Gary Hanson, Chair
Steve Kolbeck, Vice Chair
Dustin Johnson, Commissioner

SOUTH DAKOTA PUBLIC UTILITIES COMMISSION

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May 22, 2008

Ms. Patricia Van Gerpen
South Dakota PUC
500 E. Capitol
Pierre, SD 57501

VIA ELECTRONIC FILING

Re: PS08-001

Dear Ms. Van Gerpen:

Enclosed for filing, please find the Commission Pipeline Safety Staff Report on the Pierre Town Border Station Fire Incident.

Sincerely,

Kara Semmler

cc. Dave Gerdes, James Robbennolt - E-mail only

South Dakota Public Utilities Commission

Memo

To: Chairman Hanson, Vice-Chairman Kolbeck, and Commissioner Johnson

From: Nathan D. Solem

CC: Patricia Van Gerpen, Kara Semmler and Daris Ormesher

Date: May 22, 2008

Re: SDPUC Pipeline Safety Staff Report on the Pierre Town Border Station Fire Incident in Docket PS08-001

Summary of Incident Facts

On February 20, 2008 leaking gas at the Montana Dakota Utility (MDU) town border station (TBS) located on Airport Road in Pierre, South Dakota caught on fire at 8:20 am. The TBS takes high pressure gas from a transmission line and reduces the pressure for delivery into the town's gas distribution system. Gas was released and estimated damages of $150,000 resulted. Consequently the incident was reported to the National Response Center and the Pipeline and Hazardous Materials Administration (PHSMA) Office of Pipeline Safety under the Pipeline Safety Regulations located in 49 CFR Part 191.

An MDU employee responded to escaping gas at the relief valve stack. The relief valve stack is located on the intermediate pressure system at the TBS. The responding employee opened the door to the regulator station building and was singed when leaking gas from inside the building ignited when the door was opened and the gas reached an ignition source.

A utility pig was received at the South Dakota Intrastate Pipeline (SDIP) pig receiving station just prior to the incident.

Figure 1. Burned TBS in Pierre, South Dakota

Staff's Role

South Dakota gas pipeline safety staff has two roles in a natural gas incident investigation:

- Monitor the operator's procedures for determining probable cause and prevention of reoccurrence under 49 CFR 192.617.
- Determine operator compliance of both Parts 49 CFR 191 and 192 code sections and the operator's operations and maintenance standards applicable to the incident.

Background

Pigging. SDIP was pigging the line as part of their efforts to comply with the integrity management portion of 49 CFR Part 192. This utility pig was inserted after Thanksgiving in November, 2007. An example utility pig is depicted below in Figure 2. Pigs traverse the line based on gas flow and push debris, in this case mainly rust and welding slag, ahead of them. Due to the normal low flow in the SDIP line, the pig had moved very little until February 20, 2008 when the high flow due to the cold temperatures drew the pig into the pig receiving station at the SDIP facility in Pierre.

Figure 2. Example Utility Pig

A second pig was launched at Gettysburg, South Dakota, 60 miles from Pierre, on February 5, 2008. Again, due to the low flow, it is anticipated that this pig will not arrive in Pierre for months until another very cold day increases the gas flow and moving force on the pig.

Process Flowsheet. The major equipment involved in this incident include: (See Figure 3 attached)

- SDIP pig receiving station
- SDIP one micron filter
- MDU one micron filter

- MDU 40 mesh V strainer
- MDU intermediate pressure regulator
- MDU intermediate pressure relief valve
- MDU building heater

Probable Cause

Direct Cause. The gasket on the V strainer flange inside the building and just ahead of the intermediate regulator failed. As a result of the failure, the TBS building filled with gas. When the door was opened, the gas ignited. The ignition source was a heater located on the TBS building just outside the door. See Figures 4 and 5 below.

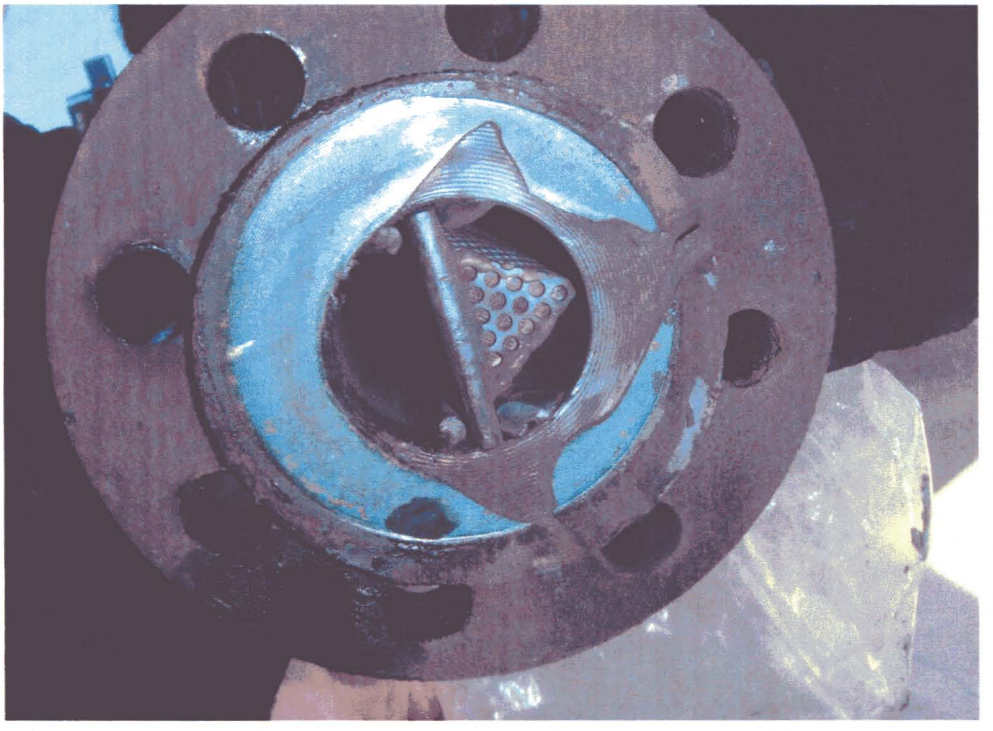


Figure 4. V Strainer Flange and Failed Gasket

Figure 5. Building Heater Ignition Source Located Outside of Door

Root Cause- Operator. MDU management's determination of probable root cause per a data response is:

> MDU received a large slug of rust/ weld debris shortly before the gasket failure (approximately 10-15 minutes). There were three other equipment failures (SDIP filter element failure, MDU filter element failure, pressure regulator boot failure) that probably occurred prior to the gasket failure. The gasket failure was the fourth equipment failure that ultimately caused the incident. The gasket is located on the V-strainer immediately upstream of the regulator. The quantity of rust received into MDU's system is unknown. It is assumed, however, to be extensive based on the four equipment failures. Each failure occurred within minutes of the prior failure in the sequence. Due to the opening of the relief valve, the gas velocity was accelerated and consequently a sandblasting effect was created with the rust/debris. Gasket material was "sanded" away which then caused the leak to occur.

Root Cause – SDPUC Staff. Commission Staff hired an expert witness, Allen Selz of Pressure Sciences Incorporated. (See attached Figure 6 for resume). His opinion of the probable root cause of failure is:

> "The photos of the gasket at the Pierre MDU TBS show that it was blown out by high pressure. I'm also suspicious that the flange holding the gasket may have not been tightened sufficiently. Rust and debris particles are only residue; they did not themselves contribute to the failure. The damage to the filter at the MDU Station appears to be buckling under high axial loading, providing additional evidence of high transient pressure probably caused by pigging.
>
> At the Pierre MDU Station, it appears that the high transient pressure blew out the gasket and was the probable cause of the failure. The failure may have been abetted by an insufficiently tightened flange."

Although there are differences in the operator's and the expert witness's opinions of probable cause, since the most immediate change to the pipeline system was the arrival of the pig and associated debris ahead of the pig, it appears that the multiple failures downstream on the MDU system could be a result of this occurrence.

Prevention of Reoccurrence

MDU. In Staff's opinion, MDU's pipeline system should function without failure in the event of an unscheduled pig arrival. Staff therefore recommends the Commission order MDU to prepare a mitigation plan within 45 days to deal with the second pig. This plan should evaluate the following items at a minimum and propose a recommended mitigation plan for this Commission to review:

- Regulator station component torquing procedure adequacy
- Prevention of ignition from the building heater
- Process flow sheet identifying equipment changes to handle the debris load and pressure transients from pigging
- A review of best available technology and procedures for handling debris and pressure transients

SDIP. In Staff's opinion, transmission company pigging operations need to be coordinated with downstream distribution companies. This is not possible when unscheduled pig arrivals occur as happened on Feb 20th. Staff therefore recommends the Commission order SDIP to prepare a plan within 45 days for a scheduled arrival of the second pig. This plan should evaluate the following items at a minimum and make a recommendation for the Commission to review:

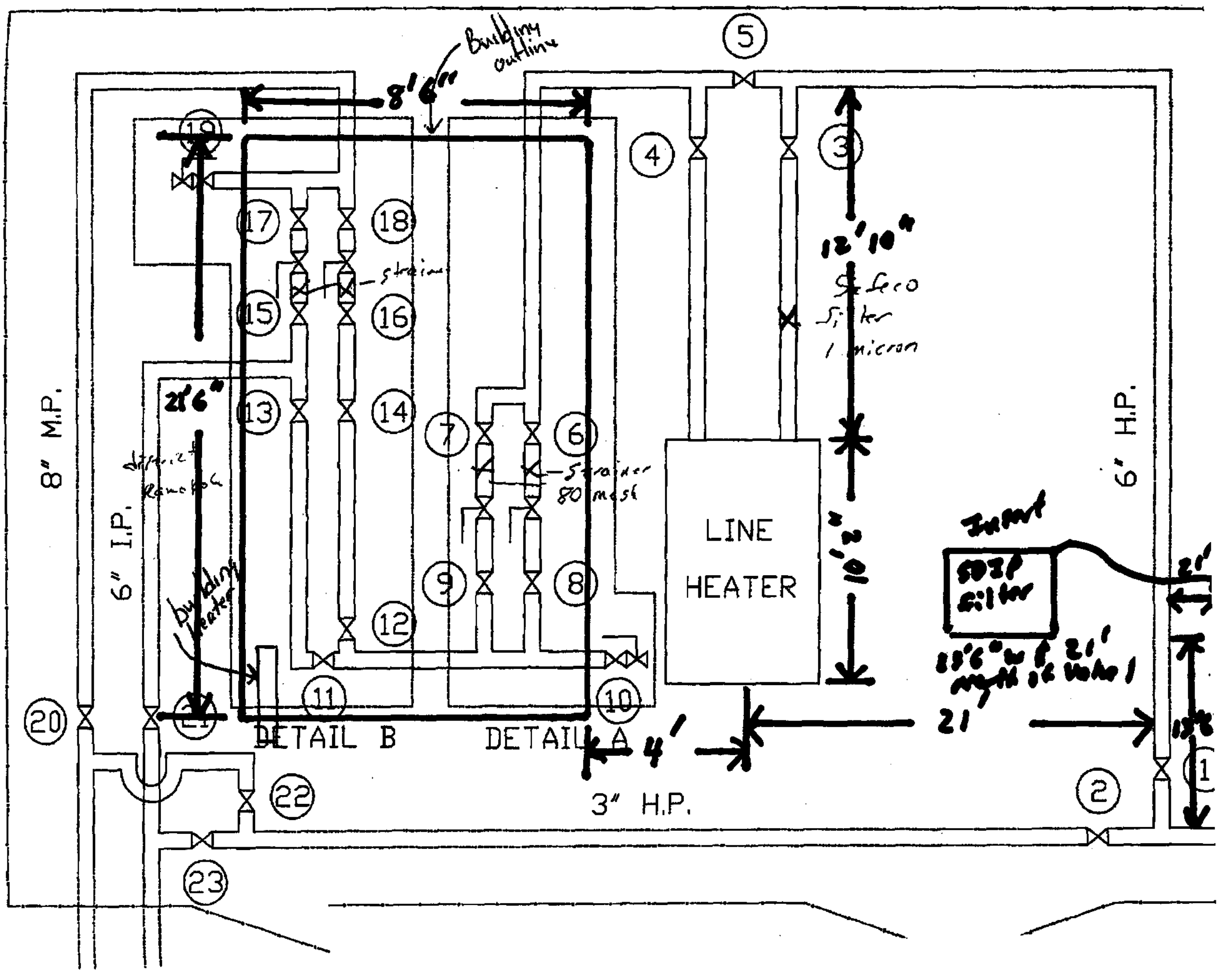
- Locating and accurately predicting the arrival of the second pig
- Locating and cutting out second pig
- Controlled gas release to draw in second pig at time coordinated with MDU
- Installation of a further upstream pig receiving and filter station
- Process flow sheet changes to handle the debris load and pressure transients from pigging with no downstream effect on the distribution company.
- A review of best available technology and procedures for:
    - Scheduled pig arrivals
    - Debris handling

- Pressure transient reduction

- Coordination plan for all future pigging operations with MDU

Compliance Review Results

A limited review of 49 CFR 191 and 192 regulations relative to this incident was conducted with no compliance issues found. In Staff's opinion, however, the Commission should issue a Notice of Concern to both MDU and SDIP that a reoccurrence due to inadequate mitigation plans by MDU and/or SDIP may be viewed as a probable violation of 49 CFR 192.617 and 49 CFR 192.143 (a).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HEATER
DETAIL A
DETAIL B
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ALLEN SELZ

Dr. Selz is President of Pressure Sciences Incorporated. He is a specialist in pressure vessel and piping design and analysis, fracture mechanics, fatigue, and failure analysis. He has had extensive experience in the conceptual and detail design and analysis, testing and construction of mechanical - systems and components to meet rigid performance and safety requirements.

In the nineteen years that Pressure Sciences has been in existence, Dr. Selz has been responsible for the solution of an unusually diverse set of engineering problems. Some of these are the following.

- Provided technical oversight of ground-based pressure vessel and pressure system safety evaluation and requalification for NASA at the Kennedy Space Center. These systems were typically high and medium pressure gas storage and supply systems.

- Obtained Pennsylvania State Special Registration of a cold isostatic press built from a 16 inch naval gun, of six non-Code high pressure vessels used for growing quartz crystals, of eight boilers and heat exchangers built to the German TRD and AD Merkblatt Codes, and numerous other special pressure vessels.

- Provided conceptual design and stress analysis for the manufacturer of a specialized semi-trailer built to transport toxic hypergolic fuels for NASA. This semi-trailer must meet very rigid new U. S. DOT design requirements and withstand several unique postulated collision and overturning accidents. As a result, he was engaged from 1997 through 2002 in research and development for the U.S. DOT to improve the crashworthiness of propane semi-trailers.

- Evaluated over three hundred riveted and welded API 12A and API 650 oil storage tanks located at an ExxonMobil refinery to the criteria of API Standard 653 using data obtained by inspectors. Developed an engineering specification, suitable for computer programming, for ExxonMobil to evaluate riveted and welded oil storage tanks according to the requirements of API Standard 653.

- Developed an engineering specification addressing design criteria, design rules and materials and corrosion concerns to recertify over one thousand small, high-pressure research vessels for the ARCO Oil and Gas Company Plano Research Center.

- Provided design and analysis support for a manufacturer of dry storage silos and hoppers, and for numerous manufacturers of ASME Code pressure vessels and API storage tanks.

- Determined the cause of a shaft failure in a large rotating heat exchanger, and quickly developed and supervised a complex repair to minimize down-time.

- Performed failure analyses of a large recuperator used in the metals industry; of a non-Code pressure vessel used for hot tar application; and of a low pressure steam sterilizer.

- Performed failure analysis, provided extensive deposition testimony; and, in 1996, provided several days of trial testimony on behalf of the plaintiff before the U.S. Court of Federal Claims in Washington, D.C. The matter involved the fatigue failure and rupture of welded stainless steel piping installed at Ellsworth AFB, in North Dakota. The piping had been subjected to hydraulic transients that were not accounted for in the design. The court issued its opinion in February, 1998, completely agreeing with the plaintiff's position.

- Performed failure analysis and subsequent redesign of rectangular expansion joints for a waste-gas incinerator, and of leaking gasketed closures for a series of rotary shell and tube dryers.

- For the Commonwealth of Pennsylvania, evaluated the public and environmental safety of a 20 million gallon refrigerated liquefied propane gas storage facility, and, in 1993, testified extensively before the President Judge of Commonwealth Court as to his findings.

- Provided expert support in commercial patent litigation involving a railroad end-of-train signal attachment device, a barbed-wire dispensing device, and a marine stern-drive shaft-sealing device. Provided deposition testimony for the first two of these matters and, in 1994, provided trial testimony on the shaft-sealing matter.

- Served as an arbitrator in a complex commercial arbitration between a large manufacturer of compressors and turbines and a licensee who claimed his license was being infringed.

- Provided expert evaluation and analysis of the failure of the breech-lock closure in several large industrial autoclaves. Depositions were taken, but the matters settled before trial.

Provided expert evaluation in determining the cause of an explosion in a scrap aluminum melting furnace. The matter settled before trial.

Served as one of three arbitrators in a matter involving an underground double-wall piping system that suffered failures during installation at a National Guard air force base in New Hampshire.

At O'Donnell & Associates, Inc., from 1978 until 1988, Dr. Selz conducted safety and failure analyses of nuclear and non-nuclear equipment, and was responsible for O'Donnell's extensive efforts in recertification, or requalification of pressure vessels and pressure systems which had been used for many years at the NASA Lewis Research Center and in various industrial settings.

He was also responsible for O'Donnell & Associates' work in support of litigation. Over a period of eleven years in this role, he had overall responsibility for over 150 such projects, and personally evaluated over sixty. He provided deposition or trial testimony in seventeen of these matters. A few of these matters are described below.

- For HALCO Mining Inc., a company jointly owned by Alcoa, the Republic of Guinea, and others, determined that a massive structural failure of an aluminum ore crusher-house was the result of design error rather than a latent defect. His preparatory work and trial testimony contributed to a significant win by HALCO and was commended in his opinion by the presiding federal judge.

- For Wanda Petroleum Company, he determined the cause of a brittle fracture in a railroad tank car operating in Canada. The initiator was the sudden loading of warmer product into the well of the cold tank car. The cause was poor materials selection and poor welding practice. Deposition testimony was taken.

- For UOP Incorporated, he determined the cause of failure of a large expansion joint in a fluidized-bed catalytic refining vessel. The multi-ply bellows was of type 321 stainless steel but failed because of intergranular stress corrosion cracking. Metallurgists working under Dr. Selz' direction were able to determine that the stainless steel had been

incorrectly processed and the titanium added for resistance to IGSCC was not uniformly distributed through the metal matrix, leaving the material unprotected against this form of corrosion. Deposition testimony was taken.

- Again for UOP, he helped determine the cause of failure of an amine vessel in the Union Oil Refinery in Romeosville, Illinois, in which a number of people were killed. The failure was caused by hydrogen embrittlement of a field-weld in the vessel. This failure was one of the principal factors in causing the refining industry to take strengthened precautions against hydrogen embrittlement in process vessels. Again, deposition testimony was provided.

- For a pressure vessel manufacturer, he evaluated the responsibilities of the parties for an accident that occurred when a worker was scalded when he opened the quick-actuating door on an autoclave accidentally left full of hot water. Deposition testimony was provided.

- For MacMillan-Bloedell, determined the cause of a catastrophic failure of a deaerator which was part of a boiler in a pulp-mill. The cause was hydrogen-induced cracking at the welds.

  For several clients, determined the causes of failure of a variety of small air tanks and provided court and deposition testimony.

Before joining O'Donnell, Dr. Selz spent twenty-one years with Westinghouse Electric Corporation, where he designed and tested nuclear control rod drive mechanisms and reactor core components, managed the design and development of a series of full scale nuclear rocket engine cores, developed prototype radioisotope power systems, and managed the design and procurement of reactor vessels for the Liquid Metal Fast Breeder Reactor (LMFBR) Program.

In the 1960s, Dr. Selz was an evening instructor in mechanics and kinematics at Carnegie-Mellon University and at the University of Pittsburgh. In the 1980s, he taught dynamics and statics courses at the Community College of Allegheny County.

After he left Westinghouse, Dr. Selz spent three years operating a company specializing in the field surface preparation (sand-blasting) and coating of steel tanks and elevated structures. He gained substantial hands-on field experience in the construction industry in general, and in construction safety in particular.

Dr. Selz received a B.S. from Carnegie-Mellon University in 1953, an M.S. from CMU in 1954, and a Ph.D. from the University of Pittsburgh in 1967, all in Mechanical Engineering. He is the originator of over twenty invention disclosures and patents, and has published numerous technical papers. He is a Registered Professional Engineer in Pennsylvania, Ohio, Texas, Florida and Oregon, and is a member of Pi Tau Sigma and the American Society of Mechanical Engineers. He was Chairman of the 1800 - member Pittsburgh Section of the ASME for the 1995 - 1996 year.

He is very active in ASME Pressure Vessel Code Committee work. He is a past member of the Post-Construction Code Main Committee which deals with pressure vessels and other components after they have been in service, and is a member of the Boiler and Pressure Vessel Main committee, its Executive Committee, and the Subcommittee on Pressure Vessels. He is Chairman of Subcommittee XII, the Subcommittee on Transport Tanks which recently issued the 2005 first edition of Section XII, *Transport Tanks.* He is a former Chairman of the Subgroup on Toughness and the Subgroup on Noncircular Vessels of the Subcommittee on Pressure Vessels, is a past chairman of the Working Group on Bolted Flange Joints of the Subcommittee on Design, and is a past member of the

Subcommittee on Design. In 2002 he was awarded the J. Hall Taylor Medal by ASME for outstanding contributions to pressure vessel safety, and in 1998 he was elected a Fellow of ASME.