifications and responsibilities of the stationary engineers, and standardizing equipment are all components of the total program. Once again, these questions remain to be resolved.

Expansion of PM to Other City Facilities

At the beginning of the 1985 budget preparation cycle, the Director of PRP requested the Energy Office to draft a plan and to estimate the cost of initiating preventive maintenance in the buildings in the Public Safety Department. These buildings include police district stations, fire houses, the dog pound, and facilities used by the Division of Traffic Engineering, about fifty buildings in all. At the present time, these facilities are superficially maintained by a few stationary engineers in the Safety Department. Safety would like to see these

engineers assigned to the Division of Maintenance so that police and fire personnel can concentrate on their safety functions and not have to be responsible for building operations and maintenance.

The Energy Office developed a plan for the expansion of the PM program to the Safety Department buildings. Included in the plan were costs for:

- o A staff/office function, specifically a systems maintenance manager to work within the PM program from the perspective of record system set-up, record keeping, and work scheduling.
- o Training of new PM personnel. Further development of the West Side Institute of Technology's maintenance training program.
- o The tools and equipment sufficient to include expansion to other buildings.
- o Materials for use in the Safety Department's buildings.
- o The compilation of the equipment inventory in these buildings. The Energy Office recommended that this work be contracted out because of the sheer volume of the information to be collected and processed.

The first year costs of this expansion were estimated to be between $100,000 and $110,000. After the inventory information is gathered and entered into the system, annual costs of approximately $65,000 would be incurred for the program in the Safety Department.

A formal proposal for implementing the PM program in the Safety Department's buildings was submitted to the

Director of the PRP department for presentation in turn to the Budget Office and City Council. Unofficially, the proposal is given a good chance of being accepted, given the Director's interest and commitment to the program, the Safety Department's interest in transferring these responsibilities, and the results achieved through this pilot project.

SUMMARY

This year's project in coordinating preventive maintenance with energy management has achieved a number of successes. The Energy Office has researched and developed the procedures for carrying out a preventive maintenance program while the Maintenance Division has successfully initiated a basic PM program in the facilities of one city division. In addition, the Energy Office has won the support of those in the Maintenance Division and the Department of Parks, Recreation and Properties for a program which combines and integrates preventive maintenance and energy management. While there is still much to do, this first step toward structuring the city's property management capability has been taken.

CHAPTER 5:

Lessons Learned and Suggestions for Application

INTRODUCTION

The Energy Office of the City of Cleveland has participated in the program of the Urban Consortium's Energy Task Force since the office's inception in 1981. Although the projects accomplished over this period of time were all devoted to different aspects of energy management, a common thread has run through the objectives of each project and the conclusions presented in each of the yearly reports: The need for a comprehensive energy management program in city operations is undeniable, pervasive, and overdue for aggressive action.

A comprehensive energy management program calls for a several-pronged approach to energy use in city operations. One of the most important lessons learned in Cleveland over the past three years is that energy improvements in and of themselves are not sufficient to save energy and to reduce or stabilize energy expenditures. A well directed city energy program must provide a full range of management, operational, and technical services. An energy program must extend further than energy audits and improvements. In some respects, these are the easy parts of an energy program; the more difficult parts involve redirection of the way in which

the city manages its facilities, personnel, and financial resources.

In this connection, however, support for energy management activities will be maintained only as long as results are, at the minimum, commensurate with investments. Success and management support for the program depend in a very direct way on the program's record of achieving and retaining energy usage reductions.

As a way of preserving past gains, Cleveland's Energy Office developed a preliminary preventive maintenance program over the last year with the city's Division of Maintenance. In order to continue the development of PM into a strong, permanent, and comprehensive program, the continued, expressed support of management is needed. This is particularly true if PM is to evolve as intended into an essential component of the department's emerging property management capability.

This year's project in Cleveland has shown that preventive maintenance has an important place in the city's maintenance program as well as having significant implications for its energy management program. We also learned that PM can be integrated into present procedures and has the potential to save energy and money. But to achieve the full potential of preventive maintenance, additional investments of time, energy and effort will have to be committed to the program.

Cooperation and Coordination

When the Energy Office first proposed this project, we were sure that the first step toward achievement of goals was gaining the cooperation of the Division of Maintenance. We found that the division was very interested because the Office could help fulfill a need already recognized by the division. The climate for implementing PM was favorable because other cases had previously been made for the Maintenance Division to introduce a preventive focus into its maintenance activities.

The Energy Office used the occasion not only to work with the division on PM but also to improve overall coordination between the two functions. This coordinative effort was assisted by the desire of the Department of Parks, Recreation, and Properties to centralize and strengthen property management services (such as energy management and building maintenance) with the department.

Project Design

The design of the project met its objectives. It made sense to work first in a small number of buildings and to develop the data systems on that limited basis. The only drawback to our use of this approach was that we did not limit the size of the project sufficiently given staff and time limitations. The establishment of the data files and systems for a preventive maintenance program was an immense job considering the volume of equipment that had to be

inventoried and the PM tasks that had to be scheduled. Judging from our experience, any future expansion of the PM program should include funds for contracting out the inventory and scheduling components.

Training

Training for the PM staff was an essential component of the project given the need to improve the engineers' technical skills and to refocus their orientation. Training was also instrumental in impressing on the staff that the city is committed to the institution and continuation of the program. We found in Cleveland that beyond the city paying the tuition the incentives of upgrading personal skills and of being part of a new program were sufficient encouragement for participation.

The Change in Focus

We learned in this project that reorienting a maintenance program from deferral to prevention is only one part of the task of reorganizing city maintenance services. From the research done in conjunction with this project, maintenance functions in other cities seem to have experienced many of the same problems which Cleveland has faced. Layoffs are frequently threatened and carried out, resources are insufficient to perform tasks adequately, and the management structures and information systems required for efficient operation and the delivery of maintenance services are simply not available. A break from the past is needed for the reinstatement of adequate maintenance services and for

the return of building equipment to reasonably reliable and efficient operating condition. Until these major changes are brought about, facilities will continue to be wasteful.

Effective maintenance presumes organization and a systematic approach because of the repetitive and programmable nature of the tasks involved. PM can change the character of a maintenance program from a series of reactions to breakdowns to a program of anticipatory actions.

The Need for Strong Management

Certainly one key to a changed focus is strong management action. Deferred and reactive maintenance programs are largely the result of situations and programs which have been allowed to drift out of control. To set them on the correct path, strong management and involvement are essential.

Cleveland's program for preventive maintenance has had strong management support from the outset. What remains to be seen, however, is how the tools and solutions developed during this project will be expanded upon and carried out. More important perhaps is how this management interest will be expressed and transmitted to those who are involved firsthand in carrying out the program. This communication is essential to continue the gains achieved during the project.

Changing the focus of a program as entrenched as maintenance programs tend to be demands active, visible

support. For without it, those involved will quickly lose sight of the promise of a new perspective and operation.

SUGGESTIONS FOR APPLICATION

Of chief importance to this project were the elements identified as integral to a preventive maintenance program. While these were covered in depth in Chapter Three, they are reviewed here as quick summary and checklist for other jurisdictions who face the need to establish a preventive maintenance program and gain better operational control over their facilties.

Understand the Problem

- o Identify problems and understand the environments in which energy management and maintenance operate.
- o Look for common problems and areas of interest among departments responsible for the maintenance function.
- o Examine and present the case for preventive maintenance by looking at the costs of not having the program.

Start Small

- o Select a discrete group of facilities in which to test the program.
- o Identify those facilities with a high potential for results and operated by cooperative management.

Become Familiar with Buildings and Equipment

- Tour buildings with maintenance personnel to become familiar with building and equipment operations and troublespots.
- Rely on the expertise of the maintenance staff.
- Identify the range of equipment with the aim of standardization.

Develop a System

- Determine how the program will operate and the type of system for equipment inventory and PM task scheduling which is needed given the available resources.
- Examine systems offered by others before the decision is made to develop your own.
- Recognize inventory compilation and task scheduling as the big jobs that they are.
- Consider contracting out the inventory and scheduling work but only on the condition that the PM staff is involved in the process.

Allocate Personnel Effectively

- Assign personnel on the basis of required tasks rather than on the location of facilities
- Ensure that task allocations are specifically defined and match employee skills and experience.
- Assign personnel solely to preventive maintenance.
- Define responsibilities for supervision.

- Make sure that the supervisior checks employee performance regularly.

Training

- Assess employee skills.
- Identify available community resources for training; use available resources if applicable before making the decision to develop a new training program.
- Identify incentives for employee participation and acceptance.

Budget Adequately

- Make sure adequate resources are available to operate the program.
- Look toward developing internal charges for PM services.

Monitor Effectiveness

- Develop and use techniques such as work order and backlog reduction, energy usage monitoring and frequency of equipment replacement for measuring the program's efffectiveness.
- Publicize results.

Keep Management Backing

- Advise upper management regularly concerning the program's progress and results.
- Campaign for the program's continuation and expansion.

CONCLUSION

The Energy Office and the Division of Maintenance in Cleveland jointly developed an initial preventive maintenance program for city facilities during this project. The tools developed form a solid basis upon which the city can continue the program and expand the provision of preventive maintenance services to other city divisions and facilities.

This project has responded strongly to the needs of both the Energy Office and the Maintenance Division's programs. Energy usage reductions have stabilized and can be expected to continue this pattern as the program progresses. In turn, the PM program has quickly become the centerpiece of the Division's reorganization and redirection. Having met both of these needs, the project has illustrated to both entities the importance of coordinated effort. In addition, the project has formed the foundation for a component of the department's emerging property management capability.

The future of preventive maintenance and energy management in Cleveland looks promising. We hope that other cities interested in developing preventive maintenance capabilities will use the research and application process developed in Cleveland during this project to start their own programs. Preventive maintenance and energy management both are programs which will save money and energy and will increase operational control over municipal facilities.

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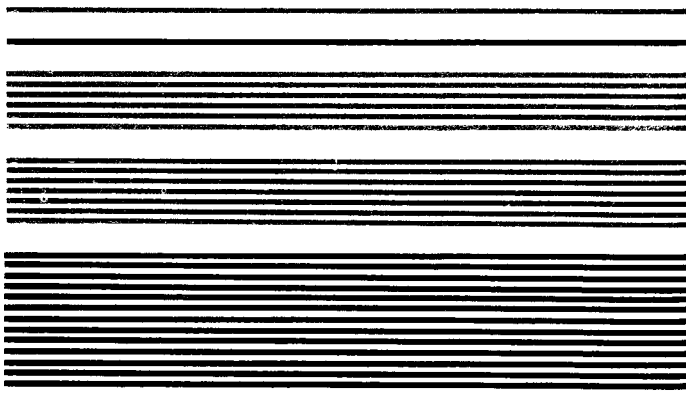

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