



PVC IS PROVEN TO BE
FOX-FRIENDLY IN
BAKERSFIELD, CALIF.

See Page 6



UNI-BELL'S NEW WEB
SITE IS UP AND
SPINNING

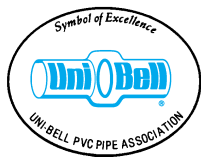
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NEW REPORT ON PVC
FORCE MAIN DESIGN

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UNI-BELL PVC PIPE NEWS

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A closer look...

INTERVIEW

An Interview With Dr. L. D. McMullen

By Dave Eckstein, Editor

Late last year I had the opportunity to interview Dr. L. D. McMullen. The purpose of the interview was to discuss the experience Dr. McMullen has had with PVC pipe at the Des Moines Water Works. L. D. is uniquely qualified to discuss issues within the water industry, as the biographical information will show.

Eckstein: This is the first in what we hope to be a series of interviews where we talk to the customers. When we talk to the customers we learn from the customers. That's really the intention. A one-on-one discussion to hear about the things we're doing right and the things we're not doing right and to hear those things about PVC pipe as well. We appreciate your time, we know time is the commodity that perhaps none of us have enough of.

McMullen: Well, I really commend you because I think customer feedback is an important thing to collect. We try to do that same thing even within our utility. Sometimes we forget, sometimes we get to running a little too fast, we think our customers are there with us and it's like that phrase "when you're at the front of the parade and you look back and nobody is behind you." We all need to look back and make sure the rest of the parade is with us and I commend you for it.

Eckstein: I sent you a few general topics just to let you know the things we were wanting to talk

SEE "McMULLEN INTERVIEW" ON PAGE 2

About Dr. McMullen

Included in the article is pertinent and enviable biographic information on Dr. McMullen. Experience chronicled from his Ph.D. in Environmental Engineering to CEO and General Manager of the Des Moines Water Works and a myriad of outside activities and organizations. Since our interview the list has grown. Most notable are two recent appointments to service the water works community from a national perspective.

Dr. McMullen now serves as Chairman of the U. S. Environmental Protection Agency's (EPA's) National Drinking Water Advisory Council. Additionally, he has recently accepted appointment to EPA's prestigious Science Advisory Board, Drinking Water Committee.

This only serves to reinforce our gratitude to L.D. for taking time from his schedule to participate in this interview. ❖

About Dave Eckstein

In addition to serving as editor for this PVC Pipe News, Dave has worked his way from Association Engineer, to Technical Director to, now, Deputy Executive Director of the Association. Included in his fifteen year tenure, have been numerous published papers on nearly every aspect of PVC pipe design and application as well as hundreds of formal presentations and seminars for which Mr. Eckstein has become one of the more sought after public speakers in our Industry.

His current assignment as Chairman of the sub-committee to update AWWA Manual 23, "PVC Pipe Design and Installation", reunites Mr. Eckstein with Dr. McMullen. L.D. had served as Chairman himself until other duties within AWWA dictated he pass on the Chair. His recommendation for successor, honored by the AWWA's Standard Council, was in fact, Mr. Eckstein. The two were first acquainted at the University of Iowa College of Engineering while Dr. McMullen taught and finalized doctoral work, and Eckstein completed his under-graduate degree. They have crossed paths several times in the subsequent twenty years professionally and personally.

We think you will agree that their comfort with each other as well as the subject matter results in a truly remarkable encounter which is our pleasure to present to you. ❖

QUESTION & ANSWER

Question: Why Is PVC Pipe Lifting That Bulldozer?
Answer: Because It Can!

Actually, restrained PVC pipe is more descriptive, especially to the folks at EBAA Iron, Inc. who did the lifting. What you're seeing is a section of 12 inch DR 18 (pressure class 150 psi) pipe with mechanical joint restraints (particularly EBAA's 2012 PV) on either end.

The other items of note are a crane registering 50,200 pounds at the hook due to the Caterpillar® D7 residing on the other end. You can anticipate seeing this promotional pictorial in several formats coming from EBAA in support documentation on their line of restraints for both PVC and iron pipes.

You know, I guess it's true, for some people you run the numbers and for some you go lift a bulldozer. The good part is that even us "numbers" people enjoy a dozer lift now and then. ❖



Technology For A Cleaner Safer Planet

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McMullen Interview

about. I guess the first thing would be to introduce Des Moines Water Works. If I could ask you, L.D., to begin with a little bit about Water Works.

McMullen: Des Moines Water Works is a public utility that operates under a Board of Trustees. We are in a special section of the Code of Iowa that allows for an independent utility but our Board has the same powers and authorities as the City Council with the exception being they can't certify taxes as it relates to the water utility. So if you think of a City Council, our Board is the same, except it deals with the water utility. It became a public utility in 1919 by a vote of the public. It was purchased from a private water utility at that time and basically has been under the same structure and same organization since that time. So we have 75 plus years of experience operating in that mode. We are a regional utility that services not only the City of Des Moines but 23 other political subdivisions surrounding us. We service two counties at the current time and are working on servicing two more counties, and there is even talk about taking our water out two more counties beyond that. We think that in the near future we will be a four county utility and very possibly a six county utility in the distant future. We deliver an average of 43 million gallons of water per day, with our peak of a little over 75 MGD. We're a one-treatment-plant water utility at the current time, although we are actively designing a second treatment plant, and also actively exploring what is called "aquifer storage recovery" as a way to help shave peak demands on our system. I think we're a utility that is maybe on the edge of a lot of things rather than being a follower. I don't think we're the leading utility in the nation, but we like to experiment with things with our 235 employees. We do so with a lot of different thoughts and ideas all the way from management to materials. We have 800 miles of pipeline in our system, which grows to more than one thousand miles of pipeline, when everything connected to us is included. This contributes to our numerous experiences, and I think we're kind of a unique utility, but that's a biased personal perspective.

Eckstein: Your biased personal perspectives are allowed and welcomed here. You know, I'm interested that you would choose to point out in an introduction, that you try things. It seems so often that trial or experimentation is not only a badge people would not want to wear but that it's nearly a bad thing by definition. Certainly a past trial that did not work can become an excuse against all further trial. Is the opportunity here eased by organization or is it more the people?

McMullen: I think that it probably is a combination, Dave. I think utilities formed under a Board of Trustees, well usually, those Trustees are business-related people. As a result I think there is more of a willingness to take a risk characterized by that type of person. I think that part of the climate helps. The second thing is the people, just as you've described. I think we've got some really innovative, creative people in our organization. We're sometimes criticized that we're technologically heavy, both from a people standpoint and also from the tools we have, but as a result of the willing-to-take-risks environment that our Board has and an innovative, creative group of employees, we end up with a dynamic synergism that promotes trying new things. But that doesn't mean we're always successful. I mean we've tried things that have just not worked well at all and you just admit that they didn't work and you shut them down, whether it's a chemical feed system or management control system, and you develop something new.

Eckstein: Well that's why I asked because you talk so much about the environment being right. If you do it right, trying means that it doesn't always work, and that can be an excuse for not trying. By not trying, you are failing in a lot of regards by keeping the current systems when they don't make sense.

McMullen: That's exactly right.

Eckstein: It seems somewhat unique to hear that point of view. It's probably why you're in a position to be talking about the possibility of incorporating an additional 4 counties with a smile. I'm sure when you take over that kind of existing system, you inherit things that up to that point were out of your control.

McMullen: And to some degree they still are, I mean we're working cooperatively with other organizations to carry out objectives and we're kind of that resource person behind the scenes helping and doing whatever we can to accomplish the end result. A good example is one of the counties we're working with, Madison County. We have been to numerous meetings talking about our water quality, the availability of our water and especially after the flood, a lot of people questioned that. Helping the group, the

INTERVIEW



"The other thing we're relying more and more upon is an accurate records system. We've been a very strong promoter of AMFM (automatic mapping facility management) systems, where we can pull up a pipe and know within fractions of an inch where it is."

—McMullen

Madison County Rural Water group, to be able to put together a plan to service that area. It's not something we want to go out there and take over and say "we're going to do it". We think we're going to need to work together in a group rather than do it all ourselves.

Eckstein: I want to introduce a little bit about Dr. L. D. McMullen. I've had the pleasure of at least being an observer of part of this as we have known each other some twenty years now, and I think it's important information for the audience. You received your bachelor in Civil Engineering from the University of Iowa, and then a masters and a Ph.D. in Environmental Engineering, also from the University of Iowa. Don't you serve on the Board of Regents?

McMullen: I'm on the College of Engineering Advisory Board; in fact I chair the College of Engineering Advisory Board at the current time and was just appointed to the Alumni Association on the Board as the College of Engineering's representative.

Eckstein: Your work experience is something else to zero in on and maybe helps set the stage for things we've already talked about personnel wise here at Water Works. I show a couple of years with the US Public Health Service and then into some instructor roles, ultimately associate or assistant professor while you were at Iowa working on your graduate degrees, followed then by a 1978 initial appointment here with Water Works as a design engineer. I show progression from design engineer to director of engineering services shortly thereafter, ultimately then on to assistant general manager, acting general manager and now CEO and general manager and in fact this is the position you've held for 10 years.

McMullen: Yes, I've been in this position for 10 years.

Eckstein: For a total of close to 20 years with Des Moines Water Works.

McMullen: I came in 1978, so about 18 years.

Eckstein: You have not limited yourself to the Des Moines Water Works. You have been very active in your profession and in the water utility area. You have done it through regional work, state activity and certainly national activity also. American Water Works Association where I have had the pleasure and privilege to join you on a couple of items. You are currently on the Board of Directors for the AWWA, past chairman of both the Continuous Quality Improvement Committee and Management Division, past member of the PVC Pressure Pipe and Fittings committee, you are past chairman of an effort in that area on the Design and Installation Manual, past member of both Water Industry Data Base Committee and Project Advisory Committee for Automatic Meter Reading. So its been a wide range of activities in which you have not only involved yourself where you have a particular interest but you've also spread it around to where the needs of others have been. American Water Works Association Research Foundation, (AWWARF) currently member of the Board of Trustees, past member of the Board of Trustees Executive Committee and Finance Committee. Association of Metropolitan Water Agencies, past president Board of Trustees, past chairman Legislative Committee, member of the Management Committee, recipient of the 1994 President's Award. You begin to see a consistency here, L.D., with not just involvement, but involvement which ultimately leads to the very top. That speaks very highly. National Drinking Water Advisory Committee member, past president of the Automatic Meter Reading Association, and I've saved this one for last so you can tell me a little bit about this one, Citizen Ambassador Program, certainly familiar with that, but an Iowa State Leadership Initiative to the Soviet Union in 1988?

McMullen: Yes, it was right before the break up of the Soviet Union, when Gorbachev was taking over, and I felt very privileged to be over there during that time period. We were a group of Iowans who went over into the agriculture parts of the country. It was primarily schools, health care, public water supplies, waste water treatment, all of that. We were over there meeting with our colleagues you might say, and to be there when the central party still had control was just a real unique opportunity because it all changed within just a few years after that trip. I'd like to go back again sometime once everything shakes out and compare it, because it was definitely a different environment from what we're accustomed to in the U.S.

Eckstein: Yes, it's a unique opportunity like you said. I had the opportunity to send my daughter over right before the Barcelona Olympics. She trained briefly at the Olympic Training Facility at Round Lake. Yeltsin had already announced "that's it", Barcelona was the end, then it was all shutting down. Like you said, it was just a window of opportunity to experience something history will never forget but most likely never recreate either.

McMullen: Exactly.

Eckstein: Well excellent, certainly the purpose in all of this ultimately is to garner more knowledge about PVC pipe and how it fits and doesn't fit. We need to know who we're talking to and I think we've accomplished that. I'd like now, if you would allow me L.D., to have you take us through your own experiences.

McMullen: No problem.

Eckstein: Part of what we're finding today is really a need to better understand the process the customer goes through in making a switch. We find a lot of people who, for whatever reason, want to make a switch to PVC pipe. PVC is the most popular water pipe product in the United States today. Still, there are opportunities for us, there are people with needs we think PVC pipe can fulfill. And we find that we can

be better at helping them make the change. That's one thing we'd like to learn more about. So we'd like to use your own experience as a sounding board. Do this for me, if you would, and go back to early in your tenure. The switch that was being thought about was to include PVC for the first time; until then I think it was ductile iron pipe only.

McMullen: Ductile and concrete.

Eckstein: Okay. Take us back to that period and what kinds of things were going on at the time that led you to PVC.

McMullen: The engineering department was responsible for maintaining records. We maintained every kind of record you could possibly think of, and one of them was main breaks. We had little cards that identified when and where every main break occurred and other information. But they didn't include any real reason for the break. So one day I just decided I was going to stick these on a map. I had a map of our distribution system, so I got a little red pencil and started coloring them all in. The majority of failures were occurring on the south side of Des Moines. And I wondered what was so unique about the south side of Des Moines? It was very obvious that something was going on on the south side that was different than what was happening on the north side. Even though the north side in general was older than the south side. So when I saw that pattern occur, I was intrigued enough to find out why. I talked to our field people and they said the pipes were all eaten up on the south side with corrosion, and I asked if they were finding that problem on the north side too, and they said not as often. That got me to thinking even more trying to figure out why this was. Des Moines turns out to be a unique geological site because the last continental glacier ended right in the middle of Des Moines. The material on the north side of the city is recent glacial till, which is well drained, and the material on the south side is very old glacial till, highly weathered and very tight, a lot of clays. In addition, Des Moines turns out to be the site of a lot of old coal mines. Coal mining was prolific and the whole city is underlain by old coal mines. Fortunately they are deep enough that even if the shafts collapse the whole city doesn't collapse in a hole. As a result of these two occurrences, the coal mining and all of the old spoils that came out of coal mining operations, and the two totally different geologies because of the glacier, it started making some sense as to why we were seeing the south side having more active corrosion than the north side. On the north side the water would drain away; there weren't high conductivity areas where corrosion cells set up very easily. There weren't all the classic soil conditions for corrosion on the north side as were on the south side. We also found out that the pockets we were finding on the north side were areas of fill that had been used for roads and that type of thing from the coal mining operations. These were very acidic and again provided a classic environment for promoting corrosive situations. So we went out and started doing a lot of soil testing. Anytime we had a main failure we picked up soil samples and also picked up coupons of pipe so we could determine if it really was a corrosion failure and what was the cause of it. What we discovered was that somewhere in the range of maybe 80 to 90 percent of our failures were due to corrosion. Maybe that wasn't the straw that broke the camel's back but that was the thing that weakened the pipe wall and caused the failure to occur. We have some very very old pipe in our system, in excess of 100 years old, that is just as good as the day it was put in because it's in the right environment. We have other pieces of pipe that corrode very rapidly that are fairly new and have failed because of the environment. Once we identified what our problem really was, corrosion, we started a main replacement program. We

replaced those pipelines causing us difficulty. And we needed to come up with an alternate material to put in. We weighed whether or not we were going to use PVC pipe or ductile iron wrapped in polyethylene. In the early days, we bid both. Our specifications allowed either because we felt that polyethylene would protect the ductile to a point that we would be all right. What ended up happening was PVC was always the pipe of choice for our contractors. Once we started finding that out, we further discovered the reason for it was price. We still allow ductile with polyethylene, but nobody ever bids it because PVC is the material of choice. And so what we have done essentially over the years is specify anything 12 inch and under should be PVC. Nothing can compete with it, especially with the environment we have. If the pipe is 12 up to probably 24 inch, then there is a period where pipe specification transition from PVC to ductile iron wrapped to concrete. Anything 24 inch and higher usually ends up being concrete. We allow ductile iron throughout that whole spectrum, but as far as price, they can't compete with concrete on the high end and they don't compete with PVC on the low

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"Even though the frost loading is what really caused it to break, the weakening of the pipe was caused by the corrosion."

—McMullen

end. The catalyst that started us down this whole path was main failures and trying to study why pipelines were failing.

Eckstein: That would have been late 70s?

McMullen: That was the late 1970s or early 1980s, somewhere in that time period.

Eckstein: I remember the talk you gave at the AWWA conference in Miami on some of the soil testings you folks had done and I believe that was in '81 or '82.

McMullen: That would have been about right.

Eckstein: When the decision was made, how universal was it within the department?

McMullen: The decision within the engineering group, which was relatively small at that time, was rather unanimous. We were working with, at that time, Johns-Mansville. Jerry Parkinson was the man who worked closely with me, and we did a lot of educating and work with our employees. I think at the time we put it (PVC) in, there were some feelings of, "it's another one of those things we're going to try, probably won't work, but we'll give it a shot". We put it in and there were the nay-sayers saying we would have the largest underground sprinkler system in the world.

Eckstein: That's not very nice!

McMullen: At first, our contractors had to familiarize themselves with it because it was a new product for them at that time. They had to learn a little bit and we watched them closely during those early times. One priority was making sure they didn't drive the pipes "home" too far, especially if the weather was cold while installing it. Our temperature for our finished water swings from 80 degrees down to around 36 degrees in the winter time. With that temperature swing, we move around a lot underground and so we had to make sure we installed it correctly. The other biggest objection we encountered was

"what are we going to do with tapping?" That was probably the most controversial issue and still is in the utility today because these were the smaller diameter pipelines in our system; the ones serving people down the street. We said if we had a corrosion problem it didn't make any sense to put the saddles on and so Jerry really worked with us using the shell cutter correctly on PVC so we could direct tap. We worked real hard with our people in that area and we learned a lot of things not to do in tapping PVC; don't push it, make sure you have a sharp shell cutter, all the things to do it right that if we didn't do we had problems. We had splits on tapping because people went real fast, yet we've learned how to do it right. We do a lot of direct tapping on PVC and that still is the way we're doing it today. Our field people still raise the saddle issue every so often but we reeducate and then they understand why we're doing it the way we are, and we continue on with direct tapping.

Eckstein: This is one of the things that I can't help but have input on any time it comes up. There is certainly a right way to do it and certainly a wrong way also. One of the things in education we try for is that saddles should not alleviate your need for care or caution while you're doing the operation. ID penetration is what we're after as a smooth operation. And you can do that whether you have a saddle on it or not. For several reasons obviously, it's an easier operation perhaps with a saddle, you're cutting less hole and hanging a lighter machine off of it, but we still want you to get through the ID penetration carefully. We've always maintained we're too easy to tap; that's been part of our problem if there is a problem.

McMullen: There's a lot of truth to that.

Eckstein: I think there's still at least pockets of that old-fashioned mentality, when you tell somebody "slow and easy" that doesn't fit with what they want to hear.

Maybe you've already begun to go where I want to go and that was to frame what expectations you had of the product. If I could start you out, you obviously didn't expect it to corrode.

McMullen: Absolutely. It was really two things, Dave: one was cost and the other was that it would be around for a long, long time. It wasn't going to corrode, and was going to be a reliable product for many years into the future. Once we put it in the ground it was going to be there forever. Price was thrown in as an additional benefit; not only was it a good, reliable product for the corrosive environments we were experiencing, but it was less expensive. So it's hard to beat it when you have both quality and price.

Eckstein: Also looking back, what were the apprehensions at the time? There were at least some concerns about tapping, were there other things?

McMullen: The only other thing of concern to us was proper installation. We thought PVC was a little more sensitive than iron or concrete, in two senses. Sometimes it's a little easy to bend it rather than laying it straight. Ductile you don't bend, it's picked up in the joints, but PVC can be picked up in the joints and bent. Rather than use fittings, the tendency is to force it a little bit. This stresses it and potentially causes a problem. The other concern was in the area of expansion and contraction. We knew our water temperature swings, so we had to make sure that if we were installing pipe in the middle of winter, it isn't driven all the way "home". We had to make sure adequate expansion and contraction were available in the joints. That was a real concern to us, but it never materialized as a problem.

Eckstein: Well that's where I was going to go next.

McMullen: It has never really been a problem. Bending of the pipe was a problem; still is today. The

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McMullen Interview



Des Moines Water Works is a public utility that operates under a Board of Trustees.

contractor likes to push it to its limit. We know if we put that pipe under stress, try to tap it before it has the ability to relieve that stress, we run a risk of it splitting. The whole problem about having to dig out each bell and all that other stuff, that's not an issue. There's enough softness that if the contractor does a good job of preparing the trench bottom, it just settles right in. But the biggest things of concern to us were making sure we didn't drive it "home" when it's cold, which has never turned out to be a problem, and making sure they don't try to over-use bending. Which is still a problem today.

Eckstein: *How does it exhibit itself as a problem?*

McMullen: They just try to do it and we don't allow them to do that. If we're laying a pipe down the road; and we know it's going to be a couple of years before we ever come in and tap it, I have a lot less concern because it has a year to relieve that stress and bending. I think our temperature swing helps us there a little because the expansion and contraction of the material, I think, has a tendency to help offset some of that stress. I'm not a plastic technician, but that would be my feeling, kind of a gut feeling. But if we're going to go down there and tap within two weeks of it going into the ground, then I am much more concerned that they don't bend that pipe and put it under a lot of stress.

Eckstein: *While we're focused on history during the early transition period, and I'm talking now about the product, your own people, our involvement; is there a thing that stands out that you'd go, "Boy, if I had the luxury to look back, we would have chosen to do this differently." Is there anything that jumps out?*

McMullen: Not a thing. I think the approach we took was very aggressive for our utility, maybe not for the industry, but for our utility at that time. I think the manufacturer came and spent a lot of time with us, and I think that was very positive at the time. It made us feel comfortable trying the product. We sold it to our management team, and they were willing to give it a try. There was some hesitance, a little bit of resistance, but they accepted it, and the same with our field people. Their attitude was, "Well, let's try it and see what happens." I think they saw from their side it was going to be a much easier product for them to handle than a piece of iron or concrete. I wouldn't do a thing differently.

Eckstein: *We find throughout our experience that if we can get the product in the hands of the people who go about the business of delivering water for a living, very seldom do we get any backwards movement. We just have to jump that first mental hurdle.*

What particular challenges does your water system offer its distribution network? You've already mentioned some pockets of high corrosion and also a pretty good temperature swing, you've talked of 36°F to 80°F (2.2°C to 26.7°C) as realistic internal water temperatures, so one can assume those are pipe wall temperatures. Other things?

McMullen: There are other things that challenge our distribution materials. One is we're in a rolling terrain, and until recently we were a one-pressure-zone utility. We end up with pressures ranging from 120 psi to 30 psi, and we have the same design constraints for the complete distribution system, whether we're at 30 or 120, so we don't have to keep track of what material is where. The one exception is our pre-stressed concrete feeder main system, which is specifically designed for the conditions it faces. We end up with some parts of our system with very high pressure in comparison to other parts of the system. Another thing, something that's a positive rather than a negative, is we're a lime softening operation, so we have a pH of 9.5 leaving the plant. All of our corrosion problems are external corrosion rather than internal corrosion. We used to have problems internally prior to getting control of the lime system back in the early 60s. We had red water problems all over the distribution system. Today, we never have red water problems in the distribution system, unless we have a main break and we stir up something. There are some places where we have some tuberculation, but in general it's really clean on the inside. We're definitely not a candidate for clean-

SEE "McMULLEN INTERVIEW" ON PAGE 8



Reader Input: Checking For Entrapped Air

By Craig Fisher, P.E.
Association Engineer

In the Spring 1996 edition of the Uni-Bell PVC Pipe News, we ran an article entitled "Air Entrapment: The Other Surge Pressure." One of the points that the article covered was testing for entrapped air. It was noted that test pressures in the field are applied by pumping additional water into the line. Also, the water required to generate the test pressure for a completely full line (no entrapped air at all) was contrasted with that required for a line with entrapped air (2% by volume). The calculation illustrated the fact that a line with entrapped air required that much more water be added to achieve the same test pressure.

Mr. Denny Muchmore, P.E., with Westech Engineering, Salem, Oregon wrote to us about the Spring 1996 article and pointed out the omission of pipe expansion in the calculation. He submitted his company's method for determining the amount of water required to bring a PVC line up to test pressure. Their method includes expansion of the pipe diameter due to the increase in internal pressure. Mr. Muchmore said there may be a slight difference between the calculated value and the actual value due to the length in the line taken up by iron fittings and joints. Mr. Muchmore reported that their method predicts actual field conditions to within $\pm 10\%$.

We have updated the Spring 1996 example in this article and have included Mr. Muchmore's input. The effects of the compressibility of the water and air are considered, as well as the expansion of the pipe diameter. Before printing the updated example in the **NEWS**, we sent it to Dr. Roland Jeppson of Utah State University for his review. He was kind enough to oblige. According to Dr. Jeppson, assuming that the entrapped air is separated from the water in a column by itself is probably closer to reality when testing a pipeline that may have air in it. (Assuming that the air is mixed throughout the water is the other option.) Our calculations are based on the first, more realistic assumption - that the entrapped air is in a column by itself.

The following example calculates the amount of water required to pressurize a line to a test pressure of 100 psig. A completely full line and a line with 2% entrapped air are analyzed.



PVC Force Main Design

Uni-Bell presents a new technical report on PVC force main design along with two updated technical reports.

UNI-TR-6, PVC Force Main Design

Those of you involved with force mains have expressed a need for design guidance which is PVC pressure pipe specific. To date, PVC pressure pipe standards and design methodology have not been considered specific to the force main application.

Where force main applications are popular, the appeal of PVC has grown rapidly. This natural progression toward PVC is due to the fact that the material is well suited for the aggressive environment created by sanitary sewage. Force main designers are increasingly turning to PVC in order to eliminate, completely, corrosion induced pipe failure.

Uni-Bell's Technical Committee responded to your needs in the form of UNI-TR-6. This technical report provides a design philosophy specific to force main applications and independent of the PVC pressure pipe standard chosen.

The American Water Works Association standards C900 and C905 both provide a design approach which is application specific. However, neither approach is intended to model the behavior of a force sewage main.

UNI-TR-6 offers guidance in calculating and designing for three crucial variables in force main design. These include long-term pressure

requirements, short-term pressure requirements and cyclic fatigue considerations.

The long-term pressure requirements of the force main system (operating pressure) are evaluated against the

Force main designers are increasingly turning to PVC in order to eliminate, completely, corrosion induced pipe failure.

long-term internal pressure capacity of PVC material, based on a 2.0 factor of safety. This allows the system to operate indefinitely at its predicted operating pressure.

The short-term pressure requirements of the system (surge pressure) are compared to the short-term pressure capabilities of PVC material, based on a 2.0 factor of safety. This 'worst case' design check ensures you that your system will endure all foreseeable surge conditions.

Cyclic fatigue calculations are performed by applying a predictive equation with a minimum 50 year design life using pressure fluctuations created during regular pump start-up and shut-down. Limited valve operation and simple system geometry permit you to pinpoint the pumping operation as the major influence in force main fatigue calculations.

All design steps in UNI-TR-6 are reviewed in an easy-to-follow design example included in the appendices. The design procedure was created with a spreadsheet application in mind. Tables provided in the appendices aide the designer by organizing hand calculated results and should also give computer enthusiasts a head start in creating a force main design spreadsheet.

Also included in the technical report are reference materials for external load design, pressure control devices, installation procedures and acceptance testing recommendations.

Your needs have motivated our Association to respond with this new and unique report. We are excited to provide this innovative technical report which reflects your ability to model the behavior in a PVC sewage force main.

UNI-TR-1, Deflection: The Pipe / Soil Mechanism

When the supply of a technical report runs low, we take the opportunity to update. It gives us the chance to add the information you want in the report.

UNI-TR-1 now has an expanded Deflection Testing section. A mandrel shop drawing has been added along with the appropriate mandrel dimensions for all common PVC sewer pipe products.

The Pipe Stiffness section of the report has been updated as well. Pipe stiffness calculations for profile wall pipes have been added to this section.

UNI-TR-1 provides a complete discussion on the theory and empirical testing related to the prediction of long-term deflection of a buried flexible pipe.

UNI-TR-5, The Effects of Ultraviolet Aging on PVC Pipe

UNI-TR-5, which was first published in 1981, has just been updated. This report summarizes the two year study Uni-Bell undertook to quantify and analyze the effects of ultraviolet radiation on PVC pipe. A complete description of the study, the evaluation methods used, the analyses conducted, and the conclusions drawn are detailed in this report. ♦

Single copies of UNI-TR-1, UNI-TR-5, and UNI-TR-6 are available free of charge from Uni-Bell. (See page 11 for details.)

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McMullen Interview

ing and relining, because of the environment or the final product we're putting through the pipeline. So our water quality allows us to focus totally on external issues, the environment around the outside of the pipe rather than having to worry at all about the inside of the pipe. External corrosion is the problem we're having to deal with, and it's not going away. We've recently identified in a budgeting process that the frequency of our main breaks at least for a period took a nose dive downward, but it's leveled out and appears to be rising again. It is causing us to take a real hard look to find out if it's a result of the weather we just experienced. There was a period last winter where frost went into the ground at a rate of three feet a week, so enormous stresses were put on pipe materials as a result of that. But Dave, each one of those failures that occurred last winter we think is a corrosion failure. Even though the frost loading is what really caused it to break, the weakening of the pipe was caused by the corrosion experienced on the external part of the pipeline. So we are looking at upping our investment in the pipeline replacement with again a real focus on what our soil tests are telling us and what our frequency is on failures in the pipeline.

Eckstein: *Would you feel that the harsh winter and subsequent loading just accelerated some of those failures, that would have spread out over time.*

McMullen: Yes, that's exactly it. And I think if we were to get into another mild winter we would see a nose dive again. It doesn't mean they aren't there, it just means as you indicated that it just speeds up the process.

Eckstein: *Well I know that's a connection you have made here that seems to be a leap of faith for some others, and that is, corrosion is not a separate topic from the beam break. Certainly it wouldn't have broken under that load had it not been weakened by something and making that correlation is what makes it a real issue for people, not just something in the periodicals.*

McMullen: The other thing we think is also a part of the problem is the movement produced by our varying water temperatures. We're looking into whether we can do a better job of keeping our temperature more even. When you're a surface water treatment plant that's kind of tough to do. But for our new treatment plant, we're looking at an alluvial water supply for it as a raw water source with the idea that there would be less of a temperature swing. We think if we can blend our aquifer storage water with cold water coming from the treatment plant, we can warm up the resultant product a little bit in the winter time. If we can warm it up even five degrees, we think we can have a real significant impact, because we think that not only is frost loading going on, but there's also the strain of contraction because of the cold. So you've got this piece of pipe that is a little bit weakened by corrosion, you're trying to pull it apart and then you put a load on it and you've got it all added together. It causes a problem. So if we can keep it in a compression state, then you can load a lot more and not cause a problem.

Eckstein: *Do you use a DR 18 product for PVC?*

McMullen: Yes, in a small diameter.

Eckstein: *Some topics constantly come up for people who are contemplating the use of PVC pipe. I'd appreciate any input you can give us as to how over a period of time, some 15 years now, your department has worked out a solution with PVC. One is the location of non-metallic pipe. What is the Des Moines Water Works doing?*

McMullen: We've tried a couple of things Dave, one of which is a tracer wire. We still put in a tracer wire with the PVC pipe. We think this makes good sense and doesn't cost much extra to put in.

Eckstein: *This is a copper wire?*

McMullen: Yes, we use the copper wire buried with the pipe. Actually it goes underneath the pipe, down first, and the pipe is then laid on top. We think that works fairly well for us, although over time it disappears because of people cutting our connections.

Eckstein: *You were working with an induced current system, weren't you?*

McMullen: Yes.

Eckstein: *So you needed continuity.*

McMullen: That's right. The other thing we're relying more and more upon is an accurate records system. We've been a very strong promoter of AMFM (automatic mapping facility

management) systems, where we have put the complete system on a computerized record system so we can pull up a pipe and know within fractions of an inch where it is. The idea is to not rely on the tracer wire, especially with the newer pipes. We take accurate measurements so we always know where the pipe is, and we can work off of property line measurements or center lines of streets or whatever. We do a fly over about every three or four years so we know where the streets have changed, and we can actually look at the outlines of streets and measure from houses. We can actually measure from anything, but surely don't want to measure from an old oak tree on the corner because it may be gone. So we're basically taking a two-prong approach: one is the tracer wire and the other is relying on a very accurate record system, with the idea that the record system is our number-one method and the tracer is secondary.

Eckstein: As you look to annex, as you look to bring in new counties, is mapping one of the up front things?

McMullen: Absolutely. In fact, all of our surrounding communities for which we're currently contracting services, this is the first thing we do, go in and map it.

Eckstein: How about leak detection.

McMullen: We've been part of an experiment for the Fluid Conservation System group. We've tried everything they've dreamed up in the PVC arena with mixed results. We don't think there is an ideal solution for leak detection on PVC pipe. Every time they come up with something new, it gets better. The acoustical system through the column of water is probably the most promising. We don't think it's quite there, it's not there as much as the metallic pipe is. We pre-locate every break and leak we have. Whether it's summer or winter. Whatever season of the year, the leak detection crew goes out and pinpoints it. They normally average plus or minus an inch on iron pipe. So it's a tremendous savings in hole size and everything else. You know exactly where you're digging, so when you go out and the utility companies are out there, there's an X on the spot and they can tell you exactly where their utilities are so you're not going to go dig into somebody else's lines. They're extremely accurate on the metallic pipe; next best is concrete. They really don't do too badly on concrete either, but PVC is one of those touchy ones. Sometimes they can do real well and sometimes they don't do well at all. The thing that's interesting is that we don't normally have a leak problem once it's installed. If there's a leak it usually shows up when we do the pressure test on new construction. Then the contractor will ask us to tell them which joint is leaking so they just dig up the one. That's been our primary experience in learning how to locate leaks on PVC pipe. It's been new installations when they have a pressure test failure and trying to figure out where it is, so they don't have to dig up every joint searching for the particular piece of pipe.

Eckstein: It is a matter of just getting it less operator sensitive or operator crafty or is it still equipment, or do you know?

McMullen: I really don't know. Other than, I think our people are pretty good at it and I think the equipment keeps improving, but you start getting some of the extraneous sounds that keep entering the picture. Especially when you start putting a user onto a pipeline and you're working through the column of water versus the sound coming through the pipe itself. There's a significant difference, but I think they're getting better every year. In time I think technology will be sophisticated enough to do leak detection on PVC as accurately as we've had with iron.

Eckstein: I've always maintained, and maybe this is my own prejudice, but if we had a bigger leak problem we'd have better leak detection equipment. It's a case of lack of market to drive the R&D.

Outside storage. You are somewhat unique in that you purchase direct from the manufacturer. You have an annual bid for pipe.

McMullen: Actually that was Jerry's recommendation, believe it or not. He told us if we were going to use PVC, and especially PVC, for repair, we should buy all the pipe ourselves. So Jerry's comment was that we were going to have to make sure we rotated our material. What we've done, we do main replacement and we provide material. And so what we're bidding on is labor and equipment for installation, so our product moves through the yard on a regular basis. As a result, we buy enough volume that we're not paying an enormous penalty on price. We solved both of our problems: keeping material rotating through the yard and the storage problem.

INTERVIEW



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—McMullen

Eckstein: You do the record keeping. You look at your breaks, better than most. Do you see a category coming up with your PVC that you would tie at all to errant backhoe operators or damage by others or by your own crews for that matter?

McMullen: We do Dave, but I would say that it would be different in different parts of the country. In our part of the country we're six feet deep, so we're down there deep in the ground and most of the other utilities are working above us, so we don't really have that much conflict. The only real conflict we've run into is we see a higher rate of pulled corporations when we're on PVC than we do if a contractor is doing a sewer line or doing something parallel to one of our lines with iron pipe. If he hooks a service line, there's a good chance he's going to yank it right out of the PVC. But that's the only thing we've really seen to be a problem, and usually it's our practice to alert the contractors working parallel to us that there's a PVC line. As you're working by it and you hit a service line, don't yank it, otherwise you're going to have a wet hole and they're really pretty good with it. Each summer we'll end up with two to four of those pulled corporations. We get them in iron pipe too, but I think the iron is a little bit more forgiving.

Eckstein: You have copper service lines?

McMullen: Yes.

Eckstein: Maintenance, you've talked about the internal corrosion as really not an issue because of a treatment process for the water itself. Anything else maintenance wise? External corrosion we've talked about.

McMullen: Not really, it's our external corrosion we worry about; our water quality is really quite good.

Eckstein: If we could change one thing about PVC pipe, what would it be?

McMullen: Probably Dave, the only thing, and it's

not the product itself, but a different way of tapping. I guess I think of Uni-Bell designing one of those flared anchors for drywall that has a wing that keeps it in. I'd like the corporation to stay in the pipe even when we could yank on the service line. We don't have a problem with it blowing out because of pressure or anything else; it's just when somebody goes by and yanks on it with a backhoe I'd like it to just stay there.

Eckstein: How about if we did some sort of a break-away on the corporation stop at the service connection instead?

McMullen: No, I just want it to stay fast. A break-away still causes a problem, we've got to dig it up and take out the break-away and put in a new one. It's the same problem as with a pulled one. Somehow figure out a way to come up with a whole different system. I think that our mindset in tapping PVC pipe is we're going to do it the same as with iron except we're going to come up with a little different cutter. If we could come up with a totally different mechanism, rather than a screwed-in corporation; push this thing in, it snaps out, it locks in there, now we've got something that's just in there forever. That would be the only thing I could think of Dave. I think installation, handling, fittings, all the other factors are no problem; I wouldn't do those differently.

McMullen: One of the points I forgot to mention is we're seeing a lot of corrosion in the last five to six years showing up in iron pipe at the corporation. We've attributed it to a stray current flowing down the service line from the home. We see a cell forming with the iron and the copper to the point that we're so convinced of it we use an insulated corporation for connecting the service line to an iron main. It's a PVC sleeve, in fact, that serves as an insulator. What we discovered is a lot of our pulled corporations in iron pipes were due to corrosion occurring at the corporation. There were no indicators elsewhere on the pipe, the rest of

the pipe was totally intact, but it was like a donut right around the corporation that was nothing but graphite. We keep both corps, insulated and not, on our trucks at all times and if we're tapping into a PVC main we use a standard corp; an iron main we do an insulated corporation. It's very controversial. I don't think the industry necessarily agrees that we're right or not, but there's enough of us in the utility business who have experienced this that I think it is a wise thing to do.

Eckstein: Are the homes grounded to the water pipe?

McMullen: Oh yeah, that's even part of the National Electrical Code today. Now they're required to put in a ground rod which wasn't done in the old days. It seems like we're finding it on more aluminum triplex coming into a home, especially some of the early aluminum triplex. The water line appears to be a better neutral than the neutral is on the electric line. The balancing between phases then is the water line rather than the aluminum. That's the other issue for us that is solved with PVC. We don't have to worry about that.

Eckstein: Finally, why do you keep using PVC?

McMullen: The same reasons we did initially are valid today. It's the best product for the soil environment we're in and it's the best product for the dollar. So the same two original issues that were there when we started this whole process more than a decade ago are still true today. We went through that little period where we had real high resin prices and PVC was expensive but we still felt, even at that time, that we had the best product for the environment our pipe was going to be in, and it was the best investment for the dollar that we could pick.

Eckstein: Thank you, L.D. I appreciate your time. ♦