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Facilities Manager

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The Challenge of the Higher Education Facilities Trust

HIGHER EDUCATION FACILITIES TRUST

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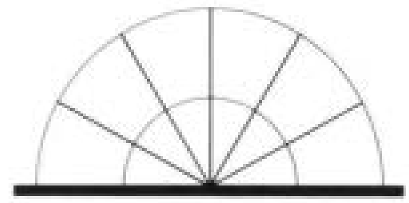
Features



Departments

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Editor
Steve Howard

Editorial Assistant
J. Roger Kurtz

Advertising
Diana L. Tringali

Subscriptions
Maxine Mauldin

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Perspective

HEFT, APPA, and You

by Walter A. Schaw

An inspiration in my life, Dr. Herman B. Wells, president of Indiana University for many years, followed a credo that "big dreams are easier to achieve than little ones."

The Higher Education Facilities Trust (HEFT) is a big dream. It addresses what APPA ought to become and the challenges we foresee. It consolidates the programs we want to develop, yet cannot currently afford to do. It is "big" not only in its multi-million dollar drive for external support but more importantly, we believe, in its concepts.

In this issue of *Facilities Manager* we will explain what HEFT is and describe the initial proposal of programs. Some projects, such as the Executive Development Institute, are already in progress. APPA's committees, officers, and Board of Directors are at work to see the ideas created by them take final shape.

Will it succeed? The key is whether HEFT truly reflects the needs and priorities of APPA's membership. With your support, and the realization that *HEFT belongs to you,* we have no doubts about its eventual success.

While the HEFT program was created by APPA's committees and Board of Directors, what APPA "ought to become" through HEFT is a question for all APPA members. That is why President Val Peterson has called for a round-table exchange of ideas and opinions at the President's Breakfast at the 74th Annual Meeting in New Orleans this July. The fourteen-point HEFT program is seen as a beginning—not a conclusion—to what APPA can become.

Recently proposed changes in accounting practice—requiring depreciation of buildings at replacement, not historic cost—hold substantial implications for how the facilities resource is viewed, and how we are measured at our institutions.

The Higher Education Facilities Trust initiative may be viewed some years from now as what we needed when we needed it. We invite you to review the specifics about HEFT in the pages to follow, consider your own needs, and come to New Orleans prepared to tell us what you think!

Walter Schaw is executive director of APPA.

We welcome your comments, opinions, and clarifications to the articles and columns in this issue. All letters should be typed, double-spaced, and no longer than 250 words; letters may be edited for clarity or brevity. Shorter letters have the best chance of being published. Send your comments to Letters, FACILITIES MANAGER, 1446 Duke Street, Alexandria, VA 22314-3492.

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The Challenge of the Higher Education Facilities Trust

by Steve Howard

The quality of the physical environment at our colleges and universities has a direct impact on the institution's capacity to attract students, retain faculty, conduct research, and teach. At the same time, campus facilities managers are the guardians of a large portion of the American economic structure. These are not earth-shattering statements, yet many in the higher education community are just beginning to realize the importance played by their campus' physical plant department.

With an estimated value of $200 billion, campus physical facilities represent more than half of all capital assets in higher education. The investment already made is tremendous indeed, but there is a responsibility now to manage these complex systems in an efficient, professional manner that places the campus facilities manager in the forefront of the administration's planning and operations team.

Since 1914, the role of the Association of Physical Plant Administrators of Universities and Colleges (APPA) has been to promote excellence and develop the professionals responsible for the administration, care, operation, planning, and development of facilities in higher education. The effective use of computers, complex new mechanical

Steve Howard is editor of Facilities Manager *and APPA's director of publications.*

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and electrical systems, new building materials and methods, energy conservation programs and expensive utility distribution systems, the problems of capital renewal/deferred maintenance—in addition to rising costs and reduced budgets—all must be addressed to meet successfully the support needs of colleges and universities. The need for enhanced managerial and technical skills, increased leadership ability, easily accessible information, and expanded research initiatives grows more urgent every year.

In order to provide the vitality and financial resources necessary to expand the critical educational, research, and support services to its members and to all of higher education, APPA has announced the establishment of the Higher Education Facilities Trust (HEFT).

"The most important ingredient in HEFT is its ability to address the professional development and level of education of the people charged with physical plant management," says H. Val Peterson, APPA president and director of physical plant at Utah State University. "HEFT will not only uplift the profession through development and educational programs, but will also uplift the members in terms of salary and title—the career path itself."

Charles R. Fazio, president of Fazio International Ltd., is serving as development counsel to APPA on the HEFT project. He describes the Higher Education Facilities Trust as a permanent, multi-million dollar endowment that will contain enough funds in its "investment corpus" to be able to pay out income to APPA to fund its expanded educational programs and professional services and make them available to APPA members.

"Think of the amazing investment that foundations and corporations have made in the physical plants of higher education in this country," says Fazio. "Billions of dollars! I would want to protect that investment. If we were to make better the people who are re-


H. Val Peterson

sponsible for running that plant, we'll be saving the country a lot of money, and you're going to make it a lot better for the students at the institution. HEFT is probably one of the few programs I've ever seen that has such an enormous impact potential."

Through the creation of HEFT, APPA will be positioned to provide programs and services critical to the future of higher education. The trust's priorities are in five fundamental areas. Taken together, the programs funded by the Higher Education Facilities Trust are the most comprehensive of their kind ever developed.

1) *Facilities Management Policy and Program Development* identifies external policies and influences that have an impact on physical plant administration, and seeks to moderate or modify negative effects and factors.

2) *Professional Development* provides a structured educational program of training and development for physical plant directors and their staffs.

3) *Facilities Management Consulting/Evaluation Services* offers assistance to physical plant managers as they assess the efficacy of their physical plant operations and implement new and improved programs for physical plant management.

4) *Facilities Management Support Services* furnish state-of-the-art research and information to assist physical plant managers in upgrading their maintenance programs and solving problems as they arise.

5) *Facilities Management Research Projects* address critical research issues and projects, particularly in the area of capital renewal and deferred maintenance.

Three major projects are currently underway or awaiting funding as pilot HEFT programs: a week-long executive development program, a capital renewal/deferred maintenance survey and report, and FACNET, an on-line data base and electronic communication service. Even while HEFT begins to solicit funding to build its multi-million dollar endowment, APPA has nonetheless moved aggressively forward on all three projects.

"APPA has a strong commitment to these programs," says Walter A. Schaw, APPA executive director. "We're going ahead with these and not let a lack of funding hold us back. For example, we're proceeding with the Executive Development Institute this summer without an endowment. We'll simply charge fees that fully support the program on a break-even basis. Donor support will allow us to reduce the fees and broaden participation among our members. Our willingness to proceed will considerably add to our credibility in securing future funding."

Executive Development Institute

The March 1987 issue of *APPA Newsletter* announced that the University of Notre Dame has been selected to develop and implement APPA's first Executive Development Institute for Facilities Managers. The program, a high-level training course designed for the top executives in college and university facilities management, will make its debut August 16-21, 1987 on the Notre Dame campus in South Bend, Indiana.

Faculty for the institute will be provided by the Notre Dame College of Business Administration. The curriculum will address the special management needs of senior physical plant administrators, including decision making, accounting and finance, leadership and motivation, making effective presentations, organizational culture, strategic planning, and the marketing of services.

The Executive Development Institute will provide a more focused version of APPA's semi-annual Institute for Facilities Management, according to Schaw. "We have long been aware of these broader training needs of the top facilities managers that go beyond the level of programming provided by the Institute for Facilities Management. We need to respond to the increasing emphasis on overall facilities management skills." The program is an outgrowth of APPA's Educational Programs Committee under the leadership of William D. Middleton of the University of Virginia.

An application for admission to the Executive Development Institute is being sent to all Institutional representatives of APPA. Participation will be limited to thirty to forty individuals and will be by invitation only. The cost per participant is $1,600 and includes all meals, housing, and educational materials. APPA will eventually be able to subsidize lower cost registration fees through corporate and foundation funding of the Higher Education Facilities Trust.

Capital Renewal/Deferred Maintenance Survey

Recent estimates of the capital renewal/deferred maintenance (CRDM) problem suggest that as much as $50 billion, or one-fourth, of higher education's physical plant assets may be at risk. APPA has recently reprinted Harvey H. Kaiser's *Facilities Audit Workbook: A Self-Evaluation Process for Higher Education*, a means for an institution to determine the level of its own deferred maintenance problem. But this enormous mortgage on the future of higher education requires a national effort as well.

Walter A. Schaw

As the premier research project to be funded by the Higher Education Facilities Trust, APPA will research the dimensions of the CRDM problem, offer its findings in publications and presentations, and recommend solutions. Dr. John Minter, a nationally-recognized education researcher and president of John Minter Associates, has been retained by APPA and, in tandem with APPA's Research and Survey Committee, has developed a research instrument by which APPA will survey the entire universe of higher education and gather important data on the following—

- inventory of planned statistical results.
- average current dollar value of annual set-asides for capital renewal by sector and by type and size (GSF) of institution.
- estimate total higher education requirement for annual capital renewal funding.
- capital renewal requirements as a percent of plant operating and maintenance, total current expenditure, and estimated replacement costs.
- average deferred maintenance amount by sector and by type and size (GSF) of institution.
- estimated total higher education requirement for funding audited and backlog lists of deferred maintenance.
- deferred maintenance requirements as percent of plant operating and maintenance, total current expenditure, and estimated replacement costs.
- estimated optimal maintenance amounts by sector and by type and size (GSF) of institutions.
- estimated optimal maintenance amounts as percent of plant operating and maintenance, total current expenditure, and estimated replacement costs.

HEFT is soliciting at least $50,000 to underwrite the CRDM project, which does not include the cost of producing a videotape to dramatize its findings. As an outgrowth of the research activity, a standing Commission on Capital Renewal may be established to combine the efforts of APPA members with boards of trustees, college presidents, and business officers to recommend, promote, and promulgate policies for higher education to solve the problem and prevent it from recurring.

On-Line Data Base

APPA seeks to create an electronic

communication network that will offer the physical plant and financial administrators of North America's colleges and universities the opportunity to enhance their technical knowledge and administrative capabilities through the exchange of information with other institutions and major companies that provide essential services to higher education.

APPA's facilities network, or FACNET, will utilize the rapidly advancing computer communication technology of a major computer manufacturer to provide members with state-of-the-art computer equipment, software, and technical support to develop an international network of institutions of higher education and major financial, service, and industrial corporations. FACNET would be developed to include the following spectrum of on-line services and resources.

Institutional/Corporate Directory. A comprehensive listing of all schools and companies that hold APPA membership, later to be extended to include National Association of College and University Business Officers, Society of College and University Planners, Council for Educational Facilities Planners, and others.

Project Library. A reference listing, created by network members, of past and present projects that members have constructed or conducted, with descriptive statements of scope and essential details.

Product Library. A reference listing, created by network members, of products available for application in specific areas of facility or management services. Each listing could be initiated by either a manufacturer or an institution and could include software, training material, equipment, and other products.

Peer Profiles Data Bank. A data file of each member institution that provides a profile of their physical plant and/or administrative organization and scope of services provided.

Special Issues Library. A reference listing and resource library established exclusively for the purpose of addressing emerging issues vital to higher education administrators, such as regulatory and legislative alerts, position statements on issues of concern, and advice on how to address problems.

Communication Services. This would include such services as electronic mail among network members, conferencing on various topics, information exchanges, brief institutional surveys, and a member newsletter, which would include member alerts and position announcements, among other news.

The FACNET proposal, prepared by Craig Roloff, director of administration at Montana State University, calls for $1 million for long-term funding and is currently under review by a major computer equipment manufacturer. This investment would provide development costs as well as additional funding for low- or no-cost equipment for members and ongoing updates of the system.

The HEFT proposal—a project involving APPA's Board, officers, committees, staff, and outside counsel—was approved by the Board of Directors in November 1986. Other projects, programs, and services awaiting funding from corporations and foundations include policy forums on major concerns of the moment, special project fellows who may serve a period of time at the APPA office on a particular project, endowed faculty chairs for the Institute for Facilities Management, intern scholarship programs, first-line supervisory training, campus evaluation teams and consulting services, preventive maintenance guidelines, hazardous materials training, and a permanent research fund for unaddressed problems.

"The Higher Education Facilities Trust presents many opportunities for APPA to better serve its member institutions," says H.C. Lott Jr., APPA president-elect and assistant vice president for plant management and construction at the University of Texas at Austin. "The priority projects presented in the HEFT prospectus are not the entire program, just the beginning. As these programs become developed, funded, and implemented, other programs, based upon a continual needs assessment of the APPA membership, will be in the planning stages.

"APPA is definitely on the move as reflected by its growth in all areas within the last five years. Due to the attitudes and volunteer efforts of our members, APPA will continue to grow with or without HEFT. However, there are many services that APPA cannot provide its members due to financial constraints. HEFT will provide the financial resources to expand present activities and develop new and innovative programs that will enhance the professional growth of APPA members. HEFT should not become APPA's driving force, but should be accepted as another program to help us reach our long-term goals of service to higher education."

The status of all three current HEFT projects, in addition to any new developments, will be announced July 19-22 at APPA's 74th Annual Meeting in New Orleans, Louisiana.

The HEFT Board of Trustees

The Higher Education Facilities Trust is established as the endowment arm of the APPA Board of Directors and is fully accountable to that body of leaders. The APPA Board recently appointed five individuals *[see sidebar]* to serve on the HEFT Board of Trustees to serve as managers of the trust. They may be appointed annually for terms of up to five years each by the APPA president.

Chaired by William W. Whitman, associate vice president for facilities at

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The HEFT Board of Trustees

William R. Dickson

Ted B. Simon

William S. Gardiner

William W. Whitman

Joe F. Evans

William R. Dickson
Dickson is senior vice president at the Massachusetts Institute of Technology in Cambridge, Massachusetts. He was a member of APPA for many years and was the closing keynote speaker at APPA's 73rd Annual Meeting in 1986. He is a 1980 recipient of APPA's Meritorious Service Award.

William S. Gardiner
Gardiner is vice president for facilities and property management at the Colonial Williamsburg Foundation in Williamsburg, Virginia. He is a long-time member and supporter of APPA and is a 1980 recipient of APPA's Meritorious Service Award.

William W. Whitman, *Chair*
Whitman is associate vice president for facilities at Iowa State University in Ames, Iowa. He was president of APPA in 1985-86 and is a 1983 recipient of APPA's highest honor, the Meritorious Service Award.

Ted B. Simon
Simon is a member emeritus who retired from Michigan State University in 1984. He served a major role in the establishment of the APPA office and was president in 1972-73. He is a 1970 recipient of APPA's Meritorious Service Award.

Joe F. Evans
Evans is associate vice chancellor for business affairs at Washington University in St. Louis, Missouri. He is a past president of the National Association of College and University Business Officers.

H.C. Lott Jr.

Continued from page 8

Iowa State University and past APPA president, the HEFT Board of Trustees will be responsible for the investments policy of endowed HEFT funds and ensure both the stability of such funds and an annual return of investments sufficient to support HEFT programs as specifically endowed by the trust's benefactors.

The HEFT Board will function within the authority of the APPA Bylaws, and its policies and activities are subject to the review of the APPA Board of Directors. HEFT's fiscal year will coincide with APPA's, April 1 through March 31, and the HEFT Board will submit an annual report on investments and an audit of such funds at the close of its fiscal year.

The Role of Fundraising Counsel

Charles Fazio has been in the fundraising profession since 1964, when he was asked by Georgetown University, his alma mater, to raise funds for its alumni development office. Since then he has raised funds for colleges and universities, major symphony orchestras, ballet companies, and resident theatres (including the Guthrie in Minneapolis). For the past decade Fazio has specialized in associations, professional societies, and their foundations.

Fazio's role with HEFT is as the project director who put together the strategy for its creation and implementation, including the creation of the HEFT Board and fundraising team. He compares his work with HEFT to the efforts of a Broadway producer. "I think the critics will love it," says Fazio. "We've got a great script and all the credibility in the world. All we need now are a couple of 'angels' to help us get it on the stage."

APPA is sending its HEFT proposal to numerous corporations and foundations that have shown a firm commitment to higher education and/or facilities. APPA leaders will exercise their leverage with corporations that provide products and services to their colleges and universities, while Fazio will emphasize the importance of HEFT to various foundations. "Foundations are going to make grants based on their own guidelines and whether you satisfy them," Fazio says. "Corporate fundraising is based on clout and if you're doing something relevant to their bottom line. If you have those two ingredients, and APPA does, you're going to raise money from a corporation."

Fazio's role will diminish as HEFT establishes its initial endowment. "After the first twelve to eighteen months, I begin to fade into a consultant role, as opposed to the activist role I play now," he says.

Selling HEFT

One of the most meaningful ways in which you as an APPA member can support the Higher Education Facilities Trust is to understand the long-term value of the program and press your vendors to participate. The member's involvement has a double edge to it.

Begin to ask your vendors if their companies have contributed to HEFT. If the vendors don't know about the trust, provide some details and contact

Charles R. Fazio

the APPA office for follow-up. At the same time, if a vendor asks, "What's this I hear about HEFT?," be prepared to discuss some of the programs and show that the trust is important not only to you and your institution, but to the entire higher education facilities management profession.

Don't forget the huge sums of money you spend annually to dozens of vendors that provide products and services to your institution. Enhancing the profession through the programs of HEFT will only increase the dollars spent by highly trained professional facilities managers to suppliers of quality products and services. *You* have a say in the matter.

APPA is the only national organization to serve the needs of and furnish leadership for your significant section of higher education. The programs of the Higher Education Facilities Trust are the primary vehicles through which physical plant administrators, institutional management, public policy makers, and leaders in higher education will have the research, information, and educational services needed to ensure that institutions of higher education remain economically viable and are able to fulfill their missions of teaching, research, and community service.

The challenge for the future is before you. Help us meet the challenge by supporting HEFT. ■

A FOUR-PART SERIES ON ELECTRICAL ISSUES

PART 2 High Voltage Cables

by Mohammad H. Qayoumi, Ph.D.

Our series began with a discussion of the problem of maintaining clean power. This article will discuss high voltage cables and their sizing, insulation, and testing.

The early electric systems at the turn of the century were direct current systems—the generation systems were small, the distribution network limited, and the voltage levels were low. The alternating current distribution systems were utilized around 1910. It was then realized that interconnecting generation sites were recognized for economic benefits. The need for higher voltages became apparent as the size of the electric networks increased in size and power carrying capability.

Presently, the transmission line voltage in the United States is 345,000, 500,000, and 765,000 volts. For distribution systems, utilities use 13,200, 69,000, and 138,000 volts. The primary voltages for medium to large customers are 13,200, 4,160, and 2,400 volts. It might be a fair question to ask why the higher voltages are used. The answer is that as the voltage of a cable is doubled, the power carrying capability of the cable is four times as much. On the other hand, as the network voltages increase, so do the amount of design, installation, and maintenance.

The power cables are critical elements of the high voltage network because they are the arteries of the system. Traditionally, that is also one of the system components that receives the least attention, possibly because out of sight is out of mind. Because cables are usually in duct banks, and because insulation that weakens prior to failure cannot be seen, inadequate attention is given to them. It is important to realize that the reliability of the electrical network can be greatly improved and costly down time avoided by relatively low attention to the cables at a minor annual cost.

Mohammad Qayoumi is associate executive vice president for facilities development and operations at San Jose State University, San Jose, California. He has a doctorate in electrical engineering and is a faculty member with APPA's Institute for Facilities Management.

Cable Sizing Criteria

A number of factors determine the proper sizing of electric cables: current capacity, voltage ratings, and physical strength.

1) Current carrying capacity

The current carrying capacity or ampacity of a cable is a function of the thermal limits of the insulation. The cable conductor is either copper or aluminum. Based on the conductor size, material, and the ambient temperature, the cable resistance per unit length can be calculated. From the resistance, the cable losses and temperature limit are determined. The National Electric Code (NEC) and the Insulated Power Cable Engineers Association (IPCEA) provide tables for ampacity for all cable sizes. It should also be mentioned that in addition to the steady state current carrying capacity of a cable, its short circuit withstand capability is equally important. This rating ensures that it can withstand short circuit current without any thermal damage until the fault is removed by fuses or circuit breakers.

2) Voltage rating:

The cable also must be able to withstand the electric field stress at the surface of the conductor, both at normal and faulted conditions. For a given voltage level, the surface field stress is inversely related to the radius of the conductor. That is why the size of the cable is determined in most instances by the surface field stress for high voltage systems; the current determines the size for low voltage systems.

3) Physical strength:

The electric cable must be able to withstand the rigors encountered during handling and installation. Normally cables perform rather well under these conditions, but only to a degree. It is usually these limitations that cause most problems during installation. These limitations include bending cables around sharp bends, because the insulation might fail to re-telescope when it is restraightened. Bending radii should not be less than twelve times the outer diameter of the conductor. The allowable side wall pressure, which is induced by pulling tension, may not be higher than 100 pounds per foot. Cables have low abrasive tolerance if dragged along rough surfaces such as gravel, wood, or metal edges. Sharp edged objects—nails, backhoe teeth, shovels, etc.—can easily puncture the cable jacket or insulation. It is important to keep in mind that cables fail at individual spots rather than over their entire length. Therefore, only a single insulation void or a damaged jacket and insulation may cause a cable to fail.

Cable Insulation

Paper impregnated lead cable (PILC)

and varnished cloth (VC) were the work horses of the industry since 1910, so there is proven empirical data for these types of cables. PILC has compound migration problems if used on vertical risers. Termination and splicing also are more difficult and time consuming and require more skilled personnel. VC cables are relatively more expensive for the quality of the dielectric but do not have the compound migration problems. The combination of VC cables for vertical risers and PILC for horizontal runs has been used successfully.

During the past two decades the petrochemical industry has introduced a variety of polyethylene compounds as insulation materials that have good insulating characteristics; i.e., high moisture resistance, low temperature characteristics, high ozone resistance, and more abrasion resistance. These cables are lighter in weight compared to PILC, and terminations and splicing are relatively easier.

Two types of insulation, ethylene-propylene rubber (EPR) and cross-linked polyethylene (XLPE), have gained wide acceptance. EPR cable has better corona resistance than XLPE; it has high heat resistance and requires less insulation material. This results in lighter-weight cable. XLPE cable has high mechanical strength, high resistance to moisture, sunlight, heat, and electrical tracking. Both EPR and XLPE have very good characteristics, but preferring one over the other has been a subject of controversy among design engineers. It should also be mentioned that EPR and XLPE have some undesirable characteristics such as high coefficient of volumetric expansion, susceptibility to ionization, and will melt down at over 100°C. Even with these shortcomings, they are preferred over PILC and VC cables in most instances.

Cable Shielding

In addition to the insulation material over the cable conductor, there are a number of additional layers over the insulation to protect it against physical and environmental damage. If the line voltage is over 2,000 volts in most cases, and all cases over 8,000 volts and below 35,000 volts, there will be a metal shielding layer between the outer jacket and insulation. Shielding is either a thin (0.005 inch) copper tape or concentrically wrapped copper wires.

If the electric field is intense for unshielded cables, surface discharges will take place and cause ionization of air particles. This will generate ozone, which will deteriorate cable insulation or jackets, and leakage current will be induced if cable surface is moist or covered with soot, salt, or dirt. Thus, for operating voltages of over 2,000 volts, shielding is required if the cable is in damp conduit, the environment is dirty (containing soot, salt, or grease), or radio and TV interference is expected.

Courtesy of The Okonite Company

Figure 1—Typical Section of High Voltage Cable

The metallic shieldings create uniform capacitance between the conductor and ground, thus eliminating surge potential buildup within a cable. It also reduces incoming surge potential on insulation, confines dielectric field to the inside of cables, provides increased safety to human life, reduces the hazards of shocks, and eliminates radio and TV interference. It is important to make sure that the shielding is always at or near ground potential by having adequate connection between shield and ground. An ungrounded floating shield can be more hazardous from a safety standpoint than unshielded cable; and if the shield punctures the outer jacket, the resultant discharge may cause heating and burning.

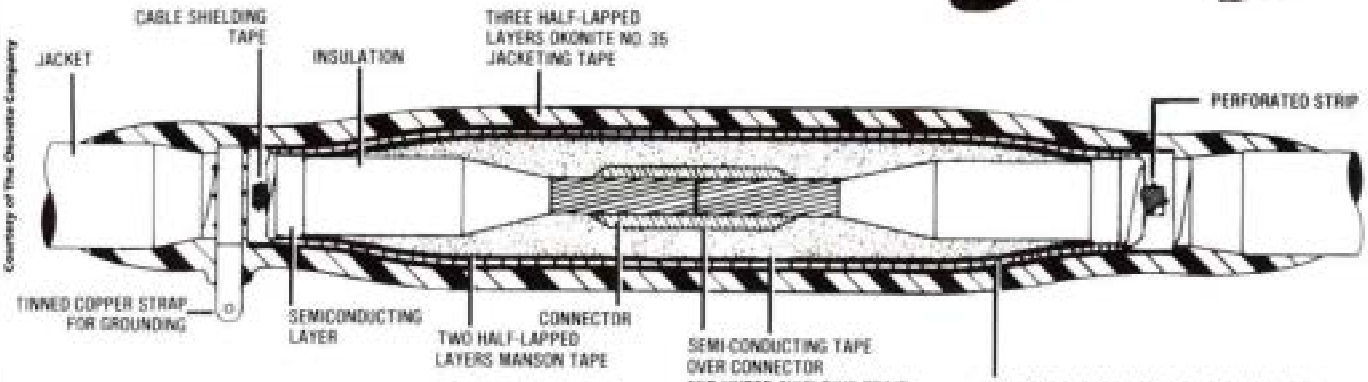
Termination and Splicing

There are different splicing and termination materials available for different types of cable insulation. PILC cable splices use lead splices, while EPR and XLPE cables use certain tapes or heat-shrink jackets. The terminal ends of a cable undergo a higher electrical stress concentration at the end of cable shielding. This stress can be relieved by installing a stress cone. It is a field assembled insulation, built up in the shape of an inverted "V" all around the cable with shielding braid. The stress cone can either be preshaped insulation kit or built up by wrapped insulation tape. For PILC cable and all outdoor installations, the cable has to be terminated with a pothead that consists of a housing filled with dielectric fluid where cable is terminated. Potheads seal cables against moisture and mechanical damage.

There are different splicing kits available, and manufacturers have a wide variety of techniques for splicing. Therefore, it is important to first make sure that the proper size and type of splice is used for every situation, that the manufacturer's recommendations are followed, and the work is performed by skilled personnel. Cable splices and terminations are usually the weakest points in a cable system, so adequate attention has to be devoted during installation and subsequent maintenance.

Cable Failures

The major cause of electrical failure is the breakdown of insulation due to absorption of moisture, dirt, grease, excessive heat, overvoltage, and aging. Moisture and dirt can cause leakage,



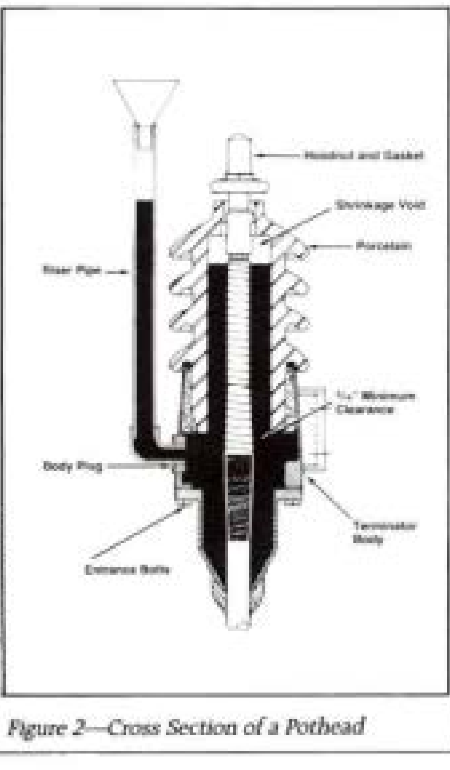
Courtesy of The Okonite Company

Figure 3—Typical Section of Cable Splice

which in turn results in tracking and eventual flashover. Any insulation deformities during manufacturing can create air pockets and insulation voids that will result in a premature failure.

High electrical field stresses cause insulation failure. The high electric stress ionizes air particles around the conductor and corona will result. Corona will heat up the insulation and produce ozone. The cable insulation will deteriorate and flashover will occur.

If a cable energizes an unloaded delta transformer, the inductance of the transformer and capacitance of the cable may experience ferro-resonance. Ferro-resonance causes overvoltages of four to six times normal voltage, which can cause a cable flashover.



Courtesy of G&W Electric Co.

Figure 2—Cross Section of a Pothead

Locating Cable Fault

Whenever a cable insulation breaks down, it will result in a low or high resistance fault. The difference is whether the conductor and outer shield are touching or if there is some resistance between the two. A thumper is used to locate the fault. The principle of operation behind a thumper is charging a capacitor to a predetermined DC voltage and connecting in series with the cable through an adjustable sphere gap. The sphere gap determines the preset voltage value.

When the capacitor reaches the preset voltage, the capacitor is instantaneously discharged and voltage pulse is sent along the cable to bombard the fault. If the pulse has sufficient magnitude, it will break through the insulation across the fault. As the energy pulse flashes across the fault, there will be a loud noise, and the fault location can be determined. If the cable is damp, deeply buried, or fully shorted, it might be difficult to hear the audible noise. A thumper detector then can be used to pick up the signal radiated along the cable.

Cable Maintenance

It is a common saying that a chain is as strong as its weakest link. In electrical systems the weakest link is usually the power cable. Even at normal conditions an electrical cable experiences stress that gradually weakens it and eventually leads to failure. Other factors that can speed up the insulation deterioration are moisture and dirt, grease, sunlight, heat, presence of ozone, vibration, and power surges. Therefore, the ambient conditions have major impact on the rate at which the cable progressively weakens.

Under normal conditions, an extra 10°-15°C temperature rise can reduce the average life of insulation by half. The type of load that it serves also has an impact. For instance, if the load is constant with infrequent low-level switching surges, the average life of the cable will be longer than the identical cable serving large motors with across-the-line starters with intermittent loads, or if the cable is subject to a higher level of lightning surges.

Insulation is a measure of opposing electrical current by insulating material. The unit for measuring resistance is ohms, which is the resistance of a material if an applied voltage of one volt can induce a current of one ampere. If a small insulation crack is caused by one of the previously mentioned causes, a low resistance path to ground is created. This will increase the leakage current and overheat the insulation, resulting in a further reduction in resistance to ground.

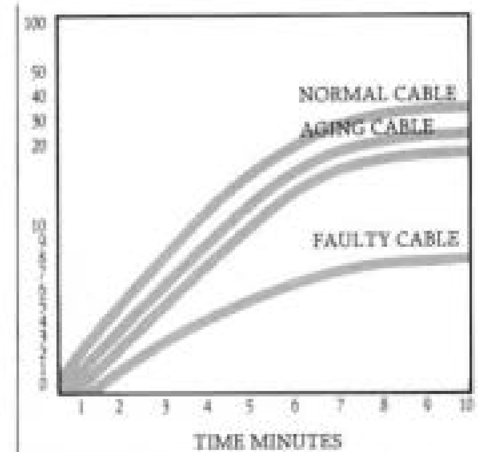
This cascading effect will continue until cable insulation failure. Testing cables in most cases can anticipate cable failures; if historical test data is kept over a period of time, it is easy to see if the drop cable insulation value is due to normal aging or is at the brink of failure.

There are three common insulation tests: insulation resistance, dielectric absorption, and high potential.

Insulation Resistance Test

This test will determine the insulation resistance between the conductor and ground. A megohmmeter is used to measure the resistance. It is basically a high voltage ohmmeter that consists of a small DC generator and a milliampere meter. The generator is hand cranked or driven by an electric motor, the latter being preferred for consistency of rotor speed. Usually megohmmeters have ranges from 100 V-5000 V.

A good insulation is indicated by an initial dip of the milliampere meter pointer toward zero, followed by a steady rise. The initial dip is due to the capacitive effect of the cable; however, if the pointer makes slight twitches down scale, it implies leakage of current along the surface of dirty insulation. In order to compare the insulation with historical record, a spot test is performed. In other words, the megohmmeter is applied for sixty seconds and the reading is recorded at the end of this time. According to IEEE 43, the minimum acceptable value of insulation resistance is one megohm per 1000 volts of rated operating voltage. For instance, in a 15V cable the minimum acceptable resistance is 15 megohm. All spot test readings should be corrected to a base temperature (i.e., 40°C) using the manufacturer's correction factor curve. A gradual decline of resistance with age is normal; however, a sudden decline means an insulation failure can be around the corner.



INSULATION RESISTANCE MEGOHMS

Figure 5—Resistance vs. Time

Dielectric Absorption Test

A dielectric absorption test provides better information than the insulation resistance spot test and is considerably longer than the insulation resistance test. Since the current is inversely related with time, insulation resistance will rise gradually for a good cable, but if it flattens rapidly will indicate otherwise. The insulation resistance is plotted against time on a log-log paper as shown in Figure 5.

The ratio of ten minutes to one minute resistance is known as polarization index. A polarization index of two or higher reflects good insulation.

High Potential Test

The above two tests cannot determine the dielectric strength of cable insulation under high voltage stress. A high potential test—or "hypot test" for short—applies stress beyond what a cable encounters under normal use. A hypot test is the only way to obtain positive proof that the cable insulation has the strength to withstand overvoltages caused by normal system surges. There are two types of hypot tests, AC and DC.

EXAMPLES OF CABLE TESTING EQUIPMENT

All courtesy of Associated Research, Inc.

Figure 4A—Megohmmeter

Figure 4B—Portable DC Hypot

Figure 4C—Cable Thumper

AC Test

The AC hypot test has a longer history and is more universally accepted. One reason for this is that the AC test is almost exclusively used for insulation breakdown. AC hypot is basically a go/no go test. It determines if the leakage current is below a certain limit or not but cannot determine quantitatively how good or bad the insulation is. The time required to perform an AC test is much shorter than the DC test, because unlike the DC test, the voltage does not have to be applied gradually. The insulation stress is applied in both polarities and the cable does not have to be discharged after the test.

On the other hand, due to cable capacitance, the reactive current is usually higher than the leakage current which is the concern. In addition, if the test is extended for a period of time, it can damage good cable. Thus the AC test is viewed as being a destructive test. One application in which the AC hypot test is used almost exclusively is the factory test by the cable manufacturer before it is shipped from the factory. The main reason for this test is to determine if the cable insulation has any discontinuities, voids, or air pockets.

DC Test

Unlike the AC test, the DC test can provide more quantitative information on cable insulation. Since much lower power levels are needed, the risk of shock hazard to the operator is less. This test will not damage the cable insulation due to dielectric heating, corona cutting, or reversing action of insulation stress.

On the other hand, the DC test requires more time to perform because the voltage has to be increased gradually to the maximum level in about ten equal increments. In each step one also has to wait long enough until the transient charging current drops to a steady state and one is convinced that the insulation has not broken down. The DC test is used after cable installation and as a periodic maintenance test. The equivalent of a cable is shown in Figure 6.

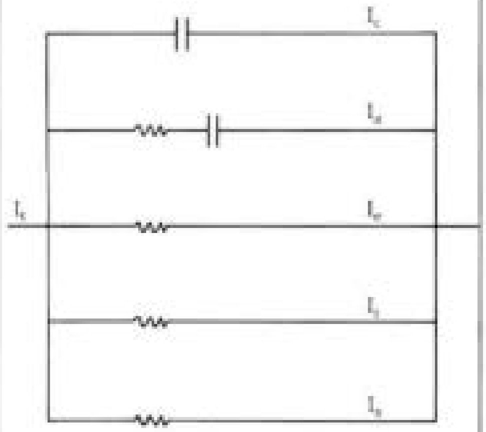


Figure 6—Equivalent Circuit of a Cable

According to Figure 6, total current has the following five components:

1. The capacitance charging current $I_c = \frac{E}{R} e^{t/RC}$ where

E = applied voltage
R = test circuit resistance
C = cable capacitance
t = time elapsed since the voltage charge

Therefore, this current component is an exponentially decaying function.

2. Absorption current is $I_a = k_1 VCT^{-K2}$ where

V = incremental change of voltage
K_1, K_2 = cable constants
t = time elapsed since the voltage change

This is also an exponentially decaying function, which normally has a higher time constant.

3. Leakage current is $I_e = E/R$ where E is the applied voltage and R is the cable resistance plus the test circuit resistance.

4. The ionization current I_i is due to ionizing air around the cable which constitutes a discharge or spark and flow of corona current. The magnitude of I_i depends on ambient temperature, humidity, and pressure.

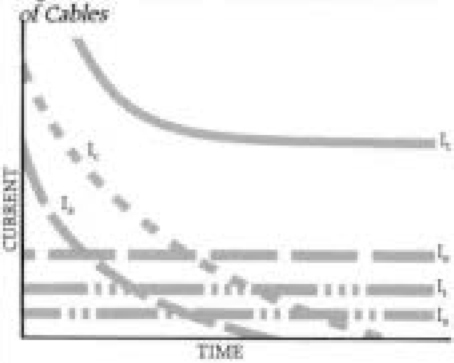
5. The surface leakage current I_s is due to surface resistivity.

Therefore, the total current measured by hypot test is the summation of the above five currents as shown below graphically:

$$I_t = I_c + I_a + I_e + I_i + I_s$$

The current of interest in the test is the leakage current. That is why steps have to be taken to segregate this component from the other four. Therefore, if one waits a few minutes, I_c and I_a decay with time. The surface and ionization currents are smaller than the leakage current. They can be bypassed by installing corona guarding and surface leakage guard circuit as shown below. According to NETA, the maximum allowable leakage current for new cable is:

Figure 7—Time vs. Current Characteristic of Cables



$$I_e = \frac{E}{K \log d_1/d_2} \text{ where}$$

E = test voltage
K = specific insulation resistance
d_1 & d_2 = outer and inner diameter of cable insulation

Testing Procedure

1—Before the test equipment is connected, disconnect both ends of a cable from the rest of circuit.

2—Clean cable termination bushing surfaces and cover bare conductor surfaces.

3—Set corona guard and surface leakage circuit.

4—Connect the test leads to one cable phase.

5—Apply grounds to all components of the circuit.

6—Apply the first voltage step.

7—Wait at least five minutes and record the current at the end of five minutes.

8—Plot the voltage against current.

9—Increase the voltage one step.

10—Repeat steps six, seven, and eight.

11—Stop the test if there is an indication of insulation breakdown as shown in the graph below.

12—Maintain the highest voltage step for at least fifteen minutes.

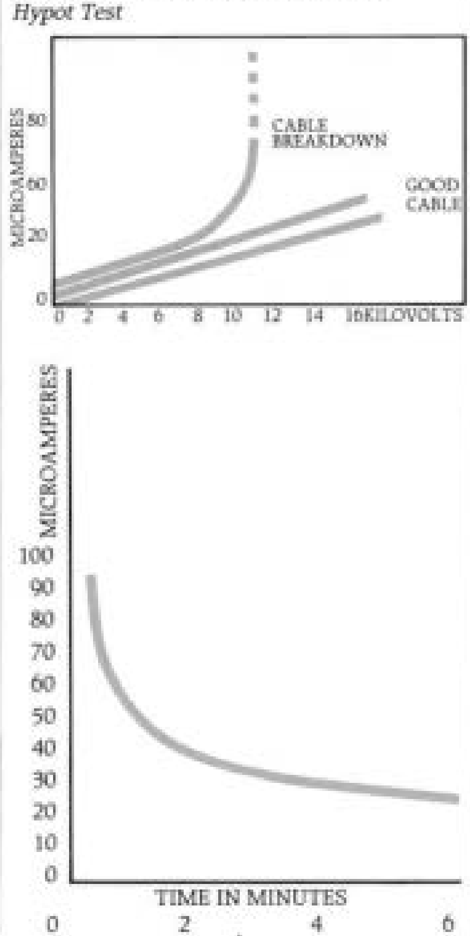
13—De-energize and discharge the cable before disconnecting the test equipment.

Test Frequency and Voltages

IPCEA (Insulated Power Cable Engineers Association) generally sets up cable test voltages based on insulation thickness. This is because for a given insulation material the AC voltage permit is constant. This determines the voltage level that the manufacturers use for testing the cable before shipping. For field installation test, a maximum value of 80 percent of the factory voltage test is used. The subsequent maintenance tests require 60 percent of factory voltage test, which is about 160 to 170 percent of operating voltage. There is no general agreement on conversion factor from AC to DC test voltage, but a factor of 1.7 to 3 is used in the literature.

As far as test frequency is concerned, empirical data indicates that cables have a higher failure rate during the first two years of service, generally due to cable weak spots and defects during manufacturing. The DC test is not very effective at installation because it fails to detect moderate cable imperfection for a new cable. But after the cable is energized with AC power for a few months, the DC test can provide extremely valuable data. It is recommended that new cables be tested yearly for the first two or three years and then tested every five or six years. A typical graph of cable test failure vs. cable age is shown in Figure 10.

Figure 9A—Current vs. Voltage for DC Hypot Test



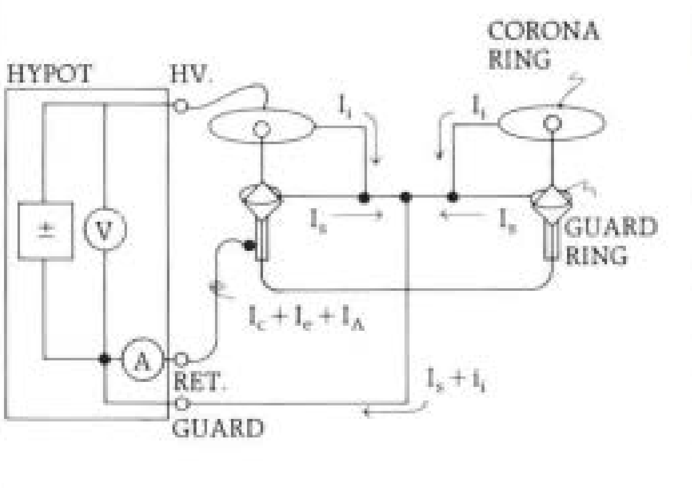


Figure 8—Typical DC Hypot Connection with Surface and Corona Ring

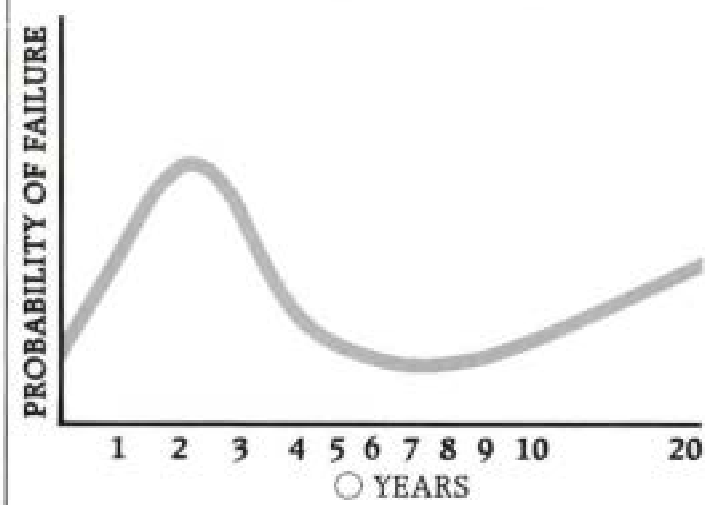


Figure 10—Probability of Cable Failure vs. Service Life

During the past few years there has been controversy and debate about test frequency and test voltage. Some people believe that frequent testing will put undue stress on cable insulation and will result in premature failure. The fact remains, however, that a systematic cable testing program can, on the average, reduce in-service failures by a factor of nine to one as opposed to no test program at all. For more up-to-date information on cable testing, refer to "IEEE Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field."

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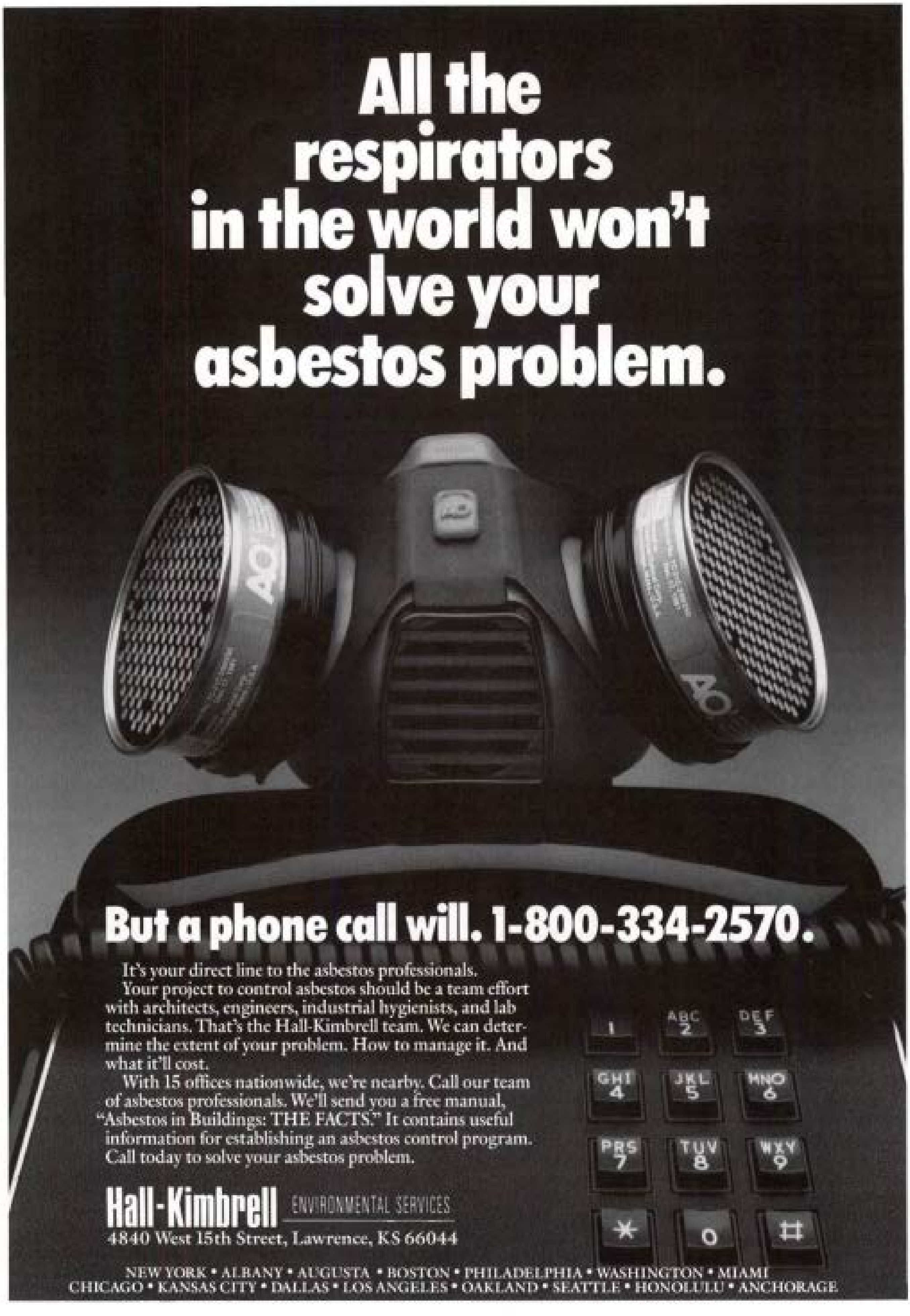
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The Cogeneration Project at Cornell University

by Robert R. Bland

This paper describes the Cornell University central heating plant (CHP) operation, provides a brief summary of the evaluation of the various options for cogeneration, and describes the cogeneration project under construction.

Cornell University Campus

Cornell University is a private, nonsectarian university and is the land-grant institution of New York State. The main campus is in Ithaca, a city of 29,000 in the Finger Lakes region of upstate New York. The campus covers 740 acres on a hill overlooking Cayuga Lake. There are more than 400 buildings on the main campus.

The total student population at the main campus has grown from 16,300 in 1973 to 17,400 in 1983; 5,800 students are housed in dormitories on campus. While there may be an increase in the number of students housed in dormitories in the future, there are no plans to significantly increase the total student population. The faculty and staff personnel total 7,450.

Central campus buildings are served by steam from the central heating plant. For air conditioning some buildings have individual systems, but there is a central chilled water system that serves more than seventy buildings. With the exception of a 1 MW hydroplant, all electricity is purchased from the local utility.

Load Served

Export steam from the CHP is used for space heating in approximately 218 buildings on campus, with a total floor area of about 8.7 million gross square feet (M GSF). The steam, at reduced pressures, is used directly in radiators and air handling coils, or it is used indirectly in hot water radiation systems. Other uses for the steam include domestic hot water production, dining uses, and some research process equipment.

Steam Distribution System

Steam is distributed to campus buildings through approximately ten miles of main steam lines. In most cases, the pipe is direct buried underground. Several types of pipe and insulation have been used since the original steam lines were installed in 1922. The most recent standard for steam lines specifies steel pipe, a composite insulation, and pittwrap covering. Insulation standards are R-11 for pipes six inches in diameter and larger, and R-8 for pipes smaller than six inches.

The current standard for condensate return lines calls for fiberglass-reinforced plastic (FRP) pipe, ureafoam insulation, and PVC covering.

History of the Central Heating Plant

The central heating plant consists of a primary structure, constructed in 1922, and several support operations. The original facility had five Babcock & Wilcox (B&W) Sterling boilers and one stack (west). They were Coxe traveling grate boilers burning anthracite coal, operating at 200 psig and rated at 28 kpph each. In 1930 an east stack and two B&W boilers were added (Boilers 6 and 7) rated at 35 kpph each. These boilers were also Coxe traveling grate boilers for anthracite coal.

In 1949 Boiler 8 (existing), with a Riley-Harrington traveling grate, was added (see Table 2—Summary of Existing Boilers). Boiler 8 was originally designed for anthracite coal and steam production at 900 psig, 825°F, although it has never been operated to produce steam above 200 psig.

In 1960 two of the original B&W boilers were removed (Boilers 1 and 2) and replaced with B&W boilers with American Engineering Company Vibragrate stokers (now Detroit Stoker Company) for bituminous coal firing. These units were some of the first water cooled Vibragrate stokers.

During the period 1967 to 1970, several boiler additions were made because of the availability of inexpensive oil and gas. Boiler 5 (existing gas boiler) replaced the old Boiler 5, and Boilers 6 and 7 (existing package gas/oil boilers) replaced the older coal boilers. Boilers 3 and 4 were removed and not replaced. In addition, Boiler 2 was converted to oil firing in 1976, because the boiler had operation and air pollution control equipment deficiencies and could no longer burn coal.

In 1975-76, several changes were made to upgrade the operation. Boiler 8 was converted for firing bituminous coal and auxiliary systems were upgraded. A new coal storage area was built. Electric circuits and water treatment were also upgraded.

Finally, in 1981, the B&W Boiler 1 was replaced with a new 90 kpph Zurn boiler spreader stoker for firing bituminous coal.

Boiler 1. Boiler 1 is a Zurn (1981) coal-fired, spreader stoker, continuous ash discharge unit with an economizer rated to generate 90,000 kpph of superheated steam at 400 psig and 550°F. It is presently being operated at 200 psig and 480°F. It does not have a combustion air heater. Controls are analog electronic. The economizer was replaced in 1985 with an extended surface economizer.

Boiler 8. Boiler 8 is a Riley Stoker (1949) coal-fired, traveling grate with air preheater and economizer, rated to generate 190 kpph of superheated steam at 900 psig and 825°F. It is presently being operated at 200 psig and 500°F. Controls are the original pneumatic.

In 1976 the ignition arches were reworked to permit bituminous coal firing, and a secondary mechanical collector was added. In addition, the lower side wall headers, the superheater, some convection tubes, the economizer (due to erosion from improper soot blowing operations), the air heater, and the I.D. fan were all replaced.

Robert Bland is senior engineer in the Facilities Engineering Department of Cornell University, Ithaca, New York. This article was presented at APPA's 73rd Annual Meeting in July 1986 but was not included in the Proceedings of the Annual Meeting.

Table 1
REQUIRED EXPORT STEAM PRESSURES (BY MONTH)

Month	Pressure (psig)	Month	Pressure (psig)
Jan	100	July	60
Feb	100	August	60
March	90	Sept.	60
April	85	Oct.	80
May	80	Nov.	85
June	70	Dec.	90

FIGURE 1
CHP USE OF FUELS

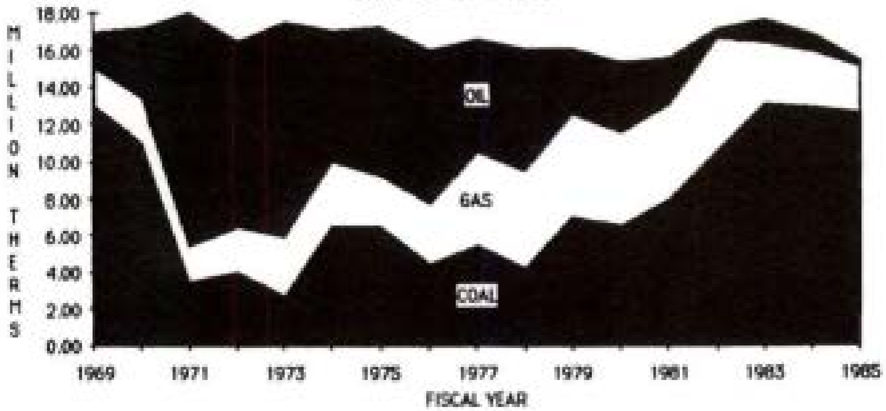
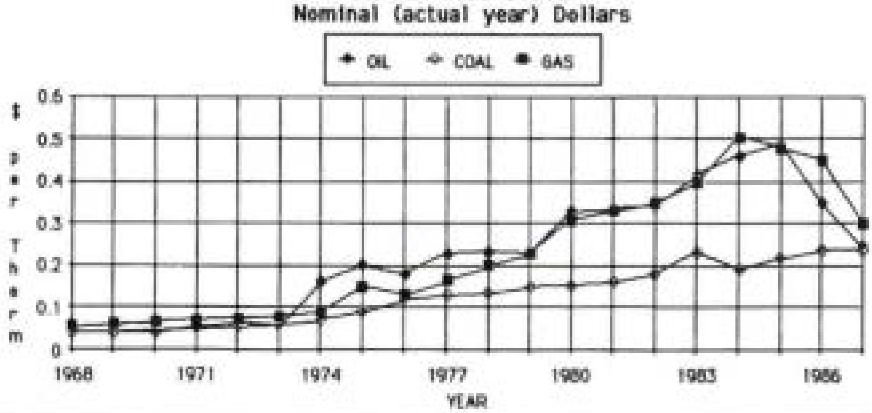


Table 2
SUMMARY OF EXISTING BOILERS

Boiler	Year	Make	Type	Fuel	MCR[a] (kpph)	Steam Rating Press/Temp. (psig)/(°F)	Economizer
1	1981	Zurn	spreader stoker	coal	80	400/550	yes
2	1960	B&W	converted vibragrate	oil	80	210/540	no
5	1966	B&W	package	gas	100	220/500	yes[b]
6	1970	Erie C.	package	oil/gas	100	205/480	no
7	1970	Erie C.	package	oil/gas	100	205/480	no
8	1969	Riley	traveling grate	coal	190	900/825	yes

FIGURE 2
CU CHP FUEL COSTS
Nominal (actual year) Dollars



History of Electric Generation

Hydroelectric generation at Cornell began in 1905 with the installation of the Fall Creek Hydroplant with an installed capacity of 125 kW. A 450 kW synchronous generator was added in 1913.

This hydroplant carried the complete load of the endowed campus until 1928, when the campus was connected to the electric lines of the Associated Gas and Electric Company. The AG&E Company provided peak and standby power, when required, for the endowed campus. AG&E bought power from the Cornell plant the rest of the time.

Two 300 kW synchronous back-pressure steam turbine generators, operating at 200 psig throttle, were installed in the central heating plant in 1940 for power generation.

Due to the decreasing cost of electricity, and utility penalty clauses for generation, the Ithaca Falls plant was shut down in 1955, the Fall Creek hydroplant was shut down in 1969, and the central heating plant generators were disconnected in 1970 and later sold.

Campus Distribution of Electric Power

Electric power is supplied by NYSE&G at 13.2 kV at separate substations for the endowed and state campus. Power is distributed in underground duct banks at 13.2 kV and 2.4 kV.

Fuel Use: Boiler Dispatch

Figure 1 shows historical fuel use, as measured in total annual million therms for coal, gas, and oil. The increase in coal usage after 1981 is due to the addition of Boiler 1 and increased duty on Boiler 8.

Figure 3 shows an approximation of actual boiler dispatch in the CHP when both coal boilers are available. Boilers are dispatched according to the load range.

During the summer months, when loads are below 65 kpph, Boiler 1 can meet all steam loads and demand swings.

Between loads of 65 kpph and 100 kpph, an additional boiler must be on-line. The load is still too small to have both Boilers 1 and 8 on because of the minimum continuous capacity of about 75 kpph preferred for Boiler 8. A gas boiler is kept running at an average 25 kpph to respond to steam demand.

Between steam loads of 100 and 145 kpph, Boilers 1 and 8 can handle all

Table 3

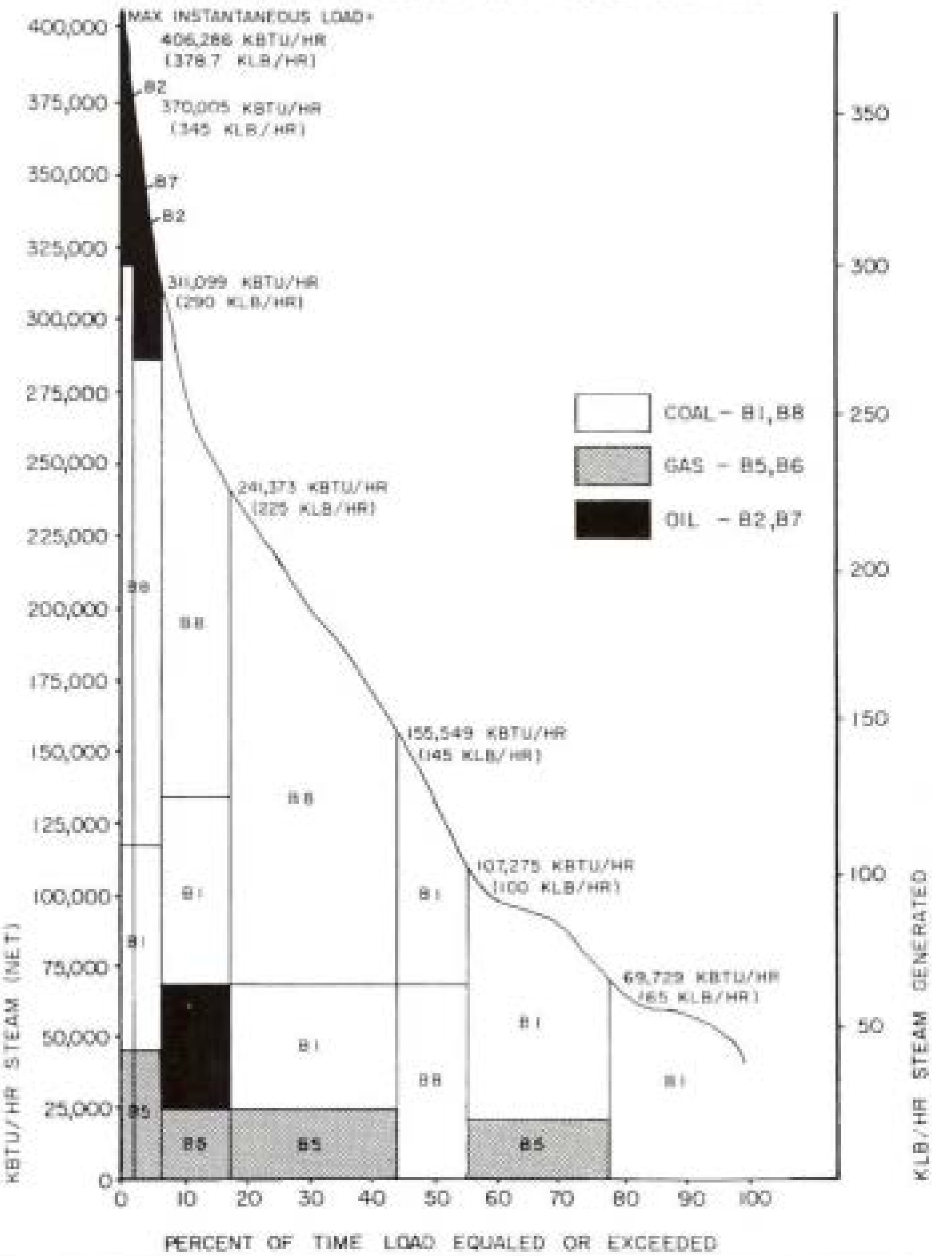
SINGLE AUTOMATIC EXTRACTION CONDENSING TURBINES-GENERATORS 100 PSIG EXTRACTION

Max. Throttle Flow (kpph)	Throttle Press. (psig)	Condenser Flow (kpph) Max./Min.	At Maximum Extraction, Full Throttle: Power (kW)	At Maximum Extraction, Full Throttle: Extraction Steam Temp (ºF)	At Zero Extraction, Full Throttle: Power (kW)
240	400	240/12	4020	340	20,000
245	800	245/18	9130	445	27,000
155	800	155/12	5810	445	17,000

(a) Turbines with smaller condensing sections were analyzed.

FIGURE 3

LOAD DURATION CURVE WITH BOILER DISPATCH



steam loads and swings. Above 145 kpph, the two coal boilers cannot adequately respond to load swings, so that a gas boiler is on-line at an average 25 kpph. Between loads of 225 kpph and 345 kpph, it is necessary to have at least four boilers on-line, and above 345 kpph five boilers are kept on-line.

Cogeneration Alternatives

The following major alternatives were studied for steam generation:

1) A new coal-fired plant operating at 800 psig; included were four coal-fired spreader stoker boilers with dry-gas scrubbers, and one gas/oil boiler for standby.

2) Existing boilers in the central heating plant.

3) A new coal-fired boiler added to existing boilers in the central heating plant.

This study was somewhat complicated by the fact that Boiler 8 is rated at 800 psig, Boiler 1 is rated at 400 psig, and all the remaining boilers are rated at 200 psig. A new boiler could be rated at either 800, 400, or 200 psig. This increases the number of cases that are possible for cogeneration. In addition, all existing boilers have different lifetimes and projected maintenance requirements.

Two main types of turbine generators are considered:

- *Straight non-condensing (SNC) turbine generator.* This is also known as topping or backpressure turbine. The different inlet conditions evaluated are:

1) 200 psig, 475°F
2) 400 psig, 550°F
3) 800 psig, 825°F

The outlet pressure is 100 psig (nominal) for export to campus.

- *Single automatic extraction condensing (SAC) steam turbine generator.* The inlet steam conditions are either 400 psig, 550°F or 800 psig, 825°F, depending on the case. Steam is extracted at 100 psig for export to campus and feedwater heating. The condenser flow has an average backpressure of 4" Hg.

Several sizes of each SNC turbine type were evaluated. The sizes of SAC turbines evaluated are listed in Table 3. Table 4 lists the cogeneration case studies without the addition of new boiler capacity.

Economic Evaluation

Cornell University is a nonprofit

educational institution and as such pays no taxes. Therefore, taxes and tax shields from tax credits and depreciation were not considered in the economic evaluation.

In addition, the university is able to borrow money for investment in building projects (including boilers and turbine-generators) at tax-exempt rates. At the time of the evaluation in 1983, long-term (twenty- to thirty-year) tax-exempt bonds were available at 9.5 to 10 percent. This is the effective cost of money for outside debt.

An annual rate of 11 percent was chosen as the cost of money to reflect the uncertainty in funding sources and the uncertainty of the return on investment funds. The sensitivity of the investments to different discount rates was checked.

Discounting & Cost Escalation Parameters

- General Inflation: 5 percent annual rate over all twenty years.
- Discount Rate: 11 percent annual rate over all twenty years.
- Construction Costs: escalate at general inflation rate of 5 percent annually.
- Variable & Fixed O&M: escalate at general inflation rate of 5 percent annually.
- Escalation Rate for Price of Fuels and Electricity: for all twenty years, the price of electricity and the price of all fuels (oil, gas and coal) were assumed to have a real price escalation of 2 percent annually, or a nominal annual escalation rate of 7.1 percent.

Value of Fuels (1983-84 $)

Since 1984 the prices for gas and oil have declined. In addition, the price for coal has increased because lower sulfur coal (less than 1.0 lb S/MBtu) has been specified to comply with site specific ambient air quality constraints. The average values of the three fuels delivered to the CHP in fiscal year 1983-84 (84 $) were:

- gas $5.50/MBtu
- oil $4.70/MBtu
- coal (depending on sulfur concentration)

0.6 lb S/MBtu	$2.52/MBtu
1.1 lb S/MBtu	$2.28/MBtu
1.9 lb S/MBtu	$1.90/MBtu

The low price for coal was used for backpressure (SNC) cases and the higher price for all condensing cases (SAC). The high price was used to reflect site specific constraints that were anticipated if the amount of coal fired was significantly increased. As shown in Figure 2, gas and oil prices have declined significantly.

Calculation of Life Cycle Economics

A simple computer model was developed on a personal computer to determine the annual fuel use and electric production for each case. This model was based on the dispatch shown in Figure 3.

The internal rate of return and net present value were calculated based on present and projected fuel costs and electric costs, combined with the calculated annual fuel use and electric production, and the capital cost for each case.

Cogeneration With Additional Coal Capacity

The existing coal boilers (Boilers 1 and 8) provide about 80 percent of the steam requirements of the university. The projected life of these boilers is about twenty years. Additional coal boilers, whether added at the existing CHP or as part of a new CHP to replace the existing CHP, would only be justified by their higher operating pressures for cogeneration, and by displacing the remaining 20 percent of the gas/oil fuel.

The study found that new coal boiler options were not economically justified. Increases in cogenerated electricity and displacement of gas/oil did not justify the extra capital cost, when compared to continued use of existing coal boilers.

Cogeneration Without Additional Coal Capacity

Figure 4 shows the electric production and the internal rate of return (IRR) as a function of the total project cost. Figure 5 shows the net present value (NPV) as a function of the capital cost.

As shown, the project (Case 1.11) with the smallest capital cost and smallest electric production has the largest IRR, but it also has the smallest NPV of the SNC cases. Case 2.20, which involves increasing the pressure on Boiler 8 to 800 psig, has the highest NPV. The largest NPV at 400 psig is Case 2.10, and the largest NPV at 200 psig is Case 1.10.

FIGURE 4

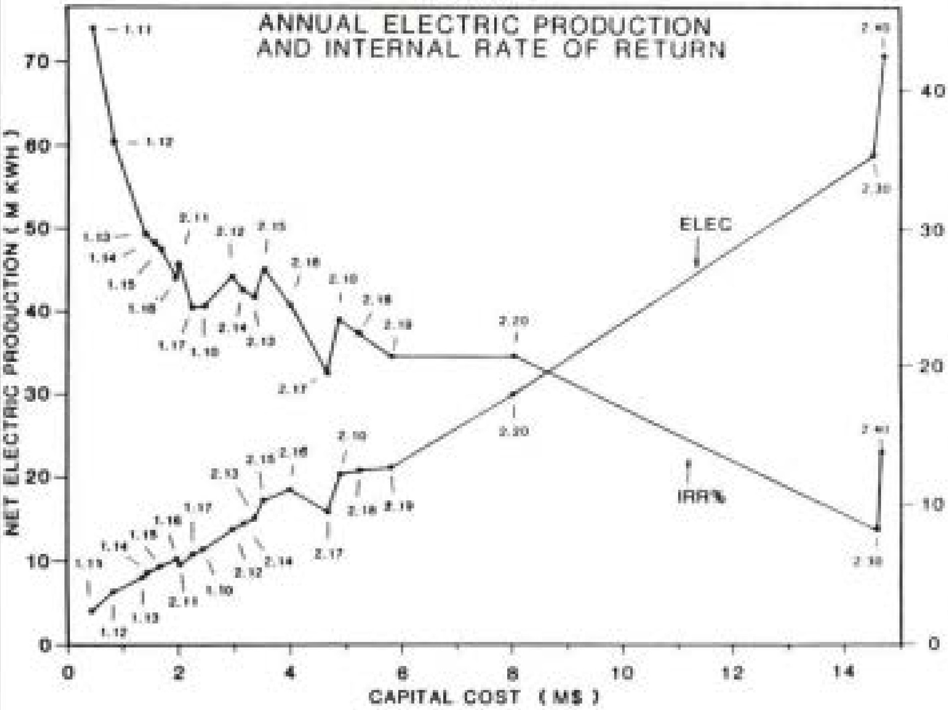


Table 4
DEFINITION OF CASES
COGENERATION CASES WITHOUT ADDITIONAL COAL CAPACITY

DESCRIPTION		TURBINE - GENERATOR SETS					
		TURBINE A			TURBINE B		
Case Number		Type	Flow (kpph)	Press (psig)	Type	Flow (kpph)	Press (psig)
All Boilers @ 200 psig							
1.0	Base Case	---	---	---	---	---	---
1.1		SNC(ss)	55	200	SNC(ms)	160	200
1.11		"	"	"	---	---	---
1.12		"	"	"	SNC(ss)	55	200
1.13	Two Each of Turbine A	"	"	"	SNC(ss)	55	200
1.14		SNC(ms)	100	"	---	---	---
1.15		"	130	"	---	---	---
1.16		"	160	"	---	---	---
1.17		"	190	"	---	---	---
B1 & B8 @ 400 psig							
2.1		SNC(ss)	55	400	SNC(ms)	160	400
2.11		"	80	"	---	---	---
2.12		"	80	"	SNC(ss)	80	400
2.13	Two Each of Turbine A	"	80	"	SNC(ss)	55	400
2.14		SNC(ms)	100	"	---	---	---
2.15		"	130	"	---	---	---
2.16		"	160	"	---	---	---
2.17		"	190	"	---	---	---
2.18		"	100	"	SNC(ms)	100	---
2.19		SNC(ms)	130	"	SNC(ms)	130	---
2.3		SAC	240	"	---	---	---
B8 @ 800, B1 @ 400 psig							
2.2		SNC(ss)	55	400	SNC(ms)	160	800
2.4		"	55	"	SAC	155	800

Key to Abbreviations:
SAC: Single automatic extraction condensing
SNC: Straight non-condensing
ss: Single Stage
ms: Multi Stage

The cases with SAC (condensing) turbines had low NPV and IRR values. The heat rate (Btu/kW-hr) more than doubled from the non-condensing backpressure cases, and the additional cogeneration did not justify the extra fuel costs and capital costs.

Project Implementation

Case 2.10 was chosen as the best case because it did not have the risk associated with increasing the pressure from a thirty-five-year-old boiler (Boiler 8), 200 psig to 800 psig on.

The project has a budget of $5.4 million. Start-up is scheduled for spring 1987. Figure 6 is a schematic diagram of the cogeneration project.

The key parts of the project are:

1. *Two SNC backpressure turbine generators* (400 psig throttle, nominal 100 psig backpressure).
   a. Single state turbine, 2 MWe asynchronous generator at 2,400 volts.
   b. Multistage turbine, 5 MWe synchronous generator at 13,200 volts.

2. *Steam pressure upgrade* from 200 psig to 400 psig for Boilers 1 and 8.
   a. Boiler 8: This involves new steam drum internals and a new superheater.
   b. Boiler 1: New trim.

3. *Steam and Feedwater System.* New feedwater pumps, feedwater lines, and steam lines are required. Included are:
   a. Spray desuperheaters to prevent thermal shock to downstream lines with a turbine trip.
   b. Pressure reducing valve stations.

4. *Condensate Polisher.* A new zeolite softener is added to polish condensate return.

5. *Steam Distribution System Modifications.* To modify the steam distribution system from superheated steam to saturated steam, additional traps and drip legs were required. In addition, a study was done to determine the need for new loops or lines to reduce the pressure drop in the system.

6. *Structural/Civil Costs.* A garage in an adjacent building was converted to a

FIGURE 5

NET PRESENT VALUE OF COGENERATION CASES WITHOUT ADDITIONAL COAL CAPACITY

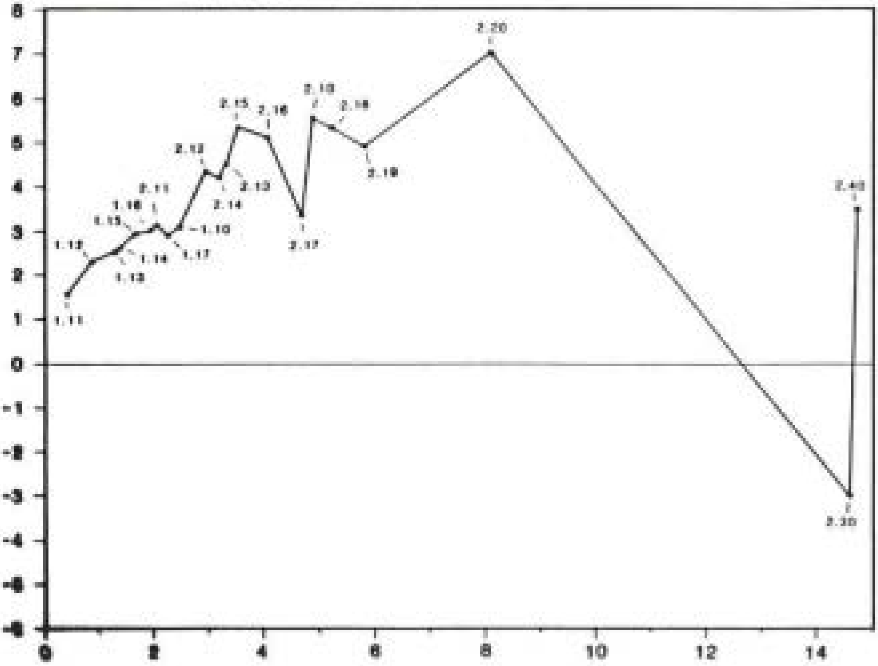
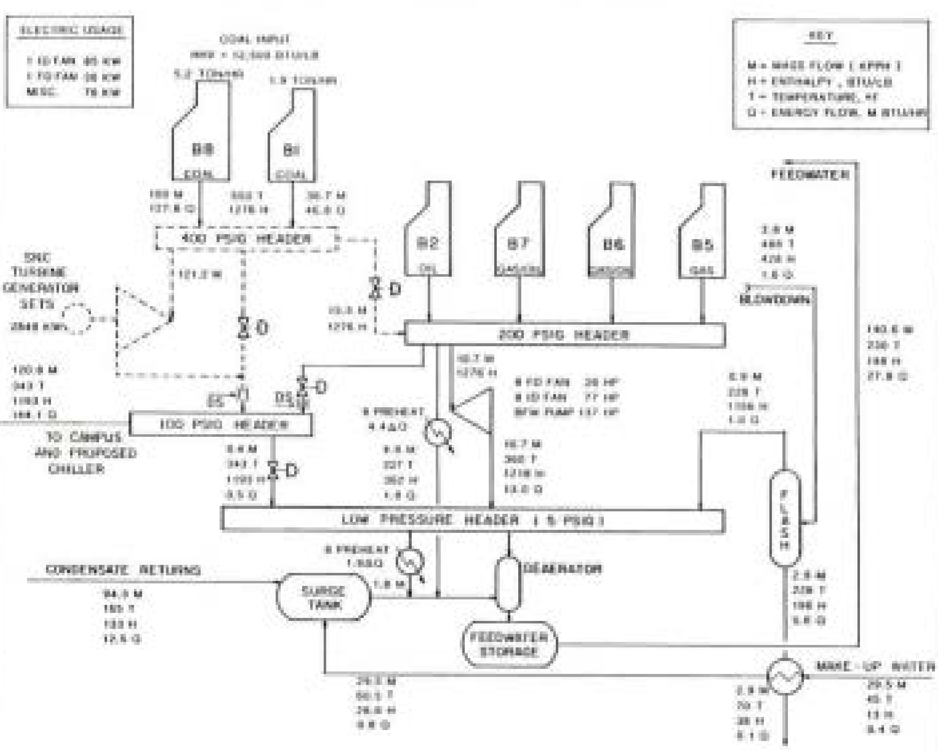


FIGURE 6

PROCESS FLOW SCHEMATIC AT MEAN ANNUAL STEAM LOAD



turbine-generator room. An interconnecting walkway is being constructed to allow access from the CHP.

Other associated projects for CHP upgrade at the present time include:

1. *Controls:* A controls project with a $1 million budget to replace the CHP controls with a new distributed digital control (DDC) system. The control system will include economic dispatch of boilers, pressure reducing valve stations, and turbine-generators.

2. *Boiler Fabric Filter.* A new fabric filter will be erected for particulate and opacity control for Boiler 1. Since 1981, Boiler 1 has not been fully permitted by the NYS DEC because of opacity violation.

3. *Coal Procurement.* Because of site specific dispersion problems, the coal sulfur specification was reduced from 1.9 lbS/MBtu (state-wide average limit) to 1.0 lbS/MBtu. The Free Swell Index was reduced to less than 5.0 to achieve better combustion on Boiler 8. As a result, fuel prices have increased. At present, all coal is supplied from eastern Kentucky coal fields.

4. *Electric System:* A new 750 kW diesel generator is being installed for emergency power. The medium voltage system is being converted from 240 kV to 480 kV.

5. *Performance Uprates for Boilers 1 and 8.* An aggressive effort to increase boiler efficiency and combustion performance has resulted in increased coal boiler duty. Efforts included improvements in control response, reductions in excess air levels, and increases in overfire air velocities and amounts.

Cornell's cogeneration project was funded by a $50,000 grant from the New York State Research and Development Authority and two grants from the New York State Energy Office: $300,000 for the turbine generator and $200,000 for controls. The rest of the facility was financed through a public debt issue.

Copies of Cornell's complete cogeneration study are available from the NYS Energy Research and Development Authority, Two Rockefeller Plaza, Albany, NY 12223; 518/465-6251. Ask for "Feasibility of Industrial Coal Conversion at Cornell University." ■

Management Resources

J. Roger Kurtz

If your department has developed an innovative program or utilized unique resources, please share them with us. Send a short description to Management Resources, FACILITIES MANAGER, 1446 Duke Street, Alexandria, VA 22314-3492.

Computer Applications

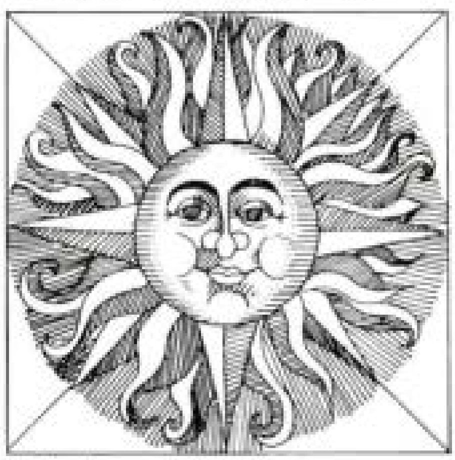
The U.S. Army complex at Ft. Irwin, California recently began using a computer-based facilities information system; the results have been a dramatic increase in efficiency and savings. Ft. Irwin, located in the Mojave Desert 150 miles east of Los Angeles, had been mothballed several times since its establishment in 1940, most recently for ten years, before the army reactivated it as a national training center. In all the transfers and transitions, records were lost and maintenance became a management nightmare. Before installing the new system, a complete inventory and deferred maintenance survey was made that was then entered in a data base. "Before this, our records were in such bad shape that the new inventory turned up about twenty buildings that we didn't even know existed," reports Captain Vance C. Johnson, chief of the project management branch. With the new system in place, any feature of the physical plant can be instantly tabulated. Maintenance needs can be anticipated and planned for, more precise budget forecasting is possible, and projects can be prioritized and monitored with ease.

Examining Building Flaws

Detailed case studies of structural failures and building flaws are being collected by the University of Maryland's Architectural and Engineering Performance Information Center. Under a grant from the National Bureau of Standards, the school is collecting 500 detailed case histories of buildings throughout the United States that have demonstrated some sort of structural failure. Included in the collection are the 1981 Kansas City Hyatt Regency skywalk disaster and the 1978 Willow Island concrete cooling tower collapse in West Virginia. Information is being gathered on a computerized data base that will have a variety of applications. Architects, for example, will be able to look for any history of structural failure in a particular type of building that they may be designing. Regulatory officials will be able to look at trends in codes and standards. Developers and building owners will be able to examine the performance of heating, roofing, ventilation, or wall systems. Even insurance companies may be able to use the information as a source for developing rate structures. Eventually the data base is intended to be accessible by computer over telephone lines.

Public Relations

The folks in the University of Virginia's alumni office like Bill Middleton—especially when he leaves town. Middleton, the school's assistant vice president for physical plant, has given the alumni office a standing offer to give presentations on behalf of the school whenever he's traveling on physical plant business. They took him up on it when he went to Denver recently, where he took some time to give a slide show and presentation about UVA happenings to a group of local alumni. "There are all sorts of opportunities for this," says Middleton. "We have alumni all over the place." It's a good idea for the school, and a great way to get on the good side of the alumni office!



Solar Energy

A half-acre solar pond that will be used to help heat a hog research building is in the works at the University of Illinois/Urbana-Champaign. The pond uses salt to store heat energy—2,000 tons of it. As it sinks, the brine at the bottom stores the energy, while the fresher water on top serves as an insulating layer. The salt will be recycled, and the bottom and sides of the pond lined to prevent salt loss and groundwater contamination. About 25 percent of the winter heat needed to warm a building housing 240 Chinese hogs will be generated by the system. The energy will also be used to dry corn. Funding for the $362,000 project is being provided by the university, International Salt Company, and Gundle Lining Systems, Inc. The pond is scheduled to be completed and in operation by the summer of 1988.

Photo by Public Relations Union College

Nott Memorial

Too Marvelous to Demolish

Union College in Schenectady, New York is deciding what to do with Nott Memorial, the domed, 16-sided, Victorian Gothic building in the center of their campus that after 112 years has fallen into a serious state of disrepair. It began in 1875 as a "Graduate's Hall," in which ceremonies and banquets could be held. At the turn of the century it was transformed into a library but later, as the books outgrew the building and the structure began to weaken, it was used as a makeshift theater. Today there is a theater in the round on the first floor and a bookstore in the lower section of the building. The upper floors and the dome have been closed for structural reasons. In the early 1970s an architectural firm examined the building and warned that immediate repair of the slate roofs was necessary for the building to avoid "demolition by neglect." Part of the problem, the architects noted, was the awkwardness of the building. Too marvelous to demolish, an 80-foot round room 100 feet high with two encircling galleries is nevertheless impractical for many uses. Renovation would also be quite costly: $2 million for the exterior and possibly $4 million for the inside. Jack Hill, Union's director of campus operations, said plans are to completely rehabilitate the building by 1995, the school's centennial year. The question is how to use it. "We've had lots of ideas," says Hill, "including things like a computer center, a museum, or a full theater." Tearing it down is out of the question since the building is an integral centerpiece for the campus. But just what the Nott Memorial will hold in its second century remains to be seen.

Birdproofing

What problem can air conditioning systems and orchards have in common? Birds—as the University of Illinois/Urbana-Champaign has discovered. The university has forty large tonnage, induced draft, redwood cooling towers that transfer heat from its air conditioning system to the atmosphere. The system worked fine until the birds—mostly pigeons—took a liking to the towers. Bird droppings, nesting debris, mottled feathers, and dead birds would plug sump screens and spray headers, slowing the water flow rate and reducing the efficiency of the towers, according to James Black, foreman for refrigeration at the university. In addition, bacteria would form, causing the wood to rot and posing a health hazard for workers. Since removing or disposing of birds is expensive and usually ineffective, the university decided to construct large screens around the towers. At first they used hardware cloth on wood frames, but this proved expensive and deteriorated quickly. Copper screening was tried next, which lasted a little longer but was also expensive and labor intensive to remove and replace when doing routine maintenance. Finally, reports Black, they discovered a polypropolene netting used by growers to protect fruit on trees and bushes from birds. The 7/8" square mesh can withstand sunlight, is lightweight, and resists mildew, acids, alkalis, and other chemicals. It can also be stapled directly onto the framing of the towers and removed and refastened quickly.

Master Planning

Ohio State University is planning ahead. The January 1987 issue of *Athletic Business* reported that last year OSU completed a comprehensive facility construction master plan that outlines the university's construction and renovation projects for the next twenty-five years. The study took one and a half years and $200,000 to complete, but that bill represents less than half of one percent of the cost of implementing the first phase of the master plan itself. Called the "scarlet phase," it will feature between $40 million and $45 million worth of renovation and new construction by 1990. Ohio State has not undertaken a major facility project in twenty years, and Athletic Director Rick Bay believes that improving the facilities is necessary for maintaining success on the playing field. "Schools that have made great strides in their competitive abilities in recent years . . . have done so after making strong commitments to their athletic facilities," he said. The scarlet phase calls for a multi-purpose athletic facility, a weight training center, a sports pavilion, and the development of a site for a sports park that would include softball and baseball fields, practice fields, a cross country course, and tennis courts. Also included in the first phase is facilities renovation of the Ohio Stadium, the St. John Arena, Finch Field House, the golf course, and the ice arena. In 1991 the second, or gray, phase would begin. It calls for completion of the sports park stadiums and completed renovation of the main stadium and other facilities. Assistant Athletic Director Dan Meinert has emphasized that the plan is not a fixed timetable; he sees it rather as a list of priorities. Funding for the master plan will come from contributions to the university's capital campaign, which has the goal of raising $350 million for a variety of academic, athletic, and extracurricular activities.

Reactor Shutdown

The University of California/Berkeley is planning to shut down and decommission its nuclear research reactor, according to a recent report in *The Chronicle of Higher Education*. The higher education weekly quoted Roderic Park, vice-chancellor of the university, as saying that the reactor was being closed due to declining research use and political opposition. The reactor has been a target of criticism ever since it was opened twenty years ago. Nuclear research will continue at the school, but only with accelerators that do not produce radiation. Dismantling the reactor could take up to four years to complete.

The Bookshelf

Labor Critiques Management

Chaos on the Shop Floor: A Workers' View of Quality, Productivity, and Management, by Tom Juravich. Philadelphia: Temple University Press. 1985. 224 pp. $19.95, hardcover.

Tom Juravich's book *Chaos on the Shop Floor* is a case history but reads like a novel. Having spent six months "on the shop floor," he is knowledgeable and battle-scarred from his repeated encounters with the high-speed production machinery and, more frustratingly, his encounters with management.

The main theme of *Chaos* is carried consistently throughout the book and is illustrated again and again through actual experiences with the machines and the operators with whom Juravich worked. He struggles with the frustrated machine-operators who know their machines from years of operating experience and who try to improve the operation and thereby the company profit picture by suggesting better ways to do things. The operators are not ever listened to by management.

Contemporary literature has numerous examples of the "deskilling of labor in the twentieth century," as Juravich calls it. The plant where the author worked could be cited as a perfect example of the deskilled jobs about which so much has been written. "One comes away [from reading the conventional wisdom] convinced that little skill is necessary to perform most factory jobs . . . yet these 'simple' tasks often look quite different from the shop floor."

The author proves his point, at least to his own satisfaction, when he attempts to do a "simple" sewing operation. "I asked her to show me how to sew. It took me five minutes to sew a single assembly and it came out completely wrong. It was clear to me that a worker could not walk in off the street, sit down at the machine, and make her rate." To the usual argument that manual dexterity is all that is required, the author cites cases where workers perfect "ingenious technique" to accomplish their job. As time went on the author "began to see the women's work from the inside. I noticed a host of skills that facilitated production. In fact, I was surprised how fundamental this 'craft knowledge' was to the operation.

Extremely interesting is the discussion of "The Forgotten Insight of Taylor." Frederick W. Taylor published his classic, *The Principles of Scientific Management* in 1911 and changed the face of the industrial world forevermore. But Taylor's ideas were complex and tedious and were never implemented in the great majority of small, localized manufacturing plants. Some large firms adopted the ideas proposed by Taylor, but the bulk of industry, as represented by the smaller plants, was essentially left unaffected.

The dramatic success of Japanese industry yields many interesting points, but the chief reason for this success, in Juravich's opinion, is based on techniques of production proposed by Taylor rather than the product of Eastern ethic. These Tayloresque techniques involve a meticulous attention to detail that Taylor espoused and the application of these principles can be said to be the root reason for the new Japanese manufacturing skill.

Juravich takes a critical look at a fairly recent industrial phenomenon known as "quality control."

> The continuing decline of basic industry and the intrusion of foreign products into our markets have stimulated much discussion about the quality of American products. . . . The tone of contemporary advertising would seem to indicate that American industry agrees with its critics. The emphasis on quality in company slogans is indicative perhaps of a corporate guilt-complex. 'Where quality is job one,' 'we really sweat the details.'

One must wonder if something else is behind the stress on quality, if perhaps a different kind of flaw is being concealed.

Many times a quality improvement program is tied to improving productivity. In many ways high volume and high quality are a contradiction in terms; quality programs often tie them together. Because of this the focus is on workmanship rather than on quality. A more apropos description would be to call them "productivity circles." This thesis is supported by the author's experiences with quality control on the shop floor. A corollary to the quality program is, in many cases, the cost to the workers of their precious craft pride. Workers are being checked—and judged—by someone who does not know or understand the job as well as they do. Their "craft knowledge" of the job is ignored or downplayed as not important to the operation.

In his final analysis the author used the word "irrational" as a synonym for management mentality and their attitude towards workers on the production line. Juravich found that much of the irrationality where he worked was due to a management style insisting on full control of all floor activities and seeing workers' craft knowledge as unimportant. Management embraced the ironhanded side of Taylor while ignoring the importance he granted to craft knowledge.

The author sees a trend here in American industry that bodes ill for our national ability to compete with other nations that are becoming more and more proficient at producing quality products and that are daily sharpening even further their collective skills to outperform this nation.

This nation is at a crisis state in manufacturing processes. In one way or another this crisis touches all Americans, but obviously affects some more than others. We can come through this time of trial if we realize that the skills and expertise we need are even now available to use. These skills are hidden in the production line workers, who are now considered for their hours on the job rather than for what they know.

Juravich concludes, "The managers in this country, at present blinded by their own schemes, possess a source of tremendous potential strength in the workers they choose to ignore. It is a source they must learn to tap before it is too late."

Chaos on the Shop Floor is available from Temple University Press, Broad & Oxford Streets, Philadelphia, PA 19122.

—Walter H. Holm
Director of Physical Plant
Eastern New Mexico State University
Roswell, New Mexico

Managing in the Real World

The Realworld Management Deskbook, by Auren Uris. New York: Van Nostrand Reinhold Company, Inc., 1983. 312 pp. $24.95, hardcover.

Duties and responsibilities of physical plant directors are often categorized similarly to those of managers in industry. *The Realworld Management Deskbook* offers modern strategies to help fulfill these assigned functions. But before developing strategies, the author emphasizes the need to understand the subtle yet ever-present undercurrents within a working environment. Uris suggests that in business, things are not as they seem on the surface. The realworld of management can be "one of big and small injustices, of favoritism, sexual harassment, of pretense and politics." Certainly, the unique setting of higher educational institutions offers a blend of these ingredients that are usually hidden from the public. And given a plant director's relationships with the many and varied aspects of campus life, reality dictates an awareness of the workplace. A plant director must have the ability to separate fact from fiction.

Few can argue with the author's contention that the business world is changing. "American business" no longer equates with "unqualified leadership." The technological revolution continues. And even within plant operations, automation and computerization has affected the office, the boiler room, energy management, security, storeroom activities—the list goes on. Perhaps, most importantly, relating to and dealing with people problems calls for ever increasing skills. Individuality means managers/directors cannot evoke a common cure for all ills. Employees are more demanding and at the same time indifferent. "Why" has become the constant challenge on the minds of workers.

Thus, Uris sets the premise for another "how to" book. Having read many such presentations over the last several years, I have found few management theories that have actually been applicable to physical plant operations. Yet books such as *The Realworld Management Deskbook* may offer ideas or thoughts relevant to day-to-day happenings. An idea's value may not be evident until weeks or months after reading but indeed eventually proves useful.

Within the framework of a changing realworld, managers must prepare themselves or be left behind. Professionalizing is Uris' prerequisite to managerial success; he believes managers should constantly pursue higher standards of performance. Self-image, ethics, and emotions are especially influential in a manager's reactions to professional responsibilities. Uris contends that self-image and ethics can be refined, molded, and thus, professionalized. Such emotions as a consistent positive outlook create a "unity of mind and behavior that optimizes managerial capabilities." All attributes interface to create the "professional."

Also stressed is the manager's need to update his or her capabilities, especially future-oriented ones. For example, the impact of the technological revolution cannot be ignored. Some managers will only be peripherally changed but most will be directly affected. Successful managers create an awareness of change; negating shortcomings affects future benefits. Those who try to just "get by" for an extended period of time undoubtedly will be passed by. Failure to adjust and readjust depicts a lack of foresight that is inexcusable.

Later chapters emphasize human relations in the workplace. Noteworthy points include:

1) *The need to motivate employees.* Traditional techniques appear outmoded. Uris thinks new strategies lead to a more realistic approach in motivating employees. One discussion centers on the positive aspects and pitfalls of praise. Interestingly, one pitfall commonly seen on college campuses is praising everyone alike, which is the equivalent of praising no one. A blanket, unmeaning praise of the group by a plant director or a president negates the efforts of the truly deserving. The use of praise must be precise, more directional.

2) *The relationship to peers.* Plant directors need good lateral relations to overcome daily problems as well as major crises. Joining forces with peers develops informal contacts necessary for workplace sanity if not survival.

3) *The boss-subordinate relationship.* Uris points out that middle managers such as plant directors are themselves sometimes the boss and sometimes the subordinate. What the manager expects of his boss likely applies equally to himself in the eyes of subordinates. From this vantage point managers can reap double rewards by the development of good boss-subordinate relations.

A particularly sensitive issue stems from sex-motivated behavior. As women assume roles traditionally held by men, sexual overtones become commonplace. Managers must ensure fair and equal treatment of all employees. The potential charges of sexual harassment only compound the problem of doing so. Obviously, the subject is controversial. The knowing manager must "be prepared to deal with it in a systematic and reasoned way so that injustice and destructive consequences can be prevented," according to the author.

In his presentation Uris covers topical and relevant issues to plant operations. And although many ideas are not particularly original, they are laden with a common sense approach to everyday problems. The book reads easily; the content is often simplistic. Uris spends a great part of the book discussing realworld applications of his thoughts, but they are often one-dimensional. The reader must understand that ideas presented in various chapters are actually intertwined into a complicated maze of interpersonal feelings and human relations.

The Realworld Management Deskbook is available from Van Nostrand Reinhold Company Inc., 115 Fifth Avenue, New York, NY 10003.

—Larry Nokes
Director of Physical Plant
Pittsburg State University
Pittsburg, Kansas

Dealing with an Adverse Economy

Opportunity in Adversity: How Colleges Can Succeed in Hard Times, by Janice S. Green, Arthur Levine, & Associates. San Francisco: Jossey-Bass Inc., Publishers, 1985. 317 pp. $21.95, hardcover.

This book is about dealing with adversity in higher education today. The chapters were written by different authors, all with different writing styles, tending to make reading somewhat disjointed. There are extremely well written portions of the book, and many of the points brought out can be applied to management situations anywhere. All in all, the book is worth wading through to gain the insights offered.

One of the graphic comments in the book is, "Adversity is of no use to the uninspired and absolutely devastating to the timid." Adversity actually gives managers in any field an opportunity to exercise their own brand of leadership and initiative, and should be viewed positively rather than negatively.

The multitude of problems facing colleges and universities today is well documented, but also with some redundancy. These problems are identified to include: a deteriorating level of preparation by those students entering higher education; an emphasis by institutions on competition rather than cooperation; the temptation to set standards and measurements; institutions competing with business training; institutions trying to attain curricular panaceas; declining enrollment; the population growing older; and the demand by students for job preparation.

The highlight of the book was Chapter 5, which was written by the president of a small college and delightful to read. He writes a great deal like Peter Townsend in *Up the Organization* and leaves the reader with a good feeling about the writer. He includes ten lessons from his experiences that are clear, concise, and appear to be usable.

Various college or university presidents are quoted throughout the book, and three of the phrases struck me as particularly interesting. The first alludes to the average stay of institution presidents being seven years: "Eventually one manages to make at least one decision against the conviction of virtually every member of the faculty." The second phrase describes one of the reasons a particular college president was replaced: "He faced extraordinarily difficult decisions, consulted widely, and then postponed." The third phrase is: "A president must be prepared to accept a defeat engineered by others without exposing those who are actually at fault." These three phrases can be applied to and by managers everywhere.

A major adverse factor affecting higher education is when the image of an institution as perceived by prospective students is different than the institution desires. One college hired a consultant to find out how they were being perceived by prospective students; what they found was not to their liking. That college was perceived as "traditional, unexciting, socially limited, and restricted to a few strong academic areas."

This points out that the public image of an institution often does not match the self-perceived mission, or direction, of that institution. Once a public image has been established, it tends to remain set unless there is an ambitious, self-conscious campaign to change it.

The difference between the perceived image by outsiders and the institution's mission statement is often quite great. A good statement of mission, or of direction, is important to an institution as well as just good management. The statement of mission should parallel the perceived image of outsiders. Well written statements of mission establish priorities, definitions, standards, and guidelines. Ways to prepare mission statements are described well in the book, but are difficult and time consuming.

My overall impression of the material is that leaders make the difference, and they can alter the trends by encouraging innovation and critical thinking. Leaders are cautioned not to talk of serious matters in vague generalities or platitudes. Institutions should be more than merely weather vanes, by planning *with* rather than for, and then establish priorities. It would help to apply coping-with-stress techniques to institutional situations as opposed to individual situations.

A consensus emerged that a key issue in higher learning is not what students should be exposed to and asked to reproduce, but what students should be able to do with their lives as a result of having gone to college. There are times to join the chorus and times to take the lead. The book stresses that now is the time to take the lead and make opportunities out of adversity.

Opportunities in Adversity is available from Jossey-Bass Inc., Publishers, 433 California Street, San Francisco, CA 94104.

—Dan R. Pilkington
Director, Department of General Services
City of Las Vegas
Las Vegas, Nevada

Index, *Facilities Manager*
Volumes 1-2, 1985-1986

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AUTHORS

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Classified line advertisements: Line ads are set in 7-point type at the rate of $5 per line or fraction thereof (5-line minimum charge); includes heading, address, and telephone number.

Classified boxed or display advertisements: Boxed ads are set in 8-point type with 10-point heads. Classified display ads must be camera-ready, black-and-white, and not longer than 3 inches. The column width is 2-1/4 inches. The rate for boxed or display ads is $40 per column inch, measured to the nearest quarter-inch (2-inch minimum charge).

Discounts: Discounts and agency commissions are not allowed for any classified advertising.

Closing dates: **May 29** for the Summer issue; **August 28** for the Fall issue.

Address: Send all classified advertisements or requests for further information to— Classifieds

FACILITIES MANAGER
1446 Duke Street
Alexandria, Virginia
22314-3492

Videotapes

Institutional Cleaning Techniques Series. Order all seven tapes currently available in the series and receive a 10% discount.

- Orientation to Institutional Cleaning
- Daily Carpet Maintenance
- Periodic Carpet Maintenance
- Resilient Floor: Daily Care (Part I)
- Resilient Floor: Daily Care (Part II)
- Resilient Floor: Periodic Restoration (Strip & Refinish)
- Restroom Sanitation

Regularly priced at $195 per tape ($170/APPA members), your price, when you buy the entire series, is only $1,228.50 ($1,071/APPA members). Specify either 1/2" VHS or 3/4" U-matic format. Add $7 shipping/handling; nonmembers must prepay. Order from APPA, 1446 Duke Street, Alexandria, VA 22314.

Grounds Maintenance Series. Order both tapes in this series—*Pruning of Woody Plants* and *Seeding and Sodding*—and receive a 10% discount. If purchased separately, your cost would be $330 ($285/APPA members). With the discount you pay only $297 ($256.50/APPA members). Specify either 1/2" VHS or 3/4" U-matic format. Add $7 shipping/handling; nonmembers must prepay. Order from APPA, 1446 Duke Street, Alexandria, VA 22314-3492.

Management/Supervision Series. Order all four tapes in the series—*Fundamental Skills of Managing People, Fundamental Skills of Communicating With People, Using Positive Discipline,* and *Giving Orders and Instructions*—and receive 10% discount. Regularly $1,050 each ($895/APPA members), the entire series may be purchased for $3,780 ($3,222/APPA members). 3/4" U-matic format only. Add $7 shipping/handling; nonmembers must prepay. Order from Publications, APPA, 1446 Duke Street, Alexandria, VA 22314-3492.

Publications

Facilities Audit Workbook, by Harvey H. Kaiser. Newly reprinted with updated reference section. Step-by-step approach helps you assess the quality of your physical plant and establish maintenance priorities; includes sample rating forms that can be modified to any facility. $35 ($25/APPA members) + $5 shipping/handling; nonmembers must prepay. Order from Publications, APPA, 1446 Duke Street, Alexandria, VA 22314-3492.

Chemical Hazards: OSHA's Hazard Communication Standard. This information-packed program manager's guide has everything you need to develop your own Right-to-Know training program. Includes a summary of the OSHA standard, formats for maintaining hazardous chemicals inventories, explanation and samples of the Material Safety Data Sheet, lessons, overhead transparencies, and posters for the workplace. $80 ($60/APPA members) + $5 shipping/handling. Order from Publications, APPA, 1446 Duke Street, Alexandria, VA 22314-3492.

1984-85 Comparative Costs and Staffing Report for College and University Facilities. Includes energy cost and consumption data. $50 ($25/APPA members) + $5 shipping/handling. Supplementary floppy disk also available. Request data either on ASCII or DataEase format. $15 each. Order book and/or disk from Publications, APPA, 1446 Duke Street, Alexandria, VA 22314-3492.

Proceedings of the 73rd Annual Meeting of APPA (Improving Management Through New Technologies). $21 ($15/APPA members) + $5 shipping/handling. Order from APPA, 1446 Duke Street, Alexandria, VA 22314.

Financing Campus Energy Conservation Projects. Collection of eight papers covering alternative financing, shared savings, municipal lease financing, bond fund pools for small institutions, and other strategies. $27 ($15/APPA members) + $5 shipping/handling; nonmembers must prepay. Order from APPA, 1446 Duke Street, Alexandria, VA 22314-3492.

Manual of Roof Maintenance and Roof Repair. Contains in-depth information pertinent to roof inspection, maintenance, repair, reroofing, and the causes of problems in built-up roofing and flashing materials. $17 ($12/APPA members) + $5 shipping/handling; nonmembers must prepay. Order from Publications, APPA, 1446 Duke Street, Alexandria, VA 22314-3492.

Index of Advertisers

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