UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

Investigation of:	*	
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THE EXPLOSION OF APARTMENT BUILDING 8701 OF FLOWER BRANCH APARTMENTS IN SILVER SPRING, MARYLAND ON AUGUST 10, 2016	*	Accident No.: DCA16FP003

Interview of: THOMAS McDOUGAL

Hiatt House Belmar
Lakewood, Colorado

Thursday,
January 19, 2017

APPEARANCES:

RAVI CHHATRE, Investigator in Charge
National Transportation Safety Board

ROGER EVANS, Senior Pipeline Investigator
National Transportation Safety Board

GARRETT COX
Linc Energy Systems
(On behalf of Mr. McDougal)

I N D E X

I N T E R V I E W

MR. CHHATRE: On the record.

Good morning. Today is Thursday, January 19th, 2017. We are currently at Hiatt House Belmar located at [redacted]. We are meeting regarding the investigation of explosion of Building 8701 Flower Branch Apartments, Silver Spring, Maryland, that occurred on August 10, 2016.

My name is Rave Chhatre. I'm with National Transportation Safety Board located in Washington, D.C. and I'm investigator in charge of this accident. The NTSB investigation number for this accident is DCA16FP003.

I would like to start by notifying everyone present in this room that we are recording this interview and we may transcribe it at a later date. Transcripts will be provided directly to the interviewee for review and identifying any typographical errors. The transcripts may be posted in NTSB's public docket.

Also, I would like to inform Mr. Thomas McDougal that you are permitted to have one other person present with you during the interview. This is a person of your choice: your supervisor, friend, family member or, if you choose, no one at all.

Please state for the record your full name, spelling of your name, organization you work for and your title, business contact information such as mailing address, and whom you have chosen to be present with you during your interview.

MR. McDOUGAL: Thomas A. McDougal. Last name is spelled

M-c-D-o-u-g-a-l. I work for Linc Energy Systems, Incorporated. That's L-i-n-c. You may contact me at [redacted] or by U.S. Postal Service at [redacted].

MR. CHHATRE: Thank you. And whom you have chosen to be with you today?

MR. McDOUGAL: Garrett Cox, G-a-r-r-e-t-t, C-o-x.

MR. CHHATRE: Thank you.

Now I'd like to go around the room and have each person introduce themselves, starting from my right. Please state your name, spelling of your name, your title and the organization that you represent, and your business contact information.

MR. EVANS: Roger Evans, R-o-g-e-r, E-v-a-n-s, National Transportation Safety Board, senior pipeline investigator. [redacted] is my cell number.

MR. COX: Garrett Cox, Linc Energy Systems; [redacted]; 11919 West I-70 Frontage Road North, Unit 109, Wheatridge, Colorado 80033.

MR. CHHATRE: Thank you very much.

INTERVIEW OF THOMAS MCDOUGAL

BY MR. CHHATRE:

Q. Mr. McDougal, please tell us your experience, education background, any formal training, anything --

A. I graduated from the University of Denver in 1966 with an

engineering degree in electronic engineering, was hired by Public Service Company of Colorado, and went to work in June of 1966 in the gas laboratory of that company. That department tested all gas appliances, gas regulators, gas meters that would be installed in the distribution and transmission line facilities of that utility. I worked there until 1995, where I retired. And after a period of about 3 months, went to work for a rep firm selling then Schlumberger natural gas regulators. I've been selling that product line and associated gas meters since June of 1995 to the current date.

Q. Thank you. And as far as the mercury regulators, are you familiar with mercury natural gas regulators?

A. I wouldn't call it mercury natural gas regulator. I would call it by the name it was manufactured under, which was Reynolds.

Q. And are you familiar with those?

A. What?

Q. Are you familiar with those?

A. I have never worked on one because Public Service Company of Colorado never installed any of them or put them in -- brought them in for testing.

Q. Okay. So all of your experience with regulators containing mercury --

A. No. It was not an item that was used in Public Service.

Q. Okay. So are you familiar with the Reynolds regulator containing mercury at all in your business?

A. None of the regulators that I have worked on or tested ever had mercury in them.
Q. Okay. Now what kind of regulators you were using?
A. What?
Q. What kind of regulators you were using in your company?
A. We used spring-loaded regulators, as was the Reynolds regulator. To differentiate between the regulators made and used by Public Service and Reynolds, was Public Service used regulators that the manufacturers installed springs for the overpressure protection. The Reynolds regulator in question here used a spring but also used mercury as a sealing agent to make sure that they had a positive seal on the relief function of the regulator, which it was the overpressure protection device in that regulator.
Q. And do you know what the function of mercury would be?
A. It was a sealing agent to prevent -- it's best to take a little step back and look at the drawing of the Reynolds regulator in question and talk about it against what Public Service used in those days as a relief overpressure protection regulator.
Q. Okay. Go ahead.
A. Okay. I have a drawing here from a patent of the Reynolds regulator. The patent number is 1800683, dated April 14th, 1931. And if you look at the regulator itself, the lower diaphragm section of the regulator had a tube going to a passage, that the end of the passage had a leather diaphragm, and on the diaphragm side of the chamber they installed mercury. And below that, they

had a spring that pushed the diaphragm case up against the lower part of the column; where in a Itron/Fisher/Rockwell/American meter, the overpressure device is arranged around the lever arm and there is a secondary spring in the column that keeps the valve closed until it hits a stop, and then at which time it comes open, overcomes the springs.

Q. Maybe we can -- maybe you can explain how the function of the spring-loaded regulator works in terms of gas --

A. Well, the Reynolds was a spring-loaded regulator, too. So their functions as supplying gas downstream of the regulator was exactly the same. What's -- where the mercury was involved is in the overpressure protection portion of the regulator.

Q. Can you elaborate more?

A. I guess maybe I really don't understand what you're saying by elaborate more.

Q. Well, tell me how the mercury works. Like, you know --

A. Well, the mercury, if -- shall we look at the drawing?

Q. Sure.

A. Let me come around.

MR. CHHATRE: We'll just label that Exhibit 1.

(Exhibit 1 marked for identification.)

MR. EVANS: Can we keep this? Or can I just get a copy of it?

MR. McDOUGAL: Yeah. You can have it. We'll make a copy of

it. [redacted].

Okay. Here is -- item 3 -- let's start with the regulator.

MR. CHHATRE: Okay.

MR. McDOUGAL: Item -- and this regulator is no different on the delivery side than the regulators today and any spring-loaded regulator.

MR. CHHATRE: Okay.

MR. McDOUGAL: Okay? You have a loading device, which is the spring on top of the diaphragm. And the -- they have a plate so that you get equal force all the way around the ring. 3 is the diaphragm, okay? It can be leather or Buna-N or whatever you want the manufacturer put in. And it pushes down and it opens the valve seat. This spring, okay, and the valve seat's over here and the high pressure is here on the lower side of this drawing, and it goes out where the number 22 is.

The pressure comes back underneath the diaphragm and pushes up the diaphragm, overcoming the tension put on it by the spring. And so it sets there in a balanced nature serving this. When the appliance that's downstream of the regulator ceases to function, pressure comes back and it comes under and it pushes this up, pushes the diaphragm up, overcoming the spring, and closes the valve seat.

MR. EVANS: And stops the flow.

MR. McDOUGAL: Stops the flow. Correct.

If you get a piece of trash, junk, whatever you want to call

it, on the valve seat preventing the orifice from completely closing, the pressure will continue to build underneath the diaphragm, and at which time in this particular regulator the pressure would be felt down this column, which is number 16 on the drawing, and it would push the diaphragm down, which is now number 18, against the spring, which is 20, and it would eventually open up. And the mercury acted as a seal, and if you read in the description of this patent, this gentleman wrote that it would be -- it could be -- other than mercury, it could be other petroleum products, oil, water, whatever. And so then when it, when the pressure got high enough that it would allow this valve to open -- it's actually a valve -- and it would then come out the relief port, which is not numbered but it's over here on the left side.

MR. EVANS: HP, right?

MR. McDOUGAL: Um-hum.

MR. EVANS: This is relief and this is --

MR. McDOUGAL: Outlet.

MR. EVANS: Vent outlet?

MR. McDOUGAL: Yes.

MR. EVANS: So regardless of what the situation is, this mechanism, the fact it's mercury has very little to do with this in this case?

MR. McDOUGAL: Normal operation, right.

MR. EVANS: So whatever you have to manipulate this for it to make it to the relief doesn't really matter that much if it's

mercury, if it's oil, however they want to do it.

MR. McDOUGAL: Right.

MR. EVANS: So in that one there, it's spring, I guess, right?

MR. McDOUGAL: Right. Now I explained the difference in this drawing. Again, what the other manufacturers --

MR. CHHATRE: Is the vent out or just --

MR. McDOUGAL: Oh, no. That's not vent out. That's relief --

MR. CHHATRE: That's (indiscernible) --

MR. McDOUGAL: This is -- this should say out --

MR. EVANS: Out to appliance.

MR. McDOUGAL: Outlet --

MR. EVANS: To appliance, yeah.

MR. McDOUGAL: -- to appliances. And I will abbreviate that. Okay.

What the other manufacturers did is add another spring and a post, typical -- that's what that one is -- on top, inside of what is listed as number 4. And so when it hit this part, the diaphragm would then continue on up and number 15 would act like a valve. You would not have that screw there.

MR. CHHATRE: Okay.

MR. McDOUGAL: And that's the way everybody makes them nowadays. And they made them that way back in the '20s, the '10s, back even in the 1800s.

Now there's one question I have and I will explain it to you guys so that you really understand it. Yes, it may have had a leather diaphragm in it. Okay? And back when this was designed all the utilities put a fogging oil in the distribution systems. First, for one reason, and it -- what became to the regulators was a benefit. All the utilities used bell and spigot pipeline because they really didn't trust threaded pipe, and it was very difficult on 6 and 8 and 10 and 12 to put threaded pipe together. It was hard to align them in the ditch to get them to go together correctly.

MR. EVANS: Right.

MR. McDOUGAL: So they went to bell and spigot and they used a substance, a rope substance called okum. And it came from the sewer. This is the way sewer lines were built. Well, sewer lines have water in them and that kept the okum wet and kept it so it wouldn't leak.

Well, when they first started doing it in the manufactured gas states, it was dry gas like natural, but guess what? It'd dry out and it would leak. So what did they do? Smart individuals, they said, well, let's put a little fogging oil in. It was a real light machine oil. And so it would soak into the okum and keep it tight so it wouldn't leak. But the big advantage was, secretly, it kept the leather diaphragms very, very pliable.

MR. EVANS: Hmm. So they lasted a long time.

MR. McDOUGAL: Lasted a long time.

So the company I worked for, about the time I went to work for them, it was about the end of replacing all the leather diaphragms. And we'd had natural gas in since '31, about the time this was patented. And what did we do? What did Public Service do? They went in and changed all the diaphragms to Buna-N. Now you got to remember Buna-N didn't come about until the late 1930s.

MR. EVANS: Um-hum.

MR. McDOUGAL: And so this regulator with the leather diaphragms was made, because of World War II, guess what? There wasn't any products available for utilities. They had to live with what they had because all the synthetic rubber went to the war effort.

Now there was one problem with this regulator that nobody ever talks about, and I think that's why my -- the company I worked for never bought any of these. Back in the days when this was designed and before that, everybody used a brass orifice and a brass valve seat or stainless steel. Okay? This one has a leather valve seat. It's what's stated in the sheets, and that's number 25.

And I hope that you -- you said, Roger, that you were going to bring pictures of your disassembly of this. And I think that's, in my opinion, in my experience, that's where you're going to find the cause of all the leak complaints that you -- that the utility experienced.

And the other one, I think -- you said, Roger, that there was

-- these were -- they had them in series, which in the business is referred to as a monitor set. And if this drawing is correct, this is -- it would be called a passive monitor set, where the second regulator would be setting downstream all the way open awaiting the inlet pressure to increase.

Why are these three drawings around the outside of the regulator? They're the drawings of the orifices. And the orifice is related -- when would this regulator shut off? When the flow -- but you've got to remember the inlet pressure can vary. And so you have to size the orifice on the inlet side of the regulator so that the mechanism has enough force, energy, to close against the inlet pressure.

MR. EVANS: So that little piece here is number 26?

MR. McDOUGAL: Yup. They're 20- -- they're figure 5, 6 and 4. Those are the regulator which would be listed under there as 27. See, each one of these are different diameter hole.

MR. EVANS: I see.

MR. McDOUGAL: So, an example. If your inlet pressure was, let's say, 100 inches, you could get by with a very large hole. But if your pressure was now, instead of -- 100 inches is about 3.1 pound. And so if you would go to 5 pounds, that orifice -- that regulator wouldn't close with an inlet pressure of 5 pounds. With that orifice it may take one of these others. And if you went to 10 pounds, it'd take even a smaller one. That's how you size natural gas regulators or even manufactured or propane

regulators.

BY MR. EVANS:

Q. So let me ask a question then. Is it possible that the -- if it was functioning through the years, then they have the right one in there, right?

A. Um-hum.

Q. Okay. Yeah.

A. Yep. They sized it correctly, yup.

Q. Because it was functioning?

A. Right. And for a long, long time there was no leak complaints, correct? According to their records.

Q. Yeah, they didn't -- it was recent.

A. It all started recently. So --

Q. This here is -- this piece of leather, what -- can you point to the piece of leather? What number is that?

A. It is number 25. It's part of the valve seat.

MR. EVANS: So, Ravi, did we go into that detail in the teardown --

MR. CHHATRE: Oh, the -- a lot of these regulators are damaged in the fire.

MR. McDOUGAL: They were damaged. Oh, I would expect so. But I would see if -- when you get that valve body, you would have found it. That would still been -- that would still be attached to that lever arm.

BY MR. EVANS:

Q. So would you say that if it's got a leather diaphragm, most definitely it would have this leather piece down here?
A. That's the way it's called out in here, in the description. I don't remember exactly which paragraph it's in.
Q. Oh, that's okay. I was just curious.
A. It's in there, and you can have that. I pulled that off the Internet from the U.S. Patent Office.
MR. CHHATRE: And this will be Exhibit 1, that will be Exhibit 2, for the record, is that right now.
(Exhibit 2 marked for identification.)
MR. McDOUGAL: So, you know, my honest opinion is that's where the problem occurred, where it started venting. And this part worked like it was designed to. Because, you know, you told me that on -- and we talked about it in that transcript, that they'd had leak complaints and then --
BY MR. EVANS:
Q. Would show up and couldn't find it.
A. Couldn't find it. Well, guess what? The little piece of dirt flicked off and finally closed, and this closed. Then it -- the gas-fired appliance started up again and this opened up and some more dirt, you know -- I say dirt, you know --
Q. Particles of some sort.
A. It's -- in the natural gas business we all say that it is clean dry gas. Okay? But when you put the pipe in the ground and

you have equipment out in the pipeline where the gas and oil come up out of the ground and you do separators, well, what comes up out with the gas and the oil is saltwater. And so, you know, you may not get it all out. The producers do, they try very hard, but their equipment will have malfunctions just like everybody else. And so some of that gets through. And in steel -- inside of steel pipe, it's not coated. And so, little fine rust develops. And, of course, when you're putting a pipe in the ground, guess what? Somebody gets some dirt in it. Okay?

Or a compressor upsets and you get what is called compressor oil down. And then that forms a -- inside the pipe junk, it dries out, and then it falls off and it gets picked up by the velocity of the gas and it, you know, gets in there. So, I mean, it's --

What you try to do when you put a regulator in, Xcel did, or that's now what the utility is called. But Public Service, just before we went to every appliance, we required here that they put in what is called a drip leg. And it is in the Uniform Mechanical Code and it is also in the new International Gas Fuel Code. And that's a little -- you come down all the piping, you get almost to the appliance. There's a T put in and you branch -- the outlet branch of the T goes to the appliance, the straight-through goes into a 6-inch nipple with a cap, and that's where all the trash is supposed to end up. Because if you get it into a gas appliance, whether it's got a standing pilot or an interim pilot or a hot igniter surface, the orifice that goes to that is, you know, very,

very, very small. And this trash will plug it up, guaranteed.

And I've -- you know, I did a lot of conversion work when I worked for Public Service, in the mountains and -- so, you know, I've seen a lot of trash. I've seen a lot of junk installed that we ripped out that were on propane or, you know.

Q. In the old days, were they putting the drip legs --

A. Yes.

Q. -- on the --

A. Around here, yes.

Q. Before they entered this?

A. Yes. And if you want me to take your piece of paper here, I will draw like what I refer to as -- and this, this is -- from here up is the ceiling in the basement. And the pipe comes in -- generally you make a 90 and you come down, and somewhere in there you put a T just before you go to the appliance, and then you have -- and this is to the appliance. And that's your drip leg. And you have a valve here, okay? And you got a cap on this little 6-inch nipple. If you got 1-inch fuel line, it's 1-inch nipple 6 inches long with a cap on it. That's where the trash is supposed to go, and it does work, surprisingly.

I will tell you that the City and County of Denver makes them put even that on a high-pressure set, and there was a -- we were doing a -- we put in some regulators at the Coca-Cola bottling plant and it was able to catch pea gravel. And it was on a horizontal run, but it caught the pea gravel. And there was so

much pea gravel in that line because the fitters had drug the pipe across the road that it filled that drip leg up twice. And it got into the regulator and, of course, then the regulator was like that. And it functioned like it was supposed to. So we opened it up and, sure enough, had rocks in the valve -- in this part of the unit. So we took it off and we cleaned the pipe out and opened the drip leg up and cleaned it out, and we had to do it a month later. So --

But so -- and, you know, you said, Roger, you had some pictures of this unit.

MR. CHHATRE: Yeah, we'll get to that.

MR. McDOUGAL: Okay.

MR. CHHATRE: I got to deal with this now.

MR. EVANS: Yeah, we have a --

MR. CHHATRE: Let me go off the record just for a second.

MR. McDOUGAL: Certainly.

MR. CHHATRE: Off the record for a second.

(Off the record.)

(On the record.)

MR. CHHATRE: So let's get back on the record. And I want to make the --

BY MR. CHHATRE:

Q. So where the regulator failure modes are concerned, are all regulator failure modes similar irrespective of the manufacturer or they are different?

A. Oh, they're about the same.
Q. Walk me through the -- what kind of failures happen in a regulator?
A. The failure that happens is -- the biggest failure that we see in the business even happens if the building is brand new, is trash coming down on the high pressure and getting on the valve seat.
Q. Okay.
A. Now the second one we see --
Q. So let's take the valve seat, dirt coming on the valve seat.
A. Yeah.
Q. Walk me through how it does --
A. That's just exactly what we were talking about, was that the valve seat never closes and so that the pressure on the underside of the diaphragm continues to increase and, theoretically, it could go to whatever the inlet pressure is.
Q. Okay.
A. And in this case, it would go down through the tube until it overcame that pressure, and then it would be venting to the outside.
Q. So mercury, in this case, is preventing the case from --
A. It's just a sealing agent. And it's nothing more than that in this case.
MR. EVANS: And this is Roger Evans.
BY MR. EVANS:

Q. When you have these type failures you're talking about, these can be intermittent, correct?
A. What?
Q. These can be intermittent?
A. Yes.
Q. They can occur, go away --
A. Occur, go away. And how do -- why do I say that? Let's say you have a little bitty piece of dirt on the valve seat so that it takes about 2 or 3 hours for it to build enough pressure to overcome the spring -- number 28?
Q. The vent spring?
A. The vent spring. But it couldn't -- if, let's say, in that 2-hour period the boiler or whatever the appliance came on and functioned, so you'd -- the pressure would go back to normal and then you would, then you'd start the cycle all over again. And if it's cold out, you know, it's going to come on and off, come on and off, so you're never going to do it. It's going to happen in the summer when there is no load for the appliance to reduce the fuel line pressure downstream of the regulator.
Q. Okay. So it's intermittent for sure, okay.
A. Yep. Now what do we see after these have been in service a long time, or any regulator? We see water gets in from the atmosphere or bugs, and they build their nest down in there, and the earwigs are the worst bugs there is. They look -- they've got a little fork on the back of their abdomen, and they love the

smell of the mercaptan in natural gas.
Q. Can you please spell that bug name? If you can.
A. I think it's e-w-e-r-g [sic]. I think. Earwig.
Q. Okay. So you talked about the fact these -- or these can be intermittent.
A. Yes.
Q. And so, when you have a failure mode or you have a blockage, you can get to the point where it sticks completely open?
A. Yes.
Q. When one -- when you have debris and it doesn't clear itself.
A. Yeah.
Q. That's possible, right?
A. That's very possible. And let's talk about this -- this same regulator has a monitor. Okay. It's setting there wide open. This spring has pushed it wide open. And guess what? The crud builds up around these two pivot points so that when it needs to move it can't.
Q. It's seized.
A. It's seized.
Q. Right.
A. And so the monitor, unless you -- that's why where I worked we always built working monitor reg sets, so that you could walk up, your meter reader could look at the gauge and say, oh, the pressure is outside the red norm, outside of the -- and we would put on the gauge, normal operation. If it was way up or way down,

he knew to send us, when he came in that night, a message that that set was in the monitor condition and we needed to go out and fix it.

I'm used to bending down and talking to fitters in the field. So --

BY MR. CHHATRE:

Q. So one way of, I guess, regulator failure, if you would, is the dirt buildup on the valve seat that will keep --

A. Dirt can keep it open, yeah.

Q. -- keep it open, yeah. Now what else can cause a regulator to fail? What else can go wrong?

A. That leather can disappear. And so now, instead of having --

MR. EVANS: And that's the leather at the seat?

MR. McDOUGAL: What?

MR. EVANS: The leather at the seat --

MR. McDOUGAL: Yup.

MR. EVANS: -- at the valve seat?

MR. McDOUGAL: Okay. You've got this seat across here and you've got this orifice that comes in there and, you know, it wears it. And so now, instead of being pure flat across here, it comes to about here and it kind of goes up like this. That's why I said I would love to see the picture of that leather valve seat.

MR. EVANS: To see if it's degraded?

MR. McDOUGAL: If it's that way. And if that's the case -- but you talked about the interim, intermittent reliefing or not --

could be the cause of why the regulator failed. And then the monitor, because it was setting for 70-plus years with the crud building up around the pivot points, just couldn't work.

BY MR. CHHATRE:

Q. Now what happens when this pivot point fail, gets stuck --

A. Yeah.

Q. -- what can -- then what happens?

A. Well, the dirt -- the dust, the dirt from in the pipeline, like I explained later -- earlier.

Q. Then what happens if a pivot point gets stuck?

A. It just seizes up around there.

Q. Okay.

A. And I've seen it. It'll happen on those regulators, too, if you have it as a passive monitor. It builds up around this valve stem. See, this is exactly how it would be setting as a passive monitor. As you can see, the valve seat's wide open. This is all the way back, and the crud builds on there. Builds on there, and guess what? When this has to go up, it can't push that crud off that stem.

MR. EVANS: Oh, yeah, I see. Right.

BY MR. CHHATRE:

Q. And what that will do then?

A. And then it won't -- if it can't move, it won't close that valve.

Q. So then the high pressure gas is coming in?

A. It comes in, goes underneath, high pressure everywhere, goes up -- this diaphragm, it may snap this off.
Q. The lever?
A. Yeah. It'll -- it could snap that plastic off.
BY MR. EVANS:
Q. So just going back to the one with the leather --
A. Yes.
Q. -- this Reynolds type. You're saying that if the lever is seized, then you will then have continuous vent?
A. Yes.
Q. Okay. So if we have debris at the leather seat, we could have continuous vent. If we seize at these two fulcrum -- the rotating points of the lever, we could have continuous.
A. Um-hum.
Q. So that I understand. What if we have a violation of a -- you know, a tear in the diaphragm?
A. It doesn't function. It's just -- the spring just flops it wide open, just like that one setting wide open. And then it's venting out there continuously.
Q. Okay. So another reason it could vent would be that the diaphragm is torn?
A. Is ripped, yep. Cracked.
Q. Cracked. If the diaphragm's cracked, it's going to vent continuously?
A. Yes.

Q. Okay. So we covered the inlet, we covered the seat, we covered the lever, we covered the diaphragm being torn. Discuss the mercury. What could --

A. Same thing could happen there. That diaphragm could be cracked, dried out.

Q. And then that would --

A. Because mercury is not a lubricant.

Q. Right. So that would be another way for it to stick open because the mercury valve down there was (indiscernible) up and then it could function properly?

A. Well, I first believed that was 25 or 4 out. I would -- I'll bet you lunch on it, Roger. That's how confident -- and you can -- Garrett will verify, I only bet on sure things.

BY MR. CHHATRE:

Q. Now, so for the record now, how often do regulators fail, in your experience?

A. Very seldom. It's due to some outside action they fail. I have a regulator in my possession that was made in 1929 and sometime after World War II it got a Buna-N diaphragm and it then was in service until 1994, when I had -- one of my fitters called me and said, I have a prize for you. I thought we got rid of all these old balance valve regulators on houses. He brought it in, and it's a huge unit. It was made by Gardner Denver for Public Service of Colorado. And it still functioned -- you know, the records are gone of when that regulator -- we had all serial --

the Public Service serialized every large regulator. And so, you know, we had a history on that unit.

BY MR. EVANS:

Q. Can we talk briefly about as far as the position of the regulator. If this gets out as normal installation point, whether it's level or kicked or upside down or what have you, does how this was -- how the regulator was mounted, is there issues with that?

A. No. With this regulator here?

Q. No, this regulator.

A. This regulator, yes. It must be in this horizontal design. The diaphragm must be in a -- the valve body, the diaphragm, must be in a horizontal run.

Q. Like two -- like zero bubble on the --

A. Yes.

Q. -- on the level?

A. Right.

Q. That's the mercury type regulators?

A. Yep.

Q. And if these get out of whack, what can go wrong with that? Let's say it's a half of bubble off on a 2-foot level.

A. On this one?

Q. Yeah.

A. It'll still function. Because if you look at the -- it would probably have to be somewhere in about 30 degrees --

Q. Oh, off level?
A. -- off level. And what you're looking at, this would still -- the main diaphragm system where you've got the working pressure downstream would still function. It's the relief function that you would probably -- see, you'd probably get that fluid level, that it was across here like this.
Q. Oh, okay. Because the mercury's going to seek its own level as you tilt it?
A. Yep.
Q. Okay. So that's across the --
A. You can never put it in with the diaphragm on the vertical, either way, or upside down.
Q. So let's just say, for instance, as the person is installing this or maybe they're doing -- they're maintaining or maybe they're making a change. What if they temporarily have the device in an oddball position? Does the mercury come back down and settle back into the bell?
A. Well, you would hope so. But if you look at the design, the lower diaphragm case has this dip in it, and that dip is for the diaphragm to operate correctly. So you could get the mercury laying down in the bottom, never be down here.
Q. Oh, so you could lose some of the mercury?
A. You could lose it all. And if you had -- if the guy took it out in the field, he pulled it off the shelf and he tipped it like this, it could run out the relief. And if he knew he was in

trouble, he would never say anything.
Q. So --
A. And he would -- it would still -- this relief would still function because of the spring and the half-moon and the leather diaphragm, it would still seal.
Q. Okay.
A. And it would eventually very quickly dry out and it would start relieving continuously.
Q. So if the mercury were to be absent from the device, then we could have venting?
A. Yes. It could crack. This would probably fail first before the diaphragm.
Q. And would -- could that be -- would that happen immediately or would that take some time before it --
A. It'd take some time, maybe a couple years.
Q. Oh, okay. Okay. So if this device, the Reynolds, has ever been out of position for -- even for 2 minutes, and the mercury were displace out of the -- out of its container, it's not all going to make its way back down to the container?
A. No.
Q. Oh, gosh.
A. Unless he tipped -- unless the fitter, when he did it, he tipped it -- oh, he's got it down in there and he tips it back. But if he's tipped it this way to start with and it runs out on the floor, he's never going to get it back.

Q. So there's a certain amount of training, I guess, that they have for the people that install these?
A. Yes.
Q. And making sure that they don't spill the mercury.
A. Yup.
Q. And they keep them level and all that. Interesting. Okay.
A. I can imagine fitters trying to put this in. Because you look at this, guess what? You can't take it apart like you do this one.
Q. Oh, yeah.
A. So how did you keep the mercury in?
Q. I mean, I'm an amateur carpenter/plumber and if I were doing this and I had to keep this in this position the entire time to pipe it up --
A. You can't do it.
Q. -- it'd give me fits.
A. You can't do it.
Q. I can't even imagine it.
A. Yes, you can, but --
Q. I mean, you can do it, but, I mean, for this one I would say that would be --
A. You have to have a union here on the inside.
Q. Union -- yeah.
A. That's the only way you're going to do it.
Q. But this, if you have this and then -- and the person's not

aware of what -- of how critical this mercury is, if they ever touch this --

A. Yes.

Q. -- and it gets out of whack and, like you were saying, it could take up to 2 years for that to show sign that the mercury is out of there, that could be a problem.

So if they're worked on -- we need to look to see if they have ever done a work order with one of these, to see what they've done in the past. No, that's critical.

MR. CHHATRE: Let's go off the record for a second here.

Off the record.

(Off the record.)

(On the record.)

MR. CHHATRE: Back on the record.

BY MR. CHHATRE:

Q. So let's just, for summary, walk through the failure modes of the regulator. So walk me through that.

A. Okay. If the regulator shuts down and is unable to cease the flow of gas into the downstream component of the regulator in the piping to the appliance, then the regulator will be then considered in a failure mode in my mind, and that as the pressure increases underneath the diaphragm assembly, which is noted as number 3, the pressure will be felt down the column, which is number 16, and it will be felt against the sealing component, which is a very small leather diaphragm, number 118, which is kept

in a closed position by 19, which is a half-moon semicircle that is pushed into the closed position by spring number 20. As the pressure increases in the column 16, it will overcome the spring pressure and then it will allow the gas to escape up through the outer section of the column 16, and then vent to the atmosphere. If the -- and that is if it was in a complete failure.

If you had a small piece of trash on the valve seat, it may take a while for the pressure to build up in the lower diaphragm case and in which case it would probably intermittently vent. It may -- you know, if you had a small enough piece it may take a half hour to 2 or 3 hours before the pressure got high enough to cause number 19 to open. And in the wintertime, winter heating season, it may never go into venting because the appliance keeps coming on and off periodically. In the summer, I would expect it would be venting pretty regularly.

Q. Outside?

A. Outside, yup. And then you would be getting leak complaints and the utility would come out and by the time they got there, it'd finish relieving, it shut off completely, and they couldn't find anything. And unless they spent a lot of time standing there, they probably would never smell it.

Q. Okay.

A. With the tenants, they'd smell it all the time off and on. You know, that is a real hard one to chase, but you got to chase it till you find it.

Q. So as far as a mercury regulator and spring-loaded regulator, what is the main difference between the two?
A. The spring-loaded regulators do it with a spring. They don't have any fluid to worry about. So that when you're installing it, you don't have to keep the regulator diaphragm in a level position. A spring-loaded regulator you can -- with a spring-loaded relief, you can put it in any position your little heart desires. You can put it upside down, you can put it vertical, you can -- you know, there's no limitation to it. With this unit, with the Reynolds, you have to keep the diaphragm on a completely level horizontal gas run, and to install it would be a real bear.
Q. Okay.
A. You'd have to put -- you should put unions downstream of it and upstream.
Q. So even in a mercury regulator, this spring component is necessary?
A. Yes.
Q. Or you can have, you can have this --
A. No, that's necessary. That is your -- that is the set point for that relief valve.
Q. Okay.
A. The tension that that spring puts to the half-moon ball is the set pressure that that will relieve at. And for --
Q. So then what is the function of mercury?
A. The mercury is a sealing agent. All it is, is it's just to

keep -- make sure you got it bubble-tight.
Q. I don't think I understand. Repeat that.
A. The bubble -- it means that there's -- you're sure you've got 100 percent shut-off; when it's closed, it's closed. That mercury, that's all it's doing. And any -- you could use any fluid in there, and they say so in the patent, that you're not limited to mercury.
Q. So even if I don't have any mercury, the regulator still will function?
A. Yeah, still will function. It just -- it may leak -- it may seep a little bit.
Q. If there is a gas in the --
A. Yeah. Well, no. If the mercury is gone or the fluid's gone, then it may not get you a perfect bubble-tight seal where there is no gas flow.
When they talk about a natural gas regulator that is a lockup reg, that means it passes no gas in the lockup position, where there is -- the valve seat is closed or the valve, the relief valve is closed and bubble-tight. That means you can -- you'll never -- you can put it on a monometer and you'll never see a bubble in that monometer.
Q. Okay. All right. So when the regulator is installed -- now are familiar with the installation of regulators in multi, I guess, family dwellings, like apartment complexes or office buildings with different meters?

A. (No audible response.)
Q. So during the maintenance, what will require an operator to disconnect the regulator from the vent line?
A. Well, if --
Q. And I'm talking about in multi-dwelling units, in your experience. Or do you have any experience in multi-dwelling units?
A. Yeah.
Q. Okay.
A. Well, you periodically need to check the function of the regulator. And what you should have is some pressure taps downstream of the regulator so that you can see what the pressure of the springs are to see if they've been adjusted incorrectly.

People's that -- they'll go into a place and they will add additional appliances and the original appliance that was there was, let's say, a water heater and a small furnace that equals 200 cubic feet when both of them are on. And over the years, they changed the water heater out to a much larger unit, then instead of using 30 cubic feet of gas an hour when it's running, it runs 50, and they changed the furnace from 125 or 150 to 250.

Well, now you get a large differential across the meter and so you don't get the correct pressure at the appliances now. So somebody comes along and adjusts the spring so that you increase the pressure, you increase the fuel line pressure.
Q. But you don't ever disconnect the regulator for that, do you?

A. No. You don't have to do it. You know, you can do it all right there in the spring tower.
Q. Right. Okay. So what will require someone to disconnect the regulator?
A. To disconnect it? Well, he's doing the check and the pressure is like 15 inches, which is more than what the appliance control should have. Then he tries to adjust the spring and, guess what, it doesn't adjust, doesn't reduce the pressure. So he's got -- and then, of course, if this vent line is piped a ways, he doesn't -- he has to go find where that is and see if there's gas coming out. Well, he goes over there and he finds, oh, there's a little gas coming out; I can smell it. Or his instrument smells it. So then he comes back, he knows he's got something wrong here in this regulator. Then he -- well, if he -- if that's what he was sent out to do, then he will then disassemble it from the valve body and see what the problem is.
Q. Now if you change the meter, will you have to disconnect the regulator --
A. No.
Q. -- on a multi-dwelling unit?
A. No. No. You don't have to touch the -- you have to shut the valve off going to that meter. And then you unscrew the two swivel nuts and then you put the new meter back on, and you go in and you properly bleed the air out of that fuel line and that meter and you relight the appliances.

MR. EVANS: This is Roger Evans.

If you do change out the appliances -- water heater, furnace -- and let's just say with the age of this building I believe they did change out the water heater. I think I heard that. But, anyway, is there a possibility that this meter was adjusted whenever they made the appliance change?

MR. McDOUGAL: It could happen, could very well. The appliance guy, if he fired up that water heater and the pilot, and he put a monometer on the controls and he wasn't getting 5 inches; he was getting 3 inches. Well, what is the -- oh, it's the regulator. He goes out there and adjusts the regulator, never tells the utility.

MR. EVANS: Okay.

BY MR. CHHATRE:

Q. With your experience with multi-dwelling units like apartment complex buildings, once a regulator is installed, you never ever have to replace -- or disconnect the regulator from the vent line?

A. No. Not unless you get -- it starts -- you know, in my experience, not until it starts relieving. Or you -- like Roger was just asking, you have all of these apartments and they keep changing everything out and they finally get to the point where this regulator is not putting enough gas into it. They had -- somebody, the appliance guys that put in the last new appliance, he's adjusted that reg all the way to the bottom and he isn't -- still isn't getting but maybe three-and-a-quarter now, three-and-

three-quarters inch of pressure at the far end. So he calls in and tells the utility, I'm not getting enough gas, there's something wrong with your regulator. And so then they send somebody out to fix it. And that's -- will be probably the first time they touch it.

MR. EVANS: Can we go off the record?

MR. CHHATRE: Off the record.

(Off the record.)

(On the record.)

MR. CHHATRE: Back on the record.

BY MR. CHHATRE:

Q. So in a multi-dwelling units, if somebody works on a meter, a customer changes -- the name changes or somebody doesn't pay the bill, you shut the meter off, then come back and turn the meter on. None of those actions will require to disconnect the regulator from the assembly --

A. No.

Q. -- of the vent line?

A. No. There's no reason to touch the regulator.

Q. So under what circumstances the regulator might be disconnected from the vent line, if any?

A. It failed. That's, you know --

Q. No, let's just say the regulator is functioning. Is there any reason --

A. If it's functioning normally, there's no reason to touch it.

Q. Okay.
A. It's when the pressure downstream isn't what you've contracted for, then that's when you touch it.
Q. But you still do not need to disconnect it from the assembly to the vent line and inlet line?
A. No, you don't necessarily have to.
Q. Okay.
A. But you'll find that the relief valve -- the relief line becomes -- some of the problems, if they terminate the relief line with I call it a double-swing connection -- that's two (indiscernible) L's that point back to the earth. If they leave it pointing at the sun, the rain, the snow comes and it fills that vent line up with water.
Q. Sure.
A. And then it rusts out the spring, what happens. And in this case, it would probably fill the lower diaphragm case with water. And if it's outside in the winter, guess what? It freezes.
MR. EVANS: It freezes and causes problems.
MR. McDOUGAL: Yup. If you don't put the screen in the vent, the bugs get down. They build a nest in the vent so it doesn't breathe properly. I mean, there's a million things.
BY MR. EVANS:
Q. Was the spring common practice, you know, with these leather-type diaphragms? Was the spring --
A. Yeah.

Q. I mean, the screen, I mean.
A. Yeah. They had screens in them.
Q. They did? Okay.
A. Yep. In fact, what they had -- on this one here, I will explain one thing here. It's really fun to run into these. When you get an inexperienced plumber or fitter out there on the regulators, they'll -- if it's venting out here because they've had trash here. Because they'll see, oh, it's threaded. Guess what they do? They put a plug in it. Then it becomes air-locked, we call it, and the diaphragm can't move. Or if it's a real long run, then this is a problem we get into: They'll put a bushing in here, in the vent, and they'll run quarter-inch tubing 50 feet.
Q. So then air pressure drop.
A. And I always -- yeah, you can't get the air in fast enough, you can't get the air out fast enough so that it operates correctly.
Q. Right.
A. Closes and opens like it's supposed to. And because they're -- if you look at ANSI Standard Z21.8, it's all spelled out what has to be done by the manufacturer to make the regulator so it will function according -- correctly.

But they'll do that and so it won't function correct. You know, it won't open and close. And I always say, put -- get yourself a straw, buddy, and breathe, see how well you breathe under water. That's what you're doing to a regulator.

There is no standards in ANSI code or in the international or fuel codes, mechanical codes on the size of the vent line. The manufacturers will tell you, and they state it very specifically in the O&M manuals, and every regulator manufacturer does it, you shall not tie two gas regulators or multiple gas regulators together on the vent line.

Q. You don't gang them, yeah.

A. You do not gang them. And you do not reduce them. And they will not tell you how far you can run it.

BY MR. CHHATRE:

Q. So you are saying the manufacturer recommendation is not to connect two regulators on a single vent line?

A. That's right. And I will give you an example. You take large boilers --

MR. EVANS: It's clear they did.

MR. McDOUGAL: Yeah. No, I saw it. It's a violation.

MR. EVANS: Look at that again.

MR. McDOUGAL: Yes. What happens --

BY MR. CHHATRE:

Q. Do you have -- I'm sorry. Not to interrupt you, but have a regulation that says that, not to connect two --

A. Well, yeah. It's the back of every O&M manual, of every -- that's operation and maintenance manual, put out by every manufacturer in the U.S., that ye shall not tie two gas regulator vents together, or multiples.

Q. Do you have a copy of that, where you can send it to us?
A. Well, you can get it right off the Internet.
Q. Okay.
A. Go to --
MR. EVANS: Oh, we'll find it, yeah.
MR. McDOUGAL: Itron.com, it's (indiscernible) --
MR. CHHATRE: Roger can --
MR. McDOUGAL: -- regulators.
MR. CHHATRE: Roger can do it.
MR. EVANS: I'll find it.
MR. McDOUGAL: But what happens if you tie them together -- this is why they talk about it. I will give you an actual installation. Coors baseball field, when it was built in the early part of 2000, the 21st Century.
MR. EVANS: It's almost new, yeah.
MR. McDOUGAL: Yup. The company I was working for, we did not get the contract to install the boilers or sell the boilers. And the general contractor installed two boilers, one what is called a lead-lag combination. And what is meant by that in the boiler business is one boiler is number 1 and it goes to full fire to take care of the load. And if the load is such that day or that moment in time, the second boiler will come on. And then the second boiler will shut off and the main boiler will then modulate to maintain the load.
MR. EVANS: Oh.

MR. McDOUGAL: See? Now you typically want to use boilers equally so their lifespan is about the same. So there was a switch and you put it on, you can switch it back and forth.

MR. CHHATRE: Which is main and which is the backup kind of deal?

MR. McDOUGAL: Yes.

MR. CHHATRE: Okay.

MR. McDOUGAL: And so they put these in and they fired them up and the first time they fired it up, the lag boiler shut down, within 30 seconds the main burner shut down. Click, click. Well, there's something wrong in the boiler control. So they checked all the boiler control, fired it up again. Same thing. They flipped the switches the other way -- it has to be in the management system. So they turned the switch the other way, fired it up, same thing.

Okay. Something wrong in the management system. They replaced it. Put a new one in, started it up, same thing. No difference. They ripped out both burners, all the -- front end of the burners, everything, regulators, everything, tore it all out. Put all brand new in. Still did it.

So they called us up and they said, you know, we're at loose ends, we have no idea. We walked down there, and per Stan (indiscernible) control, said it's going to cost you $1,000 for us to come down there, tell you what's wrong. So we walked in. And I said, well, fire it up. And they fired it up, just -- and it

did just what I've been describing. And I said, somebody got a pipe wrench? They go, what? Yeah, I just need -- they gave me a pipe wrench. I went over to one of the regulators and I took the spring tower cap off. I said, fire it up.

MR. EVANS: It's going to run like a top.

MR. McDOUGAL: Yeah. What happens is the lag boiler would shut down and the regulator would shut off. Guess what? It pushed all this air out. The vent line was one for both regulators. These regulators were -- the upper diaphragm case was about like that, and that vent line was a little old inch and a quarter and about 200 feet long. That gas pressure -- that air pressure went over at the other regulator and pushed it down, put more gas pressure in, and the overpressure switch did what it was supposed to do. I saw more gas pressure, too high for what we're doing, shut it -- it opens up and shut the whole thing down.

MR. EVANS: Yup.

MR. McDOUGAL: I said -- it took me about a half hour, 45 minutes in the place. And I go, get your check, Stan, we're going home.

BY MR. EVANS:

Q. So as far as that discussion goes, in looking at this photograph of their --

A. Yeah.

Q. -- of their typical arrangement.

A. Yeah.

Q. Then, can they design their system to overcome this situation?
A. Yeah, run separate vents.
Q. No, but I'm -- no. I'm sorry.
A. Oh.
Q. But with this being against the code, we have regulators tied into the same exhaust, right?
A. Yup. You got to run separate vents on each of them.
Q. Yeah, supposed to run separate vents. But if they've had it like this for years and it's working, did they do something in the system to --
A. No.
Q. -- overcome a problem that they could have sooner or later?
A. No. They just poor-boy'd it. That's what I call it.
Q. Oh, they --
A. It works.
Q. Cheap.
A. Yup.
Q. They did it on the cheap.
A. Yup.
Q. Okay.
A. And so when this one shuts off, the gas -- you know, the air pressure tries to go up and it goes down here and it probably raises the pressure in that fuel line.
Q. Um-hum. Okay. I got it.

A. Enough so that -- but, you know, see, now Slumberge or Itron today or Sprague, this spring that's set in here is set for 7 inches over set point. Okay. So if you're --

MR. CHHATRE: Seven inches over what?

MR. McDOUGAL: It's set to go off -- go into beginning of relief function, starting to leak, starting to let gas pressure out 7 inches over the set point.

MR. CHHATRE: Okay.

MR. McDOUGAL: So if the set point is 7 inches --

MR. CHHATRE: Of water column.

MR. McDOUGAL: -- of water column, this valve down here on this regulator or any Slumberge with that black spring, will start to vent at 7 inches over set point. Now --

MR. CHHATRE: That's 14 inches --

MR. McDOUGAL: That's 14 inches. Okay. All the appliance controls -- now remember this -- have a stamp on them that says 13.5 MAOP. Do you know what MAOP means?

MR. EVANS: Maximum operating pressure.

MR. McDOUGAL: Pressure -- absolutely. All appliances controls in the U.S. are pressure tested to 21 inches. And so at about 16 inches this regulator is in full vent.

MR. EVANS: So that's a safety factor?

MR. McDOUGAL: It's a safety factor.

MR. EVANS: Right.

MR. McDOUGAL: So you're not going to --

MR. EVANS: Ever see it.

MR. McDOUGAL: -- work the -- now I have seen appliance controls that have been warped and leaked like a sieve around everything, and it's because the regulator that was installed did not have a overpressure protection device, and that -- i.e., that is like Maxitrol -- Slumberge, Itron makes one that's called an N, and it's very limited in application. And so you don't use it on appliances where your inlet pressure can exceed the 21 inches.

BY MR. EVANS:

Q. So going back to the failure modes.

A. Okay.

Q. We're back on the record?

MR. CHHATRE: Yes. We have been on the record.

BY MR. EVANS:

Q. This is Roger Evans. As far as we -- in the lab when these were being tested, Ravi mentioned yesterday that he heard the noise, he could hear the noise when they put the gas through the vent of the regulator. We have witnesses who are saying that they heard this racket right before the explosion. I think there's two people that are saying that they heard some peculiar noise. One guys says he hears a swoosh sound and was smelling gas.

So can you comment, at least, on the noises that one could expect and where those noises are coming from and why they're making the noise?

A. I would suspect that this, the vent chamber --

Q. On the mercury side?
A. -- on the mercury side was dry and probably that little diaphragm in there was ruptured, was cracked open -- dried out, cracked open, and it was blowing and --
Q. True.
A. -- and it could be fluttering. That diaphragm could be fluttering and that's -- you could hear that. You could also, could have heard this fluttering, flapping. You could have heard the diaphragm flapping if it was cracked.
Q. Would this be a metallic kind of sound or would this be some sort of a --
A. That could be, because that's a ball and a spring, half-moon. You know --
Q. So the mercury side could make a noise of --
A. If it was dry.
Q. -- a metallic nature if it was dry?
A. Yeah. Did you find any mercury in it?
BY MR. CHHATRE:
Q. Now going back to -- well, we saw it post-fire, so we wouldn't see any mercury.
A. You didn't?
MR. EVANS: No.
MR. McDOUGAL: No. I would be that's where the noise was coming from.
BY MR. CHHATRE:

Q. But the question I have is, going back to the failure modes of the regulator, in any of these three modes you described earlier -- seat, valve seat leaking, not shutting because of debris, or you can have a crack in the diaphragm or the, I guess the pivots getting stuck.
A. Um-hum.
Q. Did I forget any other modes?
A. Yeah. And then here's the relief down here. This diaphragm could have --
Q. No, but I mean for the high pressure gas to get into here before it seized here.
A. Yeah.
Q. These are the three modes you explained. Did I forget any other mode, regulator failure mode?
A. Yep.
Q. You said I forgot one more or I did not?
A. You could -- well, let's say you got a crack here.
Q. In the diaphragm.
A. The spring is going to push it down, okay. There's nothing, there's -- you know, because the pressure across here is now equalized, okay, so there's nothing to force it up, overcome that spring force. The spring force comes open; that's open 100 percent.
MR. EVANS: So a tear in the diaphragm --
MR. McDOUGAL: Diaphragm. Would open that open up full

blast.

BY MR. CHHATRE:

Q. So all my incoming gas pressure is now in the regulator here and venting out?

A. And downstream, too. Going into the meter sets, going in all those apartments.

Q. If the diaphragm has failed?

A. Yes.

Q. So if the diaphragm fails, has a crack, let's just say --

A. Yes.

Q. -- then the appliances and my meters will see the --

A. Right. Were there stoves in the appliances, in the --

MR. EVANS: Yeah, there's stoves in them. There was gas stoves.

MR. McDOUGAL: Did any of them talk about flames about that tall?

MR. CHHATRE: No.

MR. EVANS: No. I don't think --

MR. McDOUGAL: Then I would say that did not rupture.

BY MR. CHHATRE:

Q. Okay. So meters also, the gas is going through meters?

A. Yeah. That's all right.

Q. So --

A. The meters are -- those meters are Rockwell 175s.

Q. And they can (indiscernible) pressure.

A. Do you want to get a picture? I'll tell you again, they're 175s. I can tell.

MR. EVANS: Yeah. Yeah.

MR. McDOUGAL: Made my Rockwell.

BY MR. CHHATRE:

Q. Okay. So diaphragm --

A. Pittsburgh meter.

MR. EVANS: Right.

BY MR. CHHATRE:

Q. So diaphragm failure is not --

A. Not evident.

Q. Evident. Okay.

A. It's right there.

Q. So now the high pressure --

MR. EVANS: Can I -- excuse me.

MR. CHHATRE: Sure.

MR. EVANS: Can we go back to the diaphragm failure, though, just to ask a question?

MR. CHHATRE: Sure.

BY MR. EVANS:

Q. On the diaphragm failure, is it possible that you could get a flame out at the appliance and get gas through into the building?

A. Yeah.

Q. Into the rooms?

A. Yeah, on the ranges, absolutely. But on the water heaters

and furnaces, when you get a flame -- if you get too much flame, that pilot light that's on that water heater isn't right on that thermal couple. It's out here. And guess what happens to that thermal couple? It cools off.

Q. And then shuts it down.

A. Shuts it down.

Q. So gas -- even if these gas ranges were, let's say, 25 years old, old technology, let's say, with those turn jobs. So you're basically saying that if we have a diaphragm failure, we could have gas going through this and venting, so you have smell outside and you have smell in the apartments?

A. And somebody would try to go -- and the pilot lights on the ranges, if it had pilot lights, could be -- you know, most of them in an apartment are greased over.

Q. Right.

A. They don't work at all. So they always light them with a match.

Q. Right.

A. So they lit -- somebody -- again, and this a question you got to ask somebody. They lit it and they turned the valve on, what's the flame like? Was it -- or was it down here like it's supposed to be or was it standing up?

Q. But my question is this. Let's just say that someone is making tea at 11:30 at night. When was it, 11:30 when this happened, or midnight? And they -- and this diaphragm tear has

occurred and now all of a sudden you have gas on an open valve on your stove. Is it --

A. It's going everywhere. And if -- the pilot light's gone out, I can tell you that, so there's no source of ignition there at the range. It's filling that whole apartment up and starting to fill the whole building, and somebody flips a light switch.

Q. Bingo. That would explain why we have certain apartments saying that the smell of gas was extremely strong, and so much so they left the apartment, if we had a tear in the diaphragm?

A. Um-hum.

Q. Okay. Thanks. Sorry to interrupt.

A. That's all right.

BY MR. CHHATRE:

Q. So diaphragm failure will have the high pressure gas go inside the building, too. However, the debris at the pivots or the valve seat will have the high pressure gas vent through --

A. Yes.

Q. -- the --

A. Yeah, that pressure would have equalized across there and then pushed that spring open and then it would have been venting outside.

Q. So will that make the noise also? In that case, will you still hear a hissing noise?

A. Yes. Because you probably -- you probably heard something fluttering, is what they heard.

It happened at 9:30 -- at 11:30 at night?

MR. EVANS: Around midnight or something.

MR. McDOUGAL: Whew. I bet that was a wake-up call. Sorry.

MR. EVANS: So when you, when you were talking about the noises. So if we have a diaphragm failure, we could have noise there. If we have the venting, full venting out we could have noise. If we have these seized up, these pivot points seized, if we have this not seating properly, the leather, at the leather piece there --

MR. McDOUGAL: Yup.

MR. EVANS: -- all these features can make noises?

MR. McDOUGAL: Yes.

MR. EVANS: When you have those problems going on.

MR. McDOUGAL: Yup. What was the inlet pressure --

MR. CHHATRE: Twenty psi.

MR. McDOUGAL: -- from the utility?

MR. CHHATRE: Twenty psi.

MR. McDOUGAL: Twenty? Twenty pounds? Well, they had the right -- the regs that they had in, it was the right regs with those 31s.

MR. CHHATRE: Right.

MR. McDOUGAL: Probably -- I'd say they should have had about a 3/8th orifice in them, on those others.

Now if they still have those Reynolds in any of those places, they need to get -- in my mind, they should be removed.

MR. EVANS: Right.

MR. McDOUGAL: You're just one second away --

MR. EVANS: From another occurrence.

MR. McDOUGAL: -- another occurrence. Exactly right. Those B31s that are painted black, those regulators have been around since 1964, that model, they are the most stable regulator that is -- that I have ever seen.

BY MR. CHHATRE:

Q. But did you not say earlier that regulator failures are not that common?

A. That's right, they're not that common. The unit themselves are well engineered, well designed, well built, well tested before they ever hit the market. And that B31, I tested in 1965 when it was first introduced here in Colorado. And I will tell you right now, it put the 730 Fisher right out of the block, out of business.

MR. EVANS: So can we go back to the, you know, the -- let's say, we know that this pipe when it came out of the building, it turned down.

MR. McDOUGAL: It did turn down, the vent line?

MR. EVANS: The vent line.

It was on a 45 or a straight down, do you --

MR. CHHATRE: Straight down.

MR. EVANS: Straight down. Okay.

MR. McDOUGAL: That's perfect.

BY MR. EVANS:

Q. So if it is straight down, you can still get animals of sorts into that pipeline?

A. Yes. Unless you have a screen.

Q. Okay.

A. And I tell the fitters that you -- when you run your vent line outside, you take this screen and you put it in the outlet of that elbow.

Q. Right. Okay. So if that screen were to get clogged, though, from some sort of insect or some other animal that makes its way into the pipe, and -- because it's not going to vent normally, right?

A. No.

Q. It's never going to vent if it's running properly.

A. That's right.

Q. So --

A. All it is, is a breathe hole for it.

Q. Right. So let's just say that that vent is blocked and we now have some sort of problem like you're talking about here, one of these other failure modes you're talking about, right? So --

A. Well, let's just say -- let's stop and -- before we get into the failure mode. Let's say this is blocked completely. On the regulators that they put in other than this one, that regulator will not function. It will be air-locked. If this vent line is plugged, it becomes air-locked and will not function. In other

words --
Q. Even with low demand days? Because this is --
A. No, it won't function. It --
Q. This is summertime.
A. Yeah. So the first water heater comes on, this won't supply the water heater. It's shut off.
Q. And the water heater -- they're going to say, hey, we got cold water in our apartment.
A. Yup.
Q. That's what they're going to -- first thing they're going to say. Okay.
So a plugged vent line in our particular instance has no bearing in this case that much, because this -- it would make this inoperative.
A. Yes.
Q. Okay. So we can --
A. Now, on this regulator, if the vent line is blocked, it will still function. Why? Because its breathe hole is here.
Q. Oh, okay. So this, on this one, if the vent line --
MR. CHHATRE: This one meaning the mercury, is what you're talking about, right?
MR. McDOUGAL: It still functions. It just -- it will never go into relief. So if that line was blocked, that regulator will work fine.
BY MR. EVANS:

Q. But if it needed the regulator because you have an upset --
A. If it needed to vent, then it wouldn't.
Q. Where is the gas going?
A. If you -- if this was blocked and you had a tear here, the same thing with --
Q. You're going back inside the house?
A. Yeah. Same thing as you got here, except you wouldn't know that this had failed because you wouldn't smell gas outside, but the same conditions would be inside. The only thing you don't have is the smell outside.
Q. Um-hum. That's the odd thing about this. We have the smell inside and outside, but it's summer, so we have someone -- if it's venting outside, it's making its way inside. But some of the odd things are they talk about their apartments smelled on the inside and that's the only place they smelled gas. And some of the people that lived there, they didn't smell it outside, they smelled it inside.
A. Then I would say that the diaphragm had a tear in it and it went wide open. It happened all at once. It wasn't a gradual --
Q. Could it be if you have a tear, though, it could still be venting outside, too?
A. Yes. Because what's happened, again, the spring forces this diaphragm down, opens this up full --
Q. Throttle, right.
A. -- full bore. Okay. You've got the meters and all the stuff

in there, inside. But if someplace, some -- you know, like you said, some lady was having tea at 11:00 at night --

MR. CHHATRE: No, I mean, nobody was. He was just kind of saying --

MR. McDOUGAL: Well, yeah, but --

MR. CHHATRE: I just want to make sure for the record because --

MR. EVANS: Right.

MR. McDOUGAL: But let's just assume that that was the case. Okay? And this was -- and this would be venting full blast. I would almost bet on it. Because that little bit of -- that little orifice in that gas-fired range isn't going to lower the pressure in the downstream fuel line fast enough to cause it.

MR. EVANS: Right.

MR. McDOUGAL: So --

MR. EVANS: Least resistance.

MR. McDOUGAL: Least resistance, it's going outside. If that was partially blocked, you know, it's going to blow and it's going to make noises. You know, the buzzing could be (makes noise).

MR. EVANS: Okay.

MR. McDOUGAL: It could be flapping, yup.

MR. CHHATRE: Interesting. Okay.

Anything else, Roger?

BY MR. EVANS:

Q. I do want to just have you talk a little bit about the --

with -- we don't need both in the bank to do this. We just one of them to do that, right?

A. Um-hum. Yep. They're not a -- it's not a passive monitor. After I saw the piping diagram. It's two regulators in parallel because this one was large enough to meet the load at that inlet pressure. That tells me that sometime way back they didn't have 20 pounds. They had something else.

Q. So can you talk to us about any time you've ever read, heard, saw of a diaphragm tear in leather?

MR. COX: Before you get into that, and I don't mean to interrupt, [redacted] do you need me to follow up or anything.

MR. CHHATRE: Yeah, let's take a few minute break.

MR. COX: Okay. Perfect.

MR. CHHATRE: Off the record.

MR. COX: Thank you.

(Off the record.)

(On the record.)

MR. CHHATRE: Back on the record.

So any more questions for you?

MR. EVANS: I think I'm good. I think I'm good to go with what we have here.

MR. CHHATRE: Okay.

BY MR. CHHATRE:

Q. Now can you think of any other way the regulators can fail?

Anything else besides stuck valve, if I understand correctly, stuck these pivot joints, and cracked or ruptured diaphragm? Anything else can cause a regulator to fail?

A. I will tell you how they test for the relief valve, and that can be a failure, but I have never seen one of those, where the valve seat falls completely off.

Q. Okay.

A. I've never seen that. And these are just put on -- they're just shoved on the shaft. That's the way everybody makes them nowadays. I've never seen one of them disappear. But that's -- in order to get 100 percent failure and do the vent -- the relief test, they pull that valve seat off, and they have to pass that. That's a really tough test.

MR. EVANS: So you're saying modern regulators have a low likelihood of putting 20 pound gas in a building?

MR. McDOUGAL: Oh, they'll live forever.

MR. EVANS: So -- but these have a likelihood of putting line pressure gas inside of a building?

MR. McDOUGAL: Yes, because that valve seat is leather.

MR. EVANS: Right.

MR. McDOUGAL: And it's not -- you know, you scuff your -- the front of your shoe and it's not smooth anymore.

MR. EVANS: Right.

MR. CHHATRE: Okay.

MR. EVANS: And do we have records that we could go back to,

perhaps, in history of explosions in homes where we know for a fact that house had exploded and saw line pressure? Is that a common occurrence or back in the day with this design?

MR. McDOUGAL: Yeah.

MR. EVANS: It was? Okay.

MR. CHHATRE: Okay.

MR. McDOUGAL: You know, eventually that leather is going to become very brittle.

MR. EVANS: Right.

MR. McDOUGAL: If you could keep it -- if you could squirt -- you had a port in here somewhere, you could squirt in some oil and you knew it would go all over that diaphragm, but the problem is it will never go out here where it's sealed, and there's where it can break, right around there. See -- yeah, it can break not where you think, here, but it can break there.

MR. EVANS: So just to go on record with this, your opinion, if anyone has, in the country, if they are using diaphragms of this style with leather in them as the diaphragm, Russian roulette?

MR. McDOUGAL: Yes. You're waiting for it to happen.

MR. EVANS: You're waiting to have a line pressure release into the building?

MR. McDOUGAL: Yes. It's going to happen.

MR. EVANS: Okay.

MR. McDOUGAL: I just can't tell you when.

MR. EVANS: Right.

MR. McDOUGAL: If I could, I'd be the richest man in the world because I'd bet on them.

MR. EVANS: Okay.

MR. CHHATRE: If not, thank you very much for coming and talking to us.

MR. McDOUGAL: You bet.

MR. CHHATRE: Appreciate your time.

MR. EVANS: Yeah, thank you so much.

MR. CHHATRE: Off the record.

(Whereupon, the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF: THE EXPLOSION OF APARTMENT BUILDING 8701 OF FLOWER BRANCH APARTMENTS IN SILVER SPRING, MARYLAND ON AUGUST 10, 2016 Interview of Thomas McDougal

ACCIDENT NUMBER: DCA16FP003

PLACE: Lakewood, Colorado

DATE: January 19, 2017

was held according to the record, and that this is the original, complete, true and accurate transcript which has been transcribed to the best of my skill and ability.

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Kay Maurer
Transcriber