IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF TEXAS
CORPUS CHRISTI DIVISION

ROGER DALE HOLLAND AND DRENDA SHEPARD HOLLAND, INDIVIDUALLY AND AS NEXT FRIENDS OF TAUSHA MARIE HOLLAND AND JESSICA NICOLE HOLLAND; WILLIE MAE HOLLAND AND J. SELMON HOLLAND Plaintiffs,	)	
vs.	)	C. A. NO. C-91-78
MONSANTO, INC.; CENTRAL POWER AND LIGHT COMPANY; AND HOUSTON LIGHTING & POWER COMPANY, Defendants.	)	

DEPOSITION OF WILLIAM PAPPAGEORGE
Taken behalf of the Plaintiffs
June 27, 1991

Reported by
Suzanne Benoist, RPR, CSR
for
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DEPOSITION OF WILLIAM PAPPAGEORGE, produced, sworn, and examined on behalf of the Plaintiffs on June 27, 1991, between the hours of eight o'clock in the forenoon and five o'clock in the afternoon of that day at the offices of Husch, Eppenberger, Donohue, Cornfeld & Jenkins, 100 North Broadway, Suite 1300, St. Louis, MO 63102, before SUZANNE BENOIST, a Registered Professional Reporter and a Notary Public within and for the State of Missouri.

APPEARANCES

The Plaintiff was represented by the law firm of Edwards & Terry, 1400 Texas Commerce Plaza, P.O. Drawer 480, Corpus Christi, Texas 78403 by Mr. Michael G. Terry.

The Defendant Monsanto was represented by the law firm of Woodard, Hall & Primm, P.C., 7000 Texas Commerce Tower, Houston, Texas 77002 by Mr. Robert A. Hall.

The Defendant Houston Lighting & Power Company was represented by the law firm of Baker & Botts, One Shell Plaza, 910 Louisiana, Houston, Texas 77002-4995 by Mr. Tracy D. Hester.

The Defendant Central Power & Light Company was represented by the law firm of Bracewell & Patterson, 2900 South Tower Pennzoil Place, Houston, Texas 77002 by Ms. Lisa D. Anouilh.

The Defendant United States of America was represented by the U.S. Department of Justice, Torts Branch, Civil Division, P.O. Box 340, Ben Franklin Station, Washington, DC 20044 by Mr. Michael T. McCaul.

INDEX OF QUETIONERS

IT IS HEREBY STIPULATED AND AGREED by and between Counsel for the Plaintiff and Counsel for the Defendant, that this deposition may be taken in shorthand by SUZANNE BENOIST, a Registered Professional Reporter and Notary Public, and afterwards signed by the Witness.

o-O-o

WILLIAM PAPPAGEORGE

of lawful age, being produced, sworn and examined on the part of the Plaintiff, deposes and says:

EXAMINATION

QUESTIONS BY MR. TERRY:

[MARKED DEPOSITION EXHIBITS NO. 1-19]

MR. TERRY: So it is stipulated by and between the parties that the original deposition will be entrusted to Mr. Hall who will secure the signature of the witness Mr. Pappageorge within -- how much time do you want?

MR. HALL: Whenever I can get it and get it to him.

MR. TERRY: 20 days?

MR. HALL: We can do it in 20 days.

MR. TERRY: Within 20 days unless that time is extended by agreement thereafter, if a signed

copy is not available an unsigned copy may be used in lieu thereof.

The deposition will be taken according to the rules, that is all objections will be reserved until the time of trial except as to the form of the question and responsiveness to the answer. So agreed?

MR. HALL: And signed before any notary public?

MR. TERRY: Yes.

MS. ANOUILH: Yes.

MR. HESTER: Yes.

MR. MCCAUL: Yes.

Q. (By Mr. Terry) Could you tell us your name sir?

A. William B. Pappageorge.

Q. Pappageorge. And where do you reside, sir?

A. In St. Louis County, Missouri.

Q. And how old a man are you?

A. I am 68.

Q. Are you currently employed on a regular basis?

A. No.

Q. Did you retire from Monsanto?

A. I did.

Q. And in what year did you retire?
A. My last working day was December 31st, '86.
Q. You remember it like most of us remember the day we got out of the Army.
A. Yes. It's different from all the other days.
Q. How long had you been with the company?
A. 35 years.
Q. Had you been employed at any other company before starting with Monsanto?
A. I was with Phillips Petroleum Company in Oklahoma.
Q. And how long were you with Phillips?
A. Four years.
Q. And before that?
A. A student.
Q. And where did you go to school?
A. Washington University in St. Louis.
Q. And the year that you graduated?
A. I got my Bachelor of Science degree in 1943 and my Master of Science degree in 1947.
Q. Was there a service break?
A. Yes.
Q. Did you go to work for Phillips after you

obtained your Masters?

A. I did.

Q. What kind of work did you do for Phillips?

A. I would categorize it as two different types. One was as a research engineer working on drilling mud problems and secondary recovery problems. The second assignment was the, as a design engineer designing facilities for refining petroleum.

Q. What year did you start with Monsanto?

A. 1947.

Q. I thought you went to Phillips in '47.

A. I'm sorry, you said Monsanto. '51 for Monsanto.

Q. I know 35 years with the company you held a great many positions and did a great many jobs but I would appreciate it if you could give me sort of a summary of your career at Monsanto in terms of your major area of responsibility.

A. I'll try to condense it.

I was involved initially in design engineering. From there I went into production supervision and then maintenance supervision and back into design engineering. Then I became, I managed the service functions at a plant in Monsanto. This is the

shipping, distribution, the utilities, generation and distribution, all the services that the manufacturing people are required to perform their tasks. Then I became a general superintendent of manufacturing at the plant in Sauget, Illinois and from there I was assigned plant manager at the plant in Anniston, Alabama. I then was designated as manager of environmental control addressing the then evolving PCB environmental issues. I had that assignment from 1970 to 1976. Through those years I picked up additional products in addition to PCB's. I was then designated as a director of environmental operations for different operating units in Monsanto through the years '77 through '85. Then in 1986 I was named manager of occupational health for the chemical unit in Monsanto.

Q. And that is the position from which you retired?

A. That is correct.

Q. You have had an opportunity to speak with attorneys representing Monsanto about this particular case.

A. I have.

Q. And you are aware that this particular case involves PCB's.

A. I do.

Q. You were kind enough to mention the specific dates that you were the manager of environmental control, 1971 through 1976.

A. Yes. The title did change but the job didn't.

Q. And you indicated that the position was either created or you were assigned to the position because of the then evolving environmental issue involving PCB's.

A. That is correct.

Q. Prior to 1900 and 71 in the various positions or job assignments that you had held had you had contact with PCB's?

A. Yes.

Q. Could you identify for me the contact that you had?

A. All right. My initial involvement was as a maintenance supervisor and superintendent. I was responsible for the activities of the electricians in the plant. This group was the group that was involved with the servicing, repair of electrical equipment which contained PCB's. It was my obligation to know proper handling, safe handling of the material.

Q. When did you have that position?

Roughly.

A. Roughly about -- from '55 to '58, roughly.

Q. And thereafter?

A. And then the next involvement as a superintendent of the services unit at this plant. I was responsible for the operation of a unit that blended chemicals for packaging and sales. That blending operation as scheduled would produce industrial hydraulic fluids which contained PCB's. There again I had to know the proper handling by the employees as well as the disposal, cleanup, all the core activities associated with an industrial chemical.

Q. And what year did you have that position?

A. That was 1962 to '64 or something like that.

Q. Then thereafter?

A. Then my next major involvement was as plant manager of the Anniston, Alabama plant at which PCB's were manufactured.

Q. And what year were you in Alabama?

A. 1965 through 1969.

Q. The two-year period between '69 and '71 did you have any direct involvement with PCB's?

A. I'm sorry. I should have said '70 instead of '71. This goes through '69 and then on the 1st of January 1970 I was assigned manager of environmental control.

Q. Okay.

In connection with your educational background you had indicated a BS and an MS.

A. Yes.

Q. Was it in chemistry or chemical engineering?

A. Chemical engineering.

Q. What did you do as the manager of environmental control?

A. I was -- my primary responsibility was to act as the focal point for all the information that was being generated both within Monsanto and elsewhere, world-wide. I tried to disseminate that information with the objective of making sure that the left hand knew what the right was doing and to try to encourage openness between the various groups that were making all these studies and this included not only Monsanto's research department, engineering department and the like but the universities, governmental agencies, private laboratories and customers.

Q. As director of environmental operations in connection with PCB's what did you do?

A. Director of environmental operations involved environmental and work place health in the broadest terms. I had a, I was assigned to a unit within Monsanto, I had a staff of appropriate types of people to help me and as far as the environmental engineer reporting to me and his relationship to PCB's was to make certain that any regulations that applied to PCB's were being followed by the plants that he was assigned to.

Q. You were concerned then with the environmental operations of Monsanto's own premises, facilities and plants?

A. That is right.

Q. And then the last year you were with the occupational health chemical unit?

A. Yes.

Q. Same thing?

A. There it related to yes, just Monsanto plants.

Q. What was the difference between occupational health and environmental operations?

A. Environmental operations had three major areas of interest, one is what we called product

safety, the proper labeling of product, proper packaging, proper shipping, proper information issued to the customer.

The secondary was environmental activities at each of the plants. What are you doing with your waste waters, what's going up your stack and what are you burning.

Then the third area was employee exposure. As director of environmental operations the unit that I was signed to represented a, roughly a fifth of Monsanto to give you an idea of the size. As manager of occupational health later I concentrated only on occupational health at Monsanto's plants for about 45 plants. So the plants were increased but the focus was narrowed.

Q. In connection with your work as director of environmental operations were you responsible for as one of the three areas you identified customer information concerning the products?

A. No.

Q. I'm sorry, then I misunderstood you.

A. I shouldn't say that. As part of the product safety activity the individual assigned to that activity and reporting to me was responsible for communicating to the customer appropriately. Either

telephone request, letter request, salesman contact, whatever it took he was to make certain that the information was forwarded quickly and accurately.

Q. This would be information of a technical nature?

A. Most of it is technically based but we try to couch it in language that we thought the recipient could understand so that a medical doctor would get a different grouping of words so to speak than the foreman at a plant.

Q. Was that function, and by that function I mean communicating information technical based in language appropriate to the person you're communicating to always a part of environmental operations? As far as you know.

A. No. Because environmental operations didn't become a recognized assignment as such in Monsanto until 1977. Prior to that that information relating to any product was primarily the responsibility of the marketing department.

Q. When you say it was the responsibility of the marketing department, was there a recognized unit or group of people that communicated technically based information?

A. There were two principle sources of

technical information, one was the research chemist and the other was Monsanto's corporate medical department.

Q. Were they part of the marketing department?

A. No. They were staff departments and served as a resource of information for the marketing people.

Q. Was there any group or unit within the marketing department that was responsible for communicating technically based information to customers prior to 1977?

A. There was an individual at least in each of the marketing groups in Monsanto that was located in St. Louis who had a strong technical background and was familiar with the product line that the group handled. He would serve as the, generally as the first technical contact the field salesman might call on. You notice I said might, he didn't have to. He could call the research fellow or the medical doctor directly but there was an individual assigned in the marketing group that had the technical know how to support the field salesman.

Q. In connection with, and forgive me, how do you pronounce the trade name for PCB, fluid used in

transformers?

MR. HALL: Askarel?

A. Askarels is the generic term for fire resistant fluids used in electrical equipment. Askarel. A-s-k, Askarel.

Q. (By Mr. Terry) And I've seen the term Aroclor?

A. Aroclor. That's a Monsanto trademark for chlorinated chemicals that involve the benzine ring.

Q. Which name is more appropriate for transformer fluid containing PCB's that would have been marketed by Monsanto so that you and I can communicate?

A. Askarel was used by the, those people that represented the manufacturer and the user of the transformers and we at Monsanto understood what they meant and did use the term Askarel also so that is more appropriate than Aroclor because Aroclor was a trademark for products that were used for many, many other uses in addition to an ingredient in transformers.

Q. Then let's use the term Askarel.

A. Very good.

Q. In the marketing department was Askarel its own product line or part of another product line?

A. In the marketing group there was an individual assisted by this technical person located in St. Louis that addressed only the uses in electrical equipment.

Q. Do you know who that individual was?

A. Yes, I do.

Q. And who was that?

A. Paul Benignus.

Q. How long did Paul occupy that position? Because I'll never pronounce his last name correctly.

A. Mr. Benignus, the position of heading the marketing group, I just don't recall exactly. It would have to be 15 years at least.

Q. Did he always have the same individual with technical know how to support him?

A. No. That individual was, that assignment was changed several times in that period of time. I don't recall all the individuals involved.

Q. Is Mr. Benignus still around?

A. Yes.

Q. Is he still with the company?

A. No. He retired in 1974.

Q. Prior to 1900 and 70 had you personally had any contact with the function of communicating technical information in lay or appropriate language

to customers?

A. In a very limited way, yes.

Q. Can you describe that way for me?

A. As plant manager at the Anniston plant I on many occasions played host to representatives of customers who came by the plant to see our facility and exchange information. During those meetings, conferences, there were times when the new technical data was available and we would share it with the customer's representatives. But as I said earlier it was quite limited. The frequency of which new data would generate wasn't that great that it involved a lot of communicating.

Q. Other than the occasional contact you would have with customers and communicate technical information while you were plant manager in Alabama did you have any other personal involvement with the process of communicating technical information to customers of Monsanto as it relates to Askarel?

A. Prior to 1970?

Q. Yes.

A. Prior to 1970, no.

Q. After 1970 was your relationship with the process of communicating technical information to customers limited to supervising those people in the

environmental volume group that were responsible for that function?

A. I didn't mean to mislead you. I was alone, I didn't have any staff at that time. As manager of environmental control I was it.

Q. Okay.

A. It was only as director of environmental operations that I had a staff. That was later, in '77.

Q. So between '70 and '76 did you personally then communicate technical information to customers?

A. Yes.

Q. And then when you were director of environmental operations, that's when you had the staff.

A. Correct.

Q. That actually did the work under your supervision.

A. Correct.

Q. In connection with Askarel while you were lead manager of environmental control was Monsanto still producing Askarel, still making it and marketing?

A. Yes.

Q. When did they cease making and marketing

Askarel?

A. They ceased manufacturing July, 1977; ceased marketing in September, 1977.

Q. Between 1970 and 1900 and 77 were there any restrictions that Monsanto placed on the sale of Askarel? That is restricted to closed systems, that sort of thing, that you're aware of?

A. I hesitate because by speaking of Askarels it was limited to electrical equipment which by definition is closed, sealed equipment.

Q. Okay.

A. There were Monsanto restrictions on the sale of PCB's for other uses but not related to Askarels.

Q. So by using the term Askarel I am defining a product designed for a closed system.

A. That is correct.

Q. Were there restrictions in place between '70 and '76 on Aroclor?

A. Yes there were.

Q. Did you deal with those in connection with dealing with customers?

A. Yes.

Q. Generally what were those restrictions on the Aroclor?

A. On the Aroclor line of products there were restrictions based on perceived ease of entry into the environment so if the use was let's say a paint that's used to mark the traffic lanes on highways that was discontinued in 1970. The use in industrial heat transfer systems where the PCB is used as a hot fluid that's used to perform some heating in a remote location, that was continued through 1971 and terminated late in '71. The use in the carbonless copy paper as a solvent for the ink, that was discontinued early 1971. Those are examples of the kinds of --

Q. Uh-huh.

A. So Monsanto's refusal to sell to these uses varied through that period of time and different dates were set up as targets.

Q. With respect to you personally did you participate in any of the decisions to terminate sales for particular uses?

A. Yes.

Q. Who else would participate in those decisions?

A. Well --

Q. I mean was it a decision made completely within the environmental control?

A. No. All I could do was to strongly advise certain approaches. The advice I was able to give was considered by an informal group which represented the marketing representatives of the group that sold these products, the research people associated with the product, the engineering people, the medical department. I'm sure I didn't get them all but it was a good size group, it's about 15, 20 people. We then took our collective thoughts and gave them, passed them on with strong recommendations they be adopted to the managers, the directors of these businesses. That in turn was taken to the, what I consider the top Monsanto, corporate Monsanto committee composed of the president, chairman of the board and his senior vice-presidents for their review and support.

Q. The initial group in this decision making process, the group of 15 or so, was that an ad hoc group for the particular use of Aroclor? Or was it a standing committee?

A. No. It's an ad hoc group addressing the Aroclors in its many uses, not just one use.

Q. Okay. So this group of 15 was ad hoc for the uses of the Aroclor.

A. Correct.

Q. Did it essentially consist of the same people more or less during the period '70 to '76?

A. Yes but I don't want to mislead you. The group was very active in '70, '71 and as the company withdrew from these sales many of those people were no longer involved so the group kind of shrank in size to the point where finally the use in electrical equipment was the only use so that was limited then to three or four people.

Q. The second level that you identified was the directors or the managers of the particular business groups. What do you mean by business groups?

A. Monsanto at the time was organized as far as its marketing approach was concerned into business groups.

Q. Defined by customers?

A. Defined by type of product sold. The two groups in Monsanto that were involved with the PCB products were the functional fluids group which tries to describe the use of fluids in industry as distinguished from a chemical that is changed and converted to some other product. The second group was known in Monsanto as the plasticizer group, they sold chemicals primarily intended to add to plastic materials to make them flexible instead of brittle.

The Aroclor PCB's were used for some of their applications.

So those groups were headed by a director and reporting to those directors were people that represented research, manufacturing, marketing and engineering. So they formed a team and addressed that particular product line.

Q. And then the next level of decision would be at the corporate officer level.

A. Yes.

Q. During this period of time was Monsanto actually refusing to sell Aroclor to customers who intended to use it for particular applications?

A. Yes.

Q. If they wanted to use it for carbonless copy paper Monsanto would refuse to sell.

A. That's right.

Q. And that was the type of decision that this decision making process ultimately resulted in.

A. Correct.

Q. The group of 15, without asking you to list all the names when the group was at its most active, generally what areas did they represent?

You, environmental control.

A. Correct.

Q. I assume there was someone from marketing?

A. There was two people from marketing, one was from the plasticizer group, the other from the functional fluids group.

Q. What other types?

A. Research directors from the two groups, a representative from the medical department, at least one, sometimes two would show up. Engineering department, corporate engineering department. A representative of corporate manufacturing and then we had of course the press relations person and we had an attorney.

Q. How --

A. I think that covers all. I have a feeling I missed somebody.

Q. Without asking you to identify the people those would roughly be the interests represented in the group of 15.

A. Correct.

Q. How were specific applications addressed? How did you decide to look at any particular application? How would a question come up so to speak?

A. Well the discussion of course was free

and moving throughout the room. Of course there had been previous informal discussions about the need for holding such a meeting and what should we do so by the time the group got together they had already in essence had defined what we eventually came to call the open use and the closed use systems. By open use we were referring to such applications as the carbonless copy paper and the paint and sealant applications, those are just examples. The sealed systems we included such things as the use in electrical equipment, the use as an industrial heating fluid and the use as an industrial hydraulic fluid. Those were considered to be closed systems. With that base in mind the group decided that we had no control over that open use. Once the product was manufactured and used it hit the environment so that decision was made to terminate sales to that as quickly as possible.

The other uses involved decisions such as educating the users for need for tight control, prevent entering the environment, but we would continue to sell to those uses barring any new information.

That's really the gist of the discussion.

Q. When the group was formed then had the

decision been reached to restrict sales to open use of PCB's?

Stated another way, would it be fair to say that as of 1900 and 71 Monsanto had made the decision not to sell PCB's or products containing PCB's to any use defined as an open use?

A. That is correct.

Q. Did you participate in the decision of the company to so restrict sales?

A. Yes.

Q. When was that particular decision made? Roughly.

A. The ad hoc group had made that decision by late February, 1970. In March we reviewed this with the two directors of the business groups and they in turn with their supervision and in April I was the spokesman that went before this top corporate committee and proposed a program for withdrawal from these markets.

Q. And we know that the top corporate people responded favorably to your proposal, accepted your recommendations.

A. I don't want to mislead. They accepted the overall plan but they were impatient with the timing so we were asked to go back and hasten the

program.

Q. They wanted you to move faster?

A. Which someone else went back later since I was not available and proposed new target dates which then the full proposal was acceptable, the access plus the timing.

Q. Were the people at the top of the corporation interested in moving faster or slower?

A. Faster.

Q. And so it was an accelerated timetable that was presented the second time around?

A. Correct.

Q. And then in 1900 and 77 Monsanto ceased to sell PCB's even to the closed system or the closed use; is that right?

A. To the remaining closed system application which was electrical equipment.

Q. So Askarel would be the last to go?

A. Correct.

Q. Between 1900 and 70 and 1900 and 77 was part of the program that you were describing making certain that the customers of Askarel, other closed system users, have as much information as possible?

A. That is correct.

Q. As much information as was available to

you?

A. Correct.

Q. From 1970 until 1977 was that program of communicating information to the end users -- let me ask the question another way.

From 1970 to 1977 was that program of providing information to the customers followed by your company?

A. Yes.

Q. Did that program include providing information to the end user?

A. Not by Monsanto.

Q. I am aware that Monsanto sold Askarel directly to customers such as utility companies. Is that correct?

A. For a period of time. That was terminated in 19, I think it was 1971 or 2, somewhere in there.

Q. Monsanto also sold Askarel to those companies that manufactured transformers such as General Electric.

A. Yes.

Q. And in fact permitted General Electric to use its own trade name to describe the Askarel fluid.

A. Yes.

Q. So when you would be communicating information between '70 and '77 to customers you would be communicating to people like General Electric for the most part.

A. For the most part, yes.

Q. Particularly if you ceased selling directly to utility companies in 1972.

A. Correct.

Q. Did you understand that the information you communicated to General Electric about Askarel would have to be communicated by General Electric to the end user?

A. Yes. That was a strong understanding.

Q. Were you aware then that General Electric had to have enough information from Monsanto, the manufacturer of the Askarel, in order to effectively communicate sufficient information to its customers?

MR. HALL: Excuse me. Would you read that back?

(WHEREUPON REPORTER READ FROM THE RECORD AS DIRECTED).

Q. (By Mr. Terry) And by that so there's no confusion would be the customers of General Electric.

A. I understand that.

Q. Okay.

A. I hesitate because Monsanto prepared

blends of fluids as specified by customers like General Electric. That blend is the Askarel. One of the ingredients is a PCB. Information relating to PCB's was certainly available from Monsanto and was conveyed to General Electric. Monsanto could not relay information regarding other ingredients that General Electric selected to put into that mixture so General Electric would have to get that information from other sources, other suppliers.

Q. I appreciate the clarification. So that I understand, the Monsanto-manufactured element of a fluid that would become Askarel would be the PCB's.

A. Correct.

Q. The other elements of the fluid would be manufactured by people other than Monsanto?

A. Correct.

Q. And then Monsanto would blend the components and produce the fluid known as Askarel.

A. Correct.

Q. Would General Electric specify the components of the fluid as far as you know?

A. Yes.

Q. Would they specify the supplier for components other than those manufactured by Monsanto?

A. There were times when they would specify

supplier but that wasn't always the case. It depended on their perception of the quality of the material from given suppliers.

Q. Setting aside the question then of the other components in the suit that made up the Askarel, for a customer like General Electric the source of information about PCB's would have to be Monsanto.

A. Definitely, yes.

Q. And Monsanto would have to communicate enough information about PCB's to its customers so that they would be able to effectively communicate enough information to their customers?

A. That is correct.

Q. And you would have recognized then that with respect to the PCB that was a component in the Askarel Monsanto was the source of information about that component?

A. We were the primary source but General Electric and others were able to get information from other sources, Government agencies, the university laboratories, private laboratories, so there's nothing to prevent them from including that information in their knowledge base to forward to their customers as appropriate.

Q. I understand that Monsanto may not have

been the exclusive source of information about PCB's but it was the primary source?

A. Correct.

Q. Would you agree that in terms of Monsanto's responsibility as the manufacturer of the PCB Monsanto had the responsibility to communicate adequate information to its customers such as General Electric?

A. Yes.

Q. And Monsanto had the responsibility to communicate enough information to its customers, General Electric, so that they would have enough information to communicate to their own customers?

A. Yes.

Q. Would it be fair to say then that Monsanto understood that the information that it communicated to its customers would be the primary source of information communicated to the end users?

A. As it relates to that component, PCB's, yes.

Q. Yes. Would you agree with me that the end users of the Askarel are generally speaking utility companies such as Houston Light and Power, Central Power and Light or would there be others that you would consider to be the end users?

A. There are many end users. I have no measure of the volumes or numbers of pieces of equipment. There are commercial buildings, Government buildings, Holiday Inns. That's throughout our society.

Q. I appreciate that, I don't mean to use the utility companies as the sole member of the class of end users but does the term end user as you understand the term include the utility companies?

A. Yes.

Q. The reason that I ask the question is I am not certain of the chain of distribution of the Askarel. My perception is that the Askarel would be supplied to General Electric, General Electric would then supply a transformer containing Askarel or using its own trade name to the end user which would be someone like the utility company or the Holiday Inn, that sort of thing.

A. That is correct.

Q. Do you know whether or not Monsanto actually prepared for its own customers, say General Electric as an example, information in a form that was intended to be communicated to the end user? And again so that we understand each other I'm still talking about that period of time of '70 to '77 when

you personally were involved in that.

A. Monsanto did not prepare a document intended for the customers of our customers.

Q. And in order to then get the information to the end user Monsanto would be relying on the intermediate at be it General Electric or someone at Westinghouse or someone else to assemble the information Monsanto provided in documents, booklets or pamphlets that the intermediate would then give to its customers?

A. That is correct. But in every case we were told by our customers to stay away from their customers. We were not allowed to communicate, so.

Q. I'll ask you about that but I don't mean to imply any particular malfeasance or misfeasance, I'm just interested in the fact that it is true that Monsanto would have to rely on its customers to assemble and publish the information to the customers or end users.

A. That was done.

Q. So you, Monsanto, would have to rely on Westinghouse or General Electric or one of your other customers to assemble the information that you provided them for transmission to the end user?

A. Correct.

Q. You had indicated that your customers, be they Westinghouse, General Electric or others had actually advised Monsanto not to deal directly with the customers of customers.

A. That is correct.

Q. Was that information communicated to you personally by these customers? Westinghouse or General Electric?

A. Informally, yes.

Q. Was that uniform from Monsanto's customer base or was it just particular for some?

A. I would describe it as typical in industry where each supplier prefers to communicate to his customers in his way and his timing and all. Doesn't want other parties bypassing them. That's my understanding.

Q. In terms of questions or requests for information from customers of customers, be it the Holiday Inn or the utility company, would Monsanto respond to information requests from them?

A. Certainly.

Q. Were there mechanisms in place to handle those questions?

A. Yes.

Q. Were the mechanisms for handling those

questions part of your department as manager of environmental control? Would those questions come to you?

A. Some of them, yes.

Q. Where else would they go or where else would they be routed?

A. They might go to the marketing representatives located in the home office. Like this technical person we talked about earlier or the manager of that marketing department.

Q. I'm sorry, I apologize for interrupting. I was of the impression that when you became manager of the environmental control group the arrangement with Mr., or with Paul, ceased.

A. No.

Q. It continued on?

A. There were key people in this communication network.

Q. Okay.

A. I just sort of supplied support and I coached and trained and communicated and they were expected to carry their message forward. They were part of the network.

Q. His function and his contact with customers and customers of customers still persisted.

A. Very much so, yes.

Q. With respect to PCB's did his, did Mr. Benignus, continue to deal directly with customers and customers of customers in connection with Askarel until the time that Monsanto ceased making it?

A. No. Until the time he retired in '74.

Q. Okay. Was he replaced by someone else?

A. Yes. He was replaced by David Wood.

Q. Did Mr. Wood continue to provide that function?

A. Yes.

Q. And I assume because PCB's are so stable and persistent that Mr. Wood is still providing that function?

A. No. Mr. Wood is no longer involved with PCB's.

Q. Is there someone who carries on?

A. Dr. John Craddock.

Q. How long did Mr. Wood fulfill that function?

A. I'm going to have to rely on my memory here on an awful lot. I would suggest he did this from '74 through --

Q. Just roughly, sir.

A. I'm trying to recall.

Q. And I know I'm reaching for details.

A. I believe Mr. Wood was still in place when the sales were terminated in '77. I don't know when he was resigned following that.

Q. Now you had indicated, and I'm changing subjects now, you had indicated that your first contact with PCB's, particularly Askarel, would have been in '55 when you as part of your maintenance supervisory responsibility became a supervisor of electricians that would come in contact with electrical equipment containing Askarel; is that correct?

A. That is correct.

Q. And I assume that what you're talking about is equipment utilized by Monsanto in its own plants or facilities.

A. That is correct.

Q. As apposed to electrical service provided to outside people.

A. Yes.

Can we take a break?

Q. Absolutely.

(RECESS TAKEN BY PARTIES.)

Q. (By Mr. Terry) The electrical equipment on the Monsanto plants and facilities, was it at one

particular plant or facility? This is in '55 to '58.

A. That was in one plant.

Q. In connection with your work as the supervisor of the electricians you had indicated that you had to make yourself knowledgeable about Askarel: proper handling, proper disposal, proper cleanup.

A. That is correct.

Q. Had you had an opportunity to make yourself knowledgeable about those subject matters before or did you have a working knowledge before '55 about those subject matters?

A. I did not.

Q. How did you make yourself knowledgeable about that subject matter, specifically the cleanup and disposal aspect of Askarel?

A. Well cleanup and disposal was the practices involving cleanup and disposal at the time was that commonly used with all of our industrial chemicals. The use of such things as saw dust to pick up spills was rather common. All of this material was taken to a place in the plant and it was generally stored in some kind of container, steel drum or what have you, and then we had a service that would pick it up and take it across the Mississippi River to Monsanto's landfill for industrial chemicals.

The information relating to employee exposure I received from two principle sources, one is reading the available documents in Monsanto, both the kind that's sent out with the products and the type that is available within Monsanto and associated with manufacturing procedures and operating instructions and the key source really was the plant physician, I sat down with him and we talked not only about PCB's but anything else that these people might be exposed to.

Q. In connection with the disposal of Askarel that your electricians would have picked up after a spill or just simply because the Askarel had to be discarded, if my understanding is correct your responsibility as the supervisor would end once the material was placed in the 55 gallon drums.

A. That is correct.

Q. Did you have any responsibility for transport to the landfill or operation of the landfill?

A. In 1955?

Q. Yes.

A. No.

Q. Have you had any responsibility in your other positions for operation of the landfill or a

landfill actually run by Monsanto?

A. I did not personally, no.

Q. At any time?

A. At any time. Correct.

Q. In terms of information communicated to customers concerning disposal of discarded Askarel at any time in your career what sort of information have you communicated?

A. The information I was able to communicate was primarily one of cautioning them about getting into the environment. When asked specifically what could be done I was able at that time to tell them you find a properly authorized landfill and dispose of it as described by the local authorities in that landfill but assure yourself if you can that that landfill does not come into contact with any water, surface water or ground water. That was in the early stages. Later when Monsanto designed and placed in operation an incinerator I was able to tell the person with the spent liquid that he could if he wished send his material to Monsanto for destruction.

Q. When did the incinerator come on line?

A. 1971.

Q. Prior to 1900 and 71 did Monsanto offer to its customers or any other entity a place to

dispose of spent Askarel?

A. No.

Q. You had indicated that you would caution those that asked you or customers that you communicated to about proper disposal in the sense of avoid getting it into the environment, use a properly authorized landfill, act in accordance with local regulations. When were you communicating that sort of information? Beginning when?

A. Beginning in 1970.

Q. It would be part of your responsibility as manager of environmental control?

A. Correct.

Q. Do you know if there was any other person or group within Monsanto that communicated such information before you started doing it in 1970?

A. There was communication regarding the proper disposal of industrial chemicals but prior to 1970 the impact on the environment of PCB's was not known so I don't know of anybody that would have been in a position to give that kind of instruction like prevent it from getting into the environment. It was treated as an industrial chemical in the broad sense.

Q. In connection with treating it as an industrial chemical in the broad sense would the

directions have been to use properly authorized landfills?

A. Yes.

Q. Who would have been communicating that sort of information to customers of Monsanto?

A. Primarily the field salesmen.

Q. Was there an established or set piece of information that would be communicated? That is, did Monsanto say this is what you will tell them, in the sense of use a properly authorized landfill?

A. Are you asking was there a piece of paper on which this was distributed?

Q. I'll state it another way so that we understand each other.

I am aware because Monsanto's lawyers were kind enough to provide some technical information that we looked at earlier that Monsanto had established pamphlets or brochures about Askarel, its components, its properties and that sort of thing and I would assume that those were made available to the sales representatives in the field and it would be the source of information that would communicate to their customers.

A. It would be a source.

Q. Okay. And the field representative then

would have a document that he could look at that would give him a source of information to communicate to customers.

A. Certainly.

Q. So the question I'm asking now is was there an established piece of information or were there documents available to the sales representatives in the field that would contain information they would communicate to customers about disposal of industrial chemicals?

A. I recall some documents that addressed landfills. I do not recall specifically at what point in time and which documents. But I also know that the field salesmen would be brought to St. Louis and have training courses in which topics of this nature would be covered. This does not mean that he had in his hands a paragraph that he read but he was expected to learn something in these training courses and use that knowledge as he made his calls and if the issue was ever brought up during his discussions with the customer representatives.

Q. Now the documents that you can recall, are they before us here in the exhibits that we have marked?

A. I haven't had a chance to look through

all of these to look for that specific wording. It's that kind of document that I vaguely recall.

Q. Okay. The training courses that the field representatives would receive, I assume that they would be hosted by Monsanto, the teachers would be Monsanto employees?

A. Yes.

Q. And there would be a set topic or a set agenda?

A. There was an agenda that covered a broad range of topics.

Q. Was each field representative expected to attend training courses such as this?

A. Yes.

Q. Is it your information that in the course of these training courses that the salesmen would receive instruction, I'm sorry, the field representatives would receive instructions on proper disposal of industrial chemicals?

A. Yes.

Q. And it would be expected then that the field representative would have that information available to communicate to the customers he would deal with.

A. Yes.

Q. Do you have any idea of how long Monsanto would have been providing that information to its field representatives in the training courses? Forever or do you know?

A. From day one. 40, 50 years.

Q. All right. For as long as you have been connected with Monsanto was there an accepted protocol for dealing with industrial chemical waste in the trade or profession?

A. Yes.

Q. And did that involve the use of landfills, authorized landfills?

A. Yes.

Q. Do you know personally what it takes to make an authorized landfill?

A. I certainly don't know the details. I do know that prior to the establishment of the Federal environmental agencies this was in the hands of the local governments and most of them were, well they were either municipalities or county approvals that were obtained. Other than that I don't know the details. I don't know what standards had to be met but I do know that they had to have the local authority's approval to dispose of certain kinds of materials.

Q. But with respect to the standards that would be set for a landfill in terms of clay liners, that sort of thing, would you know those details personally?

A. Not for every state at that time, no. I do know there was a summary in one of the trade journals by state of what types of materials were permitted but that was available in 1970, that's why I remember that.

Q. But would it be fair to say that for as long as you have been connected with Monsanto it has been recognized that Askarel in terms of disposal prior to 1970 was treated as an industrial chemical?

A. Yes.

Q. To be disposed of as industrial chemicals were to be disposed of?

A. Yes.

Q. And the primary method of disposal was properly authorized landfill.

A. At that time, yes.

Q. And that information would have been communicated to the field representatives of your company either by documents such as the exhibits that we have seen or as part of their training courses.

A. That is correct.

Q. And it would be expected that they would communicate that information to customers.

A. Yes.

Q. Are you aware of the chemical properties or properties of Askarel?

A. I'm aware of some of them.

Q. Without going into a detailed discussion of its properties is it fair to say that it has a high order of stability?

A. I hesitate because I want to make certain that we don't confuse Askarels with PCB's. There are some components in the Askarels that don't have this high order of stability.

Q. Well then specifically the PCB's.

A. PCB, many of the isomers, which are the different related chemicals in that family, do exhibit high order of stability.

Q. Is it essentially inert?

MR. HALL: Are PCB's inert, is that the question?

A. I have a hard time answering that, it's a little bit subjective. Under certain conditions you might say it's not inert, that there are ways to conduct some chemical reactions with them. One of the obvious ones is just high temperature incineration,

that's a chemical reaction in itself. But I guess the best way to describe them is they are resistant to many chemical reactions that could take place in the environment.

Q. (By Mr. Terry) Do they have low volatility?

A. They do.

Q. And very low water solubility?

A. They do.

Q. Would it be fair to say that PCB's are persistent in the environment?

A. Yes. That's been demonstrated.

Q. And the PCB's generally are persistent?

A. Some of the isomers.

Q. And that is one of the reasons that Askarel was a desired or desirable fluid for transformers.

A. I don't know that that was the driving interest in them. The reason they were used in transformers is twofold, one is their resistance to flame, for fire and the other was their excellent insulating property, they do not conduct electricity. So those two characteristics are what made them so good for this application.

Q. And the fact that they retain those

properties because of their persistence.

A. I suppose one could describe it that way. I don't know that it's because of their persistence, it's their relative inactivity chemically. Their stability.

Q. I'm sorry, perhaps we're not communicating because you attach more significance to the term persistence than I do. Not so much, I don't mean to apply so much the persistence in the environment but the chemical properties of Askarel are maintained for a long time.

A. Under normal operating conditions, yes.

Q. And that is one of the reasons that Askarel was such a desireable fluid for use in transformers?

A. That is one of them, yes.

Q. Not only did it have low flame properties, not only were the dielectric properties desirable but the fluid was not subject to change under normal operating conditions.

A. That is correct.

Q. And therefore had a very long life, long useful life.

A. That's correct.

Q. And it is that long useful life of the

property that in another sense causes it to persist in the environment, it is not subject to change as other components are. Is that fair?

A. I have a hard time relating the environment with the many forces at play that are available compared to a fluid that's in a sealed container and about the only stress it undergoes is internal arcing, there's no oxygen, no bacteria, no other chemicals so I have a hard time comparing the two. They're different.

Q. Would it be fair to say that Monsanto recognized for as long as you had been aware that the chemicals in Askarel had to be properly disposed of whatever the standard for proper disposal was?

A. Yes.

Q. And that that was information communicated to the customers of Askarel?

A. Yes.

Q. And intended to be communicated to the customers of the customers of Askarel, be it General Electric's customers --

A. That was my understanding, yes.

Q. Were directions for proper disposal routinely communicated to customers of Monsanto?

A. Will you help me with the definition of

routinely? Is this once a week or with each shipment?

Q. Okay. We have not talked about the methods whereby Monsanto would communicate information to its customers and that's probably unfair.

I am aware that most of the customers of Monsanto for this particular product would be customers of long standing. General Electric, I assume that the business relationship between Monsanto and General Electric persisted for a long time.

A. Yes.

Q. So in terms of communicating information to General Electric it was unlikely that Monsanto would treat every sale as if it were the only sale.

A. That's a fair assumption, yes.

Q. And the same would be true with Westinghouse; correct?

A. Yes.

Q. But would it be, also be fair to say that at some point during the relationship that existed between Monsanto and customers of Askarel that one of the elements communicated to the customer would be that the product has to be properly disposed of?

A. Yes. That's one of the elements.

Q. And it would be intended by Monsanto that the customer then communicate that information to its

customers or end users of the Askarel.

A. Yes.

Q. Is it also fair to say that for as long as you had been with Monsanto the term proper disposal of Askarel meant authorized landfill, up until the time Monsanto put in place or put on line its incinerator?

A. Yes. And then later on of course the regulatory agencies laid down some more stringent guidelines.

Q. Setting aside the advent of the regulatory agencies would it be fair to say that during your time with Monsanto proper disposal of Askarel has always meant use of an authorized landfill? And that would be so that we understand each other a landfill that is proper under the governing rules of the particular jurisdiction?

A. Yes. But there was a period there where with the availability of incinerators, not only Monsanto's but commercial units, where the advice was strongly if it's a liquid you take it to an incinerator and only landfill solid waste contaminated with PCB's such as the saw dust that we used to clean up or the dirty coveralls the worker used and so on.

Q. When did, approximately, the notion that

PCB fluids or fluids containing PCB should be incinerated come in?

A. I would suggest that as far as Monsanto was concerned it came in when we were able to demonstrate that it was feasible to incinerate and this happened in about the middle of 1970.

Q. When you say feasible to incinerate what do you mean?

A. Well, up until then PCB's were looked upon as fire resistant and it was assumed that incineration might not be practical, might not be doable, it's only when our laboratories start working with different conditions of incineration they were able to establish that indeed you can do it when you reach the right temperature and the right amount of oxygen and keep the material in those conditions for a given period of time you can destroy it. So a burner had to be designed to do those things which was finally done in the middle of 1970 and Monsanto constructed the first unit capable of destroying PCB's.

Q. By combustion?

A. By combustion.

Q. Prior to that was it impossible to burn Askarel? Or was it considered impossible to destroy

PCB's by combustion?

A. It was considered that PCB's would resist combustion. This does not mean that someone out there didn't do it almost unknowingly if the right temperature was reached. But we found that anything less than about 1,600, 2,000 degrees Fahrenheit would not destroy all the PCB's.

Q. My understanding is that Askarel is not, is Askarel uniformly PCB's?

A. No. Askarels contain in some cases chlorobenzenes --

Q. Other components.

A. Other components.

Q. Now I understand when you're telling me that it was determined that PCB's could not be destroyed by combustion until the temperatures reached 1,600 to 2,000 degrees Fahrenheit but the question is could Askarel be burned or do you know?

A. I can only speak for the PCB component, unless that temperature was reached the chances were it couldn't.

Q. And escape into the atmosphere.

A. Up the stack.

Q. But would there be components in the fluid whatever they might be that would actually

combust, burn, as I would understand the term?

A. Yes. It is possible to have components that burn at lower temperatures.

Q. So while you could incinerate Askarel in the sense if it would burn you would not be incinerating or combusting or destroying the PCB's until you reached the desired temperature and conditions that Monsanto discovered in 1970?

A. That is my understanding, yes.

Q. Beginning then between '70 and '71 the recommendation would be if feasible to incinerate Askarel in order to destroy the PCB's using a properly designed and operating incinerator?

A. Yes.

Q. And if that was not available then you would go to the authorized landfill.

A. Yes.

Q. Prior to 1970 would the directions to customers then be to put it in an authorized landfill?

A. Yes.

Q. And then after 1970 or '71 Monsanto offered its own incinerator for those customers that chose to use it whenever yours went on line.

A. After our unit was in operation, yes.

Q. And for a fee you would burn stuff for

them.

A. Correct. And we were also in a position to be able to point to commercial units that were being erected or operated.

Q. Did you either personally or did Monsanto after 1971 make specific recommendations for particular commercial units?

A. After -- yes, starting about '72 or thereabouts we were able to refer to units.

Q. How did Monsanto --

MR. HALL: Excuse me, we were able to do what?

A. Refer to commercial units.

Q. (By Mr. Terry) How did Monsanto make the determination that a commercial unit could be referred to? Was there a certification process that you were aware of? Did you make your own independent assessment?

A. We made an assessment. I visited at least two sites and had engineers with me and we discussed the operation that was being offered and we were satisfied that they had the resources, the analytical laboratory and the unit to do the incineration, that they could do a responsible job and then we would be in a position to recommend that a

customer consider using those commercial units.

Q. Can you identify the commercial units that you assessed and discussed?

A. There was one up in Blasdell, New York, up near Niagra, and there was another unit outside Philadelphia in Gloster City. The one in New York I think was operated by Chem-trol, C-h-e-m, dash, t-r-o-l, and the one outside Philadelphia was the Rollins unit as I remember.

Can I take a break?

Q. Sure.

(RECESS TAKEN BY PARTIES.)

Q. (By Mr. Terry) Do you remember if there were any other commercial incineration units that Monsanto would recommend by name other than Chem-trol and Rollins?

A. In time we were able to recommend a unit up in Chesterfield, Illinois, I believe it was operated by a company known as Nuclear Engineering. Then the Pearl Company was able to start units in Baton Rouge, Louisiana and in Deer Park, Texas.

Those are the only commercial units that come to mind at the moment.

Q. It would be accurate to say that for so long as Ascholor was sold for use in transformers that

there would be spent or scrap Ascholor?

MR. HALL: You you mean Askarel?

Q. (By Mr. Terry) Askarel, I'm sorry. Askarel.

A. It was understood that after the liquid served its useful function and could no longer do it a decision had to be made whether it should be retreated and try to recycle it or it was untreatable and had to be disposed of. We understood that there would be occasions when there would be material that had to be disposed.

Q. Was it known -- excuse me.

(DISCUSSION HELD OFF THE RECORD.)

(WHEREUPON REPORTER READ FROM THE RECORD AS DIRECTED).

Q. (By Mr. Terry) Were you aware that there would be PCB's or Askarel in solid scrap?

A. Certainly.

Q. And that the solid scrap had to be handled in such a way that the PCB's were extracted before disposal of the solid scrap.

MR. HALL: Did you say extracted?

MR. TERRY: Yes.

A. I'm not aware of any requirement in that period of time in which solid material, an example being saw dust with PCB's in it, had to be extracted

before you could dispose of the saw dust.

Q. (By Mr. Terry) I'm thinking in terms of transformer, if a transformer was going to be scrapped the liquids had to be extracted before the transformer was scrapped; is that right?

A. I am not familiar with the procedure used in the scrapping salvaging operation. I'm aware that the unit has to be drained and all the free fluid collected and I'm aware that there are metals inside, steel core and core windings and then occasionally there are either plastic or wood blocks to support the internal parts.

I forgot your question now.

Q. Okay. In connection with scrapping of transformers were you of the opinion that the fluids would be drained from the transformer before it was scrapped?

A. You mean the user of the unit before he transferred it to the salvage yard would drain it?

Q. Without discussing who was responsible for draining the fluids.

A. Eventually if you're going to get to the inside it has to be drained.

Q. And that the fluids inside the transformer had to be treated as an industrial

chemical in terms of the method that they should be disposed.

A. That is correct.

Q. And that the same procedure for disposing industrial chemicals had to be followed for the fluid extracted from the transformer when it was scrapped.

A. Yes.

Q. Now --

MR. HALL: Excuse me. Would you mind reading that last question back please?

(WHEREUPON REPORTER READ FROM THE RECORD AS DIRECTED).

Q. (By Mr. Terry) In terms of the method of disposing of transformers, the proper method of disposing transformers, Monsanto would not instruct manufactures of transformers how to do that would you?

A. No. We were not in a position to offer any advice along those lines.

Q. But Monsanto did instruct people on how to dispose of the fluids.

A. Of the PCB's.

Q. Okay. The PCB's that were a component of the fluid.

A. In those units that had PCB's. There is mineral oil also in transformers.

Q. I'm sorry, that was overly broad.

In terms of those transformers that used PCB's or Monsanto fluid that contained PCB's you would instruct on the proper disposition of the fluids.

A. To the customer of Monsanto, yes.

Q. When did you become aware that there was a health hazard associated with PCB's?

MR. HALL: Do you mean when did Mr. Pappageorge individually become aware of that?

MR. TERRY: Yes.

A. I was made aware that the material could affect the health of people starting in about 1955 when my workers had to be certain that they didn't get their hands in it and kept it there too long or to breathe any fumes, those kinds of things. I was aware that there can be a health effect.

Q. (By Mr. Terry) You mentioned two methods of absorption, one would be skin contact and the other would be inhalation.

A. That is correct. Because there's ingestion also but that would be unlikely.

Q. Unlikely your workers would be eating it.

A. There was some concerns about dirty hands, eating a sandwich or a candy bar.

Q. Other than accidental ingestion?

A. Right.

Q. Beginning in 1900 and 55 when you became aware that there was a health hazard and that the methods of absorption that you needed to be concerned about were skin contact and inhalation what was the nature of the health hazard that you were concerned about?

A. Depends on the degree of exposure, how much material. I was tuned in really to the early warning symptoms that would prevent serious harms and the early warning symptoms were two: the one relating to breathing is the feeling in the chest similar to a severe chest cold with coughing and painful breathing. That tells me the worker was exposed to too many fumes, he should have been wearing his respirator when he's performing whatever it was he was doing.

The other early warning symptom was the chapped skin effect, the skin looked like chapped hands from having the skin exposed to PCB's. That told me that the worker should have worn protective gloves and -- if I paid attention to those two early warning symptoms it would avoid any serious effect with over exposures of greater magnitude.

Q. What did you understand the serious effect to be?

A. The ultimate one of course is death,

liver damage. But that occurs at very, very high exposure levels.

Q. Any other long term consequences of exposure that you were aware of back in 1955?

A. Liver damage was the long term. There was a secondary skin symptom that I personally never saw and that's chloracne. That would have been another checkpoint in terms of gauging over exposure. But chloracne, I have the understanding that it's a temporary condition, eventually when a worker is withdrawn from that environment it clears up.

Q. Did you know in 1900 and 55 to '58 when you were supervising the electricians whether or not there were threshold limit values for PCB's?

A. Yes there were. In about '50's, yes.

Q. And did Monsanto have in place a system for determining whether or not the workers were exposed to threshold limit values?

A. We would check the amount of material -- and this has to do with amount in the breathing air -- we would check that on a random kind of basis by the plant industrial hygienist and determine the amount of PCB's in the air near the job site and unless the practice is changed there was no need to remeasure it as long as it was acceptable, low enough.

Q. So in your capacity as a supervisor you would rely both on the industrial hygienist who advised you that the air quality was satisfactory by the then established threshold limit values and you would watch your own workers to see if there were any of these signs that you mentioned, chapped hands or breathing difficulty?

A. Yes.

Q. When did you or do you have an opinion as to whether or not PCB's are carcinogenic?

A. I have an opinion, yes.

Q. And what is that opinion?

A. My opinion is that they are not human carcinogens.

Q. Are you aware of any studies that indicate they are?

A. I have never read a report that describes such a study for human effect.

Q. Do you have an opinion or has your opinion about the health hazards associated with the PCB's changed at all from 1955 to the present?

A. No.

Q. So as far as you are concerned the state of information available concerning PCB's effect on the health of human beings exposed to it has remained

pretty constant since 1955?

A. Yes.

Q. And so the information at least in your opinion that is presently available about the health effects on human beings from exposure to PCB's is the same as it was in 1955?

A. Correct.

Q. And in 1955 Monsanto knew as much as it knows now about the health effects on human beings from exposure to PCB's?

A. I have a hard time with knowing as much now. We know more because more studies have been done but the effects noted from these studies have not changed the original premises that were based on fairly limited studies back in the '50's.

Q. Okay. So while the base data is much larger now than it was then the conclusion in terms of what health hazard is actually posed to human beings from exposure to PCB's is the same now as it was then.

A. Yes.

Q. And the significance of the health hazard from human beings exposed to PCB's is the same now as it was back in 1955.

A. That's my understanding.

Q. Has the level of concern about health

hazards to human beings associated with PCB's changed as far as you can tell?

MR. HALL: You mean generally or in Monsanto or what?

Q. (By Mr. Terry) Well, I'm asking for your perception and if you need to qualify it in terms of generally or within Monsanto I can understand that.

A. The concern has always been there. I don't know that we're any less concerned now or then. We still say these are industrial chemicals, if abused or misused you can hurt people, and if you follow our instructions you will not see any health effects.

I don't know how else to put it.

Q. Okay. So at least as far as you personally are concerned, or are aware, the level of concern or worry about health hazards associated with exposure to PCB's is the same within Monsanto now as it was back in 1955?

A. Yes.

Q. Was that worry or concern about health hazards associated with exposure to PCB's communicated by Monsanto to its customers?

A. Well, the instructions regarding voidance of vapors and skin contact were based on that concern. I don't know that the word concern itself appeared in

any communication to the customers.

Q. I appreciate the heading would not be by the way we're really worried about this, but if a corporation is concerned about health hazards they would communicate adequate instructions for safe use of the product, warning concerned with improper use about what could happen to customers.

A. That's right. This reflects the concern.

Q. Did Monsanto do that?

A. Yes.

Q. And in your opinion were the instructions Monsanto communicated to its customers for safe use of the product adequate?

A. Yes.

Q. And had they been adequate since 1955?

A. Yes.

Q. Were the warnings communicated by Monsanto of risks associated with improper use in your opinion adequate?

A. Yes.

Q. And were they adequate from 1955 until Monsanto ceased selling the stuff?

A. Yes.

Q. And this information would be communicated by Monsanto to its customers.

A. Yes.

Q. And as that information pertains to PCB's Monsanto would be aware that it was the primary source of such information to its customers.

A. Yes.

Q. Because Monsanto was at least in this country the sole supplier of PCB's.

A. Well I hesitate because there's some indication that some PCB's were imported so can you stick the word sole in there as the principle supplier.

Q. I'm sorry. Within the continental United States Monsanto was the sole domestic source of PCB's.

A. Correct.

Q. If there were any other PCB's manufactured outside the country, imported into the United States, you don't know particularly one way or the other do you?

A. That is true.

Q. In terms of domestic supply, manufactured in this country, Monsanto was the sole supplier?

A. As best as I could determine, yes.

Q. So in terms of information available, instructions of safe use, warnings for the consequences of improper use to the customers of

Monsanto as it relates to PCB's Monsanto would be the primary source.

A. Yes.

Q. Would Monsanto anticipate that its customers would communicate that information to end users?

A. Yes.

Q. So that the end users would have the information necessary to know how to use the material properly and the risks associated with improper use as it pertains to health hazards?

A. That was the intent, yes.

Q. In your opinion did Monsanto have a responsibility to see to it that the end users of PCB products had information concerning safe use and warnings of the consequences of improper use?

A. No. I don't believe Monsanto was in any position to assume that kind of responsibility not being involved in the distribution, the designing equipment, whatever else might have been added to it after it left our plant.

Q. Perhaps I'm not making myself clear. I do not mean to imply that I am asking you whether or not Monsanto had the responsibility to deal directly with the end users to communicate the information

because as we have discussed earlier you may not have known who they were and your customers would rather you not deal directly with their customers.

A. That's true.

Q. In terms of however Monsanto providing information, instructions for safe use and warnings concerning hazards to its customers and directing or suggesting that its customers communicate that information to the end users Monsanto recognized that it was important that the end users had the information; correct?

A. Certainly.

Q. And while you would not deal directly with the end users Monsanto would take steps to see to it that the information was available to your customers and that they were urged to communicate it to the end users.

A. That is true.

Q. Because when Monsanto as the sole domestic supplier of PCB's recognized that they had the responsibility for getting that information, instructions and warnings, out to people.

A. That is true.

Q. And Monsanto relied on its customers to communicate that information to end users.

A. Yes.

Q. Do you know or have an opinion as to whether or not your customers did in fact communicate that information to end users?

A. I have an understanding based on some observations and comments that I was exposed to through the years, I was personally involved in reviewing documents, drafts of documents prepared by General Electric and Westinghouse in which this kind of information was mentioned. I have no way of knowing what the final draft looked like but there's every reason for me to believe that something close to the draft I saw was mailed or sent or delivered to the customers of those two Monsanto customers.

Other than those two definite examples I do not have any information regarding what other Monsanto customers relayed to their customers.

Q. Okay. When did you do this work that you have described with GE and Westinghouse?

A. It was in 1970.

Q. Prior to your work with General Electric and Westinghouse are you aware of anyone else within Monsanto that did the same kind of thing with customers? That is assist them in the preparation of information?

A. I am personally not aware. That doesn't mean it didn't happen. I don't know.

Q. Are you aware of any attempt made by Monsanto to determine if the customers of your customers, that is the end users actually dealing with the PCB's, were receiving the information that you communicated to your customers in terms of instructions for safety, use and warnings for the consequences of improper use?

A. I do not know.

Q. Would you agree with me that it was reasonably foreseeable for Monsanto that the end users of the PCB's would need information about safe use or warnings about the consequences of improper use?

A. Well, it depends on the situation. I can see where if our customer, if Monsanto's customer --

Q. I'm sorry, you're getting ahead of me. I'm not asking about, I'm not asking you to evaluate at this particular time right now whether or not the customer, Monsanto customer, is actually communicating or failing to communicate information.

A. I understand.

Q. Would you agree with me that Monsanto could foresee that it was necessary for the end user to have information about safe use, warnings for

improper use without regard to source?

A. That would depend. There are situations where the supplier of the electrical equipment also provides services so that the ultimate owner of that piece of equipment has nothing to do with it.

Q. Like the Holiday Inn fellow.

A. Yes.

Q. Okay.

A. The GE Corporation has roving teams of service people that pull up to the unit and do what's appropriate. So I can see where the Holiday Inn manager has nothing to do with that transformer sitting outside the room that you're occupying.

Q. Apart from situations where the end user is closer to a consumer as I would be a consumer of electricity, and I don't have any earthly idea of what happens on the other side of the wall plug, have never, ever looked, of course it scarce me to death, but in terms of a consumer, apart from an end user who's essentially a consumer, there are other end users who are not, who actually deal with the equipment themselves. You understand that?

A. Yes.

Q. That class of end user who actually deals with the equipment itself, for that class of end user

is it fair to say that Monsanto was aware that that class of end user needed information about instructions for safe use or clarification for the consequences of unsafe use of PCB's?

A. Yes.

Q. And Monsanto realized that the primary source of that information was itself.

A. Yes.

Q. And Monsanto made the decision to rely on its customers to communicate that information.

A. Yes.

Q. Monsanto was aware that that kind of information was necessary not only for the equipment containing PCB's while in operation but that kind of information was necessary for disposal of PCB's.

A. Yes.

Q. And again Monsanto made the decision to communicate that information to its customers and relied on them to communicate it to the end users.

A. Yes.

Q. We have before us some literature --

(DISCUSSION HELD OFF THE RECORD.)

(LUNCHEON RECESS TAKEN BY PARTIES.)

Q. (By Mr. Terry) Mr. Pappageorge, you were identified by Monsanto as a person that I should

request to take the deposition of and in connection with that I served on the attorneys from Monsanto a subpoena duces tecum or a request that certain documents be provided.

Did you personally have anything to do with the assembling of the documents that have been provided?

A. No.

Q. I had asked Monsanto to produce all documents relating to directions, instructions and/or warnings supplied by Monsanto Company to customers, known users and others concerning use, disposal of and health hazards associated with the use and disposal of dielectric fluids such as Askarel containing PCB's from 1930 to the present. And this is the material that they gave me. Okay?

A. Okay.

Q. Can you find for me the warnings and instructions connected with disposal that Monsanto supplied customers?

A. I'll try.

Q. Okay.

A. (Reviewing Document).

Q. And by the way so the record is clear, by this material it is the material that the court

reporter has previously marked as discovery exhibits to your deposition.

A. (Reviewing Document).

MR. HALL: Mr. Terry, to be sure that you're clear on this and I'm clear on it it's my understanding that these documents were produced to you by Mr. Ben McDonald; is that correct?

MR. TERRY: May we go off the record?

MR. HALL: Sure.

(DISCUSSION HELD OFF THE RECORD.)

(WHEREUPON REPORTER READ FROM THE RECORD AS DIRECTED).

A. I've looked through the -- wait a minute, I've got to look through these yet. (Reviewing Document).

In response to your question I have looked through the documents that have been submitted, I find no specific reference to the use of authorized landfills. I do find in a few of these documents the cautionary words that convey to the reader the fact that these materials should not be introduced into the environment. Those words appear on the copy of the label, Exhibit --

Q. (By Mr. Terry) Would you pull out the ones where you find the words sir?

A. All right.

Q. You don't have to tell me what they are yet, just pull them out and set them aside.

A. All right.

These are the documents that I see.

Q. The first one you have identified as Discovery Exhibit No. 5 which is a letter from you entitled Dear Sir. And I assume that you're making reference to the statement:

"We wish to strongly re-emphasize with you the importance of avoiding direct or accidental PCB contamination of feed, food and packaging material and of preventing PCB's from escaping into the environment."

A. Yes.

Q. And this was a letter prepared by you in April, 1900 and 72?

A. Yes.

Q. To whom was it given?

A. To all customers on record with Monsanto for the previous three year period or more.

Q. You make reference to extreme care as taken in the handling, use, storage and disposal of these materials in this letter.

A. I do.

Q. Prior to 1900 and 72 had Monsanto ever

delivered to its customers that kind of direction or warning?

A. Yes.

Q. When?

A. Starting in 1970 as best I recall.

Q. And how was that done?

A. There was a letter addressed to the customers on record mailed in February of 1970 and starting in May of 1970 that information was included on the labels of the products.

Q. But the letter from 1970, the other one is not here?

A. I have not seen it here, no.

Q. Nor are the labels that contain the same directions?

A. There's a copy of a label here.

Q. Okay. We'll get to those later.

Were there any directions or amplification or instructions given in connection with the use of the term extreme care and disposal or any reference to any accepted procedure or protocol for extreme care and disposal?

A. No. That was left up to the judgment of the owner of the liquid and his resources.

Q. Just use extreme care to avoid letting it

into the environment.

A. Right.

Q. Anything in that letter that indicates that extreme care should be used in disposal to avoid injury or risk of injury to humans?

A. Not in those words, no.

Q. Any suggestion or indication that improper disposal can result in injury to humans?

A. In this letter?

Q. Yes.

A. No.

Q. But it is true that improper disposal can result in injury to humans?

A. Coupled with other actions by humans. It's not just the disposal itself, something else must take place to get the human in contact or exposed.

Q. But if the term improper disposal includes disposal other than as is proper for an industry chemical or other than is proper for PCB's there is a risk of exposure to humans is there not?

A. There is a risk. I don't know how to measure it.

Q. And when you have that risk of exposure of the PCB's to humans there is a risk of injury. Is there not?

A. Yes.

Q. So it is fair to say that it is foreseeable to Monsanto that if the material is improperly disposed of there is a risk of injury to humans.

A. Yes. As I said but I don't know how you would measure that. The risk is not in my opinion great.

Q. I understand that you may quantify it as a slight risk but there is a risk is there not?

A. Yes.

Q. And it is fair to say that it is reasonably foreseeable to Monsanto that if the material they sell is not properly disposed of that there can be people who are hurt.

A. It's possible.

Q. And that is one of the reasons that you advise your customers to dispose of the material properly.

A. That's yes, one of the reasons.

Q. You have also selected Discovery Exhibit No. 8 and folded it open to Page 18.

A. Yes.

Q. What is Discovery Exhibit No. 8?

A. This is a copy of a product bulletin, the

title, The Aroclor Polychlorinated Polyphenyls.

Q. What is the date that was prepared?

A. As best as I can tell it's August, '71.

Q. Is there an earlier publication that accomplished the same result?

A. There were publications describing the use of these materials as dielectrics, some of them we've looked at here. (Indicating). But there was no publication that was exactly in the composition as this document. This is a little more detailed.

Q. So the document that we are looking at is not an update of an already published document.

A. Not to my knowledge, that's correct.

Q. But represents a new document created by Monsanto in 1971.

A. Yes.

Q. And it did not, so that I understand, it did not replace an existing document that you were using for the same purpose.

A. That is correct.

Q. Now what is it on Page 18 that you had referred to?

A. Page 18 is devoted to the, subject matter at the top: Proper Handling Of PCB's By The Electrical Industry To Avoid Environmental

Contamination.

Q. May I see that?

A. Sure. (Indicating).

Q. Are you referring to the entire substance of this page?

A. As far as the title I just read, yes. And I'm referring in terms of proper disposal the precautions are here.

For example the fourth paragraph down it starts off:

"Therefore it's essential to do all that is possible to avoid environmental contamination with PCB's."

The next paragraph:

"PCB's must not be introduced in any waters or marine areas. Spills or leakage must be contained."

Then it goes on to describe the availability of incineration for liquid waste and then -- that's about it.

Then it says call Pappageorge if you have questions.

Q. And this would be distributed to the customers?

A. Yes.

Q. And that, the reference to the incinerator is, at the time of that publication you have your incinerator on line and you will take care of used fluids for customers.

A. True.

Q. At the rate of three cents per pound.

A. At that point yes, three cents.

Q. Isn't that what it says there?

A. (Reviewing Document). Yes. It does.

Q. Any specific directions in that discovery exhibit that you're looking at about how the customer is supposed to dispose of used fluids containing PCB's if they don't send it to Monsanto?

A. Well there is the reference to, the expression several others provide facilities for proper incineration and destruction so that would indicate that there are other incinerators in addition to Monsanto available.

Q. And they would be the two that you identified earlier, I assume, Chem-trol in New York and Rollins?

A. Those two come to mind. There may have been others that I don't remember.

Q. Anything else that tells, in that instrument, that tells the customer what he's supposed

to do with used fluids if he doesn't send them to Monsanto?

A. That's all it says.

Q. Just don't let it into the environment.

A. Correct.

Q. You also pulled Discovery Exhibit No. 3 which says that Monsanto will burn it at the rate of three cents per pound.

A. Yes.

Q. Then you have -- anything else in there about disposal on that exhibit?

A. That's it.

Q. You gave me Discovery Exhibit No. 4 which again says you all will burn it at the rate of three cents per pound.

A. And also includes the reference to -- well, the sentence we talked about earlier, extreme care should be taken to avoid entry, it's on that label.

Q. When was that published?

A. This label? '71.

Q. And you gave me No. 2 which I assume is the same.

A. It's the same except that No. 2 was used with No. 3 because the incineration statement was not

imprinted on this label.

Q. And it is on this.

A. It is on the subsequent printing.

Q. Okay. Anything that you can show me that predates 1971 where Monsanto gave directions to its customers about proper disposal?

A. I don't see them here and as I said earlier I vividly recall reading some bulletins in the 1950, 1960 time frame but I just do not remember the specific time nor the specific bulletin. But there were references to, I remember a reference that's implied, don't just spill this in the back yard kind of statement, those aren't the exact words. There were references to proper disposal in authorized landfills, I remember those very vividly.

Q. Now do you know where those are today?

A. I can only assume they're at the law department at Monsanto as the custodian of those documents if they're still around. I don't know.

Q. The documents that you remember seeing that are not here today, do you know to whom they were given?

A. Just like the documents we saw, they were given to the customers of Monsanto either by the sales representative or by direct mailing or when they

visited the offices of Monsanto or their clients they would be given copies unless they already received one.

Q. Is it your testimony and can you testify that publications that Monsanto has not produced contained instructions about proper disposal of fluids containing PCB's manufactured by Monsanto and were in fact delivered to customers?

A. That's my understanding, yes.

Q. Do you have any personal knowledge that that occurred?

A. Can you help me with the word personal?

In other words did I give the document to a customer? No.

Q. For example did you say to the field representatives make sure they get this or did you participate in the training courses that said listen, you guys make sure that the customer gets this. We are concerned about these fluids escaping into the environment, make sure then proper disposal is required. Did you do anything like that?

A. I did all of those things starting in 1970.

Q. I understand that.

A. But prior to that I was not involved.

Q. Do you understand that that was done by others?

A. That is my understanding.

Q. Who might those others be that would do that?

A. Well certainly all the field salesmen and there were many, many of those. Mr. Benignus was the key individual in all of this. I would suggest that he might have even been the author of such a document that I have in mind.

I don't know what else to add except that in my involvement with the activity and Mr. Benignus I was left with the vivid understanding that these materials were supposed to be responsibly handled. At no time was anybody instructed to dump it down the sewer for example.

Q. Now in the material that you did extract from the documents produced by Monsanto that we have identified and set apart in a separate pile, in those materials it is apparent that Monsanto is concerned that the customers use extreme care in proper disposal.

A. That is the intent behind the statement, yes.

Q. And in fact the words extreme care are

used.

A. Right.

Q. And I understand from our earlier discussion that the same level of concern that existed after 1971 existed before; is that correct?

A. Not quite. Until Monsanto had information that PCB's could be an environmental problem the material was perceived to be typical of many industrial chemicals, treated with respect but it doesn't require the extreme care, the terminology we finally used after we learned more about presence in the environment and potential harm to the environment.

Q. Would it be fair to say then that the information communicated in 1970 or '71 represented a departure from the information communicated earlier?

A. Yes. It was a departure.

Q. Did Monsanto have more concern about PCB's after 1970 than they had had earlier?

A. Certainly.

Q. And was that heightened concern communicated to customers?

A. Yes.

Q. When did Monsanto become aware that it was necessary to communicate to its customers heightened concern?

A. I would suggest -- this is an evolving kind of concern -- so I would suggest that it became a consensus of the managers in Monsanto in late 1969 and was accomplished by the February, 1970 letters.

Q. What was it that had caused this change in the level of concern in 1969?

A. It was the identification of some of the PCB's by reputable laboratories of small amounts of PCB's in the environment in samples that were not necessarily industrially related which was totally new to Monsanto. We didn't expect that an industrial chemical would end up in pine needles in Sweden for example or in infants' hair in Stockholm where the initial studies took place. Followed by that report we got reports that some birds -- now these were allegations as distinguished from proven scientific data -- that some birds were being harmed by PCB's and that their reproduction was being affected. That was covered by several laboratories in '68, '69, '70. Later it was demonstrated it was DDT that was the culprit but not PCB's but anyway in 1970 we assumed PCB's were the culprit therefore it heightened our concern.

There were reports that fish were taken out of the Great Lakes and analyzed and PCB's were

found. There it was a matter of presence, there was no reported connection between a harm and presence. There was a report out of the Government laboratories in Gulf Breeze, Florida that tests with juvenile shrimp, young shrimp, showed that they were very sensitive to PCB's in the water.

It's that kind of information that heightened the concern on the part of Monsanto.

Q. Would it be fair to characterize that kind of information as information that there was a level of PCB's in the environment generally as apposed to confined to industrial locations?

A. I don't know that PCB's have been --

Q. I'm not saying --

A. -- determined as generally present. There are spots. In most cases these spots I'm going to call them are associated with industry. There are a few examples like those I mentioned in Sweden that we've never been able to associate with industry, where one can speculate where the PCB's came from.

Q. Now the first report you mentioned was the one coming out of Sweden that reported the presence of PCB's in samples of human tissue or hair.

A. That was one of their studies, yes.

Q. That came to the attention of Monsanto

about 1968 or '69?

A. Let me think. I'm going to say 1967.

Q. Prior to the study from Sweden that came to the attention of Monsanto in 1967 had Monsanto received, to your knowledge, any information from any source indicating the presence of PCB's in an unexpected place?

A. No.

Q. The reports that you identified about the birds, those were eventually determined to be the result of exposure to DDT.

A. Yes.

Q. But the other reports that you mentioned, the one coming out of the Great Lakes and the young shrimp in Florida, those are PCB's.

A. Yes.

Q. Did those reports indicate the presence of PCB's in the fish or in the water? In the shrimp or in the water?

A. The Great Lakes samples were PCB's in the fish. No one could tell us where the fish had been, up what streams and found their way into the Great Lakes. No one knew what the fish had been exposed to. The shrimp were done in a laboratory setting where the water was deliberately contaminated and I guess the

shrimp have eggs or whatever it is, anyway they hatched the young shrimp and the young shrimp didn't survive.

Q. The study on the Great Lakes, the fish, about when was that that it came to the attention of Monsanto?

A. We started hearing about those in 1969. And there was a meeting held in Duluth, Minnesota in March of 1970 at which all this was summarized.

Q. On the basis of information available to Monsanto beginning in 1967 until 1900 and 70 of the same character as the studies that you have identified coming out of Sweden and the fish in the Great Lakes, did Monsanto conclude it was necessary to advise its customers to use extreme care in disposal?

A. That was an important factor, yes.

Q. Why did you conclude from studies in Sweden and Great Lakes fish to advise customers to use extreme care in disposal?

A. Well, we wanted to make certain that the materials were handled responsibly and we believed by using strong language like the use of the word extreme was more likely to get the attention of the reader of the label or the memoranda that he received and we felt that this was one way to communicate and get some

responsible, favorable behavior, on the part of the customer.

Q. Did you conclude or assume that improper disposal or irresponsible handling had resulted in contamination evidenced by the study in Sweden and the fish in the Great Lakes and others?

A. We frankly speculated that it was the PCB's that got out of control, that found their way into these samples. Just which use contributed the PCB's to the environment we at that time really didn't know. So we felt that advising everyone who bought it from us to do whatever they could to prevent it getting in the environment would be a responsible and important first step to controlling further contamination of the environment.

Q. Did Monsanto conclude that improper disposal was a likely or probable cause of contamination in the environment as reflected by the study in Sweden and the Great Lakes fish?

A. The study in Sweden was very difficult for us to evaluate primarily because some of the samples like those I talked about earlier we could not associate with an industrial application and we really didn't know enough about the Swedish industries to make even a reasonable guess.

The Lake Michigan we did speculate that some of those PCB's must be coming from some factory somewhere. Not necessarily right up close to the Great Lakes but on some water system that eventually ended up in the Great Lakes.

Another thought was that the use in what we eventually called the open uses, when finally disposed and I have in mind as an example the carbonless copy paper, when it hit the waste basket and was sent to say a city incinerator we speculated and to this day have no real scientific data that much of the PCB's went up the stack into the atmosphere, carried around the world almost and then rains, it ends up in the pine forests of Sweden and this is how it's conceivable that the pine needles shows a PCB.

I would emphasize this is all speculation. No studies have ever been designed to demonstrate this.

Q. I understand from your answer that Monsanto concluded that if a product containing PCB were incinerated in a normal fashion, in a regular incinerator for paper for example, that that kind of combustion would be inadequate to combust the PCB's.

A. That is correct.

Q. Because that kind of incineration would

not have the temperature, 1,600 degrees to 2,000 degrees Fahrenheit you mentioned.

A. Not normally.

Q. Probably not have the specific conditions that Monsanto determined were necessary for combustion.

A. That is correct.

Q. So normal incineration the PCB's would simply go up the exaust stack and be disbursed.

A. That's my understanding.

Q. It would appear to me then that Monsanto concluded that improper disposal of PCB's was a likely or probable explanation for PCB contamination found in the place where you would not otherwise expect it.

A. Yes.

Q. And as a result Monsanto modified the information communicated to customers who dealt with PCB's.

A. Yes.

Q. Used the term extreme care as apposed to care for example?

A. That's an example, yes.

Q. Would you agree with me then that the instructions given before 1970 were not adequate?

A. Were not adequate for preventing PCB's

getting into the environment.

Q. Were not adequate to communicate to the users the necessity for proper disposal of PCB's?

A. Well I have trouble with the word proper. The word proper in 1960's was different than it is today. The technology has changed, the knowledge has changed.

Q. But with respect to Askarel the technology has not changed beyond the use of an incinerator designed by Monsanto; correct?

A. True. But the incinerator was not available in the '60's.

Q. Right.

A. So we had to say use a landfill.

Q. That's right. And after 1970 to the customers of Askarel you said use extreme care. Correct?

A. To prevent it entering the environment.

Q. Right. Use extreme care in disposal; correct?

A. And use, handling, all the steps. Shipping. Extreme care every step.

Q. But with respect to disposal Monsanto elected to exchange the information communicated and said now, beginning in 1970, they said use extreme

care did they not?

A. True. But not just disposal now.

Q. I understand that.

A. I know you're interested in disposal but this applied to every step of the process of manufacturing, shipping, using, and finally disposal.

Q. On the basis of that is it fair to conclude that in 1970 Monsanto concluded that the level or the kind of instructions given at that time were not adequate?

A. For which period of time?

Q. Prior to 1970. Did you conclude that the instructions you were then giving were not adequate and needed to be changed?

A. They were adequate to satisfy the knowledge available at that time.

Q. Why did you change them then?

A. Because new information came by that told us review your practices and as we reviewed them we decided more must be done. You can only act on information. If there was no information in 1960 that PCB's were a problem disposal and landfill is still responsible, perceived to be responsible.

Q. Disposal in an approved landfill is still responsible isn't it?

A. Not today I don't believe, no.

Q. Was it in 1970?

A. 1970? From Monsanto's viewpoint it was limited to those materials that could not be incinerated. In other words none liquid waste could be sent to a landfill.

Q. But the liquid waste had to be incinerated?

A. That was our strong recommendation. We had no authority to enforce it.

Q. Where was that strong recommendation communicated to the customers? Because the only thing I've seen so far is Monsanto says we'll burn it if you want at three cents a pound. Where was the strong recommendation communicated to the customer?

A. I know I've told many a customer over the phone, I know I wrote many a memo or letter in response to a question in which I indicate that, the conditions of burning and so on. I recall putting together a document in which it listed some thoughts I had on how to handle liquid waste, solid waste -- I forget the third category, just some suggestions as sort of a guideline to disposal.

Q. Where is the guideline to disposal? Do you know?

A. I don't know where it is today.
Q. Was it communicated to customers?
A. Yes.
Q. Which customers was it communicated? Those that asked or all of them?
A. I'm sorry?
Q. Who got the guidelines to disposal?
A. I can't tell you specifically but I do know that stacks of these were sent to the field representatives and he would as he made his calls leave them. I do know that we went some in response to self calls and letter inquiries. I don't remember if a general mailing was made. I don't remember.
Q. And you prepared the guidelines to disposal?
A. Yes.
Q. And when did you do that?
A. I'm going to say 1971.
Q. Had there been any prior guidelines to disposal that you're aware of?
A. Not of that type, no.
Q. Of any type dealing with PCB liquids?
A. As I said earlier I recall some bulletins describing the Askarel use in which reference was made to disposal in authorized landfills. That's the

closest thing that I recall that resembled a guideline to disposal.

MR. TERRY: Mr. Hall, may I speak with you for a moment?

MR. HALL: Sure.

(DISCUSSION HELD OFF THE RECORD.)

Q. (By Mr. Terry) I'm trying to ask you to recreate for me the thought process that you and other individuals in the company went through that led to this change in emphasis that is identified in the exhibits that we do have. Are you with me?

A. I think I am, yes.

Q. Where you went from care in disposal to extreme care in disposal. Okay?

A. Yes.

Q. Now it would appear to me from that that it was decided that the disposal of fluids containing PCB's was not being done well enough or may not have been done well enough that disposal of fluids containing PCB's was a likely or probable explanation for the presence of PCB's in the environment that you were learning of at that time. Is that a fair statement?

A. Yes. When you say probable source, yes.

Q. And you and I had discussed earlier and I

am aware that Monsanto did not conduct an in-department investigation to determine the disposal practices of the ultimate users of fluids containing PCB's; correct?

A. That is correct.

Q. But Monsanto did make a determination that it was necessary to emphasize more strongly than they had in the past the necessity for proper disposal of fluids containing PCB's.

A. Starting in 1970, yes.

Q. Is it fair to say that Monsanto made the decision then that the instructions for disposal and the warnings of risks associated with improper disposal were not, that were being given at the time, prior to the change, were not adequate to accomplish the desired result, proper disposal?

A. Based on our new knowledge they were not adequate.

Q. Would it be fair to say that in your opinion the information that had been communicated earlier was sufficient information to result in proper disposal but simply lacked emphasis?

A. That is a highly probable contribution to the PCB's being found in the environment is this lack of emphasis, it's a highly probable source of the

problem.

Q. All right. Now this lack of emphasis on proper disposal techniques, do you have an opinion as to whether or not generally speaking users of industrial chemicals did not properly dispose of chemicals?

A. I'm in no position to know all of the industrial chemical users. I can accept the concept that there were some that did not handle industrial chemicals in a manner I would call responsible. It would not surprise me if some of that did not go on.

Q. Do you have an opinion as to whether or not if the fluids containing PCB's used by or used for transformers had been properly disposed of in accordance with accepted practices existing from '55 to '70 that those practices would have prevented the PCB's contained in those fluids from escaping into the environment generally?

A. Yes.

Q. And what is that opinion?

A. I'm sorry, you said that the practices --

Q. The question was do you have an opinion and you said yes.

MR. HALL: You do have an opinion, he's asking what is the opinion.

Q. (By Mr. Terry) I'm sorry, I remember the beginning of the question.

A. If the user of these Askarel fluids containing PCB's had exercised practices or handled the material as we do for industrial chemicals generally PCB's would not have entered the environment to the extent that there would be an effect noted and unless the sample is taken very, very close to the site the chances are in my opinion they would not have been detected in the general environment.

Q. Do you have an opinion as to whether or not burning or causing the combustion of Askarel fluid in any matter other than the Monsanto incinerator variety effectively destroys the PCB's; burns them, combusts them?

A. I have an opinion, yes.

Q. And what is that, sir?

A. It is my considered opinion that exposing PCB's to temperatures less than the 1,600, 2,000 range we talked about earlier and without enough oxygen present and without keeping the material at that temperature for the time period required, I would suggest that a few of the PCB's might be destroyed, especially those with very little chlorine attached but the majority of the PCB's would be evaporated,

volatilized and would end up with the stack gasses.

Q. And go the same place.

A. Go out into the atmosphere and I don't know where they'll end up then.

Q. But you wouldn't want to be downwind would you?

A. Not voluntarily, no. Depends again on the concentrations.

Q. And inhalation of PCB's that escape from stack gasses in the manner that I have described is a way to absorb or come in contact with PCB's.

A. That is a way, yes.

Q. Do you have an opinion as to whether or not incinerating Askarel in a conventional manner, less than 1,600 degrees Fahrenheit, is a method of proper disposal?

A. I have an opinion, yes.

Q. What is that opinion?

A. I would not describe it as a method of proper disposal.

Q. Has it ever been considered a method of proper disposal?

A. Not to my knowledge.

Q. If an end user is properly disposing of Askarel or liquids containing PCB's would he burn it?

Would he burn the liquid to dispose of it?

A. Will you define burn for me because it's so close to incinerate?

Q. Other than using the Monsanto technique?

A. Just ordinary burning as most of us would understand it?

Q. Yes.

A. No. I would suggest that that would not be acceptable.

Q. Prior to the invention by Monsanto of an incinerator suitable for burning liquids containing PCB's what was the method of disposing of liquid PCB's other than approved landfills?

A. I cannot speak because I don't know what methods were used.

Q. I'm sorry, I'm not asking about methods being used and forgive me because it was a poor question.

Prior to 1900 and 71 when Monsanto put on line its incinerator what would have been an acceptable approved method of disposing of liquids containing PCB's other than an approved landfill?

A. There was no other acceptable method of disposal.

Q. When you were in charge of the

maintenance electricians and actually dealing with -- and I get the impression that this is about as close as you came to hands on dealings with transformers containing PCB's?

A. I guess, yes, that's an accurate description.

Q. Did you consider it your responsibility to see to it to the proper disposal of liquids containing PCB's?

A. Yes.

Q. Do you have an opinion as to whether or not it is the responsibility of the end user of the liquids containing PCB's to see to their proper disposal?

A. I do have.

Q. And what is that?

A. It's up to the end user who's in possession of the liquid that is no longer usable to arrange for proper disposal because he's the one with the most information regarding what the material is, what use was it in, what contaminants it might contain. In other words he knows more about that material than anyone else does so the responsibility is his to send it to the right place.

Q. Where it will be properly disposed of.

A. Correct.

Q. Do you have an opinion as to whether or not it is the responsibility of the end user to take any steps to insure that the place he sends it is the right place?

A. Certainly I do.

Q. What is that?

A. It's his responsibility to make sure that the place he sends it to is appropriate for that particular material.

Q. In your opinion were the end users of liquids containing PCB's for use in transformers other than that class of user we defined earlier as consumer, the Holiday Inn manager type.

A. I see.

Q. Are you of the opinion that that class of end user had enough information prior to 1970 to know and appreciate the necessity for the proper disposal of liquids containing PCB's?

A. It's my opinion they did.

Q. And was that information generated by Monsanto and communicated through its customer base or was it information available to them from other sources as well?

A. A good bit of that information originated

with Monsanto. This does not preclude that Monsanto's customers didn't have additional information and relayed the total package of information on to their customer regarding the product they sold them and materials involved.

Q. Do you have any reason to believe that customers of Monsanto that used your liquids or liquids that you blended for them according to their specifications in electrical transformers failed to communicate to their customers sufficient information concerning the need and the significance of proper disposal?

A. First part of your question do I have what?

Q. An opinion.

A. Yes, I do.

Q. And what is that opinion?

A. It's my opinion that Monsanto's customers who manufactured these transformers with PCB fluids did a more than adequate job conveying information to the purchaser of that apparatus.

Q. Specifically with respect to the need for adequate disposal. Was that kind of information in your opinion communicated to the ultimate user by Monsanto's customers?

A. In my opinion, yes.

Q. Just for informational purposes sir if I may. These documents, and by these I'm referring to Exhibits 5, 8, 4, 3 and 2, have all been identified as being approved and distributed after 1970, '71.

A. Correct.

Q. Now the other documents that you have before you, the first one being Exhibit 18, Askarel Inspection and Maintenance Guide. What is the approximate date of that publication?

A. (Reviewing Document). I cannot tell looking at this document.

Q. We have other documents that have the same title, for example 19 I believe is one and 15 is one, 16 is one and I can't tell if these things with the pixies on them belong in the same category. Do you know?

A. I'm sorry?

Q. These with the pixies on the cover, do they belong to the same category of documents as this?

A. They're roughly the same kinds of documents, addressing Askarel fluids in transformers.

Exhibit 14, 18 and 19 appear to have the same look about them but unless we can look at almost every word they appear to be reprintings or maybe even

some slight alterations or changes from publication to publication.

Q. I guess the question I'm leading up to sir is is there any way for you to arrange these in chronological order?

A. I'm just not familiar --

Q. Without reading each word.

A. I don't know that I can do that. I don't know the cataloging system.

Q. That's all right. We'll get someone else to do that.

Now the ones that are labeled Monsanto Inspection and Maintenance Guide, what is the distribution of these? Do they accompany an order?

A. If it's the first order generally the salesman has been by and has left this document and the order is placed --

Q. Each customer gets one of these?

A. For sure one copy. They're of course available at any time with requests. In fact copies of these were also sent to some of Monsanto's customers in big bundles and they were overlaid with the customer's, Monsanto's customer's name and then forwarded it to their customers.

Q. Now these here, do they get the same

distribution?

A. Yes.

Q. And these here, that's 13 and 12.

A. Yes.

Q. How about these, which are 11 and --

A. 10 and 11. Yes. Same kind of situation. Every effort was made --

Q. To give these to the customers?

A. Right.

Q. How about this one?

A. Number 7?

Q. Right.

A. That's a, this one happens to have a date on it, that's 1960, this is probably one of the earliest ones we have here, a pre cursor to some of these others.

Q. Okay. Thank you, sir and with the understanding that in the event I am successful in my request for additional paper I get a chance to meet with you I pass the witness.

(RECESS TAKEN BY PARTIES.)

MR. HESTER: I have decided not to ask any questions of Mr. Pappageorge but I would like to reserve the opportunity to ask him questions if we have a follow up deposition.

I pass the witness.

MS. ANOUILH: I also pass the witness with the reservation of asking questions if we resume at a later date.

MR. MCCAUL: Very few questions.

EXAMINATION

QUESTIONS BY MR. MCCAUL:

Q. My name is Mike McCaul, I'm with the Justice Department and I represent the United States in this lawsuit. We've been brought in as a third party defendant by your corporation, Monsanto Corporation.

Are you aware of that lawsuit first of all?

A. This is the first I heard of it.

Q. Okay. Are you aware of any of the allegations?

A. Allegations?

Q. That's the first you heard of the lawsuit I take it.

A. First I heard of it.

Q. In your subpoena duces tecum it asks you to produce all documents related to the sale of fluids containing PCB's by Monsanto. Do you have any documents that would relate to the sale of PCB's to

the United States or any of its agencies?

A. I don't have any documents of any kind.

Q. None in your possession.

A. That's correct.

Q. And you have no knowledge which forms the basis of the allegations made by Monsanto Corporation against the United States?

A. Since I don't know what the allegations are.

Q. Why don't I go ahead and refer to the third party complaint and see if you have any knowledge of this.

In the third party complaint Monsanto alleges that the United States through the Defense Logistics Agency delivered or caused to be delivered batteries containing led and used electrical transformers containing PCB oil to the metals recycling site referred to by the plaintiff.

Do you have any knowledge which forms the basis for those allegations?

A. I do not.

Q. And you would not have any documents which would substantiate these allegations I take it?

A. That is correct.

Q. Are you aware of any communications which

were made between Monsanto and the United States as an end user?

A. I'm aware that the United States through its different departments and agencies was listed as a customer of Monsanto's.

Q. Okay.

A. As a result they got the customer letters that were mailed out at intervals.

Q. And let me specify the question even more. In the Corpus Christi area are you aware of any communications to the United States or any of its agencies?

A. Not specific to the area, no.

Q. And again you said you do not have any documents which would reflect sale of PCB materials to the United States?

A. I don't have any, no.

Q. Does anyone from the Monsanto corporation have those documents?

A. I do not know.

Q. Who would be the proper person to talk to if any documents exist?

A. I would ask the Monsanto legal department.

Q. Are you aware of any mandatory statutes

or regulations which would prohibit the United States from selling transformers or electrical equipment?

A. No I'm not.

Q. Again your legal department would be the best contact person?

A. That's where I would go.

Q. As far as any documents which would reflect the sale of these type of materials to the United States again the legal department would be the best source?

A. If they're in existence I would go to the legal department and ask.

MR. MCCAUL: That's all the questions I have at this time.

MR. HALL: I don't have any questions for you Mr. Pappageorge.

_____

WILLIAM PAPPAGEORGE

IN WITNESS WHEREOF, I have hereunto set my and and seal _____.

My commission expires _____.

_____

[NOTARY PUBLIC]

NOTARIAL CERTIFICATE

STATE OF MISSOURI)
)
CITY OF ST. LOUIS)

I, SUZANNE BENOIST, a Registered Professional Reporter and a duly commissioned Notary Public within and for the State of Missouri, do hereby certify that WILLIAM PAPPAGEORGE, the witness whose deposition is hereinbefore set forth, was duly sworn by me and that this transcript of such deposition is a true record of the testimony given by such witness.

I further certify that I am not related to any of the parties to this action by blood or marriage, and that I am in no way interested in the outcome of this matter.

IN WITNESS WHEREOF, I have hereunto set my hand and seal July 16, 1991.

My Commission expires October 7th, 1991.

_____

NOTARY PUBLIC

KARPOWICZ REPORTING COMPANY
316 Merchants Laclede Building
408 Olive Street
St. Louis, MO 63102-2722
(314) 621-8883

July 16th, 1991

Woodard, Hall & Primm, P.C.
7000 Texas Commerce Tower
Houston, Texas 77002
ATTN: MR. ROBERT A. HALL

RE: HOLLAND VS. MONSANTO

Dear Mr. Hall,
This letter, incorporated as the last page of the deposition of WILLIAM PAPPAGEORGE taken on June 27, 1991 will serve as notice to you that the testimony is now ready for reading and signing of same.

I have enclosed the original transcript along with an errata sheet on which any necessary corrections should be made.

After the transcript has been reviewed and the signature page signed and notarized please return it to Mr. Terry so that the original transcript can be filed with court.

Sincerely yours,

SUZANNE BENOIST
REGISTERED PROFESSIONAL REPORTER

IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF TEXAS
CORPUS CHRISTI DIVISION

ROGER DALE HOLLAND AND DRENDA SHEPARD HOLLAND, INDIVIDUALLY AND AS NEXT FRIENDS OF TAUSHA MARIE HOLLAND AND JESSICA NICOLE HOLLAND; WILLIE MAE HOLLAND AND J. SELMON HOLLAND Plaintiffs,	)	
vs.	)	C. A. NO. C-91-78
MONSANTO, INC.; CENTRAL POWER AND LIGHT COMPANY; AND HOUSTON LIGHTING & POWER COMPANY, Defendants.	)	

DEPOSITION OF WILLIAM PAPPAGEORGE

Taken behalf of the Plaintiffs
June 27, 1991

EXHIBITS

Reported by
Suzanne Benoist, RPR, CSR

Karpowicz Reporting Company
(314) 621-8883
Registered Professional Reporters

Monsanto

Monsanto ASKARFL

Inspection and Maintenance Guide

Monsanto

ASKAREL

Inspection and Maintenance Guide

HOL 000208

HOLLAN 7202-002062

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SECTION A
TRANSFORMER ASKAREL

I. INTRODUCTION:

This manual describes the operating characteristics of transformer *askarel liquid* insulation and how it differs from mineral oil.

The information given is based on facts gathered by Monsanto over 30 years as producer of askarel, plus knowledge gained from the experience of transformer manufacturers and users. This guide is provided to outline the very simple maintenance required for askarel fluid in "modern" transformers and to offer suggestions for the sealing and maintaining of askarel in old units. By following this guide, users will obtain maximum service from askarel insulation with a reasonable minimum of maintenance. If questions arise relating to the designing and building of transformers — these should be referred to regular transformer suppliers.

Monsanto gratefully acknowledges the assistance, guidance, and the contributions of certain data by the following:

Frank M. Clark.....General Electric
Edward L. Raab.....General Electric
James G. Ford.....Westinghouse Electric
George Shombert, Jr.....Allis Chalmers

II. HISTORY OF TRADE NAME TYPES

"Askarel" is the generic name for non-combustible (fire-resistant) liquid insulation. In this respect, the insulation is completely different from ordinary transformer mineral oils. Transformer askarel is marketed by Monsanto. Whatever the trademarked brand, the askarel contains Monsanto's Aroclor (chlorobiphenyl) . . . one of the best liquid insulations developed by science. This inert compound is chemically stable, fire-resistant, heat stable, non-corrosive, and has high dielectric strength under the operating conditions encountered in transformers.

Askarel liquid insulation is made by thinning Aroclor 1260 with trichlorobenzene or tri-, tetrachlorobenzene mix. The first transformer askarel was made in 1932, in accordance with General Electric Company's patents, and was trademarked Pyranol 1488. Westinghouse, too, offered this askarel insulation in 1936 under their trademark Inerteen.

In the mid-1940's, as shown in the following table, tin tetraphenyl was added to General Electric's Pyranol to scavenge hydrogen chloride. Shortly thereafter, Westinghouse added phenoxy propene oxide to Inerteen for the same purpose. In 1963, General Electric replaced tin tetraphenyl with a diepoxide scavenger. This new formula, which replaces previous Pyranols, is called Transformer Pyranol A13B3B. *Thus, today the two commercial types of formulations are General Electric's Transformer Pyranol A13B3B type and Westinghouse Inerteen PPO (7336-9) type.*

The composition changes made in transformer askarel formulations are shown in Table I.

Table I

THE COMPOSITION OF TRANSFORMER ASKARELS

	Pyranol					Inerteen PPO
	1488	1467	1470	A13B3B	Inerteen	(7336-9)
Year Introduced.....	1932	1944	1952	1963	1936	1945
Ingredients:						
Aroclor 1260.....	60	60	45	45	60	60
Trichlorobenzene.....	40	40	40	40	40	40
Tetrachlorobenzene.....			15	15		
Tin tetraphenyl.....		0.125	0.125			
Phenoxy propene oxide.....						0.20
Diepoxide.....				0.125		

OTHER BRAND NAMES

Various electrical equipment manufacturers use other trade-marked names for askarel liquid insulation, such as Chlorextol (Allis-Chalmers); Noflamol (Wagner Electric); Saf-T-Kuhl (Kuhlman Electric). These askarel insulating liquids are one or the other of the two standard formulations. Still other manufacturers, who designate their insulation only by its generic name, askarel, assign it a number or code. By this number, Monsanto knows whether to furnish Pyranol A13B3B or Inerteen PPO (7336-9) type formulation to the user.

III. OFFICIAL TRANSFORMER ASKAREL SHIPPING SPECIFICATIONS

The official shipping specifications for the two modern transformer askarel formulations are shown in Table II.

Table II

OFFICIAL TRANSFORMER ASKAREL SHIPPING SPECIFICATIONS

Typical Properties	General Electric Co. Transformer Pyranol A13B3B	Westinghouse Transformer Inerteen PPO (7336-9)
Color, APHA	150 max.	150 max.
Condition	Clear	Clear
Water content, ppm (ASTM D1533-60)	30 max.	30 max.
Acidity, mg. KOH/g. (ASTM D974-55)	0.014 max.	0.014 max.
Dielectric Strength, 25°C., 0.1 inch gap (ASTM D877-49)	35 KV, min.	35 KV, min.
Dielectric Constant, 100°C., 1 KC (ASTM D924-49)	3.8 to 4.3	3.7 to 4.0
Volume Resistivity, 100°C., 500 volts DC 0.1 inch gap, 10^9 ohm-cm.	100	100
Inorganic chlorides, ppm. (ASTM D1821 and G.E. Method E4C41B)	0.10 max.	0.10 max.
Refractive index, 25°C. (ASTM D901-56)	1.6075 to 1.6085	1.6137 to 1.6147
Viscosity at 37.8°C. (ASTM D88-56) Saybolt Universal Seconds	41 to 45	54 ± 2
Pour point °C. (ASTM D-97-57)	—44 or lower	—32 or lower
Specific gravity 15.5/15.5°C. (ASTM D287)	1.560 to 1.571	1.560 to 1.568
Burn point (ASTM D92)	None to boiling	None to boiling
Distillation range (ASTM D20-56) corrected for stem and barometric pressure	1st drop 210°C. min. 35% 240 to 256 55% 290 to 330 65% 385 to 400 95% 395 to 415	1st drop 200°C. min. 40% below 270°C. 90% 395 to 415°C.
Fixed chlorine	60.5 ± 5%	59.1% min.
Corrosion test	After heating with aluminum for 6 hrs. at 200 to 220°C., the aluminum must not be corroded on either visual or weight inspection and the askarel should meet the following specifications:	
Color, APHA	200 max.	200 max.
Acidity, mg. KOH/g.	0.014 max.	0.014 max.
Inorganic chlorides ppm.	2.0 (tent.)	2.0 max.
Condition	Clear	Clear
Scavenger content	0.115 to 0.135% Diepoxide	0.18 to 0.22% phenoxy propene oxide
Arc formed gases	Less than 1.0% of total combustible gases including carbon monoxide, hydrogen and volatile hydrocarbons.	
Coefficient of Thermal Expansion (ASTM D1903), CC./CC./°C.	0.0007	0.0007

The above two formulas are used in modern transformers. There are a number of units in service dating back to 1933 with askarels of somewhat different compositions. These will be compatible with the above modern formulations.

IV. INTERCHANGEABILITY AND STABILITY

A. Interchangeability:

The two general types of askarel insulation shown in Table II can be either mixed or interchanged and there will be no difference in the operation of the transformer. However, askarel insulation *must never be mixed* with mineral oil.

Over 2% mineral oil in askarel begins to lower its fire resistance. Further, materials of construction in the transformer that are compatible with askarel may not be compatible with oil and vice-versa. For example: a significant amount of askarel in a transformer built for mineral oil will attack gaskets, adhesives, core bindings, impregnating varnishes, etc.

B. Stability:

Askarel liquid insulation is highly pure, fire-proof liquid made under close chemical control. It does not vary in composition like the commercial range of mineral oils.

Askarel does not deteriorate when exposed to air, heat, hot metal; it does not break down over long use to form conducting or corrosive chemicals; it does not oxidize or sludge. Askarel will remain perfectly stable year after year unless broken down by exposure to severe arcing.

The only real "enemy" of askarel is *contamination by water.* Keeping askarel water-free will insure long-time service.

Askarel is heavier than water. If water gets into askarel insulation, only a tiny amount (125 ppm) dissolves — the rest floats on top.

V. DIRECTIONS FOR HANDLING

A. Keep Dry:

In handling, storing, sampling, inspecting askarel — and in operating askarel transformers — take every precaution to guard the askarel insulation from exposure to high humidity and moisture contamination. Keep 5, 30, or 55 gallon drums of askarel dry; lay stored drums on their sides with the bung at the highest point from floor to keep water off the drum head (which can be sucked into the askarel by the drum "breathing"). This precaution is not necessary when drums are stored indoors, which is the preferred way of storing.

B. Use Ordinary Personal Precautions:

Transformer askarel has been made, handled, and used for over 30 years without causing toxic or other ill effects. It can be handled with only minor precautions. If accidentally spilled on hands, no serious skin irritation will occur. However, liquid askarel has a solvent action (similar to paint thinner) on the fats and oils of the skin and prolonged contact may lead to drying and chapping of the skin.

In case of contact, wash off the skin with soap and water; remove and dry clean saturated clothing. Clean up spills with rags, sawdust or absorbent clay. Eye contact may result in painful irritation but no permanent damage to tissues. If askarel gets in the eyes, flush with large amounts of water. As with all eye first-aid, refer to a physician. To relieve irritation, physicians have used a 1% Pontocaine as well as opthalmic cortisone acetate solution, or castor oil.

Infrequent exposure to askarel vapors will not cause ill effects. However, prolonged exposure to high vapor concentrations should be avoided. If hot askarel must be handled in a closed or confined area, provide the area with ordinary exhaust ventilation — or — wear an organic cartridge respirator approved by the U. S. Bureau of Mines.

VI. EXPECTED SERVICE LIFE

Properly designed and installed askarel transformers will give trouble-free service for a minimum of 30 years. Since their introduction in 1932, the manufacturers report finding the over-all failure rate to be less than 0.5% for all units under test and service conditions. The Edison Electric Institute's report (1956-1958) on their member utilities publishes the failure rate for askarel transformers as 0.13 per hundred banks per year. Even the rare reports of failure are invariably found to be due to improper sealing that allows moisture to enter.

VII. DIELECTRIC STRENGTH — MOISTURE RELATIONSHIP

The dielectric strength of askarel is highly sensitive to excess moisture; not sensitive to ordinary dissolved contaminants. While the dielectric strength can also be lowered by severe arcing, askarel turns noticeably black or has particles of sooty carbon floating in it if arcing has occurred. Then the transformer should be repaired and the askarel replaced.

New askarel has a minimum dielectric strength of 35 KV at 25°; a maximum moisture content of 30 ppm. If the dielectric strength is checked periodically and decreases significantly — this indicates moisture pick-up, arcing, or both. When the dielectric strength has dropped to 26 KV or less, an analysis for water is necessary. If water is found in excess of 100 ppm at 25° C., its source should be located and corrections made.

When the moisture content approaches 125 ppm (saturation level), the dielectric strength of askarel drops below the value required for efficient insulating. The moisture content should not be allowed to rise over 70 ppm; it should be held as near as possible to 30 ppm. Maintaining a low moisture level will assure high dielectric strength and top operating efficiency.

Table III shows the relationship of dielectric strength vs. moisture and Table IV indicates the approximate water solubility limits in askarel and mineral oil.

Table III

RELATION OF "BREAKDOWN STRENGTH" TO AMOUNT OF DISSOLVED WATER IN ASKAREL AND MINERAL OIL

Water Content (PPM)	Breakdown Voltage (ASTM) Askarel	Mineral Oil
0	70 KV	50 KV
20	55	39
40	47	30
60	40	26
80	38	22
110	10	5

Table IV

APPROXIMATE SOLUBILITY OF WATER IN TRANSFORMER ASKAREL AND MINERAL OIL

Temperature °C.	°F.	Amount of Water (PPM) Dissolved Askarel	Mineral Oil
—30	—22	8	8
—20	— 4	16	10
—10	14	28	13
0	32	41	20
10	50	65	33
20	68	94	58
30	86	128	85
40	104	170	130

TURBIDITY

. . . may be the visual sign of undissolved water, or may indicate contamination from core materials, dirt, or deteriorating construction materials. Cloudiness may also result from cold precipitation of tin tetraphenyl "scavenger" that was used in the earlier Pyranols. This scavenger begins to come out of solution around 15°F. above zero. To redissolve it requires heating to 150 - 200°F. and agitation.

High dielectric strength will quickly indicate that any turbidity present is not moisture; that the insulating efficiency of the askarel is still excellent. However, if the dielectric strength is below 26 KV, moisture should be determined, using the Karl Fischer method (ASTM D1533-60).

The dielectric strength test for askarel serves primarily as an indicator for moisture. It is by far the most important maintenance test for transformer askarel.

VIII. TYPICAL VALUES FOUND IN ASKAREL FLUID UNDER VARIOUS USE CONDITIONS

Table V gives the entire spectrum of properties that are typical for freshly-made transformer askarel as it goes through the various normal and abnormal conditions of use.

The data in Table V are in terms of *only* the askarel *fluid* and do not refer to insulation resistance or power factor measurements on the over-all transformer insulation.

Several utilities studying the power factor values of the over-all transformer insulation system indicate that the unit power factor of a new askarel transformer should range from 1% *to not over* 5%. This would generally correspond with the askarel *fluid* properties as given under heading "B".

Table V

TYPICAL VALUES FOUND IN ASKAREL FLUID UNDER VARIOUS CONDITIONS OF USE

	A	B	C	D	E	F
	New askarel	Askarel in properly* built new or rebuilt units prior to use.	After normal operation; a survey of 50 units, most 2-5 yrs. old; some 10.	Non-arced but slightly contaminated askarel in improperly* built units, new or slightly used.	Same askarel as in Column D — after refining.	Heavily arced askarel due to neglect and internal electrical malfunction.
Inspection Check Points						
Color	Light straw	Light straw	Light straw	Can have foreign shades, blue, green, red cast.	Foreign shades remain showing extraction of oil soluble color.	Black
Clarity	Clear, free from particles	Clear, practically free from particles	Clear, trace of particles	Clear, slight amount of particles	Clear, free from particles	Contains carbon particles
Moisture 25°C.	30 ppm	30 ppm	10-70 ppm all dissolved water	20-100 ppm all dissolved water	30 ppm	Near 125ppm saturation level — plus possible undissolved water
Dielectric Strength 25°C., 0.1" gap	35 KV minimum	35-48 KV	35-45 KV	30-42 KV	40-45 KV	5-15 KV
Volume Resistivity 100°C., 500 Volts, DC., 0.1" gap	100×10^9 ohm-cm. minimum usually 500-1,500	40×10^9 ohm-cm. minimum usually at least 100×10^9	$15\text{-}400 \times 10^9$ ohm-cm.	about 5×10^9 ohm-cm.	at least $1{,}500 \times 10^9$ ohm-cm.	about 3×10^9 ohm-cm.
Power Factor:						
100°C. 60 cycles	2-5%	10-25%	10 to near 80%	30 to 100%	2-5%	100%
25°C. 60 cycles	0.05-0.1%	0.5-2%	0.5 to near 10%	about 7 to over 15%	0.1-0.2%	at least 25%

**A properly built transformer is defined as one in which the materials of construction are chemically and electrically compatible with askarel.*

Starting ideally with situation "*B*", *it is normal to expect the power factor of the fluid in a satisfactorily operating askarel transformer to increase as shown under heading* "*C*". The "over-all" power factor of the *transformer* in normal service is expected to rise, but preferably not much beyond 5%. In this normal situation, the moisture level of the askarel fluid and its dielectric strength will be satisfactory, as shown in *heading* "*C*".

Occasionally the power factor of a non-arced, satisfactorily-operating askarel transformer is found to be relatively high, i.e., 15%. *In this case, the power factor of the askarel fluid will also be high*, perhaps as high as 50% at 20°C. and 60 cycles.

It is not good practice merely to note that high power factor of the askarel fluid is to be expected. The important step is to check dielectric strength and note whether there has been a downward trend. A downward trend in dielectric strength very likely indicates moisture entrance and should be confirmed by a Karl Fischer test for water.

The importance of any abnormalities in dielectric strength and moisture content of the askarel fluid cannot be overemphasized! Where abnormal values for the dielectric strength or moisture content occur, the power factor of the transformer can be expected to be abnormally high; the expected high power factor of the askarel fluid will induce this.

The indication that a high power factor on the transformer and on the fluid is due to contamination can be verified by earth refining the askarel fluid and noting whether after refining the test results correspond with heading "*E*".

Assuming no mechanical defect or arcing, if the power factor of a *new askarel transformer* is relatively high, the power factor of the *fluid* will also be high, giving the situation under heading "*D*". This reflects contamination that should have been removed by the manufacturer of the transformer.

In absence of mechanical defect, where there are no abnormal losses in dielectric strength, and no moisture pick-up in non-arced askarel — the use history shows that a relatively high power factor for the askarel fluid (as compared with mineral oil) is to be expected. Normally, high power factor is due to contamination and not deterioration of the askarel operation.

As shown by F. M. Clark in his book, "*Insulating Materials For Design and Engineering Practice*," John Wiley & Sons, N. Y., 1962 — activated alumina can be used in the circulating system to bring the power factor down and keep it as low as possible.

IX. CHECK POINTS FOR MAINTAINING ASKAREL INSULATION

A. General Considerations:

Modern askarel transformers with welded construction or silicone gaskets for hand hole-cover, switch and terminal compartment covers, with properly constructed bushings require little or no maintenance. With properly constructed transformers, annual or semi-annual visual inspection and dielectric strength test of the askarel fluid should suffice for routine maintenance checking over many years of service.

However, many askarel units were installed in the early 1930's — before the development of some of the better modern gasketing materials and before improved designs were developed for sealing out moisture. Such early units should be, and can be, modernized. Leaky or deteriorated gaskets should be replaced. If the askarel has become contaminated, it should be reconditioned. At the same time, a general clean-up of the unit and possible refinishing may be desirable.

If it is not convenient to take an old transformer out of service for general repairs, leaky gaskets can be sealed temporarily by painting over the leaky area with epoxy cement.

A survey of users indicates a good number of early-built askarel transformers (over 20 years old) are kept in continuous service in critical installations by the following steps (instead of modernization).

The operating units are equipped with compound pressure gauges for reading pressure above and below atmospheric. Positive pressure is maintained on the shell by introducing nitrogen at 2 to 3 pounds above atomspheric. Regular workmen in the area daily record the temperature and pressure. If a sudend pressure drop is noted more nitrogen is introduced and the gaskets are checked for leaks with soap solution. Leaks are sealed by applying epoxy cement.

B. Modern Sealing Procedures:

Transformer purchasers should specify the following modern techniques for sealing:

1. **Welding Construction:** Covers, radiator connections, switch and terminal housings, instrument connections, etc. should be welded.
2. **Bushing Connections:** The most satisfactory bushings are the type with rolled-on flanges and two ring seals rolled into a depression in the porcelain — sealed with silicone rubber rings held under compression. Metal-to-glass or metal-to-porcelain sealed bushings are also satisfactory.

   If for any reason the above type bushings cannot be used then use a porcelain or glass bushing with a silicone or Viton gasket retained in a groove. The gasket can be either rectangular or circular cross section, usually ¼ inch thick.
3. **Small Size Connections:** When not possible to weld, small size connection seals should be made with Flexitallic stainless steel rings. The surfaces must be machined and parallel. The filler between the steel laminations of the Flexitallic ring should be either silicone or Viton.

4. **Gaskets For Hand-Hole Covers:** Modern design specifies silicone gaskets. Such gaskets must be retained in a groove. The groove preferably is machined into the flange or cover. However, it can also be formed by welding concentric steel strips to the flange or the cover.

   Generally the gaskets should be 5/16 to ½ inch thick for covers, depending on the depth of the groove. A rectangular section is usually used.

   The silicone material should be Dow-Corning No. 50 Silastic or equivalent. This is a low compression set material. For best sealing 20 to 25% compression is recommended, with ample clearance in the groove to allow for this compression.

   No cement is required. With reasonable care the gasket is removable without damage and is reusable.

   Silastic 50 is slightly swelled by askarel which contributes to the tightness of the seal. It is not deteriorated by askarel fluid or vapors. It resists weathering and it is thermally stable and flexible at all operating temperatures. It is an excellent moisture barrier.

Notes: a. Dow-Corning, Midland, Michigan will supply a list of Silastic 50 gasket fabricators to all transformer manufacturers or users. They will also furnish technical data.

b. Any user of Pyranol transformers, made by General Electric Company at Rome, Ga., will receive prompt and generous help for converting to the modern silicone or Viton gaskets by contacting the General Electric Company's Service Engineering Department at Rome, Ga.

See Appendix K: Seals, Properties and Procurements.

C. The Older Sealing Arrangements:

The older type gaskets consist of either cork or cork-nitrile rubber combinations or straight nitrile rubber.

1. **Cork-Nitrile Combinations:** Covers for the main tank, hand-holes, switch and terminal chambers, relief diaphrams etc. are held in place by studs welded to the flange or by bolts. The gaskets are cut with openings and placed over the bolts. Often Shellac (Westinghouse Style No. 1150419, or General Electric Company's Glyptal 1276) is used to cement the cork to the flanges.

   The following is recommended for sealing with the cork — nitrile rubber combination:

   Use Armstrong NC-757 cork-nitrile material or equivalent. The gasket can be cut from a single sheet or by scarfing strips of the material. A convenient method for joining strips is to make a Keystone Type joint. For this, Westinghouse, Sharon, Pa., offers their gasket cutter Style No. 328 B614 G01, (about $15).

   The joints should be cemented and the gasket also cemented to the flange, using one of the above cements. Excess cement should not be allowed to reach the interior of the transformer.

After installation and bolting, the outside edge of the gasket should be coated thoroughly with epoxy cement to increase weather resistance.

This epoxy cement is a paste to which a curing catalyst is added immediately before use. Typical are:

a. Epoxy Patch Kit #1-C
Hysol Corporation, Olean, N. Y.

b. Scotchcast Resin #4
Minnesota Mining and Manufacturing Co.
St. Paul, Minnesota

c. Adhesive A-1 and Activator Type B
Armstrong Products Company
Argonne Rd., Warsaw, Ind.

d. Adhesive 9860-1, Synthetics Organic Company, Cleveland, Ohio, used with activator diethylene triamine (Carbide and Carbon Chem. Co.)

2. **Straight Nitrile Rubber:** When straight nitrile rubber was originally used, invariably the gasket was recessed in a groove. This was to prevent gasket flow and to protect the material against excessive compression. Although this type seal was not cemented, the nitrile rubber gasket is not reuseable.

Since grooves or stops have already been provided for the nitrile rubber seal, Silastic 50 can be easily substituted and is recommended. This conforms with modern practice.

X. PERIODIC FLUID INSPECTION AND WHAT CHECKPOINTS MEAN

On a regular schedule — at six, nine, or twelve month intervals — make a simple visual inspection of your askarel insulation and run a dielectric strength check.

A. Visual Inspection:

Askarel is a clear, faint-yellow liquid. After long-term use this color may gradually intensify to light brown. The fluid should remain clear and free from turbidity or cloudiness.

Any color change — such as to a green, red or blue cast — indicates extraction of impurities from the solid insulation. If a distinct foreign color pick-up is noted, check the complete range of electrical characteristics and notify the transformer maker. The electrical characteristics may be found to be unimpaired. Color change alone (except for black) is not a danger signal since the contamination is not likely to impair the dielectric strength.

B. Dielectric Strength:

If the dielectric strength has decreased significantly from the last inspection, or if it has gradually decreased below 26 KV range (at 25°C.) — RUN A CHECK FOR MOISTURE. Use ASTM D901, D877 (Karl Fischer Method).

The dielectric strength of askarel is the major indicator to the operating efficiency of your liquid insulation and of the askarel transformer itself. Besides the "visual" inspection tests, dielectric strength is the only test necessary to run on a routine basis. Well-sealed askarel transformers have service records of 25 to 30 years on the original askarel. New askarel has a minimum dielectric strength of 35 KV at 35°C., a maximum moisture content of 30 ppm.

XI. INSPECTION CHECK LIST

1. If askarel is clear, even though darkened to light brown; has no sediment or turbidity; has dielectric strength over 26 KV . . . give it the inspection "OK".
2. If askarel is clear; has foreign color of blue, green, red . . . it is "extracting color" from internal materials. This is not, of itself, an operating hazard when the dielectric strength stays over 26 KV and moisture remains low. However, this rare occurrence calls for checking into condition of the interior construction and consulting the transformer maker.
3. If askarel is clear; but dielectric strength drops to 22 or lower KV, and moisture rises over 80 ppm . . . the askarel is ready for simple "refining". If the moisture is near the saturation level (about 125 ppm), a thorough inspection should be made for water droplets in the transformer tank, and even for "globules" or water floating on the askarel surface. If found, the transformer manufacturer should be consulted for reconditioning both the transformer and the fluid.
4. If askarel is dark brown to black; if black particles of carbon are seen; and dielectric strength is low . . . the askarel has been broken down by arcing. It cannot be refined and should be discarded.

If any of these four simple inspection tests appear out of the ordinary, or the relationship between appearance and test values is abnormal — contact your transformer supplier for a complete analysis.

Whenever a sample is to be shipped to Monsanto, please follow the directions shown under: "SAMPLING ASKAREL".

XII. CONTAMINATION IN TRANSFORMERS

Unlike mineral oil which can oxidize, sludge and deteriorate — askarel breaks down in transformer use *only when strongly arced.*

Thus, while askarel does not decompose in normal use — it can be contaminated more readily than the relatively non-polar mineral oil.

For example the following Table VI shows how a small amount of synthetic rubber or a bit of varnished cloth markedly increases the power factor of the askarel. Please note, however, that *such minor contamination has no adverse effect on the dielectric strength.* As explained, moisture entrance through faulty seals seems the only contaminant in normal use that lowers the dielectric strength of transformer askarel.

Table VI

EFFECT OF COMMON INSULATION MATERIALS ON POWER FACTOR AND DIELECTRIC STRENGTH (HEAT AGED 96 HOURS IN ASKAREL AT 100°C.)

Material Immersed	Askarel After Exposure: Power Factor, Percent at 60 cyc., 100°C.	Askarel After Exposure: Dielectric Strength 25°C.
None (control)	1.0	35 KV
Black varnished cloth	85.0	42
Copper	1.5	40
Pressboard	2.0	37
Manila paper	1.5	39
Phenol formaldehyde resins	1.6	41
Shellac	6.0	36
Iron	5.0	39
Synthetic rubber	70.0	39

Similarly, trace contaminants from commonly used construction materials can lower the volume - resistivity of askarel, without affecting its dielectric strength. Table VII shows this.

Table VII

EFFECT OF COMMON INSULATION MATERIALS ON VOLUME RESISTIVITY OF ASKAREL

Sample	Volume Resistivity x 10^9 ohm-cm (at 100°C., 500 Volts DC., 0.1" gap)
1. New askarel before heat aging	2,000
2. New askarel after heat aging 96 hours at 100°C.	1,900
3. After heat aging with 1 sq. inch specimens of:	
a. Phenolic resin tap changer material	1,200
b. Paper	750
c. Grade A press board (tan)	500
d. Grade A press board (gray)	500
e. Grade A press board, laminated strip	400
f. Cotton wrapping	300
g. Glyptal 1276 cement, cured 48 hrs. at 110°C.	100

While trace contamination easily lowers volume resistivity from high levels, it is important as previously noted in Table V Case F, that heavy contamination (as when arced) does not lower the resistivity below the order of 10^9 ohm-cm. at 100°C.

The different behavior of askarel vs. mineral oil in these respects can be summarized as follows:

High power factor and low volume resistivity in transformer mineral oils are commonly regarded as "danger signals" that the oil has deteriorated and broken down chemically.

This is NOT TRUE of askarel liquid insulation, unless the dielectric strength is low.

XIII. REFINING ASKAREL FOR RE-USE

A. Filtering Through Dry Blotter Paper to Remove Moisture and Extraneous Particles:

Most operators prefer portable refining apparatus, such as a plate press fitted with a dolly, (available from Sparkler, Mundelein, Ill., Westinghouse Maintenance and Repair Dept., Chicago, or General Electric Co., Pittsfield, Mass.); or the earthen cartridge filter type, (available from Industrial Filter Corp., Lebanon, Ind.). Filter paper liners for the plate press are available from Carl Schleicher and Schuell Company, Keane, New Hampshire and manufacturers of filter presses listed above.

The filter paper must be dried immediately before use. For best results, spread the paper for maximum surface exposure in a hot air circulating oven and heat it for 4 to 6 hours at 110°C.

If possible do not take the transformer out of service until ready to filter the fluid. This will keep the transformer coils relatively hot and dry. Processing the fluid should start immediately after de-energizing the unit.

Circulate the askarel hot (but not over 55-60°C.) through the filter fitted with the dry paper liners.

After filtration the dielectric strength of the askarel should be 35 KV minimum.

1. **Precautions:** Filtering should not be done when the relative humidity exceeds 75%.
2. Any flexible hoses and gaskets on the refining equipment should be lined with or made of materials that will not be softened by contact with askarel fluid. (Silicone or Teflon-lined, or flexible metal materials are suitable.)

Table VIII

GUIDE TO RATE OF DISSOLVED WATER REMOVAL BY FILTERING ASKAREL THROUGH A PAPER PRESS

Passes Through Paper Press	Water in Askarel PPM
0	115
1	35
2	22
3	18
4	12
5	10
6	10

B. **Earth Treatment for Maximum Improvement of Power Factor and Volume-Resistivity:**

1. **Procedure:**

(The askarel liquid should be relatively dry prior to the following earth filtration.)

Use finely divided Attapulgus clay or Fuller's earth (dried and activated by heating for 12 hours at 300-350°F. immediately prior to use) as a coating on the filter paper surface. The amount of earth used should be 0.1 to 0.2 per cent by weight on the weight of the askarel to be treated. (Askarel weighs about 13 pounds per gallon).

To deposit the earth evenly, stir one-third of the earth with a small portion of askarel in a clean container. Pump the mixture through the filter and follow with two more one-third portions. Then circulate askarel taken from near the top of the transformer, pass it hot (not over 55-60°C.) through the earth coated filter and feed back through the bottom transformer outlet. Continue circulation until the fluid is clear and test shows that the electrical properties are fully restored.

2. **Effect of Earth on Removal of Scavengers:**

Only slight and insignificant loss (by selective absorption) of tintetraphenyl and epoxides occurs when askarel is refined by treatment with 0.1 to 0.2 per cent by weight of earth. To remove significant amounts of the scavengers requires repetitious treatment with much larger amounts of earth.

3. **Table IX — Approximate Relationship Between Power Factor, Volume-Resistivity and Dielectric Strength of Transformer Askarel:**

Power Factor (60 cyc.)		Volume Resistivity x 10^9 ohm-cm. (at 100°C., 500 Volts DC., 0.1" gap)	Dielectric Strength 25°C., 0.1" gap
100°C.	25°C.		
2%	0.05%	1500	35 KV
5%	0.1%	500	35
15%	0.7%	100	35
20-25%	2.0%	60-70	35
40-50%	—	25	35

If it is desired (although these factors are not generally considered important for askarel transformers), to keep the power factor as low as possible and the resistivity as high as possible, hang a container of anhydrous alumina or activated clay in the circulating system of the transformer.

XIV. CLEANING ARCED TRANSFORMERS

If a unit has arced so that the askarel is no longer fit for use, a thorough cleaning of the unit is necessary before refilling with new askarel insulation and returning it to service*. Follow this procedure:

A. Drain out all dark, carbon-contaminated askarel. (Discard by dumping or burying where it will not contaminate a water supply.)

B. Carefully brush carbon deposits from internal parts and insulation, using a soft bristle brush making sure that insulation is not damaged.

C. Flush thoroughly using new askarel (*not* an oil, *not* a cleaning solvent).

D. Flush a second time with fresh askarel; drain; then fill to the proper level with new askarel.

E. Energize transformer to warm the fluid for 24 to 48 hours; then circulate the askarel through a filter, returning it to the unit filtered and ready for use.

* This assumes that the cause of arcing has been established and corrections made. When severe arcing occurs, major repairs are usually necessary and the unit rebuilt. This procedure can be applied for flushing out repaired units.

XV. SAMPLING ASKAREL

Take a sample as close to the top of the liquid surface as possible. (Many large askarel transformers have a built-in sampling tube near the surface for convenient sampling). Then, to make sure that your SAMPLE truly represents your askarel insulation, take another sample from the bottom. If additional sampling tube connections are contrived on the valves for easier sampling, make the tubes of clean glass, stainless steel, aluminum or tin for rigid types; and silicone or Teflon tubing for flexible types.

Use NEW containers for the askarel sample. A new and thoroughly pre-dried small-mouth quart glass bottle fitted with a Bakelite screw cap fitted with an aluminum or tin bottle cap liner is recommended for "quick on-the-site testing." (If complete analysis is to be made, a 5-pint size sample is required).

Be sure that the new bottle does not stand open to collect dust or moisture. Rinse the sample bottle and cap lining two or three times with askarel from the transformer; then fill it. If the sample will be tested promptly, a clear glass bottle can be used. If sample is to be stored indefinitely, use an amber glass bottle or wrap clear glass with aluminum foil.

A. Select a dry day. Do not sample insulation on a warm, moist day when humidity exceeds 75%, and . . .

B. Make sure that the askarel is at least as warm as the surrounding air. (Cold liquids can condense moisture from humid air.)

C. When sampling askarel from transformers, it is best to take the sample when the unit is warm and operating at average or maximum load. Especially as a check on moisture (as reflected by a dielectric strength test), sampling the warm askarel more truly represents its condition during operation.

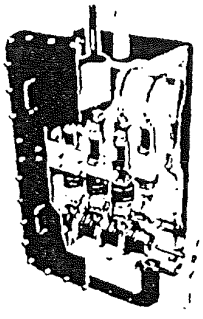
   Experience shows that water will migrate from a transformer's solid insulation to the askarel liquid and vice versa, depending on temperature. Therefore, when the transformer is hot, the moisture is most likely to be found in the liquid. This accounts largely for periodic variations in dielectric strength. For example: a relatively high dielectric strength may be found during winter months and a relatively low dielectric strength during the summer months on samples taken from the same unit.

SECTION B

ASKAREL FILLED SWITCHES AND TERMINAL CHAMBERS

I. INTRODUCTION:

High voltage leads are usually connected to askarel or mineral oil-filled network transformers and power centers through terminal chambers and switches. In some cases terminal chambers are not used, and the high voltage leads are connected directly to the switch terminals. They may be filled with either askarel or mineral oil. Switches are usually rotary or drum type fitted with a revolving block and porcelain unit as the principal element arranged for three-phase service. (A cutaway view of a typical terminal chamber-switch combination is shown for reference.)



Askarel transformers with attached switches have been in use for about 30 years. When they were first introduced, the availability of insulating and gasketing materials was rather limited and even the best materials at the time had no service history. As a result, inadequate gasketing materials such as cork, nitrile rubber, and nitrile rubber-and-cork particles were used. While satisfactory for a limited period of time, these materials cannot be depended on for the expected long life of the equipment.

The terminal chamber is usually above or below the switch compartment and separated by a steel wall through which the bushings are inserted. When bushings are properly selected and correctly installed, there is no leakage from one compartment to the other. With poor bushing seals, and the terminal chamber above the switch, potting compounds or cable oil can seep into the askarel. When the terminal chamber is below the switch, askarel can drain into the terminal chamber.

II. SOURCES OF CONTAMINATION

There are three possible sources of contamination for askarel in switches and terminal chambers; they rank in this order of frequency: (1) water entering through poor gaskets; (2) decomposition products from arcing when switch is used to break magnetizing current; (3) entrance of pothead or cable compounds through leaky bushing seals.

Unlike an askarel transformer where the amount of contaminant is likely to be very small (probably only trace amounts) in relation to the volume of askarel fluid — in switches or terminal chambers with faulty seals, the amount of contamination can be relatively large.

Experience has shown that, based on the number of installed askarel-switch units, the percentage of failures is extremely small. When investigated, it has been found that most failures originate in the switch chamber. Water is the chief source of contamination. However, heavy contamination of askarel with petrolatum and asphalt material, due to leakage, have caused a few failures.

Petrolatum is used frequently for filling terminal chambers. When either cable oil or petrolatum seeps into askarel, no great harm results. The fire resistance will be somewhat decreased and power factor of the askarel will increase with an accompanying drop in resistivity. While highly undesirable, it is doubtful that failure of the unit results. Where asphaltic compounds are used in place of petrolatum, the danger is increased somewhat because asphaltic contamination may cause excessively high dielectric losses in the askarel.

When the terminal chamber is below the switch chamber, the potting compound can be contaminated by askarel if the bushing seals are leaky. This is undesirable because the askarel will increase the power factor and conductivity of the potting compound or cable oil and develop heat from dielectric loss. If this mixture is drawn into the cable insulation, a cable failure is likely. This again emphasizes the importance of tight bushing assemblies.

III. SEALING SWITCHES AND TERMINAL CHAMBERS

Proper bushing construction, use of Silastic seals and welding wherever possible is highly desirable (as covered in Section A). Where an elastomeric seal is to be used in contact with both askarel and petroleum oil, DuPont's Viton is suggested.

For new equipment the user should specify these modern sealing arrangements to keep out contaminants and minimize maintenance.

IV. MAINTENANCE FOR ASKAREL FILLED SWITCHES

A. Switches used for grounding after power source has been de-energized will not undergo arcing.

B. Switches interrupting magnetizing current will be subject to arcing; the amount of decomposition will depend on power interrupted, time and frequency of operation. As a general rule, the liquid should be checked after 5 to 10 operations.

1. On newly installed switches, check the askarel at 3, 6 and 12 month intervals; if found satisfactory, check once annually thereafter. With proper attention to the gasketing of covers and bushings, experience will probably indicate that less frequent inspection is warranted.

2. Check askarel for:

   a. Dielectric strength (ASTM D877): It should be 26 KV minimum. If dielectric strength is low, confirm presence of water by Karl Fischer method ASTM D-1533. Filter to remove moisture. Dielectric strength should then be 30 KV minimum.

   b. Presence of carbon from arcing: Fluid should be relatively free of carbon. If badly arced and very black, replace fluid. If only minute amounts of carbon are present, filtration is recommended. Check power factor of liquid (should not be over 5% at 25°C. and 60 cycles). Flush out switch chamber with several gallons of fresh askarel before refilling.

3. If there is discoloration, high power factor, detectable change in specific gravity or refractive index, or if fluid flashes below 250°F., there is a possibility of seepage of potting compound into the switch compartment. In this case, correct any leaky bushing seals with proper replacements and fill with new askarel.

4. If terminal chamber is below switch, check potting compound for presence of askarel (can usually be detected by odor or by an increase in specific gravity). If askarel is present, correct any leaky bushing seals with proper replacements, and renew compounds.

5. Examine cover gaskets visually. Deterioration can be detected by swelling and cracking of the exposed edge. In cases of severe deterioration, liquid seepage is usually present.

6. Check for leakage at packing gland of switching shaft. If leaking, repack with a Silastic ring type gasket.

SECTION C

ANALYTICAL SERVICES ON TRANSFORMER ASKAREL AVAILABLE FROM MONSANTO

Transformer users not wishing to make their own fluid analyses can obtain the service from Monsanto. Simply contact Monsanto and specify what analyses are wanted. You will be sent the proper-sized sample container filled with fresh askarel. When you receive this, empty it and carefully take your sample (following the procedure for sampling in this guide). Send the container to Monsanto's laboratory. Charges listed include sample container, shipping, handling and laboratory costs.

Types of Analyses Available

Analysis 1)

ROUTINE MAINTENANCE CHECK

Total Charge: $20.00

To determine the general condition of the fluid and find whether further analysis is necessary. (one-quart sample required)

Properties Tested
Color and Condition
Dielectric Strength
Moisture

You will be notified of the results of this test. If further testing is indicated, and you want a complete analysis, you will be sent a five-pint sample container. This sample will be used for the following series of tests:

Analysis 2)

COMPLETE ANALYSIS

Total Charge: $50.00

(a) To determine the extent of fluid contamination, (b) earth refinement to determine what degree of restoration of electrical and insulating properties is possible, (c) check test to see how the fluid responded to earth treatment.

a) Complete Analysis: to determine the extent of contamination

Properties Tested
Color and Condition
Specific Gravity
Refractive Index
Water
Free Chlorides
Acidity
Dielectric Strength
Power Factor, Dielectric Constant, and Resistivity

b) Earth Refinement Response:

Consists of treatment for 2.5 hours at 50-60°C. with 0.1 to 0.2 percent by weight of properly conditioned Attapulgus clay and then filtration through dry filter paper.

c) Analysis After Laboratory Earth Refinement:

Properties Tested
Refractive Index
Water
Free Chlorides
Acidity
Dielectric Strength
Power Factor, Dielectric Constant, and Resistivity

You will be notified of the results of this test series on your sample. Then after refining your entire transformer fluid fill you can check on the results by requesting the following analysis:

Analysis 3)

ANALYSIS AFTER EARTH REFINEMENT

Total Charge: $30.00 (This charge will not apply when analyses 1 and 2 have already been made.)

To determine whether the entire lot of the askarel fill responded to the same extent as the laboratory sample. (five-pint sample required)

Properties Tested
Color and Condition
Refractive Index
Water
Free Chlorides
Acidity
Dielectric Strength
Power Factor, Dielectric Constant, and Resistivity

To arrange for the tests described above write to the following address:

Paul G. Benignus
Monsanto Chemical Company
800 North Lindbergh Blvd.
St. Louis 66, Missouri

Samples to be tested should be clearly marked for identification and sent directly to:

Monsanto Chemical Company
W. G. Krummrich Laboratory
Monsanto, Illinois
Attention: R. Kuster

APPENDIX A — Askarel Stability and Composition of Arc Formed Gas:

Askarel insulation is one of the most inert, chemically-stable heat resistant, non-corrosive liquids known. It will not break down, oxidize or sludge when exposed to air and high temperatures, 150°C. or even somewhat higher. Arcing, however, will break down the compound to liberate some hydrogen chloride and small amounts of carbon.

APPROXIMATE COMPOSITION
ARC FORMED GAS FROM TRANSFORMER ASKAREL

Gas	Amount
carbon monoxide	0.3 per cent
carbon dioxide	0.3
oxygen	0.6
inert gases	1.5
hydrogen chloride	97.3

(note the absence of phosgene)

This arc-formed gas is non-flammable and non-combustible. These requirements must be met in accordance with the Underwriters' Laboratory for permission to use the term askarel.

Mineral oil evolves combustible hydrogen and hydrocarbon gases.

For all practical purposes, the amount of gas liberated from mineral oil or askarel under a given set of conditions is about 100 cubic centimeters per kilowatt-second.

APPENDIX B

SOLUBILITY OF GAS IN
TRANSFORMER ASKAREL

	Percent of Gas By Volume Corrected to:			
	25°C. 760 mm		0°C. 760 mm	
	25°C.	100°C.	25°C.	100°C.
Carbon dioxide	71%	47%	—	—
Air	5.7	4.9	5.8	5.0
Nitrogen	6.0	4.8	5.5	4.4
Hydrogen chloride[1]	37.8	50.9	—	—

1) In absence of scavenger

APPENDIX C

APPROXIMATE VAPOR PRESSURE vs.
TEMPERATURE FOR TRANSFORMER ASKAREL

Temperature °C	Inerteen PPO, 7336-9	Transformer Pyranol A13B3B
40	1 mm Hg.	0.9 mm Hg.
60	5	3.5
80	9	8.3
100	30	18
120	60	32
140	90	53

APPENDIX D

EFFECT OF TEMPERATURE ON
DIELECTRIC STRENGTH OF ASKAREL

Temperature °C.	Dielectric Strength
—60	67 KV
—40	63
—20	57
0	55
20	50
40	50
60	48
80	45

APPENDIX E

COMPARISON QF THE APPROXIMATE VISCOSITY IN
SAYBOLT UNIVERSAL SECONDS OF TRANSFORMER
ASKARELS AND MINERAL OIL

Temp. °C.	Transformer Pyranol A13B3B	10-C Mineral Oil	Inerteen PPO, 7336-9
—20	1,000	1,000	2,800
0	100	150	195
20	70	85	85
40	45	49	50
60	39	40	40
80	34	34	36
100	30	30	33

APPENDIX F

THE DENSITY OF INERTEEN PPO
7336-9 AND TRANSFORMER PYRANOL A13B3B
Approx. Density gm/cc.

Temperature °C.	Inerteen PPO, 7336-9	Transformer Pyranol A13B3B
0	1.574	1.577
20	1.552	1.555
40	1.529	1.532
60	1.507	1.510
80	1.485	1.488

APPENDIX G

The thermal conductivity values of transformer Pyranol A13B3B at 27°C. and 58°C. are 26.2 and 25.8 x 10^{-5} calories centimeters^{-1}, degrees centrigrade^{-1}, second^{-1}, respectively. Or, approximately 0.06 BTU per (hr.) (sq. ft.) (°F.) per foot. This same approximation applies to Inerteen PPO (7336-9).

APPENDIX H

Heat Capacity

Over the temperature range of 25° to 125°C. the specific heat of transformer askarel is close to 0.30 calories per gram per degree.

APPENDIX I

Coefficient of Expansion

The average coefficient of expansion of transformer askarel over the temperature range 20 to 100°C. is 0.007 cc/cc/°C. One gallon would increase to 1.056 gallons on heating from 20 to 100°C.

APPENDIX J

Fire-Resistance

To use the generic name "askarel," the fluids must be approved by the Underwriters' Laboratories as possessing adequate fire-resistance and freedom from forming explosive gases when arced. These liquids do not have a burn point (ASTM D92-33) (Cleveland open cup method) up to about 205°C., at which temperatures they begin to boil. The significance of this is that they do not burn or support combustion under conditions encountered in transformer operation. Thus the danger of secondary explosion (or fire) is eliminated.

APPENDIX K

Seals, Properties and Procurement

Dow Corning Corporation, Midland, Michigan with District's at Atlanta, Boston, Chicago, Cleveland, Dallas, Los Angeles, New York City, Washington, D. C. and Toronto has available Bulletin 09-019, August 1962 entitled "**Silastic Design Data**". This lists the gasket fabricators throughout the country from whom the "Silastic 50" gasketing can be purchased in sheet, extrusions or molded shapes.

Generally Silastic 50 sheet goods are stocked by local die cutters, hence, could be generally purchased locally. Usually, small quantities of gaskets are die cut. If larger quantities are needed, tools are made of the same type used to cut other elastomers.

Where the gasket is extruded for fitting into a machined groove or between gasket stops, Dow-Corning advises use of a scarved joint. This joint is then cemented using Dow Corning's Silastic 140 (clear) or their RTV 731 (white) materials, which air cure.

Dow Corning points out that the local "rubber" fabricators purchase the Silastic 50 in billet form. This is worked on a roll mill in preparation for sheeting or extrusion. Then to obtain the desired physical properties the fabricator must oven cure the Silastic 50 for 24 hours at 480°F.

SPECIFICATIONS*

	Color.....White
	Specific Gravity at 77°F. .....1.20 ± 0.02
ASTM D676 —	Hardness, Shore A. Scale.....45 to 60
ASTM D412 —	Tensile Strength, psi. min.....800
ASTM D412 —	Elongation, percent, min.....250
ASTM D395	Compression Set after 22 hours at 300°F., percent, max..... 30

* All physical properties measured on 0.075 inch thick samples molded 5 minutes at 240°F., and oven cured 24 hours at 480°F.

General Electric Company, Redmond Circle, Rome, Ga., uses silicone or DuPont's Viton wherever it is not possible or desirable to weld. For some small seals, where good matching surfaces are provided, Flexitallic stainless steel rings are used.

By contacting the Engineering Services Department of General Electric Company, Redmond Circle, Rome, Ga., users of Pyranol transformers made prior to development of these modern seals will obtain prompt assistance for conversion.

Users of askarel transformers made by other manufacturers should contact the original transformer manufacturer, or Monsanto for assistance in converting to these modern seals.

NOTES

MONSANTO
FUNCTIONAL FLUIDS DEPT.

800 N. LINDBERGH BLVD.
ST. LOUIS, MISSOURI 63166

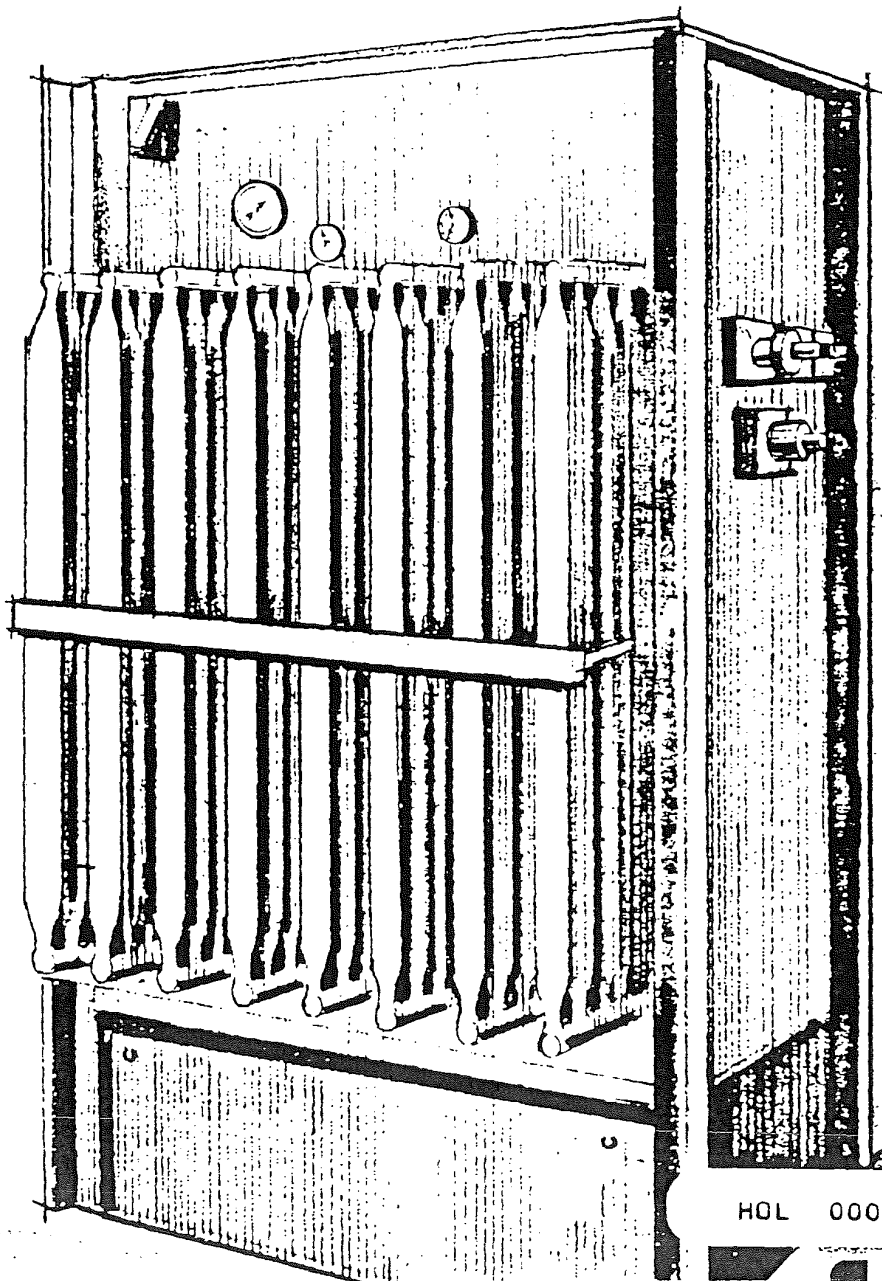
The information herein regarding obtaining optimum results from askarel fluids in your transformer has been accumulated by Monsanto for over 30 years from the experience of makers and users of askarel transformers and it is believed will be helpful.

Nothing herein shall be construed as applying to other than askarel insulation. Data and maintenance suggestions herein do not apply to the other components of the transformer. All operating and maintenance suggestions recommended by the manufacturer of the transformer should also be carefully followed.

Because these maintenance directions apply only to the askarel insulation, Monsanto disclaims any liability for damage to property or injury to persons arising from transformer operation.

HOLLAN 7202-002092 Litho in U.S.A.

when Specifying Transformers here's how to get more performance and save money



Monsanto

ASKAREL

the fire-resistant dielectric preferred by specifiers who want to save money now and for years to come

askarel fire-resistant transformers offer

Lower Operating Costs
due to lower power losses

High Impulse Strength
giving a margin of safety against transformer failure

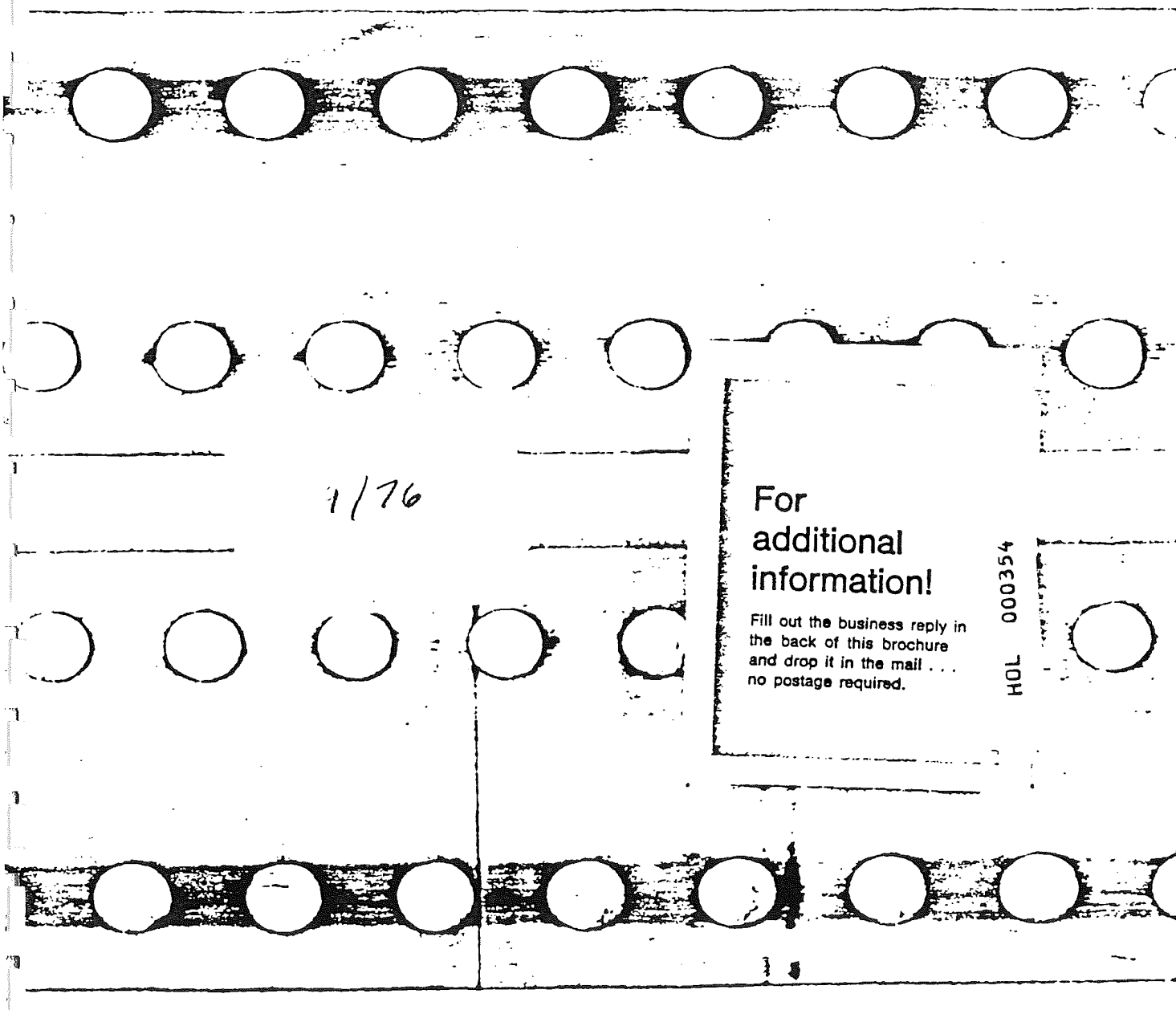
Low Maintenance Costs
install them and leave 'em alone

Low Installation Costs
place them where YOU want them placed

Fire Resistance
askarel provides safety from fire

Quietness
naturally designed to be quieter than open dry types

Reliability
more than 30 years of trouble-free operation



1/76

For additional information!

Fill out the business reply in the back of this brochure and drop it in the mail . . . no postage required.

HOL 000354

HOLLAN 7202-002208

why askarel...

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Askarel units deliver a steady power flow year after year, offering lower operating and maintenance costs, quietness and dependability. They are fire-resistant and allow you to place them where YOU want them placed, right at the point of use if you choose. Think of the savings in installation alone!

Askarel will not oxidize or sludge; remains chemically stable when subjected to elevated temperatures and will not corrode metals.

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HOL 000355

HOLLAN 7202-002209

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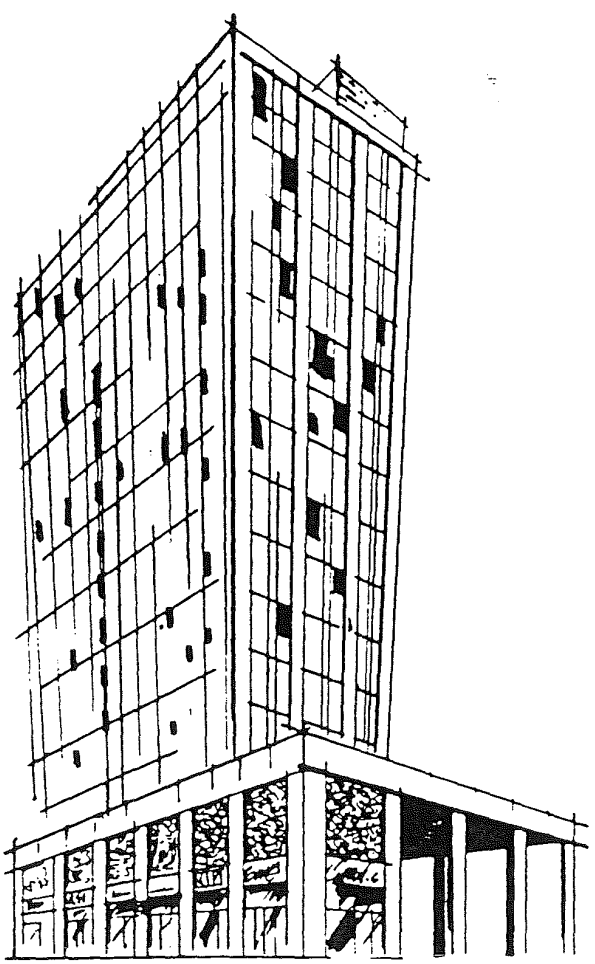

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HOLLAN 7202-002210

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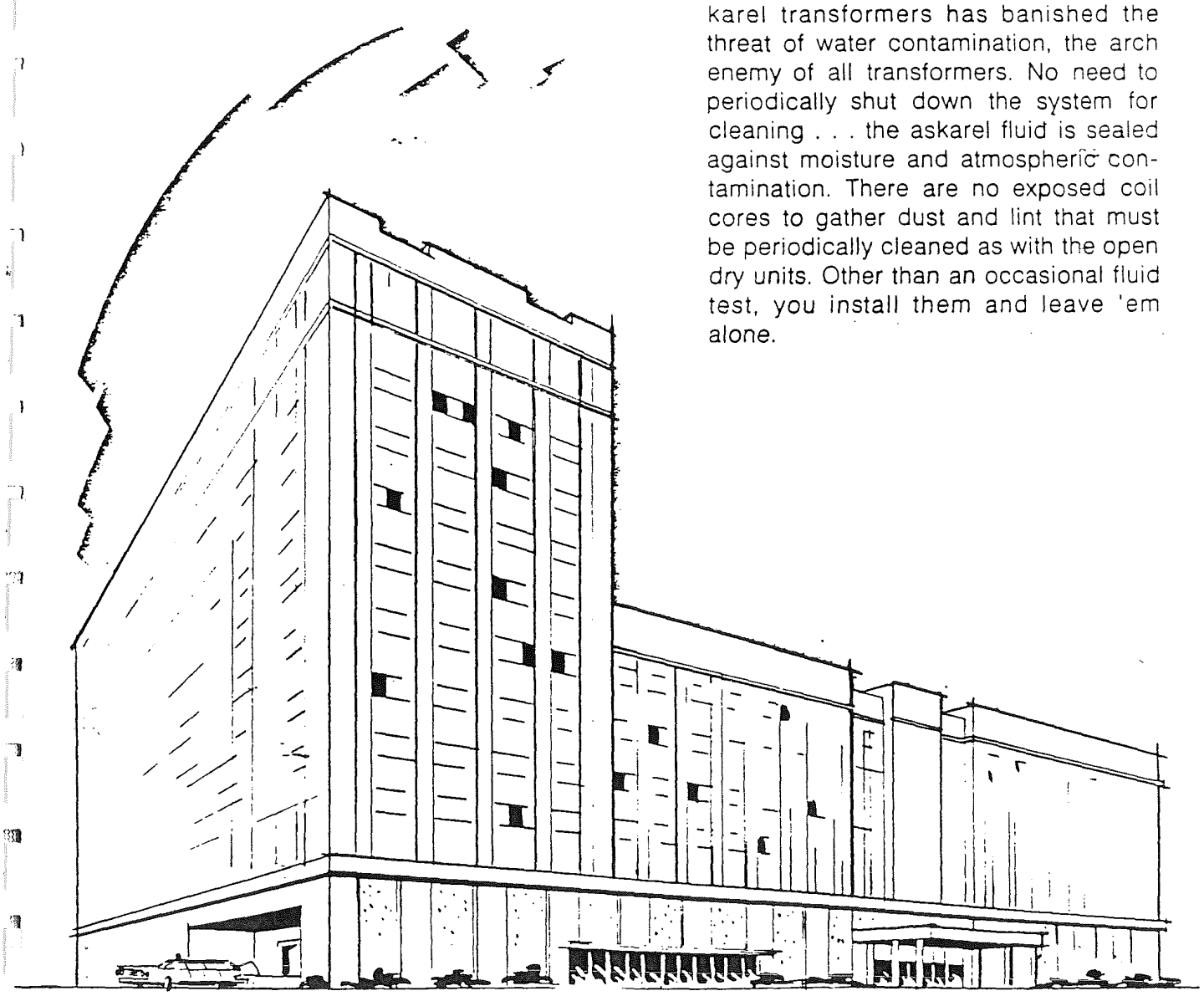

askarel fire-resistant transformers can give you lower installation costs

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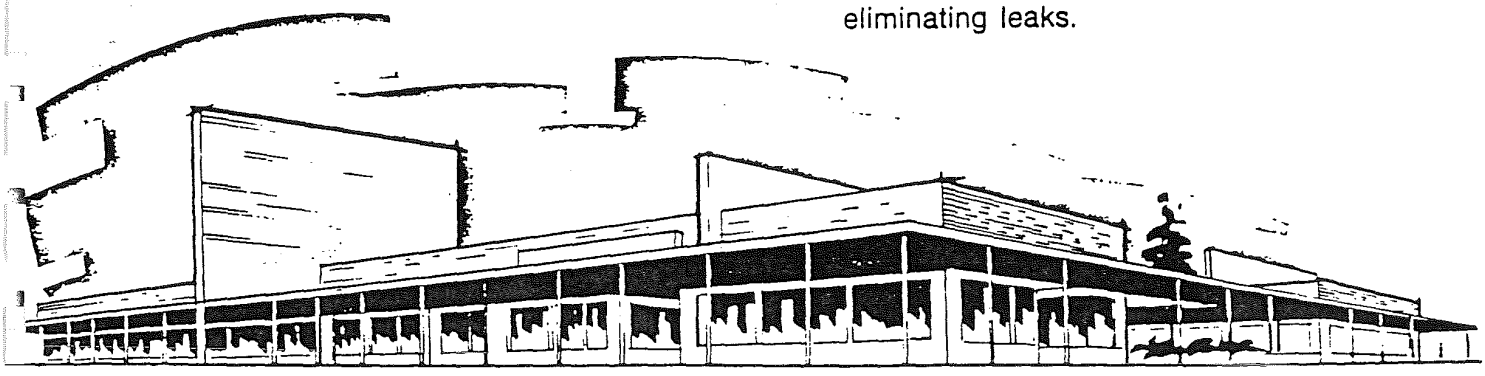

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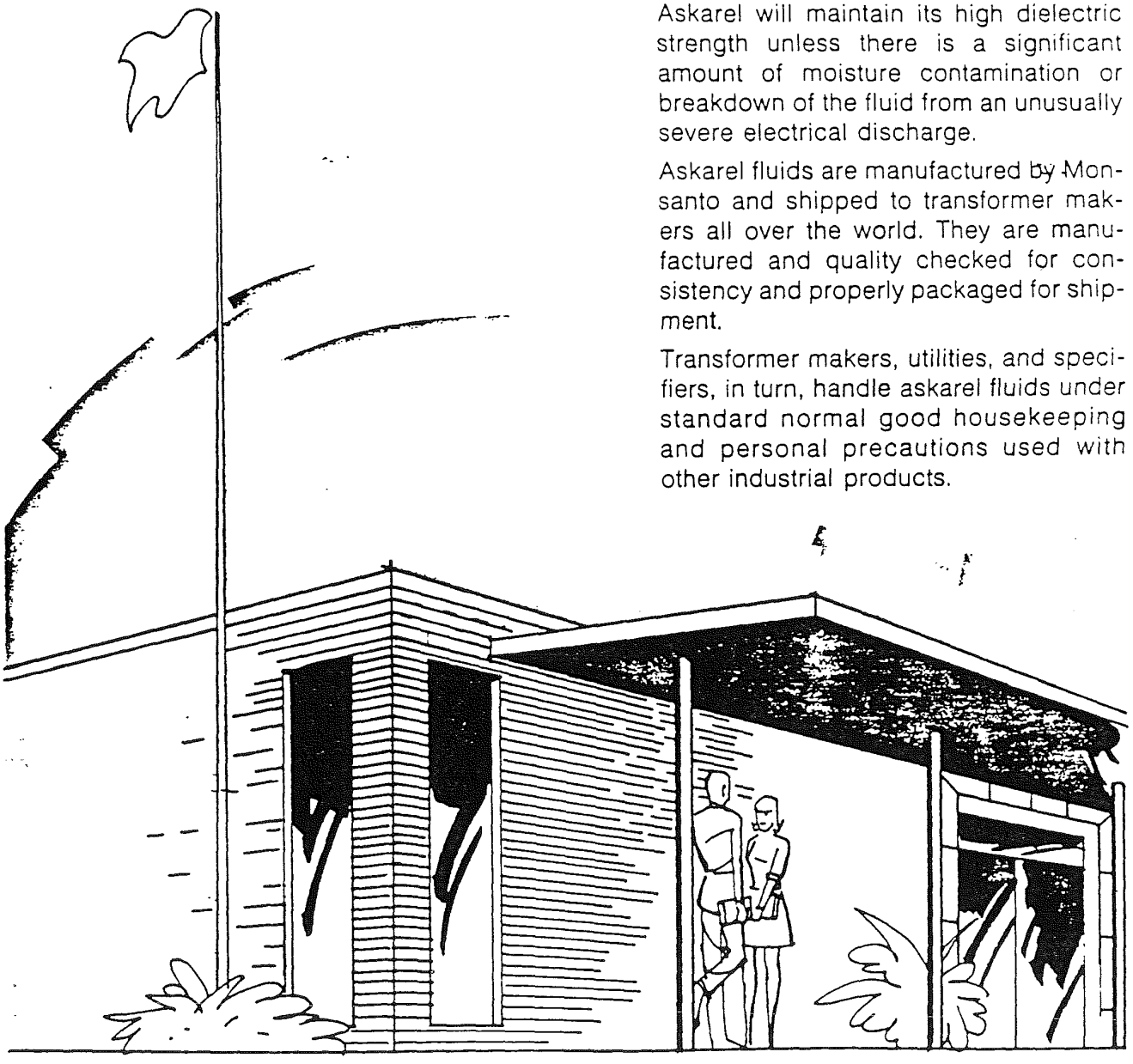
HOLLAN 7202-002213

askarel fluids
maintain high dielectric strengths

The most significant and reliable measurement of transformer askarel electrical performance is its dielectric strength. Askarel will maintain its high dielectric strength unless there is a significant amount of moisture contamination or breakdown of the fluid from an unusually severe electrical discharge.

Askarel fluids are manufactured by Monsanto and shipped to transformer makers all over the world. They are manufactured and quality checked for consistency and properly packaged for shipment.

Transformer makers, utilities, and specifiers, in turn, handle askarel fluids under standard normal good housekeeping and personal precautions used with other industrial products.



before you specify... consider askarel transformers

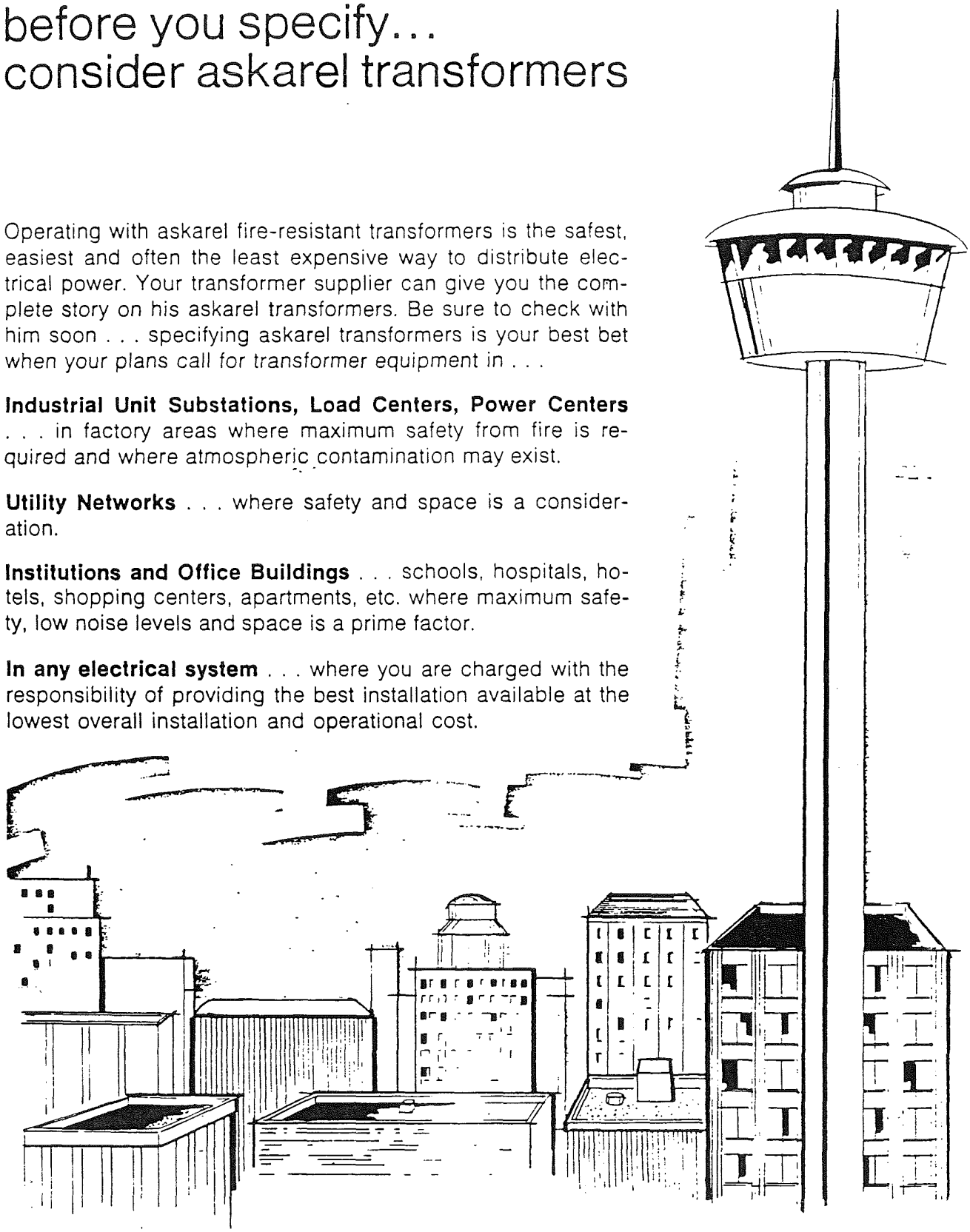
Operating with askarel fire-resistant transformers is the safest, easiest and often the least expensive way to distribute electrical power. Your transformer supplier can give you the complete story on his askarel transformers. Be sure to check with him soon . . . specifying askarel transformers is your best bet when your plans call for transformer equipment in . . .

Industrial Unit Substations, Load Centers, Power Centers . . . in factory areas where maximum safety from fire is required and where atmospheric contamination may exist.

Utility Networks . . . where safety and space is a consideration.

Institutions and Office Buildings . . . schools, hospitals, hotels, shopping centers, apartments, etc. where maximum safety, low noise levels and space is a prime factor.

In any electrical system . . . where you are charged with the responsibility of providing the best installation available at the lowest overall installation and operational cost.



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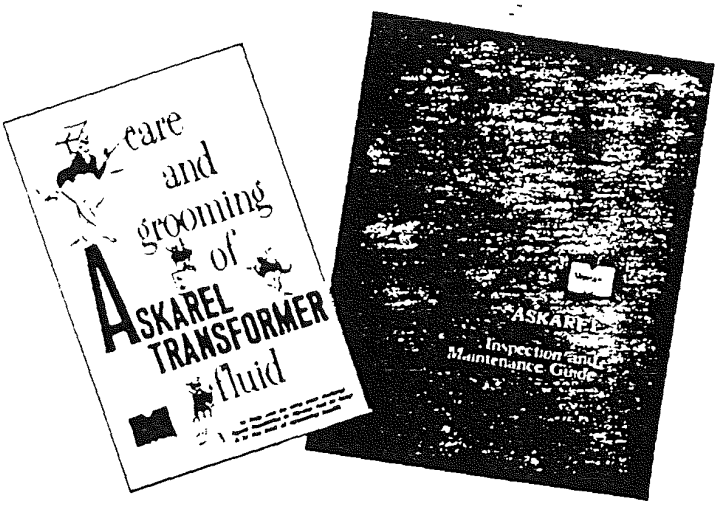
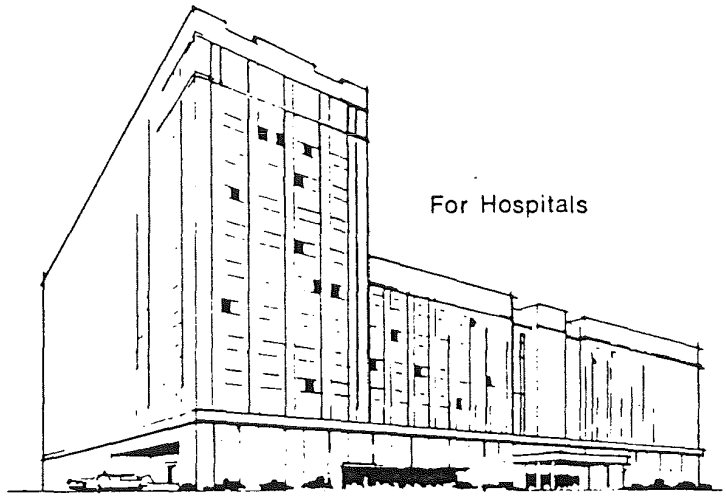
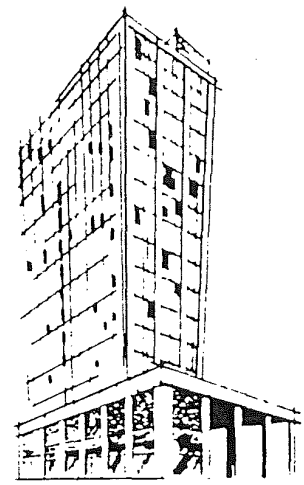


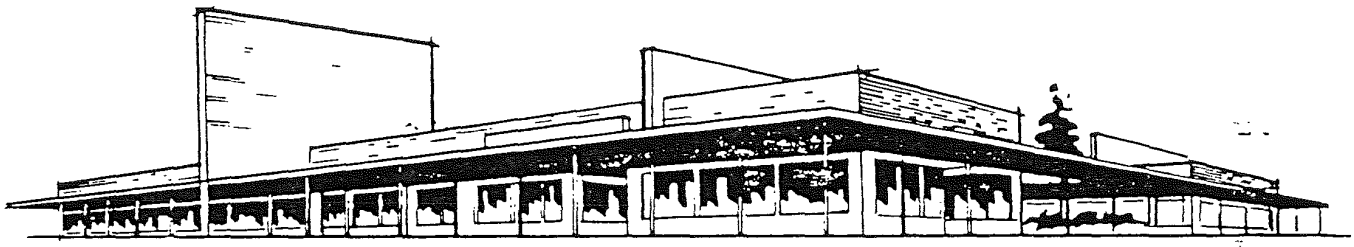
Monsanto will be happy to supply you with a copy of "The Care and Grooming of Askarel Transformer Fluid" or "Monsanto Askarel Inspection and Maintenance Guide." Ask your supplier to get your copy for you, or simply return the attached business reply card.



For Hospitals

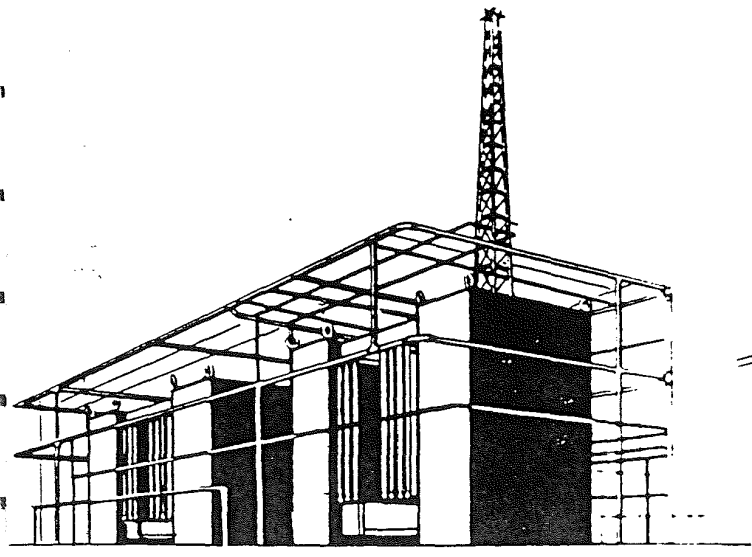


For High-rise Buildings



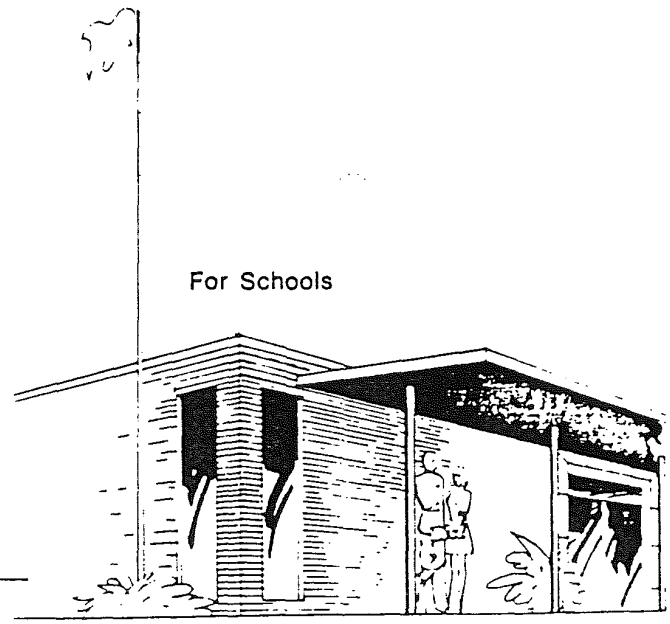
For Shopping Centers

specify askarel for your next job!



For Industrial Load Centers

For Schools



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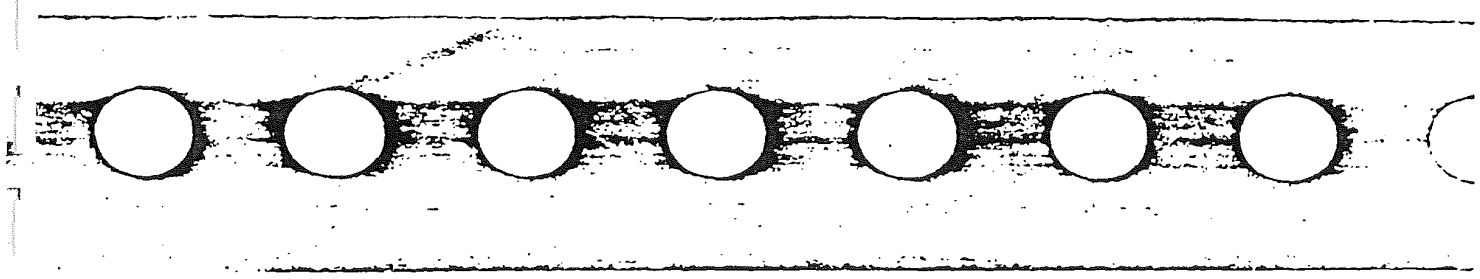

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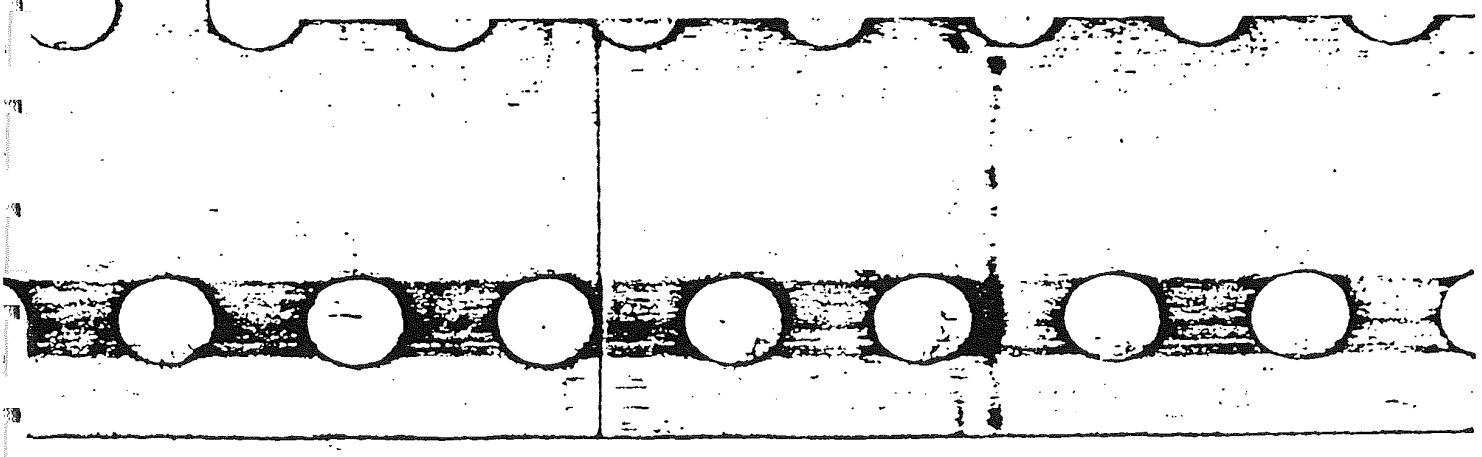

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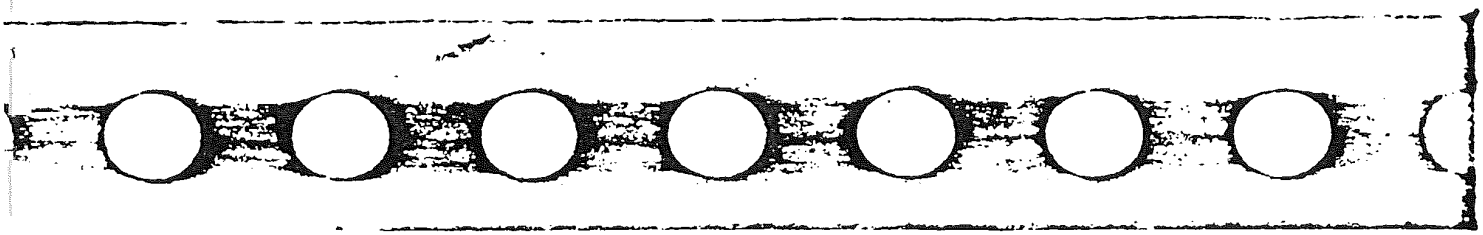

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Functional Fluids Dept. 323
800 North Lindbergh Blvd.
St. Louis, Missouri 63166

Please send the literature checked

- ☐ The Care & Grooming of Askarel Transformer Fluid
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Name/Title_____

Company_____

Address_____

City/State/Zip_____

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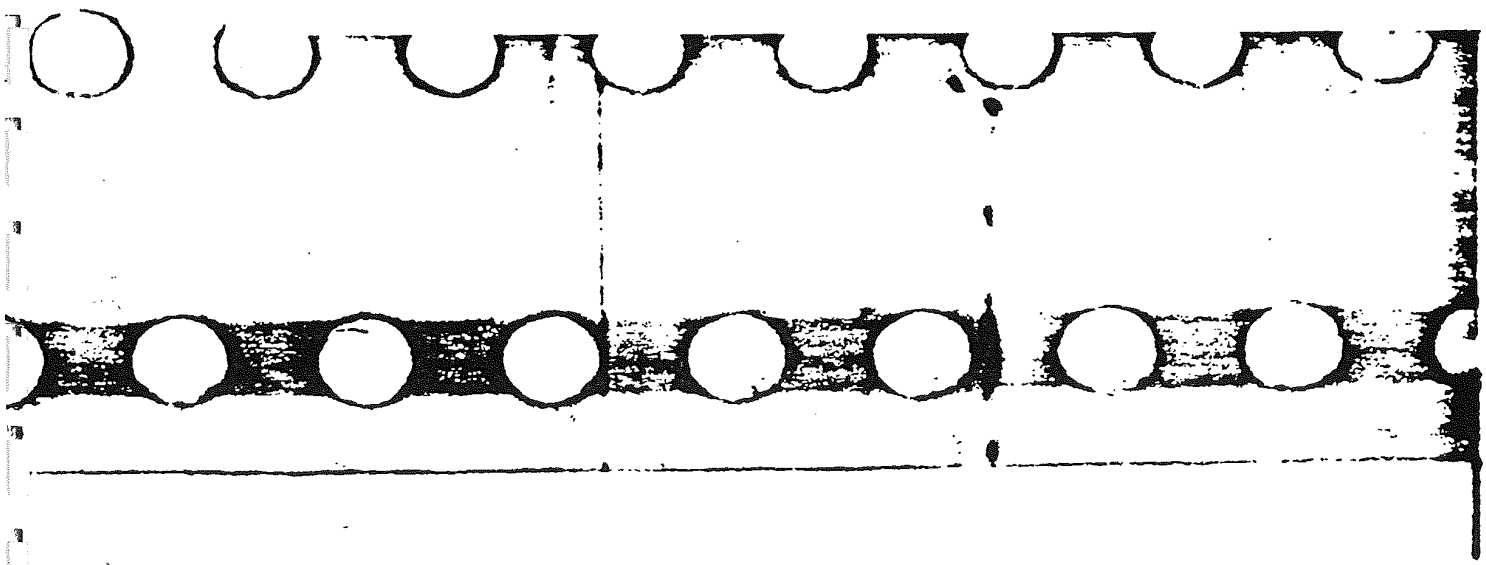

HOLLAN 7202-002219

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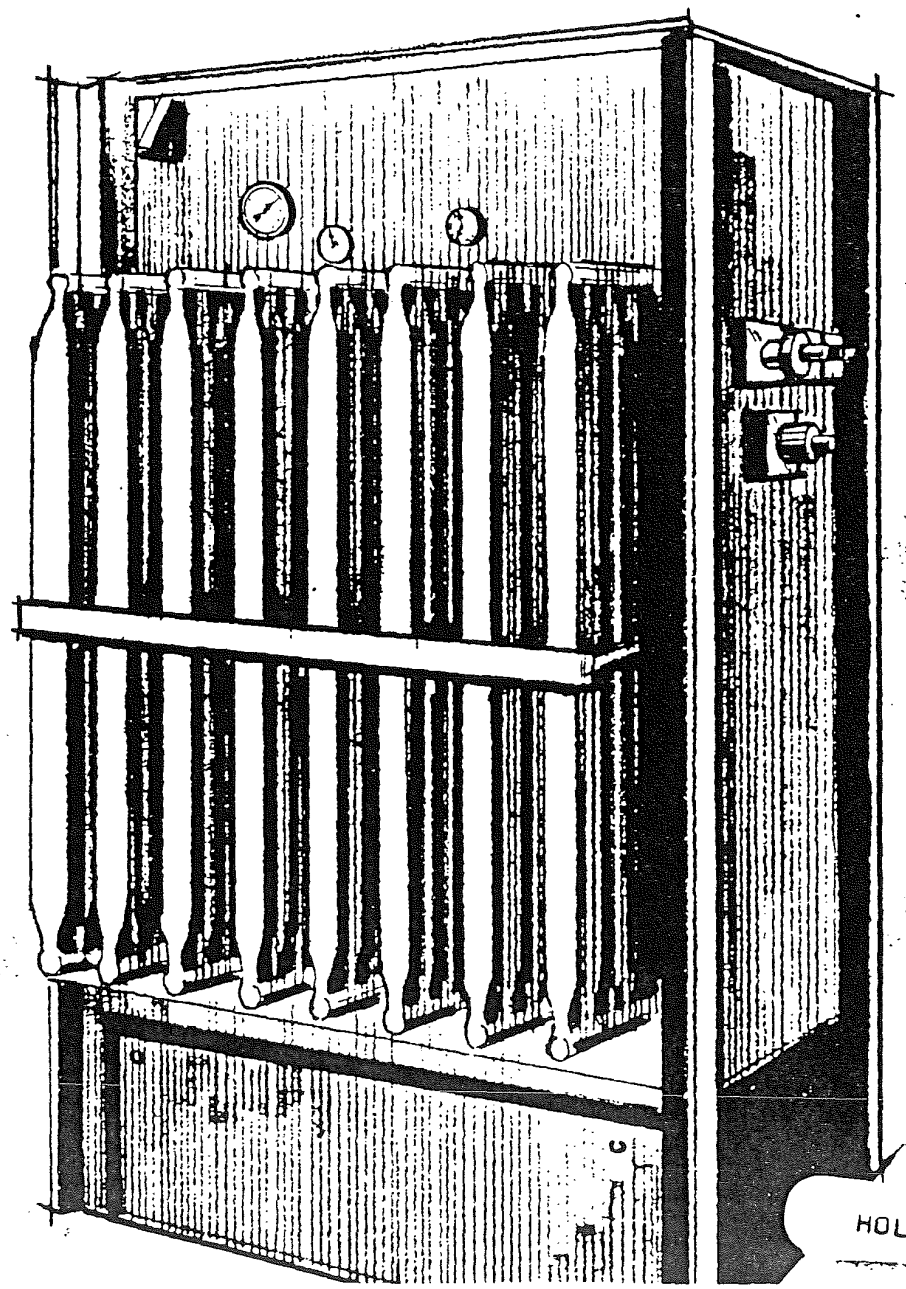
when Specifying Transformers here's how to get more performance and save money



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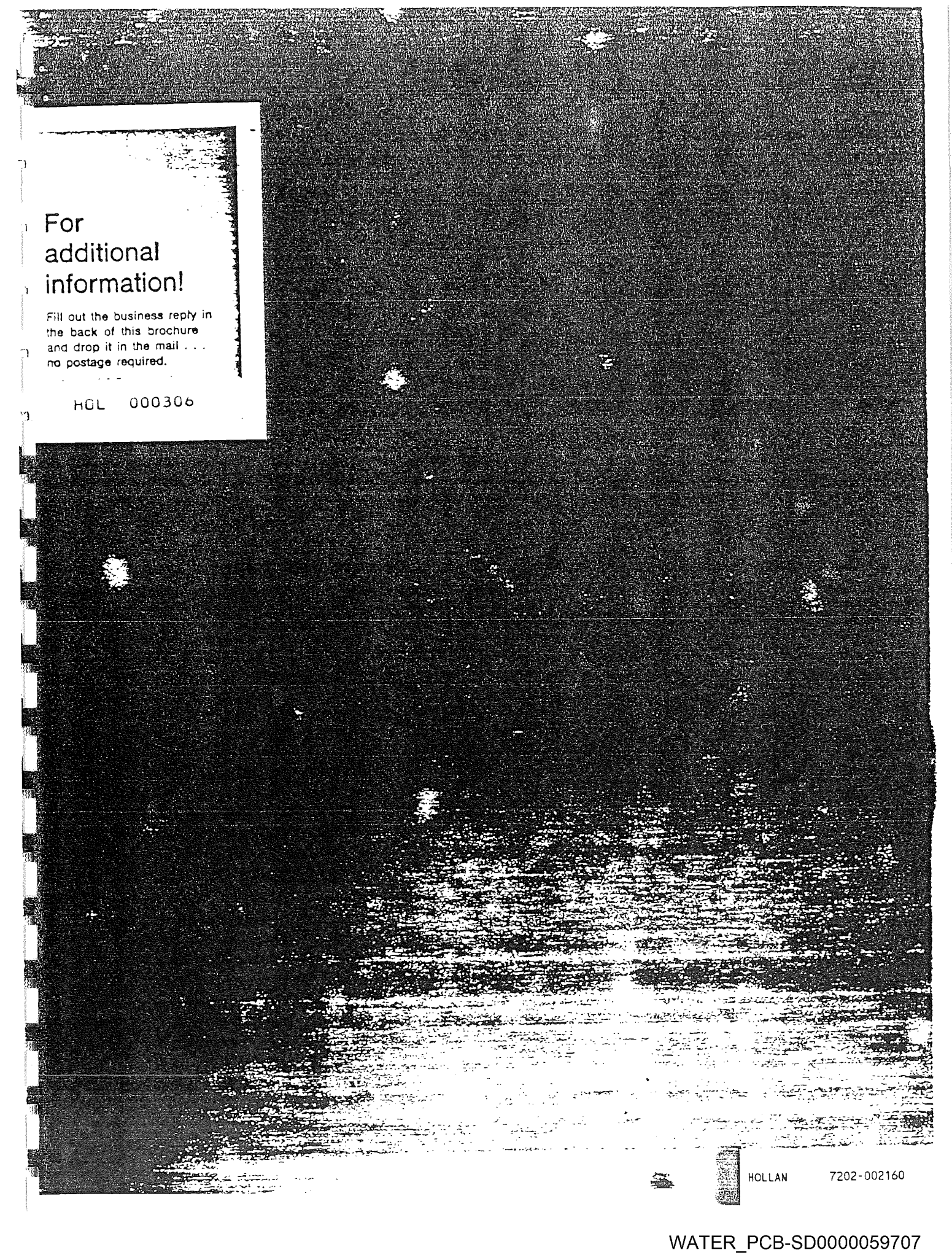

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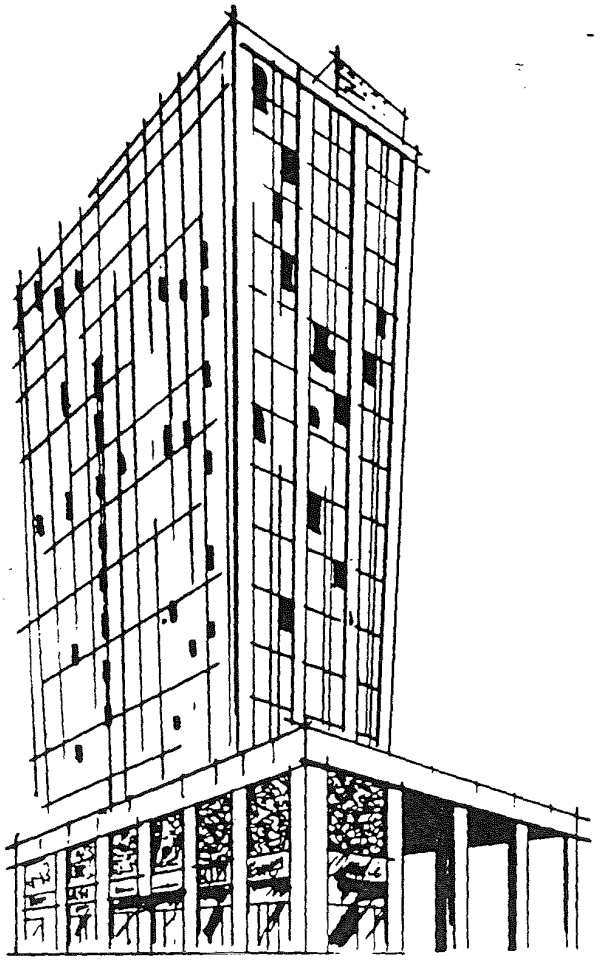

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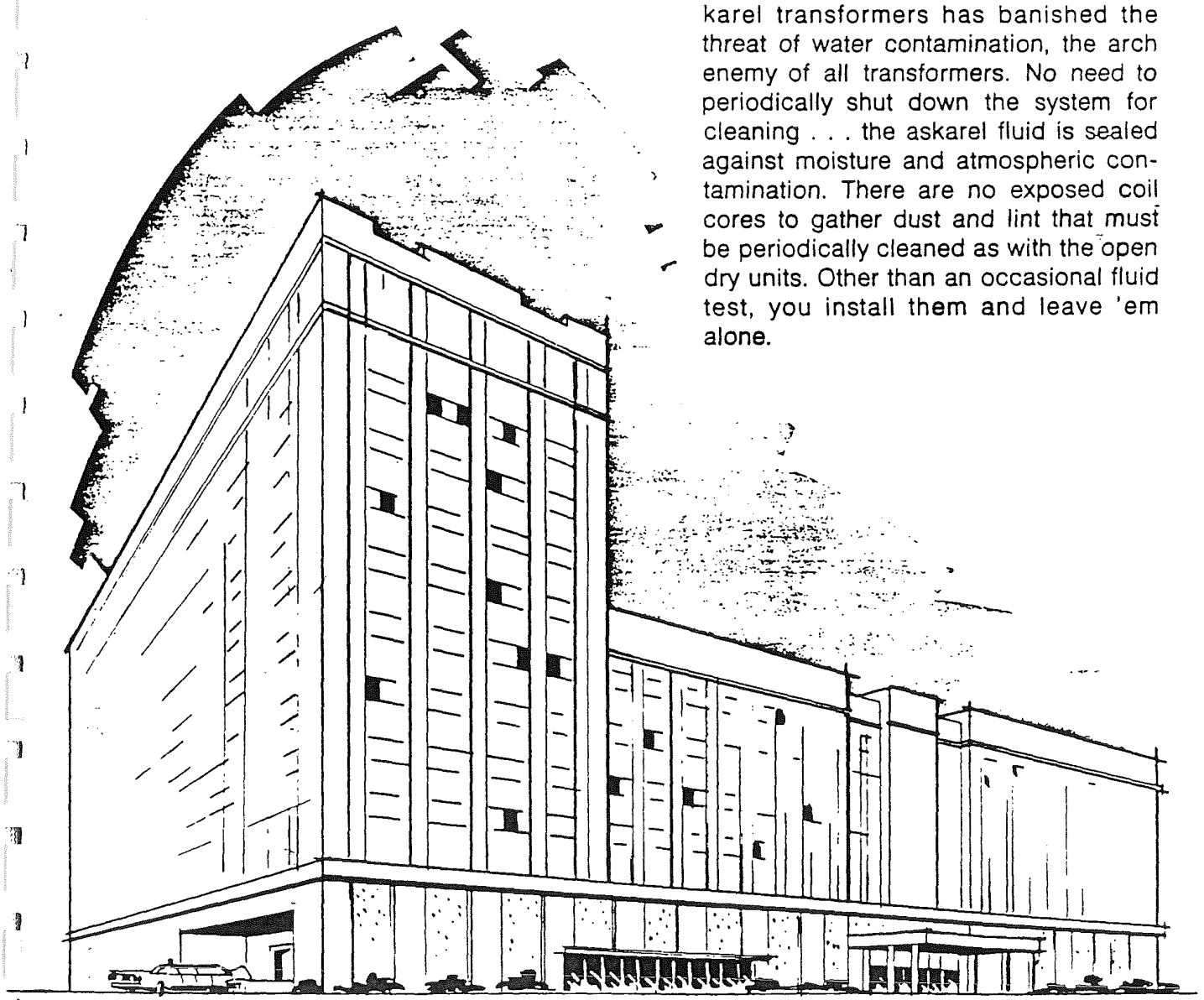

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HOLLAN 7202-002163

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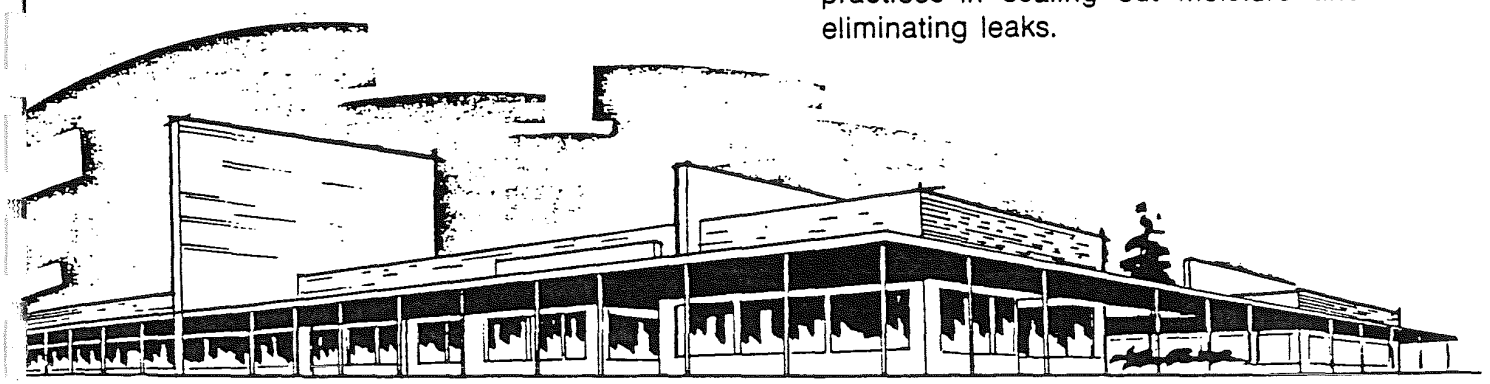

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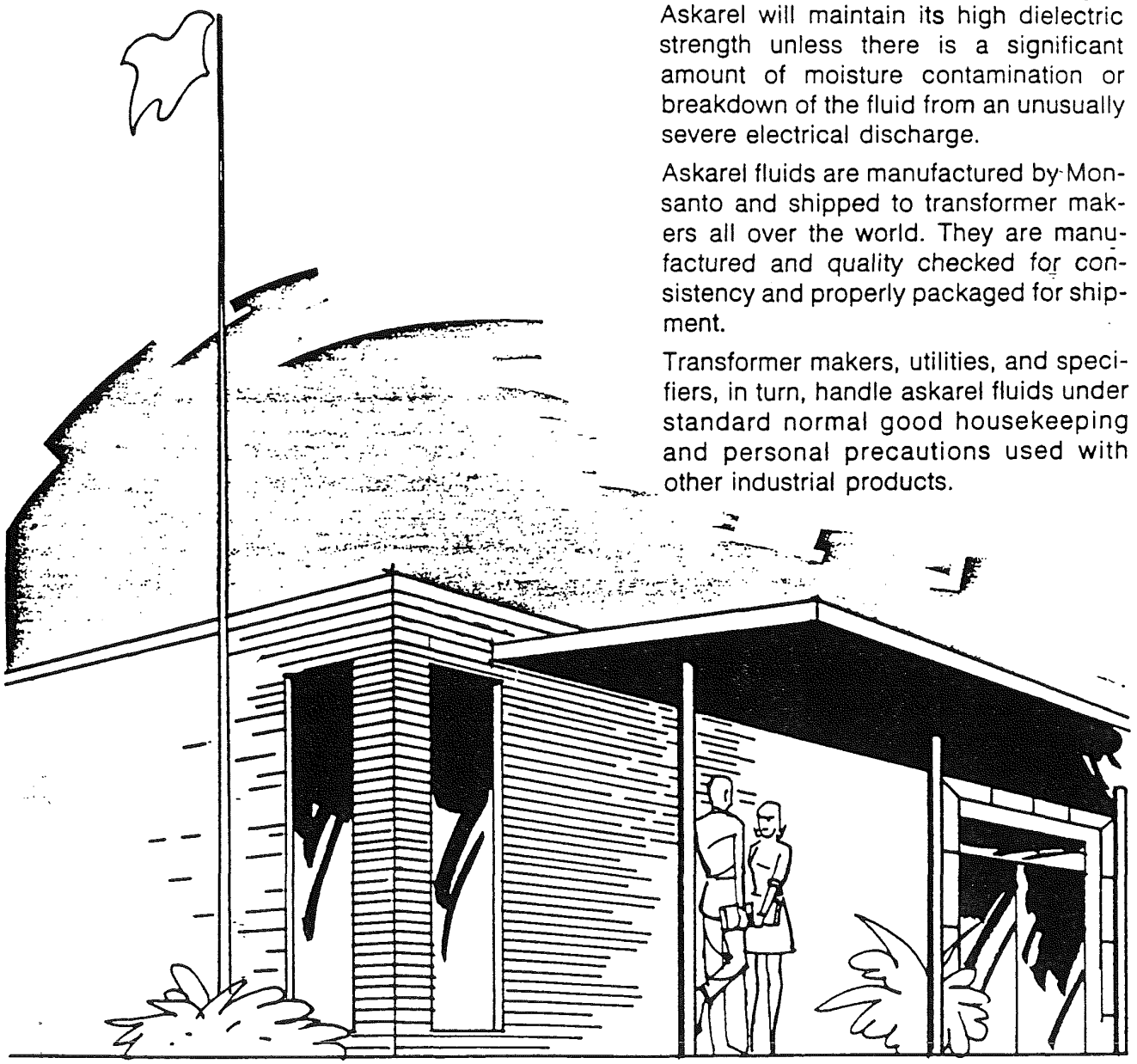


before you specify... consider askarel transformers

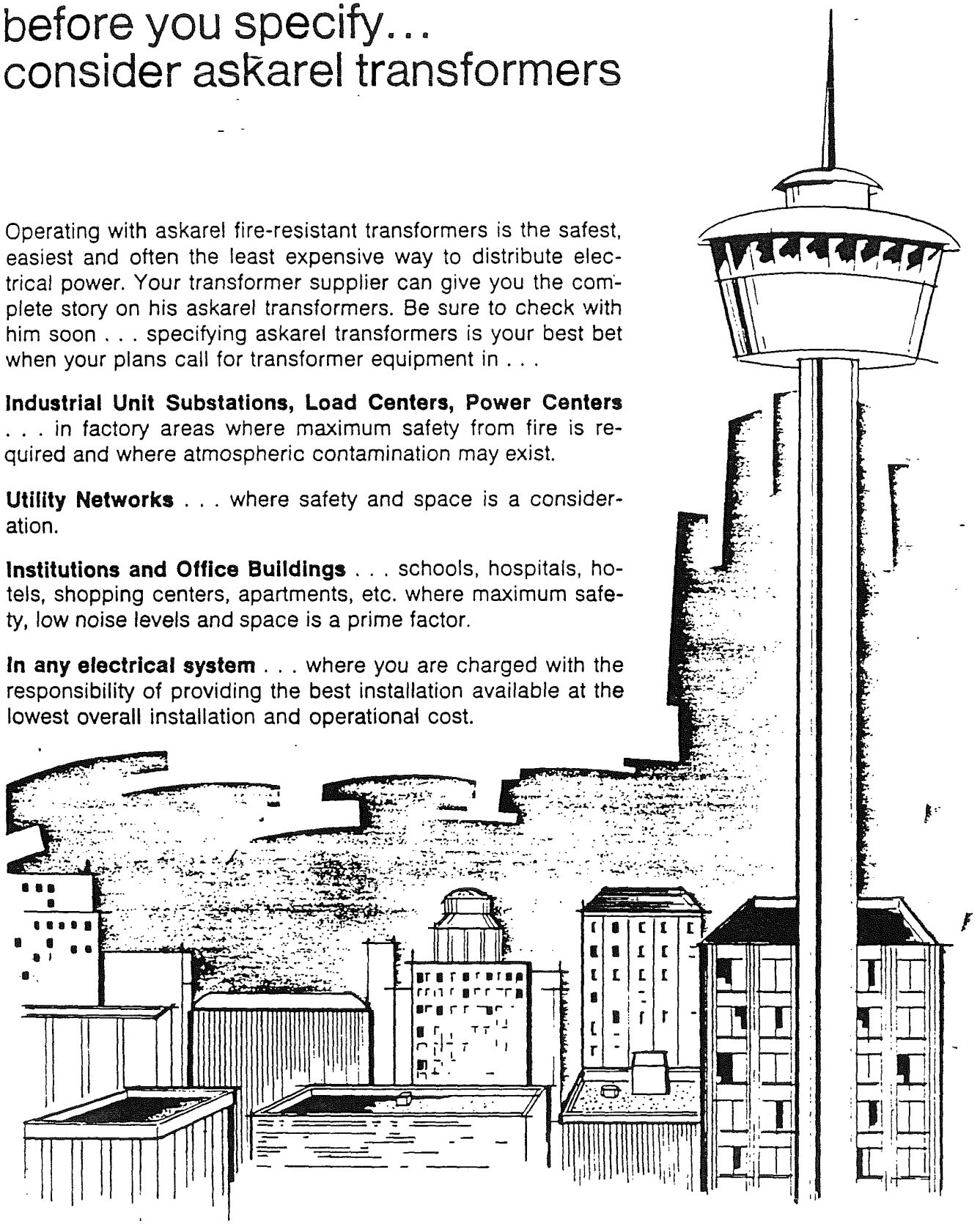
Operating with askarel fire-resistant transformers is the safest, easiest and often the least expensive way to distribute electrical power. Your transformer supplier can give you the complete story on his askarel transformers. Be sure to check with him soon . . . specifying askarel transformers is your best bet when your plans call for transformer equipment in . . .

Industrial Unit Substations, Load Centers, Power Centers . . . in factory areas where maximum safety from fire is required and where atmospheric contamination may exist.

Utility Networks . . . where safety and space is a consideration.

Institutions and Office Buildings . . . schools, hospitals, hotels, shopping centers, apartments, etc. where maximum safety, low noise levels and space is a prime factor.

In any electrical system . . . where you are charged with the responsibility of providing the best installation available at the lowest overall installation and operational cost.



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HOLLAN 7202-002167

send for detailed information...

Monsanto will be happy to supply you with a copy of "The Care and Grooming of Askarel Transformer Fluid" or "Monsanto Askarel Inspection and Maintenance Guide." Ask your supplier to get your copy for you, or simply return the attached business reply card.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

FIRST CLASS
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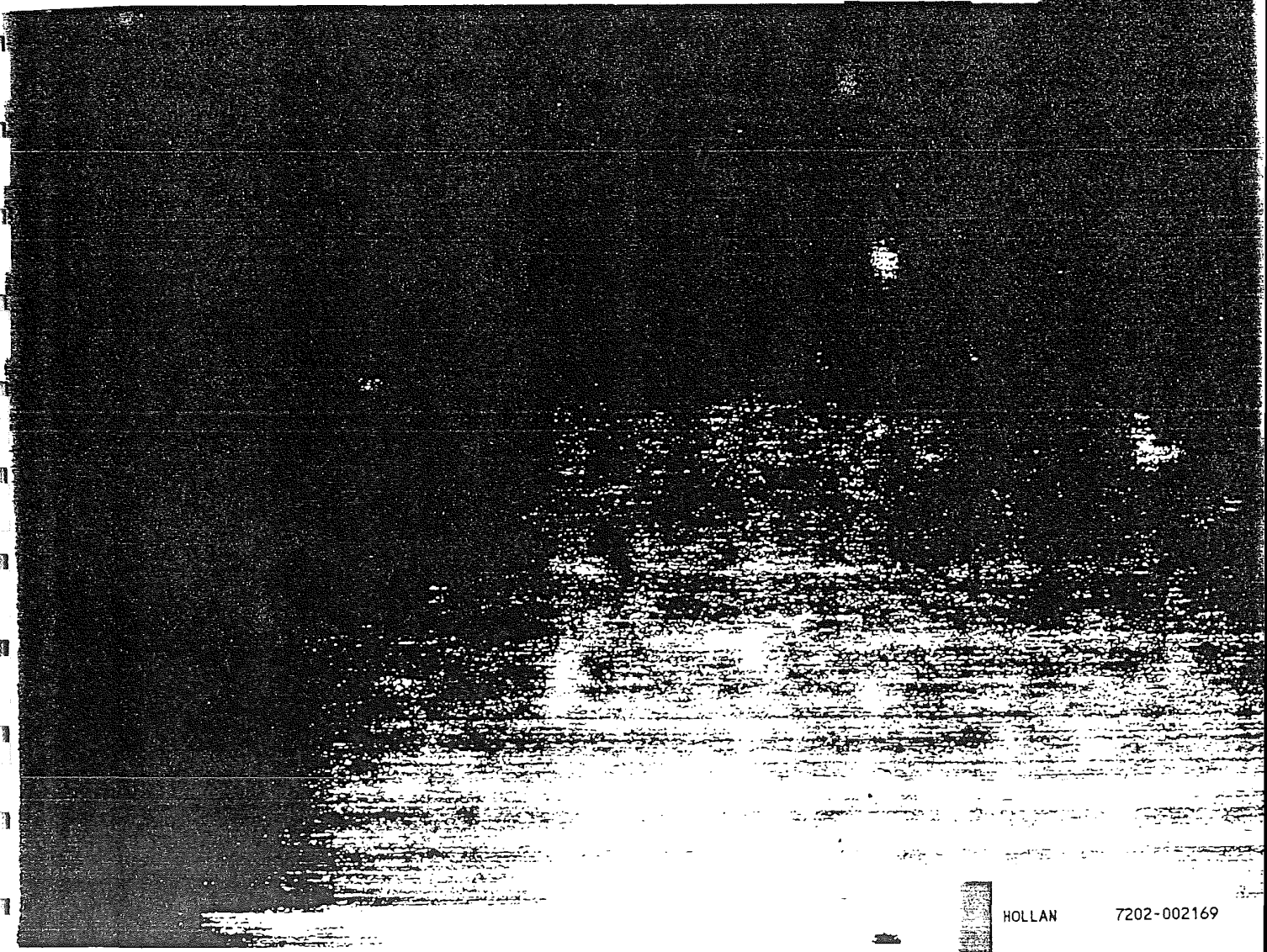

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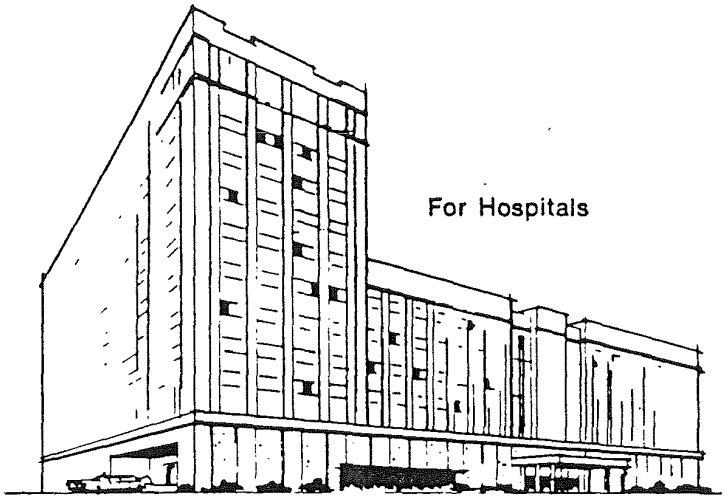
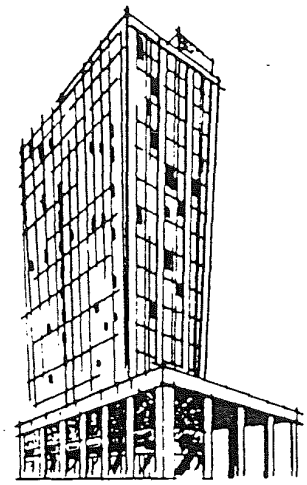
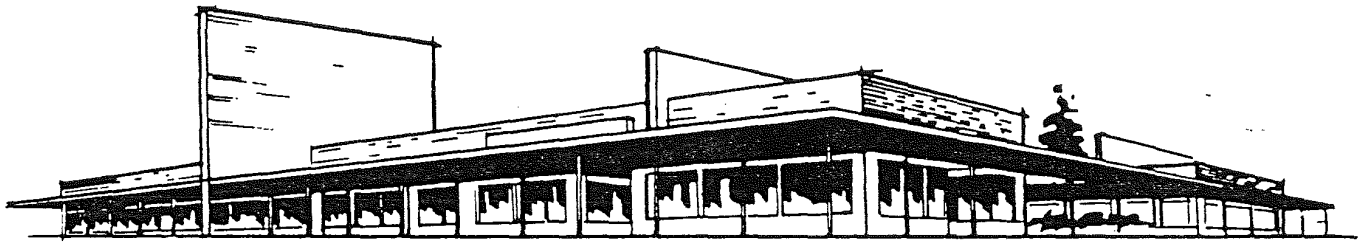


For Hospitals

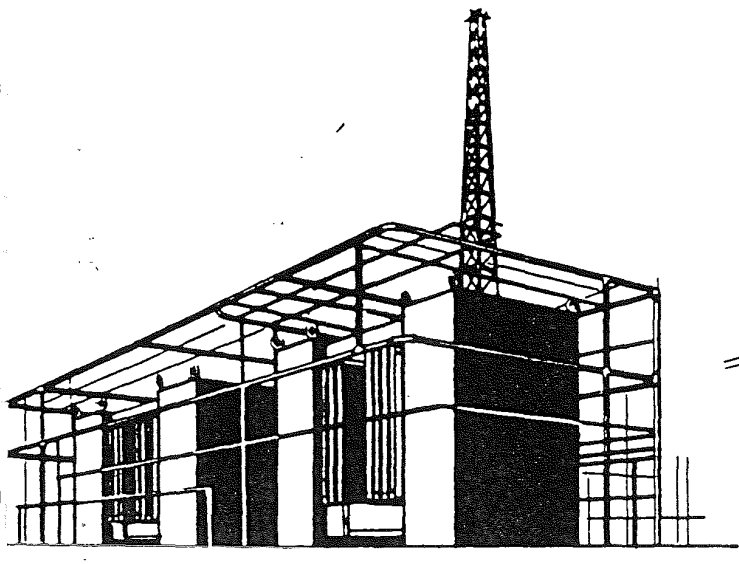


For High-rise Buildings

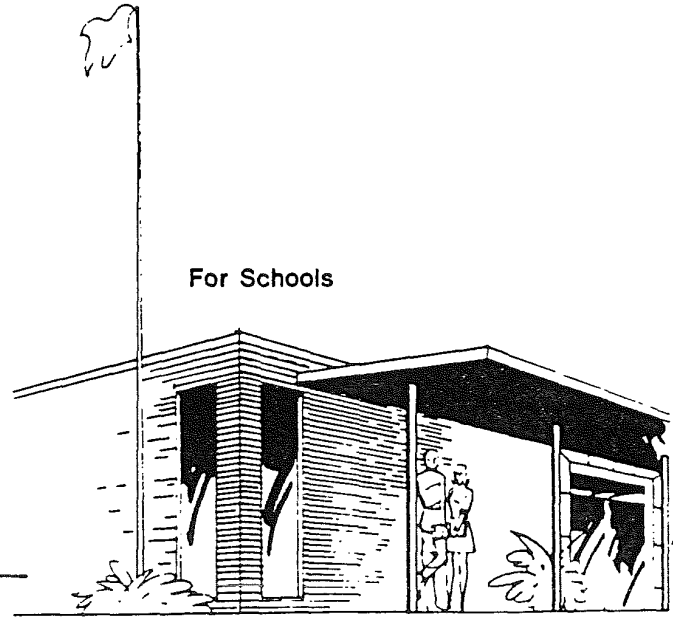


For Shopping Centers

specify askarel for your next job!



For Industrial Load Centers



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Inspection and Maintenance Guide

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ASKAREL

Inspection and Maintenance Guide

SECTION B
ASKAREL FILLED SWITCHES AND TERMINAL CHAMBERS

SECTION C

Appendix

Askarel liquid insulation is made by thinning Aroclor 1260 with trichlorobenzene or tri-, tetrachlorobenzene mix. The first transformer askarel was made in 1932, in accordance with General Electric Company's patents, and was trademarked Pyranol 1488. Westinghouse, too, offered this askarel insulation in 1936 under their trademark Inerteen.

In the mid-1940's, as shown in the following table, tin tetraphenyl was added to General Electric's Pyranol to scavenge hydrogen chloride. Shortly thereafter, Westinghouse added phenoxy propene oxide to Inerteen for the same purpose. In 1963, General Electric replaced tin tetraphenyl with a diepoxide scavenger. This new formula, which replaces previous Pyranols, is called Transformer Pyranol A13B3B. *Thus, today the two commercial types of formulations are General Electric's Transformer Pyranol A13B3B type and Westinghouse Inerteen PPO (7336-9) type.*

The composition changes made in transformer askarel formulations are shown in Table I.

Table I

THE COMPOSITION OF TRANSFORMER ASKARELS

	Pyranol					Inerteen PPO
	1488	1467	1470	A13B3B	Inerteen	(7336-9)
Year Introduced.....	1932	1944	1952	1963	1936	1945
Ingredients:						
Aroclor 1260.....	60	60	45	45	60	60
Trichlorobenzene.....	40	40	40	40	40	40
Tetrachlorobenzene.....			15	15		
Tin tetraphenyl.....		0.125	0.125			
Phenoxy propene oxide.....						0.20
Diepoxide.....				0.125		

OTHER BRAND NAMES

Various electrical equipment manufacturers use other trade-marked names for askarel liquid insulation, such as Chlorextol (Allis-Chalmers); Noflamol (Wagner Electric); Saf-T-Kuhl (Kuhlman Electric). These askarel insulating liquids are one or the other of the two standard formulations. Still other manufacturers, who designate their insulation only by its generic name, askarel, assign it a number or code. By this number, Monsanto knows whether to furnish Pyranol A13B3B or Inerteen PPO (7336-9) type formulation to the user.

III. OFFICIAL TRANSFORMER ASKAREL SHIPPING SPECIFICATIONS

The official shipping specifications for the two modern transformer askarel formulations are shown in Table II.

IV. INTERCHANGEABILITY AND STABILITY

A. Interchangeability:

The two general types of askarel insulation shown in Table II can be either mixed or interchanged and there will be no difference in the operation of the transformer. However, askarel insulation *must never be mixed* with mineral oil.

Over 2% mineral oil in askarel begins to lower its fire resistance. Further, materials of construction in the transformer that are compatible with askarel may not be compatible with oil and vice-versa. For example: a significant amount of askarel in a transformer built for mineral oil will attack gaskets, adhesives, core bindings, impregnating varnishes, etc.

B. Stability:

Askarel liquid insulation is highly pure, fire-proof liquid made under close chemical control. It does not vary in composition like the commercial range of mineral oils.

Askarel does not deteriorate when exposed to air, heat, hot metal; it does not break down over long use to form conducting or corrosive chemicals; it does not oxidize or sludge. Askarel will remain perfectly stable year after year unless broken down by exposure to severe arcing.

The only real "enemy" of askarel is *contamination by water*. Keeping askarel water-free will insure long-time service.

Askarel is heavier than water. If water gets into askarel insulation, only a tiny amount (125 ppm) dissolves — the rest floats on top.

V. DIRECTIONS FOR HANDLING

A. Keep Dry:

In handling, storing, sampling, inspecting askarel — and in operating askarel transformers — take every precaution to guard the askarel insulation from exposure to high humidity and moisture contamination. Keep 5, 30, or 55 gallon drums of askarel dry; lay stored drums on their sides with the bung at the highest point from floor to keep water off the drum head (which can be sucked into the askarel by the drum "breathing"). This precaution is not necessary when drums are stored indoors, which is the preferred way of storing.

B. Use Ordinary Personal Precautions:

Transformer askarel has been made, handled, and used for over 30 years without causing toxic or other ill effects. It can be handled with only minor precautions. If accidentally spilled on hands, no serious skin irritation will occur. However, liquid askarel has a solvent action (similar to paint thinner) on the fats and oils of the skin and prolonged contact may lead to drying and chapping of the skin.

Table III

RELATION OF "BREAKDOWN STRENGTH" TO AMOUNT OF DISSOLVED WATER IN ASKAREL AND MINERAL OIL

Water Content (PPM)	Breakdown Voltage (ASTM) Askarel	Mineral Oil
0	70 KV	50 KV
20	55	39
40	47	30
60	40	26
80	38	22
110	10	5

Table IV

APPROXIMATE SOLUBILITY OF WATER IN TRANSFORMER ASKAREL AND MINERAL OIL

Temperature °C.	°F.	Amount of Water (PPM) Dissolved Askarel	Mineral Oil
—30	—22	8	8
—20	— 4	16	10
—10	14	28	13
0	32	41	20
10	50	65	33
20	68	94	58
30	86	128	85
40	104	170	130

TURBIDITY

. . . may be the visual sign of undissolved water, or may indicate contamination from core materials, dirt, or deteriorating construction materials. Cloudiness may also result from cold precipitation of tin tetraphenyl "scavenger" that was used in the earlier Pyranols. This scavenger begins to come out of solution around 15°F. above zero. To redissolve it requires heating to 150 - 200°F. and agitation.

High dielectric strength will quickly indicate that any turbidity present is not moisture; that the insulating efficiency of the askarel is still excellent. However, if the dielectric strength is below 26 KV, moisture should be determined, using the Karl Fischer method (ASTM D1533-60).

The dielectric strength test for askarel serves primarily as an indicator for moisture. It is by far the most important maintenance test for transformer askarel.

VIII. TYPICAL VALUES FOUND IN ASKAREL FLUID UNDER VARIOUS USE CONDITIONS

Table V gives the entire spectrum of properties that are typical for freshly-made transformer askarel as it goes through the various normal and abnormal conditions of use.

The data in Table V are in terms of *only* the askarel *fluid* and do not refer to insulation resistance or power factor measurements on the over-all transformer insulation.

Several utilities studying the power factor values of the over-all transformer insulation system indicate that the unit power factor of a new askarel transformer should range from 1% *to not over* 5%. This would generally correspond with the askarel *fluid* properties as given under heading "B".

Starting ideally with situation "*B*", *it is normal to expect the power factor of the fluid in a satisfactorily operating askarel transformer to increase as shown under heading* "*C*". The "over-all" power factor of the *transformer* in normal service is expected to rise, but preferably not much beyond 5%. In this normal situation, the moisture level of the askarel fluid and its dielectric strength will be satisfactory, as shown in *heading* "*C*".

Occasionally the power factor of a non-arced, satisfactorily-operating askarel transformer is found to be relatively high, i.e., 15%. *In this case, the power factor of the askarel fluid will also be high*, perhaps as high as 50% at 20°C. and 60 cycles.

It is not good practice merely to note that high power factor of the askarel fluid is to be expected. The important step is to check dielectric strength and note whether there has been a downward trend. A downward trend in dielectric strength very likely indicates moisture entrance and should be confirmed by a Karl Fischer test for water.

The importance of any abnormalities in dielectric strength and moisture content of the askarel fluid cannot be overemphasized! Where abnormal values for the dielectric strength or moisture content occur, the power factor of the transformer can be expected to be abnormally high; the expected high power factor of the askarel fluid will induce this.

The indication that a high power factor on the transformer and on the fluid is due to contamination can be verified by earth refining the askarel fluid and noting whether after refining the test results correspond with heading "*E*".

Assuming no mechanical defect or arcing, if the power factor of a *new askarel transformer* is relatively high, the power factor of the *fluid* will also be high, giving the situation under heading "*D*". This reflects contamination that should have been removed by the manufacturer of the transformer.

In absence of mechanical defect, where there are no abnormal losses in dielectric strength, and no moisture pick-up in non-arced askarel — the use history shows that a relatively high power factor for the askarel fluid (as compared with mineral oil) is to be expected. Normally, high power factor is due to contamination and not deterioration of the askarel operation.

As shown by F. M. Clark in his book, "*Insulating Materials For Design and Engineering Practice*," John Wiley & Sons, N. Y., 1962 — activated alumina can be used in the circulating system to bring the power factor down and keep it as low as possible.

4. **Gaskets For Hand-Hole Covers:** Modern design specifies silicone gaskets. Such gaskets must be retained in a groove. The groove preferably is machined into the flange or cover. However, it can also be formed by welding concentric steel strips to the flange or the cover.

   Generally the gaskets should be 5/16 to ½ inch thick for covers, depending on the depth of the groove. A rectangular section is usually used.

   The silicone material should be Dow-Corning No. 50 Silastic or equivalent. This is a low compression set material. For best sealing 20 to 25% compression is recommended, with ample clearance in the groove to allow for this compression.

   No cement is required. With reasonable care the gasket is removable without damage and is reusable.

   Silastic 50 is slightly swelled by askarel which contributes to the tightness of the seal. It is not deteriorated by askarel fluid or vapors. It resists weathering and it is thermally stable and flexible at all operating temperatures. It is an excellent moisture barrier.

Notes: a. Dow-Corning, Midland, Michigan will supply a list of Silastic 50 gasket fabricators to all transformer manufacturers or users. They will also furnish technical data.

b. Any user of Pyranol transformers, made by General Electric Company at Rome, Ga., will receive prompt and generous help for converting to the modern silicone or Viton gaskets by contacting the General Electric Company's Service Engineering Department at Rome, Ga.

See Appendix K: Seals, Properties and Procurements.

C. The Older Sealing Arrangements:

The older type gaskets consist of either cork or cork-nitrile rubber combinations or straight nitrile rubber.

1. **Cork-Nitrile Combinations:** Covers for the main tank, hand-holes, switch and terminal chambers, relief diaphrams etc. are held in place by studs welded to the flange or by bolts. The gaskets are cut with openings and placed over the bolts. Often Shellac (Westinghouse Style No. 1150419, or General Electric Company's Glyptal 1276) is used to cement the cork to the flanges.

   The following is recommended for sealing with the cork — nitrile rubber combination:

   Use Armstrong NC-757 cork-nitrile material or equivalent. The gasket can be cut from a single sheet or by scarfing strips of the material. A convenient method for joining strips is to make a Keystone Type joint. For this, Westinghouse, Sharon, Pa., offers their gasket cutter Style No. 328 B614 G01, (about $15).

   The joints should be cemented and the gasket also cemented to the flange, using one of the above cements. Excess cement should not be allowed to reach the interior of the transformer.

XI. INSPECTION CHECK LIST

1. If askarel is clear, even though darkened to light brown; has no sediment or turbidity; has dielectric strength over 26 KV . . . give it the inspection "OK".
2. If askarel is clear; has foreign color of blue, green, red . . . it is "extracting color" from internal materials. This is not, of itself, an operating hazard when the dielectric strength stays over 26 KV and moisture remains low. However, this rare occurrence calls for checking into condition of the interior construction and consulting the transformer maker.
3. If askarel is clear; but dielectric strength drops to 22 or lower KV, and moisture rises over 80 ppm . . . the askarel is ready for simple "refining". If the moisture is near the saturation level (about 125 ppm), a thorough inspection should be made for water droplets in the transformer tank, and even for "globules" or water floating on the askarel surface. If found, the transformer manufacturer should be consulted for reconditioning both the transformer and the fluid.
4. If askarel is dark brown to black; if black particles of carbon are seen; and dielectric strength is low . . . the askarel has been broken down by arcing. It cannot be refined and should be discarded.

If any of these four simple inspection tests appear out of the ordinary, or the relationship between appearance and test values is abnormal — contact your transformer supplier for a complete analysis.

Whenever a sample is to be shipped to Monsanto, please follow the directions shown under: "SAMPLING ASKAREL".

XII. CONTAMINATION IN TRANSFORMERS

Unlike mineral oil which can oxidize, sludge and deteriorate — askarel breaks down in transformer use *only when strongly arced.*

Thus, while askarel does not decompose in normal use — it can be contaminated more readily than the relatively non-polar mineral oil.

For example the following Table VI shows how a small amount of synthetic rubber or a bit of varnished cloth markedly increases the power factor of the askarel. Please note, however, that *such minor contamination has no adverse effect on the dielectric strength.* As explained, moisture entrance through faulty seals seems the only contaminant in normal use that lowers the dielectric strength of transformer askarel.

XIII. REFINING ASKAREL FOR RE-USE

A. Filtering Through Dry Blotter Paper to Remove Moisture and Extraneous Partciles:

Most operators prefer portable refining apparatus, such as a plate press fitted with a dolly, (available from Sparkler, Mundelein, Ill., Westinghouse Maintenance and Repair Dept., Chicago, or General Electric Co., Pittsfield, Mass.); or the earthen cartridge filter type, (available from Industrial Filter Corp., Lebanon, Ind.). Filter paper liners for the plate press are available from Carl Schleicher and Schuell Company, Keane, New Hampshire and manufacturers of filter presses listed above.

The filter paper must be dried immediately before use. For best results, spread the paper for maximum surface exposure in a hot air circulating oven and heat it for 4 to 6 hours at 110°C.

If possible do not take the transformer out of service until ready to filter the fluid. This will keep the transformer coils relatively hot and dry. Processing the fluid should start immediately after de-energizing the unit.

Circulate the askarel hot (but not over 55-60°C.) through the filter fitted with the dry paper liners.

After filtration the dielectric strength of the askarel should be 35 KV minimum.

1. **Precautions:** Filtering should not be done when the relative humidity exceeds 75%.
2. Any flexible hoses and gaskets on the refining equipment should be lined with or made of materials that will not be softened by contact with askarel fluid. (Silicone or Teflon-lined, or flexible metal materials are suitable.)

Table VIII

GUIDE TO RATE OF DISSOLVED WATER REMOVAL BY FILTERING ASKAREL THROUGH A PAPER PRESS

Passes Through Paper Press	Water in Askarel PPM
0	115
1	35
2	22
3	18
4	12
5	10
6	10

A. Drain out all dark, carbon-contaminated askarel. (Discard by dumping or burying where it will not contaminate a water supply.)

B. Carefully brush carbon deposits from internal parts and insulation, using a soft bristle brush making sure that insulation is not damaged.

C. Flush thoroughly using new askarel (*not* an oil, *not* a cleaning solvent).

D. Flush a second time with fresh askarel; drain; then fill to the proper level with new askarel.

E. Energize transformer to warm the fluid for 24 to 48 hours; then circulate the askarel through a filter, returning it to the unit filtered and ready for use.

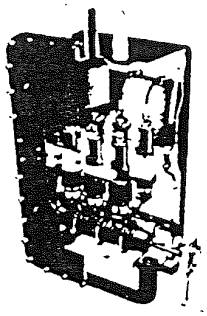
* This assumes that the cause of arcing has been established and corrections made. When severe arcing occurs, major repairs are usually necessary and the unit rebuilt. This procedure can be applied for flushing out repaired units.

SECTION B

ASKAREL FILLED SWITCHES AND TERMINAL CHAMBERS

I. INTRODUCTION:

High voltage leads are usually connected to askarel or mineral oil-filled network transformers and power centers through terminal chambers and switches. In some cases terminal chambers are not used, and the high voltage leads are connected directly to the switch terminals. They may be filled with either askarel or mineral oil. Switches are usually rotary or drum type fitted with a revolving block and porcelain unit as the principal element arranged for three-phase service. (A cutaway view of a typical terminal chamber-switch combination is shown for reference.)



Askarel transformers with attached switches have been in use for about 30 years. When they were first introduced, the availability of insulating and gasketing materials was rather limited and even the best materials at the time had no service history. As a result, inadequate gasketing materials such as cork, nitrile rubber, and nitrile rubber-and-cork particles were used. While satisfactory for a limited period of time, these materials cannot be depended on for the expected long life of the equipment.

The terminal chamber is usually above or below the switch compartment and separated by a steel wall through which the bushings are inserted. When bushings are properly selected and correctly installed, there is no leakage from one compartment to the other. With poor bushing seals, and the terminal chamber above the switch, potting compounds or cable oil can seep into the askarel. When the terminal chamber is below the switch, askarel can drain into the terminal chamber.

II. SOURCES OF CONTAMINATION

There are three possible sources of contamination for askarel in switches and terminal chambers; they rank in this order of frequency: (1) water entering through poor gaskets; (2) decomposition products from arcing when switch is used to break magnetizing current; (3) entrance of pothead or cable compounds through leaky bushing seals.

Unlike an askarel transformer where the amount of contaminant is likely to be very small (probably only trace amounts) in relation to the volume of askarel fluid — in switches or terminal chambers with faulty seals, the amount of contamination can be relatively large.

1. On newly installed switches, check the askarel at 3, 6 and 12 month intervals; if found satisfactory, check once annually thereafter. With proper attention to the gasketing of covers and bushings, experience will probably indicate that less frequent inspection is warranted.

2. Check askarel for:

   a. Dielectric strength (ASTM D877): It should be 26 KV minimum. If dielectric strength is low, confirm presence of water by Karl Fischer method ASTM D-1533. Filter to remove moisture. Dielectric strength should then be 30 KV minimum.

   b. Presence of carbon from arcing: Fluid should be relatively free of carbon. If badly arced and very black, replace fluid. If only minute amounts of carbon are present, filtration is recommended. Check power factor of liquid (should not be over 5% at 25°C. and 60 cycles). Flush out switch chamber with several gallons of fresh askarel before refilling.

3. If there is discoloration, high power factor, detectable change in specific gravity or refractive index, or if fluid flashes below 250°F., there is a possibility of seepage of potting compound into the switch compartment. In this case, correct any leaky bushing seals with proper replacements and fill with new askarel.

4. If terminal chamber is below switch, check potting compound for presence of askarel (can usually be detected by odor or by an increase in specific gravity). If askarel is present, correct any leaky bushing seals with proper replacements, and renew compounds.

5. Examine cover gaskets visually. Deterioration can be detected by swelling and cracking of the exposed edge. In cases of severe deterioration, liquid seepage is usually present.

6. Check for leakage at packing gland of switching shaft. If leaking, repack with a Silastic ring type gasket.

b) Earth Refinement Response:

Consists of treatment for 2.5 hours at 50-60°C. with 0.1 to 0.2 percent by weight of properly conditioned Attapulgus clay and then filtration through dry filter paper.

c) Analysis After Laboratory Earth Refinement:

Properties Tested
Refractive Index
Water
Free Chlorides
Acidity
Dielectric Strength
Power Factor, Dielectric Constant, and Resistivity

You will be notified of the results of this test series on your sample. Then after refining your entire transformer fluid fill you can check on the results by requesting the following analysis:

Analysis 3)

ANALYSIS AFTER EARTH REFINEMENT

Total Charge: $30.00 (This charge will not apply when analyses 1 and 2 have already been made.)

To determine whether the entire lot of the askarel fill responded to the same extent as the laboratory sample. (five-pint sample required)

Properties Tested
Color and Condition
Refractive Index
Water
Free Chlorides
Acidity
Dielectric Strength
Power Factor, Dielectric Constant, and Resistivity

To arrange for the tests described above write to the following address:

Paul G. Benignus
Monsanto Chemical Company
800 North Lindbergh Blvd.
St. Louis 66, Missouri

Samples to be tested should be clearly marked for identification and sent directly to:

Monsanto Chemical Company
W. G. Krummrich Laboratory
Monsanto, Illinois
Attention: R. Kuster

HOL 000297

APPENDIX C

APPROXIMATE VAPOR PRESSURE vs.
TEMPERATURE FOR TRANSFORMER ASKAREL

Temperature °C	Inerteen PPO, 7336-9	Transformer Pyranol A13B3B
40	1 mm Hg.	0.9 mm Hg.
60	5	3.5
80	9	8.3
100	30	18
120	60	32
140	90	53

APPENDIX D

EFFECT OF TEMPERATURE ON
DIELECTRIC STRENGTH OF ASKAREL

Temperature °C.	Dielectric Strength
—60	67 KV
—40	63
—20	57
0	55
20	50
40	50
60	48
80	45

APPENDIX E

COMPARISON QF THE APPROXIMATE VISCOSITY IN
SAYBOLT UNIVERSAL SECONDS OF TRANSFORMER
ASKARELS AND MINERAL OIL

Temp. °C.	Transformer Pyranol A13B3B	10-C Mineral Oil	Inerteen PPO, 7336-9
—20	1,000	1,000	2,800
0	100	150	195
20	70	85	85
40	45	49	50
60	39	40	40
80	34	34	36
100	30	30	33

HOL 000299

APPENDIX K

Seals, Properties and Procurement

Dow Corning Corporation, Midland, Michigan with District's at Atlanta, Boston, Chicago, Cleveland, Dallas, Los Angeles, New York City, Washington, D. C. and Toronto has available Bulletin 09-019, August 1962 entitled "**Silastic Design Data**". This lists the gasket fabricators throughout the country from whom the "Silastic 50" gasketing can be purchased in sheet, extrusions or molded shapes.

Generally Silastic 50 sheet goods are stocked by local die cutters, hence, could be generally purchased locally. Usually, small quantities of gaskets are die cut. If larger quantities are needed, tools are made of the same type used to cut other elastomers.

Where the gasket is extruded for fitting into a machined groove or between gasket stops, Dow-Corning advises use of a scarved joint. This joint is then cemented using Dow Corning's Silastic 140 (clear) or their RTV 731 (white) materials, which air cure.

Dow Corning points out that the local "rubber" fabricators purchase the Silastic 50 in billet form. This is worked on a roll mill in preparation for sheeting or extrusion. Then to obtain the desired physical properties the fabricator must oven cure the Silastic 50 for 24 hours at 480°F.

SPECIFICATIONS*

	Color ..... White
	Specific Gravity at 77°F. ..... 1.20 ± 0.02
ASTM D676 —	Hardness, Shore A. Scale ..... 45 to 60
ASTM D412 —	Tensile Strength, psi. min. 800
ASTM D412 —	Elongation, percent, min. 250
ASTM D395 —	Compression Set after 22 hours at 300°F., percent, max. 30

* All physical properties measured on 0.075 inch thick samples molded 5 minutes at 240°F., and oven cured 24 hours at 480°F.

General Electric Company, Redmond Circle, Rome, Ga., uses silicone or DuPont's Viton wherever it is not possible or desirable to weld. For some small seals, where good matching surfaces are provided, Flexitallic stainless steel rings are used.

By contacting the Engineering Services Department of General Electric Company, Redmond Circle, Rome, Ga., users of Pyranol transformers made prior to development of these modern seals will obtain prompt assistance for conversion.

Users of askarel transformers made by other manufacturers should contact the original transformer manufacturer, or Monsanto for assistance in converting to these modern seals.

MONSANTO
FUNCTIONAL FLUIDS DEPT.

800 N. LINDBERGH BLVD.
ST. LOUIS, MISSOURI 63166

The information herein regarding obtaining optimum results from askarel fluids in your transformer has been accumulated by Monsanto for over 30 years from the experience of makers and users of askarel transformers and it is believed will be helpful.

Nothing herein shall be construed as applying to other than askarel insulation. Data and maintenance suggestions herein do not apply to the other components of the transformer. All operating and maintenance suggestions recommended by the manufacturer of the transformer should also be carefully followed.

Because these maintenance directions apply only to the askarel insulation, Monsanto disclaims any liability for damage to property or injury to persons arising from transformer operation.

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Monsanto ASKAREL

Inspection and Maintenance Guide

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Inspection and Maintenance Guide

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SECTION A
TRANSFORMER ASKAREL

I. INTRODUCTION:

This manual describes the operating characteristics of transformer *askarel liquid* insulation and how it differs from mineral oil.

The information given is based on facts gathered by Monsanto over 30 years as producer of askarel, plus knowledge gained from the experience of transformer manufacturers and users. This guide is provided to outline the very simple maintenance required for askarel fluid in "modern" transformers and to offer suggestions for the sealing and maintaining of askarel in old units. By following this guide, users will obtain maximum service from askarel insulation with a reasonable minimum of maintenance. If questions arise relating to the designing and building of transformers — these should be referred to regular transformer suppliers.

Monsanto gratefully acknowledges the assistance, guidance, and the contributions of certain data by the following:

Frank M. Clark.....General Electric
Edward L. Raab.....General Electric
James G. Ford.....Westinghouse Electric
George Shombert, Jr.....Allis Chalmers

II. HISTORY OF TRADE NAME TYPES

"Askarel" is the generic name for non-combustible (fire-resistant) liquid insulation. In this respect, the insulation is completely different from ordinary transformer mineral oils. Transformer askarel is marketed by Monsanto. Whatever the trademarked brand, the askarel contains Monsanto's Aroclor (chlorobiphenyl) . . . one of the best liquid insulations developed by science. This inert compound is chemically stable, fire-resistant, heat stable, non-corrosive, and has high dielectric strength under the operating conditions encountered in transformers.

Askarel liquid insulation is made by thinning Aroclor 1260 with trichlorobenzene or tri-, tetrachlorobenzene mix. The first transformer askarel was made in 1932, in accordance with General Electric Company's patents, and was trademarked Pyranol 1488. Westinghouse, too, offered this askarel insulation in 1936 under their trademark Inerteen.

In the mid-1940's, as shown in the following table, tin tetraphenyl was added to General Electric's Pyranol to scavenge hydrogen chloride. Shortly thereafter, Westinghouse added phenoxy propene oxide to Inerteen for the same purpose. In 1963, General Electric replaced tin tetraphenyl with a diepoxide scavenger. This new formula, which replaces previous Pyranols, is called Transformer Pyranol A13B3B. *Thus, today the two commercial types of formulations are General Electric's Transformer Pyranol A13B3B type and Westinghouse Inerteen PPO (7336-9) type.*

The composition changes made in transformer askarel formulations are shown in Table I.

Table I

THE COMPOSITION OF TRANSFORMER ASKARELS

	Pyranol					Inerteen PPO
	1488	1467	1470	A13B3B	Inerteen	(7336-9)
Year Introduced.....	1932	1944	1952	1963	1936	1945
Ingredients:						
Aroclor 1260.....	60	60	45	45	60	60
Trichlorobenzene.....	40	40	40	40	40	40
Tetrachlorobenzene.....			15	15		
Tin tetraphenyl.....		0.125	0.125			
Phenoxy propene oxide.....						0.20
Diepoxide.....				0.125		

OTHER BRAND NAMES

Various electrical equipment manufacturers use other trade-marked names for askarel liquid insulation, such as Chlorextol (Allis-Chalmers); Noflamol (Wagner Electric); Saf-T-Kuhl (Kuhlman Electric). These askarel insulating liquids are one or the other of the two standard formulations. Still other manufacturers, who designate their insulation only by its generic name, askarel, assign it a number or code. By this number, Monsanto knows whether to furnish Pyranol A13B3B or Inerteen PPO (7336-9) type formulation to the user.

III. OFFICIAL TRANSFORMER ASKAREL SHIPPING SPECIFICATIONS

The official shipping specifications for the two modern transformer askarel formulations are shown in Table II.

Table II

OFFICIAL TRANSFORMER ASKAREL SHIPPING SPECIFICATIONS

Typical Properties	General Electric Co. Transformer Pyranol A13B3B	Westinghouse Transformer Inerteen PPO (7336-9)
Color, APHA	150 max.	150 max.
Condition	Clear	Clear
Water content, ppm (ASTM D1533-[illegible])	30 max.	30 max.
Acidity, mg. KOH/g. (ASTM D974-55)	0.014 max.	0.014 max.
Dielectric Strength, 25°C., 0.1 inch gap (ASTM D877-49)	35 KV, min.	35 KV, min.
Dielectric Constant, 100°C., 1 KC (ASTM D924-49)	3.8 to 4.3	3.7 to 4.0
Volume Resistivity, 100°C., 500 volts DC 0.1 inch gap, 10^9 ohm-cm.	100	100
Inorganic chlorides, ppm. (ASTM D1821 and G.E. Method E4C41B)	0.10 max.	0.10 max.
Refractive index, 25°C. (ASTM D901-56)	1.6075 to 1.6085	1.6137 to 1.6147
Viscosity at 37.8°C. (ASTM D88-56) Saybolt Universal Seconds	41 to 45	54 ± 2
Pour point °C. (ASTM D-97-57)	—44 or lower	—32 or lower
Specific gravity 15.5/15.5°C. (ASTM D287)	1.560 to 1.571	1.560 to 1.568
Burn point (ASTM D92)	None to boiling	None to boiling
Distillation range (ASTM D20-56) corrected for stem and barometric pressure	1st drop 210°C. min. 35% 240 to 256 55% 290 to 330 65% 385 to 400 95% 395 to 415	1st drop 200°C. min. 40% below 270°C. 90% 395 to 415°C.
Fixed chlorine	60.5 ± 5%	59.1% min.
Corrosion test	After heating with aluminum for 6 hrs. at 200 to 220°C., the aluminum must not be corroded on either visual or weight inspection and the askarel should meet the following specifications:	
Color, APHA	200 max.	200 max.
Acidity, mg. KOH/g.	0.014 max.	0.014 max.
Inorganic chlorides ppm.	2.0 (tent.)	2.0 max.
Condition	Clear	Clear
Scavenger content	0.115 to 0.135% Diepoxide	0.18 to 0.22% phenoxy propene oxide
Arc formed gases	Less than 1.0% of total combustible gases including carbon monoxide, hydrogen and volatile hydrocarbons.	
Coefficient of Thermal Expansion (ASTM D1903), CC./CC./°C.	0.0007	0.0007

The above two formulas are used in modern transformers. There are a number of units in service dating back to 1933 with askarels of somewhat different compositions. These will be compatible with the above modern formulations.

IV. INTERCHANGEABILITY AND STABILITY

A. Interchangeability:

The two general types of askarel insulation shown in Table II can be either mixed or interchanged and there will be no difference in the operation of the transformer. However, askarel insulation *must never be mixed* with mineral oil.

Over 2% mineral oil in askarel begins to lower its fire resistance. Further, materials of construction in the transformer that are compatible with askarel may not be compatible with oil and vice-versa. For example: a significant amount of askarel in a transformer built for mineral oil will attack gaskets, adhesives, core bindings, impregnating varnishes, etc.

B. Stability:

Askarel liquid insulation is highly pure, fire-proof liquid made under close chemical control. It does not vary in composition like the commercial range of mineral oils.

Askarel does not deteriorate when exposed to air, heat, hot metal; it does not break down over long use to form conducting or corrosive chemicals; it does not oxidize or sludge. Askarel will remain perfectly stable year after year unless broken down by exposure to severe arcing.

The only real "enemy" of askarel is *contamination by water.* Keeping askarel water-free will insure long-time service.

Askarel is heavier than water. If water gets into askarel insulation, only a tiny amount (125 ppm) dissolves — the rest floats on top.

V. DIRECTIONS FOR HANDLING

A. Keep Dry:

In handling, storing, sampling, inspecting askarel — and in operating askarel transformers — take every precaution to guard the askarel insulation from exposure to high humidity and moisture contamination. Keep 5, 30, or 55 gallon drums of askarel dry; lay stored drums on their sides with the bung at the highest point from floor to keep water off the drum head (which can be sucked into the askarel by the drum "breathing"). This precaution is not necessary when drums are stored indoors, which is the preferred way of storing.

B. Use Ordinary Personal Precautions:

Transformer askarel has been made, handled, and used for over 30 years without causing toxic or other ill effects. It can be handled with only minor precautions. If accidentally spilled on hands, no serious skin irritation will occur. However, liquid askarel has a solvent action (similar to paint thinner) on the fats and oils of the skin and prolonged contact may lead to drying and chapping of the skin.

In case of contact, wash off the skin with soap and water; remove and dry clean saturated clothing. Clean up spills with rags, sawdust or absorbent clay. Eye contact may result in painful irritation but no permanent damage to tissues. If askarel gets in the eyes, flush with large amounts of water. As with all eye first-aid, refer to a physician. To relieve irritation, physicians have used a 1% Pontocaine as well as opthalmic cortisone acetate solution, or castor oil.

Infrequent exposure to askarel vapors will not cause ill effects. However, prolonged exposure to high vapor concentrations should be avoided. If hot askarel must be handled in a closed or confined area, provide the area with ordinary exhaust ventilation — or — wear an organic cartridge respirator approved by the U. S. Bureau of Mines.

VI. EXPECTED SERVICE LIFE

Properly designed and installed askarel transformers will give trouble-free service for a minimum of 30 years. Since their introduction in 1932, the manufacturers report finding the over-all failure rate to be less than 0.5% for all units under test and service conditions. The Edison Electric Institute's report (1956-1958) on their member utilities publishes the failure rate for askarel transformers as 0.13 per hundred banks per year. Even the rare reports of failure are invariably found to be due to improper sealing that allows moisture to enter.

VII. DIELECTRIC STRENGTH — MOISTURE RELATIONSHIP

The dielectric strength of askarel is highly sensitive to excess moisture; not sensitive to ordinary dissolved contaminants. While the dielectric strength can also be lowered by severe arcing, askarel turns noticeably black or has particles of sooty carbon floating in it if arcing has occurred. Then the transformer should be repaired and the askarel replaced.

New askarel has a minimum dielectric strength of 35 KV at 25°; a maximum moisture content of 30 ppm. If the dielectric strength is checked periodically and decreases significantly — this indicates moisture pick-up, arcing, or both. When the dielectric strength has dropped to 26 KV or less, an analysis for water is necessary. If water is found in excess of 100 ppm at 25° C., its source should be located and corrections made.

When the moisture content approaches 125 ppm (saturation level), the dielectric strength of askarel drops below the value required for efficient insulating. The moisture content should not be allowed to rise over 70 ppm; it should be held as near as possible to 30 ppm. Maintaining a low moisture level will assure high dielectric strength and top operating efficiency.

Table III shows the relationship of dielectric strength vs. moisture and Table IV indicates the approximate water solubility limits in askarel and mineral oil.

Table III

RELATION OF "BREAKDOWN STRENGTH" TO AMOUNT OF DISSOLVED WATER IN ASKAREL AND MINERAL OIL

Water Content (PPM)	Breakdown Voltage (ASTM) Askarel	Mineral Oil
0	70 KV	50 KV
20	55	39
40	47	30
60	40	26
80	38	22
110	10	5

Table IV

APPROXIMATE SOLUBILITY OF WATER IN TRANSFORMER ASKAREL AND MINERAL OIL

Temperature °C.	°F.	Amount of Water (PPM) Dissolved Askarel	Mineral Oil
—30	—22	8	8
—20	— 4	16	10
—10	14	28	13
0	32	41	20
10	50	65	33
20	68	94	58
30	86	128	85
40	104	170	130

TURBIDITY

. . . may be the visual sign of undissolved water, or may indicate contamination from core materials, dirt, or deteriorating construction materials. Cloudiness may also result from cold precipitation of tin tetraphenyl "scavenger" that was used in the earlier Pyranols. This scavenger begins to come out of solution around 15°F. above zero. To redissolve it requires heating to 150 - 200°F. and agitation.

High dielectric strength will quickly indicate that any turbidity present is not moisture; that the insulating efficiency of the askarel is still excellent. However, if the dielectric strength is below 26 KV, moisture should be determined, using the Karl Fischer method (ASTM D1533-60).

The dielectric strength test for askarel serves primarily as an indicator for moisture. It is by far the most important maintenance test for transformer askarel.

VIII. TYPICAL VALUES FOUND IN ASKAREL FLUID UNDER VARIOUS USE CONDITIONS

Table V gives the entire spectrum of properties that are typical for freshly-made transformer askarel as it goes through the various normal and abnormal conditions of use.

The data in Table V are in terms of *only* the askarel *fluid* and do not refer to insulation resistance or power factor measurements on the over-all transformer insulation.

Several utilities studying the power factor values of the over-all transformer insulation system indicate that the unit power factor of a new askarel transformer should range from 1% *to not over* 5%. This would generally correspond with the askarel *fluid* properties as given under heading "B".

Table V

TYPICAL VALUES FOUND IN ASKAREL FLUID UNDER VARIOUS CONDITIONS OF USE

	A	B	C	D	E	F
	New askarel	Askarel in properly* built new or rebuilt units prior to use.	After normal operation; a survey of 50 units, most 2-5 yrs. old; some 10.	Non-arced but slightly contaminated askarel in improperly* built units, new or slightly used.	Same askarel as in Column D — after refining.	Heavily arced askarel due to neglect and internal electrical malfunction.
Inspection Check Points						
Color	Light straw	Light straw	Light straw	Can have foreign shades, blue, green, red cast.	Foreign shades remain showing extraction of oil soluble color.	Black
Clarity	Clear, free from particles	Clear, practically free from particles	Clear, trace of particles	Clear, slight amount of particles	Clear, free from particles	Contains carbon particles
Moisture 25°C.	30 ppm	30 ppm	10-70 ppm all dissolved water	20-100 ppm all dissolved water	30 ppm	Near 125ppm saturation level — plus possible undissolved water
Dielectric Strength 25°C., 0.1" gap	35 KV minimum	35-48 KV	35-45 KV	30-42 KV	40-45 KV	5-15 KV
Volume Resistivity 100°C., 500 Volts, DC., 0.1" gap	100×10^9 ohm-cm. minimum usually 500-1,500	40×10^9 ohm-cm. minimum usually at least 100×10^9	$15\text{-}400 \times 10^9$ ohm-cm.	about 5×10^9 ohm-cm.	at least $1{,}500 \times 10^9$ ohm-cm.	about 3×10^9 ohm-cm.
Power Factor:						
100°C. 60 cycles	2-5%	10-25%	10 to near 80%	30 to 100%	2-5%	100%
25°C. 60 cycles	0.05-0.1%	0.5-2%	0.5 to near 10%	about 7 to over 15%	0.1-0.2%	at least 25%

**A properly built transformer is defined as one in which the materials of construction are chemically and electrically compatible with askarel.*

Starting ideally with situation "*B*", *it is normal to expect the power factor of the fluid in a satisfactorily operating askarel transformer to increase as shown under heading* "*C*". The "over-all" power factor of the *transformer* in normal service is expected to rise, but preferably not much beyond 5%. In this normal situation, the moisture level of the askarel fluid and its dielectric strength will be satisfactory, as shown in *heading* "*C*".

Occasionally the power factor of a non-arced, satisfactorily-operating askarel transformer is found to be relatively high, i.e., 15%. *In this case, the power factor of the askarel fluid will also be high*, perhaps as high as 50% at 20°C. and 60 cycles.

It is not good practice merely to note that high power factor of the askarel fluid is to be expected. The important step is to check dielectric strength and note whether there has been a downward trend. A downward trend in dielectric strength very likely indicates moisture entrance and should be confirmed by a Karl Fischer test for water.

The importance of any abnormalities in dielectric strength and moisture content of the askarel fluid cannot be overemphasized! Where abnormal values for the dielectric strength or moisture content occur, the power factor of the transformer can be expected to be abnormally high; the expected high power factor of the askarel fluid will induce this.

The indication that a high power factor on the transformer and on the fluid is due to contamination can be verified by earth refining the askarel fluid and noting whether after refining the test results correspond with heading "*E*".

Assuming no mechanical defect or arcing, if the power factor of a *new askarel transformer* is relatively high, the power factor of the *fluid* will also be high, giving the situation under heading "*D*". This reflects contamination that should have been removed by the manufacturer of the transformer.

In absence of mechanical defect, where there are no abnormal losses in dielectric strength, and no moisture pick-up in non-arced askarel — the use history shows that a relatively high power factor for the askarel fluid (as compared with mineral oil) is to be expected. Normally, high power factor is due to contamination and not deterioration of the askarel operation.

As shown by F. M. Clark in his book, "*Insulating Materials For Design and Engineering Practice*," John Wiley & Sons, N. Y., 1962 — activated alumina can be used in the circulating system to bring the power factor down and keep it as low as possible.

IX. CHECK POINTS FOR MAINTAINING ASKAREL INSULATION

A. General Considerations:

Modern askarel transformers with welded construction or silicone gaskets for hand hole-cover, switch and terminal compartment covers, with properly constructed bushings require little or no maintenance. With properly constructed transformers, annual or semi-annual visual inspection and dielectric strength test of the askarel fluid should suffice for routine maintenance checking over many years of service.

However, many askarel units were installed in the early 1930's — before the development of some of the better modern gasketing materials and before improved designs were developed for sealing out moisture. Such early units should be, and can be, modernized. Leaky or deteriorated gaskets should be replaced. If the askarel has become contaminated, it should be reconditioned. At the same time, a general clean-up of the unit and possible refinishing may be desirable.

If it is not convenient to take an old transformer out of service for general repairs, leaky gaskets can be sealed temporarily by painting over the leaky area with epoxy cement.

A survey of users indicates a good number of early-built askarel transformers (over 20 years old) are kept in continuous service in critical installations by the following steps (instead of modernization).

The operating units are equipped with compound pressure gauges for reading pressure above and below atmospheric. Positive pressure is maintained on the shell by introducing nitrogen at 2 to 3 pounds above atomspheric. Regular workmen in the area daily record the temperature and pressure. If a sudend pressure drop is noted more nitrogen is introduced and the gaskets are checked for leaks with soap solution. Leaks are sealed by applying epoxy cement.

B. Modern Sealing Procedures:

Transformer purchasers should specify the following modern techniques for sealing:

1. **Welding Construction:** Covers, radiator connections, switch and terminal housings, instrument connections, etc. should be welded.

2. **Bushing Connections:** The most satisfactory bushings are the type with rolled-on flanges and two ring seals rolled into a depression in the porcelain — sealed with silicone rubber rings held under compression. Metal-to-glass or metal-to-porcelain sealed bushings are also satisfactory.

   If for any reason the above type bushings cannot be used then use a porcelain or glass bushing with a silicone or Viton gasket retained in a groove. The gasket can be either rectangular or circular cross section, usually ¼ inch thick.

3. **Small Size Connections:** When not possible to weld, small size connection seals should be made with Flexitallic stainless steel rings. The surfaces must be machined and parallel. The filler between the steel laminations of the Flexitallic ring should be either silicone or Viton.

4. **Gaskets For Hand-Hole Covers:** Modern design specifies silicone gaskets. Such gaskets must be retained in a groove. The groove preferably is machined into the flange or cover. However, it can also be formed by welding concentric steel strips to the flange or the cover.

   Generally the gaskets should be 5/16 to 1/2 inch thick for covers, depending on the depth of the groove. A rectangular section is usually used.

   The silicone material should be Dow-Corning No. 50 Silastic or equivalent. This is a low compression set material. For best sealing 20 to 25% compression is recommended, with ample clearance in the groove to allow for this compression.

   No cement is required. With reasonable care the gasket is removable without damage and is reusable.

   Silastic 50 is slightly swelled by askarel which contributes to the tightness of the seal. It is not deteriorated by askarel fluid or vapors. It resists weathering and it is thermally stable and flexible at all operating temperatures. It is an excellent moisture barrier.

Notes: a. Dow-Corning, Midland, Michigan will supply a list of Silastic 50 gasket fabricators to all transformer manufacturers or users. They will also furnish technical data.

b. Any user of Pyranol transformers, made by General Electric Company at Rome, Ga., will receive prompt and generous help for converting to the modern silicone or Viton gaskets by contacting the General Electric Company's Service Engineering Department at Rome, Ga.

See Appendix K: Seals, Properties and Procurements.

C. The Older Sealing Arrangements:

The older type gaskets consist of either cork or cork-nitrile rubber combinations or straight nitrile rubber.

1. **Cork-Nitrile Combinations:** Covers for the main tank, hand-holes, switch and terminal chambers, relief diaphrams etc. are held in place by studs welded to the flange or by bolts. The gaskets are cut with openings and placed over the bolts. Often Shellac (Westinghouse Style No. 1150419, or General Electric Company's Glyptal 1276) is used to cement the cork to the flanges.

   The following is recommended for sealing with the cork — nitrile rubber combination:

   Use Armstrong NC-757 cork-nitrile material or equivalent. The gasket can be cut from a single sheet or by scarfing strips of the material. A convenient method for joining strips is to make a Keystone Type joint. For this, Westinghouse, Sharon, Pa., offers their gasket cutter Style No. 328 B614 G01, (about $15).

   The joints should be cemented and the gasket also cemented to the flange, using one of the above cements. Excess cement should not be allowed to reach the interior of the transformer.

After installation and bolting, the outside edge of the gasket should be coated thoroughly with epoxy cement to increase weather resistance.

This epoxy cement is a paste to which a curing catalyst is added immediately before use. Typical are:

a. Epoxy Patch Kit #1-C
Hysol Corporation, Olean, N. Y.

b. Scotchcast Resin #4
Minnesota Mining and Manufacturing Co.
St. Paul, Minnesota

c. Adhesive A-1 and Activator Type B
Armstrong Products Company
Argonne Rd., Warsaw, Ind.

d. Adhesive 9860-1, Synthetics Organic Company, Cleveland, Ohio, used with activator diethylene triamine (Carbide and Carbon Chem. Co.)

2. **Straight Nitrile Rubber:** When straight nitrile rubber was originally used, invariably the gasket was recessed in a groove. This was to prevent gasket flow and to protect the material against excessive compression. Although this type seal was not cemented, the nitrile rubber gasket is not reuseable.

Since grooves or stops have already been provided for the nitrile rubber seal, Silastic 50 can be easily substituted and is recommended. This conforms with modern practice.

X. PERIODIC FLUID INSPECTION AND WHAT CHECKPOINTS MEAN

On a regular schedule — at six, nine, or twelve month intervals — make a simple visual inspection of your askarel insulation and run a dielectric strength check.

A. Visual Inspection:

Askarel is a clear, faint-yellow liquid. After long-term use this color may gradually intensify to light brown. The fluid should remain clear and free from turbidity or cloudiness.

Any color change — such as to a green, red or blue cast — indicates extraction of impurities from the solid insulation. If a distinct foreign color pick-up is noted, check the complete range of electrical characteristics and notify the transformer maker. The electrical characteristics may be found to be unimpaired. Color change alone (except for black) is not a danger signal since the contamination is not likely to impair the dielectric strength.

B. Dielectric Strength:

If the dielectric strength has decreased significantly from the last inspection, or if it has gradually decreased below 26 KV range (at 25°C.) — RUN A CHECK FOR MOISTURE. Use ASTM D901, D877 (Karl Fischer Method).

The dielectric strength of askarel is the major indicator to the operating efficiency of your liquid insulation and of the askarel transformer itself. Besides the "visual" inspection tests, dielectric strength is the only test necessary to run on a routine basis. Well-sealed askarel transformers have service records of 25 to 30 years on the original askarel. New askarel has a minimum dielectric strength of 35 KV at 35°C., a maximum moisture content of 30 ppm.

XI. INSPECTION CHECK LIST

1. If askarel is clear, even though darkened to light brown; has no sediment or turbidity; has dielectric strength over 26 KV . . . give it the inspection "OK".
2. If askarel is clear; has foreign color of blue, green, red . . . it is "extracting color" from internal materials. This is not, of itself, an operating hazard when the dielectric strength stays over 26 KV and moisture remains low. However, this rare occurrence calls for checking into condition of the interior construction and consulting the transformer maker.
3. If askarel is clear; but dielectric strength drops to 22 or lower KV, and moisture rises over 80 ppm . . . the askarel is ready for simple "refining". If the moisture is near the saturation level (about 125 ppm), a thorough inspection should be made for water droplets in the transformer tank, and even for "globules" or water floating on the askarel surface. If found, the transformer manufacturer should be consulted for reconditioning both the transformer and the fluid.
4. If askarel is dark brown to black; if black particles of carbon are seen; and dielectric strength is low . . . the askarel has been broken down by arcing. It cannot be refined and should be discarded.

If any of these four simple inspection tests appear out of the ordinary, or the relationship between appearance and test values is abnormal — contact your transformer supplier for a complete analysis.

Whenever a sample is to be shipped to Monsanto, please follow the directions shown under: "SAMPLING ASKAREL".

XII. CONTAMINATION IN TRANSFORMERS

Unlike mineral oil which can oxidize, sludge and deteriorate — askarel breaks down in transformer use *only when strongly arced.*

Thus, while askarel does not decompose in normal use — it can be contaminated more readily than the relatively non-polar mineral oil.

For example the following Table VI shows how a small amount of synthetic rubber or a bit of varnished cloth markedly increases the power factor of the askarel. Please note, however, that *such minor contamination has no adverse effect on the dielectric strength.* As explained, moisture entrance through faulty seals seems the only contaminant in normal use that lowers the dielectric strength of transformer askarel.

Table VI

EFFECT OF COMMON INSULATION MATERIALS ON POWER FACTOR AND DIELECTRIC STRENGTH (HEAT AGED 96 HOURS IN ASKAREL AT 100°C.)

Material Immersed	Askarel After Exposure: Power Factor, Percent at 60 cyc., 100°C.	Askarel After Exposure: Dielectric Strength 25°C.
None (*control*)	1.0	35 KV
Black varnished cloth	85.0	42
Copper	1.5	40
Pressboard	2.0	37
Manila paper	1.5	39
Phenol formaldehyde resins	1.6	41
Shellac	6.0	36
Iron	5.0	39
Synthetic rubber	70.0	39

Similarly, trace contaminants from commonly used construction materials can lower the volume - resistivity of askarel, without affecting its dielectric strength. Table VII shows this.

Table VII

EFFECT OF COMMON INSULATION MATERIALS ON VOLUME RESISTIVITY OF ASKAREL

Sample	Volume Resistivity x 10^9 ohm-cm (at 100°C., 500 Volts DC., 0.1" gap)
1. New askarel before heat aging	2,000
2. New askarel after heat aging 96 hours at 100°C.	1,900
3. After heat aging with 1 sq. inch specimens of:	
a. Phenolic resin tap changer material	1,200
b. Paper	750
c. Grade A press board (tan)	500
d. Grade A press board (gray)	500
e. Grade A press board, laminated strip	400
f. Cotton wrapping	300
g. Glyptal 1276 cement, cured 48 hrs. at 110°C.	100

While trace contamination easily lowers volume resistivity from high levels, it is important as previously noted in Table V Case F, that heavy contamination (as when arced) does not lower the resistivity below the order of 10^9 ohm-cm. at 100°C.

The different behavior of askarel vs. mineral oil in these respects can be summarized as follows:

High power factor and low volume resistivity in transformer mineral oils are commonly regarded as "danger signals" that the oil has deteriorated and broken down chemically.

This is NOT TRUE of askarel liquid insulation, unless the dielectric strength is low.

XIII. REFINING ASKAREL FOR RE-USE

A. Filtering Through Dry Blotter Paper to Remove Moisture and Extraneous Partciles:

Most operators prefer portable refining apparatus, such as a plate press fitted with a dolly, (available from Sparkler, Mundelein, Ill., Westinghouse Maintenance and Repair Dept., Chicago, or General Electric Co., Pittsfield, Mass.); or the earthen cartridge filter type, (available from Industrial Filter Corp., Lebanon, Ind.). Filter paper liners for the plate press are available from Carl Schleicher and Schuell Company, Keane, New Hampshire and manufacturers of filter presses listed above.

The filter paper must be dried immediately before use. For best results, spread the paper for maximum surface exposure in a hot air circulating oven and heat it for 4 to 6 hours at 110°C.

If possible do not take the transformer out of service until ready to filter the fluid. This will keep the transformer coils relatively hot and dry. Processing the fluid should start immediately after de-energizing the unit.

Circulate the askarel hot (but not over 55-60°C.) through the filter fitted with the dry paper liners.

After filtration the dielectric strength of the askarel should be 35 KV minimum.

1. **Precautions:** Filtering should not be done when the relative humidity exceeds 75%.
2. Any flexible hoses and gaskets on the refining equipment should be lined with or made of materials that will not be softened by contact with askarel fluid. (Silicone or Teflon-lined, or flexible metal materials are suitable.)

Table VIII

GUIDE TO RATE OF DISSOLVED WATER REMOVAL BY FILTERING ASKAREL THROUGH A PAPER PRESS

Passes Through Paper Press	Water in Askarel PPM
0	115
1	35
2	22
3	18
4	12
5	10
6	10

B. **Earth Treatment for Maximum Improvement of Power Factor and Volume-Resistivity:**

1. **Procedure:**

(The askarel liquid should be relatively dry prior to the following earth filtration.)

Use finely divided Attapulgus clay or Fuller's earth (dried and activated by heating for 12 hours at 300-350°F. immediately prior to use) as a coating on the filter paper surface. The amount of earth used should be 0.1 to 0.2 per cent by weight on the weight of the askarel to be treated. (Askarel weighs about 13 pounds per gallon).

To deposit the earth evenly, stir one-third of the earth with a small portion of askarel in a clean container. Pump the mixture through the filter and follow with two more one-third portions. Then circulate askarel taken from near the top of the transformer, pass it hot (not over 55-60°C.) through the earth coated filter and feed back through the bottom transformer outlet. Continue circulation until the fluid is clear and test shows that the electrical properties are fully restored.

2. **Effect of Earth on Removal of Scavengers:**

Only slight and insignificant loss (by selective absorption) of tintetraphenyl and epoxides occurs when askarel is refined by treatment with 0.1 to 0.2 per cent by weight of earth. To remove significant amounts of the scavengers requires repetitious treatment with much larger amounts of earth.

3. **Table IX — Approximate Relationship Between Power Factor, Volume-Resistivity and Dielectric Strength of Transformer Askarel:**

Power Factor (60 cyc.)		Volume Resistivity x 10^9 ohm-cm. (at 100°C., 500 Volts DC., 0.1″ gap)	Dielectric Strength 25°C., 0.1″ gap
100°C.	25°C.		
2%	0.05%	1500	35 KV
5%	0.1%	500	35
15%	0.7%	100	35
20-25%	2.0%	60-70	35
40-50%	—	25	35

If it is desired (although these factors are not generally considered important for askarel transformers), to keep the power factor as low as possible and the resistivity as high as possible, hang a container of anhydrous alumina or activated clay in the circulating system of the transformer.

XIV. CLEANING ARCED TRANSFORMERS

If a unit has arced so that the askarel is no longer fit for use, a thorough cleaning of the unit is necessary before refilling with new askarel insulation and returning it to service*. Follow this procedure:

A. Drain out all dark, carbon-contaminated askarel. (Discard by dumping or burying where it will not contaminate a water supply.)

B. Carefully brush carbon deposits from internal parts and insulation, using a soft bristle brush making sure that insulation is not damaged.

C. Flush thoroughly using new askarel (*not* an oil, *not* a cleaning solvent).

D. Flush a second time with fresh askarel; drain; then fill to the proper level with new askarel.

E. Energize transformer to warm the fluid for 24 to 48 hours; then circulate the askarel through a filter, returning it to the unit filtered and ready for use.

* This assumes that the cause of arcing has been established and corrections made. When severe arcing occurs, major repairs are usually necessary and the unit rebuilt. This procedure can be applied for flushing out repaired units.

XV. SAMPLING ASKAREL

Take a sample as close to the top of the liquid surface as possible. (Many large askarel transformers have a built-in sampling tube near the surface for convenient sampling). Then, to make sure that your SAMPLE truly represents your askarel insulation, take another sample from the bottom. If additional sampling tube connections are contrived on the valves for easier sampling, make the tubes of clean glass, stainless steel, aluminum or tin for rigid types; and silicone or Teflon tubing for flexible types.

Use NEW containers for the askarel sample. A new and thoroughly pre-dried small-mouth quart glass bottle fitted with a Bakelite screw cap fitted with an aluminum or tin bottle cap liner is recommended for "quick on-the-site testing." (If complete analysis is to be made, a 5-pint size sample is required).

Be sure that the new bottle does not stand open to collect dust or moisture. Rinse the sample bottle and cap lining two or three times with askarel from the transformer; then fill it. If the sample will be tested promptly, a clear glass bottle can be used. If sample is to be stored indefinitely, use an amber glass bottle or wrap clear glass with aluminum foil.

A. Select a dry day. Do not sample insulation on a warm, moist day when humidity exceeds 75%, and . . .

B. Make sure that the askarel is at least as warm as the surrounding air. (Cold liquids can condense moisture from humid air.)

C. When sampling askarel from transformers, it is best to take the sample when the unit is warm and operating at average or maximum load. Especially as a check on moisture (as reflected by a dielectric strength test), sampling the warm askarel more truly represents its condition during operation.

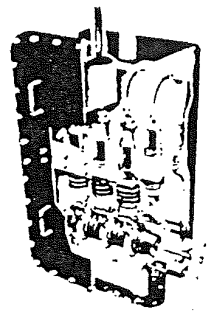
Experience shows that water will migrate from a transformer's solid insulation to the askarel liquid and vice versa, depending on temperature. Therefore, when the transformer is hot, the moisture is most likely to be found in the liquid. This accounts largely for periodic variations in dielectric strength. For example: a relatively high dielectric strength may be found during winter months and a relatively low dielectric strength during the summer months on samples taken from the same unit.

SECTION B

ASKAREL FILLED SWITCHES AND TERMINAL CHAMBERS

I. INTRODUCTION:

High voltage leads are usually connected to askarel or mineral oil-filled network transformers and power centers through terminal chambers and switches. In some cases terminal chambers are not used, and the high voltage leads are connected directly to the switch terminals. They may be filled with either askarel or mineral oil. Switches are usually rotary or drum type fitted with a revolving block and porcelain unit as the principal element arranged for three-phase service. (A cutaway view of a typical terminal chamber-switch combination is shown for reference.)



Askarel transformers with attached switches have been in use for about 30 years. When they were first introduced, the availability of insulating and gasketing materials was rather limited and even the best materials at the time had no service history. As a result, inadequate gasketing materials such as cork, nitrile rubber, and nitrile rubber-and-cork particles were used. While satisfactory for a limited period of time, these materials cannot be depended on for the expected long life of the equipment.

The terminal chamber is usually above or below the switch compartment and separated by a steel wall through which the bushings are inserted. When bushings are properly selected and correctly installed, there is no leakage from one compartment to the other. With poor bushing seals, and the terminal chamber above the switch, potting compounds or cable oil can seep into the askarel. When the terminal chamber is below the switch, askarel can drain into the terminal chamber.

II. SOURCES OF CONTAMINATION

There are three possible sources of contamination for askarel in switches and terminal chambers; they rank in this order of frequency: (1) water entering through poor gaskets; (2) decomposition products from arcing when switch is used to break magnetizing current; (3) entrance of pothead or cable compounds through leaky bushing seals.

Unlike an askarel transformer where the amount of contaminant is likely to be very small (probably only trace amounts) in relation to the volume of askarel fluid — in switches or terminal chambers with faulty seals, the amount of contamination can be relatively large.

Experience has shown that, based on the number of installed askarel-switch units, the percentage of failures is extremely small. When investigated, it has been found that most failures originate in the switch chamber. Water is the chief source of contamination. However, heavy contamination of askarel with petrolatum and asphalt material, due to leakage, have caused a few failures.

Petrolatum is used frequently for filling terminal chambers. When either cable oil or petrolatum seeps into askarel, no great harm results. The fire resistance will be somewhat decreased and power factor of the askarel will increase with an accompanying drop in resistivity. While highly undesirable, it is doubtful that failure of the unit results. Where asphaltic compounds are used in place of petrolatum, the danger is increased somewhat because asphaltic contamination may cause excessively high dielectric losses in the askarel.

When the terminal chamber is below the switch chamber, the potting compound can be contaminated by askarel if the bushing seals are leaky. This is undesirable because the askarel will increase the power factor and conductivity of the potting compound or cable oil and develop heat from dielectric loss. If this mixture is drawn into the cable insulation, a cable failure is likely. This again emphasizes the importance of tight bushing assemblies.

III. SEALING SWITCHES AND TERMINAL CHAMBERS

Proper bushing construction, use of Silastic seals and welding wherever possible is highly desirable (as covered in Section A). Where an elastomeric seal is to be used in contact with both askarel and petroleum oil, DuPont's Viton is suggested.

For new equipment the user should specify these modern sealing arrangements to keep out contaminants and minimize maintenance.

IV. MAINTENANCE FOR ASKAREL FILLED SWITCHES

A. Switches used for grounding after power source has been de-energized will not undergo arcing.

B. Switches interrupting magnetizing current will be subject to arcing; the amount of decomposition will depend on power interrupted, time and frequency of operation. As a general rule, the liquid should be checked after 5 to 10 operations.

1. On newly installed switches, check the askarel at 3, 6 and 12 month intervals; if found satisfactory, check once annually thereafter. With proper attention to the gasketing of covers and bushings, experience will probably indicate that less frequent inspection is warranted.

2. Check askarel for:

   a. Dielectric strength (ASTM D877): It should be 26 KV minimum. If dielectric strength is low, confirm presence of water by Karl Fischer method ASTM D-1533. Filter to remove moisture. Dielectric strength should then be 30 KV minimum.

   b. Presence of carbon from arcing: Fluid should be relatively free of carbon. If badly arced and very black, replace fluid. If only minute amounts of carbon are present, filtration is recommended. Check power factor of liquid (should not be over 5% at 25°C. and 60 cycles). Flush out switch chamber with several gallons of fresh askarel before refilling.

3. If there is discoloration, high power factor, detectable change in specific gravity or refractive index, or if fluid flashes below 250°F., there is a possibility of seepage of potting compound into the switch compartment. In this case, correct any leaky bushing seals with proper replacements and fill with new askarel.

4. If terminal chamber is below switch, check potting compound for presence of askarel (can usually be detected by odor or by an increase in specific gravity). If askarel is present, correct any leaky bushing seals with proper replacements, and renew compounds.

5. Examine cover gaskets visually. Deterioration can be detected by swelling and cracking of the exposed edge. In cases of severe deterioration, liquid seepage is usually present.

6. Check for leakage at packing gland of switching shaft. If leaking, repack with a Silastic ring type gasket.

SECTION C

ANALYTICAL SERVICES ON TRANSFORMER ASKAREL AVAILABLE FROM MONSANTO

Transformer users not wishing to make their own fluid analyses can obtain the service from Monsanto. Simply contact Monsanto and specify what analyses are wanted. You will be sent the proper-sized sample container filled with fresh askarel. When you receive this, empty it and carefully take your sample (following the procedure for sampling in this guide). Send the container to Monsanto's laboratory. Charges listed include sample container, shipping, handling and laboratory costs.

Types of Analyses Available

Analysis 1)

ROUTINE MAINTENANCE CHECK

Total Charge: $20.00

To determine the general condition of the fluid and find whether further analysis is necessary. (one-quart sample required)

Properties Tested
Color and Condition
Dielectric Strength
Moisture

You will be notified of the results of this test. If further testing is indicated, and you want a complete analysis, you will be sent a five-pint sample container. This sample will be used for the following series of tests:

Analysis 2)

COMPLETE ANALYSIS

Total Charge: $50.00

(a) To determine the extent of fluid contamination, (b) earth refinement to determine what degree of restoration of electrical and insulating properties is possible, (c) check test to see how the fluid responded to earth treatment.

a) Complete Analysis: to determine the extent of contamination

Properties Tested
Color and Condition
Specific Gravity
Refractive Index
Water
Free Chlorides
Acidity
Dielectric Strength
Power Factor, Dielectric Constant, and Resistivity

b) Earth Refinement Response:

Consists of treatment for 2.5 hours at 50-60°C. with 0.1 to 0.2 percent by weight of properly conditioned Attapulgus clay and then filtration through dry filter paper.

c) Analysis After Laboratory Earth Refinement:

Properties Tested
Refractive Index
Water
Free Chlorides
Acidity
Dielectric Strength
Power Factor, Dielectric Constant, and Resistivity

You will be notified of the results of this test series on your sample. Then after refining your entire transformer fluid fill you can check on the results by requesting the following analysis:

Analysis 3)

ANALYSIS AFTER EARTH REFINEMENT

Total Charge: $30.00 (This charge will not apply when analyses 1 and 2 have already been made.)

To determine whether the entire lot of the askarel fill responded to the same extent as the laboratory sample. (five-pint sample required)

Properties Tested
Color and Condition
Refractive Index
Water
Free Chlorides
Acidity
Dielectric Strength
Power Factor, Dielectric Constant, and Resistivity

To arrange for the tests described above write to the following address:

Paul G. Benignus
Monsanto Chemical Company
800 North Lindbergh Blvd.
St. Louis 66, Missouri

Samples to be tested should be clearly marked for identification and sent directly to:

Monsanto Chemical Company
W. G. Krummrich Laboratory
Monsanto, Illinois
Attention: R. Kuster

APPENDIX

APPENDIX A — Askarel Stability and Composition of Arc Formed Gas:

Askarel insulation is one of the most inert, chemically-stable heat resistant, non-corrosive liquids known. It will not break down, oxidize or sludge when exposed to air and high temperatures, 150°C. or even somewhat higher. Arcing, however, will break down the compound to liberate some hydrogen chloride and small amounts of carbon.

APPROXIMATE COMPOSITION
ARC FORMED GAS FROM TRANSFORMER ASKAREL

Gas	Amount
carbon monoxide	0.3 per cent
carbon dioxide	0.3
oxygen	0.6
inert gases	1.5
hydrogen chloride	97.3

(note the absence of phosgene)

This arc-formed gas is non-flammable and non-combustible. These requirements must be met in accordance with the Underwriters' Laboratory for permission to use the term askarel.

Mineral oil evolves combustible hydrogen and hydrocarbon gases.

For all practical purposes, the amount of gas liberated from mineral oil or askarel under a given set of conditions is about 100 cubic centimeters per kilowatt-second.

APPENDIX B

SOLUBILITY OF GAS IN
TRANSFORMER ASKAREL

	Percent of Gas By Volume Corrected to:			
	25°C. 760 mm		0°C. 760 mm	
	25°C.	100°C.	25°C.	100°C.
Carbon dioxide	71%	47%	—	—
Air	5.7	4.9	5.8	5.0
Nitrogen	6.0	4.8	5.5	4.4
Hydrogen chloride[1]	37.8	50.9	—	—

1) In absence of scavenger

APPENDIX C

APPROXIMATE VAPOR PRESSURE vs.
TEMPERATURE FOR TRANSFORMER ASKAREL

Temperature °C	Inerteen PPO, 7336-9	Transformer Pyranol A13B3B
40	1 mm Hg.	0.9 mm Hg.
60	5	3.5
80	9	8.3
100	30	18
120	60	32
140	90	53

APPENDIX D

EFFECT OF TEMPERATURE ON
DIELECTRIC STRENGTH OF ASKAREL

Temperature °C.	Dielectric Strength
—60	67 KV
—40	63
—20	57
0	55
20	50
40	50
60	48
80	45

APPENDIX E

COMPARISON QF THE APPROXIMATE VISCOSITY IN
SAYBOLT UNIVERSAL SECONDS OF TRANSFORMER
ASKARELS AND MINERAL OIL

Temp. °C.	Transformer Pyranol A13B3B	10-C Mineral Oil	Inerteen PPO, 7336-9
—20	1,000	1,000	2,800
0	100	150	195
20	70	85	85
40	45	49	50
60	39	40	40
80	34	34	36
100	30	30	33

APPENDIX F

THE DENSITY OF INERTEEN PPO
7336-9 AND TRANSFORMER PYRANOL A13B3B
Approx. Density gm/cc.

Temperature °C.	Inerteen PPO, 7336-9	Transformer Pyranol A13B3B
0	1.574	1.577
20	1.552	1.555
40	1.529	1.532
60	1.507	1.510
80	1.485	1.488

APPENDIX G

The thermal conductivity values of transformer Pyranol A13B3B at 27°C. and 58°C. are 26.2 and 25.8 x 10^{-5} calories centimeters^{-1}, degrees centrigrade^{-1}, second^{-1}, respectively. Or, approximately 0.06 BTU per (hr.) (sq. ft.) (°F.) per foot. This same approximation applies to Inerteen PPO (7336-9).

APPENDIX H

Heat Capacity

Over the temperature range of 25° to 125°C. the specific heat of transformer askarel is close to 0.30 calories per gram per degree.

APPENDIX I

Coefficient of Expansion

The average coefficient of expansion of transformer askarel over the temperature range 20 to 100°C. is 0.007 cc/cc/°C. One gallon would increase to 1.056 gallons on heating from 20 to 100°C.

APPENDIX J

Fire-Resistance

To use the generic name "askarel," the fluids must be approved by the Underwriters' Laboratories as possessing adequate fire-resistance and freedom from forming explosive gases when arced. These liquids do not have a burn point (ASTM D92-33) (Cleveland open cup method) up to about 205°C., at which temperatures they begin to boil. The significance of this is that they do not burn or support combustion under conditions encountered in transformer operation. Thus the danger of secondary explosion (or fire) is eliminated.

APPENDIX K

Seals, Properties and Procurement

Dow Corning Corporation, Midland, Michigan with District's at Atlanta, Boston, Chicago, Cleveland, Dallas, Los Angeles, New York City, Washington, D. C. and Toronto has available Bulletin 09-019, August 1962 entitled "**Silastic Design Data**". This lists the gasket fabricators throughout the country from whom the "Silastic 50" gasketing can be purchased in sheet, extrusions or molded shapes.

Generally Silastic 50 sheet goods are stocked by local die cutters, hence, could be generally purchased locally. Usually, small quantities of gaskets are die cut. If larger quantities are needed, tools are made of the same type used to cut other elastomers.

Where the gasket is extruded for fitting into a machined groove or between gasket stops, Dow-Corning advises use of a scarved joint. This joint is then cemented using Dow Corning's Silastic 140 (clear) or their RTV 731 (white) materials, which air cure.

Dow Corning points out that the local "rubber" fabricators purchase the Silastic 50 in billet form. This is worked on a roll mill in preparation for sheeting or extrusion. Then to obtain the desired physical properties the fabricator must oven cure the Silastic 50 for 24 hours at 480°F.

SPECIFICATIONS*

	Color . . . . . White
	Specific Gravity at 77°F. . . . . 1.20 ± 0.02
ASTM D676 —	Hardness, Shore A. Scale . . . . . 45 to 60
ASTM D412 —	Tensile Strength, psi. min. 800
ASTM D412 —	Elongation, percent, min. 250
ASTM D395 —	Compression Set after 22 hours at 300°F., percent, max. 30

* All physical properties measured on 0.075 inch thick samples molded 5 minutes at 240°F., and oven cured 24 hours at 480°F.

General Electric Company, Redmond Circle, Rome, Ga., uses silicone or DuPont's Viton wherever it is not possible or desirable to weld. For some small seals, where good matching surfaces are provided, Flexitallic stainless steel rings are used.

By contacting the Engineering Services Department of General Electric Company, Redmond Circle, Rome, Ga., users of Pyranol transformers made prior to development of these modern seals will obtain prompt assistance for conversion.

Users of askarel transformers made by other manufacturers should contact the original transformer manufacturer, or Monsanto for assistance in converting to these modern seals.

NOTES

MONSANTO
FUNCTIONAL FLUIDS DEPT.

800 N. LINDBERGH BLVD.
ST. LOUIS, MISSOURI 63166

The information herein regarding obtaining optimum results from askarel fluids in your transformer has been accumulated by Monsanto for over 30 years from the experience of makers and users of askarel transformers and it is believed will be helpful.

Nothing herein shall be construed as applying to other than askarel insulation. Data and maintenance suggestions herein do not apply to the other components of the transformer. All operating and maintenance suggestions recommended by the manufacturer of the transformer should also be carefully followed.

Because these maintenance directions apply only to the askarel insulation, Monsanto disclaims any liability for damage to property or injury to persons arising from transformer operation.

KM-CLB-1500 HOLLAN 7202-002125 Litho in U.S.A.