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DOCUMENT DESCRIPTION: Sales Literature and Advertising

Pfizer QUIGLEY COMPANY, INC.

Manufacturers of Refractories — Insulations

235 E. 42nd Street New York, N.Y. 10017

INSULAG

WATER RESISTANT REFRACTORY LAGGING

INSULAG

A superior refractory lagging with unsurpassed insulating and sealing properties for use on high or low temperature equipment.

Can be applied on hot or cold metal surfaces.

Fuel savings, constant temperatures and increased production result from its use.

Increases in thickness after application and retains this increased volume throughout its entire range of service temperatures.

Does not collapse after it has set, from contact with water, oil or steam.

Is non-injurious as contains no mineral wool or fine slag particles which are irritants to the body.

Develops high mechanical strength upon drying and withstands shock, moderate abrasion and vibration.

Can be applied by gun in thin coats to effect a perfect seal.

Block insulation is effectively covered and protected.

Makes a good expansion jointing.

Has excellent insulating qualities.

Weight expanded 36 lbs. to a cubic foot.

Expands approximately ½" for each inch applied if installed immediately after mixing.

Has temperature range of 2200°F. limit for interface temperature.

3 lbs. usually covers one square foot 1" thick.

Sets firmly on cold set in 24 hours.

Can be applied by gun, grout or trowel.

Packed in 100 lb. multiwall, moisture-proof bags. Proper instructions for use enclosed in each bag.

SPECIAL APPLICATIONS

¼" coating applied by Quigley C. O. Gun on new open hearth silica roofs—increases life by eliminating initial spalling.

½" coating on brick-lined doors when new, prevents spalling.

Sealing Tuyers when banking Blast Furnaces.

Insulation and sealing Bustle Pipes.

Expansion Joints at jamb in Coke Ovens.

Insulating walls for comfort between furnaces in working areas of Reheat Furnaces.

When banking Blast Furnace seal Bosh usually by spraying.

Insulate outside of Reheat Furnace.

Cover block insulation on outside Stoves.

Spraying Annealing Oven interiors to seal cracks and spalling.

Sealing Regenerator chambers in Rolling Mills.

SUMMARY OF PROPERTIES

Temperature Range	2200°F. Interface
Setting Characteristics	Hydraulic Set
Application	By Gun, Grout or Trowel
Thermal Conductivity K factor in B.t.u./ sq. ft./inch thk./ hr./°F.	@ 500°F. .56 @ 1000°F. .70 @ 1500°F. .84
Spalling	Negligible
Weight	36# to a cubic foot
Coverage	3# covers 1 sq. ft. 1" thick
Packing	50# bags

Pfizer QUIGLEY COMPANY, INC.

Manufacturers of Refractories — Insulations

235 E. 42nd Street New York, N.Y. 10017

AG—3321#4—5M—3-70—AMP. (This cancels and supersedes all previous literature) Printed in U.S.A.

Pfizer QUIGLEY COMPANY, INC.

Manufacturers of Refractories — Insulations — Paints

235 E. 42nd Street New York, N.Y. 10017

INSULAG

WATER RESISTANT REFRACTORY LAGGING

GREAT STRENGTH — QUICK SETTING — LIGHTWEIGHT — HIGH TEMPERATURE
EXPANDS — DOES NOT SHRINK — WATER & OIL RESISTANT — FIREPROOFING

INSULAG

A superior refractory lagging with unsurpassed insulating and sealing properties for use on high or low temperature equipment.

Can be applied on hot or cold metal surfaces.

Fuel savings, constant temperatures and increased production result from its use.

Increases in thickness after application and retains this increased volume throughout its entire range of service temperatures.

Does not collapse after it has set, from contact with water, oil or steam.

Is non-injurious as contains no mineral wool or fine slag particles which are irritants to the body.

Develops high mechanical strength upon drying and withstands shock, moderate abrasion and vibration.

Can be applied by gun in thin coats to effect a perfect seal.

Block insulation is effectively covered and protected.

Makes a good expansion jointing.

Has excellent insulating qualities.

Weight expanded 36 lbs. to a cubic foot.

Expands approximately ¼" for each inch applied if installed immediately after mixing.

Has temperature range of 2200°F. limit for interface temperature; 2000°F. direct flame.

3 lbs. usually covers one square foot 1" thick.

Sets firmly on cold set in 24 hours.

Can be applied by gun, grout or trowel.

Packed in 50 lb. multiwall, moisture-proof bags. Proper instructions printed on each bag.

HOW TO MIX and APPLY INSULAG

Mix INSULAG and water (50# bag Insulag to 3½ gal. water — approx. 60% Insulag to 40% water) — to consistency of heavy plaster. Mixed INSULAG must be applied in 30 min. DO NOT MIX MORE than can be applied in 30 min. After INSULAG has been applied, do not trowel out air pockets that honeycomb INSULAG during bloating period. Use wet trowel about an hour later to smooth out. INSULAG trowels out smooth, hard and white. For reinforcing use 2x2 — 16 Ga. square mesh or metal lathe on 16" centers, well secured. Can be applied with Trowel-Gun or grout. No weather proofing is necessary. INSULAG can be painted — no sizing is necessary. Quigley AAA Paints in aluminum and colors are available.

SUMMARY OF PROPERTIES

Temperature Range	2200°F. Interface
Setting Characteristics	Hydraulic Set
Application	By Gun, Grout or Trowel
Thermal Conductivity K factor in B.t.u./ sq. ft./inch thk./ hr./°F.	@ 500°F. .56 @ 1000°F. .70 @ 1500°F. .84
Spalling	Negligible
Weight	36# to a cubic foot
Coverage	3# covers 1 sq. ft. 1" thick
Packing	50# bags

Pfizer QUIGLEY COMPANY, INC.

Manufacturers of Refractories — Insulations — Paints

235 E. 42nd Street New York, N.Y. 10017

LAG-332B=6-5M-6/69-AMP. *(This cancels and supersedes all previous literature)* Printed in U.S.A.

INSULAG

Reg. U. S. Pat. Off.

A HIGHLY EFFICIENT INSULATING LAGGING

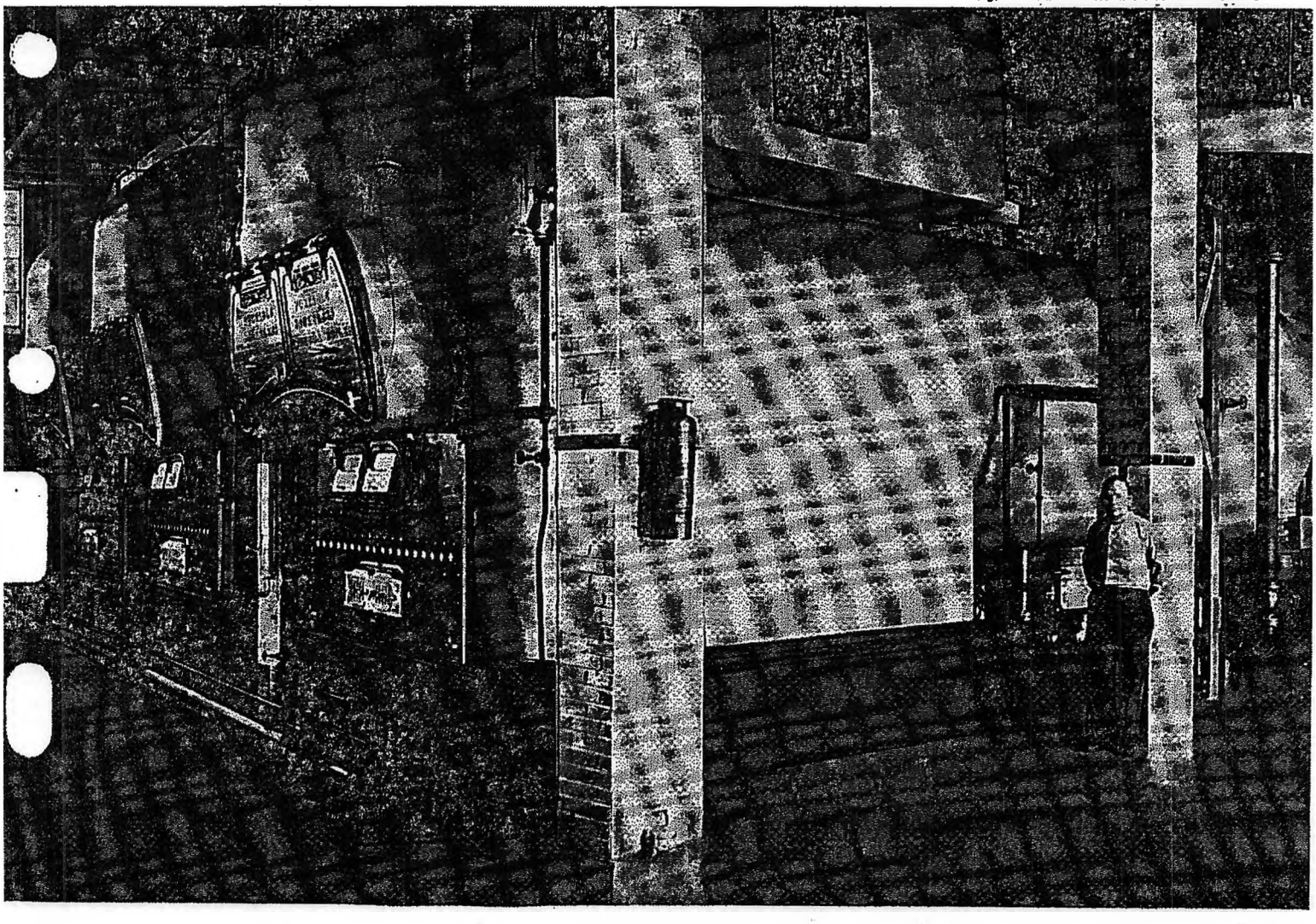
With Air-setting Properties for a Wide Range of Temperature Applications

WATER RESISTANT—ECONOMICAL

Bulletin No. 332-F

A QUIGLEY PRODUCT

Fig. 1 — Three Boilers Insulated With INSULAG.



INSULAG is a superior refractory lagging with unsurpassed insulating properties for use on high or low temperature equipment. It can be applied on hot or cold metal surfaces, and as a finishing coat for insulation.

INSULAG possesses at recommended temperatures exceptionally high refractory and insulating properties. INSULAG is used at operating temperatures at which other laggings fail.

Its unusual low heat storage and low thermal conductivity make INSULAG a most effective insulator for the control of temperatures. INSULAG permits reduction in thickness of heavy refractory walls and, in turn, decreases the heat capacity of the total structure. Fuel savings, constant temperatures and increased production result from its use.

INSULAG increases in thickness after application and retains this increased volume throughout its entire range of service temperatures. INSULAG, after it has set, does not dissolve or collapse from contact with water, oil or steam, which properties make it an outstanding product.

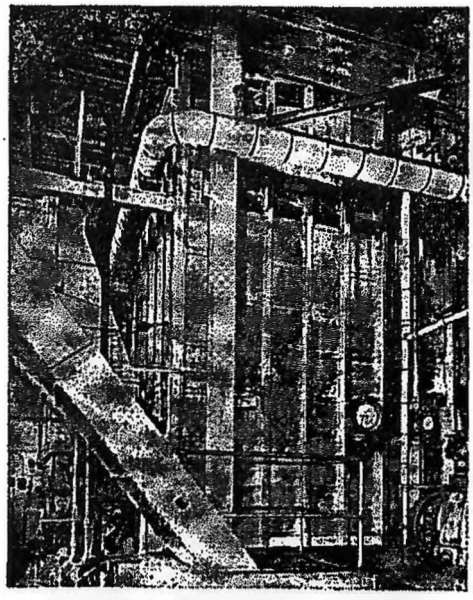


Fig. 1—Walls, Ducts, Casings, Drums of Large Boilers Insulated With INSULAG.

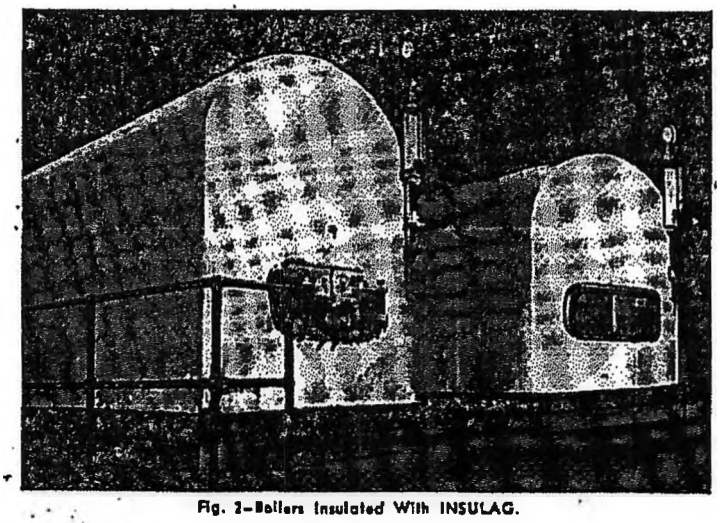


Fig. 2—Boilers Insulated With INSULAG.

POWER PLANTS—INSULAG meets the engineer's demand for a suitable material for covering turbines, feed water heaters, hot liquid storage tanks, drums, smoke flues, stacks, pipes and flanges. It is also recommended as insulation in back of refractory tile of water wall boilers and outside fire brick walls in boiler furnace construction.

ON BOILER DRUMS—INSULAG, used on the boiler drums because it does not crack in service, can be walked on without destruction, and does not collapse due to steam leaks or water dripping on same.

FIRE-PROOFING—Bins, walls, roof structures, furnace rooms, columns, etc., may be protected against fire by applying INSULAG as a veneer coating. The fire retardant properties of INSULAG render it ideal for this purpose.

GENERAL USES—INSULAG has such a wide range of uses that it is indispensable as a plastic lagging in plants using fuel fired furnaces. It is "the lagging material of a thousand uses."

PROPERTIES OF INSULAG vs. FIRE BRICK

Heat Conductivity B.t.u./Sq. Ft./In. Thick/°F./per hour

MEAN TEMPERATURE	INSULAG	FIRE BRICK
500°F.	.56	—
1000°F.	.70	8.15
1500°F.	.84	9.99
Approximate weight per cu. ft. applied	36 lbs.	130 lbs.
Heat storage per lb. per °F	.24 B.t.u.	.24 B.t.u.
Heat Storage for same insulating effect	1/40	1.

QUICK SUMMARY

1" equals 9" of fire brick in insulating value.
1/40 heat storage capacity of fire brick for same heat flow.
High mechanical strength.
Operating temperature 2200°F. Interface.
Light weight—yet rugged and strong.
Sets quickly.
Adaptable—suitable for practically every lagging need.
Water resistant—steam, oil or water leaks do not destroy.
Expands—an inch applied is more than an inch when dried.

INSULAG is shipped in 50 lb. bags, net.

Copyright, 1947 Quigley Co., Inc.

This bulletin becomes effective as of October 1, 1948, and cancels in its entirety all previously issued bulletins or data referring to this product.

PROPERTIES OF INSULAG

LOW THERMAL CONDUCTIVITY—INSULAG retains practically constant insulating values throughout its service range, so that under varying conditions and temperature changes there is no appreciable loss of insulating efficiency. *One inch* of INSULAG has an insulating value equal to about *nine inches* of fire brick and has about *1/40* the heat storage capacity of fire brick walls of equal heat flow. Therefore, relatively thin applications of INSULAG may be substituted for heavy masses of refractories; heat losses are reduced and furnace production is increased.

HIGH MECHANICAL STRENGTH—INSULAG *is different.* It develops high mechanical strength upon drying and successfully withstands shock, moderate abrasion and vibration. The impact of a hammer will cause a dent in INSULAG and may even crack it, but the blow will not cause it to break away readily from the equipment to which it was applied. This is most advantageous on drums, tanks, pipe lines and other equipment subject to rough usage.

HIGH TEMPERATURE LIMITS—INSULAG will withstand a wide range of applications for high temperature direct exposure and is recommended for interface temperatures up to 2200°F.

EXPANSION — INSULAG expands after application; physical shrinkage eliminated.

LIGHT WEIGHT— On the average, three pounds of INSULAG covers 1 square foot to a thickness of 1 inch. Varying conditions, methods of application, hard troweling, kinds of surfaces, variations in mixing, water content, and temperature of surfaces at time of application may require more material.

QUICK SETTING — INSULAG cold-sets firmly in 24 hours to 48 hours and in much less time when subjected to heat. The quick drying and setting characteristics of INSULAG permit troweling to a smooth finish suitable for painting.

ADAPTABILITY—INSULAG possesses properties necessary for "roughing" coat and "finishing" coat, or two coats by one application. The user of INSULAG does not find it necessary to carry in stock two or three different materials for the same job.

WATER RESISTANT—INSULAG, after setting, does not dissolve or collapse from contact with water, oil or steam. This is a decided advantage in plant maintenance. INSULAG is a superior product for insulating equipment exposed to the weather.

NON-INJURIOUS—INSULAG contains no mineral wool, or fine slag particles which are irritants to the hands or other parts of the body.

A feature of INSULAG which particularly appeals to many users is the beautiful, smooth, white surface of a troweled finished job.

If desired an INSULAG troweled finished job can be treated with Quigley TRIPLE-A Protective Coatings in white, black, colors or aluminum.

Various combinations of INSULAG with other INSULINE Products can be made for specific applications.

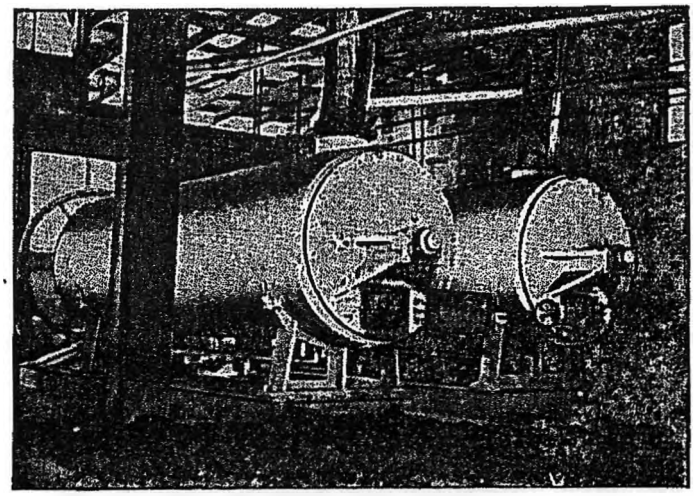


Fig. 4—Steam Driers Coated With INSULAG. No Wrapping or Painting Necessary.

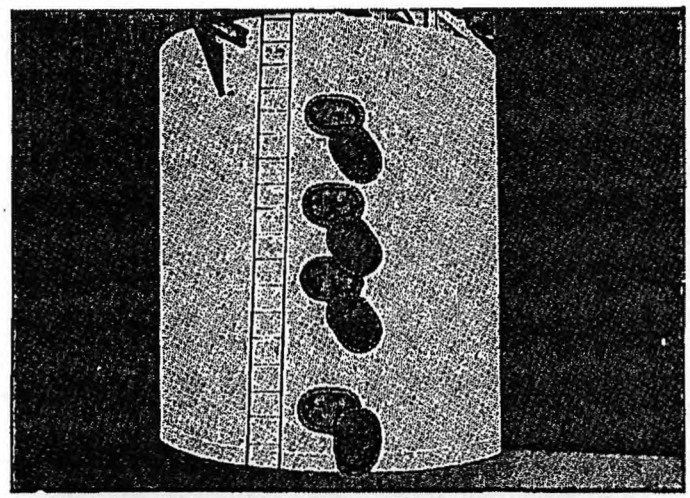


Fig. 5—Dorr Thickener (24 ft. diam. x 18½ ft. high) Insulated With INSULAG.

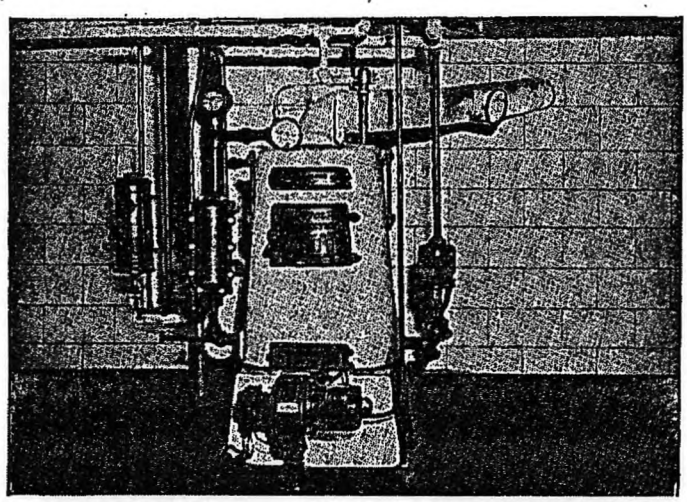
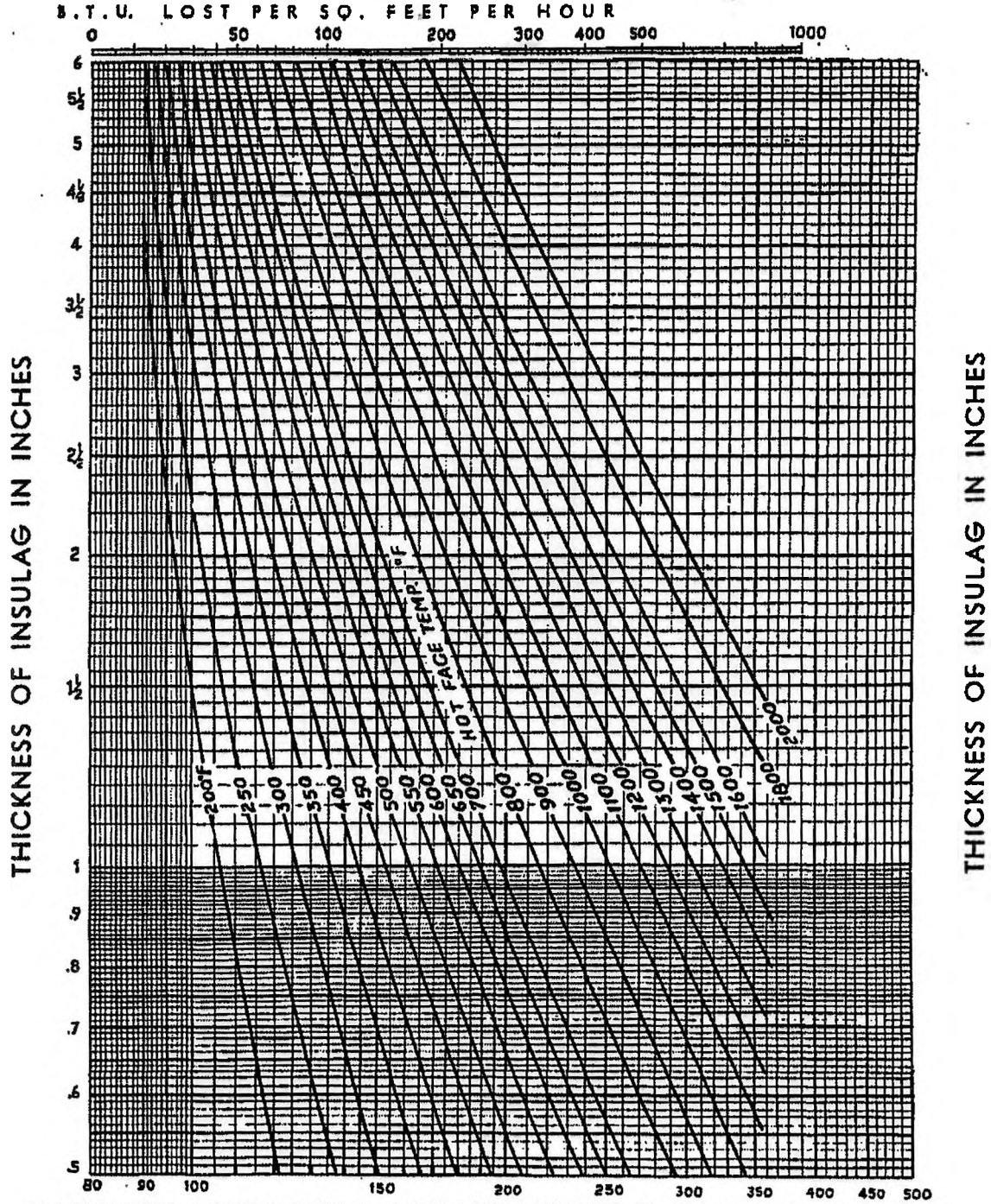


Fig. 6—Water Tank and Boiler Domestic Fuel Oil Burner Insulated With INSULAG.

INSULAG—THICKNESS IN INCHES REQUIRED FOR VARIOUS HOT FACE TEMPERATURES



TEMPERATURE OUTSIDE FACE OF INSULATION DEGREES FAHR. *BASED ON STILL AIR AT 80°F.*

THIS CURVE IS BASED ON THE INSULATING MATERIAL CAST AND DRIED AND WITH A SURFACE EMISSIVITY FACTOR OF 0.89.

How to Determine Heat Savings Effected by INSULAG.

Chart above indicates the heat loss through graduated combination thicknesses of INSULAG, as well as the temperature of the outside surface of the INSULAG at given temperature for the hot surface.

1. To determine the thickness of INSULAG required to give an outside surface temperature.
   Example; Temperature of the hot surface is 500°F. What total thickness will give a temperature of about 130°F.? Follow 130°F. line upward until it meets 500°F. curve line. At this point follow horizontal line and read 2 in. Therefore a 2 in. thickness of INSULAG is required.
2. To determine the heat loss through given thickness of INSULAG or from outside face temperature.
   Example; Similar conditions as that given under "1". From 130°F. at bottom of chart follow upward until you read 90 B. t. u.'s on the upper scale.

Pfizer QUIGLEY COMPANY, INC.

Manufacturers of Refractories — Insulations

235 E. 42nd Street New York, N.Y. 10017

Printed in U.S.A.

Bulletin 311F-5M-11-69-CWP

INSULAG

REG. U. S. PAT. OFF.

FIREPROOFING CEMENT



INSULAG is a fire retardant, lightweight formulation, having a fire and water resistant smooth white surface.

INSULAG weighs only 40 pounds per cubic foot; 1/3rd the weight of concrete, common brick or other such fire proofing materials. Therefore, excessive loads are not added to existing structures, or those under design.

INSULAG was subjected to exhaustive fire-proofing tests by a nationally recognized research laboratory and large oil refinery. Their reports proved INSULAG is capable of withstanding THERMAL SHOCK without spalling or destruction when 100 lb. per square inch water pressure was played on it by hose, with nozzle, at all distances, and at all temperatures up to 2000°F.

INSULAG is the ideal fireproof protection for Structural Columns, Beams, Channels and Angles, LP Gas Tanks, Oil Tanks, Tower Skirts, Pipe Line Supports and All Exposed Steel in Oil Refineries, Steel and Chemical Plants.

INSULAG is regulary used as a Refractory Insulation by all types of industries, inside and outside of furnaces and boiler settings, for temperatures up to 2200°F. It is also used for many types of insulations inside and outside of buildings, regardless of climate and without weather proofing.

INSULAG is the only material required for a fireproofing and water resistant insulating job.

BE ASSURED OF YOUR FIREPROOFING BY USING INSULAG

PROPERTIES OF INSULAG A FIREPROOFING CEMENT

LOW THERMAL CONDUCTIVITY—1" has insulating value of 9" Firebrick

HIGH MECHANICAL STRENGTH—Withstands vibration—Moderate Abrasion

HIGH TEMPERATURE LIMITS—2200°F.

LIGHT WEIGHT—Trowelled: 40 lbs. per cu. ft.
Gunned: Approx. 45 lbs. per cu. ft.

QUICK SETTING—(2-24 hours) Depending upon temperature and atmospheric conditions

NON-INJURIOUS—Contains no mineral wool.

WATER RESISTANT—After setting does not dissolve or collapse in contact with water, steam or oil. Does not require water-proofing.

ADAPTABILITY—Roughed or scratched, Coat and Finish Coat with one product INSULAG. Trowels to a hard smooth, white finished surface.

Pfizer QUIGLEY COMPANY, INC.

Manufacturers of Refractories — Insulations

235 E. 42nd Street New York, N.Y. 10017

INSULAG FOR FIRE PROOFING

Where to Use

ACID PLANTS—
Structural Steel for Absorption—Glover—Lussac Towers and Tanks

CHEMICAL PLANTS—
Structural Steel for Heaters—Chemical Units—Still and Tanks

COAL COLLIERIES AND MINES—

COPPER—LEAD—ZINC MINES—
Structural Steel—Bins—Underground Timber Supports

GLASS PLANTS—
Structural Steel—Melt Room

LUMBER MILLS—
Structural Steel—Fuel Bin—Burner—Dry Kilns

OIL REFINERIES—NATURAL GASOLINE PLANTS—

CARBON PLANTS—ASPHALT PLANTS—
Structural Steel—Vessel Skirts—Pipe Stanchions—Supporting Steel of Towers—Heaters—Crackers—Tanks—Gas Absorbers—Evaporators—Decarbonizing Units

PAINT MANUFACTURERS—
Structural Steel—Storage Tanks—Warehouse—Varnish Plants

PAPER MILLS—
Structural Steel—Recovery Furnace Room—Stock Rooms

STEEL MILLS—
Structural Steel Supports—
Blast Furnace—Conveyors—Scrubbers—Stoves
By-Products Plant—Distillation Unit
Coke Oven Plant—Pusher—Quenching Equipment.
Stock Piles—Conveyors—Coke—Coal

SMELTERS—
Structural Steel Supports
Anode Furnace Room
Convertor—Platform Struts
Refinery—Pouring Platform
Reverbatory

WAREHOUSES—Inflammables—
Structural Steel

How to Use

INSULAG A FIREPROOFING CEMENT

REINFORCEMENT or SUPPORT for STRUCTURAL STEEL

Use flat expanded diamond mesh, with metal spacers or
Use high rib lath or other suitable reinforcements, all to have corner beads.
On Larger Surfaces, weld on studs, to which attach square mesh welded fabric with opening of not less than 2"x2".

INSTALLATION

Can be Cast—Trowelled or Gunned by using above conventional methods of reinforcements.

MIXING

For Cast or Trowelled installations, add sufficient water to make a smooth easy-working mixture. Use clean, fresh water at 60-65°F. An average mixture takes about ten and one-half (10½) gallons of water to a one hundred (100) pound bag. Mix only quantity that can be applied within twenty (20) minutes.

For Gun Applications use minimum air pressure and maximum quantity of clean fresh water at 60°F., but no higher than 90°F., that permits placement without slump.

APPLICATION

A one and three quarters (1¾) inch thickness is required for a three (3) hour fire resisting rating. Apply by either Cast—Trowel or Gun method.

A one and one eighth (1⅛) to one and one quarter (1¼) inch thickness of mixed INSULAG which will bloat to one and five eighth (1⅝) to one and three quarters (1¾) inch. Allow to set. If a smooth finish is required, SCRATCH or ROUGHEN this surface before applying the one eighth (⅛) inch finishing coat.

If the original application has dried, same should be moistened prior to applying the finished coat. For the finish coat, INSULAG should be mixed with water, allowed to bloat and remixed. This finished coat should be trowelled smooth.

Additional Fire Resistance Rating can be secured by increasing thickness of INSULAG.

Bulletin 333—#3—FP—5M—3-70—AMP.

AN OPPORTUNITIES IN ENGINEERING FEATURE

ENGINEE

AND PUBLIC

Existing and potential developments in engineering skills and technology can be put to good use in various areas of public health. Although significant contributions have been made by engineers to clinical and diagnostic medicine, many other areas could benefit from the application of existing technology and from engineering approaches.

William A. Nelson, M.D.[1]

Mount Sinai School of Medicine of the City University of New York

The adaptation of engineering techniques and the broader use of engineering technology to the solution of medical problems is an especially appealing concept. When one considers the impact on medicine of engineering expertise and technology that has already taken place, such devices as heart lung machines, kidney dialysis units, or improved diagnostic instruments immediately come to mind. The space program, naturally, has contributed to physiological monitoring instrumentation and signal processing, as well as to a better understanding of certain body processes. An entire subprofession, bioengineering, with over 2500 members, now functions as part of both the engineering and medical communities.

The channels of communication that have developed between the engineering and medical communities have followed naturally from activities of this type. A wide variety of conferences and symposia are held annually with such topics as instrumentation, artificial organs, and patient-monitoring systems dominating the discussion sessions. Several journals specializing in bioengineering, with an emphasis on similar topics, now exist. Many universities have standing committees of engineering and medical faculty to consider those areas of mutual cooperation and interest.

These developments are important, and the contributions of engineering to these areas of medicine will continue to expand. So far, however, their overall impact on health has been limited. This can be demonstrated, in part, by a survey recently taken at Mount Sinai Hospital in New York City. The causes of treatment of all 1088 patients in wards and semiprivate and private rooms during one day were reviewed to determine the use of electronic diagnostic or monitoring equipment (excluding x-ray machines, electrocardiographs, or routine laboratory equipment for the analysis of blood specimens (tissue biopsies, etc.). The results appear in Table 1 [1].[2] During the 24-hr period of Jan. 15, 1970, only 3.8 percent of the patients received treatment utilizing various electronic gear, and only 14.3 percent received such treatment at any time during their hospitalization. If one also excludes electroencephalography, used extensively in the neuropsychiatric department, and hardly a new device, these percentages drop to 2 and 5 percent, respectively. Additionally, Table 1, which also lists the electronic equipment used, shows only three devices that were developed in the last decade.

This limited use was not from unawareness on the part of the clinical staff nor from unavailability in the hospital. *Fortune* magazine of January, 1970, the very month of this survey, stated that Mount Sinai Hospital was "one of the most extensively automated big hospitals in the nation." What this limited use does know is that much of contemporary engineering is irrelevant to the everyday problems of patient care.

Additional evidence of the lack of impact of technology on the nation's health can be obtained from an analysis of the life expectancy of the U. S. population over a period of time. An infant born today can expect a life expectancy 25 years longer than a child born in 1900. Antibiotics and vaccines, which have virtually wiped out communicable diseases, have been the major factors in this increased life expectancy. However, the attempts of medicine and technology to prolong life in adulthood have been, to date, singularly unsuccessful. Figure 1 shows that the life expectancy of U. S. white males, *at age 60*, has not improved in the last 100 years [3].

For engineering and technology to achieve a maxi-

[1] Assistant Professor, Department of Community Medicine.
Based on a presentation made by the AIChE Aerospace Division.

[2] Numbers in brackets designate references at end of article.

RING

GEARING

with impact on public health. It will be necessary to look beyond the operating room and the research laboratories of the major medical centers to the development of community medicine, to regional medical facilities, and to the municipal departments of health. Preventive medicine, occupational health, delivery of medical care, accident prevention, and the health aspects of inner-city ghetto living all offer problems of immense scope to challenge the engineering community, problems whose solutions can have a dramatic impact on public health. We have been able to send a man to the moon in an environment clean enough to perform major surgery, yet a large number of America's workers labor in dust conditions that would be considered intolerable even by nineteenth-century standards. In other circumstances, a patient can await replacement of a mitral valve in a $150-a-day room while a few blocks away a child is doomed to a life of impairment as a result of permanent brain damage suffered from eating leaded paint falling from the ceiling into his crib.

For a significant impact to be made in many of these broad areas of community health, it is not necessary that new, sophisticated technology or elaborate gadgetry be developed. What is needed is the application of existing technology to this relatively neglected class of medical problems. Of equal importance is the need for an engineering systems approach to such large-scale health issues. In many areas of community health, models can be developed, system components and their interactions defined quantitatively, and changes and their consequences simulated as part of a comprehensive approach to the solution of urban health problems. A consideration in detail of a specific example of these broad problems—that of the health effects associated with the commercial and industrial uses of asbestos—will illustrate the role of the engineer in their solution.

Asbestos-associated Disease

Knowledge of a deleterious health effect from occupational exposure to asbestos dates from 1907, when Montague Murray, a physician at London's Charing Cross Hospital, described the severe lung scarring found in a 1900 autopsy performed on a 33-year-old former asbestos-textile worker who had been the sole survivor of a group of 10 individuals em-

TABLE 1

Utilization of Electronic Equipment* by Patients at Mount Sinai Hospital, January, 1970, at Any Time during Their Hospitalization

	Number	Percent
Patients surveyed	1038	100.0
Patients using electronic device	149	14.3
on day of survey	47	3.3
during admission prior to day of survey	128	12.3

*Excluding ECG, x-ray, and service laboratories, but including EEG, isotope scanning, electromyography, audiometer, artificial kidney, pacemakers, etc.

Electronic Equipment Used on Day of Survey or during Admission

Device	Frequency of use
Artificial kidney	2
Audiometer	2
ECG	66
EMG	3
Electronic transducer	6
Emmerson chest suction	2
Hypothermic mattress*	3
Monitoring system	90
Pacemaker*	11
Pulsemeter	1
Radioisotope scanner	21
Respirator (Bennet)	9
Rotating tourniquets*	3
Ultrasonic nebulizer	10
Total	188

*Developed in the last decade.

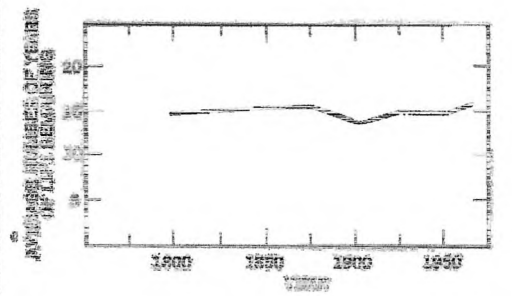


Fig. 1 Life expectancy at U. S. mills varies, as can be, has not improved in the last 200 years.

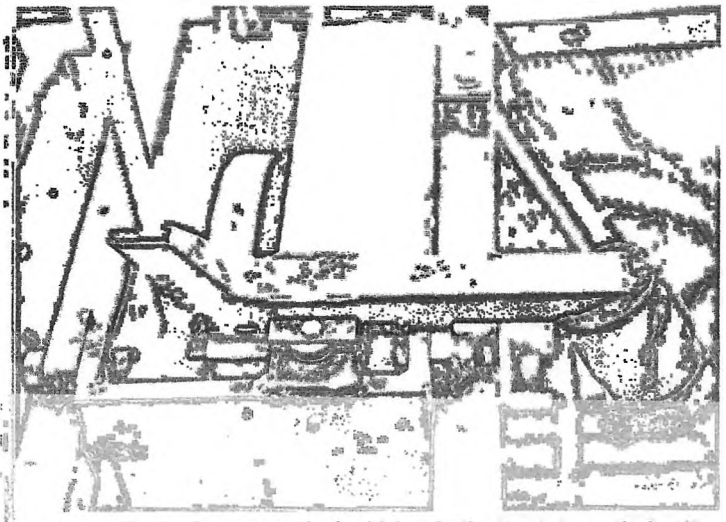
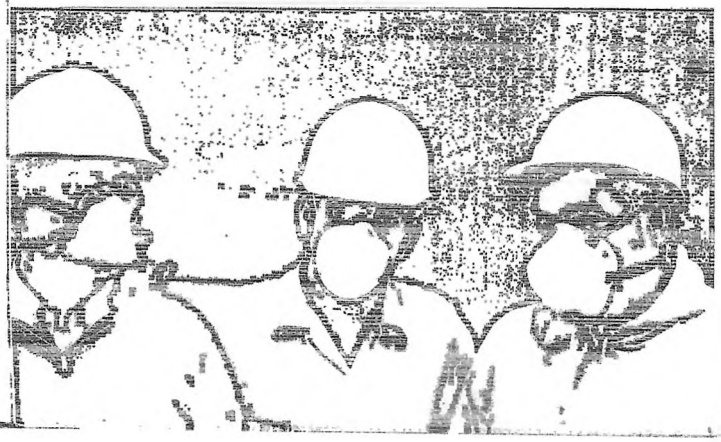


Fig. 2. Entrance port of a high-velocity low-volume dust collection system for a band saw. The port is located directly under the cutting table, which has been moved aside in this photograph. At velocities in excess of 10,000 ft/sec, three times typical blade velocities are generated.



Fig. 3. The cutting of asbestos-containing pipe covering with a band saw equipped with a high-velocity dust-collection system.

Fig. 4. Three single-use respirators, especially suitable for use in construction sites, manufactured by the Welsh Manufacturing Co., the 3M Co., and Americom Optical Co.



ployed in a factory since 1886 [3]. A 1930 British study [4] further documented the pervasive presence of asbestosis (the term applied to the pulmonary fibrosis and scarring resulting from the inhalation of significant quantities of asbestos) in factory workers. This led to the imposition of what were thought to be stringent control measures in British factories producing asbestos products. Later research uncovered the existence of an additional problem. Lung cancer was suggested as being causally associated with an asbestos exposure in 1933 [5], and the association was fully confirmed in 1948 [6] and 1955 [7] studies.

In spite of this long history of disease, studies of Selikoff, Hammond, and Churg [8] demonstrated that an extensive health problem still exists in the U.S. asbestos industry. From observations made in the 1963 membership of the New York and New Jersey locals of the asbestos insulation workers union, a catastrophic health experience has been documented. Table 2 documents the mortality experience of this group of workers through 1971. One in five of the deaths of these workers was from lung cancer, nearly one in 10 from mesothelioma, a disease so rare in the general population that perhaps only one in 10,000 deaths are from this cause; one in 10 from cancer of the gastrointestinal tract, three times that expected, one in 10 from other cancers, and almost one in 10 from asbestosis, an occupational disease identified over 70 years ago. Nearly 40 percent of these workers' deaths can be attributed to their occupational exposure to asbestos. Moreover, recent studies of an asbestos-products manufacturing facility point to the existence of an even greater health problem in factories [9].

In addition to the extent of the disease experience,

TABLE 2

Deaths among 625 N.Y.–N.J. Insulation Workers Observed Prospectively 1943–1971, after Reaching 20 Years from Onset of Work

	Expected	Observed	Percent
Total workers, 625	—	—	—
Total deaths, all causes	299.5	423	100.0
Lung cancer	11.2	84	19.8
Pleural mesothelioma	—	8	1.9
Peritoneal mesothelioma	—	20	4.7
Cancer: stomach, colon, rectum	12.8	41	9.7
Cancer: all other sites	28.2	37	8.8
Asbestosis	—	32	7.6
All other causes	235.6	201	47.5

two other important concepts were revealed in these studies. The problems introduced by the long latent between onset of asbestos exposure and the incidence of disease and the effects of exposure on the mortality of disease. In virtually all cases, the occupationally related deaths from asbestos exposure came only after 20, 30, 40, or more years since onset of exposure. This, of course, has presented considerable difficulties in attempting to apply proper control measures based on information of disease experience produced by inadequately evaluated environmental exposures of past decades. In short, there is excessive time lag in the feedback loop.

The other problem demonstrated by the mortality experience of these workers is that a synergistic effect exists between occupational asbestos exposure and cigarette smoking in the development of lung cancer. From a study of the mortality experience of individuals whose smoking habits were known, it was found that 42 of the deaths of 255 smoking asbestos workers were from lung cancer, whereas only one of 32 deaths of 87 nonsmokers was of lung cancer. Thus, while an asbestos exposure alone may give rise to some increased risk of lung cancer, the combination of asbestos exposure and cigarette smoking is especially deleterious to health. A cigarette smoking asbestos worker has approximately a 91 times increased risk of dying of lung cancer as an individual who neither smokes nor works with asbestos. Here, as in many other medical problems, we are dealing with multiplier systems.

Unfortunately, the health problems associated with asbestos extend beyond those individuals directly exposed to those exposed only by virtue of working in the vicinity of the application of asbestos products, to the families of asbestos-factory workers, and to people who simply live in the neighborhood of mines or factories. Mesothelioma has been shown to occur in excess in shipyard employees such as welders, carpenters, pipefitters, and others only indirectly exposed to asbestos [10]. Exposures at lower than occupational levels have also been linked to mesothelioma found in family and neighborhood exposures in London [11] and Pennsylvania [12]. Here we are concerned with a problem of entirely different dimensions. The asbestos exposures from products such disease were much lower than those of the insulation workers previously discussed, and the risk of asbestos-related disease was concomitantly reduced. However, the number of individuals potentially exposed is numbered in the tens of millions. Of special concern in this context is the widespread dissemination in recent years of asbestos into the environment through the spray fireproofing of high-rise office buildings, a process now banned in several cities.

Engineering Approaches to Environmental Control

Having identified the scope of the health problems associated with the use of asbestos and asbestos products, a cooperative effort was initiated at Mount Sinai School of Medicine to control human exposures to asbestos. Here the clinical and epidemiological staff was supplemented by engineers, industrial hygienists, physicists, and even toxicologists to evaluate all aspects of the health problem and to develop and implement various control solutions. Data were obtained on the variety of products incorporating asbestos and the potential dust exposures that might occur during their manufacture and use. Studies utilizing optical and electron microscopy and electron microprobe analysis documented the air levels and tissue burdens of asbestos from occupational and environmental exposure. Research on control strategies was mounted to reduce asbestos exposures to all segments of the population.

In the initial efforts to develop control measures to protect workers on construction sites and shipyards who cut, fit, and apply asbestos-containing thermal insulation, it was found that much existing technology had never been applied in this industry.

An inexpensive new technique for the control of dust generated by mixing asbestos cements was accomplished by requiring the manufacturer to ship these cements in plastic bags to which water can be added and mixing accomplished without generation of dust.

Severe inconsistencies in the area of respiratory protection were quickly revealed. Although insulation contractors would supply workers with half-face-mask, replaceable-filter respirators approved by the Bureau of Mines, they were completely ineffective in protecting the workers. As no respirator maintenance program existed in any construction site, the respirators soon became contaminated inside and out and often were in a state of disrepair. Additionally, their use by individuals with impaired breathing ability was precluded by the relatively high air resistance of the filter. A three-year effort involving safety equipment manufacturers, the Bureau of Mines, industrial-hygiene engineers from Mount Sinai School of Medicine, and Johns-Manville Corp. has finally culminated in the availability of three economical, approved, comfortable respirators having minimum breathing resistance.

One area now under development that offers the opportunity for technological transfer specifically from aerospace technology is that of room air cleaning systems. As yet, no effective portable room air-cleaning system is available for use in the asbestos-insulation industry. While dust control directly at the source of generation is the most desirable, occasionally widespread dissemination occurs that requires different control concepts. In cooperation with engineers at Florida Institute of Technology, room cleaning systems are now being developed and tested. In this study, such procedures as air curtains and directed air-cleaning systems are under consideration.

Problems of Implementation

As in all problems having significant impact on various groups in society, implementation of identified solutions to problems can be slow, difficult, and frustrating. Many of the solutions forthcoming from the M.S.S.M. Insulation Industry Research Program were not immediately implemented, although they could have reduced dust exposures to one-tenth that which existed in the past. While their cost was modest in terms of the total expense for insulation work, in the absence of assurance of "across the

board" implementation by industry, no single contractor wished to be placed at even a slight economic disadvantage. Thus action by the federal government was necessary, and an improved, but still inadequate, asbestos standard was promulgated by the Department of Labor on June 7, 1972, which incorporated some of the foregoing procedures [13].

It is important that engineering input be available for such implementation processes, especially to individuals proposing courses of action or budgetary commitments by the government. Without such input, political or economic considerations will dominate the governmental decision-making process. Thus many research results and much technical development may be wasted without the commitment of engineers to the full process of development *and* implementation of the work.

Occupational Health

Asbestos was described in detail to illustrate the full scope of a health problem and the different aspects where the approach and the knowledge of engineers proved of benefit. An engineering systems analysis of the commercial and industrial uses of asbestos defined the scope of the problem, problem engineering expertise was utilized in the implementation developed to assess occupational and environmental exposure, engineering technology was identified or developed to control the excessive asbestos exposures found, and finally, engineering input into the regulatory process was of benefit in the initial steps taken by government to control the uses of asbestos.

An additional 250,000 workers are directly exposed to asbestos. Another 4,000,000 are exposed indirectly by virtue of their jobs. The effect on health achieved by adequately controlling the occupational use of this substance alone could result in a saving of over 5000 lives annually. Additionally, proper control of the work environment can significantly reduce the exposure and risk to the general public. However, asbestos is only one substance found in the occupational workplace. Silica, talc, and other dusts are ubiquitous in the work environment. Coal chemicals are on the toxic substances list of the National Institute for Occupational Safety and Health. Engineers in refineries, chemical plants, and other factories are often exposed unknowingly to many of these substances. Fewer than 400 of these have established occupational standards of exposure. In many cases, the full scope of the health aspects of these substances has not been established, especially the long term effects and the effects of different combinations of materials. A multitude of urgent challenges await both the medical and engineering communities now.

Summary

While engineering and technology have had an impact on some areas of medicine, many additional areas exist where a transfer of engineering skills and technology can have a significant impact on the solution of major health problems. These lie in areas where the need for new developments is far less than the need for an analytical engineering approach and the application of existing technology. Many areas of health could benefit, but it will be necessary for the medical community to be educated as to what the potential contributions of engineers might be. While it is the medical community that requires the education, the initiative for this process must come from the engineering community. However, in bridging the communications gap that exists between parts of these two communities, engineers must reach out beyond the departments of medicine or physiology to the departments of community medicine or occupational health. Epidemiologists and sociologists as well as surgeons and biophysicists must be contacted. Speak also to psychologists concerned with the mental health of workers confined to the drudgery of a single task on a massive assembly line and those concerned with making the workplace, the home, or the automobile safer.

However, as important as communication between engineers and the medical community is, it is only a first step. Dialogues at long range are singularly unproductive. Also of limited productivity is the procedure of engineers coming to medicine with a gadget, a technique, or a material and asking for a use. What is productive is for engineers and health professionals to work together, on a daily basis, to solve real problems confronting us. The engineer must still remain in contact with the engineering community. He must stay current with new information and new technology, but for full effectiveness in the field of public health he must become totally immersed in its activities. It might be appropriate to close by suggesting that engineers apply "Sutton's law" to their search for an involvement in public health. Willie Sutton, when asked why he robbed banks, replied "because that's where the money is." If engineers wish to make an impact on public health, they must go where the problems are.

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THE COVER

ENGINEERING FOR HEALTH

A notorious lack of communication between the medical and engineering communities has undoubtedly deprived mankind of vast areas of potential benefit. Although our current space programs have done much to develop channels of cooperation between these important professions, it appears that it will be left largely to the engineer to show the way. The need is not so much for new developments as it is for simply the application of existing engineering technology and methods to medicine and public health. It's a real challenge for the engineer. Our cover this month symbolizes engineering in medicine. Read about it in an article beginning on page 18.

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