PipingSolutions, Inc.

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Engineering Consulting Services Overview

PipingSolutions, Inc. is an engineering consulting and software development company. PipingSolutions, Inc. was initially the Engineering Software and Consulting Division of AAA Technology and Specialties Co., Inc. AAA Technology was founded in 1971 to provide top quality services and products to many facets of the process industry. In 1999, AAA Technology spun off the Engineering Software and Consulting Division to form a separate corporation called PipingSolutions, Inc. AAA Technology continues to design, manufacture, market, and supply a complete range of pipe hangers and supports as described on their website http://www.aaatech.com.

PipingSolutions provides consulting services to companies that need our unique expertise in performing specific engineering studies and continues to develop, market, supply and support our engineering solutions software. Together, PipingSolutions and AAA Technology (prior to 1999) have invested many man years of software development resources in the software shown under the "Products" heading of this website. PipingSolutions has successfully completed numerous consulting projects for a wide variety of clients throughout the world. We specialize in reducing overloaded engineering departments and in solving problems that frequently are considered more complex than in-house staff members are prepared to handle, for whatever reason.

Our engineers and consultants typically have more than 20 years experience and some have advanced degrees. Our experience and expertise along with our commitment to providing top-notch serve to our clients should give you the comfort of knowing that we are on the assignment to find "Solutions" for your problems.

The services offered by PipingSolutions are outlined below. For more details, please contact PipingSolutions at 713-849-3366.

PipingSolutions provides the following consulting services:

➢ ***Piping Flexibility and Stress Analysis*** – Our piping stress analysis consulting service consists of: 1.) collecting field data, if required, 2.) generating piping isometrics, if required, 3.) constructing a TRIFLEX® computer model of the piping system along with any connected equipment and 4.) processing analyses with the appropriate loading conditions.

We perform analyses for clients with the following analysis considerations:

▪ *Rotating Equipment Loading Studies* - Casing and Nozzle Loading Studies are performed by PipingSolutions to determine compliance with NEMA Std. for Steam Turbines, API Std. 617 for centrifugal compressors and API Std. 610 for centrifugal pumps. Based upon discussions with our clients, PipingSolutions then processes additional analyses incorporating the appropriate piping and restraint modifications. The end results that we deliver are piping systems that apply loads on rotating equipment that are within the allowable limits of the appropriate rotating equipment standard.

▪ *Piping Code Compliance Stress Analysis Studies* – Piping systems operating at very high or very low temperatures are generally difficult to design so that the stress levels are within the stress allowable limits set forth within the appropriate piping code. PipingSolutions' staff model and perform the appropriate analyses and identify overstressed areas within piping systems. Once overstressed conditions are identified, PipingSolutions' staff modifies the piping system configuration and or the restraints in order to achieve piping systems operating within the stress limits that are defined in the applicable piping code.
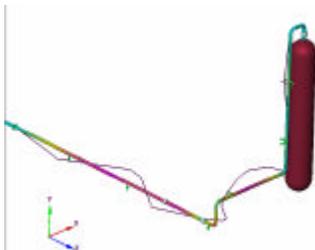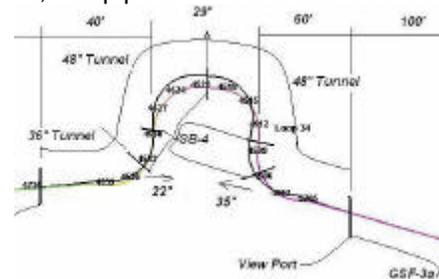
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- *Anchor and Restraint Design Studies including the Sizing and Selection of Spring Hangers* – PipingSolutions has extensive experience analyzing and designing a wide variety of anchors and restraints including low friction slide bearings for operating temperatures up to 1,000 deg F, insulated supports and anchors for operating temperatures of -300 deg F to 1,750 deg F, axial restraints, limit stops, guides with or without gaps, hold down clamps, shoes, sway struts, sway braces and hydraulic snubbers. PipingSolutions specializes in performing the required piping stress analyses and designing the required anchors and restraints to the applicable structural code or standard. In essence, PipingSolutions delivers the entire design for the piping system as well as the anchors and restraints. If the client desires, we can work with our sister company, AAA Technology, to fabricate the desired anchors and restraints and deliver the entire package to your jobsite.

- *Buried Pipeline Stress Analysis Studies* – PipingSolutions performs the required piping stress analyses necessary to properly evaluate buried pipelines for movements, soil/pipe interaction and stresses. The simulation of the soil to pipe interaction is frequently one of the most complex properties to evaluate and simulate. Given reasonably accurate soil properties, PipingSolutions constructs a model of the pipeline and processes TRIFLEX® analyses. PipingSolutions is fully capable of interpreting the results generated and making recommendations for modifications, if required. Anchor Flanges and Concrete Anchor Blocks can be designed or the alternative Steel Anchor Clamps and Anchor Frames can be designed when more expedient solutions are required. The end results PipingSolutions obtains for our

clients are buried pipelines that function in a repeatable manner within the appropriate piping code's criteria as the pipeline is cycled from shutdown to operating conditions and back. We specialize in eliminating problems in existing pipelines and gathering systems.

- *Vibrating Piping System Studies* – PipingSolutions constructs piping models using TRIFLEX® and evaluates the piping systems' susceptibility to vibration at differing frequencies. For piping systems, we compute natural frequencies and then the mode shapes. We offer recommendations for how to avoid vibration problems in new piping systems and in how to eliminate vibration problems in existing piping systems.

- *Earthquake Simulation Studies* - PipingSolutions constructs piping models using TRIFLEX® and evaluates the piping systems' response to earthquake loadings on the piping systems and the restraint structures. We then evaluate the results of the analysis, consult with our client and recommend modifications to the piping system should they be necessary. The end results of PipingSolutions' studies are piping systems that function within the piping code allowables under earthquake loadings.

- *Studies of the Effects of Water Hammer and other Transient Flow Conditions* – Given the water hammer event or transient flow description, PipingSolutions constructs piping models using TRIFLEX® and evaluates the piping systems' response to the water hammer or other transient flow loadings on the

piping systems and the restraint structures. We then evaluate the results of the analysis, consult with our client and recommend modifications to the piping system should they be necessary. The end results of PipingSolutions' studies are piping systems that function within the piping code allowables under transient flow conditions with restraint loadings within the design range. Our ultimate goal is the elimination of water hammer effects or, at a minimum, the effective handling of the effects of the water hammer loadings. In the event that the water hammer or other transient flow loadings are not known, PipingSolutions can have the piping system instrumented and can collect the data or can simulate the loadings using the appropriate commercially available fluid flow software.

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- *Rotating Equipment Imbalance Studies* – Given the imbalance numerical data, PipingSolutions constructs piping models using TRIFLEX® and evaluates the piping systems' response to the equipment imbalance as well as the restraint structures. We consult with our client and recommend modifications to the piping system should they be necessary. The end results of PipingSolutions' studies are piping systems that function within the piping code allowables under the equipment imbalance conditions. Our ultimate goal is the elimination of equipment imbalance and the minimization of the piping systems' vibrating response to the equipment imbalance.

- **Pressure Relief Piping System Simulation** - PipingSolutions:
   - Performs in-plant data collection, if required to model the piping system,
    - Constructs a model of the piping system using TRI*HEADER™ to determine pressure and temperature of piping components during exhaust as well as the phase composition, density and velocity of the fluid as it flows through the piping system,
    - Constructs a piping model using TRIFLEX® and processes a static analysis to determine the movements, forces, moments and stresses in the piping system as a result of the steady state loadings,
    - Given the process data and the timings of each loading event, conducts a time history analysis of the piping system using TRIFLEX® to accurately simulate the relieving event. Our report of conclusions to our client includes a detailed statement of the stresses required by the piping code and their compliance with the allowables as well as a similar statement of our findings in regards to fatigue.
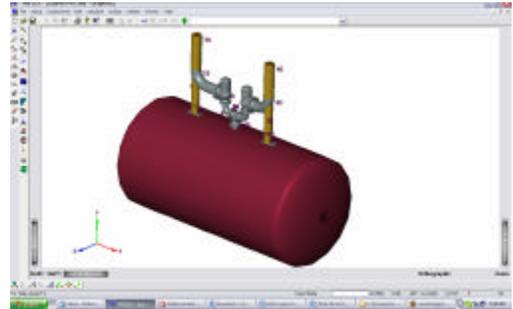
    Our goal is to insure that our clients' pressure relief systems are rated correctly and function as intended without resulting in an over stressed condition.

- **Finite Element Analysis Studies** - PipingSolutions:
    - Constructs a finite element model of the component to be analyzed using the commercially available software best suited for the project,
    - Imposes the client specified loads and design conditions on the model,
    - Processes analyses to evaluate deflections, rotations, linear and non-linear reactions, seismic effects, fatigue, heat transfer, stresses, etc.
    - Our reports include a statement of the assumptions, the analysis methods, the limits of applicability, the analysis results and our conclusions. Reports also include color plots and/or drawings of key areas of interest of the component being analyzed, deflected shapes of appropriate parts of the component and animated results, if applicable.
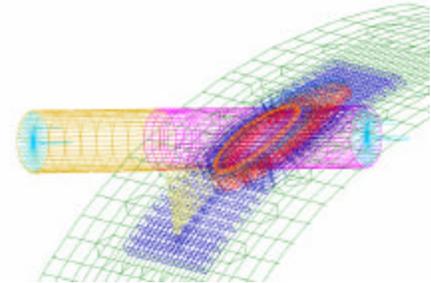
- **Structural Analysis and Design Services** – PipingSolutions:
    - Constructs structural models using TRIFLEX® and other structural programs to compute deflections, rotations, forces, moments and stresses in steel structures accordance with the AISC standard.
    - Processes analyses to evaluate deflections, rotations, forces, moments and stresses in structures as a result of various steady state loadings, non-linear loadings, soil effects, transient loadings, seismic effects, etc.
    - Designs structures and foundations in accordance with client's loading requirements and results of analytical work performed in the study stage,
    - Conducts feasibility studies in the planning stage in order to provide our clients with solid financial numbers on which management budgetary decisions can be made.
    - Develops innovative design solutions for difficult to solve cases. Historical review of past work reveals substantial savings for our clients in the fabrication of the structures designed as well in the installation of the fabricated structures.
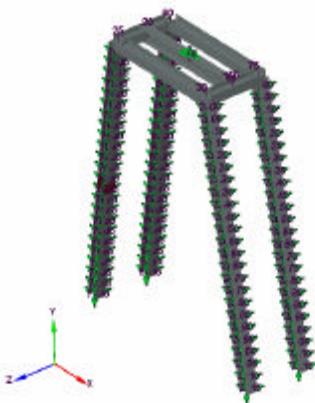
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➢ *Pipe Hanger Assessment Services* – PipingSolutions:
- Performs in-plant pipe hanger and support surveys,
- Documents the survey results,
- Assesses the suitability of the supports for continued service, and
- Field supervision of removal and replacement of pipe supports and restraints.

Piping movements and loads can be verified in the shut down and operating conditions. Replacement pipe hangers and restraints can also be designed. Detailed reports of findings are provided to the client at the conclusion of the project.

➢ *Piping Data Collection and Isometric Generation Services* – PipingSolutions:
- Sends it staff into the plant or industrial location to collect the required descriptive information and dimensions
- Generates isometric drawings with complete bills of materials.
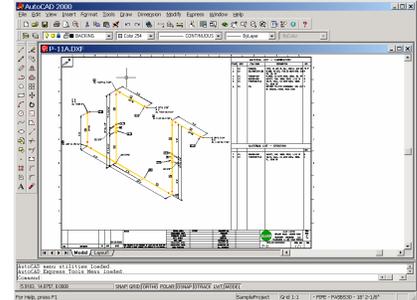
➢ *Flare Header Piping System Rating and Design* - This service consists of modeling an existing or new emergency relief system including pressure relief valves and knock-out drums on the TRI*HEADER computer program. The piping system will then be evaluated by simulating a variety of blow down or relieving cases. Flow problems will be identify and a variety of possible flow solutions can be tested in the computer model to identify the optimum solution. The TRI*HEADER software used by PipingSolutions has a well-tested data base that is used to perform rigorous VLE, heat transfer and two phase flow calculations in order to accurately predict fluid behavior throughout the emergency relief system. Thermal effects are taken into consideration and choked flow conditions are identified and located. PipingSolutions can analyze existing piping networks for problem areas or we can optimize piping networks solving for minimum pipe sizes necessary to meet flow requirements.

API 650 Tank Rating and Design - This service consists of designing a new API tank or rating an existing API tank on our TRI*TANK650 computer program in accordance with API Std. 650.

➢ *Nozzle Stress Analysis and Design* - This service consists of modeling a branch connection or a structural attachment on a piping system, pressure vessel, heat exchanger or tank. Our staff would utilize the applicable calculation techniques set forth in the Welding Research Council Bulletins No. 107 and/or No. 297. These WRC Bulletins are referenced in the ASME Section VIII Boiler and Pressure Vessel Code. A detailed report of our findings and recommendations is provided for each nozzle stress calculation performed by PipingSolutions.

PIPINGSOLUTIONS specializes in finding solutions for:
- *Hot buried pipelines & unique anchoring system for buried pipelines*
- *High temperature & Cryogenic process piping systems*
- *Relief process piping systems*
- *Rotating equipment piping systems*
- *Vibrating piping systems*
- *Chronic problem piping systems*