

THE TRANSFORMER ASKAREL FLUID MARKET

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I. INTRODUCTION

Since the 1930's Monsanto has been a proprietary supplier of Askarel to the domestic transformer market. This study was initiated to analyze our market and the factors that influence Askarel demand. The results of this study will, hopefully, provide not only a tool for understanding our end markets but a source for decisions affecting askarel's growth.

The objectives of this study were to:

1. Define the askarel market and its attitude towards askarel.
2. Document our market share and project askarel demand.
3. Analyze those influences on demand that we can favorably affect. Include the possible influences on demand of new askarel pricing, advertising and field sales effort.

The information in the study was gathered from published sources, telephone and personal contacts with twelve utilities, seven service agencies, six key askarel transformer manufacturers, four industrial firms and four architectural and engineering (A&E) firms. (See Appendix F). The personal contacts were limited to firms in the St. Louis area (for convenience) and firms east of the Mississippi where all of the significant askarel transformer manufacturers and the majority of the largest utilities and other market influences are concentrated. Personal calls on industrial and A&E firms were limited and the consulting engineer audience was not contacted.

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II. RESULTS AND CONCLUSIONS

Significant results and conclusions found during this study are summarized in this section according to the three objectives of this report.

A. The Askarel Market and Its Attitude Towards Askarel

Askarel is used only because it provides safety from fires and explosion. Askarel's safety image must be protected "at all costs", and certainly in accordance with the value we place on our entire market.

Askarel participates in only three of the four transformer markets: These three markets are industrial*, utility** and commercial. Askarel has not participated in the residential market because transformers have been outside atop poles where people or property were not considered in danger from a transformer fire or explosion.

1. The Residential Market

Residential transformer market growth will continue to outpace industrial, commercial and utility growth.

Although this market was not surveyed under the report objectives, a 50-100 M lb opportunity was uncovered for askarel in the unit residential transformer (URT) market. Here safety is important as transformers are located on or near the ground close to each residence. Monsanto opportunities include our plastics technology for corrosion resistant URT tank materials.

Action // Both of the above opportunities should be investigated in 1970. Allis Chalmers and GE expressed interest in discussing dielectric medium and corrosion-resistant transformer tank materials with Monsanto. Leading utilities that promote differing URT concepts include: Duke Power, Virginia Electric & Power Co. and Southern California Edison Co.

* Includes government purchases.

** The utility market includes transformers owned by the utility for its use (i.e. generating plants, electrical transmission, network distribution). It does not include transformers purchased by the industrial and commercial customer. It does not include residential transformers although they are owned by the utility.

2. The Industrial Market

Our largest end market is the industrial firm. This market represents 60% of our total demand.

Unit substations (secondary and primary) installed indoors, on rooftops, and close to buildings represent over 90% of askarels use and from 18-33 M lb in unsold potential.

About 3.7 M lb of this unsold potential is dry type indoor and 0.6 M lb is in gas filled indoor and outdoor secondary substations. The remainder is in oil filled outside substations.

Our opportunity to expand participation in the oil filled portion of this market is not appealing unless the askarel transformer price is shown equal to the cost of the oil filled unit plus the cost of required fire protection devices (fog sprays, fire barriers etc.) and the average annual dollar loss due to oil filled fires and explosions. The prevalence of "it's standard practice" on transformer selection indicates industry does not closely analyze this approach to the economics of askarels safety. Monsanto can successfully study and use this sales tool in industry.

Action

In the industrial market askarel is neither losing nor gaining significant ground on dry type indoor substation demand. Our long term position in this market is endangered unless askarel transformers maintain design superiority over dry type and unless we insure, after thirty years of service, that faulty askarel transformers designs are prevented. These observations center upon:

- a. New advanced dry type indoor substation designs now offer impulse strengths equal to askarel at competitive prices.
- b. Large, old-time askarel users like General Motors, Ford and Chrysler emphasize the same dislike - leaks from faulty gaskets and bushings and internal vapor phase corrosion in the askarel unit. This problem is a major reason why General Motors is the major proponent of gas filled designs, and why GM and other industrial firms will not maximize askarels use.

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- c. The profitability of the askarel transformer is unsatisfactory between 15-34 KV voltages due to large insulation clearances thus a large tank design. According to Westinghouse, askarel transformer manufacturers do not fully understand this design problem. The trend in industrial secondary substations is to these voltage levels - and so is dry type design technology.

The industrial market for askarel transformers is widely dispersed and is not dictated by several industries as expected. About 50% of our demand is shared by primary metals, chemicals and the automotive industry. The remaining 50% is evenly spread through 10-15 industries including:

Paper	Rubber
Mining	Food
Textiles	Stone-Clay-Glass
Electronics	Drug
Petroleum	Aviation

We can expect the dissimilar industrial environments of aviation, food, electronics, drug and rubber to lead to the choice of askarel for major reasons other than proven reliability, contaminated environments and heavy concentrated loads which together or separately typify our three largest consumers. This diverse demand picture justifies Askarel market contacts by industry. A starting point is the petroleum, paper and textile markets, all of which have a low proportion of askarel units to total secondary substation units according to ITE and GE unit sales reports. Allis Chalmers, Pittsburgh has recently surveyed the industrial transformer market regarding preferences and demand. These results should now be available to Monsanto to assist our industrial marketing approach.

Action: See it

Action / A new opportunity suggested by Stone and Webster, a leading engineering firm, should be screened for demand and need by Monsanto in high temperature, high voltage cable insulation and fire resistant dielectric-coolant mediums. Present solid insulating materials and the use of oil as the dielectric-coolant medium do not meet safety and heat dissipation requirements according to Stone and Webster. Our Flutec-Imperial Smelting technology may be an entre here.

3. The Commercial & Utility Market

These two markets are summarized together because of the influence of the utility on the transformer decisions in these markets. These markets combined represent 40% of Askarels demand. Utility owned network transformers and commercial/utility owned indoor secondary substations represent over 70% of our sales volume to these markets.

Our overall market atmosphere is unsatisfactory.

- a. Many large utilities minimize askarels use and do not specify askarel unless absolutely required. This includes large askarel network users contacted and Consolidated Edison, New York, who controls about 45% of the entire network transformer market.
- b. The large utilities not only control the network transformer market but also are the largest influence in the commercial transformer market. Unfavorable prejudice is thus affecting askarels commercial secondary substation market.
- c. We are losing market position to dry type secondary substations where sales are running at least 2:1 dry to askarel and the trend favors dry type. Similarly our network transformer market share is approximately 20% and shows no gain in position over oil-filled which dominates the remaining 80% of the network market.

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Our most significant problem is the utilities reluctance to expose personnel and customers to askarel fumes and irritation. This has resulted both from several widely publicized explosions and frequent bothersome transformer leaks. Our commercial market growth is further hindered by cost concious decisionmakers in the utilities who disfavor askarels high installation costs (venting and vaulting and weight of unit) and the higher price of askarel vs dry type of smaller substation sizes (500 KVA range) which are popular for upper floor high rise use.

4. Results and conclusions for askarels markets have been summarized above. Other important market sectors are:

a. The Transformer Manufacturer

Our major customers are unbiased towards askarel and they are not aggressively pursuing advanced askarel designs to compete with dry type technology. Their emphasis is on lowering costs and developing new dry-type designs to compete with improved technology from Zinsco, Federal Pacific Electric and Sorgel.

Westinghouse So. Boston is "the exception to the rule" as they actively push askarel in competition with Sharon's dry type units.

None of the manufacturers appear aware of askarels market position (Westinghouse underestimates our market demand by 50%) nor of the askarel transformers market-image as in-depth account penetration was not found during any call on this study.

b. Insurance, Codes and Agencies

Insurance rates are not a governing factor in the type of transformer selected. The key criteria are the minimum provisions of the National Electrical Code, upon which transformer installation policy and insurance premium rates are based.

Agencies are covered under section 6.

Action
We must address ourselves to frequent utility technical service visits to neutralize emotions on askarel's toxicity and handling. A successful reduction of askarel's installation design requirements could offset lower priced 500 KVA size dry type units.

The attitudes of the consulting engineers were not assessed during this study. The decisions of the smaller utility and the commercial customer in his area are influenced by the consulting engineer.

B. Document Our Market Share and Project Askarel Demand

Prior discussion highlighted askarel's demand by end market, industrial, commercial-utility, and residential. Askarel's estimated potential and market share summarized by major transformer type is:

Transformer	Total* Market in M lb Askarel	% Total Units			
		Ask	Oil	Dry	Gas
Residential Units	**	0	100	0	0
Generating-Transmission	**	0	100	0	0
Primary Substations	30	5	95	0	0
Secondary Substations	22	44	30	23	3
Network	18	20	80	0	0
Rectifier	3	25	75	0	0
Furnace	3	2	96	--- 2 ---	
Specialty	**	5	15	80	-
Precipitation	1	50	50	0	0
Commercial Pad and Pole & Misc	>30	5	94	--- 1 ---	
Total	>104	<16	>78	6	1

*Based on only direct sales to key transformer manufacturers
16.5 M lb out of 21 M lb blended sales in 1968.

The market for those transformer types asked (**), residential, generating-transmission and specialty, was not assessed in this study as they had either insignificant or no known askarel participation and potential. Residential (except URT) and generating-transmission units, although large markets, are oil filled, outside and remote from the hazards of fire. Specialty units have askarel participation in precipitation units and this is reported separately. Other askarel sales in the specialty group are estimated at 5% for instrument and transportation units. However, this total market category offers insignificant potential now dominated by mini-sized (1 KVA) dry type units.

Our market share for those markets in which we now participate does not exceed 16%. Dry types have 6.7 M lb of our market, concentrated in indoor secondary substations. Sales are split about 50% commercial-utility and 50% industrial. Gas-filled units represent only 0.6 M lb directed to the industrial market, primarily to General Motors. Oil filled outdoor units dominate all our markets except secondary substations.

B(con't) Projected Demand

Historical mathematical correlations indicate askarel growth rate above 7% per year through 1975. However askarel sales appear leveling and will not progress at that rate due to our static network market share and increasing popularity of the commercial dry type substation transformer.

Quarterly transformer orders as reported by Edison Electrical Institute offers the only measure of transformer sales activity found capable of anticipating satisfactorily our yearly fluctuation in sales. Other ten year historical correlations of askarel sales with selected quarterly and annual measures of the economy, construction, transformer shipments and sales and energy consumption failed to anticipate yearly sales fluctuations.

Results for predicting askarel demand for the period 1964 through 1969 estimated and forecast 1970 by this method are as follows:

Year	% Change*** (est)	% Change (Actual)
1964-65	4%	32%
1965-66	2	5
1966-67	30	21
1967-68	-19	-7
1968-69	-14	-14 (est)
1969-70	0-5%	

Note that although fluctuation was correctly identified for 1964-1969, the exact magnitude is questionable. Our 1970 prospects by this method indicate sales at the same 16 M lb level as our estimated 1969 performance (ignoring strike impact).

- C. Analyze those influences on demand that we can favorably effect. Include possible influences on demand of new pricing, advertising and field sales effort.

1. Advertising

Our advertising program should be directed only to the consulting engineer, 2000 of whom are members of the Consulting Engineers Council.

- a) The large industrial and utility firm is an experienced, biased audience that relies on technical seminars and technical associations like EEI & IEEE for current developments. Penetration will require personal contacts.
- b) The consulting engineer influences the smaller industrial firm and the commercial area of the smaller utility. Larger utilities are usually the dominant influence in their commercial area.

Four important transformer selection criteria that are now part of our advertising theme are (questionable askarel advantages to the experienced specifier.

These four criteria are impulse strength, installation costs, location versatility and maintenance problems.

Our theme would benefit by citing specific, unique cases where dollar savings in installation costs and the location of the unit were realized with askarel. Impulse strength should be de-emphasized.

2. Pricing

A change in askarel's price even to + 20-30% would not appear to significantly effect profitability on the average size askarel transformer. Our costs represent only 12-13% of the total transformer cost. Profitability is good, ranging up to an estimated 48% gross on 1500 KVA sizes.

Profitability on smaller size askarel transformers in the 500 KVA range appears marginal at 20%. This explains why askarel prices are not competitive in this size with dry type in the commercial substation market.

An increase of less than 1% in askarel's price if needed to justify increased research and field effort should not affect our demand nor prompt transformer price increases.

3. Field Sales and Marketing Effect

Only through increased personal contact with utilities and industry can we expect to improve our market position and maximize Monsanto new opportunities.

Action

Monsanto technical visits have been appreciated by utilities and industrial firms. Firms contacted encouraged visits about once per year to educate on askarel's care and handling, reclamation and testing. To produce results in improved image and to gain in-depth market understanding personal contact annually to an estimated 50-100 large firms in our diverse industrial market and to about 25 large investor owned utilities is required.

The large utility and industrial firms have only several dominating decision makers on askarel transformers. Active participation in technical associations and close in-depth reviews of all changes in askarel transformer standards and installation code requirements are readily available avenues to pursue improved askarel transformer costs.

RECOMMENDATIONS

1. Our most important objective should be to improve our market image and aggressively counter our unfavorable position in the commercial-utility network and substation market.

Initiate an askarel personal contact program beginning in 1970 for at least two in-depth calls annually on the largest investor owned utilities (approximately 25).

Primary objectives should include:

- 1) Service on askarel care and handling, reclamation and testing and good penetration at the Utility Distribution Engineering decision making levels.
- 2) Document additional cases and isolate the transformers and manufacturer(s) where faulty gaskets and vapor phase corrosion problems continue to occur on askarel units. The respective manufacturer should be appraised of our findings. Our ultimate goal should be to insure the entire market place, industrial commercial and utility, receives transformers equipped with askarel with a guarantee backed by the manufacturer and by Monsanto on the performance of the "unit".

With the assistance of CED installation design costs should be analyzed to minimize these requirements for the askarel unit. These installation provisions can be analyzed from input received from the utility and from the provisions of the National Electrical Code.

Our research effort should be addressed to askarel insulations that offer improved costs for the smaller size (500 KVA, <15 KV) range) askarel substation unit. And secondly to the longer range need of improved insulation technology at 15-34 KV. Cooperative Monsanto-transformer manufacturer research efforts should be solicited. An increase in askarel's price to justify this effort, if needed, should be approved.

It is recommended that our advertising program be directed to the consulting engineer audience. This will penetrate both the commercial markets of the smaller utility and the smaller industrial plant market. Our theme should center on specific unique cases where dollar savings were realized in installation costs and in the location of the unit.

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2. New opportunities for askarel and plastics technology in the unit residential transformer market should be assessed in 1970 by either Commercial Development or Marketing. Calls should be made on Allis Chalmers, General Electric and those key utilities that promote differing URT concepts as listed in this report.
3. Marketing or commercial development should "screen" in 1970 the demand and need for new cable insulations and fire resistant dielectric-coolant mediums with personal contacts to Stone-Webster and several cable manufacturers.
4. In 1970 marketing should contact industrial firms in our diverse markets to further appraise the total industrial position of askarel. These contacts should emphasize:
 - a. Reasons for askarel's choice vs the specific industrial environment.
 - b. Exact cost evaluations of the industrial askarel transformer vs outside oil filled units.
 - c. Total askarel potential by each industry segment (i.e., aviation vs. petroleum vs. chemical etc.)

III. ASKAREL TRANSFORMER MANUFACTURER

A. Askarel Customers -- Types Produced

Only our key transformer askarel customers: Westinghouse, General Electric, Allis Chalmers, ITE, and Maloney and Wagner in St. Louis were contacted regarding their production. The product mix offered industry by these manufacturers is quite varied. Table I is a summary of data accumulated during visits and from the records of the National Electrical Manufacturers Association (NEMA) regarding the transformer mix of our customers.

Each manufacturer, typically, produces most transformer types from specialty to large power units. Their production line includes both dry, oil-filled and askarel. Note that of our large customers: General Electric, Rome, is primarily substation oriented; Westinghouse, South Boston, will by 1970 have essentially all askarel production, with Sharon handling competitive dry types. ITE produces only substations to support their switchgear production. The larger manufacturers, General Electric, Westinghouse, and Allis Chalmers, divide production between different plants. Conversely, the smaller plants, Wagner, H. K. Porter, etc., produce all transformers at a single location.

The production of askarel transformers is usually a small part of the transformer output of each company, but can be a large portion of an individual plant's production. As askarel finds major volume only in secondary substations and network units, as much as 90 percent of each manufacturer's output is oil filled units.

All our key customers, except Allis Chalmers, also produce dry type and gas filled units. Allis discontinued dry type production in the 1950's. Advanced dry type technology and aggressive market penetration appears centered among those manufacturers where askarel production is incidental or non-existent. Key dry type manufacturers include: Federal Pacific Electric, Hevi-Duty, Zinsco Electrical Products, Los Angeles, and Sorgel in Milwaukee.

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Competitive pressure from these producers has forced renewed dry type attention by Westinghouse, General Electric and Allis.

B. Askarel Consumption by Type

Our key customers, Allis Chalmers, General Electric, Westinghouse and ITE, together in 1968 represented 14.1 million pounds, or 75 percent of our 18.7 million pound domestic sales. The remaining 25 percent was split between ten smaller transformer manufacturers (10 percent) and service shops and the transformer user (15 percent). However, both General Electric, Pittsfield, and General Electric, Rome, have blended in a 45:55 and 80:20 askarel:chlorobenzene ratio respectively. Thus the actual market significance of our key accounts is higher. In 1968 they represented 16.5 million pounds, or 79 percent of 21 million pounds finished blend market.

Table II displays the significance of each manufacturer contacted to our business, and the significance of each transformer type to our askarel sales. The substation market represents about 68 percent of our business, with secondary substations our key market. Network transformers represent 18 percent and other 14 percent.

General Electric, Rome, Westinghouse and ITE are heavily committed in askarel to substation production. Conversely, General Electric, Pittsfield, and Maloney are heavy network transformer producers. Only Westinghouse and General Electric appear to be major factors in askarel's miscellaneous markets.

C. Marketing Organization

Each transformer manufacturer is organized similarly to serve the transformer market. Corporate sales are usually divided into industrial and utility groups or divisions. As under Monsanto's original "district" manager concept, the salesman reports administratively to the sales manager, and "functionally" to the marketing manager for that particular product group. Each product group is supported by a separate marketing, engineering, and planning staff.

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The Salesmen

The field representatives are multi-product, industry specialists. They are not profit oriented marketers. Thus they unquestionably do not care what type transformer is sold -- oil, dry, or askarel, as long as they get the order. The representative is normally responsible for only one to two large industrial accounts, or one to two utilities and several smaller accounts. With Westinghouse and General Electric, the large number of products per representative often justifies a single representative handling all General Electric electrical power equipment requirements to one account. A representative would also handle motors, switchgear, cable, capacitors, generators, etc.

In-depth account penetration by transformer representatives was not found during any call on this study. Contact is maintained by the representative with only the key specifiers at the large utility and industrial account. These people would include the manager of distribution engineering of the utility and the chief engineer, or project engineer, of industrial corporate engineering. Technical service representatives are available for specific problems that cannot be solved by the customer. Representatives do not provide customer service visits on a routine basis. Operating and maintenance personnel of the utilities indicated that they did not see the transformer representative at all. This lack of service philosophy was also found at A & E's contacted during this study.

The sales representatives' lack of enthusiasm for pushing the askarel transformer is due to the unwillingness of manufacturers to inform representatives of the more profitable products. Our position is good with Westinghouse, however, as South Boston with askarel actually competes with Sharon with dry types. Note Appendix C. As most other manufacturers offer all types of transformers, they indicated:

1. Favoritism for one type may lead to loss of the contract or order. The transformer often represents a very small part of the total project bid. Often it is as little as two percent of the manufacturer's bid package that would include motors, switchgear, generators, etc.

2. They could not trust the field with profitability data.
3. The user nearly always states his specific preference of transformer type. This is especially true for the utility. The engineering or consulting firm will evaluate bids based on quotes received for each type of transformer, then he, too, will specify the type.

Marketing Management and Support

The marketing manager for askarel transformers normally reports to the plant manager and provides "functional guidance" to the field representative. A marketing manager normally handles one or two of the following transformer classes: Distribution transformers (less than 500 KVA units), small power transformers (501 to 10,000 KVA -- which represents the present askarel market), and for the large power transformers. This transformer class overlap varies depending upon the product mix of the plant and the size of the company. For example, Zeke Zehnder, Marketing Manager at Wagner Electric, has product and market responsibility for all power, distribution, and small power transformers. Conversely, Dave Keiser, Westinghouse, South Boston, has product and market responsibility for only askarel and oil units in the small power class.

The marketing manager has reporting to him a staff of applications engineers (product specialists) and market planning personnel. The applications engineering group receives each request for bid and handles pricing, delivery, and minor systems engineering. They coordinate with the engineering group on all bids that require a design deviation from their "standard" transformer line, which is a common occurrence. In addition, the applications engineer is required more often than the representative to answer technical customer inquiries like: a) askarel toxicity, b) current trends in transformer selection for unique installation requirements, and other "what are people doing?" type questions.

The lack of profit motivation was found to exist throughout the applications engineering and market manager levels. Of all those personnel contacted at our customers, the marketing personnel at Allis (Milwaukee and Pittsburgh), Wagner, Moloney, and General Electric, Pittsfield, were not really sure whether oil or askarel or dry was the most profitable. General Electric, Rome; ITE; and Westinghouse,

South Boston and Sharon acknowledged that askarel was more profitable than oil. However, just "get the damn order" is the order of the day, except for South Boston's askarel preference.

Product and Market Planning

The market manager is the focal point for this function. This industry, however, is characterized by minimum effort on new-product planning and market analysis. This is particularly true for askarel transformers. Even when asked, "How important is the commercial versus industrial market to your total substation business, and what is the significance of specific industries (steel versus automobile versus paper, etc.) to your total substation business?" few market managers, product planners or applications engineers had the answer. Westinghouse and General Electric, Rome, Georgia, had answers -- thanks to a well-staffed market research-planning group reporting to the marketing manager. Information is classed by computer for all bid requests received according to transformer type, geographical location of the customer, and the industry. Allis-Chalmers and ITE simply were not abreast of their market position. ITE estimated in a meeting that the construction market represented about ten percent of their secondary substation sales. However, a manual breakout revealed the construction market represented 23 percent of their business. Allis-Chalmers' situation seems even worse as all substation sales are made indirectly through the Switchgear Division in Milwaukee. The marketing manager in Pittsburgh has little direct contact with the end market.

Specific comments regarding organization and marketing capability addressed to each manufacturer personally contacted is as follows:

General Electric - Pittsfield and Rome, Georgia

General Electric's marketing organization for electrical products is divided into the industrial and utility sales divisions. Market headquarters are located at the producing plant. The industrial sales division is comprised of electrical machinery (motors, transformers, turbines, switchgear, cable, etc.), marine equipment, and the

electronics groups. Salesmen call only on specific industrial customers, while their counterparts in the utility sales division handle similar products and call only on specific utilities. Transformer orders are referred back to the market headquarters of the producing location for pricing, delivery, etc. Technical support is provided each salesman through installation and service engineering (I & SE) specialists located in each district office.

Westinghouse - Sharon and South Boston

Both Westinghouse and General Electric are similarly organized to serve the transformer market. Corporate sales is divided into three groups: Electronic components, distribution and service, and industrial sales. Industrial group salesmen are specialists handling all industrial products consumed by that specific customer. Utilities and industrial accounts are served by the industrial sales group. At South Boston, Dave Keiser, Marketing Manager, has a staff of six to nine "inside" salesmen (applications engineers) who handle orders and provide technical support to the field. Keiser will assume responsibility for the market and product planning group for substations and networks when they relocate to South Boston from Sharon.

ITE, Philadelphia

ITE is organized into two major groups, one of which is the Power Group. This group consists of several profit center divisions. These divisions include Transformers-Rectifiers, Switchgear, Victor Company (porcelain) and the Power Circuit Breaker (PGB) Division. The T-R division employs thirty to forty salesmen who differ from their General Electric and Westinghouse counterparts. They are:

1. More specialized - handling only the products of their division.
2. Responsible for both sales and engineering service. ITE has only one "applications engineer" in Philadelphia for transformers and one for rectifiers. Conversely, General Electric and Westinghouse have an applications

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engineering staff, plus the customer service engineers.

Allis-Chalmers, Milwaukee and Pittsburgh

The Milwaukee group is the marketing arm for most of Allis' askarel filled transformers. Market guidance, deliveries, pricing, etc., on the transformer comes from the market manager in Pittsburgh. Both Milwaukee and Pittsburgh have applications engineers. Milwaukee has four to six applications engineers specialized by industry -- mining metals, rubber, petroleum, chemical, utility, etc. This group quotes prices, delivery, and answers generally to the prospective customer. They coordinate with the Pittsburgh applications engineering group.

Milwaukee satisfies askarel and oil filled requirements through the Pittsburgh plant. Dry types are purchased outside from Sorgel, Standard Transformer, and others. The Switchgear division is separate from the Pittsburgh organization, which is part of the Utility Division. This organizational split compounds the "care less" attitude towards askarel. The Switchgear Division does not share in Allis' transformer profits.

The trend here seems to favor more active marketing by Pittsburgh. Allis is having success with new gas-filled units at General Motors, and generally have taken an aggressive market posture. A study was initiated several months ago by Fosdick and Associates, New York, for Allis in Pittsburgh. The study objectives are similar to ours, they include demand by specific industry, attitude analysis, and future transformer demand. Fosdick will personally contact over one hundred key industrial firms and will submit their final report to Allis in Pittsburgh in December 1969. Sheffey Massey, Marketing Manager for Allis in Pittsburgh, has agreed to discuss results with Monsanto. The Allis salesmen are like ITE men -- more specialized than General Electric and Westinghouse. They handle only the products of the Switchgear Division.

Pittsburgh is responsible for both creative and applications engineering on each of their transformer types except the unit substation. "Creative" refers to new transformer designs, and major modifications to existing designs. The

Milwaukee group appears responsible for creative engineering on substations.

Moloney Electric - St. Louis

Moloney supplies only askarel filled network units to utilities. Rhinehart termed their salesmen as "order takers" for this market. The large network user, according to Moloney, usually gives you a certain percentage of their business whether you are high bidder or not.

They serve only the domestic market, through full-time district transformer representatives (estimate twenty). About six regional offices are located in major cities east of the Mississippi to serve the big investor-owned utilities. West of the Mississippi they have a regional office in Dallas and several distributors, the largest serving the West Coast. They estimate 80 percent of their sales are direct. Distributors usually handle complimentary electrical equipment, while each Moloney's representative handles their entire transformer line.

D. Costs and Profitability

Based on cost analysis input provided by Allis Chalmers for indoor secondary unit substation, askarel represents between twelve and thirteen percent of the total transformer cost, including material, labor, and overhead. This compares to 1.6 to 1.8 percent for oil for the same type and size unit.

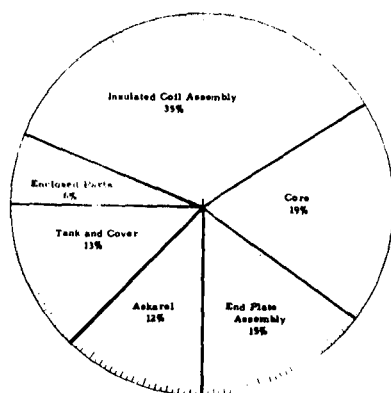


FIGURE 1: Typical Transformer Costs

Figure 1 illustrates typical manufacturing costs applicable to askarel filled units. The core and coil together represent 54 percent; the supporting end plate assembly (core and frame) 15 percent; the tank and cover (including cooling coils) 13 percent; and miscellaneous enclosed parts 6 percent.

Askarel's cost increases only slightly with increase in transformer size. Cost analysis input shows askarel is about 12 percent of the cost on a 500 KVA unit, and 13 percent on a 2500 KVA unit.

The overall transformer cost is typical of a high volume commodity product. Allis reports that materials (including fluid) represent 75 percent of the unit cost, while labor is only 7 percent and overhead 18 percent. Labor and supervisory costs are directed at the coil, tank and end plate (frame) assembly.

Askarel versus Oil versus Dry Type

The total transformer cost, excluding fluid, appears essentially equivalent for both oil and askarel units up to 15 KV primary voltage. For units above 15 KV primary voltage, the askarel insulation class increases one level, thus increasing askarel's costs. Historically, most of the network and secondary substation units sold are 15 KV and below. The trend, however, for both commercial and industrial substations is to 15 to 34 KV units.

The basic design difference between oil and askarel units (networks and secondary substations) include only internal paint (askarel often is not painted, oil is); pressure relief device (standard on askarel, optional on oil); and the wire coating. However, these exceptions appear to vary from manufacturer to manufacturer and many market "universally compatible" units that use either oil or askarel. Askarel's cost picture was found to rapidly deteriorate at those manufacturers not heavy in substation production, who were geared for predominately oil filled units, i.e., networks, pad-mounts, pole units, etc. Primary reason for this situation is the requirement for non-standard gasketing, fluid and test procedures, etc.

The dry type unit cost versus askarel is reported from essentially the same to about 5 percent above askarel for

equivalent type and sizes. Dry type costs, however, are reported above askarel for units above 50 BIL due to increased insulation requirements. Improved insulation technology is present with dry type substation units now being offered at 95 BIL by Federal Pacific Electric, Zinsco and Sorgel. They have assured the utilities market that expected market demand will allow equivalent pricing with askarel at the 95 BIL level. Current pricing quotes (discussed later) indicate these units are now about 10 percent above askarel.

Profitability

The askarel transformer is more profitable than oil to manufacturing plants heavily committed to askarel production. Acknowledging this fact were General Electric, Rome, ITE, and Westinghouse, South Boston. All are key producers of secondary unit substations (askarel's primary market).

Askarel units appear to generate acceptable to good profits ranging between 20 to 40 percent gross. Table III displays estimated profits for 500, 1500, and 2500 KVA units based on cost and pricing input from Allis and Westinghouse. Although the volume of askarel per transformer varies from manufacturer to manufacturer, this breakout is representative.

The average unit size is in the 1000 to 1500 KVA range, indicating 30 to 40 percent average gross profit. Note that profitability decreases substantially with decreased transformer size.

Gross profit on oil filled secondary substation transformers ranges from 6 to 8 percent below that of askarel filled. This difference comes from the lower cost of oil required for each transformer, assuming other costs essentially equal. For example, oil costs on an Allis substation transformer rated at 1500 KVA, < 15 KV primary are \$74 (2373 pounds @ \$0.031/pound) versus askarel at \$665 (4113 pounds @ \$0.166/pound). This represents an 8 percent difference in profitability as the askarel transformer sells 125 percent higher than the oil filled units. This profitability difference should be applicable to all transformers where "universally compatible" design and significant askarel sales versus oil are realized by the manufacturer on that unit. At present we find only secondary substations and possibly network transformers in this category.

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Future Profitability

Between 15 to 34 KV primary voltage design, askarel economics are regarded as unfavorable by General Electric and Westinghouse. Askarel's cost and gross profit advantage over oil deteriorates between 15 and 34 KV, as noted earlier. This condition is apparently due to askarel's lack of ability to uniformly distribute voltage stresses. The phenomena is not fully understood according to Westinghouse, however, it does require large insulation clearances, thus a larger design. In view of increasing demands for higher voltage units in the 15 to 34 KV range and improving dry type design at these voltages, Westinghouse has specifically addressed their future askarel plans to developing a high temperature unit that will overcome these problems.

The period of 1968-69 generally has been regarded as a time of over supply with deteriorated industry transformer prices. Industry is partially offsetting this profit squeeze by aggressive marketing and improving costs. General Electric, Rome, will convert all substations from high priced copper windings to aluminum by 1970. Other economic moves are obvious: Westinghouse, South Boston, with new facilities; Allis Chalmers, Pittsburgh, pushing for new 1242 design. Manufacturers are optimistic for 1970 when they hope prices will rebound to 1966-1967 levels.

E. The Market Demand by Type

Askarel fluid enjoys a diverse use in at least nine different transformers ranging from secondary and primary substations to an occasional pole top transformer designed for inside use. However, two of these transformers, secondary substations and network units, dominate our sales with about 80 percent of our market. Based on the data presented earlier for our key customers in Table II, our estimated market demand is as follows:

Share by Transformer Type

	<u>Total</u>	<u>Secondary Substations</u>	<u>Primary Substations</u>	<u>Network</u>	<u>Others</u>
Volume (M lb)	16.5	9.8	1.4	2.9	2.4
% Total	100	59	9	18	14

Secondary Substations or "Load Centers" represent about 59 percent of the askarel demand. Askarel substations, however, share a considerable part of this market with dry and oil types. From the transformer production input of ITE, Allis, General Electric and Westinghouse, who dominate this market, askarel's market share is not over 44 percent:

Market Share Askarel vs. Competition

	<u>Total</u>	<u>Askarel</u>	<u>Dry</u>	<u>Gas</u>	<u>Oil</u>
Volume					
(M lb askarel)	22.2	44%	30%	3%	23%

The above demand has been converted to equivalent askarel volume per transformer. Dry types represent about 33 percent of this market, while oil is about 23 percent. The impact of gas filled units on Westinghouse's production was not determined. Excluding Westinghouse, the gas filled transformer represents about 3 percent of substation demand.

Primary Substations represent about 9 percent of our sales, with outdoor oil units dominating this marketplace. Askarel's market share is less than 5 percent, with those units on askarel being installed indoors, close to a building or in a hazardous outside environment where safety from fire is required.

Network Transformers -- Network demand is about 18 percent of our total market. Askarel's market share is approximately 20 percent, with oil representing the remaining 80 percent. The dry type network market appears negligible at present. They are popular for indoor upper floor applications. Our share is based on historical AC network transformer surveys by Edison Electrical Institute. EEI annually, for the period 1944 to 1961, reported installed network transformers by the utilities as follows:

<u>Period</u>	<u>% Askarel</u>	<u>Period</u>	<u>% Askarel</u>
1944-46	6.2	1953-55	18.7
1947-49	10.4	1959-61	17.0
1950-52	12.9	1968 (est.)	20.0

Currently, manufacturers report askarel network transformer production running from 15 to 60 percent of total production. Westinghouse and General Electric, the market leaders, report 17% and 33% respectively.

Others - All other transformer types represent an estimated 14 percent of the askarel demand. Within this category are:

Rectifier Transformers - Annual consumption of askarel in rectifier units exceeds 600,000 pounds based on General Electric, Pittsfield production estimates. The market is 25 percent askarel and 75 percent oil.

Furnace Transformers - Askarel's participation appears less than 100,000 pounds annually, based on General Electric, Pittsfield production estimates. Askarel's sales are confined to the small induction foundry furnaces with only 2 percent of the large arc furnace demand. Askarel shares the induction furnace market with dry type and 98 percent of the arc furnaces units are oil equipped.

Precipitation Transformers - A 300,000 pound annual askarel demand based on General Electric and Westinghouse, Sharon input. Askarel shares this market about 50:50 with oil.

Transportation Transformers - None in 1969. However, askarel demand averages yearly 100,000 pounds with equal share for oil filled units.

Growth rates of the above transformers by type could not be reliably assessed from manufacturers' input. The only area that showed promise of demand growth above the standard industry "6 to 7 percent per year" rate was transportation transformers. General Electric indicated the demand for these units will increase as new rapid transit systems are constructed. The 100 M pound askarel demand reflects this market annually over the next three-to-five year period. This should increase to the levels of rectifier demand (600M) in the late '70's if the weight of askarel does not rule in favor of oil. General Electric indicates this may be the case, as askarel increases the cost per car by \$1000 to \$1500 based on a one dollar per pound value on weight per car. One transformer per car is required at 200 to 300 gallons per unit.

Table IV summarizes askarel's total estimated market share by type and total for those markets in which we now participate. Our market share does not exceed 16 percent. Oil, with at least a 78 percent share, dominates all our markets, except secondary substations and our mini-market, rectifier transformers. Dry type transformers represent 6 percent or less of our total market, however, are quite heavy in our major market place secondary substations.

Table IV also indicates the importance of each major end market; commercial, industrial, utility and defense, to our business. This is discussed in the next section.

F. Demand by End Market

The industrial market represents about 60 percent of our askarel fluids' end market, while the commercial market has about 12 percent and the utilities 28 percent. This section will discuss how each askarel transformer type is used in the industrial, utility, and commercial markets and the importance of particular end market segments (i. e. primary metals, generating plants, etc.) to our business. The why's of selection is discussed under the Attitudes and Selection Criteria section.

Industrial Use

The industrial market includes all manufacturing locations separate from institutions, offices, shopping centers, etc., which are considered the Commercial Market. The typical industrial plant is characterized by heavy, widely varying electrical needs. Different types of transformers are required to selectively meet these demands.

Industrial plants are served by the utility at voltages up to 69 KV. This voltage is then stepped-down by primary substations and secondary substations to utilization voltages. The secondary unit normally feeds the plant motors, fans, etc., at 480/600 volts, while the primary will provide direct supply to the higher voltage needs of large motors, strip mill drives, etc., and to other secondary units in plants having widely dispersed load concentrations (steel mills, aluminum mills and chemical plants).

The bulk of all volume potential to the industrial market appears concentrated in primary, secondary, rectifier and furnace type transformers (Table IV). All of these markets, except two, are dominated by oil because units are:

1. Outside (most primary)
2. High dielectric liquid volume (Primary and furnace transformer volumes reach 5,000 to 10,000 gallons per unit.)
3. High voltage requirements (Primary, rectifier and arc furnace reach up to 69 KV.)

The above factors have ruled out askarel consideration except for those units installed indoors where National Electrical Codes require askarel or vaulting. It appears as though some rectifier and large furnace units are installed indoors, however, General Electric, Pittsfield stated, "Oil is used in large rectifier and furnace units indoors because the cost of a vault overshadows the \$10,000 to \$14,000 extra for askarel fluid in these units." In-depth industrial feedback on the subject of rectifier, furnace, precipitation, and primary substations for askarel versus oil was not obtained. General Motors did note that unlike the rest of the industry they have ordered several large askarel equipped arc furnace units; however, delays for "non-standard" materials and leakage problems in gaskets and bushings have been problems. They would like to continue to specify askarel, however, economically it is questionable.

From Table IV the bulk of our business in industry (totalling 7.8 M of 9.9 M pounds) is in secondary unit substations. Our market share in this specific market is estimated over 50 percent of the available business, with oil and dry types sharing the remainder. The impact of the dry type unit in industry does not appear to be as significant as in the commercial-utility markets, which will be discussed later. Gas filled units find a major demand in industry, primarily at General Motors, who continue to pioneer and promote new gas designs.

The industrial market for askarel, both in present sales and potential, may be more widely dispersed than we anticipated. Complete by-industry totals for askarel substations sales could be obtained only from ITE, who represents about 20 percent of askarel's blended consumption to this market. This data, plus General Electric, Rome's input of the total available substation market gives a useful picture of our key industrial markets. This data is summarized in Table V.

Our key markets are primary metals, automotive and chemicals, which together account for about 50 percent of all askarel substations. No single market appears to dictate our business, however, automotive is the largest single consumer and they prefer askarel over all other types. Calls on General Motors, Ford, and Chrysler confirmed this fact.

The remaining 50 percent of our business appears widely dispersed in the paper, petroleum, stone-clay-glass, aviation, electronics, rubber, drug, and food industries. Major unsold potentials exist in the paper, textiles, and petroleum markets, each having a smaller proportion of askarel units compared to all units. The petroleum industry characteristically favors oil-filled units, while A & E firms indicated the paper industry trend is to "clean room" environments that house all electrical equipment. In these cases, dry type units can be used because of the clean environment. Factors affecting askarel's selection, including the transformer environment, are discussed under "Attitudes and Selection Criteria."

Utility and Commercial Use

Commercial buildings, as the expression is used, includes all buildings not involved in manufacturing or processing a product. Included are office buildings, hotels, colleges, hospitals, shops, shopping centers, and similar non-manufacturing facilities.

Electric distribution service to this market involves systems with unique problems. However, power service normally comes from the utility owned network or pad-mounted transformer. The network transformer commonly serves the downtown area from a "grid" of units, employed in over 300 of our large cities. The network serves several customers and is traditionally vaulted, either under ground beneath street or sidewalk. Large demands (> 750 KVA) often justify one or two

"spot" network units per customer. If the load and building is large, several units may be located in the basement and on upper floors. These are utility owned. If the load is large and the utility rate structure permits, the customer can purchase the transformer, pay reduced rates, and design his distribution on the load center (secondary unit substation) principle, much as the industrial plant. These units then are installed indoors, without vaults, and are either of askarel or dry type design.

Other transformer requirements in the commercial building are standard, smaller dry type units (500 KVA or below) used for stepping down 480 to 600 volts from the larger network or substation unit to 120 volts. The latter voltage serves incandescent lighting and small electrical appliance needs. The 480/120 volt dry type units are found on each floor of a multi-story building and are usually mounted on the floor, wall or ceiling, or in distribution closets for the 500 KVA size unit.

Generating Plants

About 5 percent of the installed capacity (KW) of a power generating plant is required for internal power within the plant to operate fans, motors, lights, etc. Indoor secondary unit substations meet this need by stepping down generated voltages of four to 13.8 KV voltages. Transformers for use within the generating plant are usually referred to as generating "auxiliary" transformers. Auxiliary power requirements are a necessary part of any power generating plant, irrespective of the generating source (hydro, pumped storage, fossil, or nuclear steam, internal combustion or gas turbine). Generally about one percent of a generator's capacity output will approximate the substation KVA requirement. This equates to three to six substations per generating plant.

From Table IV the utility market for askarel represents precipitation transformers and secondary substations for generating plants, all network transformer sales for commercial use, and a less than five percent share of the utility-owned pole and pad-mounted units for commercial use. These units are normally utility owned, although they serve the commercial customer.

Our present established position in this market is in network transformers (excluding low volume precipitation transformers). Our market share of 20 percent does not appear stable. As displayed earlier on page 24, EEI reports through 1961 indicated askarel share at 17 percent. Contacts with utilities indicate that during recent years, because of larger multi-story buildings, inside basement network vaults and upper floor networks are becoming increasingly popular. Unfortunately, dry types for upper floor service are preferred (weight and askarel's installation costs), and often oil is used inside because utilities feel askarel must be vaulted anyway (fear of explosion and fumes). Giants like Public Service Gas & Electric and Consolidated Edison and an industry leader, Virginia Power and Electric plus two others of twelve utilities responding indicated a decline in askarel's share of their installed network transformers. Two other utilities reported status-quo conditions while three indicated gains in askarel's share. Table VI summarizes the findings for these specific utilities who represented 52 percent of the network market in 1953-55, and an estimated 68 percent in 1968.

An actual decline in our share since the last EEI report of 17 percent (See page 24) appears questionable as manufacturers indicate 1968 production at about 20 percent askarel. This would indicate other large utilities have favored the askarel unit. At best, it appears, however, we will only maintain our current market position in a cloud of unfavoritism towards askarel transformers.

In the commercial market our established position is in the secondary sub station unit purchased by the commercial customer. Here dry type competition appears quite strong. According to manufacturing input, more dry type than askarel units are sold to this market. ITE sales records reflect in 1968, 78 askarel units versus 102 dry types -- a ratio of 1 to 1.3. Similarly, Power Magazine's annual Energy Systems Design Survey (October, 1969) reports every year since 1960 that of between 50 to 100 firms surveyed in the small industrial - large commercial class, dry type is definitely more popular. A trend couldn't be established from their

data. However, of the total available secondary substation market quoted on by General Electric the dry type share of available business had increased 4-7 percent since 1964-65. If we include dry type units sold by Zinsco, Sorgel and Federal Pacific Electric, a realistic ratio of askarel versus dry units sold to the commercial market would appear to approach 1 to 2, with the trend favoring dry type. This indicates that at least 3 M pounds of available askarel business is held by dry type, indoor substation units.

Each utility has a series of rate schedules for supplying power to customers under various conditions. One of the bases for establishing rates is the transformer or substation ownership. The large user often finds it necessary or economical to purchase power at higher voltage, such as 4.16 or 13.8 KV. The customer may then elect to furnish his transformers or substations to convert this higher voltage to the utilization voltage. On purchasing the transformer he shares the utility's fixed charge burden and receives rate compensation. This concept is applicable in theory to large loads (i.e. shopping centers, universities, hospitals), and to tall high-rise buildings (i.e. offices, apartments, and hotels) outside the downtown metropolitan area. Power Magazine surveys indicate that between sixty and seventy percent of all smaller customers (5MW and below) distribute below 600 volts, and between twenty and thirty percent distribute between 4.16 to 13.8 KV. The trend is towards higher voltage service to satisfy continued growth in large load buildings. Thus the commercial indoor substation concept will grow in popularity.

IV. ORGANIZATION AND DECISIONS BY THE TRANSFORMER MARKET

A. Industrial

The individual plant engineer appears to have a questionable influence on transformer selection for new plants. However, his role does become significant for replacement units and new transformers for expansions to existing facilities.

The central engineering or "corporate staff" group of the large corporation is perhaps the single most important influence on transformer specifications. This central

group, headed by the Chief Engineer and composed of representatives from each division evolve corporate "standards" that include transformer guidelines. Corporate staff design engineering personnel normally adhere to the "standards." Thus the large industrial firm has little dependence upon the outside consultant or A & E to select his transformer.

The small industrial firm, however, is unlike the large corporation. He lacks internal engineering, and his projects do not warrant large (i. e., Bechtel, Sverdrup & Parcel) A & E contracts. Thus, his decision is influenced by the consultant who engineers his new project. Normally, their jobs are not large millions-of-dollars repeat projects, and "standard" practices do not prevail. He is more dollar conscious and the consultant will choose with less regard for total long-range performance.

Each large industrial firm contacted appeared to have one or two key dominating decision makers at the corporate and divisional level, who are recognized both within the corporation and outside by the transformer manufacturer as the prime contact on transformer specifications and corporate policy; for example:

General Motors Detroit, Michigan	Howard A. Baldwin, V.P. Eng. Jerry Stein, Sr. Engr. Chev. Div.
Ford Motor Co. Detroit, Michigan	Mike Yugovich, Chief Elec. Eng.
U.S. Steel Corp. Pittsburgh, Pa.	Roy L. Leventry, Chairman, Central Maintenance Harry Frostick, Mgr. Design Engr.
Minnesota Mining & Mfg.	John Devich, Mgr. Elec. Eng.

Little need was found for Monsanto advertising to the large industrial firm. Normally, these engineers are older, experienced men who have standard practices

years old. They rely on membership in the Institute of Electrical and Electronic Engineers (IEEE) and technical seminars as sponsored by McGraw-Hill (Power Magazine) for new transformer technology trends, etc. This situation was also found at four A & E firms contacted. General Motors, Ford and U.S. Steel did appreciate prior technical sessions by Monsanto. Generally, they recommended periodic one to two year visits with key corporate engineers and with plant engineers for technical service support on: Askarel reclamation, handling, toxicity, etc.

B. Utility and Commercial

Of 3600 utilities in the United States, less than 500 control about 80 percent of all customers and of all generating capacity. These 500 are the private, investor owned utilities who have the network systems and serve the major metropolitan cities with generating and distribution power to the commercial and industrial customer. Of the remaining 3100 utilities, 3050 are the smaller public and cooperatives owned by municipalities and private groups respectively. They have little effect on askarel transformer demand. The other 50 utilities are Federal utilities, like Bonneville and TVA, who supply wholesale generated power (13 percent of the total U.S. demand) to isolated large power industries such as aluminum plants, to government users like the Atomic Energy Commission and the public utilities. These utilities have little impact on either industrial or commercial transformer selections.

The transformer decisions for distribution, small power transformers in the investor-owned utility rests with a selected few individuals in each utility. The Group having primary responsibility is Distribution Engineering. My contacts with the Manager or Superintendent of this group indicated they were principle decision makers with responsibility for the planning and performance of all distribution and small power transformers in their service area. Responsibility for large power, including "auxiliary" generating plant transformer requirements, rests with the Generating and Transmission Group. Generating and Transmission

was always found as a separate function from Distribution, however, there is much inter-communication between groups on transformer performance, preferred suppliers, etc. At both Consolidated Edison, New York and Commonwealth Edison, Chicago, the heads of both groups were familiar with the performance records of askarel units in distribution and generating plant applications.

The utility has a major role in the selection of askarel transformers. He governs the choice of transformers for his metropolitan area (networks and padmounts), for his generating plants (substations), and the larger utilities maintain much influence over the commercial market whether the customer purchases the transformer or not. Many customers are reluctant to purchase transformer types that are not favored by the utility. Drawings and specifications on large commercial buildings are usually submitted to the utility engineering group by the consultant for review and approval. Drawings include the indoor electrical "service entrance" design, electrical equipment and transformers. Thus the utilities have an impact on the consultants' selection and viewpoint.

Of eleven utilities responding, seven indicated they "own and maintain" the majority of their network and padmount transformers, and they "control" the commercial type of substation units. Included are some of our largest utilities:

Consolidated Edison, New York
Commonwealth Edison, Chicago
Public Service Electric & Gas, Newark
Virginia Electric & Power, Richmond
Baltimore Gas & Electric

The smaller utility relies heavily on the A & E and consultant for transformer requirements. They simply do not have the engineering staff nor demand to design and engineer their installations. The utility, like industry, relies heavily on their industry association, Edison Electrical Institute (EEI) for new technology and industry news. Little evidence was found during utility contacts that would draw decision results from advertising our product. The engineers here are, like the A & E and industry, experienced with firm prejudices.

If product experience has been good the utility will continue their support. Considerable evidence supporting the need for increased Monsanto technical service was uncovered. This is discussed under Attitudes and Selection Criteria.

C. A & E versus Consulting Engineer

It is important to note here that the A & E normally designs and constructs the utility generating plants, while the consultant (consulting engineer) is the engineering source for commercial jobs. A & E's are large, engineering firms like Bechtel, R. M. Parsons, Stone-Webster, etc. The largest are capable of designing both industrial and utility generating projects. Whereas some are specialists; i. e. Stone-Webster, New York handles generating plants; Rust Engineering, Alabama only industrial projects. The largest are members of The National Constructors Association (NCA) -- see bibliography. Conversely, the consulting engineers are independent contractors who manage their own businesses. Firms vary from a small operation of a single professional engineer to several hundred engineers and architects. Over 2000 key consulting engineers are members of the Consulting Engineers Council -- see bibliography. This council membership appears to represent singly the most significant group for market influence through the advertising media due to this enormous audience. The Executive Secretary of the Consulting Engineers Council agreed to support and assist efforts by Monsanto in a survey of this group regarding their transformer preferences and decision-making influence.

D. The Insurance Company and Electrical Code Provisions

The National Electrical Code Committee membership consists of both mutual and underwriting insuring companies. The electrical equipment manufacturers, industry associations (i. e., NEMA), the utilities, the contractors and the International Brotherhood of Electrical Workers Union representatives. The code was last revised September 1968 and is revised every three years. The code contains basic minimum provisions considered necessary for safety within public and private buildings and lots, and industrial substations. These provisions are accepted minimum standards for insurance inspectors and all government installations. The code doesn't

cover mines, ships, railway cars, aircraft, automotive equipment, or equipment of a railroad or utility. However, these groups, as well as most state codes, consider these provisions as their minimum standards.

Deviations from code provisions would occur outside the large metropolitan area in smaller cities and towns without municipal electrical inspectors, who interpret the electrical code for new installations. However, industrial plants in general follow the code but are normally not "bothered" by electrical inspectors. In both these exceptions, the insuring agent would be the governing factor to insure code safety standards are met. In the infrequent case where a conflict in code interpretation exists between the municipal (or state) inspecting authority and the insuring company, the inspecting authority governs.

Fire insurance bodies appear not to recommend Askarel over dry types or oil filled. They only require adherence to the electrical codes for the standard insurance rate. Fire insurance premiums are approved only on meeting code requirements and are based on plant value and the class of industry insured (i. e., textile, automotive).

Transformer insurance can be of two types, fire insurance (mutual or underwriting companies) or electrical breakdown insurance (above companies or independent companies). Fire insurance covers all elements except damage by electrical breakdown. They insure all property except the faulty piece of electrical equipment. A separate electrical breakdown policy is required to cover self damaged electrical equipment. According to Factory Mutual, electrical breakdown policy premium rates are not different for oil, dry, or Askarel units as long as the code is met. If it isn't, they won't insure the equipment. Most installations do not have breakdown insurance because of its expense.

V. ATTITUDES AND SELECTION CRITERIA

Askarel's image with the utilities contacted in this study was entirely unsatisfactory. Many have reluctantly used and lived with askarel fluid for years because they have had little choice when safety from fires is required.

Askarel's basic problem is one of toxicity and handling. Workers do not like the fluid because it irritates the skin and residual Aroclor 1260 is sticky and difficult to remove from spills, leaks and inside arced transformers. This situation is felt in the marketplace. Consolidated Edison, who controls about 45 percent of the entire network transformer market, has chosen to absolutely minimize askarel in either 1) networks outside or inside buildings, 2) substation units for generating plants, due to a record of several law suits from explosions in askarel units. In one case two people died "in the HCl fumes," and in the other two cases fumes caused adverse feedback from the building occupants. Union Electric and Virginia Electric and Power Company began phasing askarel out of their network system following similar conditions of fumes, resulting from an explosion that created adverse publicity.

This situation is detrimental to the growth of not only our utility business, but our commercial business due to the utilities' strong role in commercial transformer decisions.

Without regard to the utilities' prejudice for or against any particular dielectric medium, Table VII is a general check list prepared on the order of preference "generally accepted" for selecting transformers of the dry, gas-filled, oil-filled, and askarel type. This check list represents eleven of perhaps the most critical characteristics weighed for transformer selection. The order of preference is a published checklist prepared and published by Allis-Chalmers in 1955. Adjustments were made based on current data and price quotes received from the manufacturers for 500 KVA and 1500 KVA units (Table VIII). Adjustments in items #7 through #11 were made subjectively based on contacts during this study. These adjustments are noted parenthetically beside the old "order of preference."

Askarel indoor substations have advantages over our prime competitor dry-type in: Lower cost of losses, height, safety, noise and general reliability. We're essentially equal in initial cost (however the smaller

sizes, 500KVA, are less expensive), impulse strength, installation costs and maintenance frequency. Disadvantages appear for the askarel units in weight, floor area, overload capacity (under forced cooling), and location versatility. Two of these conditions of equality or disadvantage appear to have developed in design since 1955; reduced size and impulse strength. Equality of installation costs and maintenance problems are subjective and will be discussed later. In this light, our askarel advertising theme centers on nine of these eleven selection criteria as askarel advantages -- cost of losses, noise, safety, reliability, maintenance, location versatility, installation costs and impulse strength. The latter four characteristics may be very questionable to the experienced transformer specifier at the utility and in industry.

Initial Costs - Total initial costs were the most often mentioned characteristic by the utility. About the same for askarel versus dry type at 1500 KVA. However, price quotes on smaller units favor dry type. The ratio is 1.27 to 1.09, askarel to dry for a 500 KVA substation versus 1.27 to 1.27 for a 1500 KVA unit. The smaller 500 KVA units are popular upper floor transformers in high rises.

Cost of Losses - Not cited by either the utilities, nor during industrial or A&E calls.

Impulse Strength - Important, especially in industry where loads can be severe and units are often subjected to large switching surges. A key current strength for askarel. Not emphasized by utilities.

Noise - Important, but indoor substation units are normally in enclosed service areas.

Forced Cooling - The rated capacity increase of the dry type unit exceeds liquid filled by over 2:1 with fans. This fact gives question to the overload capacity advantage of an askarel unit.

Installation
Costs -

An extremely important advantage over oil units that must be vaulted for inside use. However Allis' rating favoring askarel is questionable as:

- 1) Venting - Askarel units, reference Article 450, National Electrical Code, requires outside venting. Utilities feel this creates an expensive requirement, particularly in tall buildings with units on several floors. Commonwealth Edison in Chicago noted that in the past several years the city has begun to enforce this code, and as a result installation costs inhibit askarels usage versus dry for high-rise apartments, offices, etc.
- 2) Weight - The heavier askarel transformer is disfavored for upper floor usage and can become a problem in building design (effects location versatility). In addition, handling of the unit by the utility is particularly difficult because of its added weight.

Location
Versatility -

Here askarel loses some industrial favor due to weight and fear of fumes and askarel leaks. Units indoors are normally installed either in penthouses (adjacent to manufacturing buildings or on roof top), on the manufacturing floor, on balconies or on overhead trusses, as close to the load as possible. Many plants with contaminated environments (aluminum, steel, chemical, etc.) favor askarel as open dry type is subject to contamination. Strangely enough, the paper and stone-clay-glass industries are in contaminated environments. However, our market share reported earlier in these industries gives question to our degree of participation. Some evidence was found that "clean room" environments are becoming popular to overcome the contaminated environment.

General
Safety -

Our record of safety, overall, appears to be askarel's primary base of existence. This factor seems to have greatly inhibited the use of gas filled units indoor as faults can create gas pressure sufficient to blow the unit.

Reliability &
Maintenance -

The most often mentioned selection criteria by industry. The reason why askarel has given generally satisfactory service to Ford, Chrysler, U.S. Steel, and the Chevrolet Division of General Motors, they report "No large problems - been using it for years." However, they did emphasize two significant dislikes similar to the utilities:

- 1) Frequent leaks due to faulty gaskets and bushings. Sticky 1260 residue and fumes irritating to personnel.
- 2) Internal corrosion problems on copper leads and tank interior. The water accumulation can not be tapped off the bottom drain valve as in an oil unit.

VI. ASKAREL MARKET OUTLOOK

A. Askarel Seasonality

Eleven and one-half years (January 1957 through July 1969) of monthly transformer pound sales were analyzed by the Management Information Systems Department (MISD) for monthly seasonality. Our monthly sales show excellent stability, indicating that our monthly sales distribution can be reliably predicted based on history, barring effects from uncontrollable variables like the strikes we are now experiencing.

The seasonal factors developed by MISD for each month of 1969 and for the first seven months of 1970 are noted on Table IX, along with actual and predicted sales. The "seasonal factor" simply states that if you divide the total anticipated yearly sales by twelve and multiply by the monthly seasonal factor, the sales for that month can be "predicted" based on history, with recent years monthly performance weighted heaviest. Reliable monthly seasonal factors require

that historical monthly sales be adjusted for uncontrollable variables (strikes, product availability etc;) the above procedure is the basis now used to determine our monthly transformer fluids budget (Shiskin). Thus we have verified the reliability of Shiskin. More important, however, after several months' experience we can use this as one measure to anticipate our final yearly sales.

Note that the "predicted values" were calculated using 6 months 1969 history and the seasonal factors developed from 11.0 years experience. The predicted values and actual values for January-July 1969 coincided at a 16.0M lb. annual demand. Actual sales were closely predicted for August and September, however July and October exceeded expectations.

Seasonality was also checked for five and one-half years (January 1964 to July 1969) of historical monthly sales for key transformer customers, including: Allis Chalmers, General Electric Pittsfield and Rome, ITE, and Westinghouse (Sharon and South Boston together). Although stability was found for our total sales, stability of quality enough to "predict" monthly performance by customer does not exist.

Graphs displaying the customers' monthly sales history (1964 - 1968) compared to our relative askarel performance were discussed with the Marketing Manager of each key customer contacted. Results of these discussions indicated:

1. Our quarterly sales cycle each year is dictated by those transformer plants producing primarily secondary unit substation transformers for the industrial market. Allis Chalmers and ITE sales best "set our pattern." Usually Aroclor sales to these companies parallel our seasonal performance. General Electric Rome was an exception to this rule in '67 and '69, due to abnormal askarel unit production cycles.
2. Total primary and secondary substation transformer shipments generally follow industrial construction activity (often low first quarter - high fourth quarter). Unfortunately the manufacturers cannot predict the magnitude of this change nor its impact on askarel specifically. Reason -- askarels small significance to total substation demand; the impact of large contracts,

and production scheduling of secondary units that is tied to switchgear production capacity (ITE and Allis specifically).

3. Manufacturers heavy in nonsubstation askarel transformers, i.e. General Electric, Pittsfield, Wagner and Moloney do not parallel substation manufacturers cycles. This is a heavy utility market (network transformers) and production is spaced more evenly throughout the year.

B. Quarterly Askarel Demand - Annual Forecast Model

In accordance with substation manufacturers observations, our total askarel sales generally follows industrial construction activity. Figure II, with supporting data in Appendix D, includes a display of quarterly industrial construction vs. askarel sales for the period 1964-1968. All that can be said is our demand often rises and falls during coincident periods with construction activity. This relationship isn't reliable for anticipating demand. Other "cyclic" relationships to our sales were investigated for:

1. Electrical Energy Demand (Kwhr).
2. Capital Expenditures on New Plants and Equipment (\$).
3. Small Power Transformer Sales (\$).
4. Transformer Shipments, > 501 KVA (units and KVA).
5. Transformer Orders, > 501 KVA (units and KVA).

Transformer Shipments and Orders, > 501 KVA, in units are shown on Figure II.

Cyclic relationships were not found between askarel and energy demand, capital expenditures, nor transformer shipments. However, useable correlation appears to exist between quarterly askarel sales and both Small Power Transformer Sales (\$M) and Transformer Orders, > 501 KVA (units). Regression analysis indicated that 60-70% of our quarterly sales variation is explained by askarel sales lagging by 4 quarters (12 months).

Figure II

Quarterly Transformer Askarel Sales
vs Transformer Shipments and Orders
>501 KVA and New Industrial Construction
1964-1968

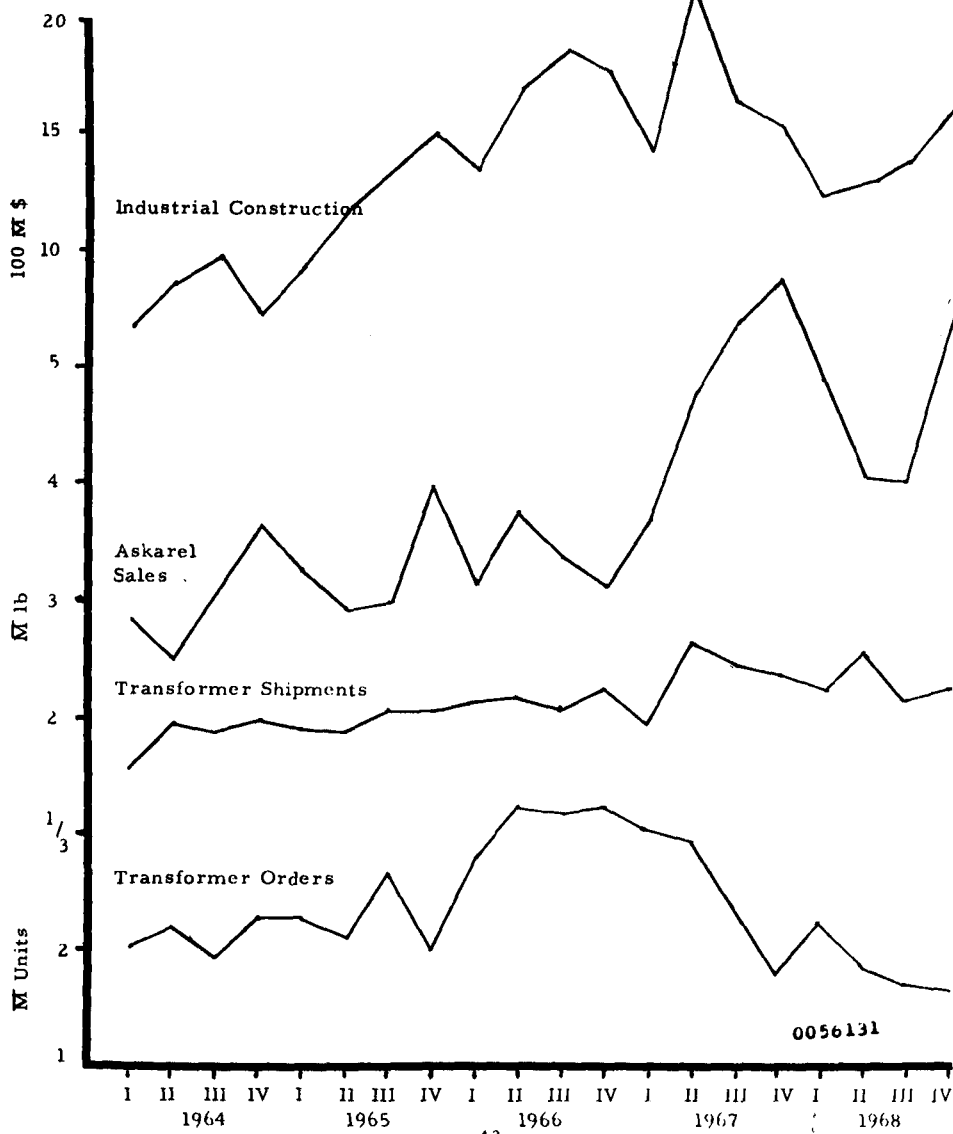


Figure III was thus developed to anticipate yearly askarel demand, based on transformer orders. Results for the period 1964 through 1969_e with forecast 1970 are shown as follows:

	<u>Askarel</u> <u>Equivalent</u>	<u>%</u> <u>Annual</u> <u>Change</u>	<u>Actual</u>	<u>%</u> <u>Annual</u> <u>Change</u>
1964	13.0		12.0	
1965	13.5	4	15.8	32
1966	13.7	2	16.7	5
1967	18.9	30	20.0	21
1968	15.3	-19	18.7	-7
1969 _e	13.2	-14	16.0*	-14
1970 _f	--		16-16.8*	0 to 5%

*Ignores strike impact

The 1970 forecast is based on orders through three quarters of 1969. Results indicate that unless orders for fourth quarter of 1969 are unexpectedly high (>2500 units), we can expect sales equivalent to, or 5 percent above, a 16 M pounds rate. Fourth quarter 1969 industry orders will be available from EEI in early January 1969.

Ten year historical transformer askarel sales were analyzed by MISD against other indicators in an attempt to find a good forecastable correlation which does parallel our sales. Rather than depend on quarterly data, these indicators were annual values. Indicators evaluated were selected measures of the economy, construction, transformer shipments and sales and energy consumption. They included:

- New industrial construction (\$)
- Total generating capacity (KW)
- Industrial use of Electrical Energy (KWHR)
- Power and Distribution Transformer Sales (\$)
- Power Transformer Shipments, KVA and Units for 501-10,000 KVA sizes and all Sizes Greater than 500 KVA
- New Industrial Construction (\$)
- Network Transformer Sales (\$)
- Gross National Product (\$)
- Durable Goods (\$)
- Utility Capital Spending (\$)
- Electric Power Consumption Kwhr
- Utility Capital Spending on Distribution Equipment (\$)
- National Defense Expenditures (\$)

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Figure III
Transformer Aroclor Demand (M lb)
vs
Transformer Orders, >501 KVA (Units)
- 4 Qtr Lag -
- 1964-68 -

Askarel
Equivalent
M lbs

6
5
4
3
2

1000 1500 2000 2500 3000 3500 4000
Orders



Distribution Range of 95% of
all Quarterly Sales 1964-68

None of the above measures were able, historically, to anticipate our yearly fluctuation in sales. This wasn't totally unexpected, however, as all manufacturers indicated that they could not reliably predict yearly industry or company transformer sales, specifically unit substations and network sales.

Although none of these measures, except the Quarterly Transformer Orders Forecast Model developed earlier, were able to correctly identify yearly sales fluctuations, several measures when regressed did approximate our historical sales with a satisfactory degree of accuracy. These measures were Utility Capital Expenditures for Electrical Distribution Equipment and Power and Distribution Transformer Shipments. Results based on a nine-year period, 1959-1968, indicated that askarel sales were historically explained with 90 percent confidence at ± 2.5 M pounds per year. Forecast confidence however assumes:

- 1) Historical progress continues without major changes in Market share and growth.
- 2) The measure can be reliably forecast.

The Department of Commerce, Bureau of Census, provides the industry totals on Power and Distribution Transformers Shipments. The department nor the industry provides forecasted transformer shipments beyond one year. Thus the measure, at present, cannot be used until the Department of Commerce initiates long-range forecasts in their annual "Outlook" issue. This step is doubtful in the foreseeable future. Utility Capital Expenditures are projected annually by Electrical World Magazine. They are considered a reliable primary source of forecasted energy and capital expenditure requirements by industry experts.

Historical correlation results with the linear equations are given in Table X for both power and distribution transformer shipments and utility capital expenditures for distribution equipment. The 1975 trend value for askarel sales is 33.6 ± 2.6 M pounds, or a range of 31 to 35.2 M pounds. This indicates an average annual growth rate for

the period 1968 to 1975 of between 7.5 and 9.5 percent per year. This range is consistent with industry's common denominator for transformer growth -- generating capacity, which according to Electrical World is projected to increase during the period 1968 to 1975 by 8.40 per cent per year from a 6.1 percent per year prior ten-year history. Askarel's lower rate projection, 7.5 percent per year, also parallels that found by semi-log trend analysis (ref: 1979 Forecasts For Long Range Planning, Aug. '69, C. N. Caputo; P. D. Craska).

However, as noted earlier, this anticipated growth rate range assumes static market share and this does not appear to reflect askarel's position. Several factors indicate we are now below market growth and will continue to grow at a slower rate in the future:

1) Network transformer market share; although approximately 20 percent, will at best remain static with increased use of oil-filled and dry-type.

2) We participate heavily in the industrial market, which during the past ten years has grown only at a rate of energy consumption parallel to that of our askarel sales (5 percent per year). Conversely, the commercial market, also a consumer of askarel transformers, has increased twice this rate and will continue at a faster pace through 1975.

Market	1968	Growth Rate	
	Value (B Kw Hr)	1960-68	1969-75
Commercial	264.2	11%	7.6%
Industrial	517.3	5	6.1

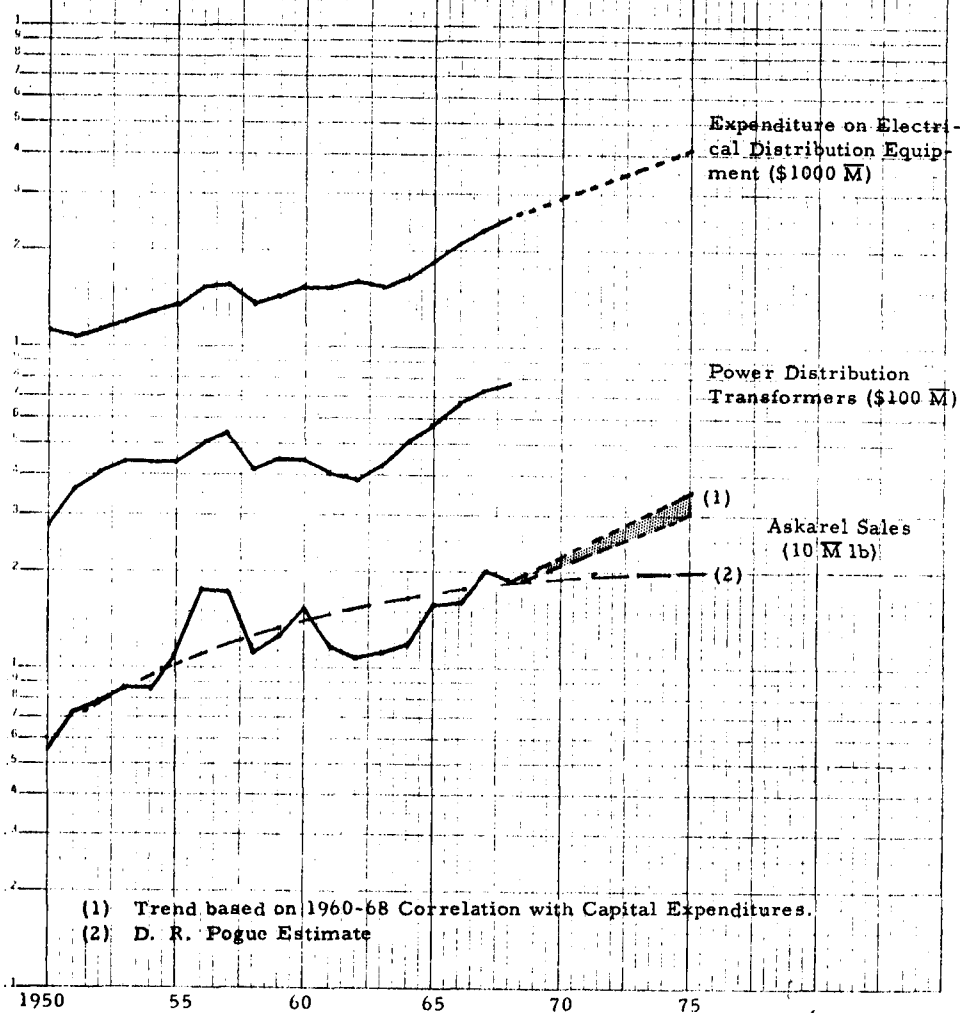
3) Dry type transformers are preferred over askarel for commercial secondary substations and this trend continues.

This discussion assumes the askarel transformer continues to participate in the industrial market without a significant loss in position. On this basis, and a decline in 1969's sales, it does not seem that prospects for 1975 will approach 30 M lb, nor will projected growth continue at our ten-year historical rate of 5 percent. Our trend appears leveling off with sales progress through 1975 not expected to appreciably exceed our 1967-68 level of 20.1 and 18.7 M pounds respectively. Note Figure IV.

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Figure IV
ASKAREL OUTLOOK
vs.
CAPITAL EXPENDITURES ON ELECTRICAL
DISTRIBUTION EQUIPMENT AND
POWER DISTRIBUTION TRANSFORMERS
- 1950-68 and 1975 -



C. New Market Opportunities

1. **Residential Market** - According to Electrical World the residential market growth for transformers currently exceeds, and will continue to outpace both commercial and industrial growth rates through 1975 and 1985 based on projected energy requirements.

Market	1968 Value B KwHr	Annual Growth 1969-75	Total Growth 1975-80
Industrial	517.3	6.1%	98%
Commercial	264.2	7.6%	91%
Residential	366.2	8.6%	112%

Currently we do not participate in this market - except perhaps secondary substations in high rise apartments.

A key concept to serve the residential demand has been the development of the unit residential transformer (URT). The URT replaces the larger padmount units and the unsightly pole top unit with small compact units located underground, on a pad outside, or on the wall of the individual residence. The location of the transformer has created a major difference of opinion between utilities and between the transformer manufacturers, who must develop satisfactory designs to meet this new concept. The pad concept utilizes oil filled units. Utilities indicate underground units are either oil, or solid-epoxy filled. The residential wall unit prefers dry type technology. Several opportunities appear to exist to overcome problems that currently inhibit acceptance of the unit residential concept:

- A fire resistant fluid offers safety to the outside pad, which is located close to the individual residence;
- A liquid or solid unit provides freedom from contamination found in the dry type wall unit.
- Askarel units are inherently quieter than dry type.

Also, the underground unit residential transformer has suffered field problems from corrosion. Transformer tanks fabricated from mild steel have failed regardless of the protective coating. Recent field tests have included epoxy finished and entire fiber-glass tank structures. Both Allis Chalmers and General Electric expressed interest in discussing dielectric medium and corrosion-resistant transformer tank materials with Monsanto.

The above areas appear to offer Monsanto an excellent chance to penetrate the residential market with askarel's safety, and quiet operation and with Monsanto plastics technology for corrosion resistant tank materials. It is important to note that Westinghouse, with a strong underground solid filled design does not encourage our activity in this market. Leading utilities that promote differing URT concepts include: Duke Power, Virginia Electric & Power, and Southern California Edison.

Residential fluids long range market potential for the new URT concept was not assessed; however, my guesstimate is 50-100 M lb annually. Utilities indicated residential units often represented 90% of their total transformer unit demand.

2. Cables - Industry needs appear unsatisfied in two areas: Insulations and dielectric mediums. Insulation material for high temperature service (200° C and above) for above ground service has created fire safety and heat dissipation problems. Several industrial cable fires have prompted FR insulation research by cable manufacturers and coatings suppliers, including DuPont. The problem is not resolved. Present cable insulation materials include butyl, polyethylene, and oil-impregnated paper, and more advanced insulations for higher voltage service.

One type of power line which is installed underground utilizes mineral oil dielectric medium. Because of its low dielectric constant (2 vs. 5 for askarel), it minimizes capacitance or energy storage. This is a desirable characteristic. Also important is power factor, since energy losses where voltage is applied show up as heat. This is difficult to dissipate in a

long pipe since the dielectric medium is not circulated. Increased EHV demands have stressed the efficiency of oil-filled cables. A leading A&E, Stone and Webster, reports little progress is being made on new insulating mediums. As higher dielectric strength also offers improved voltage-carrying capability, we may see justification for looking at new fluids for this area. Of course, the medium must show an improved dielectric constant over that now possessed by askarel blends. Fluorocarbon and cryogenic cooling are among possible new cable dielectric media. Flutec technology may provide an entre' here for Monsanto.

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TABLE I

TRANSFORMER MANUFACTURE - ASKAREL CUSTOMERS

Transformers	Market				Type							-Dielectric- Medium				
	Residential	Utility	Industrial	Commercial	Lg. Power	Primary Substation	Secondary Substation	Network	Pad-Mounts	Pole	URT	Specialty and Misc.	Dry	Oil	Askarel	Gas
ALLIS CHALMERS																
Pittsburgh		*	*	*		*	*	*	*	*		(2)		*	*	*
Gadsen, Ala. (4)	*		*	*					*	*	*	*	*	*	*	*
Milwaukee		*	*		*											
GENERAL ELECTRIC																
Hickory, N.C. (4)	*	*	*	*				*	*	*	*	*	*	*	*	*
Pittsfield	*	*	*	*	*		*	*	*	*		(3)	*	*	*	*
Rome		*	*	*		*	*						*	*	*	*
ITE		*	*	*		*	*					(1)	*	*	*	*
MALONEY	*	*		*	*			*	*	*	*			*	*	
WAGNER	*	*		*	*	*		*	*	*	*			*	*	
WESTINGHOUSE																
Athens, Ga. (4)	*		*	*				*	*	*	*		*	*	*	*
Sharon		*	*	*	*			*	*	*	*	*	*	*	*	*
So. Boston (5)		*	*	*		*	*	*	*	*	*	(3)		*	*	*
Muncie (4)		*		*	*									*	*	*
OTHERS not contacted (4)																
Kuhlman	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*
McGrav-Edison	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Niagra	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*
Standard Transf.	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*
Hevi-Duty	*	*	*			*	*	*	*	*	*	*	*	*	*	*
R.E. Uptegraf	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*
Esco	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*
Federal Pacific	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*
H. K. Porter	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*
Sierra Transf.	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*

Askarel types include:

- (1) Rectifier and transportation.
- (2) Rectifier, transportation and instrument.
- (3) Includes rectifier, transportation, furnace and precipitation.
- (4) Not contacted--data from NEMA not verified with company.
- (5) Planned by 1970.

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TABLE II
TRANSFORMER ASKAREL SALES (BLENDED)
BY TRANSFORMER TYPE - 1968

(Millions of pounds)

	<u>Total</u>	<u>% Total</u>	<u>Transformer Type</u>			
			<u>Secondary Substations³</u>	<u>Primary Substations</u>	<u>Network</u>	<u>Other</u>
ITE	1.98	9.5	1.92			0.06
Allis	1.63	7.8	1.14	0.16	0.33	
Wagner	0.10	0.5		0.10		
GE, Pittsfield	2.90	13.9			1.00 ²	1.90 ²
GE, Rome	4.07	19.5	4.07			
Westinghouse	5.60	26.7	2.63	1.18	1.35	0.44
Maloney	<u>0.24</u>	<u>0.1</u>	—	—	<u>0.24</u>	—
Subtotal	16.52	79.0	9.76	1.44	2.92	2.40
Total 1968 Sales	21.0					
% Total Sales			59%	9%	18%	14%

¹ Includes predominately precipitation, furnace, transportation and rectifier units.

² Estimated.

³ "Load Centers"

TABLE III
TYPICAL PROFITABILITY & COSTS OF ASKAREL
FILLED SECONDARY SUBSTATIONS (LOAD CENTERS)

COST COMPARISONS

<u>KVA</u>	<u>Askarel Mfg. Cost</u>	<u>Allis</u>			<u>Westinghouse</u>		
		<u>Price Per Lb.</u>	<u>Lb./ Tnsf.</u>	<u>Ask. Cost</u>	<u>Price Per Lb.</u>	<u>Lb./ Tnsf.</u>	<u>Ask. Cost</u>
500	11.8%	\$0.166	2402	\$ 400	\$0.135	3000	\$405
1500	12.3	0.166	4113	665	0.135	4780	655
2500	13.3	0.166	5200	865	0.135	6210	840

PROFITABILITY

<u>KVA</u>	<u>Total¹ Transformer Cost</u>	<u>- - - - High-Low Range - - - - -</u>		
		<u>Sales Price²</u>	<u>Gross Profit</u>	<u>%</u>
500	\$3722	\$4640 (2)	\$918	20
1500	5849	8580-9586	2731-3737	32-39
2500	7124	12480-13707	5356-6583	43-48

¹ From Allis Chalmers input. Total cost includes estimated freight of 5% sales price. A 2500 KVA Askarel unit with fluid weighs 14-16,000 pounds. Freight charges @ 600 miles totals <\$200 @ \$1.24/cwt. or 1-2% of sales price.

² Range for Allis and Westinghouse quotes Monsanto 10-69 for standard 13.8 KV, 60 cycle, 65° rise unit.

Note: Allis provided low quotes for these sizes.

TABLE IV

ESTIMATED ASKAREL MARKET SHARE BY TYPE
AND
PARTICIPATING END MARKET DISTRIBUTION

(Million pounds Askarel and % Units)

Type	Dielectric				Askarel Only			Total
	Ask	Oil	Dry	Gas	Industrial	Commercial	Utility	
Network								
%	20	80					100	100
Vol.	2.9	14.6					2.9	2.9
Secondary Substations								
%	44	23	30	3	80	15	5	100
Vol.	9.8	5.0	6.7	0.6	7.8	1.5	.5	9.8
Primary Substations								
%	5	95			90		10	100
Vol.	1.4	29			1.3		0.1	1.4
Precipitation								
%	50	50			60		40	100
Vol.	0.3	0.3			0.15		0.15	0.30
Rectifier								
%	25	75			100			100
Vol.	0.6	2			0.6			0.6
Furnace								
%	2	96	-- 2 --		100			100
Vol.	<0.1	3	--<0.1 --		<0.1			<0.1
Others*								
%	<5	>94	- <1 --			50	50	100
Vol.	1.4	>28				0.4	1.0	1.4
Total								
%	<16	>78	<6	<1	60	12	28	100
Vol.	16.5	>81	6.7	0.6	9.9	1.9	4.9	16.5

* My estimate includes commercial pad-mounts, pole and miscellaneous.
Excludes impact of small specialty (dry types) and large generating-transmission units (oil filled).

TABLE V.

1968 INDUSTRIAL MARKET DEMAND
SUBSTATION TYPE TRANSFORMERS

Number of Units

Industry	Industry ¹	Askarel ²
	% Total Units	% Total Units
Automotive	5%	21%
Primary Metals	15	14
(Steel)	(7)	(8)
(Aluminum and non-ferrous)	(8)	(6)
Chemicals	11	14
Paper	10	3
Petroleum	10	3
Textile	4	<1
Stone, Clay & Glass	3	-
Mining	2	-
Others	25	45
Totals	100%	100%

1. Based on 1968 Total Known Available Market of 3300 Units
General Electric, Rome, Georgia
2. Based on 1968 Total Askarel Transformer Unit Sales of
434 Units - ITE, Philadelphia, Pennsylvania

TABLE VI

SELECTED UTILITY NETWORKS
(>20,000 KVA CAPACITY)

Utility	1968 ²		1953-55 ¹	
	Total Units	% Askarel	Total Units	% Askarel
Baltimore Gas & Electric	360	67	245	47
Boston Edison	471	20	284	15
Virginia Electric and Power	435	65-75	178	91
Con. Edison, N. Y.	18,000	<1	9541	8
Louisville Gas & Electric	250	100	117	75
Ohio Edison	175	<1	124 ⁴	2 ⁴
Ohio Power	150	3	145 ⁴	0 ⁴
Cincinnati Gas & Electric	307	0	256	0 ⁴
Kansas City Power & Light	249	100	111	100
Public Service Gas & Electric	4500	~1	2359	2
Commonwealth Edison	1800	89	972	83
Union Electric	450 ³	< 50	271	69
Total	27,147		14,603	
% Total Net-work market	68%		51.5%	

1 - Edison Electrical Institute
2 - D. R. Pogue Survey

3 - D. R. Pogue Estimate
4 - 1956-58 Data

TABLE VII

General Check List for Selection of Load Center
Unit Substation Transformers

Characteristics	Important Influences (*)			Transformer Type			
	A&E	Industry	Utility	Oil Filled	Askarel Filled	Open Dry Type	Sealed Dry Type
1. Initial Cost	*	-	*	1	2	2	3
2. Annual Cost of Losses	-	-	-	1	1	2	3
3. Physical Specifications							
a) Weight	*	-	*	2	4	1	3 (4)
b) Floor Area	-	-	-	1 (2)	1 (2)	2 (1)	2
c) Height	-	-	-	1	1	2	2
4. Impulse & Surge Strength (KV-Bil)	*	*	-	1	1 (2)	2	2 (1)
5. Audio Noise	-	-	*	1	1	2	2
6. Forced Air Cooling	-	-	-	2	2	1	3
7. Installation Costs	-	-	*	4	2 (3)	3	1
8. Location Versatility	*	-	*	4	3	2	1 (2)
9. General Safety	*	-	*	4	2	3	1 (2)
10. General Reliability	*	*	-	1	1	2	1
11. Maintenance	*	*	-	2	2 (3)	3	1

Note: (a) Units are rated 1, 2, 3, 4 in decreasing order of preference. Numbers indicate importance of influence.

(b) If units are rated the same they are considered essentially equal.

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TABLE VIII

Transformer Characteristics & Price Comparison
Indoor Secondary Substation (Load Center)
13.8 KV to 480 v, 60 cycle, 3 phase¹

	----- 1500 KVA -----				----- 500 KVA -----			
	<u>Oil</u>	<u>Askarel Filled</u>	<u>Open Dry</u>	<u>Sealed Gas</u>	<u>Oil</u>	<u>Askarel Filled</u>	<u>Open Dry</u>	<u>Sealed Gas</u>
Initial Cost ²	1	1.27	1.27	2.30 ³	1	1.25	1.08	1.79 ³
Losses (watts)								
Full load	19,800	19,800	22,050	-	9,900	9,900	10,700	--
No load	3,400	3,400	5,050	-	2,050	2,050	1,900	--
Physical Spec's								
Weight (lb)	10,200	12,180	8,500	12,700	5,140	6,150	3,400	7,100
Floor Area (sq ft)	29.9	29.9	21.0	28.8	23.6	23.6	16.6	24.5
Height (in)	83	83	90	112	67	67	90	90
Impulse Strength (Bil)	95	95	54	95	95	95	54	95
Forced Air Cooling (% Inc.)	15	15	33	-	15	15	33	--
Noise (dc)	60	60	65	64	56	56	60	59
Maintenance:	Fluid test Leaks Filtering	Fluid test Leaks Filtering	Clean and blow off Moisture on shut-down	Leaks	(Same as for 1500 KVA)			

1. Based on data and quotes from G.E., Allis Chalmers, Westinghouse and Zinsco Electrical Products (dry type).
2. Based on lowest price quoted compared to oil at \$6,800 (1500 KVA) and \$3,720 (500 KVA).
3. Comparison made on quote for outside gas-filled versus oil.
4. 95 KV Bil units available at 10% above quoted price for 50 KV Bil units per Zinsco 11/69.

TABLE IX

Domestic Transformer Aroclor Sales

In Thousands of Pounds

<u>Month</u>	<u>Actual</u>	<u>Seasonal Factor</u>	<u>Seasonally Adjusted (Predicted)</u>
January	1145	83.4	1120
February	1018	86.2	1150
March	1303	103.9	1380
April	1236	92.6	1230
May	1089	92.6	1230
June	1364	103.7	1380
July	1558	82.2	1090
August	1330	105.7	1400
September	1411	106.0	1410
October	1851	106.7	1420
November	1505*	113.1	1505
December	1630*	122.9	1630
Total	16.0 M		16.0 M

1970

January	83.9
February	85.0
March	103.9
April	93.0
May	92.2
June	103.7
July	81.9

*Seasonally Adjusted - "Predicted Values"

TABLE X

DOMESTIC ASKAREL SALES OUTLOOK
AND HISTORICAL CORRELATION
by
NEW TRANSFORMER INDICATORS
- 1959 to 1968 and 1975 -

Year	Askarel Actual M lbs.	Power ¹ & Distribution Transformers M \$	Askarel Predicted M lbs.	Utility ² Capital Expenditures Elec. Dist. Equip. E \$	Askarel Predicted M lbs.
1959	12.5	450	12.4	1.413	11.1
60	14.2	450	12.4	1.565	12.3
61	11.8	418	11.1	1.550	12.2
62	10.9	389	11.1	1.593	12.54
63	11.1	425	11.9	1.568	12.3
64	12.0	501	13.5	1.688	13.31
65	15.8	578	15.2	1.861	14.7
66	16.5	661	17.9	2.108	16.7
67	20.0	735	16.9	2.349	18.7
68	18.7	778	18.6	2.564	19.6
75	19.0	-	-	4.200	33.6

1 - Source - Department of Commerce (Equation) Askarel Sales (M lbs) =
 $2.55 + 0.0219 (1) \pm 2.0 \text{ M lbs.}$

2 - Source - Electrical World (Equation) Askarel Sales (M lbs) =
 $-0.43 + 0.0081 (2) \pm 2.5 \text{ M lbs.}$

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APPENDIX A

Some Transformer and Dielectric Terminology

In order to reacquaint many of us with some basic terminology, several key definitions of dielectric and transformer properties are in order and will aid our understanding of transformer askarel's function:

The Transformer

The transformer transfers energy from one alternating electric circuit to another alternating circuit. It consists essentially of two coils, wound on an iron core, which forms a closed magnetic circuit. When power is supplied to one coil at a definite frequency and voltage, power can be taken from the other coil at the same frequency and at the same or at a different voltage. A transformer, which receives power at one voltage and delivers it at the same voltage, is called a one-to-one transformer. When it receives power at one voltage and delivers power at a higher voltage, it is called a step-up transformer. And when it receives power at one voltage and delivers power at a lower voltage, it is called a step-down transformer.

The coil, or winding, to which power is supplied is called the primary; and the coil, or winding, from which power is taken is called the secondary. In the ordinary transformer, the coils, wound of insulated copper or aluminum wire or strap, are insulated from the iron core and from one another, so that the primary and secondary electric circuits are entirely separate and insulated from each other.

Since there are no moving parts in the machine it is called a static, or stationary, transformer. The cost per kilowatt of capacity is low compared to that of other electrical apparatus. The losses are small and the efficiency is correspondingly high -- higher than that of any other electrical power machine. Efficiencies of large transformers may be 99 percent or more. They require little attention and maintenance costs are low. The average life expectancy of a transformer is twenty to thirty years.

Transformer Action

In a transformer the iron core is laminated and made up of sheet steel punchings clamped in place. The supply or primary winding (p) is wound on one leg of the core, while the secondary winding (s),

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of a different number of turns, is wound on the opposite leg. (To reduce losses, half of each coil is wound on each leg in commercial transformers.) The supply current from G to the primary winding, P, sets up a magnetic field (flux), ϕ , in the iron core. This flux, ϕ , also links the turns of the secondary winding, S, and sets up an alternating (opposite) magnetic force in the winding. Because of the voltage "induced" in the secondary winding, it can be used to supply current and power.

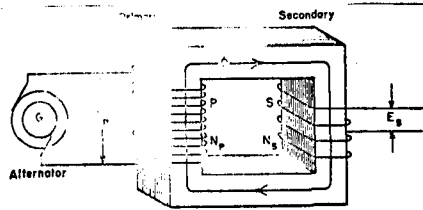


FIG. 1-8. Elementary step-down transformer.

Dielectric

A dielectric is an insulating material (gas, liquid or solid) when it is used to store electrostatic energy. This material in a transformer actually prevents the flow of energy, and is also referred to as insulation.

Dielectric Strength

The ability of a dielectric to prevent a spark or arc when between two electrodes is referred to as its dielectric strength. Many variables enter into the measurement, but using an ASTM test with a gap of 0.1 inches between the electrodes, oil has a dielectric strength of 26,000 to 30,000 volts; Aroclor, 30,000 to 35,000 volts; air 5,000 to 10,000 volts; and gas (SF_6 ; C_4F_8 etc.) approaches the strength of oil and askarel under pressure.

Impulse Strength

If, instead of applying the test voltage slowly as in the measurement of dielectric strength, it is applied suddenly as a pulse, sometimes quite different results are obtained. This test is intended to approximate the characteristics of a lightning or severe overload surge. Whereas Aroclor has a dielectric strength higher than oil, askarel impregnated insulation has a lower impulse strength. This is a serious shortcoming in Aroclor transformer applications.

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Dielectric Constant

The minimum energy storage under a vacuum is called capacitance and is taken as unity. Air and most gases have capacitance of 1.0006, and this is referred to as dielectric constant. Petroleum oil has a dielectric constant of about 2.2, and Aroclor of around 5. Thus, Aroclor in a certain size capacitor can store four or five times the energy of air, or over twice as much as oil. Or, to look at it another way, an Aroclor-filled capacitor can be half the size of an oil-filled capacitor and still do the same job. In capacitors, the higher the dielectric constant, the better (other things being equal); in a transformer it is as important. However, a high dielectric constant in the presence of contaminants does degrade the insulation quality of the dielectric.

Power Factor

This is one of the more confusing terms as power factor, dissipation factor, loss factor, and loss tangent are all used to describe the same characteristic. However, the quantities are numerically equal only at low values. All of the terms can be considered as referring to the energy loss that occurs in a dielectric when an alternating voltage is applied. Part of the loss can come from leakage of the current through the dielectric system, and another part from what can be thought of as the friction from rotating molecules. Both show up as heat in the dielectric. A perfect dielectric would return as much energy as was put in to charge it. The difference, the power factor, is the energy lost as heat. The lower it is, the better.

Resistivity

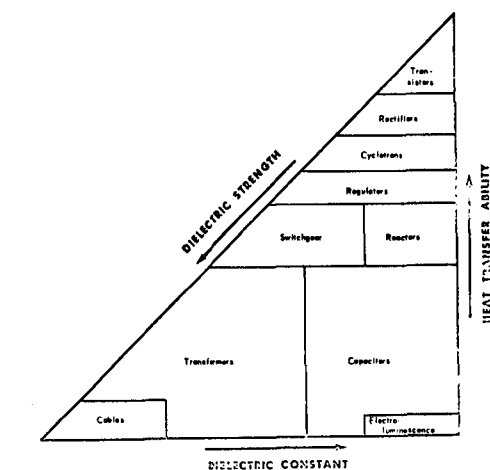
This is simply a measure of the resistance of the dielectric to the passage of direct current. It is measured in ohm-cm. Oil ranges from 10^{13} to 10^{14} ohm-cm, and Aroclor from 10^{12} to 10^{13} at room temperature. The higher, the better.

Note: A liquid dielectric can be used as an insulator, as in a cable; as a dielectric as in a capacitor; as a coolant in a transistor; or for a combination of reasons, as in a transformer where the dielectric serves as both insulant and coolant.

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However, there are many other important uses for other dielectrics and these are indicated in pictorial form below:

APPLICATIONS OF LIQUID DIELECTRICS



(after T.D. Collinson, N.R.L.)

This shows the relationship of the application to three major characteristics of the dielectric: Ability to withstand high voltage, ability to store or insulate from electricity, and heat transfer quality.

Rated KVA

The kilovolt-ampere output of the transformer which can be delivered at rated secondary voltage and rated frequency without exceeding the rated temperature rise.

Voltage or Turn Ratio

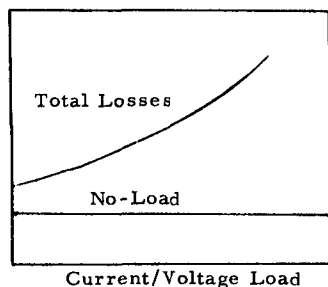
The ratio of the number of turns ("turn ratio") in the primary and secondary windings. The rated voltage (open-circuit) of a transformer is closely proportional to the turn ratio, or number of turns, in the primary windings divided by the number of turns in the secondary windings. For example, a substation unit "stepping down" from 34 KV (primary) to 13.8 KV (secondary) has a turn ratio of about 3 to 1.

Insulation

Solid and liquid or dry dielectric insulation separates the solid insulated high-voltage winding from the low-voltage winding. This dielectric insulation carries the highest voltage and occupies the most limited space; hence it usually operates at highest stress. Stress is maximized in large ducts rather than smaller ducts, thus askarel and oil designs attempt to minimize insulation clearances.

Losses

Reduction in transformer efficiency due to internal power loss. Losses come from resistance and leakage within the windings and core. These losses are a function of the length and size of coil used, and core quality and weight. These losses together vary from one percent of the full load rating (KVA) for large transformers to three to five percent for the small sizes. No-load losses are core losses under no-load conditions. These losses usually remain practically constant at all loads of constant voltage supply. However, total losses rise rapidly above no-load values when load is applied.



BIL

Standard basic impulse insulation level as established by The Institute of Electrical and Electronic Engineers, Edison Electrical Institute, and The National Electrical Manufacturers Association. This "impulse" test level is that value where the insulation will not break down on voltage surges of high magnitude and short duration. Lightning or sudden switching surges are examples of impulse surges. The standard BIL of most oil and askarel distribution and power distribution equipment is the value assigned below:

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Reference Class, KV	Basic Impulse Insulation Level, KV	Common Insulation Level (dry type) KV	Reference Class, KV	Basic Impulse Insulation Level, KV	Common Insulation Level (dry type) KV
1.2	30	10	69	350	-
2.5	45	20	92	450	-
5	60	25	115	550	-
8.7	75	35	138	650	-
	95*	-	161	750	-
15	110	50	196	900	-
23	150	-	230	1050	-
34.5	200	-	287	1300	-
46	250	-	345	1550	-

* The 95 KV BIL was established for certain types of equipment in the 15 KV class.

Under special conditions equipment having lower BIL ratings may be furnished. No industry standard impulse levels have been established for dry type transformers. The above values are past common practice. Newer designed dry types have 95 KV BIL ratings for 15 and 23 KV reference ratings.

Audio Sound

Transformers are noisy when energized. The noise is a hum generated by vibration in the laminated core structure. The iron core actually lengthens and shortens due to its changing magnetization causing a "hum." Low noise level designs with definite sound ratings in decibels (db) are important selection criteria. A basic selection rule is to choose a transformer with db rating lower than the average decibel level of the area in question. Typically, a three decibel increase in sound level has the effect of almost doubling the sound volume as detected by the human ear.

The following table shows average ambient noise levels in common installation areas:

<u>Area</u>	<u>Average Sound Level (decibels)</u>
Average home	30-45
Retail Store	45-55
Office area (without machines)	45-70
Office area (with machines)	50-75
Average factory	79-95

APPENDIX B

TRANSFORMER USE AND TYPES

Transformers are used to meet a wide range of requirements. Energy must be transferred from its originating source (generating plant) to the user (residence, factory, etc.) as economically as possible. High voltage permits economical energy transfer with lower line resistance losses. Thus, large power transformers are used at generating stations to step-up the generated voltage to high levels (115 to 765 KV) for transmission. The transmission voltages are then stepped down by transformers at the substation for local distribution. The step-down to local distribution is normally done in several transformation phases. That is, at the large outdoor or vault substation where step-down to medium voltage (13.8 to 69 KV) occurs; at various load centers near or in the building or plant where step-down to secondary distribution (480 to 600 volts typical) levels occurs; and at subdistribution points where final step-down to various utilization voltages is accomplished. Typical final step-down transformation is for residential, building and factory lighting, air conditioners, and miscellaneous small electrical equipment and appliances.

Designations

Manufacturers provide a wide range of transformer types, sizes and designs for both indoor and outdoor application. Units are listed and designated according to function, KVA capacity, phase and voltage characteristics, method of cooling, noise level rating and type of enclosure and construction -- all for specific applications. As a fluid supplier we should have some understanding of the various types, their normal application, and where askarel units fit in the overall picture. Figure 1* was developed for this purpose and is discussed below. Data is based on transformer standards (NEMA) and contacts with transformer manufacturers.

Voltage versus Rated KVA Service

Most manufacturers and service agencies (EEL, NEMA, etc.) recognize transformers broadly by primary voltage and the rated KVA size. Normally all smaller transformers with voltages 1 to 69 KV, of 1 to 500 KVA sizes, are classed "distribution." All transformers above 500 KVA are classed "power." (Note Fig 1.) Power transformers are

*All figures referenced follow Appendix B
vii

often further defined by "small power" ranging from 500 to 10,000 KVA, and "large power" for units over 10,000 KVA. This classification was developed not to stereotype transformers but to better understand transformers in terms of their voltage-KVA size range. In addition, the organization of the utility and transformer manufacturers are normally defined according to these "distribution" and "power" classifications. For example, the Westinghouse production and marketing-engineering organization is divided into Small Power at Sharon and South Boston, Distribution (residential and commercial) predominantly at Hickory, North Carolina, and Large Power at Muncie, Indiana. Utility engineering groups who specify transformers are normally headed by the Superintendent of Distribution and the Superintendent of Transmission and Generation (large power). Transformer order and shipment statistics compiled by NEMA, EEL, and others are classed broadly into less than 500 KVA, 500 to 10,000 KVA, and greater than 10,000 KVA ranges, which correspond to the distribution, small power and large power classes respectively.

In actual practice, and as you will see on Figure 1, the transformer KVA rating is often found to overlap from distribution into power service. For example, secondary substation transformers are manufactured in sizes ranging from 112.5 to 2500 KVA, and furnace transformers are rated from less than 100 KVA for small foundry induction units to 100,000 KVA on large arc furnaces in steel mills. Thus, the "power versus distribution" lingo is hazy for many specific transformer types. Some manufacturers have both small power and distribution units produced by the Distribution Department because it is an economical production mix. For example, the Distribution Department of General Electric, Pittsfield produces utility network units, 300 to 2500 KVA, while the medium transformer (small power) department at Rome produces secondary unit substations, 112.5 to 2500 KVA.

Transmission Step-up and Tie (Large Power)

The largest transformer (Tab A) is for extra high voltage (EHV) service. These units step-up from generated voltage (less than 69 KV) to high economical transmission voltages of 115 to 765 KV range. Sizes range from 25,000 KVA to 1 M KVA for giant units serving the new, but increasingly popular, EHV ranges of 500 to 765 KV. These units are installed outdoors and oil filled.

Substations

All substations are made up of one or more substation type transformers linked mechanically and electrically. Their design includes protective switchgear assemblies. Substations are normally of unit type design, indicating factory assembled.

Primary Substations (Large and Small Power)

The first point of transformation (Tab A) of the "primary" voltage down to medium or "secondary" high voltage. Normal ranges are 34.5 to 138 KV primary, and 5000 KVA to 30,000 KVA or higher. Actual "standards" cover a range from 6.9 to 138 KV and sizes 500 to 10,000 KVA as shown on the figure. These units are oil filled (few are askarel), outdoor units designed for utility distribution and industrial plant use. Normally, in industry, the primary substation will feed a "secondary" substation located indoors at voltages of less than 35 KV. The primary substation may also directly feed large voltage users, i.e., arc furnace transformers at 34 to 69 KV.

Secondary Substations (Small Power-Distribution)

The point of transformation (Tab A) from medium to low voltage. Typical ranges are 2.2 KV to 34.5 KV primary in sizes 500 to 2500 KVA; low voltage is 480 volts (normal). These units are usually askarel filled, dry type or gas filled indoor or roof-top units designed for either commercial, industrial or utility auxiliary power needs inside the generating plant. Outdoor substations are usually oil filled unless the unit is close to the building -- then askarel may be used in lieu of a fire-resistant barrier, according to the National Electrical Code.

Secondary substations are often referred to as "load centers" or "power centers" transformers. This terminology is an outgrowth of the popular physical location of these units in indoor load center areas where the user enjoys a "packaged system" of secondary substation transformer (s) and protective equipment enclosed in a functional attractive switchboard design. Figures 2, 3, 4, and 5, illustrate askarel, dry type, and gas filled secondary unit substations.

Furnace Transformers (Small Power and Distribution)

Not shown on Figure 1. Large units are arc furnace transformers used for supplying electric power to direct arc melt furnaces. Smaller units serve induction furnaces for foundries. Both are normally indoor units. Arc units normally range from 10 to 100 MVA, with 13.8 to 34 KV voltage, while induction units average 250 to 5,000 KVA at 2.4 to

34 KV voltages. The arc furnace is oil filled (few askarel), while smaller induction units are oil, askarel and dry type.

Rectifier Transformer (Small Power-Distribution)

Not shown on Figure 1. Indoor units that rectify AC current to DC current for primarily aluminum, steel and chlorine production. They operate normally at 13.8 KV, with larger units up to 130 KV. Sizes range from less than 100 KVA to 10,000 KVA. Smaller rectifier transformers are oil and askarel filled, while large units are oil filled.

Network Transformer (Small Power)

The point of transformation (Tab A) from medium to low voltage by the utility in large cities. This unit is normally underground and vaulted with parallel, interconnecting circuitry to other network transformers to form a fail-safe "network grid" throughout the city. When one unit fails, the load is picked up by another unit in the grid. A "spot network" unit is a network transformer off the grid that serves a remote or very large commercial customer. Primary voltages are 2.2 to 13.8 KV in sizes 500 to 2500 KVA. Secondary user voltages are 480 volts and below. Units are oil and askarel filled. A network unit is shown in Figure 6.

Note: Large commercial customers outside the network often choose to purchase power at 2.2 to 13.8 KV and transform to low voltage via the secondary substation, located inside his building.

Specialty and Miscellaneous (Distribution)

Final transformation point with transformers to supply electric power for control, machine tool, signaling, luminous tool, cold-cathode, lighting, series street lighting, transportation, and low voltage general purpose applications. Standards for this class range up to 500 KVA with voltage to 69 KV. However, these are nearly all mini-sized dry type transformers at mini-voltages; most at less than 600 volts and below 1 KVA. Several transformer types are exceptions to this stereotype class:

- a) Transportation (Railroad) Transformers - Rectifier type units normally restricted to smaller sizes (less than 100 KVA) for use on electric trains (one per car). Units are of askarel and oil design.

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- b) Instrument Transformers - Small units that give over-voltage protection or change current or voltage to values suitable for instruments, meters and relays. Instrument transformers are usually askarel filled for 15 KV and above, and dry or solid type for less than 15 KV. Sizes are small, 10 to 15 KVA.
- c) Precipitation Transformers - These transformers are of the rectifier type. They supply DC power to utility and industry power plant stacks to electrically filter out ash decomposition products. Normal voltages are less than 50 KV, and sizes are estimated at less than 500 KVA. These units are askarel or oil filled.

Commercial Pad, Pole and Subway (Distribution and Small Power)

These units have been arbitrarily lumped into a single category on Tab B to display units serving the commercial market, not defined by the network and secondary substation types. These transformers may be:

- a) Pad-mounted - Encase, oil-filled units for outdoor installation near the building on a factory-assembled pad support. Normal size, 75 to 500 KVA (some to 2500 KVA) $\leq$ 18 KV.
- b) Pole - Unencased oil filled transformers suitable for mounting on a pole or similar structure. Same sizes as commercial pad-mounted units. A pole-top unit is shown on Figure 7.

The above units are about 95 percent oil filled, the remainder are askarel filled. They transform from medium to low voltage by the utility, and are prevalent in suburban shopping centers, universities, etc.

Residential Pole, Pad and URT (Distribution)

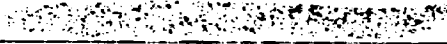
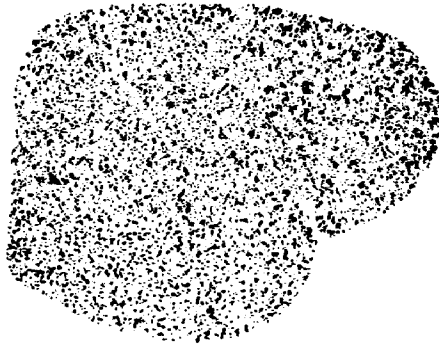
Lump category shown on Tab B to display the residential market. Commercial transformer definitions for pole and pad mount are the same for residential, except for size and voltage. These units are the final transformation point from utility medium voltages of 2.2 to 25 KV to the home owner's lighting and appliance voltage levels of 240/120 volts. Sizes are 25 to 167 KVA. Residential pole or pad units normally serve several customers, however, the unit residential distribution (URT) concept is receiving much attention. In URT, each

residence is served through a URT unit located immediately adjacent to, or in, the residence, above ground, or under the ground in a submergible vault type design.

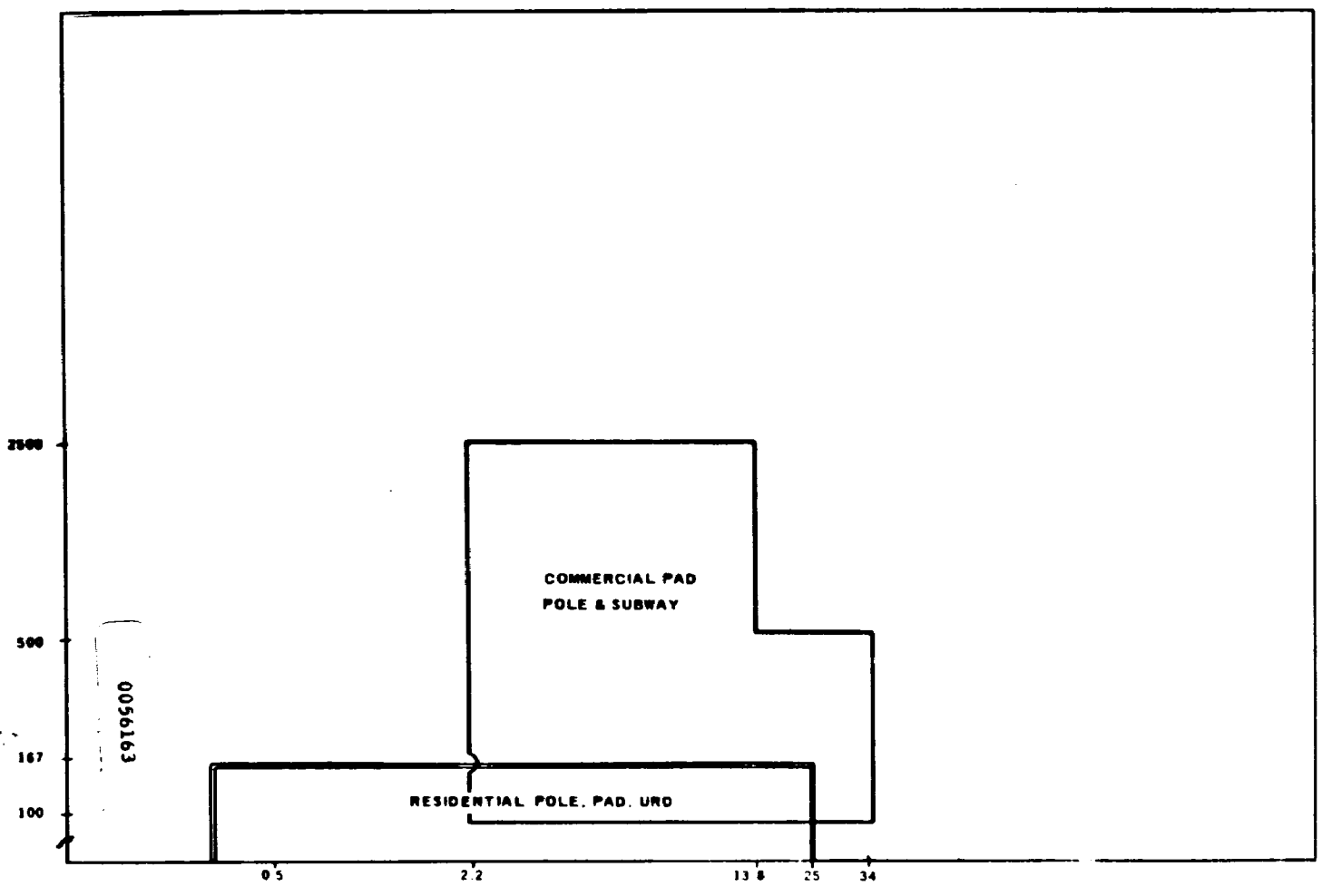
Residential transformers are oil filled. Newer URT designs are dry type, oil and of epoxy solid encased design (Westinghouse).

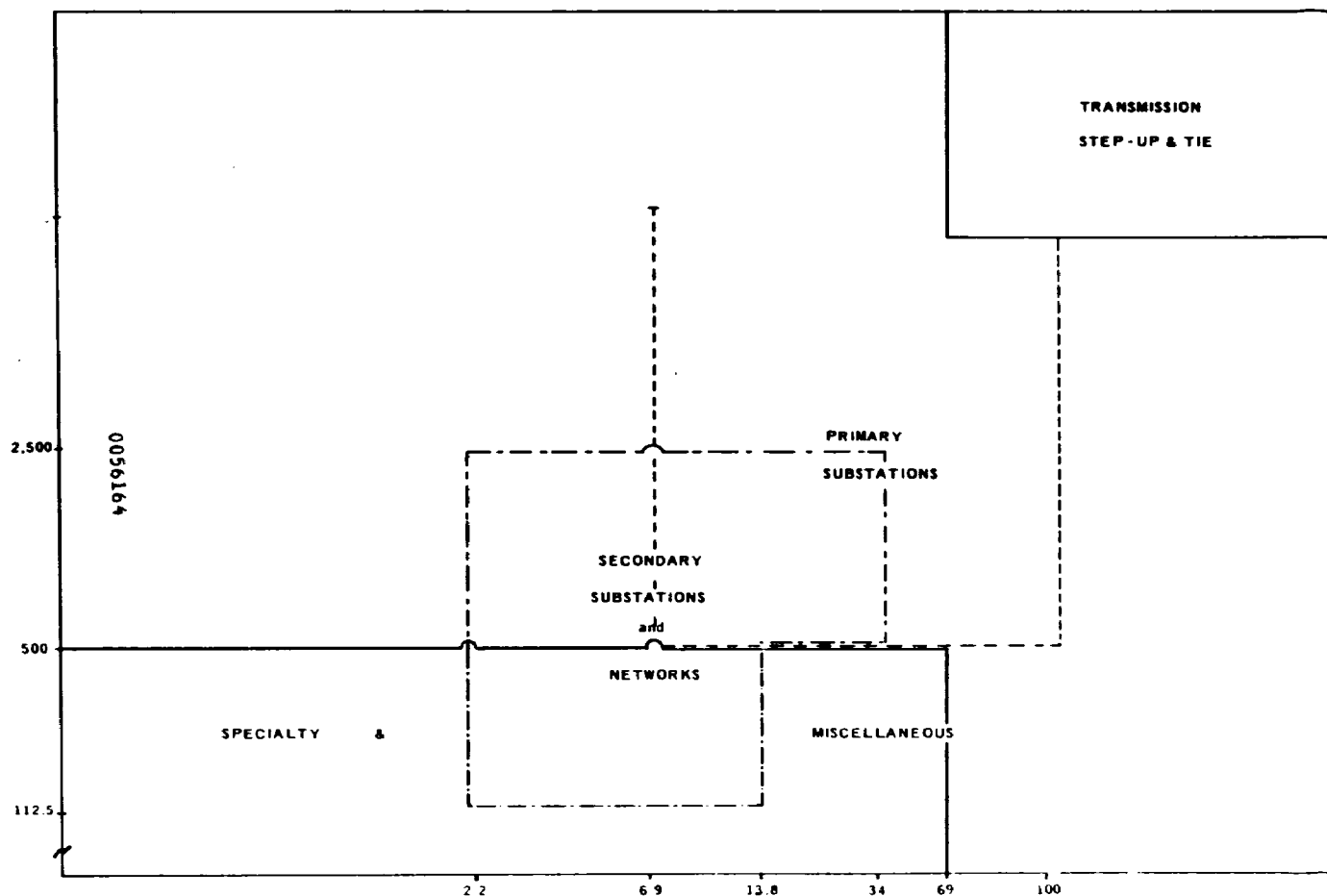
The present askarel market in terms of voltage and transformer KVA size is illustrated on Tab C. Our voltage range extends typically from 2.2 KV to 34 KV (max) in transformer sizes from 300 KVA to 2500 KVA. Askarel types include the network, secondary substations, primary substations, induction furnace and rectifier transformers. We also participate in lower sizes below 500 KVA in transportation, precipitation, and instrument transformers.

THE ASKAREL MARKET



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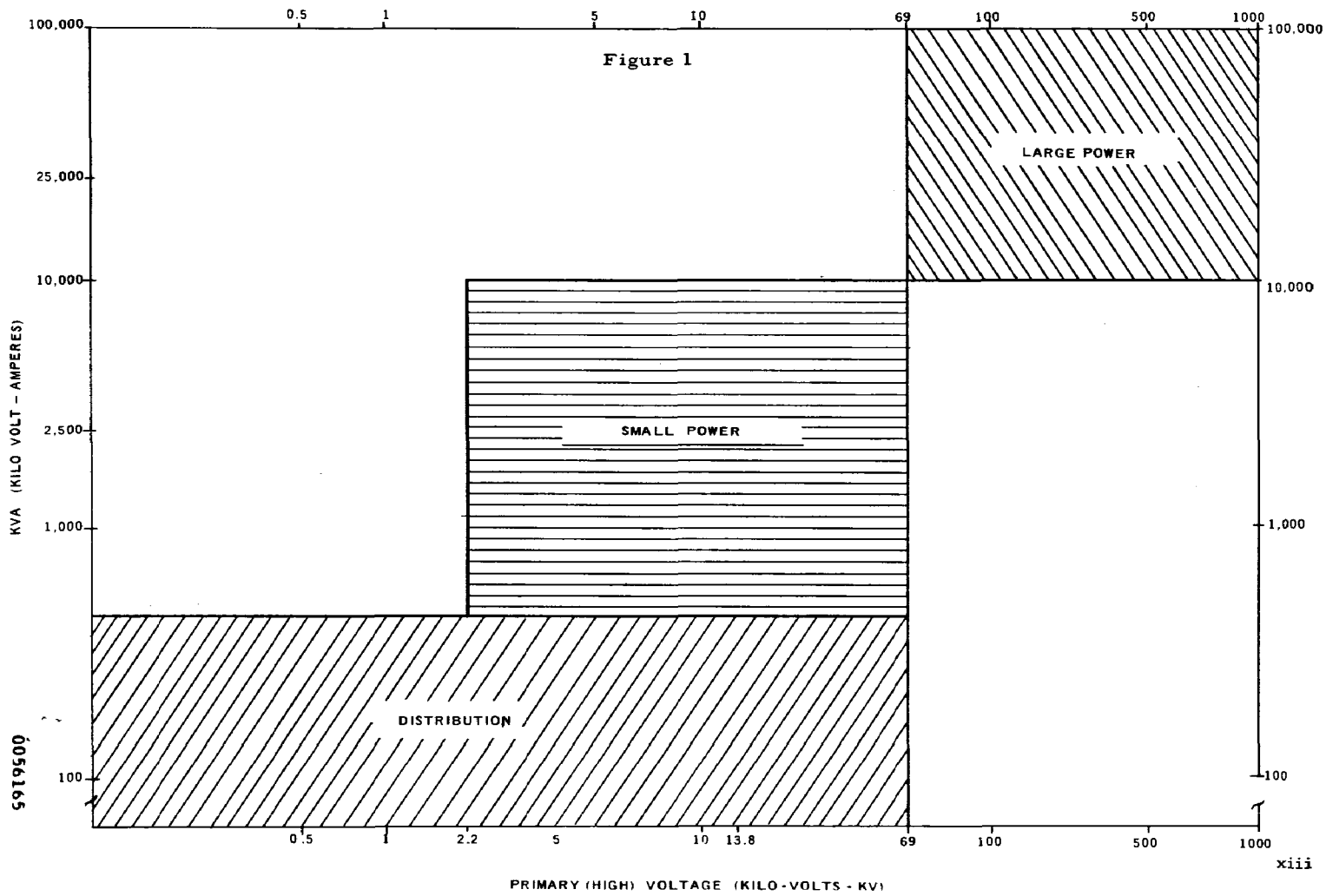


Figure 2

Askarel Substation Design

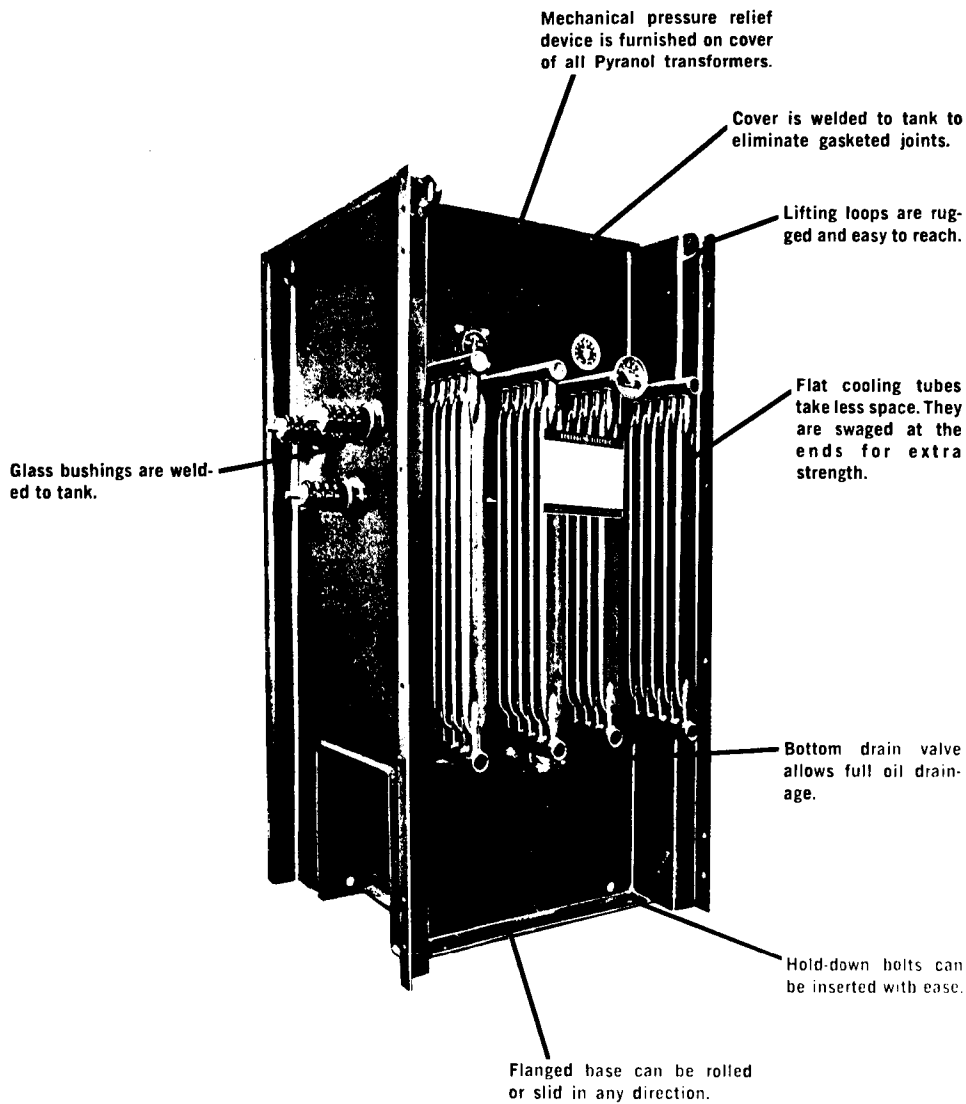
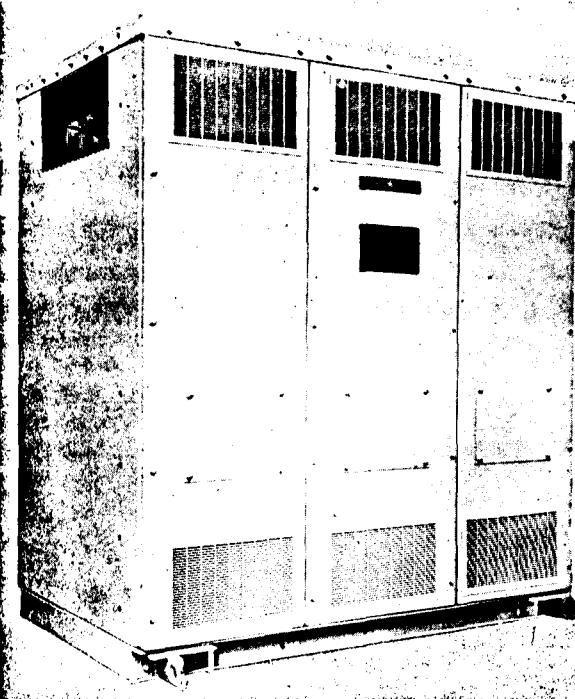


Figure 3

Dry Type Substation Design



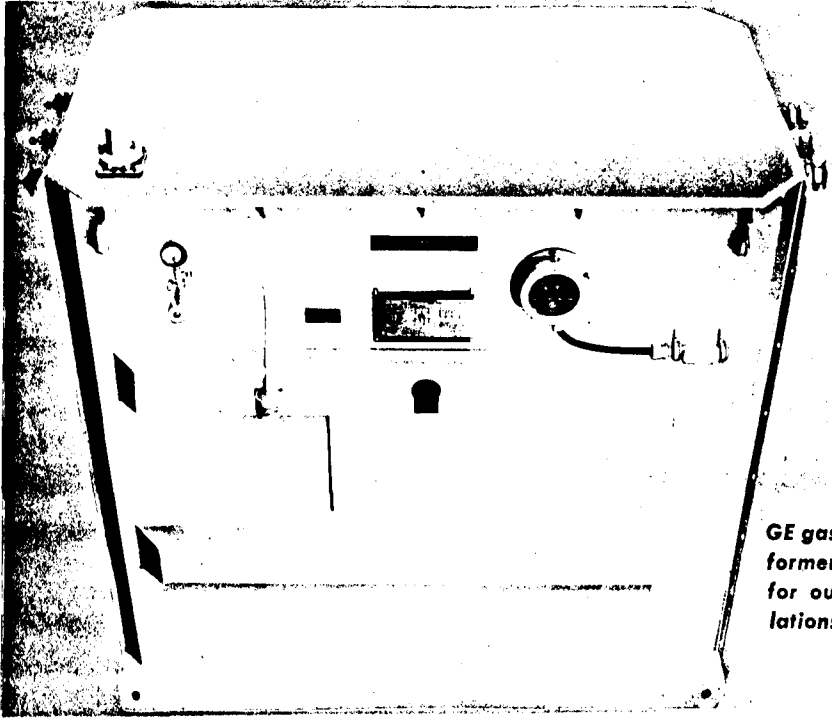
**General Electric's 15 kV
open-dry type trans-
formers provide compact
substations in applica-
tions where high capa-
cities are required.**

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Figure 4

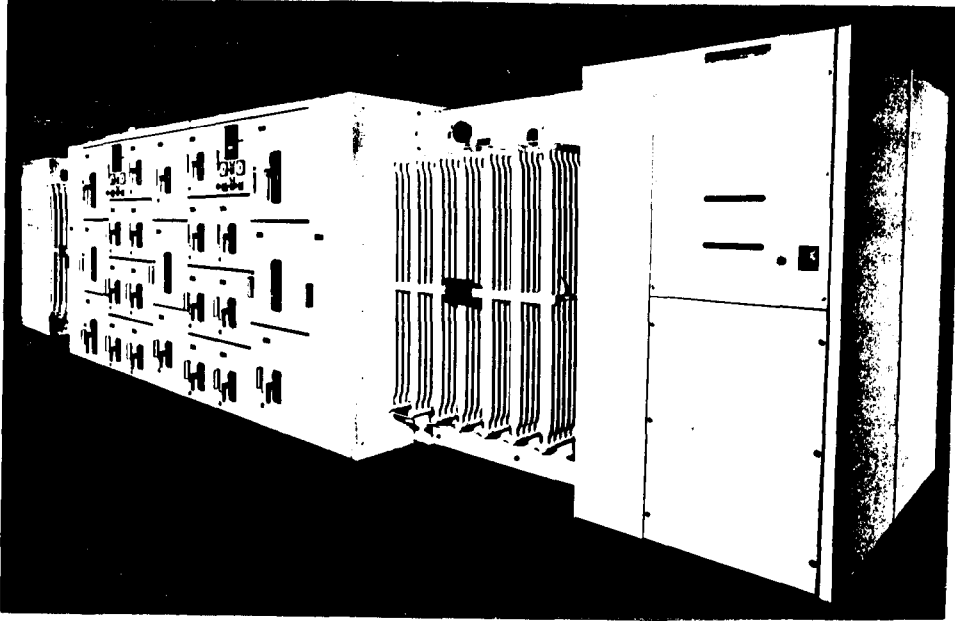
Gas Filled Substation Design



GE gas-filled transformers are ideal for outdoor installations.

Figure 5

Load Center with Two
Askarel Filled Unit Substations

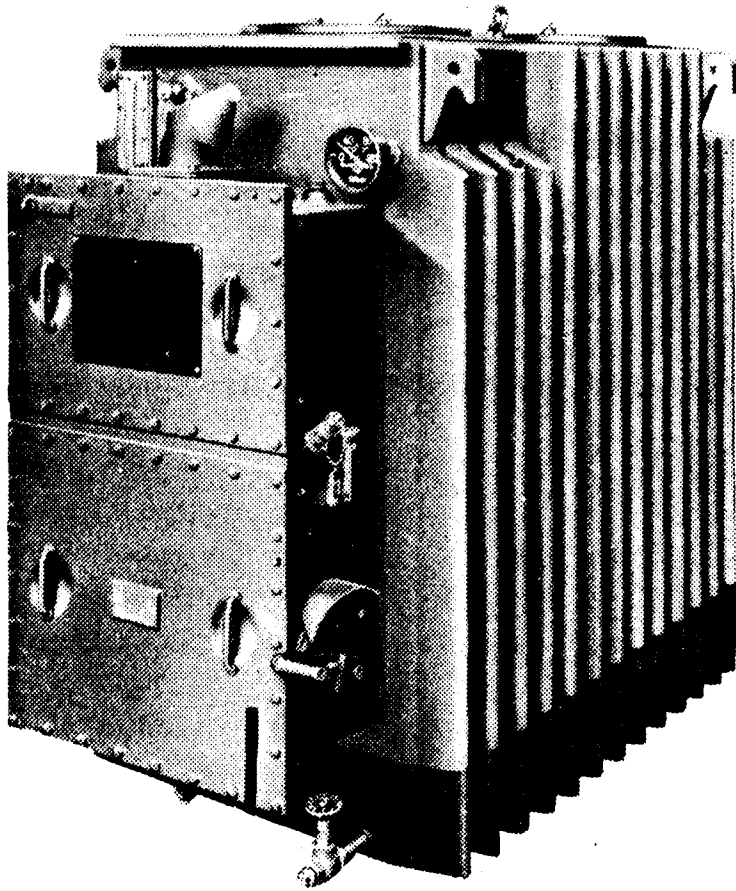


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Figure 6

Liquid Filled Network Transformer

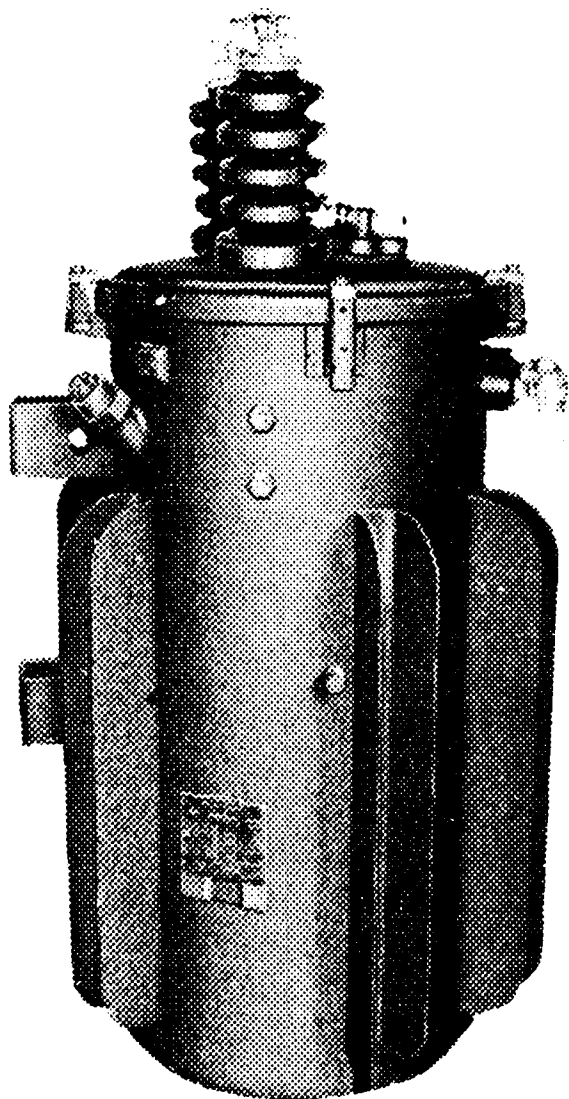


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Figure 7

Pole Type Oil-Filled Transformer



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POWER TRANSFORMER DIVISION, SOUTH BOSTON, VIRGINIA

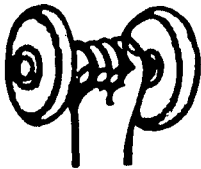
SALES LETTER 69-7

FILE 47-000



CUT COSTS

WHY INERTEEN?

INCREASED
STRENGTH

FIRE RESISTANT



QUIET

If you can get your customers to specify Inerteen filled transformers for their power center (secondary unit substation) requirements, you will be in the best possible position to get the order.

Attached is a copy of booklet O/FF-14 prepared by Monsanto Company outlining the reasons why Askarel (Inerteen) filled transformers should be specified. If you get with it early enough (before your customer firms up his specifications) you can frequently get Inerteen specified instead of a dry type.

This is important because the superiority of the rectangular core form transformers built by South Boston as told in SA 10099 and DB 47-350 will put you in the preferred position. Add to that the fact that 1. the price will be right, and 2. the shipment will be shorter and you're in!

So use the attached booklet (more copies are available on request), get Inerteen specified and you'll be holding the winning hand!

David P. Keiser

D. P. Keiser
Marketing Manager
South Boston, Va. Plant

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October, 1969

SFE-004, 009-012, 014, 024, 037-040, 044, 045, 047, 051, 052

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APPENDIX D

Transformer Askarel Sales Transformer Shipments and Orders (> 501 KVA) and New Industrial Construction* 1965 - 1968

	Askarel (M lbs)	Transformers (> 501 KVA)		New Construction (M \$)
		Shipments (Units)	Orders (Units)	
<u>1964</u>				
I.	2849	1529	1904	679
II.	2492	1901	2138	873
III.	3062	1857	1899	986
IV.	3639	1961	2229	727
<u>1965</u>				
I.	3248	1882	2269	937
II.	2918	1847	2079	1278
III.	2979	2048	2623	1352
IV.	3941	2054	1988	1561
<u>1966</u>				
I.	3144	2797	2110	1364
II.	3763	3215	2174	1713
III.	3487	3186	2077	1855
IV.	3125	3212	2245	1771
<u>1967</u>				
I.	3687	1914	3019	1447
II.	4690	2613	2939	2617
III.	5369	2439	2357	1663
IV.	5774	2391	1773	1551
<u>1968</u>				
I.	4903	2267	2208	1256
II.	4092	2559	1853	1318
III.	4026	2150	1696	1400
IV.	5660	2250	1633**	1610

* Sources

- a) Transformer Shipments and Orders - Edison Electrical Institute, New York
- b) New Industrial Construction - Survey of Current Business, Dept. of Commerce

** Orders by quarter for 1969 are: 1806(I), 1474(II) and 2593 (III) units.

APPENDIX E

Bibliography

1. Electric Power Distribution for Industrial Plants 4th ed.
IEEE Publication No. 141, August 1969.
2. Dry-Type Versus Liquid-Filled Transformers for Industrial
Applications by W. M. Terry Jr., Asst. Chief Engineer,
Allis-Chalmers. Presented to The American Power Conference
(1955).
3. Electric Systems for Commercial Buildings, IEEE Publication
No. 241, October 1964.
4. Energy Systems Design Survey, Power Magazine, Div. of
McGraw Hill, New York, October 1969.
5. Electric Distribution Equipment, A Special Report, Power
Magazine, October 1965.
6. Insulation Systems for Electrical Design, Wiley & Sons,
F. Clark, 1958.
7. Liquid Dielectrics and Aroclor, A Market Study, OD 1134,
John S. Harris, August 15, 1956.
8. Industrial Electricity, Volume Two, Timbie and Wilson,
1949, Wiley & Sons.
9. U.S. Industrial Outlook - 1969, U.S. Department of Commerce,
Business and Defense Services Administration.
10. Electrical World, 20th Annual Electrical Industry Forecast,
McGraw-Hill, September 15, 1969.
11. Directory of International Engineering and Construction Services -
1968, National Constructors Association, Washington D. C.
12. Directory of the Consulting Engineers Council (1969-70),
Consulting Engineers Council, Washington D. C.

APPENDIX F

List of Personal Contacts Made During This Study

Transformer Manufacturers

Allis Chalmers, Pittsburg, Pa.
Allis Chalmers, Milwaukee, Wisc.
General Electric Company, Rome, Ga.
General Electric Company, Pittsfield, Mass.
ITE Circuit Breaker, Philadelphia
James Ford, Sharpsville, Pa.
Maloney Electric, St. Louis, Mo.
Wagner Electric, St. Louis, Mo.
Westinghouse Electric Company, Sharon Pa.
Westinghouse Electric Company, South Boston, Va.

Architectural and Engineering Firms

Charles T. Maine, Boston, Mass.
Russ Engineering Co., Birmingham, Ala.
Stone & Webster, Boston, Mass.
Sverdrup & Parcel, St. Louis, Mo.

Industrial Contacts

Chrysler Motor Co., Detroit, Mich.
Ford Motor Co., Detroit, Mich.
General Motors Co., Detroit, Mich.
U. S. Steel, Pittsburgh, Pa.

Utilities

Baltimore Gas & Electric, Baltimore, Md.
Boston Edison Co., Boston, Mass.
Cincinnati Gas & Electric Co., Cinn., Ohio
Commonwealth Edison Co., Chicago
Consolidated Edison Co., New York, N. Y.
Kansas City Gas & Electric Co., Kansas City, Mo.

Utilities (Cont.)

Louisville Gas & Electric, Louisville, Ken.
Ohio Edison Co., Akron, Ohio
Ohio Power Co., Canton, Ohio
Public Service Gas & Electric Co., Newark, New Jersey
Union Electric Co., St. Louis, Mo.
Virginia Electric & Power, Richmond, Va.

Service Agencies and Others

Department of Commerce, Bureau of Business Services
Administration, Washington D. C.
Edison Electrical Institute, New York, N. Y.
Electrical World, Div. of McGraw-Hill, New York, N. Y.
Factory Mutual Insurance, Boston, Mass.
Federal Power Commission, Washington, D. C.
National Electrical Manufacturers Assoc. (NEMA)
Power Magazine, Div. of McGraw-Hill, New York