PETROCHEMICAL & OIL FACILITY ENGINEERING SERVICES
Thornton Tomasetti serves clients worldwide in the fields of structural and civil engineering, transportation/infrastructure, and advanced analysis for applied science research. A pioneer in the design of high-rise, long-span, fabric, blast-resistant and other special structures, the firm is also known for innovative bridge rehabilitation, blast and seismic design and retrofit, and development of software for government and private industry.

We set ourselves apart from traditional engineering companies by developing advanced simulation software that is widely used by government and industry in the United States and abroad. Combining theory, testing, investigation and practice, the firm’s continually expanding knowledge base of blast, shock, impact and nonlinear material behavior effects leads to better designs, enhancing the safety of the nation’s tall buildings, infrastructure, military assets, and petrochemical processing facilities.

Our advanced analysis tools improve approaches to litigation and retrofits and produce risk analyses that increase the objectivity of decision-makers responsible for hazard and disaster mitigation planning.
SERVICES

Vapor-Cloud-Explosion Blast Estimates
We perform blast-characterization analysis of deflagrations, deflagration-to-detonation transition and detonations for onshore and offshore facilities exposed to accidental hydrocarbon release. We use a variety of methods to accurately estimate building-envelope applied loads and line-of-site loads from vapor cloud explosions. Analytical approaches include the TNO multi-energy and BST methods. Our fast-running computational fluid dynamic (CFD) modeling method propagates VCE blast loads to account for shielding, channeling and reentrant corner effects not provided in line-of-site methodologies.

Building-Occupant Vulnerability Quantification
We use sophisticated modeling to predict building-envelope damage – and the corresponding threat to occupants – caused by blast overpressure and impulse. The models include such factors as distribution of building occupants and hazards posed by exterior doors, punched windows and glass curtain walls.

Security-Vulnerability Assessments
We perform security and vulnerability assessments for intentional chemical facility attacks. Our assessments also estimate blast, toxic, and fire hazards associated with these attacks. Accurate SVA results help facility owners and operators make appropriate adjustments to security measures and inventory quantities.

Strengthening of Occupied Buildings
We design strengthening measures for new and existing occupied buildings, both on- and offshore, to meet quantitative-risk-assessment and consequence-based facility siting requirements, as mandated by OSHA PSM Regulation 29 CFR 1910.119 and API RP 752.

Quantitative Risk Assessment for Facility Siting
We help our petrochemical and oil-services clients determine the best placement for structures and for building occupants within a facility by predicting the maximum risk – both individual and societal – of lethality. We evaluate risk based on construction type and estimated structural damage as determined by overpressure-impulse damage curves. We also produce revised damage curves based on building strengthening or retrofits to help our clients optimize facility-siting decisions.

Accident Investigations
Our specialized expertise in accident and forensic investigation includes site control, evidence collection, property loss, cause and origin, and root cause and expert witness investigation support for accidental vapor cloud and bursting-pressure-vessel explosions. We also perform life-expectancy and failure analyses for equipment affected by known metallurgical and weld deficiencies, including corrosion.

Hazard Mitigation: Blast, Fire, Toxic & Fragment
Our hazard-mitigation services include shield design to mitigate fragment-impact damage and perforation. We perform thermal-response analysis of shelter-in-place buildings under radiant-heat-flux and jet-impingement fire loads. And we design modifications to conventional building envelopes, such as strengthening to resist postulated peak applied-pressure and impulse loading and enhancements to increase thermal longevity and reduce toxic infiltration, to decrease risk to occupants.

Natural Hazard Mitigation: Wind and Earthquake
We evaluate facilities for loads imposed by seismic and wind events and design retrofits to achieve satisfactory performance for structures, piping and other elements critical to plant operations. We also design retrofits and other modifications for combined accidental and natural risk mitigation.

Downhole Tool Verification Testing, Fragment Velocity & Blast Characterization
We provide analysis to predict the characteristics of an accidental failure during tool testing in high-pressure and extreme high- and low-temperature environments that simulate downhole conditions. The resulting data are crucial to developing appropriate design criteria for test cells to protect test personnel. We use proprietary time-stepping software, along with 2D axis-symmetric and 3D CFD numerical calculations, to efficiently model fragment velocities and shock loading. Both approaches allow for moving rigid objects, such as moving flanges, end plugs, and failing walls, to better estimate nitrogen and water release under high pressure.

Design for High-Pressure/Extreme-Temperature Test Cells
We provide analysis and design for hardened test enclosures that are used to validate oil-services tool performance under extreme pressures and temperatures that simulate downhole conditions, to protect test personnel against unforeseen test fixture failures. We are experienced in the design of a variety of test cell types, including pits with hardened lids; walk-in test cells with and without roofs, to allow crane access; and tabletop coffins. We design cost-effective structural barriers to resist fragment perforation and blast loads, using proprietary nonlinear dynamic finite-element analysis calculations that enable efficient modeling.
Mitigating Hazards Throughout the Petrochemical and Oil Services Industries

For more than 50 years, we have provided quality engineering, R&D, investigative, and field-testing services for clients handling explosive and flammable materials. We help clients understand and prioritize risks, and offer cost-effective solutions to help manage them.
**KEY PERSONNEL**

Reach our leadership team at Petrochem@ThorntonTomasetti.com.

**Jim Wesevich, P.E., S.E.**

Jim has more than 29 years of experience mitigating blast hazards for land-based and offshore petrochemical facilities and for U.S. government installations. He is skilled in building assessment and retrofitting using consequence or quantitative risk assessment-based facility-siting studies, following API-recommended practices for buildings occupied exposed to vapor cloud explosions. Jim, who is the firm’s petrochemical market sector leader, uses sophisticated analysis models to assess existing building components and formulate structural upgrades to protect building occupants, and validates designs through open-air and shock tube testing. He also provides design support for blast-hardened test cells to mitigate accidental blast and fragment hazards from high-pressure and extreme-temperature validation testing in environments that simulate pneumatic and hydrostatic downhole tool conditions. Jim’s expertise includes incident investigations, particularly those involving vapor cloud explosions and bursting pressure vessels. He has performed investigations for BP, Amoco, Bayer, Total (Buncefield), Valero, CF, Motiva, PMV (Coatzacoalcos) and others. He is skilled in site control, protocols, evidence collection, root-cause determination, and expert witness investigation support.

+1.512.580.1751 (Texas)

**James M. Weeks, P.E.**

With more than 35 years of leadership and engineering experience, Jim has been the lead structural design engineer for office buildings, laboratories, production plants, pump stations, control buildings, and test and storage facilities for clients in the petrochemical and nuclear industries. He has particular expertise in the design and analysis of structures subjected to dynamic loads and is experienced in linear and nonlinear finite-element analysis. Jim has also performed accident investigations for vapor cloud explosions and other energy-industry-related issues in the U.S. and Mexico.

+1.505.349.2832 (New Mexico)

**Thomas Berry, P.E.**

Tom is a licensed mechanical engineer with more than 35 years of industry experience involving facilities and process design, manufacturing operations and process analysis. He specializes in the analysis and investigation of building systems; chemical and petrochemical processes; and equipment used in manufacturing, industrial and commercial facilities using Six Sigma methodology. He leads multidisciplinary teams of professionals performing forensic investigations and offers expert witness services.

+1.213.330.7007 (California)

**Pawel Woelke, Ph.D., P.E.**

Pawel specializes in material and structural-integrity analysis, with a focus on the failure of pipelines, pressure vessels, hazardous-materials packaging and other petrochemical facility elements. He also tackles challenging engineering problems in automotive, rail, shipping, energy storage and other industries, as well as advanced analysis of extreme events (e.g., explosions, impact, fire) and their effects on critical infrastructure. A strong background in predictive failure modelling and failure analysis, coupled with expertise in materials, enables Pawel to provide unique insights into the behavior of structures and materials subjected to extreme loads and environments.

+1.212.367.2983 (New York)

**Phil Thompson**

Phil has more than 27 years of experience in blast effects and computer simulation, specializing in the effects of explosions on petrochemical facilities, buildings, ships and submarines. He has conducted extensive research into terrorist attacks on critical industrial and commercial infrastructure, design of explosive protective systems, design and management of large-scale explosive trials and holistic vulnerability assessments. Phil has consulted on several large offshore projects and has advised operators on the use of explosives offshore for decommissioning, risk to pipelines and installations from unexploded ordnance, and safety of ROVs.

+44.13.8382.8271 (Scotland)

**Darren Tennant**

Darren is an expert in 3D nonlinear finite element analysis. He has more than 30 years of experience evaluating the response of structures subjected to impact, collapse, explosive effects and thermal/fire loading. He validates fast-running modules and high-fidelity physics-based software as part of testing programs for computational structural dynamics, computational fluid dynamics and coupled CFD codes. He has contributed to test programs, forensic studies, infrastructure retrofits and building projects, nuclear plants and nuclear transport evaluations, and power infrastructure vulnerability studies.

+1.505.349.2820 (New Mexico)

**Phill Thompson**

Phill has been the lead structural design engineer for major infrastructure assets, relying on computational simulations of extreme events and physical testing as a basis for design. He has also investigated some of the largest collapse cases in the U.S., including the World Trade Center and Tropicana Casino garage collapses, and has served as an expert witness and a consulting expert. Phil also heads the firm’s Weidlinger Applied Science practice.

+1.212.367.3074 (New York)

**Phill Thompson**

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**Najib Abboud, Ph.D., P.E.**

During his more than 25 years in the industry, Najib has performed hazard mitigation design and rehabilitation for major infrastructure assets, relying on computational simulations of extreme events and physical testing as a basis for design. He has also investigated some of the largest collapse cases in the U.S., including the World Trade Center and Tropicana Casino garage collapses, and has served as an expert witness and a consulting expert. Najib also heads the firm’s Weidlinger Applied Science practice.

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RELEVANT PROJECTS

Buncefield, England
A large vapor cloud explosion at the Buncefield oil depot near Hemel Hempstead, England, produced damage to surrounding properties that far exceeded what existing safety-assessment methods would have predicted. We analyzed badly damaged cladding from the adjacent Northgate office building, using simplified single-degree-of-freedom and high-fidelity finite-element analyses to estimate the blast-wave shape and explosion magnitude. Our analysis showed that the explosion was a complex deflagration of the vapor—not a high-order detonation or deflagration-to-detonation transition, as other investigators had reported. This discovery held significant public safety implications for similar facilities.

Port Arthur, Texas
We developed detailed structural retrofits for blast hardening of the NAC building at a Total refinery. The single-story structure consists of eight-inch-thick unreinforced and reinforced CMU walls with a noncomposite steel deck roof supporting three inches of concrete. Blast-resistant structural upgrades included strengthening the CMU walls and adding a cap roof. We validated and modified the blast loads to more accurately reflect the applied blast loads on the structure. All structural components were designed to meet the medium response criteria set forth by ASCE. Our design minimized downtime and interruptions to operations inside the building.

Calvert County, Maryland
We performed detail engineering for a sound-barrier wall to prevent noise levels from exceeding allowable limits at noise-sensitive areas south and west of the Dominion Cove Point Liquefied Natural Gas (LNG) Terminal after a proposed expansion of the facility. The design included a hardened section that could resist blast overpressure to protect occupied buildings south of the terminal.

Paramount, California
We provided structural blast design support for a central control room at the Paramount Petroleum Corporation. The hardened structure and placement of the control room building were designed to protect process-unit operators from postulated accidental vapor cloud explosions. We used pressure and impulse contours from four potential explosive-source locations to meet the facility siting requirements of the American Petroleum Institute, Recommended Practice 752 for buildings located at hazardous facilities covered by OSHA PSM regulation (29 CFR 1910.119). Our team determined the makeup of the building walls, roof, and door and window systems in accordance with the applied blast loads and nonlinear dynamic single-degree-of-freedom analysis to meet an acceptable level of damage and glazing hazard.
Thornton Tomasetti provides engineering design, investigation and analysis services to clients worldwide on projects of every size and level of complexity. We are a 100 percent employee-held organization of 1,200 engineers, architects, sustainability practitioners and support professionals collaborating from offices across North America and in Asia-Pacific, Europe, Latin America and the Middle East. We focus on providing a diverse suite of integrated services and leading innovation in our industry to ensure the continued success of our clients.

Offices Worldwide

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China  Maine  Pennsylvania  Washington, D.C.
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