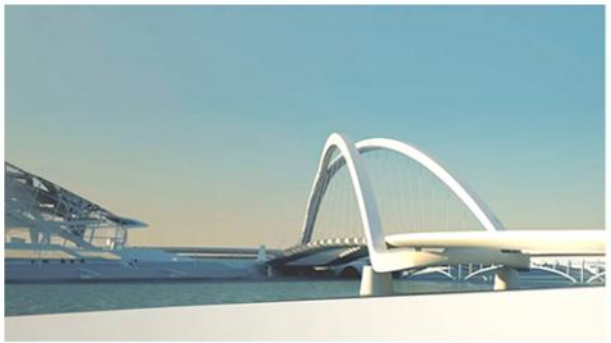
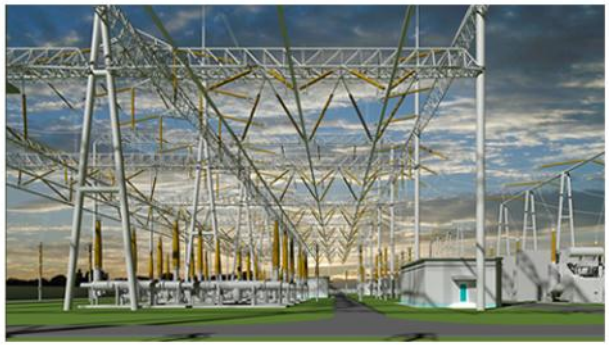
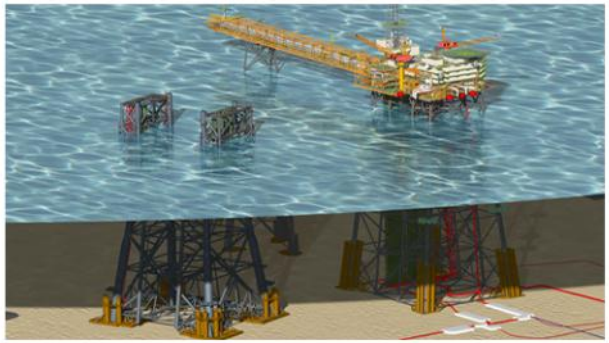




Introduction to AutoPIPE

Badreddine Ziane

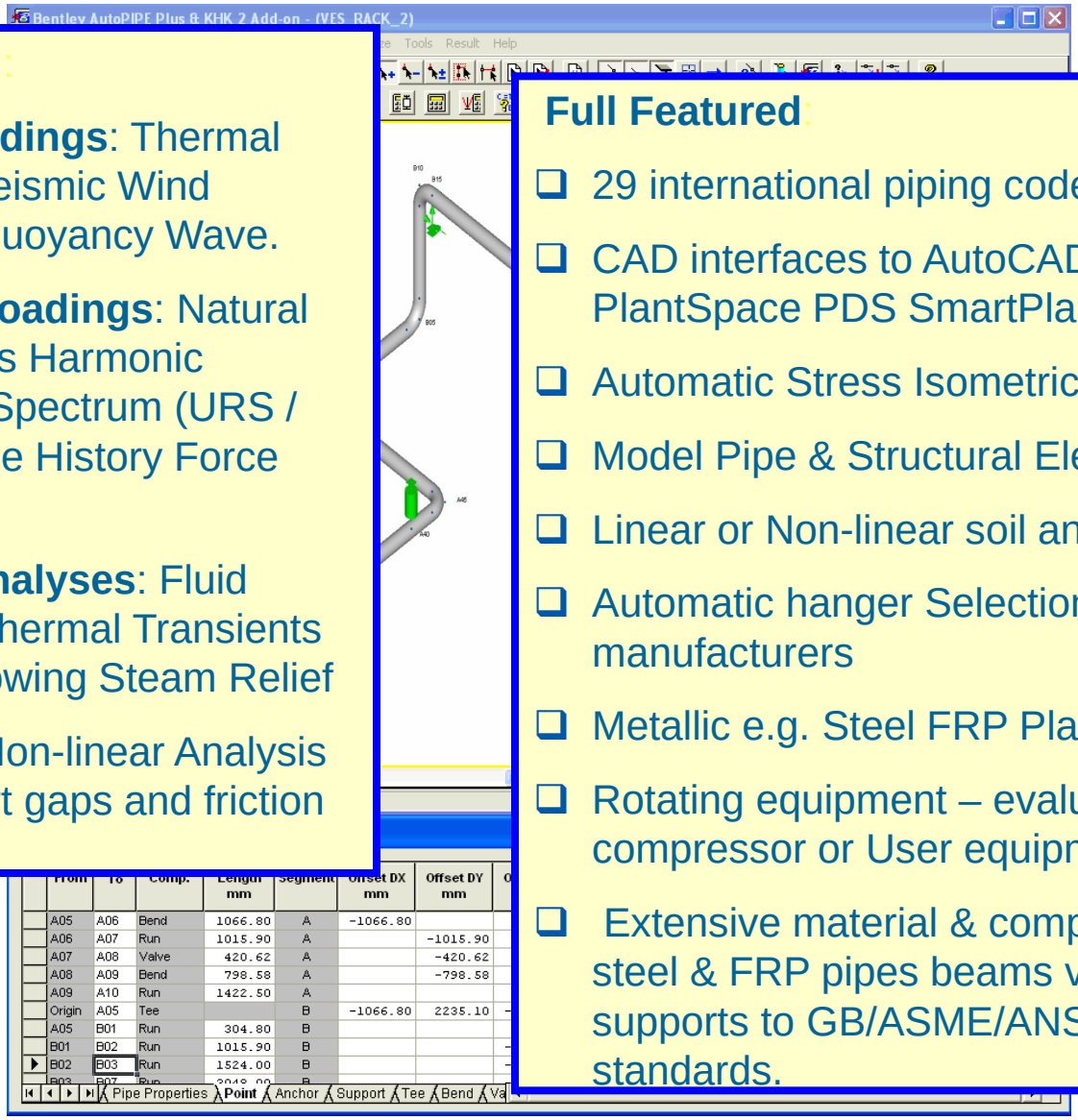
Vejle, 5th – 6th November 2012

Bentley Sustaining Infrastructure

What is AutoPIPE?

Full Featured:

- **Static Loadings**: Thermal pressure Seismic Wind Hydrotest buoyancy Wave.
- **Dynamic loadings**: Natural Frequencies Harmonic Response Spectrum (URS / MSRS) Time History Force Spectrum
- **Special Analyses**: Fluid Transient Thermal Transients Thermal Bowing Steam Relief
- Linear or Non-linear Analysis with support gaps and friction



Full Featured:

- 29 international piping codes
- CAD interfaces to AutoCAD AutoPLANT PlantSpace PDS SmartPlant and PDMS
- Automatic Stress Isometric
- Model Pipe & Structural Elements
- Linear or Non-linear soil analysis
- Automatic hanger Selection with 21 spring manufacturers
- Metallic e.g. Steel FRP Plastic pipes
- Rotating equipment – evaluate pump turbine compressor or User equipment
- Extensive material & component libraries for steel & FRP pipes beams valves flanges & supports to GB/ASME/ANSI JIS DIN standards.

Bentley Sustaining Infrastructure

A user sample

Certification of EN13480

Please refer to
Per Oscarson
Phone +46 10 505 13 20
Fax +46 10 505 13 10
E-mail per.oscarson@afconsult.com

Date
2007-11-27

Reference

Bentley Systems Inc
Attn: Mr Mark Upston
CAE Product Manager
15 Alcalde Road
Santa Fe, NM 87508
USA

Subject
Acceptance of AutoPIPE version 8.60 in accordance with the Rules of EN13480
Metallic industrial piping - Part 3: Design and calculation

Industries

AutoPIPE

ISO 9001

ASME NQA-1

ASME N45.2

10CFR50 app B

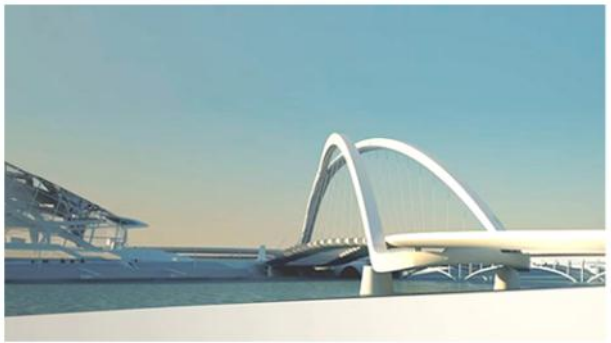
Caesar

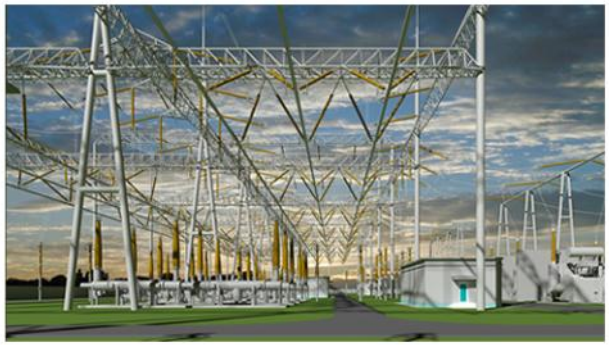
- Power (22 years)
- Process (26 y
- Offshore rs)
- Buri Cross-Country Pi

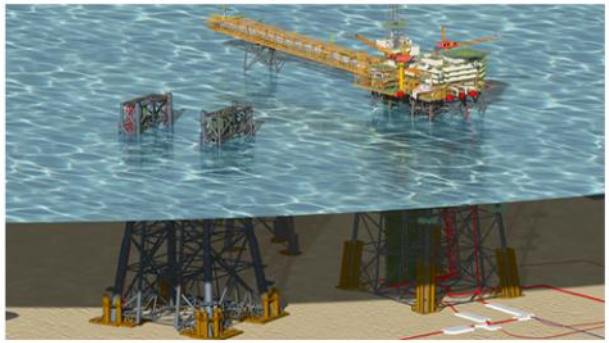
No Recognized QA

AutoPIPE audited by NUPIC & NRC Customers for 20 years. ADLPipe by NRC customers since 1967

STAAD for Nuclear Structural Analysis also audited by NUPIC & NRC Customers.





Case Studies

Bentley
Sustaining Infrastructure

MECON Ltd India
Blast Furnace Complex

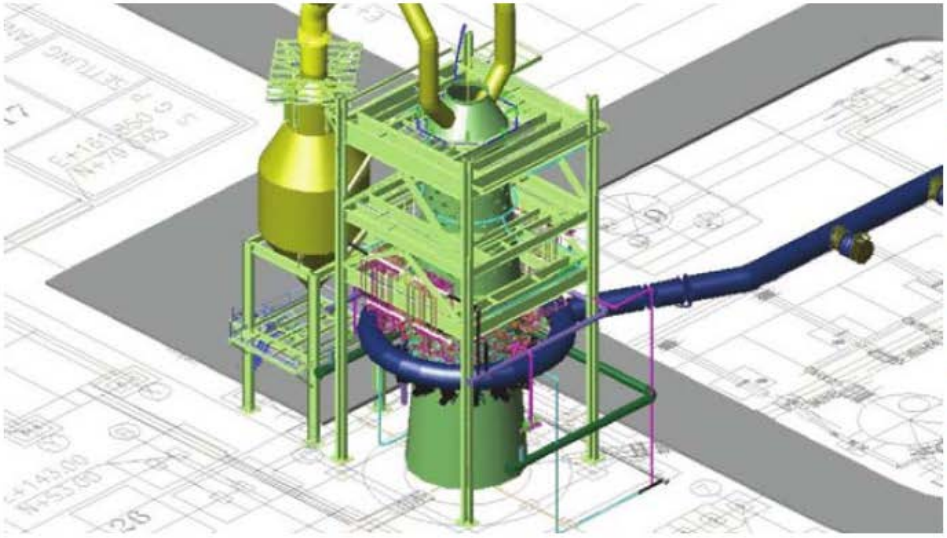
MECON Limited

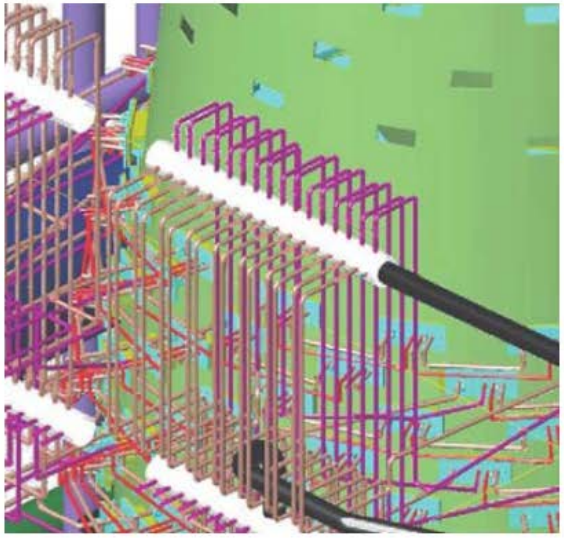
262-Cubic-Meter Blast Furnace Complex

Karnataka, India

The scope of work involved in designing this 262-cubic-meter blast furnace complex for Kalyani Steels Limited was daunting. For MECON Limited to design a hot-blast system, blast furnace with cast house, gas cleaning plant, dust catcher, material feeding system, and interplant pipelines, it required working seamlessly across a multidiscipline design team.

To accomplish this task, MECON deployed the interoperable capabilities of Bentley products, including AutoPLANT, AutoPIPE, and STAAD.Pro to produce a 3D model of the complex. The Bentley tools enabled MECON to export the 3D model to other CAD modeling software quickly and easily. Indeed, Bentley solutions were especially beneficial for shortening the design schedule and producing flawless deliverables.





Ausenco Engineer Pvt India Continuous Polymerization Plant

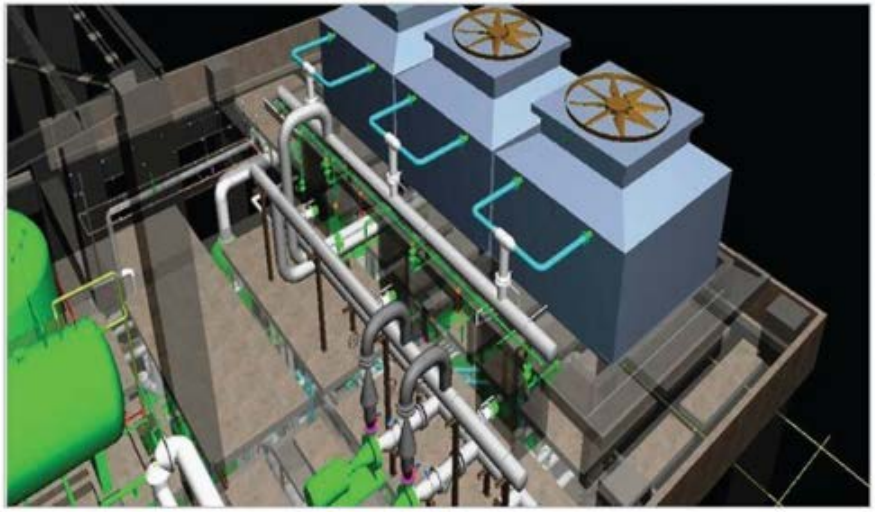
Ausenco Engineers Pvt. Limited (Ausenco Sandwell)

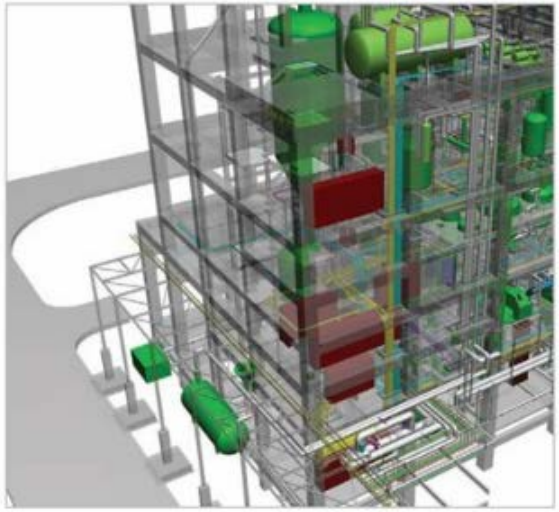
Continuous Polymerization Plant

Bajpur, India

Polyplex India set up an 8.7-meter-wide polyester (PET) film line with a continuous process chips plant and metalizer at a new location in Bajpur, India. Ausenco Sandwell developed the 3D model to generate a clash-free piping and equipment layout for the chips plant comprised of 180 to 200 pieces of equipment and 650 lines. The project also called for high-end process conceptualization, piping material specification, and modeling of specialized equipment.

AutoPLANT was used to develop a model meeting all process requirements and extract drawings, isometrics, and bills of quantity. The stress model for critical pipelines analysis was created in AutoPIPE and structural design and detailing was completed using STAAD.Pro and ProSteel. The modeling seamlessly integrated all design groups and contributed to achieving a tight execution schedule with minimum rework.





ESI Inc USA
Evergreen Community Power

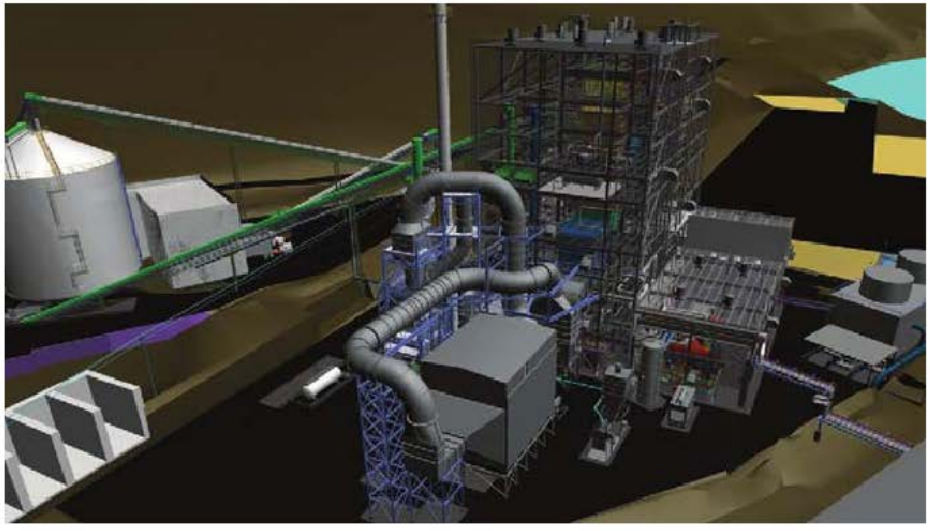
ESI Inc. of Tennessee

Evergreen Community Power

Reading, Pennsylvania, United States

ESI Inc. was commissioned to engineer and design a renewable-energy circulating fluidized bed boiler with a 33-megawatt turbine to replace an existing fossil fuel-fired boiler for Phoenix Technology Holdings. The facility will convert biomass-derived material into electricity for a Reading, Pa.-based host paper mill. ESI designed the system with leading-edge air pollution control equipment to ensure that all emissions are as low as possible for a facility of this size.

The fast-track schedule with extensive engineering deliverables could not be met with traditional 2D design. To meet the challenge, ESI hired experienced designers and 3D modeling specialists to complete its largest project to date using AutoPIPE and STAAD.Pro. The designers used hand sketches or 2D drawings to complete sections of the design while 3D specialists created the detailed model.



Walsh Group USA
Alvarado Water Treatment Plant Expansion

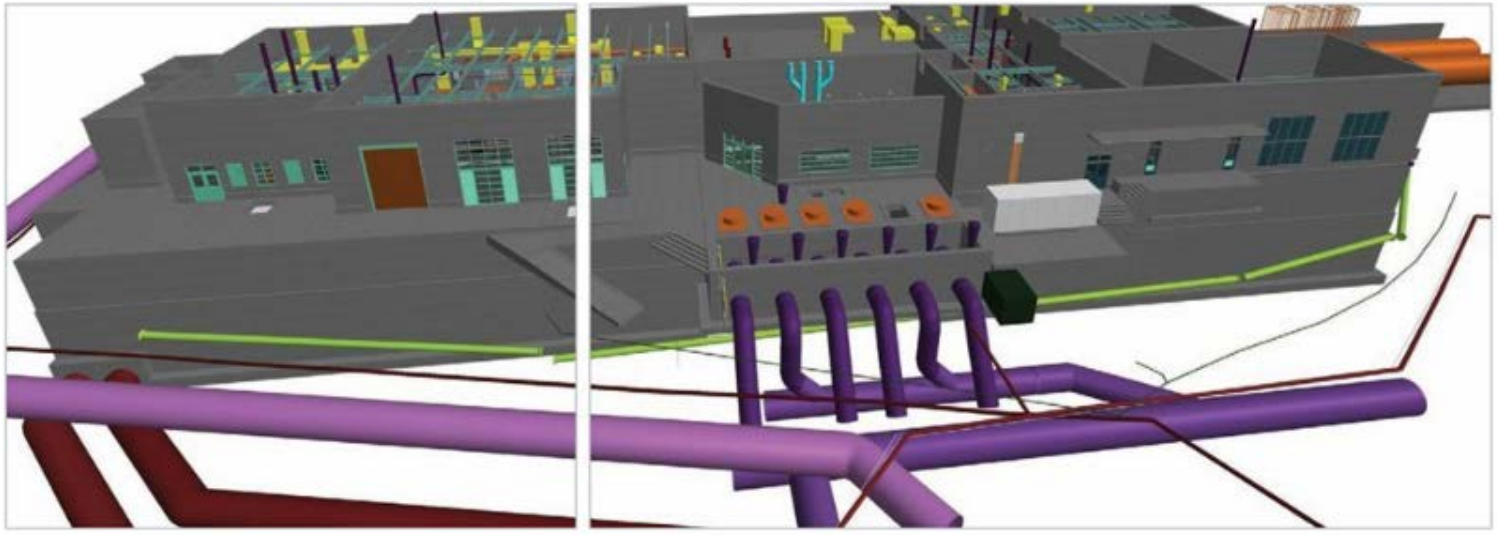
The Walsh Group/Archer Western Contractors

Alvarado Water Treatment Plant Expansion

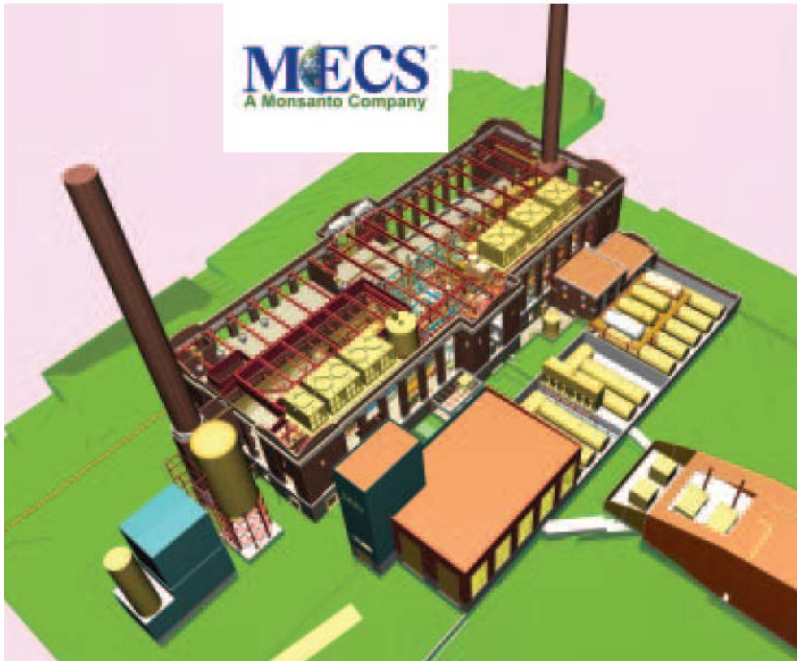
San Diego, California, United States

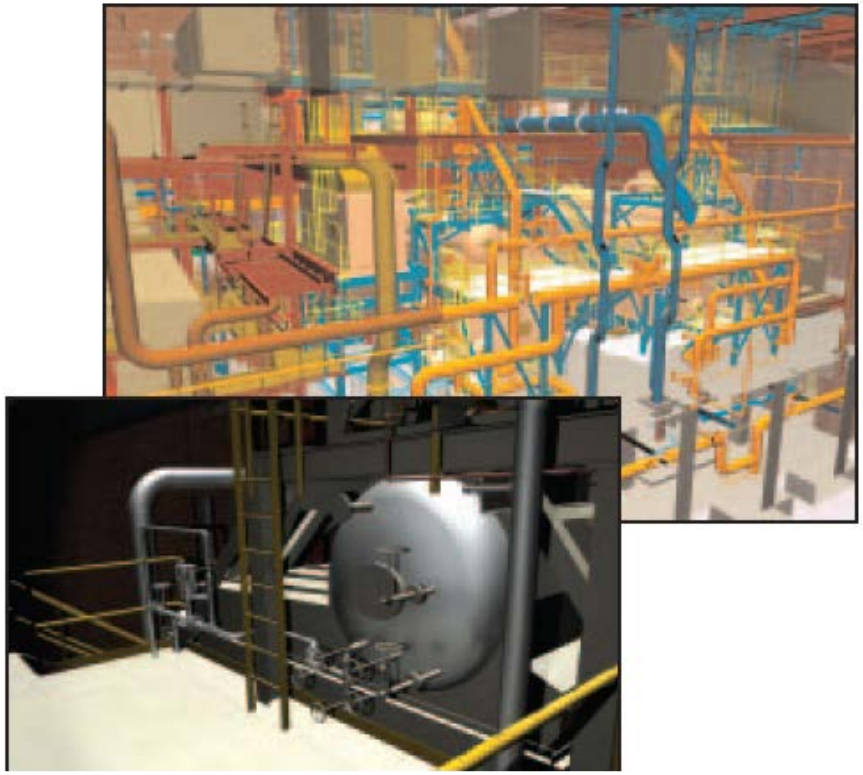
The Alvarado Water Treatment Plant is one of three facilities that supplies San Diego, Calif., with drinking water. In Phase IV of the expansion project, Archer Western Contractors is installing a new ozone system that will increase the output from 120 to 200 million gallons per day. The $65 million project includes designing a 14,000-cubic-yard concrete structure, purchasing and installing the ozone system, and all ancillary equipment and site work.

Archer used MicroStation, PlantSpace, AutoPIPE, and ProjectWise Navigator to convert the designers' 2D documents into 3D models to coordinate all systems, verify the design, and collaborate with subcontractors and vendors. An accurate model with structural, mechanical, electrical, piping, and equipment details helped prevent conflicts, enhance constructability, and forecast equipment issues.



Monsanto Enviro Chem Systems USA Powerhouse Renovation





Bentley® AutoPIPE® also allowed for stress analysis to be done by computer, rather than by trial and error. "Once you cut into piping, the existing guides and supports act differently," Reim said. "We had to plan very carefully not to overload the system. There was potential for huge damage."

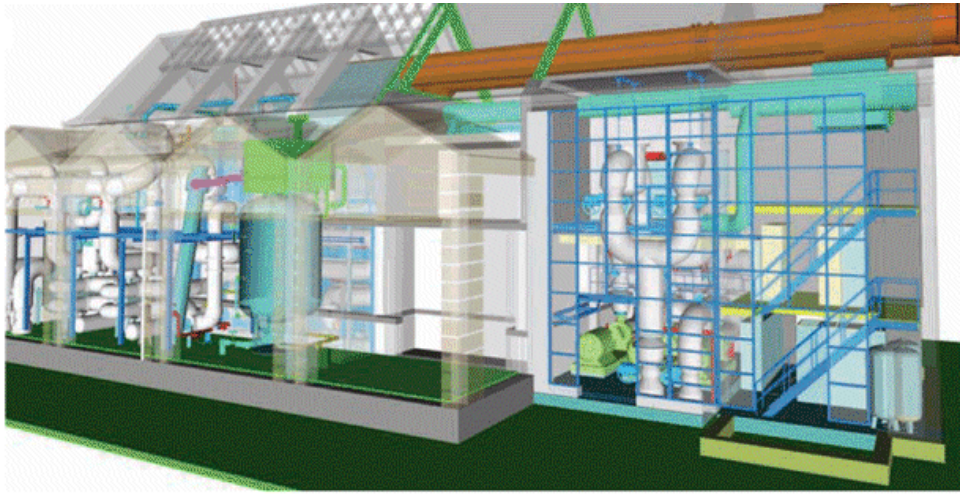
Norsk Energy
District Heating - OSLO

Hoff District Heating Central

Norsk Energi

This project involves the installation of as much new heating capacity as possible in an historical building operated by Hoff Heating Central in Oslo. The detailed engineering and building of the plant is to be completed within 18 months. During this period, all internal structures must be removed, but the facades must be kept intact. Also, new structures are to be erected and new equipment is to be installed.

Since the building is very small compared to the amount of equipment and piping needed to be installed, it was a challenging and complex job to design the plant. Great efforts were made to achieve acceptable service, maintenance, and escape areas. Since designing and building were carried out in parallel, it was also vital to check for interferences between piping and structure, equipment, electrical installations, and so on.

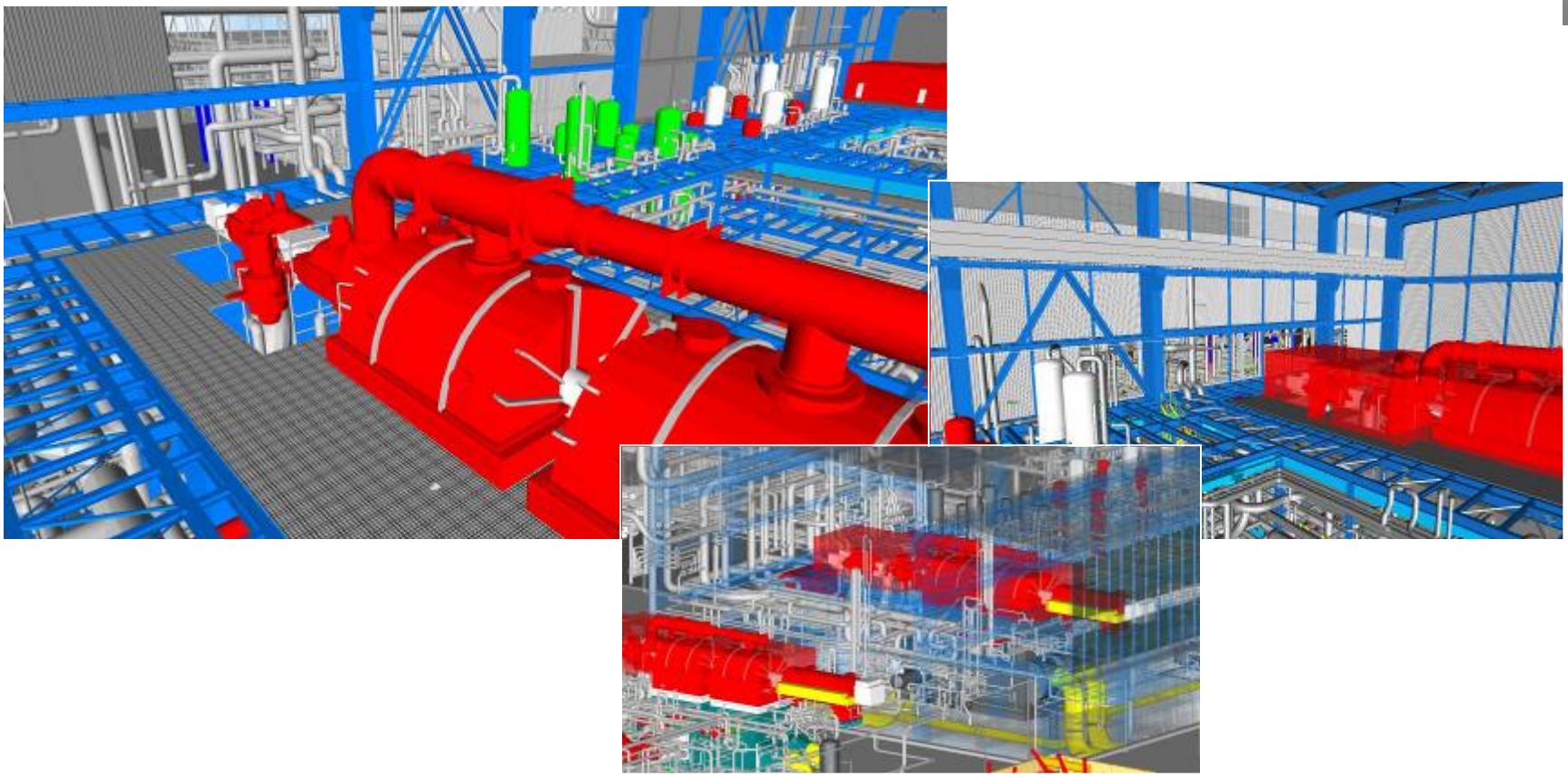


Norsk Energi used AutoPLANT for detailed engineering and construction. AutoPIPE was used for pipe stress calculations. Models have been exported from 3D Piping to AutoPIPE. Interference checking was carried out with Explorer, in parallel with pipe-routing.

The Bentley software made it possible to reduce man-hours in design and engineering of the plant. The ability to share 3D information during the design phase meant that the company used the software not only as a design tool, but also as a communication and discussion tool. This resulted in better quality, from the design phase to the end product, and reduced both engineering and manufacturing costs. ▪

ENEL Power

TORRE VALDALIGA Italy
660W Oil Fired Power



Petrochim Engineering Russia Crystallizer Disk Regenertiv

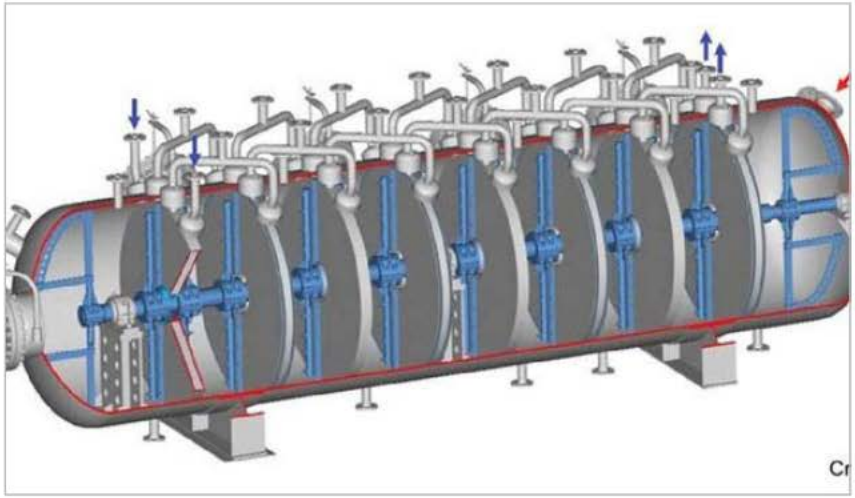
Petrochim Engineering

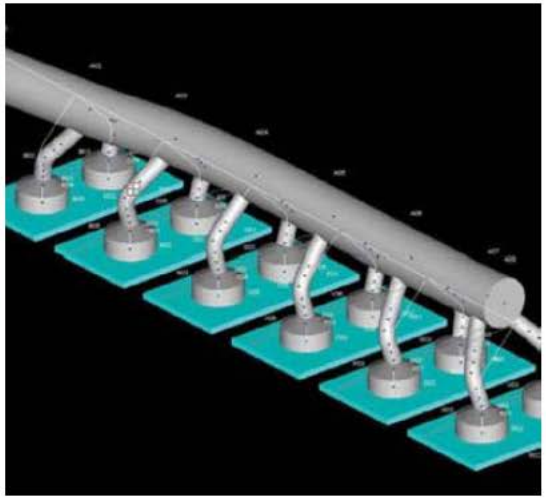
Crystalliser Disk Regenerativ

Orsk and Kstovo, Russia

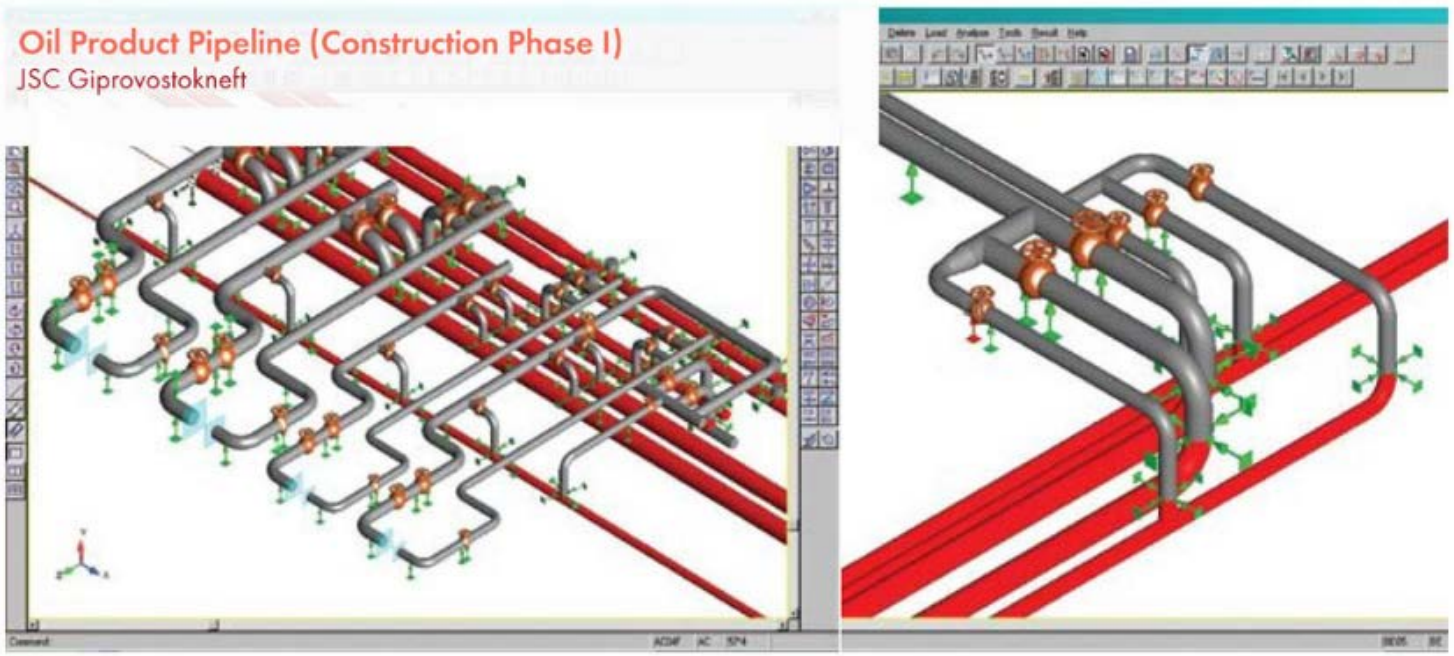
Russian firm Petrochim Engineering, in cooperation with Israel-based Yutec Technologies, designed a disk-type crystallizer for a dewaxing unit to obtain higher quality oils to meet strict emission regulations. The goals were to reduce overall dimensions, ensure soundless unit operation, and define loads on vessel body and internals with maximum accuracy.

AutoPIPE designed the crystallizer components, reduced vessel dimensions, and defined optimum locations for disks and supports on the 8-meter bearing hollow shaft. Using this software for calculation of forces due to external loads also accelerated design. The new unit increased dewaxed oil yield by 3 to 4 percent and decreased oil content in slack wax by 30 percent. Harmful solvent leaks were completely eliminated, and noise was considerably reduced.





JSC Giprovostokneft
Oil Pump Station Russia



JSC Giprovostokneft's project was to model a terminal tank farm, part of the Kstovo-Yaroslavl-Kirishi-Primorsk trunk oil product pipeline. The new oil pipeline will establish a new light-oil export corridor for shipment via the Primorsk marine terminal near Saint Petersburg in Russia. The project includes construction of line facilities, rehabilitation of an existing head pump station, construction of six intermediate pump stations, and rehabilitation of a terminal tank farm.

Using AutoPIPE, the firm designed and analyzed the above-ground and underground pipelines in a complicated geologic and climatic environment. It automated the calculation of pipeline/soil interaction characteristics and developed a procedure for active length calculation with the selection of optimum soil points. AutoPIPE compliance with Russian standards, codes, and regulations also enabled the firm to avoid the purchase of additional certified software tools.

Rebis Russia
N Field Facilities Siberia

Rebis Russia

The Project of the N Field Facilities Construction

Tomsk, Russia

Successful design and construction of this plant project in Tomsk, Russia, in the southwest of Siberian Federal District, hinged on the ability of Rebis to collaborate across several of its engineering departments. The design institute implemented Bentley software to create a common design environment, which helped increase productivity on specific design sections and reduce design time.

Using the software's 3D modeling capabilities, the project team produced high-quality drawings in less than a third of the time required for traditional drafting methods. Moreover, Bentley's AutoPIPE helped the project team determine pipe manifold tension, define legs and hose nipple stress, and determine the drift limit of pipelines and shifting bearing.

NK Rosneft Russia
Siberian Oil Processing Field

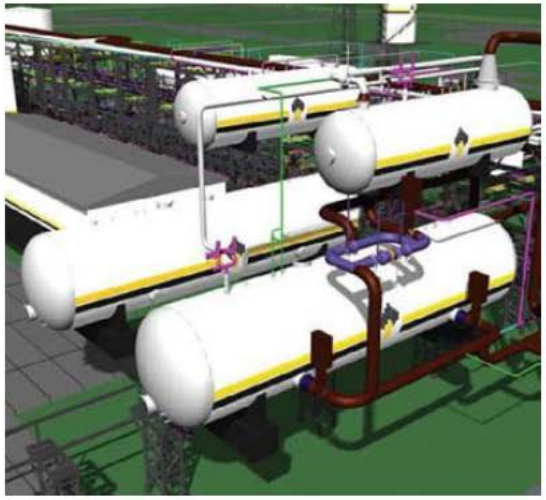
NK Rosneft–NTC

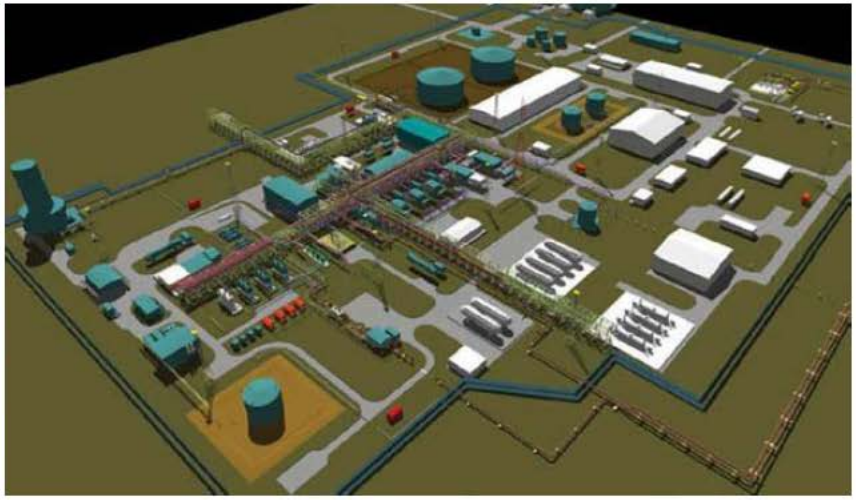
VNK1

Krasnoyarsk, Russia

As part of a major Siberian oil field development project, this project encompassed the development of an oil processing facility in the Krasnoyarsk Territory. The facility will be one of the largest crude extraction and processing plants in Siberia, Russia.

To optimize team performance, engineers and subcontractors from various disciplines were trained to use Bentley products. AutoPIPE and AutoPLANT allowed simultaneous model development among disciplines and enabled fast design reviews. Bentley products minimized project development time and improved overall project quality.





Frabricom GDF SUEZ
SITA Re-Energy Project Netherlands

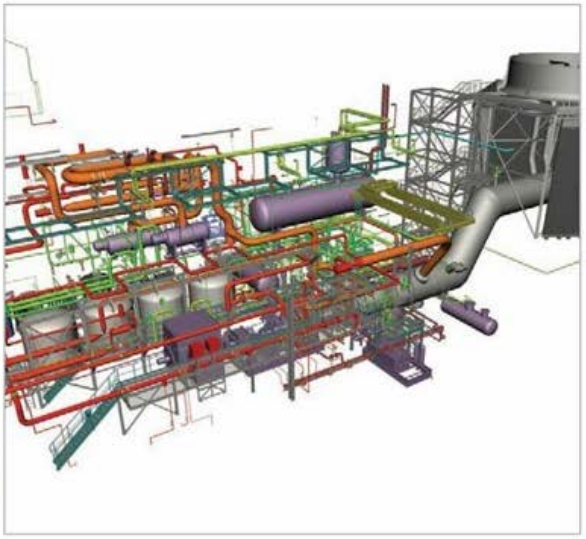
Fabricom GDF SUEZ

SITA Re-Energy Baviro Project

Roosendaal, Netherlands

Baviro is a $31.8 million SITA Re-Energy project in Roosendall, Netherlands. It is a high-efficiency incineration installation for industrial and domestic waste with a capacity of 291,000 tons a year. Fabricom's project goals for this waste-to-energy installation were to increase capacity to meet the growing demand for waste disposal and to recover more sustainable energy from waste.

Fabricom relied on AutoPLANT, AutoPIPE, and ProSteel for delivery of 2D and 3D information, leading to faster communication among all of the parties involved. The project was based on interoperability between services. By reusing the data for all civil, building, plant, and structural project teams, the company saved time and improved data reliability.



Energotechnika Pojekt Sp.z
EC Zeran Power Plant Poland

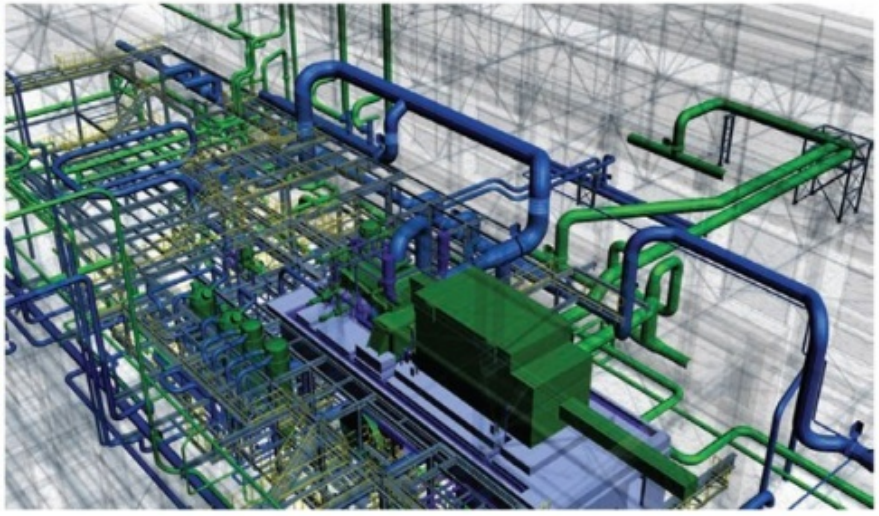
Energotechnika Projekt Sp.z o.o.

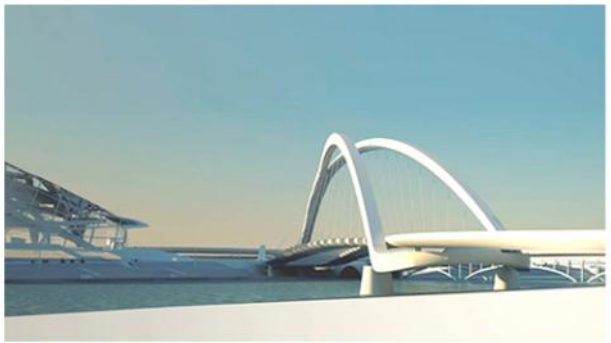
EC Zeran Modernization

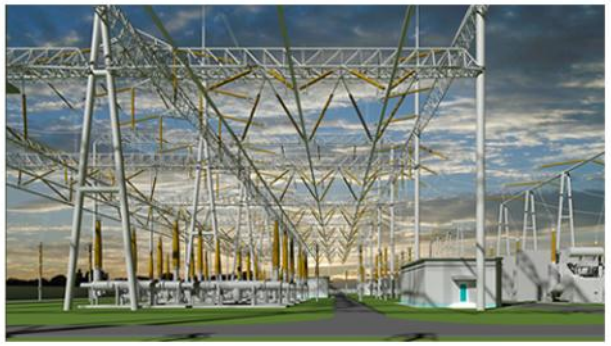
Warszawa, Poland

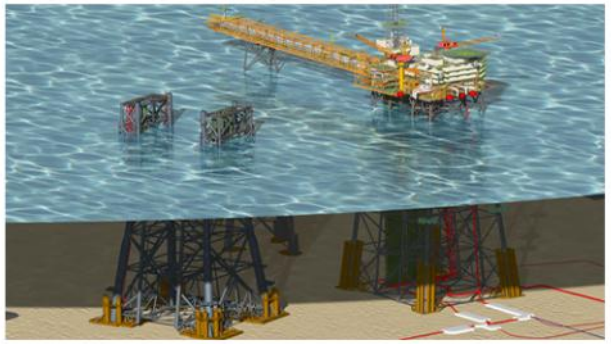
Energotechnika Projekt's primary objective is to develop and execute capital projects on schedule, within budget, and with operational excellence. For the $55 million EC Zeran Modernization project in Warszawa, Poland, the firm replaced an aging turbine with modern equipment that optimized the fluidized boiler, enabling greater efficiency in thermal-to-electric energy conversion.

The challenge was to install the modern turbine in the existing facilities and coordinate installation between branches within a short time. The design team used Bentley Structural, AutoPIPE, and AutoPLANT to shorten design time and reduce the number of people involved in the project.







Piping Environments

Bentley
Sustaining Infrastructure

AutoPIPE Finite Element

SAP IV

A STRUCTURAL ANALYSIS PROGRAM

FOR STATIC AND DYNAMIC RESPONSE OF LINEAR SYSTEMS

by

Klaus-Jürgen Bathe

Edward L. Wilson

Fred E. Peterson

June 1973

2. THE EQUILIBRIUM EQUATIONS FOR COMPLEX STRUCTURAL SYSTEMS

2.1 Element to Structure Matrices

The nodal point equilibrium equations for a linear system of structural elements can be derived by several different approaches [1],[2],[7],[13], [20],[30]. All methods yield a set of linear equations of the following form

$$M\ddot{u} + C\dot{u} + Ku = R \qquad (1)$$

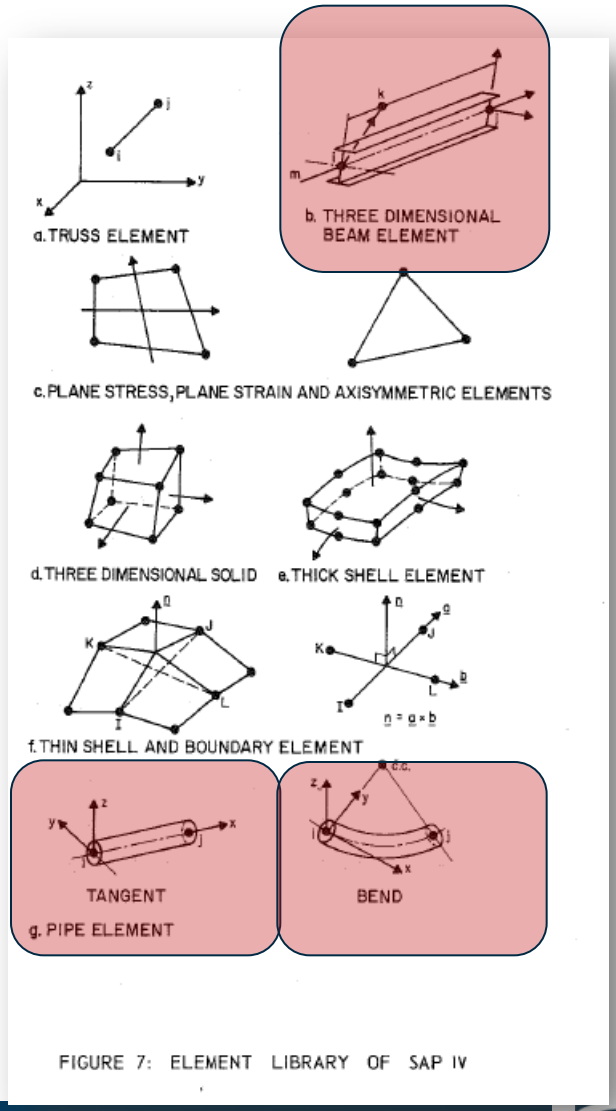


FIGURE 7: ELEMENT LIBRARY OF SAP IV

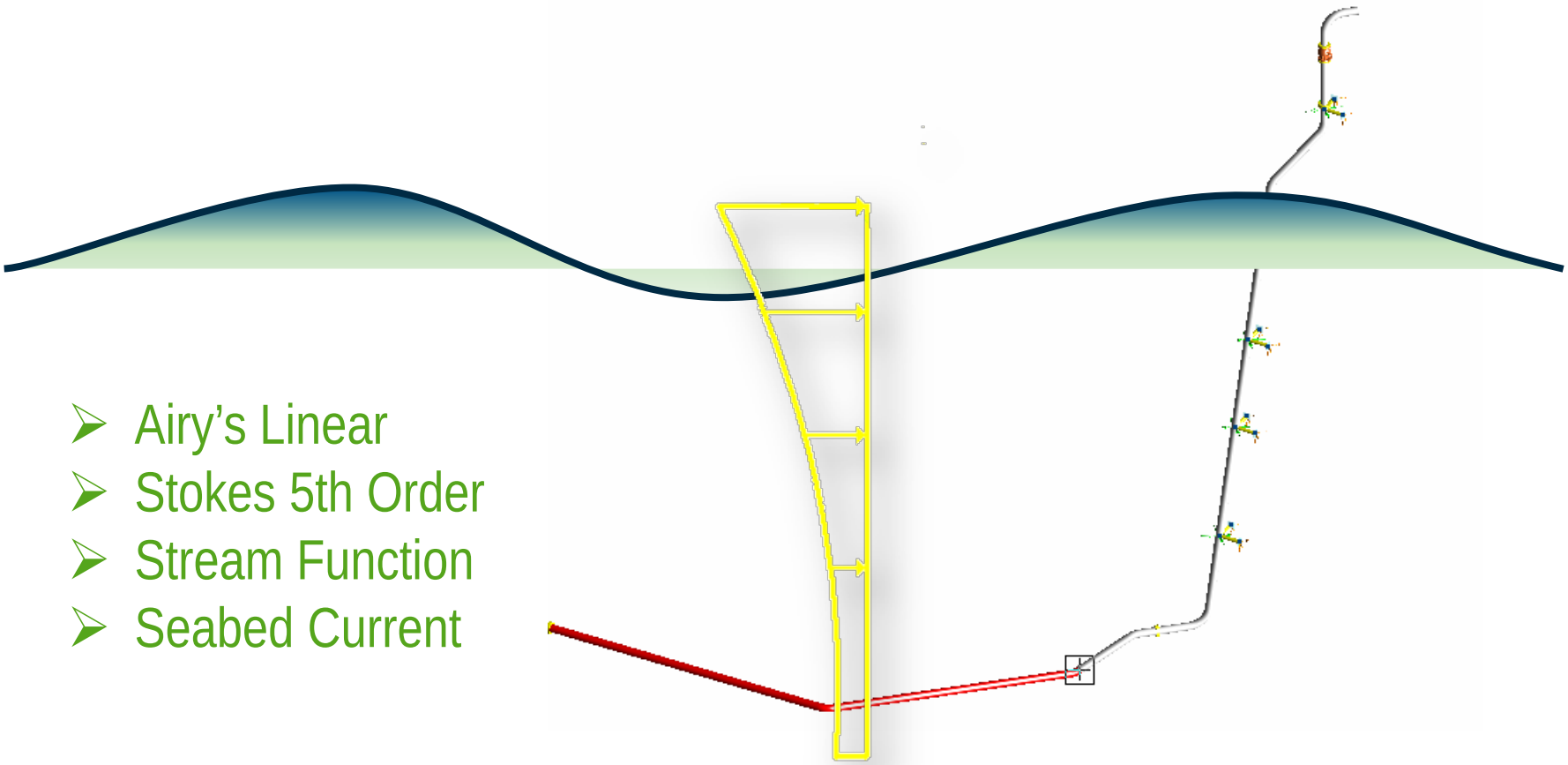
AutoPIPE Advanced Capabilities

AutoPIPE provides unique capabilities underground and subsea pipeline analysis, dynamic loading, nonlinear restraints and orthotropic piping analysis.

Summary of advanced AutoPIPE capabilities:

Feature	Feature
Built-in Wave loading	Non-Linear Gaps & Friction
Buried Pipeline Analysis	Steam Relief Valve load calculator
Pipe/Structure Interaction	FRP/GRP pipe analysis
Calculation of local stresses	Jacketed piping
Time History dynamic analysis	Thermal Bowing Analysis
Fluid Transient Modeler	Thermal Transient

Wave Loadings – Pipeline Riser



- Airy's Linear
- Stokes 5th Order
- Stream Function
- Seabed Current

Buried Piping

Recognized by American Society of Civil Engineers

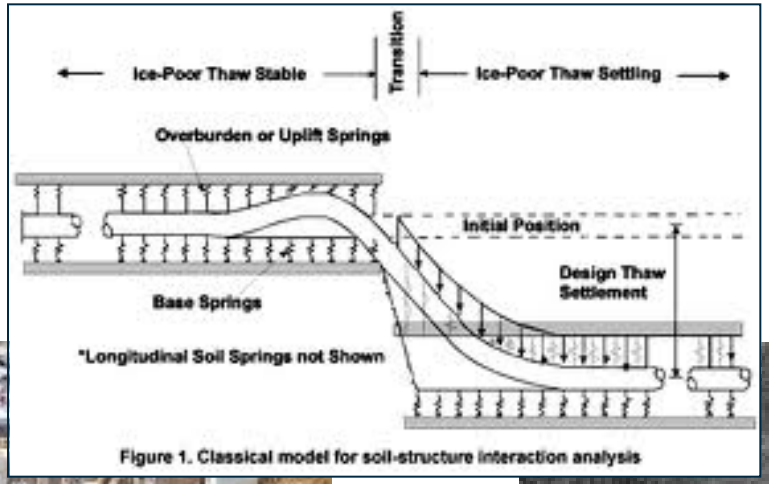
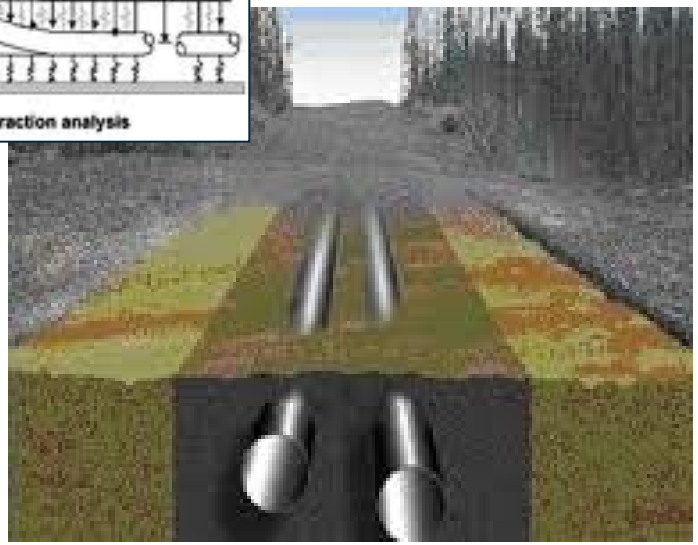
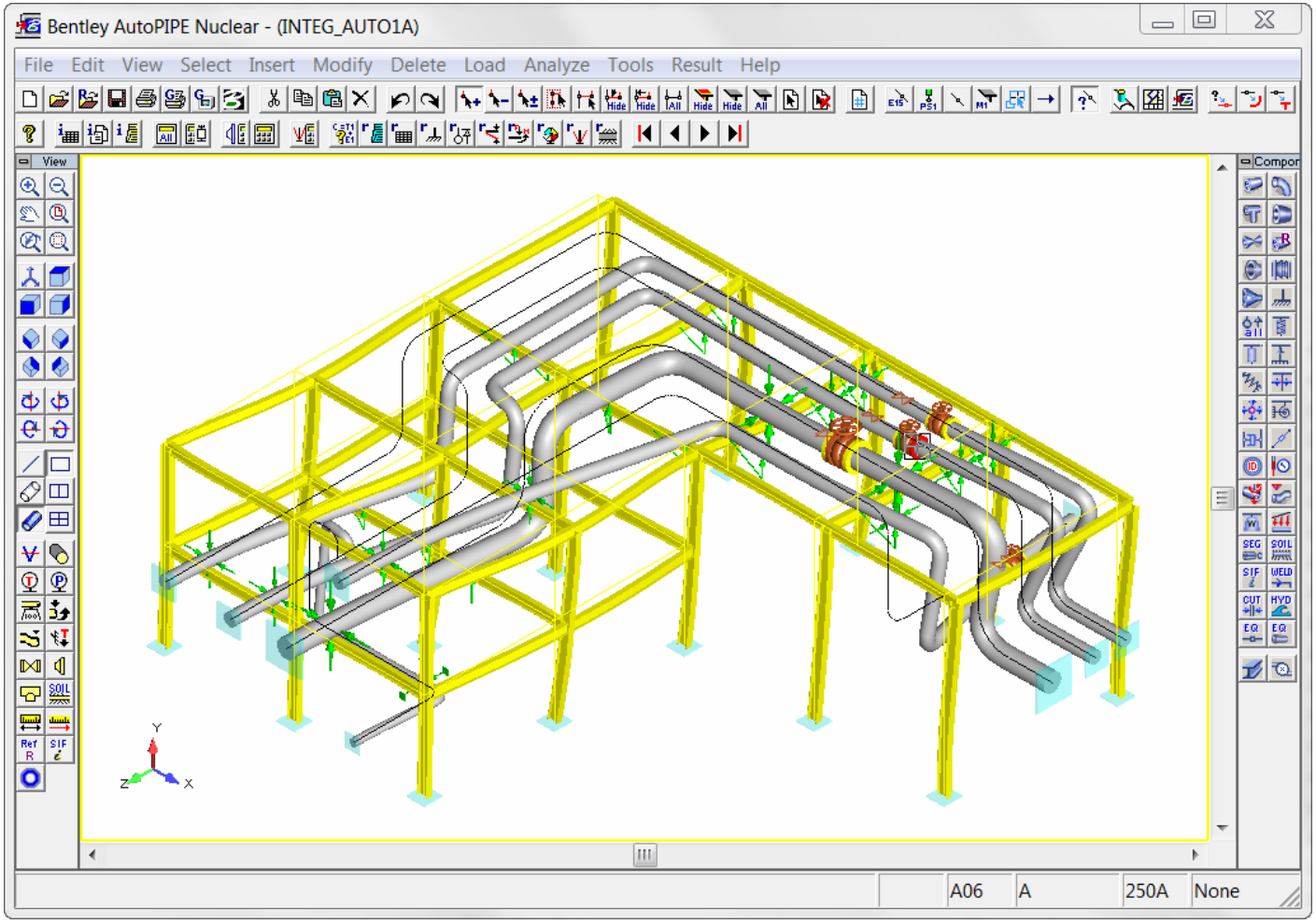


Figure 1. Classical model for soil-structure interaction analysis

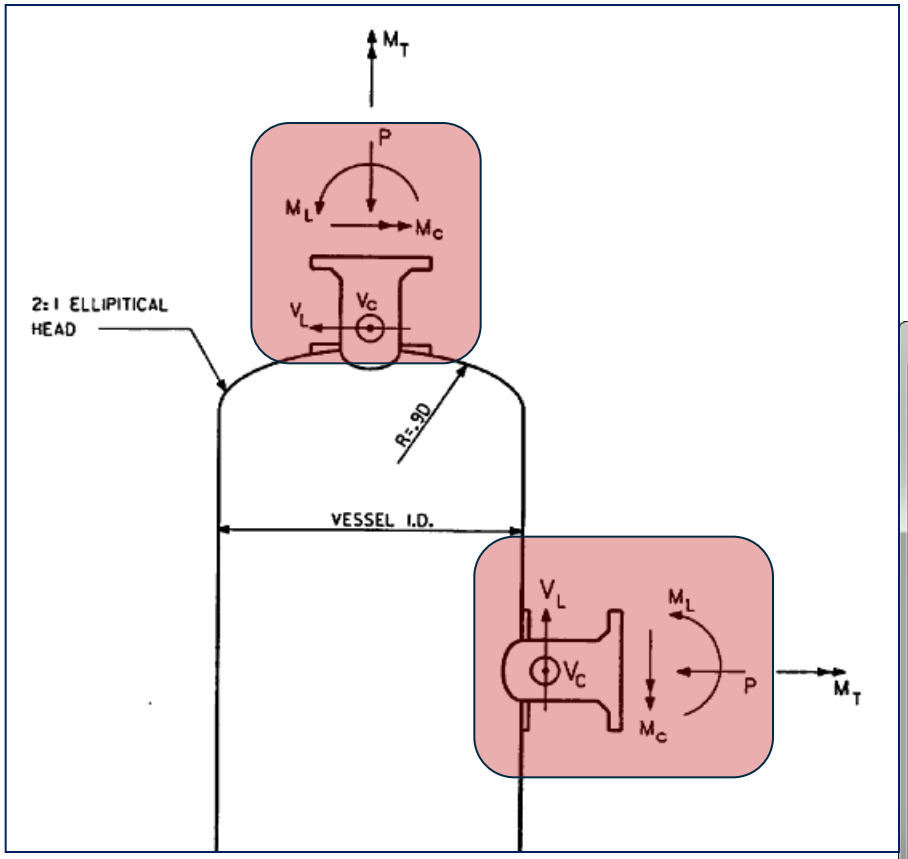


Pipe / Structure Interaction

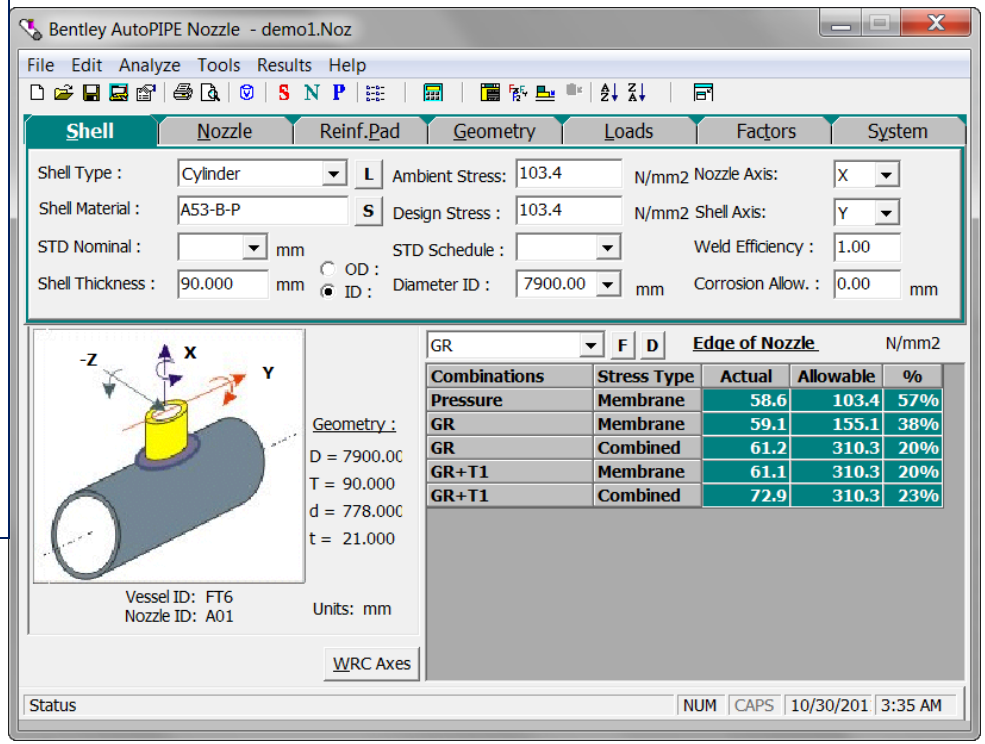


Bentley Sustaining Infrastructure

AutoPIPE Nozzle - Local Vessel Stress

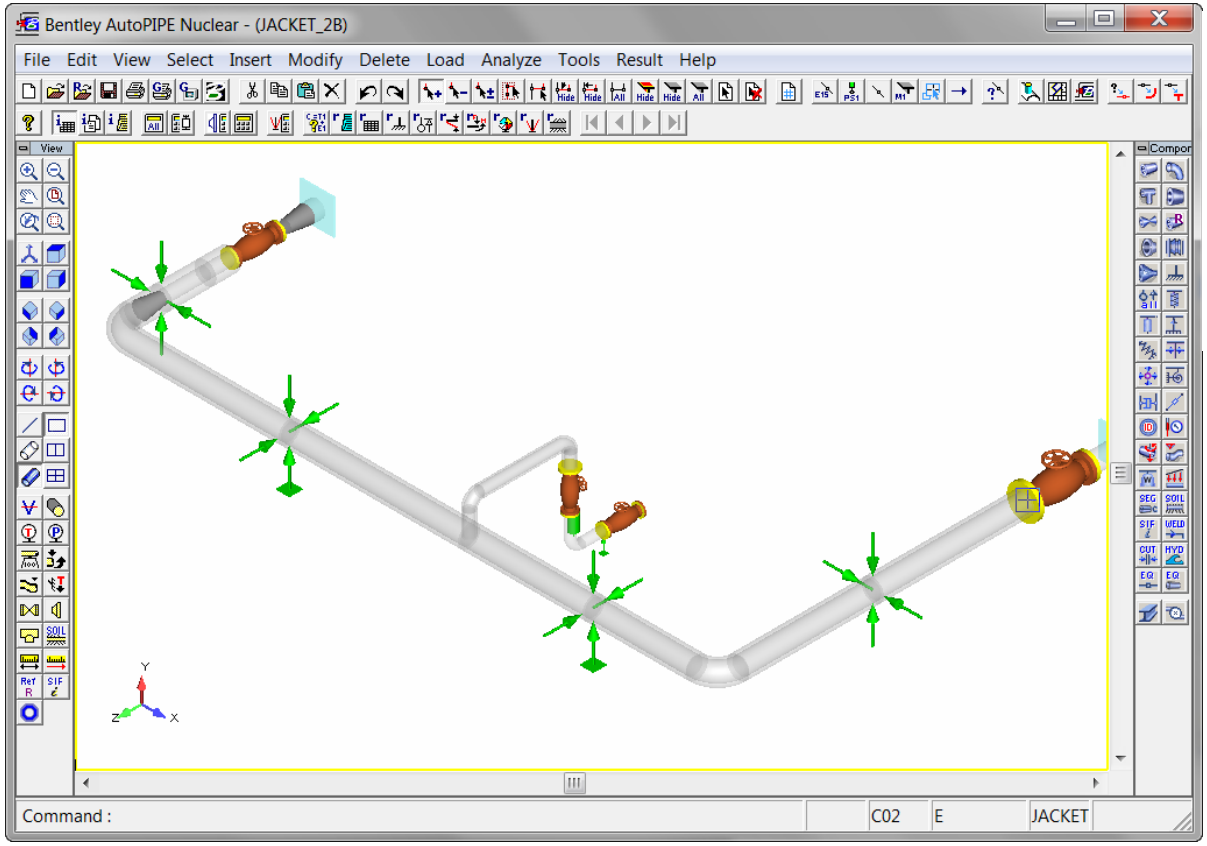


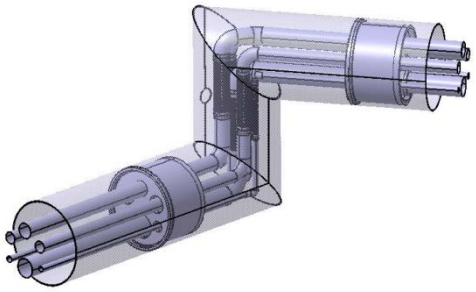
- WRC 107/ WRC 297
- PD5500
- KHK
- API650



Bentley Sustaining Infrastructure

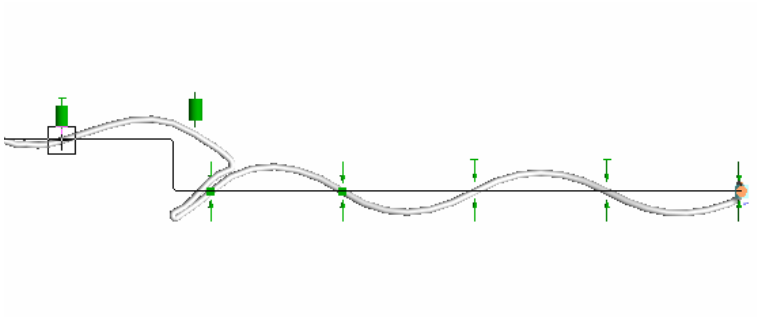
Jacketed Piping

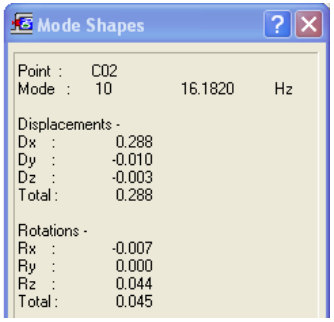




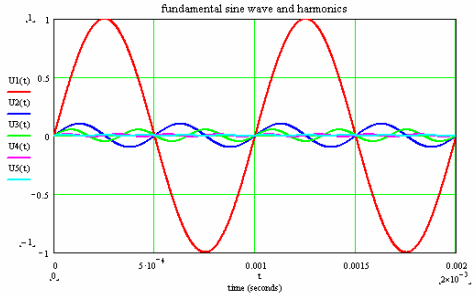
Dynamic Analysis

Modal Analysis

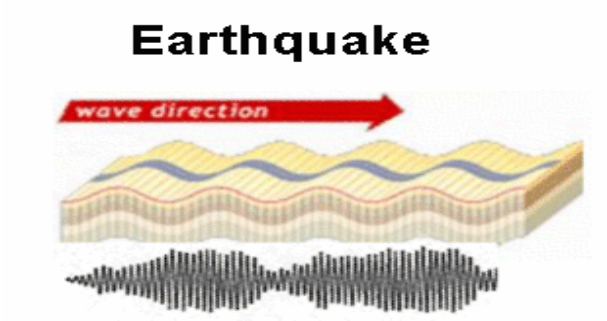




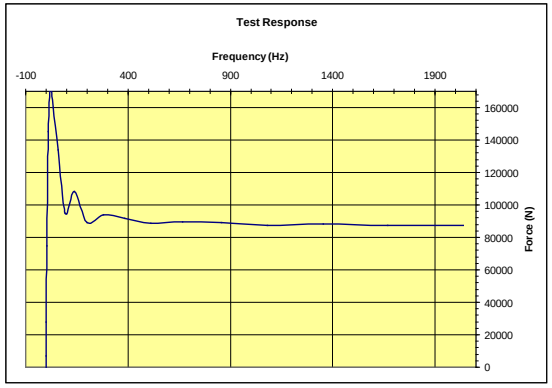
Harmonic Analysis



Response Spectrum



Time History Analysis



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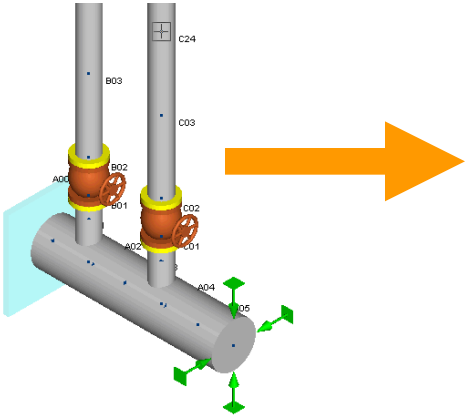
Non-Linear Analysis

Key Benefits vs Caesar

- AutoPIPE Advanced non-linear engine from Prof. Emeritus (UC Berkeley) for friction gapped supports and soil
- Real-World loading using load sequencing e.g. Gravity then pressure then Temperature then Seismic
- Apply gaps & friction to any loadcase. Building codes like UBC must design with no friction in Seismic load cases



AutoPIPE load sequence
GR ->P1->T1->E1

Caesar 1 lumped load vector
GR+P1+T1+E1

Load sequencing is not a new concept it's been around for many years in Abaqus ANSYS and other high end FEA programs .

Non-linearGuide Support Behavior

AutoPIPE

- Guide – Integral Horiz + Vertical
- All four bearing surfaces behave as integral but with independent bearing springs upward and laterally – 'real-world' guides

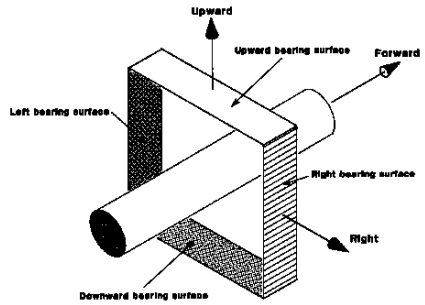
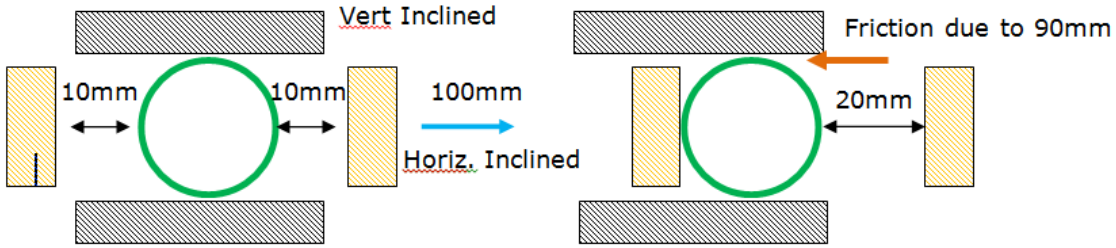
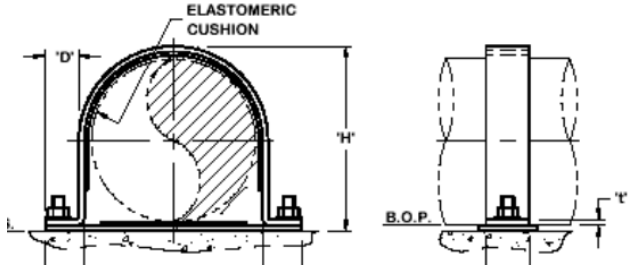


Figure H-9: Diagram of a guide showing bearing surfaces

Caesar

- 2 supports required for Guide + Y
- Only 1 gap permitted
- Separate Vertical and horizontal supports *give unrealistic friction loads and movement under structural movement*





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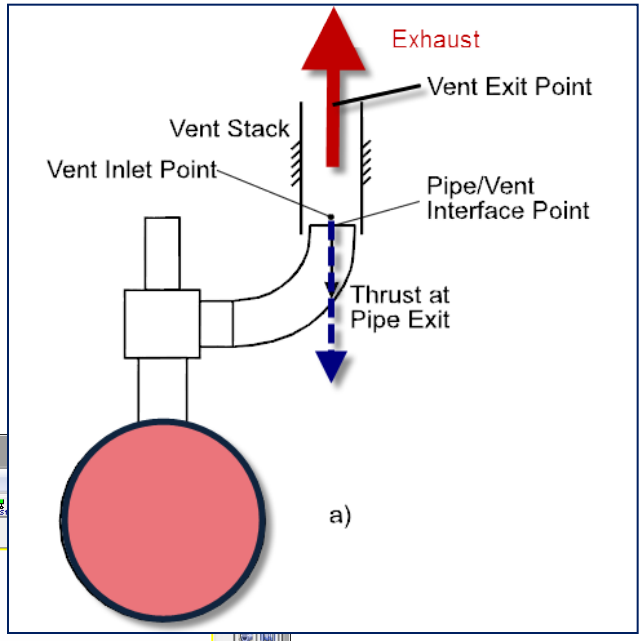
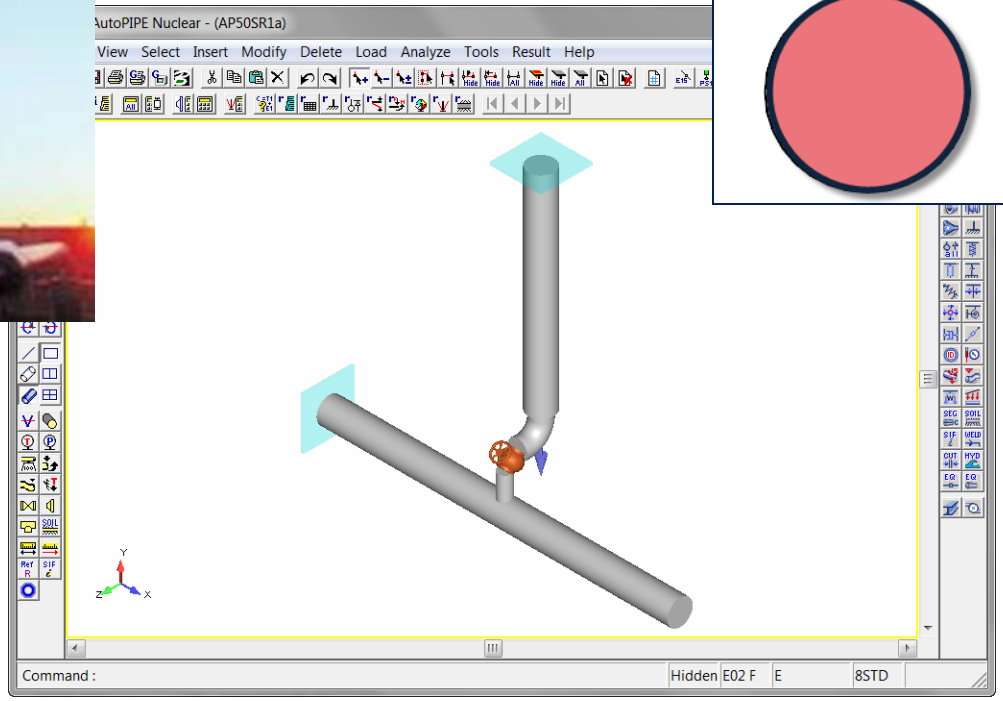
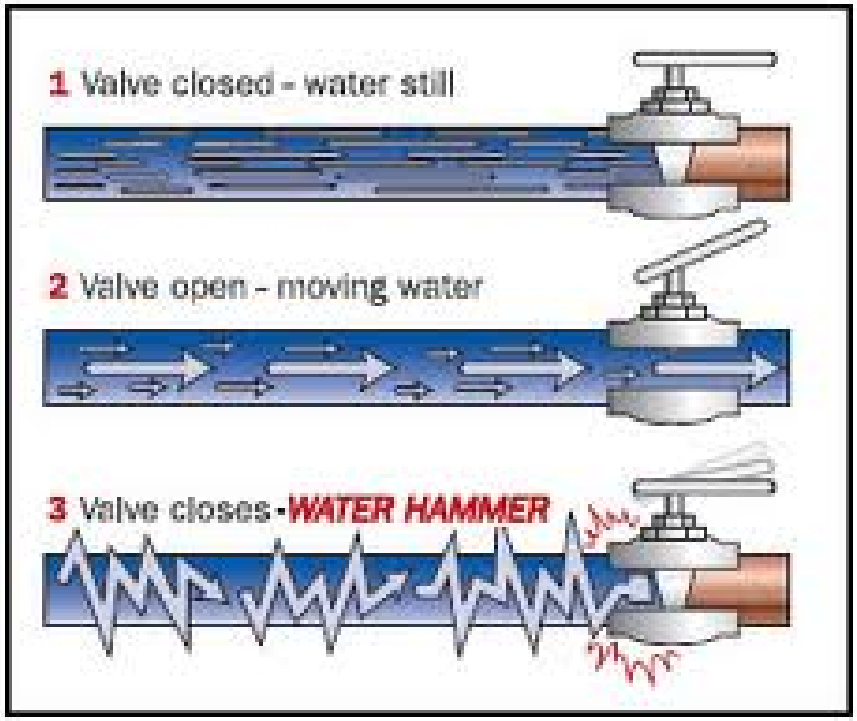
Steam Safety Valve

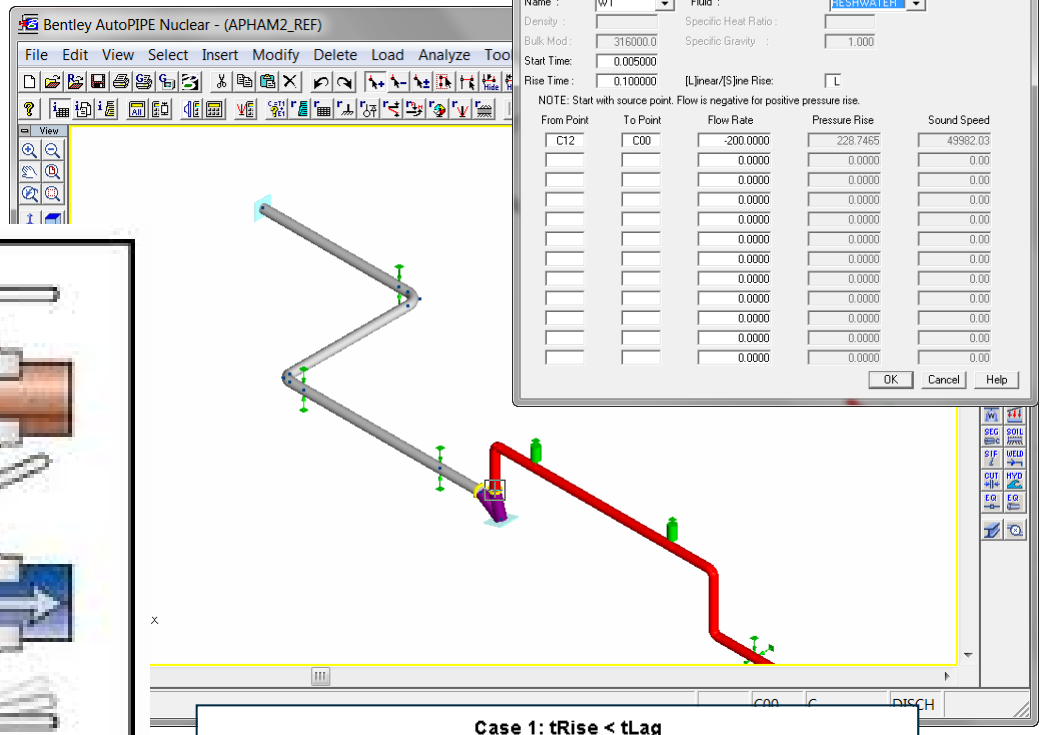


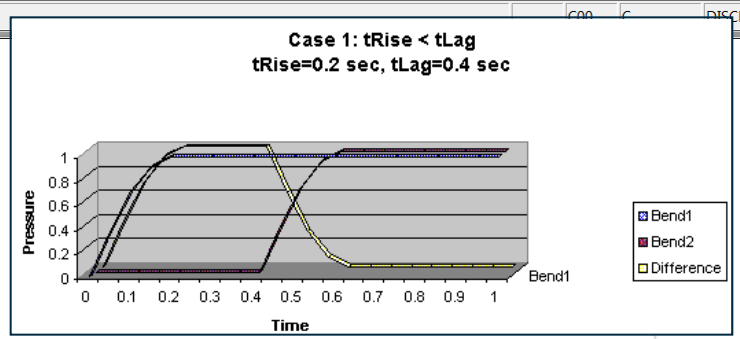


Fluid Transient (Water Hammer)

Fluid Transients for any Liquid, Steam, Gas







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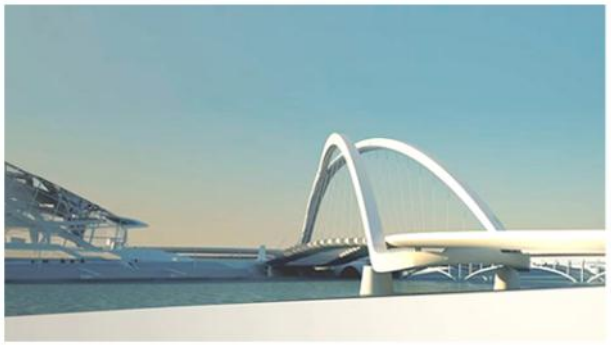

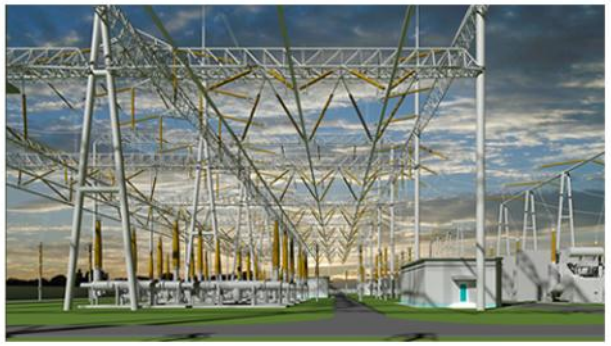


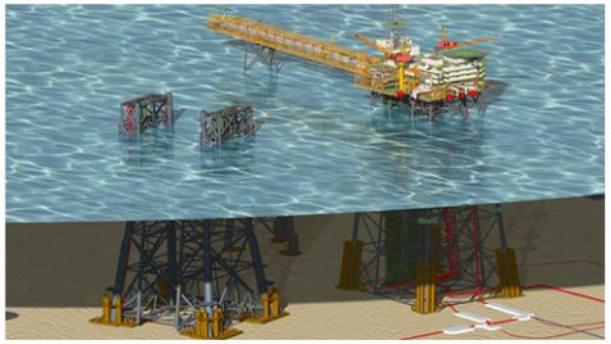

For more information, please visit our dedicated webpage:
www.bentley.com/**en-US**/Products/Bentley+**AutoPIPE**/

Or contact me at badreddine.ziane@bentley.com

Thank you

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