PIPESTRESS Version 4.1.0 Enhancements

The main enhancements included in PIPESTRESS Version 4.1.0 since the last released version (4.0.0) are outlined below followed by a description of compatibility with previously released versions.

1. New Code Editions

Code edition	IDEN card	TITL card
B31.1 Ed. 2018	CD=0	CV=18
ASME NB-3600 Ed. 2019	CD=1	CV=25
ASME NC-3600 Ed. 2019	CD=2	CV=26
ASME ND-3600 Ed. 2019	CD=3	
B31.3 Ed. 2018	CD=4	CV=15
RCC-M Volume B Ed. 2018	CD=7	CV=10
RCC-M Volume C Ed. 2018	CD=8	CV=10

2. Dynamic susceptibility

Dynamic susceptibility is presented in ICONE22-30702 paper: “ON VIBRATION PROPERTIES OF PIPING SYSTEMS AND PRACTICAL MEASURES FOR PREVENTING VIBRATION DAMAGES”, Lennart G. Jansson and Lingfu Zeng, July 7-11, 2014, Prague.

The dynamic susceptibility parameter DS is useful to determine the sensitivity of the piping to vibrations. It is defined for every eigen mode as:

$$DS = \sigma_{max} / V_{max}$$

where:

σ_{max} = maximum modal stress (psi or MPa)
$V_{max} = D_{max}.\omega$ = maximum velocity (in/s or m/s)
D_{max} = maximal modal displacement (in or m)
$\omega = 2\pi f$ = circular frequency (rad/s)

3. Steam tables

The most recent and precise formulations for water and steam properties have been programmed according to IAPWS 97 + Rev. 2007.

4. Increased limits (number of elements, number of anchors and generated points, etc.)

There is no limit anymore on the number of elements or on the number of anchors. The maximal number of automatically generated nodes has been increased to 140608 for the “Y” category and for the “Z” category.

5. Implementation of R.G. 1.207 Rev.1

Regulatory Guide 1.207 deals with the effect of light water reactor water environment on the fatigue properties of piping within the reactor pressure boundary.

The most recent revision 1 (June 2018) is now available by entering CU=3 in the TITL card.

6. Calculations of displacements, rotations and accelerations in user-defined local coordinates system (DLCS card)

Local coordinates can be specified at any point by means of the new DLCS card. Displacements, rotations and accelerations are then output in report R-1e in the so-defined local coordinates.

Applied forces and moments, as well as anchor and support movements, can be expressed in these local coordinates by means of the new option LO=L.

The directions of supports and anchors can also be defined in these local coordinates by means of the new option LO=L.

7. New values of option BR in the TITL card: BR=3 and BR=4

The BR option determines how branches are modeled. Three methods are available:

Rigid: the imaginary element connecting the centerline with the surface of the run pipe has zero flexibility

Pipe: the imaginary element connecting the centerline with the surface of the run pipe has the same cross section as the branch pipe (same as `BRAN TE=2`)

Class 1: the imaginary element connecting the centerline with the surface of the run pipe has zero flexibility (same as Rigid). However, in the case of small-branch branch connections that meet the dimensional limitations of ASME NB-3683.8 (RCC-M B 3683.8.b), an element of negligible length with local flexibility for the bending moments is inserted at the surface of the run pipe according to ASME NB-3686.5 (RCC-M B-3684.4).

The branch modeling is determined by the BR value and either the calculation code or the actual class of the tees, depending on the value of field MX:

BR option	Modeling method for Class 1	Modeling method for non-Class 1
BR = 0 (default)	Class 1	Rigid
BR = 1	Class 1	Pipe
BR = 2	Class 1	Class 1
BR = 3 **(new)**	Pipe	Pipe
BR = 4 **(new)**	Rigid	Rigid

8. True mixed class calculations

By default, the bend flexibilities and branch modeling are determined according to the calculation code (card IDEN field CD).

If the new option MX=1 is entered in the TITL card, the bend flexibilities and branch modeling are determined according to the actual class of the bends and tees, as specified by the cards CLS1, CLS2, CLS3 and CL31.

9. New feature for enabling/disabling stress post-processing according to the load case (STON/STOF)

The stress calculation can now be enabled (card STON) or disabled (card STOF) for particular load cases specified in the new field CA.

10. New field HR in the TITL card for Highest Stress reports

By default, the 20 highest stress ratios are output in report R-4.

The new field HR in the TITL card allows to specify a minimum stress ratio σ_{min} : all ratios higher or equal to σ_{min} are then output in report R-4.

11. New parameter for the modal extraction algorithm

A new PP card MMAX has been added to control the modal extraction algorithm. It can be used to improve the convergence when the model has a high number of symmetries.

12. Enhancements in POSTR

- Possibility to define the coordinates system (global or local) for printing the reactions at restraints: common control with the new field GL in the OPTN card, or specific control with the field GL in the SUPP card.
- New field PR in the OPTN card for always printing the results as MAX/MIN.
- New NODE card for printing the displacements, rotations and accelerations in global or local coordinates system.
- Increase of memory: especially 95’000 groups can be defined instead of 5’000.
- Possibility to define an unlimited number of constituent cases in the GROU card.
- New STAR card for printing a line of stars.

13. Enhancements in COMPPS

A new option JUMP_BLANK has been introduced to ignore all blank lines during the comparison. The option READ_BLANK can be used to re-enable the comparison of blank lines.

14. Correction of Errors and Implementation of Minor Enhancements

- The stability of the static non-linear algorithm has been improved for the cases where friction and non-linear elements are modelled.
- A new parameter (field E4) is introduced in the PCAS and PACC cards in order to make the ADAMOS algorithm more robust when gapped restraints (GAPR card) with very high stiffnesses are modeled.
- JUNC cards are automatically generated at extremities of elements to which very small stiffnesses may be given by the user: SPRS/SPRF, MTXS/MTXF and BEAM with R1=1 or R2=1. There is thus no need for the user to enter JUNC cards manually after these elements, as recommended in the past.
- For buried piping, PIPESTRESS 4.0.0 crashed when the length of the remaining straight elements in the sequence TANG-BRAD-TANG was equal to zero or slightly negative. PIPESTRESS 4.0.0 crashed also when a TANP card was followed by TANG.

  A small tolerance has been added in version 4.1.0 to avoid these issues.

PIPESTRESS Version 4.1.0 Enhancements

Compatibility

PIPESTRESS Version 4.1.0 may generate different solutions than earlier versions due to the correction of the following errors in Version 4.0.0:

1. Results may be incorrect when laminar stratification is defined and one of the vertical coordinates describing the laminar flow is equal to 0.

   See Error Report No. 135.

2. The internal forces and moments at the extremity of an element may be incorrectly output by POSTR when the extremity is the start point of the element (as modeled in PIPESTRESS input file) and it corresponds to a tee junction (i.e. 3 or more elements meet at this point).

   See Error Report No. 136.

3. The stress indices C1, C3, K1, K2 and K3 are calculated incorrectly for elbows with a longitudinal weld defined as “as welded” when code RCC-M Class 1 (B3600) is used:

   - K1, K2, K3 are calculated by PIPESTRESS according to B3683.2a) instead of B3683.7a)2): consequently K1, K2 and K3 are equal to 1.3 instead of respectively 1.8, 1.4 and 1.7.
   - PIPESTRESS does not apply the rules given by B3683.7a): consequently C1 is calculated only from the value of the fitting instead of C1 = C1fitting × C1weld, and C3 is calculated only from the value of the fitting instead of C3 = max(C3fitting, C3weld). The values of C1 and C3 are incorrect only if $t \leq 6mm$ or $\delta/t > 0.1$, with t = thickness of piping and δ = mismatch.

   See Error Report No. 137.

4. Field GX is not read for NCAS cases with TY=1 and TY=2. The gravity factor in the X direction is therefore taken as zero.

   See Error Report No. 138.

5. The internal forces and moments of an element may be incorrectly output by POSTR when one (or both) end point of the element is defined in at least two junction cards JUNC.

   See Error Report No. 139.

6. For PIPESTRESS version 3.8.0 and earlier, the stratification effects may not be calculated correctly for load cases that contain at least one STRF card with ME=3 when the following conditions are met:

   - The card STRF with ME=3 is the first STRF card in the model
   - One or more OPER cards for declared load cases are entered afterwards but before any CROS card or STRF card with ME ≠ 3

   In this case, the STRF card with ME=3 card is reset to 0 right after the OPER cards.

   See Error Report No. 140.

7. For ASME Class 1 piping, it is possible to evaluate the environmental fatigue effects according to R.G. 1.207 Revision 0 by entering CU=1 in the TITL card.

   The field WC in the same card is related to the water chemistry and determines the transformed dissolved oxygen factor O' for Ni-Cr-Fe alloys.

   However, the description of field WC in PIPESTRESS user's manual is incorrect. The option WC=1 shall be used indeed for PWR Water Chemistry in place of WC=0. The description of field WC shall be replaced as follows:

   - WC = 0 for BWR Normal Water Chemistry (NWC) (default)
   - WC = 1 for PWR or for BWR Hydrogen Water Chemistry (HWC)

   See Error Report No. 141.

8. The direction of a restraint defined with LO=3 may not be calculated correctly in the following cases:

   - the first member connected to the restraint is a bend defined with a BRAD card. In this case, PIPESTRESS uses the local directions of the bend instead of the local directions of the second connected member (same as LO=2)
   - the second member connected to the restraint is a bend defined with a BRAD card. In this case, PIPESTRESS uses the local directions of the first connected member instead of the local directions of the bend (same as LO=2)
   - the second member connected to the restraint is a bend defined with a BEND card and the restraint is located at the start point of the bend. In this case, PIPESTRESS uses the local directions at the end point of the bend instead of the local directions at the start point of the bend.

   See Error Report No. 142.

9. The mismatch (MM), length of fillet weld (field CX) or taper thickness (field TM) defined at the end point of a member is not considered for the start point of the consecutive member if a restraint is defined at that point.

   In the following example, the mismatch 2/32” is only considered for point 110 of member 100-110. The mismatch information is lost for point 110 of member 110-120 and the default value is used:

```
* Restraint – case 1
ANCH PT=100
TANG PT=110 DX=1’6” EW=2 MM=2/32”
RSTN PT=110 DY=1
TANG PT=120 DX=1’6”
```

```
* Restraint – case 2
ANCH PT=100
TANG PT=110 DX=1’6” EW=2 MM=2/32”
TANG PT=120 DX=1’6”
…

RSTN PT=110 DY=1
```

   See Error Report No. 143.

PIPESTRESS Version 4.1.0 Enhancements

Some other modifications in PIPESTRESS Version 4.1.0 may also generate different solutions than earlier versions:

- The stability of the static non-linear algorithm has been improved for the cases where friction and non-linear elements are modelled. The solution found could be a different one than the one found by PIPESTRESS 4.0.0 among all the valid solutions.
- The results of thermal transients may change because the IAPWS steam tables are now used by default. To avoid those changes, the previous steam tables may still be used by entering CF=0A in the TITL card.
- The logic for the Highest Stress report generation has slightly changed. Some stress ratios were skipped in the previous versions, e.g. only one line was output for two contiguous elements that have almost the same stress ratio (±0.001). This is not the case anymore: all lines are output.
- The mechanical solution is calculated more precisely and may be slightly different from previous versions when elements with very small stiffnesses (SPRS/SPRF, BELW, MTXS/MTXF and BEAM with R1=1 or R2=1) are present.
- The anchor reactions in report R-6b may be different. Indeed, the reactions are not given anymore in the local coordinates of the connected piping but in the actual local coordinates of the anchor itself (see field LO). Likewise, the actual local coordinates of anchors are output in report P-4 instead of the local coordinates of the connected piping.

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