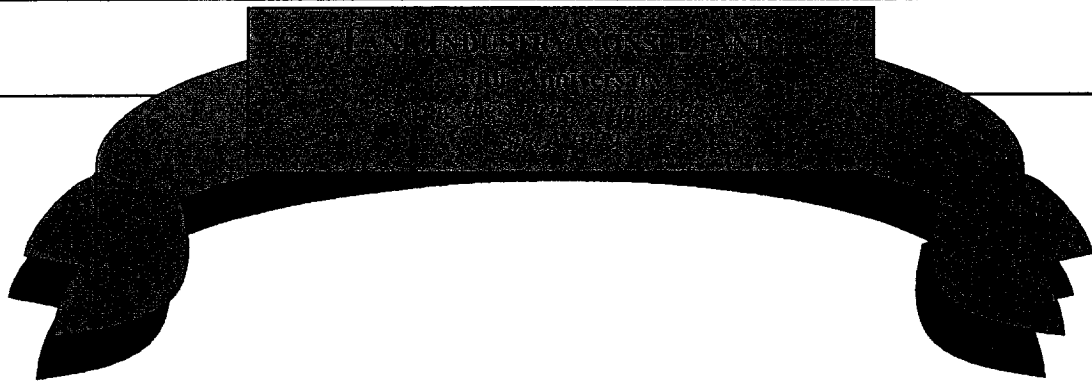


Tank Talk



TIC Celebrates 20th Anniversary by Responding to the Needs of More Tank Owners

By E. Crone Knoy, P.E., Chairman & Founder, TANK INDUSTRY CONSULTANTS

One glance at this issue of Tank Talk probably alerted you to the fact that 1999 is a banner year for Tank Industry Consultants—our 20th year as a professional engineering firm specializing in the design, evaluation, and maintenance of storage tanks. Since my wife, Cindy, and I founded the company in 1979, TIC has performed engineering inspection and design services on petrochemical tanks, gas holders, hazardous waste containments, pressure vessels, bulk storage, and industrial process tanks. However, the firm has been known primarily in the water-storage tank market.

TIC has always had the expertise to provide storage tank engineering services to both the industrial and water markets; however, our staff has been kept amply busy fulfilling the needs of our water supply clients and we have not actively pursued industrial work. Our expertise in all types of storage tank engineering was recognized when in 1988 I was asked to testify before the House of Representatives Marine and Fisheries Oversight Committee concerning the safety of steel tank standards. The hearings were prompted by the historic Ashland Oil tank collapse that dumped 3.9 million gallons of diesel fuel into the Monongahela River. I testified that the industry already had many excellent standards in place, and was capable of developing any additional standards needed to prevent catastrophic occurrences. Work began almost immediately on the development of API Standard 653, *Tank Inspection, Repair, Alteration, and Reconstruction*, and I became one of the first groups of 653 Inspectors certified.

TIC continued to be called on by industrial clients when problems occurred, but our personnel utilization in our grass roots business of water-storage tanks precluded us from making our tank management services widely available to

the industrial sector. A real breakthrough came in 1998 when Steve Meier brought his 23 years of tank engineering and construction experience with Chicago Bridge & Iron Company to TIC. John Lieb added similar expertise to our staff earlier this year. Along with Steve and John have come Royce Laverman, David Baird, and other senior consultants. This increased experience and knowledge base has enabled TIC to more aggressively offer our services to industrial tank owners whose products in storage pose a considerable risk to the human life, the environment, and our potable water supply.

As we complete our 20th year of service to the storage industry, it is our goal to assist and educate tank owners to limit the number of times they have to call us when they are in trouble. By utilizing proper tank management, their risks can be reduced so catastrophes no longer occur.

In the 39 years I have been in the tank business, I have met many extraordinary people throughout the storage tank industry. I have been blessed to call many of my co-workers, colleagues, and TIC's clients "*friend*." It is with great anticipation that I look forward to the coming years and witness the continued growth of Tank Industry Consultants. This year will offer many challenges and opportunities to our staff and me. May 1999 be a banner year for you also.

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VOC Emissions and Changes in Structural Standards

Two areas of risk at the forefront of industrial containment infrastructure operations are **Emissions from Volatile Fluids** and **Changes in Structural Codes**.

The emission of volatile organic compounds continues to be an issue with which all industrial storage tank owners must contend. The use of the proper seals on floating roof tanks and the monitoring of their performance help minimize the risk of emissions. API has developed a testing protocol for evaluating the efficiency of floating roof seals. Test equipment has been developed for certifying seal loss factors. These advancements by API provide tank owners the information needed to plan the mitigation of emissions from tanks as a part of their overall VOC emissions control program.

Royce J. Laverman, Senior Consultant for Tank Industry Consultants, developed this equipment and protocol for API while with CBI. Royce is now available to share his expertise with tank owners, tank constructors, and seal manufacturers as a part of the services offered by TIC.

Structural codes are changing, and one of the most influential persons effecting some order out of chaos is Stephen W. Meier, TIC's Vice-President of Engineering and Technology. Incorporating NEHRP (National Earthquake Hazard Reduction Program) information into the section on non-building structures in IBC (International Building Code) 2000 is a major step in the implementation of more standardized codes. The intent is for the present array of building codes (BOCA, UBC, SBC, SSBC, and so forth), which vary from state to state, to become integrated into one code that will eventually be adopted by all of the United States and its political subdivisions. Ultimately, it is hoped that European and Asian nations will also adopt this code so that it can become globally accepted.

Until these building codes can be officially merged, having an agreement between industry leaders to utilize specialized design criteria for storage tanks is a tremendous accomplishment. This agreement is especially important in designing tanks to tolerate seismic loadings. New maps pinpointing locations of seismic risk heretofore unacknowledged are incorporated in these new standards. This new information is especially important when upgrading existing facilities to minimize seismic risk.

Independent Liquid Terminal Association Conference "Bulk Liquid Terminal and Aboveground Storage Tank Operations"

June 14 – 15, 1999

Houston, Texas

Tank Industry Consultants
Booth #1202

Tank Talk® is published as an informational resource for the storage tank industry. For past issues of Tank Talk, or to learn more about the services offered by TIC, please contact:

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Industry Updates

Regulations, standards, and codes within the storage tank industry are constantly changing—evolving to meet the needs of the public, and adapting to changes in technology. The following are brief updates on several relevant industry standards.

AWWA D100 Welded Steel Tanks for Water Storage: Discussions are taking place to determine what changes will be required in the next revision. The biggest change will likely be concerning the use of pressure stability for shells in compression.

AWWA D102 Coating Steel Water Storage Tanks: The Task Force met last fall and made significant progress in determining what coating systems will be recommended in the new standard. It is hoped that a revised standard can be issued in 2000.

AWWA Dxxx (Proposed D170) Composite Elevated Water Storage Tanks: Draft ballot #4 is now in process. A new ballot is anticipated before the Task Force Committee Meeting to be held at the Annual Meeting in June.

AWWA Tank Manual M-42 (November 1998) is now available for purchase from AWWA. The cost for the Manual is \$65 for members. Call 1-800-926-7337 to order a copy.

ACI 350 Environmental Concrete Engineering Structures: Ready for review and general membership comments. The seismic requirements for liquid-containing structures will be published as a separate document, *ACI 350.3*. This document is also ready for review. When published, *ACI 350.3* will correspond with *ACI 318-95* and *UBC-94* seismic requirements.

ACI 371 Guide for the Analysis, Design, and Construction of Concrete Pedestal Water Towers: Has been published and is available from the American Concrete Institute

API 650 Welded Steel Tanks for Oil Storage: 10th Edition, October, 1998 is now available.

Clever Engineering Eliminates Short Circle Water Circulation Problems

By Todd D. Moore, P.E., S.E., Chief Engineer, Tank Industry Consultants

Poor circulation in water storage tanks has been a problem for water utilities for many years. Inadequate circulation can lead to stagnant water and poor water quality. In the past several years, state health authorities have enacted tighter regulations governing circulation of water inside storage tanks.

Initial attempts to alleviate poor circulation in water storage tanks included installing separate inlet and outlet pipes on opposite sides of the tank. However, this can cause the water to flow in a direct path between the inlet and outlet pipes, short-circuiting the water. The stored water not in this direct path can become stagnant. Further attempts to solve this problem included installing baffles and pipe elbows to direct the water around the tank. Russ Williams of the Chester Water Authority in Chester, Pennsylvania devised a creative solution that may be of benefit to other tank owners.

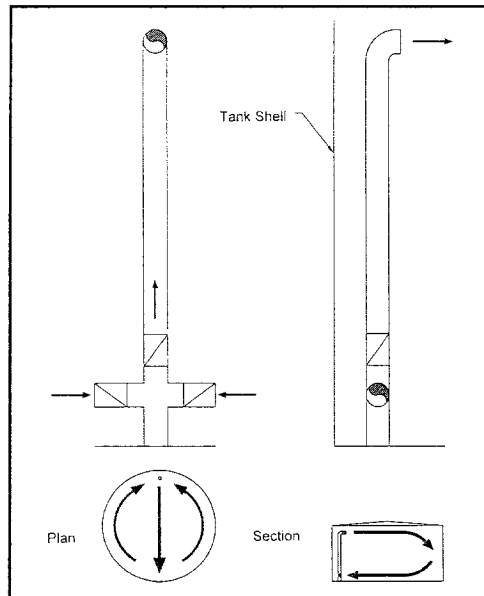
The CWA's ground storage tank had a single inlet/outlet pipe projecting through the floor near the vertical shell of the tank. To help eliminate water stagnation, the inlet/outlet pipe was fitted with a pipe cross just above the floor. Two check valves, oriented to allow water into the pipe, were installed on the horizontal runs of the cross. Another check valve allowing flow into the tank was installed on

the vertical run of the cross. The pipe was then extended to near the top capacity level and was equipped with a 90-degree elbow at the termination. The elbow was oriented to direct the incoming water towards the opposite side of the tank.

This circulation design allows the incoming water to enter the tank near the top and flow across the tank to the opposite side. When the water is withdrawn from the tank, the water exits the inlet/outlet pipe through the two check valves on the sides of the pipe near the floor. This causes the flow of water around the shell from the opposite side of the tank to the inlet/outlet pipe.

The influx of water at the top directed towards the opposite side of the tank creates movement of water within the tank. This mixes the incoming chlorinated water with the water already in the tank, which may have a lower chlorine residual. The withdrawing of the water through the two outlet pipes located almost parallel to the shell creates a natural flow around the shell towards the outlets.

The installation of this cross and corresponding check valves has significantly increased the amount of circulation within the tank and narrowed the range of chlorine residuals in the tank—proof that the cross is increasing the circulation and eliminating stagnant areas within the tank.



Our special thanks to Russell C. Williams, P.E., and the Chester Water Authority for allowing us to share this information with our readers.

Todd Moore, TIC Project Engineer for the Chester Water Authority project is a graduate of Notre Dame with an MS in Civil Engineering from Rose-Hulman Institute of Technology. Todd is actively involved in TIC's new tank construction and tank rehabilitation projects. He is a licensed Professional Engineer in numerous states, and a Registered Structural Engineer in the State of Illinois.

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AWWA Annual Conference and Exposition

The 1999 American Water Works Association Annual Conference and Exposition will be held in Chicago, June 20th through June 24th. This Conference is one of the best in the water industry featuring a comprehensive technical program that addresses the most pressing issues facing the water industry. The Conference serves as a forum for the standards committees to meet and discuss their work. Crone Knoy, Founder of TIC, is chair of the Steel Elevated Tanks, Standpipes & Reservoirs Committee that oversees the work of the D100, D102,

D103, and D104 Revision Task Forces. Those committees will be meeting on Wednesday, June 23rd. Call or write TIC for a schedule of the meeting times and locations.

Over 500 exhibitors will be on hand to showcase the latest products, technology, and services for the water industry. Representatives of TIC will be on hand to "talk about tanks" at booth numbers 608 and 609. Please stop by and see them.

For Conference registration information, contact AWWA at 1-800-926-7337, or visit their website at www.awwa.org.

TIC Hosts Industrial Tank Seminar in Alaska

Advancements in Aboveground Storage Tank Management

Alaska — in February?

At the urging of the Alaska Department of Environmental Conservation, Steve Meier, John Lieb, and Ken Jacobi of Tank Industry Consultants presented a customized three-day aboveground storage tank seminar in Anchorage, Alaska February 23 to 25. With a great deal of help from a number of people at Alaska DEC, including Dan Hopson, Ken Rogowski, and Larry Katkin, the well-attended seminar was prepared and orchestrated from start to finish within a period of about 4 weeks—a feat some doubted could be accomplished.

The seminar focused on API 653 and upcoming changes in codes and standards, including seismic design criteria. There were also discussions of the latest approaches to tank management including coatings, foundations, leak detection, and secondary containment.

Although billed as a "seminar," the meetings developed into a free exchange of ideas and concerns between the attendees and the instructors. Several noteworthy industry leaders—including Phil Myers of Chevron, and Tarik Haj-Hamou of Geo-Syntec—shared their expertise through mini-presentations during the three-day program.

Dan Hopson, Environmental Specialist at the AK DEC, had these comments at the conclusion of the seminar:

Alaska's topography and climate pose unique problems for the petroleum industry. It is a region of high seismic activity, challenging sites for tank foundations, and extremes of wind and temperature. In addition, Alaska has some of the most stringent state regulations on tank design and maintenance. So it was especially rewarding for our tank professionals (owner/operators, inspectors, engineers, and regulators) to discuss technical issues with guidance from TIC's experts in their recent seminar. Thanks to TIC's flexibility in customizing the form and content of the seminar, we were able to focus on subjects of interest to the Alaskan community.

I think all 50 or so participants came away with a deeper understanding of API 653 inspections and industry standards for seismic design and tank coatings. The technical reference materials and new contacts within the industry were a solid bonus. Thanks for a job well done. We hope Steve, John, and Ken enjoyed their brief stay here on "the last frontier."

Our three Chicago-area natives returned with glowing reports of the beauty of Alaska—and amazement that the weather was really very comparable to that in Chicago during the same period. However, all agreed that they didn't very often find elk and moose just outside their homes in Chicagoland.

TIC Engineers' at Aboveground Storage Tank Conference

Steve Meier and John Lieb spoke at the recent **National Institute for Storage Tank Management, Second Annual National Conference on Aboveground Storage Tanks**. Mr. Meier's presentation was entitled "Upcoming Changes to Seismic Design Criteria. John Lieb's presentation was on "Proper Installation and Retrofitting of Double Bottoms."

For a copy of either or both presentations will, please call, write, or e-mail your request to Tank Industry Consultants.

TIC Storage Tank Seminars Coming to California

Throughout the year, Tank Industry Consultants hosts water storage tank and industrial storage tank seminars at selected sites throughout the United States. These seminars are designed to provide tank owners, engineers, and regulators with the information needed to design, construct, and rehabilitate storage tanks for current and future use.

The next two-day seminar will be held in **Irvine, California, on August 12 & 13, 1999**. The seminar will feature the attendee's choice of either a water tank or industrial tank focus on Day One, and a joint session that will cover common topics on Day Two. The schedule for the second day includes detailed information on seismic regulations, design, and retrofit; tank fabrication and construction; and corrosion control and coatings.

Other seminars are being planned for the Baltimore area this fall, and in Houston, Texas early in 2000.

If you would like more information about the up-coming California seminar or future seminars, please write, fax, or e-mail your mailing information to:

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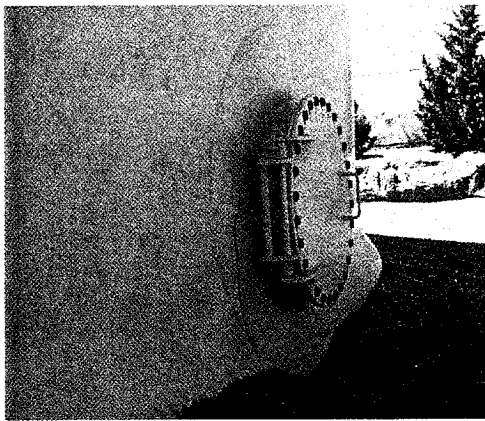
Changes to Seismic Design Standards

By: *Stephen W. Meier, P.E., S.E.*, Vice-President of Engineering and Technology

National design standards first began to include procedures for the design of liquid storage tanks to resist earthquakes in the 1970's. The basic design standards and codes for tanks focused on providing better details and structural resistance based on observed behavior and problems. This evolution in the design standards has reduced both the frequency and the severity of problems with liquid storage tanks when they are exposed to ground motion.

The goal of seismic design criteria for engineers and code writers is first and

foremost the safety of the public. To accomplish this, the approach has often been directed at preventing collapse or catastrophic failure. The performance or serviceability of the structure



exposed to after shocks, minimizing property damage, or surviving the "big one" has not been incorporated into today's building codes. Early methods, which are still in use today by most liquid storage tank standards, are based on a prescribed earthquake load measured against an allowable stress in the components of the structural system.

Since engineers first began to consider lateral loads from ground motion in the design of structures, the fundamental basis of the design load has changed very little. The methods for establishing the level of seismic ground motion and accelerations has continued to be defined into four basic zones that roughly approximated an event with a return interval of 475 years. As maps were developed, the boundaries were often skewed to fit local political or jurisdictional issues. New parameters to consider the influence of the type of soil, the importance of the structure to post earthquake society, and the

ductility of different types of structural systems and materials were added to the methods as knowledge increased. As a result of impending changes to seismic design criteria, structures in many areas of the country will have to be designed to withstand a much more severe seismic event. This is particularly true of structures east of the Rocky Mountains.

Several changes either have been made or will be incorporated into earthquake design standards such as the 1997 National Earthquake Hazard Reduction

Program (NEHRP) Provisions, ASCE 7, and the upcoming International Building Code 2000, which replaces UBC, SBC, and BOCA.

Owners and operators of liquid storage tanks

should factor these changes into their facility upgrade and operational readiness planning. It is often practical and economical for existing tanks and vessels to be upgraded to these new seismic criteria in order to remain compliant with the governing building code. However, retrofits patterned after building-type structures solutions are expensive and often not suitable for tanks and vessels. A seismic retrofit of a storage tank should begin with a thorough evaluation of the existing structure, with particular attention to tank details that may be susceptible to damage in an earthquake. The design of the retrofit should be performed by a structural engineer experienced in the behavior of tanks and knowledgeable in details used in tank construction. Properly retrofitted, many tanks—whether of steel or concrete—can offer significant continued service life and provide a degree of seismic stability comparable to new structures built to current, more rigid standards.

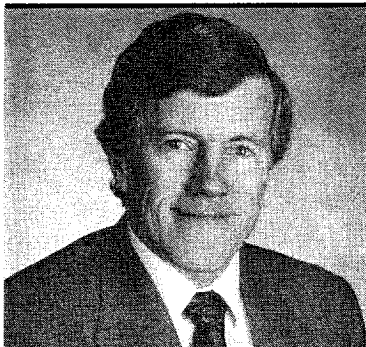
Changes in Seismic Design Criteria

- The seismic hazard map will be defined based on a 2% probability of exceedence in 50 years instead of the previously used 10%. Thus the return interval increases from 475 years to about 2500 years (i.e. a larger event). Based on scientific studies, this is considered to be a more appropriate level of margin against collapse across the US. Practically, this means that many areas that may have previously been exempt will now require design and detailing for an earthquake event.
- The maximum considered earthquake ground motion is reduced to provide an economically feasible lower bound design earthquake that will somewhat equate to a design level similar to present requirements.
- Nonbuilding structure requirements are being added to upcoming codes and standards.
- A site-specific soil evaluation is highly recommended for many areas of the US. The soil conditions will often have a larger impact on the design event than is presently included in some codes.
- Importance Factors are based on the hazard posed to public health and safety by the material stored, as well as the need for the tank following the earthquake.
- The shape of the fundamental response spectrum will be a direct function of the natural period of the structure. This has direct and significant impact on longer period structures.
- Requirements for piping connections details, provisions for sloshing, and anchorage ductility will be added.
- Fluid and soil-structure interaction will be permitted within prescribed limits.

Steve Meier is a member of the National Earthquake Hazards Reduction Program Provisions Update Committee and Technical Subcommittee 13-Nonbuilding Structures. He has also been very active in AWWA D100 and D170 Water Tank Standards Committee work.

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New Faces Bring Added Expertise to TIC



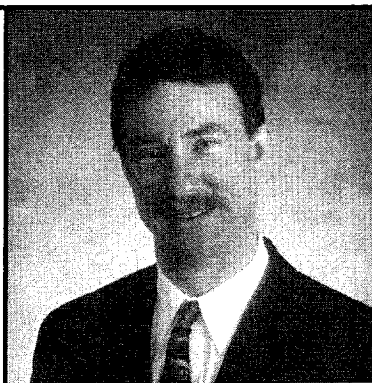
John M. Lieb, P.E.

John Lieb joined TIC as *Chief Engineer-Industrial*. A nationally recognized expert in the design of plate structures including specialty plate structures for water, petroleum, chemical, and granular industries throughout the world, John brings to TIC over 24 years experience in the design and detailing of complex ground level and elevated structures. These structures have included tanks certified to API 650 and API 620, stamped and non-stamped ASME pressure vessels, AWWA water storage tanks, granular storage and handling systems, and a wide variety of plate structures and structural systems designed in accordance with various international codes and standards. John is a member the American Petroleum Institute (API) and is active on API's Subcommittee on Pressure Vessels and Tanks and several Special Task Forces currently including Task Forces on external pressure and frangibility issues. He is also an ANSI/API 653 Certified Aboveground Storage Tank Inspector.

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Ken Jacobi has nearly 25 years experience in industrial and water tank coatings application and technology. For more than 16 years, Ken supervised a variety of painting functions for one of the largest storage tank fabricators and erectors. There he was responsible for sales and technical support, preparation of paint procedures and/or review of nuclear procedures, and field execution of painting work on tank linings, stack and penstock liners, sugar silos, and other miscellaneous tank work. He coordinated the coating of more than 120 tanks and vessels in Saudi Arabia, and was responsible for coating inspection in fabrication shops including inspection for all nuclear work. He has also been a technical representative for international coating manufactures. As TIC's *Headquarters Regional Manager*, Ken's experience with state-of-the-art coatings has proven to be invaluable to TIC's clients, providing coatings solutions for today's technological and environmental concerns.

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Kenneth A. Jacobi

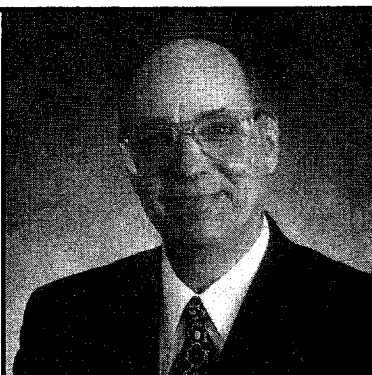


David D. Baird Jr., P.E.

Since his retirement from Chicago Bridge & Iron Company, **Dave Baird** has been a consultant for Tank Industry Consultants. Dave has over 37 years experience designing, engineering, and managing steel plate structures and related systems both in the United States and at a number of overseas locations. A graduate of the University of Kansas, Dave managed a number of departments at CBI with product line responsibility worldwide for fixed and floating roof flat bottom storage tanks, granular storage structures, and spherical pressure vessels, among a number of other types of structures. He was responsible for all of CBI's engineering activities in Singapore, Indonesia, Australia, and other countries in the Asia-Pacific area. He was Project Engineering Manager for a major wind tunnel for NASA; for an Advanced Seal Delivery System for the U.S. Navy; and Project Manager for Magnetic Energy Storage development work for the Nuclear Defense Agency.

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Royce Laverman, Tank Industry Consultants' *Senior Consultant*, is a nationally recognized expert on issues involving storage tank emissions including floating roofs, roof seals, and testing protocol. Among his key accomplishments are the development of storage tank emission calculation methods and equipment loss factors that have been adopted by the United States Environmental Protection Agency for use by the petroleum and petrochemical industries. Well known within the American Petroleum Institute for his outstanding work on various committees including API's Environmental Technical Advisory Committee, Royce is also a member of the American Society of Mechanical Engineers and the Cryogenic Society of America. Royce brings to TIC nearly 40 years of experience with a major storage tank constructor. During his career he has been granted fourteen U.S. Patents.



Royce J. Laverman, MSME