Cloud Compatible

CAEPIPE™

Information Document

From the CAdvantagE™ Library

SST SYSTEMS, INC.

The *FASTEST* Solutions for Piping Design and Analysis

SST Systems, Inc. produced this document for distribution to piping analysis software evaluators.

Information contained herein is subject to change without prior notice.

CAEPIPE Information Document Version 13.10

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CAEPIPE - Pipe Stress Analysis Software

Rapidly Create & Analyze Piping Systems

of Any Complexity with the Least Effort

Why CAEPIPE

- **Easy to (re) Learn, Cuts your time in half**
- **Acclaimed user-interface, Quick to Learn and Use**
- **Uniquely Quick Iterative Studies**
- **Most Cost-effective**
- **Realistic Graphical Visualization using industry-standard OpenGL ®**
- **Verified results accuracy**
- **30+ Years! Mature, Robust and Comprehensive**

Easier • Faster
More Productive

• Design Better Piping, Faster ***• Reduce Overall Costs***

• Make Your Job Easier ***• Become Twice as Productive***

Get DONE faster when you use CAEPIPE's carefully designed features for rapid modeling, powerful analyses with quick solution times, and easy results review. You will benefit from being **able to quickly evaluate alternate design solutions** ("what-if" scenarios).

Avoid frustration when you work with the elegantly simple and intuitive user-interface to model or edit simple or complex piping systems.

Save your money because first, CAEPIPE costs less and second, you will see dramatically increased productivity. CAEPIPE pays for itself faster than others do, if at all.

CAEPIPE - the first pipe stress analysis software on the PC back in 1983 - was an immediate success when it entered the energy, process and aerospace markets. Since that time, most of SST Systems' efforts have been directed towards aggressively providing CAEPIPE's large and loyal installed user base with enhancements and improvements that have made CAEPIPE comprehensive and robust.

Now, in its latest generation, it allows you to perform complete static and dynamic analyses, check your design for compliance with required piping codes (ASME, B31, European, Canadian, Swedish and more) and with guidelines (WRC, NEMA, API), among many other things.

Find out why more and more companies stuck with costly competing software (with costly capital costs, needlessly required training costs, that run in the thousands of dollars every year) are switching to CAEPIPE. Download a free evaluation copy that you can **learn to use in 20 minutes or less**. (go to www.sstusa.com).

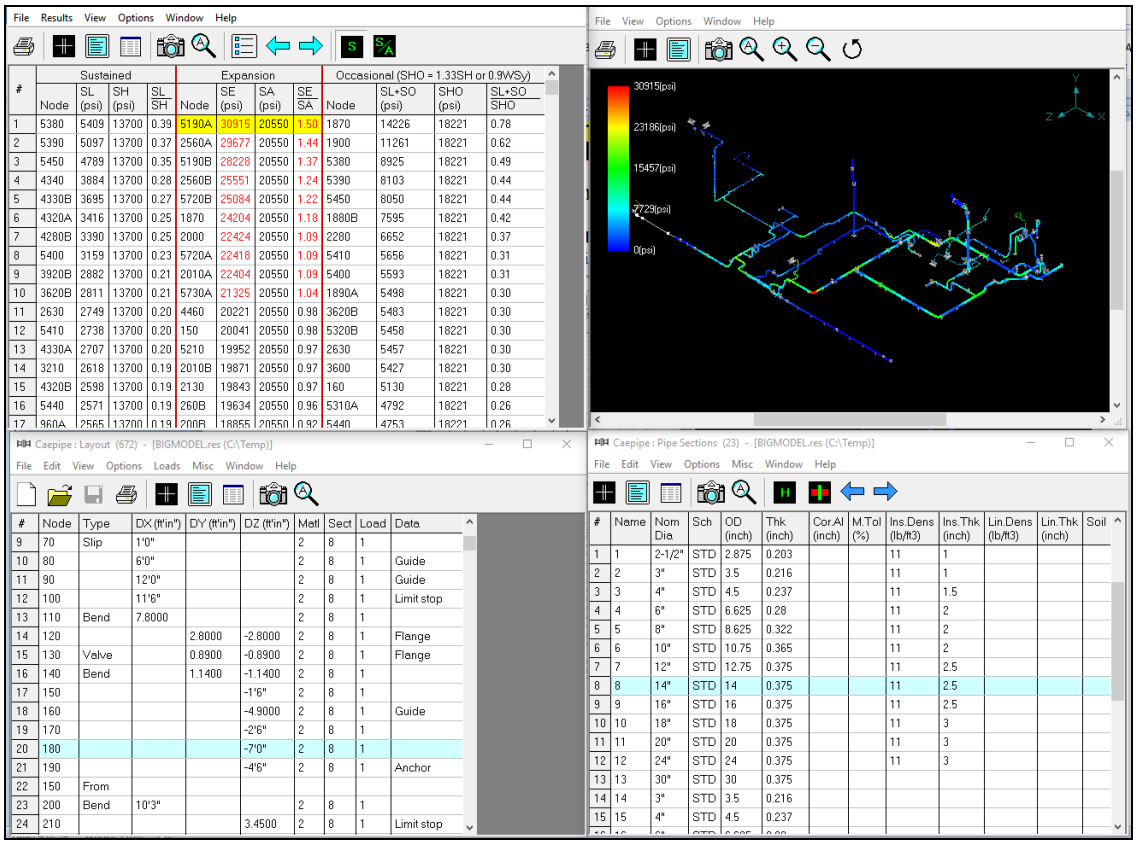
This document contains a non-comprehensive list of CAEPIPE's features. We suggest you print this document before reviewing it.

Recommended System Requirements

- Processor: 3.0 GHz Intel Pentium IV or higher, AMD Athlon dual-core processor or higher
- Memory: 2 GB RAM or higher
- Operating System: Windows XP/Vista/7/8/8.1/10/11 or Windows Server all versions
- Display: 1280 x 800 or higher, with True Color
- Video Card: 256 MB or greater video RAM, OpenGL 1.1 or later, DirectX 9.0 or later, drivers updated with the latest manufacturer's drivers (Motherboard-integrated video cards not recommended for desktop systems.)

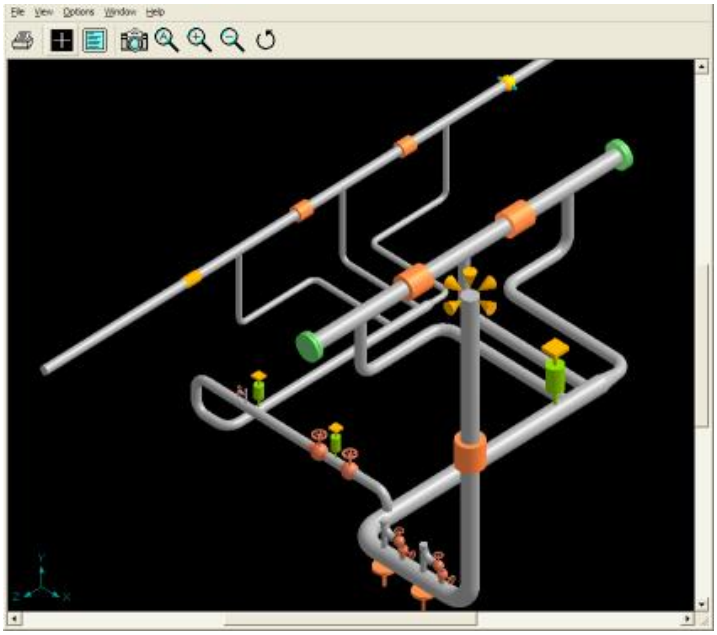
Modeling Capabilities

- Native 32-bit Windows application (compatible with 64-bit OS) with an acclaimed user interface
- Multiple, independently resizable windows
    - View Results, Graphics, Input and Details – all at the same time



- Industry standard OpenGL® graphics, capabilities include:
    - Zoom, pan and rotate
    - 3D Rendering
    - Selective showing and plotting of various entities
    - View from any direction (automatic iso and plan views)
    - Color coded stress contour mapping

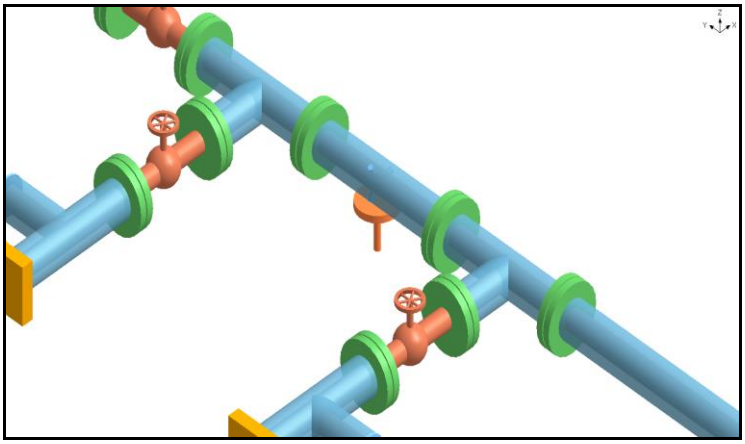
- Copy image from the graphics window to the clipboard
- Several graphics output formats - HPGL, DXF, EPS, EMF
- Plot of single line graphics to AutoCAD format
- Specify title for plot separate from model
- Print in color (Low/Medium/High Resolution, and Black/White background)
- No anisotropic graphical distortions upon window resizing



- Easy model generation and powerful editing features including numerous shortcuts
- Instantaneous error checking of input data

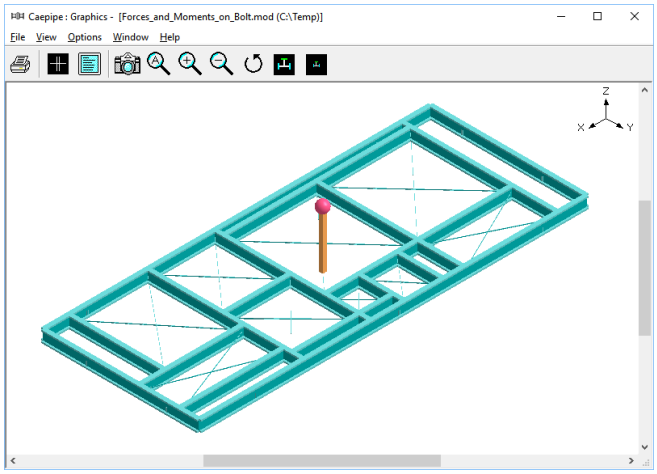
Various element types

- Pipe
- Elbow/Bend (Flexibility factor, User SIF, Different material, Thickness, etc.)
- Miter bend (Flexibility factor, User SIF, Different material, Thickness, etc.)
- Jacketed pipe (with concentric core pipe being routed automatically along with jacket pipe)
- Jacketed bend (with concentric core bend being routed automatically along with jacket bend)

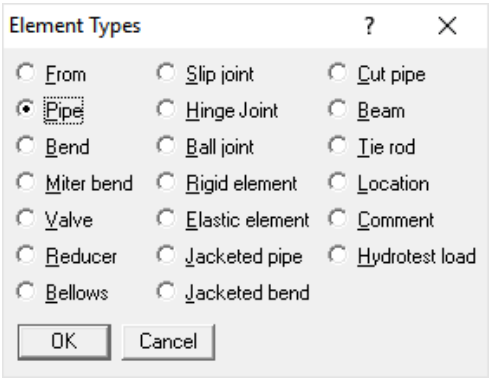


- Reducer (concentric and eccentric)

- Rigid element
- Valve
- Bellows
- Slip joint (with friction)
- Hinge joint (with friction and rotation limits)
- Ball joint (with friction and rotation limits)
- Beam (end releases, beta angle, shear deformation)



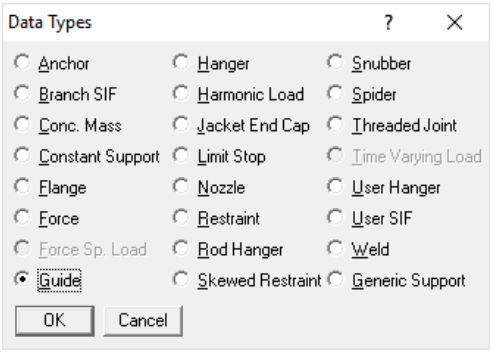
- Elastic element
- Tie rod (with different stiffnesses and gaps in tension/compression)
- Cold spring (cut short or long)



Various support types

- Tag names for all supports (including Anchors and Nozzles)
- Rigid and flexible anchor
- Release anchors during hanger design
- Two-way rigid restraint
- Skewed restraint (translational or rotational)
- Guide (with gap, friction and stiffness)

- Hangers
    - Variable spring support
    - Constant support
    - User defined
    - Rod hanger
- Limit stop (with gap, friction and stiffness)
- Snubber (rigid or flexible)
- Generic Support
- Supports can be connected to other nodes



Other useful data

- Flange
- Force and moment
- Jacket end cap (welds core pipe to jacket pipe)
- Spider (ties core pipe to jacket pipe)
- Nozzles attached to cylindrical and spherical shells
- Weld
- Threaded joint
- Concentrated mass
- SIFs (tee, branch, and such) as per Piping Codes listed below and ASME B31J

Built-in databases

- Pipe sizes (ISO, ANSI, JIS and DIN, including bend radius data)
- Insulation materials (densities)
- 35 spring hanger catalogs
- Flanges (weights, SIFs) for ASME and DIN
- Large Valve library (types, lengths, weights); User-definable too
- Material libraries for commonly used materials and codes (user-definable too)
- B31.1 and B31.3 Material libraries with over 400 materials
- Nozzle flexibilities according to WRC 297, API 650 and PD5500
- SIF values for different components from each piping code
- AISC library of beam sections (user-definable too)
- Spectrum Libraries corresponding to EL Centro, Uniform Building Code and Nuclear Regulatory Commission (NRC) Guide 1.60
- Design Fatigue Curves corresponding to ANNEX 3-F of ASME Section VIII, Division 2 (2021)

Piping codes

Sl. No.	Piping Code and Description	Metallic / Nonmetallic Piping
1	ASME B31.1 (2024) - Power Piping	Metallic
2	ASME B31.1 (1967) - Power Piping	Metallic
3	ASME B31.1 (1973) - Power Piping	Metallic
4	ASME B31.1 (1977) - Power Piping	Metallic
5	ASME B31.1 (1980) - Power Piping	Metallic
6	ASME B31.3 (2022) - Process Piping	Metallic
7	ASME B31.4 (2022) - Pipeline Transportation Systems for Liquids and Slurries	Metallic
8	ASME B31.5 (2022) - Refrigeration Piping and Heat Transfer Components	Metallic
9	ASME B31.8 (2022) - Gas Transmission and Distribution Piping Systems	Metallic
10	ASME B31.9 (2020) - Building Services Piping	Metallic
11	ASME B31.12 IP (2023) - Hydrogen Piping	Metallic
12	ASME B31.12 PL (2023) - Hydrogen Pipelines	Metallic
13	ASME NM.1 (2022) - Thermoplastic Piping Systems	Nonmetallic
14	ASME NM.2 (2022) - Glass-Fiber-Reinforced Thermosetting-Resin Piping Systems (GRP/FRP)	Nonmetallic
15	ASME Class 2 (1980) - ASME Section III, Subsection NC - Class 2	Metallic
16	ASME Class 2 (1986) - ASME Section III, Subsection NC - Class 2	Metallic
17	ASME Class 2 (1992) - ASME Section III, Subsection NC - Class 2	Metallic
18	ASME Class 2 (2015) - ASME Section III, Subsection NC - Class 2	Metallic
19	ASME Class 2 (2017) ASME Section III, Subsection NC - Class 2	Metallic
20	ASME Class 2 (2021) - ASME Section III, Subsection NC - Class 2	Metallic
21	ASME Class 2 (2023) - ASME Section III, Subsection NC - Class 2	Metallic
22	ASME Class 3 (2017) - ASME Section III, Subsection ND - Class 3	Metallic
23	ASME Class 3 (2021) - ASME Section III, Subsection ND - Class 3	Metallic
24	ASME Class 3 (2023) - ASME Section III, Subsection ND - Class 3	Metallic
25	ISO 14692-3 (2017) - Petroleum and Natural Gas Industries - Glass Reinforced Plastics (GRP/FRP) Piping	Nonmetallic
26	EN 13480 (2020) - Metallic industrial piping	Metallic
27	EN 13941 (2019) - District heating pipes	Metallic
28	BS 806 (1986) - Construction of Ferrous Piping Installations for and in Connection with Land Boilers (British)	Metallic
29	DNV-ST-F101 (2021) - Submarine pipeline systems	Metallic
30	IGEM (2012) - Institution of Gas Engineers and Managers (IGEM) IGE/TD/12 Edition 2 (UK)	Metallic
31	Norwegian (1983) - Process design	Metallic
32	Norwegian (1990) - Process design	Metallic
33	RCC-M (1985) - Design and Construction Rules for Mechanical Components of PWR Nuclear Islands (French)	Metallic
34	RCC-M (2018) - Design and Construction Rules for Mechanical Components of PWR Nuclear Islands (French)	Metallic
35	RCC-M (2020) - Design and Construction Rules for Mechanical Components of PWR Nuclear Islands (French)	Metallic
36	RCC-M (2022) - Design and Construction Rules for Mechanical Components of PWR Nuclear Islands (French)	Metallic

Sl. No.	Piping Code and Description	Metallic / Nonmetallic Piping
37	CODETI (2013) - CODE DE CONSTRUCTION DES TUYAUTERIES INDUSTRIELLES (French)	Metallic
38	Stoomwezen (1989) - Dutch Power piping code	Metallic
39	Swedish (1978) – Swedish piping code	Metallic
40	Z183 (1990) - Oil Pipeline Systems (Canadian)	Metallic
41	Z184 (1992) - Gas Pipeline Systems (Canadian)	Metallic
42	Z662 (2019) - Oil & Gas Pipeline Systems (Canadian)	Metallic
43	NONE (for AWWA M11 applications, and for applications in aircraft, aerospace & defence industries)	Metallic

Units in any combination

- SI
- Metric
- English
- Any combination of above

Rotating equipment

- NEMA SM-23 (Turbines)
- API 610 (Vertical and Horizontal pumps)
- ANSI/HI 9.6.2 (Rotodynamic pumps)
- API 617 (Compressors)

Flange Qualification

- Flange & Bolt stresses as per ASME Section VIII Division 1
- Flange with High Strength Bolts as per NC.3658.3 of ASME Section III Class 2 (2017)
- Flange equivalent pressure as per
    - NC.3658.1 of ASME Section III Class 2 (2017) or
    - Eq. 6.6.1-2 of EN 13480-3 (2020)

Internal and External Pressure Design of pipe and pipe fittings as per SS EN 13480-3 (2017)

Allowable loads on nozzles to spherical and cylindrical shells as per EN 13445-3:2014/A8:2019

Local shell stresses as per WRC Bulletin 537 and evaluation of those stresses as per ASME Section VIII, Division 2 for Nozzles attached to Cylindrical and Spherical Vessels

Evaluation of Hollow Circular Attachment (Lug) and Solid Rectangular Attachment (Lug) welded to Pipe as per ASME Section III Subsection NC & ND and EN 13480-3.

Design Wind Force as per ASCE/SEI 7-16

Static Seismic g's as per ASCE/SEI 7-16

Snow & Ice loads as per ASCE/SEI 7-22

Design Wind Forces as per EN 1991-1-4 (2010)

Remaining Strength of Corroded Pipeline evaluation as per ASME B31G (2023)

Simplified Fatigue Evaluation for the applicable piping codes

Detailed Fatigue Evaluation with applicable guidelines from ASME Section VIII Division 2 (2021)

Non-linearities

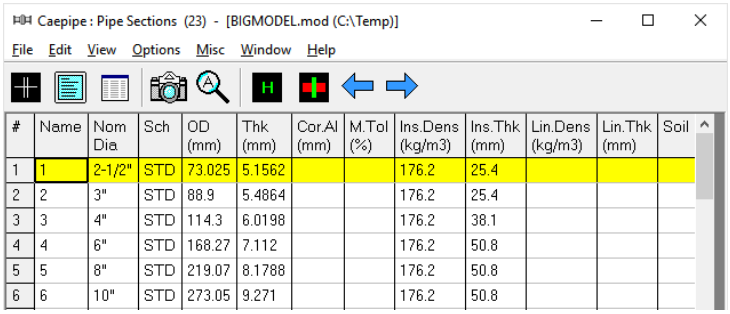
- Friction in Ball, Hinge and Slip joints
- Gaps and friction in Limit stops and Guides
- Rotation limits in Ball and Hinge joints,
- Tension/compression stiffnesses and gaps in Tie rods

Nozzle stiffnesses

- WRC 297
- API 650
- PD 5500

List window – Fully editable and printable

- Display/edit itemized listings of components/materials/sections/etc. with all details
- Copy and Paste various element types and data types using list window



#	Name	Nom Dia	Sch	OD (mm)	Thk (mm)	Cor.Al (mm)	M.Tol (%)	Ins.Dens (kg/m3)	Ins.Thk (mm)	Lin.Dens (kg/m3)	Lin.Thk (mm)	Soil
1	1	2-1/2"	STD	73.025	5.1562			176.2	25.4			
2	2	3"	STD	88.9	5.4864			176.2	25.4			
3	3	4"	STD	114.3	6.0198			176.2	38.1			
4	4	6"	STD	168.27	7.112			176.2	50.8			
5	5	8"	STD	219.07	8.1788			176.2	50.8			
6	6	10"	STD	273.05	9.271			176.2	50.8			

- Many keyboard shortcuts for quick and efficient operation
- Node search feature

Block and Edit operations

- Generate new piping from existing piping
- Comments in the model (make as many comments anywhere)
- Change material, pipe size, load and offset distance in one click
- Changes updated immediately in all open windows
- Edit, split and combine elements
- Merge models interactively
- Copy and Paste single or multiple elements with supports (including user defined allowable loads)
- Extensive Find and Replace command
- Powerful multiple UNDO and REDO command
- Finding and Editing of Comment texts

Automatic backup and periodic saving of model data

Default settings for ease of use, for example

- When a bend is input, by default, the radius, radius type, thickness, material and flexibility factor from the previous bend are used.
- When a hanger is input, the defaults are set from the previous hanger.

Conversion of a time function to a force spectrum

Local coordinate system shown graphically for most elements including nozzles

Automatic node number increment (can be turned off)

Specify slope for an element

Large model sizes (7,000 elements with node numbers up to 99,999)

Redefining a model's vertical axis without affecting the layout

Rotate sections of piping model

Analysis Features

Static linear/non-linear analysis

- Empty Weight
- Sustained
- Expansion
- Operating
- Design
- Occasional
- Hydrotest
- Cold Spring

Automatic spring hanger design

- 35 hanger catalogs (US, European, Japanese and Indian manufacturers)

Loads

- Weight and up to 10 pressures (i.e., up to 11 sustained cases)
- External pressure(s) can also be input
- External forces and moments for 10 thermal cases + 1 sustained case + 3 static seismic cases
- Hydrotest case
- Up to 10 thermal loads with 50+ thermal ranges (expansion)
- Up to 10 operating cases (combination of weight, pressure and temperature)
- Design case (combination of weight, design pressure and design temperature)
- Flange equivalent pressures for 10 operating cases
- Rotating equipment reports for 10 operating cases
- Up to 4 wind loads (occasional)
- Up to 3 static seismic accelerations (occasional)
- Specified Displacements for Thermal (up to 10 cases)
- Specified Displacements for Design case
- Specified Displacements for Winds (up to 4 cases)
- Specified Displacements for Static Seismic (up to 3 cases)
- Building Settlement
- Force Spectrum load (occasional)
- Seismic response spectra (occasional) – Uniform Level (including Specified Displacements)
- Seismic response spectra (occasional) – Multi-level (including Specified Displacements)
- Power Spectral Density (PSD) data for Random Vibration
- Harmonic loads, e.g., periodic excitation from equipment such as pumps (occasional)
- Time history loads, e.g., a fluid hammer (occasional)

- Non-repeated anchor movement: (settlement)
- Peak pressure for occasional loads
- 100+ load combinations
- Support Load Summary for 150+ load combinations

Analysis options

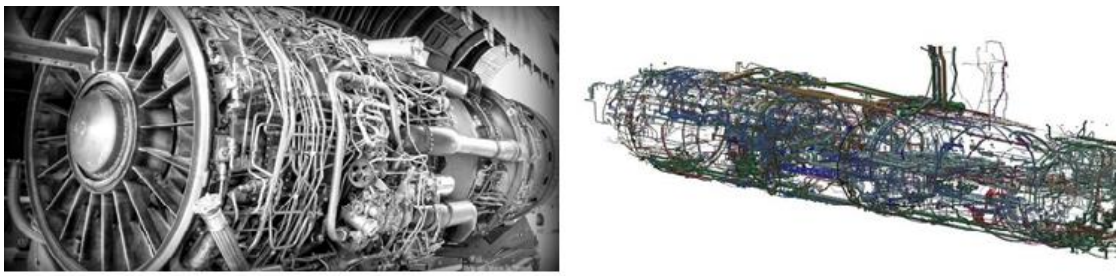
- Thermal case = Operating – Sustained (recommended)
- Solve Thermal case independently

Modal analysis: Fast solver – Includes Dynamic Susceptibility analysis with recommendation provided in Clause A.2.7 of SS EN 13480-3 2017/A3-2020.

Seismic response spectrum analysis

- Uniform response spectrum analysis
- Multi-level response spectrum analysis
- Combination method: Square Root of Sum of Squares (SRSS) or Absolute (ABS) sum or Closely spaced modes as per USNRC Guide 1.92 or Naval Research Laboratory (NRL) sum
- Spectrum Types: Frequency (or Period) versus displacement, velocity or acceleration. Linear or logarithmic interpolation, multiple units supported
- Level summation can be either SRSS or ABS for Multi-level response spectrum analysis
- Spectrum entered interactively or through user created text file
- Export of element forces and moments in Local coordinate system contributed by each mode participating in Response Spectrum analysis in .csv format

Random Vibration Analysis



Tubings in Turbofan Engine and 3D Piping Model of Submarine

- Random Vibration analysis of piping, tubing & ducting in aircraft, aerospace and defense industries
- Power Spectral Density (PSD) data can be entered interactively or through user created text file or through user defined PSD library
- Response to PSD load by Normal Mode (Approximate) or by Normal Mode (Standard) method
- PSD Types: Displacement/Acceleration versus Frequency/Period. Linear or Logarithmic interpolation, multiple units supported
- Probability factors: 1 Sigma (68.27%), 2 Sigma (95.45%) and 3 Sigma (99.73%)
- Modal Summation: Square Root of Sum of Squares (SRSS) or Absolute (ABS) sum or Closely Spaced Modes (CSM) as per USNRC Guide 1.92 or Naval Research Laboratory (NRL) sum
- Fatigue Calculations as per Steinberg's Method
- Export of element forces and moments in Local Coordinate System contributed by each mode participating in Random Vibration analysis in .csv format

Missing mass correction for uniform response spectrum analysis

Time history analysis

Force spectrum analysis

Harmonic analysis

Pressure Relief Value loading analysis

FRP piping analysis (user-definable allowables for different directions)

Refinement of Nodal Mesh based on Mass Modeling Frequency

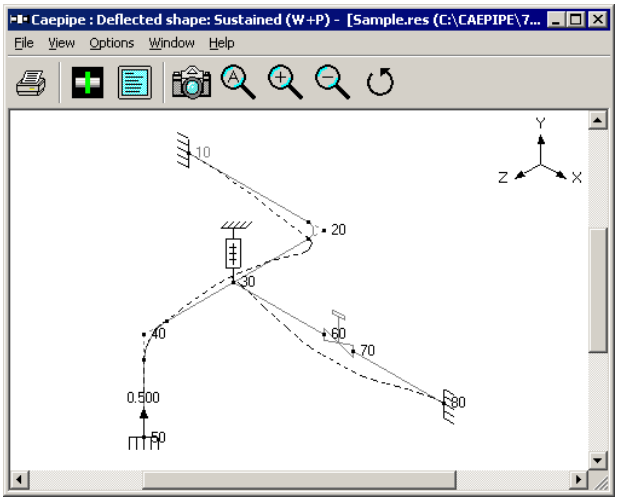
Refinement of Branch Elements to compute Flexibility Factors at Branch in accordance with ASME B31J and EN 13941

Buried piping analysis including automatic discretization of elements as per ASME B31.1 (2014)

Results Review

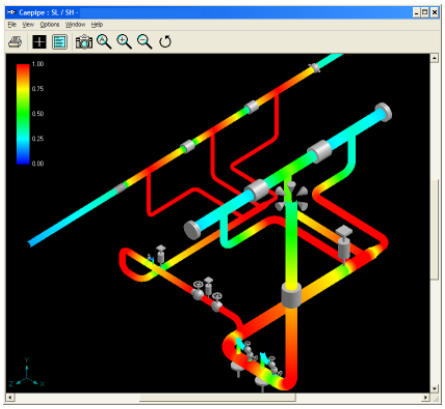
• Output

- Displacements at
  - All nodes
  - Ball joints (with bending displacements)
  - Flexible joints (Bellows, Slip, Hinge and Ball joints)
  - Guides, Hangers, Limit stops
  - Minimum and maximum displacements for each load case
- Deflected shape (animation possible)



- Support loads for all load cases
- Support load summary (150+)
- Element forces and moments (local and global)
- Internal and External Pressure Design results as per EN 13480-3 (2017)
- Status of Nonlinearities such as pipe lifting off at resting/sliding supports, gap closure at supports and tie rods, friction at supports and expansion joints

- Stresses
    - Code compliance stresses
    - Sorted code stresses
    - Von Mises, Maximum and Minimum stresses
    - Operating stresses for nondestructive examination (NDE)
    - Operating stresses for Impact Test as per ASME B31.5
    - Color coded stresses and stress ratios



- Hanger report
- Flange report
- Simplified Fatigue Evaluation
- Detailed Fatigue Evaluation
- Rotating equipment reports
- Frequencies and mode shapes (animation possible)
- Response spectrum analysis results
- Center of gravity, weight of each element and total weight
- Clean, Concise, Clearly Organized, Formatted and Customizable reports

Analysis Options

Code : Piping code = B31.3 (2014)
Include axial force in stress calculations
Do not use liberal allowable stresses

Temperature : Reference temperature = 70 (F)
Number of thermal cycles = 7000
Number of thermal loads = 3
Thermal = Operating - Sustained
Use modulus at reference temperature

Pressure : Pressure stress = PD / 4t
Peak pressure factor = 1.00
Include Bourdon effect
Use pressure correction for bends

Dynamics : Cut off frequency = 200 Hz
Number of modes = 5
Include missing mass correction
Use friction in dynamic analysis

Misc. : Include hanger stiffness
Vertical direction = Y

B31.3 (2014) Code compliance (Sorted stresses)

Sustained				Expansion				Occasional (SHO = 1.33SH or 0.9WSy)			
Node	SL (psi)	SH (psi)	SL SH	Node	SE (psi)	SA (psi)	SE SA	Node	SL+SO (psi)	SHO (psi)	SL+SO SHO
5380	5409	13700	0.39	5190A	30915	20550	1.50	1870	14226	18221	0.78
5390	5097	13700	0.37	2560A	29677	20550	1.44	1900	11261	18221	0.62
5450	4789	13700	0.35	5190B	28228	20550	1.37	5380	8925	18221	0.49
4340	3884	13700	0.28	2560B	25551	20550	1.24	5390	8103	18221	0.44
4330B	3695	13700	0.27	5720B	25084	20550	1.22	5450	8050	18221	0.44
4320A	3416	13700	0.25	1870	24204	20550	1.18	1880B	7595	18221	0.42
4280B	3390	13700	0.25	2000	22424	20550	1.09	2280	6652	18221	0.37
5400	3159	13700	0.23	5720A	22418	20550	1.09	5410	5656	18221	0.31
3920B	2882	13700	0.21	2010A	22404	20550	1.09	5400	5593	18221	0.31
3620B	2811	13700	0.21	5730A	21325	20550	1.04	1890A	5498	18221	0.30
2630	2749	13700	0.20	4460	20221	20550	0.98	3620B	5483	18221	0.30

Overstressed nodes shown in reverse text

Quick review of key results under "First-level Checks"

Print preview for reports and graphics

Bill of Materials, Table of contents and Revision records in reports

Neutral file input and output (.mbf)

Export of input and output to ASCII and MS-EXCEL (.csv) file format

Export and Import of Material Library through ASCII Material Library Batch file (.mlb)

Export of stress model as 3D reference geometry to 3D plant design systems PDMS, E3D and CADMATIC

Export of Deflected shape as 3D reference geometry to 3D plant design systems PDMS, E3D and CADMATIC

Compact and fast: Program size still approximately 3.1 MB!

Related Features

Widest Support for Importing / Exporting data

Import data from plant design systems (optional)

- AVEVA's PDMS/E3D
- Intergraph's PDS and SmartPlant 3D
- Autodesk's AutoCAD Plant 3D
- CADMATIC
- Dassault Systems' CATIA
- Bentley's AutoPLANT
- AVEVA's Tribon (ship building)
- Other plant design software that produce piping layout in PCF format

Import data from pipe stress analysis programs (built-in)

- Hexagon's CAESAR II versions up to and including 14.00
- Algor's PipePak

Import Time History / Force Spectrum data from Computational Fluid Dynamics and Flow Analysis programs (built-in)

- PIPENET
- FLOWMASTER
- ROLAST
- AFT Impulse

Export to

- 2D DXF (built-in)
- Aveva's PDMS/E3D (built-in)
- CADMATIC (built-in)
- Piping Component File (PCF) format (built-in) which can be read by many 3rd party products
- Hanger Report to LICAD software (built-in)
- HEXAGON's CAESAR-II (optional)
- HEXAGON's PIPESTRESS (optional)

Advanced 32-bit Windows technology

- Multithreading: Layout, Graphics, Animation and Analysis run in separate threads
- Robust Exception handling: Better error diagnostics
- Memory mapped files: Really fast data access
- Ability to change display and print fonts for text and graphics

Advanced software features

- Super-fast dynamic scrollbar with tracking scroll box in real-time for text and graphics
- Dynamic updating of data in all open windows – Layout, List and Graphics
- Synchronization of the highlight/cursor between all open text and graphics windows
- Simultaneous visual updates of deflected and mode shapes. Simply switch between different load cases (or mode shapes) to show corresponding deflected (or mode shape).
- Flashing cursor in graphics window synchronized at all times with the input window
- A pop-up context menu of frequently used commands in Graphics window
- Graphics scales dynamically in real-time. Simply resize the window for fast and dynamic resizing.

Industries served by CAEPIPE

- Power (fossil & nuclear)
- Refinery
- Fertilizers
- Sugar & Food Processing
- Steel / Metal Process
- Aircraft and Aerospace
- Defense Industries
- Oil & Gas production (onshore & offshore)
- Chemical & Petrochemical
- Pharmaceutical
- Paper & Pulp
- Water & Waste Treatment
- Building Services
- Ship Building

SST continues to constantly enhance and improve CAEPIPE.
Please check with us if you do not see a feature listed in this document.
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