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Energy Conservation in Uniroyal, Inc.

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By

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ABSTRACT

In the last year, rapid developments have led to the establishment of industry conservation goals and monitoring by the Department of Commerce and the Federal Energy Administration, via the various industry associations.

Since 1972, Uniroyal has progressed more than half way toward the 1980 goal of 15% established for the rubber and chemical industries. This paper will describe details of the program with emphasis on new input, such as the computerized tracking method now in use.

Plant studies have provided an assessment of "base" loads vs. process loads, important when considering unit energy consumption. These vary, particulary with the climate and with the ratio of electrical to fuel energy inputs. Also, in-plant metering of steam has produced some surprises. Priorities for projects and lines of attack for conservation depend upon such analyses.

Of great importance is the energy content of raw materials and programs to reduce or recycle rejected portions.

A study of organization for conservation in various other companies was made to develop recommendations for improving the Uniroyal program. A composite of the best features will be presented.

INTRODUCTION

During the year 1974, the Federal Energy Administration and the Department of Commerce have been working closely with various industry groups to bring the matter of energy conservation into better focus. In most cases, the linking pin for this activity has been the appropriate industry association. Most manufacturers belong to industry associations and furnish them figures on various subjects, and often use these associations to assemble information and deal with matters of mutual interest--in particular with government bodies.

Thus, it was natural to use this connection to establish goals for conservation and to establish a format and channel for measurement of progress toward these goals. It was also thought by many that the establishment of voluntary goals and monitoring would reduce the likelihood of mandatory or arbitrary action on the part of the government.

Almost any measure of conservation has its own pitfalls. The preferred measure is unit consumption; that is, total energy consumption in Btu divided by pounds of production. The biggest pitfall in this is the problem of base load, as we shall see later. Another trap is change in product mix. Radial tires consume more energy in their production than conventional crossply tires, and the percentage of radials has been increasing right along. While radials save more than enough energy on the road to offset this, the tire producers' figures on unit consumption are penalized.

Btu's in fuels used are added to the equivalent electric power usually taken at 10,000 Btu/kwh. Adjustments are made for product mix and for OSHA/EPA required devices using energy.

Uniroyal, being in a variety of businesses, reports through several industry associations --for textiles through the ATMI, for chemicals through the MCA, and for rubber products through the RMA.

GOALS, 1974 RESULTS, AND FUTURE PLANS

Uniroyal has set a goal to reduce unit energy consumption 15% by 1980, using 1972 as the base year. This is in keeping with goals established by the various industry associations, after considerable discussion with the United States Department of Commerce and the Federal Energy Administration. That is not to say that we will necessarily be satisfied with that level of performance once it has been achieved. We intend to continue our efforts indefinitely.

Although our operations in other countries are also participating in the overall Company conservation program, they are not involved in the specific goals established for the United States. In Canada the government has begun similar activity through various industry associations, although this has not yet reached the same stage as in the United States.

Our facilities in the United States operated in 1974 at a unit energy consumption about 7% below that of 1972, in spite of the dips in the economy in the last quarter of the year. Where heating and air conditioning loads represent the major portion of the load, some rather striking accomplishments were recorded. Some examples:

1. In a large industrial park / warehousing complex which we operate in Ohio, we used 17.5% less electric energy in 1974 than in 1973. An even greater reduction was made in fuel over the 1973 heating season--average coal usage was reduced from 52 to 18½ tons/day.

2. In the new corporate management and research complex in Connecticut, electrical energy in 1974 was reduced 16% from 1973 and oil consumption, 42%. Both of the above kinds of reduction were made largely by changing operating criteria and establishing close policing of the operations.

3. A new computer-controlled, load - shedding system is being installed in the Connecticut complex and is expected to save an additional 15% in energy. The cost of installing such a system in any facility depends to some extent on the amount of centralized wiring and controls already existing. In this case, we had just about everything but the computer unit and soft-wear itself--therefore, the payout is very fast. We are evaluating the advisability of installing load - shedding systems in two factories, one of which is new and has a rather complete and integrated wiring system--the other is older and will require considerable wiring. In the older plant, about one-third of the cost would be in installation, including wiring. Nevertheless, a payout of less than two years is anticipated. Interestingly, not all of the energy to be saved is electrical. For example, some of the devices subject to periodic shedding are air-moving units (fans and blowers), many of which, when operating, are bringing in cold air and exhausting heated air. In these instances, electrical load - shedding will also reduce fuel consumption.

4. Other steps taken or planned by various plants include much more complete steam metering to pinpoint usage (which has already produced a number of surprises), reduction of air flow in buildings, substitution of low-energy fluorescent lighting for higher intensity fluorescent lamps, relocation of air intakes, tuning up boiler operation, installing stack gas heat recovery devices, changing to spot from area lighting, repairing broken glass windows with plastic, use of air-cleaning devices to allow more recycling , flash steam recovery, automatic shutdown valves on major equipment, replacing oversized motors, installing or extending condensate recovery systems, preheating raw water makeup with exhaust steam (e.g., from steam-driven pumps), reduction of mixing and curing cycles, improved cooling water systems and heating coil arrangements.

Our goals for 1975 are much more specific than last year and the year before, and our total company goal is an actual weighted composite of the goals of each plant. These, in turn, are made up of savings from specific projects, each of which has a time schedule and follow-up plan.

INFORMATION FLOW - COMPUTER PROGRAM

Early in Uniroyal's energy program, it was decided to redesign the format of the log sheets used at the factories, to accomplish four main objectives:

1. Establish uniformity of terminology and system.
2. Provide the plant engineer with data he needs.
3. Allow for monitoring by corporate engineering.
4. Build a data base for engineering design and for utility contract negotiations.

This redesign was done in a workshop held at Company headquarters in October, 1971, by a task force made up of plant, divisional, and corporate engineers, and placed in use at the beginning of 1972.

The result was a series of four log sheets for each plant so designed that they can be kept running for a full year. Each month's information is entered on a new line below that for the previous month. Samples of these log sheets are shown in Figures 1, 2, 3, and 4.

Initially, the key data from these log sheets were plotted on graphs. By the end of 1972, it was possible to include a 12-month's moving line for each of the factors being plotted:

Electrical Load Factor

Kilowatt Hours Per Pound of Product

Pounds of Steam Generated Per Million Btu Fuel Burned

Pounds of Steam Per Pound of Product

Several typical graphs were displayed at the April, 1974 UMR-MEC Conference. The maintenance of these graphs for 80 factories consumed excessive time, and at the end of 1973, a program was written to suit our computer configuration and provide a monthly printout. This printout presents data for the latest month and for 12-months moving, so that seasonal variations are eliminated. All plants and Divisions are included, and copies of the printout for each Division and plants within the Division go to each Divisional Coordinator and are available for use by corporate engineering staff. This is the general source of information on energy usage for management, industry associations, and government.

Besides the four factors mentioned above, the printout shows considerable other useful information, including Divisional progress toward goals. Sample divisional and plant pages are shown in Figures 5 and 6.

A diagram of the information flow described above is seen in Figure 7.

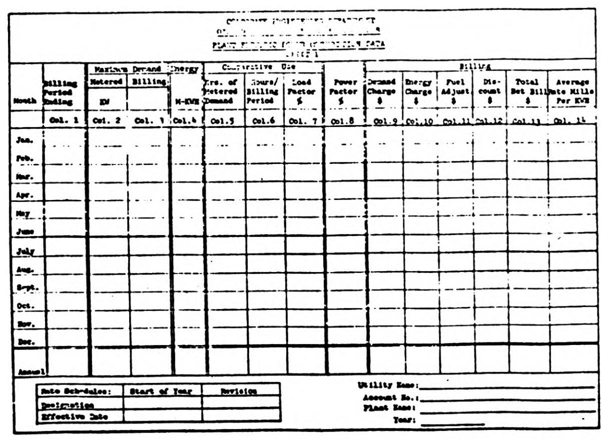


FIG. 1

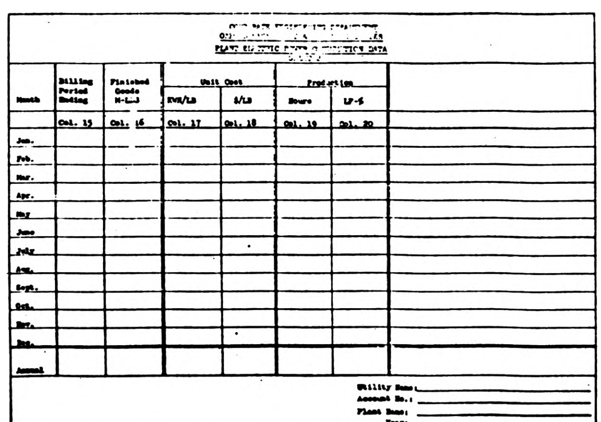


FIG. 2

CORPORATE [illegible] DEPARTMENT
OXFORD [illegible] CENTER

POWER SERVICES REPORT
Steam and Water

Month	Prod. M lbs.	Steam Generated M lbs.	Fuel* Consumed	Fuel* Consumed	Fuel* Cost M $	Fuel* Cost M $	$ Steam / MM BTU	$ Steam / # Prod.	Fuel* Cost / MM BTU	Fuel* Cost / MM BTU	City Water M Gals	City Water Cost $	Gal. C.W. / #Prod.	City Water Cost($) / M gal.
Jan.														
Feb.														
Mar.														
Apr.														
May														
June														
July														
Aug.														
Sept.														
Oct.														
Nov.														
Dec.														
Total														
Aver.														

*Enter Fuel category and units of measure for primary and secondary boiler fuel.

Utility Name: ______
Account No.(If Any): ______
Plant Name: ______
Year: ______

FIG. 3

CORPORATE [illegible] DEPARTMENT
OXFORD [illegible] CENTER

NON-BOILER FUEL REPORT

Month	Fuel No. 1 Type (1)	Qnty. (2)	Cost (3)	Cost / MM BTU	Fuel No. 2 Type (1)	Qnty. (2)	Cost (3)	Cost / MM BTU	Fuel No. 3 Type (1)	Qnty. (2)	Cost (3)	Cost / MM BTU	Total Cost Boiler and Non-Boiler Fuel	Remarks
Jan.														
Feb.														
Mar.														
Apr.														
May														
June														
July														
Aug.														
Sept.														
Oct.														
Nov.														
Dec.														
Annual														

(1) Indicate Type: e.g., oil, coal, gas, etc.
(2) Indicate Units: tons, gals., lbs. (of fuel).
(3) Cost: Total dollars for this fuel.

Utility Name: ______
Account No. (If Any): ______
Plant Name: ______
Year: ______

FIG. 4

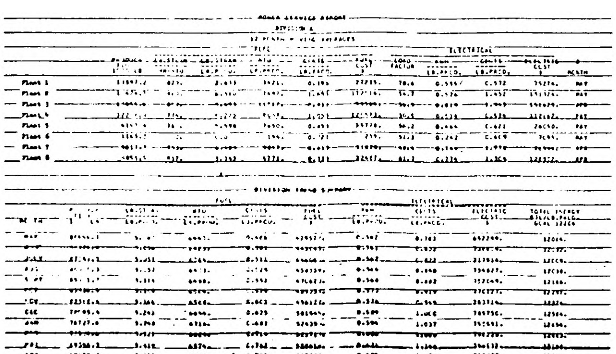


FIG. 5

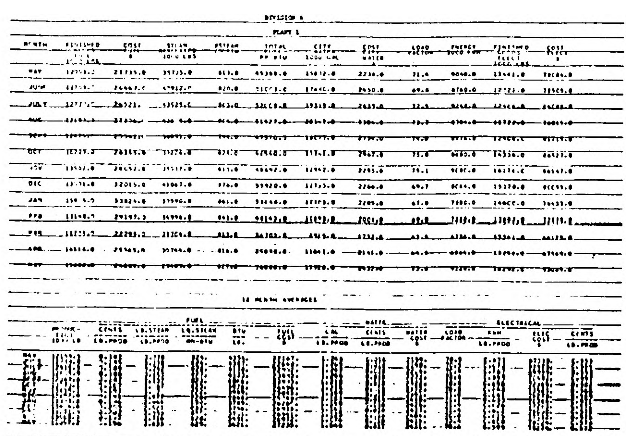


FIG. 6

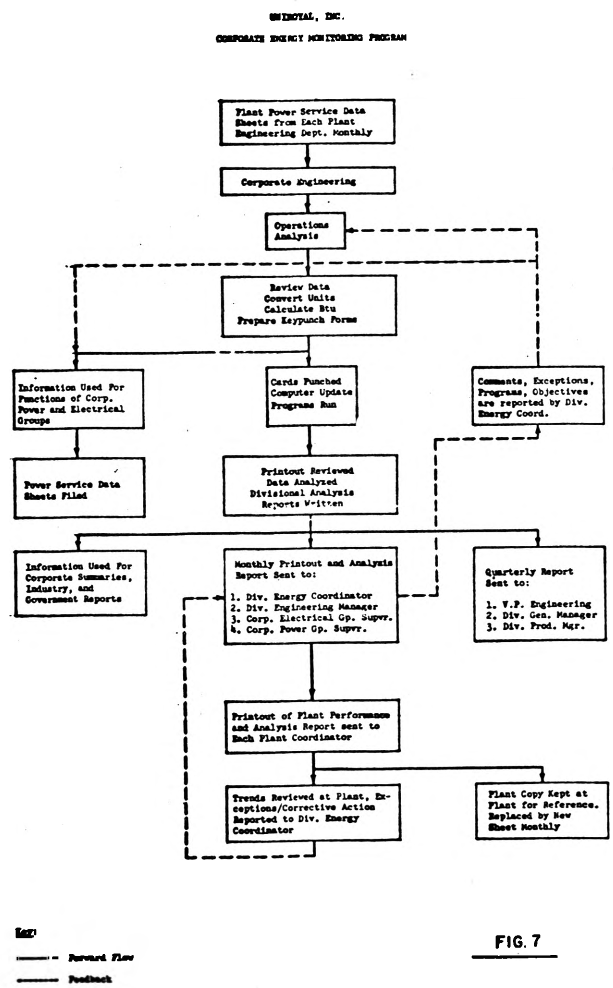


FIG. 7

BASE LOAD

Intuitively we would expect that energy consumption in a factory has both fixed and variable components. The variable portion goes up and down pretty much with the rate of production, while the fixed portion stays relatively stable. I say relatively because if we count building heating and lighting in the fixed portion, this will obviously vary with season of the year and with climate. To illustrate, the graphs in Figure 8 show the unit usage, in one division (for plants) of electricity and steam varying substantially with production rate. At the lower production end the unit usages become asymptotic--there is a base load that is required regardless of production. As production increases, the usage gets better and better, the rate of change being of function of the base load.

To get at this in greater depth, our Power Services Department determined the Sunday (no production) steam loads for various seasons, production loads at various production levels, and "degree days" for each day in the year at a number of factories.

The Sunday load in summer can be considered as the closest figure available to represent base load, because it is the residual load on a non-production, non-heating day. In summer, the Sunday load is strictly base load, but in winter it is base load plus heating load. By plotting Sunday loads against atmospheric temperature, we obtain a curve which is flat at temperatures above 65 degrees F and sloped at temperatures below 65 degrees F. This indicates that heating systems are turned on at 65 degrees F, and the heating consumption follows a linear relation to outside temperature. From the slope of the curve, we can compute the increase in hourly load per degree drop, which when multiplied by 24 represents steam consumption per degree day. Knowing the number of degree-days for the area, we can compute the steam consumption used for heating. The average Sunday load in summer also represents idling steam consumption on weekends and holidays. Having derived total heating steam consumption and total idling steam consumption, we can say that the balance of the steam generated during the year was used for production, which can be computed by difference.

This kind of analysis can help one to decide whether, in spite of low production levels, a plant is actually improving its energy consumption performance. Also, it can help to point the direction for concentration of effort.

Graphical representation of typical figures obtained for various plants which are generally similar are shown in Figures 9 and 10. A tabulation of the numbers is also given in Table 1. At this point we can make the following judgments:

Plant B needs to sharpen up its weekend (no load) situation; Plant C should look to its production operation; Plant D seems out of line on heating load; base load in all plants looks like fertile ground for searching out improvements.

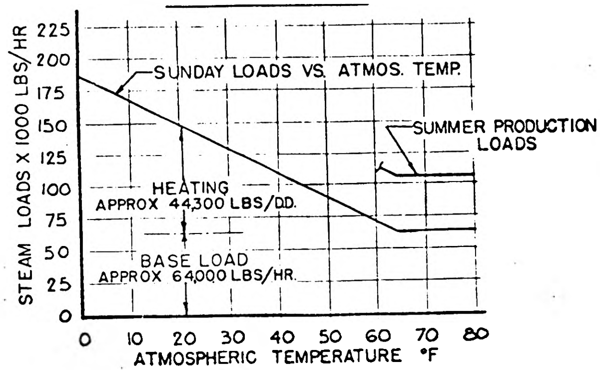


FIG. 9

ENERGY IN MATERIALS

Opportunities for energy conservation lie not only in the manner of use of conversion energy (that is, the fuel and electric power expended) in making a product from raw materials but also in the materials and supplies themselves. Here we are concerned with the amount of energy that has already been expended to bring the materials from their natural sources to the factory door, including extraction, transportation, and processing. Alternatively if the materials are substitutes for or derivatives of fossil fuels, heats of combustion can be used. This would be on the assumption that a saving of material would relieve the shortage of fossile fuels by an equivalent Btu content somewhere in our economic system.

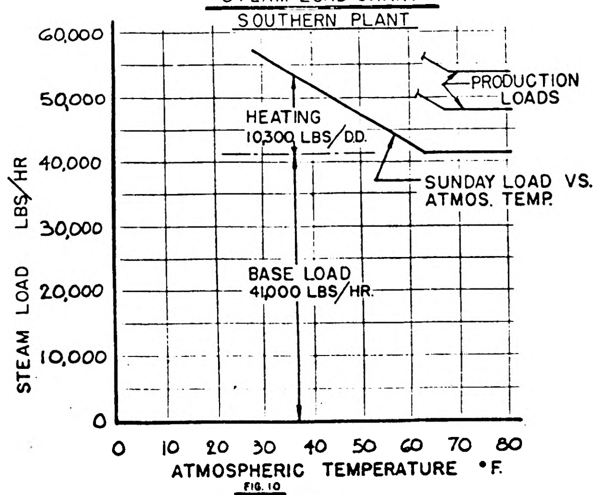
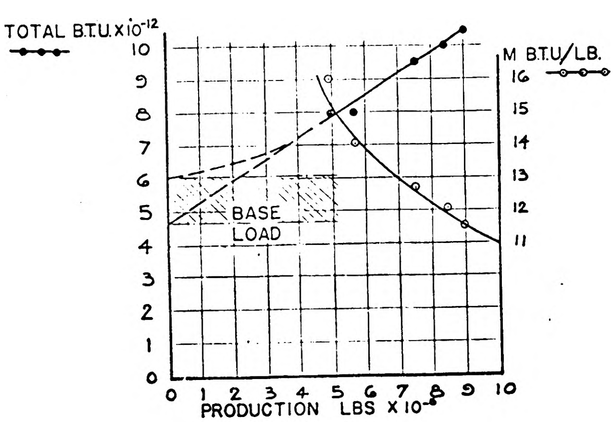


FIG. 10



DIVISION "B"

FIG. 8

TABLE 1

STEAM LOAD ANALYSIS

PLANT	A	B	C	D	E
Peak Summer Load Lbs/Hr.	82,000	75,000	210,000	130,000	58,000
Normal Summer Load Lbs./Hr.	70,000	51,000	170,000	108,000	45,000
Weekend Load Lbs./Hr.	19,000	41,000	85,000	64,000	17,000
Weekend Load / Normal Load	27%	80%	50%	59%	38%
% Steam for Production	87%	70%	66%	47%	64%
% Steam for Weekend & Holidays	10%	24%	17%	16%	10%
% Steam for Heating	3%	6%	17%	37%	26%
No. of Degree-Days	3,500	2,200	5,989	7,839	7,020
Plant Floor Area Sq. Ft.	1,056,700	1,379,719	3,080,995	1,752,321	1,167,185
Steam Required Per Degree-Day	3,927	10,300	33,000	44,300	14,400
Steam Required Per Degree Day Per Ft.^{2}	.004	.007	.011	.025	.012
Cost of Steam $ Per M Lbs.	$ 0.71	$ 0.84	$ 1.05	$ 1.58	$ 1.55
Boiler Effic. %	83%	82%	81%	76%	83%
Total Steam Generated 1974 - M Lbs.	473,429	413,193	1,363,076	1,015,061	417,461
Steam for Production (W.E.'s & Htg. Excl.)	411,883	289,235	899,630	477,079	267,175
Total Product 1974 M Lbs.	159,029	130,882	180,516	170,713	81,952
Lbs. Production Steam / Lb. Product (1974)	2.59	2.21	4.98	2.79	3.26

TABLE 2

ORGANIZATION FOR ENERGY CONSERVATION

SUMMARY OF FACTORS BY COMPANY

Company	1974 Sales*	No. of Plants	No. of Employees	Chief Exec. Support	Formal Policy Council	Responsible Staff Official	Corporate Coordinator Dept.	Corporate Coordinator Staff	Corporate Coordinator Time	Corp. Engin. Service	Results Affect Line Pay	Plant Goals Set By	Div. Coord.	Plant Coord. Individual	Plant Coord. Committee
A	3,498	65	60,926	Yes	Yes	Engineering Director	Engineering	3	Full	Yes	No	Plant	Yes	Yes	Yes
B	4,939	142	53,300	Yes	No	Exec. V.P. Manuf. & Engineer'g.	Tech. Center Admin.	0	Full	No	No	Plant	Yes	Yes	No
C	1,744	76	38,000	Yes	No	V.P. Corp. Develop't.	Development	0	Part	No	No	Plant	Yes	Yes	No
D	5,320	500	110,000	Yes	Yes	Executive V.P.-Staff	Feedstock & Energy Planning	0	Full	No	Yes	Plant/ Division	Yes	Yes	Yes
E	899	9	5,820	Yes	No	Director Corp. Engin.	Engineering	1	Part	Yes	No	Plant	-	No	Yes
F	961	31	15,300	Yes	No	Vice Pres. Manuf'g.	Manufacturing	0	Part	No	No	Plant	No	No	Yes
G	1,929	39	54,410	Yes	No	Vice Pres. Manuf'g.	Manufacturing	1	Part	Yes	No	Plant/ Division	Yes	Yes	Yes
H	5,256	103	154,166	Yes	No	Exec. V.P. Manuf'g.	Engineering	-	Part	Yes	No	Corp. Engin.	No	Yes	Yes
Uniroyal	2,301	89	64,000	Yes	No	Vice Pres. Admin.	Engineering	3	Part	Yes	No	Plant	Yes	Yes	Yes

* Millions of Dollars

Three possibilities, at least, present themselves as energy saving through materials--namely, substitutions of material with lower energy contents, reduction of waste and recycling. The first of these considerations depends on the assumption that material cost reflects energy content and, other things being equal, we seek the lowest cost raw material. The other two would obviously be important at any time, regardless of energy content.

Now, however, the skyrocketing cost of energy (and also of materials) as well as the increasing shortages of fossil fuels emphasize a dimension of materials and supplies that is becoming more and more prominent. Consequently, we have embarked on a program of accounting for materials on the basis of energy content as well as on cost. Programs to reduce scrap, increase recycling, and substitute materials are now being considered in the light of energy conservation and reported on as adjuncts to conversion energy savings.

To give a measure of the significance of this, we have found, for example, that the energy content of the materials contained in a tire are approximately twice the amount of energy (fuels and electric) that we use to produce a tire from them.

As we get further into this question, interesting ramifications develop. For example, it is a pretty well accepted fact that production of a radial tire consumes more conversion energy than production of a cross-ply tire, perhaps as much as 15% more. On the other hand, a set of radial tires on an automobile may increase gas mileage by up to 10% and a radial tire will out last a cross - ply tire by quite a margin. The amount of energy saved in operation of the car is considerably more than the additional energy used to produce the set of tires.

When we think of material substitutions to save energy, one that comes to mind is natural rubber as against synthetic. On the other hand, natural rubber usually takes more energy for breakdown and mixing into a compound. There are controlled viscosity types of natural rubber available but these are more costly. Obviously, this kind of tradeoff has to be worked out with some care.

As an example of a supply item that has offered an opportunity for energy conservation is the solvent used for making rubber cements. Primarily for environmental considerations, many plants have switched to water-based cements and in so doing have saved the heat content of the solvents, which were usually petroleum-based, representing a not inconsiderable quantity of energy.

ENERGY BALANCE - PILOT PROGRAMS

The concept here is simple -- first to subdivide a process into all of its steps, determine the energy input and output of each step on a "textbook" basis, add up all the pluses and minuses, and arrive at a "textbook" net energy usage; and second, to actually measure the energy input (or output) step by step and see how close it is to the theoretical.

The point is that this kind of an analysis will reveal something beyond what we have been measuring up to now -- which has been the actual usage of energy on a current basis, compared to some base period, such as 1971 or 1972. While we may be doing better than 1971 or 1972, we may be missing some rather large opportunities for real conservation.

If the above approach is taken carefully for each step of the process, we believe the results will pinpoint areas for i n t e n s i v e study and for process modifications.

We are presently doing this on one of our chemical processes and one process that involves mixing and vulcanization, not primarily chemical. We can only say at this time that we expect the pilot studies to enable us to polish the technique and tell us whether it is worthwhile to carry it out on all of our various processes.

ORGANIZATION FOR CONSERVATION

In a large company consisting of several divisions and numerous plants, it is important to have a chain of command that is concerned with energy conservation from the top of the house down to each factory worker. This is such a specialized and important effort that each organizational level needs someone assigned specifically to look out for it. Most companies recognize this.

Beyond this generality, however, we noticed that there were some variations from one company to another in the way they were organized, and we decided to look into this a little further. We selected eight large companies which were reported by various government agencies to have accomplished more than the average in conservation, and obtained a description of their organization. Our idea was to determine what seemed to be the best features of each and then to use these to improve our program, if applicable.

The results are shown in Table 2.

None of the companies except Uniroyal is identified. While there are a number of details behind this summary, the best features seem to be as follows:

Formal Energy Policy Council

Engineering Vice President Responsible for Conservation

Full-Time Coordinator in Corporate Engineering Department

Divisional Coordinators

Plant Coordinators

Plant Committee or Task Force

Good features that some or all companies had, in addition to the specific organization structure, included:

Personal Involvement of the Chief Executive

Conservation Included as a Factor in Line Management Compensation

Joint Goal-Setting (as against super-imposed goals)

Some of the above features obviously depend on the basic company structure. If there is no Corporate Engineering Department, the Corporate Coordinator must be under some other Corporate Vice President. If there is no formalized management-by-objective compensation plan, there would be no way to include a factor related to energy conservation

As a result of this analysis, a recommendation was made to establish an Energy Policy Council in Uniroyal. This is receiving consideration at this time. Otherwise, our organization pretty much incorporates the applicable good features found in this investigation.