minutes

SPI

PIPE RESOURCE ORGANIZATION MEETING

South Seas Plantation
Captiva Island, Florida
Meyer Room

Friday
May 11, 1990
8:30 a.m.

Attendees:

Alan Bailey, Occidental Chemical
Michael Barish, Borden Chemicals & Plastics
Chris Bozman, Vista Chemical Company
Sherry Carr, CertainTeed Corporation
George Dillon, Dow Chemical Company
Rick Flammer, Vista Chemical Company
Don Goodman, Occidental Chemical Corporation
Roy Gottesman, VI
Clark Graybill, PPG Industries
Walt Hermes, Borden Chemicals & Plastics
Nora Jacobs, Edward Howard and Company
Jerry Koral, Atochem, N.A.
Peter Lloyd, Occidental Chemical Corporation
Doug Niewoehner, Air Products and Chemicals
Bob Novick, CertainTeed Corporation
Dave Peters, Occidental Chemical
Bob Petrich, Rohm and Haas Company
Cal Rehfuss, Georgia Gulf Corporation
Erv Schroeder, Shintech Inc.
Doug Sherly, Air Products and Chemicals
Dan Stanowick, Edward Howard and Company

I. **SELF-INTRODUCTIONS**

Following self-introductions, the minutes of the February 14, 1990 meeting were approved on motion by Walter Hermes, seconded by George Dillon.

II. **AGENCY REPORT ON STATUS OF MARKETING/COMMUNICATIONS PROGRAM**

A. **Advertising Program**

Dan Stanowick reported that three ads emphasizing case histories showing the desirable properties of PVC pipe in the areas of durability, water quality and economics

The Vinyl Institute, A Division of The Society of the Plastics Industry, Inc.
Wayne Interchange Plaza II, 155 Route 46 West Wayne New Jersey 07470 (201) 890-9299

were placed in the AWWA Journal starting in February. These three ads will be run consecutively for three months, stopped for one month, and then rerun again on the same schedule during the next year. Dan Stanowick also noted that the ads will be used in directory or special issues of such publications as Public Works, Civil Engineering and the Municipal Index.

Peter Lloyd noted that in addition to the Vinyl Institute ads, there were a number of additional advertisements on PVC pipe in the last AWWA Journal.

B. **Pocket Folder**

Dan Stanowick reported that the information package has been completed and is being sent out in response to requests from the ads. He further noted that a letter to some 80 influentials had been sent out, including the pocket folder package.

Dave Peters suggested that the agency inquire of the 80 influentials if they have any information that could serve as case histories, or to be used in advertising programs.

Assignment:

Dan Stanowick is to send a letter to the list of 80 influentials to determine if they have any items for input into the advertising program either as case histories or other materials.

There was brief discussion concerning dissemination of the information packages. Roy Gottesman expressed the view that it is more desirable to have the packages freely available than to have them sit on our shelves unused. With this in mind, the committee agreed to have Roy use discretion as to whether there should be any charges for requests of a significant number of copies of the information package.

C. **Public Relations/Communications Programs**

Dan Stanowick reported that he has answered a few inquiries from editors and that he has several research projects underway which might lead to stories involving such topics as water main breaks and market growth projections. He advised that the technical bibliography listing has been completed, and that he is taking the three testimonial ads and working to develop full-blown case histories on them for inclusion in the information package.

Assignment: Dan Stanowick has the assignment to issue a press release on the availability of the technical information listing.

D. **Cost/Benefit Summary Reports**

Mr. Stanowick reported that these summaries of the IFT Cost/Benefit Study have been put into a new format, which has been distributed to committee members.

Assignment: Mr. Stanowick has the continuing assignment to complete the publication of these cost/benefit summary reports and to see that they receive additional publicity.

E. **Other New Programs**

Mr. Stanowick noted that the AWWA Convention is to be held in Cincinnati on June 17-21, 1990 and suggested that he attend this show, particularly to be on the look-out for public relations/advertising opportunities. The group agreed that this was worthwhile and Mr. Stanowick will attend this show.

Assignment: Dan Stanowick is to attend the AWWA Convention in Cincinnati to seek out potential public relations/advertising opportunities for PRO.

Mr. Novick advised the group that there is a very large construction project underway in Cape Coral, Florida using three different PVC lines, including pressure effluent pipe up to 20" in diameter. There is a potential of some 10 million pounds of PVC in this program, and he suggested that this might represent a public relations opportunity.

Assignment: Dan Stanowick has the assignment to make contact with the appropriate people in Cape Coral to investigate this for possible publicity purposes.

Roy Gottesman suggested that work get started on identifying potential candidates for a new series of testimonial ads. Inasmuch as there is considerable effort involved in obtaining suitable testimonial candidates, the group agreed that this was worthwhil and should be undertaken.

Assignment: Dan Stanowick has the assignment to seek out and identify suitable potential candidates for the next series of testimonial ads.

III. UNI-BELL COOPERATIVE PROGRAM REPORT

Bob Walker was unable to attend this meeting because of unexpected surgery to his daughter. He did provide a letter report to Dave Peters which is appended to these minutes.

Roy Gottesman highlighted the major features of this report, and reported on the recent Uni-Bell Annual Meeting. He also passed around a copy of the long-awaited text book by Dr. Moser, entitled "Buried Pipe Design" and indicated that Vinyl Institute members wishing to receive copies at a reduced discount price should advise him so that they could be included in the Uni-Bell initial order.

Roy Gottesman also provided the group with copies of the recent Uni-Bell newspaper, which highlighted past case histories.

IV. PLASTIC PIPE AND FITTINGS ASSOCIATION

Michael Barish reported that this group had held its meeting in California at the end of February and is becoming more active. At the PVC Product Line Committee meeting, they discussed the highrise market research study and received a commitment from the PPFA general membership to co-fund this project up to a sum of $6,000. He further noted that PPFA is reconsidering its purpose. Whereas in the past they have always adopted a defensive posture, this year it is reassessing its position, as they want to become more pro-active. Walt Hermes, who is on the PPFA Board, advised the group that the Board of Directors is trying to set-up the organization to become more active and even consider an advertising program. Another meeting of this PPFA planning group is scheduled for June 26th, and the organization is in the process of reorganizing some of its groups.

Mr. Barish posed the question as to how might we spend our money more effectively in PPFA. For example, is there any interest in pooling the financial resources of those VI members who participate in PPFA.

Rick Flammer suggested that the PRO group consider what the role of small diameter PVC pipe is in its overall program.

It was agreed that after PPFA gets through its current planning sessions, they will have determined a long-term agenda for that organization and, once established, PRO can make a decision of what facets, if any of that program, it wishes to support.

V. MARKET RESEARCH/HIGHRISE MARKET

Peter Lloyd provided a summary on the survey involving a study of PVC/CPVC drain waste and vent and plumbing pipe in highrise buildings. In essence, the bidders were asked to quote on a market research program to include the following elements:

1. A survey and quantification of the volume of residential and commercial highrise construction in the United States from 1985 to present and provision of a forecast to 2,000.

2. A survey and quantification of current materials used for DWV and water supply plumbing in highrise construction by marketshare, dollar value and volume.

3. A review of the 5 major national building codes (CABO, BOCA, IAPMO, SBCCI and ICBO) as applied to the use of DWV and plumbing pipe in highrise construction. Included was to be an evaluation of the technical restrictions preventing the use of thermoplastics and a prioritization in order of ability to prevent the use of PVC plumbing and DWV materials.

4. An estimation of the volume and marketshare of PVC DWV and PVC/CPVC plumbing materials in highrise construction if these code restrictions could be removed. Included also was to be a breakdown estimate by prioritized list of restrictions, so that the most important codes and individual restrictions would be identified separately.

5. Provision of a written report and presentation at a place of PRO's choosing to present these results at a PRO meeting.

Peter Lloyd reported that the following quotations had been received:

Springborn Laboratories:
Cost - $21,000 Time - 6 months

Leading Edge:
Cost - $52,000 Time - 6 months

BCC (Business Communications Company):
Cost - $22,000 + expenses* Time - 6-8 weeks

*Copies of codes, telephone charges, reproduction estimated at $500.

Peter Lloyd recommended that the BCC proposal be accepted. Mike Barish made a motion to accept the BCC proposal. The motion was seconded by Jerry Koral and approved unanimously.

Assignments:

Peter Lloyd is to obtain a contract from BCC for submission to Roy Gottesman so that it can be executed.

Walter Hermes is to advise PPFA that the contract is being awarded to BCC for this project, but that PPFA will have to pay for any separate presentation to its group at a future PPFA meeting.

VI. OLD BUSINESS

A. California EIR

Roy Gottesman advised the group of some recent activity involving contacts with the Plumbers' Union that may represent an opportunity for concluding the EIR process in a manner favorable to PVC and CPVC. He advised that he would be informing the Executive Board of this possibility on May 12th to seek their approval for any future contacts.

B. NSF Standards 14/61

Roy Gottesman advised the group of his understanding that a satisfactory resolution to the marking of pipes relative to approvals under these two standards has been reached, but awaits formal NSF Board action.

VII. NEW BUSINESS

At the request of Chairman Peters, Don Goodman provided the group with an update on Rule 11-68 of the South Coast Air Quality District in California, which could affect the ability to join small diameter pipe. He noted that as of January 1, 1991, emissions of volatile organics greater than 250 grams per liter will no longer be permitted. Currently, emissions of 650 grams per liter are allowed. He noted that few, if any current pipe cements, will meet this new standard and this could threaten the entire solvent cement industry. While this might be an area of concern, it was noted that compression fittings or the use of epoxy joining agents would overcome this potential problem.

It was generally agreed that there is no action for the Vinyl Institute to be carrying out here at this time, but that Don Goodman should continue to monitor this situation by contact

with Naresh Patel at IPS, so that we can be aware of developments.

It was further agreed to keep this item on the agenda for the next PRO meeting for an update.

Assignment: Don Goodman is to continue contact with Naresh Patel at IPS and to advise the PRO group if any action on the part of the Vinyl Institute is necessary here.

Peter Lloyd noted that there is a threat that medium density polyethylene could encroach on the potable water market in large diameter applications. While this is happening in Europe, he noted that it has not appeared in the United States as yet. He further noted that about a year ago, the Uni-Bell PVC Pipe Association was requested to also consider representing polyethylene pipe. Inasmuch as there is massive overcapacity in polyethylene, Mr. Lloyd indicated that he felt that polyethylene producers will be looking for other markets and that the pipe market could represent such an opportunity. He further noted that some contacts between BFGoodrich Canada and Dupont suggest that this may be taking place.

Assignment: Peter Lloyd is to continue to monitor the situation with regard to the use of medium density polyethylene in the potable water market and to keep the PRO group advised.

Roy Gottesman informed the group of a recent paper by Peter Mayerhofer dealing with sewer relining, which represents a growth potential for PVC. Roy agreed to provide the group with information on this, and a copy of the abstract of Mayerhofer's paper is included with these minutes.

It was further agreed that we should continue to monitor this market to see whether it represents an opportunity for PVC in view of the needs to rebuild the crumbling infrastructure.

Rick Flammer inquired about ASTM activity in relation to recycled material, indicating that we do not want to see recycled material enter into pipes used in the potable water market, and want to be sure that certain applications covered by ASTM standards are written to indicate where recycled material can be used.

Peter Lloyd noted that there is activity on this in the ASTM process, and that he and Frank Borrelli, along with others are involved.

Assignment: Peter Lloyd is to update the PRO group on activity relating to ASTM standards involving recycled post-consumer material at the next PRO meeting.

VIII. **NEXT MEETING**

The next meeting of PRO will take place on Wednesday, August 22nd at the Vinyl Institute office in Wayne, starting at 9:30 a.m. A separate notice and agenda will be sent out well in advance of this meeting.

IX. **ADJOURNMENT**

On motion of Mike Barish, seconded by Peter Lloyd, the meeting was adjourned.

Respectfully submitted,

Roy T. Gottesman

UNI-BELL PVC PIPE ASSOCIATION
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Dallas, Texas 75234-7362
Phone (214) 243-3902 Fax (214) 243-3907

May 9, 1990

Mr. David Peters
Chairman, Pipe Resource Organization of the VI
c/o Occidental Chemical Corporation
PVC Resins and Compounds Division
Armand Hammer Blvd.
Pottstown, PA 19464

Dear Dave,

It would appear that the Vinyl Institute's staff and Executive Board have planned another excellent annual meeting event and managed to find the perfect location. Unfortunately, my daughter required some unexpected surgery that will preclude my attendance. To hopefully minimize the impact our absence might have on your meeting, I have taken the time to prepare the following written summary specific to your Uni-Bell agenda items.

Pivotal Cities

Uni-Bell member company personnel and their distributors have investigated the market potentials for Orlando, Pittsburgh and Nashville. Their assessments are:

Orlando, Florida - Orlando is not growing as fast as it did thought the 1970's and much of the 1980's. However, their economic base is still relatively strong and the size of Orlando is such that 5.0 million pounds per year is our estimated PVC water pipe potential. Peripheral impact will be minor (< 0.5 mil. lbs/yr.) because Orange County already accepts PVC water pipe for mains up to 12 inches in diameter.

Nashville, Tennessee - Nashville is estimated to represent an annual PVC water pipe potential of about 3.6 million pounds. The peripheral impact could increase that amount by 0.8 million pounds.

Pittsburgh, Pennsylvania - Pittsburgh's economy is healthier than most people would think but the city is almost fully developed. Replacement of older lines will help. Estimated PVC water pipe potential is 1.0 million pounds annually. Many of the neighboring suburban jurisdictions already allow PVC, but Pittsburgh's approval could boost annual PVC pipe sales in the metropolitan area by an additional 3.0 million pounds. The "City of Steel" will be a real challenge, if targeted.

I am also enclosing copies of our latest Pivotal City Progress Report. CTL029367

University/Engineering Textbook

McGraw Hill has published the long awaited *Buried Pipe Design* text. The hard bound book is comprised of over 200 pages, and properly includes PVC pipe in a manner commensurate with its widespread acceptance and performance advantages. This book should have a very positive influence on PVC pipes' marketability.

As an added bonus, the Vinyl Institute is acknowledged in the book's preface (page viii) for their, "encouragement and support." We had hoped to keep our profile very low relative to our involvement in the book's development. However, given that Dr. Moser has included a listing of acknowledgements, we certainly have no problem with the Vinyl Institute's inclusion. Your support to the Piping Systems Institute and to Uni-Bell's efforts is evidence of your commitment to piping markets. The Vinyl Council of Canada was initially a co-sponsor for the text.

Our promotional efforts, regarding the text, have been initiated in our most recently published *Uni-Bell PVC Pipe News*. We will be coordinating with McGraw Hill and Dr. Moser the promotion of the text to college professors and engineering department heads.

The text will retail for $42.50. We offer the Vinyl Institute and its members the opportunity to purchase copies of the text at a 33.4 percent discount price plus shipping. Please advise us within the next two weeks so that we can include your books in our initial order.

I have enclosed a copy of the text for your meeting. We ask that it be returned as it is our first and only copy. Even Dr. Moser does not have a copy yet.

Piping Systems Institute (PSI)

On May 1 the Uni-Bell Board of Directors agreed to co-sponsor a 1990 session of PSI with the Vinyl Institute. Uni-Bell's Market Development Committee has recommended that the course be held the week beginning December 2 to minimize scheduling conflicts and work load demands for the targeted audience, i.e., state highway engineers, municipal waterworks engineers and consulting engineers. We plan to begin distribution of registration materials five to six months in advance to allow the public sector engineers plenty of time to obtain travel authorization.

We invite PRO representatives to provide us with names and addresses of individuals whom they wish to invite. We can also provide PRO representatives with registration packets for their personal distribution.

Other

PRO representatives should be interested to know that the PVC pipe industry's competition appears to be stepping up their anti-PVC efforts. Their latest attack includes a full page color ad on the back cover of this month's *AWWA Journal* (copy enclosed). Perhaps this ductile iron producer is trying to counterbalance the impact of PRO's advertising.

The National Clay Pipe Institute (NCPI), in their latest newsletter, "Sewer Sense," has published an article about a PVC sewer pipe job in Allen County, Ohio. Our sources tell us the job was improperly installed and that Allen County is very satisfied with their PVC sewer pipe and they continue to specify PVC sewer pipe. Copies of the article are enclosed. I am trying to arrange a meeting with Allen County for next Thursday to obtain more complete information.

The Summer 1990 issue of our own *PVC Pipe News* has just been published. This issue emphasizes long-term performance and durability of PVC pipe, two areas identified in Sommer's pipe market perceptions report as being of greatest concern. I am including copies for distribution at your meeting.

Dave, please pass on my regrets to all the PRO representatives regarding my inability to attend. If we can be of further assistance or answer any questions during or after your meeting, you are invited to call our office. I hope that this written submittal was helpful, but not so helpful as to preclude my invitation to PRO meetings in the future.

Sincerely,

UNI-BELL PVC PIPE ASSOCIATION

Robert Walker, P.E.
Executive Director

RPW/vac

Enclosures

cc: Roy Gottesman

CTL029369

SEWER RELINING - A GROWTH POTENTIAL FOR PVC

P. MAYRHOFER*

Sewerage systems started in Europe in the middle of the last century and the installed length of municipal sewerage has reached today an estimated length of 1,4 mio km. Some 20% of it are in urgent need of repair and hundreds of billon DM are required for refurbishment until the year 2000.
This paper provides an overview of renovation and trenchless replacement technologies involving PVC and discusses some criteria for system selection. The estimated market size and factors affecting its development are presented.

INTRODUCTION

Sewerage systems have been installed in Europe from the middle of last century onwards and present today a major outlet for PVC pipes (Table I).

The existing network represents however the full spectrum of what was state of the art at the time of installation, reflecting the development of materials and pipelaying technology over a period of some 150 years.

Not only that, but the growing systems also had to be adapted to an increase in population and changing lifestyles which resulted in ever increasing volumes of sewage produced and in a drastic change of its constituents.

Whilst systems built before the turn of the century were designed for 5 l. sewage per day per user, todays user produces 200 l. per day and more.

Household chemicals now in use were then not invented. Traffic loads have changed from horse-drawn carts to trucks with loads of up to 25 t per wheel and the accompanying vibrations.

Today the installed length of municipal sewerage has reached an estimated length of 1,4 million kilometers (1).

Assuming a replacement cost of 1000 DM/m (2) this network would be valued at $1,4 \times 10^{12}$ DM and forms probably the largest asset of cities, municipalities or public utilities.

* European Vinyls Corporation International SA/NV, Belgium

CTL029370

ECOLOGICAL CONSIDERATIONS

Without functioning sewerage networks, modern civilisation is unthinkable.

Unsound sewers can cause infiltration of groundwater or exfiltration of sewage, depending on whether the pipes are below or above the groundwater level. Both are equally problematic.

The W. German network transports annually 3,1 bn m3 sewage from private households plus 1,3 bn m3 industrial sewage and 3,6 bn m3 rain and groundwater to sewage treatment plants. Of this, some 6-10% are lost on the way (3) potentially contaminating ground water.

A major factor are the waste pipes connecting private premises with the municipal sewerage because they are less frequently below the groundwater level.

The total length of these pipes can be assumed as being twice the length of the public sewerage system (e.g. in W. Germany 600.000 Km). Being on private land and of small diameter, they are rarely inspected. Some assumptions state that as many as 60% of those pipelines leak (3).

Infiltration of groundwater, on the other hand, lowers the groundwater table and can cause foundations to sag or trees to die off. On top, sewage treatment plants get overloaded and become inefficient and also the risk of exfiltration of sewage is increased by the higher total flow.

Nor should it be overlooked that any leakage is damaging the bedding of the pipeline, preparing the ground for more trouble in the future.

THE SIZE OF THE PROBLEM

Depending on the pipes used, a calculatory service life ranging from 40 to 100 years is assumed.

With an average lifespan of 70 years, 10-15% of the installed pipes have already passed this time (4) and an additional 20.000 km annually would need refurbishing (Figure 1).

Actually only 400 Km of sewerpipe have been renovated in W. Europe in 1988 (5) and renovation expenditure represents in certain countries only 0,5% (6) of the replacement value of their network, theoretically requiring pipes with a service life of 300 to 500 years.

However, age is not the only cause of deterioration as the main extensions of the public sewer network in Europe took place from 1950 until the 80's (Figure 2).

In W. Germany for instance, the length of installed sewers has quadrupled and the degree of connection has risen from 50% to over 90% during that period.

The rapid development after the war explains perhaps why the best materials were not always used and why expansion took priority over inspection and maintenance.

With the high degree of connection that exists in most countries today (Figure 3), network extensions will mainly take place in rural areas. In the more densly populated regions, the focus will have to be on rehabilitation. In order to plan for repair, renovation or replacement, the network has to be inspected.

The exact knowledge of the current state of sewers is very limited as over 90% of Europe's public network have a diameter below 800mm and are thus not of the "man entry" type.

Despite the advent of close circuit TV, the degree of inspection is low.

In W. Germany for example only 34% of sewers below 800mm diameter have been inspected (4).

Based on such inspections an estimated 20% of the W. European sewerage are in need of repair.

TECHNOLOGY OVERVIEW

ISO TC 138 WG 12 "Relining", established mid 1989, classifies rehabilitation techniques into renovation, trenchless replacement and open cut replacement (Figure 4). The latter is not different from laying new pipe and is therefore not further treated here.

It should be noted however that the social costs involved in open trench pipelaying - dirt, noise, traffic diversions, loss of trade etc. - are becoming more and more unacceptable.

Legislation under preparation, like the update of the UK Public Utilities and Services Act, proposes a road rental charging system. Thereby, the nominated contractor would pay for the time during which the traffic was disrupted. This makes the costs to society quantifiable and thus trenchless technology becomes more attractive.

If a reduction of pipe diameter is hydraulically not acceptable, only replacement can be considered.

However, the smooth finish of lining materials often counteracts the hydraulic effects of loss of cross sectional area, in some cases even increasing the flow capacity.

Trenchless replacement can be carried out by pipe bursting and microtunneling.

Pipe bursting is a technique in which the old pipe is cracked via a percussive or non-percussive air or hydraulic driven mole.

The new pipes are either pulled in by the mole or pushed in after it. PVC's high E - modulus enables it to resist the high axial loads involved.

This technique can be used where the old pipe is surrounded by compactible soil. Since the fragments of the old pipe can present a risk, damaging new product pipes (e.g. PE gas pipes), short PVC pipes are often used to form an outer protection. Amongst other applications in sewerag , this could present excellent potential for the use of recycled PVC.

Microtunneling includes pipe jacking and thrust boring techniques used for non man-entry diameter pipes. Slurry or screwconveyor tunnelers are used and, provided the jacking length is kept within limits, PVC jacking pipes can be envisaged.

Pipeline renovation techniques using PVC include linings with discrete pipes, close fit pipes, spirally wound pipes and lining with pipe segments.

Lining with short pipes (e.g. Uponor Uponal, Wavin etc.) can be used wherever the inner diameter of the old pipe is large enough to accept a pipe with the hydraulically necessary cross section and where the old pipe has not collapsed or deformed.

Close-fit sewer lining Insituform's "NU Pipe" is a folded rigid PVC pipe which is softened by heating so it can be reeled into a manhole and then expanded within the old pipe. This technique gives an interference fit and as there is no annular space, there is no need for grouting.

Spiral winding of rigid PVC profiles is applied to the production of pipes above but also below ground where it permits the formation of a pipe inside a damaged sewer.

To ensure watertightness, either a solvent seal or a gasket situated in a groove in the profile itself is used.

The Ribloc Expanda pipe process has been developed for cases where the lining is required to be in contact with the pipe wall. The Ribloc tube, after it has exited at the next manhole, is reverse wound. By choosing a suitable sealant/adhesive, the spiral joints are allowed to slip, expanding the diameter to a size equal to the inside diameter of the old pipe.

To achieve pipes of greater stiffness, the reinforcement of such profiles with continuous glass fibre can be envisaged.

PVC segments include products like Friedrichsfeld's BKU. They are used in the lining of man accessible installations including storm sewer overflow basins. Potential applications exist in PVC linings of package type sewer treatment plants being installed by industry to treat their own sewage.

The cost of renovation is typically between 40 and 70% of renewal (7). With the exception of lining with short pipe sections, where specially prepared pipe segments can be used, the lateral reconnection of users largely relies on excavation. This reduces the advantages of the "no-dig" approach according to the number of connections to be made.

With remote controlled connection equipment becoming increasingly available, this negative influence should reduce.

SELECTION CRITERIA

A French source (8) lists 70 different rehabilitation techniques and provides a grid for selection.

Methodical approaches are also suggested by the VAV in Sweden (9), the ATV in Germany (10) and the WRc in the UK (7), of which the latter is perhaps the most widely applied.

This subject is therefore not treated here in great depth. However, when considering the renovation options described in this paper, the most significant issue besides hydraulic capacity, material and (closely related) installation and structural considerations, is economics.

A fundamental factor influencing ecnomics and hence the choice of renovation systems is the expected service life.

PVC pipes have a proven track record (11) in sewerage applications with regard to long term properties, chemical resistance etc.

Nevertheless, they are still disadvantaged compared to clay pipes and other conventional materials by currently applied service life assumption in net present value calculations (Table II).

The WRc pipes materials selection manual (12) proposes a "limitation of use" approach. It suggests that provided a material is correctly selected, specified, installed and operated within the recommended limits, there is no reason why different service lifes should be assumed.

Consequently, financial comparisons should be carried out on the basis of total initial installed costs only.

It is hoped that the establishment of international standards for sewer linings adds to the credibility of solutions offered by PVC pipes and therefore makes this approach acceptable to the end user.

THE SIZE OF THE OPPORTUNITY

As mentioned earlier, approx. 20% or 280.000 km of sewers in W. Europe are estimated to be in need of rehabilitation today, with another 200.000 km coming to the end of their useful service life during the next 10 years.

Critical sewers, typically in core areas where trenchless technologies promise to offer the largest cost savings, account for approx. 20% of the installed network.

This leaves some 96.000 km which are likely to be repaired in W. Europe up to the year 2000.

Using the current market share of PVC of approx. 15% in the relevant diameters leaves us with a potential refurbishment market of 13.000 km PVC pipe over the period under consideration.

Although the potential for the renovation of pipes smaller than 200mm diameter is larger, it is a less accessible market and therefore not included here.

Further possibilities include PVC applications in the lining market for waterpipe refurbishment.

FACTORS AFFECTING THE DEVELOPMENT

Several hundred billion DM will have to be spent in W. Europe for sewer rehabilitation until the year 2000, making it one of the largest areas of expenditure by the relevant authorities.

W. German estimates alone run at 50 bn DM for public sewers, 40 bn DM for private sewers and 25 bn DM for rainwater storage over the next 10 years.(2)

The UK privatised water authorities have budgetted investments of some 6 billion £ for sewer mains over the same period.(13)

It is not only the increasing environmental awareness of the electorate that forces the authorities to make the money available.

In Germany, water pollution is now a criminal offence punishable with up to 5 years inprisonment (14) and the UK water act introduced during 1989 places pollution control under the responsibility of the newly formed National River Authority.

Nevertheless, the implementation of a sewer refurbishment programme could require at least 3 years before having a significant effect on the capital programme of a municipality (7).

Contractors are not yet promoting PVC pipes and their perception of installation speeds may lead them to charge different rates, depending on their experience with other materials.

Manufacturers must therefore sell PVC pipes to the city engineers on their properties in order to gain acceptance.

This is of particular importance where municipalities start to use their own workforce to carry out refurbishments. Neutrally supervised trial installations would provide a way to demonstrate the capabilities of PVC systems. Resulting reports (e.g. WAA Information and Guidance notes) could help to overcome the reluctance of specifiers and contractors.

CONCLUSIONS

There is no universal sewer refurbishment method but sizeable opportunities exist for PVC systems using virgin or recycled PVC.

The market is still in its infancy and planned refurbishment will not start immediately as the sewerage system has first to be inspected and capital has to be budgetted.

PVC systems have to complete with established techniques (GRP or PE pipes, Insituform etc.)

In order to gain credibility with and acceptance form specifyers and contractors, the PVC industry should

- support standardisation
- participate in neutrally supervised trial installations
- sell PVC on its properties at the engineering level.

In the sewer refurbishment market, PVC is part of the solution and not part of the problem.

REFERENCES

1 Kennedy RA, 'The European No-Dig market for pipes and sewers larger than 250mm", No-Dig 89 Proceedings, London, UK, 1989

2 Info-Dienst Baubedarf, Kommunale Abwasserkanäle 1, Hauptverband der Deutschen Bauindustrie e.V., Wiesbaden, Germany

3 Stein D, Zeitschrift für angewandte Umweltforschung 1 (1988)65

4 Keding M, Stein D, Witte H, 'Ergebnisse einer Umfrage zur Erfassung des Istzustandes der Kanalisation der Bundesrepublik Deutschland', Korrespondenz Abwasser 2 (1987) 118-122

5 Kennedy RA, 'The dynamics of the European market for large diameter pipes', Corporate Development Consultants, UK, 1989

6 Snaterse C, 'Feststellung, Klassifizierung und Behebung von Schäden an Kanälen in den Niederlanden', 2nd International conference on pipeline construction, Hamburg, W. Germany, 1989

7 Water Research Centre, Sewerage Rehabilitation Manual, Swindon, UK, 1986

8 Rehabilitation, Comment choisir parmi 70 procédés, Bonna, Nancie, France 1989

9 Svenska Vatten-och Avloppsverksföreningen, 'Renovering av Avloppsledningar', VAV P 66, Stockholm, Sweden, 1989

10 Gesellschaft zur Förderung der Abwassertechnik, ATV Merkblatt M 143, St. Augustin, W. Germany

11 Walton D, Elzink WJ, 'Long term behaviour of buried U PVC sewer pipe', Constr. Bldg. Mat 3, (1989) 58-63

12 Water Research Centre, Pipematerials selection manual, Marlow, UK, 1988

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13 Offering circular, Offer for Sale of shares of UK water groups, UK 1989

14 Schmenken W, 'Rechtliche Konsequenzen der Strafgesetzgebung', 2nd International conference on pipeline construction, Hamburg, W. Germany 1989

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	1987 %	Growth 91/87 % p.a.	1991 %
Water mains & Services	15	+1.5	15
Gas	negl.	0	negl.
Sewer	31	+5	35
Building	26	+1	25
Agriculture & Road drainage	15	+0.6	14
Conduit and Ducting	13	-3	11
Total	100 = 1.235 Kt	+1.7	100 = 1.320 Kt

Table I W. European PVC pipe market by sub-sector
Source : EVC

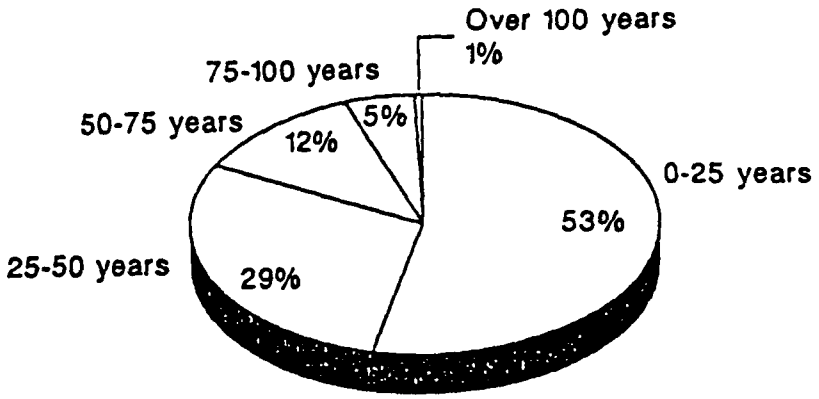
	Years (1)
Conventional new sewers (non-plastic)	100
New sewers in PVC	40
Lining systems(2)	50

(1) UK nationally agreed figures for project appraisal

(2) Only for lining systems based on established techniques

Source: WRC Sewage rehabilitation manual.

Table II Calculatory service life of new sewers and rehabilitation options.



Source: Korrespondenz Abwasser, 2/87, p119

Figure 1 Age structure of sewers in W. Germany

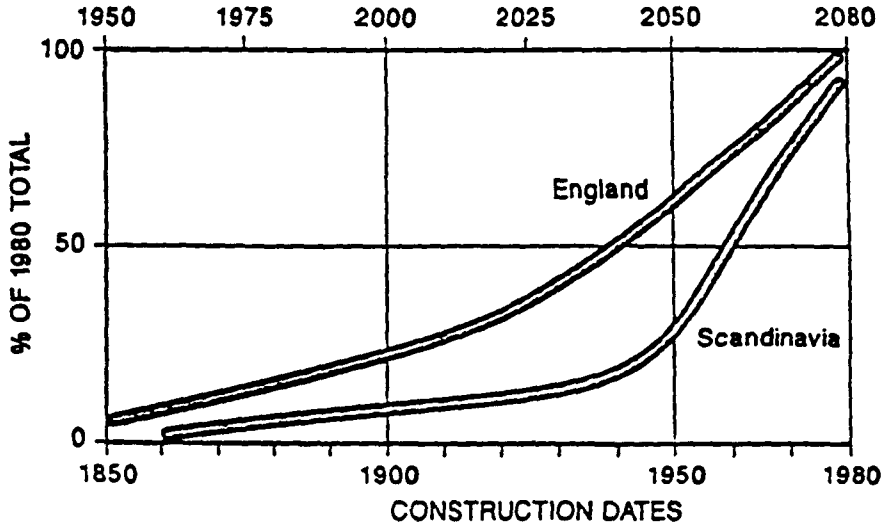


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Figure 2 Percentage of sewers older than 100 years
Source : various

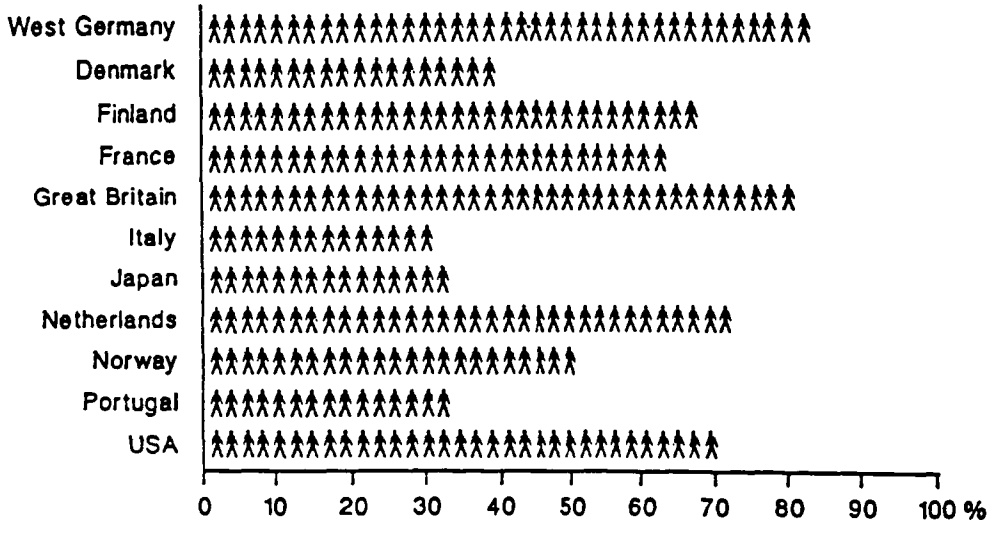

Figure 3 Percentage of population connected to public sewers
Source : Daten zur Umwelt 86/87, UBA S. 366

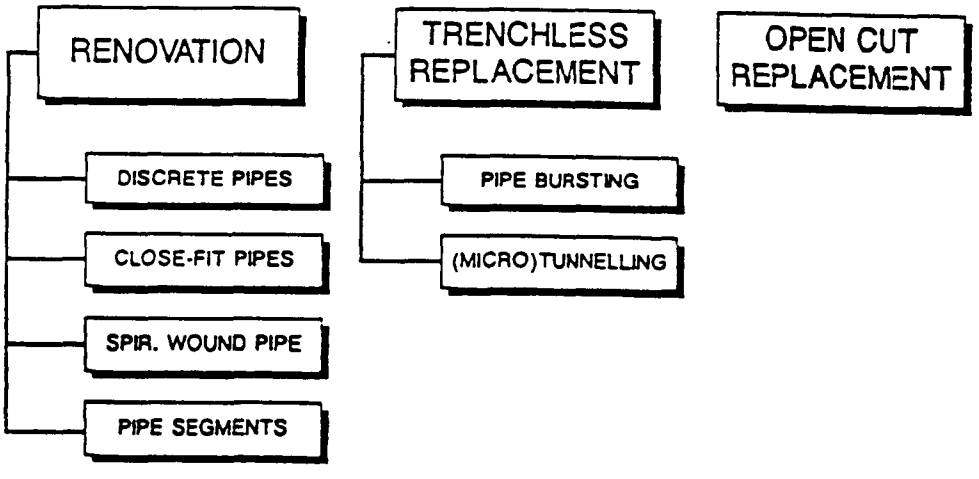

Figure 4 Rehabilitation of pipelines, systems using PVC

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ECOLOGICAL CONSIDERATIONS

Without functioning sewerage networks, modern civilisation is unthinkable.

Unsound sewers can cause infiltration of groundwater or exfiltration of sewage, depending on whether the pipes are below or above the groundwater level. Both are equally problematic.

The W. German network transports annually 3,1 bn m3 sewage from private households plus 1,3 bn m3 industrial sewage and 3,6 bn m3 rain and groundwater to sewage treatment plants. Of this, some 6-10% are lost on the way (3) potentially contaminating ground water.

A major factor are the waste pipes connecting private premises with the municipal sewerage because they are less frequently below the groundwater level.

The total length of these pipes can be assumed as being twice the length of the public sewerage system (e.g. in W. Germany 600.000 Km). Being on private land and of small diameter, they are rarely inspected. Some assumptions state that as many as 60% of those pipelines leak (3).

Infiltration of groundwater, on the other hand, lowers the groundwater table and can cause foundations to sag or trees to die off. On top, sewage treatment plants get overloaded and become inefficient and also the risk of exfiltration of sewage is increased by the higher, total flow.

Nor should it be overlooked that any leakage is damaging the bedding of the pipeline, preparing the ground for more trouble in the future.

THE SIZE OF THE PROBLEM

Depending on the pipes used, a calculatory service life ranging from 40 to 100 years is assumed.

With an average lifespan of 70 years, 10-15% of the installed pipes have already passed this time (4) and an additional 20.000 km annually would need refurbishing (Figure 1).

Actually only 400 Km of sewerpipe have been renovated in W. Europe in 1988 (5) and renovation expenditure represents in certain countries only 0,5% (6) of the replacement value of their network, theoretically requiring pipes with a service life of 300 to 500 years.

However, age is not the only cause of deterioration as the main extensions of the public sewer network in Europe took place from 1950 until the 80's (Figure 2).

In W. Germany for instance, the length of installed sewers has quadrupled and the degree of connection has risen from 50% to over 90% during that period.

The rapid development after the war explains perhaps why the best materials wer not always used and why expansion took priority over inspection and maintenance.

With the high degree of connection that exists in most countries today (Figure 3), network extensions will mainly take place in rural areas. In the more densly populated regions, the focus will have to be on rehabilitation. In order to plan for repair, renovation or replacement, the network has to be inspected.

The exact knowledge of the current state of sewers is very limited as over 90% of Europe's public network have a diameter below 800mm and are thus not of the "man entry" type.

Despite the advent of close circuit TV, the degree of inspection is low.

In W. Germany for example only 34% of sewers below 800mm diameter have been inspected (4).

Based on such inspections an estimated 20% of the W. European sewerage are in need of repair.

TECHNOLOGY OVERVIEW

ISO TC 138 WG 12 "Relining", established mid 1989, classifies rehabilitation techniques into renovation, trenchless replacement and open cut replacement (Figure 4). The latter is not different from laying new pipe and is therefore not further treated here.

It should be noted however that the social costs involved in open trench pipelaying - dirt, noise, traffic diversions, loss of trade etc. - are becoming more and more unacceptable.

Legislation under preparation, like the update of the UK Public Utilities and Services Act, proposes a road rental charging system. Thereby, the nominated contractor would pay for the time during which the traffic was disrupted. This makes the costs to society quantifiable and thus trenchless technology becomes more attractive.

If a reduction of pipe diameter is hydraulically not acceptable, only replacement can be considered.

However, the smooth finish of lining materials often counteracts the hydraulic effects of loss of cross sectional area, in some cases even increasing the flow capacity.

Trenchless replacement can be carried out by pipe bursting and microtunneling.

Pipe bursting is a technique in which the old pipe is cracked via a percussive or non-percussive air or hydraulic driven mole.

The new pipes are either pulled in by the mole or pushed in after it. PVC's high E - modulus enables it to resist the high axial loads involved.

This technique can be used where the old pipe is surrounded by compactible soil. Since the fragments of the old pipe can present a risk, damaging new product pipes (e.g. PE gas pipes), short PVC pipes are often used to form an outer protection. Amongst other applications in sewerage, this could present excellent potential for the use of recycled PVC.

Microtunneling includes pipe jacking and thrust boring techniques used for non man-entry diameter pipes. Slurry or screwconveyor tunnelers are used and, provided the jacking length is kept within limits, PVC jacking pipes can be envisaged.

Pipeline renovation techniques using PVC include linings with discrete pipes, close fit pipes, spirally wound pipes and lining with pipe segments.

Lining with short pipes (e.g. Uponor Uponal, Wavin etc.) can be used wherever the inner diameter of the old pipe is large enough to accept a pipe with the hydraulically necessary cross section and where the old pipe has not collapsed or deformed.

Close-fit sewer lining Insituform's "NU Pipe" is a folded rigid PVC pipe which is softened by heating so it can be reeled into a manhole and then expanded within the old pipe. This technique gives an interference fit and as there is no annular space, there is no need for grouting.

Spiral winding of rigid PVC profiles is applied to the production of pipes above but also below ground where it permits the formation of a pipe inside a damaged sewer.

To ensure watertightness, either a solvent seal or a gasket situated in a groove in the profile itself is used.

The Ribloc Expanda pipe process has been developed for cases where the lining is required to be in contact with the pipe wall. Th Ribloc tube, after it has exited at the next manhole, is reverse wound. By choosing a suitable sealant/adhesive, the spiral joints are allowed to slip, expanding the diameter to a size equal to th inside diameter of the old pipe.

To achieve pipes of greater stiffness, the reinforcement of such profiles with continuous glass fibre can be envisaged.

PVC s gments include products like Friedrichsfeld's BKU. They are used in the lining of man accessible installations including storm sewer overflow basins. Potential applications exist in PVC linings of package type sewer treatment plants being installed by industry to treat their own sewage.

The cost of renovation is typically between 40 and 70% of renewal (7). With the exception of lining with short pipe sections, where specially prepared pipe segments can be used, the lateral reconnection of users largely relies on excavation. This reduces the advantages of the "no-dig" approach according to the number of connections to be made.

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With remote controlled connection equipment becoming increasingly available, this negative influence should reduce.

SELECTION CRITERIA

A French source (8) lists 70 different rehabilitation techniques and provides a grid for selection.

Methodical approaches are also suggested by the VAV in Sweden (9), the ATV in Germany (10) and the WRc in the UK (7), of which the latter is perhaps the most widely applied.

This subject is therefore not treated here in great depth. However, when considering the renovation options described in this paper, the most significant issue besides hydraulic capacity, material and (closely related) installation and structural considerations, is economics.

A fundamental factor influencing ecnomics and hence the choice of renovation systems is the expected service life.

PVC pipes have a proven track record (11) in sewerage applications with regard to long term properties, chemical resistance etc.

Nevertheless, they are still disadvantaged compared to clay pipes and other conventional materials by currently applied service life assumption in net present value calculations (Table II).

The WRc pipes materials selection manual (12) proposes a "limitation of use" approach. It suggests that provided a material is correctly selected, specified, installed and operated within the recommended limits, there is no reason why different service lifes should be assumed.

Consequently, financial comparisons should be carried out on the basis of total initial installed costs only.

It is hoped that the establishment of international standards for sewer linings adds to the credibility of solutions offered by PVC pipes and therefore makes this approach acceptable to the end user.

THE SIZE OF THE OPPORTUNITY

As mentioned earlier, approx. 20% or 280.000 km of sewers in W. Europe are estimated to be in need of rehabilitation today, with another 200.000 km coming to the end of their useful service life during the next 10 years.

Critical sewers, typically in core areas where trenchless technologies promise to offer the largest cost savings, account for approx. 20% of the installed network.

This leaves some 96.000 km which are likely to be repaired in W. Europe up to the year 2000.

Using the current market share of PVC of approx. 15% in the relevant diameters leaves us with a potential refurbishment market of 13.000 km PVC pipe over the period under consideration.

Although the potential for the renovation of pipes smaller than 200mm diameter is larger, it is a less accessible market and therefore not included here.

Further possibilities include PVC applications in the lining market for waterpipe refurbishment.

FACTORS AFFECTING THE DEVELOPMENT

Several hundred billion DM will have to be spent in W. Europe for sewer rehabilitation until the year 2000, making it one of the largest areas of expenditure by the relevant authorities.

W. German estimates alone run at 50 bn DM for public sewers, 40 bn DM for private sewers and 25 bn DM for rainwater storage over the next 10 years.(2)

The UK privatised water authorities have budgetted investments of some 6 billion £ for sewer mains over the same period.(13)

It is not only the increasing environmental awareness of the electorate that forces the authorities to make the money available.

In Germany, water pollution is now a criminal offence punishable with up to 5 years inprisonment (14) and the UK water act introduced during 1989 places pollution control under the responsibility of the newly formed National River Authority.

Nevertheless, the implementation of a sewer refurbishment programme could require at least 3 years before having a significant effect on the capital programme of a municipality (7).

Contractors are not yet promoting PVC pipes and their perception of installation speeds may lead them to charge different rates, depending on their experience with other materials.

Manufacturers must therefore sell PVC pipes to the city engineers on their properties in order to gain acceptance.

This is of particular importance where municipalities start to use their own workforce to carry out refurbishments. Neutrally supervised trial installations would provide a way to demonstrate the capabilities of PVC systems. Resulting reports (e.g. WAA Information and Guidance notes) could help to overcome the reluctance of specifiers and contractors.

CONCLUSIONS

There is no universal sewer refurbishment method but sizeable opportunities exist for PVC systems using virgin or recycled PVC.

The market is still in its infancy and planned refurbishment will not start immediately as the sewerage system has first to be inspected and capital has to be budgetted.

PVC systems have to complete with established techniques (GRP or PE pipes, Insituform etc.)

In order to gain credibility with and acceptance form specifyers and contractors, the PVC industry should

- support standardisation
- participate in neutrally supervised trial installations
- sell PVC on its properties at the engineering level.

In the sewer refurbishment market, PVC is part of the solution and not part of the problem.

REFERENCES

1 Kennedy RA, 'The European No-Dig market for pipes and sewers larger than 250mm", No-Dig 89 Proceedings, London, UK, 1989

2 Info-Dienst Baubedarf, Kommunale Abwasserkanäle 1, Hauptverband der Deutschen Bauindustrie e.V., Wiesbaden, Germany

3 Stein D, Zeitschrift für angewandte Umweltforschung 1 (1988)65

4 Keding M, Stein D, Witte H, 'Ergebnisse einer Umfrage zur Erfassung des Istzustandes der Kanalisation der Bundesrepublik Deutschland', Korrespondenz Abwasser 2 (1987) 118-122

5 Kennedy RA, 'The dynamics of the European market for large diameter pipes', Corporate Development Consultants, UK, 1989

6 Snaterse C, 'Feststellung, Klassifizierung und Behebung von Schäden an Kanälen in den Niederlanden', 2nd International conference on pipeline construction, Hamburg, W. Germany, 1989

7 Water Research Centre, Sewerage Rehabilitation Manual, Swindon, UK, 1986

8 Rehabilitation, Comment choisir parmi 70 procédés, Bonna, Nancie, France 1989

9 Svenska Vatten-och Avloppsverksföreningen, 'Renovering av Avloppsledningar', VAV P 66, Stockholm, Sweden, 1989

10 Gesellschaft zur Förderung der Abwassertechnik, ATV Merkblatt M 143, St. Augustin, W. Germany

11 Walton D, Elzink WJ, 'Long term behaviour of buried U PVC sewer pipe', Constr. Bldg. Mat 3, (1989) 58-63

12 Water Research Centre, Pipematerials selection manual, Marlow, UK, 1988

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13 Offering circular, Offer for Sale of shares of UK water groups, UK 1989

14 Schmenken W, 'Rechtliche Konsequenzen der Strafgesetzgebung', 2nd International conference on pipeline construction, Hamburg, W. Germany 1989

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