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This report is: ☐ INTERIM ☒ FINAL and mainly: ☐ NEW ☒ REVIEW

DESCRIPTIVE SUMMARY WITH CONCLUSIONS:

This report provides the detailed information requested by the Chlor-Alkali Business Team on the status of non-asbestos diaphragms. The EPA has proposed a rule to ban the use of five asbestos containing products and phase out all remaining uses of asbestos in the United States over the next ten years. Permits for importation and use of asbestos for chlorine cell diaphragms may be required during a phase out period, and an exemption from the proposed rule for chlorine cell diaphragms may be possible. The white asbestos (H#2 and H#1) used for diaphragms at all Dow locations would probably be unavailable due to closure of asbestos mines in the United States. Stockpiling of asbestos and the use of alternate white asbestos sources (Z2 and Z1) are being evaluated.

Membrane cells offer an alternative technology, but complete conversion to membrane cells would require a very substantial amount of capital. The use of non-asbestos diaphragms as well as membrane cells would be preferred if an acceptable non-asbestos diaphragm was available. The patent literature contains many different versions of non-asbestos diaphragms by many different companies, but none are being used commercially by any major chlor-alkali manufacturers.

Three different versions of non-asbestos diaphragms have been developed by Dow. Porous Teflon diaphragms are probably not economically justified versus converting to membranes. Slurry drawn Teflon bonded potassium titanate diaphragms show promising results, but potassium titanate could be regulated similar to asbestos in the future. Slurry drawn Teflon bonded talc diaphragms offer the best chance of utilizing non-asbestos diaphragms. Additional research is needed to improve the talc diaphragm formulation to resolve strength and cell performance problems. A research plan has been prepared, and work should begin during May, 1986.

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NON-ASBESTOS DIAPHRAGM DEVELOPMENT STATUS

This report provides the detailed information requested by the Chlor-Alkali Business Team on the status of non-asbestos diaphragms. The EPA has proposed a rule to ban the use of five asbestos containing products and phase out all remaining uses of asbestos in the United States over the next ten years. Permits for the importation and use of asbestos for purposes such as chlorine cell diaphragms would be required during the phase out period. The closures of asbestos mines in the United States and Canada would probably result from the immediate ban of the major uses of asbestos. This would probably mean that the white asbestos (H#2 and H#1) normally used for diaphragms at all Dow locations would be unavailable. Stockpiling of asbestos to minimize this disruption, and the importation and use of alternate white asbestos sources (Z2 and Z1) will probably be required. All of the above aspects are discussed in detail in Section I of Appendix A.

There are mainly two courses of action which allow the phase out of asbestos diaphragms. The first option is the complete conversion to membrane cells, and the second option is the use of non-asbestos diaphragms as well as membrane cells. The complete conversion to membrane cells would require a substantial amount of capital. The Texas AS&TL and Chlor-Alkali Technology Center personnel are evaluating the exact conversion costs and impact on the membrane cell development program. Complete conversion to membrane cells in ten years is probably impractical. Some of these considerations are discussed in Section IV of Appendix A.

The second option of utilizing non-asbestos diaphragms and membrane cells would be preferred. The capacity (longterm) converted to membrane cells would probably be equivalent to the amount of NaOH

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being evaporated to 50%. The cell energy required to produce chlorine and cell effluent from diaphragm cells is projected to remain lower than membrane cells. Around 40% of the cell effluent produced is presently sent to user plants instead of the evaporators. However, for this option to be viable, non-asbestos diaphragms with acceptable costs and cell performance are needed. This report reviews the status and development details of non-asbestos diaphragms produced by Dow and competitors in Appendix B.

Three different versions of non-asbestos diaphragms have been developed by Dow. The advantages and disadvantages of each type are compared in Table I. Porous teflon diaphragms were extensively evaluated and scaled up to M82 size cells. These diaphragms were costly ($9,000/installed diaphragm), and the problems of dewetting and installation in pocket cells were not satisfactorily resolved. Resin treated brine was also required to reduce the plugging rate. The diaphragm production rate for porous teflon is relatively low. It would require about $5,000M capital to set up facilities to produce enough diaphragms for a 10% conversion rate to phase out in 10 years assuming a 10-year teflon diaphragm life. Conversion to membrane cells would probably be just as cost effective as conversion to porous teflon diaphragms. These aspects are discussed in detail in Section I of Appendix B.

Slurry drawn teflon bonded talc diaphragms were evaluated for six months on six M83 cells at the Midland Division. The cost and diaphragm production rate for talc diaphragms are similar to standard asbestos diaphragms. A full series of M83 cell talc diaphragms was produced and shipped to the Texas Division Chlorine-4 Plant. These diaphragms were not successfully started-up due to severe anolyte foaming problems. These diaphragms then fell apart during attempts to correct the foaming problems. The cause of the foaming was talc floating in the anolyte from a non-bonded redip step to seal microcracks. This redip step should be eliminated. The strength problems should be corrected by increasing the %TFE latex and bonding at 360°C. Additional development work would also be necessary to improve the erratic cell performance. Despite the negative reaction generated by the series failure, I believe that these diaphragms can be optimized by modifying the formulation to give satisfactory results. The diaphragm strength problems should be corrected by similar changes made in developing titanate diaphragms which were originally produced by substituting titanate for talc using the same process. The talc diaphragms are discussed in detail in Section II of Appendix B. A proposed research plan was developed for these diaphragms giving goals, people needed, facilities needed, and an initial testing schedule. These are discussed in Part E of Section II.

Teflon bonded potassium titanate diaphragms are similar in several respects to teflon bonded talc diaphragms. They offer additional advantages of superior chemical resistance with stable operation demonstrated for three years in lab cells. These diaphragms were never scaled up to production size cells. The most significant disadvantage is that potassium titanate fiber could be regulated similar to asbestos due to similar health concerns. The knowledge used in optimizing these diaphragms should be applicable to improving talc diaphragms. These diaphragms are discussed in Section III of Appendix B.

The patent literature abounds with many different versions of non-asbestos diaphragms by many different companies. Dow does not have a strong patent position, but there should be no problems in using either calendared porous teflon diaphragms or slurry drawn teflon bonded talc or titanate diaphragms. Two competitors have scaled up porous teflon diaphragms to production size cells. Occidental (Hooker) reported favorable results for their version, and ICI (using Gore-Tex) reported favorable results with plans for commercialization. The noticeable lack of further activity in the last four years by these competitors probably means that they also determined that these diaphragms were not economically justified versus membrane cells. It is doubtful that Dow could license our technology to the competitors or that we could use their diaphragms without modifictions. This is due to the difference in current density of 0.4 amps/in^2 for Dow versus over 1.0 amp/in^2 for the competitors. Evaluation of the Gore-Tex material was required in defense of our patent. Samples of the Gore-Tex diaphragms were evaluated in lab cells. These diaphragms were very loose, had a low efficiency, and high hypochlorite. A larger pore size can be used satisfactorily by the competitors at the higher current densities. These details are discussed in Section IV of Appendix B.

In summary, porous teflon diaphragms are probably not economically justified versus converting to membranes. Slurry drawn teflon bonded talc diaphragms offer the best chance of utilizing non-asbestos diaphragms. Additional research would be needed to improve the talc diaphragm formulation to solve strength and cell performance problems. A potential research plan has been determined for further talc diaphragm development. All locations should be made aware of the probable supply loss for H#2 and H#1 white asbestos and consider stockpiling or use of alternate sources such as Z2 and Z1.

John Gross

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Attachments

db

TABLE 1

COMPARISON OF NON-ASBESTOS DIAPHRAGMS

DIAPHRAGM	ADVANTAGES	DISADVANTAGES
1. POROUS TEFLON - Calendered Sheet	1. Dow patent issued 2. Five year life demonstrated in lab cells 3. Scaled up to Production sized cells a) MG3 cells for six months b) MB2 cells for three months 4. Excellent chemical resistance and strength 5. Acceptable current efficiencies and start-up gpl NaOH 6. Nonregulated status	1. Costly at apprx. $9,000/diaphragm 2. Labor intensive fabrication process 3. Difficult installation for pocket cells a) Seaming b) Sealing c) Punctures 4. Diaphragm plugging requires resin treated brine & acid diap. wash 5. Dewetting causes 200 mv penalty at times requiring CO_2 removal from brine & rewetting with surfactants. 6. Low diaphragm production rate/unit
2. TEFLON BONDED TALC - Slurry Drawn	1. Dow patent allowed 2. Scaled up to prod. size cells a) 6 MB3 cells for 6 months b) Full Series 3. Production rate capability & cost similar to standard asbestos diaphragms at approximately $2,000/diaphragm 4. Nonregulated status	1. Major failure on full series start-up a) Foaming due to nonbonded redip b) Fell apart due to low strength with bonding at 360°C required & a higher % TFE 2. Poor chemical resistance of talc with erratic gpl/head 3. Marginal current efficiencies 4. Caustic draw carrier causes storage and shipping problems 5. Further development research needed
3. TEFLON BONDED Potassium Titanate - Slurry Drawn	1. Active patent disclosure 2. 3 year life demonstrated in lab cells 3. Production rate capability, draw system, & draw procedure similar to standard asbestos diaphragms. $3,000/diaphragm 4. Excellent chemical resistance 5. Lab cell current efficiencies & performance similar to standard asbestos diaphragms.	1. Potential regulation similar to asbestos 2. One supplier (Otsuka) 3. Needs to be scaled up to production sized cells. Largest size cells to date were 150 amp intermediate cells.

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APPENDIX A

ASBESTOS REGULATION EFFECTS

I. ASBESTOS STOCKPILING AND ALTERNATE SOURCES

Roddey Peebles set up a meeting with personnel from the Brakegate Limited Company that currently supplies the blue asbestos used in the standard M83 diaphragm. They presented data from the Asbestos Information Association regarding the proposed new EPA rule and the projected impact on the asbestos manufacturers. The chlor-alkali industry presently represents only about 2% of the asbestos usage. About 70% of the asbestos is used to make asbestos cement pipe and sheet. The Canadian Mines supply over 80% of the U. S. asbestos market, and the few U. S. mines in operation account for about 10% of the market.

The result of the proposed U. S. ban on five asbestos products would probably be that all the mines in the U. S. would shut down as well as many in Canada. Some of the more developed European countries and Canada might follow the U. S. lead in banning asbestos. Most of the third world nations would probably continue to use asbestos products with proper regulations to minimize their risk to health problems associated with asbestos. The World Health Organization presently supports this concept of risk assessment. More people are dying in these countries from the lack of clean drinking water than from asbestos usage, and asbestos cement pipe offers them a cost effective means of providing water suppies. Therefore supplies of asbestos will probably continue to be available. Russia presently supplies about 70% of the world with asbestos and keeps increasing production. Brakegate will continue to supply blue asbestos from mines in South Africa, and white abestos from Zimbabwe. The Canadian asbestos mines in particular may challenge the U. S. asbestos ban. The probable date projected for the rule to take effect is January 1, 1989, but it could be tied up in court for some time. The earliest date projected is January 1, 1988.

The above results would probably mean that the white asbestos normally used for most Dow diaphragms would quickly become unavailable. The Vermont asbestos mine that supplies Hooker #2 and Hooker #1 only operates for a portion of the year presently. Not only the U. S. plants would be affected, but also Canada and Stade which use all white asbestos diaphragms drawn with Hooker #1 and Hooker #2. Our main alternate asbestos sources were Bell 4T and 3T from Canada. The Bell 4T was used extensively at the Texas Division and typically gives a looser diaphragm at the same refinement settings. The possibility exists that this might also become unavailable if the mines shut down. Another alternate source of white asbestos is from Brakegate with mines in Zimbabwe. Some of our competitors have already converted to using Z-1 and Z-2 white asbestos for diaphragms to replace Hooker #1 and Hooker #2. They even report better consistency and efficiencies. More highly refined versions are available as Z1A and Z2M for tighter diaphragms. Six M83 cells were produced with Z-2 asbestos used to replace Hooker #2 in the standard diaphragm formulation. These have been in operation for two months on S-2 at the Louisiana Division Chlorine-1 Plant. These diaphragms were looser than the standard diaphragms, but additional refinement or the use of Z2M should be able to correct this. Brakegate could also supply replacements for 7M asbestos used for cell treating and for 3F-700 asbestos used for pulping. A full series of diaphragms drawn using Z2 asbestos may be needed to further optimize the drawing parameters and provide sufficient data for this alternate source.

Stockpiling of asbestos might also be desirable to allow continued use of Hooker #2 and Hooker #1 white asbestos. This would prevent having the possibly poorer cell performance problems associated with trying to quickly adjust to alternate sources of asbestos. The purpose of this would not be to avoid the proposed rule since U. S. permits would be needed both for usage and importation of asbestos. The amount of asbestos needed for the U. S. was estimated at 575M lbs/year based on a 3-year average diaphragm life assuming about 5215 operating cells and 330 lbs asbestos weight/diaphragm. Assuming a conversion rate to membrane cells or non-asbestos diaphragms of at least 10%/year for 10 years, about 3MM lbs of asbestos would be needed. Assuming that both blue and white asbestos were stockpiled at an average cost of 57¢/lb, the cost of the asbestos would be about $1,700M. If the rate of conversion was allowed to be only 5%/year, the above values would double. The storage of the asbestos would need to be done on the Dow Plant site in warehouses capable of meeting all asbestos regulations. The storage cost is the true incremental cost, since the asbestos cost would occur anyway. Stockpiling asbestos would not necessarily be needed if Bell 4T was available or if the Z2 asbestos continues to demonstrate acceptable performance.

One aspect of the proposed EPA rule is that during the first year of the 10-year phase-out period only one-third of the yearly average asbestos usage based on 1981, 1982, and 1983 would be allowed. It would be impractical to meet this requirement by conversion to membrane cells or porous teflon diaphragms. The use of slurry drawn teflon bonded talc or titanate diaphragms with production rates similar to standard asbestos diaphragms would probably be about the only chance of meeting this assuming further development work resulted in acceptable cell performance. The asbestos usage has been decreasing during the last several years with the M83 cell conversion and use of Gulf Coast standard M83 diaphragms. Data are being obtained on the actual asbestos usage. If we were already averaging a 3-year diaphragm life, about 1738 cells/year would have to be rediaphragmed in the U. S. Of these cells, only about 579 could be rediaphragmed with asbestos, and the remaining 1144 cells would have to be replaced with membrane cells or use non-asbestos diaphragms. Hopefully a more practical rate of conversion will be allowed for chlorine cell diaphragms following the chlor-alkali industry responses to the proposed rule.

AIA North America

NEWS & NOTES

January 31, 1986

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EPA ISSUES PROPOSED RULE TO BAN CERTAIN PRODUCTS AND PHASE OUT REMAINING USES OF ASBESTOS

At a news conference on Jan. 23, EPA Administrator Lee M. Thomas announced that the U.S. Environmental Protection Agency (EPA) is proposing a rule to ban the use of five asbestos-containing products and phase out all remaining uses of asbestos in the United States over 10 years. The proposed rule was published in the *Federal Register* on Jan. 29, 1986.

As reported (N&N Dec.), EPA submitted its proposed rule to the U.S. Office of Management and Budget (OMB) for review on Dec. 13. The EPA proposal has been a matter at issue within the government for the last year in regard to legal and policy questions raised by Section 9 of the Toxic Substances Control Act (TSCA), i.e. whether the risks that EPA believes are unreasonable, and that are subject to jurisdiction of the U.S. Consumer Product Safety Commission (CPSC) and U.S. Occupational Safety and Health Administration (OSHA), should be referred to these regulatory agencies. While OMB had earlier recommended to EPA that such referral to CPSC and OSHA was appropriate, clearance was given by OMB to publish the proposed rule following the most recent review process.

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According to Thomas' statement, the agency is "taking this action because of the significant and well-documented threat to health that asbestos represents. It is a known human carcinogen that causes lung cancer and mesothelioma. Asbestos is released into the air through its life cycle, from mining to processing to use and final disposal. As a result, it is present in the ambient air and presents a serious health risk to the American people. No level of exposure is without risk. Our action today begins the process of eliminating that risk. As a result of what we are proposing, we estimate that about 1900 cancer deaths from asbestos will be avoided."

The products EPA proposes to ban are:

- A/C pipe and fittings
- Roofing felts
- Flooring felts (and felt-backed sheet flooring)
- Vinyl-asbestos floor tile
- Asbestos clothing

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In addition, under the proposed rule, EPA would allow only those persons with permits issued by EPA to mine or import asbestos for use in products that are not banned. This would be accomplished by authorizing persons to mine or import a percentage of the average amount of asbestos mined or imported yearly during 1981, 1982 and 1983 starting with 30 percent in year 1 and declining to 3 percent in year 10. However, EPA did set forth three alternative approaches for further regulation of asbestos which are less severe than the actual proposal. Essentially, these alternatives would ban certain products "soon after promulgation" of a final rule, asbestos friction products about 5 years later, and ban remaining asbestos products about 10 years later.

The rulemaking procedure calls for submission of comments 90 days after publication in the Federal Register (Apr. 29, 1986) with public hearings to later follow. After this, EPA will assess the record and then will likely prepare and submit to the U.S. Office of Management and Budget (OMB) a final rule for review. It is safe to assume that EPA's preparation and submission to OMB of any final rule will not, at the earliest, occur before sometime in 1987. This would mean an effective date of Jan. 1, 1988 or, if a final rule is published within the last four months of next year, the effective date would be Jan. 1, 1989.

It is emphasized that EPA's action at this time is a proposed rule to ban and phase out asbestos uses; it is not a final rule. There are many complex issues to be addressed and reconciled in the lengthy rulemaking process. AIA/NA is fully persuaded that the proposal to ban and phase out all current uses of asbestos is unwarranted and inconsistent with the international consensus favoring controlled use of asbestos. The Association does not believe that EPA will be able to support with substantial evidence its preliminary finding of "unreasonable risk" which was necessary to issue the proposed rule.

INSPECTIONS, TRAINING NOT TO BE CUT BACK AS RESULT OF GRAMM-RUDMAN ACT, OSHA SAYS

Inspections and training conducted by the Occupational Safety and Health Administration will not be adversely affected by budget reductions mandated by the Gramm-Rudman deficit reduction bill according to the agency. Cutbacks will be accommodated by continuation of a current hiring freeze, discontinuation of overtime pay, and limitations on travel.

Although the agency has no specific budget-change figures yet, the bill obviously will have an impact.

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Volume 2 Issue 3

QUIN-T REPORT

WORLD HEALTH ORGANIZATION

ASBESTOS...."general trend toward a more sensible approach." Dr. Döbrössy, Chief of THE WORLD HEALTH ORGANIZATION, praised the Doll/Peto Report on the Effects on Health of Exposure to Asbestos as a major achievement. It will help diffuse the publicity that the asbestos issue has received, that has diverted attention from the REAL RISKS AND NEEDS in the field of cancer prevention. Many of the perceived cancer risks need to be put in proper perspective. The Doll/Peto report will lead us to "....un retour a une plus grande sagesse."

BRITISH HEALTH AND SAFETY COMMISSION

Sir Richard Doll, Emeritus Professor Medicine, University of Oxford, and Julian Peto, Professor of Epidemiology, Institute of Cancer Research, University of London, have just issued a report on the Health Effects of Asbestos Exposure for the Health and Safety Commission of Great Britain. This two and a half year study should put to rest some of the misconceptions, inaccuracies, and incomplete information on asbestos fiber that has caused so much anxiety and irrational fears in the public sector. The risks associated with smoking, automobile accidents, and pharmaceuticals are compared with bike riding, swimming and skiing. Even common activities such as traveling by air (high altitude radiation), eating broiled steaks and drinking water are not without risk. Living has risks associated with it. Table I lists the relative risk so that common, everyday activities can be compared.

TABLE I

LIFETIME RISK PER 100.000

EXTRA HIGH RISK	
• Smoking (all causes of death)	21.900
HIGH RISK	
• Motor vehicle, U.S.A., 1975 (deaths)	1.600
ELEVATED RISK	
• Cirrhosis of liver, moderate drinker (deaths)	290
• Skiing, 40 hours per year (death)	220
MODERATE RISK	
• Drowning deaths, all recreational causes	190
• Natural background radiation, sea level (cancer)	110
***LOW RISK[1]**	
• Cycling (deaths)	75
• Person sharing room with smoker (cancer)	75
• Diagnostic X-rays, USA (cancer)	75
***VERY LOW RISK[2]**	
• Vaccination for small pox, per occasion (death)	22
• One transcontinental air flight per year (death)	22
***EXTREMELY LOW 'RARE-EVENT' RISK[3]**	
• Lightning (deaths)	3
• Charcoal broiled steak, one per week (cancer)	3
• Environmental asbestos risk[4], 1985 (cancer)	1

*Risk level where few would commit their own resources to reduce the risk further:
1. 70/100.00: 2. 7/100.000: 3. 1/100.000

"RARE-EVENT"

What is evident from Table I is that the estimated lifetime risk from environmental exposure to asbestos per 100,000 people ranks below getting struck by lightning, death in a hurricane or eating charcoal broiled steak, all of which are included in the "Rare-Event" category. Certain risks are often overlooked, eventhough they are perhaps two magnitudes of order, more hazardous in terms of cancer than environmental asbestos. They are natural background radiation, tobacco smoke from sharing a room with a smoker, radiation from diagnostic x-rays, and high altitude radiation from being a frequent airline passenger. Lifetime risk of 1 in 100,000 is used by the WORLD HEALTH ORGANIZATION as an acceptable goal world-wide. Put in another way, 1 per 100,000 would equate to a loss of life expectancy of 1 hour.

The loss of life expectancy in days and hours from various causes is shown in Table II.

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TABLE II
LOSS OF LIFE EXPECTANCY FROM VARIOUS CAUSES

Cause	Loss Of Life Expectancy (Days)
Occupational accidents	
o Trade	30
o Manufacturing	43
o Service	47
o Government	55
o Transportation & Public Utilities	164
o Agriculture	277
o Construction	302
o Mining, Quarrying	328
Smoking	
o Respiratory Cancer, Emphysema, & Pulmonary Heart Diseases	690
o All Causes in (1) Plus Ischaemic Heart Disease	1355
o All Causes Probably Attributable To Smoking	1618
Other	
o Exposure to Passive Smoking 1 hr/day	14 hrs
o Working in Building for 40 Years (Smoker)	2 hrs
(Assuming 0.001f/cc chrysotile) (Non-Smoker))	23 min
0 Attending High School for 3 Years (assuming 0.001 f/cc Chrysotile)	5 min

INITIATOR RATHER THAN PROMOTOR

In the Doll/Peto Report, there is considerable discussion as to whether asbestos is a carcinogenic initiator or promoter, and if there is an exposure level below which there is no biological activity. There seems to be general agreement that inhalation of very small chrysotile fibers are not harmful, because they are readily expelled from the respiratory system. In the environment there are hundreds of thousands of particles and fibers. It is estimated that the number of asbestos fibers that occur naturally are outnumbered by other fibrous minerals by 10 to 1. Therefore, the pathalogical possibility of a critical hit by a single small fiber would seem to be extremely unlikely. The mechanism involved probably is a multi-hit, multi-stage carcenogenic process. Practically everyone on the planet, in the course of breathing, will have a huge number of mineral fibers in their lungs. The chances of disease developing from environmental asbestos is highly unlikely. This may indeed indicate a threshold level below which there is no biological activity.

In addition, there is evidence that asbestos may be a promoter rather than a carcinogen itself. That is, it ma act as a catalyst along with the initiator resulting in a health effect that is exponential rather than a linear dose-response relationship. Asbestos exposure and cigarette smoking is a good example of this phenomenon. The chemistry of the asbestos fiber and its structure may cause a synergistic reaction with tobacco which is the carcinogenic initiator. The "threshold and promoter" rather than the "initiator" theory would account for the extremely low "RARE-EVENT" risk noted in Table I for environmental exposure to asbestos.

ENVIRONMENTAL EXPOSURE OVERSTATED

Even if the figure of 1/100,000 for environmental asbestos was in error on the low side by a factor of 3 or 4, it would still fall into the category of a "RARE-EVENT". There is a good possibility that the amount of asbestos in the environment is considerably overstated. Much of the published data on this subject is based o past occupational exposure. Risk assessments using mathematical models based on this information certainly wi result in overstating the risk because: (1) exposure of workers in the past was heavy compared to today's occupational setting; (2) asbestos is only 10% of the mass fiber loading in the ambient air; (3) current metho of measurement are more sensitive and can distinguish between asbestos and other mineral fibers; (4) fine fibe which are the most active biologically, are a minute part of environmental contamination, and (5) vastly impro control of asbestos mining and manufacturing has made the health risk of environmental exposure all but a remo possibility.

IGNORE MINIMAL RISK

The advances in measurement technology and the ability to identify minute amounts of contaminant has had a tremendous impact on our Federal Regulatory Agencies. We are literally awash in a sea of risks. Clearly, an attempt to ban a "RARE-EVENT" risk rather than balance the cost against the benefit will result in social and economic paralysis.

ELECTRICAL INSULATIONS
P O BOX 309
MILTON N H 03270
[illegible]

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IV. MEMBRANE CELL CONVERSION COST CONSIDERATIONS

The complete conversion to membrane cells would require a substantial amount of capital particularly if a complete phase-out in 10 years was required. The Texas Research and Chlor-Alkali Tech Center personnel are evaluating the conversion costs. Capital would be required for the flat plate cells, membrane, headers, buswork and other cell area changes. Brine treating changes with resin beds and removal of CO_2 would be needed. Resin beds for condensate supply to the catholyte may also be needed. Changes in the Division power/steam balances would occur as a result of the lower steam usage. Our competitors save power and steam but Dow primarily would save steam using membranes. This would require a site specific study for capital needed for condensing steam turbines or other modifications. The NaOH evaporator systems may eventually benefit and allow operation of a single effect without salt removal equipment. However, the transition period would upset some operations until the systems were modified as membrane cells provided the evaporator feed. The anolyte saturation problem is more difficult if complete conversion to membrane cells takes place requiring evaporation of brine for solid salt or pumping depleted anolyte for use as a mining fluid at the salt domes. The Division acid/base balances can also be upset due to the requirement for higher purity HCl. The lower quality aqueous HCl would need to be handled appropriately.

Options to reduce the rate of capital spending by using the retrofit membrane (envelope) concept could be considered. However, since Dow operates at 0.41 amps/in^2 versus the 1.5 amps/in^2 for many competitors diaphragm cells, this option will be less attractive. It would primarily save cell area capital at the risk of sealing problems and other debugging. Other capital requirements would be about the same. At \$60/ft^2 for Nafion and approximately 5,215 cells in the U. S. at 1,000 ft^2/cell, about \$300MM capital for membranes would be spent every approximately two years. Even with Dow membranes at \$20/ft^2, about \$100MM capital for membranes would be needed. Obviously, the higher current density (2.0 amps/in^2) flate plate membrane cells are a better deal for us.

Present membrane cell performance and projections still indicate that M83 diaphragm cells will produce chlorine and NaOH for users of cell effluent using less total cell energy. To maintain this option, non-asbestos diaphragms would be needed and would continue to produce around 40% of the chlorine and caustic for Dow.

APPENDIX B

NON-ASBESTOS DIAPHRAGM DEVELOPMENT STATUS

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DOW NON-ASBESTOS DIAPHRAGM DEVELOPMENT STATUS

I. POROUS TEFLON DIAPHRAGMS

A. Development History

1a) CRI Reports - LAD 282, 347, 848, 849, 850, 851, and 852

b) Patents - One has been issued (4,224,130) which covers pore sizes, fabrication, and use within a chlorine cell. A disclosure on seaming and sealing methods is inactive.

2. Early Testing - Initial lab cell testing led to the development of a diaphragm math model and selected the best commercially available material. A joint development program with Fluorotechniques resulted in the M7R1000 porous teflon diaphragm material which was scaled up to 3 M63 cells. Cell performance was not as good as desired and numerous installation problems were encountered. To further improve the diaphragm, it was realized that the fabrication process of the diaphragm material had to be optimized. This led to purchasing the right to fabricate materials using the process developed by Fluorotechniques. Some of the M7R1000 matrial operated for five years in the lab cells.

3. Optimization of the Fabrication Process With Lab Cell Evaluation - A lab sized calendar system was set up and fractional factorial experiment designs were used to optimize the process for optimum lab cell performance. The basic formulation is described below:

Raw Materials: Teflon #6 fine powder
Diamond crystal NaCl G-95 yps (3-5 micron size)
Varsol carrier medium

Process Steps: Fibrillation of teflon powder
Slurry mixture - 82% NaCl, 18% TFE with Varsol
Cake formation - filtration and press
Calendering to form a sheet
Sintering at 360°C
Water leaching to remove salt
Zonyl FSN surfactant for wet-out

The optimization resulted in the development of the C-80 formulation and porous teflon diaphragm material. This was better than M7R1000 and gave cell performance closer to standard asbestos diaphragms. Lab testing showed that lower hardness (resin treated) brine and CO_2 degassed brine improved the teflon diaphragm cell performance stability. A 150 to 200 mv increase in cell voltage was due to plugging and dewetting of the diaphragm. A weak acid diaphragm wash was needed to restore the plugged diaphragm, and rewetting with surfactant was necessary to eliminate the gas build-up. Other methods of making a more hydrophillic diaphragm such as surface grafting with SO_3H, using TiO_2 or other fillers, and etc. were evaluated. These were not very satisfactory.

4. Production Size Diaphragm Testing - A large production size calendar system was set up at Cell Service. Work was done to re-optimize fabrication parameters using lab cell evaluations. Pocket seaming and sealing techniques were developed and cell installation methods evaluated. These methods were successful but required significant labor and extreme care to prevent poking holes in the diaphragm. Three M82 sized cells were installed at the test stand and operated for 125 days. Cell performance was not as good as desired due to gas blinding that was more severe than previously noticed due to pH control upsets. This required rewetting the diaphragm, and probably CO_2 removal from the feed brine would be needed to reduce this problem. Disassembly of the cells showed severe backscreen corrosion due to deactivation using the EPR rubber. The Pourbaix diagram for iron corrosion illustrates that steel corrodes in the high pH region at the potential of an inactive backscreen.

5. Other Versions (Western Division) - CRI reports GP2018 and GP2737 are some of the reports that describe work done at the Western Division to develop a porous teflon diaphragm. The process was somewhat similar in using a calendar with variations in fabrication techniques. In an attempt to make a more hydrophillic diaphragm, fillers such as feldspar, talc, zirconium, Al_2O_3, TiO_2, and etc. were added. Feldspar was selected as the best candidate, and it showed better stability to gas blinding from pH upsets. Similar to results seen in Louisiana Division testing, the diaphragm strength was cut in half by the use of enough filler to prevent dewetting. These diaphragms were not scaled up to production size cells. The lower diaphragm strength may not have been sufficient for the installation, seaming, sealing, and etc. processes.

B. Further Development Needs:

1. Diaphragm Installation - The numerous factors of seaming, sealing, and prevention of tearing holes during diaphragm installation into pocket cells need further development. Presently, this is very labor intensive and requires numerous minor modifications to the cathode such as turning the burr to the inside. Installation into graphite or sheet anode cells was somewhat difficult. Installation into today's three piece version of a mesh anode (from expansion of sheet to mesh) would result in "swiss cheese". Extensive grinding and rework to the mesh anode assembly would be needed. It is essentially these same difficulties that led to the flat plate membrane cell development. Indeed, the porous teflon diaphragm installation problems would also be solved by a flat plate cell design with the proper grinding of anodes and modifications to prevent "flapping" now needed for membranes. Corrosion of the inactive backscreen would have to be resolved by different materials of construction or by making an active backscreen with further sealing problems.

2. Diaphragm Dewetting - Work to solve the dewetting or gas build-up problem was not totally successful previously. The use of hydrophillic inorganic fillers or ion exchange membrane polymers added to the diaphragm should probably be studied further. It should be noted that this problem is not as severe for looser (large pore size) diaphragms designed to run at higher current densities (1.5 amps/in^2). The plugging problem due to brine hardness which requires the use of resin treated brine would probably be less severe at a higher current density with a larger pore size diaphragm.

C. Projected Diaphragm Costs on a Production Basis

1. Diaphragm Material Costs

a. Raw Materials: For C-80 material of 165 lbs diaphragm weight (75g/ft^2 after leaching)

80% NaCl = 660 lbs X \$0.10/lb = \$66/diaph.
20% TFE = 165 lbs X \$6/lb = \$990/diaph.
\$1,056/diaph.
or \$1.06/ft^2

(Plus Varsol carrier and Zonyl FSN surfactant for wet-out)

b. Labor: Mixing, calendaring, seaming, and leaching are used to produce a teflon pocket. Production of three M82 diaphragms required four persons/shift for these operations plus supervision. This resulted in around 110 manhours per diaphragm. Some amount of scrap also occurred. The ballpark costs were approximately \$2,200 or \$2.20/ft^2.

This was for M82 cells with 47 pockets. M83 cells have the same total area, but with 67 pockets more labor would be used to make pockets, seam, seal, leach and etc. to obtain one diaphragm. If this scaled up at the ratio of 67/47 or 1.43, the labor costs might be

$3,140/diaphragm or $3.14/ft^2

Subtotal $4,196/diaphragm or $4.20/ft^2

Diaphragm Material Costs

2. Diaphragm Installation Costs

a) Raw Materials

1) EPR rubber for backscreen $600/cell or $0.60/ft^2
2) Cathode pockets-burr on inside, cathode flange plate on bottom - Premium Cost - $300/cell or $0.30/ft^2

b) Labor:

1) Holes punching in EPR rubber	- 8 hrs/cell
2) Welding flanges & grinding pockets	- 48 hrs/cell
3) Grinding anodes & placing EPR doughballs	- 20 hrs/cell
4) Installation of pockets & then backscreen assembly	- 20 hrs/cell
	96 hrs/cell for an M82

For an M83 cell, the labor would probably increase to 138 hrs/cell which would give costs of about:

$2,750/diaph. or $2.75/ft^2

Sub-Total $3,650/diaph. or $3.65/ft^2

Diaphragm Installation Costs

3. Incremental Diaphragm Costs

The cost of producing a porous teflon diaphragm independent of facilities fixed costs, allocations and etc. would be the sum of 1 and 2 above.

Diaphragm Material Cost	$4,196/diaph. or $4.20/ft^2
Diaphragm Installation Cost	$3,650/diaph. or $3.65/ft^2
	$7,846/diaph. or $7.85/ft^2

These costs are ballpark only but should help us to understand the magnitude of the costs involved. These are not documented in CRI reports and most records have disappeared from records retention considerations.

4. Fixed Costs for Facilities

Equipment Cost - The original set up with a production size calendar, oven, building, hoods, air conditioning, and etc. was about $300M. Most of the labor for installation was done by Cell Service and the total installed cost would have more than doubled the above cost. The calendar was bought used and assembled from various parts at a cost of approximately $67M. The cost for a new calendar capable of producing the porous teflon was quoted as about $250M. This equipment was dismantled and the calendar and oven were transferred to Russellville for use at Danville.

a) Capacity Needed:

For the U. S., approximately 5215 cells or approximately 81 series of 64 cells each was assumed.

- At a 3-year asbestos diaphragm life, approximately 1738 cells/yr or approximately 27 series/yr would need to be rediaphragmed.
- Assuming a 10% conversion rate/yr, 522 cells or 8.1 series/yr would need to be replaced with teflon. For a 10-year teflon diaphragm life, this would become the rate for continuous operation for the U. S.

b) Calendar Line Production Rate:

The calendar rate is the bottleneck. Work to increase the rate indicated that about one M82 cell diaphragm per day could be made working three shifts. However, 67 pockets are needed for an M83 cell and the production rate might be decreased by 47/67 or only 0.70 M83 diaphragms per day. Assuming 350 operating days/year, 245 diaphragms or about 3.8 series/yr/calendar line could be produced.

This indicates that at least two calendar lines would be required to convert the U. S. in 10 years assuming a 10-year teflon diaphragm life. This might be acceptable if some conversion to membrane cells was also underway. If a 10-year teflon diaphragm life was not achieved, a faster membrane conversion or a third calendar line would be needed. It is also clear that the teflon diaphragm production could not keep up with initial need for rediaphragming based on a three-year asbestos diaphragm life. This means that asbestos diaphragm production would continue and that the Cell Service building and facilities would not be available for several years.

c) Equipment Requirements:

An air conditioned fabrication building would be needed for two calendar lines consisting of the following: a) fibrillation blenders, cake filters and cake presses with hood ventillation for Varsol fumes, b) calendars, c) ovens, and d) seaming apparatus.

A building with an overhead crane would be needed for the following: a) leaching, b) cathode assembly, c) diaphragm installation, d) teflon powder and NaCl storage and etc., and e) office space.

d) Installed Cost Guesstimate:

The major equipment cost would probably exceed $1,000M, and the total installed cost would probably be about $5,000M. The major cost items are the calendars, and a substantial cost reduction might be possible by transferring the calendar from Danville and finding another used one. This guesstimate is probably ± 50% at best.

The total manpower needed for a calendar line operation would be around 60 people including a support staff of two engineers, vacation relief and etc. Labor costs were already included in the incremental diaphragm cost.

e) Cost Per Diaphragm:

Depreciation for the capital cost, allocations, taxes, insurance, and etc. would probably run around $750M/year minimum.

For a production rate of 522 cells/year, this would add another approximately $1,435/diaphragm or $1.44/ft^2.

5. Approximate Total Cost For Porous Teflon Diaphragms

By adding the fixed cost for facilities and etc. to the incremental cost, the total cost was determined.

Incremental cost	$7,846/diaphragm or $7.85/ft^2
Facilities Cost	$1,435/diaphragm or $1.44/ft^2
TOTAL COST	$9,281/diaphragm or $9.29/ft^2

Based on these rough estimates of costs, the true cost is probably between $7,000 and $11,000/diaphragm or $7 to $11/ft^2. A more detailed study would obviously be needed if this option was being pursued. However, this information and several other factors are sufficient to indicate the magnitude of the problems associated with porous teflon diaphragms.

D. Diaphragm Production Rate Capability and Concerns

This was discussed previously in figuring the capacity needed. Conversion of the U. S. chlorine cell diaphragms at 10% per year using two calendar lines might be possible. Assuming a 10-year teflon diaphragm life, this would be the continuous production rate needed to maintain the U. S. rediaphragming needs. The rediaphragming capability is significantly lower than the slurry drawn teflon bonded talc/titanate diaphragms.

E. Potential Research Requirements:

1) People and Goals:

a) The efforts of about one researcher would be required for up to two years for lab cell testing. The goal would be to solve the dewetting or gas build-up problem by incorporating a hydrophillic inorganic filler or a fluoropolymer with sulfonic acid pendant group.

b) The efforts of about one researcher would be required for up to two years to improve diaphragm installation and sealing techniques.

c) If items a and b above were successful, a production size evaluation would be needed. This would require the total effort of about six people for one year or more for a test stand evaluation of three cells.

2) Facilities:

Following the shutdown of the non-asbestos diaphragm project, oxygen depolarized cathode project,and H_2O_2 project; the lab and production sized fabrication facilities were dismantled. Equipment, buildings, and lab space were transferred to other groups.

a) Lab Testing - The lab cells exist and no additional equipment is needed for lab cell evaluation. However, the lab porous teflon fabrication facilities would have to be set back up. The calendar and oven are currently being stored in a warehouse. It would probably cost about $20M to set back up if lab space is available. An additional \$30M would be needed if a building was required. Some of this cost might have to be capitalized.

b) Intermediate Size Cells Testing - The 150 amp, 500 amp, and 2000 amp size cells, components, and buswork were scrapped. The rectifiers were transferred to Midland. The lab calendar was capable of producing diaphragms for these cells. The usefulness of the intermediate sized cells in evaluating cell performance was not worth the effort. These type cells were primarily used for testing seaming and sealing methods. It is doubtful that testing would be done on this scale again. It would probably cost about \$40M to set up and buy cell components.

c) Production Size Cell Testing - The capability exists to operate the test stand for evaluation of up to six M83 cells. Instrumentation, headers, and other modifications would be needed to set up again. These would cost about \$20M. The resin beds for brine treating and the CO_2 degassing tank were transferred. These would cost about \$40M capital.

The production sized fabrication facilities were dismantled with the oven and calendar sent to Russellville for use at Danville. The building was converted to office space. It would cost a significant amount to set up again. Based on the original cost, it would probably be about \$750M capital if the calendar was returned from Danville. It could be substantially more if a new calendar had to be bought at approximately \$250M cost.

3. Recommendations:

The high research costs for porous teflon diaphragms, the high diaphragm costs of approximately \$9,000/diaphrgm, and the significant installation problems make further research for this option undesirable. Research efforts would probably be better spent on developing the slurry drawn teflon bonded talc/titanate diaphragms and membrane cells.

II. TEFLON BONDED TALC DIAPHRAGMS

A. Development History

1. a) CRI Reports

EMR-217, TCL-568, TCL-579, LAD-1048

b) Patents

A patent has been allowed and will issue in the next 2 to 3 months.

2. Early Testing

Lab cell testing and intermediate cell testing were done by Midland AS&TL to develop a slurry drawn nonasbestos diaphragm. A variety of fluoropolymers and inorganic fillers were screened. Talc was chosen as the best filler, and the type used was not expected to have any problems of toxicity similar to asbestos. The formulation was optimized, and the following formulation was settled on for production testing:

Raw Material:

81% Talc (Cyprus Mistron Vapor talc)
10% Teflon 30 Latex
9% Teflon fiber, 1/4" size

Drawing Process:

190 gpl solids draw slurry - (approximately 600 to 700 lb. diaphragm weight)
Cell effluent used as draw carrier
Vacuum cycle controlled

Bonding Process:

Dried at 110°C
Bonded at 343 to 349°C and heat cycle closely controlled
- Microcracks formed at this stage

Redip:

Another draw step to fill microcracks

Redry:

Dried at 110°C (Bonding was not done again to prevent further microcracks.)

NOTE: Surfactants for wetout were not required due to the NaOH draw.

Production size diaphragms were drawn and installed on the end of a series. These diaphragms were operated for 6 months, and this may have been the longest time for any lab cell diaphragms as well. The performance was not stable on gpl/lead and the efficiencies were not as good as desired. However, the performance was deemed to be satisfactory for scale up to a full series of cells.

3. Production Testing of A Full Series

The drawing process worked well and diaphragm production went well to produce a full series. These cells were shipped to the Texas Division for erection due to shutdown of the Midland Division Chlorine Plant. Some of the cells were sent to Texas Division AS&TL for evaluation in a test stand to allow operating experience to be obtained prior to start up of the full series. The cells were shipped satisfactorily, but the performance on the test stand was not particularly good. Severe anolyte foaming occured when these cells where started up and they were very loose. The head/gpl relationship was unstable particularly when HCl was added for cell pH control. Other aspects of cell performance were also lower than stanoard asbestos diaphragms. Four cells were also shipped to the LAD AS&TL for possible erection on a test stand. However this was delayed and these cells were placed in a nonhumidity controlled warehouse. Inspection of these cells when they arrived showed that they were in good shape. However, inspection six months later showed severe rusting and crumbling of the diaphragm with the development of numerous holes. This demonstrated that storage and shipping of cell effluent drawn diaphragms must be done with the humidity controlled.

The full series was erected at the Texas Division Chlorine 4 plant. During start up, severe anolyte foaming occurred that could not be controlled by typical methods. It was noticed that talc and teflon fibers were floating in the anolyte and foam, and it was decided that these would have to be flushed from the system. An end cover was removed, air rods were installed, and an attempt was made to flush the material out of the open end cover. However, it was noticed at that time that large sections of the diaphragms were actually floating out. The series was dismantled and closely inspected with samples taken for evaluation.

4. Testing to Determine and Correct the Cause of the Catastrophic Failure

The catastrophic failure was duplicated at the Texas test stand by installing air rods. These diaphragms also came apart in pieces. The work to identify the cause of the foaming and strength problems was done with lab cell evaluations by La. AS&TL.

The cause of the severe anolyte foaming problem was conclusively demonstrated to be due to the talc floating in the anolyte as the result of the nonbonded redip used to seal microcracks. This problem can be prevented by eliminating the redip step. The long term diaphragm stability may not be as good as desired if further deterioration of the microcracks continued. However, the redip will not solve the problem. Formulation and draw procedure changes are needed to correct the problem of the microcracks.

The cause of the strength problem was shown to be due to using a bonding temperature that was too low. The samples of the diaphragms showed that they did contain the 17 to 19% total teflon required by the formulation. Bonding at 343 to 349°C gave an average diaphragm tensile strength of 39 psi versus 66 psi at 360°C. This is still only about 1/3 the strength of a standard kynar bonded asbestos diaphragm. It is not known for certain if any quality control problems occurred during production of the diaphragms at Midland such as an actual lower bond temperature versus oven set tings and instrumentation read out. Production diaphragms were also not sacrificed for strength testing and lab cell testing. Research personnel were being reassigned to other areas during that time. To prevent the catastrophic failure of the talc diaphragms, a higher bond temperature of 360°C was recommended. This was not used previously to prevent the teflon fiber from melting which caused more microcracks. However, this was not observed in intermediate size diaphragms (150 amp cells).

B. Further Development Needs

1. Additional Testing to Determine If The Catastrophic Failure Problem is Solved

   Talc diaphragms need to be scaled up to production cells without the nonbonded redip step and with bonding at 360°C. This would demonstrate that the catastrophic failure problem on start up could be eliminated.

2. Long Term Strength, Chemical Resistance and Cell Performance Concerns

   a. Strength

      The strength of this diaphragm even when properly bonded at 360°C may be lower than desired. By drawing in cell effluent, the talc diaphragm has a ceramic like appearance after bonding. However, this appearance is a poor indication of its wet strength. At 318°C fusing of NaOH occurs giving the ceramic character to the diaphragm, but this quickly changes following start-up of the diaphragm. Early testing was done using potassium titanate in place of talc at La. AS&TL while using the rest of the same formulation and draw procedure. The potassium titanate has excellent chemical resistance, but this diaphragm was shown to be crumbling apart after 3 months of lab cell operation with erratic performance. It was found that the NaOH used in the draw carrier inhibited melting and flowing of the TFE similar to previous observations on its effect in bonding with Kynar. In solving this problem for titanate diaphragms, it was necessary to eliminate the NaOH by using 15% NaCl solution as the draw carrier. It was also found to be necessary to increase the amount of Teflon latex used to 30% and increase to 360°C bond temperature.

b. Chemical Resistance

The talc is not as stable in the 2.0 pH anolyte as desired. This results in an erratic head/gpl behavior at times particularly when controlling the anolyte pH in the desired range. $MgCl_2$ addition and other treating were necessary to correct the low gpl NaOH and hypochlorite problems. Long term stability problems may also result from anolyte dissolving the talc on the anolyte surface and breaking the teflon to talc bonding. Crumbling of the anolyte surface of the talc diaphragms was observed in lab cell testing. This problem can be improved by increasing the teflon content of the diaphragm and perhaps by adding in a more acid resistant filler.

c. Cell Performance

The voltage data were satisfactory but the current efficiency versus gpl NaOH relationship needs to be improved. Further optimization of the cell performance by controlling drawing system variables would be needed. Optimization of the operating conditions versus cell performance may also have to be done to correct any problems that are not solved in diaphragm manufacturing.

C. Projected Diaphragm Costs on a Production Basis

1. a) Raw Materials

For a 600 lb. diaphragm weight
81% talc ≐ 486 lbs. x $0.17/lb = $83/diaph
10% TFE 30 = 60 lbs. x $6.55/lb = $383/diaph
9% TFE Fiber = 54 lbs. x $20/lb = $1,080/diaph.

(Cell Effluent draw carrier also used) $1,556/diaph.

b) Labor

- Assumed labor of about $350/diaph.

  (If the nonbonded redip and redry was eliminated, costs would be similar to std. diaphragms.)

Total	$1,906/diaph.

2. Fixed Costs for Facilities

The long term assumption would be that the cell service building would be used. Modifications to the bonding oven and drawing vat would be needed. Pipelines for cell effluent and HCl or storage tanks would be needed. Minimal additional costs would be needed relative to the standard Kynar bonded asbestos diaphragm. A thorough cost study would be needed.

D. Diaphragm Production Rate Capability and Concerns

The production rate of talc diaphragms should be comparable to the standard asbestos diaphragm. For a 3 year standard diaph life, it would take only about 3 years to convert all U. S. Dow chlorine plants, assuming at least a 3 year talc diaphram life. Obviously the talc diaphragm strength and life need to be improved to be equivalent or better than standard diaphragms. New permits might be required to use talc and to have a discharge from Cell Service with HCl neutralization of the cell effluent draw carrier needed.

The used talc diaphragms that were removed from operation at the end of their life would have to be washed off to recover the cathode. The ability of the present washer system, asbestos disposal system, etc. to handle talc is not known. Disposal of used diaphragms could require new permits, equipment modifications, and result in a lower recovery of cathodes.

E. Potential Research Requirements

1. People and Goals

a. Lab Cell Testing

The efforts of 2 researchers for over 2 years would be needed. The initial goals would be to elminate catastrophic failure problems with the talc diaphragms, improve diaphragm strength, improve chemical resistance, and improve cell performance. The test program and formulation changes are expected to be similar to those previously used in optimizing teflon bonded titanate diaphragm on this scale. The following parameters would be evaluated:

- Formulation changes to improve strength, life, chemical resistance, stability and storage life.
  * Higher % TFE 30 Latex
  * Bonding at 360°C
  * Combinations with other inorganic fillers with superior chemical resistance
  * Na_2CO_3 or NaCl draw carrier in place of cell effluent
- Formulation changes to eliminate microcracks.
  * Evaluate changes listed above
  * Addition of other inorganic fibers or polymer fibers
- Formulation and draw procedure changes to allow use of existing Cell Service equipment.
  * Lower gpl solids in draw vat
  * Na_2CO_3 or NaCl draw carrier in place of cell effluent
  * Aclon latex or powder (bonds at lower temp. like Kynar)

The long term goals would be to develop a nonasbestos diaphragm superior in performance and lifetime compared to the standard kynar bonded asbestos diaphragms. The characteristics of an ideal diaphragm are listed below:

- Environmentally acceptable in all phases of handling
  * Raw materials, diaphragm production, disposal

- Physically and chemically stable
  * No holes, no jelling, no blistering, capable of low pH operation
  * Long life to match metal anode coating life

- Hydrophillic
  * No wet out problems, surfactants, pH dips, no dewetting

- Easily produced and handled
  * Science vs. art, all parameters well understood and controlled
  * Reproducible results, very uniform diaphragm to diaphragm
  * Quality control parameters for production and installation easily met
  * Drawn in existing facilities with minor modifications
  * Automated, computer control
  * Ability to be stored for long times and shipped easily
  * Low price consistent with present diaphragm costs

- Excellent Cell Performance
  * Starts up easily and reaches desired gpl NaOH without treating
  * Long wash life, $\geq$6 mos. at approximately 3 ppm brine hardness
  * Maintains high efficiencies throughout cell life
  * High current and power efficiencies at optimum conditions
    - $\leq$1.0 ACKWH/lb Cl_2 @ 0.4 amp/in^2,"2L" M83, 2.77 volts, 80°C temp.
    - $\geq$98% NaOH C.E. @ 125 gpl NaOH, 295 gpl NaCl & above conditions
  * Low H_2, $\leq$0.01% H_2 in Cl_2 cell gas
  * Easily operated (almost "fool proof")
  * Adaptable to desired cell designs, and current density
  * Demonstrated performance and lifetime in production cells

The following testing would be needed both on lab cells and production cells:

- Fractional factorial experiments to optimize lab cell performance by optimizing diaphragm fabrication parameters.

- SAS analyses of production cell performance versus diaphragm drawing variables and cell operating conditions to optimize cell performance with consistent production of optimum diaphragms consistently operated at the optimum conditions.

Improved cell performance compared to standard asbestos diaphragms would be worth several million dollars per year as listed by the following:

	Cost Savings for Gulf Coast
- 30 mv lower cell voltage	\$1,500/yr
- 1% higher NaOH current efficiency	\$1,500/yr
- 5 year diaph life vs. 3 year life	\$1,000/yr
- Increased cathode reuse rate by 30%	\$2,500/yr

b. Plant Scale Testing

This would require the efforts of 1 additional researcher for over 2 years to set up equipment, assist diaphragm drawing, and follow the plant cell evaluation. Additional help would be needed from Cell Service personnel in setting up equipment and drawing diaphragms. Additional help would be needed from cell operations personnel in operating the test cells.

- Depending on the probability of banning asbestos, the first goal of this work might be to prove that the catastrophic failure of these diaphragms could be eliminated by bonding at 360°C and not using the redip to seal microcracks. Although the lab cell evaluation indicates this, it was not proven on a production scale. This testing would be for 6 cells and would require a minimum of 6 months run time. If more time appears to be available, it might be better to scale up improved formulations.

- The second goal of this testing would be to scale up the best formulation and draw procedures determined from lab testing which have improved strength, chemical resistance and cell performance. Again a minimum of 6 cells and 6 months evaluation time would probably be needed before making other tests.

- The third goal of this testing would be to scale up to a full series test as warranted based on successful previous scale ups. Careful quality control including sacrificing production diaphragms for lab cell evaluations is a must to prevent any significant problems on this scale testing. Evaluation of these cells for at least a year would be needed before deciding to routinely produce these diaphragms.

2. Facilities

a. Lab Cell Testing

These exist and no further equipment is needed.

b. Intermediate Cell Testing (3 Pocket Cell, 500 amp)

A draw vat system would need to be set up at a cost of approximately $10M. Lab cell testing would be done from samples cut from intermediate size cells.

c. Production Size Cell Testing

The test stand could be set back up at a cost of approximately $20M or testing could be done on the end of a series.

- Diaphragm drawing considerations are listed below:

1. To utilize the cell effluent draw and standard talc diaphragm draw procedure, another draw vat would have to be set up. The cost of moving equipment from Midland versus buying new equipment would be checked. A ball park cost for new equipment consisting of a draw vat, blending tank, piping,

valves, instrumentation and addition to the overhead crane system would be about $200M. This assumes that space is available at Cell Service and that the vacuum compressor could be used. Cell effluent would have to be piped into the block to make diaphragms for a full series test. This would probably cost another $50M and need HCl usage for ditch pH control of a new permitted outfall.

2. Hopefully the formulation, draw procedure and draw carrier could be optimized and allow use of the Cell Service drawing vat system. Then at least 2 weeks would be needed in the draw schedule to produce diaphragms for a test stand evaluation.

- Diaphragm bonding considerations are listed below:

  1. For initial testing, the Stebbins Oven at Port Allen would be contracted for the bonding oven. It may be possible to utilize this for a full series test as well.

  2. For long term use, the Cell Service oven would need to be modified to allow bonding at 360°C for TFE. This might cost $50M. It may be necessary to buy a new oven or move ovens from Texas Cell Service that were capable of higher temperature if the Cell Service oven can not be modified.

3. Recommendation and Timing

The teflon bonded talc diaphragms should be further developed to improve strength, chemical resistance, cell performance, etc. Production size cell testing would be needed to prove that the problems resulting in catastrophic failure had been eliminated. These diaphragms could be produced at a rate similar to standard asbestos diaphragms allowing complete conversion in 3 to 4 years.

The cost of the diaphragms with draw system modifications would be similar to standard asbestos diaphragms. The minimum production cell evaluation time is illustrated by the critical path plan assuming that the new EPA rule would take effect on Jan. 1, 1989. The efforts of about 3 researchers would be needed for over 2 years to further develop these diaphragms as well as the assistance of Cell Service and cell operations personnel. The cost for facilities would be about $260M for initial testing with additional costs needed to modify the bonding oven for long term operation.

TEFLON BONDED TALC DIAPHRAGM DEVELOPMENT SCHEDULE

Year / Month	1986 (5–12)	1987 (1–12)	1988 (1–12)
Lab Cell Testing	Improve strength, life, etc. (5–3) ---->		
	Improve draw procedure (10/1986–7/1987) ---->		
		Optimize performance & drawing (2–12) ---->	Support production cell optimization -- -- ->
Production Cell Testing	Set up draw vat (cell effluent draw) (6–3) ---->		
		Draw DIAPH ----> Evaluate on 6 M83 Cells (3–12) ---->	Life study -- -- ->
		Draw DIAPH ----> (NaCl Draw) Evaluate on 6 M83 Cells (5–12) ---->	Life study -- -- ->
Full Series Testing		Draw DIAPH ----> (optimized) (9–12)	Evaluate on M83 series ---->
Optimization Study		Assuming Earliest Date EPA Rule Effective Jan. 1, 1988	SAS data analyses ----> performance vs. drawing vs. operation
			Draw ----> DIAPH
			Evaluate 6 ----> M83 Cells
			Assuming EPA Rule Effective Jan. 1, 1989

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III. TEFLON BONDED POTASSIUM TITANATE DIAPHRAGMS

A. Development History

1. a) CRI Reports

   LAD-1056.

   b) Patents

   A disclosure is presently active (filed 12/4/84).

2. Early Testing

   Potassium titanate is an inorganic fiber chosen for further testing due to its outstanding chemical resistance to low pH anolyte. Initial lab cell testing was done by substituting potassium titanate for talc in essentially the same formulation and draw procedure used for talc diaphragms. As discussed previously in Section II. B. 2a., these diaphragms were unstable, and it was necessary to modify the formulation and draw procedure.

3. Lab and Intermediate Cell Testing

   A fractional factorial designed experiment was conducted to optimize the draw procedure and formulation versus lab cell performance. The following formulation and draw system were found to be optimum:

   Raw Materials:

   62% Potassium titanate (OTSUKA Chemical Co.)
   30% Teflon 30 latex
   8% Teflon 1/4" fiber

   Drawing Process:

   35 gpl titante slurry concentration
   15% NaCl solution draw carrier
   Typical vacuum cycle and procedure similar to standard kynar bonded asbestos diaphragms
   550 lbs. diaphragm weight (maximum thickness allowed)

   Bonding Process:

   Bonded at 360°C for 20 minutes for TFE 30

   Wet Out:

   24 hour soak with 0.5% wt. Triton X114

This produced diaphragms that were stable with cell performance in the same range of standard asbestos diaphragms. Long term stability testing showed stable (good strength and performance) diaphragms for over 3 years in lab cell tests. These diaphragms were looser on start up than asbestos diaphragms requiring $MgCl_2$ treatment to tighten the diaphragm. No microcrack problems were observed in intermediate cell drawing evaluation (500 amp cells).

B. Further Development Needs and Concerns

1. Potential Regulation

The potassium titanate fibers and numerous other inorganic fibers have produced mesotheloma in laboratory animals similar to asbestos when the right aspect ratio (fiber length vs. diameter) was used. Dupont no longer produces titanate for this reason. Otsuka Chemical Company in Japan is the only supplier presently.

2. Scale-Up

These diaphragms were never scaled up to production sized cells before testing was dicontinued.

3. Cell Performance

Investigation of the use of a filler to increase start up gpl NaOH should be done. The use of a Na_2CO_3 draw carrier versus a NaCl carrier should be done to improve the long term storage of these diaphragms in a nonhumidity controlled environment.

C. Projected Diaphragm Costs on a Production Basis

1. a. Raw Materials:

For 550 lb. diaph. weight

62% Titanate	= 341 lbs. x $2.85/lb =	$972/diaph
30% TFE-30 Latex	= 165 lbs. x $6.55/lb =	1,080/diaph
8% TFE Fiber	= 44 lb. x $20/lb =	880/diaph
(15% NaCl draw carrier and Triton X114 also used)		$2,932/diaph

b. Labor

Assumed labor of approximately (essentially would use same as std. diaph.)		$350/diaph
	Subtotal	$3,282/diaph

2. Fixed Costs for Facilities

The long term assumption would be that use of the Cell Service drawing system and buildings would be possible. The bonding oven would have to be modified for the higher bonding temperature of TFE. Relative to standard kynar bonded asbestos diaphragms, minimum additional costs would be needed. This would require further study to determine the exact costs since a production scale diaphragm has not been produced.

D. Diaphragm Production Rate Capability and Concerns

The production rate of titanate diaphragms should be essentially equivalent to standard kynar bonded asbestos diaphragms. For a 3 year standard diaphragm life, it would thus take only about 3 years to convert totally to these diaphragms assuming that the titanate diaphragm life was 3 years or longer. The LAD Cell Service presently has capability to handle the Gulf Coast production on 2 shifts with 5 days/week operation based on producing 4 diaphragms per 8 hour shift. A third shift could be utilized if needed due to the "learning curve" involved in a transistion period. Permitting may be required to use potassium titanate and more toxicity data may be required.

The titanate diaphragms that were removed from operation at the end of their life would have to be washed off to be able to recover the cathode. Whether the cathode washer system would handle this properly and whether the asbestos removal system would work well are not known. Disposal of the used diaphragms could require new permits and equipment modifications or result in a lower recovery of cathodes.

E. Potential Research Requirements

1. People

a. The efforts of 2 people for 2 years would be needed to scale-up titanate diaphragms to production size cells at the test stand. Lab cell testing would also be needed to further optimize start up gpl NaOH and evaluate the use of a Na_2CO_3 draw carrier.

2. Facilities

a. Lab Cell Evaluation

All of the facilities exist for this scale testing.

b. Intermediate Size Cells

Equipment to draw these size diaphragms would need to be set up again. This would cost about $10M. Lab cell evaluation from diaphragm samples would be done instead of intermediate size cell operation.

c. Production Size Cells

The existing standard diaphragm drawing facilities could be used. A period of at least 2 weeks would have to be allowed in the Cell Service asbestos diaphragm drawing schedule. The Gulf Coast Cell Service consolidation makes this more difficult than previously. The Stebbins oven in Port Allen would be contracted for bonding the diaphragms. It would cost about $20M to set the test stand back up or these could be run on the end of a series.

3. Recommendations

The potential regulation of titanate makes further research on this option less attractive. The concepts used to optimize the titanate diaphragm should be utilized to improve the talc diaphragms. This is further discussed in that section.

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IV. PATENT STATUS OF NONASBESTOS DIAPHRAGMS AND SCALE UP TO PRODUCTION CELLS BY DOW AND COMPETITORS

A. Literature Review

The patent literature abounds with several different versions of nonasbestos diaphragms by many different companies. The patent activity can be subdivided into the following 3 major types of diaphragms: 1) Deposited fibrous fluoropolymers with or without inorganic fillers, 2) PTFE fabrics or felts as a support media for various inorganic fillers, and 3) PTFE sheets produced by calendaring or expansion.

1. Some of the companies with U.S. Patents of the type 1 diaphragms are listed below:

   a. BASF Wyandotte (9 patents)

      4,183,793; 4,210,515; 4,193,861; 4,125,451; 4,154,666; 4,175,023; 4,126,536; 4,036,729; 4,175,541

      These involve slurry drawing from fluorocarbon fibers such as Aclon 2100 (PCTFE), Kel F-81 (CTFE), or polyvinylidene fluoride

   b. Solvay

      4,204,941; Slurry drawing of inorganic fibers and fluoropolymers.

   c. Dow

      Teflon bonded talc diaphragms and teflon bonded titanate diaphragms are similar to this type diaphragm. The teflon bonded talc patent has been allowed and will issue in 2 to 3 months.

   d. Scale-up Activity

      The Dow TFE bonded talc diaphragms may be the only full production size diaphragms produced of this type.

2. Some of the companies with U.S. patents of the type 2 diaphragms are listed below:

   a. Olin (10 patents)

      4,184,939; 4,168,221; 4,216,072; 4,207,164; 4,167,469; 4,166,785; 4,165,271; 4,207,163; 4,184,939; 3,980,544

      These involve a support fabric (PTFE) impregnated with Silica, sepiolite, $MgCl_2$, sand, etc. and sometimes bonded with polyphenylene sulfide resin (Ryton PPS V-1).

b. PPG

4,170,539; 4,170,537

These involve treatment of a hydrophobic PTFE microporous matrix (Porex P1000) with inorganic fillers ($ZrOCl_2$, MgO, etc.) and a hydrophyllic fluorocarbon with pendant groups of COOH or SO_3H (Nafion 601 polymer). Another patent ties up potassium titanate as the inorganic filler.

c. Scale-up Activity

The literature does not indicate that these were operated on production size cells.

3. Some of the companies with U.S. patents of the type 3 diaphragms are listed below:

a. Calendared PTFE sheets usually with a leachable pore former.

1. Dupont (4 patents)

4,189,369; 4,188,469; 3,702,267; 4,153,520 (hydrophyllic fluoropolymers)

2. ICI (6 patents)

4,156,639; 4,153,530; 3,930,979; 3,890,417; 4,098,672; 4,127,706

3. Occidental (Hooker)

4,170,540 ($CaCO_3$ pore former); 4,107,005; 4,113,922 (grafted)

4. BASF Wyandote

3,944,477; 3,878,082 (installation method)

5. General Plastics

3,281,511 (alumina filler)

6. Dow

4,224,130

This patent covered pore sizes, fabrication, and use within the cell. A disclosure on seaming and sealing methods was inactivated.

b. Expanded PTFE sheet produced by an extrusion process

1. Gore (5 patents)

   4,025,679; 4,187,390; 4,110,392; 4,096,227; 3,962,153

2. ICI & Gore

   4,089,758

   Use of expanded PTFE sheet (Gore-Tex grade L10231 sheet) and impregnation with TiO_2 for wettability.

c. Scale Up Activity

Several companies have scaled up to production cells.

1. Dow

   Fluorotechniques M7R1000 scaled up to M63 size cells. Dow C-80 scaled up to 3 M82 size cells.

2. Occidental (Hooker)

   Scaled up to full size test cells and reported in 1982 Chlorine Institute meeting and other symposium as very successful.

3. ICI-Gore

   Scaled up to full size (120 Kamp) cells and reported as successful in 1982 London Symposium. These were claimed as an asbestos diaphragm replacement with commercialization and licensing scheduled for 1983.

B. Literature References

1. Modern Chlor Alkali Technology, Volume 1, 1979, pp. 36-40.
2. Modern Chlor Alkali Technology, Volume 2, 1982, pp. 38-42.
3. Chlorine Production Processes: Recent and Energy Saving Developments, 1981, pp. 73-80.
4. DerWent Patent Abstracts.

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DOW CONFIDENTIAL INFORMATION

ST0312147

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MEETING TO DISCUSS WORKING DRAFT ASBESTOS PROTOCOL

February 11, 1975

Those present to the best of my knowledge.

Dr. William E. Baker
President, Bell Telephone Laboratories, Inc.
Murray Hills, New Jersey 07974

Dr. Arnold L. Brown
Mayo Clinic
Rochester, Minnesota

Dr. Ed Burger, Jr.
National Science Foundation
Washington, D. C.

Center for Science in the Public Interest
1779 Church Street, N. W.
Washington, D. C.

Dr. Morris Cranmer, Director
National Center for Toxicological Research
Pine Bluff, Arkansas 71601

✓ Environmental Defense Fund
1525 18th Street, N. W.
Washington, D. C. 20036

✓ Dr. Samuel S. Epstein
Case Western Reserve University
Cleveland, Ohio

Ms. Doris M. Fagan
Executive Secretary
Asbestos Textile Institute
Willow Grove, Pennsylvania

✓ Dr. Al Harvey
R. T. Vanderbilt and Company
East Norwalk, Connecticut 06550

✓ Health Research Group
2000 P Street, N. W.
Washington, D. C. 20036

Dr. Robert M. Hehir
Consumer Product Safety Commission
Bethesda, Maryland 20207

others present I knew:

Dr. Gary Flamm FDA

Mr. Evan Satorius
also for Legal rep of Johns Manville asbestos or of Canada mfg. ?

Dr. Wm. Nicholson
Mt. Sinai

Dr. Tardiff - EPA.

Dr. Loren Will
U. of Iowa
(has NCI contract)

Dr. Stanton

Dr. Shapiro FDA

Dr. Moore NIEHS

Dr. Goodman M.D.
S. Carolina

Dr. A. Pelfrene
Eppley Inst.
(Has NCI contract)

Dr. Joe Jackson
Executive Director
Asbestos Cement Pipe Producers Association
Washington, D. C. 20009

Dr. Paul Kotin
Vice President, Health, Safety and Environment
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Denver, Colorado

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File - Beam

THE DOW CHEMICAL COMPANY

MIDLAND, MICHIGAN 48640

2030 Dow Center
September 26, 1980

cc Moolenaar
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L. D. Adcock, 2020	M. E. Nevill, 2030
K. L. Burgess, 1803	D. A. Rausch, 2020
F. D. Hoerger, 2030	R. E. Wing, 2020
C. J. Kalil, 2030	B. Woodhouse, 2020

RE: REPORT OF INDUSTRY-GOVERNMENT CONFERENCE SPONSORED BY ASBESTOS INFORMATION ASSOCIATION/NORTH AMERICA; SEPTEMBER 17-18, 1980, ARLINGTON, VIRGINIA

This conference was well attended - about 250. It consisted of three panel sessions and four other speakers.

The first session, three papers, reviewed and updated recent medical research on asbestos health effects.

Dr. Hans Weil, Professor of Medicine, Tulane University, summarized epidemiology studies. His own recently published paper, mostly on data from the Quebec mining and milling, shows a dose-response in asbestosis and lung cancer, some increase in gastrointestinal cancer at "high doses" but no excess cancer rate in 20-year industrial exposure at 25 fibers/ml. Also, asbestosis appears to be related to dust concentration; pleural cavity disorder can be correlated with length of time of exposure; radiographic effects are not related to smoking; the peak in cancer incidence occurs at about 35 years after exposure.

In a medical conference on asbestos at Cardiff, Wales in the preceding week, similiar results were reported by a NIOSH study of textile workers in South Carolina. In addition, no excess gastrointestinal cancer was found in a new paper on the textile workers in the Midlands, England. Dr. Weil was careful to mention that there is nothing new on the New Jersey-New York insulators (Selikoff, Mt. Sinai). He said that although those results, which show a 3-4% excess GI tract cancer, may not be spurious, the dose estimates may be too low. The recent reconstruction of the measurements are thought to be an underestimation. He mentioned seeing a photograph of a 1938 carding room in England and said he could not believe the exposure would be only 5-6 fibers/ml.

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A comment from the audience mentioned the EPA's Water Quality Criteria Document and the very low numbers proposed in it for effluents. Dr. Weil referred to a "weakened case" for evidence of GI cancer and advised cautious consideration of the New Jersey-New York insulators data.

Dr. Paul Kotin, Vice-President, Johns-Manville Company reported on a Cancer Conference in New York also in the preceding weeks. Dr. Kotin is an excellent speaker but his talk could not add much to the medical summary. NIEHS studies conclude that asbestos is a weak but definite carcinogen. He stressed the co-effect of asbestos and smoking as shown by Selikoff earlier and in a very recent paper on amosite workers. Kotin said the GI cancer data is unconvincing and only an allegation.

Dr. Kenneth Crump, a mathematician, President of Science Research Systems, Incorporated, gave a talk on risk assessment and epidemiological studies. His presentation did not shed much light on his topic. He is a contractor to the EPA and maybe OSHA for epidemiological studies. He has apparently done some work for EPA on risk from insulation in schools to children 6 to 18 years old from exposure to asbestos - and used as his data base the New Jersey-New York insulators study. I was shocked at this and a commentator asked a question about it but there was no controversy, I think mainly because the audience didn't understand the slide. Dr. Crump spoke in a halting manner, was hard to understand, the transparency slide was too small and the mikes weren't working.

The second panel was entitled an Industry-Government panel and had three representatives of each.

The President of Asbestos Corporation Limited, largest producer of long fibers, talked about the stagnation of growth of the industry in the past 6 to 10 years. Mine and mill can meet the 2 fibers/ml standard but not the lower value of 0.1 proposed by NIOSH. The present standard provides a safe work environment with little or no risk. The chemical industry is eager to supply asbestos markets with substitutes. Politicians and journalists perpetuate the scare. If the U.S. lowers the standard, the world supply of asbestos will be dependent upon the Russians.

Mr. John McKinney, Chief Executive Officer, Johns-Manville, said his company is the largest producer of asbestos fibers. He said that Johns-Manville policies will be based upon evidence and data. He defended the 2 fibers/ml standard. If "the weight of the evidence" is that a product cannot be used safely, Johns-Manville will not produce it. The real problem is not that the regulators may lower the standards since the evidence will defeat that. However, asbestos may be put out of the market because of rash, unsupported statements by government officials and environmentalists to the media. He cited the Califano release projecting some 285,000 deaths from asbestos as an example. This number is probably 30 times too high. It is due to overexposure in the past which is not continuing in the present. What happened in textile factories in England at the turn of the century is not happening today. The other factor which may put asbestos out is the mounting number of liability and personal injury suits. Johns-Manville supports compensation for those injured because of overexposure in the past. The 4,000 cases of litigation are in a slow process which does not provide just or prompt compensation. There is some hope that the Asbestos Health Compensation Act, SB 2847 sponsored by Senator Hart will provide prompt compensation.

Mr. T. O. Mathues, Vice-President, Manufacturing, GM, explained the users side. He made the point that there is a difference between loose fibers and products fabricated of asbestos and binders such as the phenolics used in brake bands. He said that GM will use substitutes wherever possible and when the substitutes do not present hazards themselves.

Mr. Richard Gross, Executive Director of the Consumer Product Safety Commission explained that no mandatory regulations were promulgated by the agency on the recall of hair dryers. The action was entirely voluntary by the manufacturers. The publicity was initiated outside the CPSC. The Commission has issued no regulations and has initiated no suits against anyone on asbestos. The ANPRM issued with EPA solicited general information, was not a regulatory tool but just initiated good discussion. As a result of this CPSC is now more product oriented and less inclined towards generic regulation of asbestos.

Dr. Warren Muir, Deputy Assistant Administrator for Toxic Substances, EPA, appeared for Douglas Costle. He said the EPA is seriously concerned with the health hazards of asbestos and all "parts of its life cycle". The EPA does not agree on the lack of risk stated by other speakers. Muir said that he can understand that if one's livelihood depends upon asbestos the "weight of the evidence" will be interpreted accordingly. The EPA is planning a Section 8, TSCA, rule this Fall and expect to have a final rule in the Spring of 1981. The ANPRM will be followed this Winter by a rule to limit and reduce the amount of asbestos in commerce. The EPA will continue on the generic approach; he again mentioned the "risks throughout the life cycle". He announced that today's Federal Register contains a notice requiring the identification of asbestos insulation in schools. This will be made final in the coming months and there will be a proposed rule to require removal of asbestos from school buildings.

Mr. R. L. Jennings, Esquire, spoke for OSHA in place of Assistant Secretary of Labor, Eula Bingham. He explained the history of the present workplace standard since 1972. Work on a reduced standard has been intermittent because of OSHA preoccupation with its generic cancer policy and the Supreme Court decision on benzene, which has slowed all work on standards. OSHA intends to publish an ANPRM on asbestos following the cancer policy in the near future, maybe next month. A proposal will follow in early 1981 and will cover the construction industry primarily. Mr. Jennings then attacked the statements by Mr. McKinney earlier that 2 fibers/ml is "safe", is "unassailable", "overwhelming". (My notes showed none of these words.) He said there is no such evidence - that we do not know precisely what the effects of low exposure are - and judgment is an important factor. He implied that OSHA's judgment is as good as anybody else's and particularly Dr. Kotin's. Mr. Jennings' remarks stimulated considerable response. The head of the International Asbestos Association in London cited a 15-year study in an asbestos cement plant which produced no evidence of asbestos disease at an exposure level of 100 fibers/year. Dr. Kotin talked about confidence limits and that you can't prove a negative. He directed the question to each of the agencies "what do you think of the Califano statement now?" The answers were unremarkable.

This heated and pointed exchange provided interest to the conference but did little to further the purposes.

A third panel on the ensuing day discussed the problems of the Public Image of the asbestos industry. The AIA/NA has not in the past entered into the public communications and education area but the chairman indicated that it's a topic for consideration. There was little new brought out by the speakers on this panel that has not already been experienced by the chemical industry. We should "ask not for whom the bell tolls".

The luncheon speaker of the second day, Mr. E. van der Rest, Chairman, Governing Council of the Asbestos International Association, recommended that invitations to the regulators, the press and the media to visit the mines and the plants are the best and most effective PR methods. He also expressed surprise and regret at the acrimonious exchanges between the industry and government people.

W H Beamer

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