



Tutorial
API 2A RP/ISO 19902/Norsok N004

ANSYS[®]

8 Dec 2020
version 2020.0.2

- ▶ In this tutorial, API 2A RP/ISO 19902/Norsok N004 Beam Design Checks are reviewed.
- ▶ A beam model of a steel frame has been used as a start FEM model.
- ▶ Beam member finder was used to recognize beam member length in 3 directions.
- ▶ The report was generated with the help of report designer.



Launch SDC Verifier

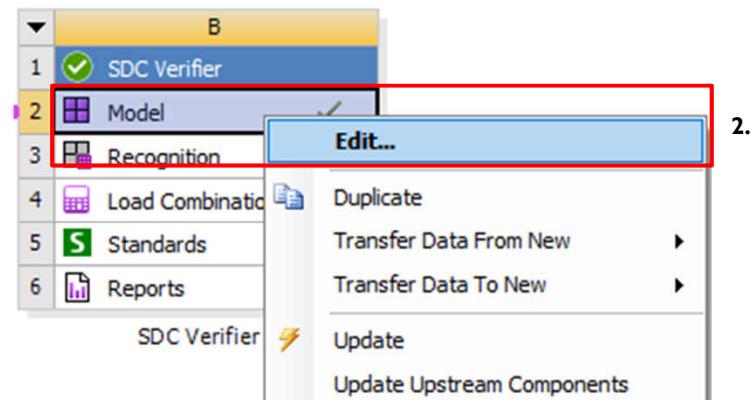
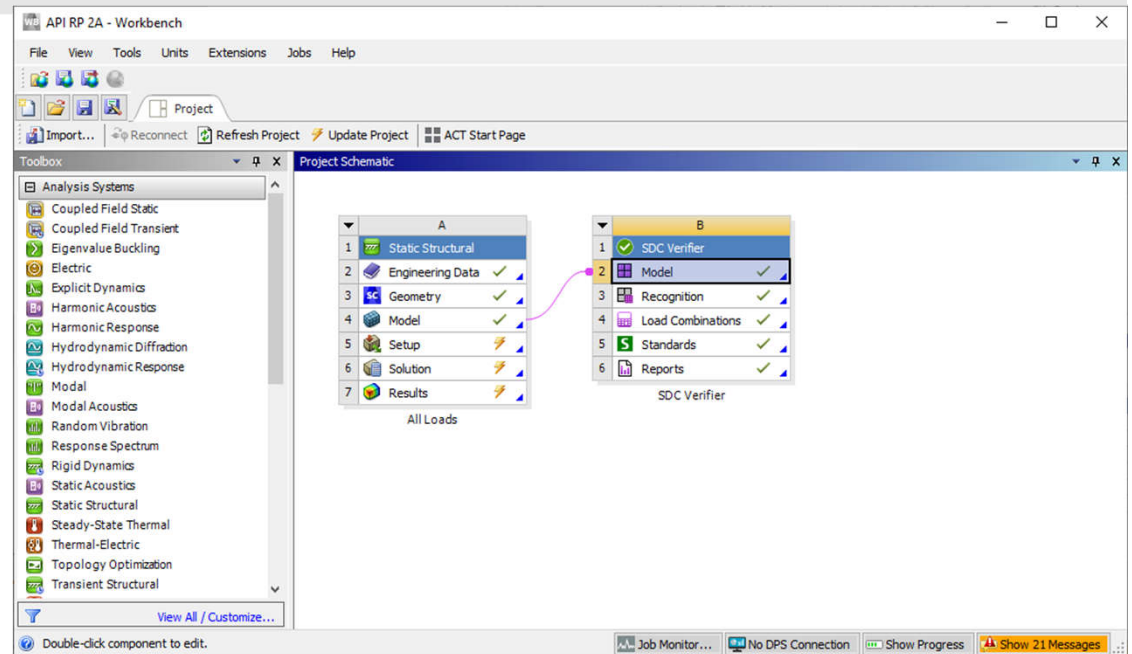


1

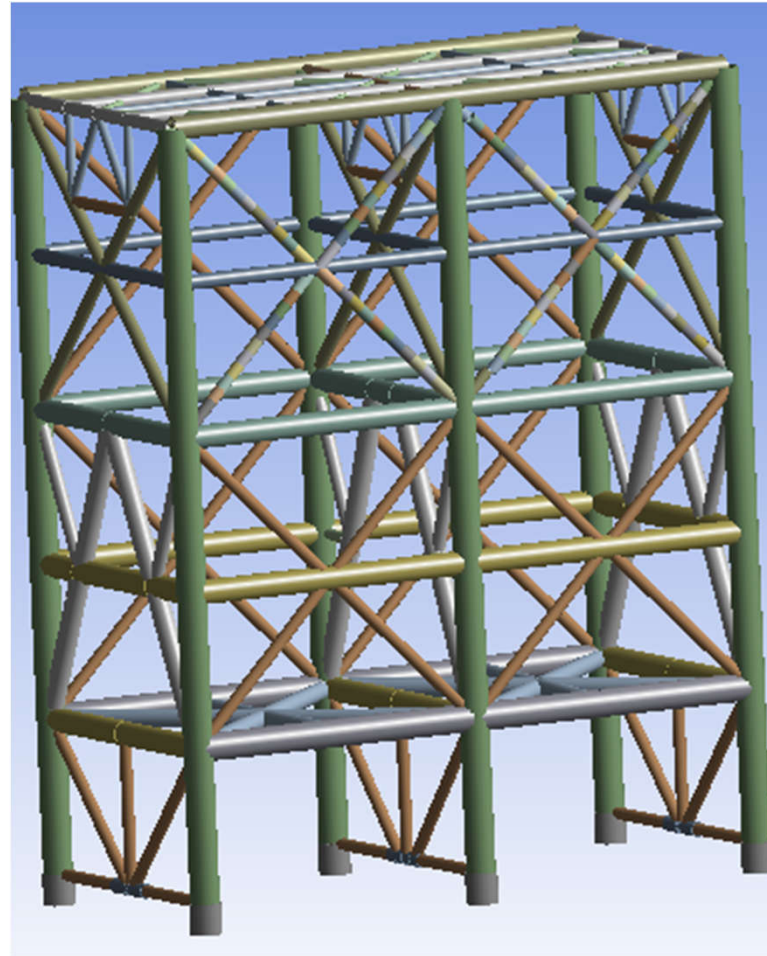
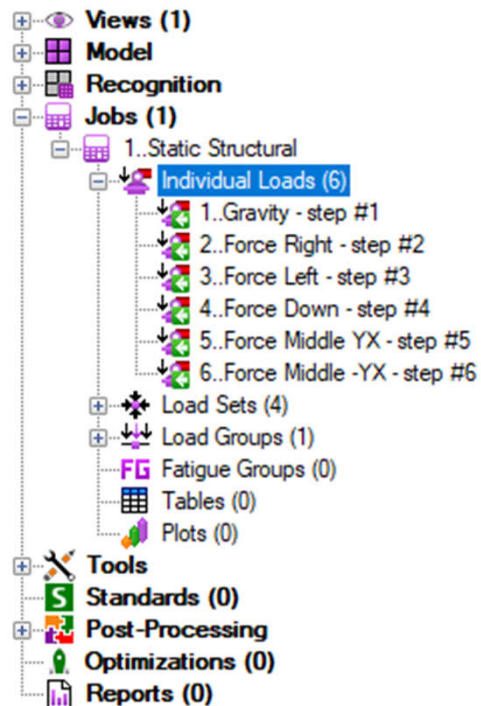
Open in Ansys Workbench
API RP 2A.wbpj

2

Double Click on  Model 
or in context menu click *Edit*



Predefined project

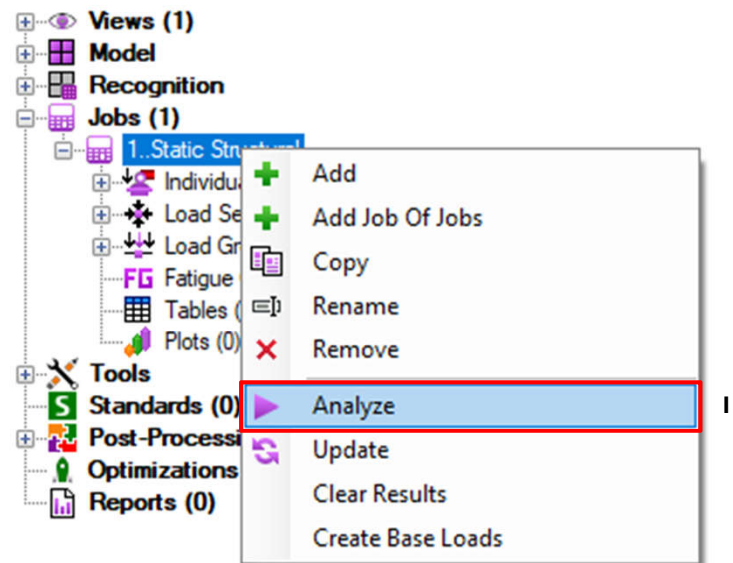


This tutorial uses project with predefined boundary condition, load combinations and load group. The model contains only circular tubes elements.

Analyze Job

1

Execute ► **Analyze** from *Static Structural* context menu



Explanation of Joints

Joint – location where different beam members connect. They are used to recognize beam member length by Beam Member Finder Tool.

There are 6 types of Joints:

1D Joint – 2 beam members that lie on the curve but with different properties;

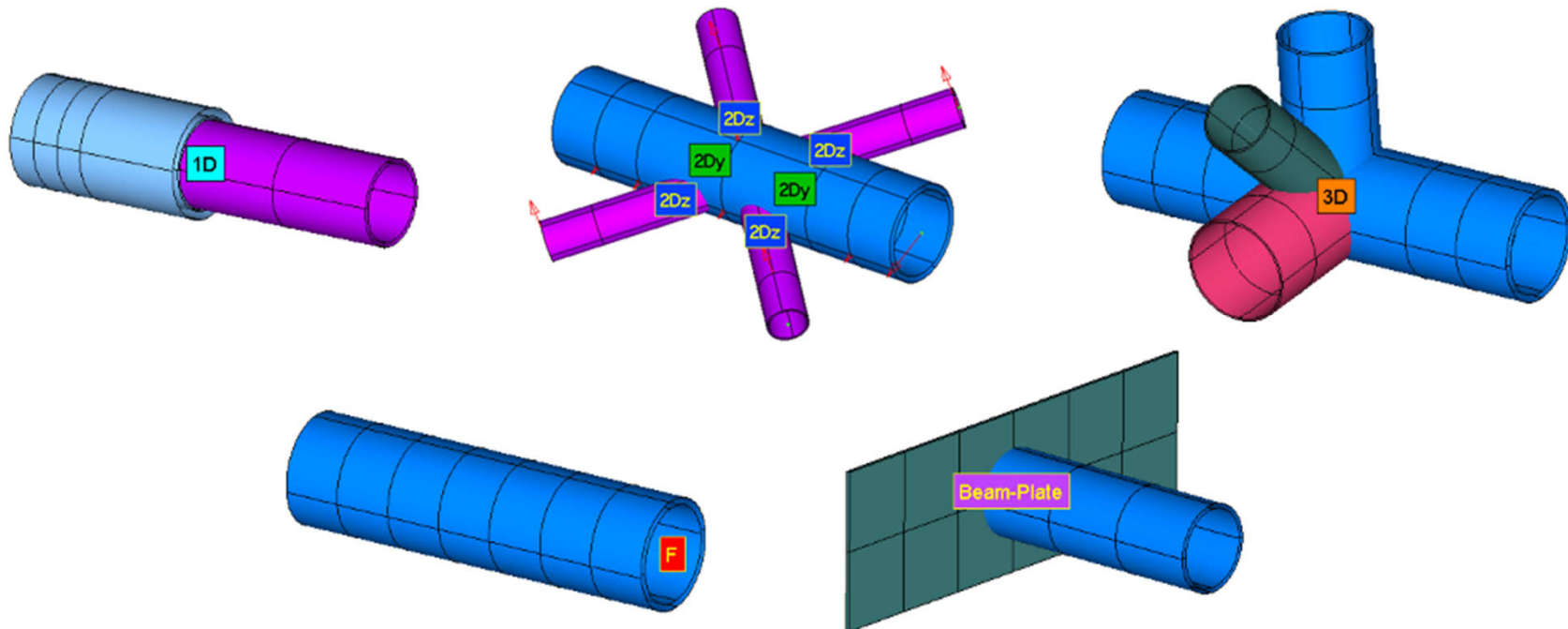
2D Joint – beam members connected in one plane;

3D Joint – beam members connected in space;

Free Joint – node which belongs only to one element (free);

Beam-Plate Joint – beam member connected to plates (perpendicularly);

User Defined;



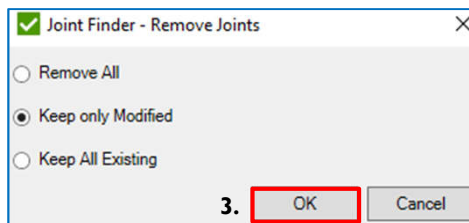
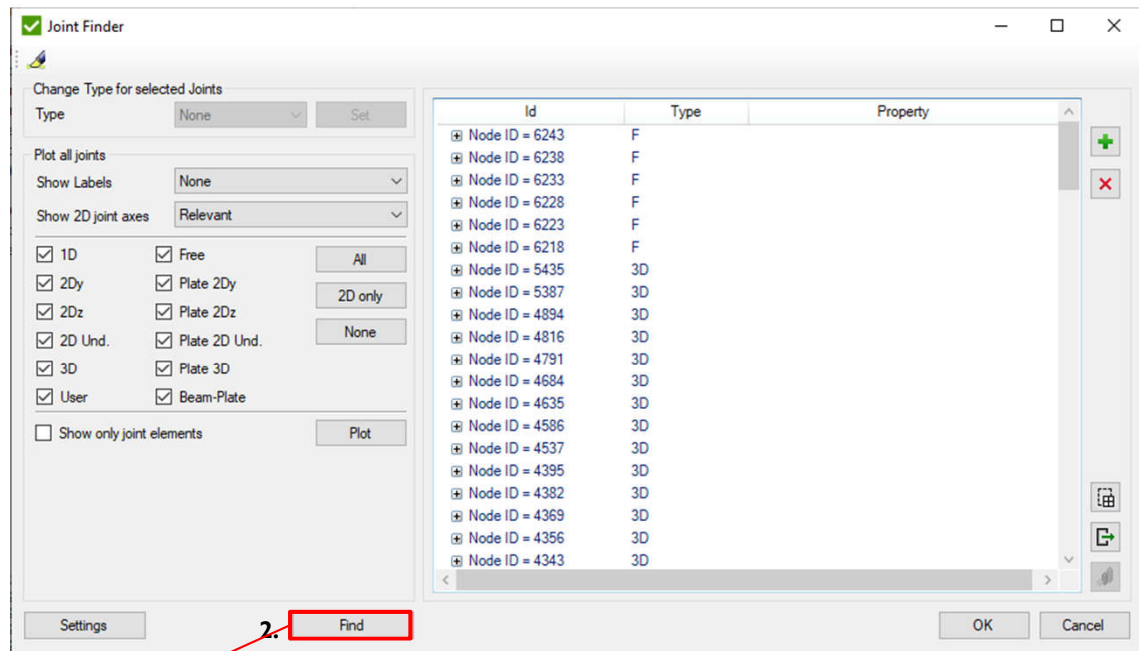
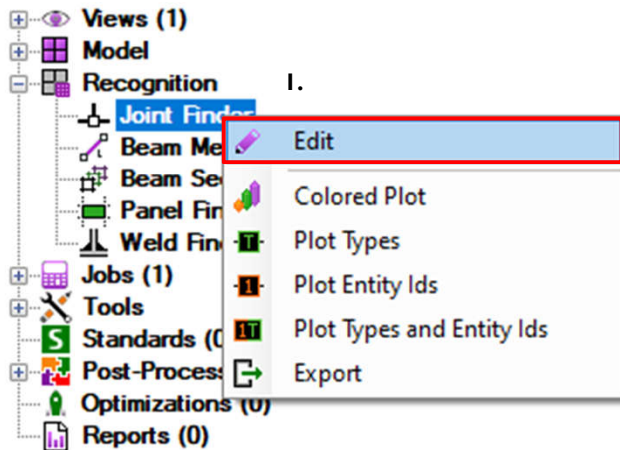
Joint Recognition

1 Execute *Edit* from *Joints* context menu

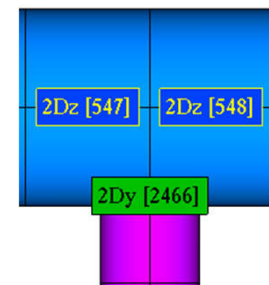
2 Press *Find*.

3 Press *Ok*.

When performing the joint recognition there are 3 options for existing joints. Default option: Keep only modified– remove all joints except edited by user. Keep all existing options should be used when additional elements were added to the model.



Node ID = 719			
Element ID = 547	2Dz	8..400x19	
Element ID = 548	2Dz	8..400x19	
Element ID = 2466	2Dy	14..200x10	



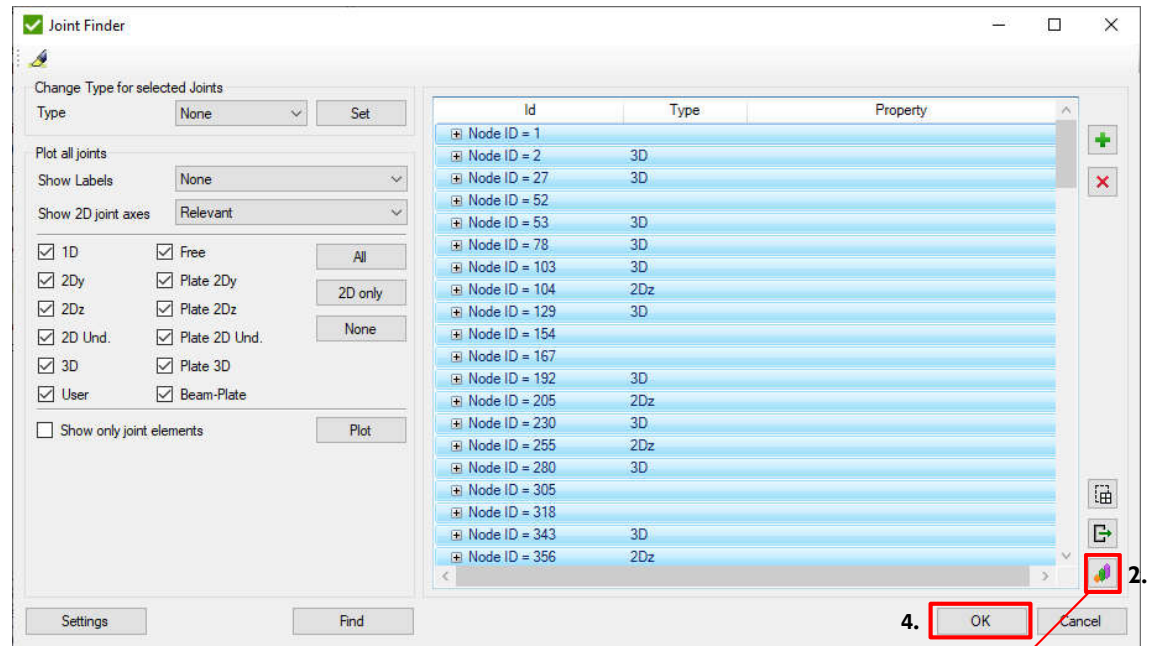
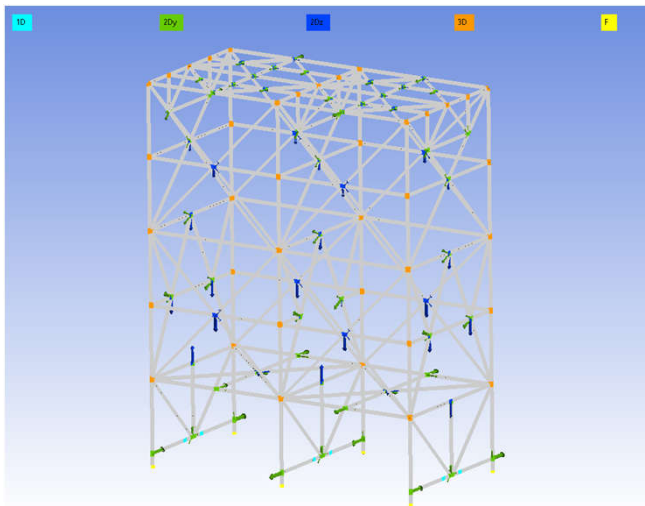
Joints Plot

1 Select All Joints (Ctrl+A).

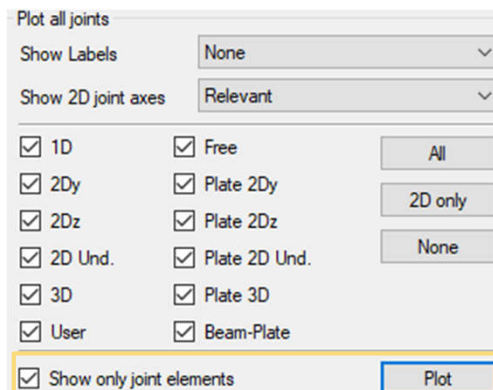
2 Press 



3 Press  Plot Joint Type Labels

4 Press OK



Plot Joints of specific type:



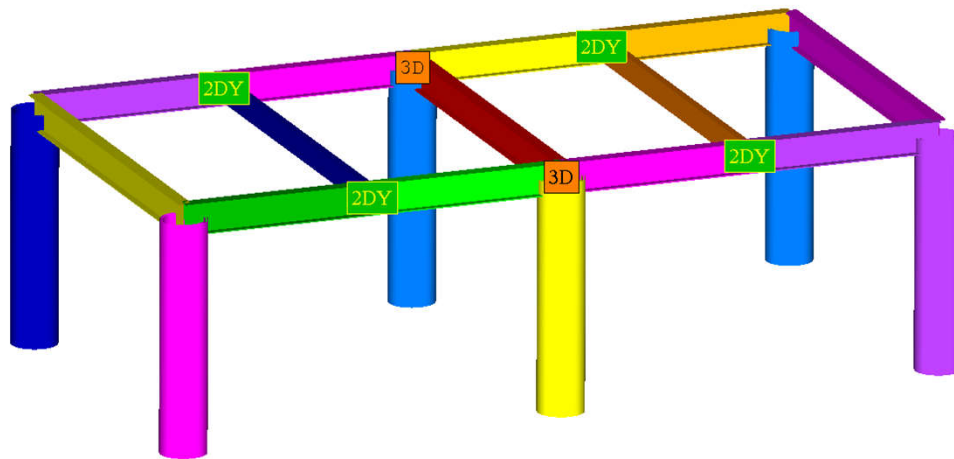
3.  Plot Joint Type Labels
 Plot Joint Type in colors

Modify Joint Type:

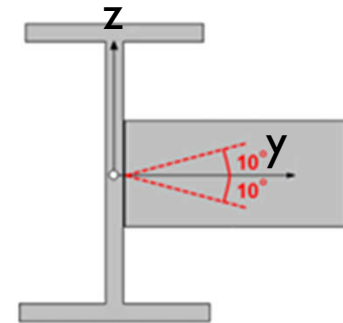


Beam Member Lengths in 2 directions

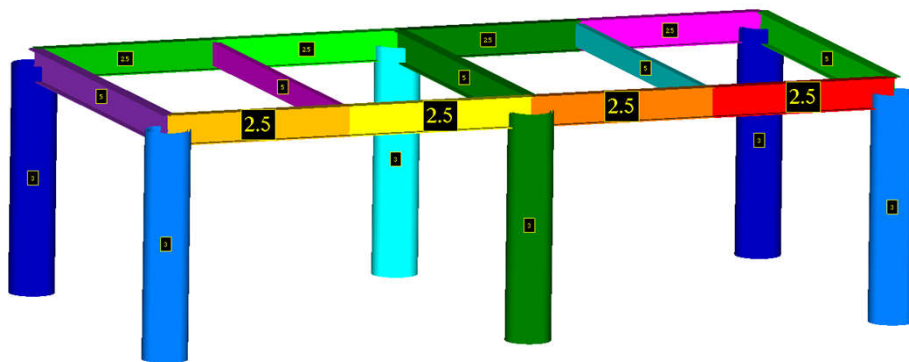
Beam Member Finder recognizes beam members and (buckling) lengths for different directions (Y, Z and Torsional).



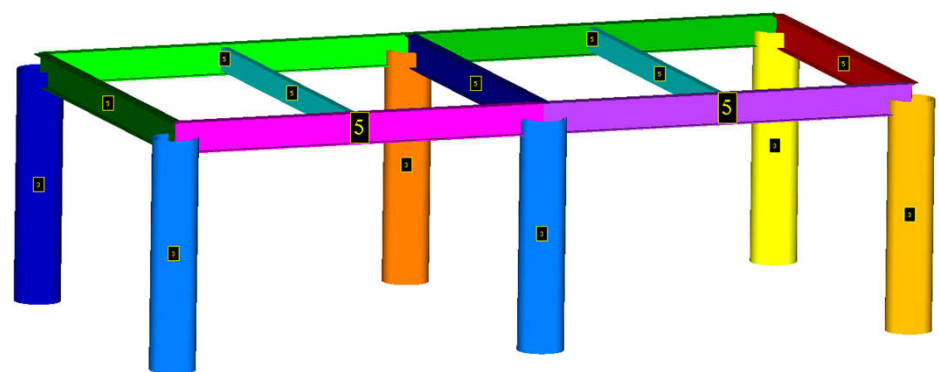
2DY
Joint



Length Y – 4 Beam Members with $L = 2.5$



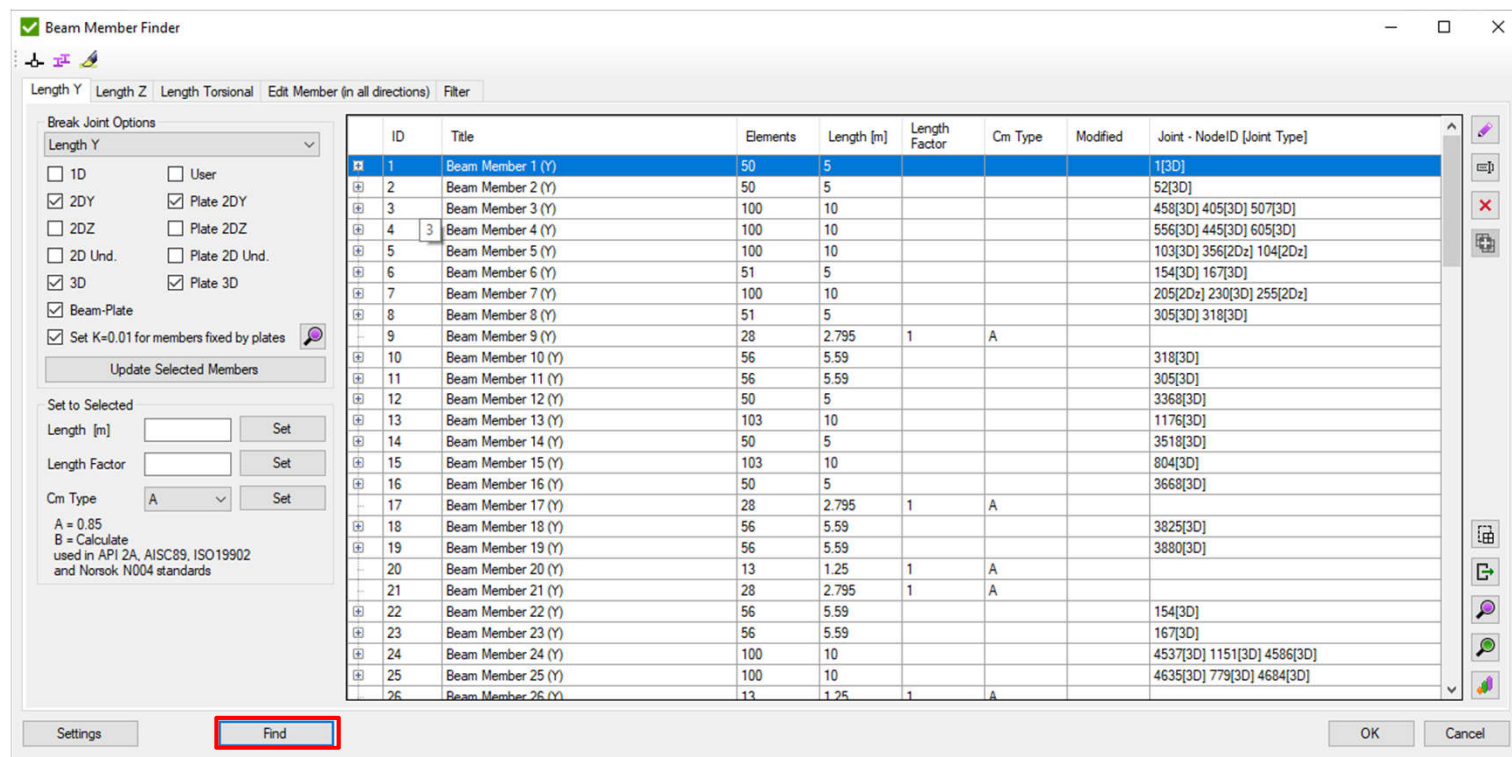
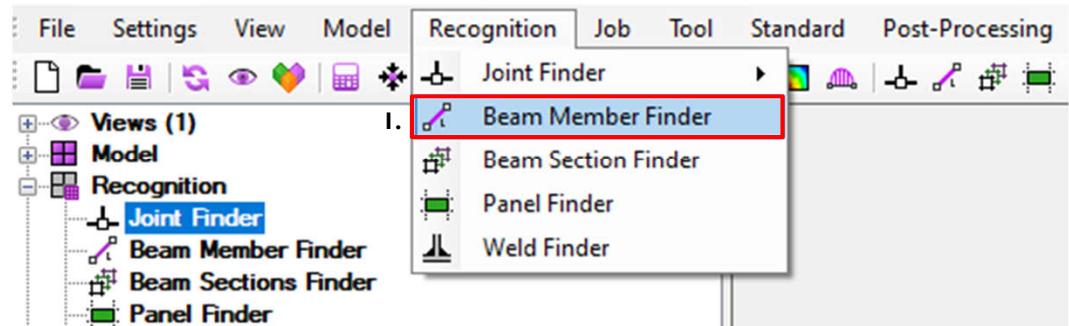
Length Z – 2 Beam Members with $L = 5$



Recognize Length

1 Execute *Recognition – Beam Member Finder*

2 Press *Find*.



Beam Member Finder interface

Break Options define what joints are used to split beam members

Change Length/Length Factor for selected beam members

Cm Type is used in API 2A, AISC89, ISO 19902 and Norsok N004 standards

Beam Member Finder

Length Y Length Z Length Torsional Edit Member (in all directions) Filter

Break Joint Options

Length Y

☐ 1D ☐ User

☒ 2DY ☒ Plate 2DY

☒ 2DZ ☐ Plate 2DZ

☒ 2D Und. ☐ Plate 2D Und.

☒ 3D ☒ Plate 3D

☒ Beam-Plate

☒ Set K=0.01 for members fixed by plates

Update Selected Members

Set to Selected

Length [m] Set

Length Factor Set

Cm Type A Set

A = 0.85
B = Calculate used in API 2A, AISC89, ISO 19902 and Norsok N004 standards

ID	Title	Elements	Length [m]	Length Factor	Cm Type	Modified	Joint - NodeID [Joint Type]
1	Beam Member 1 (Y)	50	5				1[3D]
2	Beam Member 2 (Y)	50	5				52[3D]
3	Beam Member 3 (Y)	100	10				458[3D] 405[3D] 507[3D]
4	Beam Member 4 (Y)	100	10				556[3D] 445[3D] 605[3D]
5	Beam Member 5 (Y)	100	10				103[3D] 356[2Dz] 104[2Dz]
6	Beam Member 6 (Y)	51	5				154[3D] 167[3D]
7	Beam Member 7 (Y)	100	10				205[2Dz] 230[3D] 255[2Dz]
8	Beam Member 8 (Y)	51	5				305[3D] 318[3D]
9	Beam Member 9 (Y)	28	2.795	1	A		
10	Beam Member 10 (Y)	56	5.59				318[3D]
11	Beam Member 11 (Y)	56	5.59				305[3D]
12	Beam Member 12 (Y)	50	5				3368[3D]
13	Beam Member 13 (Y)	103	10				1176[3D]
14	Beam Member 14 (Y)	50	5				3518[3D]
15	Beam Member 15 (Y)	103	10				804[3D]
16	Beam Member 16 (Y)	50	5				3668[3D]
17	Beam Member 17 (Y)	28	2.795	1	A		
18	Beam Member 18 (Y)	56	5.59				3825[3D]
19	Beam Member 19 (Y)	56	5.59				3880[3D]
20	Beam Member 20 (Y)	13	1.25	1	A		
21	Beam Member 21 (Y)	28	2.795	1	A		
22	Beam Member 22 (Y)	56	5.59				154[3D]
23	Beam Member 23 (Y)	56	5.59				167[3D]
24	Beam Member 24 (Y)	100	10				4537[3D] 1151[3D] 4586[3D]
25	Beam Member 25 (Y)	100	10				4635[3D] 779[3D] 4684[3D]
26	Beam Member 26 (Y)	13	1.25	1	A		

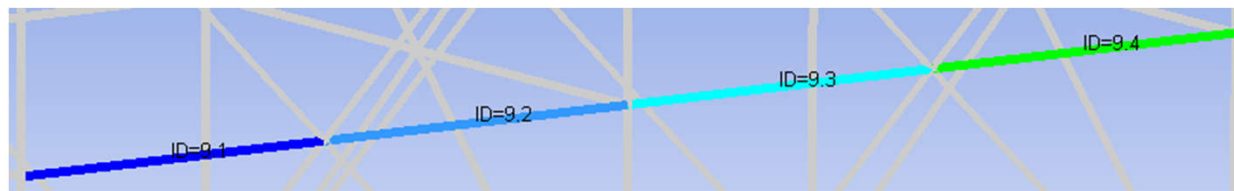
Settings Find OK Cancel

Colored Plot of members with labels (ID, Length, Factor or Cm Type).

- Plot selected members
- Plot Members ID labels
- Plot Full Members ID labels
- Plot Length labels
- Plot Cm Type labels
- Plot Length Factor labels
- Plot Joints for Selected Members
- Plot Members Y and Z axes

Beam Member – straight line. If it contains joints it is split on sub members

9	Beam Member 9	32	10				1103[2Dz] 201[3D] 2221[2Dz]
9.1	Sub Member 9.1	8	2.5	1	A		
9.2	Sub Member 9.2	8	2.5	1	A		
9.3	Sub Member 9.3	8	2.5	1	A		
9.4	Sub Member 9.4	8	2.5	1	A		



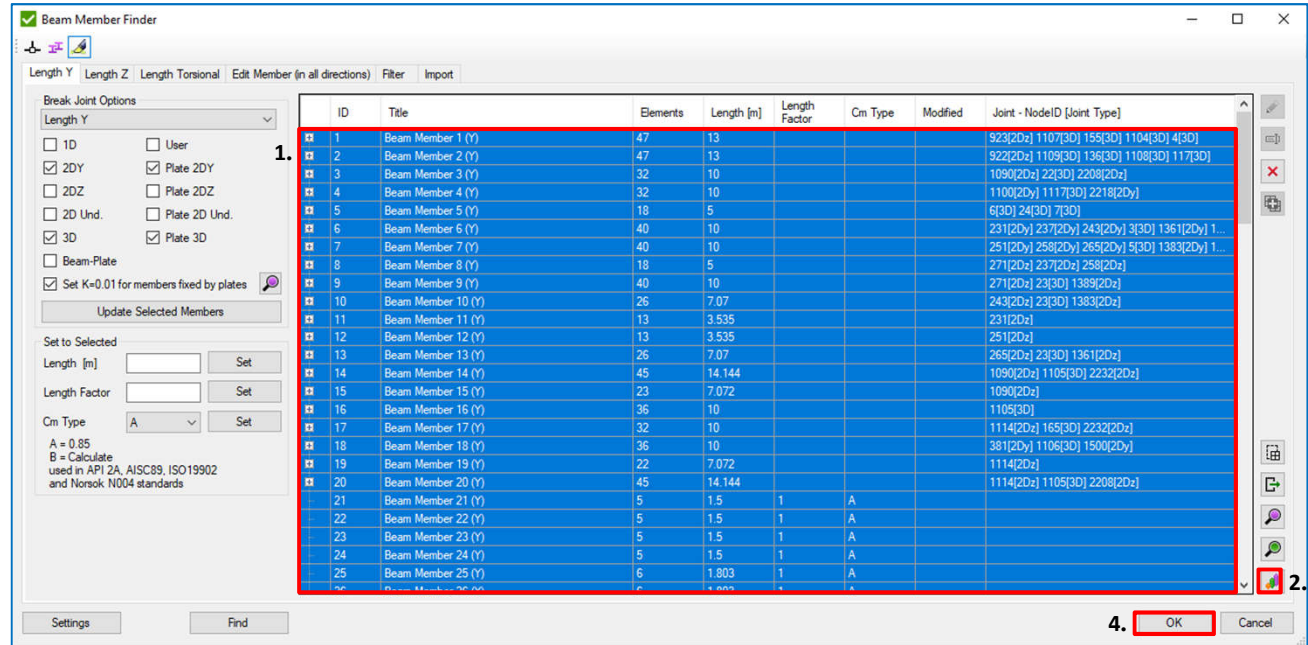
Beam Member's Length Plot

1 Select All Beam Members (Ctrl+A)

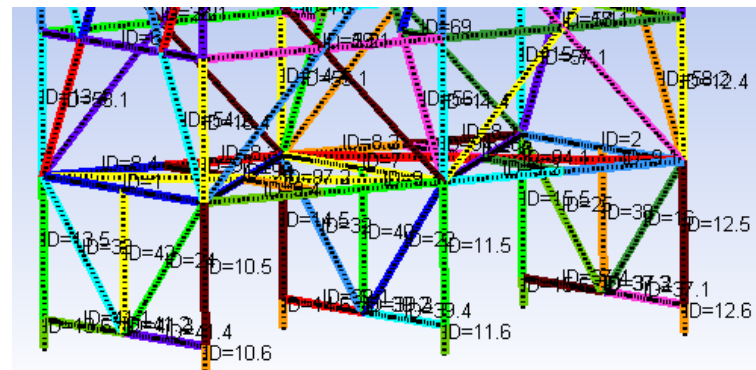
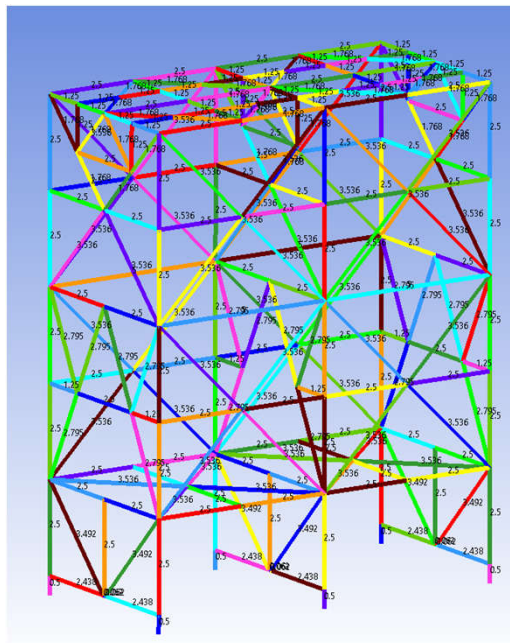
2 Press 









3 Press  Plot Length labels

4 Press OK




4. OK



-  Plot selected members
-  Plot Members ID labels
-  Plot Full Members ID labels
-  Plot Length labels
-  Plot Cm Type labels
-  Plot Length Factor labels
-  Plot Joints for Selected Members
-  Plot Members Y and Z axes

3.

Also it is possible to display beam members IDs by pressing

 Plot Members ID labels

Cm – reduction factors

Cmy and Cmz reduction factors are used in combined axial and bending check. API RP 2A description:

$$\frac{f_c}{\phi_c F_{cn}} + \frac{1}{\phi_b F_{bn}} \left\{ \left[\frac{C_{my} f_{by}}{\left(1 - \frac{f_c}{\phi_c F_{ey}}\right)} \right]^2 + \left[\frac{C_{mz} f_{bz}}{\left(1 - \frac{f_c}{\phi_c F_{ez}}\right)} \right]^2 \right\}^{0.5} \leq 1.0 \quad \text{..... (D.3.2-1)}$$

TABLE D.3-1
EFFECTIVE LENGTH AND BENDING
REDUCTION FACTORS FOR
MEMBER STRENGTH CHECKING

Situation	Effective Length Factor K	Reduction Factor Cm ⁽¹⁾
Superstructure Legs		
Braced	1.0	(a)
Portal (unbraced)	K ⁽²⁾	(a)
Jacket Legs & Piling		
Grouted Composite Section	1.0	(c)
Ungouted Jacket Legs	1.0	(c)
Ungouted Piling Between Shim Points	1.0	(b)
Jacket Braces		
Face-to-face Length of Main Diagonals	0.8	(b) or (c)
Face of Leg to Centerline of Joint Length of K-Braces ⁽³⁾	0.8	(c)
Longer Segment Length of X-Braces ⁽³⁾	0.9	(c)
Secondary Horizontals	0.7	(c)
Deck Truss Chord members	1.0	(a),(b) or (c)
Deck Truss Web Members		
In-Plane Action	0.8	(b)
Out-of-Plane Action	1.0	(a) or (b)

Notes to Table D.3-1:

(1) Use whichever is more applicable to a specific situation. Values of the reduction factor C_m referred to in the above table are as follows:

(a) 0.85

(b) $0.6 - 0.4 \left(\frac{M_1}{M_2} \right)$, no more than 0.85, or less than 0.40, where M_1/M_2 is the ratio of smaller to larger moments at the ends of that portion of the member unbraced in the plane of bending under consideration. M_1/M_2 is positive when the number is bent in reverse curvature, negative when bent in single curvature.

(c) $1.0 - 0.4 \left(\frac{f_c}{\phi_c F_e} \right)$, or 0.85, whichever is less

By default **Cm Type** is equal to A = 0.85 for all members. It is possible to modify Cm Type for selected members:

Cm Type

A = 0.85
B = Maximum (0.6 - 0.4 * (M1/M2),
1 - 0.4 * (fc / (PhiC * Fe)))

In SDC Verifier B = minimum from (b) and (c)

Cmy and Cmz factors for ISO 19902 can be found in the Table 13.5-1 and are used in the formula 13.3-3.

Cmy and Cmz factors for Norsok N004 Rev3 can be found in the Table 6-2 and are used in the formula 6.27

API RP 2A-LRFD



API RP*2A-LRFD 93 ■ 0732290 0507612 001 ■

Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms — Load and Resistance Factor Design

API RECOMMENDED PRACTICE 2A-LRFD (RP 2A-LRFD)
FIRST EDITION, JULY 1, 1993

American Petroleum Institute
1220 L Street, Northwest
Washington, DC 20005



This “Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms — Load and Resistance Factor Design” (LRFD) contains the engineering design principles and good practices that have been the basis of the API RP2A working strength design (WSD) recommended practice, now in its 20th Edition. The LRFD provisions have been developed from the WSD provisions using reliability based calibration.

API RP*2A-LRFD 93 ■ 0732290 0507612 T48 ■

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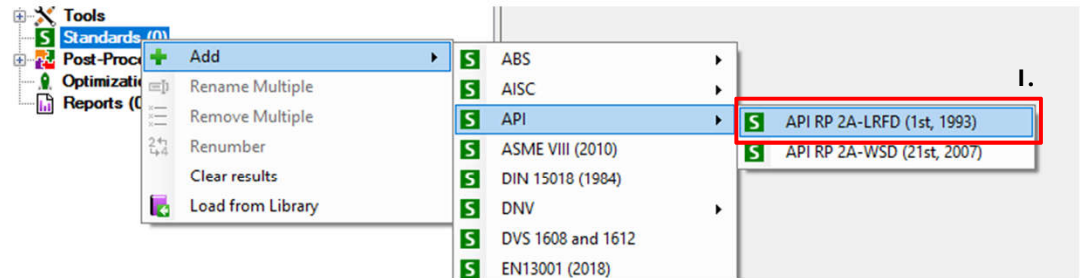
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Add API RP 2A-LRFD standard

1

Execute *Standards* => *Add* => *API RP 2A-LRFD (1st, Jul 1993)*.



SECTION D CYLINDRICAL MEMBER DESIGN

C_x = critical elastic buckling coefficient

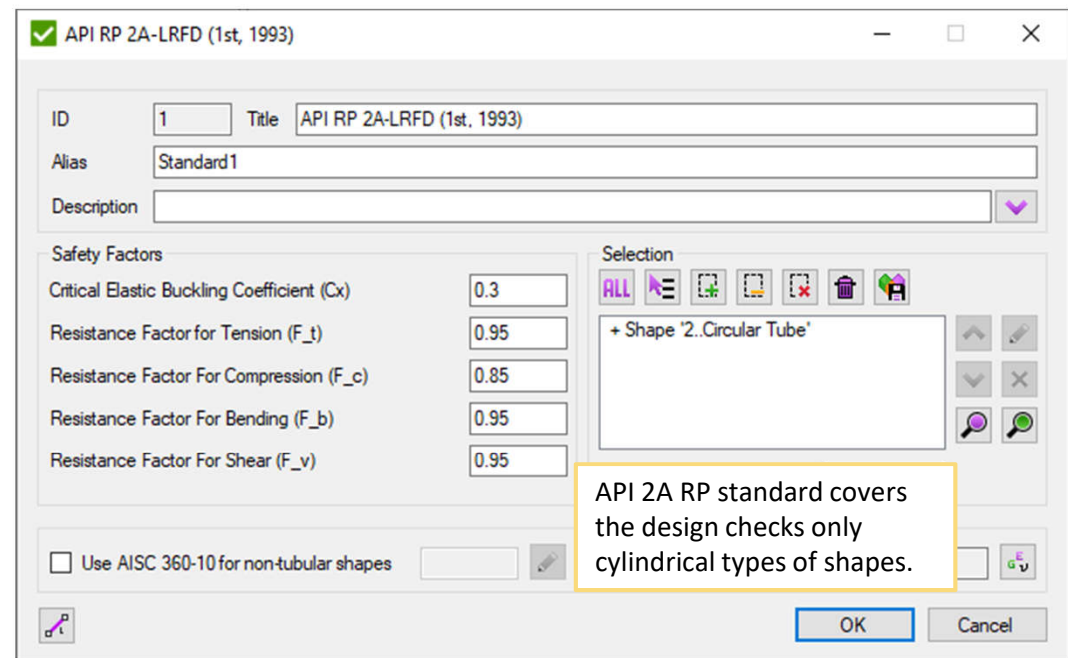
The theoretical value of C_x is 0.6. However, a reduced value of $C_x = 0.3$ is recommended for use in Equation D.2.2-3 to account for the effect of initial geometric imperfections within API Spec 2B tolerance limits, Reference D2.

ϕ_t = resistance factor for axial tensile strength, 0.95

ϕ_c = resistance factor for axial compressive strength, 0.85


ϕ_b = resistance factor for bending strength, 0.95.

ϕ_v = resistance factor for beam shear strength, 0.95



Define Material Characteristics

1

Press  to set the material yield stress and tensile strength

2

Tensile Strength: **360e6**

3

Yield Stress: **240e6**

4

Press **Set**

5

Press **OK**

API RP 2A-LRFD (1st, 1993)

ID: 1 Title: API RP 2A-LRFD (1st, 1993)

Alias: Standard1

Description:

Safety Factors

Critical Elastic Buckling Coefficient (Cx): 0.3

Resistance Factor for Tension (F_t): 0.95

Resistance Factor For Compression (F_c): 0.85

Resistance Factor For Bending (F_b): 0.95


Resistance Factor For Shear (F_v): 0.95

Selection

+ Shape '2..Circular Tube'

Elements: 6404

☐ Use AISC 360-10 for non-tubular shapes

Materials with Yield = 0: 0 

OK Cancel

Material Fatigue Parameters

Materials	Tensile Strength [Pa]	Yield Stress [Pa]
1. Structural Steel	360000000	240000000

Properties

Tensile Strength [Pa]: 360e6

Yield Stress [Pa]: 240e6

Set

Update from Ansys

OK Cancel

Extreme table for bending check

1 Execute *Table* from the **Bending Stress Check** context menu

2 Press  to select load

3 Load Type: **Load Group**

4 Load: **1..Load Group 1**

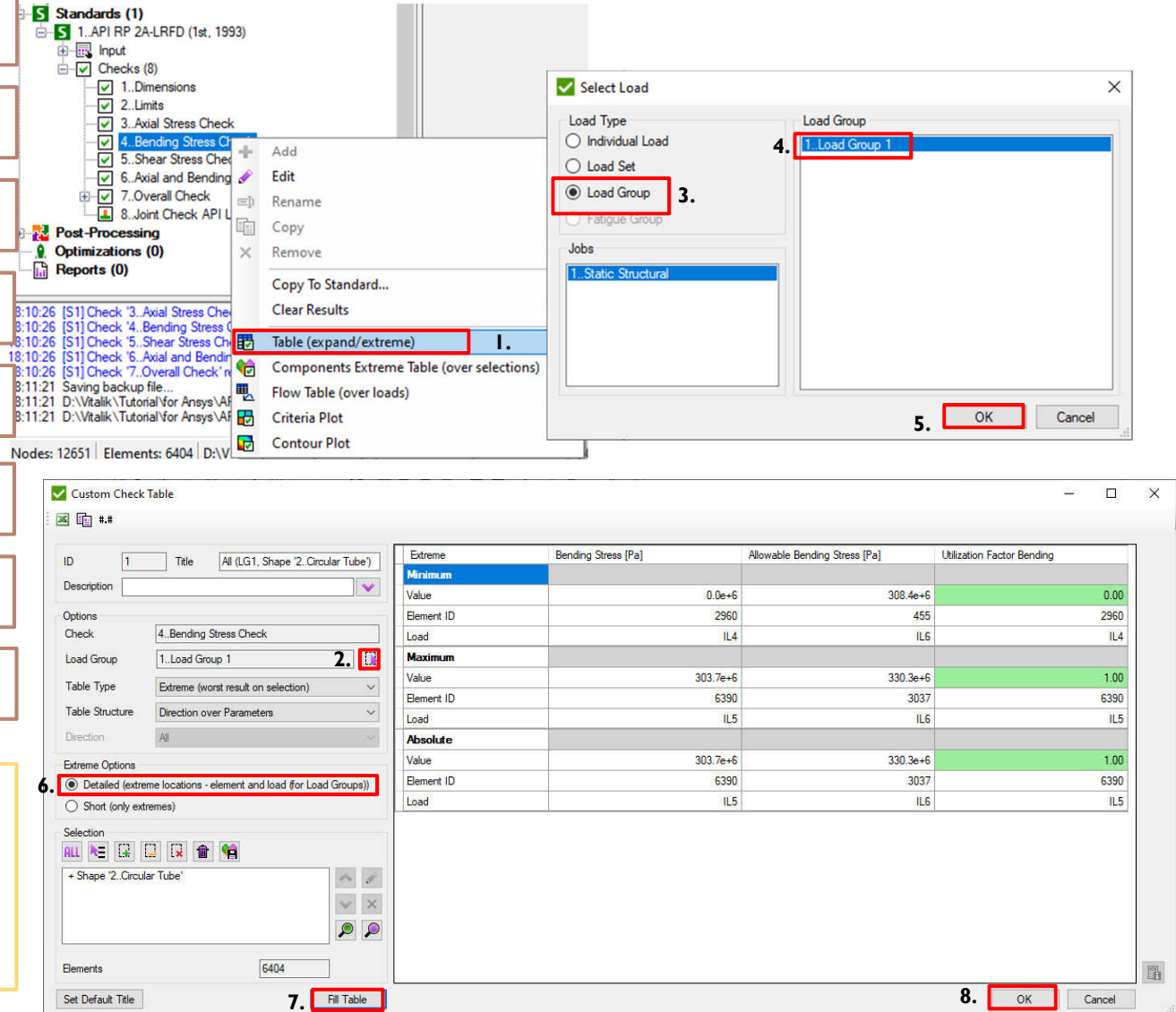
5 Press *OK*

6 Extreme Options: **Detailed**

7 Press *Fill Table*

8 Press *OK*

Overall Check contains results from all checks. With the help of one table/plot it is possible to verify if the model passes the checks (< 1). Overall Utilization Factor = worst Uf among all checks.



Standards (1)

- 1.API RP 2A-LRFD (1st, 1993)
 - Input
 - Checks (8)
 - 1..Dimensions
 - 2..Limits
 - 3..Axial Stress Check
 - 4..Bending Stress Check
 - 5..Shear Stress Check
 - 6..Axial and Bending
 - 7..Overall Check
 - 8..Joint Check API L

Post-Processing

- Optimizations (0)
- Reports (0)

8:10:26 [S1] Check '3..Axial Stress Check'
8:10:26 [S1] Check '4..Bending Stress Check'
8:10:26 [S1] Check '5..Shear Stress Check'
8:10:26 [S1] Check '6..Axial and Bending'
8:10:26 [S1] Check '7..Overall Check'
8:11:21 Saving backup file...
8:11:21 D:\Vitalik\Tutorial for Ansys\AF
8:11:21 D:\Vitalik\Tutorial for Ansys\AF

Nodes: 12651 | Elements: 6404 | D:\V

Select Load

Load Type

- ☐ Individual Load
- ☐ Load Set
- ☒ Load Group
- ☐ Fatigue Group

Jobs

- 1..Static Structural

Load Group

- 1..Load Group 1

Custom Check Table

ID: 1 Title: All (LG1, Shape '2..Circular Tube')

Description:

Options

Check: 4..Bending Stress Check

Load Group: 1..Load Group 1

Table Type: Extreme (worst result on selection)

Table Structure: Direction over Parameters

Direction: All

Extreme Options

- ☒ Detailed (extreme locations - element and load (for Load Groups))
- ☐ Short (only extremes)

Selection

+ Shape '2..Circular Tube'

Elements: 6404

Set Default Title

Extreme	Bending Stress [Pa]	Allowable Bending Stress [Pa]	Utilization Factor Bending
Minimum			
Value	0.0e+6	308.4e+6	0.00
Element ID	2960	455	2960
Load	IL4	IL6	IL4
Maximum			
Value	303.7e+6	330.3e+6	1.00
Element ID	6390	3037	6390
Load	IL5	IL6	IL5
Absolute			
Value	303.7e+6	330.3e+6	1.00
Element ID	6390	3037	6390
Load	IL5	IL6	IL5

Fill Table

OK

Criteria Plot for Bending Stress Check

1 Execute *Criteria Plot* from **Bending Stress Check** context menu

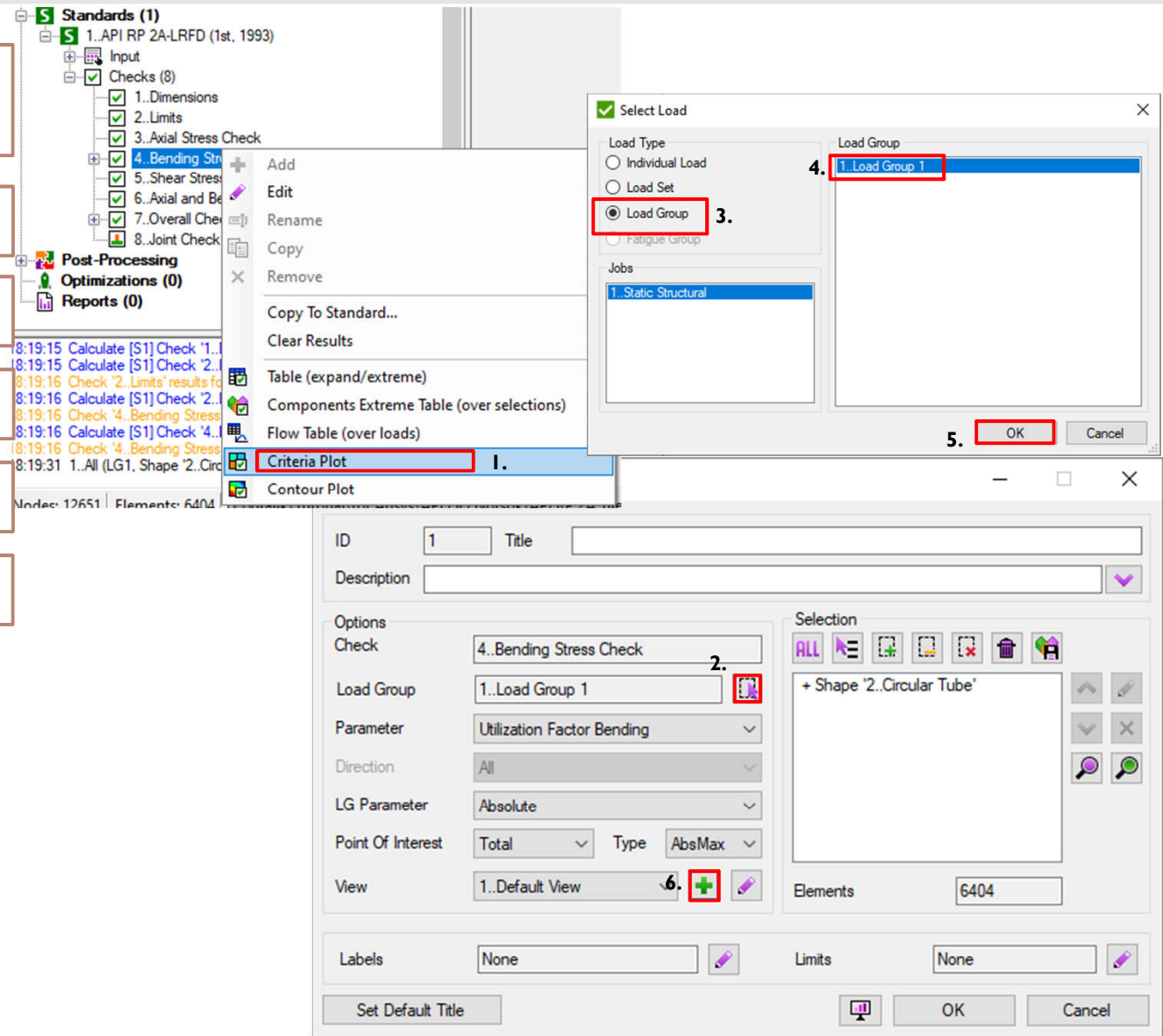
2 Press  to select load

3 Load Type: **Load Group**

4 Load: **1..Load Group 1**

5 Press **OK**

6 Press to add view



The screenshot illustrates the steps to create a Criteria Plot for a Bending Stress Check in SDC Verifier. The tree view on the left shows the project structure under 'Standards (1)' and '1..API RP 2A-LRFD (1st, 1993)'. The 'Checks (8)' folder is expanded, showing '4..Bending Stress Check' selected. A context menu is open over this check, with 'Criteria Plot' highlighted. The 'Select Load' dialog is open, showing 'Load Group' selected under 'Load Type' and '1..Load Group 1' selected under 'Load Group'. The 'Criteria Plot' dialog is open, showing the 'Options' tab with 'Check' set to '4..Bending Stress Check', 'Load Group' set to '1..Load Group 1', 'Parameter' set to 'Utilization Factor Bending', 'Direction' set to 'All', 'LG Parameter' set to 'Absolute', 'Point Of Interest' set to 'Total', and 'View' set to '1..Default View'. The 'Selection' tab shows the selection of 'Shape '2..Circular Tube'' and 'Elements' set to '6404'. The 'Labels' and 'Limits' are both set to 'None'. The 'OK' button is highlighted.

Criteria plot for overall check

1

Execute  from **Overall Check** context menu

2

Press  to select load

3

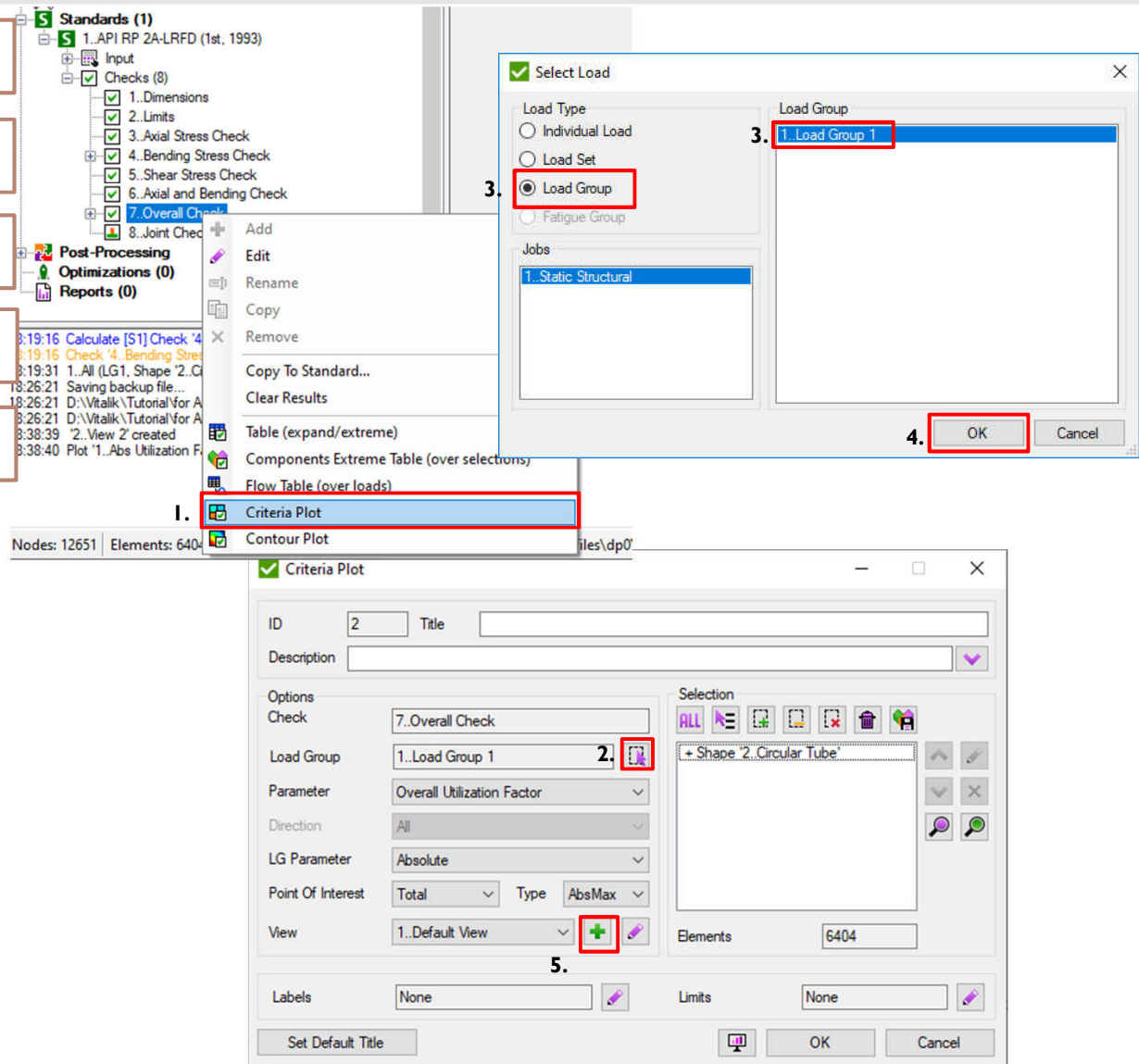
Load Type: **Load Group**. Load: **1..Load Group 1**

4

Press **OK**

5

Press  to add view



Plot. Create View

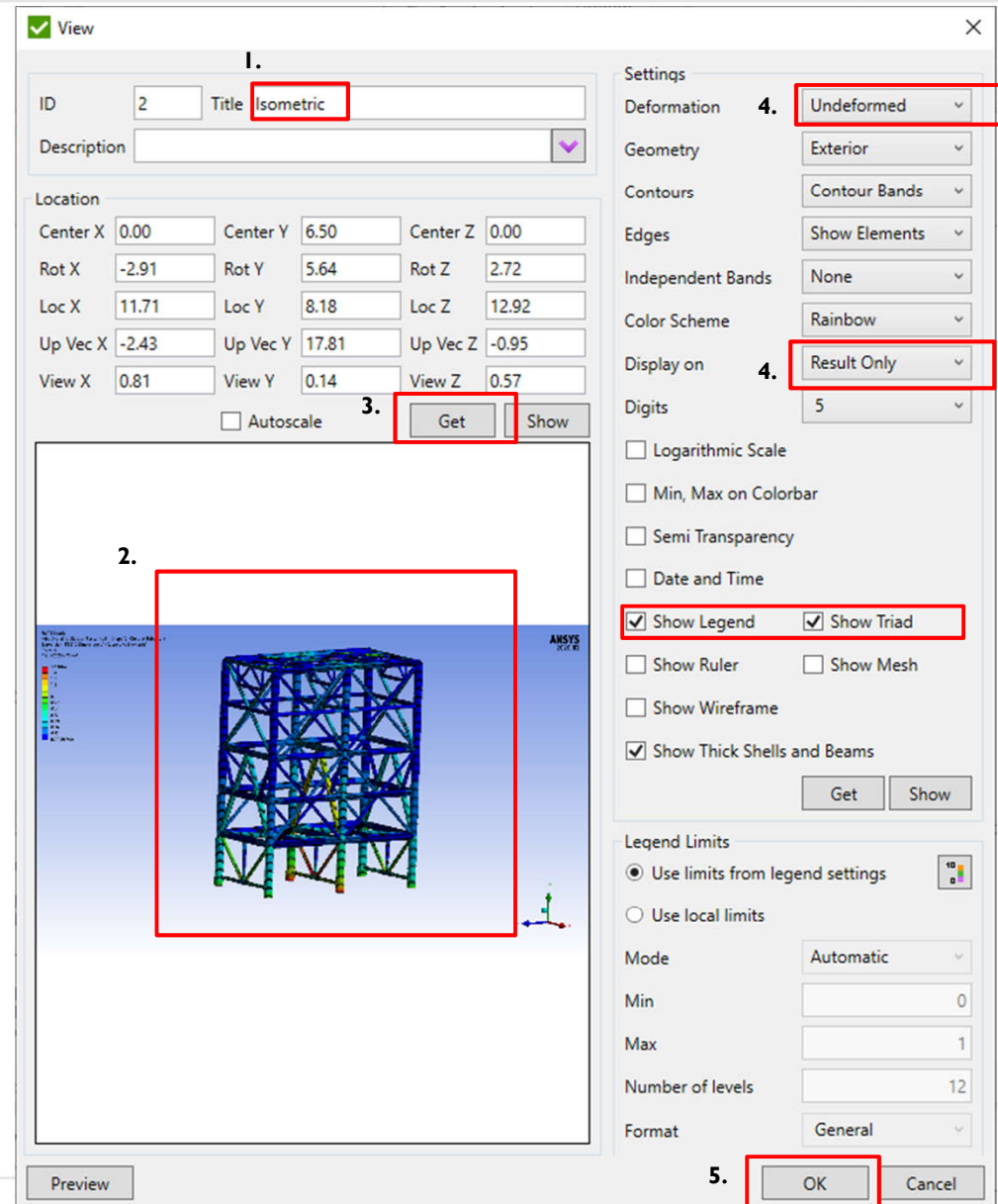
1 Title: **Isometric**

2 Orient model in Ansys Mechanical as shown on the picture

3 Press *Get*

4 Deformation: **Undeformed**
Display on: **Result Only**
Show Legend: **On**
Show Triad: **On**

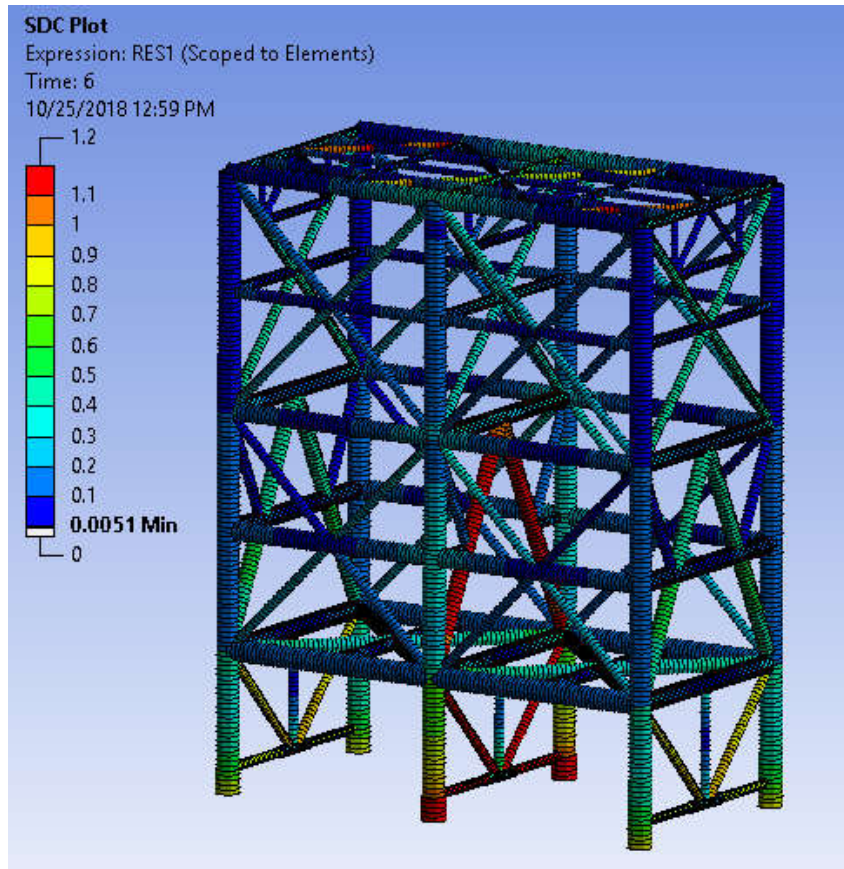
5 Press *OK*



Display Plot

1 Press  to display plot

2 Press OK



Contour Plot


ID: 1 Title: Abs Overall Utilization Factor (LG1, Shape '2..Circular Tube', v1)
Description:

Options
Check: 7..Overall Check
Load Group: 1..Load Group 1
Parameter: Overall Utilization Factor
Direction: All
LG Parameter: Absolute
View: 1..Default View

Selection
ALL
+ Shape '2..Circular Tube'
Elements: 6404

Labels: None Data Conversion: No Averaging

Set Default Title

1.  2. OK Cancel

2.

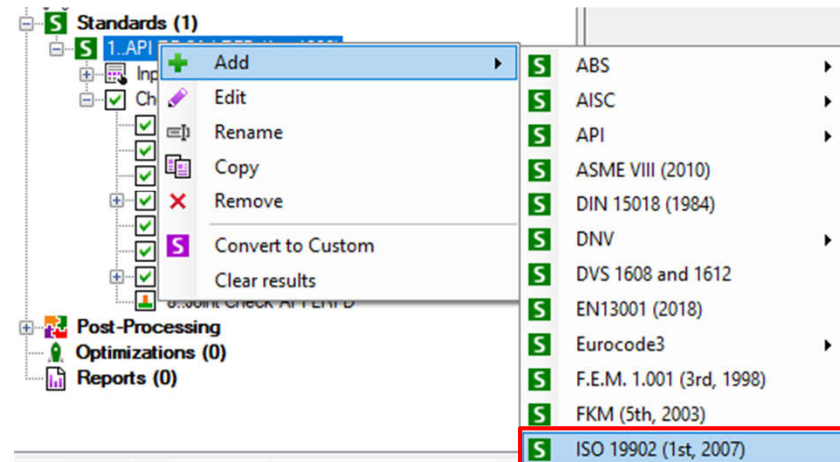
Add ISO 19902 standard

1

Execute *Standards* => *Add* => *ISO 19902* (1st, Dec 2007).

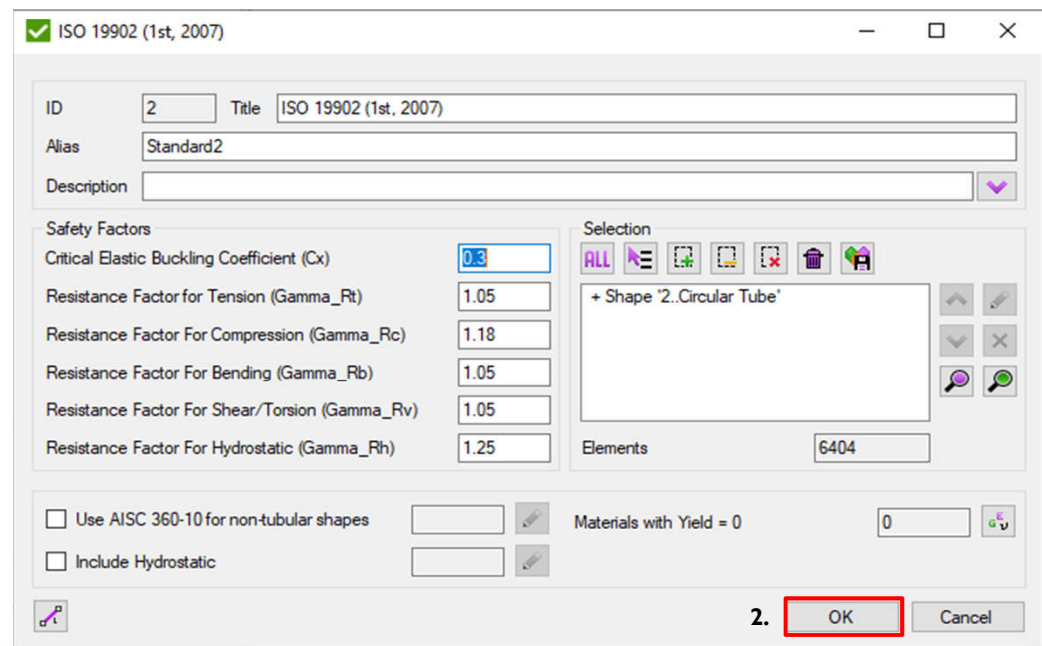
2

Press *OK*



1.

ISO 19902 procedure is similar to API 2A RP. In overall check it is possible to verify if the structure passes all checks : Overall Utilization Factor = worst U_f among all checks < 1.
Add extreme table and criteria plot for '1..Load Group 1' the same as for API standard.



2.

OK

Cancel

ISO 19902 standard

C_x is the elastic critical buckling coefficient, see below;

The theoretical value of C_x for an ideal tubular is 0,6. However, a reduced value of $C_x = 0,3$ should be used in Equation (13.2-10) to account for the effect of initial geometric imperfections within the tolerance limits given in Clause 21. A reduced value of $C_x = 0,3$ is implicit in the value of f_{xe} used in Equations (13.2-8) and (13.2-9).

$\gamma_{R,t}$ is the partial resistance factor for axial tensile strength, $\gamma_{R,t} = 1,05$.

$\gamma_{R,c}$ is the partial resistance factor for axial compressive strength, $\gamma_{R,c} = 1,18$.

$\gamma_{R,b}$ is the partial resistance factor for bending strength, $\gamma_{R,b} = 1,05$;

$\gamma_{R,v}$ is the partial resistance factor for shear strength, $\gamma_{R,v} = 1,05$;

$\gamma_{R,h}$ is the partial resistance factor for hoop buckling strength, $\gamma_{R,h} = 1,25$.

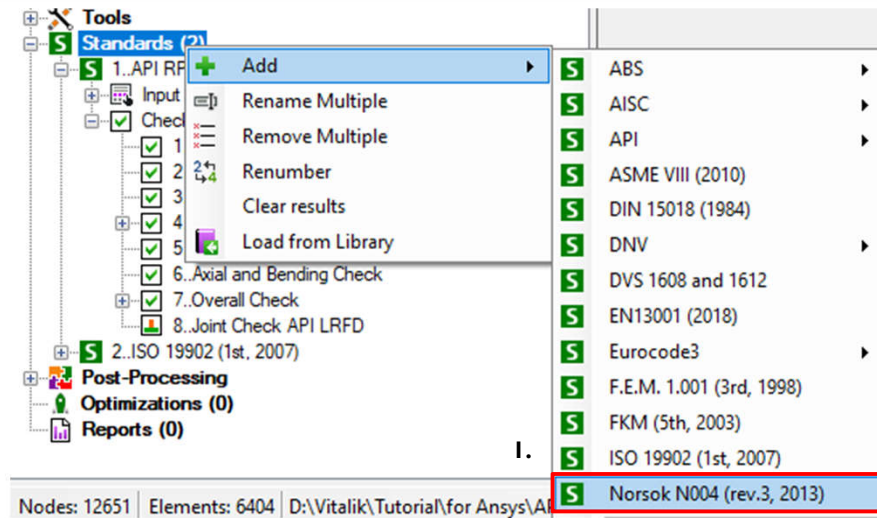
Add Norsok N004 standard

1

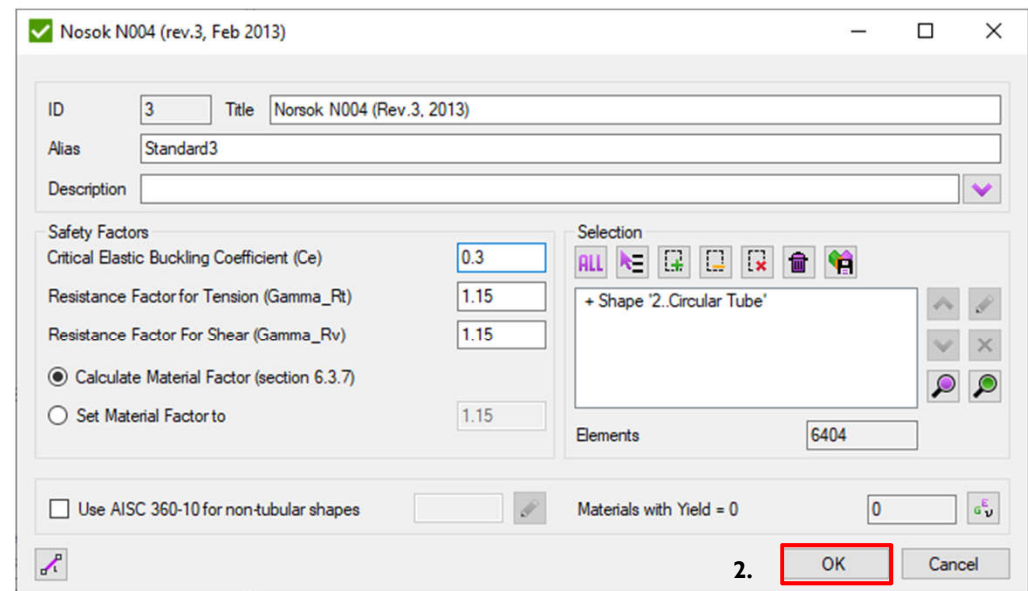
Execute *Standards* => *Add* => *Norsok N004 (rev.3, Feb 2013)*.

2

Press *OK* twice



Norsok N004 procedure is similar to API 2A RP. In overall check it is possible to verify if the structure passes all checks : Overall Utilization Factor = worst U_f among all checks < 1 .



Add Norsok N004 standard

$$\begin{aligned}
 C_e &= \text{critical elastic buckling coefficient} = 0.3 \\
 \gamma_{R,t} &= \text{material factor for tension} = 1.15 \\
 \gamma_{R,v} &= \text{material factor for shear} = 1.15 \\
 \gamma_M &= \text{see section 6.3.7} \\
 \gamma_M &= 1.15 \quad \text{for } \bar{\lambda}_s < 0.5 \\
 \gamma_M &= 0.85 + 0.60\bar{\lambda}_s \quad \text{for } 0.5 \leq \bar{\lambda}_s \leq 1.0 \\
 \gamma_M &= 1.45 \quad \text{for } \bar{\lambda}_s > 1.0
 \end{aligned} \tag{6.22}$$

where

$$\bar{\lambda}_s = \frac{|\sigma_{c,Sd}|}{f_{cl}} \cdot \lambda_c + \left(\frac{\sigma_{p,Sd}}{f_h} \right)^2 \cdot \lambda_h \tag{6.23}$$

where f_{cl} is calculated from Equation (6.6) or Equation (6.7) whichever is appropriate and f_h from Equation (6.17), Equation (6.18), or Equation (6.19) whichever is appropriate.

$$\lambda_c = \sqrt{\frac{f_y}{f_{cle}}}, \text{ and } \lambda_h = \sqrt{\frac{f_y}{f_{he}}} \tag{6.24}$$

f_{cle} and f_{he} is obtained from Equation (6.8), and Equation (6.20) respectively.

$\sigma_{p,Sd}$ is obtained from Equation (6.16) and

$$\sigma_{c,Sd} = \frac{N_{Sd}}{A} + \frac{\sqrt{M_{y,Sd}^2 + M_{z,Sd}^2}}{W} \tag{6.25}$$

N_{Sd} is negative if in tension.

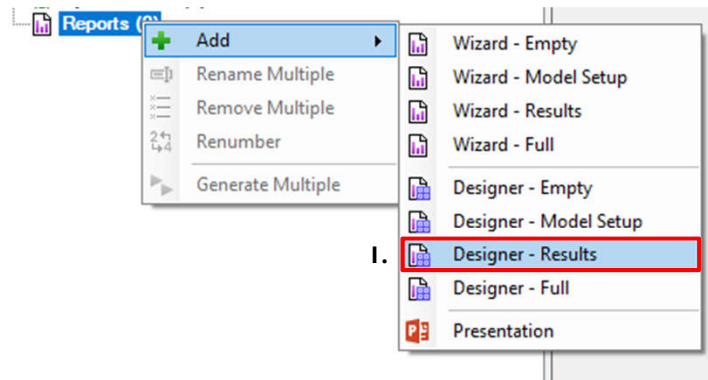
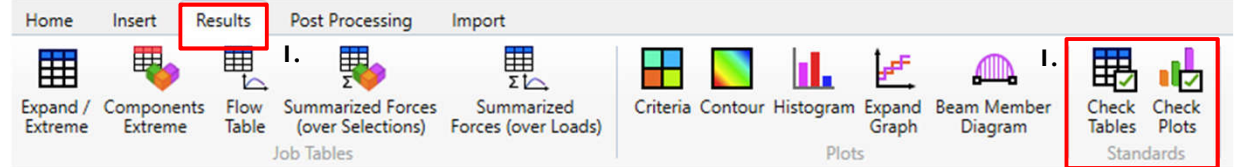
Report

1

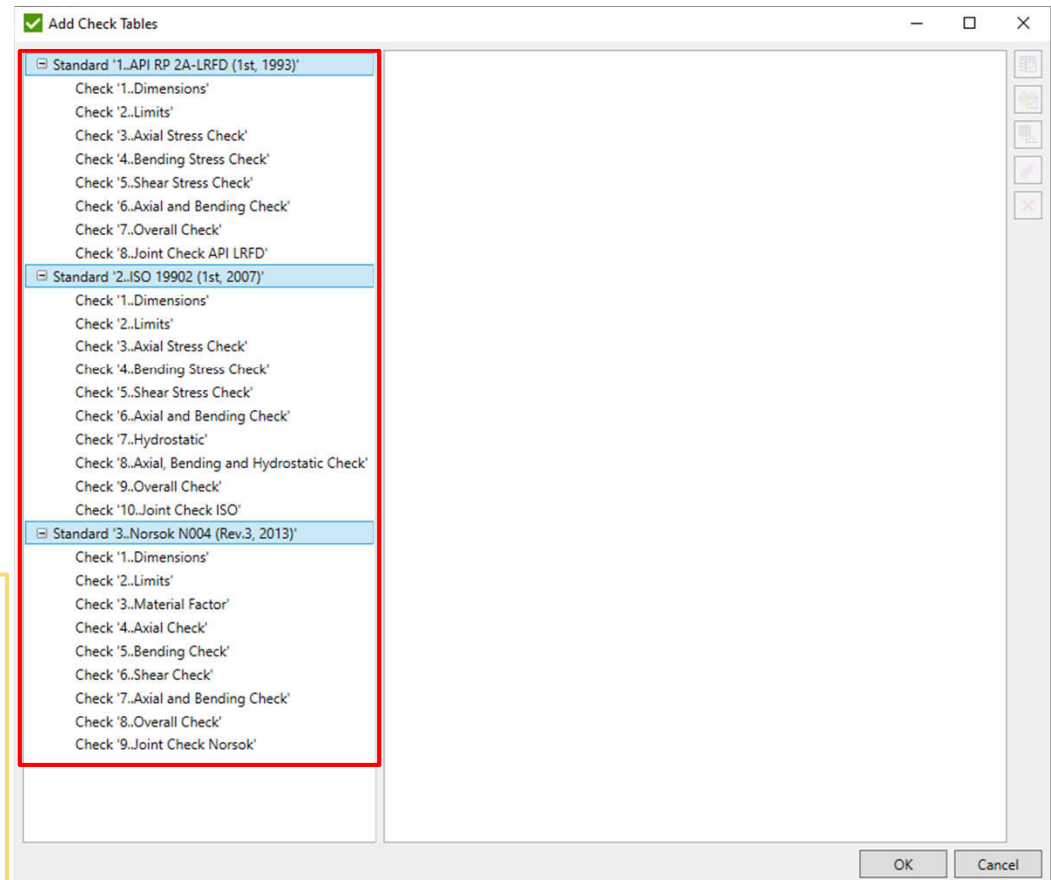
Execute *Reports – Add – Designer – Results*.

2

Results – Check Tables/Check Plots - all checks except the '**8.Overall check**' in each standard.




2.



There are 4 templates of the reports:
Empty – only first page and preface items are included;
Model Setup – description of the model data (materials, properties, components, boundary conditions) is included;
Results – for each load extreme displacement tables, stress and displacement plots are included. Predefined tables: sum of reaction forces, stresses/displacements summary tables;
Full – Model Setup + Results + all tables created in Job.

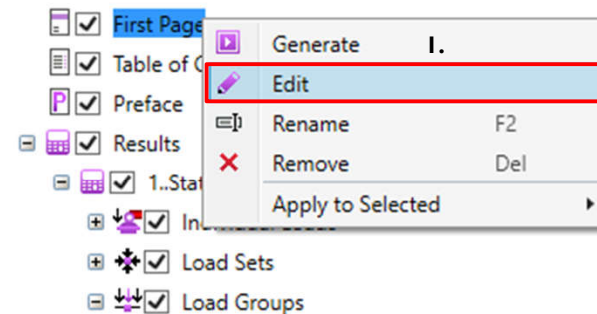
Report. First Page

1 Right click on *First Page* => *Edit*.

2 Press  to load engineer and customer info from library


3 Select Image *From View* and pick '2..Isometric'.


4 Press *OK*.



First Page Editor


Engineer details

Engineer: Support 




Company: SDC Verifier 

E-mail: support@sdcverifier.com

Phone: +31 15 30-10-310


Address: Zijlvest 25 [...] 

Web Site: sdcverifier.com

Logo:   


☐ Put logo on report plots


Project Details

Number: Version: 1 

Name: New Project


Customer details

Contact Person: customer 




Company: company 

E-mail: customer@company.com



Phone: +31 15 555-55-55


Address: Zijlvest 25 [...] 

Web Site: company.com

Logo:   

Image

☐ From file  

☒ From View 2..Isometric 

Buttons: Custom Fields, OK (highlighted with a red box), Cancel

Save Project Save Report Save Report As **Generate** **Export to Word** Export to PDF Report Settings

Overall Check

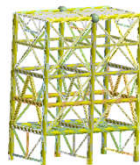
Page 31 of 32

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New Project



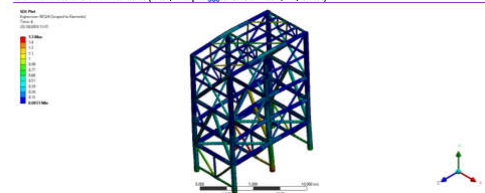
Engineer:	Support
Customer:	customer
Project Number:	
Version:	1
Date:	07/12/2020

API 2A RP

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Category Parameters	Elemental Custom Check Shape 'Z_Circular Tube' 5				
All (LG1_Shape 'Z_Circular Tube')					
Standard	AISI 201 RP		Check	[S1] Z_Overall Check	
Load Group	LG1_Load Group 1		Selection	Shape 'Z_Circular Tube'	
Extreme	Absolute Axial	Absolute	Absolute Shear	Absolute Axial	Overall Utilization
	Load	Bending Mx	Force Vx	Bending My	Factor
Minimum					
Value	0.00	0.00	0.00	0.00	0.00
Element ID	4521	2958	2769	4944	485
	1.4	1.4	1.4	1.4	
Maximum					
Value	1.26	1.00	1.05	1.63	1.6
Element ID	2661	6390	3405	8365	638
	1.5	1.5	1.5	1.5	
Absolute					
Value	1.26	1.00	1.05	1.63	1.6
Element ID	2661	6390	3405	8365	638
	1.5	1.5	1.5	1.5	

This paragraph represents result plot profiles previously created in a job.
Abs Overall Utilization Factor (LG1, Shape '2_Circular Tube', v1, Total

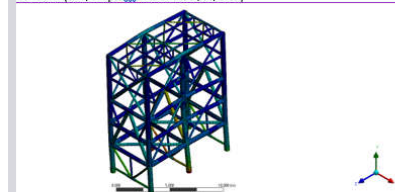


Check	[S1] 7 Overall Check	Point	Total
Load Group Selection	LG1 Load Group 1 Shape '2_Circular Tube'	Parameter View	Absolute Overall Utilization Factor 1. Default View

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Value					
Elemental Custom Check					
Shape '2_Circular Tube'					
6					
<p>IS</p> <p>resents result table profiles previously created in a job.</p> <p>Circular Tube</p> <p>ISO 19992 (1st Dec 2007)</p>					
Local Group 1	Check Selection		[ISO] 2_Overall Check Shape '2_Circular Tube'		
Absolute Axial Um	Absolute Bending Um	Absolute Shear Um	Absolute Shear Torsional Um	Absolute Axial Bending Um	Overall Utilization Factor
0.00	0.00	0.00	0.00	0.00	0.00
421	2555	2769	3162	4824	48.1
14.4	14.4	14.4	14.4	14.4	14.4
1.28	0.96	1.04	0.10	1.75	1.0
2661	6390	3405	480	6385	63.9
15.5	15.5	15.5	15.5	15.5	15.5
1.28	0.96	1.04	0.10	1.75	1.0
2661	6390	3405	480	6385	63.9
15.5	15.5	15.5	15.5	15.5	15.5

resents result plot profiles previously created in a job.
ion Factor (LG1, Shape '2_Circular Tube', v1, Total)

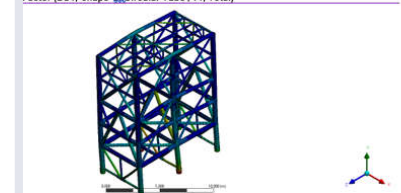


Point	Total
Overall Check	
Load Group 1	
Load Group 2	
Load Group 3	
Load Group 4	
Load Group 5	
Load Group 6	
Load Group 7	
Load Group 8	
Load Group 9	
Load Group 10	
Load Group 11	
Load Group 12	
Load Group 13	
Load Group 14	
Load Group 15	
Load Group 16	
Load Group 17	
Load Group 18	
Load Group 19	
Load Group 20	
Load Group 21	
Load Group 22	
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Load Group 91	
Load Group 92	
Load Group 93	
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Load Group 95	
Load Group 96	
Load Group 97	
Load Group 98	
Load Group 99	
Load Group 100	

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to result table profiles previously created in a job.					
ular Tube™					
N004 (Rev. 3 Feb. 2013)		Check	[53] Overall Check		
of Group 1		Selection	Shape 2 Circular Tube		
Absolute al UJ	Absolute Bending UJ	Absolute Shear UJ	Absolute Torsional UJ	Absolute Bending UJ	Overall Utilization Factor
0.00	0.00	0.00	0.00	0.00	0.00
4821	2958	2769	3162	4944	4971
IL4	IL4	IL4	IL4	IL4	IL4
1.24	1.09	1.14	0.11	1.83	1.83
2661	6390	3405	480	6385	6385
IL5	IL5	IL5	IL5	IL6	IL6
1.24	1.09	1.14	0.11	1.83	1.83
2661	6390	3405	480	6385	6385
IL5	IL5	IL5	IL5	IL6	IL6

ts result plot profiles previously created in a job:
Factor (LG1, Shape "2_Circular Tube", v1, Total)



Overall Check and Group 1	Point Parameter	Total Absolute Overall Utilization Factor
Group 1	1.00	1.00
Group 2	1.00	1.00
Group 3	1.00	1.00
Group 4	1.00	1.00
Group 5	1.00	1.00
Group 6	1.00	1.00
Group 7	1.00	1.00
Group 8	1.00	1.00
Group 9	1.00	1.00
Group 10	1.00	1.00
Group 11	1.00	1.00
Group 12	1.00	1.00
Group 13	1.00	1.00
Group 14	1.00	1.00
Group 15	1.00	1.00
Group 16	1.00	1.00
Group 17	1.00	1.00
Group 18	1.00	1.00
Group 19	1.00	1.00
Group 20	1.00	1.00
Group 21	1.00	1.00
Group 22	1.00	1.00
Group 23	1.00	1.00
Group 24	1.00	1.00
Group 25	1.00	1.00
Group 26	1.00	1.00
Group 27	1.00	1.00
Group 28	1.00	1.00
Group 29	1.00	1.00
Group 30	1.00	1.00
Group 31	1.00	1.00
Group 32	1.00	1.00
Group 33	1.00	1.00
Group 34	1.00	1.00
Group 35	1.00	1.00
Group 36	1.00	1.00
Group 37	1.00	1.00
Group 38	1.00	1.00
Group 39	1.00	1.00
Group 40	1.00	1.00
Group 41	1.00	1.00
Group 42	1.00	1.00
Group 43	1.00	1.00
Group 44	1.00	1.00
Group 45	1.00	1.00
Group 46	1.00	1.00
Group 47	1.00	1.00
Group 48	1.00	1.00
Group 49	1.00	1.00
Group 50	1.00	1.00
Group 51	1.00	1.00
Group 52	1.00	1.00
Group 53	1.00	1.00
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Group 55	1.00	1.00
Group 56	1.00	1.00
Group 57	1.00	1.00
Group 58	1.00	1.00
Group 59	1.00	1.00
Group 60	1.00	1.00
Group 61	1.00	1.00
Group 62	1.00	1.00
Group 63	1.00	1.00
Group 64	1.00	1.00
Group 65	1.00	1.00
Group 66	1.00	1.00
Group 67	1.00	1.00
Group 68	1.00	1.00
Group 69	1.00	1.00
Group 70	1.00	1.00
Group 71	1.00	1.00
Group 72	1.00	1.00
Group 73	1.00	1.00
Group 74	1.00	1.00
Group 75	1.00	1.00
Group 76	1.00	1.00
Group 77	1.00	1.00
Group 78	1.00	1.00
Group 79	1.00	1.00
Group 80	1.00	1.00
Group 81	1.00	1.00
Group 82	1.00	1.00
Group 83	1.00	1.00
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Group 85	1.00	1.00
Group 86	1.00	1.00
Group 87	1.00	1.00
Group 88	1.00	1.00
Group 89	1.00	1.00
Group 90	1.00	1.00
Group 91	1.00	1.00
Group 92	1.00	1.00
Group 93	1.00	1.00
Group 94	1.00	1.00
Group 95	1.00	1.00
Group 96	1.00	1.00
Group 97	1.00	1.00
Group 98	1.00	1.00
Group 99	1.00	1.00
Group 100	1.00	1.00

Prepared by		Prepared for	
SDC Verifier		company	Company