PRESSURE VESSEL DESIGN BY PVElite SOFTWARE COURSE BASED ON ASME SEC. VIII DIV. I

Instructed by: Hossein Sadeghi

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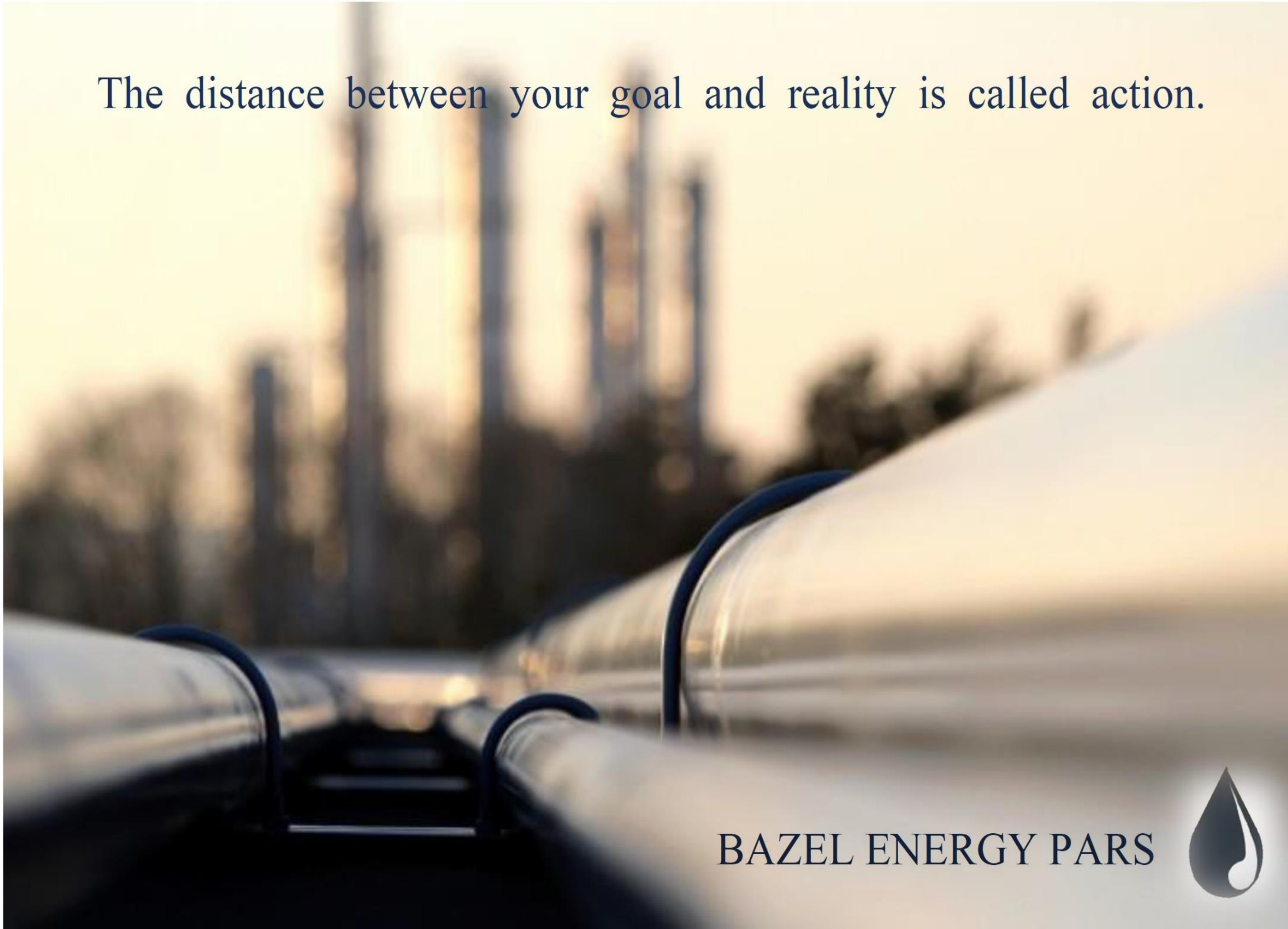
Email Address: Sadeghi.hosseyn@outlook.com

Mobile: +989125195694

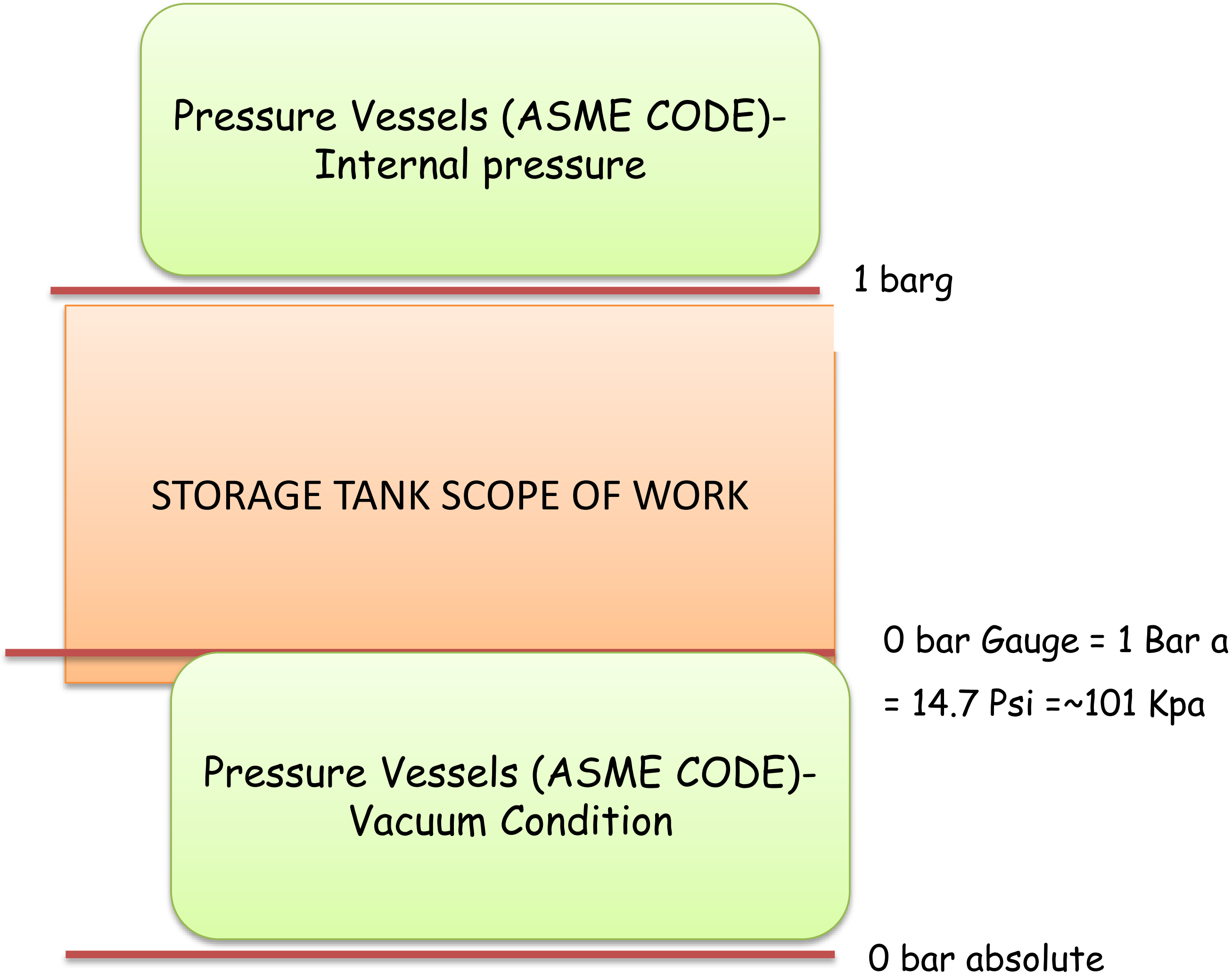

The distance between your goal and reality is called action.
BAZEL ENERGY PARS

Pressure vessel Course

- What will we have during this course?

1. INTRODUCTION TO ASME CODE
2. GENERAL REQUIREMENTS
3. MATERIAL REQUIREMENTS
4. GENERAL DESIGN REQUIREMENTS
5. DESIGN FOR INTERNAL PRESSURE
6. DESIGN FOR BUCKLING
7. DESIGN OF FLAT HEADS & COVERS
8. DESIGN OF OPENINGS
9. DESIGN OF OTHER ATTACHMENTS (INCLUDING PRESSURE PART AND NON PRESSURE PARTS)
10. PVElite Software
11. Code calc Software
12. Nozzle Pro Software
13. EXAMPLE PROBLEMS

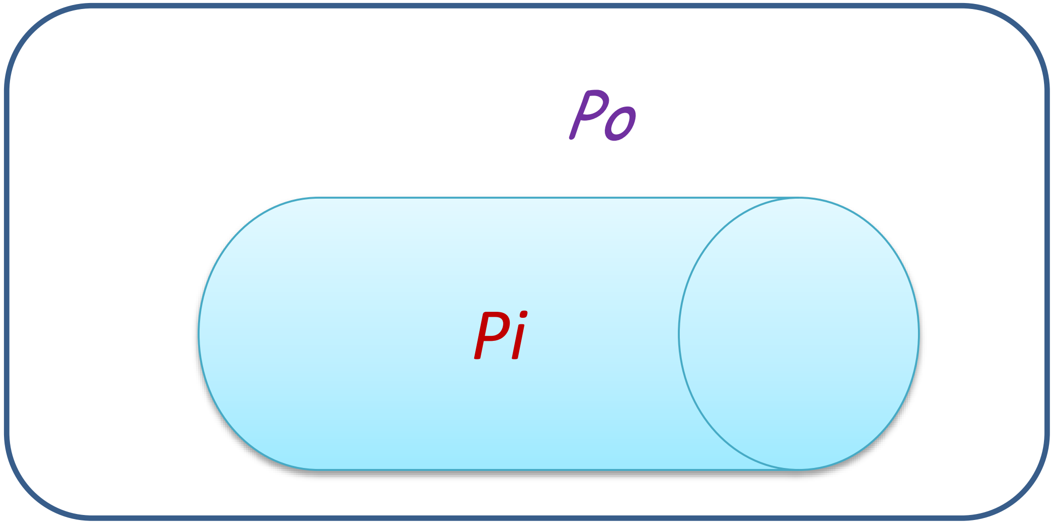
CODE INTRODUCTION



CODE INTRODUCTION

- Consider a vessel with an internal pressure pi and external pressure po and

  Pi ≠ Po :



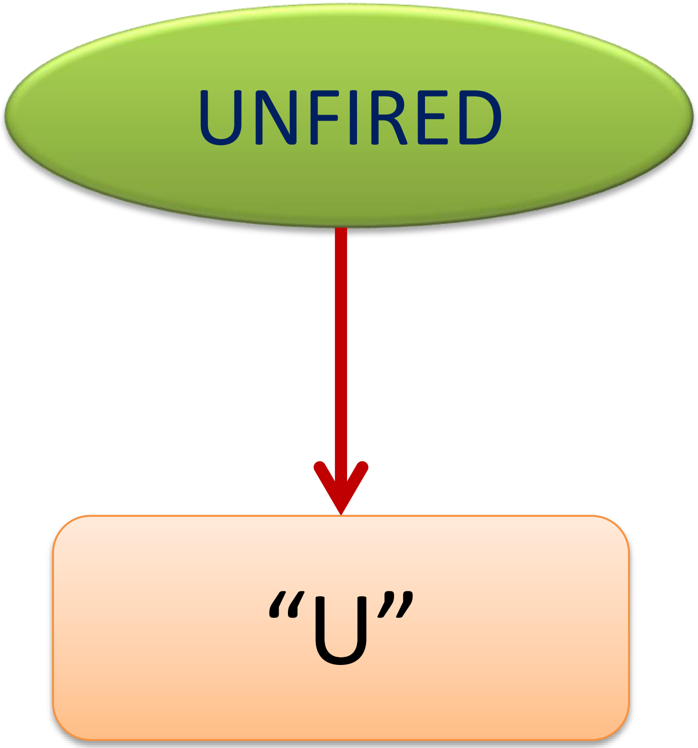
ASME

ASME BPV code

- Sec.I Power Boilers
- Sec.II Materials
- Sec.III Nuclear Fuel Containers
- Sec.IV Heating Boilers
- Sec. V Non Destructive Examination
- Sec. VI Operation of heating boilers
- Sec. VII Operation of power boilers
- Sec. VIII Pressure vessels
- Sec. IX Welding and Brazing
- Sec. X Fiber-Reinforced plastic PV
- Sec. XI Inspection of nuclear power plant
- Sec. XII Transport tanks

COMPARSION OF PRESSURE VESSEL CODES:

- Div. I UP TO 3000 PSI : DESIGN BY FORMULA
- Div. II UP TO 10000 PSI: Alternative Rules (BASED ON ANALYSIS)
- Div III FOR MORE THAN 10000 PSI: Alternative Rules for Construction of High Pressure Vessels (BASED ON ANALYSIS)


UNFIRED
"U"

- Contents of ASME Section VIII, Div.1

  - Subsection A : General Requirements (UG)
  - Subsection B : Methods of Fabrication (UW, UF, UB)
  - Subsection C : Classes of Materials (UCS, UHA, …) and Part UHX
  - Mandatory Appendices
  - Non-mandatory Appendices

- IMPORTANT NOTES :

- Code rules do not address deterioration due to Service
- Code is not a design handbook. Engineering judgment must be exercised
- Code does not address all aspects
- Code does not prohibit the use of computer programs
- Code does not deal with care and inspection
- Code does not approve or endorse proprietary items
- Revisions become mandatory six months after publication
- Code Cases become effective on approval

UG-4 Materials

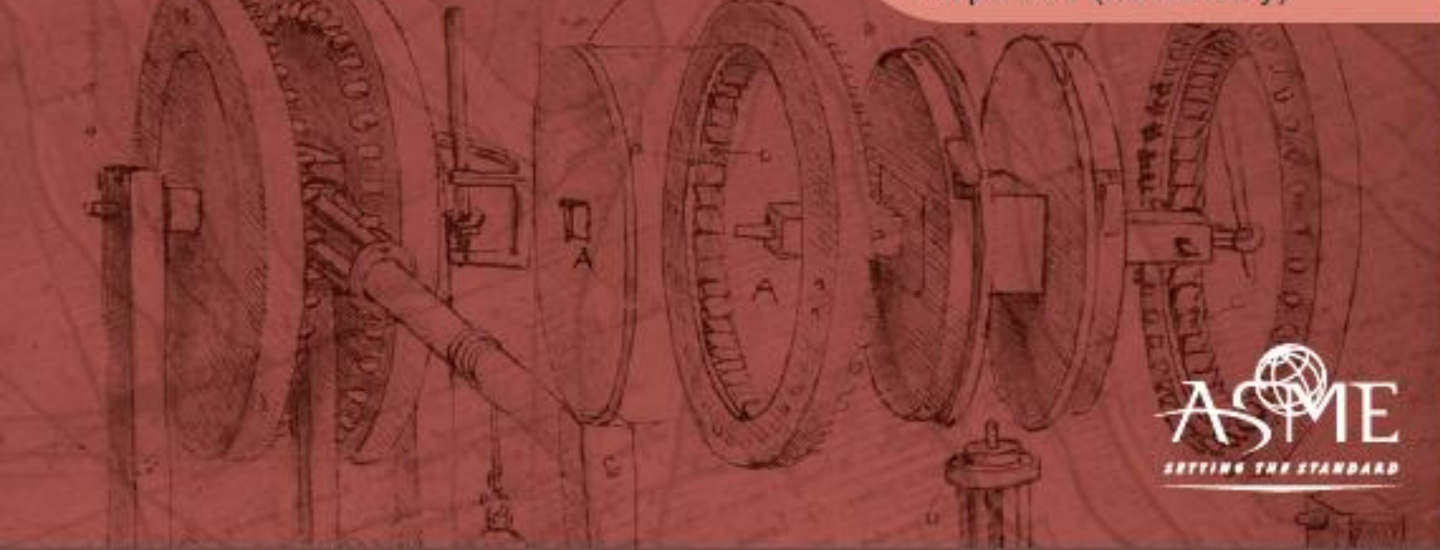
(a) Material subject to stress due to pressure shall conform to one of the specifications given in ***Section II, Part D***

ASME BPVC.II.D.C-2015

SECTION II
MATERIALS

2015 ASME Boiler and Pressure Vessel Code
An International Code

Part D
Properties (Customary)



ASME
SETTING THE STANDARD

Section II, Part D

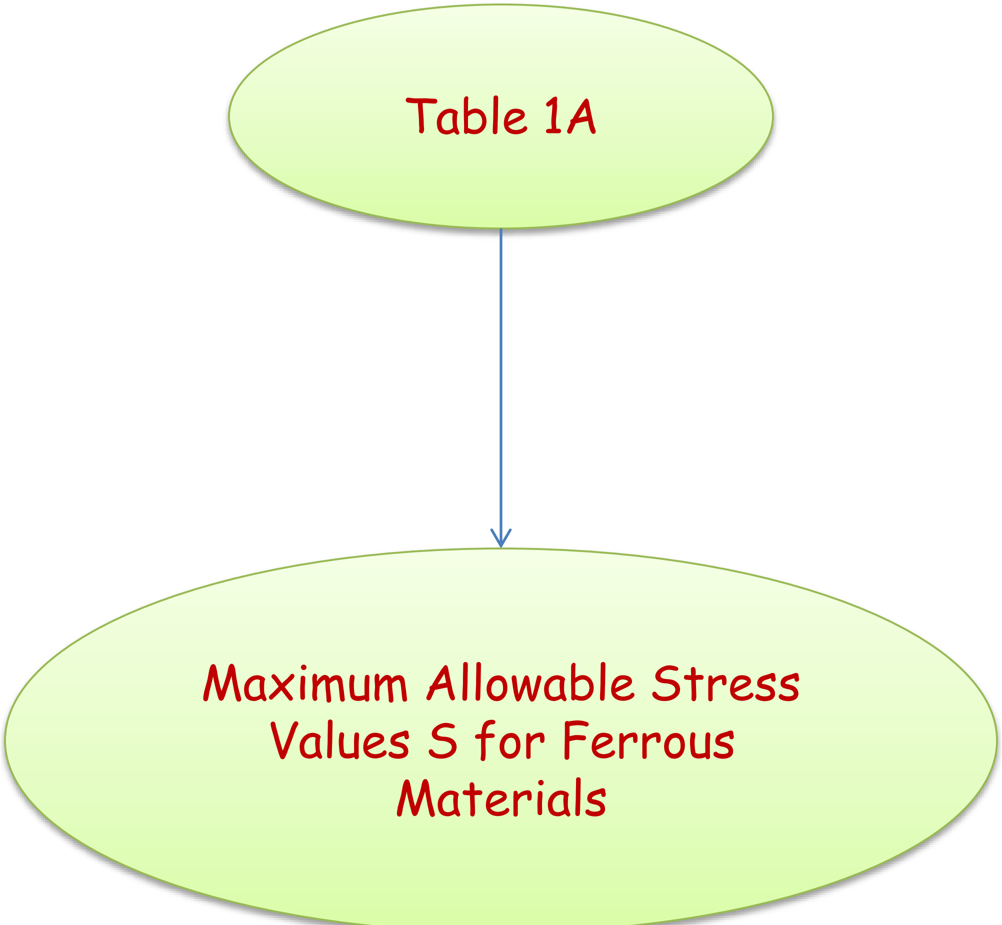


Table 1A (Cont'd)
Section I; Section III, Classes 2 and 3;* Section VIII, Division 1; and Section XII
Maximum Allowable Stress Values *S* for Ferrous Materials
(*See Maximum Temperature Limits for Restrictions on Class)

Line No.	Nominal Composition	Product Form	Spec. No.	Type/Grade	Alloy Desig./ UNS No.	Class/ Condition/ Temper	Size/Thickness, in.	P-No.	Group No.
1	Carbon steel	Wld. pipe	SA-134	A283C	K02401	...	...	1	1
2	Carbon steel	Plate	SA-283	C	K02401	...	...	1	1
3	Carbon steel	Plate	SA-285	C	K02801	...	...	1	1
4	Carbon steel	Smls. & wld. pipe	SA-333	1	K03008	...	...	1	1
5	Carbon steel	Smls. & wld. tube	SA-334	1	K03008	...	...	1	1
6	Carbon steel	Wld. tube	SA-334	1	K03008	...	...	1	1
7	Carbon steel	Plate	SA-516	55	K01800	...	...	1	1
8	Carbon steel	Smls. pipe	SA-524	II	K02104	...	...	1	1
9	Carbon steel	Wld. pipe	SA-671	CA55	K02801	...	...	1	1
10	Carbon steel	Wld. pipe	SA-671	CE55	K02202	...	...	1	1
11	Carbon steel	Wld. pipe	SA-672	A55	K02801	...	...	1	1
12	Carbon steel	Wld. pipe	SA-672	B55	K02001	...	...	1	1
13	Carbon steel	Wld. pipe	SA-672	C55	K01800	...	...	1	1
14	Carbon steel	Wld. pipe	SA-672	E55	K02202	...	...	1	1
15	Carbon steel	Sheet	SA-414	C	K02503	...	...	1	1
16	Carbon steel	Plate	SA/EN 10028-3	P275NH	...	...	$\leq 2^1/_4$	1	1
17	Carbon steel	Bar	SA-36	...	K02600	...	...	1	1

Line No.	Min. Tensile Strength, ksi	Min. Yield Strength, ksi	Applicability and Max. Temperature Limits (NP = Not Permitted) (SPT = Supports Only) I	III	VIII-1	XII	External Pressure Chart No.	Notes
1	55	30	NP	300 (Cl. 3 only)	NP	NP	CS-2	W12
2	55	30	NP	300 (Cl. 3 only)	650	650	CS-2	...
3	55	30	900	700	900	650	CS-2	G10, S1, T2
4	55	30	NP	700	650	650	CS-2	W12, W14
5	55	30	NP	700	650	650	CS-2	W12, W14
6	55	30	NP	NP	650	650	CS-2	G24, W6
7	55	30	850	700	1000	650	CS-2	G10, S1, T2
8	55	30	NP	NP	1000	650	CS-2	G10, T2
9	55	30	NP	700	NP	NP	CS-2	S6, W10, W12
10	55	30	NP	700	NP	NP	CS-2	S6, W10, W12
11	55	30	NP	700	NP	NP	CS-2	S6, W10, W12
12	55	30	NP	700	NP	NP	CS-2	S6, W10, W12
13	55	30	NP	700	NP	NP	CS-2	S6, W10, W12
14	55	30	NP	700	NP	NP	CS-2	S6, W10, W12
15	55	33	NP	700	900	650	CS-2	G10, T1
16	56.5	...	NP	NP	400	400	CS-2	G10, G18
17	58	36	650	650 (SPT)	900	650	CS-2	G10, G15, T1
18	58	36	NP	700	650	650	CS-2	G9, G10, T1

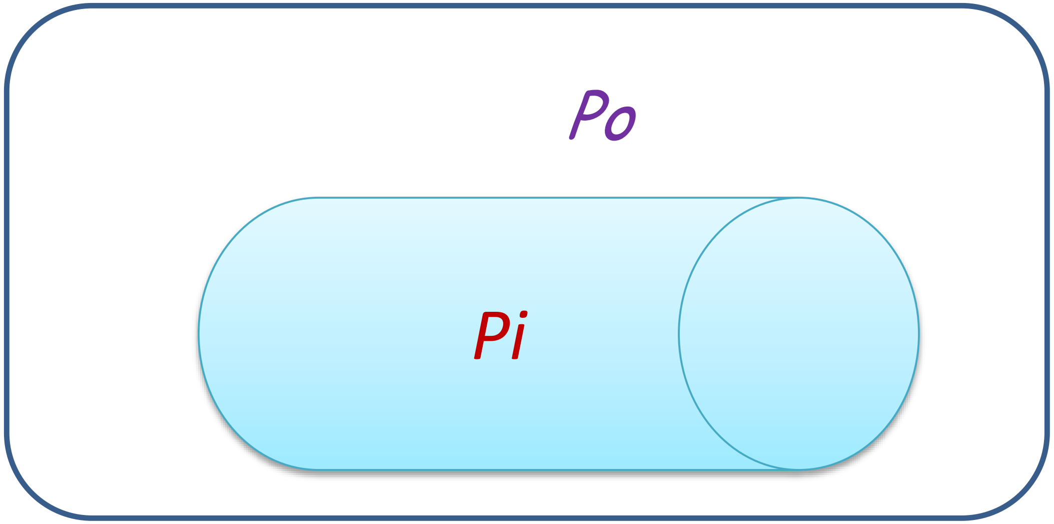
Line No.	Maximum Allowable Stress, ksi (Multiply by 1000 to Obtain psi), for Metal Temperature, °F, Not Exceeding													
	−20 to 100	150	200	250	300	400	500	600	650	700	750	800	850	900
1	15.7	...	15.7	...	15.7	...	...	...	...	...	...	...	...	...
2	15.7	15.7	15.7	...	15.7	15.7	15.7	15.3	14.8	...	...	...	...	...
3	15.7	15.7	15.7	...	15.7	15.7	15.7	15.3	14.8	14.3	*13.0*	*10.8*	*8.7*	*5.9*
4	15.7	...	15.7	...	15.7	15.7	15.7	15.3	14.8	14.3	...	...	...	...
5	15.7	...	15.7	...	15.7	15.7	15.7	15.3	14.8	14.3	...	...	...	...
6	13.4	13.4	13.4	...	13.4	13.4	13.4	13.0	12.6	...	...	...	...	...
7	15.7	15.7	15.7	...	15.7	15.7	15.7	15.3	14.8	14.3	*13.0*	*10.8*	*8.7*	*5.9*
8	15.7	15.7	15.7	...	15.7	15.7	15.7	15.3	14.8	14.3	*13.0*	*10.8*	*8.7*	*5.9*
9	15.7	...	15.7	...	15.7	15.7	15.7	15.3	14.8	14.3	...	...	...	...
10	15.7	...	15.7	...	15.7	15.7	15.7	15.3	14.8	14.3	...	...	...	...
11	15.7	...	15.7	...	15.7	15.7	15.7	15.3	14.8	14.3	...	...	...	...
12	15.7	...	15.7	...	15.7	15.7	15.7	15.3	14.8	14.3	...	...	...	...
13	15.7	...	15.7	...	15.7	15.7	15.7	15.3	14.8	14.3	...	...	...	...
14	15.7	...	15.7	...	15.7	15.7	15.7	15.3	14.8	14.3	...	...	...	...
15	15.7	15.7	15.7	...	15.7	15.7	15.7	15.7	15.7	*15.6*	*13.0*	*10.8*	*8.7*	*5.9*
16	16.1	16.1	16.1	...	16.1	16.1	...	...	...	...	...	...	...	...
17	16.6	16.6	16.6	...	16.6	16.6	16.6	16.6	16.6	*15.6*	*13.0*	*10.8*	*8.7*	*5.9*
18	16.6	...	16.6	...	16.6	16.6	16.6	16.6	16.6	*15.6*	...	...	...	...
19	16.6	16.6	16.6	...	16.6	16.6	16.6	16.6	16.6	*15.6*	...	...	...	...
20	17.0	...	17.0	...	17.0	17.0	17.0	17.0	16.5	...	...	...	...	...
21	17.0	...	17.0	...	17.0	17.0	17.0	17.0	16.5	...	...	...	...	...
22	17.0	...	17.0	...	17.0	17.0	17.0	17.0	16.5	...	...	...	...	...

UG-4 Materials

PRESSURE PARTS or NON PRESSURE PARTS

UG-4 Materials

- Consider a vessel with an internal pressure pi and external pressure po and Pi ≠ Po :



UG-4 Materials

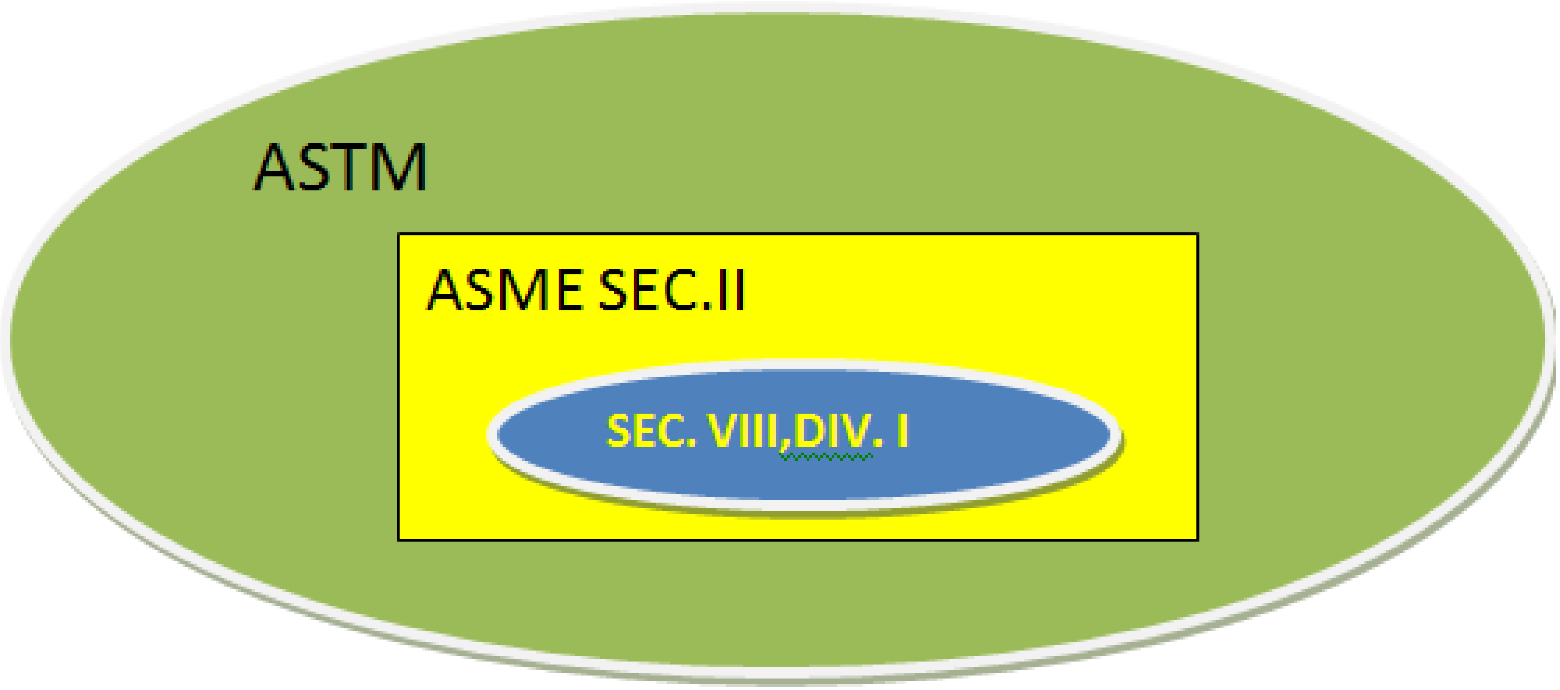
(b) Material for nonpressure parts, such as skirts, supports, baffles, lugs, clips, and extended heat transfer surfaces, need not conform to the specifications for the material to which they are attached or to a material specification permitted in this Division, but if attached to the vessel by welding shall be of weldable quality

UG-4 Materials

The allowable stress values for material not identified in accordance with UG-93 shall not exceed 80% of the maximum allowable stress value permitted for similar material in Subsection C.

UG-93 ??

UG-4 Materials



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UG-4 Materials

(a) Material subject to stress due to pressure shall conform to one of the specifications given in ***Section II, Part D***

UG-4 Materials

(d) Materials other than those allowed by the rules of this Division shall not be used.

(e) Materials outside the limits of size and/or thickness given in the title or scope clause of the specifications given in Section II, and permitted by the applicable part of Subsection C, may be used if the material is in compliance with the other requirements of the specification,6 and no size or thickness limitation is given in the stress tables. In those specifications in which chemical composition or mechanical properties vary with size or thickness, materials outside the range shall be required to conform to the composition and mechanical properties shown for the nearest specified range.

- (f) Service requirements to be considered by designer (corrosion, erosion, oxidation, and other deterioration during their intended service life)- See Section II, Part D, Non-mandatory Appendix A

UG-16 (Design-General)

(b) Minimum Thickness (After Forming) of Pressure Retaining Components:

General	1.5 mm + C.A.
Unfired Steam boilers	6 mm + C.A.
Air, Water & Steam Service	2.5 mm + C.A.

UG-16 (Design-General)

Notes:

1. The minimum thickness does not apply to heat transfer plates of plate-type heat exchangers

2. this minimum thickness does not apply to the inner pipe of double pipe heat exchangers nor to pipes and tubes that are enclosed and protected from mechanical damage by a shell, casing, or ducting, where such pipes or tubes are NPS 6 (DN 150) and less.

3. This minimum thickness does not apply to the tubes in air cooled and cooling tower heat exchangers if all the following provisions are met:

(- a)Tubes shall not be used for lethal service applications

(- b)The Tubes shall be protected by fins or other mechanical means

(-c) the tube outside diameter shall be a minimum of 3/8 in. (10 mm) and a maximum of 11/2 in. (38 mm)

(-d) the minimum thickness used shall not be less than that calculated by the formulas given in UG-27 or 1-1 and in no case less than 0.022 in. (0.5 mm).

UG-16 (Design-General)

(C) Mill Under tolerance:

1- Plate material shall be ordered not thinner than the design thickness

Plate Material= Min. $\begin{cases} 0.25\text{mm} \\ 6\% \text{ of plate thickness} \end{cases}$

Pipe Material= 12.5 % of Nominal Thickness

(Minimum Thickness = Nominal Pipe thickness x 0.875)

(e) Corrosion Allowance in Design Formulas:

Corrosion allowance to be added to all formulas

UG-16 (Design-General)

Example:

1- Plate material with nominal thickness of 10 mm

Plate Material= Min. { 0.25mm ; 6% x 10 mm= 0.6 mm }

So, Minimum thickness with above mentioned ordered thickness is:
10-0.25=9.75 mm

2- Pipe 10" sch. Std (Nominal thickness= 9.27mm) :

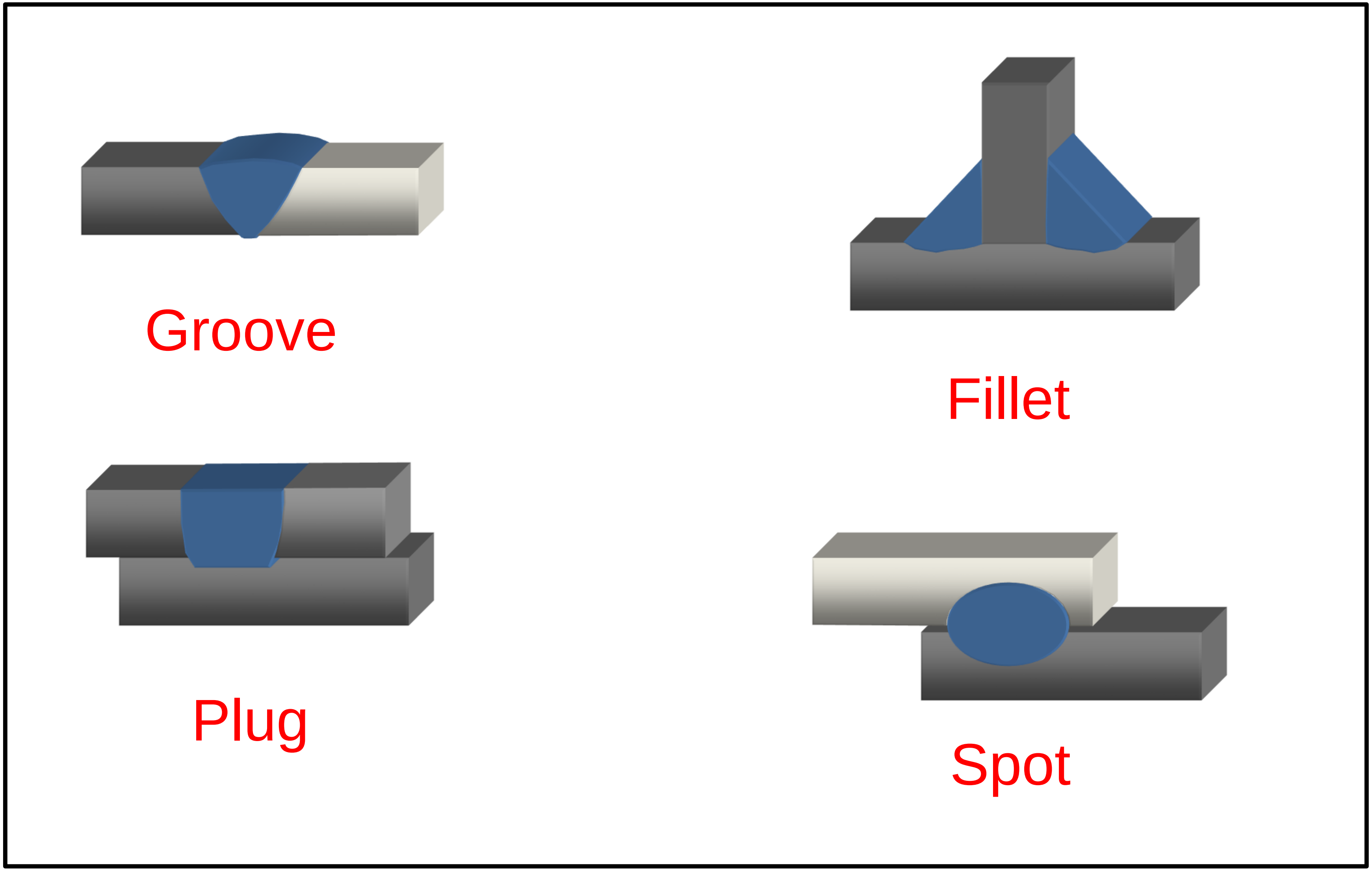
Minimum Thickness = 9.27x 0.875= 8.11 mm

WELDING

- According to AWS A2.4 we have following type of welds:

1. GROOVE WELD (جوش شیاری)
2. Fillet WELD (جوش نبشی)
3. PLUG OR SLOT WELDS (جوش های دکمه ای)
4. STUD WELDS (جوش های زائده ای)
5. SPOT OR PROJECTION WELDS (جوش های نقطه ای)
6. SEAM WELDS (جوش های نواری)
7. BACK OR BACKING WELDS (جوش های پشت بند)
8. SURFACING WELDS (جوش های سطحی)
9. EDGE WELDS (جوش های لبه ای)

WELDING

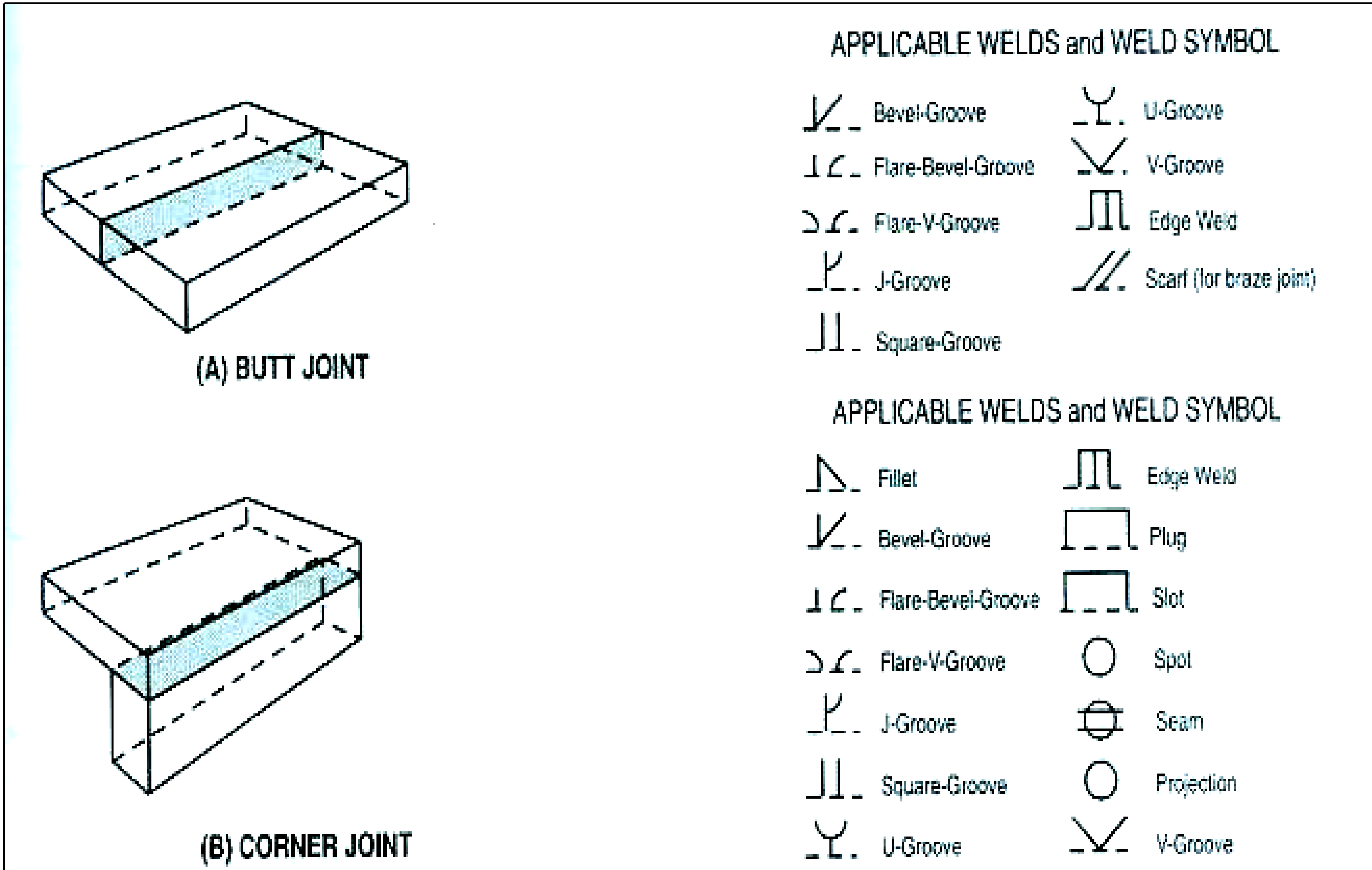


WELDING

TYPE OF JOINTS:

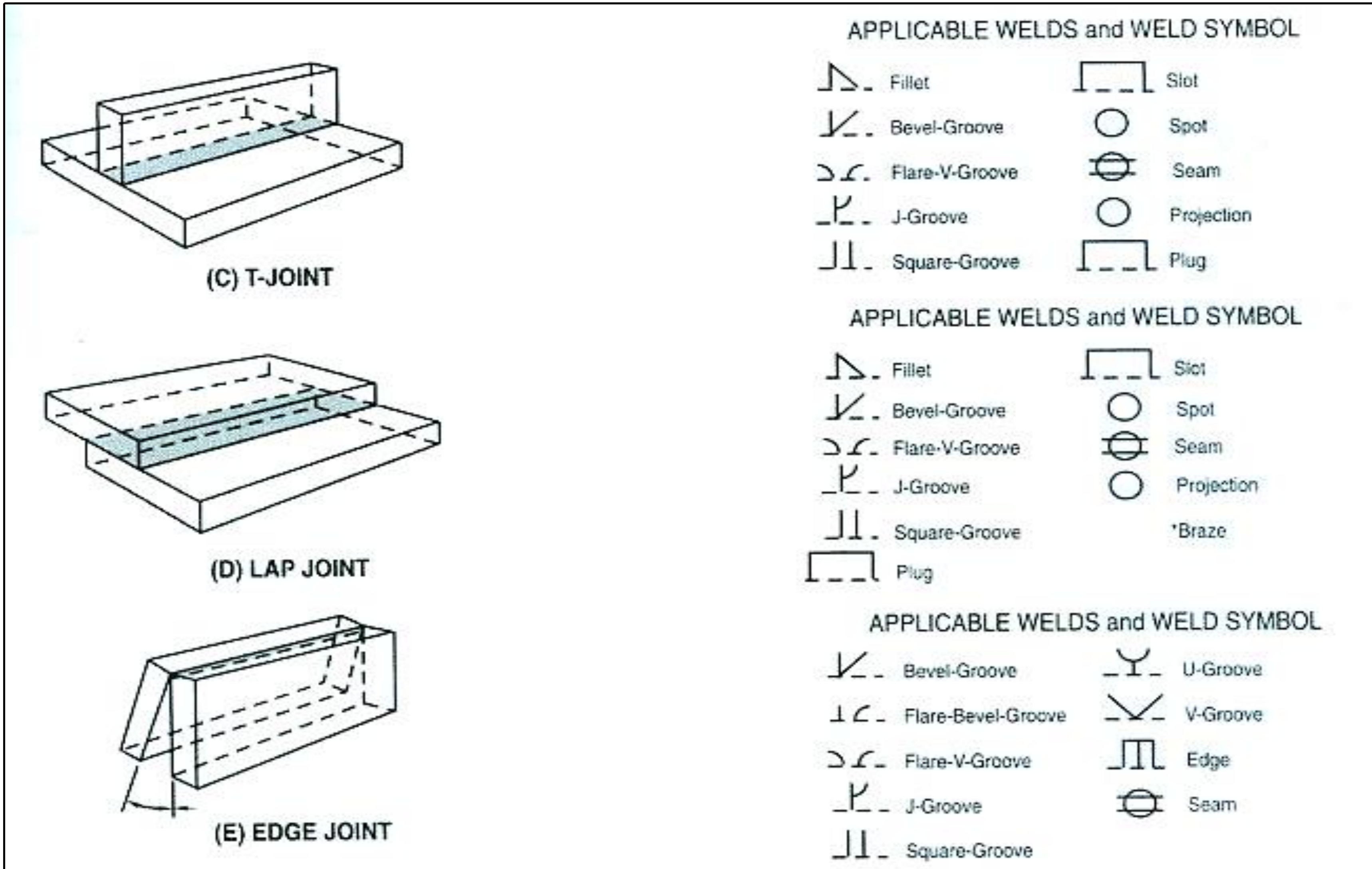
1. Butt joint (لب به لب)
2. Corner joint (گوشه ای)
3. T-joint (سپری)
4. Lap joint (لبه روی هم)
5. Edge joint (لبه ای)

WELDING



(A) BUTT JOINT
(B) CORNER JOINT
APPLICABLE WELDS and WELD SYMBOL
Bevel-Groove
U-Groove
Flare-Bevel-Groove
V-Groove
Flare-V-Groove
Edge Weld
J-Groove
Scarf (for braze joint)
Square-Groove
APPLICABLE WELDS and WELD SYMBOL
Fillet
Edge Weld
Bevel-Groove
Plug
Flare-Bevel-Groove
Slot
Flare-V-Groove
Spot
J-Groove
Seam
Square-Groove
Projection
U-Groove
V-Groove

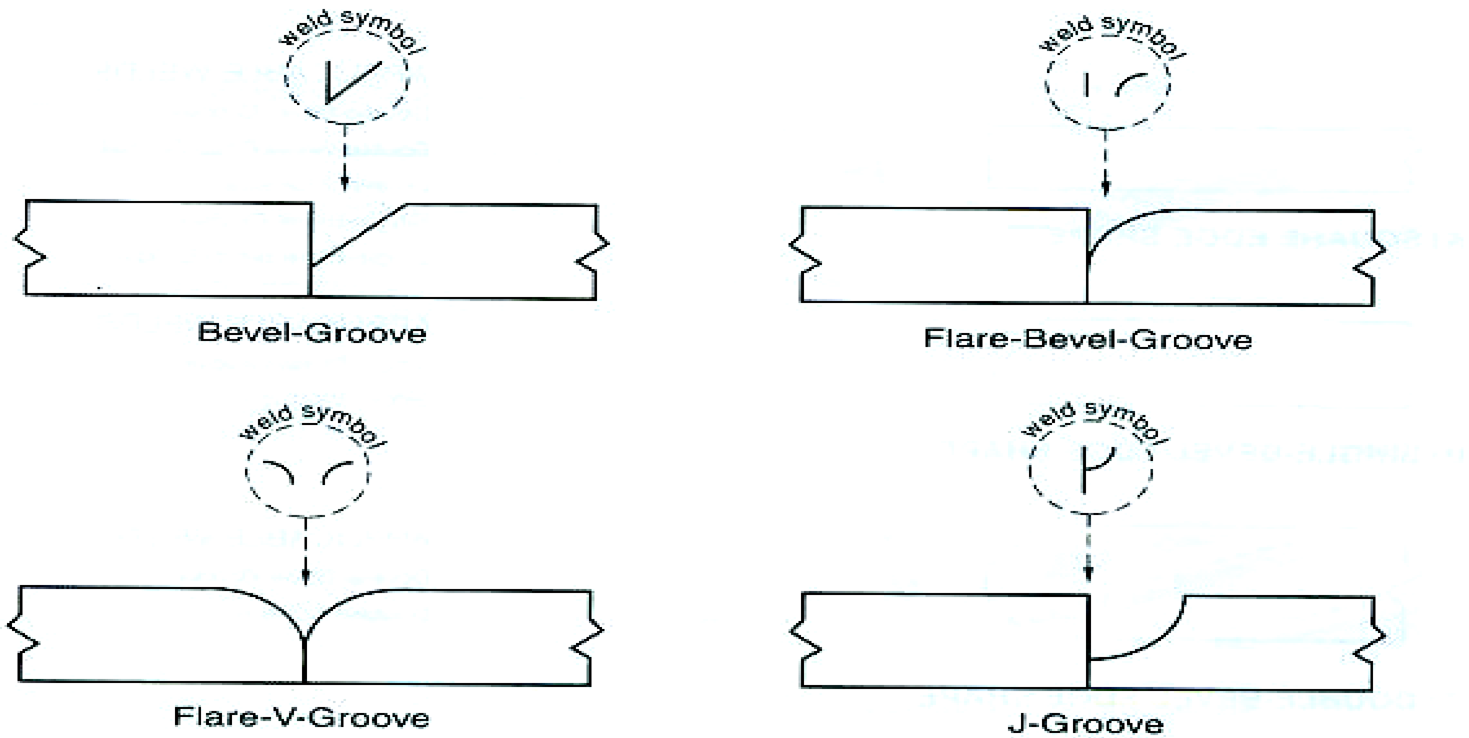
WELDING



(C) T-JOINT
APPLICABLE WELDS and WELD SYMBOL
Fillet
Bevel-Groove
Flare-V-Groove
J-Groove
Square-Groove
Slot
Spot
Seam
Projection
Plug
(D) LAP JOINT
APPLICABLE WELDS and WELD SYMBOL
Fillet
Bevel-Groove
Flare-V-Groove
J-Groove
Square-Groove
Plug
Slot
Spot
Seam
Projection
*Braze
(E) EDGE JOINT
APPLICABLE WELDS and WELD SYMBOL
Bevel-Groove
Flare-Bevel-Groove
Flare-V-Groove
J-Groove
Square-Groove
U-Groove
V-Groove
Edge
Seam

TYPE OF GROOVE:

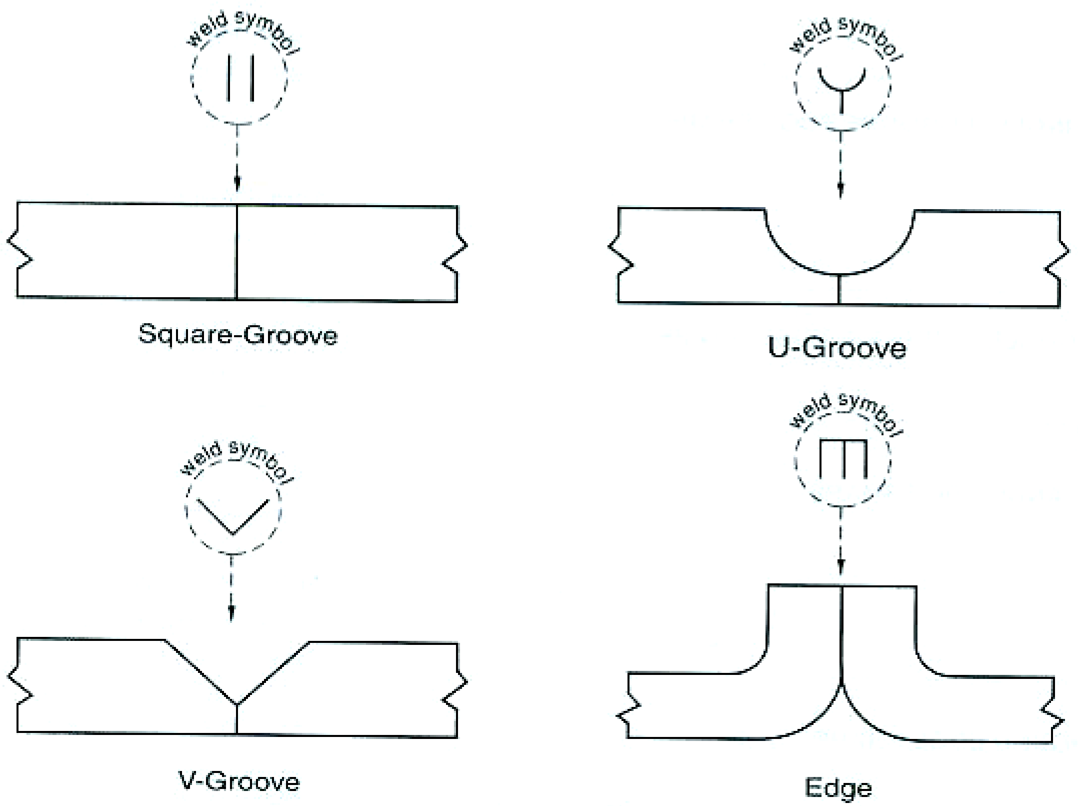
Butt joint



WELDING

TYPE OF GROOVE:

Butt joint



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Process Units Design

Construction Consulting

Static Equipment Design

Static Equipment Fabrication

Fabrication & Shop Drawings Preparation

Our process and mechanical team comprises experts with a strong foundation in process and mechanical engineering, as well as functional and industry-specific domain knowledge and standards ready to reduce your project cost with an excellent qualified and optimum design.

In addition to process design, conceptual and basic engineering, and project management services, we offer consulting services such as plant or project audits, process troubleshooting, value engineering facilitation and participation, risk and HAZOP studies, and design reviews.






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Web site: www.bep-co.com

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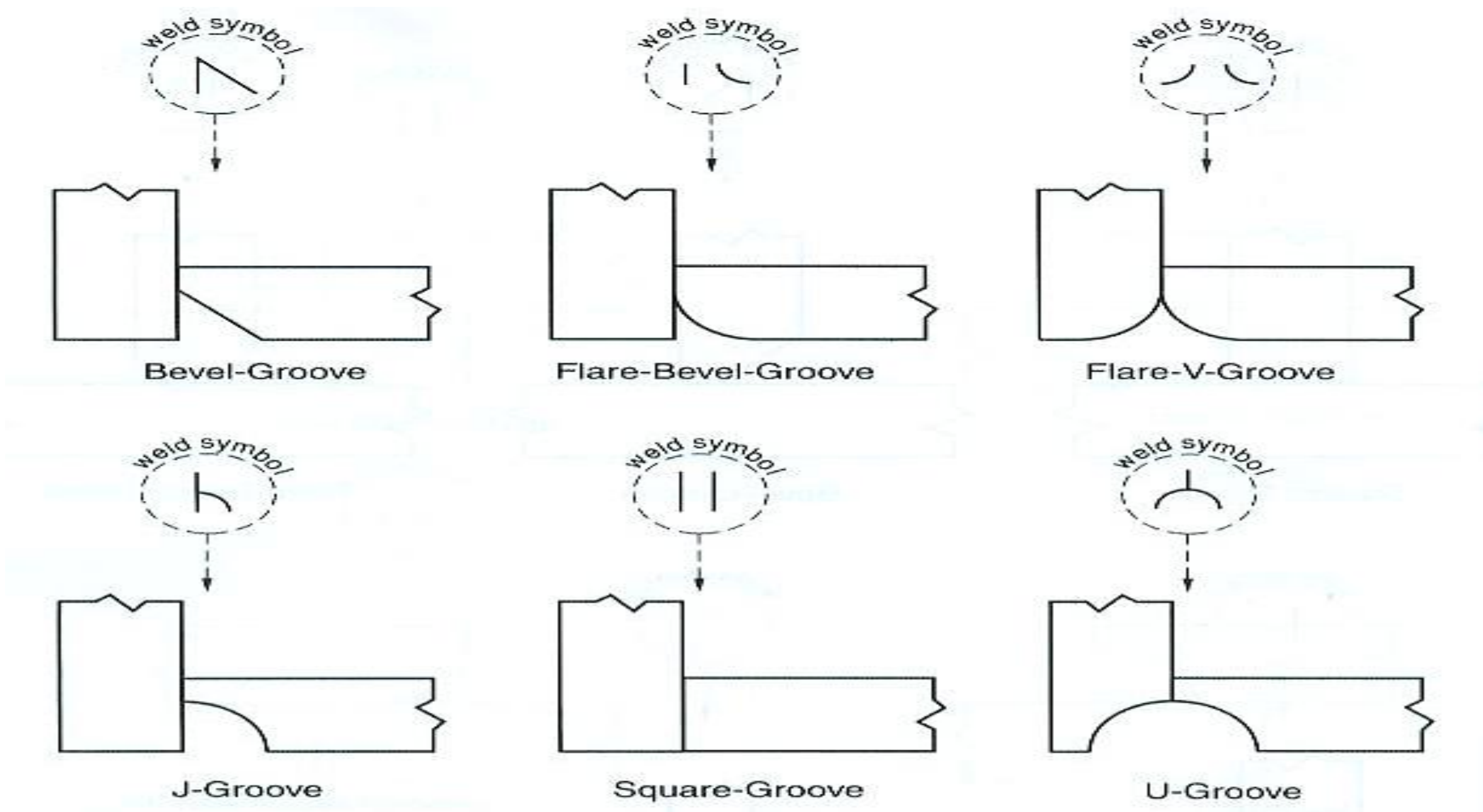
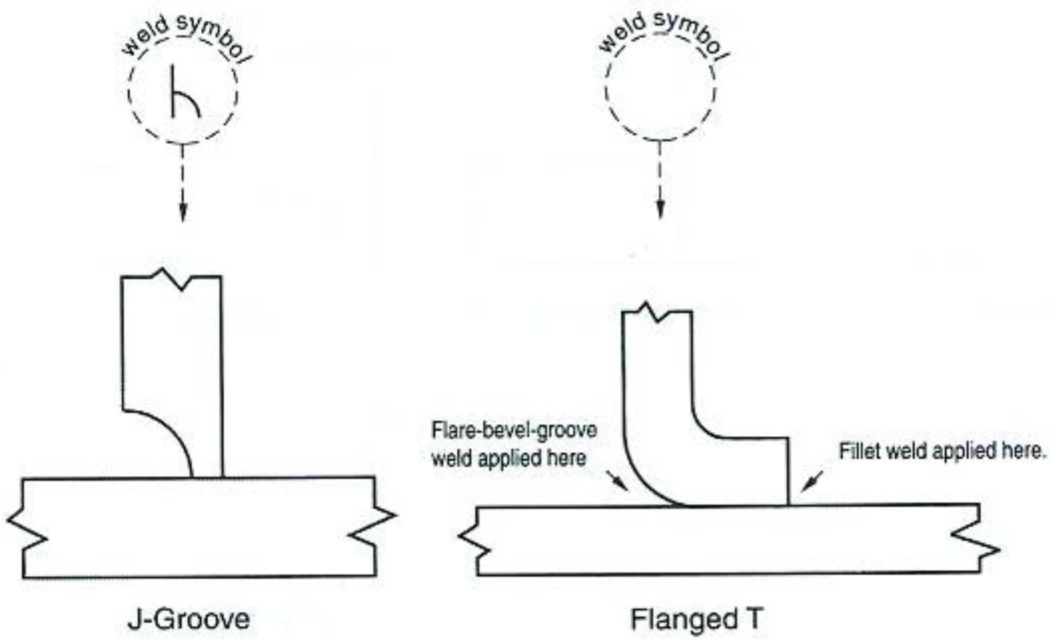
WELDING

Corner joint (گوشه ای)

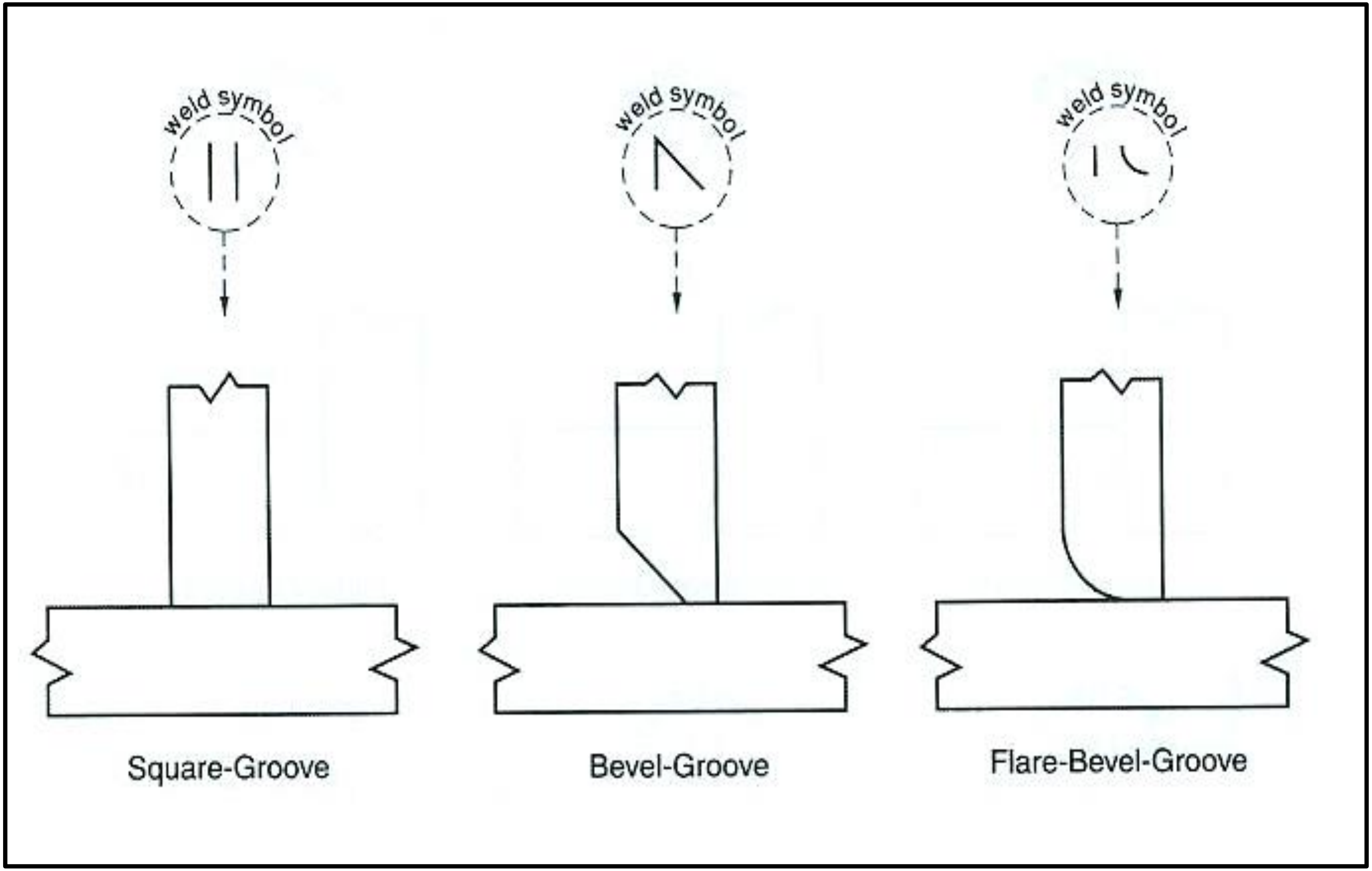


WELDING

T-joint (سپری)

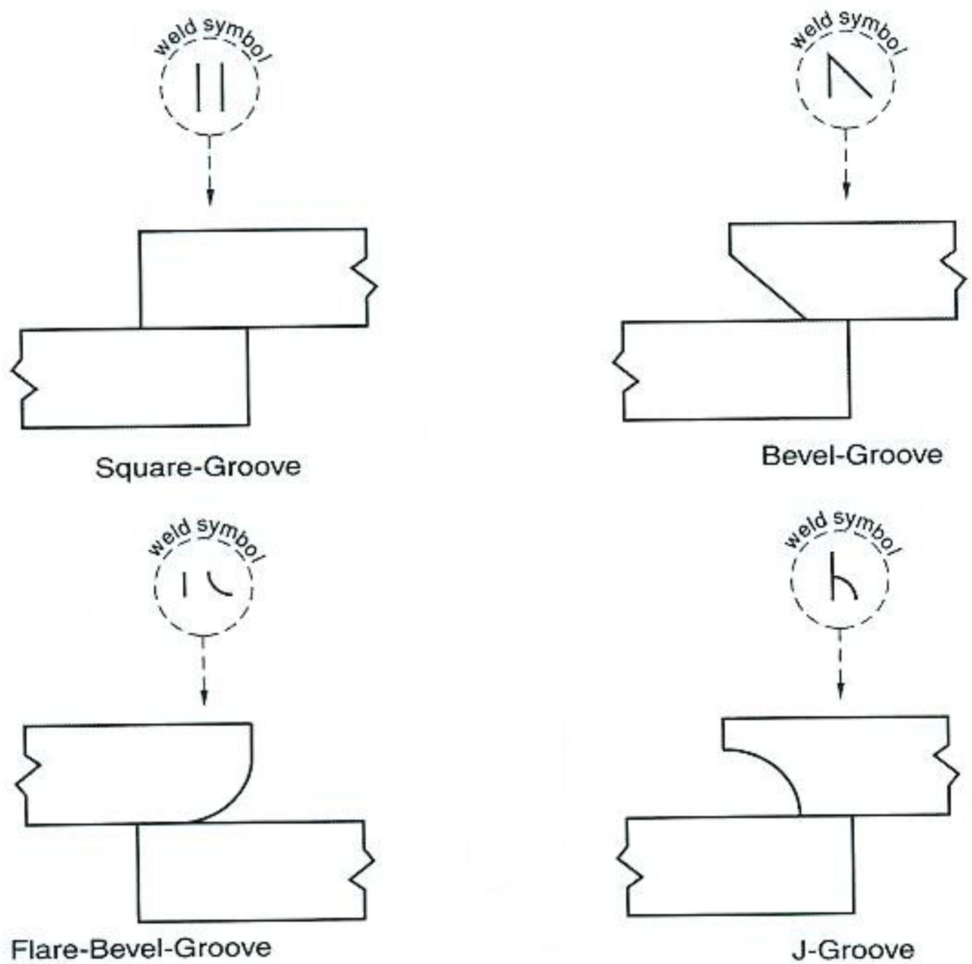


WELDING

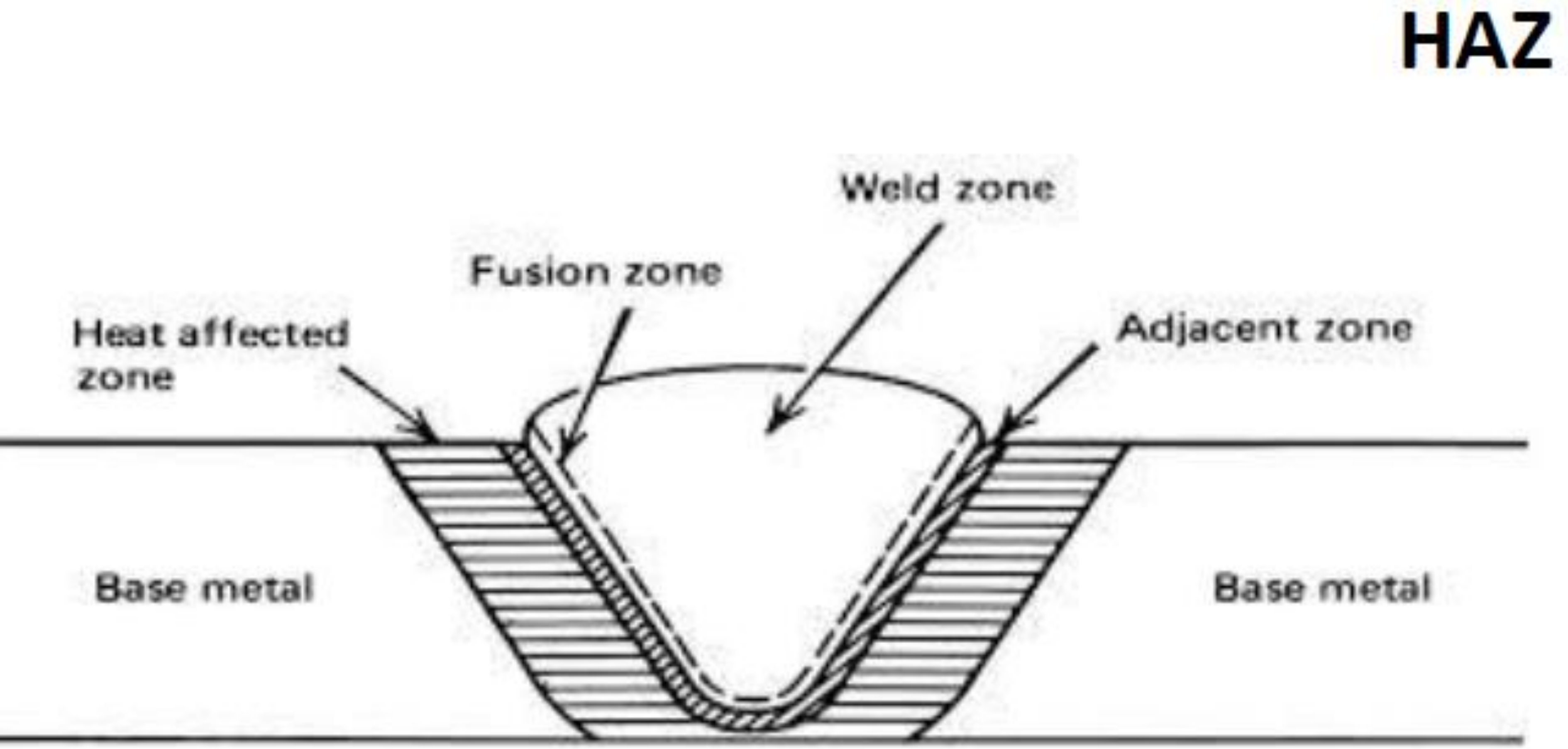

weld symbol
weld symbol
weld symbol
Square-Groove
Bevel-Groove
Flare-Bevel-Groove

WELDING

Lap joint (لبه روی هم)



UG-18 (HAZ)



HAZ
Weld zone
Fusion zone
Heat affected zone
Adjacent zone
Base metal
Base metal

HAZ

- ناحیه متأثر از حرارت ((Heat Affected Zone: HAZ) قسمتی از فلز جوش است که در آن اگر چه فلز پایه ذوب نشده است اما ساختار و دانه بندی آن در اثر حرارت ناشی از جوشکاری تغییر یافته است. در پایان فرآیندهای جوشکاری به دلیل سرعت بالای سرد شدن، ساختارهای مارتنزیتی تشکیل میگردد. این نواحی مستعد ایجاد ترک در قطعه جوشکاری شده هستند. وقتی فلزات و آلیاژ هایی که استحاله چند شکلی ندارند مانند مس، نیکل، آلومینیوم، جوش داده میشوند، ریز ساختار در HAZتغییر نمیکند با این وجود که ممکن است تبلور مجدد یا رشد دانه در آن اتفاق بیفتد. این در حالیست که در فلزات و آلیاژ هایی که استحاله چند شکلی دارند)مانند فولادها(تغییرات ریز ساختاری قابل ملاحظه ای در ناحیه متاثر از حرارت رخ میدهد که این تغییرات خواص مکانیکی و رفتار عملی اتصال جوش را تحت تأثیر قرار میدهد .

HAZ

وسعت و گستردگی ناحیه متاثر از حرارت به عوامل زیر بستگی دارد

- روش جوشکاری
- سرعت جوشکاری
- درجه حرارت پیشگرم
- تعداد پاس های جوشکاری
- ابعاد قطعه
- شکل طرح اتصال
- شکل حوضچه جوش

HAZ

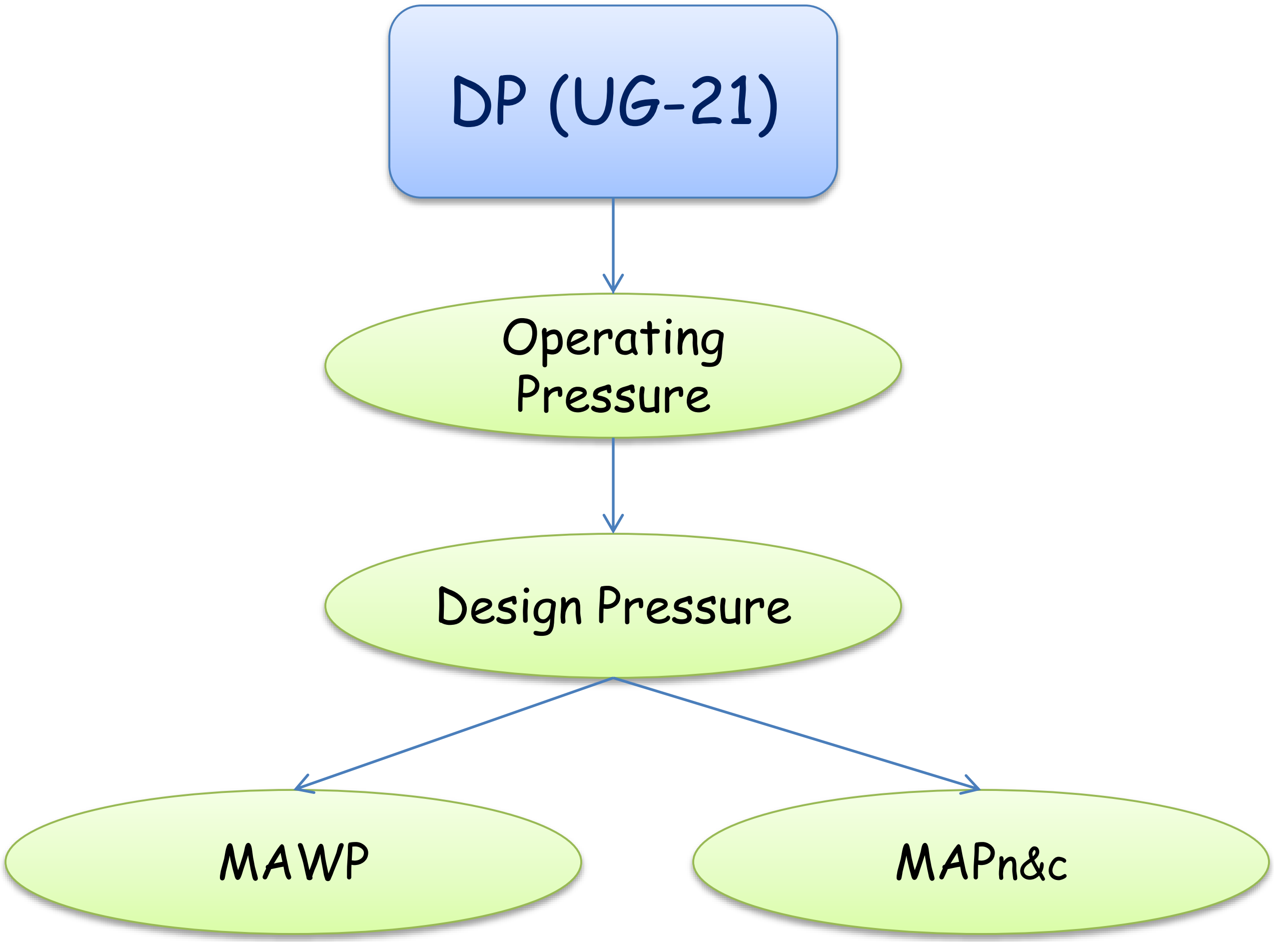
- روش جوشکاری در جوشکاری قوس الکتریکی دستی، وسعت ناحیه HAZ دارای کمترین مقدار است و به 2 تا ۸.2 میلیمتر میرسد. در جوشکاری با الکترودهای پوششدار وسعت این ناحیه ۳ تا ۱۹ میلیمتر است در حالی که در جوشکاری گازی به ۲۹ تا ۲۸ میلیمتر میرسد. علت این است که در روشهای جوشکاری با قوس الکتریکی، امکان تمرکز حرارت در یک نقطه وجود داشته در حالی که در روشهای گازی، حرارت در سطح توزیع شده و در نواحی اطراف ناحیه متاثر از حرارت گسترش مییابد . جنس فلز پایه : در فلزاتی که ضریب انتقال حرارت)هدایت حرارتی(بالاتری دارند، ایجاد تمرکز حرارت غیرممکن است بنابراین منطقه HAZ در فلزات و آلیاژهای آلومینیوم و مس نسبت به فولادها از وسعت بیشتری برخوردارند. در بین فولادها نیز وسعت ناحیه متاثر از حرارت در فولادهای کربنی بیشتر از سایر فولادها میباشد.
- سرعت جوشکاری : هر چقدر میزان سرعت جوشکاری بالاتر باشد، وسعت ناحیه متاثر از حرارت کوچکتر میگردد؛ زیرا حرارت تولیدی در ناحیه جوش فرصت انتقال به نواحی اطراف و پراکنده شدن را ندارد
- درجه حرارت پیشگرم : هر چه میزان دمای پیشگرم قطعه جوشکاری کمتر باشد، وسعت منطقه HAZ کمتر خواهد شد؛ زیرا چنانچه فلز تا حد قابل ملاحظه ای پیشگرم شود، در واقع هنگام جوشکاری به گرمتر شدن نواحی اطراف جوش کمک شده است
- تعداد پاس های جوشکاری : در جوش تک پاسی، به دلیل اعمال حرارت ورودی بیش از حد و طولانی شدن زمان جوشکاری و همچنین طولانی شدن زمان انجماد، وسعت ناحیه متاثر از حرارت افزایش می یابد

HAZ

- ابعاد قطعه : قطعات ضخیم تر، قدرت جذب حرارت بیشتری داشته و سرعت سرد شدن جوش نیز افزایش می یابد . متغیرهای جوشکاری : متغیرهایی مانند شدت جریان، ولتاژ و قطر الکترود نیز بر وسعت ناحیه HAZ تاثیر میگذارد. زیرا با افزایش شدت جریان، ولتاژ و قطر الکترود وسعت ناحیه HAZ افزایش می یابد .
- شکل طرح اتصال : بطور مثال با مقایسه بین جوش نبشی و جوش لبه ای در صورتی که ضخامت ورق در محل هر دو نوع اتصال با هم برابر باشد، به دلیل سرعت سرد شدن بالاتر در جوش نبشی، وسعت ناحیه متاثر از حرارت در آن کوچکتر از جوش لبه ای میگردد .
- شکل حوضچه جوش: همچنین در دو نوع یکسان جوش نبشی چنانچه گرده جوش در یکی از اتصالات به شکل محدب باشد، سطح تماس جوش با فلز پایه بیشتر شده و در نتیجه حرارت را سریعتر به محیط اطراف منتقل میکند. این امر سبب می شود که وسعت ناحیه HAZ نسبت به گرده مقعر جوش، بیشتر گردد.

منبع: مرکز پژوهش و مهندسی جوش ایران ، ساختار متالورژیکی مقاطع جوشکاری شده

Design Pressure (UG-21)



Design Pressure (UG-21)

❖ Operating Pressure: Operating pressure is a normal pressure which we will expect in normal operation condition.

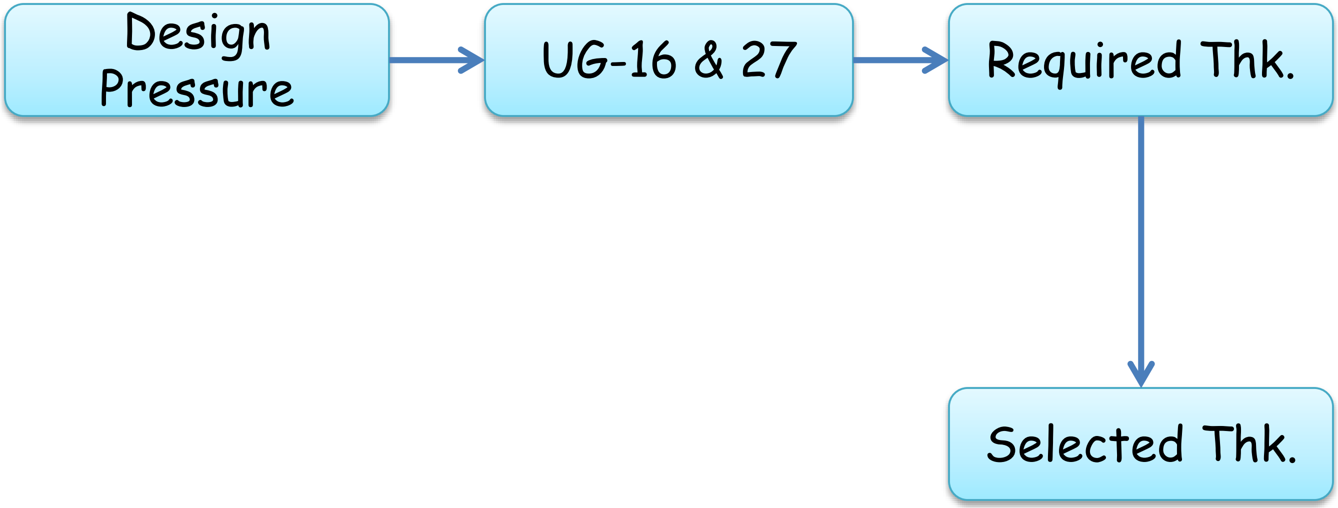
❖ Design Pressure : The most severe condition of coincident pressure (including coincident static head in the operating position) and temperature expected in normal operation.

<u>As per Megysey Handbook: Design Pressure = Max. (OPx1.1 or OP+30 Psi)</u>

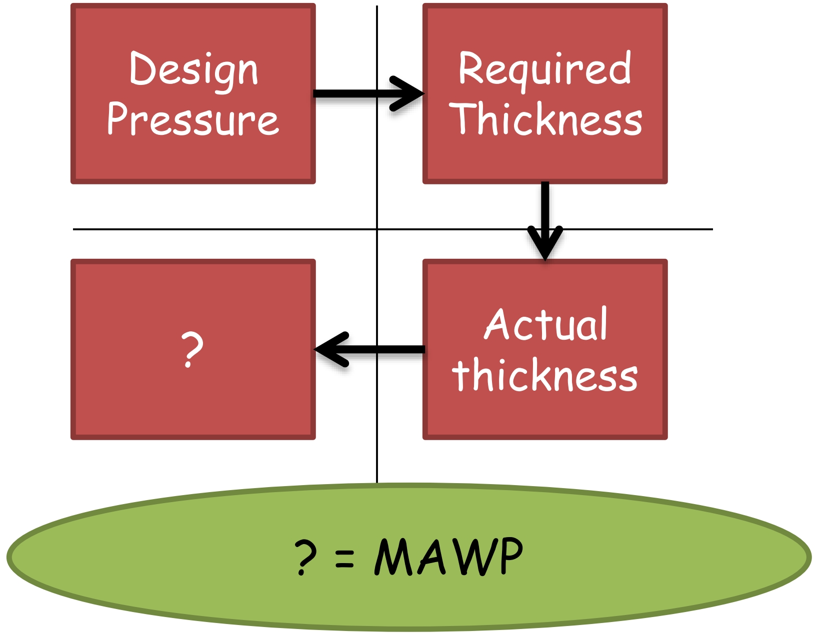
❖ MAWP :Maximum Allowable Working Pressure (corroded and in service condition)

❖ MAWPn&c (MAPn&c): Maximum Allowable Working Pressure New and Cold

MAWP



MAWP



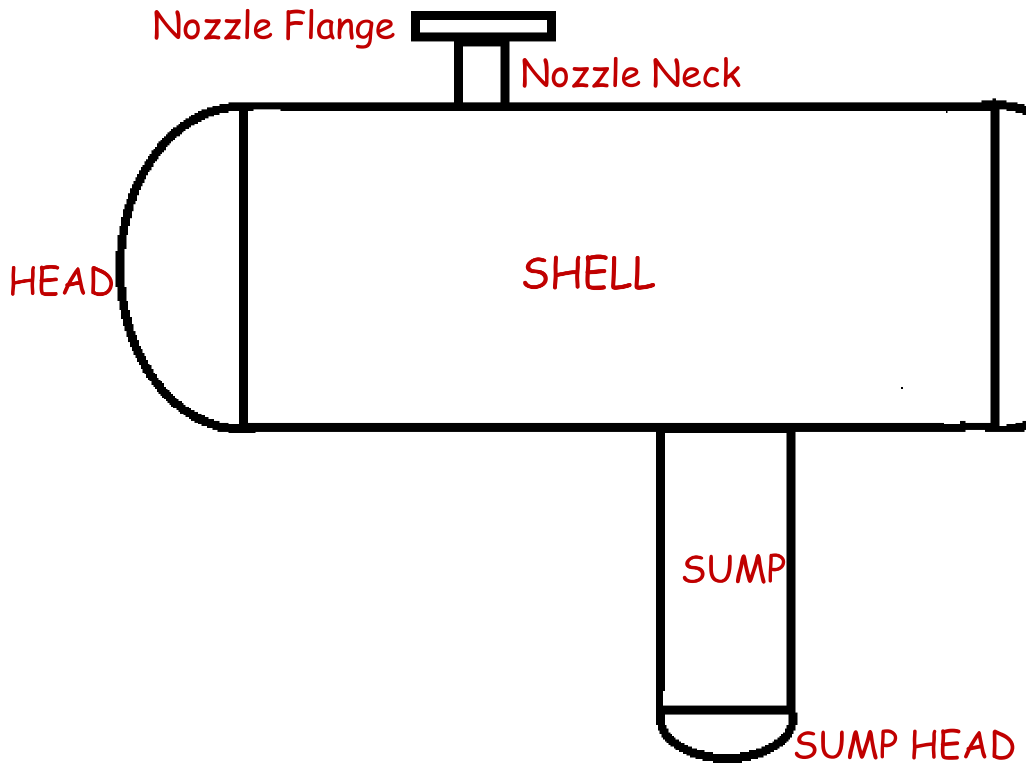
MAWP > Design Pressure

Design Pressure (UG-21)

- ❖ Minor Parts : Parts such as Nozzle, Flange, Reinforcement pad, etc.
- ❖ Major Parts: Parts such as Shell, head, body flange, etc.
- ▪ Note based on Design specifications:

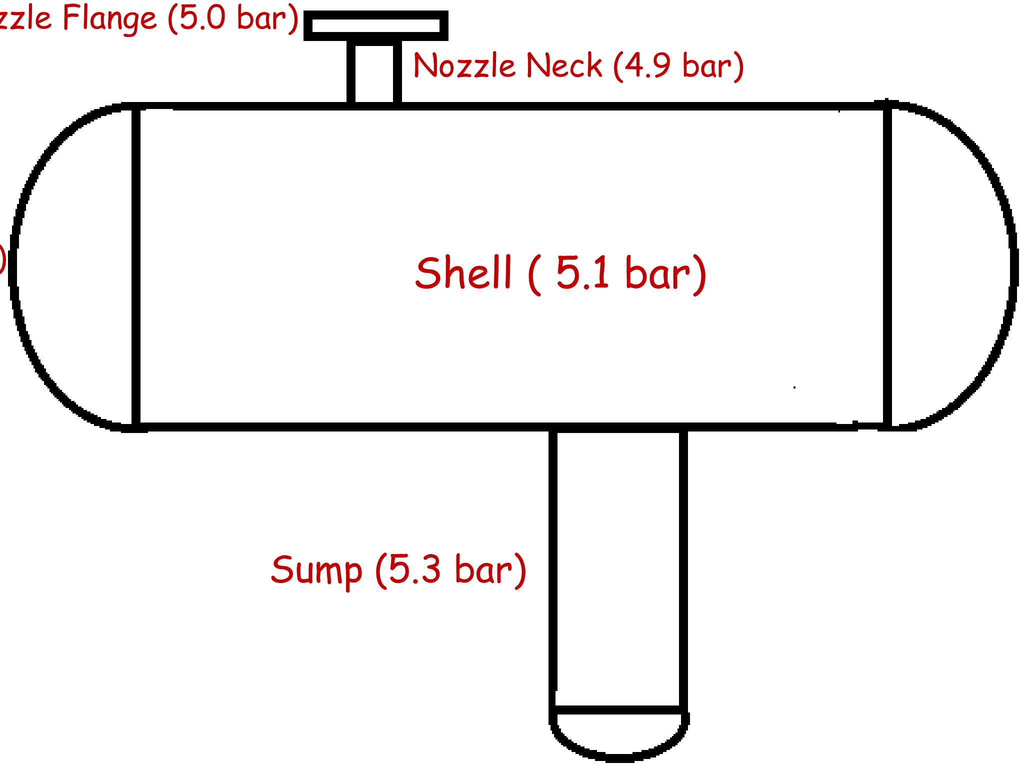
<u>«MAWP shall not governed by a Minor parts of pressure vessels»</u>

MAWP



MAWP total = Min. ($MAWP_{shell}$, $MAWP_{head}$, $MAWP_{sump}$, $MAWP_{nozzle}$, $MAWP_{Flange}$)

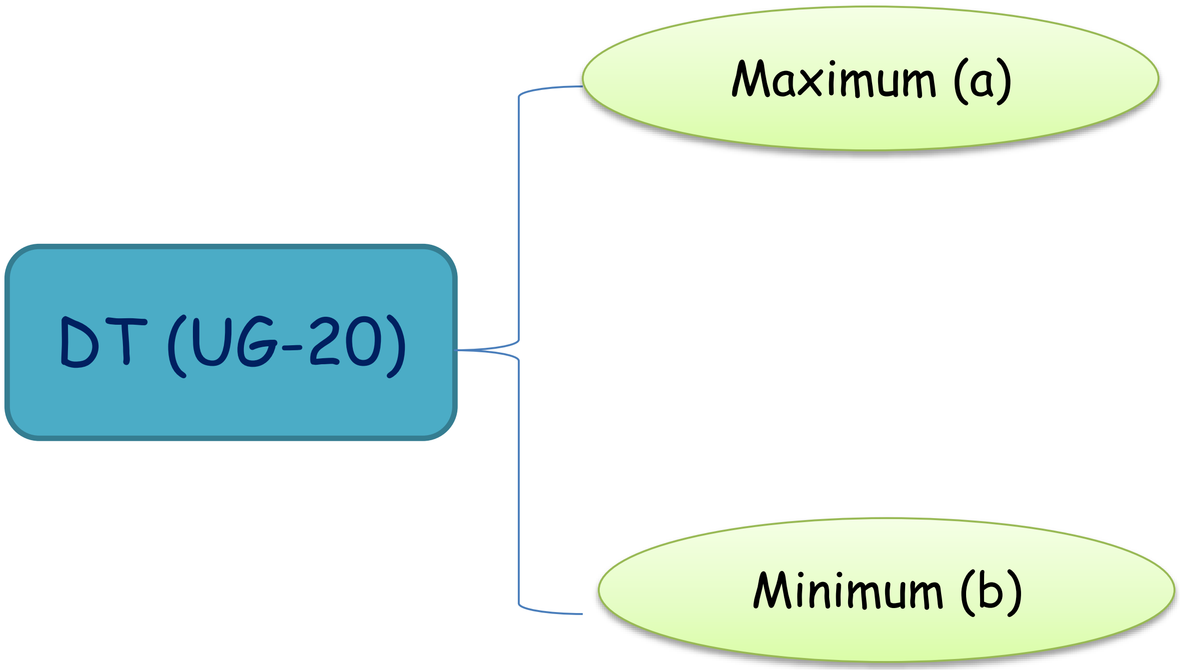
MAWP (EXAMPLE)



MAWP total = Min. (5.1 bar, 5.2 bar, 5.3 bar, 4.9 bar, 5.0 bar) = 4.9 bar

So, MAWP is Governed by a Nozzle neck (if we increase schedule of nozzle the next part which will governed MAWP is Nozzle Flange!)

Design Temperature (UG-20)



Other Consideration : Impact Test, MDMT

Design Temperature (UG-20)

- ✓ IMPORTANT NOTE:

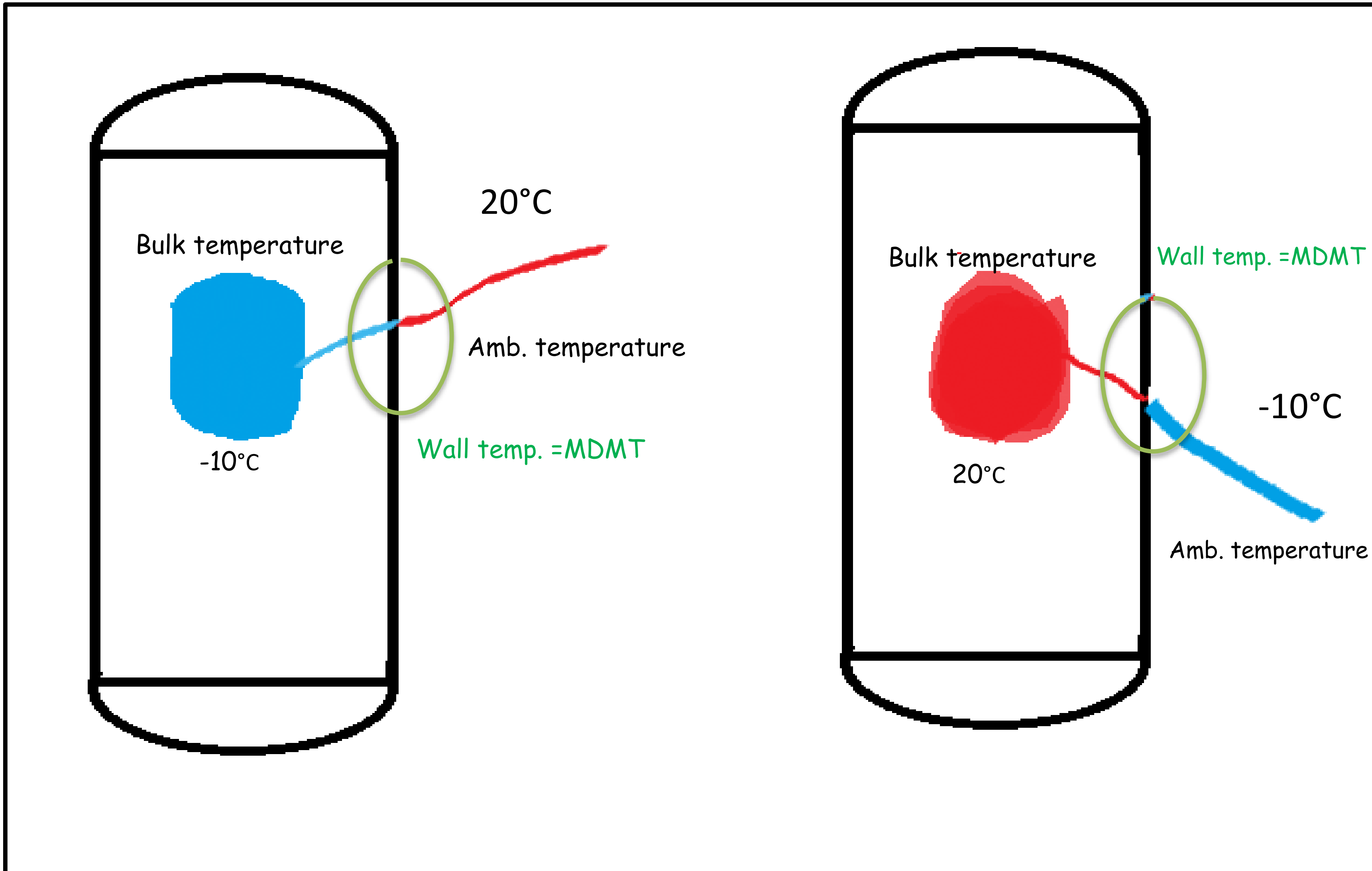
  The MDMT marked on the nameplate shall correspond to a coincident pressure equal to the MAWP.

<u>But, What does it mean??!</u>

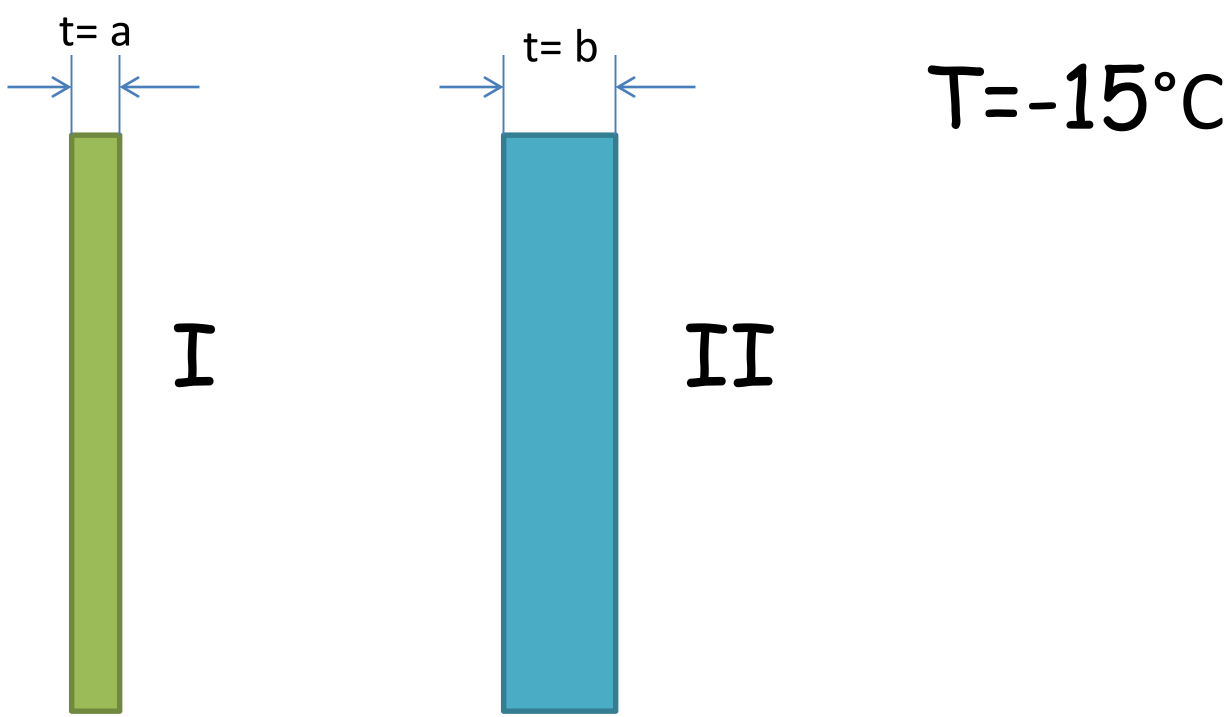
Design Temperature (UG-20)

- ✓ What is MDMT?
- ✓ MDMT is minimum design metal temperature.
- ✓ The MDMT which was defined by <u>Process</u> is a minimum design required temperature based on MMT.
- ✓ The MDMT that will computed by <u>Mechanical</u> is allowed minimum temperature which vessel could be suffer without any fail.

Design Temperature (UG-20)



Design Temperature (UG-20)



1. consider b > a , and MDT (Minimum Design Temperature) in both condition is the same.
2. Brittlement in number II is more than I. So, Vessel's MDMT in II < I
3. Thickness has direct effect on vessel's MDMT and it should be calculated by Mechanical calculation in accordance to UCS-66

Design Temperature (UG-20)

UG-20 (f)

- (1) Material is limited to P-No.1 Gr. No.1 or 2 and the thicknesses don't exceed the following:
  - (-a) 13 mm for materials listed in Curve A of Figure UCS-66;
  - (-b) 25 mm for materials listed in Curve B, C, or D of Figure UCS-66.
- (2) The completed vessel shall be hydrostatically tested.
- (3) Design temperature is no warmer than 345°C nor colder than −29°C.
- (4) The thermal or mechanical shock loadings are not a controlling design requirement.
- (5) Cyclical loading is not a controlling design requirement.

IMPACT TEST

- Toughness: Toughness is, broadly, a measure of the amount of energy required to cause an item - a test piece or a bridge or a pressure vessel - to fracture and fail. The more energy that is required then the tougher the material. So, The ability of a material to withstand an impact blow is referred to as notch toughness.

- context of an impact test: a measure of the metal's resistance to brittle or fast fracture in the presence of a flaw or notch and fast loading conditions

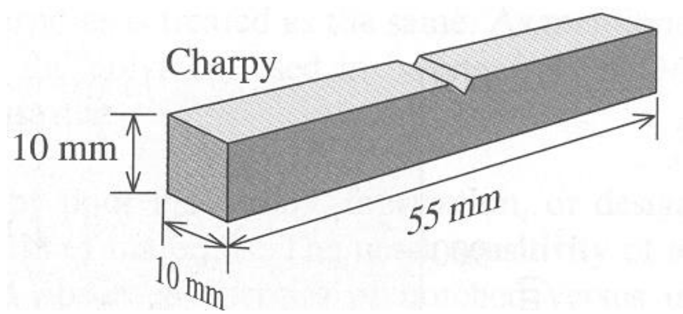
- There are two main forms of impact test, the Izod and the Charpy test. Both involve striking a standard specimen with a controlled weight pendulum travelling at a set speed. The amount of energy absorbed in fracturing the test piece is measured and this gives an indication of the notch toughness of the test material.

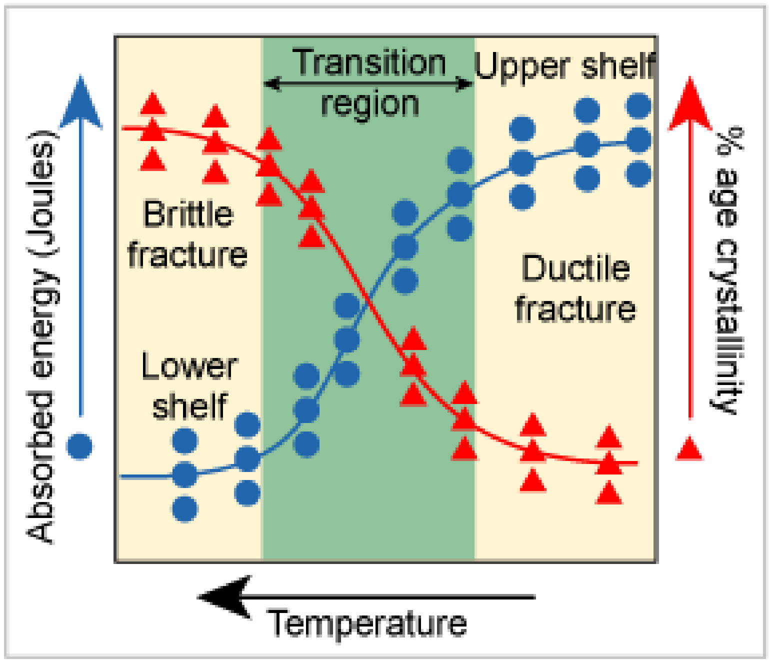
IMPACT TEST

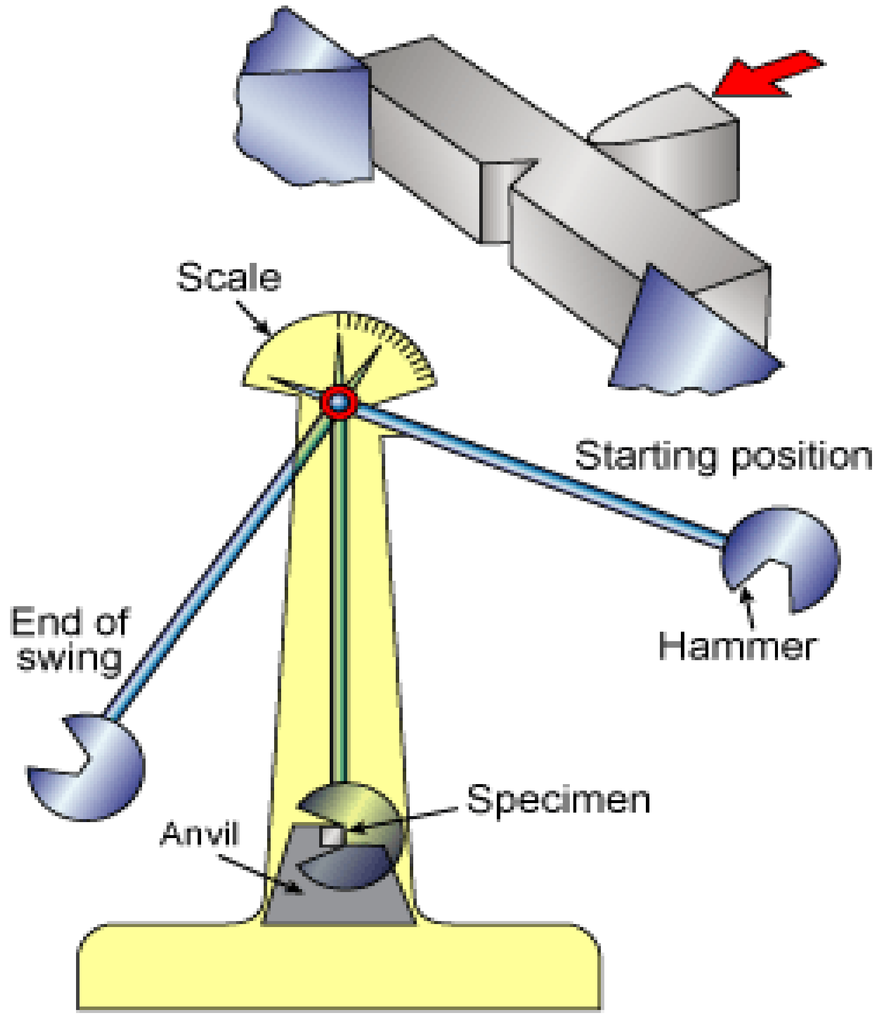
- These tests show that metals can be classified as being either 'brittle' or 'ductile'. A brittle metal will absorb a small amount of energy when impact tested, a tough ductile metal a large amount of energy.

- The energy absorbed is the difference in height between initial and final position of the hammer. The material fractures at the notch and the structure of the cracked surface will help indicate whether it was a brittle or ductile fracture.

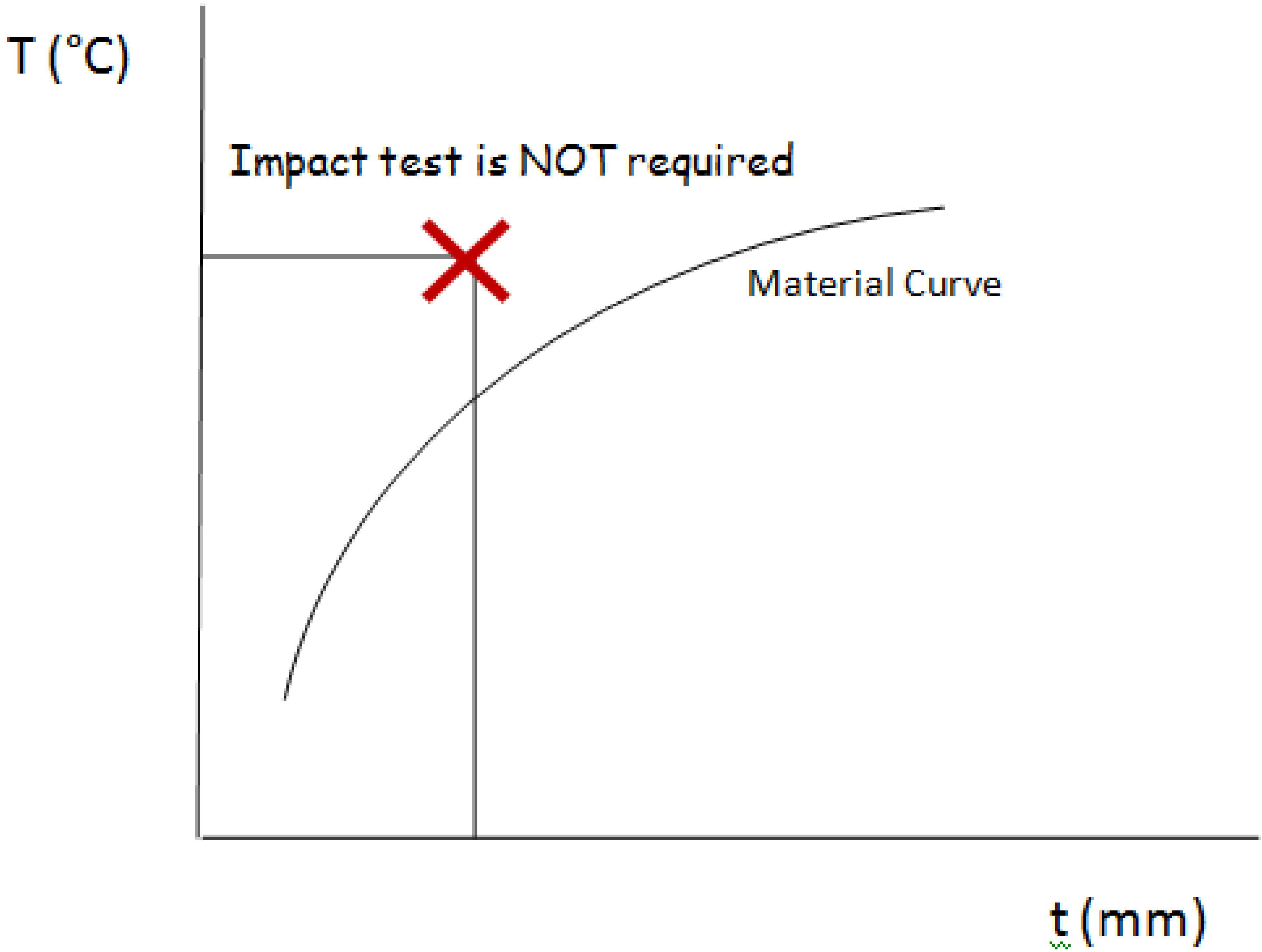
IMPACT TEST


Charpy
10 mm
55 mm
10 mm

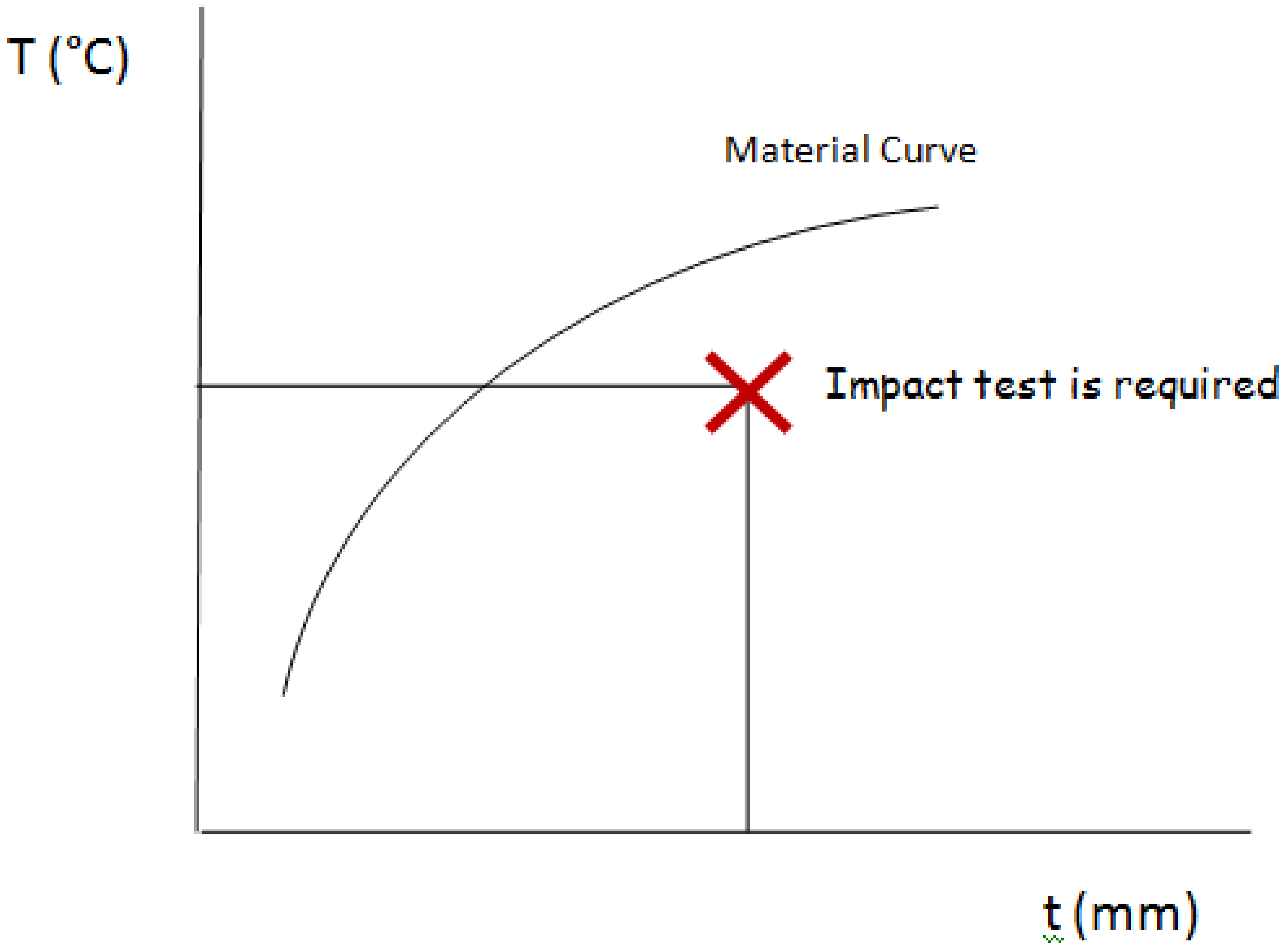

Transition region
Upper shelf
Brittle fracture
Ductile fracture
Lower shelf
Absorbed energy (Joules)
% age crystallinity
Temperature


Scale
Starting position
End of swing
Hammer
Specimen
Anvil

IMPACT TEST



IMPACT TEST



IMPACT TEST

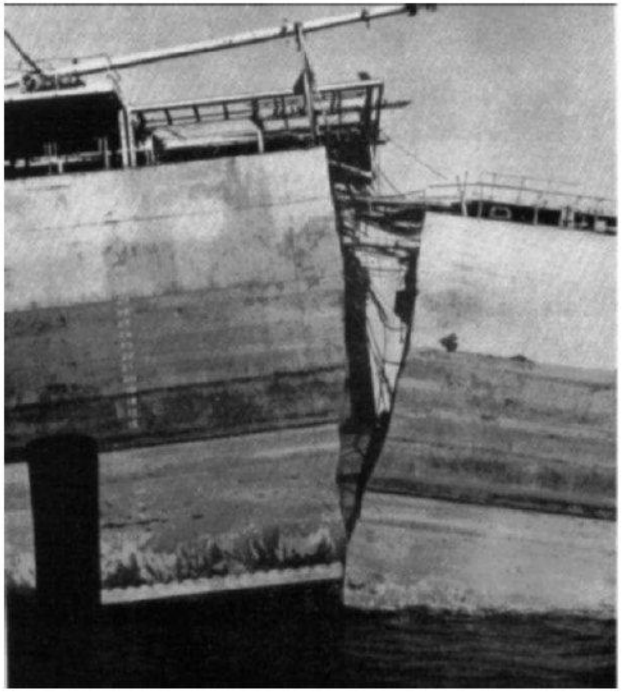
	Alloy	Impact energy [J (ft·lb)]
1.	1040 carbon steel	180 (133)
2.	8630 low-alloy steel	55 (41)
3.	c. 410 stainless steel	34 (25)
4.	L2 tool steel	26 (19)
5.	Ferrous superalloy (410)	34 (25)
6.	a. Ductile iron, quench	9 (7)
7.	b. 2048, plate aluminum	10.3 (7.6)
8.	a. AZ31B magnesium	4.3 (3.2)
	b. AM100A casting magnesium	0.8 (0.6)
9.	a. Ti–5Al–2.5Sn	23 (17)
10.	Aluminum bronze, 9% (copper alloy)	48 (35)
11.	Monel 400 (nickel alloy)	298 (220)
13.	50:50 solder (lead alloy)	21.6 (15.9)
14.	Nb–1 Zr (refractory metal)	174 (128)

Table 8.1

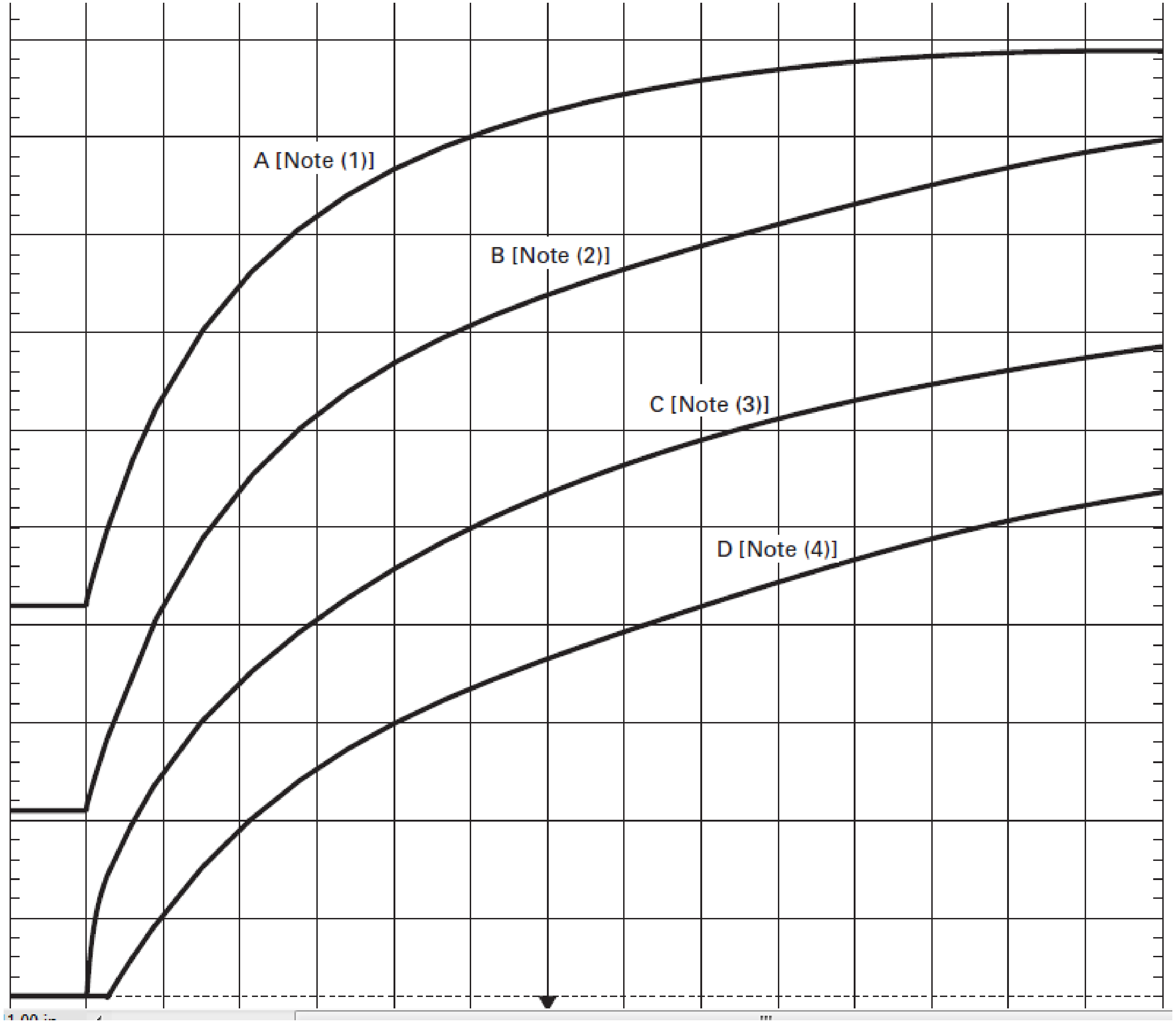
Impact Test (Charpy) Data for Some of the Alloys of Table 6.1.

Brittle Fracture

- Failure of Liberty ships in WW II - Low-carbon steels were ductile at RT tensile tests, they became brittle when exposed to lower-temperature ocean environmets.The ships were built and used in the Pacific Ocean but when they were employed in the Atlantic Ocean, which is colder, the ship's material underwent a ductile to brittle transition.



UCS-66



UCS-66

(1) Curve A applies to:

(a) all carbon and all low alloy steel plates, structural shapes, and bars not listed in Curves B, C, and D below;

(b)SA-216 Grades WCB and WCC if normalized and tempered or water-quenched and tempered; SA-217 Grade WC6 if normalized and tempered or water-quenched and tempered.

(2) Curve B applies to:

(a) see below:

SA-216 Grade WCA if normalized and tempered or water-quenched and tempered

SA-216 Grades WCB and WCC for thicknesses not exceeding 2 in. (50 mm) , if produced to fine grain practice and water-quenched and tempered

SA-217 Grade WC9 if normalized and tempered

SA-285 Grades A and B

SA-414 Grade A

SA-515 Grade 60

SA-516 Grades 65 and 70 if not normalized

SA-612 if not normalized

SA-662 Grade B if not normalized

UCS-66

(2) Curve B applies to:

- SA/EN 10028-2 Grades P235GH, P265GH, P295GH, and P355GH as rolled SA/AS 1548 Grades PT430NR and PT460NR (b) except for cast steels, all materials of Curve A, if produced to fine grain practice and normalized, that are not listed in Curves C and D below;
- (c) all pipe, fittings, forgings and tubing not listed for Curves C and D below;
- (d) parts permitted under UG-11 shall be included in Curve B even when fabricated from plate that otherwise would be assigned to a different curve.

UCS-66

(3) Curve C applies to:

(a) see below:

- SA-182 Grades F21 and F22 if normalized and tempered SA-302 Grades C and D
- SA-336 F21 and F22 if normalized and tempered, or liquid quenched and tempered
- SA-387 Grades 21 and 22 if normalized and tempered, or liquid quenched and tempered
- SA-516 Grades 55 and 60 if not normalized
- SA-533 Types B and C Class 1
- SA-662 Grade A
- SA/EN 10028-2 Grade 10CrMo 9–10 if normalized and tempered

(b) all materials listed in 2(a) and 2(c) for Curve B if produced to fine grain practice and normalized, normalized and tempered, or liquid quenched and tempered as permitted in the material specification, and not listed for Curve D below.

UCS-66

(4) Curve D applies to:

- SA-203
- SA-508 Grade 1
- SA-516 if normalized or quenched and tempered
- SA-524 Classes 1 and 2
- SA-537 Classes 1, 2, and 3
- SA-612 if normalized
- SA-662 if normalized
- SA-738 Grade A
- SA-738 Grade A with Cb and V deliberately added in accordance with the provisions of the material specification, not colder than −20°F (−29°C)
- SA-738 Grade B not colder than −20°F (−29°C)
- SA/AS 1548 Grades PT430N and PT460N
- SA/EN 10028-2 Grades P235GH, P265GH, P295GH, and P355GH if normalized
- SA/EN 10028-3 Grade P275NH

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info@bep-co.com

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+ 98 21 4411 03 09

UG-22 (Loadings)

Loads to be considered for design of PV

1. Pressure including Internal, External, Static head of liquid, Hydrotest, abnormal pressure

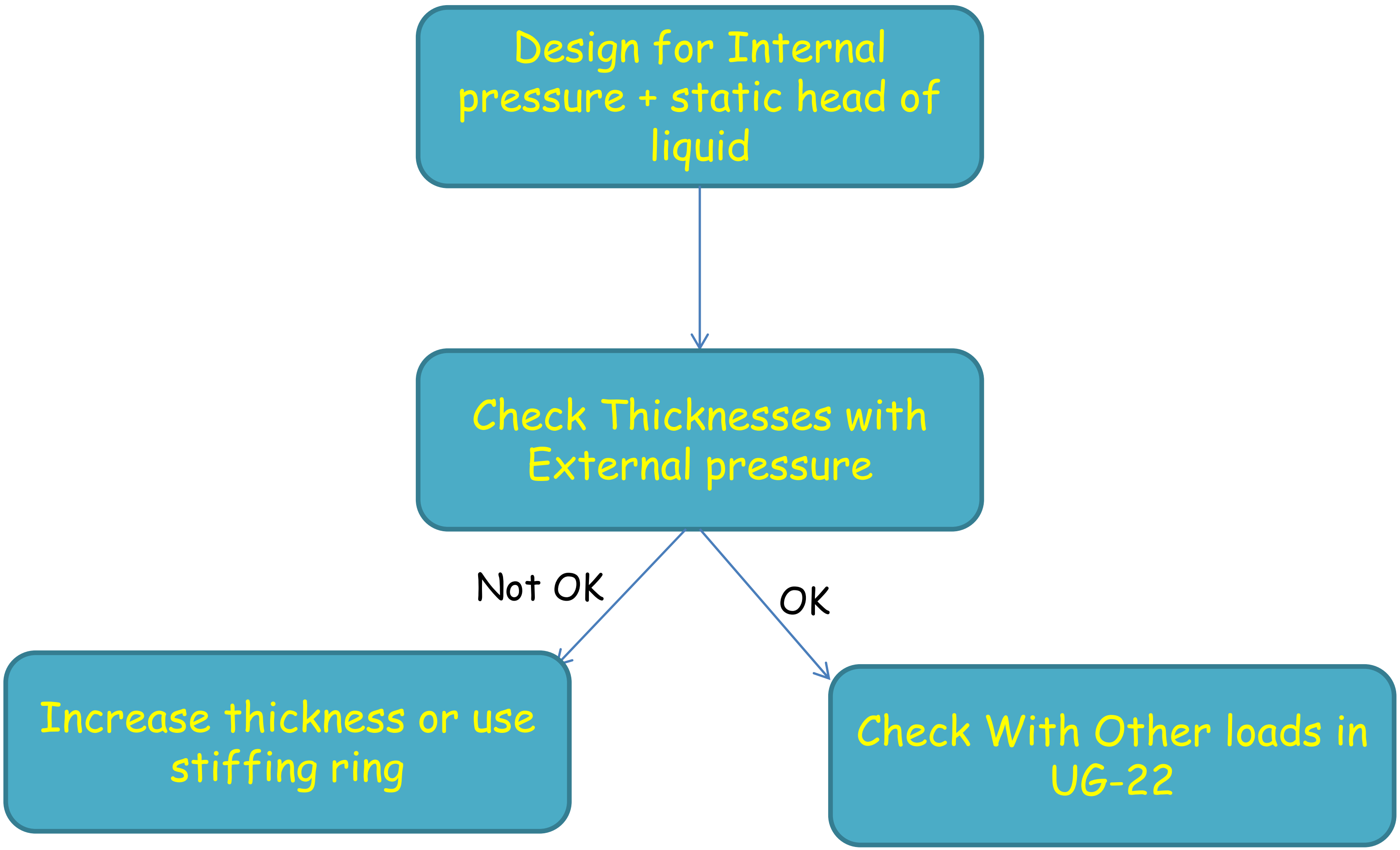
2. Weights including weight of the vessel and normal contents under operating or test conditions, weight of attached equipment, internals, vessel supports

3. temperature gradients and differential thermal expansion;

4. Wind, snow, and seismic reactions

5. Cyclic and dynamic reactions

Sequence of design



UG-23

MAXIMUM ALLOWABLE STRESS VALUES

Max. Allowable Tensile stress (Subpart 1 of Section II, Part D. Section II)

Max. Allowable longitudinal compressive stress

- The maximum allowable stress value is the lowest of the following:

- (1) the specified minimum tensile strength at room temperature divided by 3.5
- (2) the tensile strength at temperature divided by 3.5
- (3) two-thirds of the specified minimum yield strength at room temperature
- (4) two-thirds of the yield strength at temperature

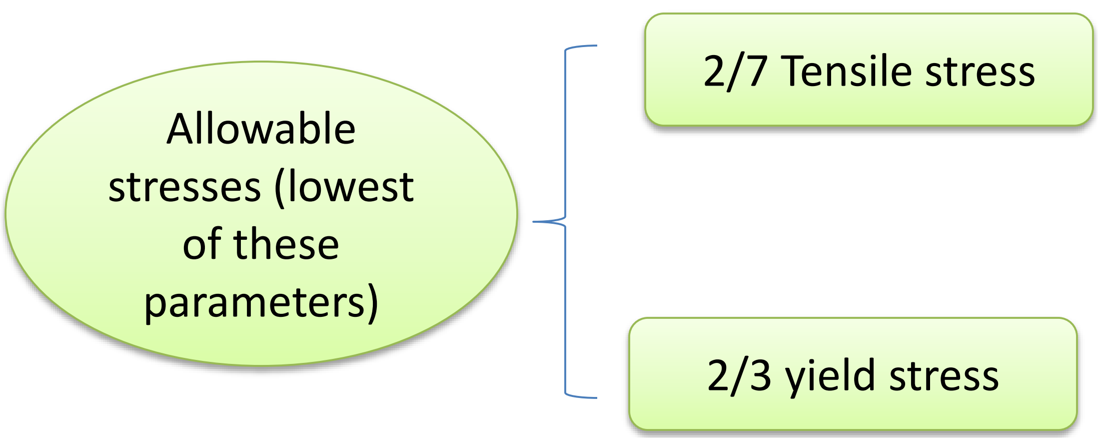


Table 1-100
Criteria for Establishing Allowable Stress Values for Tables 1A and 1B

Product/Material	Room Temperature and Below: Tensile Strength	Room Temperature and Below: Yield Strength	Above Room Temperature: Tensile Strength		Above Room Temperature: Yield Strength		Above Room Temperature: Stress Rupture		Above Room Temperature: Creep Rate
Wrought or cast ferrous and nonferrous	$\frac{S_T}{3.5}$	$\frac{2}{3} S_Y$	$\frac{S_T}{3.5}$	$\frac{1.1}{3.5} S_T R_T$	$\frac{2}{3} S_Y$	$\frac{2}{3} S_Y R_Y$ or $0.9\, S_Y R_Y$ [Note (1)]	$F_{avg} S_{R\ avg}$	$0.8\, S_{R\ min}$	$1.0\, S_c$
Welded pipe or tube, ferrous and nonferrous	$\frac{0.85}{3.5} S_T$	$\frac{2}{3} \times 0.85\, S_Y$	$\frac{0.85}{3.5} S_T$	$\frac{(1.1 \times 0.85)}{3.5} S_T R_T$	$\frac{2}{3} \times 0.85\, S_Y$	$\frac{2}{3} \times 0.85\, S_Y R_Y$ or $0.9 \times 0.85\, S_Y R_Y$ [Note (1)]	$(F_{avg} \times 0.85) S_{R\ avg}$	$(0.8 \times 0.85)\, S_{R\ min}$	$0.85\, S_c$

NOTE:
(1) Two sets of allowable stress values may be provided for austenitic stainless steels in Table 1A, and nickel alloys and cobalt alloys in Table 1B, having an S_Y/S_T ratio less than 0.625. The lower values are not specifically identified by a footnote. These lower values do not exceed two-thirds of the yield strength at temperature. The higher alternative allowable stresses are identified by a footnote. These higher stresses may exceed two-thirds but do not exceed 90% of the yield strength at temperature. The higher values should be used only where slightly higher deformation is not in itself objectionable. These higher stresses are not recommended for the design of flanges or for other strain-sensitive applications.

Section II, Part D-MANDATORY APPENDIX 1

- The higher alternative allowable stresses are identified by a footnote to the tables. These stresses exceed two-thirds but do not exceed 90% of the minimum yield strength at temperature. The higher stress values should be used only where slightly higher deformation is not in itself objectionable. These higher stresses are not recommended for the design of flanges or other strain-sensitive applications.

Endnotes UG-23(d)

- UG-23(d) permits an increase in allowable stress when earthquake or wind loading is considered in combination with other loads and pressure defined in UG-22. The 1.2 increase permitted is equivalent to a load reduction factor of 0.833. Some standards which define applicable load combinations do not permit an increase in allowable stress, however a load reduction factor (typically 0.75) is applied to multiple transient loads (e.g., wind plus live load, seismic plus live load, etc.).

UG-25 CORROSION

- (a) The user or his designated agent (see U-2) shall specify corrosion allowances other than those required by the rules of this Division.
- (b)corrosion, erosion, or mechanical abrasion
- (c) Material added for these purposes need not be of the same thickness for all parts of the vessel if different rates of attack are expected for the various parts.
- (d) No additional thickness need be provided when previous experience in like service has shown that corrosion does not occur or is of only a superficial nature.
- (e) Telltale Holes : shall have a diameter 1.5 mm to 5 mm and have a depth not less than 80% of the thickness required for a seamless shell of like dimensions.

UG-26 LININGS

- (a) The user Corrosion resistant or abrasion resistant linings, whether or not attached to the wall of a vessel, shall not be considered as contributing to the strength of the wall except as permitted in Part UCL

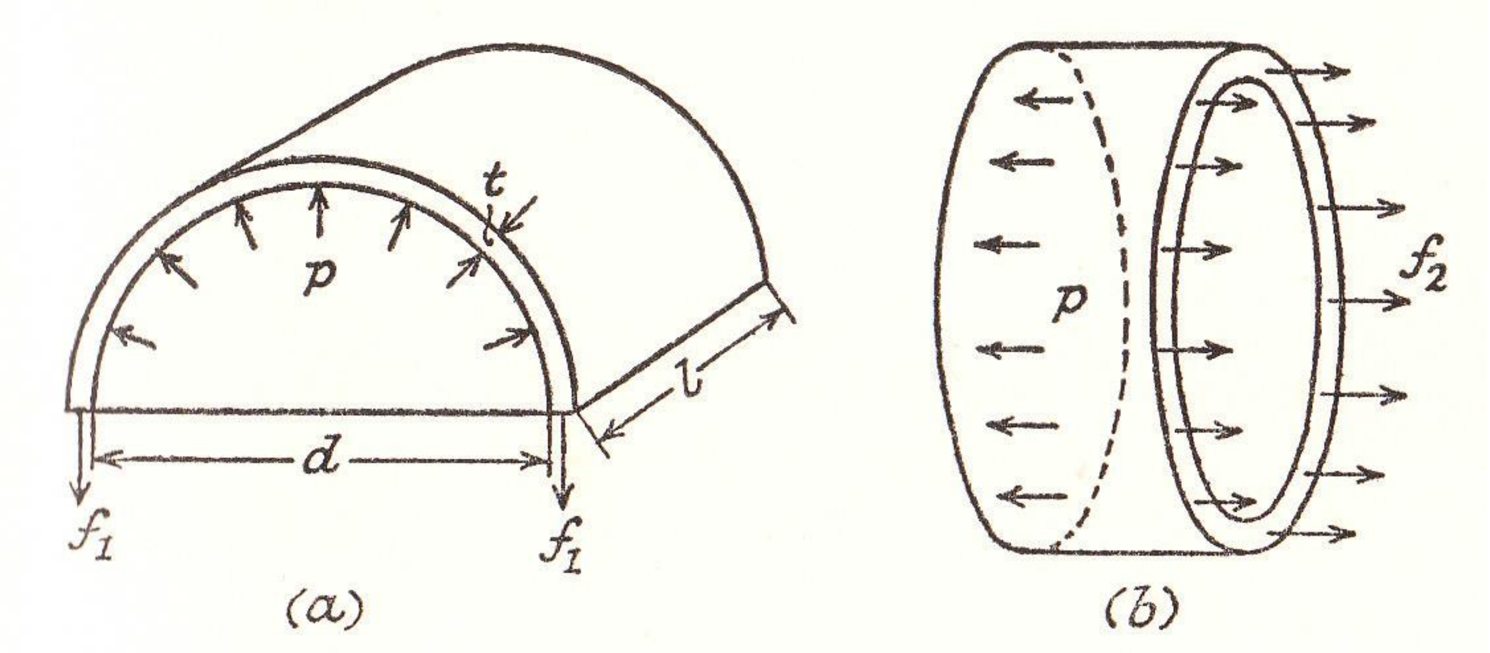
Lining

cladding

Refractory

Coating

- Hoop (circumferential) stress :
- This is the stress trying to split the vessel open along its length. Confusingly, this acts on the longitudinal weld seam (if there is one).



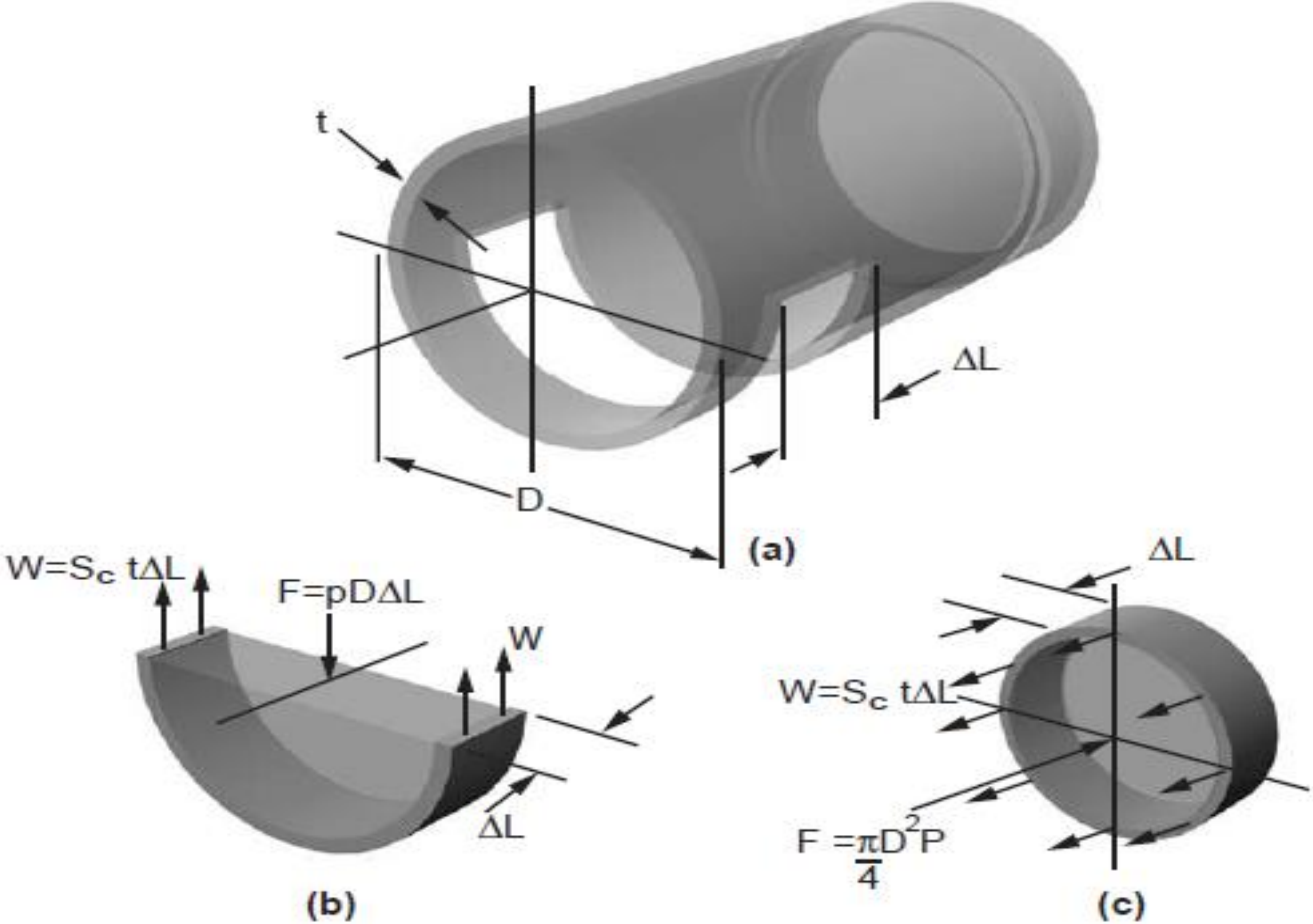


Figure 7.1 Forces and stresses in a pressurized cylinder.

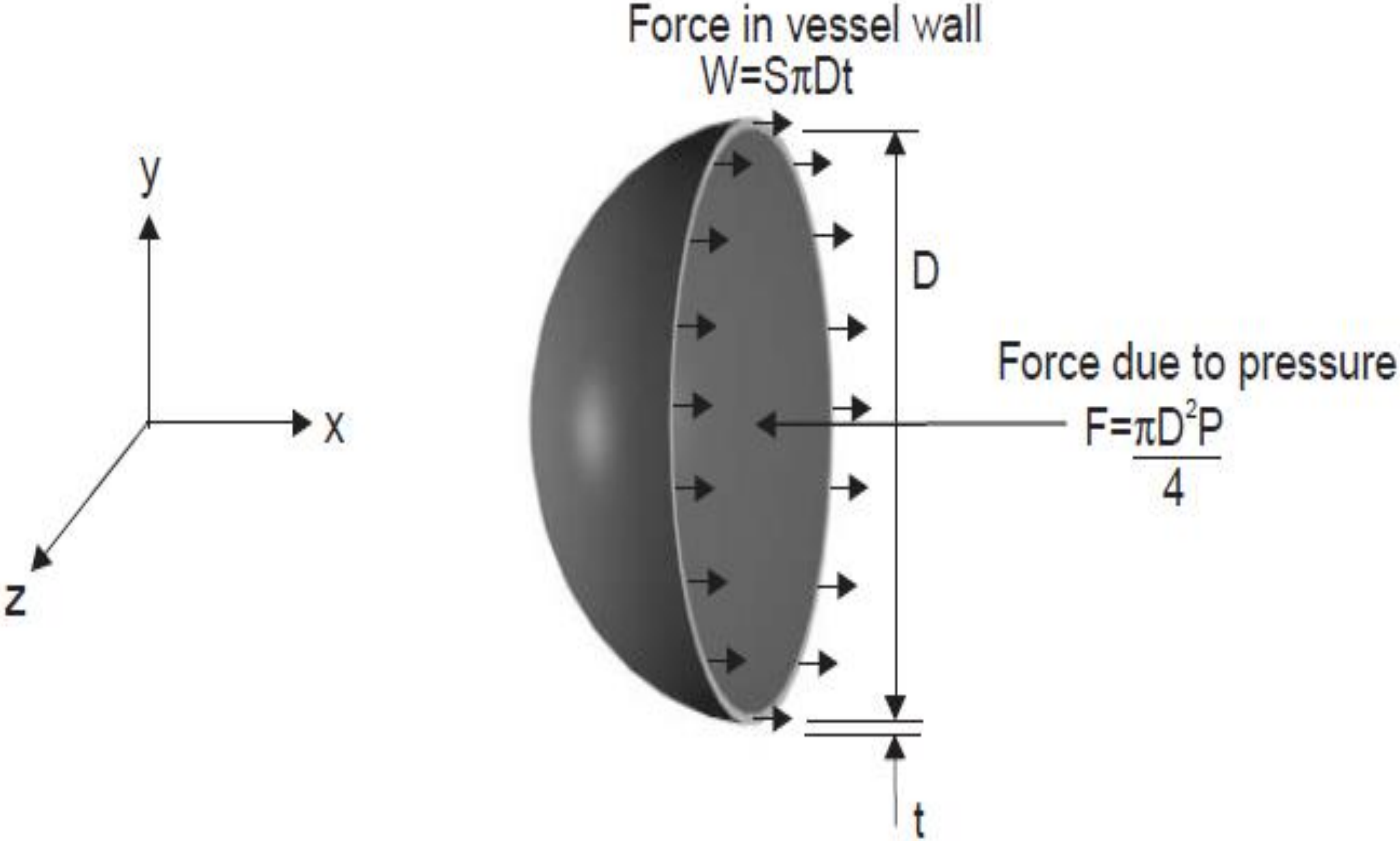


Figure 7.2 Forces and stresses in a sphere under pressure.

UG-27

- circumferential stress :

$$S_C = \frac{RP}{t}$$

where: R = inside radius of the cylinder
t = thickness of cylinder
P = internal pressure

- Longitudinal stress :

$$S_L = \frac{RP}{2t}$$

where: R = inside radius of the cylinder
t = thickness of cylinder
P = internal pressure

UG-27 (Question)

- According to our knowledge about circumferential and longitudinal stresses, Failure could be happen in a pressure vessel in which direction?

UG-27

- Circumferential Stress (Longitudinal Joints): When the thickness does not exceed one-half of the inside radius, or P does not exceed 0.385SE, the following formulas shall apply:

$$t = \frac{PR}{SE - 0.6P} \quad \text{or} \quad P = \frac{SEt}{R + 0.6t} \qquad (1)$$

- Longitudinal Stress (Circumferential Joints). When the thickness does not exceed one-half of the inside radius, or P does not exceed 1.25SE, the following formulas shall apply:

$$t = \frac{PR}{2SE + 0.4P} \quad \text{or} \quad P = \frac{2SEt}{R - 0.4t} \qquad (2)$$

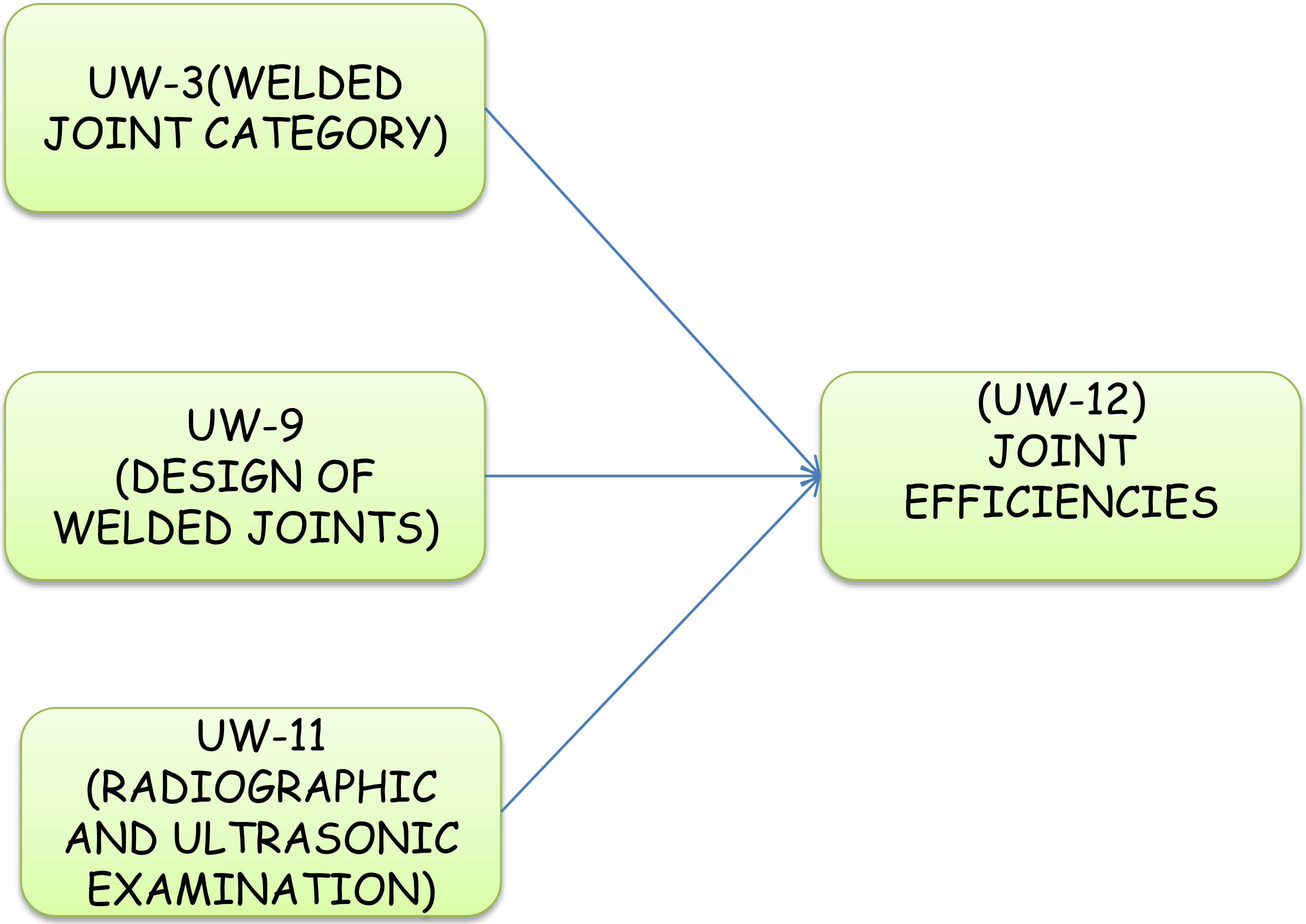
- Spherical Shells. When the thickness of the shell of a wholly spherical vessel does not exceed 0.356R, or P does not exceed 0.665SE, the following formulas shall apply:

$$t = \frac{PR}{2SE - 0.2P} \quad \text{or} \quad P = \frac{2SEt}{R + 0.2t} \qquad (3)$$

Table UW-12
Maximum Allowable Joint Efficiencies for Arc and Gas Welded Joints

				Degree of Radiographic Examination		
Type No.	Joint Description	Limitations	Joint Category	(a) Full [Note (1)]	(b) Spot [Note (2)]	(c) None
(1)	Butt joints as attained by double-welding or by other means that will obtain the same quality of deposited weld metal on the inside and outside weld surfaces to agree with the requirements of UW-35. Welds using metal backing strips that remain in place are excluded.	None	A, B, C, and D	1.00	0.85	0.70
(2)	Single-welded butt joint with backing strip other than those included under (1)	*(a)* None except as in (b) below	A, B, C, and D	0.90	0.80	0.65
		(b) Circumferential butt joints with one plate offset; see UW-13(b)(4) and Figure UW-13.1, sketch (i)	A, B, and C	0.90	0.80	0.65
(3)	Single-welded butt joint without use of backing strip	Circumferential butt joints only, not over $\frac{5}{8}$ in. (16 mm) thick and not over 24 in. (600 mm) outside diameter	A, B, and C	NA	NA	0.60
(4)	Double full fillet lap joint	*(a)* Longitudinal joints not over $\frac{3}{8}$ in. (10 mm) thick	A	NA	NA	0.55
		(b) Circumferential joints not over $\frac{5}{8}$ in. (16 mm) thick	B and C [Note (3)]	NA	NA	0.55
(5)	Single full fillet lap joints with plug welds conforming to UW-17	*(a)* Circumferential joints [Note (4)] for attachment of heads not over 24 in. (600 mm) outside diameter to shells not over $\frac{1}{2}$ in. (13 mm) thick	B	NA	NA	0.50
		(b) Circumferential joints for the attachment to shells of jackets not over $\frac{5}{8}$ in. (16 mm) in nominal thickness where the distance from the center of the plug weld to the edge of the plate is not less than $1\frac{1}{2}$ times the diameter of the hole for the plug.	C	NA	NA	0.50
(6)	Single full fillet lap joints without plug welds	*(a)* For the attachment of heads convex to pressure to shells not over $\frac{5}{8}$ in. (16 mm) required thickness, only with use of fillet weld on inside of shell; or	A and B	NA	NA	0.45
		(b) for attachment of heads having pressure on either side, to shells not over 24 in. (600 mm) inside diameter and not over $\frac{1}{4}$ in. (6 mm) required thickness with fillet weld on outside of head flange only	A and B	NA	NA	0.45
(7)	Corner joints, full penetration, partial penetration, and/or fillet welded	As limited by Figure UW-13.2 and Figure UW-16.1	C and D [Note (5)]	NA	NA	NA

- For joint efficiency issue we must review below clauses:



UW-3 WELDED JOINT CATEGORY

- The term "Category" as used herein defines the location of a joint in a vessel, but not the type of joint.

- (a) Category A: Longitudinal and spiral welded joints within the main shell, communicating chambers or any other joints.

- (b) Category B: Circumferential welded joints within the main shell, communicating chambers or any other joints.

- (c) Category C. Welded joints connecting flanges and tubesheets, or flat heads to main shell, to formed heads, to transitions in diameter, to nozzles, or to communicating chambers

- (d) Category D. Welded joints connecting communicating chambers66 or nozzles to main shells, to spheres, to transitions in diameter, to heads, or to flat-sided vessels

Figure UW-3
Illustration of Welded Joint Locations Typical of Categories A, B, C, and D

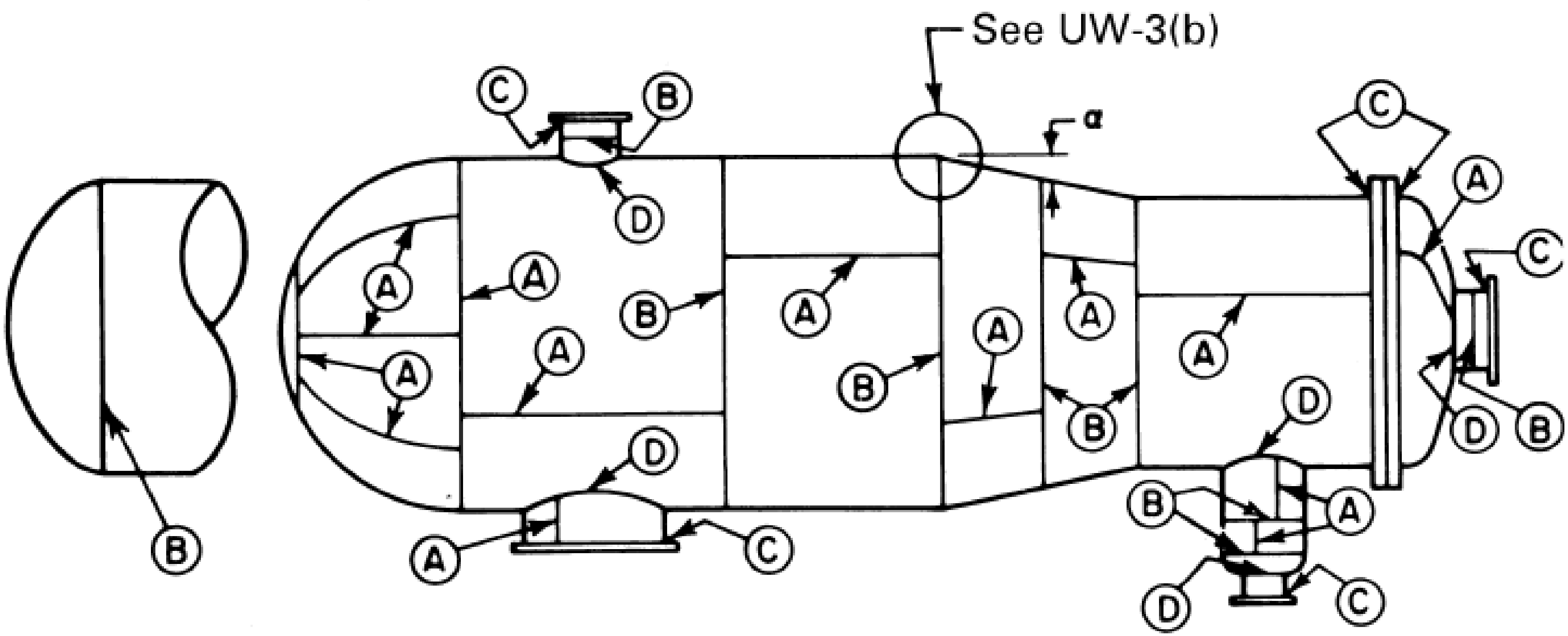


Table UW-12
Maximum Allowable Joint Efficiencies for Arc and Gas Welded Joints

Type No.	Joint Description	Limitations	Joint Category	Degree of Radiographic Examination: (a) Full [Note (1)]	(b) Spot [Note (2)]	(c) None
(1)	Butt joints as attained by double-welding or by other means that will obtain the same quality of deposited weld metal on the inside and outside weld surfaces to agree with the requirements of UW-35. Welds using metal backing strips that remain in place are excluded.	None	A, B, C, and D	1.00	0.85	0.70
(2)	Single-welded butt joint with backing strip other than those included under (1)	*(a)* None except as in (b) below	A, B, C, and D	0.90	0.80	0.65
		(b) Circumferential butt joints with one plate offset; see UW-13(b)(4) and Figure UW-13.1, sketch (i)	A, B, and C	0.90	0.80	0.65
(3)	Single-welded butt joint without use of backing strip	Circumferential butt joints only, not over $\frac{5}{8}$ in. (16 mm) thick and not over 24 in. (600 mm) outside diameter	A, B, and C	NA	NA	0.60
(4)	Double full fillet lap joint	*(a)* Longitudinal joints not over $\frac{3}{8}$ in. (10 mm) thick	A	NA	NA	0.55
		(b) Circumferential joints not over $\frac{5}{8}$ in. (16 mm) thick	B and C [Note (3)]	NA	NA	0.55
(5)	Single full fillet lap joints with plug welds conforming to UW-17	*(a)* Circumferential joints [Note (4)] for attachment of heads not over 24 in. (600 mm) outside diameter to shells not over $\frac{1}{2}$ in. (13 mm) thick	B	NA	NA	0.50
		(b) Circumferential joints for the attachment to shells of jackets not over $\frac{5}{8}$ in. (16 mm) in nominal thickness where the distance from the center of the plug weld to the edge of the plate is not less than $1\frac{1}{2}$ times the diameter of the hole for the plug.	C	NA	NA	0.50
(6)	Single full fillet lap joints without plug welds	*(a)* For the attachment of heads convex to pressure to shells not over $\frac{5}{8}$ in. (16 mm) required thickness, only with use of fillet weld on inside of shell; or	A and B	NA	NA	0.45
		(b) for attachment of heads having pressure on either side, to shells not over 24 in. (600 mm) inside diameter and not over $\frac{1}{4}$ in. (6 mm) required thickness with fillet weld on outside of head flange only	A and B	NA	NA	0.45
(7)	Corner joints, full penetration, partial penetration, and/or fillet welded	As limited by Figure UW-13.2 and Figure UW-16.1	C and D [Note (5)]	NA	NA	NA

Question!

❖ The following information is given in a data sheet. Please compute required and selected thickness for shell.

- Cylindrical shell:

➢ Design pressure : 5 barg
➢ Design Temperature: 150 °C
➢ Material : SA-516 70
➢ C.A.: 3 mm
➢ Vessel I.D : 3000 mm

- Spherical shell:

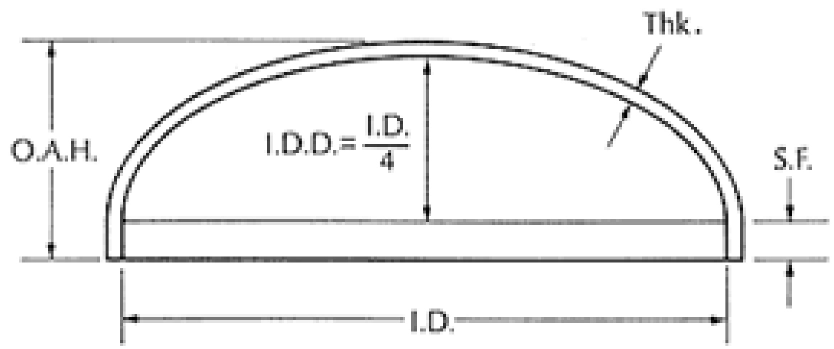
➢ Design pressure : 5 barg
➢ Design Temperature: 150 °C
➢ Material : SA-516 70
➢ C.A.: 3 mm
➢ Vessel I.D : 3000 mm

UG-32 FORMED HEADS, AND SECTIONS, PRESSURE ON CONCAVE SIDE

- (a) The minimum required thickness at the thinnest point after forming of ellipsoidal, torispherical, hemispherical, conical, and toriconical heads under pressure on the concave side (plus heads) shall be computed by the appropriate formulas in this paragraph

UG-32 FORMED HEADS, AND SECTIONS, PRESSURE ON CONCAVE SIDE

- (c) Ellipsoidal Heads



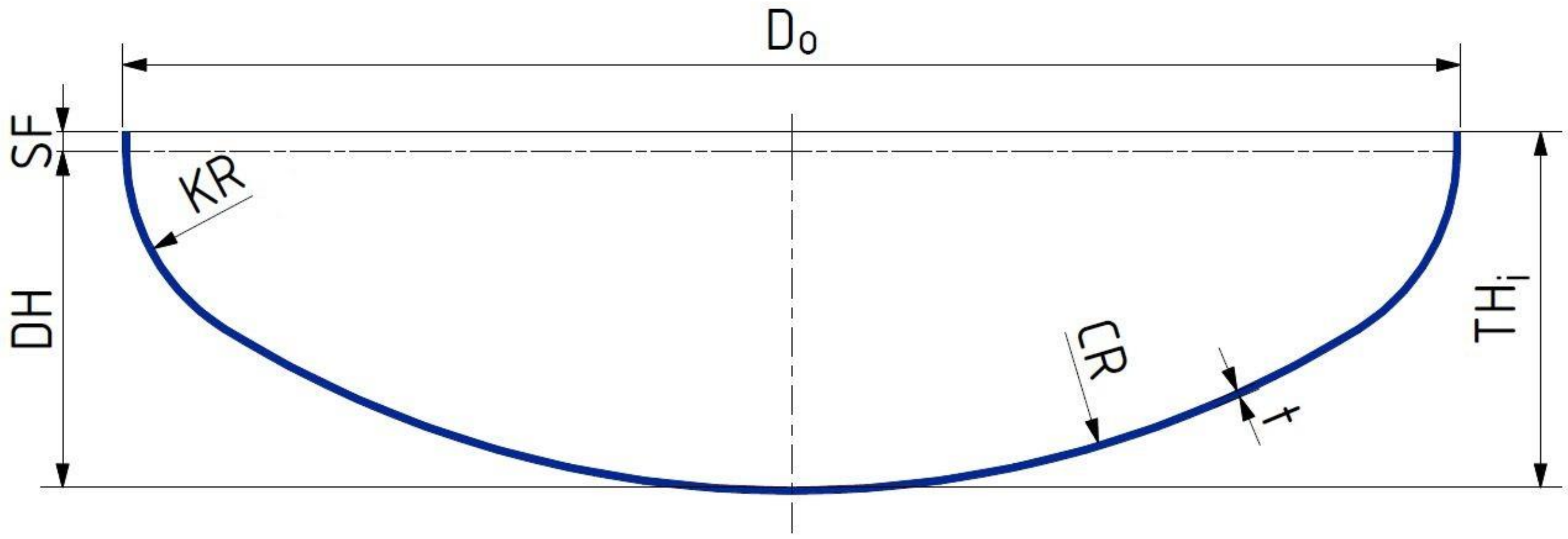
ASME • ELLIPTICAL (2:1 RATIO)

Research

- Do research about skirt of head (straight Flange)

UG-32 FORMED HEADS, AND SECTIONS, PRESSURE ON CONCAVE SIDE

- An acceptable approximation of a 2:1 ellipsoidal head is one with a knuckle radius of 0.17D and a spherical radius of 0.90D.



UG-32 FORMED HEADS, AND SECTIONS, PRESSURE ON CONCAVE SIDE

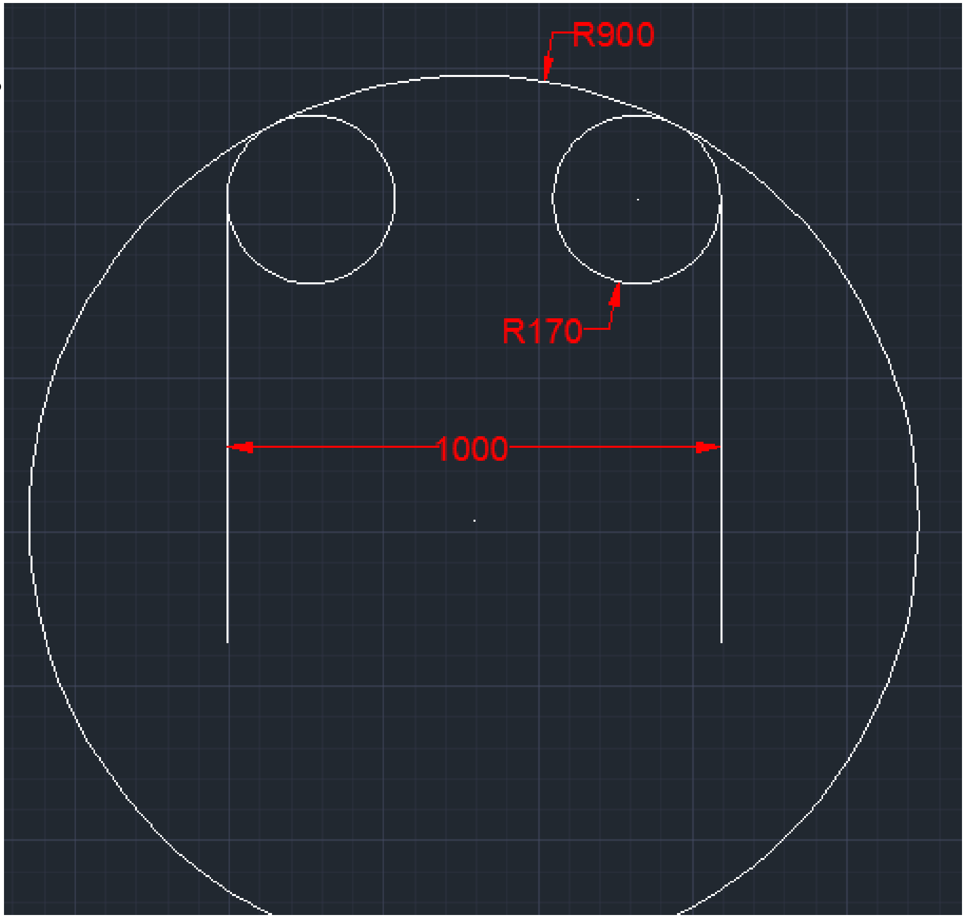
- (c) Ellipsoidal Heads ($t_s/L \geq 0.002$):

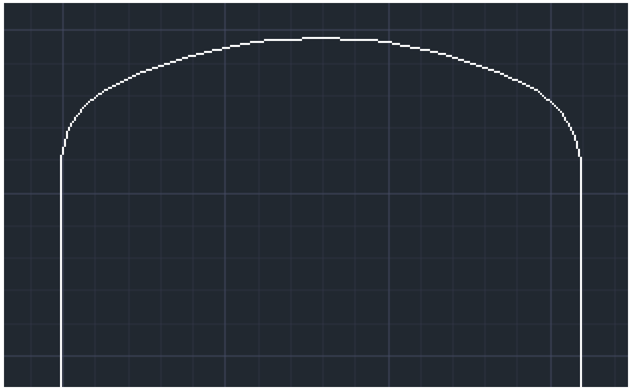
- The required thickness of a dished head of semiellipsoidal form, in which half the minor axis (inside depth of the head minus the skirt) equals one-fourth of the inside diameter of the head skirt, shall be determined by

$$t = \frac{PD}{2SE - 0.2P} \quad \text{or} \quad P = \frac{2SEt}{D + 0.2t}$$

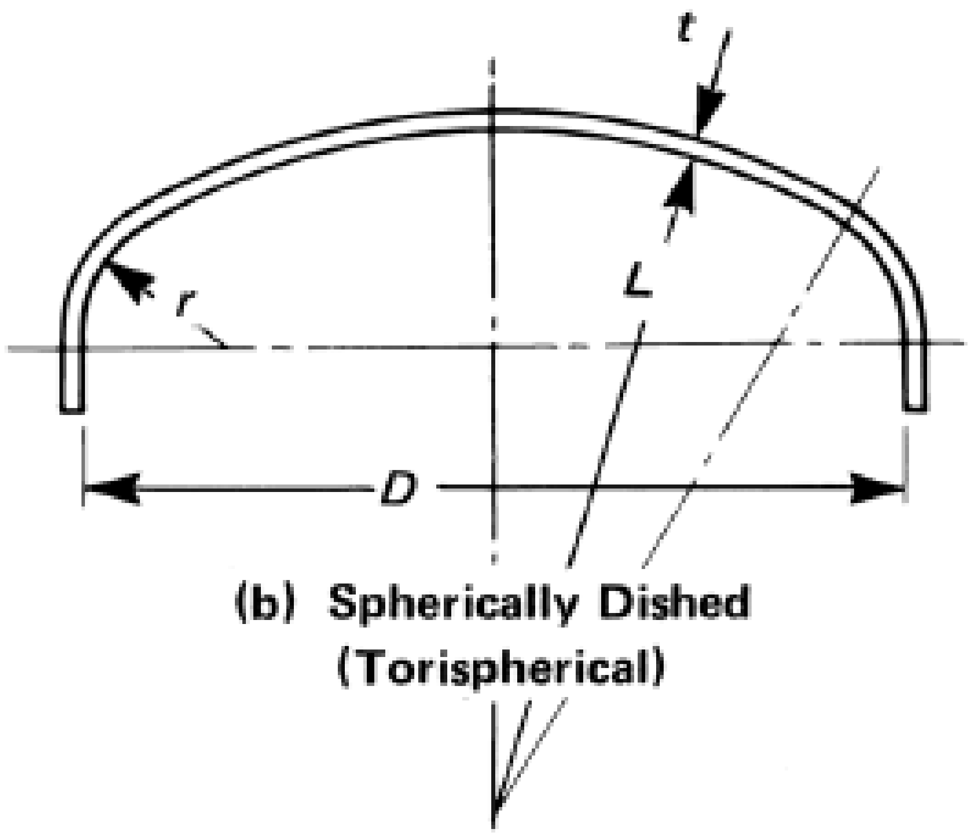
- NOTE: For ellipsoidal heads with $t_s/L < 0.002$, the rules of 1-4(f) shall also be met

- (c) Ellipsoidal Heads:
-





- (d) Torispherical Heads With t s/L ≥ 0.002:



(b) Spherically Dished
(Torispherical)

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UG-32 FORMED HEADS, AND SECTIONS, PRESSURE ON CONCAVE SIDE

- (d) Torispherical Heads With t s/L ≥ 0.002:

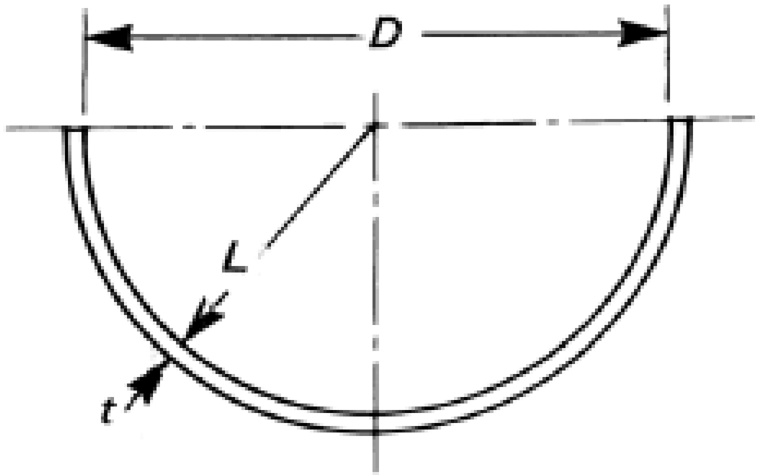
- The required thickness of a The required thickness of a torispherical head for the case in which the knuckle radius is 6% of the inside crown radius and the inside crown radius equals the outside diameter of the skirt [see (i)] shall be determined by

$$t = \frac{0.885PL}{SE - 0.1P} \quad \text{or} \quad P = \frac{SEt}{0.885L + 0.1t}$$

- Torispherical heads made of materials having a specified minimum tensile strength exceeding 70,000 psi (485 MPa) shall be designed using a value of S equal to 20,000 psi (138 MPa) at room temperature and reduced in proportion to the reduction in maximum allowable stress values at temperature for the material

- (e) Hemispherical Heads :
- The When the thickness of a hemispherical head does not exceed 0.356L, or P does not exceed 0.665SE, the following formulas shall apply:

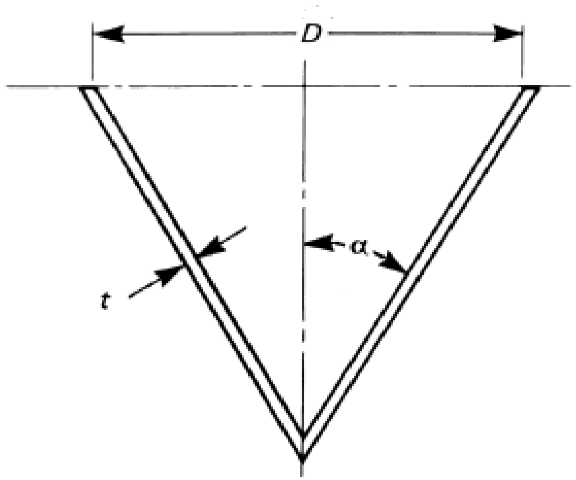
$$t = \frac{PL}{2SE - 0.2P} \quad \text{or} \quad P = \frac{2SEt}{L + 0.2t}$$



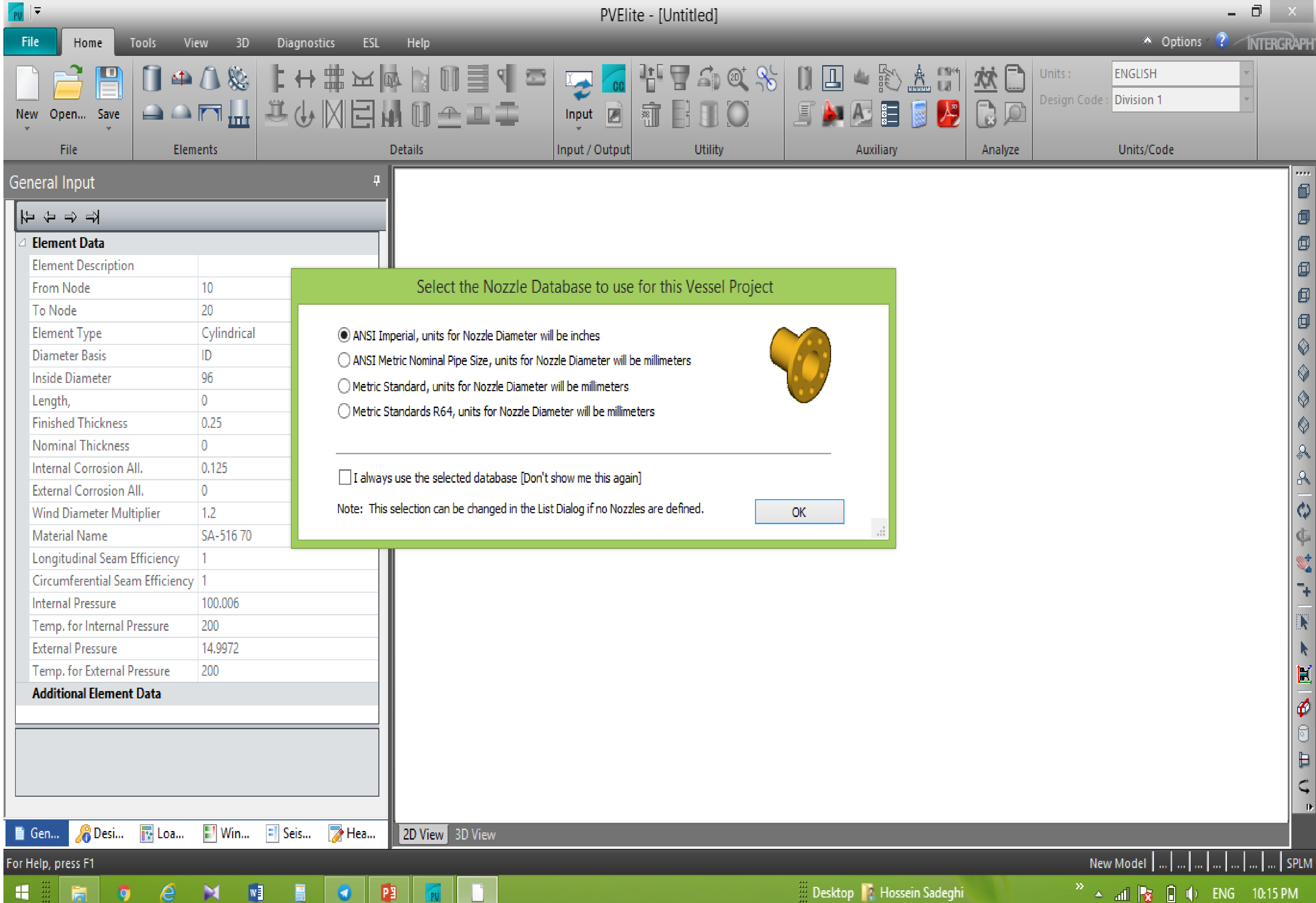
(c) Hemispherical

- (f) Conical Heads and Sections (Without Transition Knuckle).
- The required thickness of conical heads or conical shell sections that have a half apex-angle α not greater than 30 deg shall be determined by

$$t = \frac{PD}{2\cos\alpha\left(SE - 0.6P\right)} \quad \text{or} \quad P = \frac{2SEt\cos\alpha}{D + 1.2t\cos\alpha}$$



(d) Conical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Nominal Thickness 0
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External Corrosion All. 0
Wind Diameter Multiplier 1.2
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Longitudinal Seam Efficiency 1
Circumferential Seam Efficiency 1
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Temp. for Internal Pressure 200
External Pressure 14.9972
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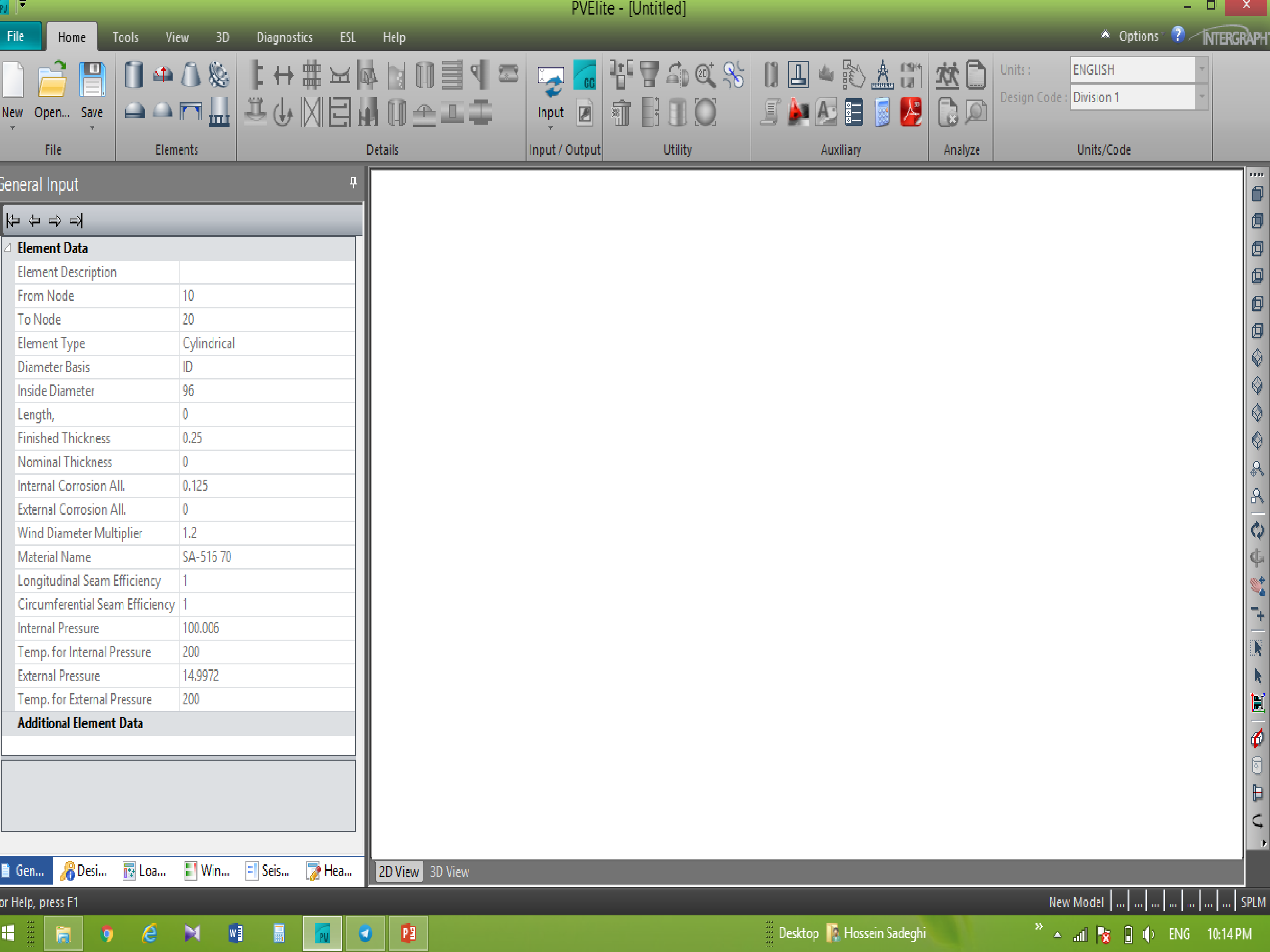
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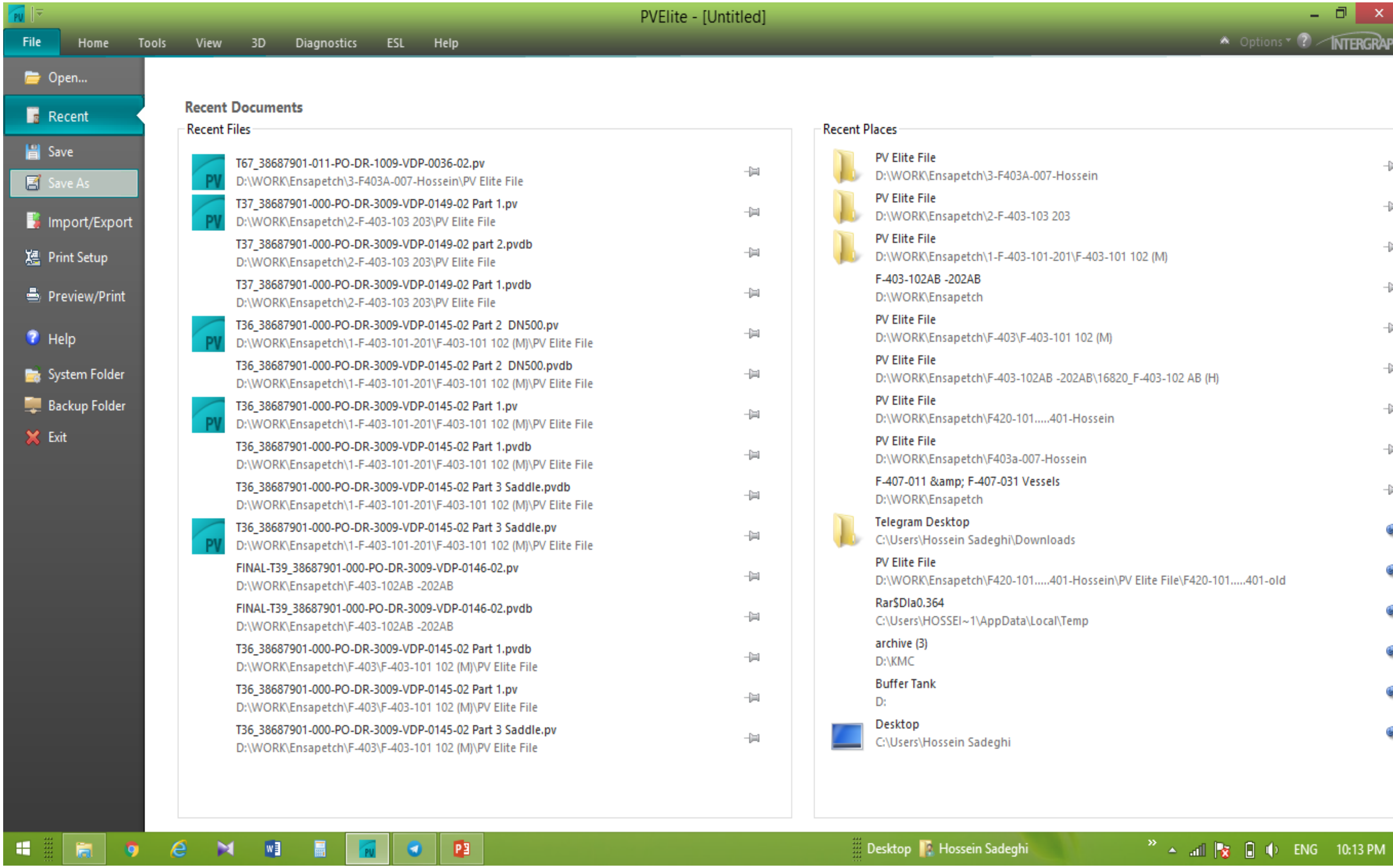

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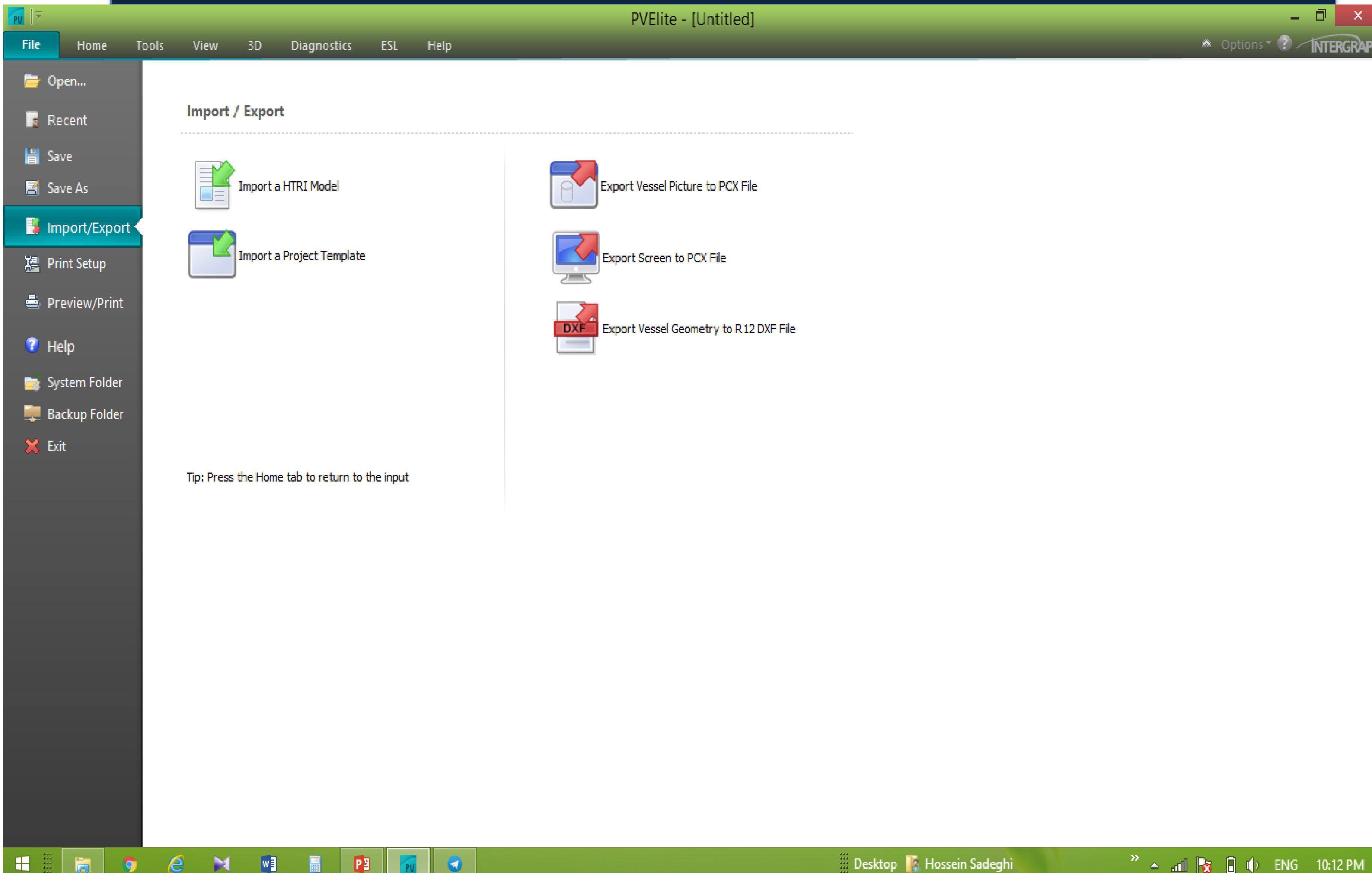


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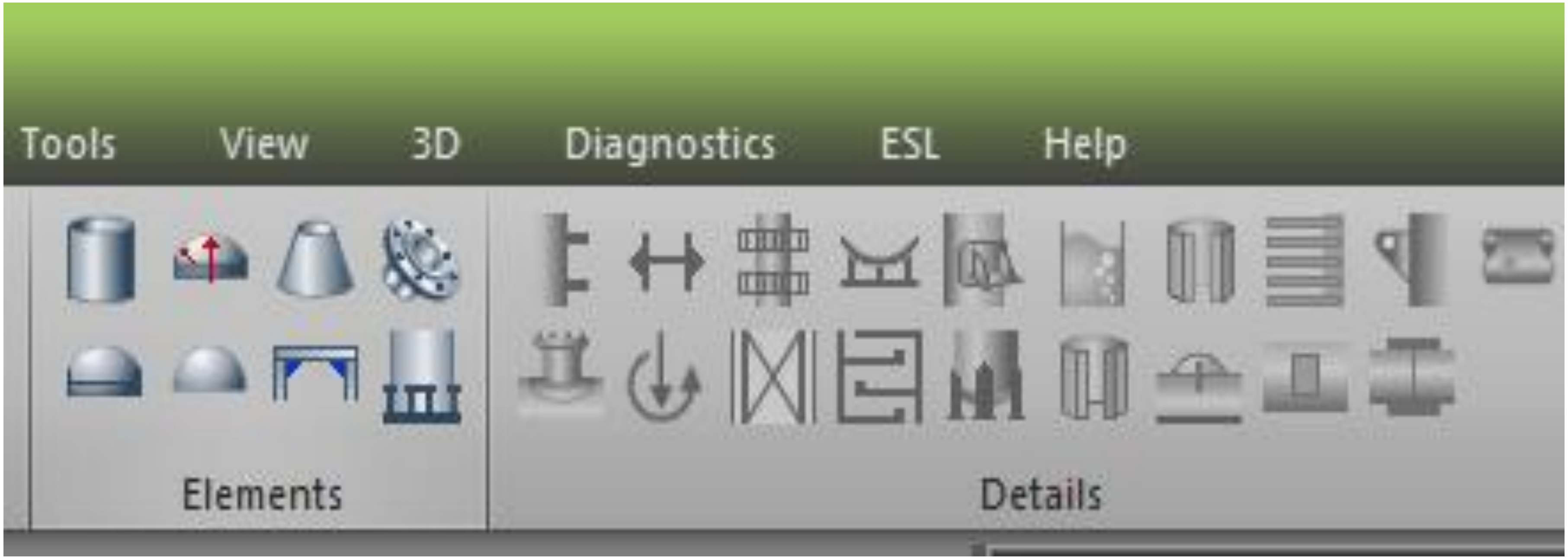

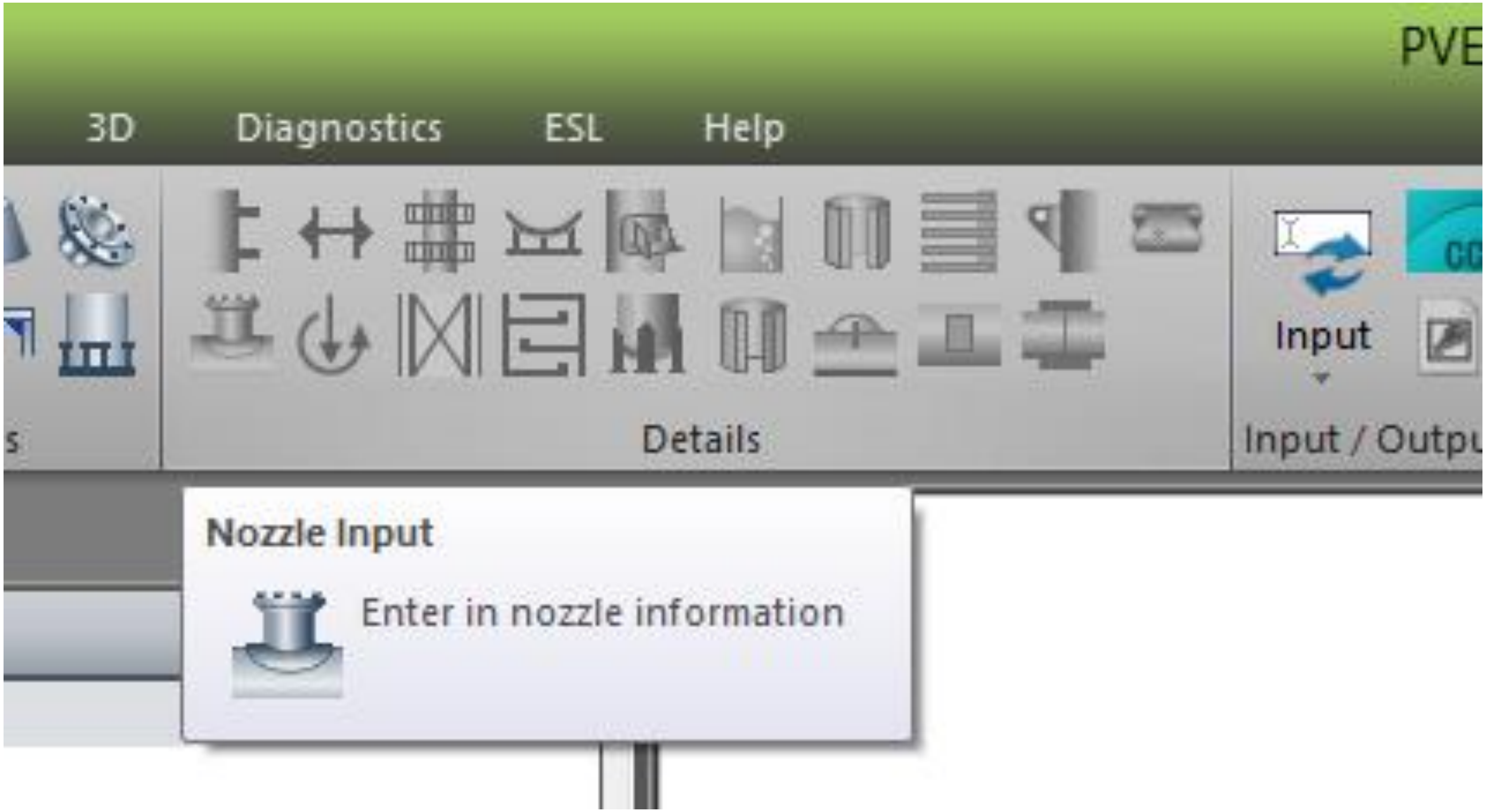
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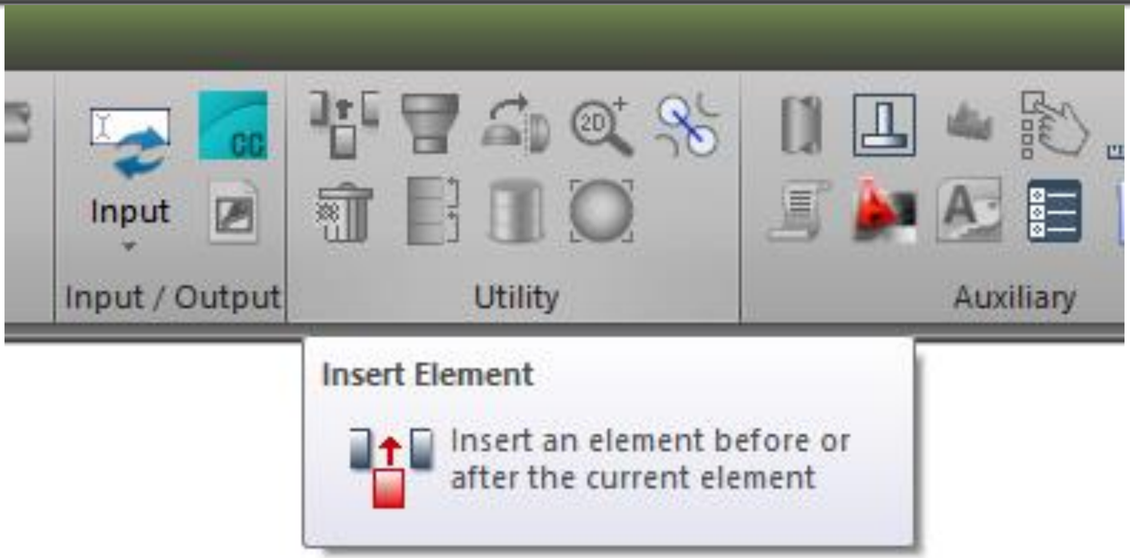
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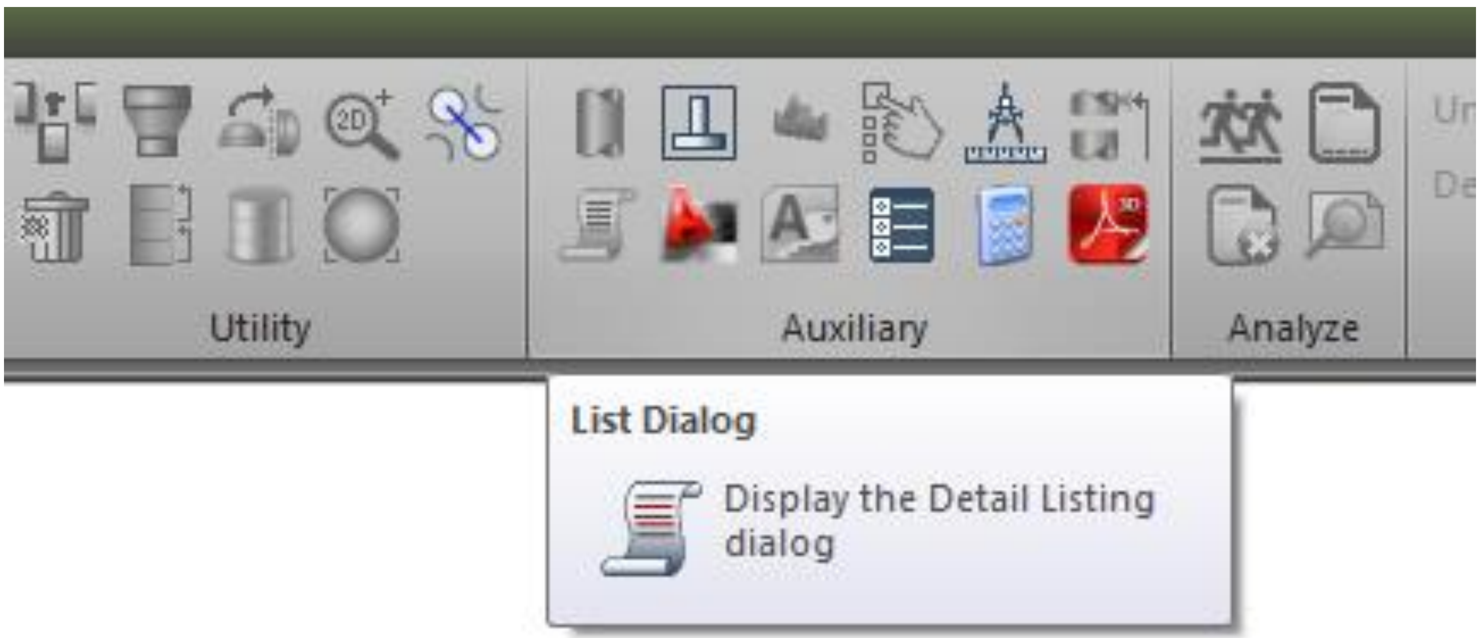

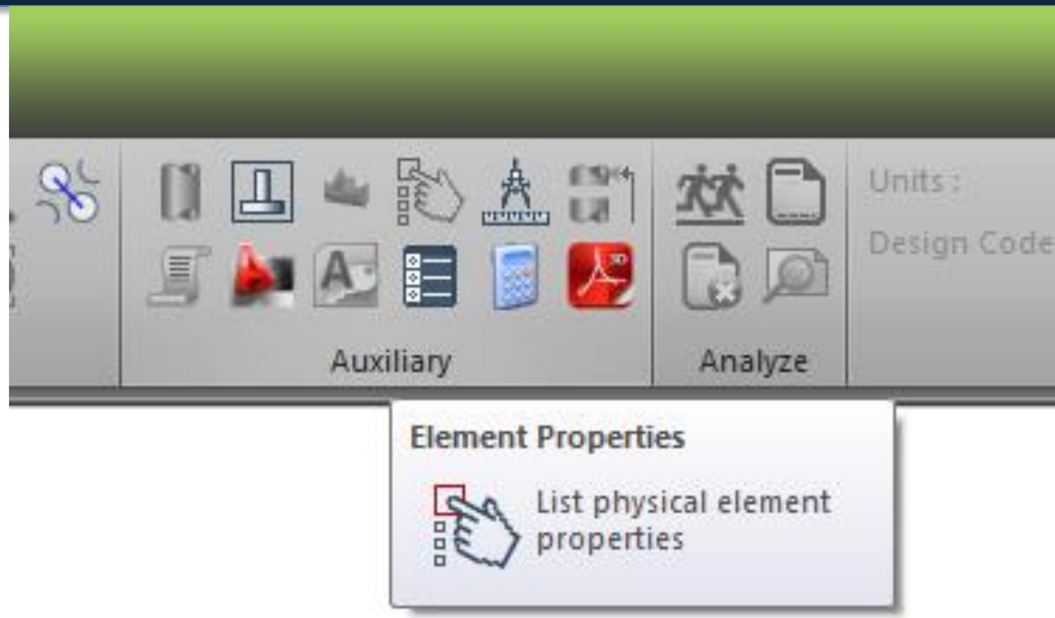
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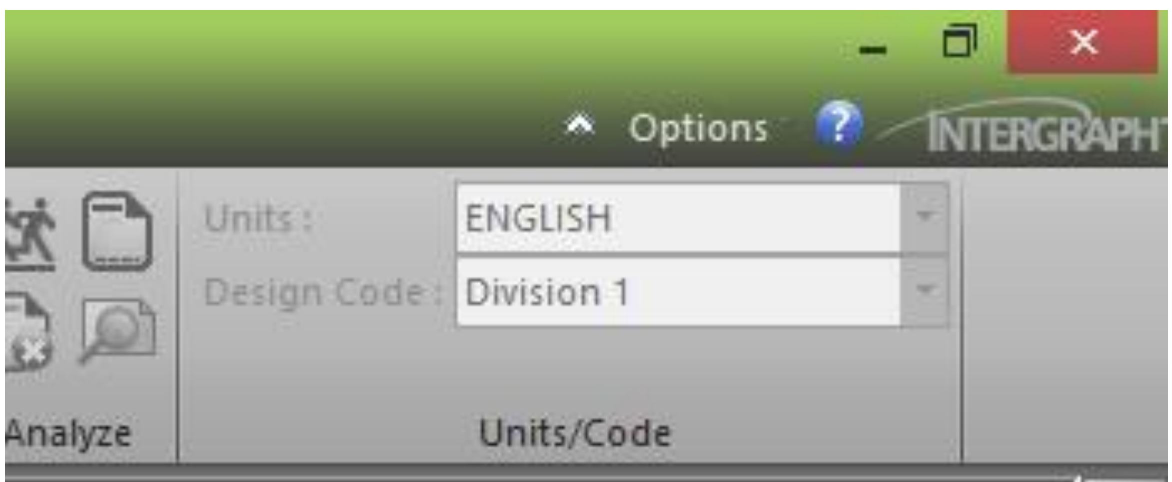
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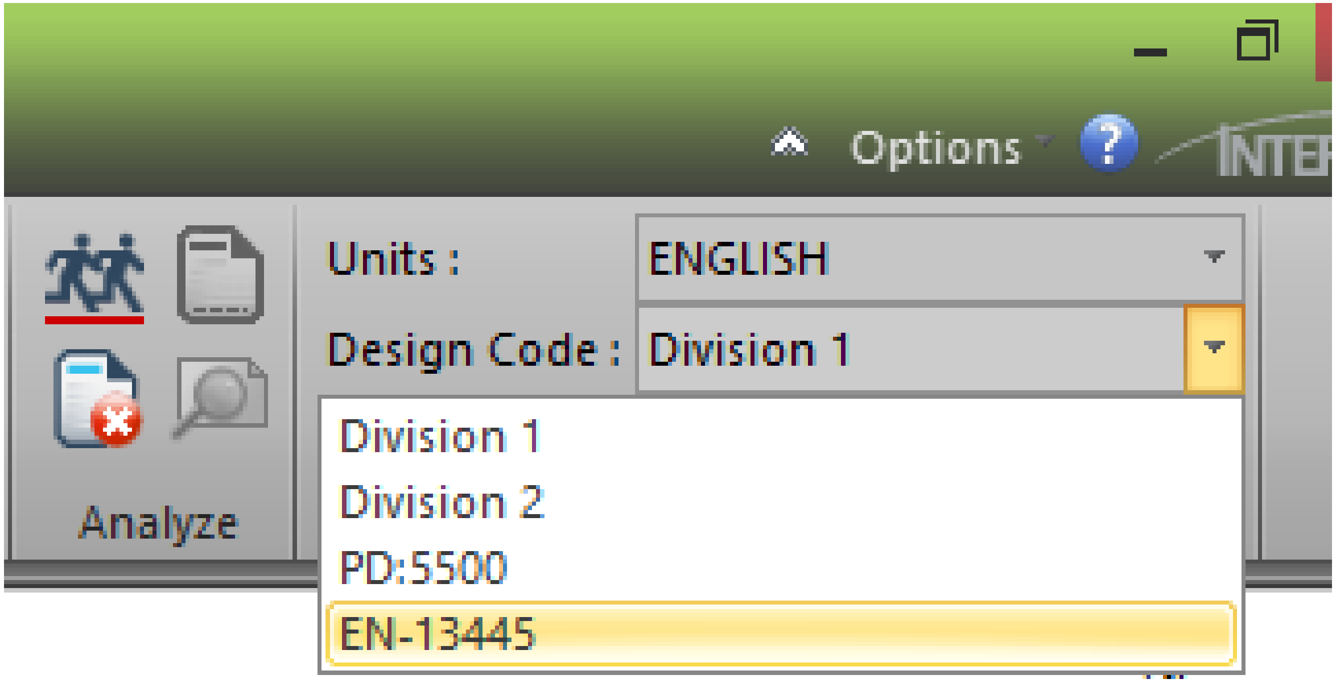
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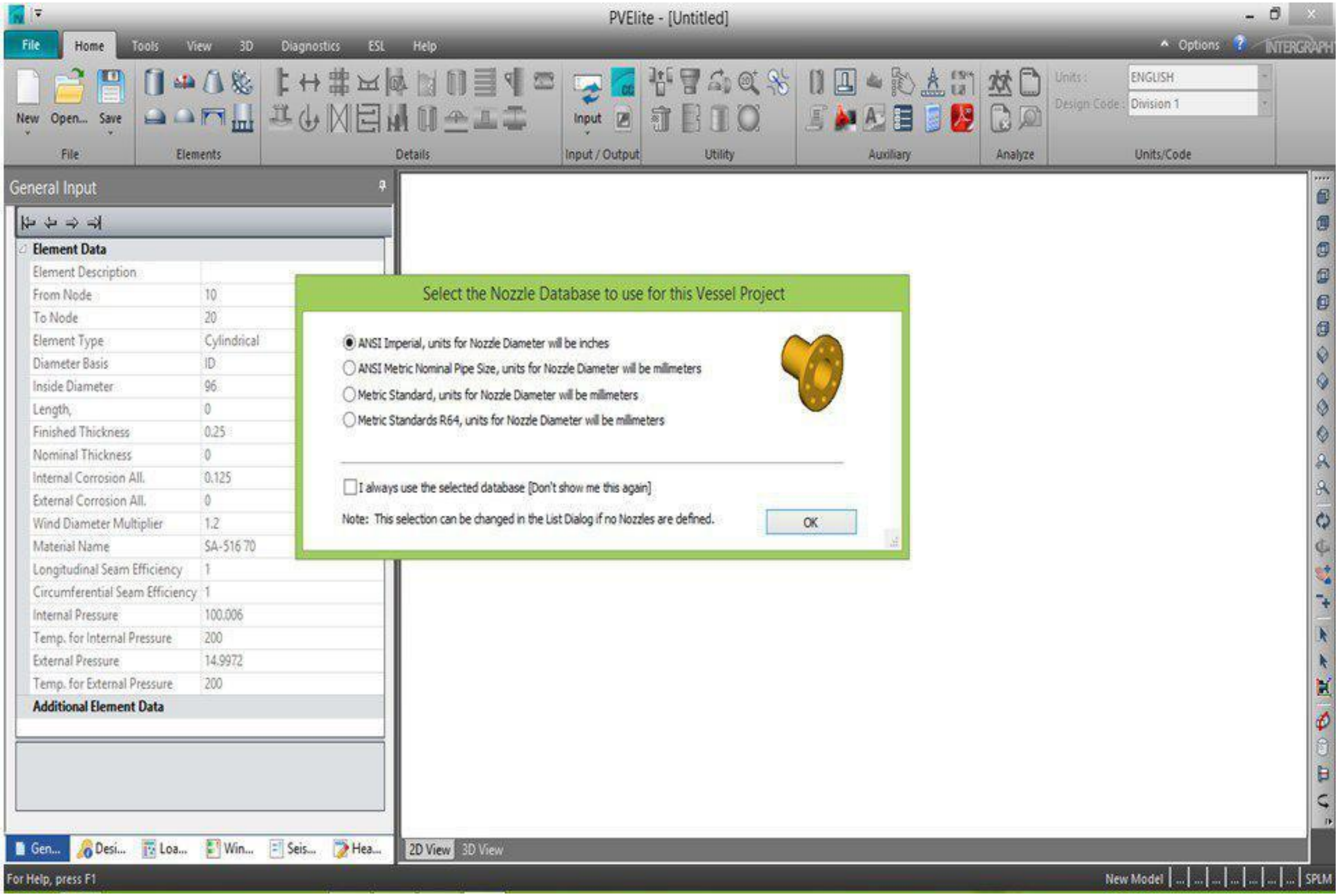

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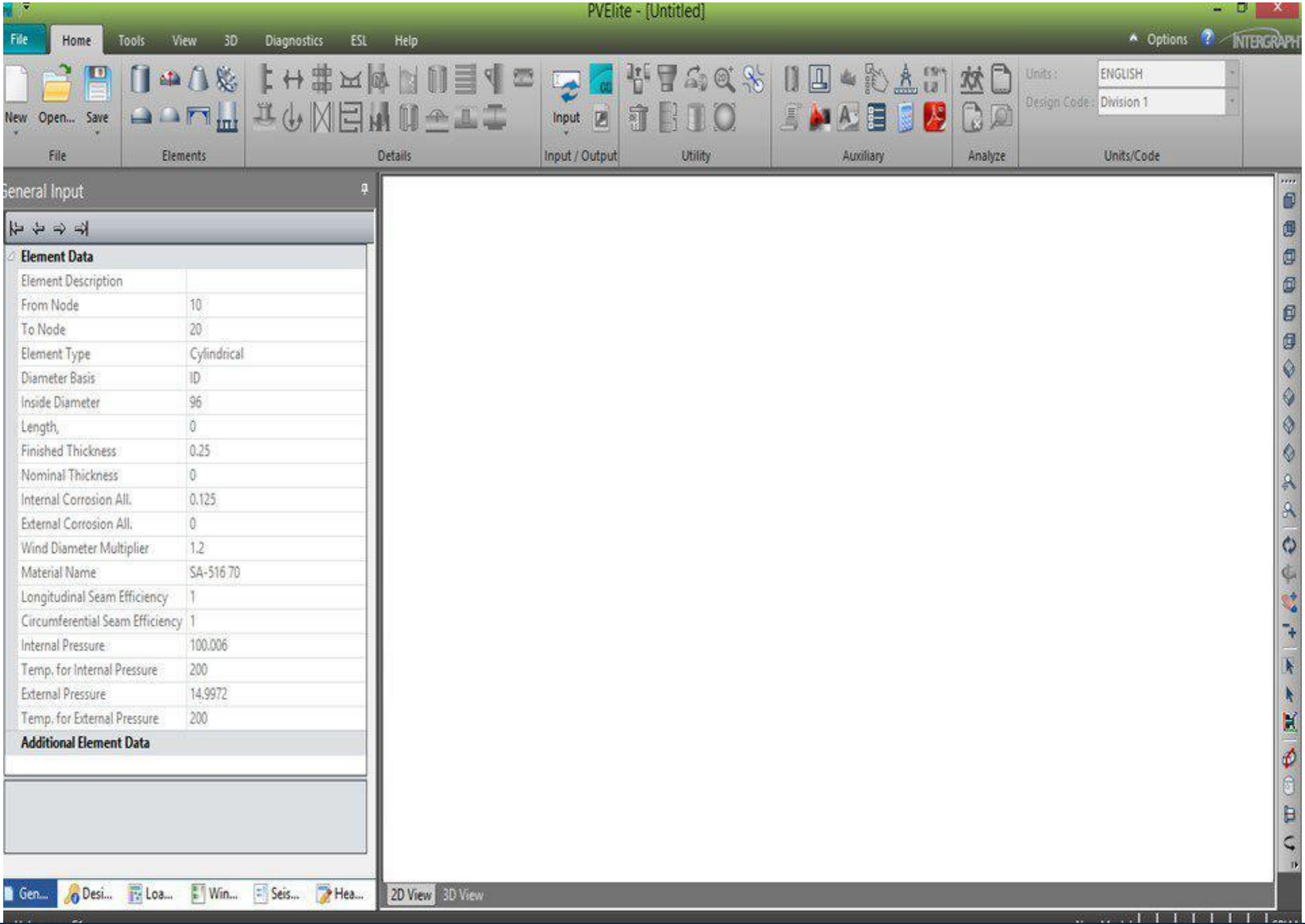

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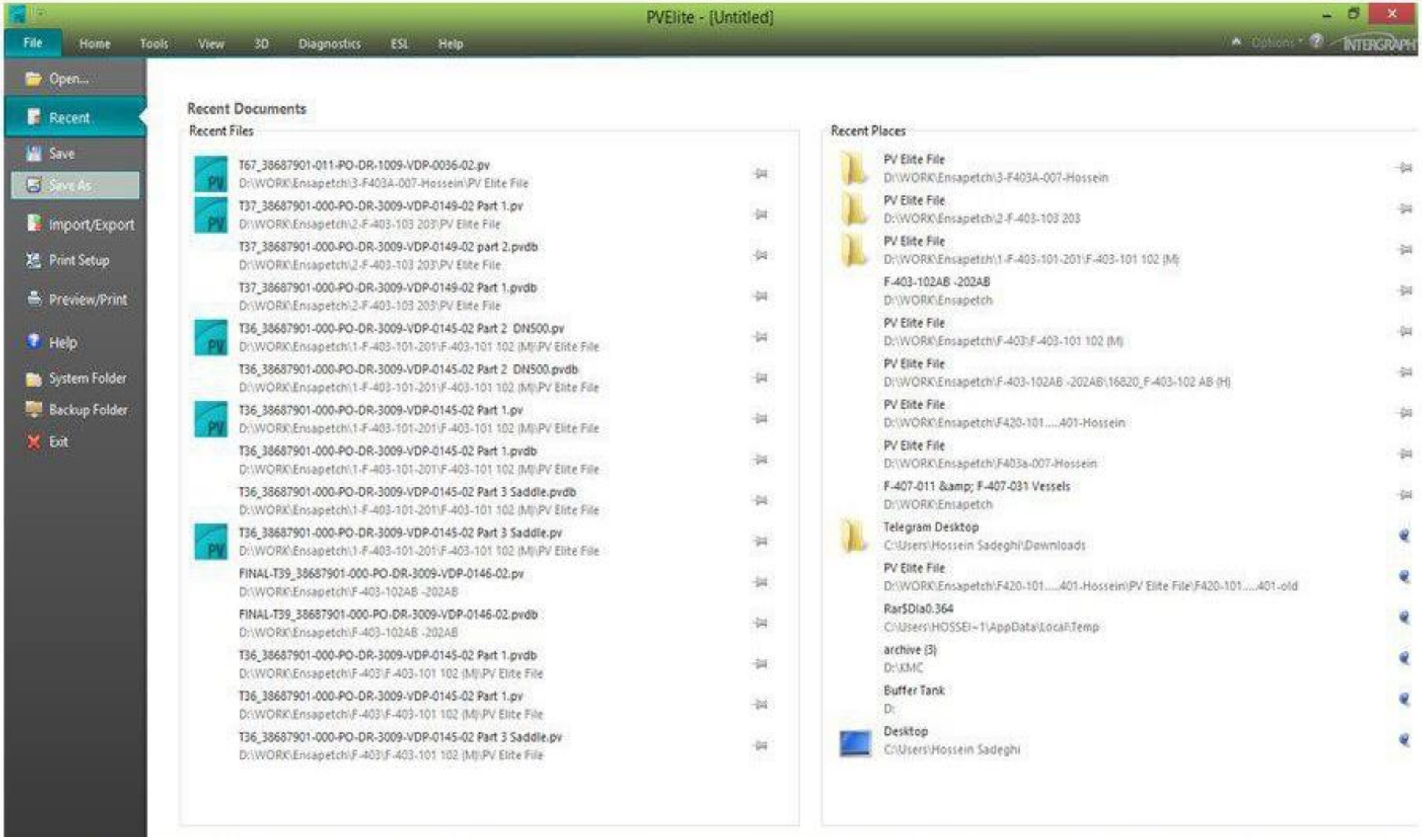

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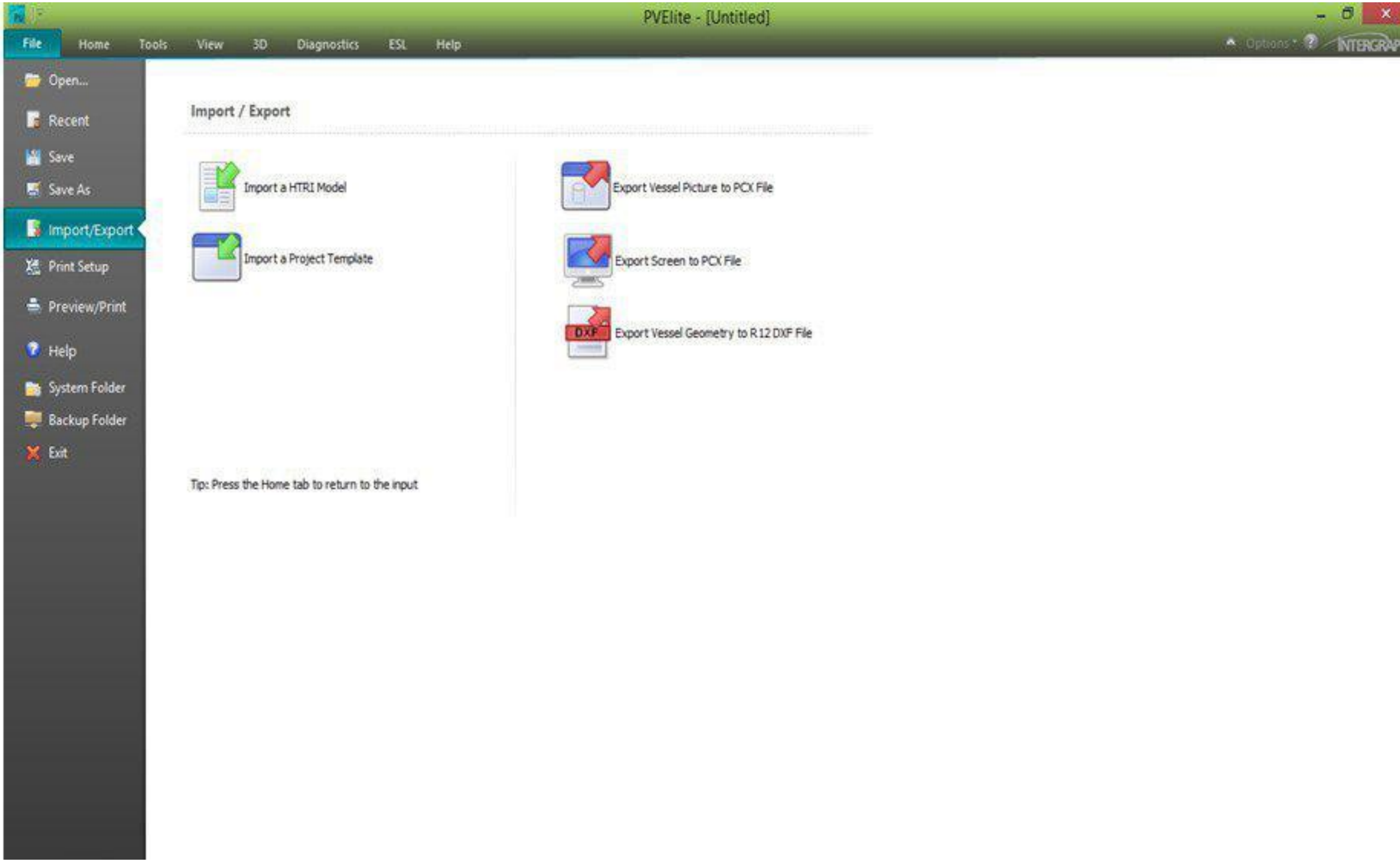

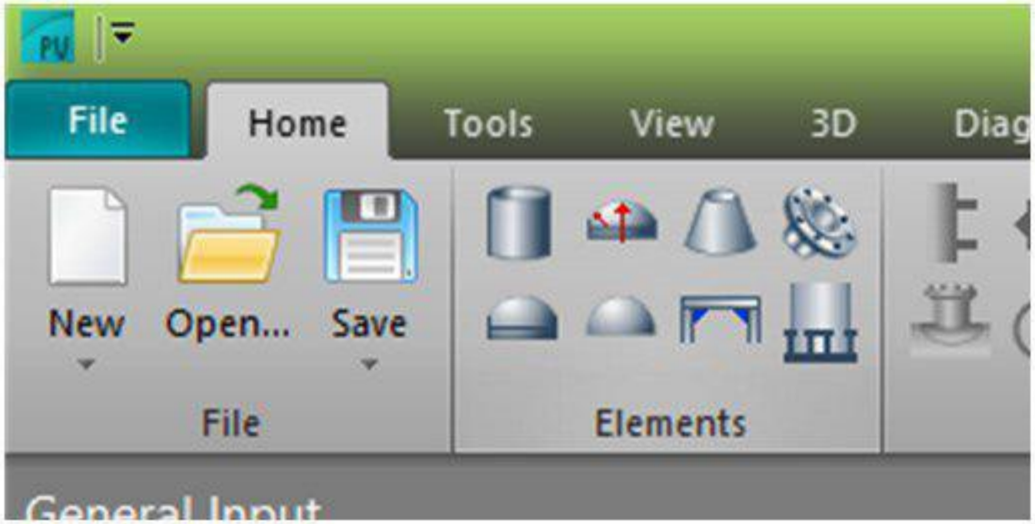
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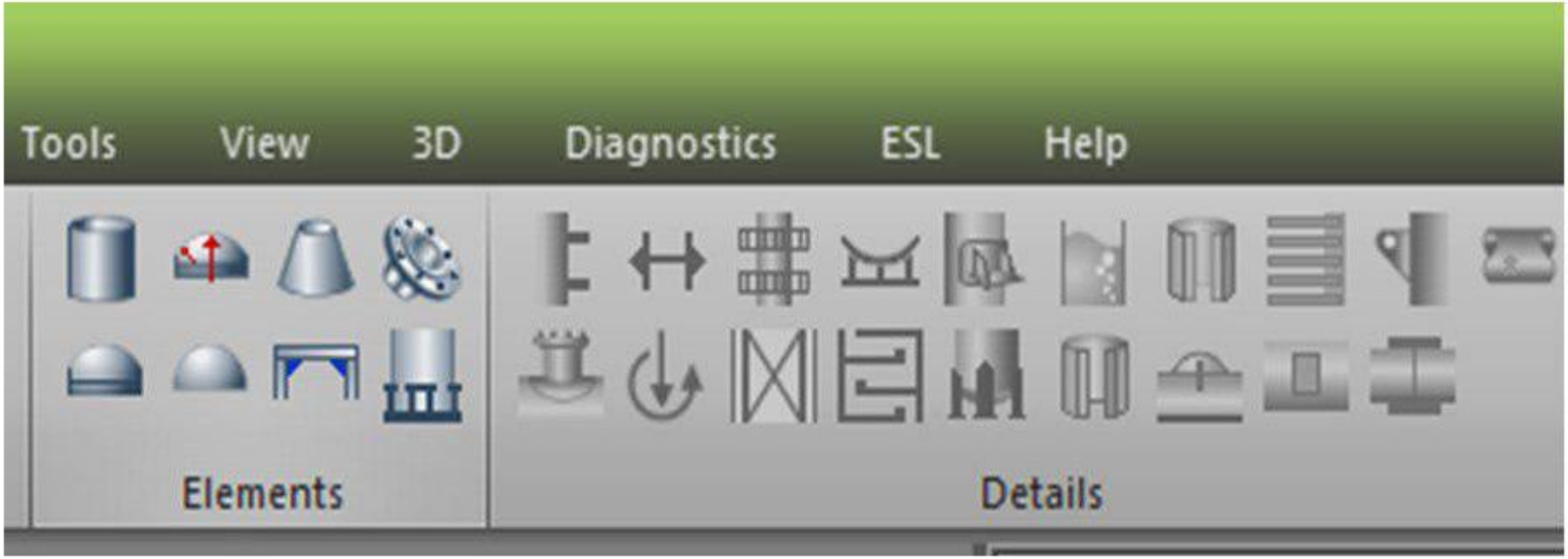

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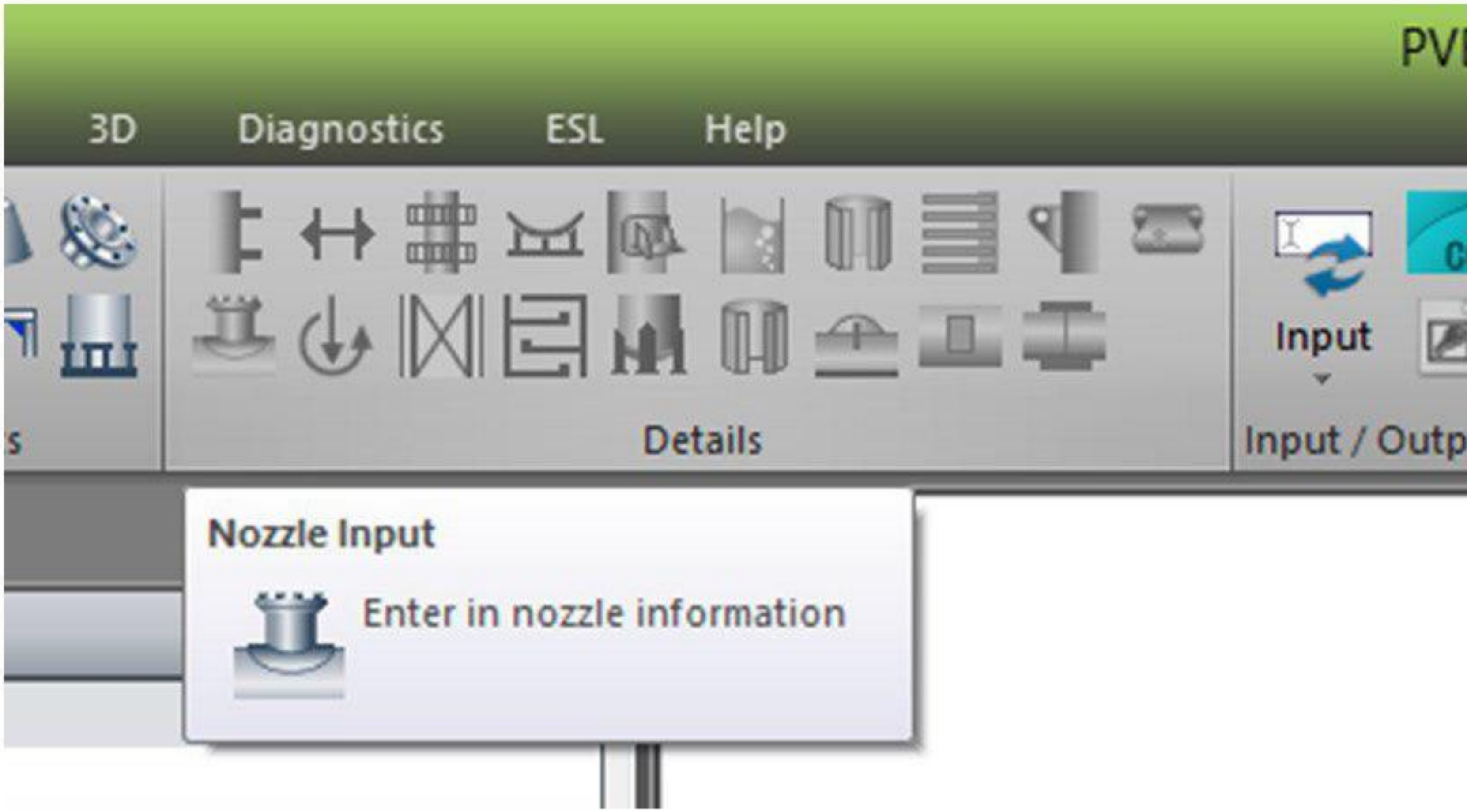

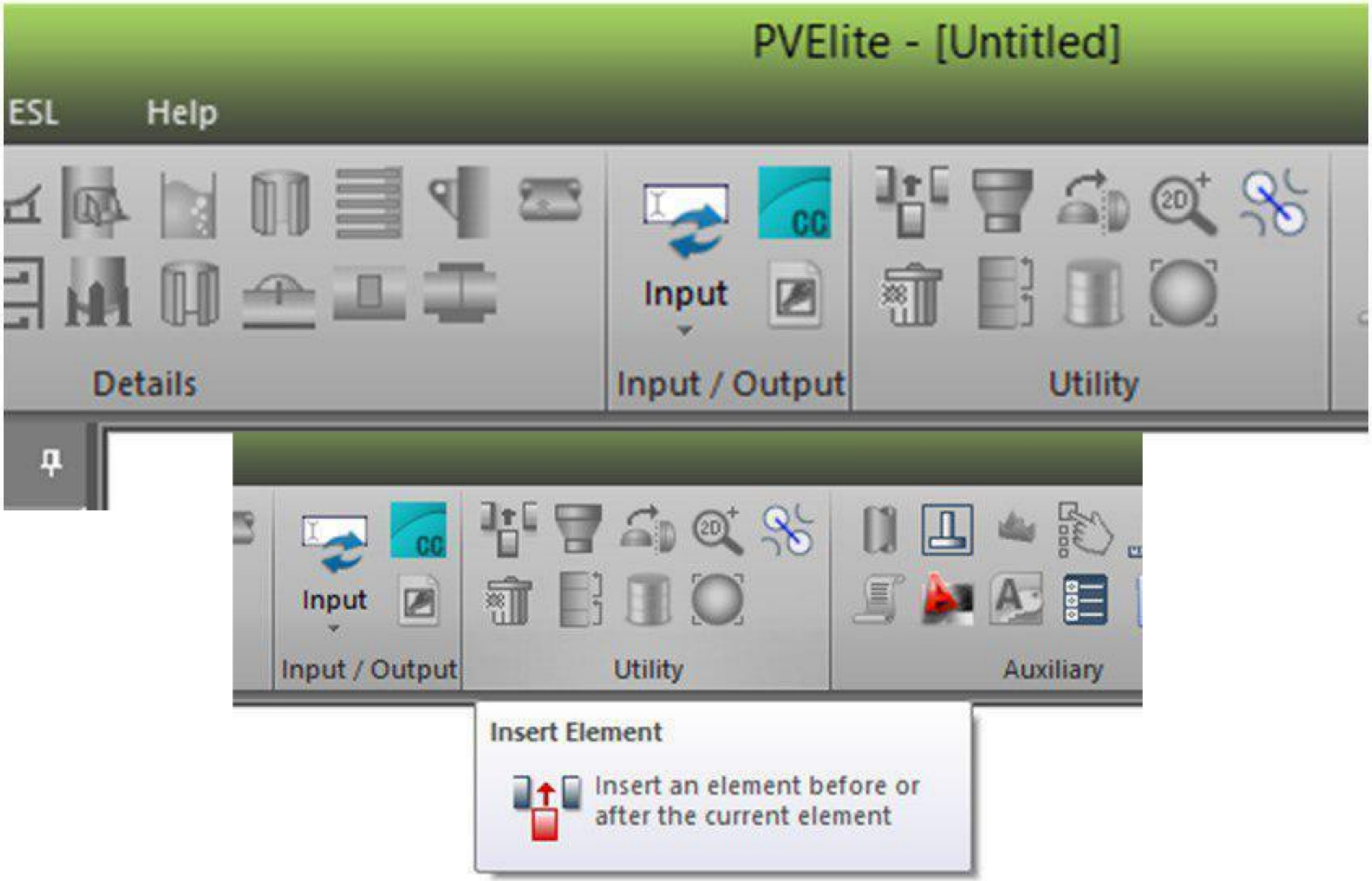
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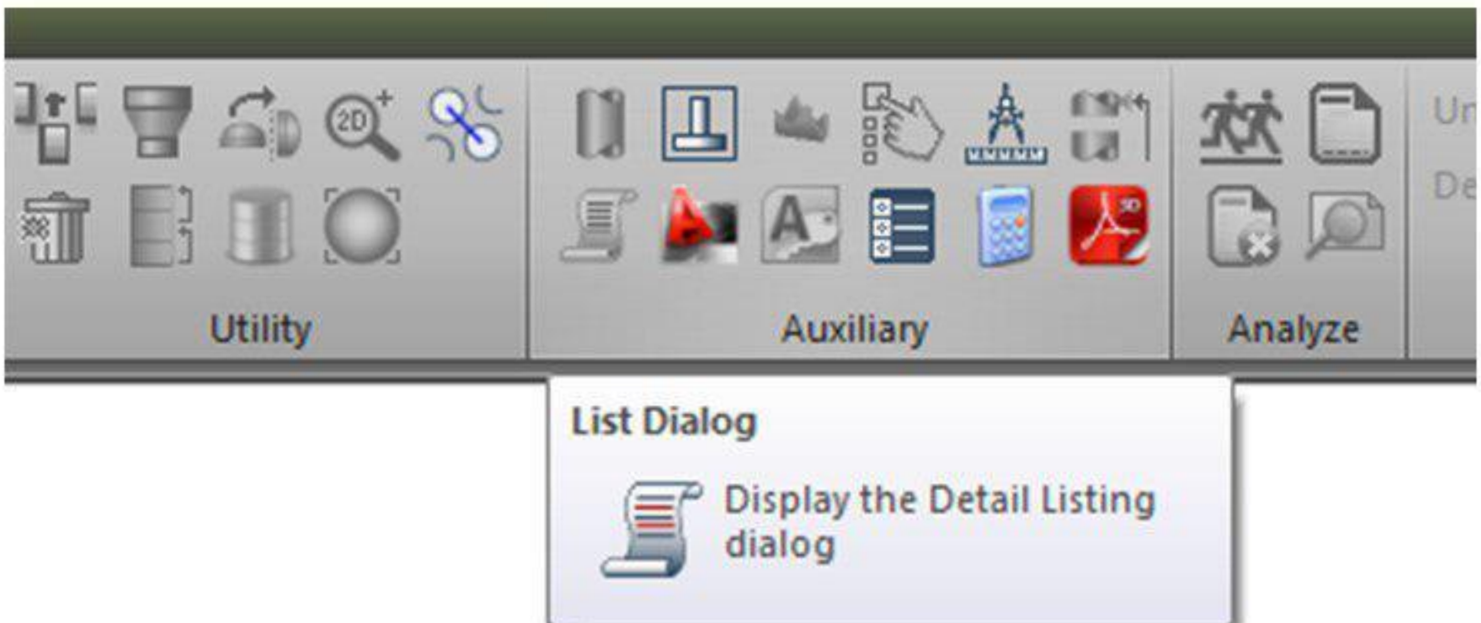

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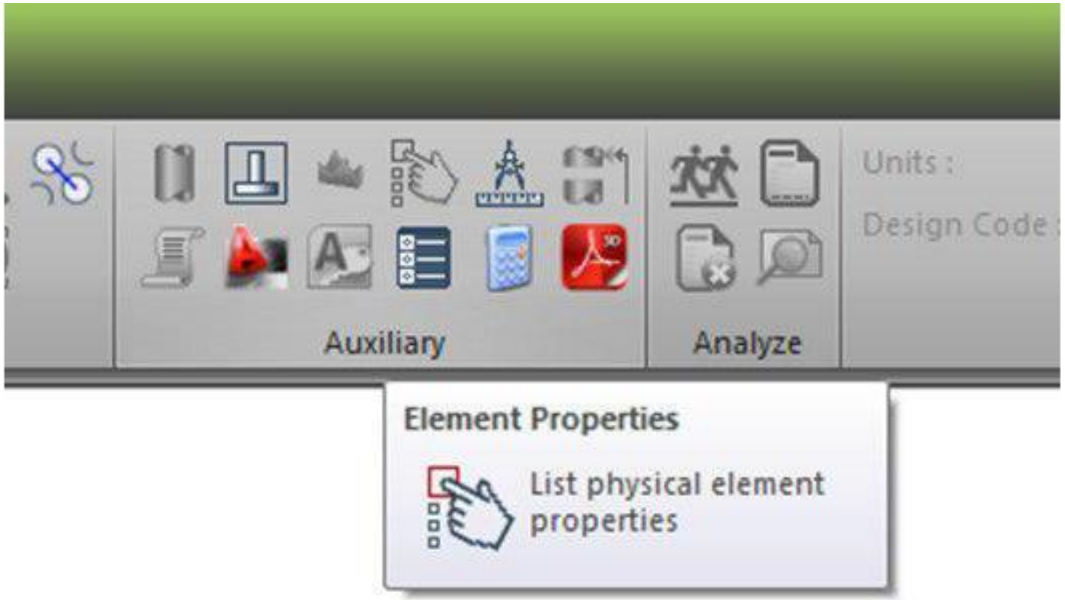

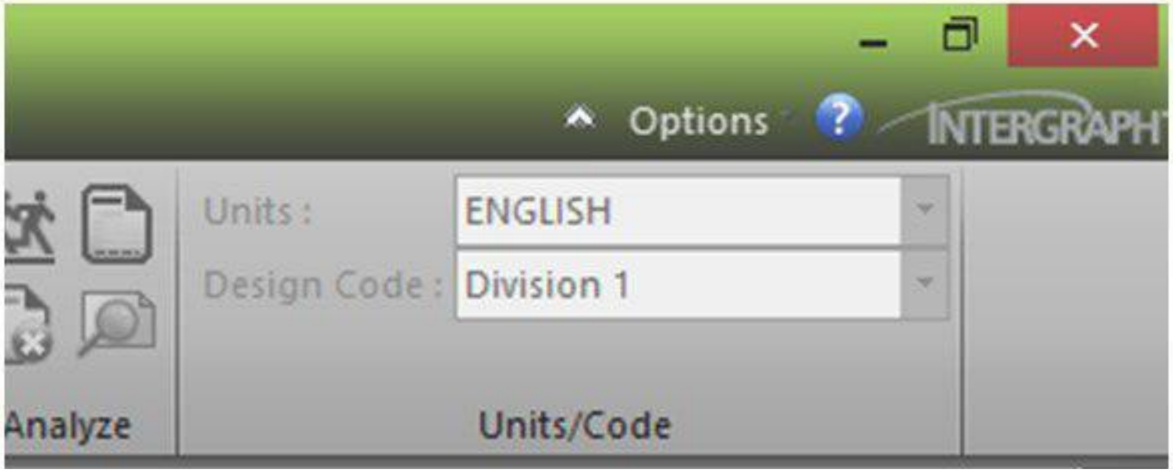

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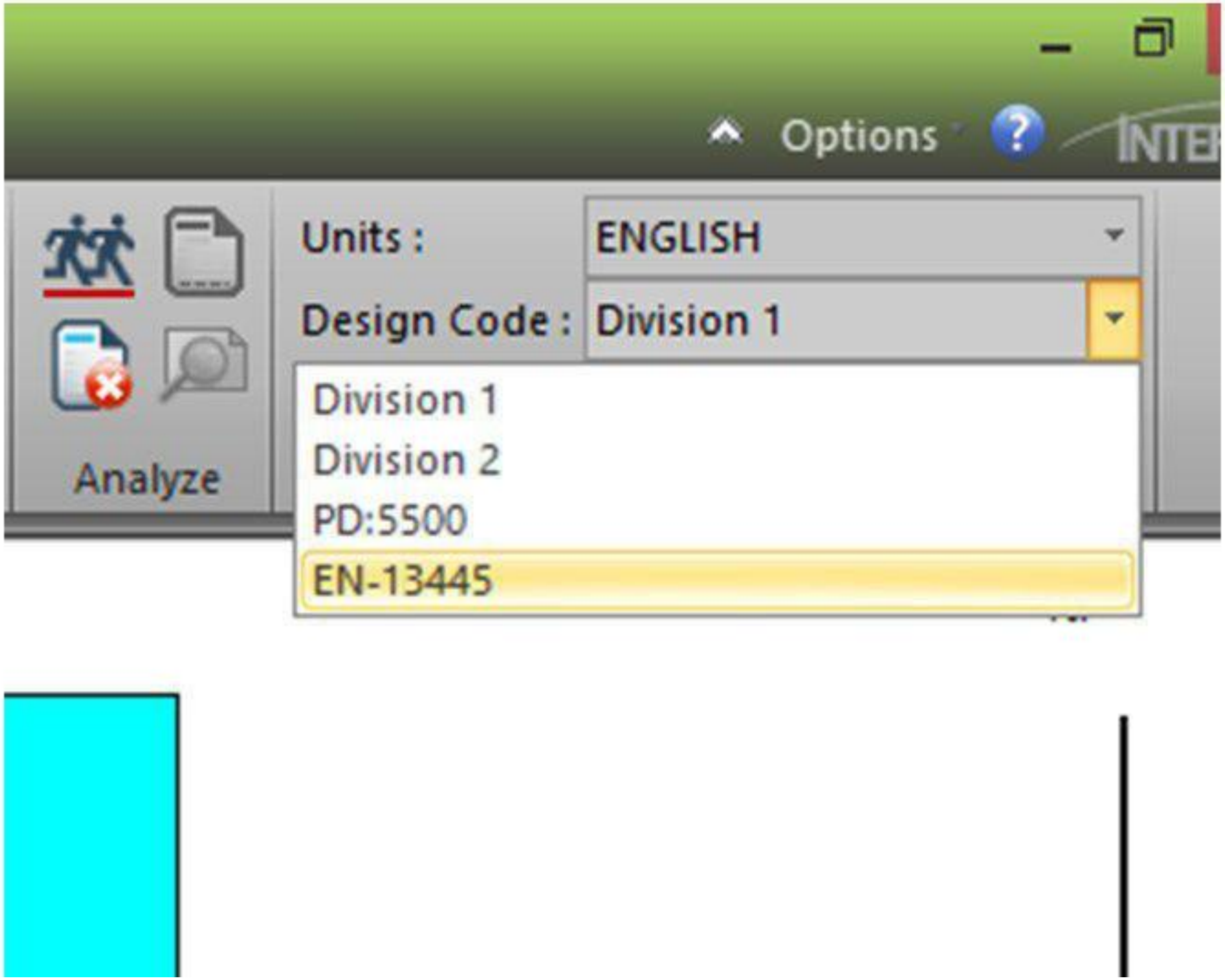

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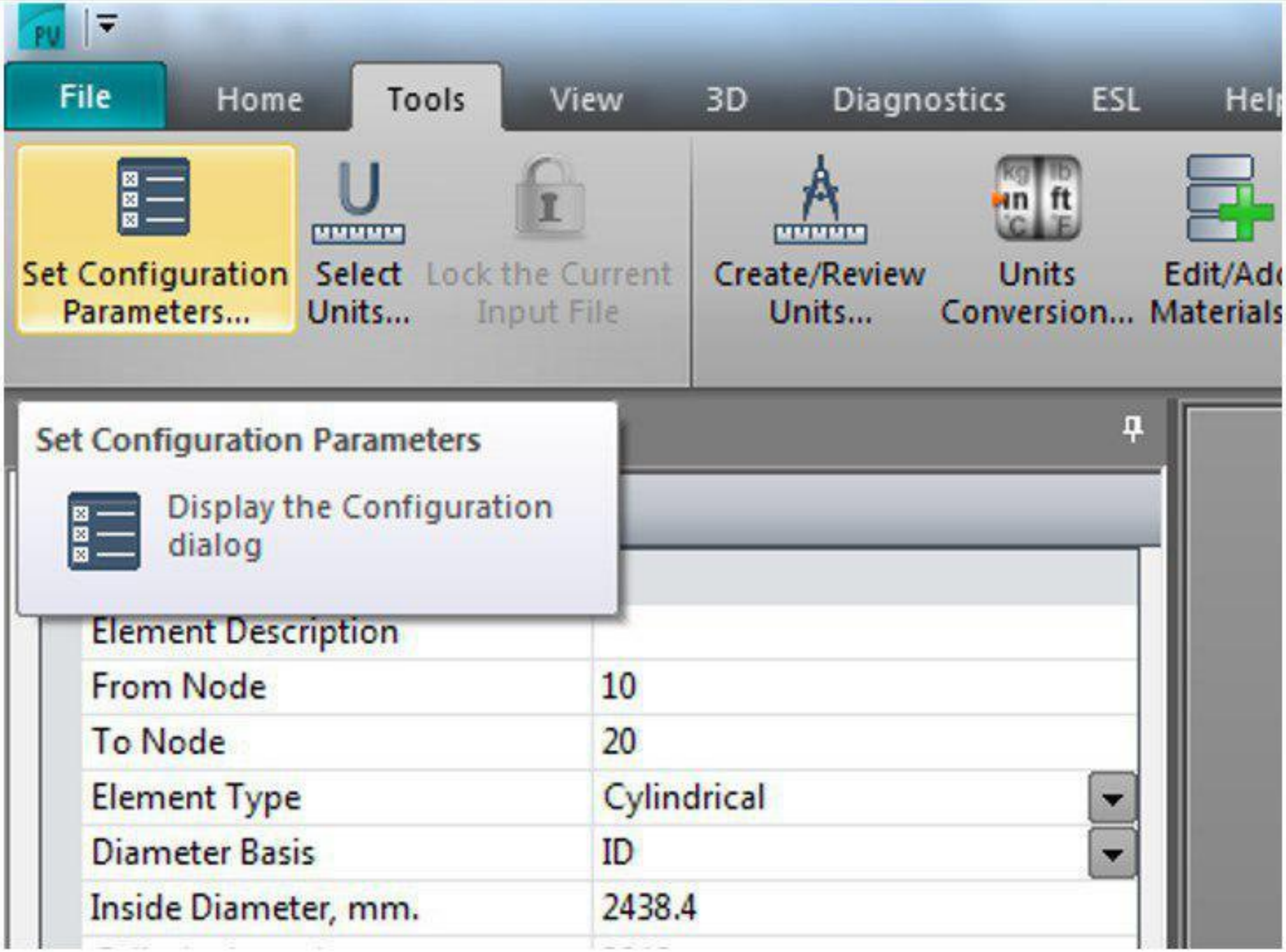

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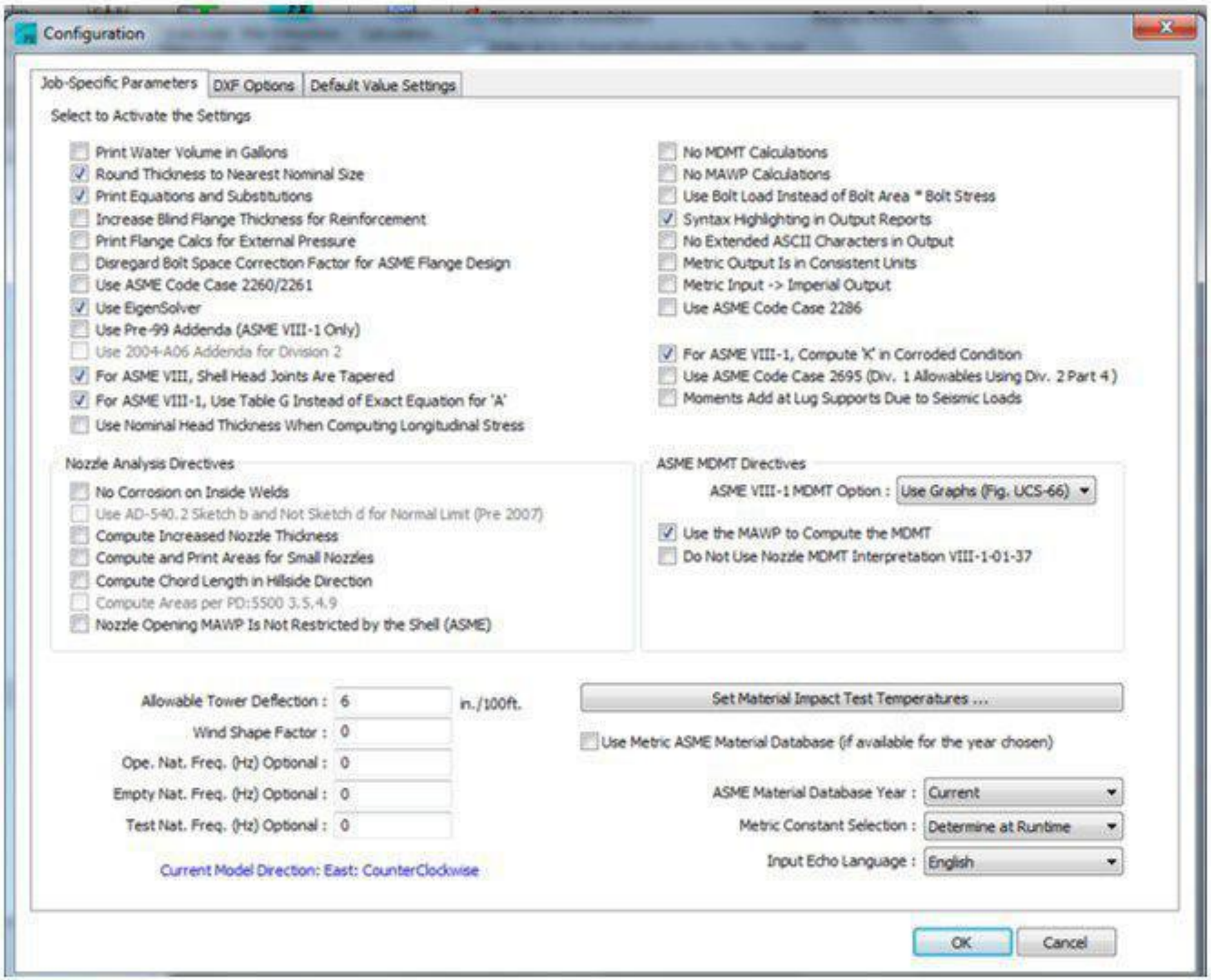

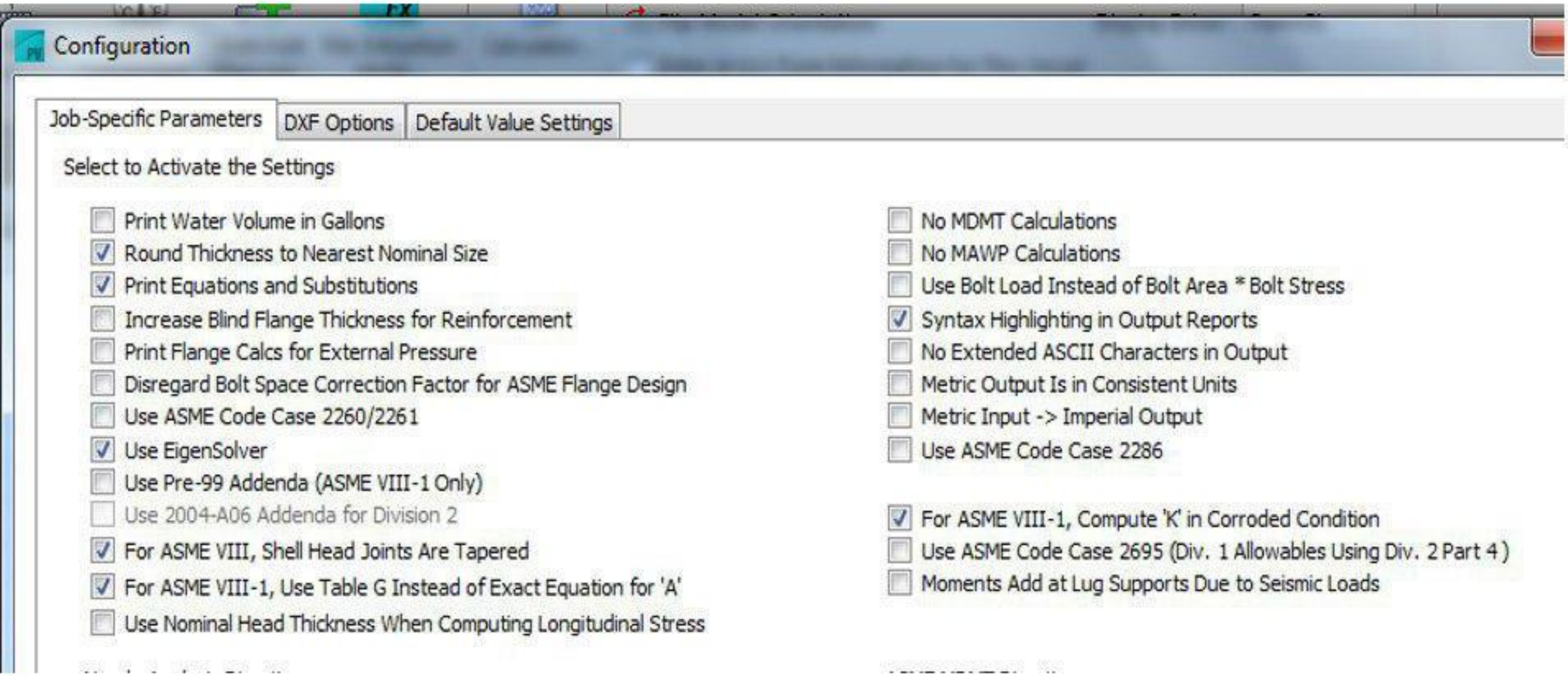
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Print Equations and Substitutions
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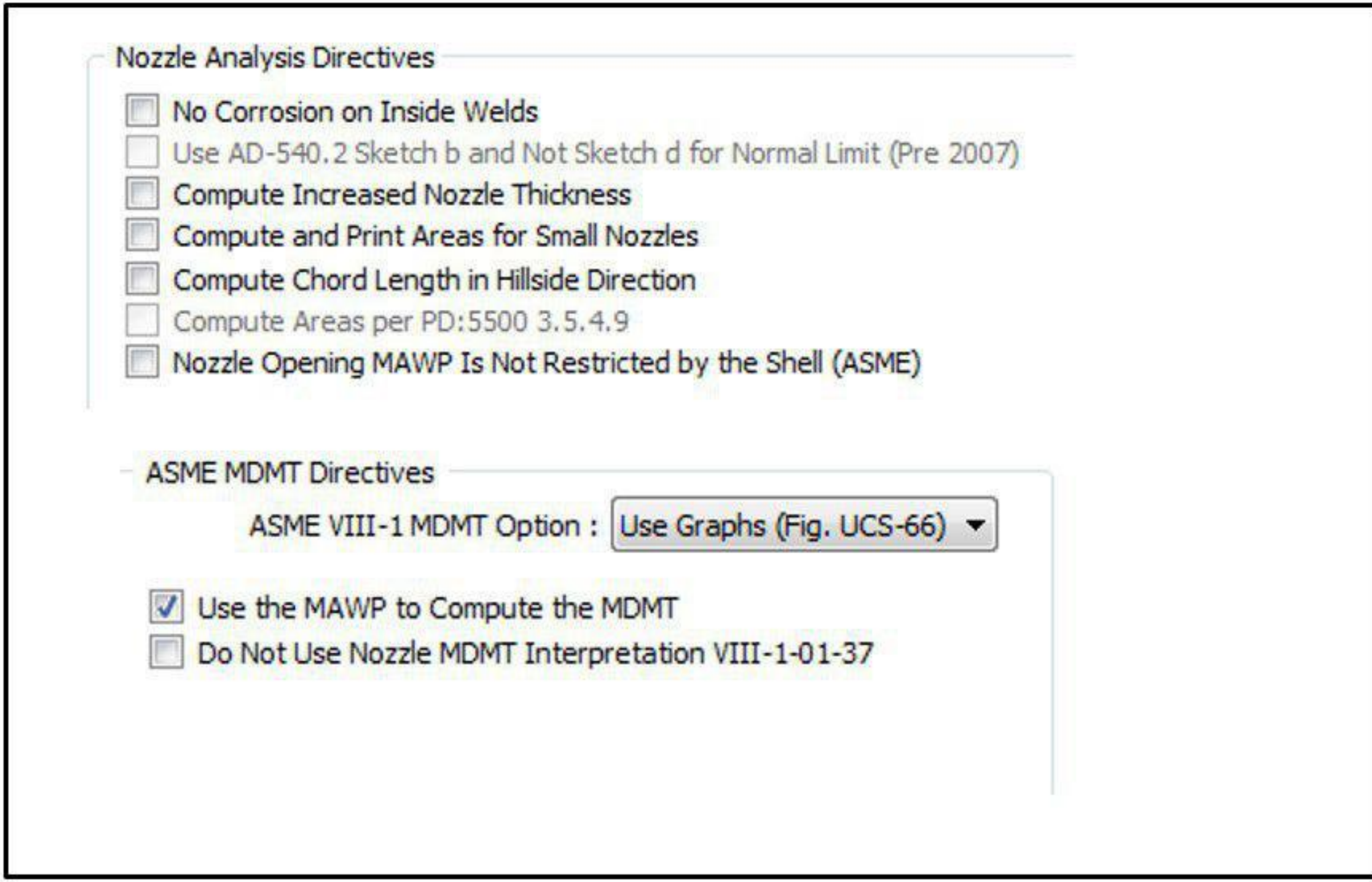
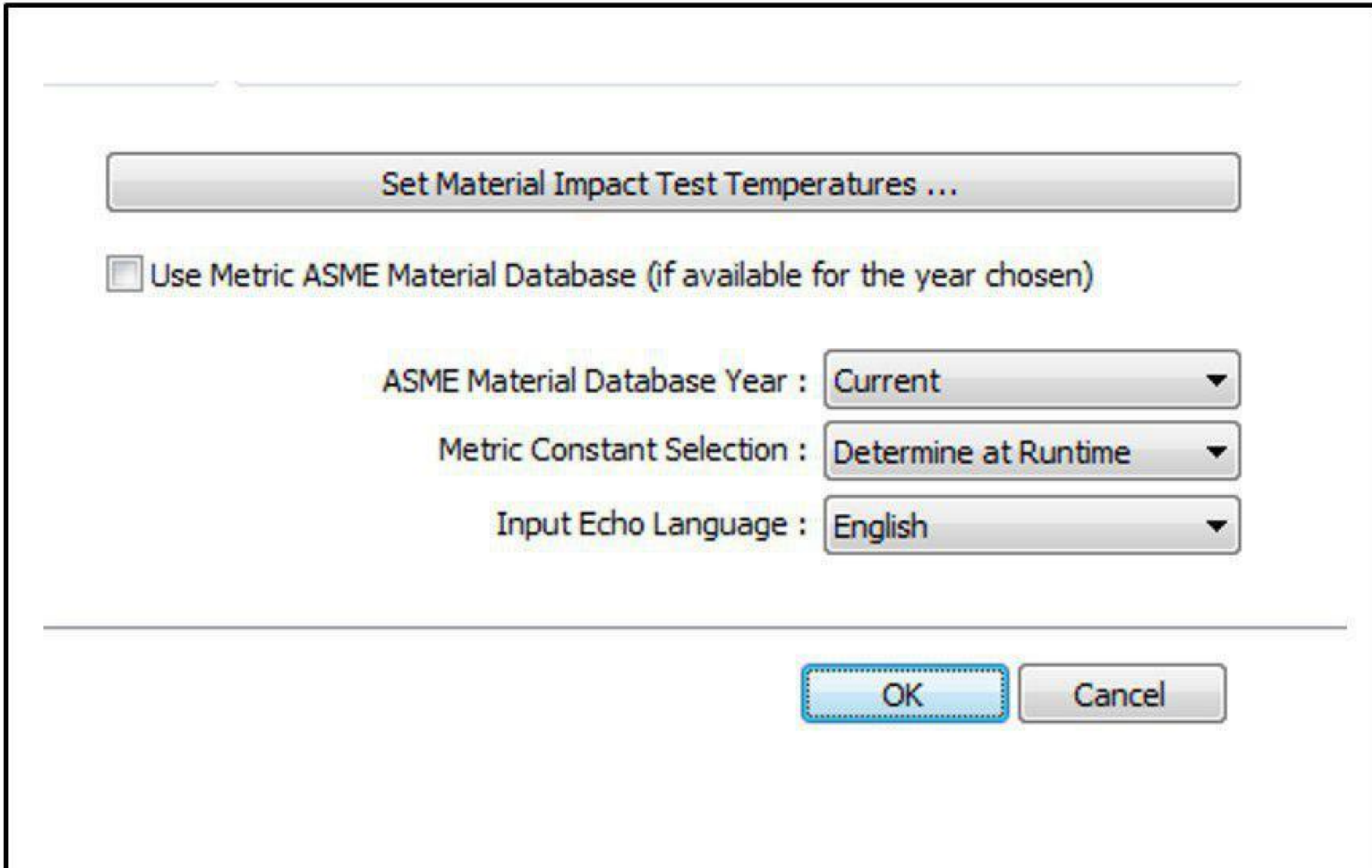
Print Flange Calcs for External Pressure
Disregard Bolt Space Correction Factor for ASME Flange Design
Use ASME Code Case 2260/2261
Use EigenSolver
Use Pre-99 Addenda (ASME VIII-1 Only)
Use 2004-A06 Addenda for Division 2
For ASME VIII, Shell Head Joints Are Tapered
For ASME VIII-1, Use Table G Instead of Exact Equation for 'A'
Use Nominal Head Thickness When Computing Longitudinal Stress
No MDMT Calculations
No MAWP Calculations
Use Bolt Load Instead of Bolt Area * Bolt Stress
Syntax Highlighting in Output Reports
No Extended ASCII Characters in Output
Metric Output Is in Consistent Units
Metric Input -> Imperial Output
Use ASME Code Case 2286
For ASME VIII-1, Compute 'K' in Corroded Condition
Use ASME Code Case 2695 (Div. 1 Allowables Using Div. 2 Part 4)
Moments Add at Lug Supports Due to Seismic Loads

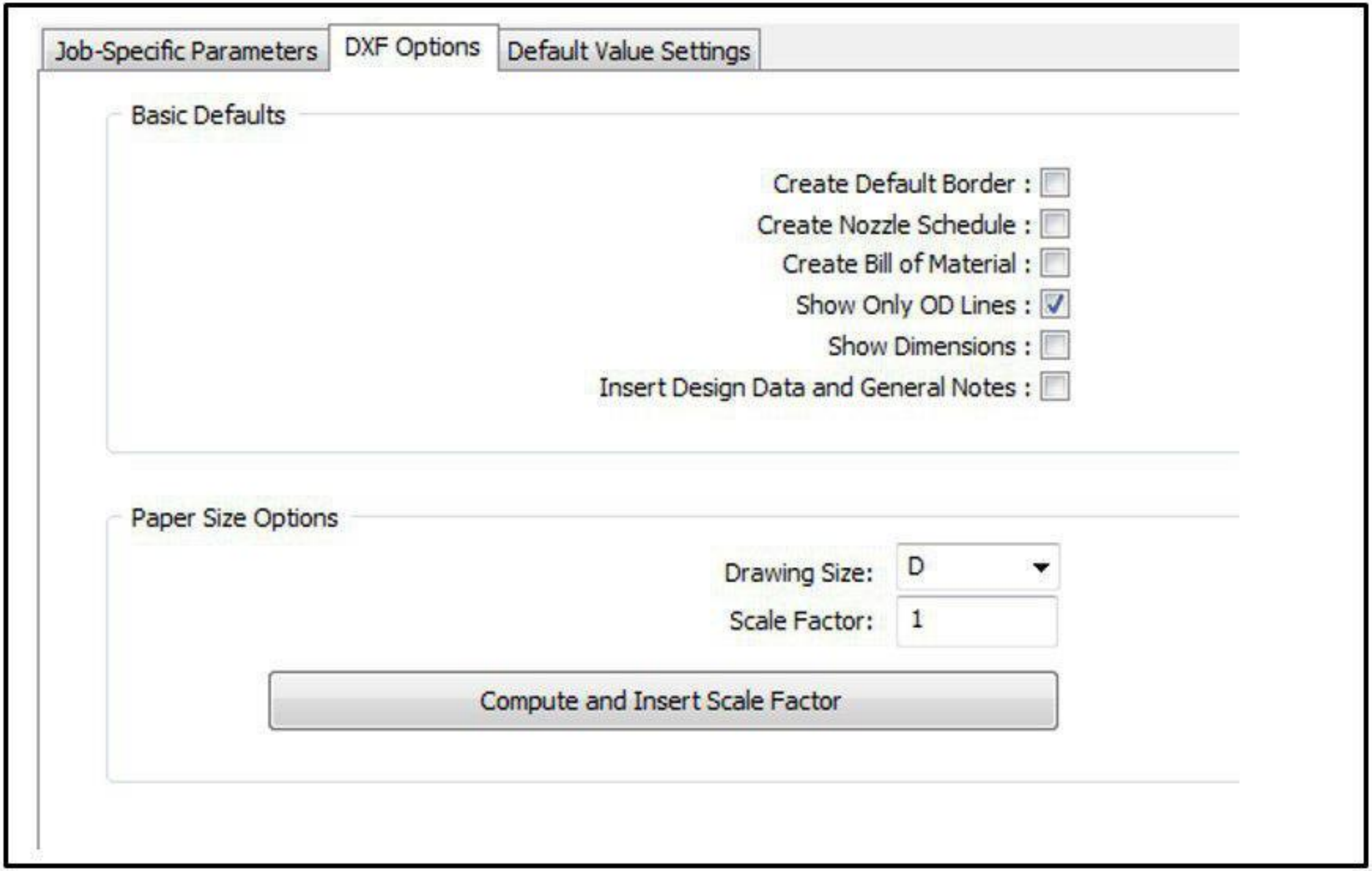

Nozzle Analysis Directives
No Corrosion on Inside Welds
Use AD-540.2 Sketch b and Not Sketch d for Normal Limit (Pre 2007)
Compute Increased Nozzle Thickness
Compute and Print Areas for Small Nozzles
Compute Chord Length in Hillside Direction
Compute Areas per PD:5500 3.5.4.9
Nozzle Opening MAWP Is Not Restricted by the Shell (ASME)
ASME MDMT Directives
ASME VIII-1 MDMT Option :
Use Graphs (Fig. UCS-66)
Use the MAWP to Compute the MDMT
Do Not Use Nozzle MDMT Interpretation VIII-1-01-37

Allowable Tower Deflection :	6	in./100ft.
Wind Shape Factor :	0	
Ope. Nat. Freq. (Hz) Optional :	0	
Empty Nat. Freq. (Hz) Optional :	0	
Test Nat. Freq. (Hz) Optional :	0	

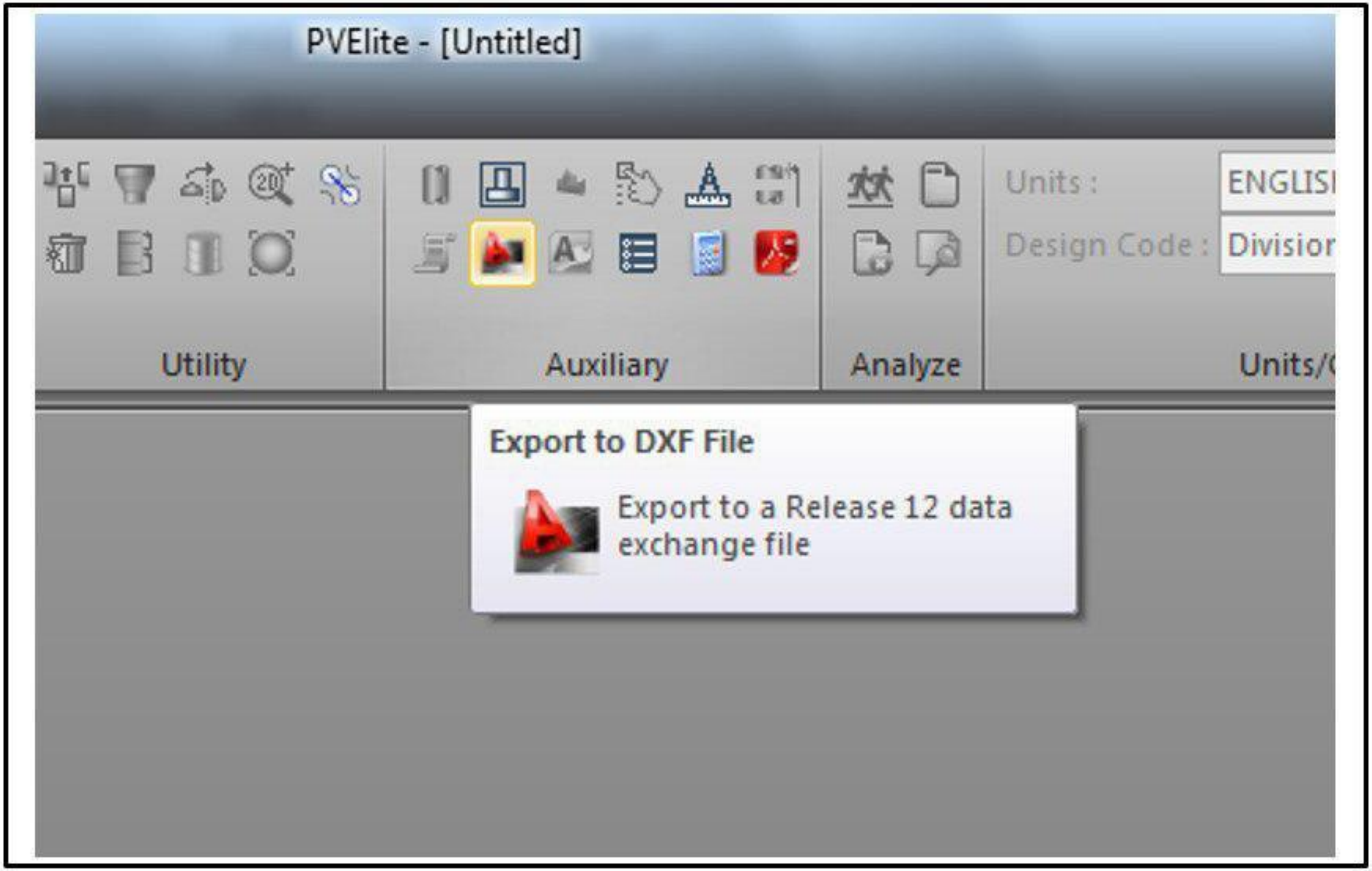
Current Model Direction: East: CounterClockwise

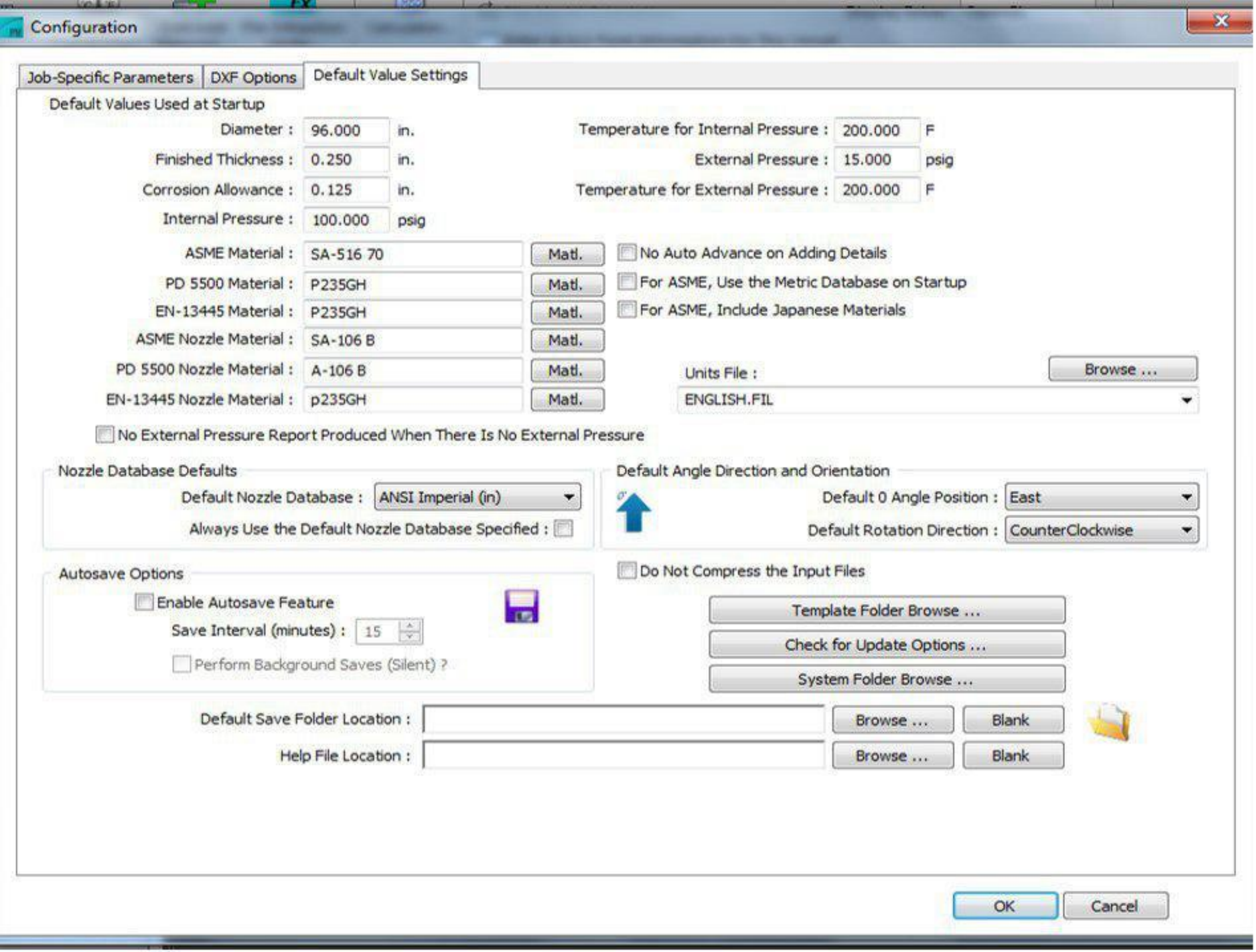

Set Material Impact Test Temperatures ...
Use Metric ASME Material Database (if available for the year chosen)
ASME Material Database Year :
Current
Metric Constant Selection :
Determine at Runtime
Input Echo Language :
English
OK
Cancel

PVElite Software

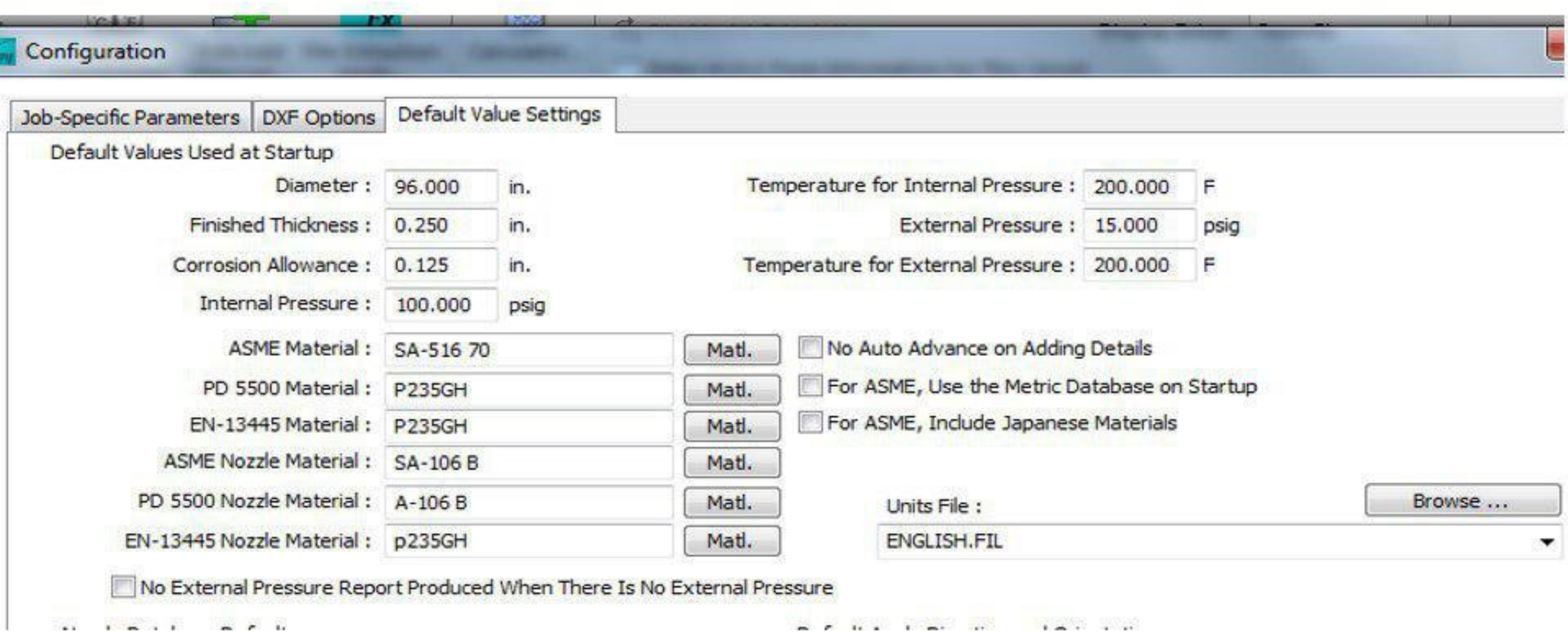


PVElite Software

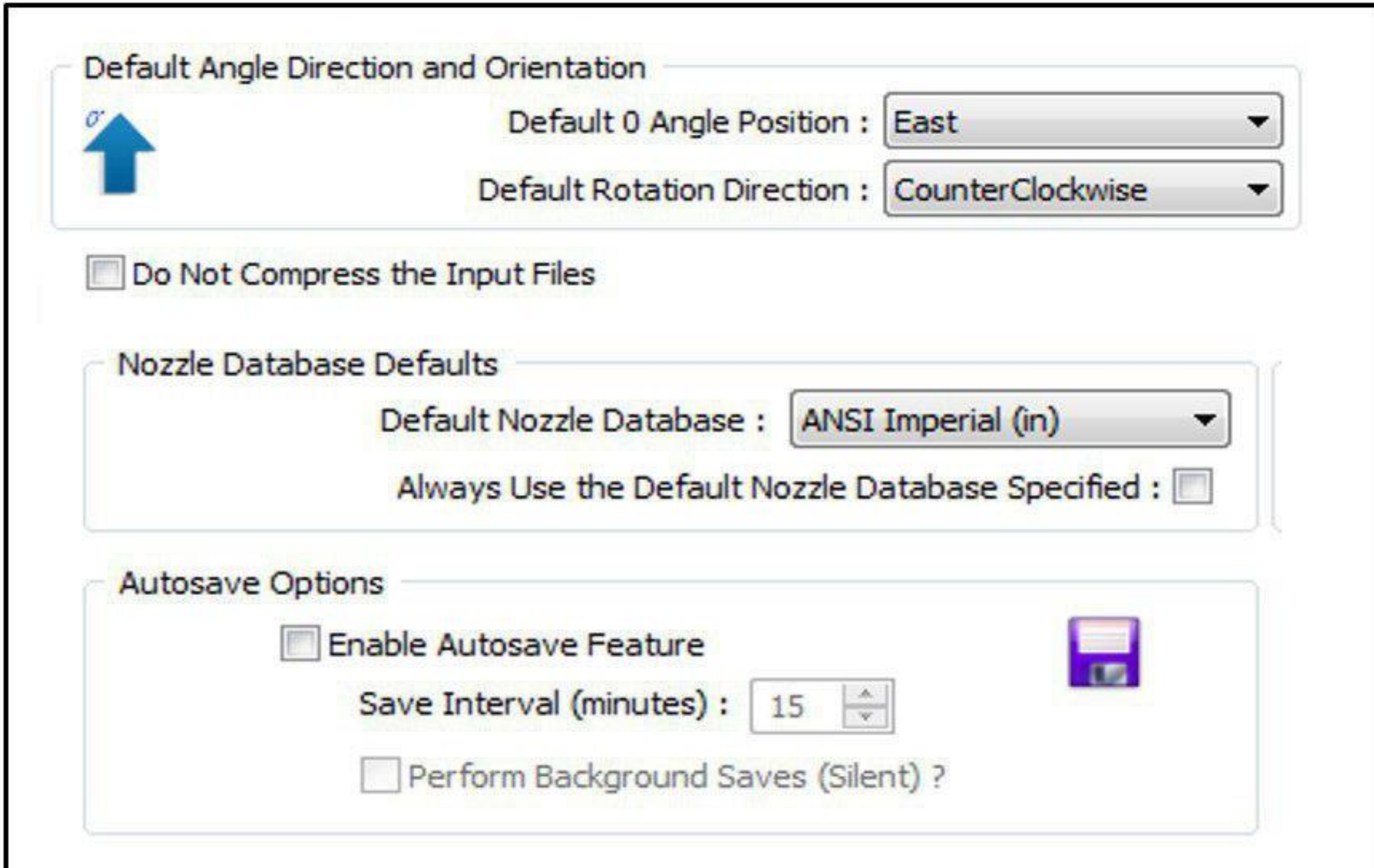



Configuration
Job-Specific Parameters
DXF Options
Default Value Settings
Default Values Used at Startup
Diameter : 96.000 in.
Finished Thickness : 0.250 in.
Corrosion Allowance : 0.125 in.
Internal Pressure : 100.000 psig
Temperature for Internal Pressure : 200.000 F
External Pressure : 15.000 psig
Temperature for External Pressure : 200.000 F
ASME Material : SA-516 70 Matl.
PD 5500 Material : P235GH Matl.
EN-13445 Material : P235GH Matl.
ASME Nozzle Material : SA-106 B Matl.
PD 5500 Nozzle Material : A-106 B Matl.
EN-13445 Nozzle Material : p235GH Matl.
No Auto Advance on Adding Details
For ASME, Use the Metric Database on Startup
For ASME, Include Japanese Materials
Units File :
Browse ...
ENGLISH.FIL
No External Pressure Report Produced When There Is No External Pressure
Nozzle Database Defaults
Default Nozzle Database : ANSI Imperial (in)
Always Use the Default Nozzle Database Specified :
Default Angle Direction and Orientation
Default 0 Angle Position : East
Default Rotation Direction : CounterClockwise
Autosave Options
Enable Autosave Feature
Save Interval (minutes) : 15
Perform Background Saves (Silent) ?
Do Not Compress the Input Files
Template Folder Browse ...
Check for Update Options ...
System Folder Browse ...
Default Save Folder Location :
Browse ...
Blank
Help File Location :
Browse ...
Blank
OK
Cancel

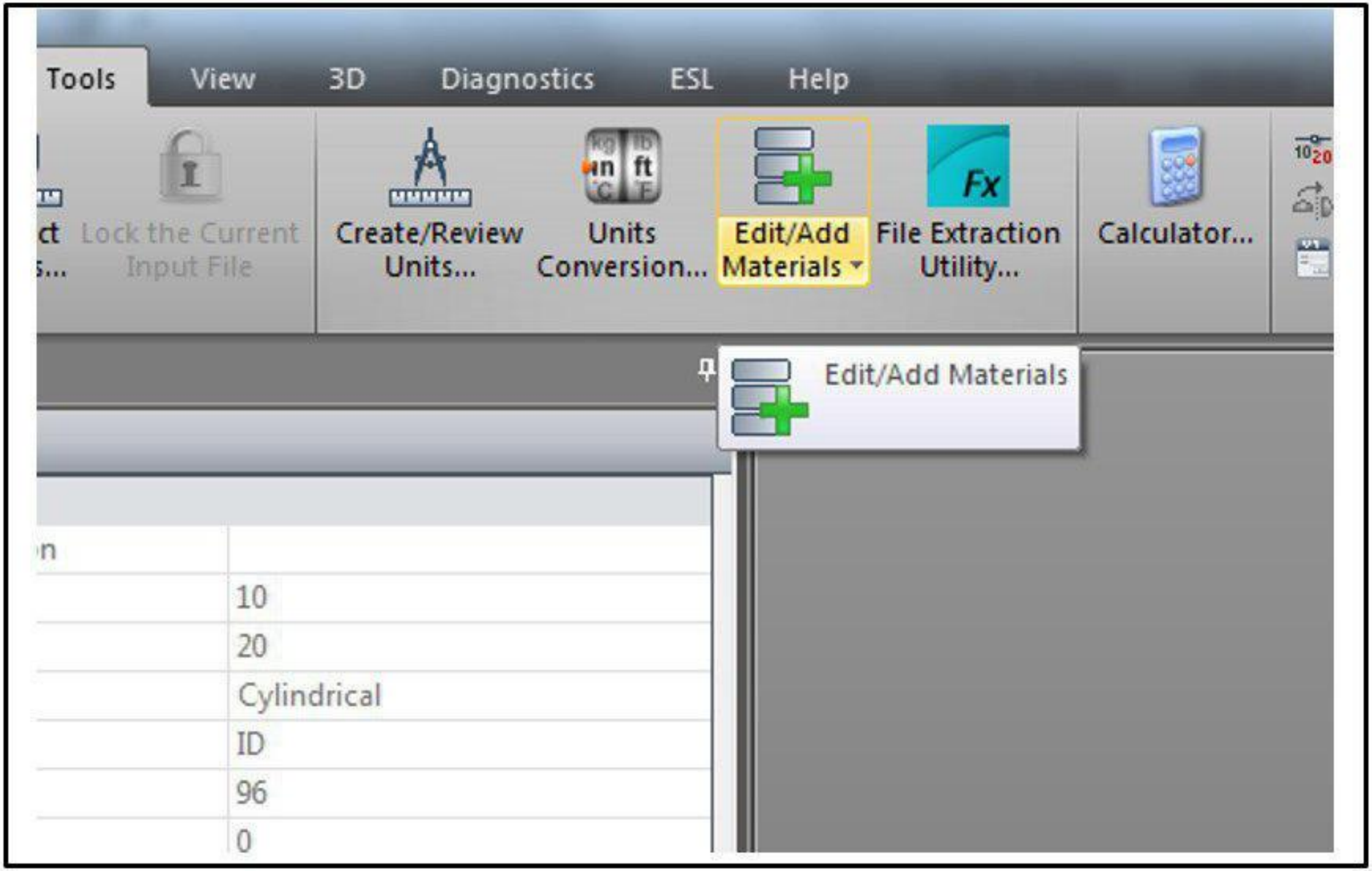
PVElite Software

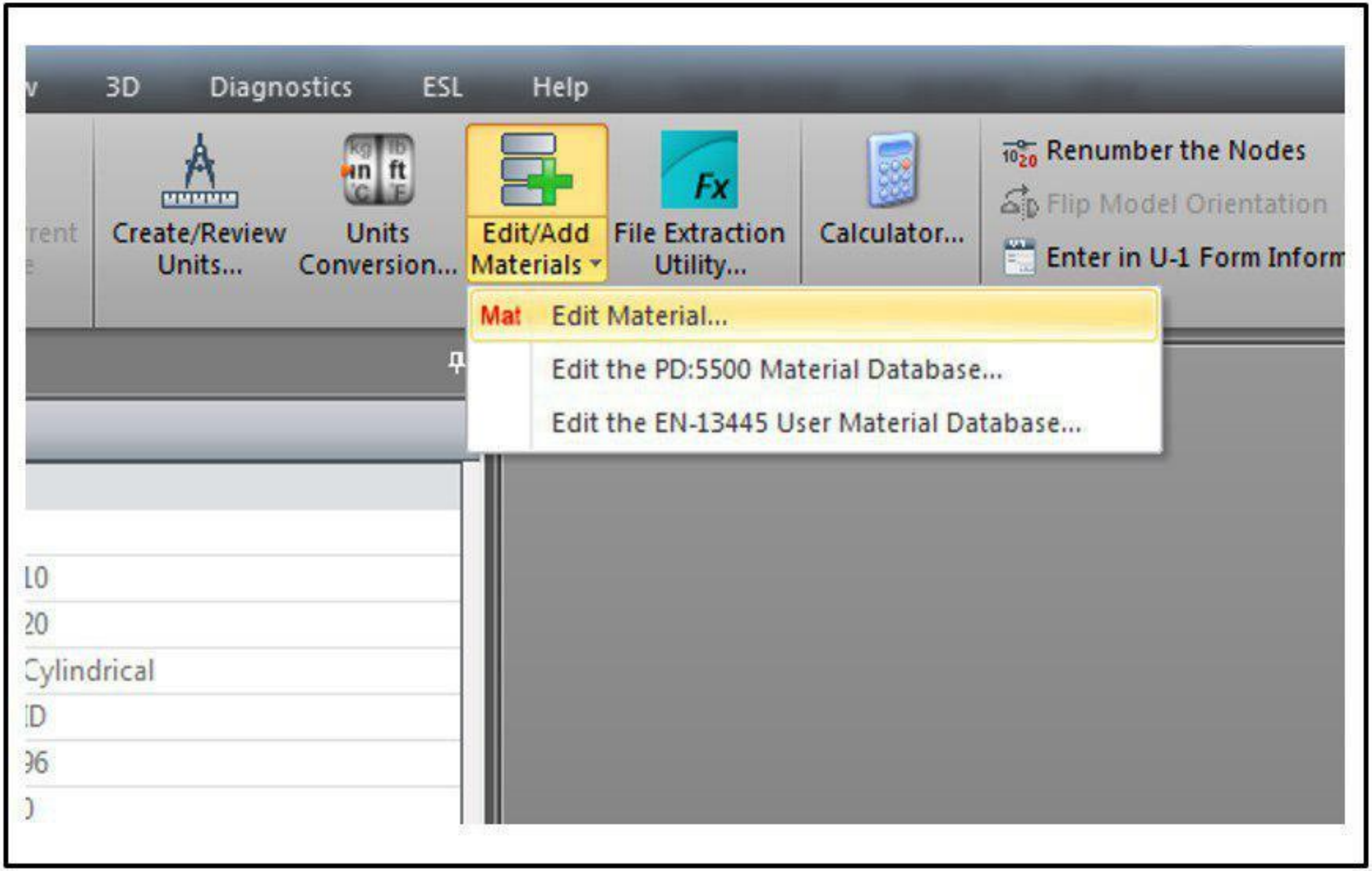


PVElite Software

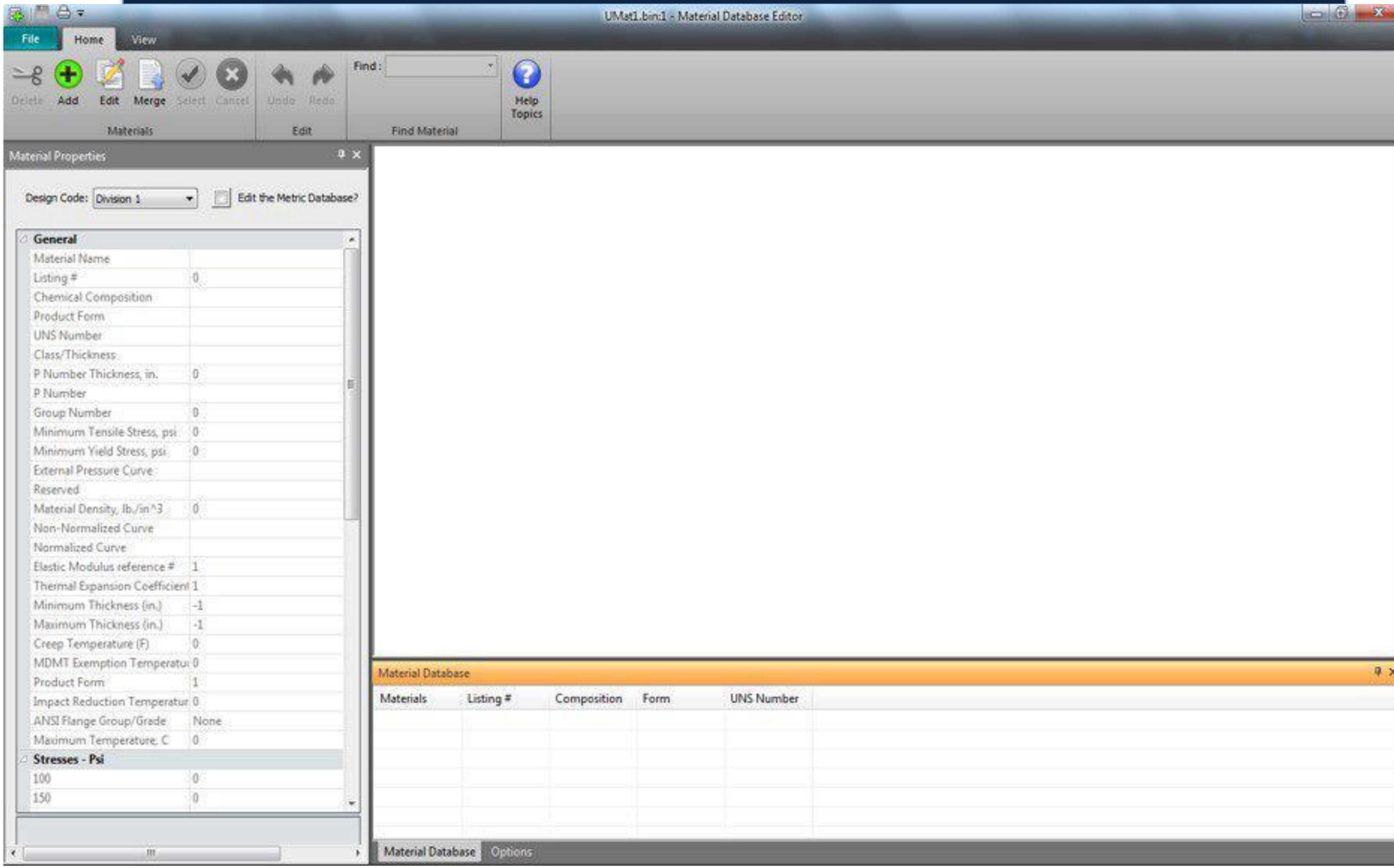


PVElite Software

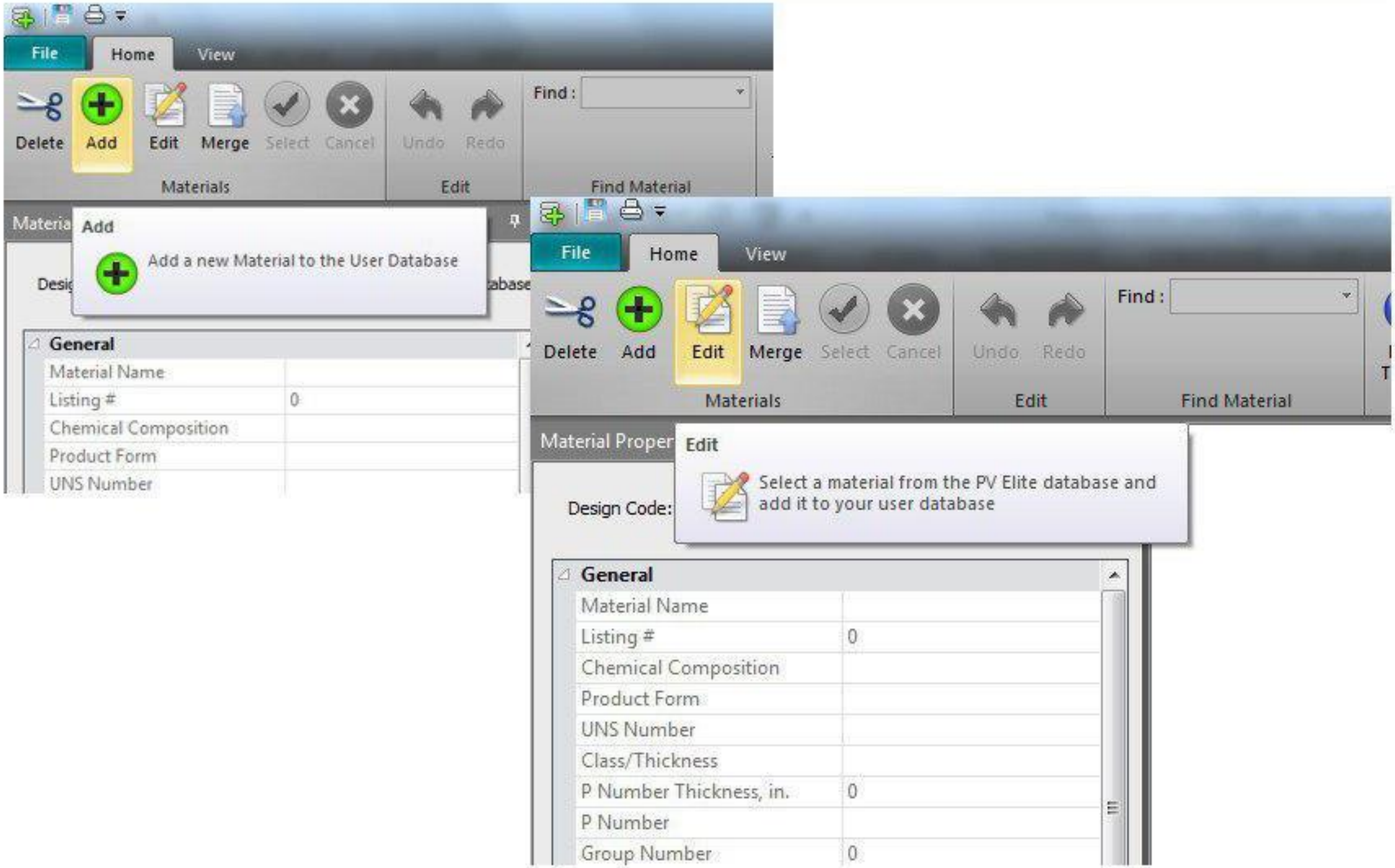



3D
Diagnostics
ESL
Help
Create/Review Units...
Units Conversion...
Edit/Add Materials
File Extraction Utility...
Calculator...
Renumber the Nodes
Flip Model Orientation
Enter in U-1 Form Inform
Mat
Edit Material...
Edit the PD:5500 Material Database...
Edit the EN-13445 User Material Database...
Cylindrical

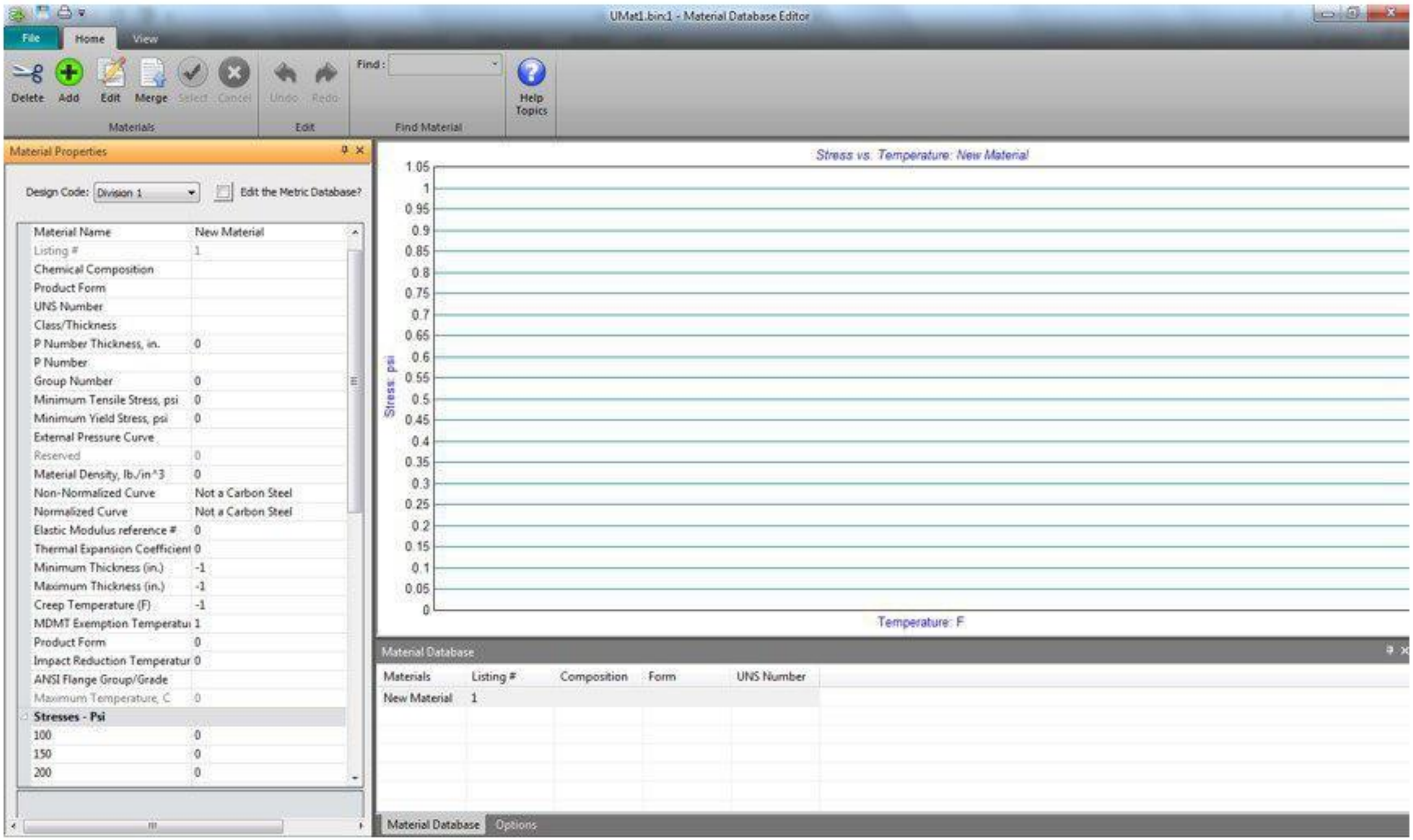
PVElite Software



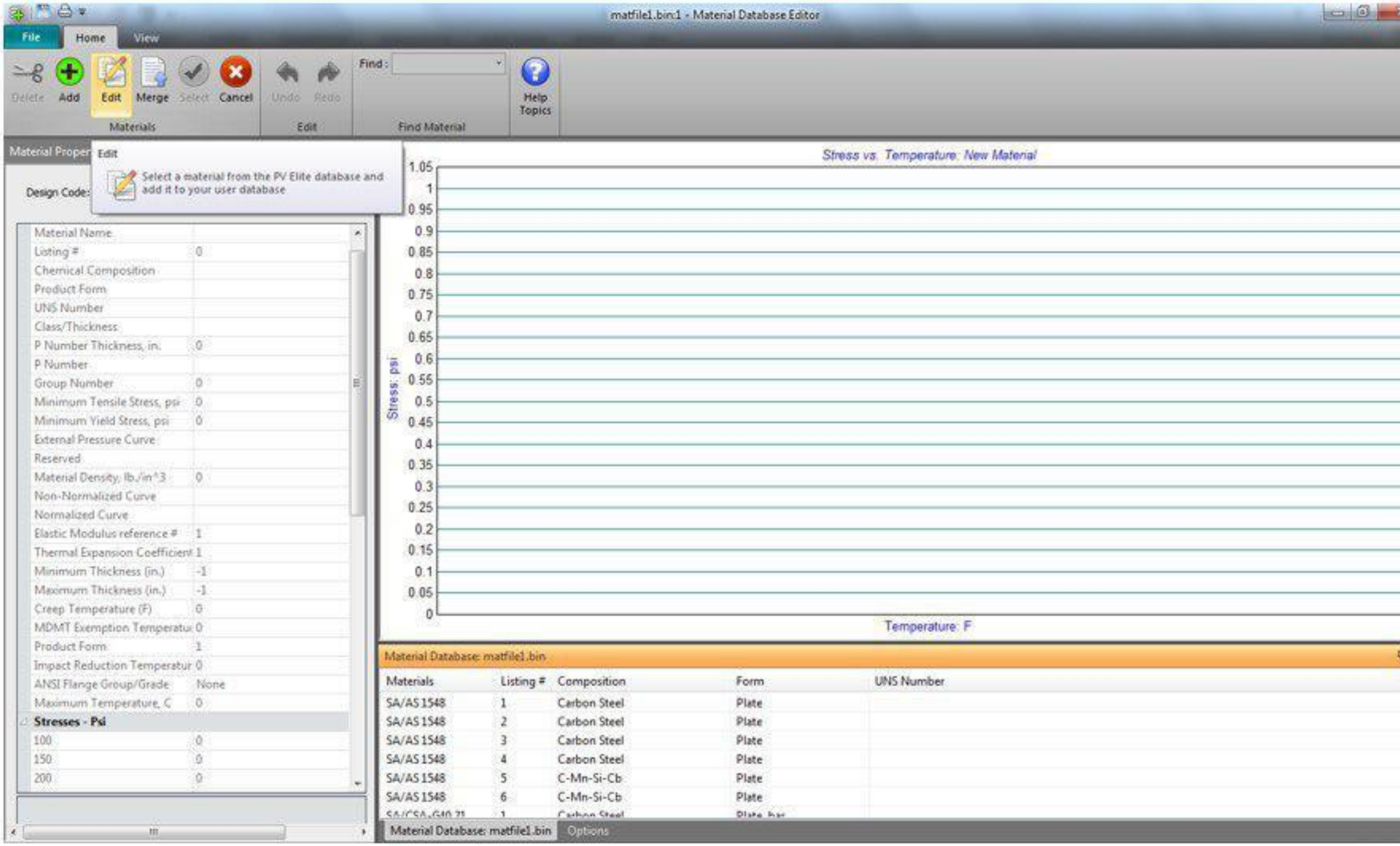
PVElite Software



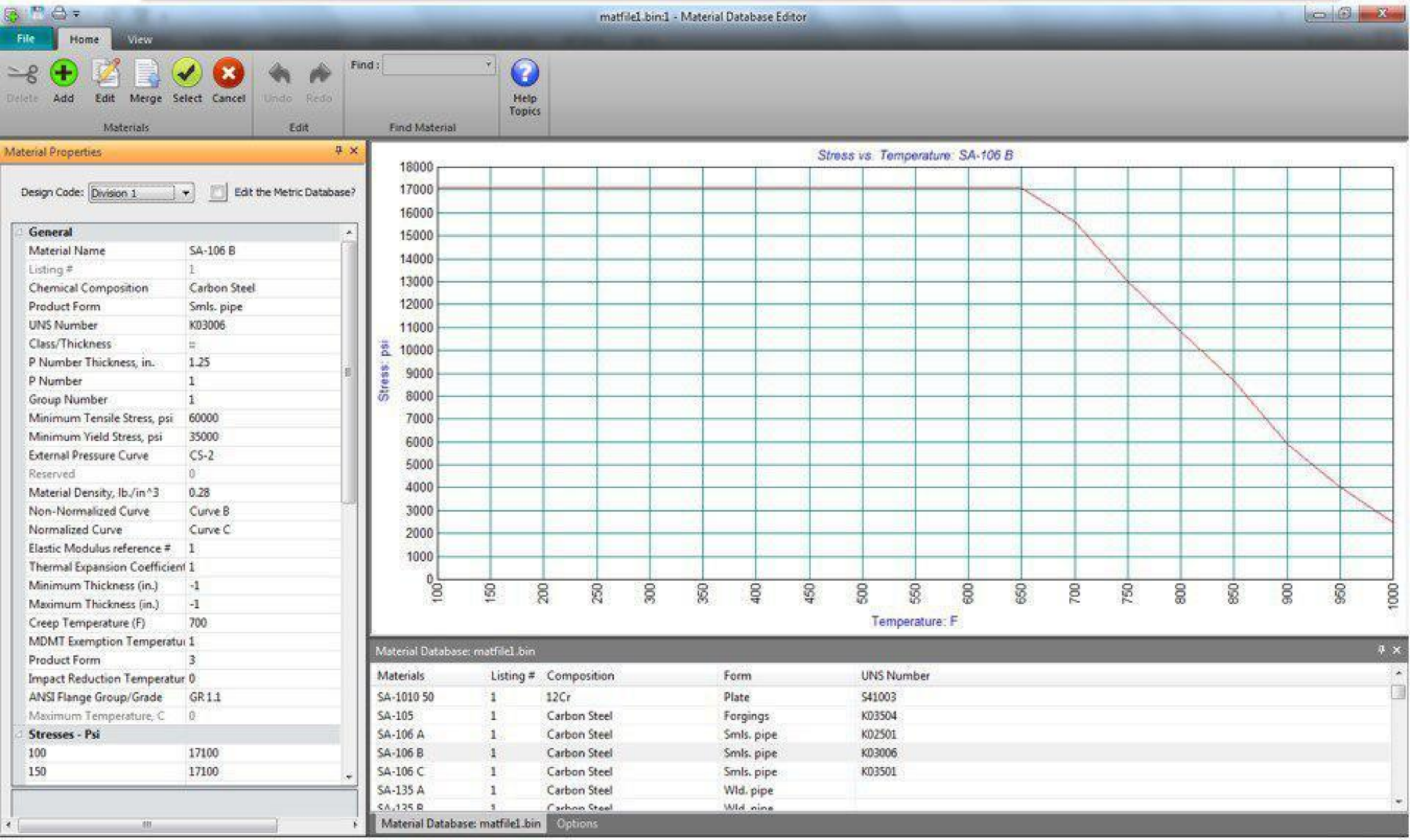
PVElite Software



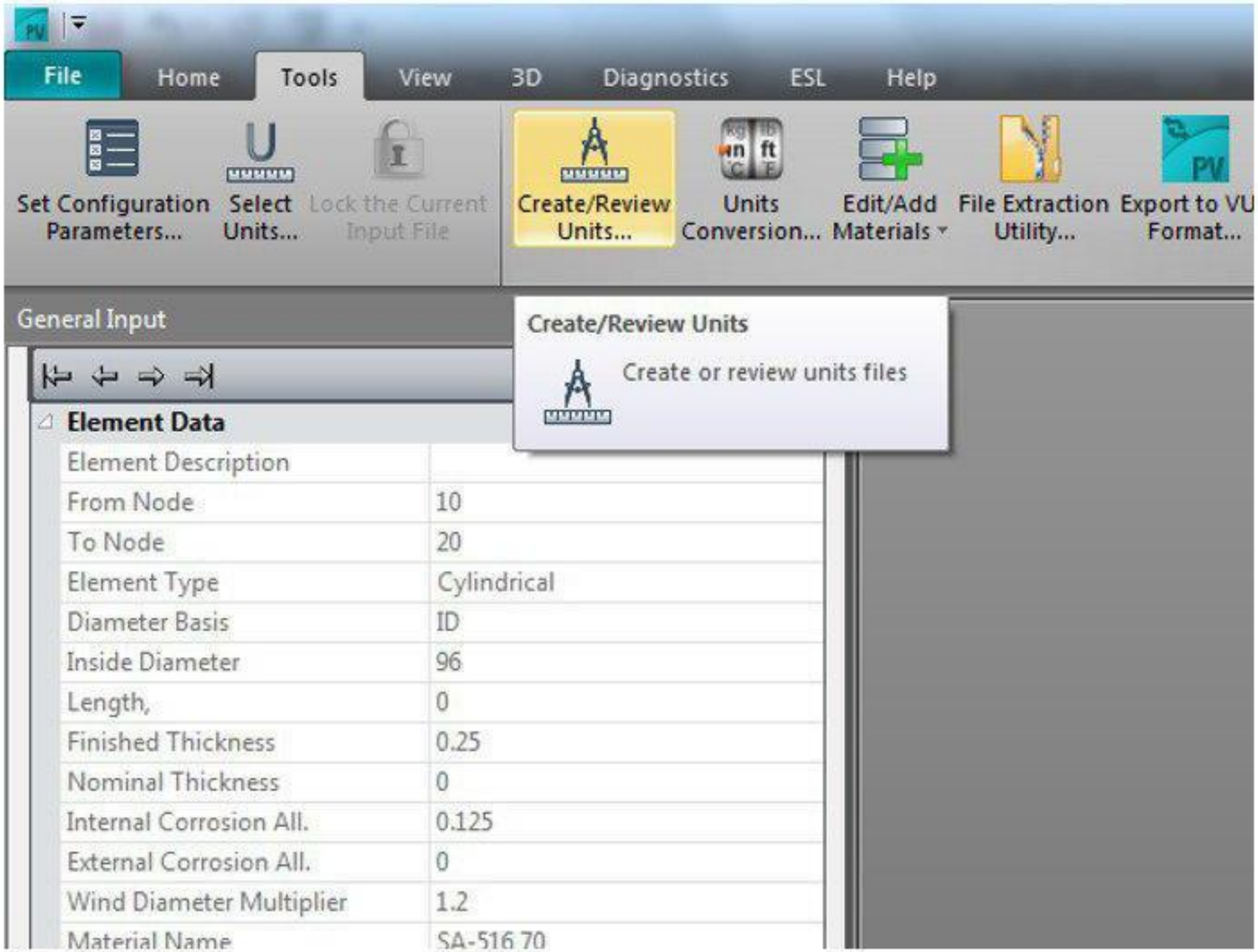
PVElite Software



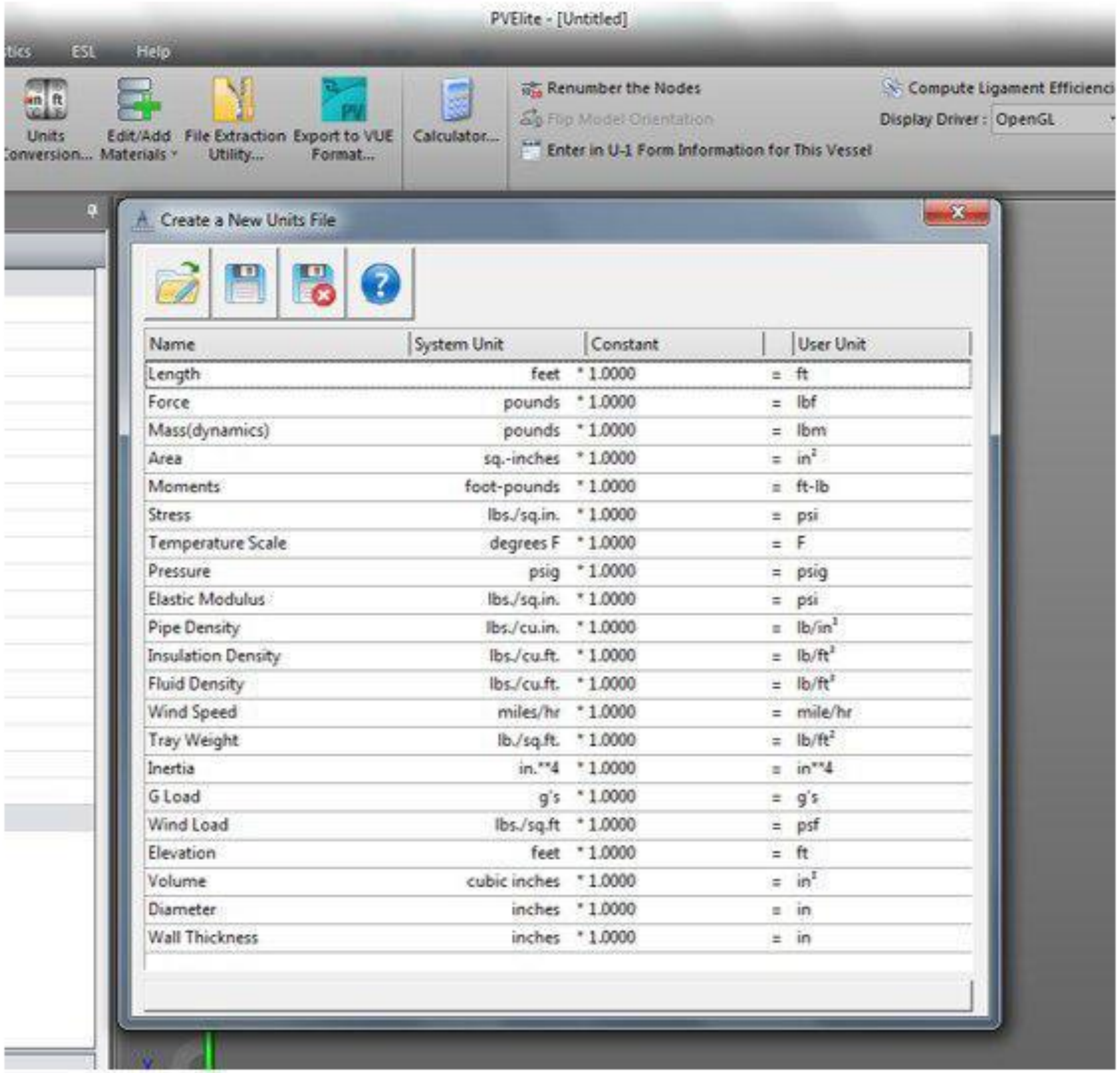
PVElite Software

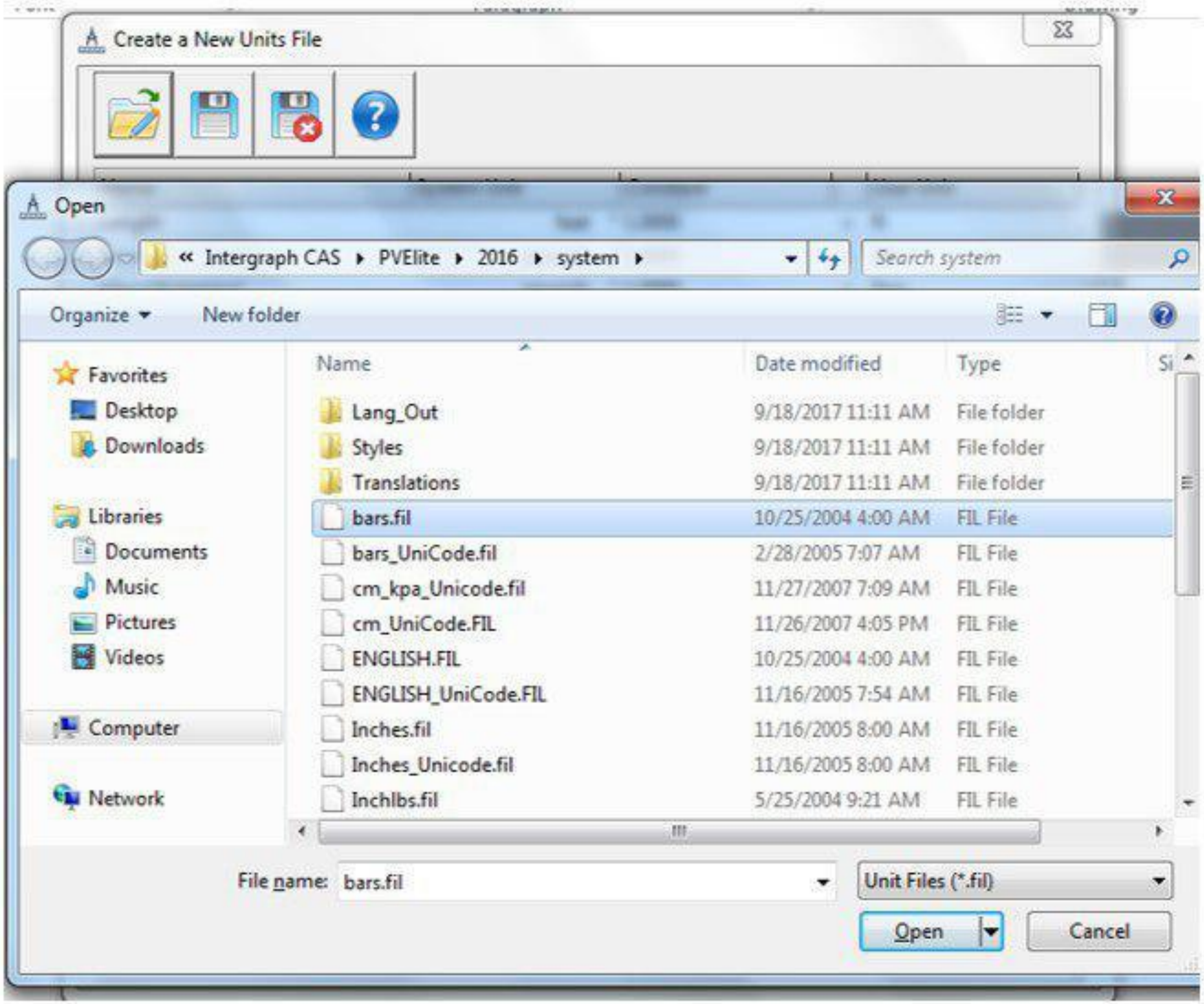


PVElite Software



PVElite Software




Create a New Units File
Open
« Intergraph CAS ▸ PVElite ▸ 2016 ▸ system ▸
Search system
Organize ▾
New folder
Favorites
Desktop
Downloads
Libraries
Documents
Music
Pictures
Videos
Computer
Network
Name
Date modified
Type
Lang_Out 9/18/2017 11:11 AM File folder
Styles 9/18/2017 11:11 AM File folder
Translations 9/18/2017 11:11 AM File folder
bars.fil 10/25/2004 4:00 AM FIL File
bars_UniCode.fil 2/28/2005 7:07 AM FIL File
cm_kpa_Unicode.fil 11/27/2007 7:09 AM FIL File
cm_UniCode.FIL 11/26/2007 4:05 PM FIL File
ENGLISH.FIL 10/25/2004 4:00 AM FIL File
ENGLISH_UniCode.FIL 11/16/2005 7:54 AM FIL File
Inches.fil 11/16/2005 8:00 AM FIL File
Inches_Unicode.fil 11/16/2005 8:00 AM FIL File
Inchlbs.fil 5/25/2004 9:21 AM FIL File
File name: bars.fil
Unit Files (*.fil)
Open
Cancel

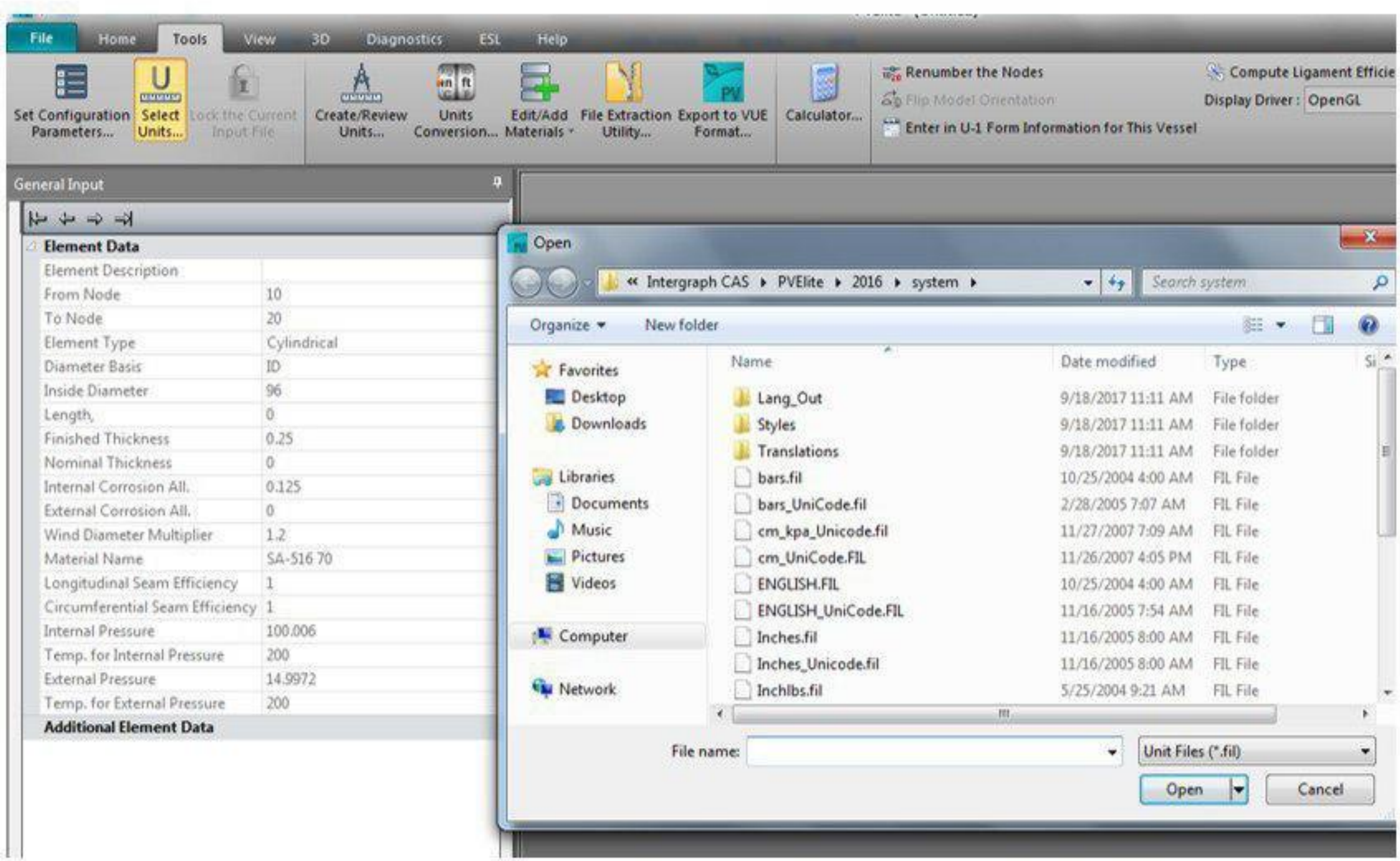
PVElite Software

Editing Units File :C:\Users\Public\Documents\Intergraph CAS\PVElite\2016\system\bars.fil

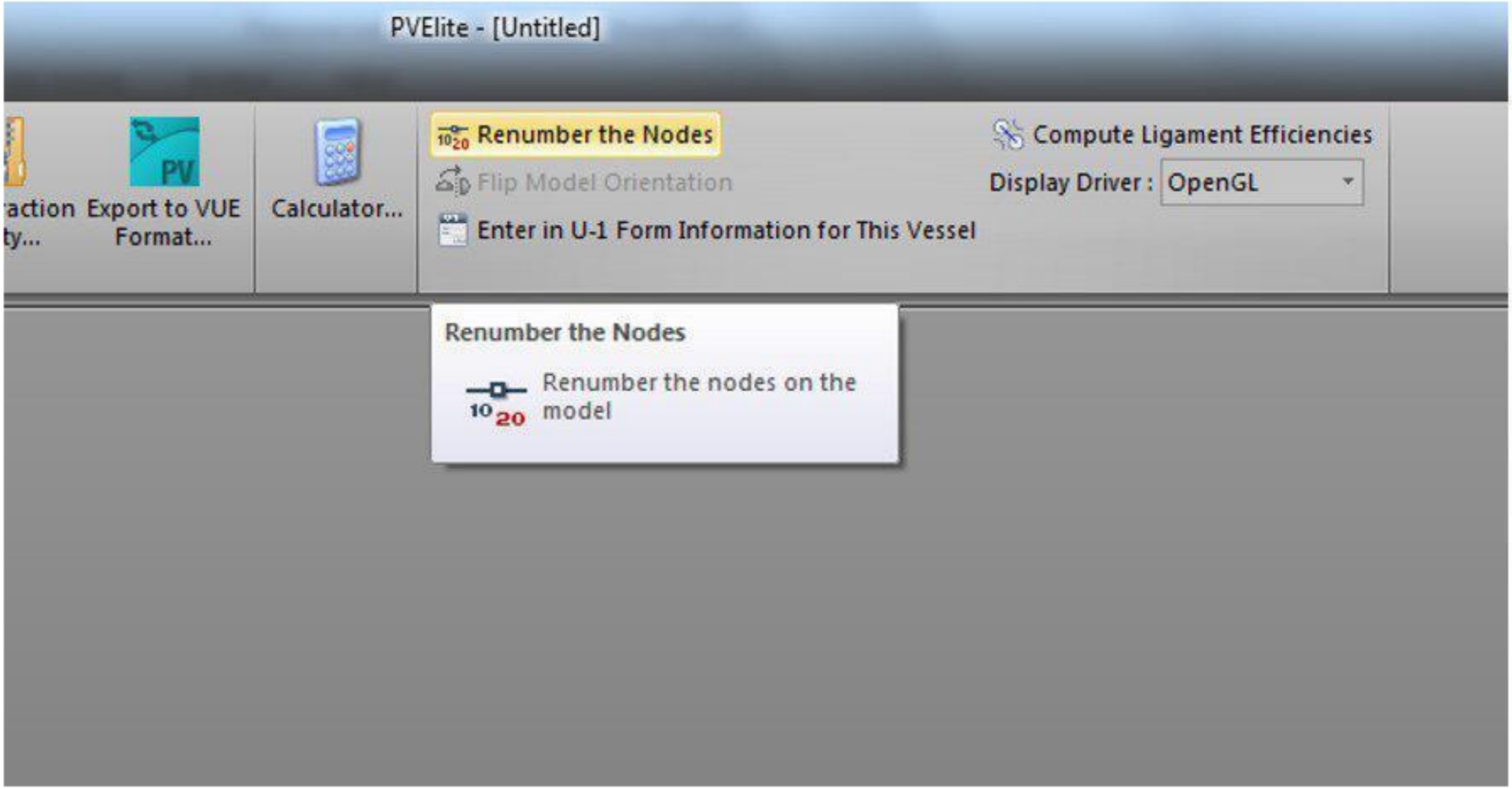
Name	System Unit	Constant		User Unit
Length	feet	* 304.799988	=	mm.
Force	pounds	* 0.453600	=	Kgf
Mass(dynamics)	pounds	* 0.453600	=	kg.
Area	sq.-inches	* 6.451600	=	cm^2
Moments	foot-pounds	* 0.138260	=	Kg-m.
Stress	lbs./sq.in.	* 0.006895	=	$N./mm^2$
Temperature Scale	degrees F	* 0.555600	=	C
Pressure	psig	* 0.068946	=	bars
Elastic Modulus	lbs./sq.in.	* 6.894600	=	KPa.
Pipe Density	lbs./cu.in.	* 0.027680	=	$kg./cm^3$
Insulation Density	lbs./cu.ft.	* 0.000016	=	$kg./cm^3$
Fluid Density	lbs./cu.ft.	* 0.000016	=	
Wind Speed	miles/hr	* 1.609300	=	
Tray Weight	lb./sq.ft.	* 0.000488	=	
Inertia	in.**4	* 41.623100	=	
G Load	g's	* 1.000000	=	g`s

lb/ft^3
kg/cm^3
kg/dm^3
lb/in^3
kg/m^3

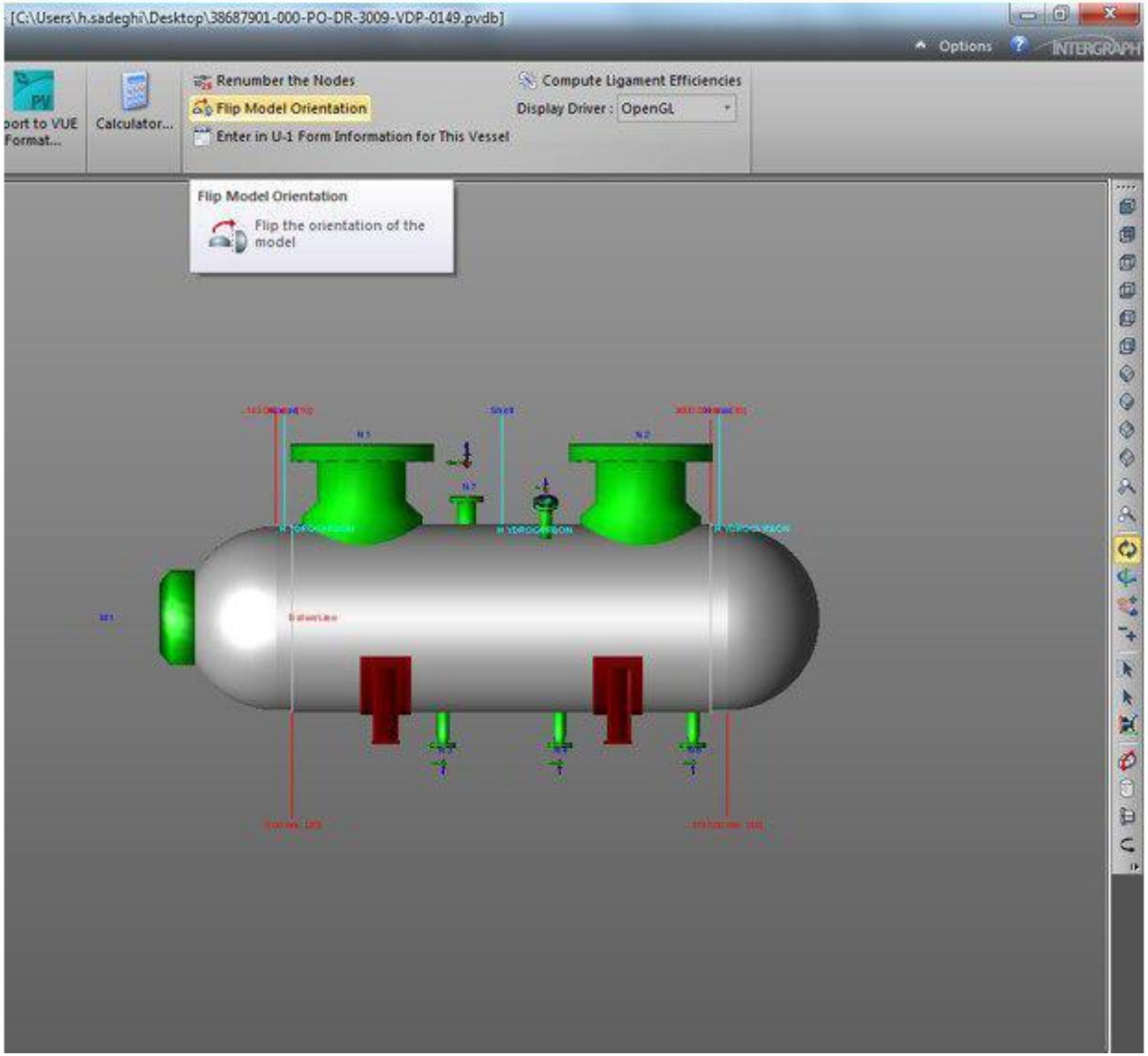
PVElite Software



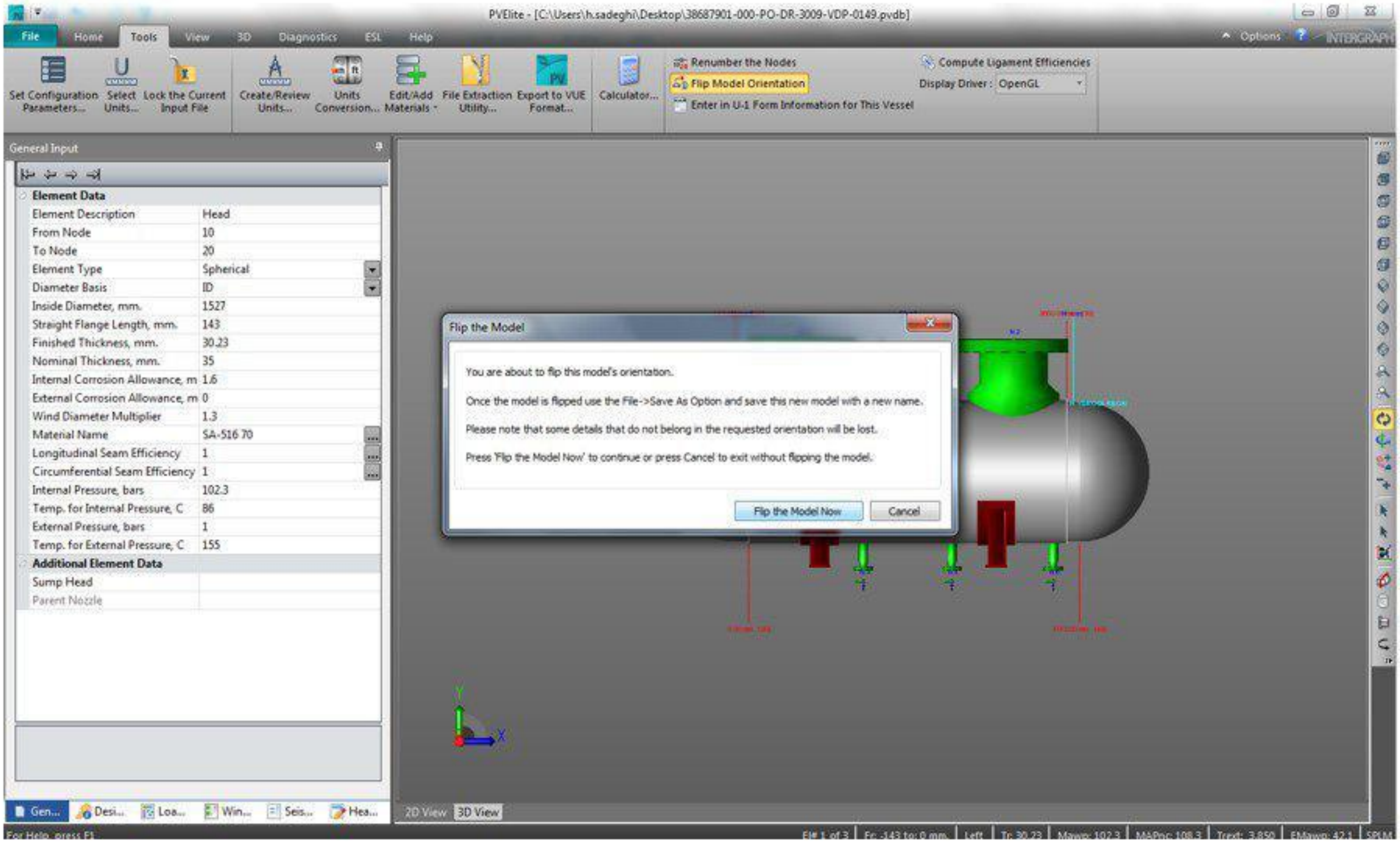
PVElite Software



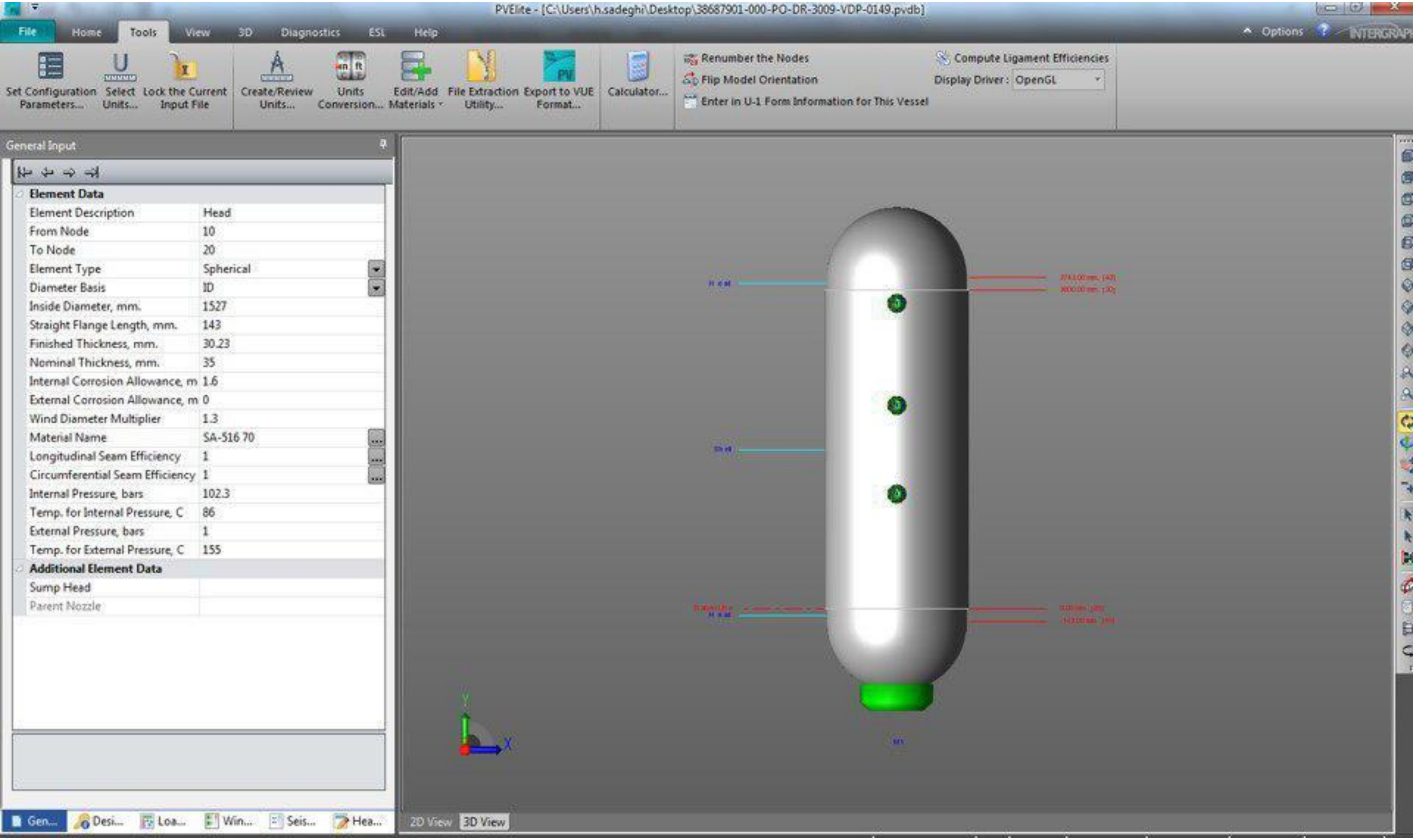
PVElite Software



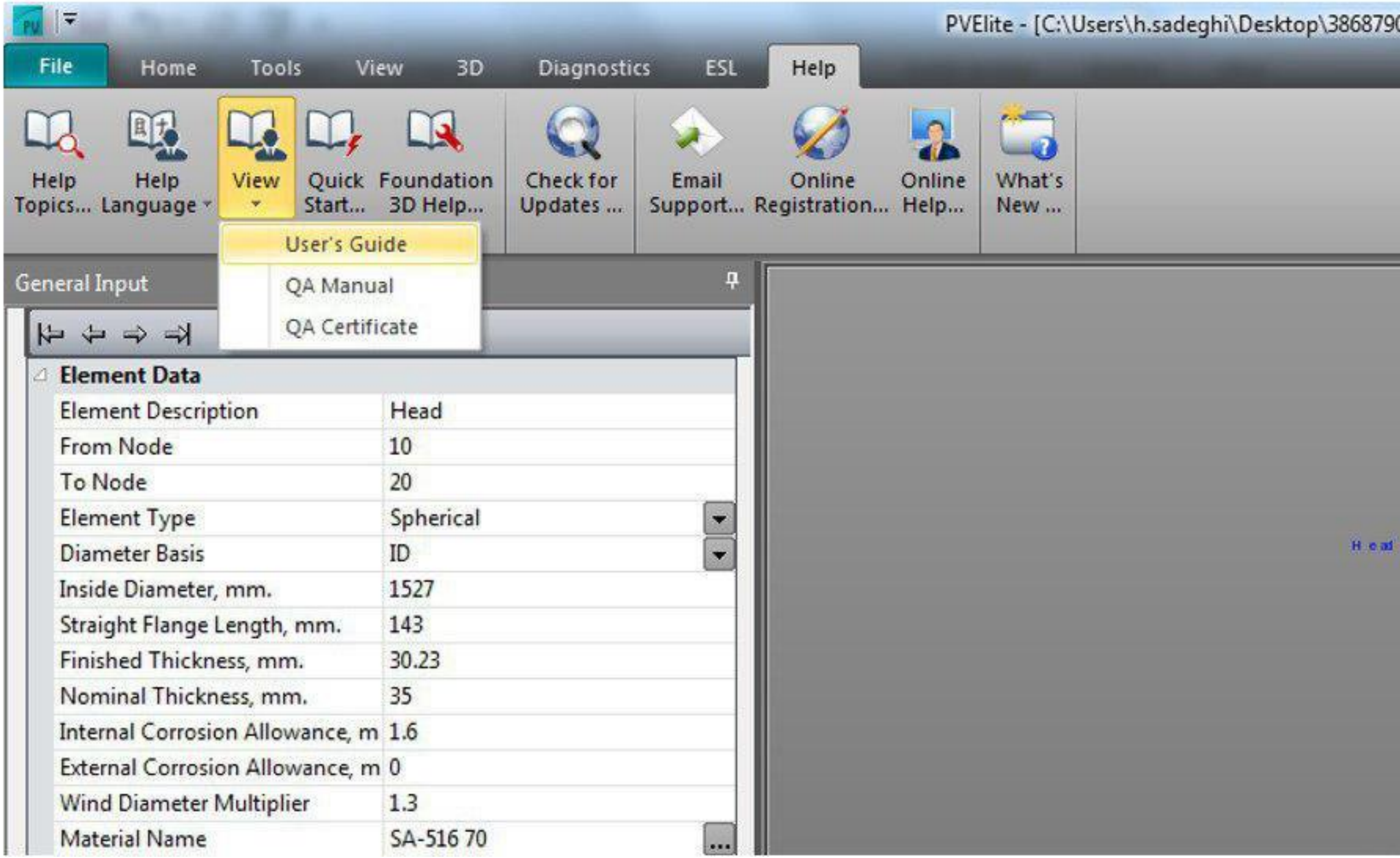
PVElite Software



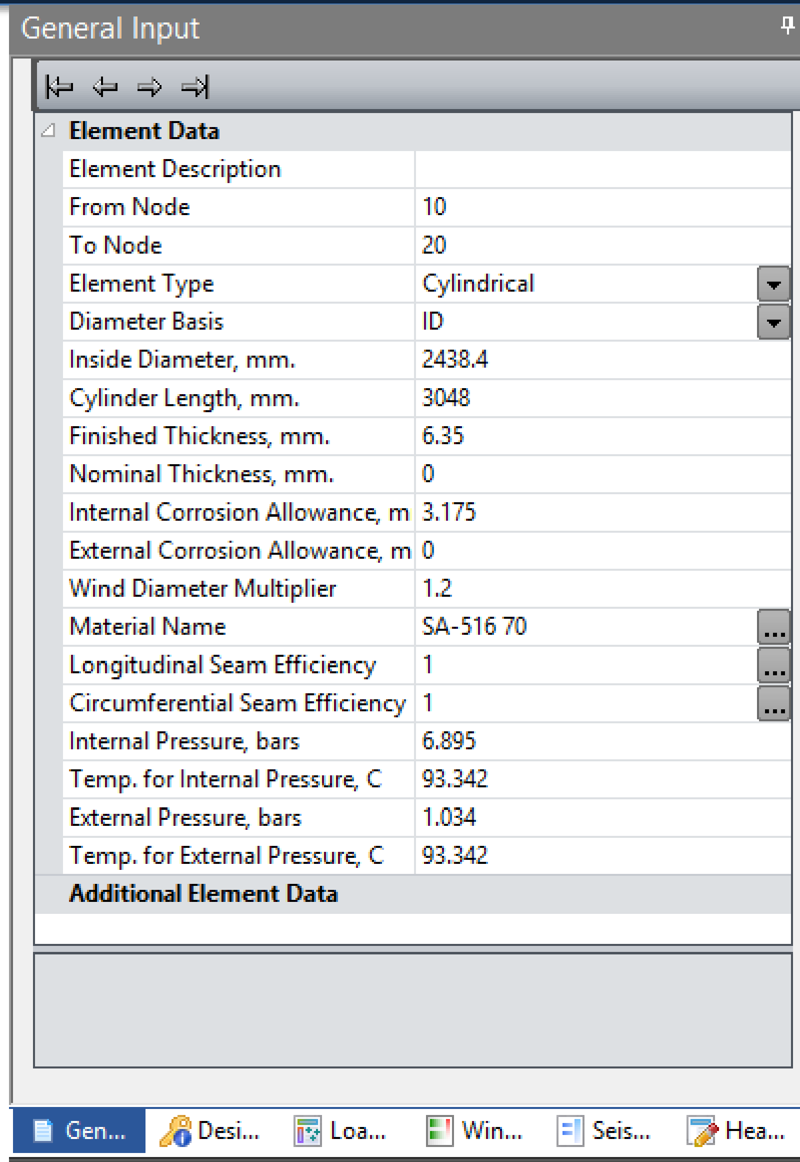
PVElite Software

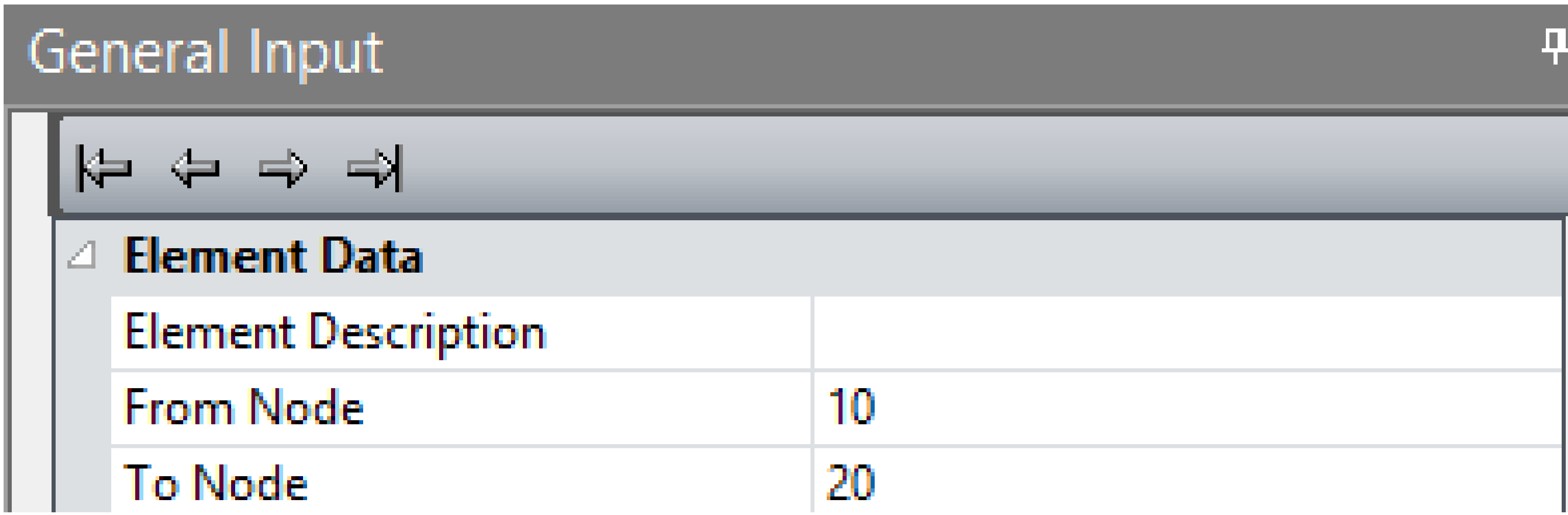


PVElite Software

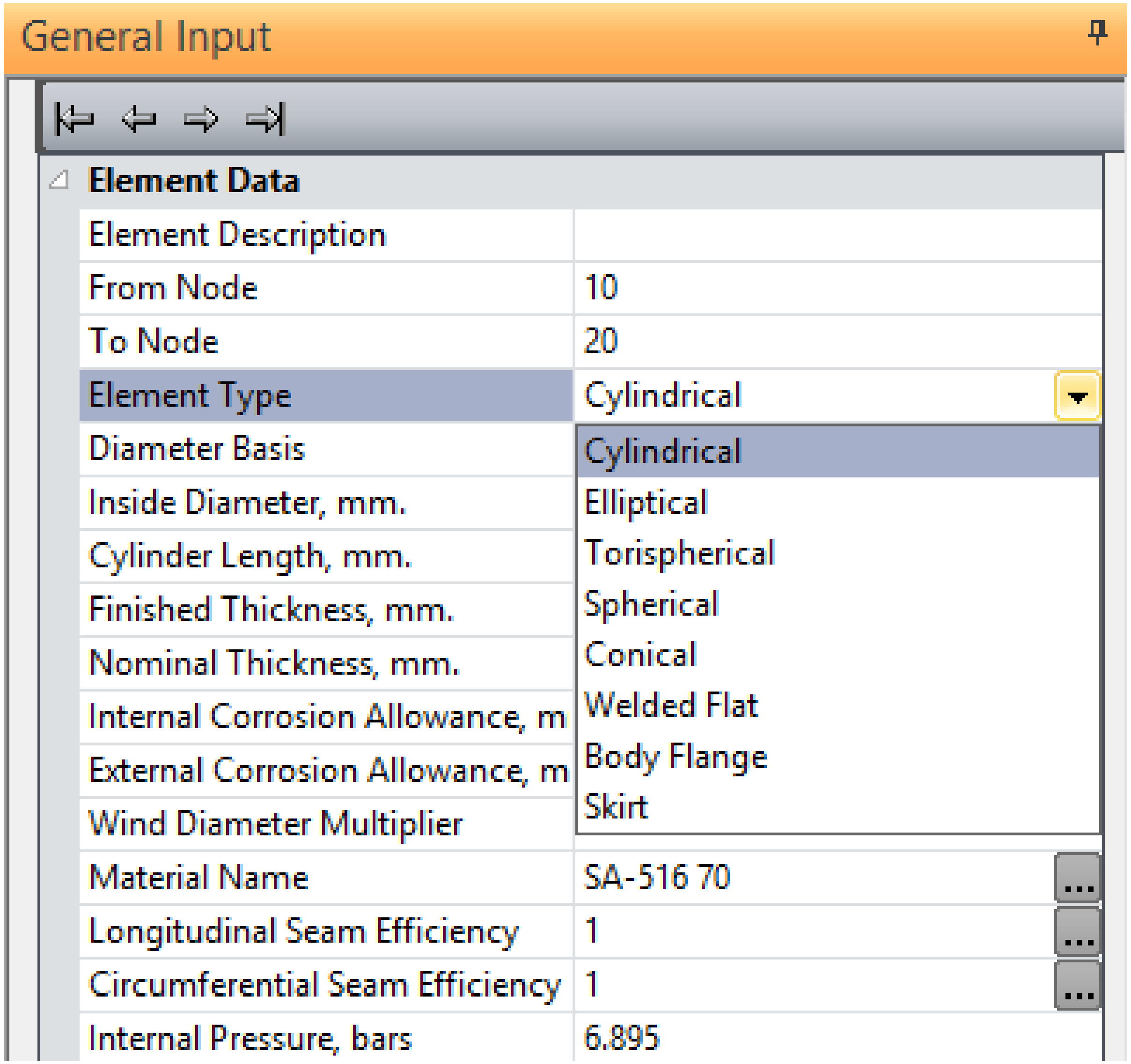


PVElite Software




General Input
Element Data
Element Description
From Node
10
To Node
20

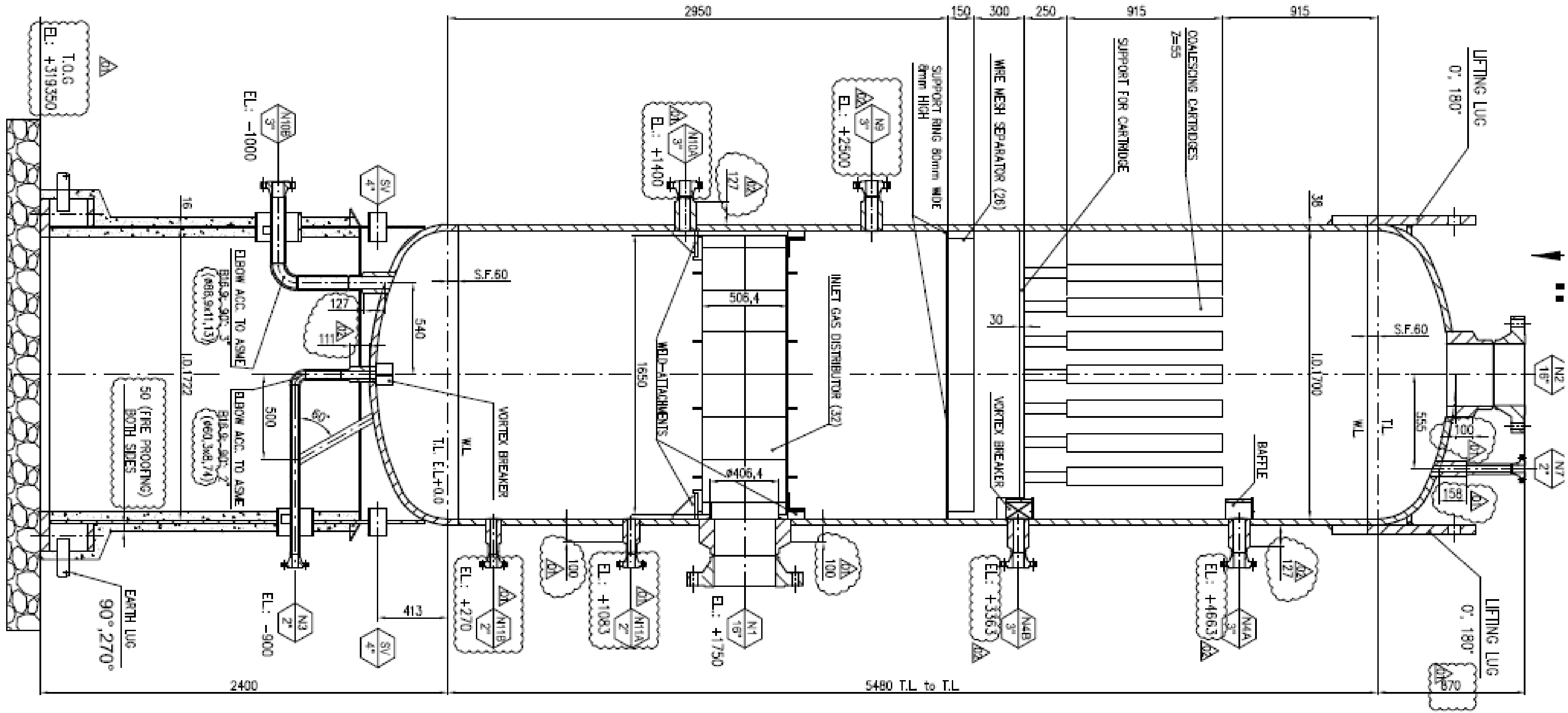
PVElite Software



Element Data	
Element Description	
From Node	10
To Node	20
Element Type	Cylindrical
Diameter Basis	ID
Inside Diameter, mm.	ID
Cylinder Length, mm.	OD
Finished Thickness, mm.	6.35
Nominal Thickness, mm.	0
Internal Corrosion Allowance, m	3.175

Inside Diameter, mm.	2438.4
Cylinder Length, mm.	3048
Finished Thickness, mm.	6.35
Nominal Thickness, mm.	0
Internal Corrosion Allowance, m	3.175
External Corrosion Allowance, m	0
Wind Diameter Multiplier	1.2
Material Name	SA-516 70
Longitudinal Seam Efficiency	1
Circumferential Seam Efficiency	1
Internal Pressure, bars	6.895
Temp. for Internal Pressure, C	93.342
External Pressure, bars	1.034
Temp. for External Pressure, C	93.342

Additional Element Data


2950
150
300
250
915
915
2400
5480 T.L. to T.L.
VORTEX BREAKER
WIRE MESH SEPARATOR (26)
SUPPORT FOR CARTRIDGE
COALESCING CARTRIDGES
INLET GAS DISTRIBUTOR (32)
LIFTING LUG
EARTH LUG
BAFFLE

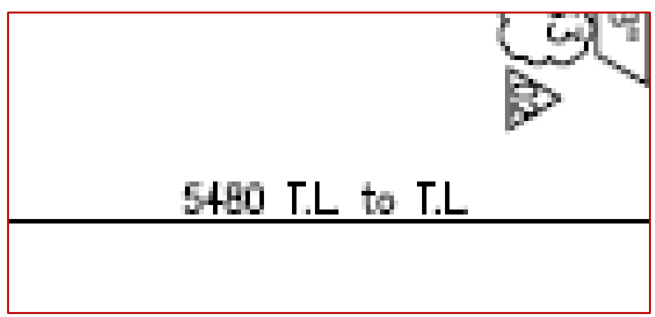

5480 T.L to T.L

Table 3-4
Effective Diameter, D_e*

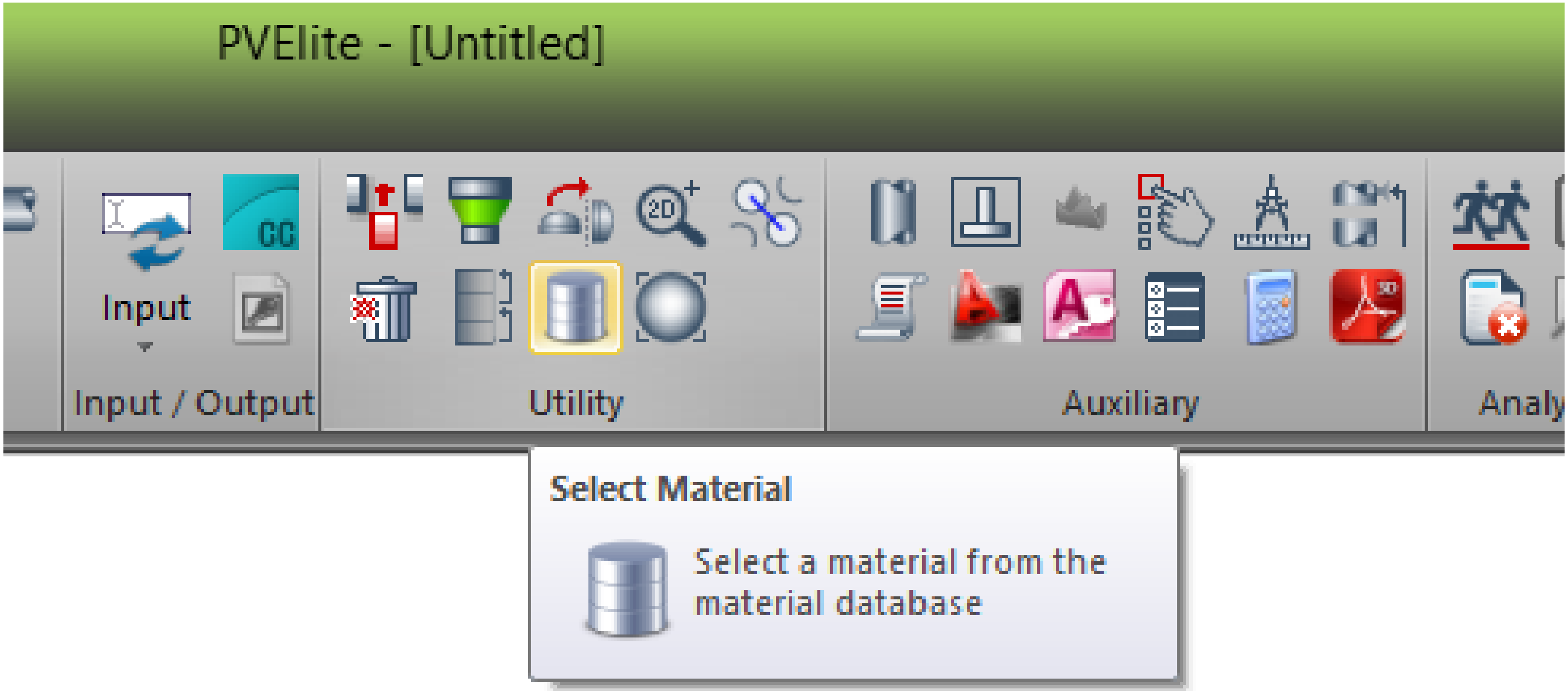
D (Vessel Diameter + 2 x Insulation Thickness)	Piping with or Without Ladders	Attached Piping, Ladders, and Platforms
≤ 4ft–0 in.	$D_e = 1.6D$	$D_e = 2.0D$
4 ft–0 in.–8 ft–0 in.	$D_e = 1.4D$	$D_e = 1.6D$
> 8 ft–0 in.	$D_e = 1.2D$	$D_e = 1.4D$

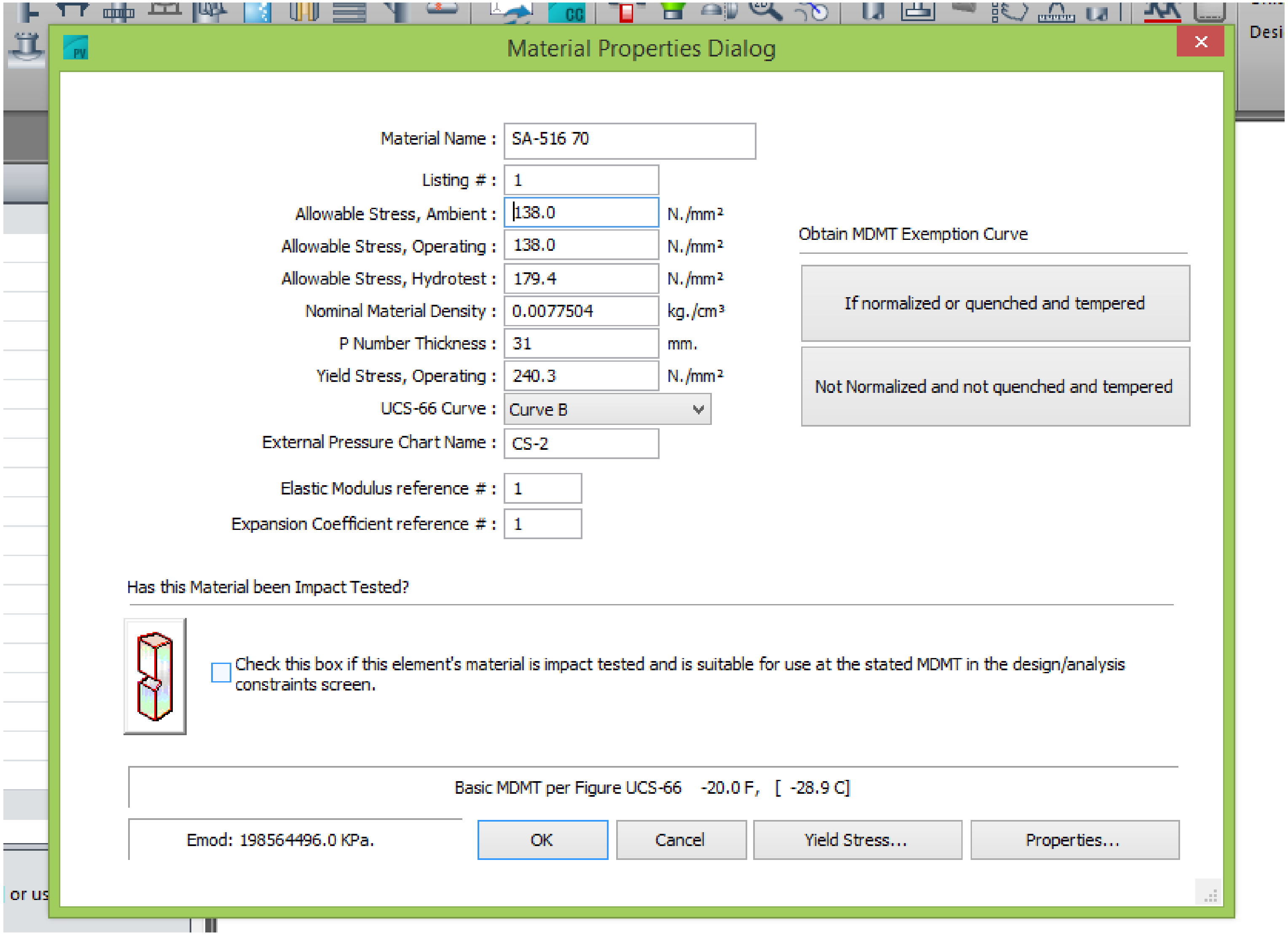
*Suggested only; not from ASCE.

Table 4-4
Effective diameter, D_e*

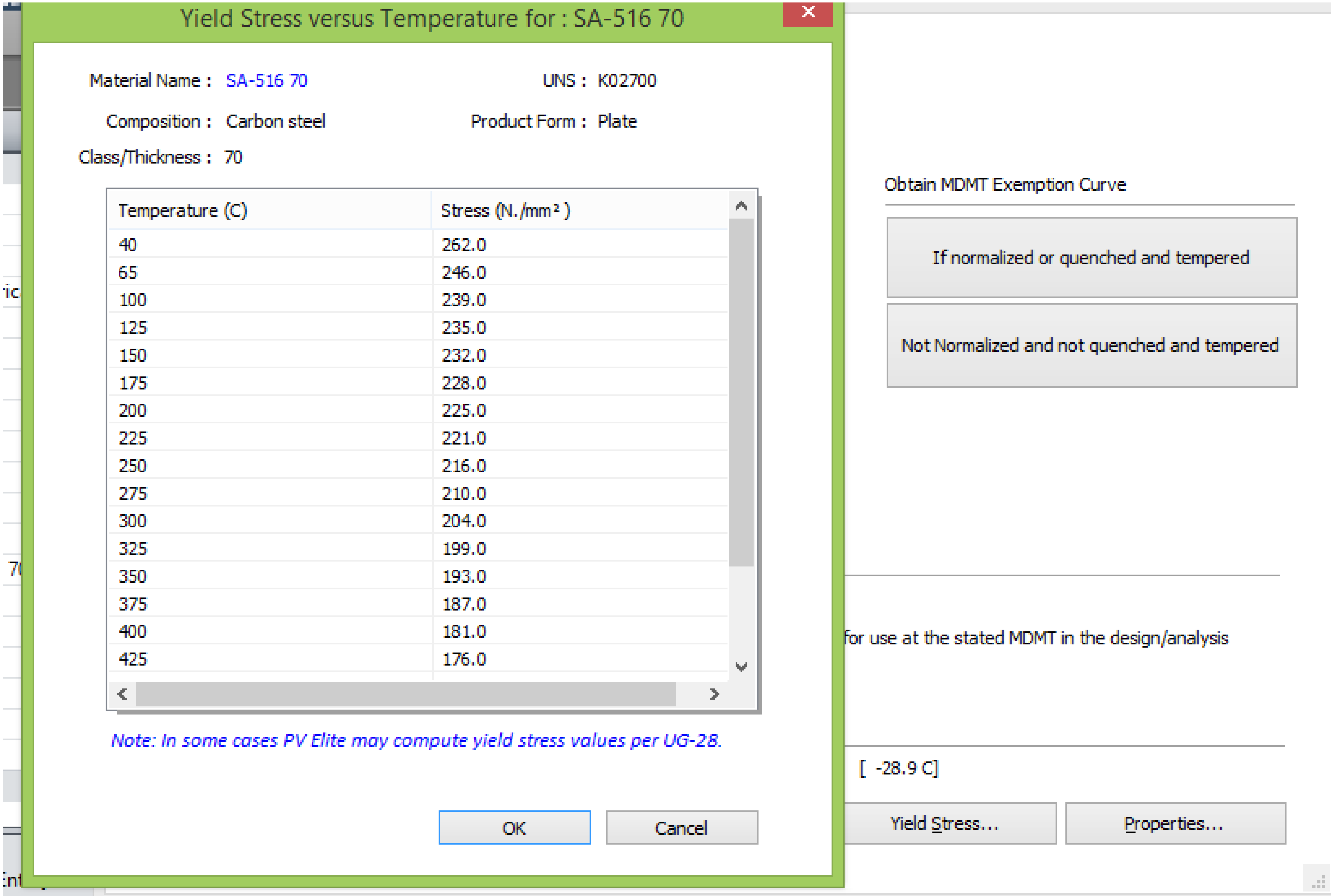
D (Vessel Diameter + 2 x Insulation Thickness)	Piping with or Without Ladders	Attached Piping, Ladders, and Platforms
≤ 4ft – 0 in.	$D_e = 1.6D$	$D_e = 2.0D$
4ft - 0 in. – 8 ft – 0 in.	$D_e = 1.4D$	$D_e = 1.6D$
> 8 ft – 0 in.	$D_e = 1.2D$	$D_e = 1.4D$

** Suggested only; not from ASCE.*


PVElite - [Untitled]
Input
Input / Output
Utility
Auxiliary
Analy
Select Material
Select a material from the material database


Material Properties Dialog
Material Name : SA-516 70
Listing # : 1
Allowable Stress, Ambient : 138.0 N./mm²
Allowable Stress, Operating : 138.0 N./mm²
Allowable Stress, Hydrotest : 179.4 N./mm²
Nominal Material Density : 0.0077504 kg./cm³
P Number Thickness : 31 mm.
Yield Stress, Operating : 240.3 N./mm²
UCS-66 Curve : Curve B
External Pressure Chart Name : CS-2
Elastic Modulus reference # : 1
Expansion Coefficient reference # : 1
Obtain MDMT Exemption Curve
If normalized or quenched and tempered
Not Normalized and not quenched and tempered
Has this Material been Impact Tested?
Check this box if this element's material is impact tested and is suitable for use at the stated MDMT in the design/analysis constraints screen.
Basic MDMT per Figure UCS-66 -20.0 F, [-28.9 C]
Emod: 198564496.0 KPa.
OK
Cancel
Yield Stress...
Properties...

PVElite Software



Yield Stress versus Temperature for : SA-516 70

Material Name : SA-516 70   UNS : K02700

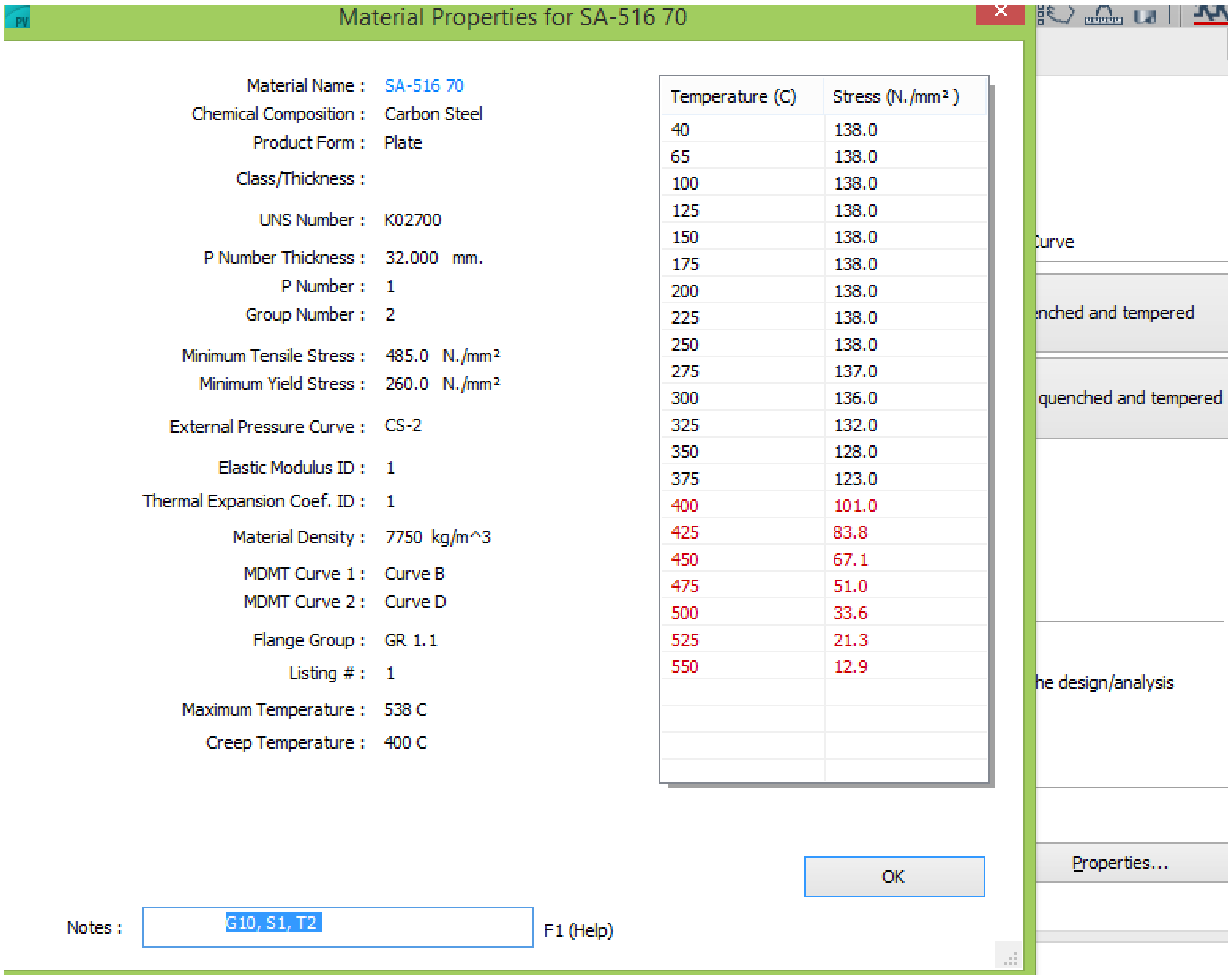
Composition : Carbon steel   Product Form : Plate

Class/Thickness : 70

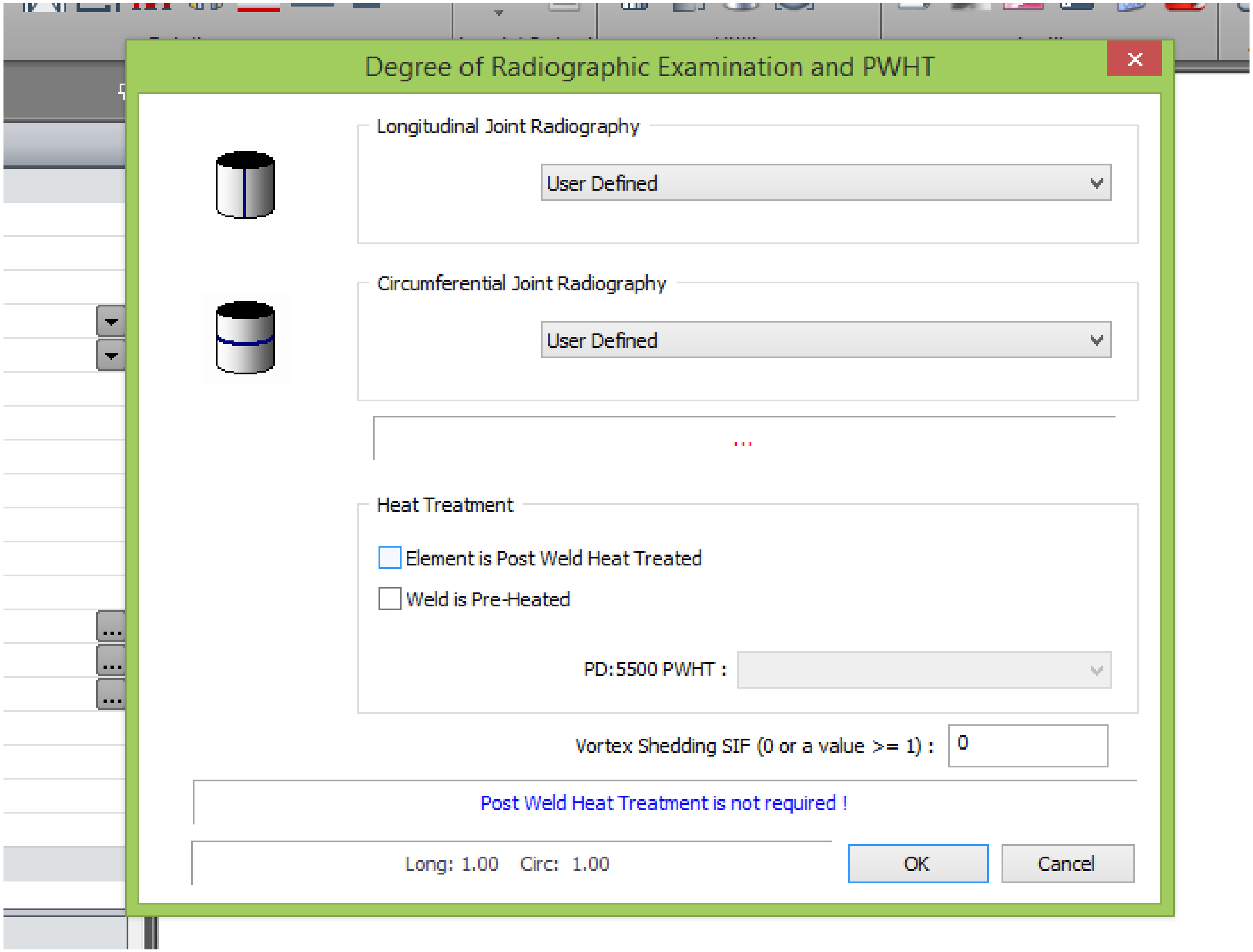
Temperature (C)	Stress (N./mm²)
40	262.0
65	246.0
100	239.0
125	235.0
150	232.0
175	228.0
200	225.0
225	221.0
250	216.0
275	210.0
300	204.0
325	199.0
350	193.0
375	187.0
400	181.0
425	176.0

Note: In some cases PV Elite may compute yield stress values per UG-28.

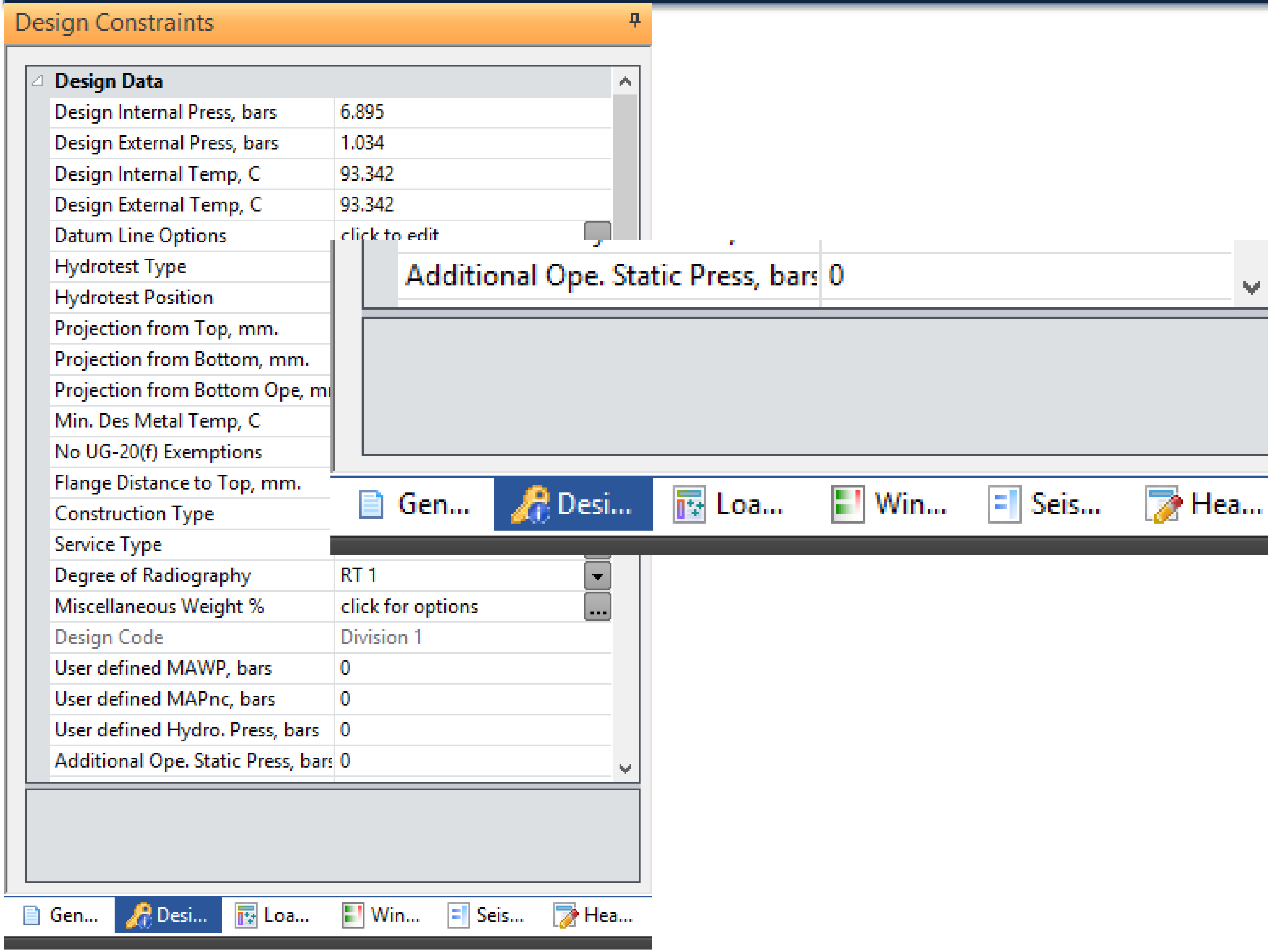
OK   Cancel



Temperature (C)	Stress (N./mm²)
40	138.0
65	138.0
100	138.0
125	138.0
150	138.0
175	138.0
200	138.0
225	138.0
250	138.0
275	137.0
300	136.0
325	132.0
350	128.0
375	123.0
400	101.0
425	83.8
450	67.1
475	51.0
500	33.6
525	21.3
550	12.9


Degree of Radiographic Examination and PWHT
Longitudinal Joint Radiography
User Defined
Circumferential Joint Radiography
User Defined
Heat Treatment
Element is Post Weld Heat Treated
Weld is Pre-Heated
PD:5500 PWHT :
Vortex Shedding SIF (0 or a value >= 1) :
0
Post Weld Heat Treatment is not required !
Long: 1.00 Circ: 1.00
OK
Cancel

PVElite Software

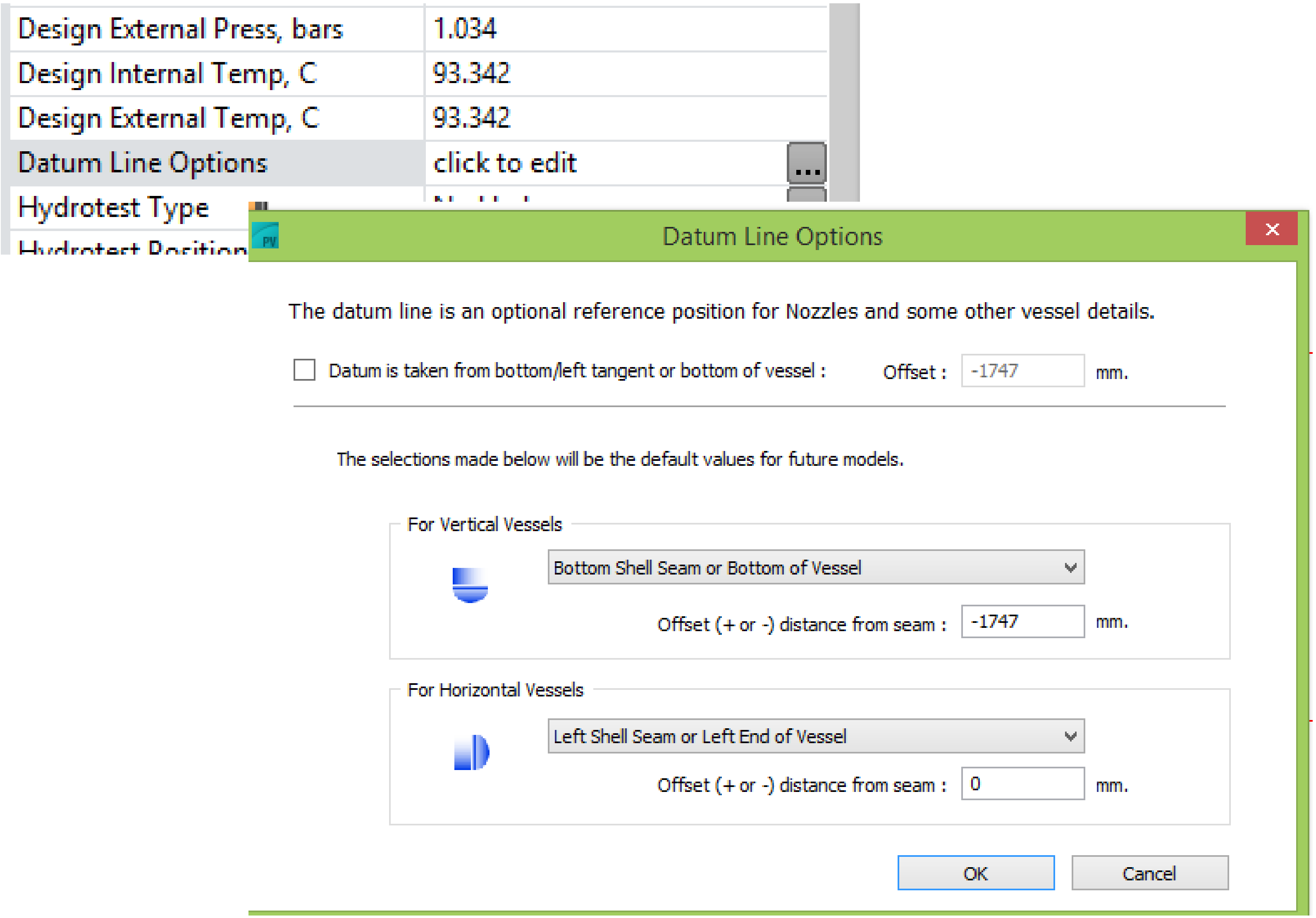


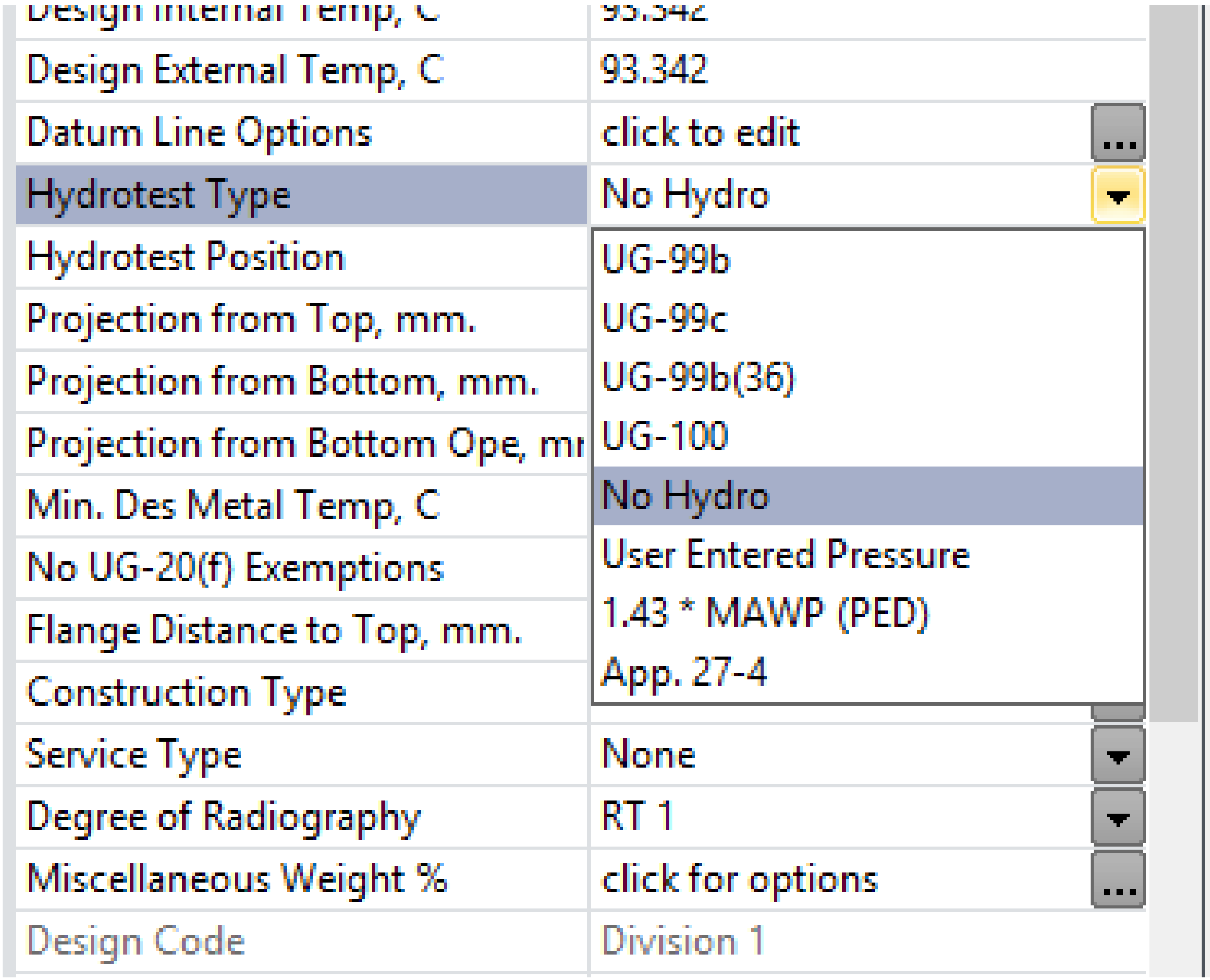
Design Constraints

Design Data	
Design Internal Press, bars	6.895
Design External Press, bars	1.034
Design Internal Temp, C	93.342
Design External Temp, C	93.342
Datum Line Options	click to edit
Hydrotest Type	No Hydro

Additional Ope. Static Press, bars	0
Use Higher Long. Stress	✔
Consider Vortex Shedding	
No Vortex Shedding for H/D <=	
Is this a heat Exchanger	☐
Corroded Hydrotest	
Hyd. Allowable is 90% Yield	

PVElite Software




Design Internal Temp, C
93.342
Design External Temp, C
93.342
Datum Line Options
click to edit
Hydrotest Type
No Hydro
Hydrotest Position
UG-99b
Projection from Top, mm.
UG-99c
Projection from Bottom, mm.
UG-99b(36)
Projection from Bottom Ope, mm
UG-100
Min. Des Metal Temp, C
No Hydro
No UG-20(f) Exemptions
User Entered Pressure
Flange Distance to Top, mm.
1.43 * MAWP (PED)
Construction Type
App. 27-4
Service Type
None
Degree of Radiography
RT 1
Miscellaneous Weight %
click for options
Design Code
Division 1

Design External Temp, C	93.342
Datum Line Options	click to edit ...
Hydrotest Type	No Hydro
Hydrotest Position	Horizontal
Projection from Top, mm.	Vertical
Projection from Bottom, mm.	Horizontal
Projection from Bottom Ope, mı	0
Min. Des Metal Temp, C	-28.8898

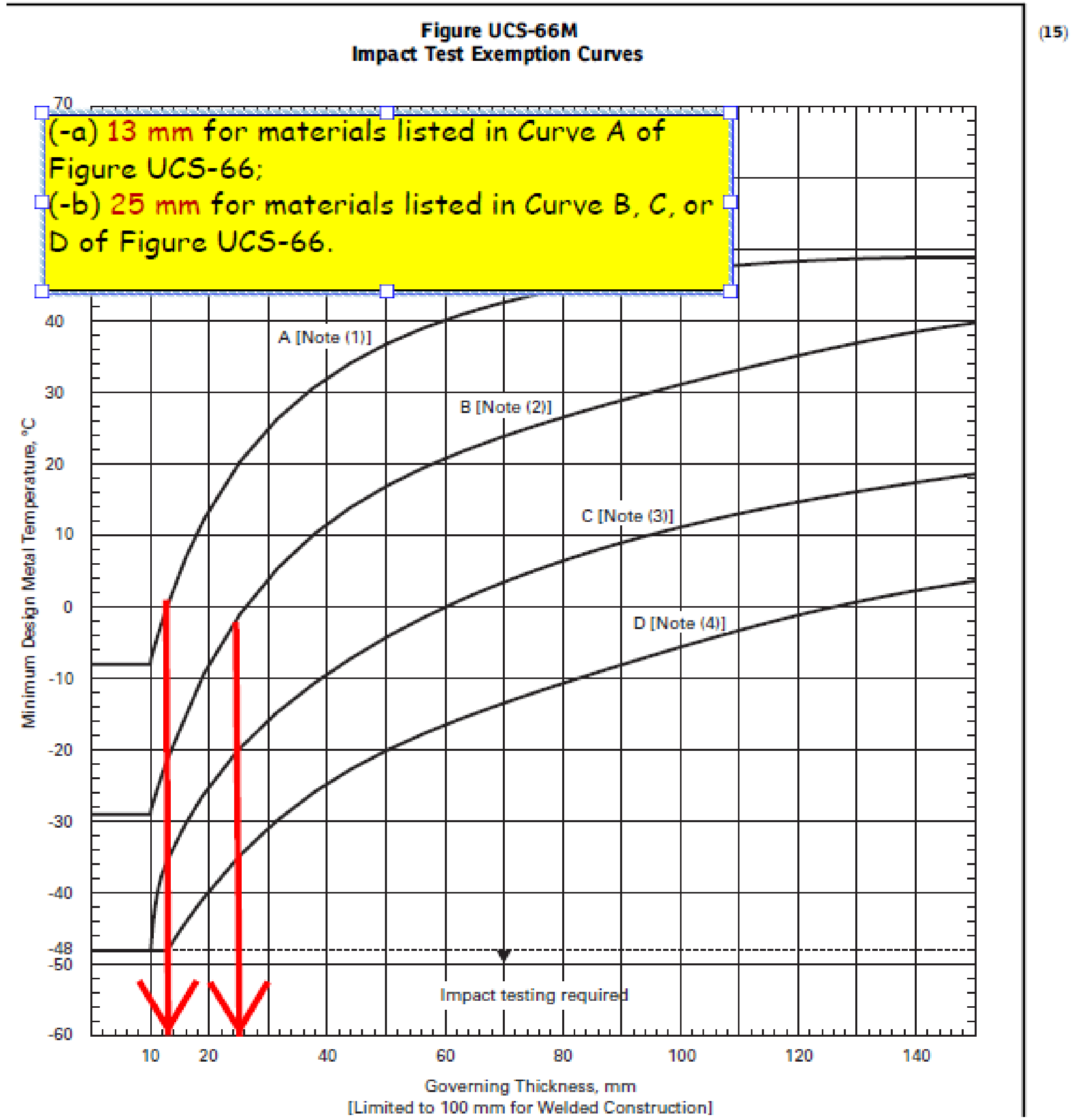
Datum Line Options	click to edit
Hydrotest Type	No Hydro
Hydrotest Position	Horizontal
Projection from Top, mm.	0
Projection from Bottom, mm.	0
Projection from Bottom Ope, mı	0
Min. Des Metal Temp, C	-28.8898
No UG-20(f) Exemptions	
Flange Distance to Top, mm.	0
Construction Type	Welded
Service Type	None
Degree of Radiography	RT 1
Miscellaneous Weight %	click for options

Design Temperature (UG-20)

UG-20 (f)

- (1) Material is limited to P-No.1 Gr. No.1 or 2 and the thicknesses don't exceed the following:
  - (-a) 13 mm for materials listed in Curve A of Figure UCS-66;
  - (-b) 25 mm for materials listed in Curve B, C, or D of Figure UCS-66.
- (2) The completed vessel shall be hydrostatically tested.
- (3) Design temperature is no warmer than 345°C nor colder than −29°C.
- (4) The thermal or mechanical shock loadings are not a controlling design requirement.
- (5) Cyclical loading is not a controlling design requirement.

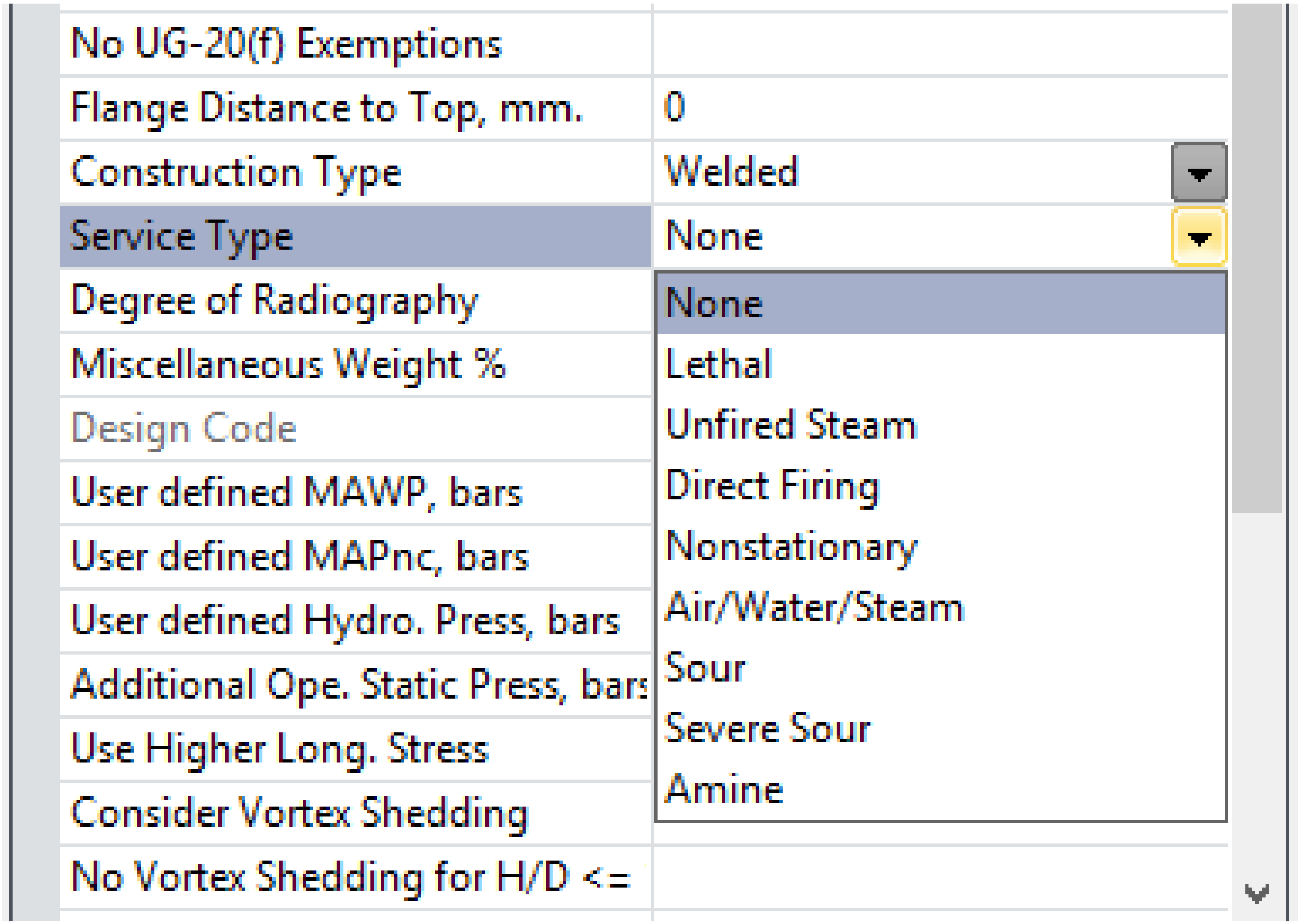
Design Temperature (UG-20)

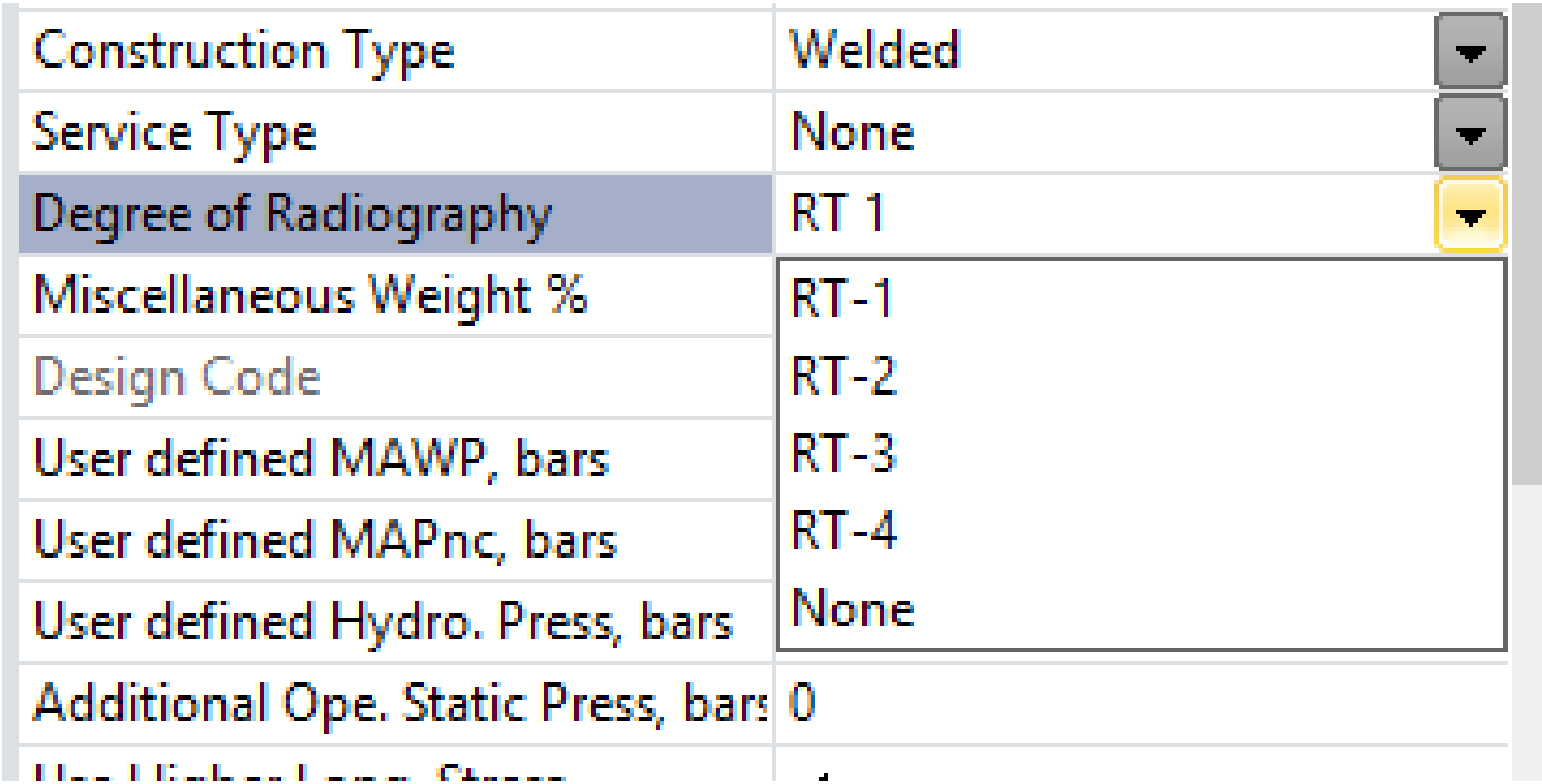


Min. Des Metal Temp, C	-28.8898
No UG-20(f) Exemptions	
Flange Distance to Top, mm.	0
Construction Type	Welded
Service Type	
Degree of Radiography	
Miscellaneous Weight %	
Design Code	
User defined MAWP, bars	0
User defined MAPnc, bars	0

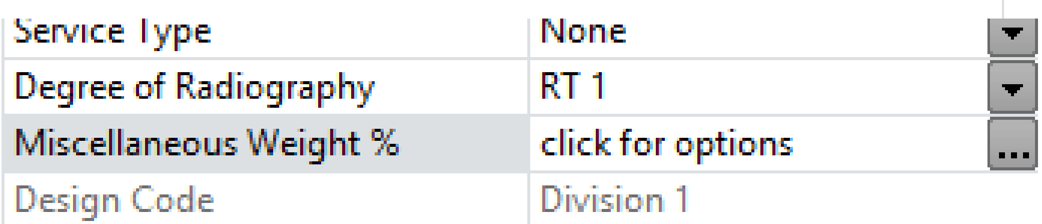
- Welded
- Press. Welded
- Brazed
- Resist. Welded

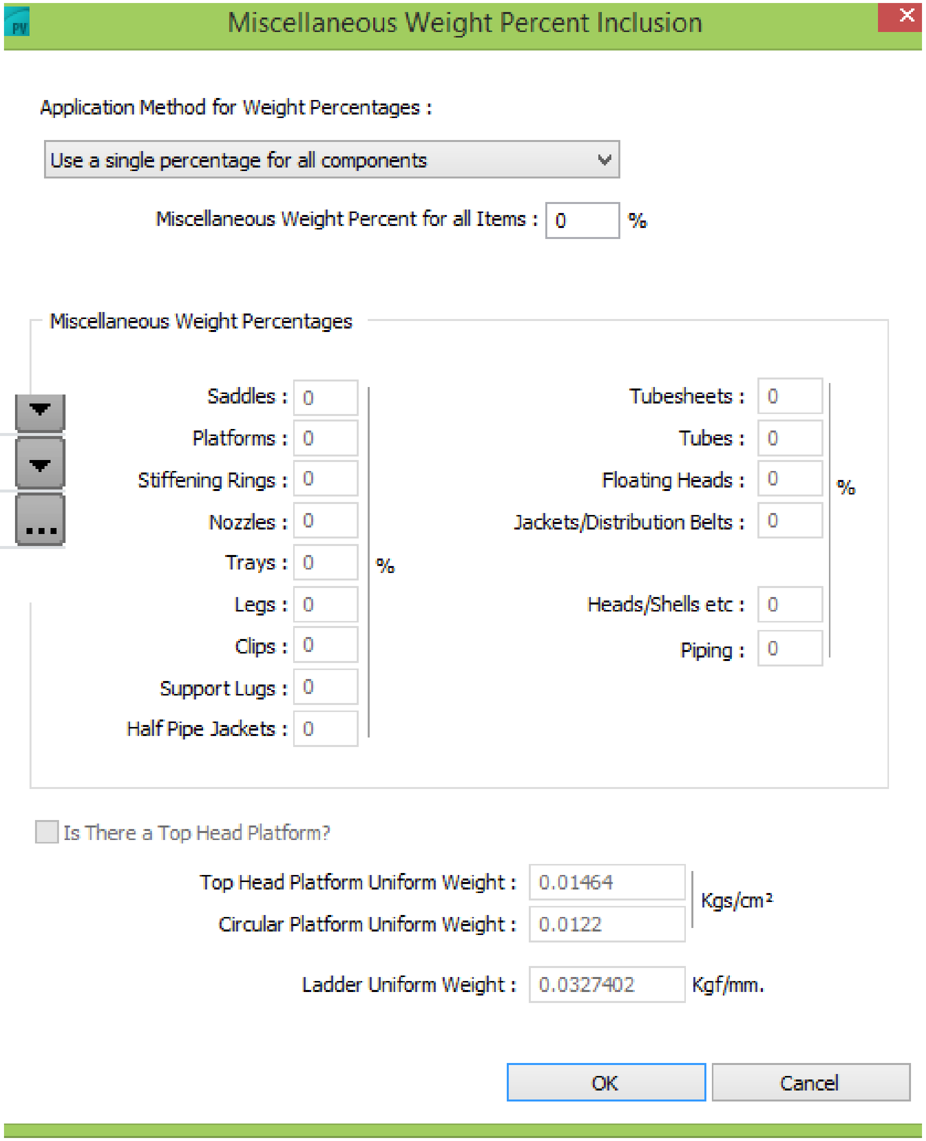
PVElite Software




Construction Type
Welded
Service Type
None
Degree of Radiography
RT 1
RT-1
RT-2
RT-3
RT-4
None
Miscellaneous Weight %
Design Code
User defined MAWP, bars
User defined MAPnc, bars
User defined Hydro. Press, bars
Additional Ope. Static Press, bars
0

PVElite Software





PVElite Software

Miscellaneous Weight %	click for options
Design Code	Division 1
User defined MAWP, bars	0
User defined MAPnc, bars	0
User defined Hydro. Press, bars	0
Additional Ope. Static Press, bars	0
Use Higher Long. Stress	✔
Consider Vortex Shedding	

Miscellaneous Weight %	Click for options
Design Code	Division 1
User defined MAWP, bars	0
User defined MAPnc, bars	0
User defined Hydro. Press, bars	0
Additional Ope. Static Press, bars	0
Use Higher Long. Stress	✓
Consider Vortex Shedding	
No Vortex Shedding for H/D <= 15	
Is this a heat Exchanger	
Corroded Hydrotest	
Hyd. Allowable is 90% Yield	

Additional Ope. Static Press, bars	0
Use Higher Long. Stress	✓
Consider Vortex Shedding	
No Vortex Shedding for H/D <= 15	
Is this a heat Exchanger	✓
Corroded Hydrotest	
Hyd. Allowable is 90% Yield	

PVElite Software

Corroded Hydrotest	
Hyd. Allowable is 90% Yield	
ASME Steel Stack	☐
ASCE Wind Exposure	C
Factor of Safety	1.5
Mean Hourly Wind Speed, Km/hr	0
Is the Stack Lined?	
Importance Factor	1
Design Modification	
Select Wall Thickness for Internal Pressu	No
Select Wall Thickness for External Pressu	No
Select Stiffening Rings for External Press	No
Select Wall Thickness for Axial Stress	No

PVElite Software

Reset Cases

Global Scalar for WI loads : 1 >

Global Scalar for EQ loads : 1 >

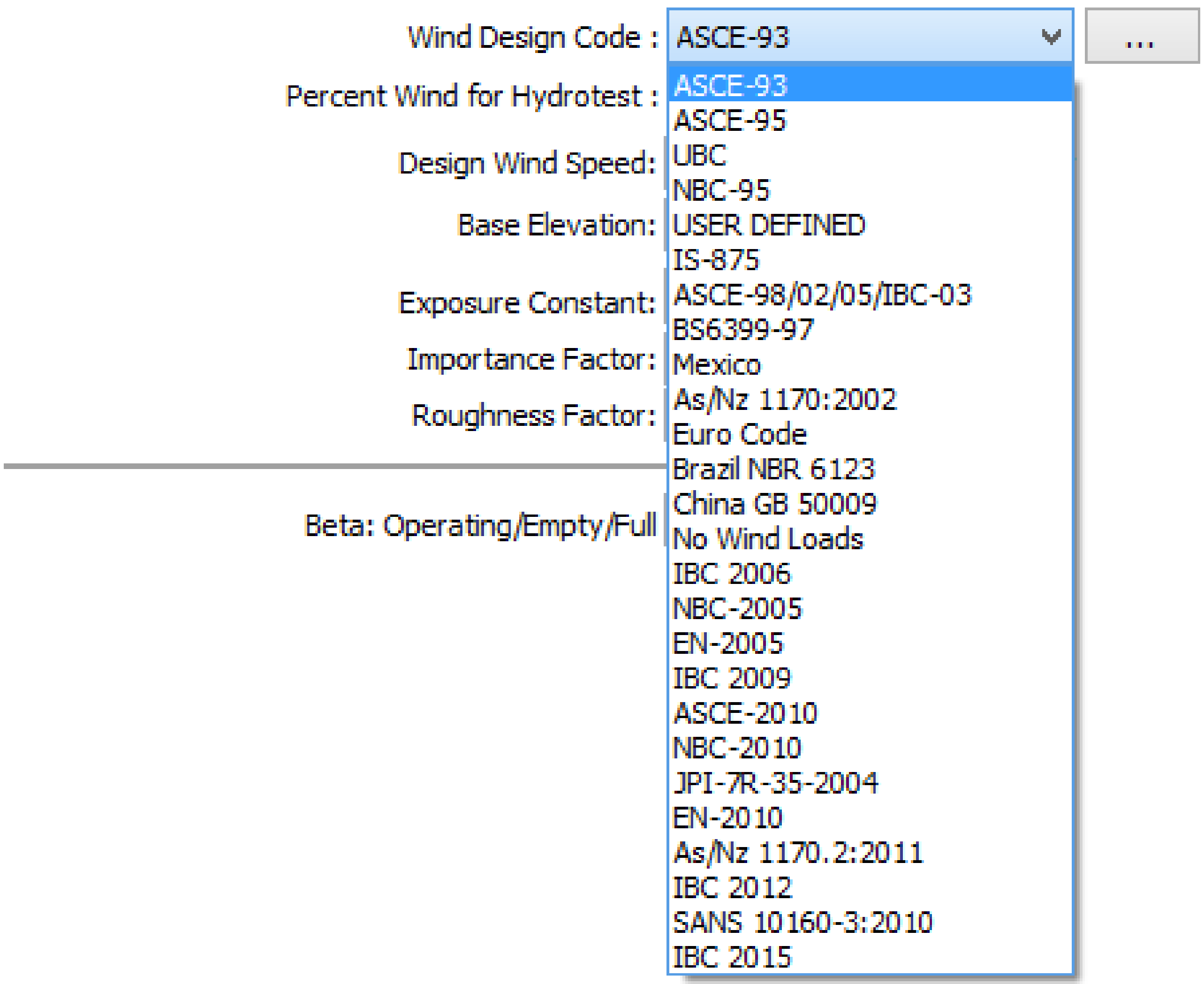
☐ Use and Allow Editing of Local Scalars in the load cases

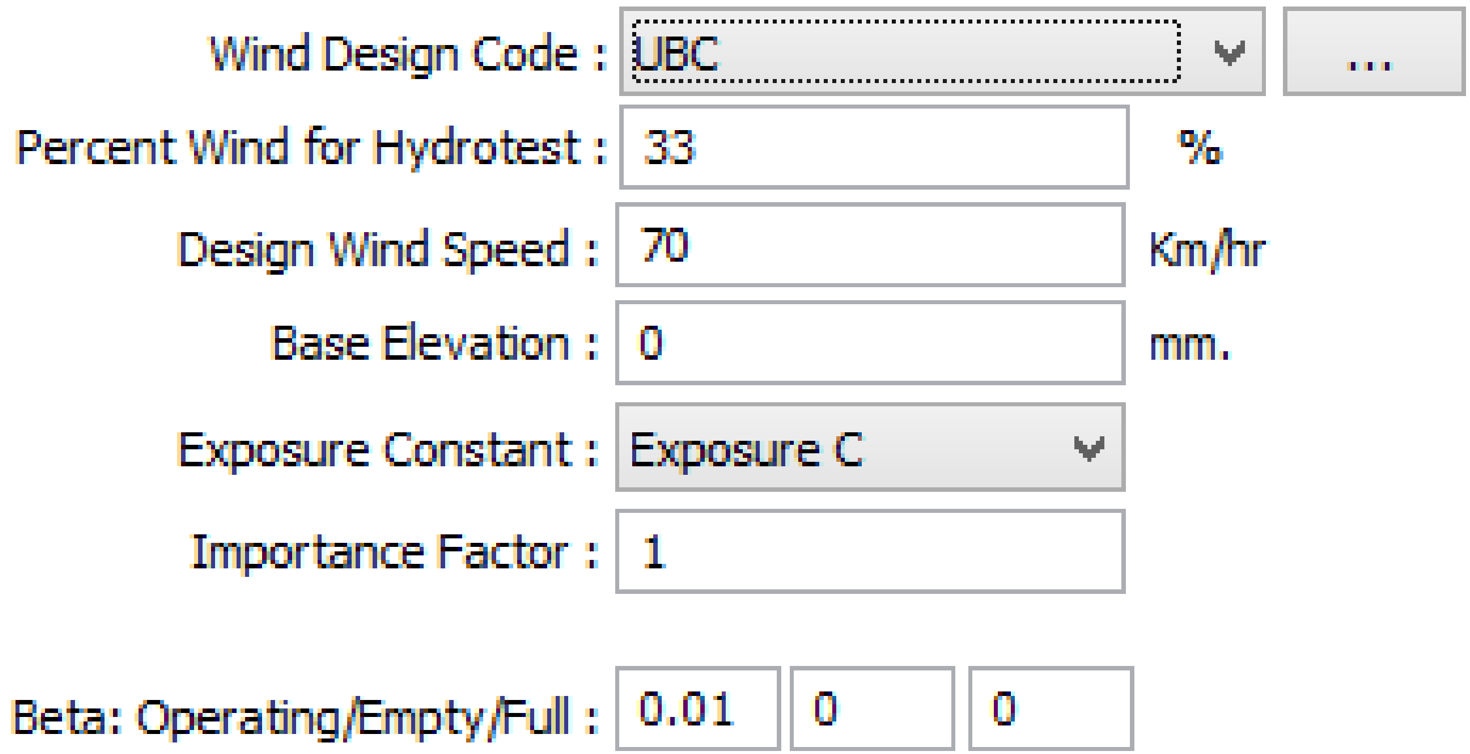
Set Load Cases to show WI and EQ Scalars

Stress Combination Load Cases	
Case 1	NP+EW+WI+FW+BW
Case 2	NP+EW+EE+FS+BS
Case 3	NP+OW+WI+FW+BW
Case 4	NP+OW+EQ+FS+BS
Case 5	NP+HW+HI
Case 6	NP+HW+HE
Case 7	IP+OW+WI+FW+BW
Case 8	IP+OW+EQ+FS+BS
Case 9	EP+OW+WI+FW+BW
Case 10	EP+OW+EQ+FS+BS
Case 11	HP+HW+HI
Case 12	HP+HW+HE
Case 13	IP+WE+EW
Case 14	IP+WF+CW
Case 15	IP+VO+OW
Case 16	IP+VE+EW
Case 17	NP+VO+OW

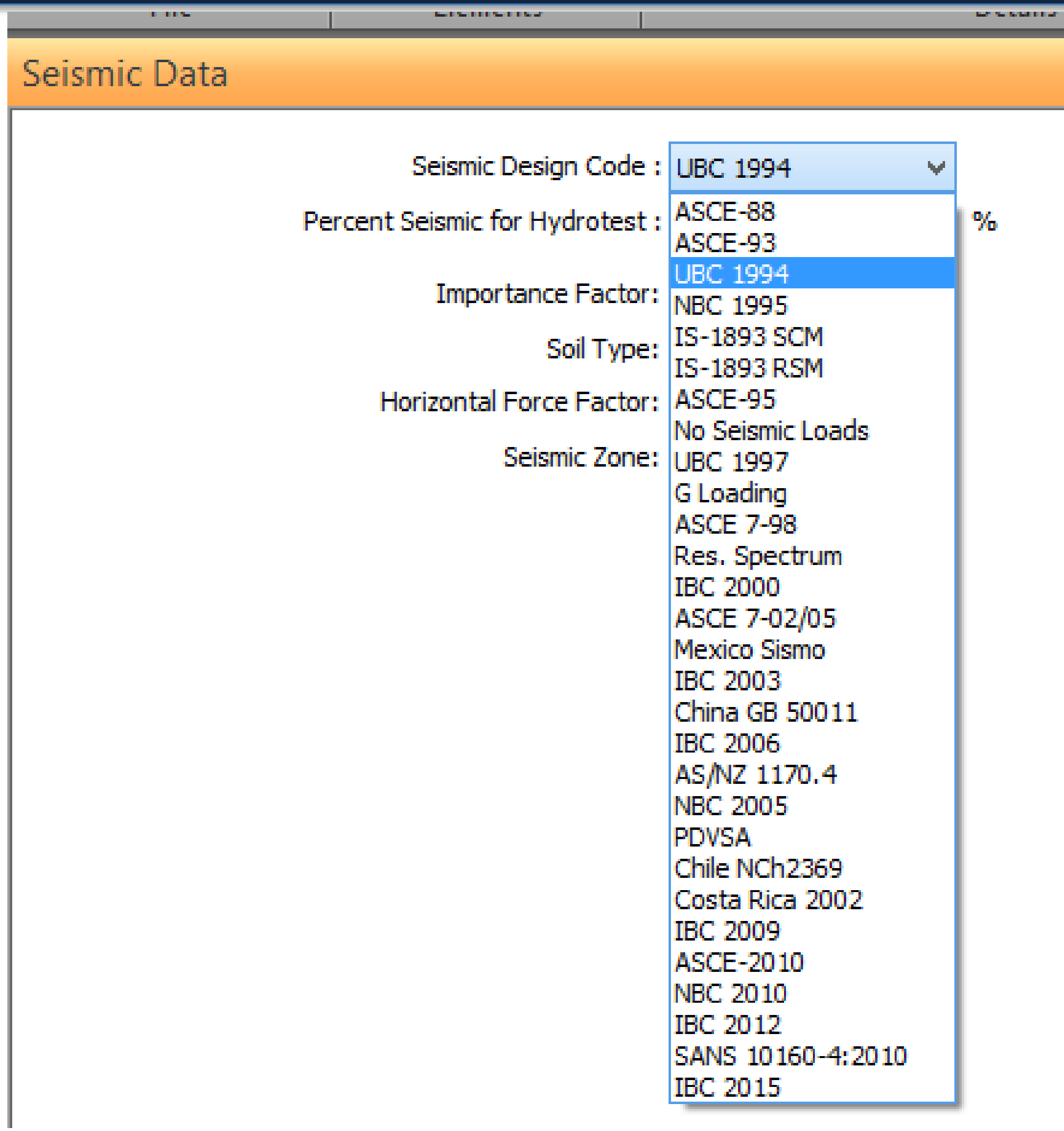
PVElite Software

Wind Data




Wind Design Code : UBC
...
Percent Wind for Hydrotest : 33 %
Design Wind Speed : 70 Km/hr
Base Elevation : 0 mm.
Exposure Constant : Exposure C
Importance Factor : 1
Beta: Operating/Empty/Full : 0.01 0 0

PVElite Software



PVElite Software

Seismic Design Code :	UBC 1997
Percent Seismic for Hydrotest :	0 %
Importance Factor:	1.25
Seismic Coefficient Ca:	0.36
Seismic Coefficient Cv:	0.84
Near Source Factor Nv:	1
Seismic Zone:	Zone 4
Force Factor R or Rp:	2
Apply Allowables per 1612.3.2 :	☐

If Building Supported fill in the following values

Component Elevation ratio hx/hr:	0
Component Amplification Factor ap:	0

hx / hr :

Enter a value for the elevation ratio if the vessel is attached to another structure, such as a building. The ratio, needed for proper analysis, is the height in the structure where the vessel is attached *hx* to the average height of the roof *hr*. Generally, this value is less than or equal to 1. For more information, see Section 1632.2, UBC 1997.

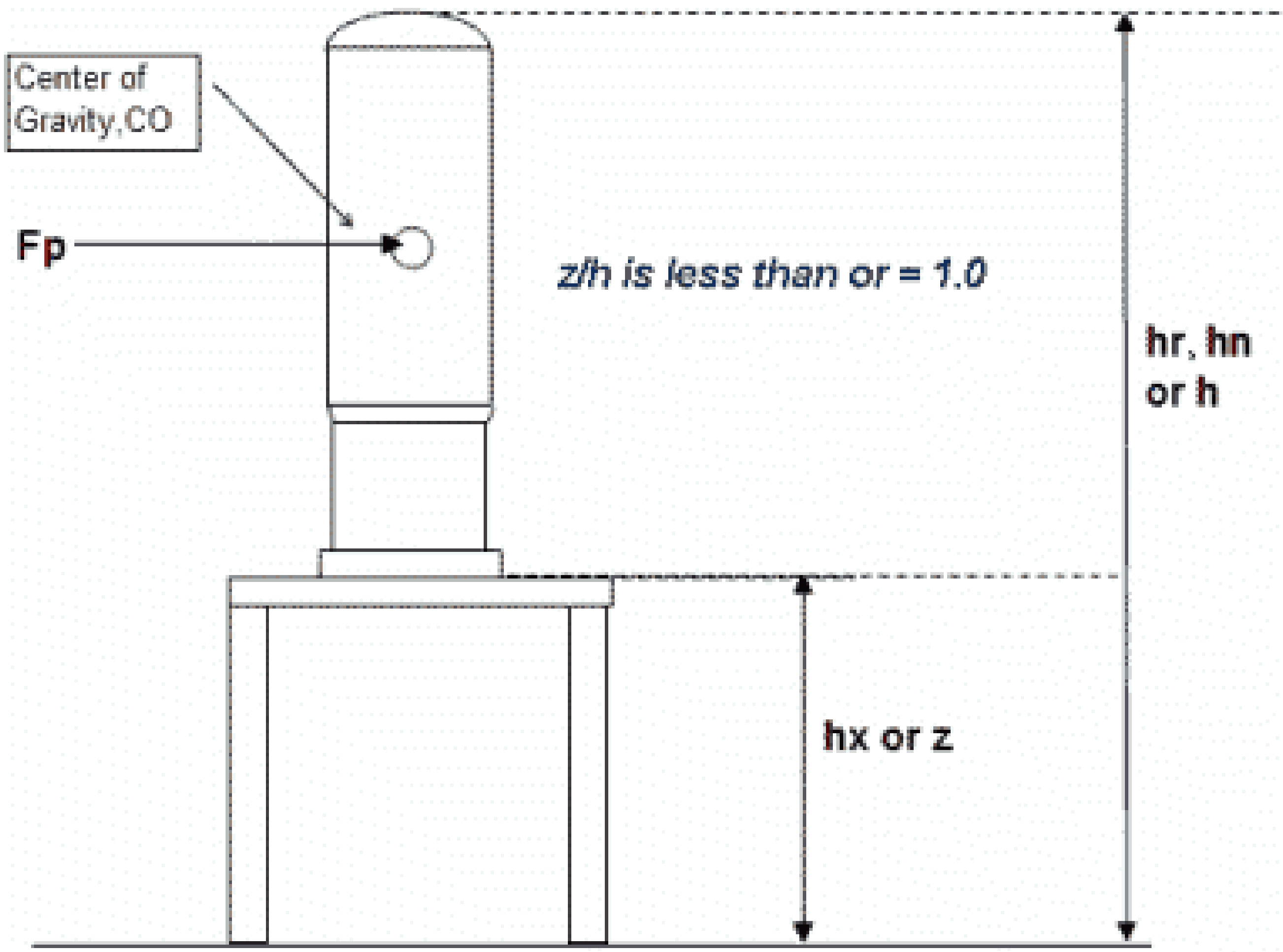

Center of
Gravity,CO
Fp
z/h is less than or = 1.0
hr, hn
or h
hx or z

Table 16-Q

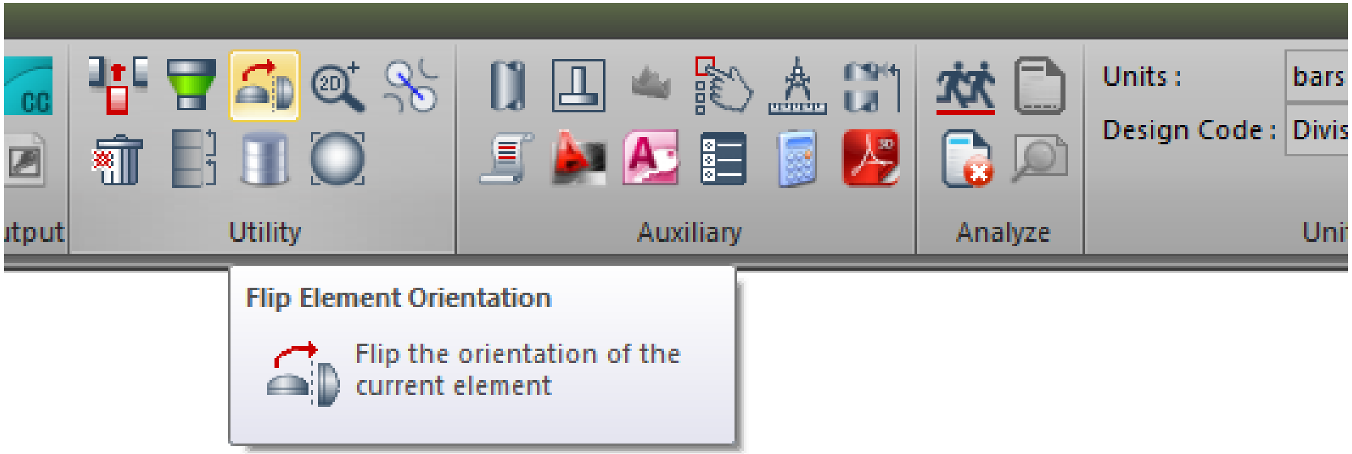
Soil Profile Type	Seismic Coefficient *Ca* for Seismic Zone Factor Z of:				
	Z=0.075	Z=0.15	Z=0.2	Z=0.3	Z=0.4
Sa	0.06	0.12	0.16	0.24	0.32Na
Sb	0.08	0.15	0.20	0.30	0.40Na
Sc	0.09	0.18	0.24	0.33	0.40Na
Sd	0.12	0.22	0.28	0.36	0.44Na
Se	0.19	0.30	0.34	0.36	0.36Na
Sf	Site-specific geotechnical investigation and dynamic site response shall be performed to determine seismic coefficients for soil profile Type *Sf*.				

Table 16-R

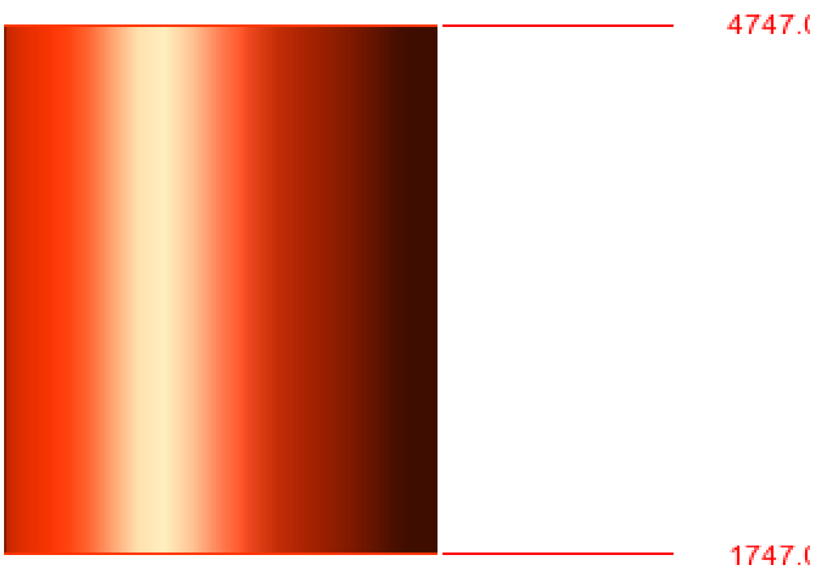
Soil Profile Type	Seismic Coefficient *Cv* for Seismic Zone Factor Z of:				
	Z=0.075	Z=0.15	Z=0.2	Z=0.3	Z=0.4
Sa	0.06	0.12	0.16	0.24	0.32Nv
Sb	0.08	0.15	0.20	0.30	0.40Nv
Sc	0.13	0.25	0.32	0.45	0.56Nv
Sd	0.18	0.32	0.40	0.54	0.64Nv
Se	0.26	0.50	0.64	0.84	0.96Nv
Sf	Site-specific geotechnical investigation and dynamic site response shall be performed to determine seismic coefficients for soil profile Type *Sf*.				

Table 16-S

Seismic Source Type	Near-Source Factor *Na*[1] for Closest Distance to Known Seismic Source of: [2,3]		
	<= 2 km	5 km	>=10 km
A	1.5	1.2	1.0
B	1.3	1.0	1.0
C	1.0	1.0	1.0



utput
Utility
Auxiliary
Analyze
Units :
bars
Design Code :
Divis
Uni
Flip Element Orientation
Flip the orientation of the current element



4747.(
1747.(

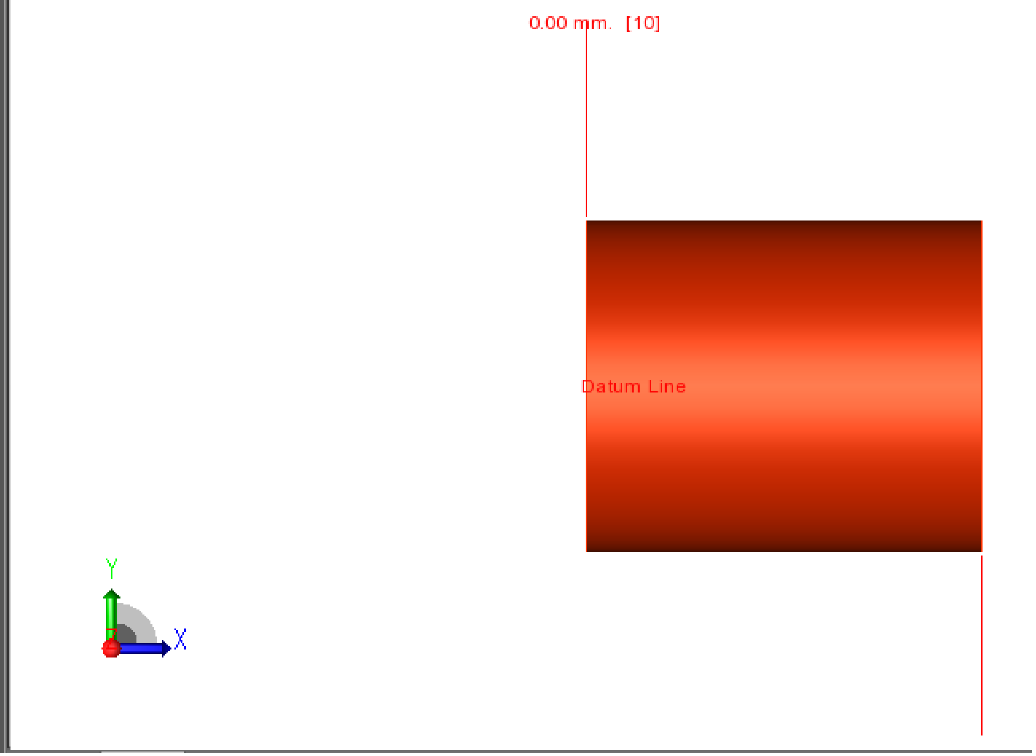
Element Data

Element Description	
From Node	10
To Node	20
Element Type	Cylindrical
Diameter Basis	ID
Inside Diameter, mm.	2500
Cylinder Length, mm.	3000
Finished Thickness, mm.	6.35
Nominal Thickness, mm.	0
Internal Corrosion Allowance, mm.	3
External Corrosion Allowance, mm.	0
Wind Diameter Multiplier	1.2
Material Name	SA-516 70
Longitudinal Seam Efficiency	1
Circumferential Seam Efficiency	1
Internal Pressure, bars	6.895
Temp. for Internal Pressure, C	93.342
External Pressure, bars	1.034
Temp. for External Pressure, C	93.342

Additional Element Data

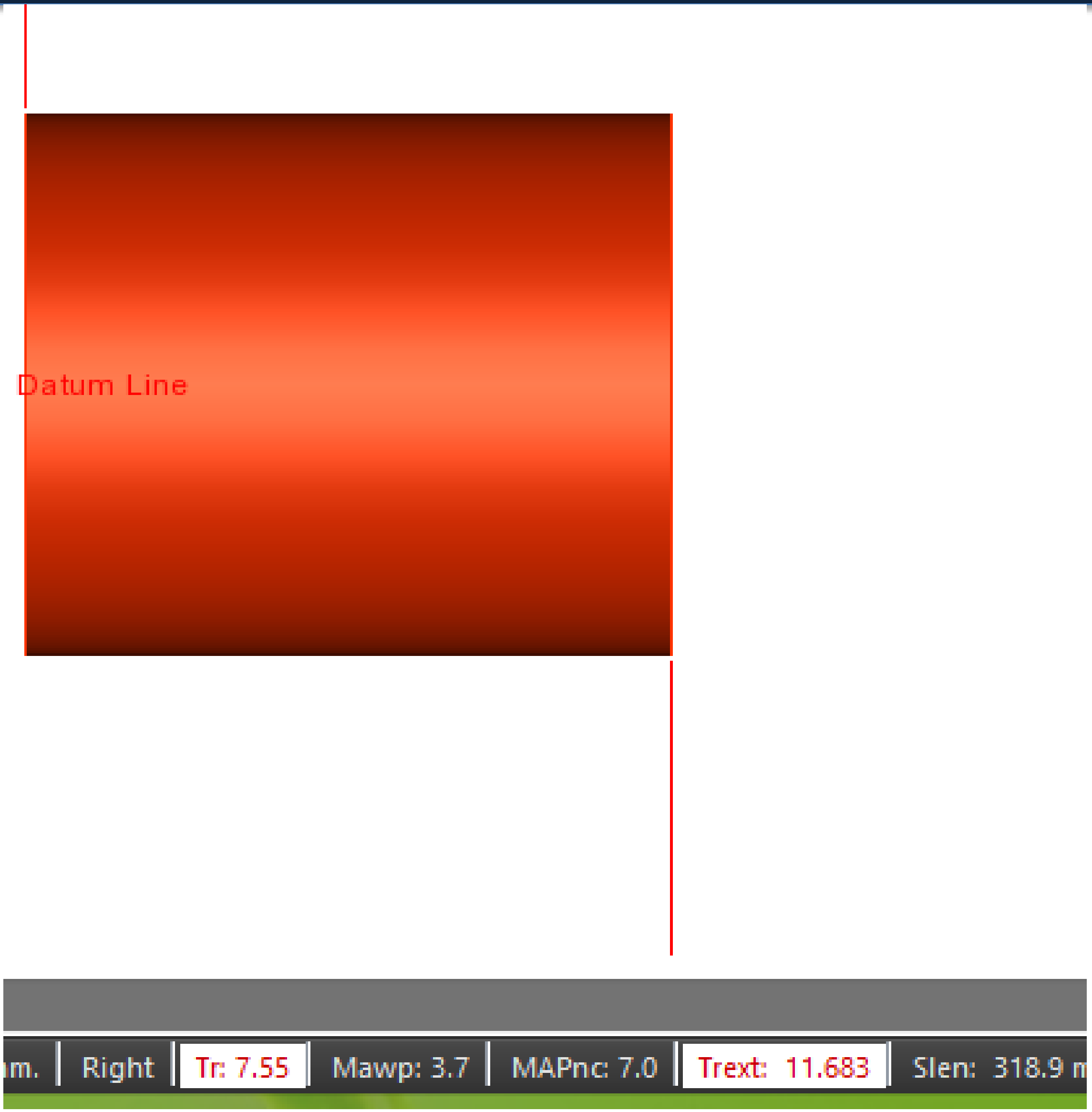
Material Name

Enter the material's name and then press [Enter] or use the database button to select it.

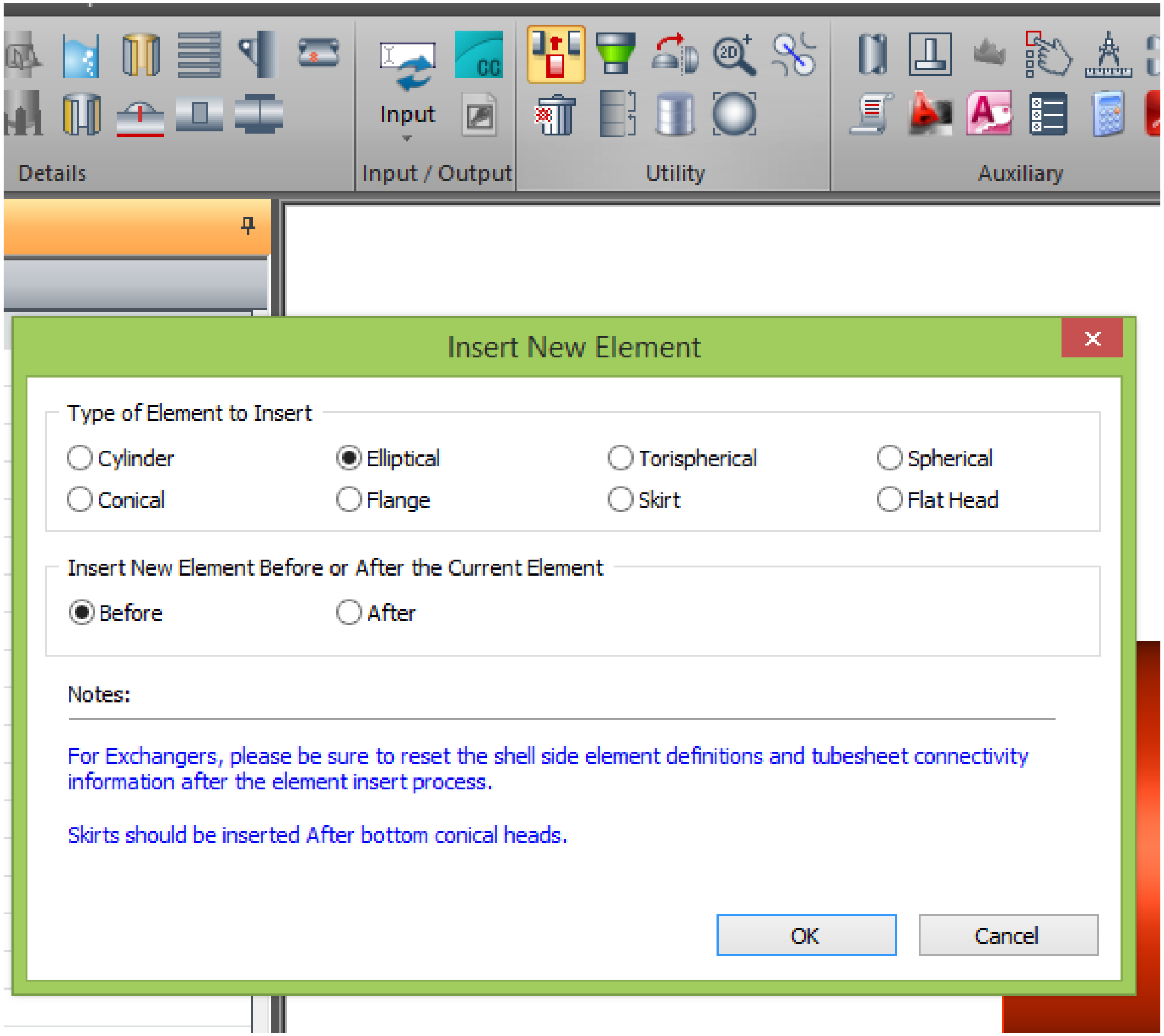


Design Constraints

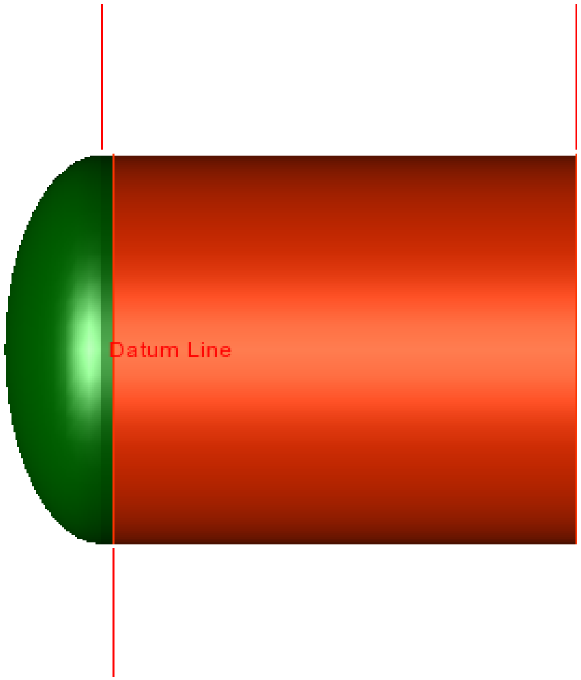
Design Data	
Design Internal Press, bars	5
Design External Press, bars	1.034
Design Internal Temp, C	100
Design External Temp, C	93.342
Datum Line Options	click to edit
Hydrotest Type	UG-99b
Hydrotest Position	Horizontal
Projection from Top, mm.	0
Projection from Bottom, mm.	0
Projection from Bottom Ope, mm.	0
Min. Des Metal Temp, C	-28.8898
No UG-20(f) Exemptions	

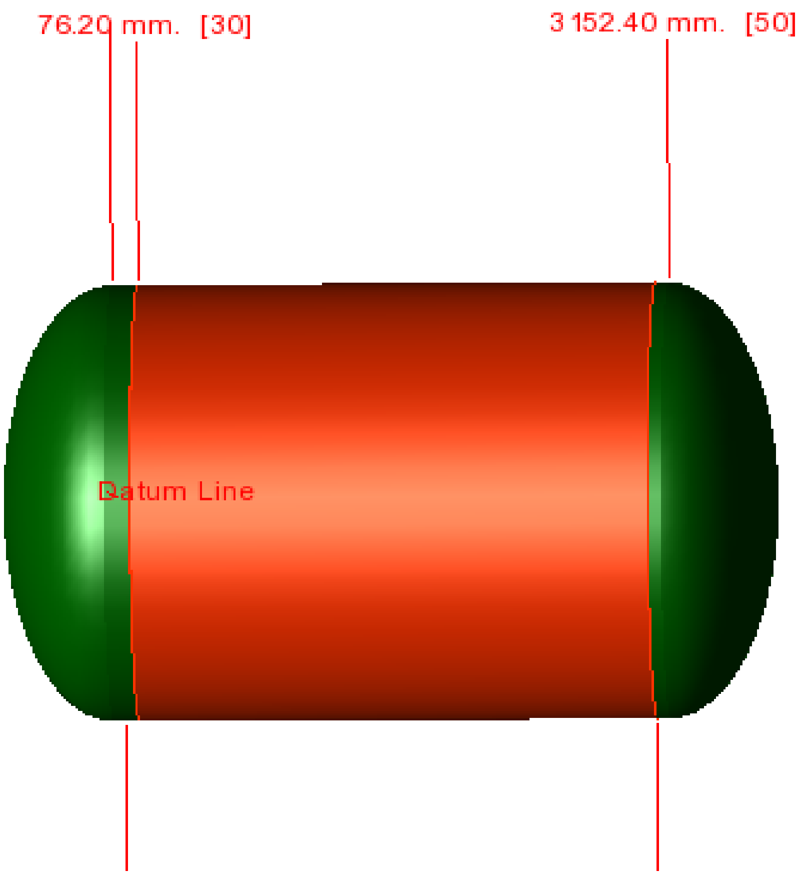

Datum Line
m.
Right
Tr: 7.55
Mawp: 3.7
MAPnc: 7.0
Trext: 11.683
Slen: 318.9 m

PVElite Software

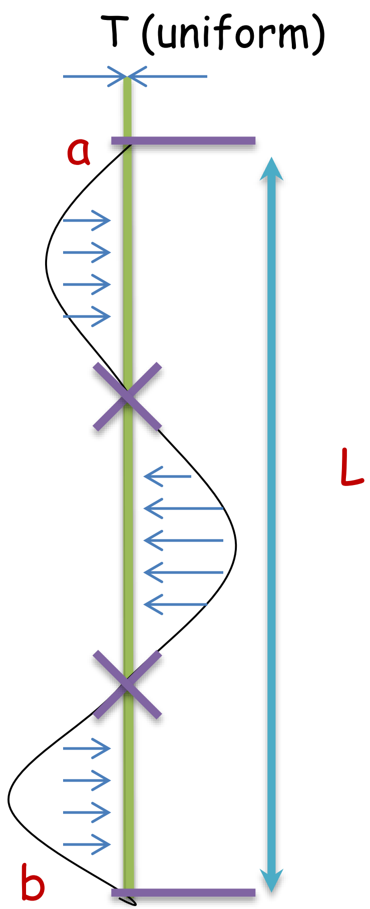


PVElite Software





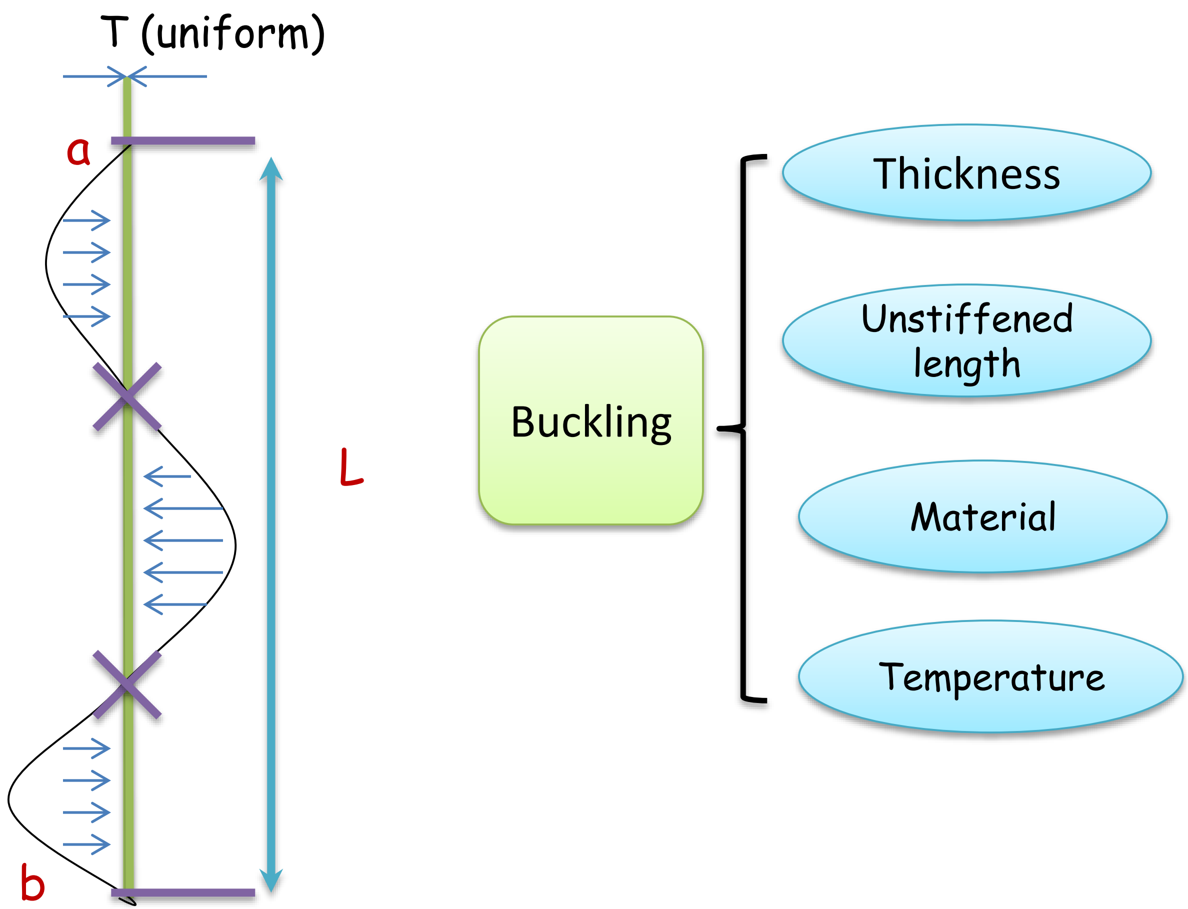
❖ Sturm-Liouville Equations (Singular Sturm-Liouville problems)



In most practical situations an eigenvalue is associated with an important physical characteristic of the problem, such as the frequency of vibration of a string or of a metal plate. In such cases the eigenfunction can be considered to describe a "snapshot" of a particular mode of vibration of the string or plate when it vibrates at the frequency determined by the associated eigenvalue. This application, and others that lead to Sturm–Liouville problems, will be developed in detail when partial differential equations are discussed in the context of *separation of variables*.

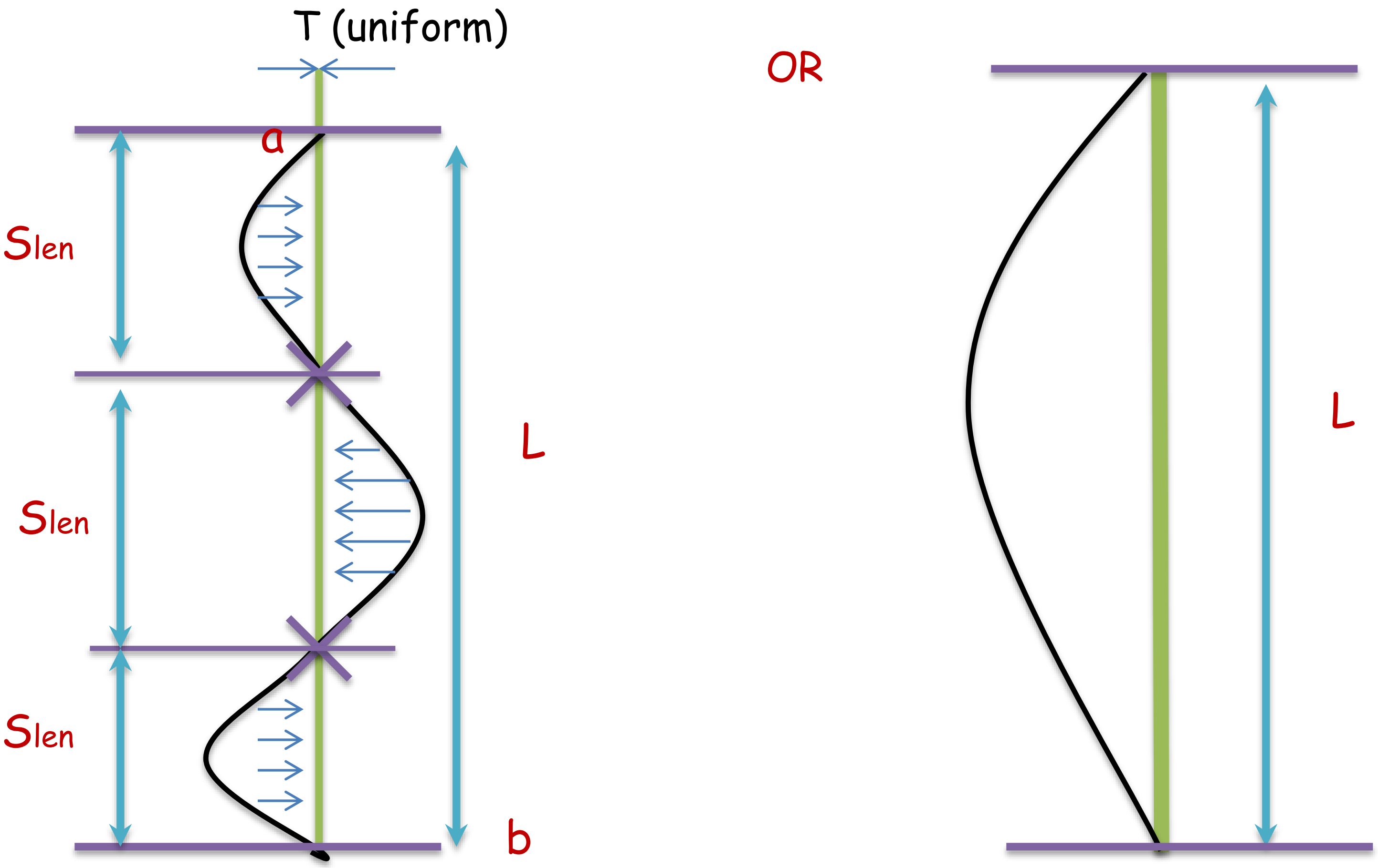
Ref. : Advanced engineering mathematics by Alan Jeffrey (*University of Newcastle-upon-Tyne)*

❖ Buckling Problem!



❖ See TABLE 8.1 Shear, moment, slope, andd eflection formulas for elastic straight beams

- Cylinder of pressure vessel



- See TABLE 8.1 Shear, moment, slope, andd eflection formulas for elastic straight beams

UG-28 (External pressure)

Figure UG-28.1
Diagrammatic Representation of Lines of Support for Design of Cylindrical Vessels Subjected to External Pressure

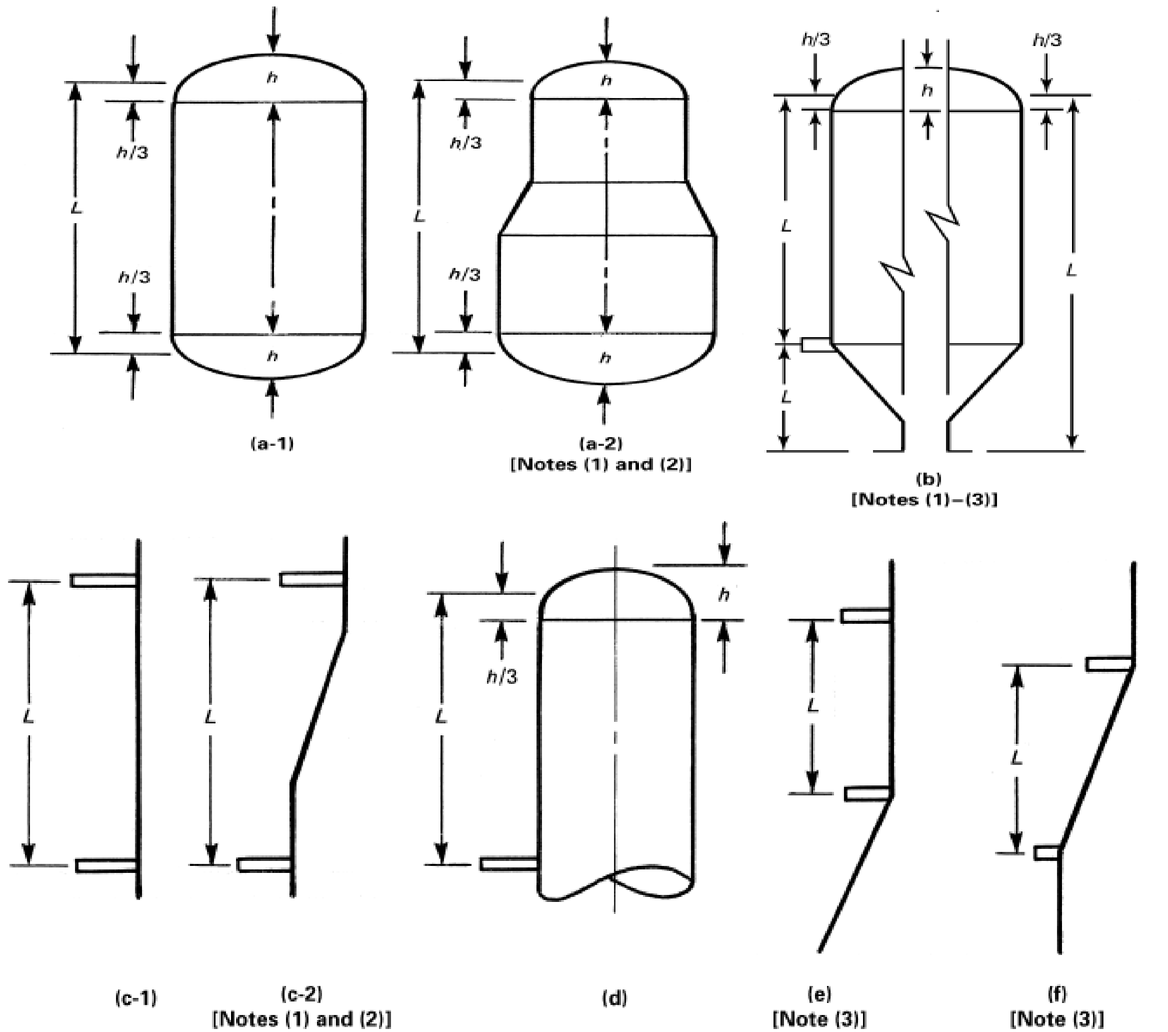
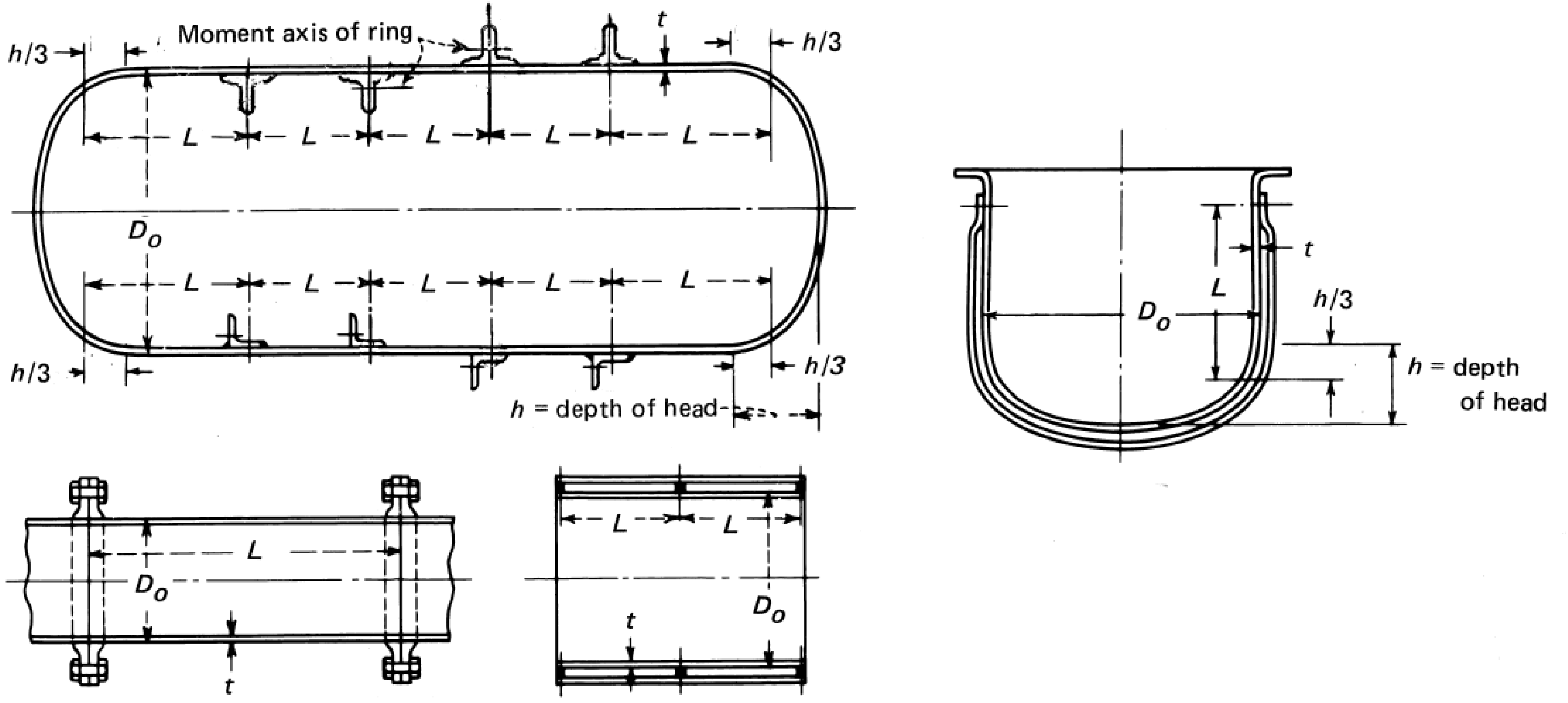
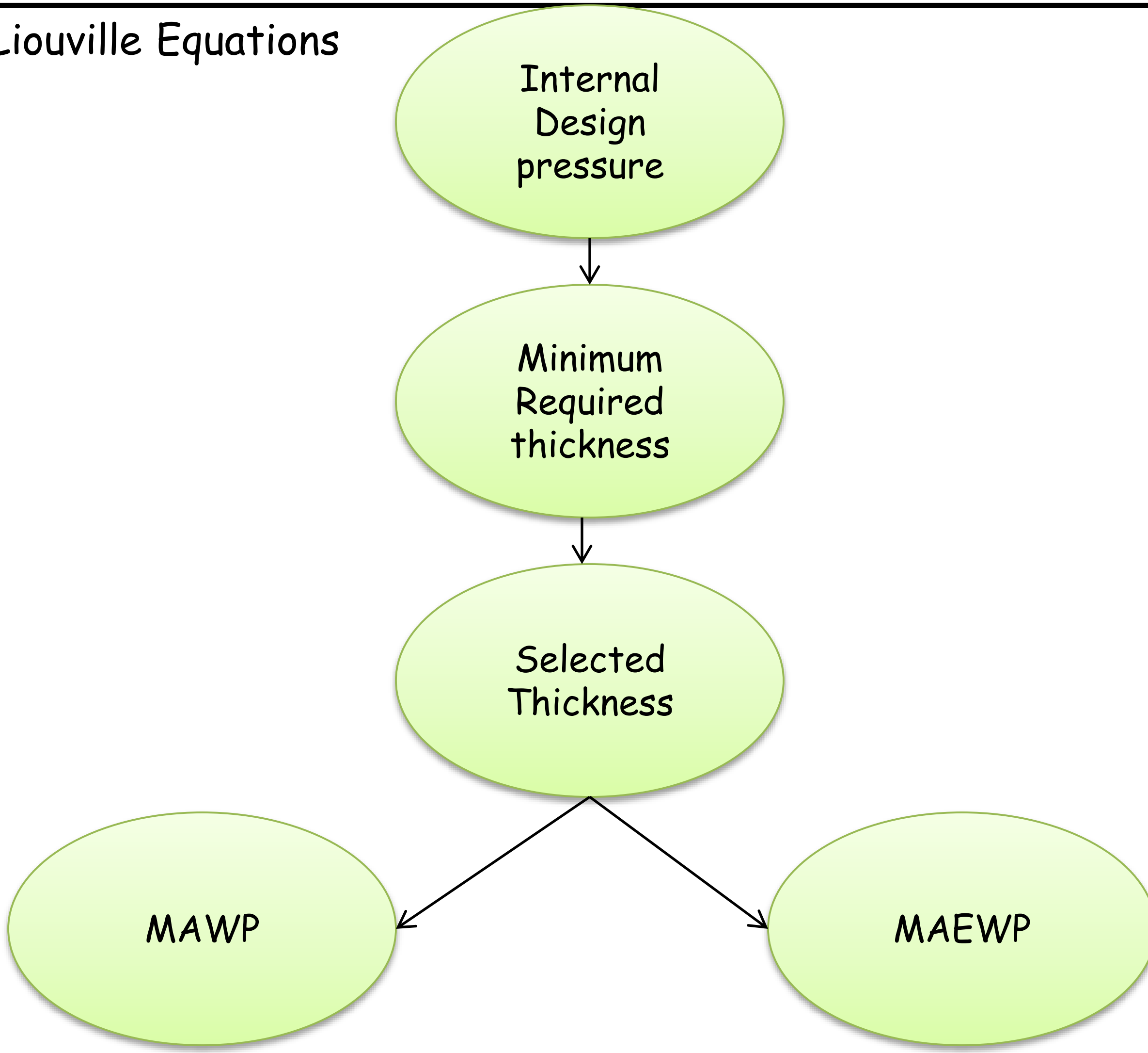


Figure UG-28
Diagrammatic Representation of Variables for Design of Cylindrical Vessels Subjected to External Pressure



❖ Sturm-Liouville Equations



UG-28 (External pressure)

As a general Low:

- MAWP is always more than Design pressure

And

- MAEWP is always more than Exernal Design pressure

<u>If External Design pressure be more than MAWEP (Pa) we have to increase thickness of vessel or using stiffing ring or using both of them!</u>

So, Simply we must calculate Pa (MAWEP) and compare it with external design pressure

UG-28 (External pressure)

As a general Low:

- ❖ (1) Cylinders having Do/t values ≥ 10:

$$P_a = \frac{4B}{3(D_o/t)}$$

- ❖ To compute B we have to Know parameter "A" which is depend to "L","t", and "D" and could be gain form Figure G of ASME SEC. II, Part D.

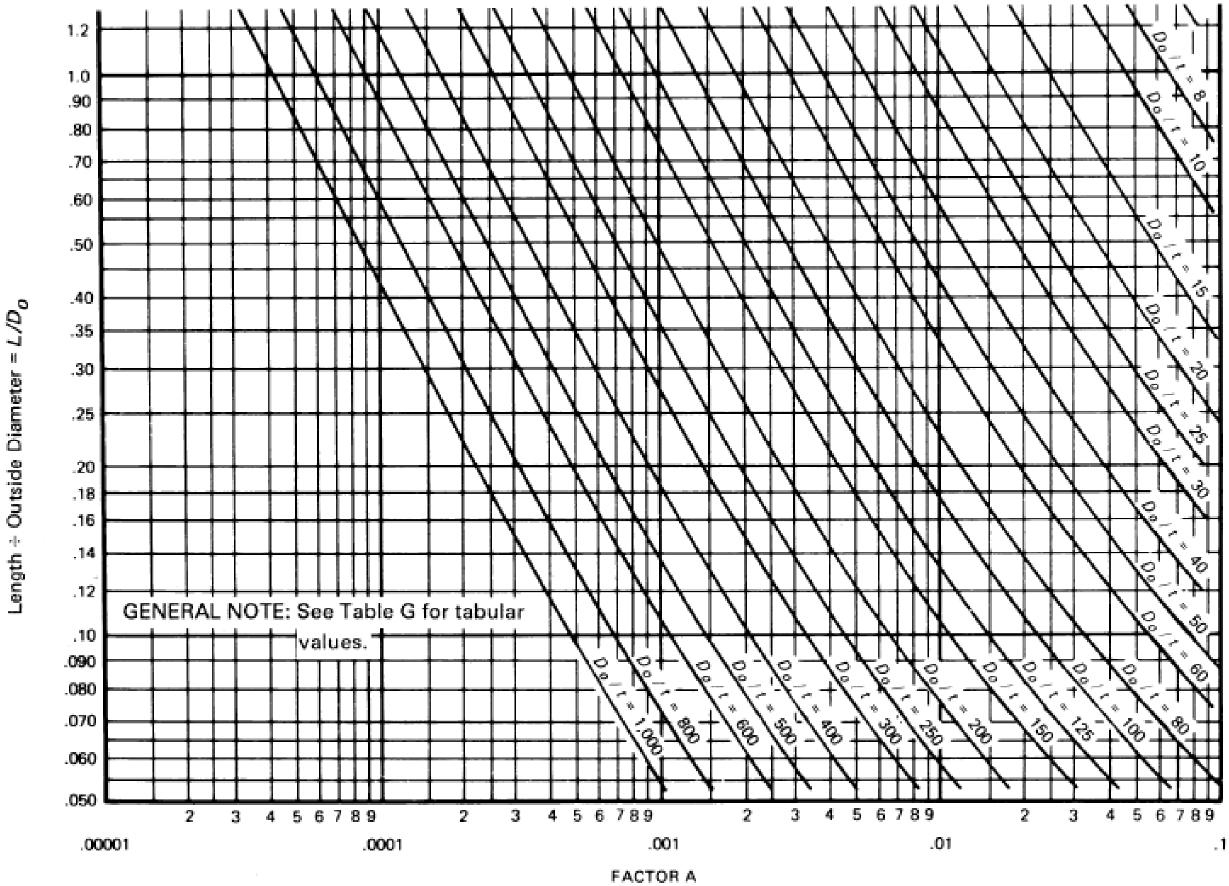
Note:

- ➢ 1- For values of L/Do greater than 50, enter the chart at a value of L/Do = 50.
- ➢ 2- For values of L/Do less than 0.05, enter the chart at a value of L/Do = 0.05.
- ➢ 3- For values of A falling to the left of the applicable material/temperature line, the value of Pa can be calculated using the following equation:

$$P_a = \frac{2AE}{3(D_o/t)}$$

UG-28 (External pressure)

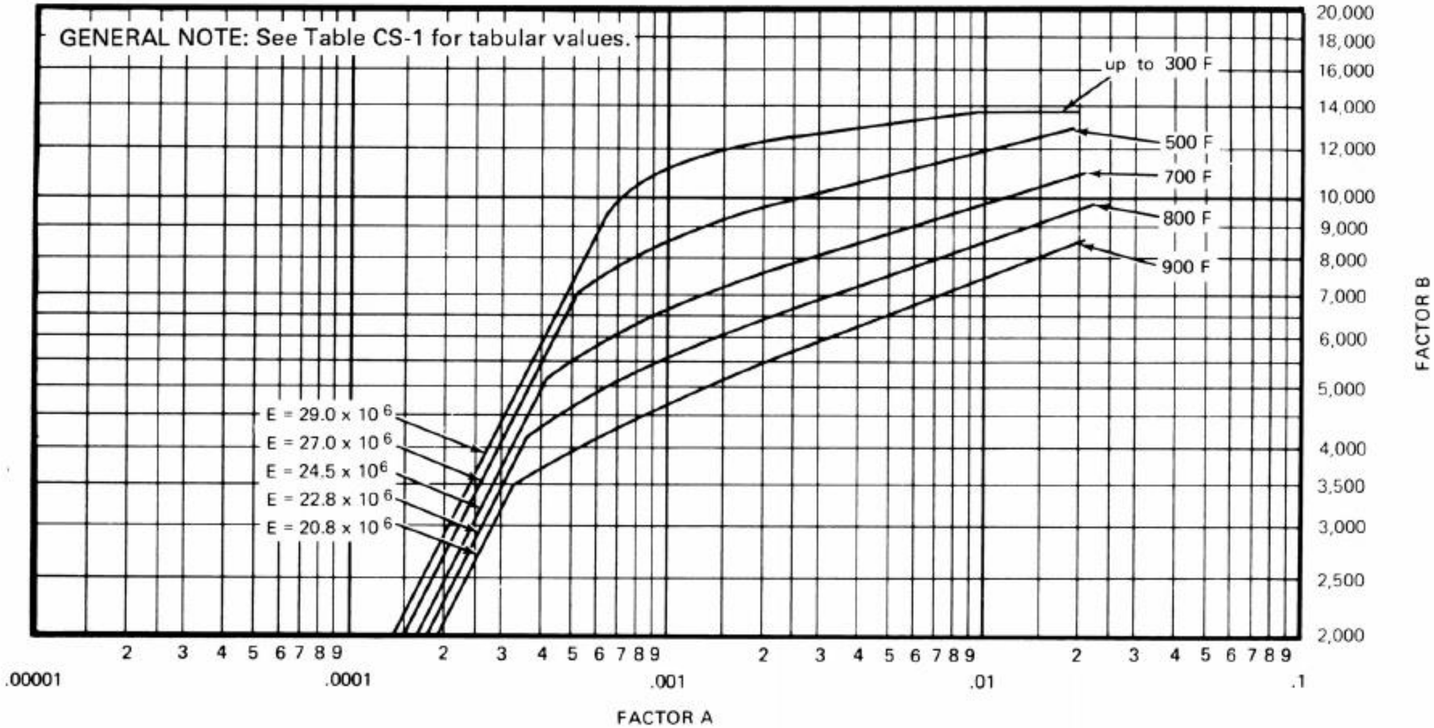
Figure G
Geometric Chart for Components Under External or Compressive Loadings (for All Materials) (Cont'd)



GENERAL NOTE: Extrapolation is not permitted except as explicitly allowed by the Construction Code.

UG-28 (External pressure)

Figure CS-1
Chart for Determining Shell Thickness of Components Under External Pressure Developed for Carbon or Low Alloy Steels With Specified Minimum Yield Strength Less Than 30,000 psi



GENERAL NOTES:

(a) The external pressure charts do not account for reduction of buckling strength due to creep under long-term loads. The effect of creep on buckling shall be considered at temperatures for which allowable stresses are shown italicized in Tables 1A, 1B, 2A, 2B, 5A, and 5B.

(b) The external pressure chart assigned for a particular material is obtained from stress tables 1A, 1B, 2A, 2B, 5A, and 5B under the column for External Pressure Chart No. for that material and is mandatory, with the exception of Tables 5A and 5B.

UG-28 (External pressure)

- (2) Cylinders having Do/t values < 10:

- Using the same procedure as given in (1), obtain the value of B. For values of Do/t less than 4, the value of factor A can be calculated using the following equation:

$$A = \frac{1.1}{(D_o/t)^2}$$

Question!

❖ The following information is given in a data sheet. Please compute required and selected thickness for shell.

- Cylindrical shell:

➢ Design pressure : 5 barg / F.V.

➢ Design Temperature: 150 °C

➢ Material : SA-516 70

➢ C.A.: 3 mm

➢ Vessel I.D : 3000 mm

➢ Vessel T.L to T.L : 7000 mm

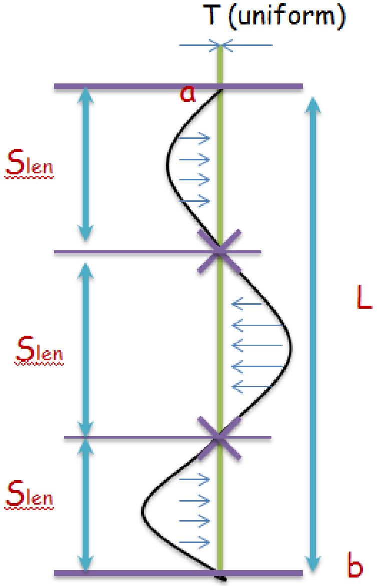
UG-29 (STIFFENING RINGS)

(a) External stiffening rings shall be attached to the shell by welding or brazing as per UG-30

❖ the available moment of inertia of a circumferential stiffening ring shall be not less than that determined by one of the following two formulas:

$$I_S = \left[D_O{}^2 L_S (t + A_S/L_S) A \right] /14$$

$$I'_S = \left[D_O{}^2 L_S (t + A_S/L_S) A \right] /10.9$$



❖ The adequacy of the moment of inertia for a stiffening ring shall be determined in accordance to UG-29 and could be referred to D.R. Moss hand book

UG-29 (STIFFENING RINGS)

- The Code provides two methods for sizing stiffening rings. Method (a) is based on the stiffening ring providing all additional stiffening, and method (b) is based on a combination of the stiffening ring and a part of the shell providing the additional stiffening. Both methods require that one assume an initial size and shape for the ring.

- (a) Stiffening ring alone:
- (b) The stiffening ring/shell combination:

EASY AS 123

- (a) Stiffening ring alone:
- 1) Determine B, where:

$$B = 0.75\left(\frac{PD_o}{t + A_S/L_S}\right)$$

As = cross-sectional area of stiffening ring, square inches.

Ls =distance between support lines on both sides of the stiffening ring, inches.

Do = outside diameter of shell, inches.

- 2) Enter appropriate external pressure chart in Section II, Part D and determine Factor A that corresponds to the calculated Factor B.

UG-29 (STIFFENING RINGS)

- 3) Determine the required moment of inertia of the stiffening ring only, Is:

$$I_S = \frac{\left[D_o^2 L_S \left(t + {A_S}/{L_S}\right) A\right]}{14}$$

- 4) Determine actual moment of inertia of ring only, I, in.4

- 5) I must be equal to or greater than Is

(b) The stiffening ring/shell combination:

1) Determine B, where:

$$B = 0.75\left(\frac{PD_o}{t + A_S/L_S}\right)$$

- As = cross-sectional area of stiffening ring, square inches.
- Ls = distance between support lines on both sides of the stiffening ring, inches.
- D0 = outside diameter of shell, inches.
- 2) Enter appropriate external pressure chart in Section II, Part D and determine Factor A that corresponds to the calculated Factor B.
- 3) Determine the required moment of inertia of the ring/shell combination, Is' , in.4

$$I_S = \frac{\left[D_o^2 L_S \left(t + {A_S}/{L_S}\right) A\right]}{14}$$

$$I_S' = \frac{\left[D_o^2 L_S \left(t + {A_S}/{L_S}\right) A\right]}{10.9}$$

UG-29 (STIFFENING RINGS)

- 4) Determine the moment of inertia of the combined ring and shell section acting together, 1', inch4. The length of shell used in the calculation shall not be greater than 1.10 (D0 t)lh. No overlap of contribution is allowed.
- 5) I' shall be equal to or greater than Is'.

- Note that the formulas for B are identical. If the value of B falls below the left end of the material/temperature curve, then A is calculated using A= 2B/E where E is the modulus of elasticity. If different materials are used for the shell and stiffening ring, then use the external pressure chart that gives the lowest value of A.

What is line of support:

- (a) a stiffening ring that meets the requirements of this paragraph;
- (b) a circumferential connection to a jacket for a jacketed section of a cylindrical shell;
- (c) a circumferential line on a head at one-third the depth of the head from the head tangent line as shown on Figure UG-28;
- (d) a cone-to-cylinder junction.

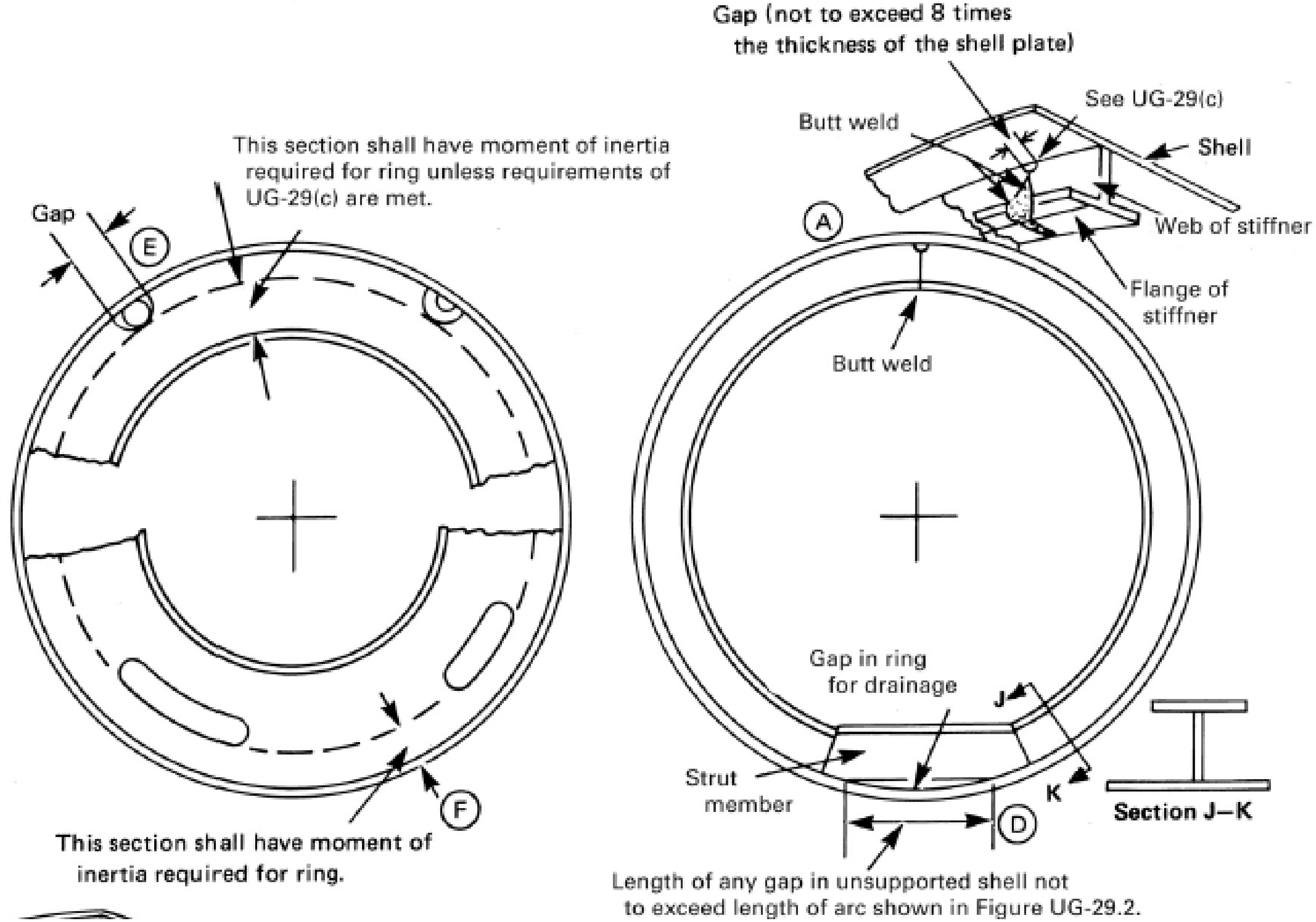
tangent line? Weld line?

UG-29 (STIFFENING RINGS)

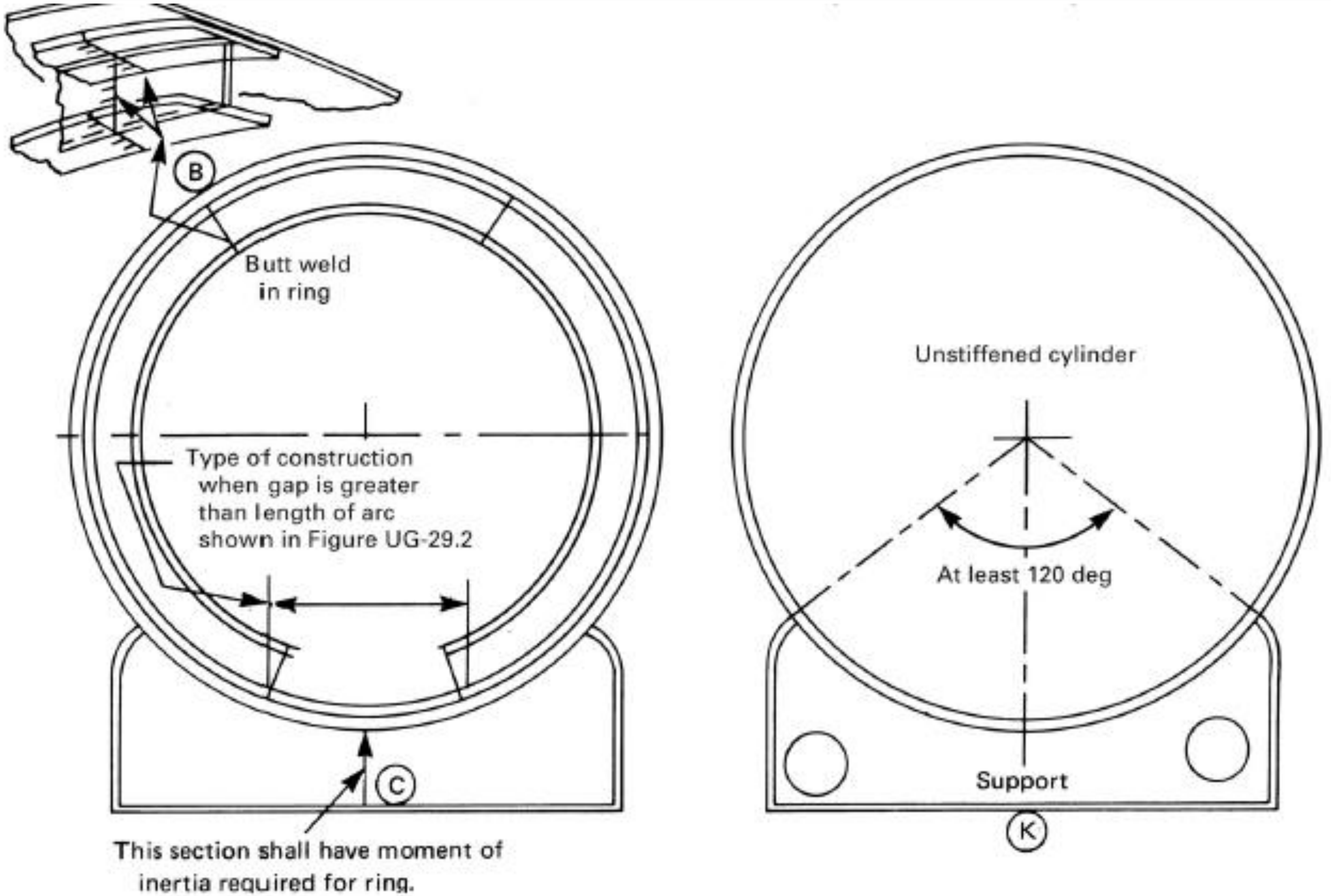
- (b) The adequacy of the moment of inertia for a stiffening ring shall be determined in (b) Stiffening rings shall extend completely around the circumference of the cylinder except as permitted in C below. Any joints between the ends or sections of such rings, such as shown in Figure UG-29.1 (A) and (B), and any connection between adjacent portions of a stiffening ring lying inside or outside the shell as shown in Figure UG-29.1 (C) shall be made so that the required moment of inertia of the combined ring-shell section is maintained.

- (c) Stiffening rings placed on the inside of a vessel may be arranged as shown in Figure UG-29.1 (E) and (F) provided that the required moment of inertia of the ring in (E) or of the combined ring-shell section in (F) is maintained within the sections indicated. Where the gap at (A) or (E) does not exceed eight times the thickness of the shell plate, the combined moment of inertia of the shell and stiffener may be used.

Figure UG-29.1
Various Arrangements of Stiffening Rings for Cylindrical Vessels Subjected to External Pressure



UG-29 (STIFFENING RINGS)



UG-29 (STIFFENING RINGS)

- (b) Any gap in that portion of a stiffening ring supporting the shell, such as shown in Figure UG-29.1 (D) and (E), shall not exceed the length of are given in Figure UG-29.2 unless additional reinforcement is provided as shown in Figure UG-29.1 (C) or unless the following conditions are met:

(1) only one unsupported shell arc is permitted per ring; and

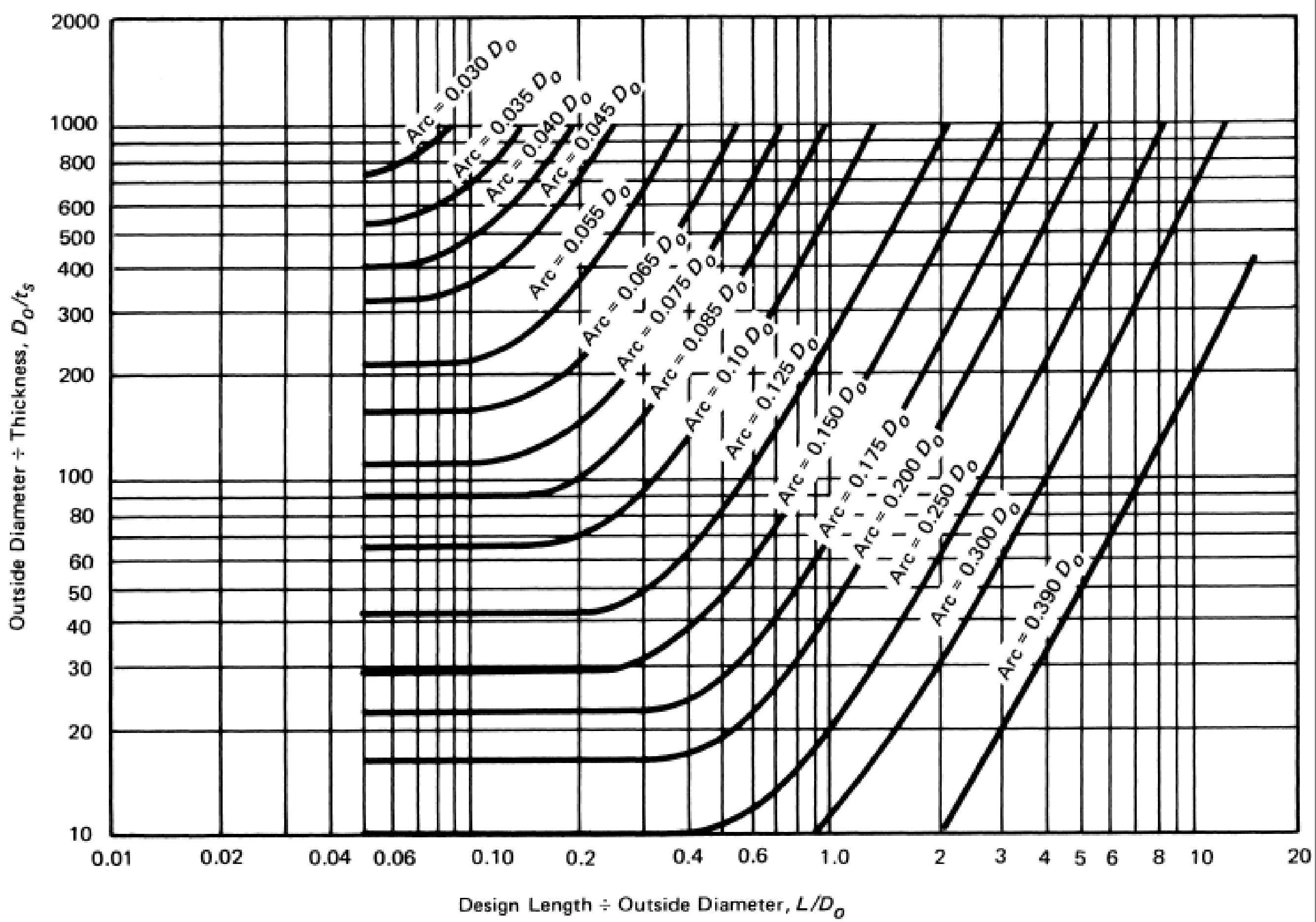
(2) the length of the unsupported shell arc does not exceed 90 deg; and

(3) the unsupported arcs in adjacent stiffening rings are staggered 180 deg; and

(4) the dimension L defined in UG-28(b) is taken as the larger of the following: the distance between alternate stiffening rings, or the distance from the head tangent line to the second stiffening ring plus one-third of the head depth.

UG-29 (STIFFENING RINGS)

Figure UG-29.2
Maximum Arc of Shell Left Unsupported Because of Gap in Stiffening Ring of Cylindrical Shell Under External Pressure



UG-29 (STIFFENING RINGS)

- (d) When internal plane structures perpendicular to the longitudinal axis of the cylinder (such as bubble trays or baffle plates) are used in a vessel, they may also be considered to act as stiffening rings provided they are designed to function as such.

- (e) Any internal stays or supports used as stiffeners of the shell shall bear against the shell of the vessel through the medium of a substantially continuous ring.

- (f) When closure bars or other rings are attached to both the inner shell and outer jacket of a vessel, with pressure in the space between the jacket and inner shell, this construction has adequate inherent stiffness, and therefore the rules of this paragraph do not apply.

Question!

❖ The following information is given in a data sheet. Please compute required and selected thickness for shell by using stiffening ring.

- Cylindrical shell:

➢ Design pressure : 5 barg / F.V.

➢ Design Temperature: 150 °C

➢ Material : SA-516 70

➢ C.A.: 3 mm

➢ Vessel I.D : 3000 mm

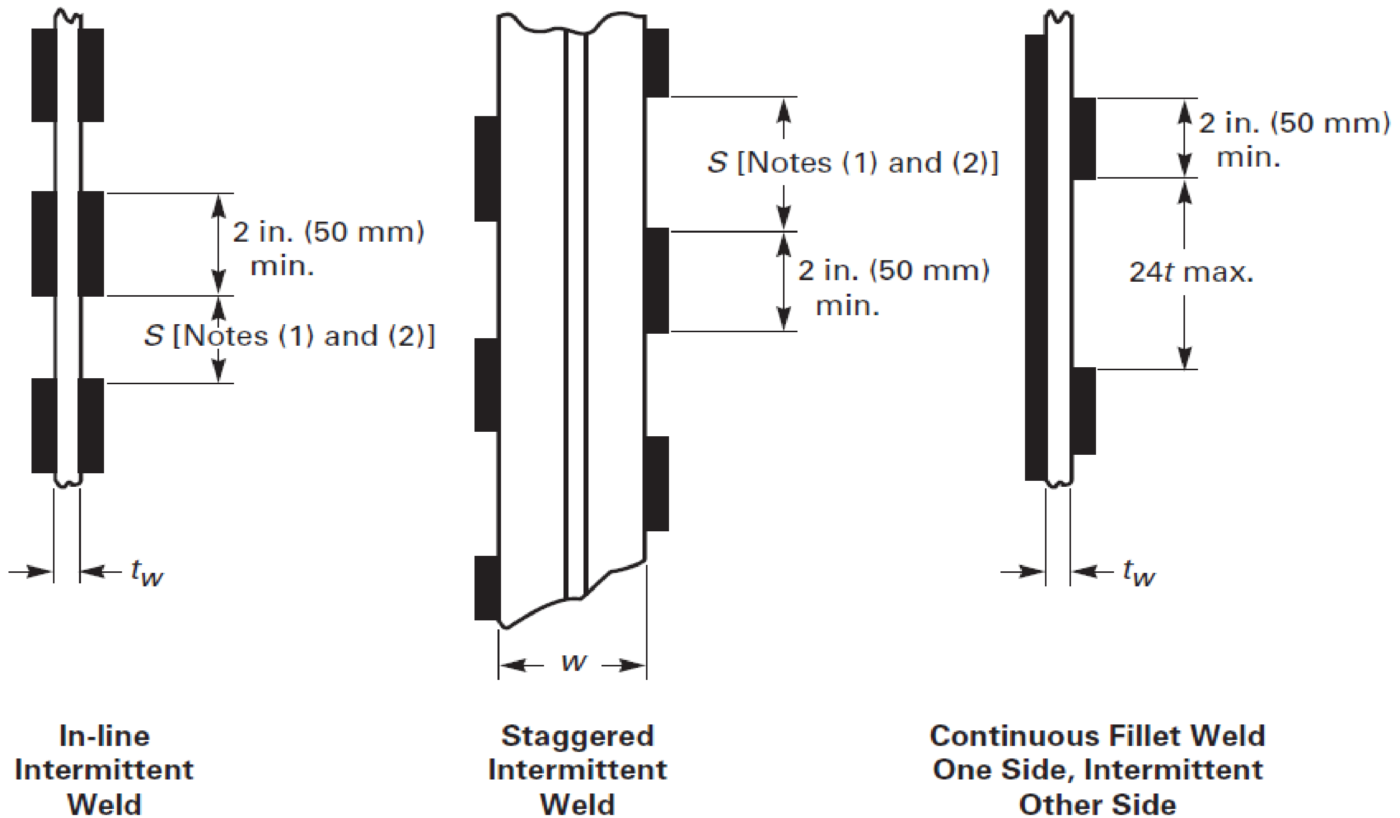
➢ Vessel T.L to T.L : 7000 mm

UG-30 (ATTACHMENT OF STIFFENING RINGS)

- (a) Stiffening rings may be placed on the inside or outside of a vessel, and except for the configurations permitted by UG-29, shall be attached to the shell by welding or brazing
- (b) Stiffening rings may be attached to the shell by continuous, intermittent, or a combination of continuous and intermittent welds or brazes.
- Some acceptable methods of attaching stiffening rings are illustrated in Figure UG-30

UG-30 (ATTACHMENT OF STIFFENING RINGS)

Figure UG-30
Some Acceptable Methods of Attaching Stiffening Rings



NOTES:
(1) For external stiffeners, $S \leq 8t$.
(2) For internal stiffeners, $S \leq 12t$

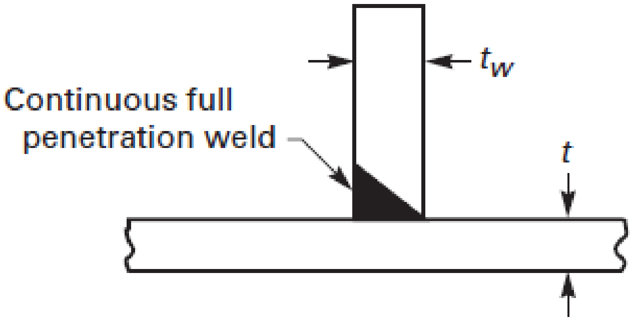
- (c) Intermittent welding shall be placed on both sides of the stiffener and may be either staggered or in-line. Length of individual fillet weld segments shall not be less than 2 in. (50 mm) and shall have a maximum clear spacing between toes of adjacent weld segments of 8t for external rings and 12t for internal rings where t is the shell thickness at the attachment.

Min. length of Weld on each side of stiffening ring

- Rings on the outside: $0.5 \times \pi \times$ Vessel OD
- Rings on the inside: $1/3 \times \pi \times$ Vessel ID

- (d) Which type of welds will be acceptable?

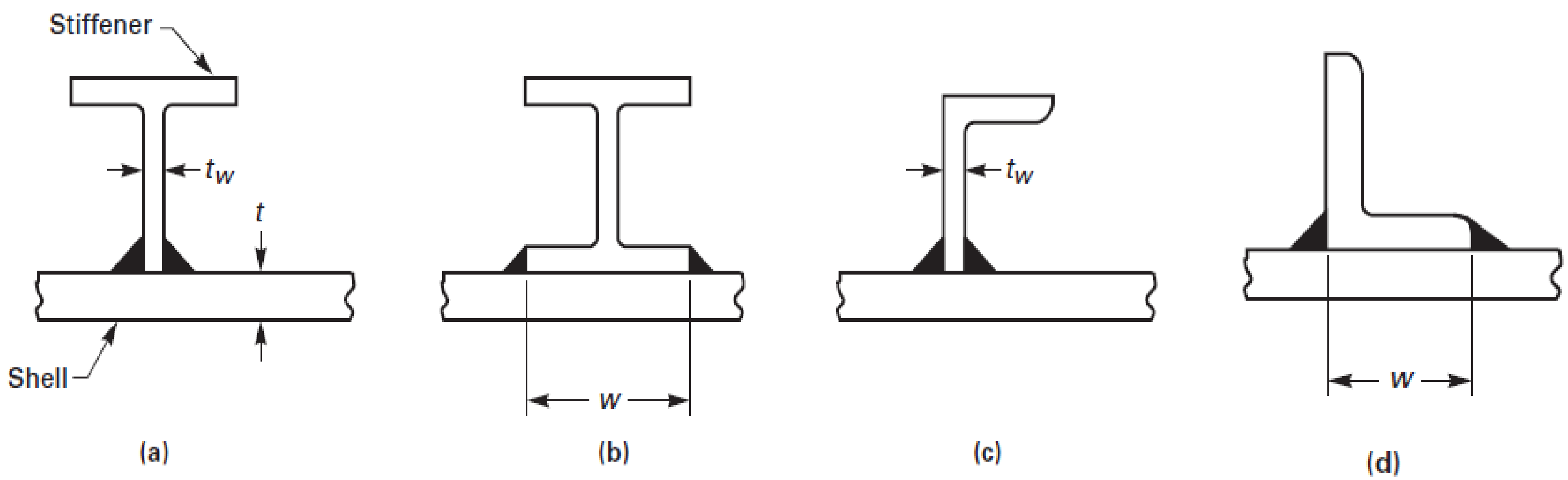
❖ A continuous full penetration weld is permitted



(e)

UG-30 (ATTACHMENT OF STIFFENING RINGS)

- Continuous fillet welding on one side of the stiffener with intermittent Welding on the other side is permitted when the thickness tw of the outstanding stiffening element [sketches (a) and (c)] or width w of the stiffening element mating to the shell [sketches (b) and (d)] is not more than 25 mm. The weld segments shall be not less than 50 mm long and shall have a maximum clear spacing between toes of adjacent weld segments of 24t



UG-30 (ATTACHMENT OF STIFFENING RINGS)

Stiffening ring attachment welds shall be sized to resist:

- the full radial pressure load
- shear loads acting radially across the stiffener
- Computed radial shear equal to 2% of the stiffening ring's compressive load.

UG-30 (ATTACHMENT OF STIFFENING RINGS)

❖ (e) Strength of Attachment Welds :

1:The radial pressure load from shell, lb/in., is equal to PLs.

2: The radial shear load is equal to 0.01PLsDO.

Where,

- Ls = one-half of the distance from the centerline of the stiffening ring to the next line of support on one side, plus one-half of the centerline distance to the next line of support on the other side of the stiffening ring, both measured parallel to the axis of the cylinder.
- P = external design pressure
- Do = outside diameter of cylindrical shell course

UG-30 (ATTACHMENT OF STIFFENING RINGS)

Minimum fillet weld leg Size of Attachment Welds (UG-30 f)

- 6 mm
- vessel thickness at the weld location;
- stiffener thickness at weld location

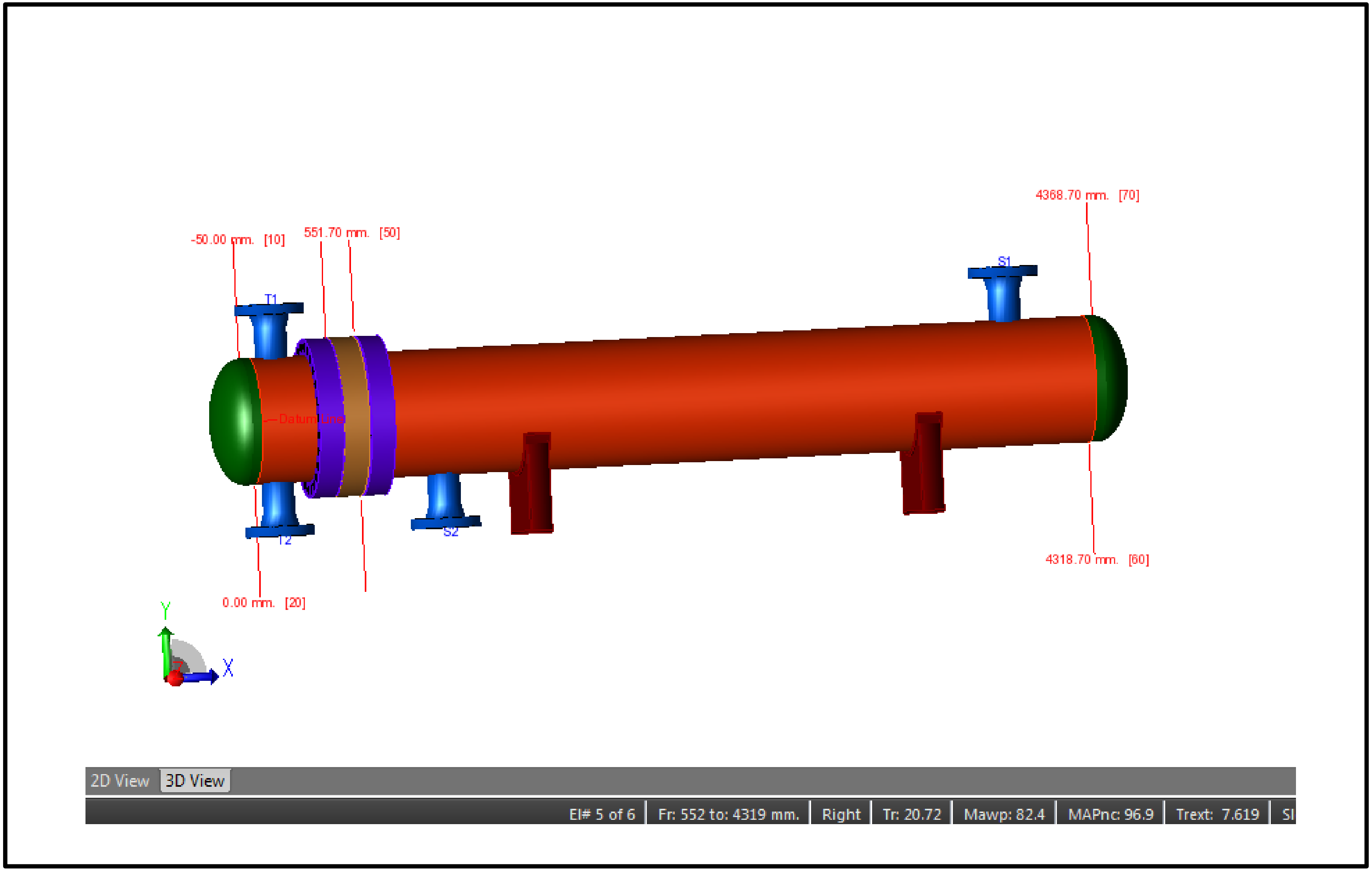
UG-31 (TUBES, AND PIPE WHEN USED AS TUBES OR SHELLS)

- (a) Internal Pressure. For required wall thickness under internal pressure see UG-27
- (b) External Pressure. For required wall thickness under external pressure see UG-28.
- (C) The thickness as determined under (a) or (b) above shall be increased when necessary to meet the following requirements:

(1) Additional wall thickness should be provided when corrosion, erosion, or wear due to cleaning operations is expected.

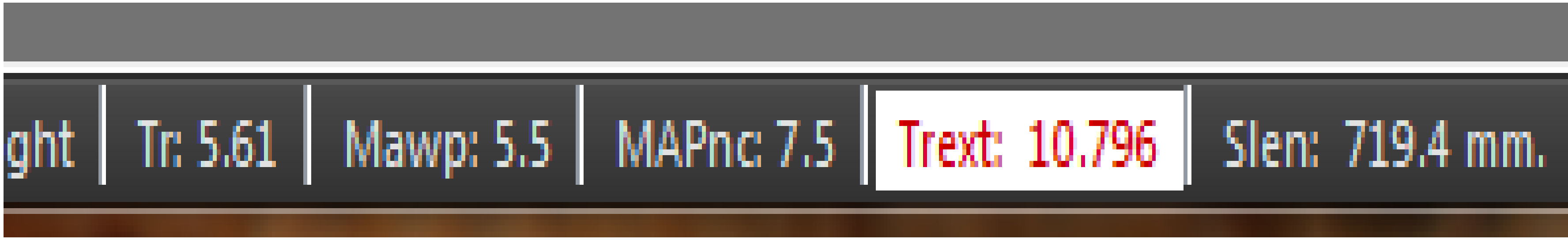
(2)Where ends are threaded, additional wall thickness is to be provided in the amount of 20/n mm (0.8/n in.)

Note : where n equals the number of threads per inch

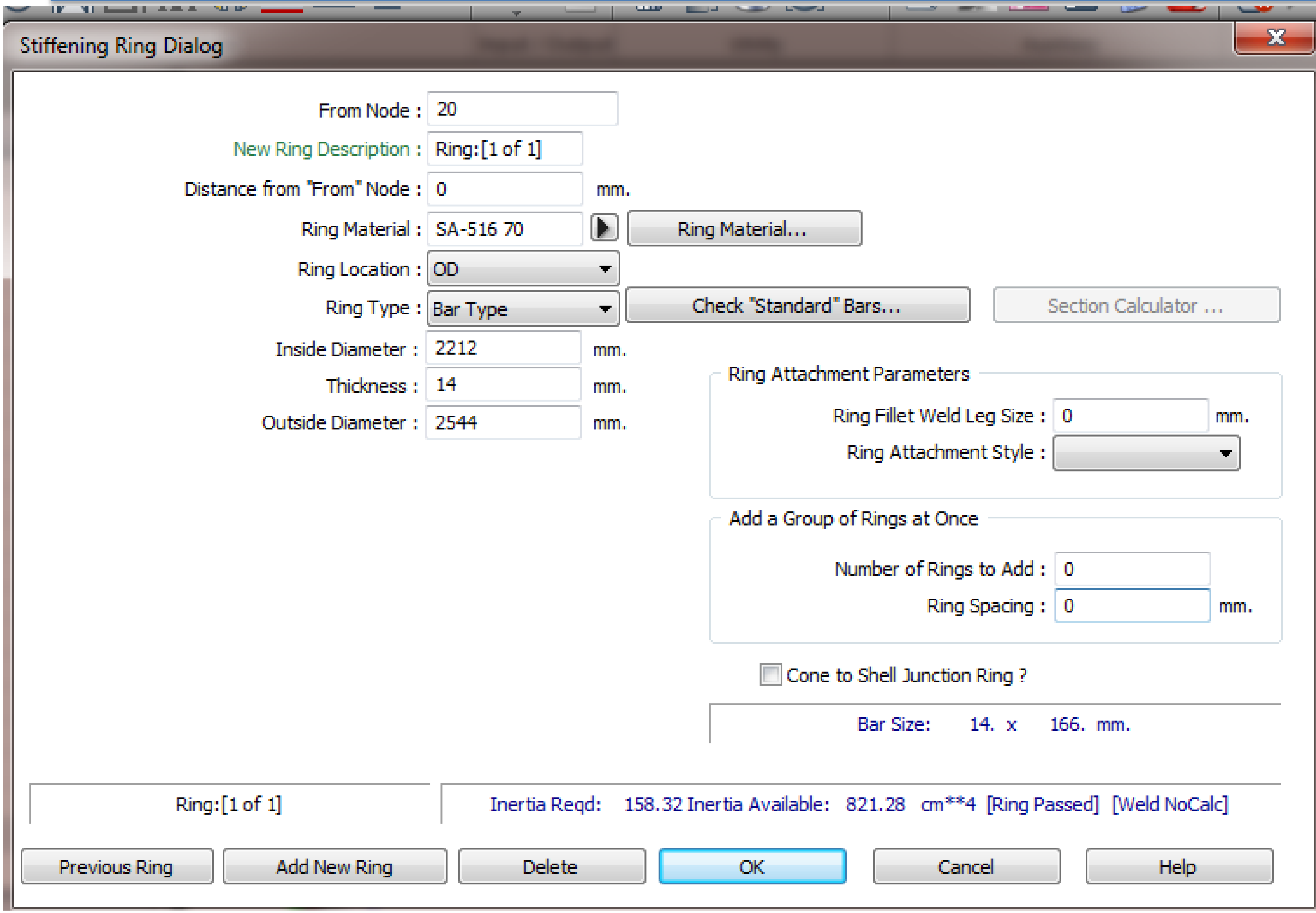


4368.70 mm. [70]
-50.00 mm. [10]
551.70 mm. [50]
S1
T1
Datum Line
S2
T2
4318.70 mm. [60]
0.00 mm. [20]
Y
X
2D View
3D View
El# 5 of 6
Fr: 552 to: 4319 mm.
Right
Tr: 20.72
Mawp: 82.4
MAPnc: 96.9
Trext: 7.619
SI

PVElite Software



PVElite Software



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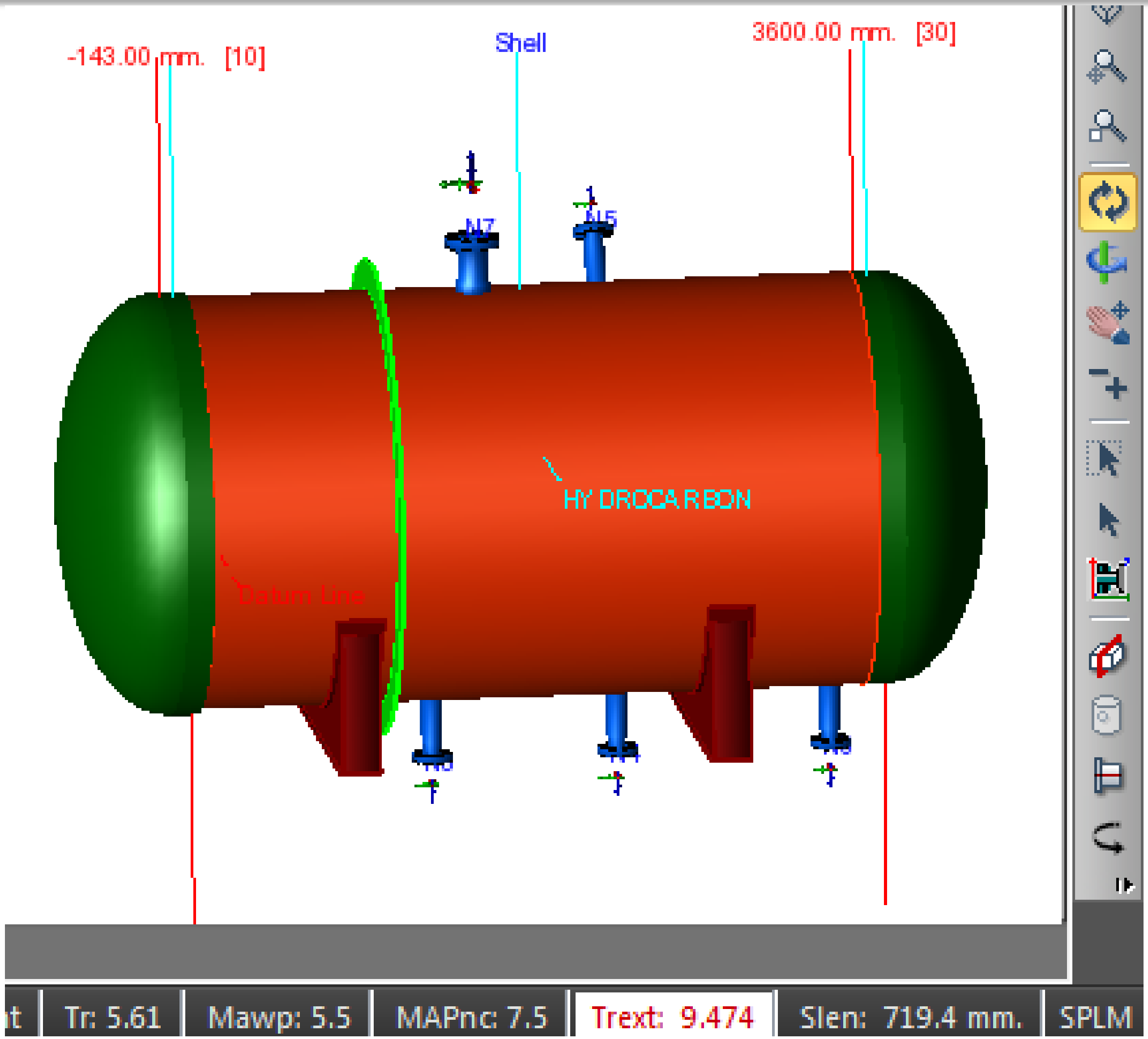

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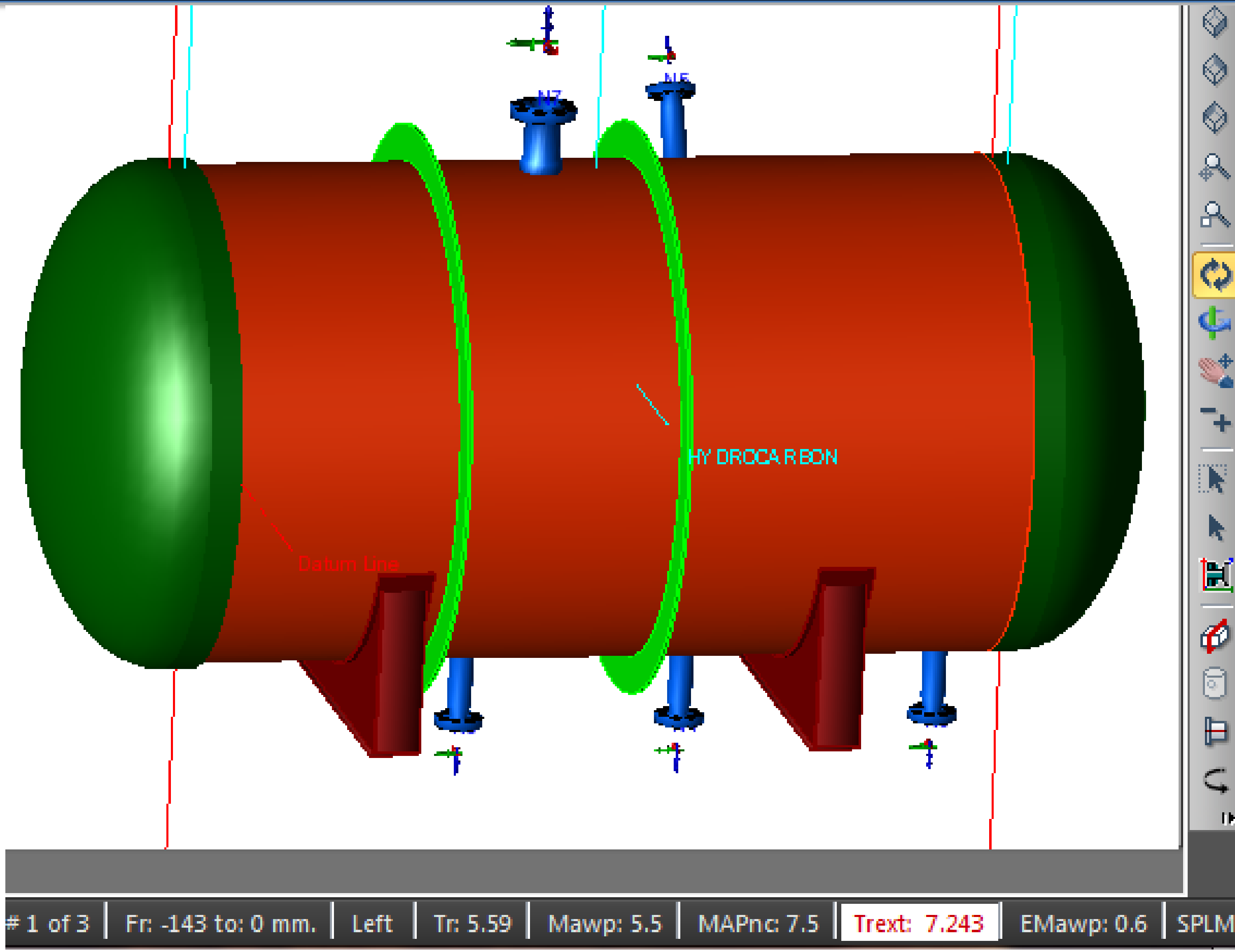

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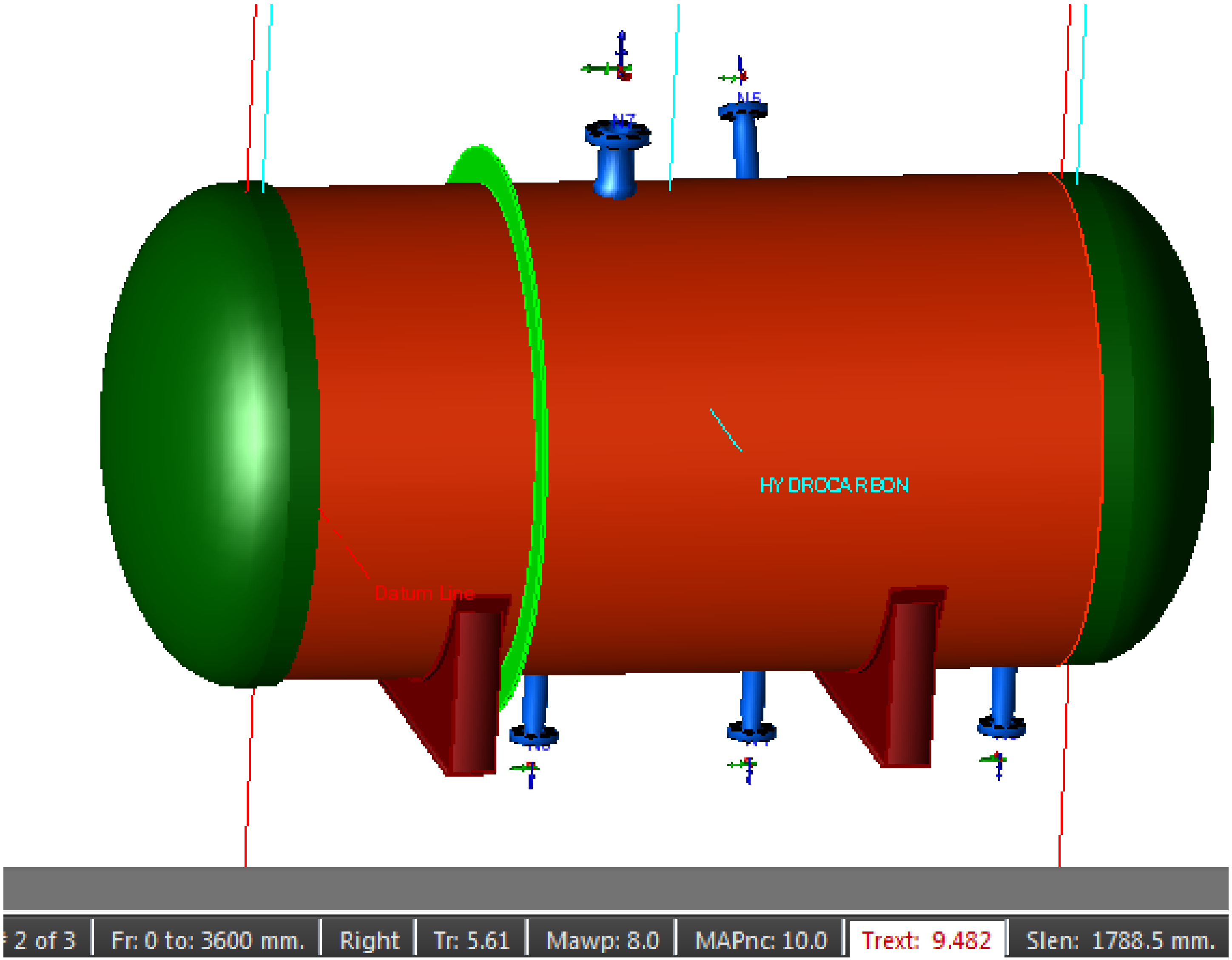
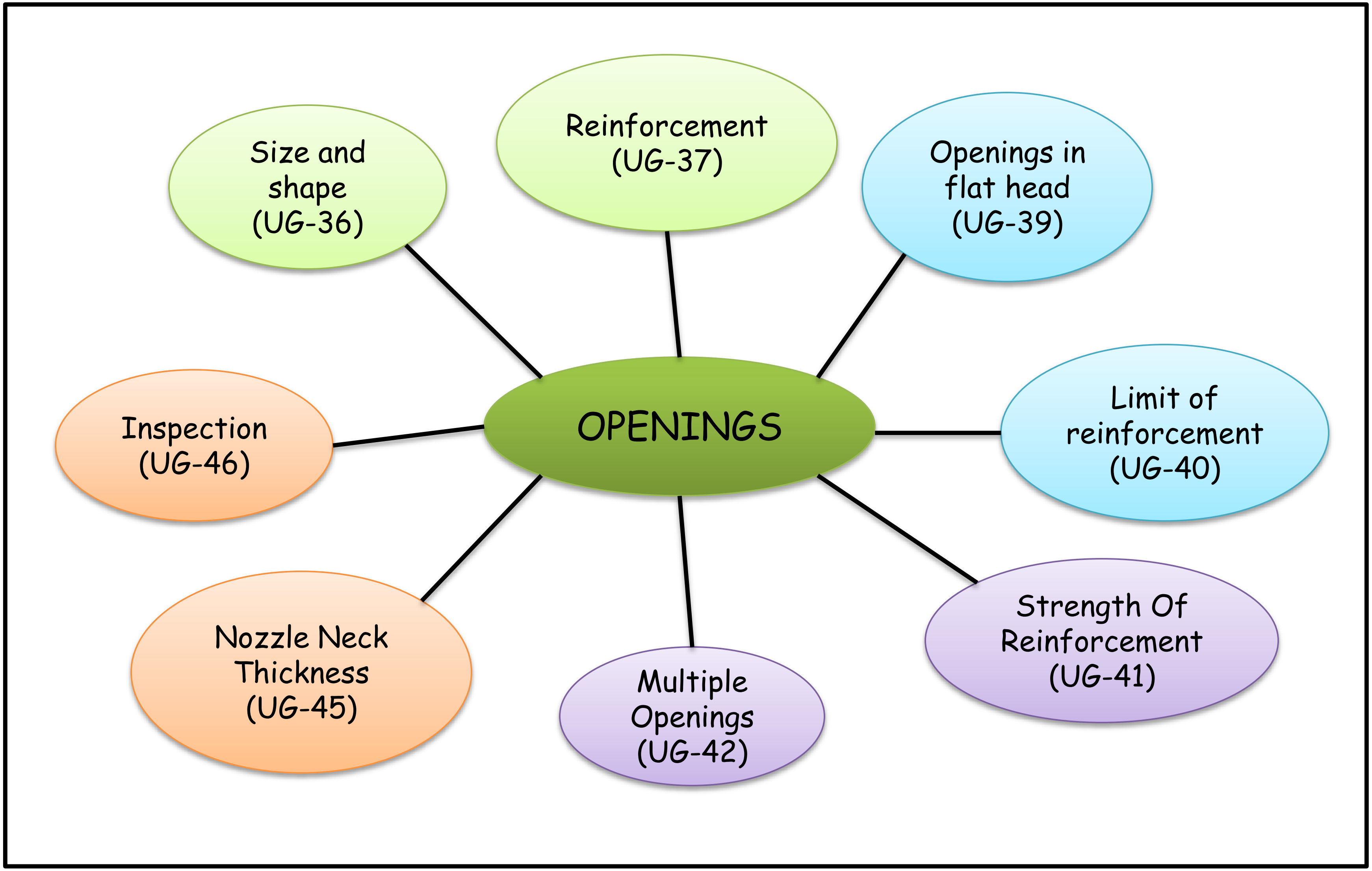
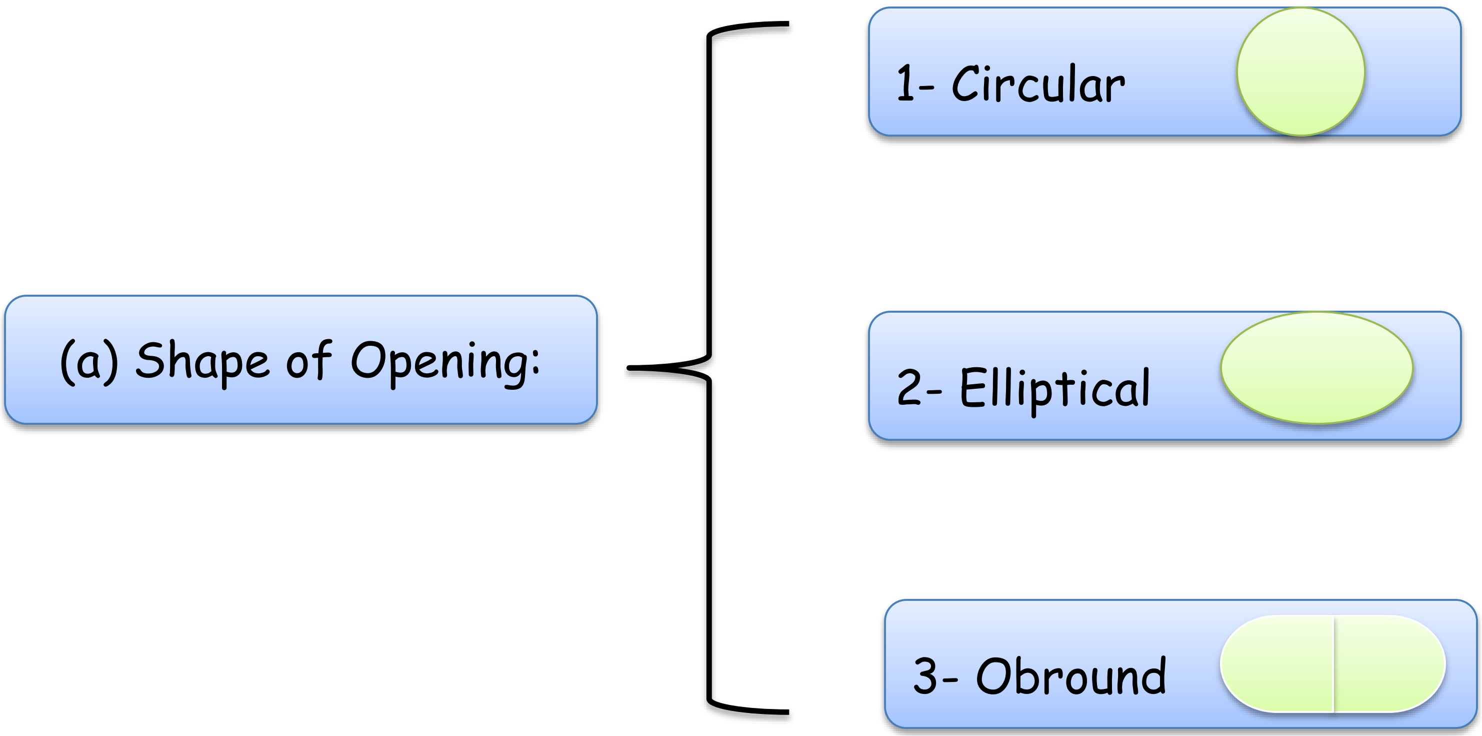


OPENINGS IN PRESSURE VESSELS





- Note: When the long dimension of an elliptical or obround opening exceeds twice the short dimensions, the reinforcement across the short dimensions shall be increased as necessary to provide against excessive distortion due to twisting moment.

UG-36 (OPENINGS IN PRESSURE VESSELS)

- (1) When the long dimension of an elliptical or obround opening exceeds twice the short dimensions, the reinforcement across the short dimensions shall be increased as necessary to provide against excessive distortion due to twisting moment.
- (2) Openings may be of other shapes than those given in (1) above, and all corners shall be provided with a suitable radius.

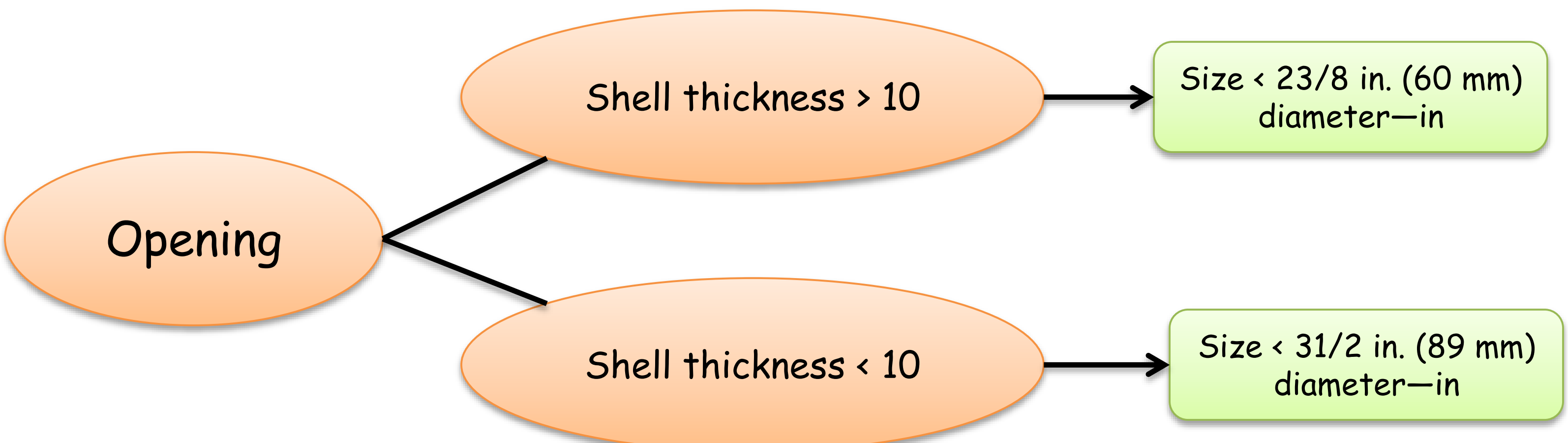
(b) Size of opening (Type of Opening):

- 1- Small opening
- 2- Normal size
- 3- Large opening

UG-36 (OPENINGS IN PRESSURE VESSELS)

1- Small opening as defined in UG-37 b and UG-36 (c) (3) Need not be confirmed to calculation of UG-37 :

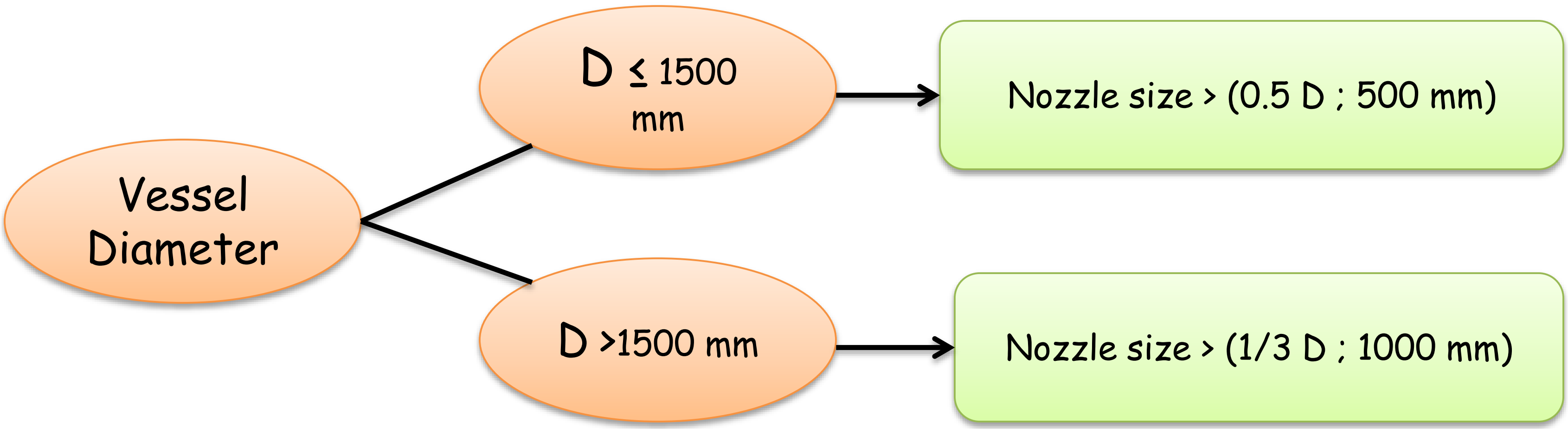
- (-1) 31/2 in. (89 mm) diameter—in vessel shells or heads with a required minimum thickness of 3/8 in.(10 mm) or less;
- (-2) 23/8 in. (60 mm) diameter—in vessel shells or heads over a required minimum thickness of 3/8 in. (10 mm);



UG-36 (OPENINGS IN PRESSURE VESSELS)

2- Normal size : Not identified as small opening nor large opening is called Normal size and will be design as per UG-37

3- Large opening as defined in UG-36 b :

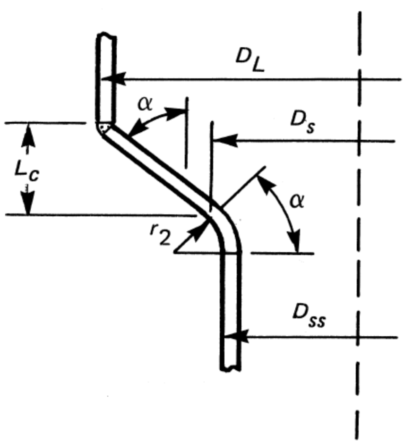


- For openings exceeding these limits, supplemental rules of 1-7 shall be satisfied in addition to the rules of this paragraph.
- Alternatively, openings in cylindrical or conical shells exceeding these limits may be designed for internal pressure using the rules of 1-10

UG-36(b)(2):

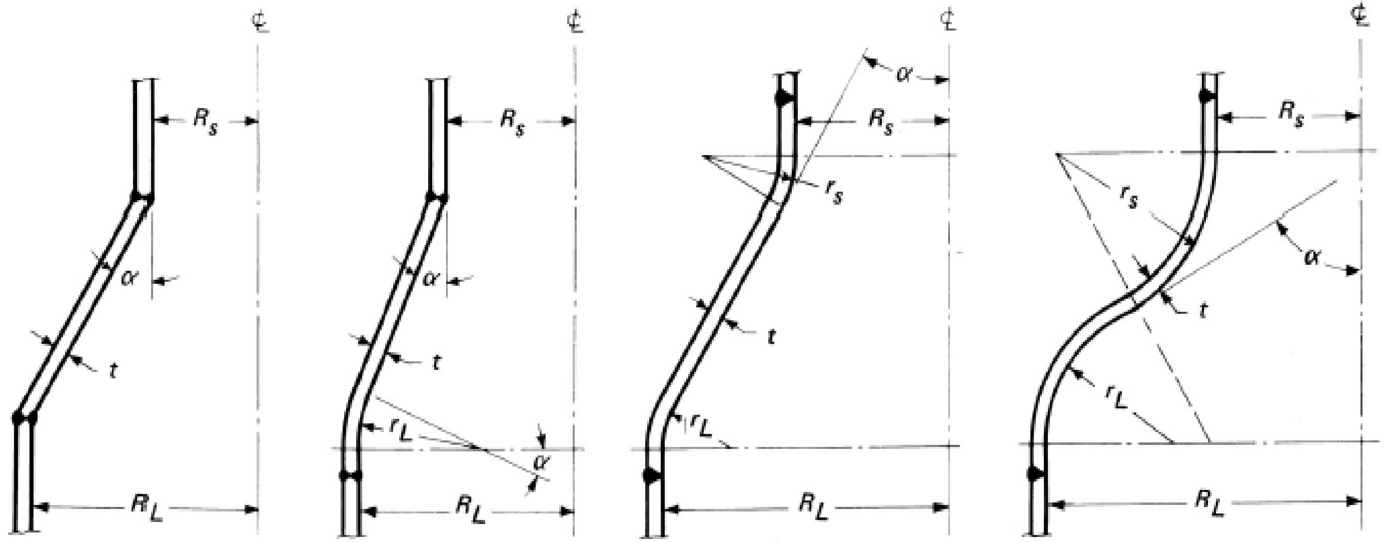
- 1- Reinforced openings in formed heads and spherical shells are not limited in size
- 2- For an opening in an end closure, which is larger than one-half the inside diameter of the shell, one of the following alternatives to reinforcement may also be used:
- ✓ (-a) a conical section as shown in Figure UG-36 sketch (a);
- ✓ (-b) a cone with a knuckle radius at the large end as shown in Figure UG-36 sketch (b);
- ✓ (-c) a reverse curve section as shown in Figure UG-36 sketches (c) and (d); or
- ✓ (-d) using a flare radius at the small end as shown in Figure UG-33.1 sketch (d).

Figure UG-33.1



(d)

Figure UG-36
Large Head Openings — Reverse-Curve and Conical Shell-Reducer Sections

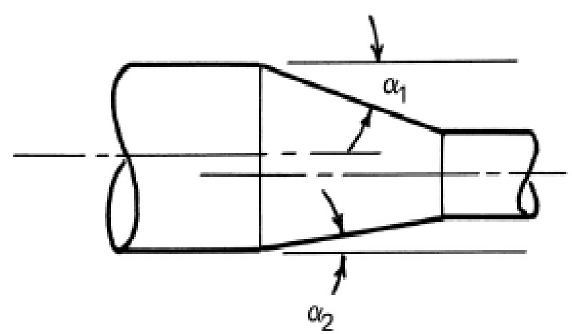


(a) [See Note(1)]

(b) [See Note(1)]

(c) [See Note(1)]

(d) [See Note(1)]

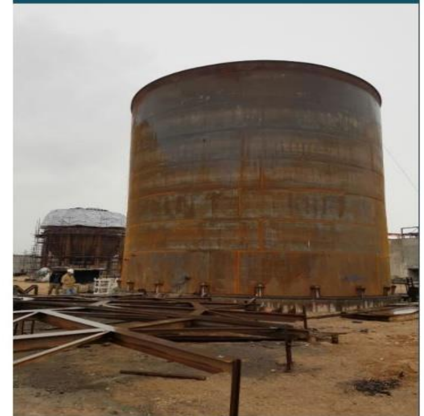


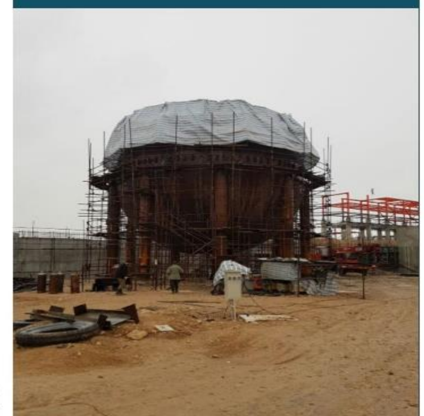
(e) [See Note(2)]

NOTES:

(1) r_L shall not be less than the greater of $0.12(R_L + t)$ or $3t$: r_s has no dimensional requirement.

(2) $\alpha_1 > \alpha_2$; therefore, use α_1 in design equations.





UG-36 (OPENINGS IN PRESSURE VESSELS)

(c) Strength and Design of Finished Openings

- 1- All references to dimensions apply to the finished construction after deduction for material added as corrosion allowance.
- 2- Openings in cylindrical or conical shells, or formed heads shall be reinforced to satisfy the requirements in UG-37 except as noted in UG-36 C,d and 3.
- (-b) Openings in flat heads shall be reinforced as required by UG-39.
- (-c) Openings in cylindrical and conical shells subjected to internal pressure may be designed to satisfy the requirements in Mandatory Appendix 1, 1-9 in lieu of the internal pressure requirements in UG-37.

UG-36 (OPENINGS IN PRESSURE VESSELS)

- 3- Openings in vessels not subject to rapid fluctuations in pressure do not require reinforcement other than that inherent in the construction under the following conditions:

- (a) opening not larger than:
- (-1) 31/2 in. (89 mm) diameter—in vessel shells or heads with a required minimum thickness of 3/8 in.(10 mm) or less;
- (-2) 23/8 in. (60 mm) diameter—in vessel shells or heads over a required minimum thickness of 3/8 in. (10 mm);

UG-36 (OPENINGS IN PRESSURE VESSELS)

- (-b) threaded, studded, or expanded connections in which the hole cut in the shell or head is not greater than 23/8 in. (60 mm) diameter;

- <u>Distance between unreinforced opening:</u>

- (-c) No two isolated unreinforced openings (in accordance with (-a) or (-b) above), shall have their centers closer to each other than the sum of their diameters;

- (-d) no two unreinforced openings, in a cluster of three or more unreinforced openings in accordance with (-a) or (-b) above, shall have their centers closer to each other than the following:

➢ for cylindrical or conical shells, $(1 + 1.5\cos\theta)(d_1 + d_2)$;

➢ for doubly curved shells and formed or flat heads $2.5(d_1 + d_2)$

- Where, d1, d2 = the finished diameter of the two adjacent openings

UG-36 (OPENINGS IN PRESSURE VESSELS)

The centerline of an unreinforced opening as defined in (-a) and (-b) above shall not be closer than its finished diameter to any material used for reinforcement of an adjacent reinforced opening.

- (d) Openings Through Welded Joints. Additional provisions governing openings through welded joints are given in UW-14.

UW-14 (OPENINGS IN OR ADJACENT TO WELDS)

- UG-36 (c) (3) (d) Openings Through Welded Joints. Additional provisions governing openings through welded joints are given in UW-14.
- (a) Any type of opening that meets the requirements for reinforcement given in UG-37 or UG-39 may be located in a welded joint.
- There is two condition for such welds:
- 1- There is a single opening and it is in accordance to UG-36 (C) (3)
- 2- There are multiple opening meeting the requirements given in UG-36 (C) (3)

UW-14 (OPENINGS IN OR ADJACENT TO WELDS)

- 1- There is a single opening and it is in accordance to UG-36 (C) (3)

- may be located in head-to-shell or Category B or C butt welded joints, provided the weld meets the radiographic requirements in UW-51 for a length equal to three times the diameter of the opening with the center of the hole at midlength.

UW-14 (OPENINGS IN OR ADJACENT TO WELDS)

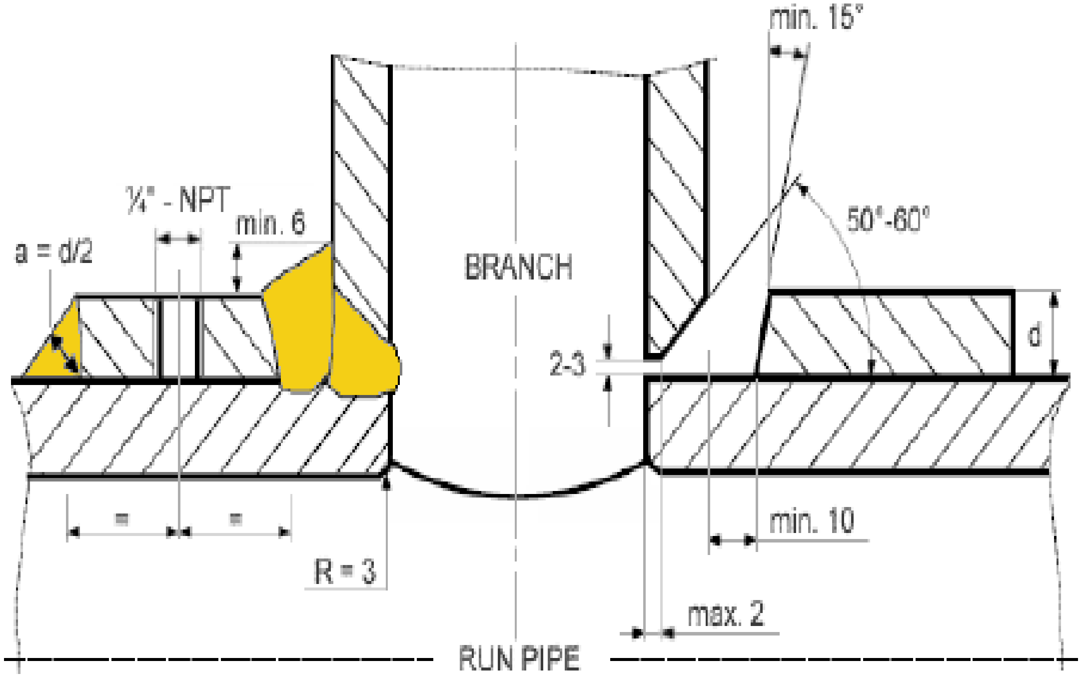
- 2- There are multiple opening meeting the requirements given in UG-36 (C) (3)

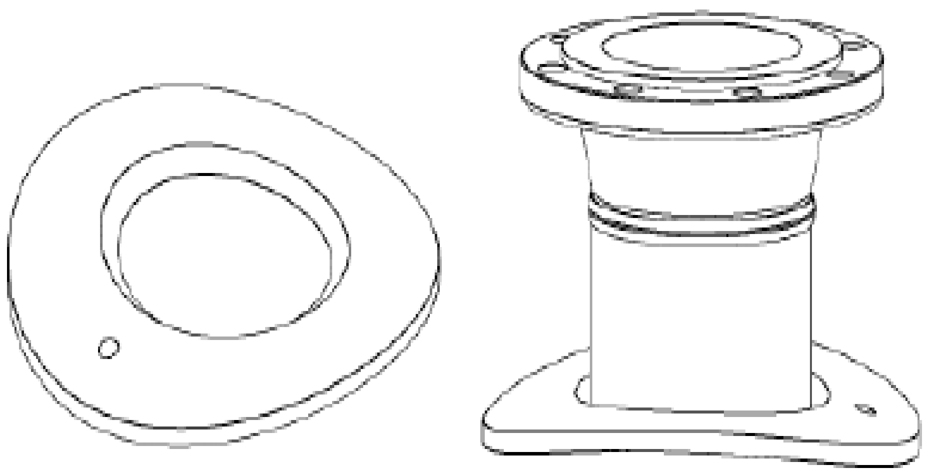
- the requirements of UG-53 shall be met or the openings shall be reinforced in accordance with UG-37 through UG-42.

UG-37 (REINFORCEMENT of OPENINGS)

- Rules in this paragraph apply to all openings other than:
- (1) small openings covered by UG-36(c)(3);
- (2) openings in flat heads covered by UG-39;
- (3) openings designed as reducer sections covered by UG-36(e);
- (4) large head openings covered by UG-36(b)(2);
- (5) tube holes with ligaments between them conforming to the rules of UG-53.

Branch Connection with Reinforcing Pad (Set-On type)



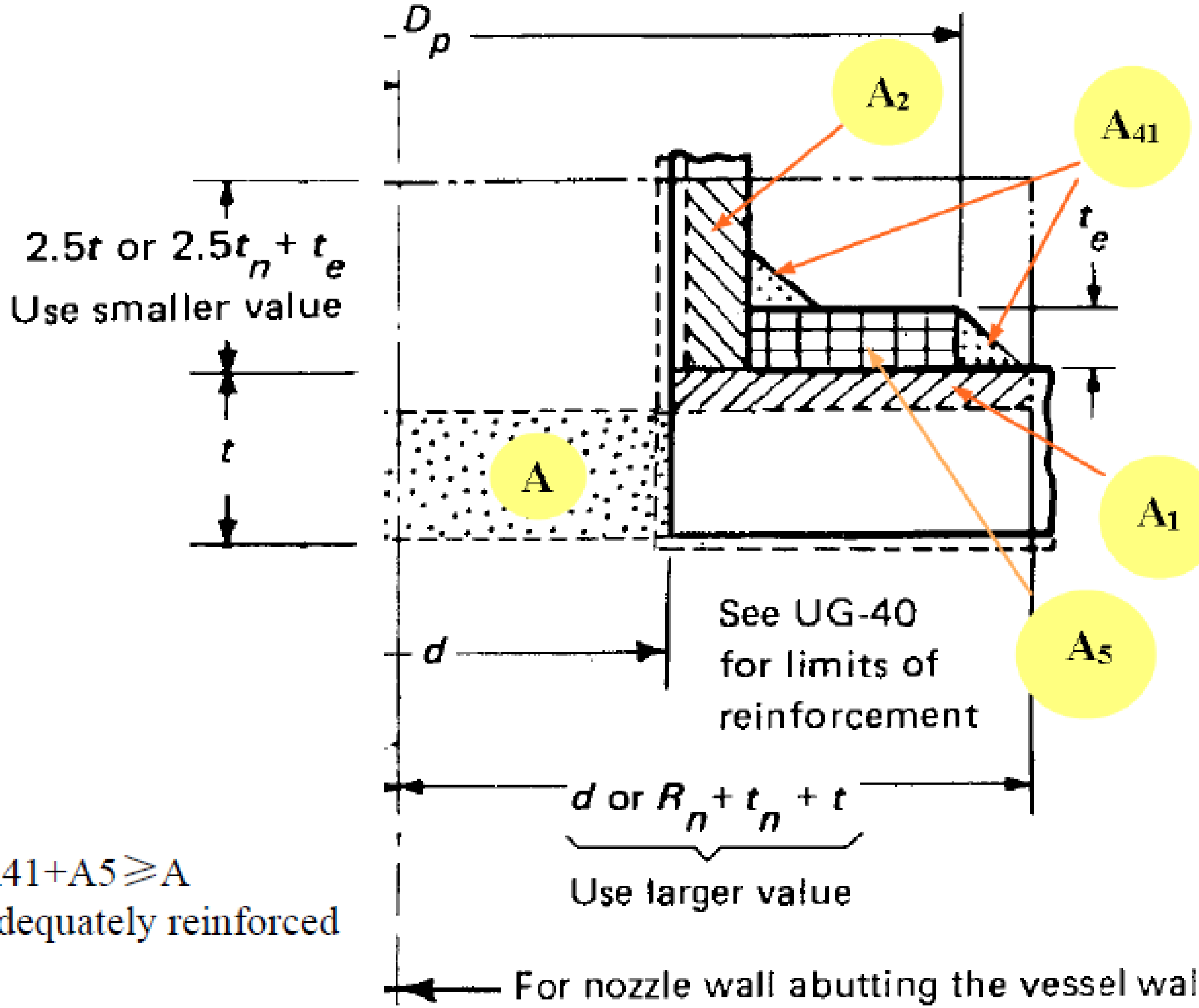


- ASME VIII, UG-37
  Is the nozzle sufficiently reinforced
- ASME VIII, UW-16
  Are the nozzle welds of adequate sizes.

UG-37 (REINFORCEMENT of OPENINGS)

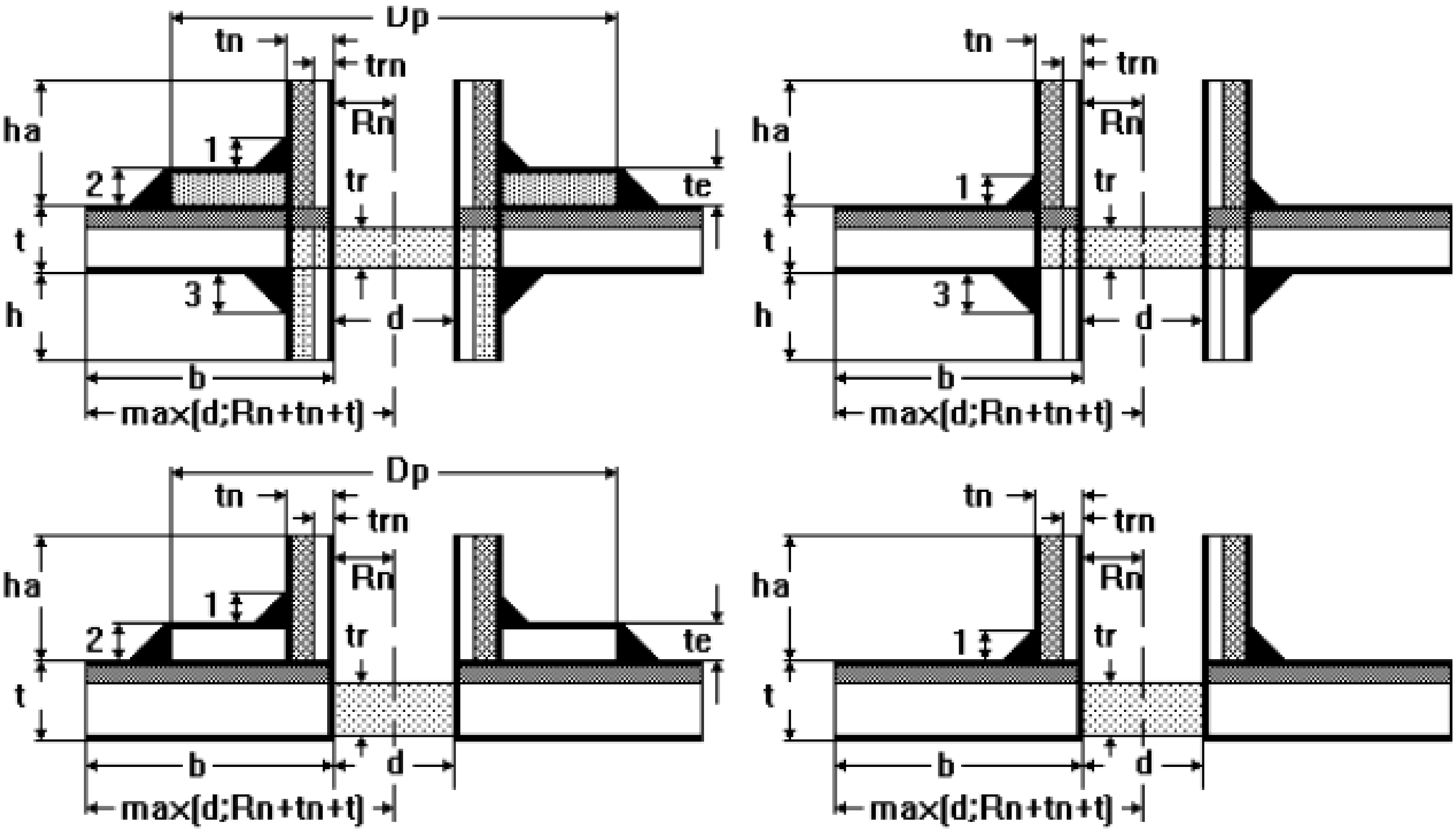
(a) Nomenclature. **The symbols used in this paragraph are defined as follows:**

- A = total cross-sectional area of reinforcement required in the plane under consideration (see Fig. UG-37.1) (includes consideration of nozzle area through shell if Sn /Sv<1.0)
- A_1=area in excess thickness in the vessel wall available for reinforcement (see Fig. UG-37.1) (includes consideration of nozzle area through shell if Sn /Sv<1.0)
- A_2=area in excess thickness in the nozzle wall available for reinforcement (see Fig. UG-37.1)
- A_3=area available for reinforcement when the nozzle extends inside the vessel wall (see Fig. UG-37.1) (Not in the exam)
- A_5=cross-sectional area of material added as reinforcement (see Fig. UG-37.1)
- A_{41}, A_{42}, A_{43}=cross-sectional area of various welds available for reinforcement (see Fig. UG-37.1)



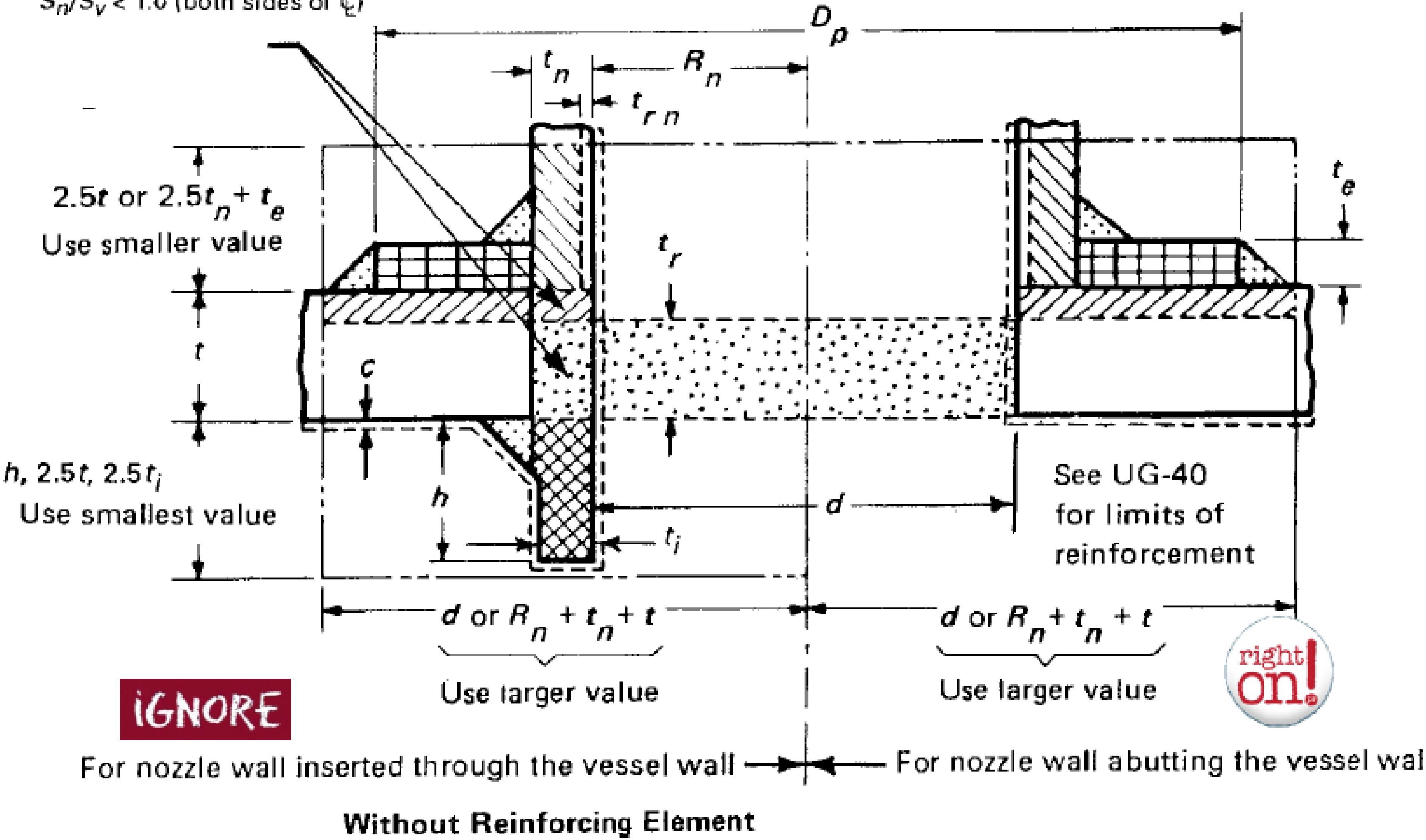
If A1+A2+A41+A5 ≥ A
Opening is adequately reinforced

ASME VIII, UG-37 The code uses the principle of the area replacement method



GENERAL NOTE:
Includes consideration of these areas if $S_n/S_v < 1.0$ (both sides of ℄)

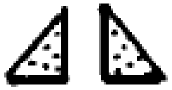
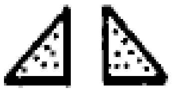
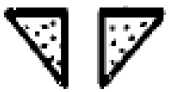
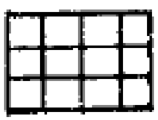
FIG. UG-37.1 NOMENCLATURE AND FORMULAS FOR REINFORCED OPENINGS



Without Reinforcing Element

$= A = d\,t_r F + 2t_n t_r F(1 - f_{r1})$	Area required
$= A_1 \begin{cases} = d(E_1 t - Ft_r) - 2t_n (E_1 t - Ft_r)(1 - f_{r1}) \\ = 2(t + t_n)(E_1 t - Ft_r) - 2t_n(E_1 t - Ft_r)(1 - f_{r1}) \end{cases}$	Area available in shell; use larger value
$= A_2 \begin{cases} = 5(t_n - t_{rn})\, f_{r2} t \\ = 5(t_n - t_{rn})\, f_{r2} t_n \end{cases}$	Area available in nozzle projecting outward; use smaller value
$= A_3 = 5t\, t_i\, f_{r2}$ $= 5t_i\, t_i\, f_{r2}$ $= 2h\, t_i\, f_{r2}$	Area available in inward nozzle; use smallest value
$= A_{41}$ = outward nozzle weld $= (\text{leg})^2 f_{r2}$	Area available in outward weld
$= A_{43}$ = inward nozzle weld $= (\text{leg})^2 f_{r2}$	Area available in inward weld
If $A_1 + A_2 + A_3 + A_{41} + A_{43} \geq A$	Opening is adequately reinforced
If $A_1 + A_2 + A_3 + A_{41} + A_{43} < A$	Opening is not adequately reinforced so reinforcing elements must be added and/or thicknesses must be increased

With Reinforcing Element Added

	A = same as A, above	Area required
	A_1 = same as A_1, above	Area available
	$A_2 \begin{cases} = 5(t_n - t_{rn}) f_{r2} t \\ = 2(t_n - t_{rn})(2.5t_n + t_e) f_{r2} \end{cases}$	Area available in nozzle projecting outward; use smaller area
	A_3 = same as A_3, above	Area available in inward nozzle
 =	A_{41} = outward nozzle weld $= (\text{leg})^2 f_{r3}$	Area available in outward weld
 =	A_{42} = outer element weld $= (\text{leg})^2 f_{r4}$	Area available in outer weld
 =	A_{43} = inward nozzle weld $= (\text{leg})^2 f_{r2}$	Area available in inward weld
 =	$A_5 = (D_p - d - 2t_n) t_e \; f_{r4}$ [Note (1)]	Area available in element
	If $A_1 + A_2 + A_3 + A_{41} + A_{42} + A_{43} + A_5 \geq A$	Opening is adequately reinforced

- The total cross sectional area of reinforcement A required in any given plane through the opening for a shell or formed head under internal pressure shall be not less than :

Required cross sectional area of reinforcement

Internal pressure :

$$A = d t_r F + 2 t_n t_r F \left(1 - f_{r1}\right)$$

External pressure:

50% of required area for internal

UG-37 (g)

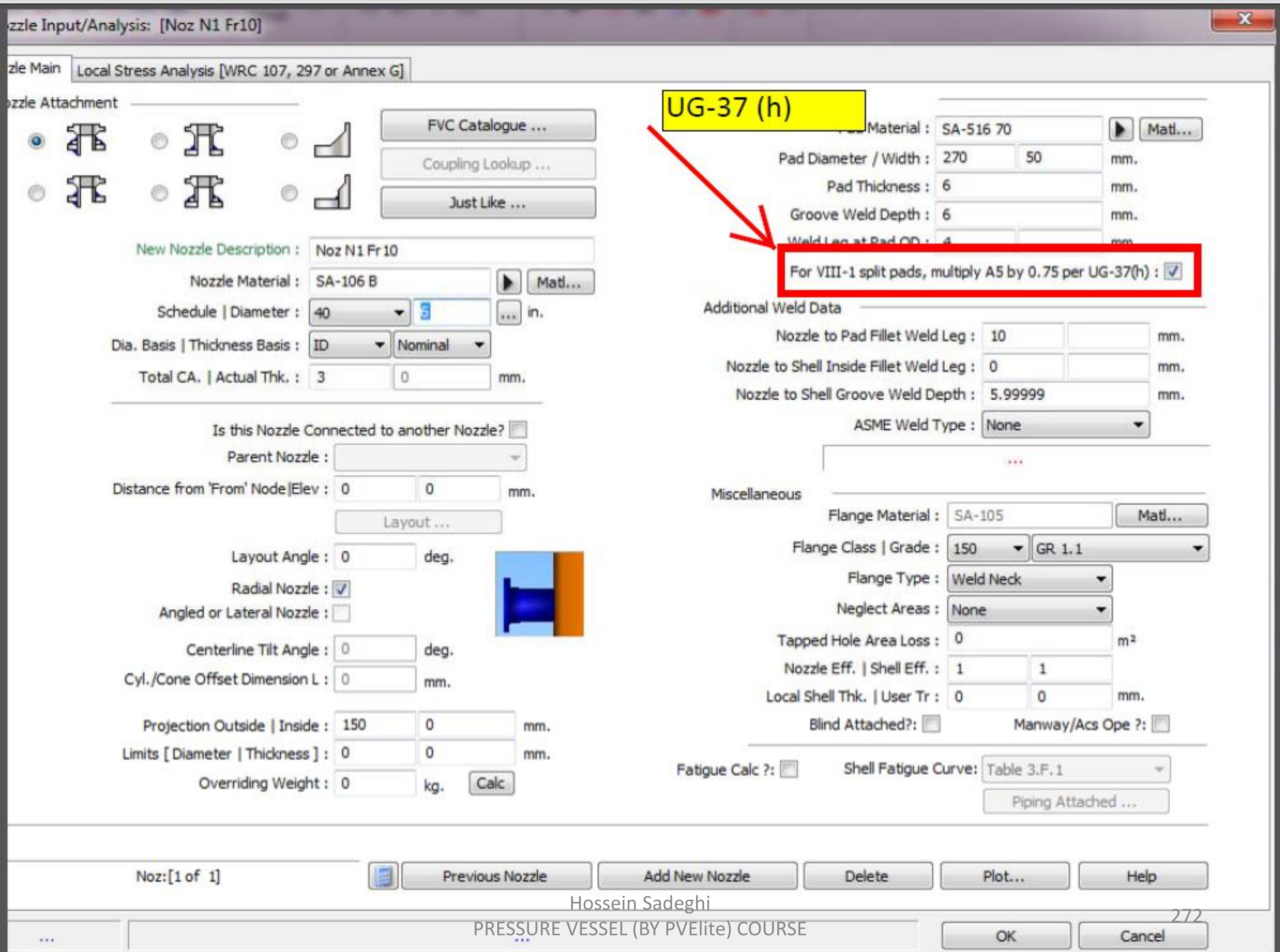
- Reinforcing plates and saddles of nozzles attached to the outside of a vessel shall be provided with at least one telltale hole 11 mm that may be tapped with straight or tapered threads.

- These telltale holes may be left open or may be plugged when the vessel is in service. If the holes are plugged, the plugging material used shall not be capable of sustaining pressure between the reinforcing plate and the vessel wall.

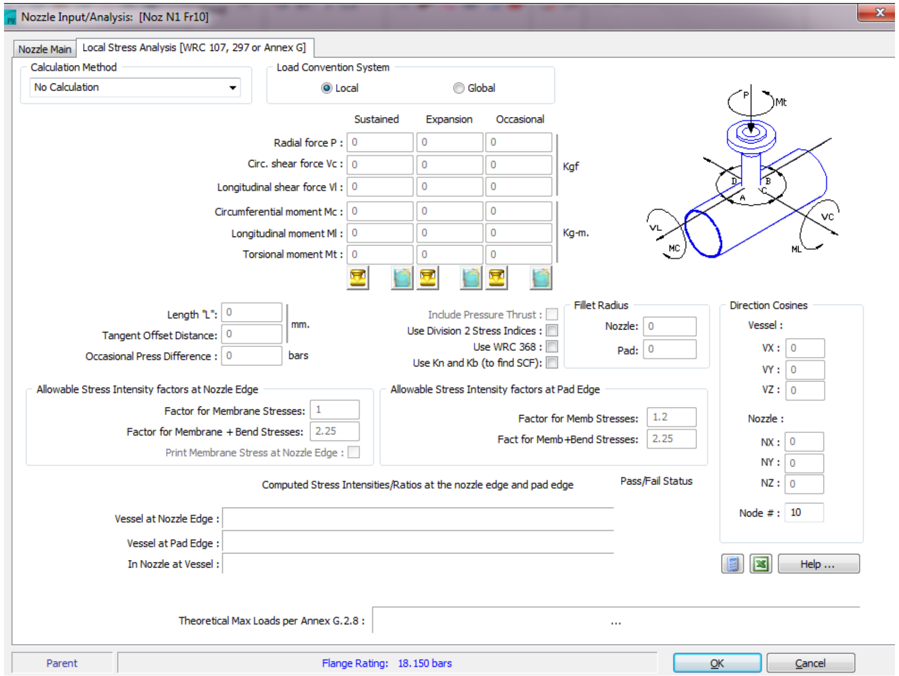
UG-37 (h)

- Segmental reinforcing elements are allowed provided the individual segments are joined by full penetration butt welds. These butt welds shall comply with all the applicable requirements of Part UW. Each segment of the reinforcing element shall have a telltale hole as required by (g). Unless the provisions given below are satisfied, the area A5 as defined in Figure UG-37.1 shall be multiplied by 0.75.

  The area A5 does not require any reduction if one of the following is satisfied:
- (1) Each butt weld is radiographed or ultrasonically examined to confirm full penetration, or
- (2) For openings in cylinders, the weld is oriented at least 45 deg from the longitudinal axis of the cylinder.


zzle Input/Analysis: [Noz N1 Fr10]
zle Main
Local Stress Analysis [WRC 107, 297 or Annex G]
zzle Attachment
FVC Catalogue ...
Coupling Lookup ...
Just Like ...
New Nozzle Description : Noz N1 Fr10
Nozzle Material : SA-106 B
Matl...
Schedule | Diameter : 40 | 6 in.
Dia. Basis | Thickness Basis : ID | Nominal
Total CA. | Actual Thk. : 3 | 0 mm.
Is this Nozzle Connected to another Nozzle?
Parent Nozzle :
Distance from 'From' Node|Elev : 0 | 0 mm.
Layout ...
Layout Angle : 0 deg.
Radial Nozzle :
Angled or Lateral Nozzle :
Centerline Tilt Angle : 0 deg.
Cyl./Cone Offset Dimension L : 0 mm.
Projection Outside | Inside : 150 | 0 mm.
Limits [Diameter | Thickness] : 0 | 0 mm.
Overriding Weight : 0 kg.
Calc
UG-37 (h)
Material : SA-516 70
Matl...
Pad Diameter / Width : 270 | 50 mm.
Pad Thickness : 6 mm.
Groove Weld Depth : 6 mm.
For VIII-1 split pads, multiply A5 by 0.75 per UG-37(h) :
Additional Weld Data
Nozzle to Pad Fillet Weld Leg : 10 mm.
Nozzle to Shell Inside Fillet Weld Leg : 0 mm.
Nozzle to Shell Groove Weld Depth : 5.99999 mm.
ASME Weld Type : None
Miscellaneous
Flange Material : SA-105
Matl...
Flange Class | Grade : 150 | GR 1.1
Flange Type : Weld Neck
Neglect Areas : None
Tapped Hole Area Loss : 0 m²
Nozzle Eff. | Shell Eff. : 1 | 1
Local Shell Thk. | User Tr : 0 | 0 mm.
Blind Attached?:
Manway/Acs Ope ?:
Fatigue Calc ?:
Shell Fatigue Curve: Table 3.F.1
Piping Attached ...
Noz:[1 of 1]
Previous Nozzle
Add New Nozzle
Delete
Plot...
Help
OK
Cancel

- The reinforcement rules in this Division are applicable for internal or external pressure and do not address the requirements for openings under the action of externally applied loadings (such as pipe reactions).

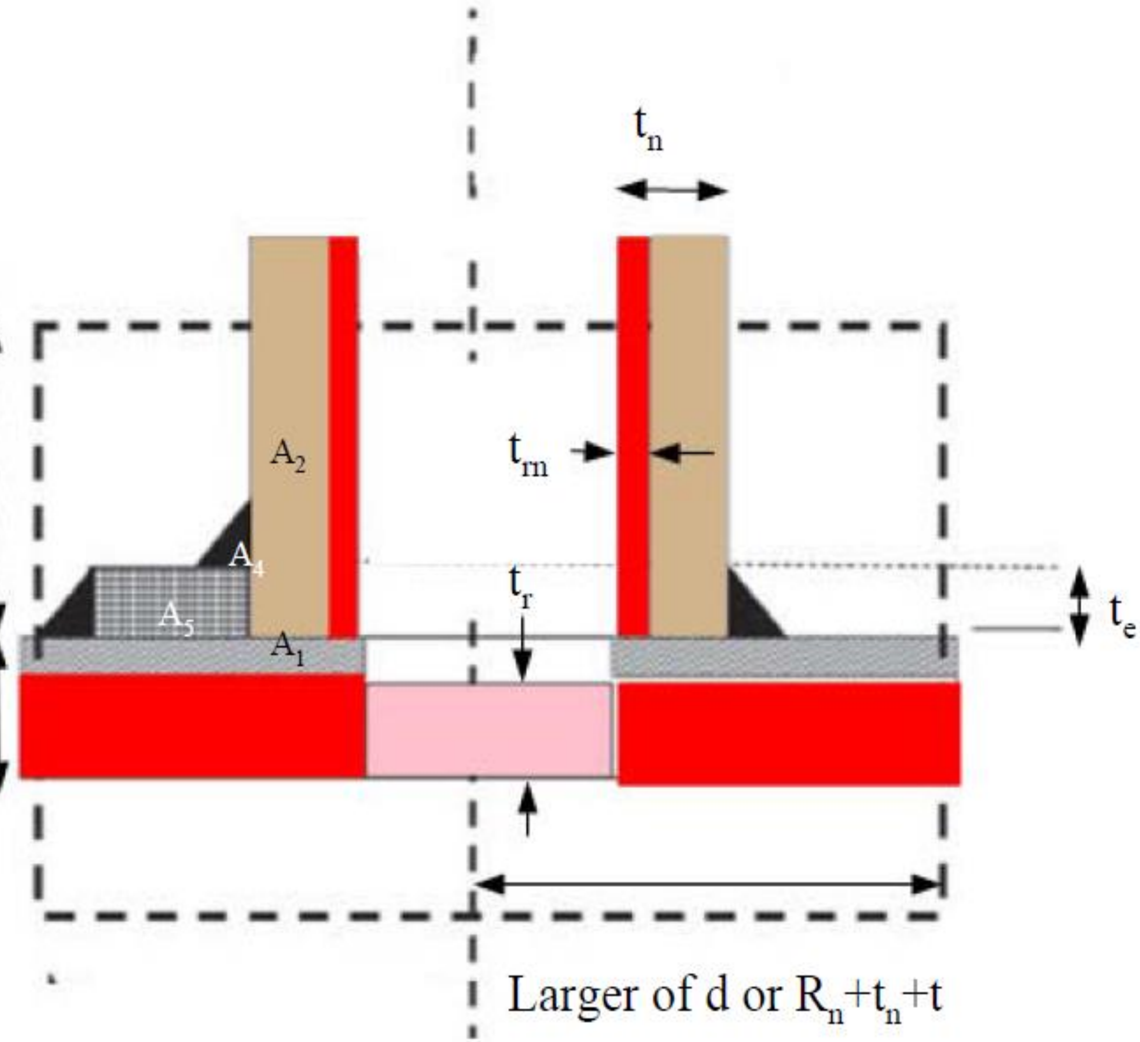


UG-40 (LIMITS OF REINFORCEMENT)

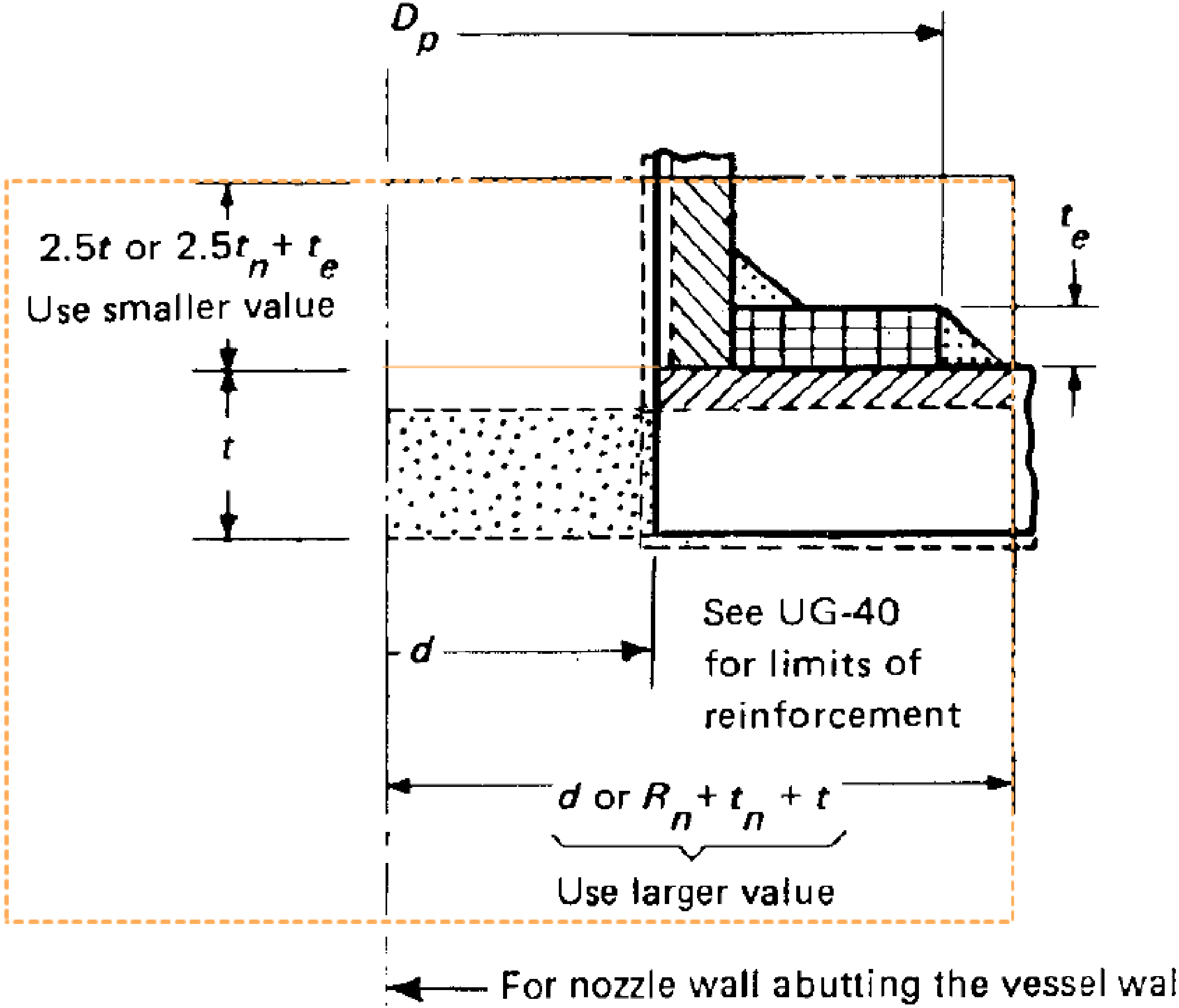
- The boundaries of the cross sectional area in any plane normal to the vessel wall and passing through the center of the opening within which metal must be located in order to have value as reinforcement are designated as the limits of reinforcement for that plane.

Required cross sectional area of reinforcement

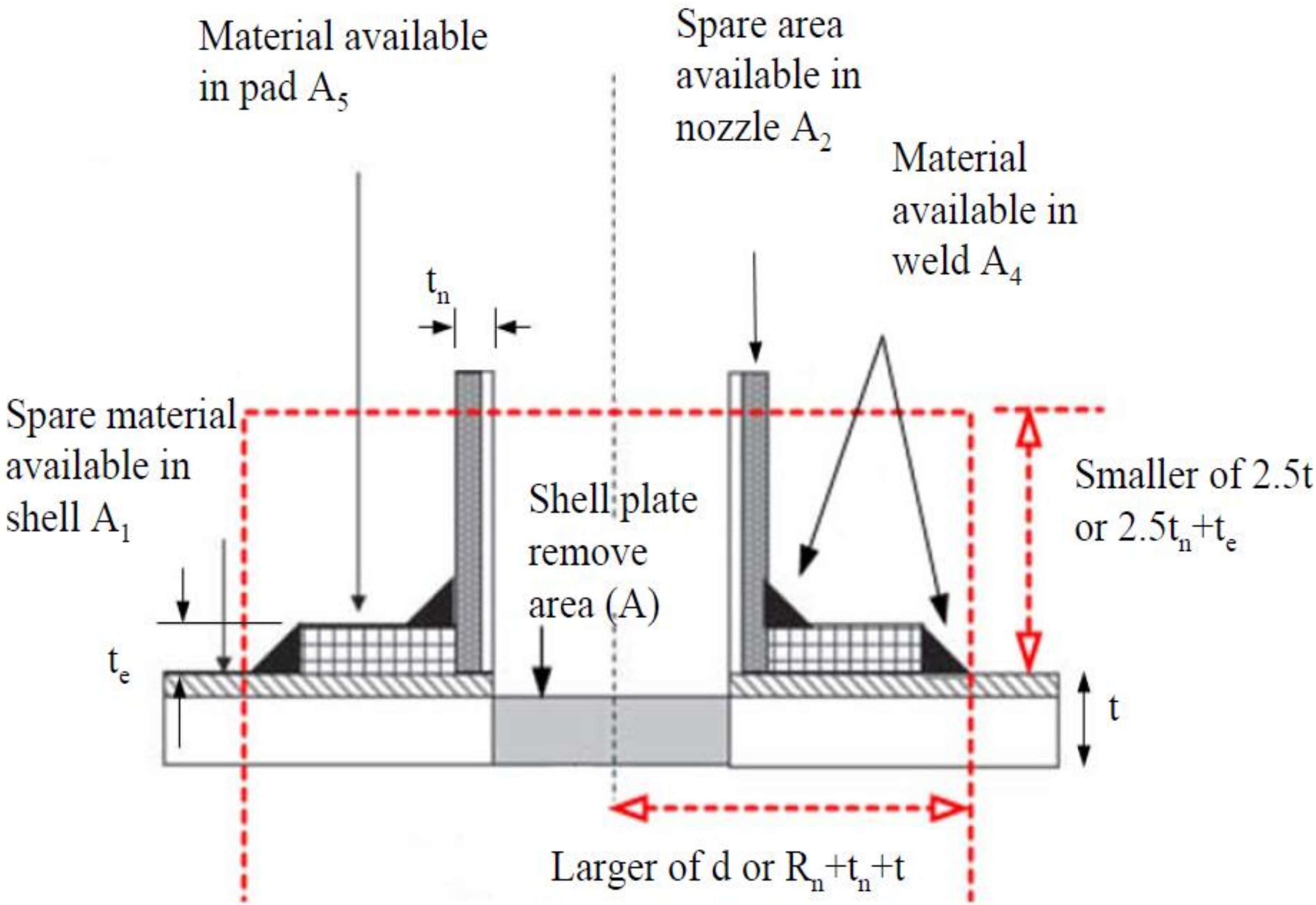
- Normal to vessel wall
- Parallel to vessel wall



t_n
Smaller of 2.5t
or $2.5t_n+t_e$
A_2
t_{rn}
A_4
t_r
t_e
A_5
A_1
t
Larger of d or R_n+t_n+t


D_p
t_e
$2.5t$ or $2.5t_n + t_e$
Use smaller value
t
See UG-40
for limits of
reinforcement
d
d or $R_n + t_n + t$
Use larger value
For nozzle wall abutting the vessel wall

UG-40


Material available in pad A_5
Spare area available in nozzle A_2
Material available in weld A_4
t_n
Spare material available in shell A_1
Shell plate remove area (A)
Smaller of 2.5t or $2.5t_n+t_e$
t_e
t
Larger of d or R_n+t_n+t

UG-40 (LIMITS OF REINFORCEMENT)

- The limits of reinforcement, measured parallel to the vessel wall is greater of following:

❖ (1) the diameter d of the finished opening;

❖ (2) the inside radius, Rn, of the nozzle plus the vessel wall thickness t , plus the nozzle wall thickness tn.

Max. (d ; (Rn + t + tn)

UG-40 (LIMITS OF REINFORCEMENT)

- The limits of reinforcement, measured normal to the vessel wall is Smaller of following: :

❖ (1) 21/2 times the vessel wall thickness t ;

❖ (2) 21/2 times the nozzle wall thickness tn plus the thickness te as defined in Figure UG-40.

Min. (2.5 t ; (2.5 tn + te)

Figure UG-40
Some Representative Configurations Describing the Reinforcement Dimension t_e and the Opening Dimension d

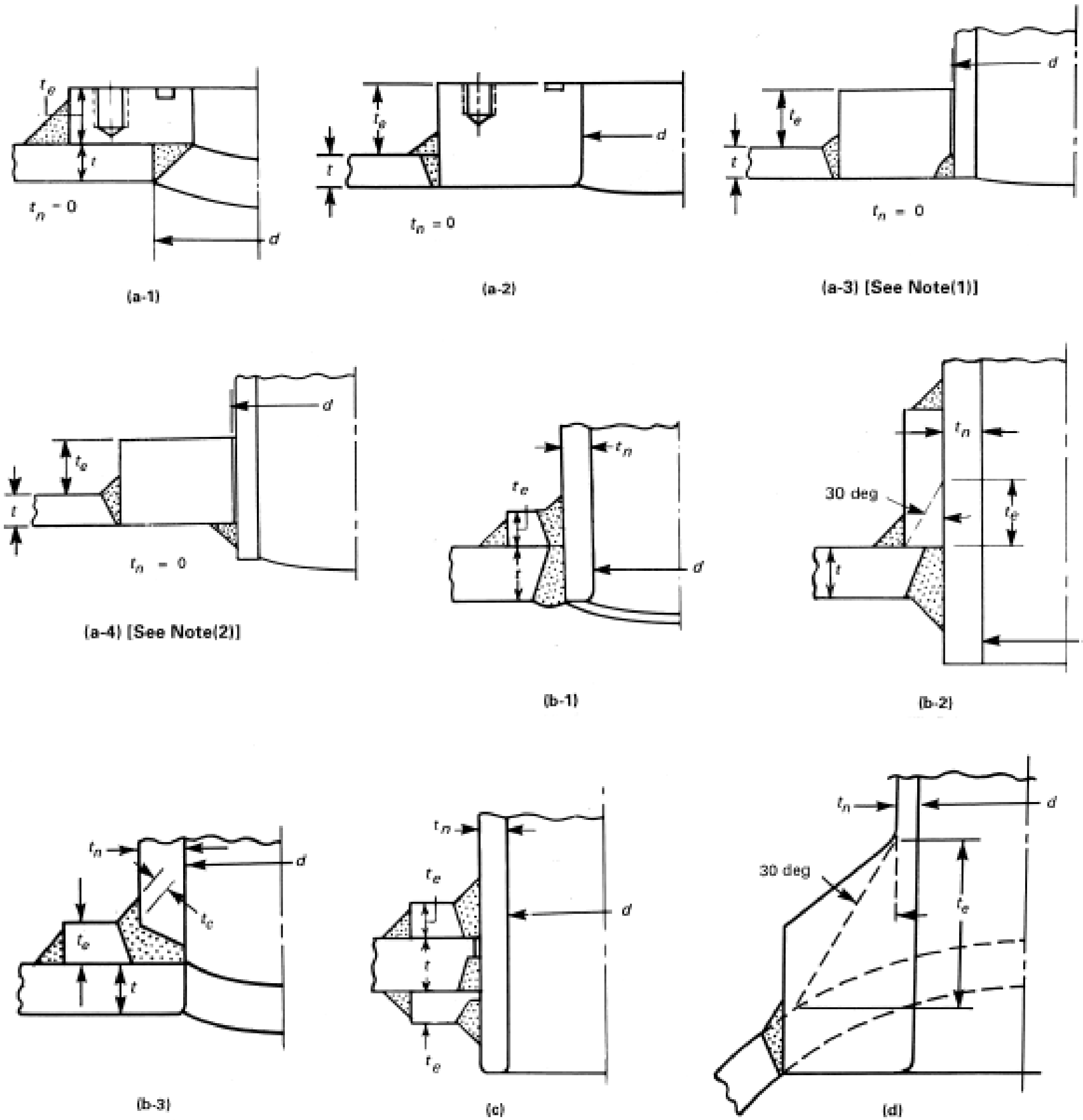
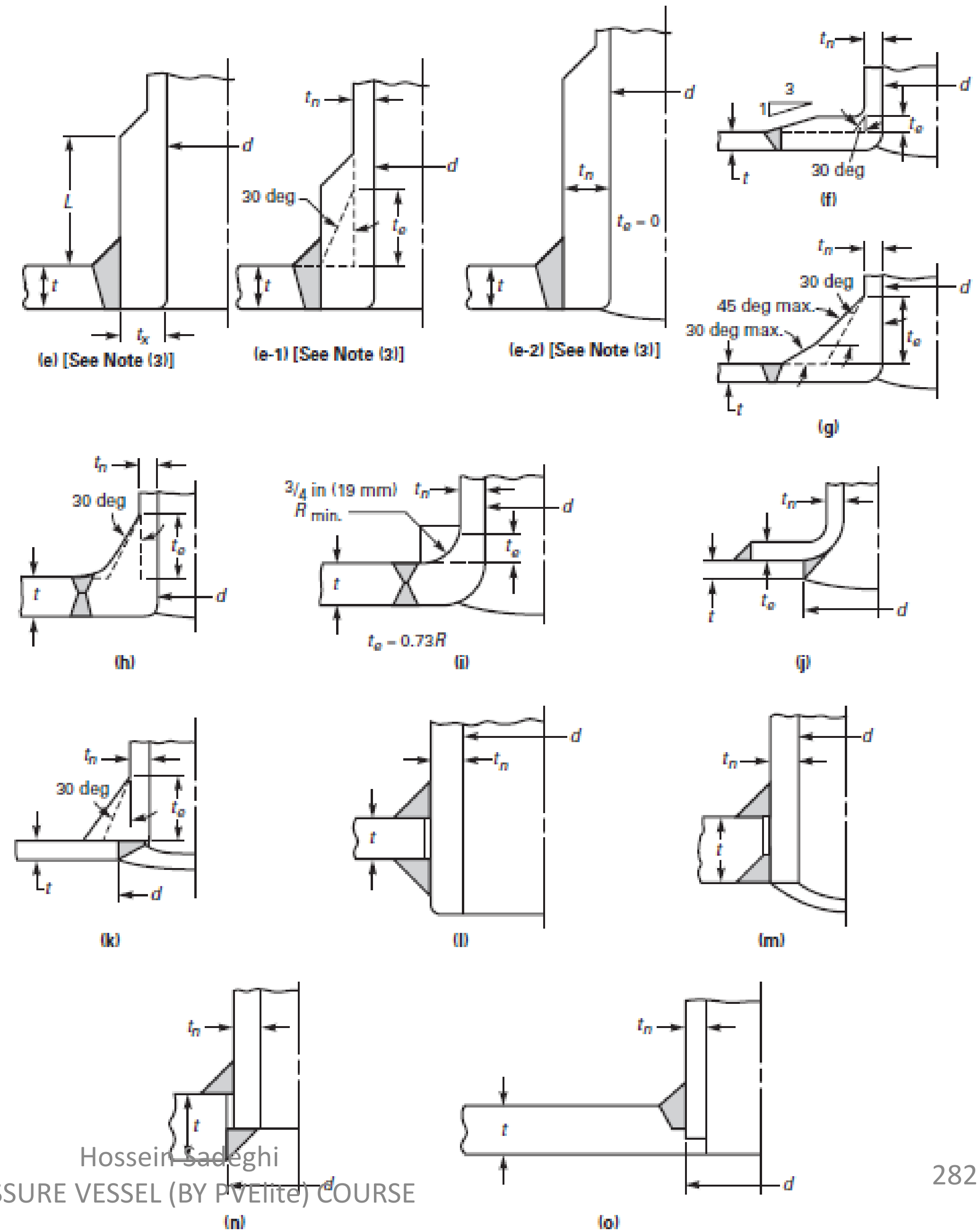


Figure UG-40
Some Representative Configurations Describing the Reinforcement Dimension t_e and the Opening Dimension d (Cont'd)

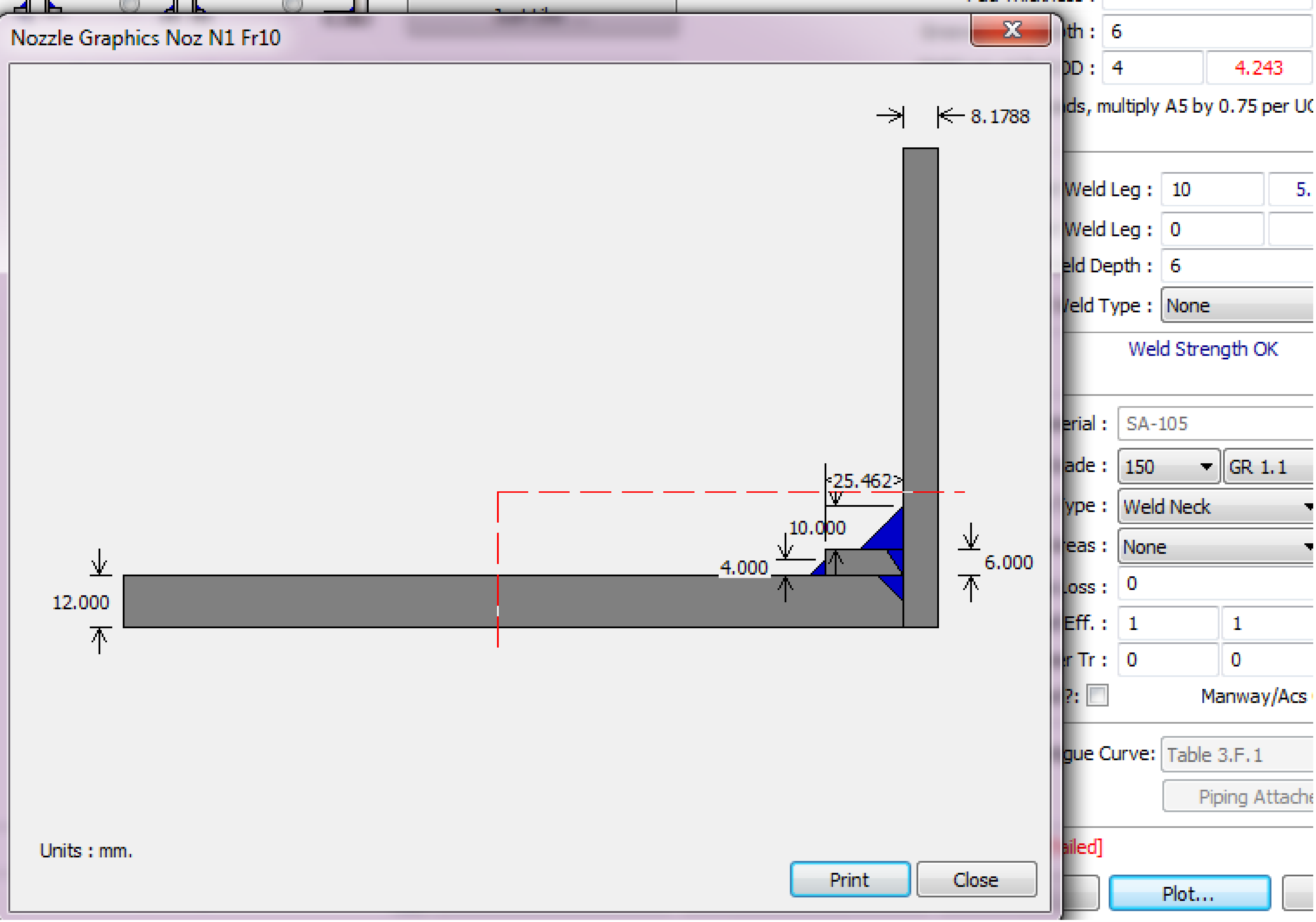


NOTES:

(1) See Figure UW-16.1, sketch (v-2) for limitations.

(2) See Figure UW-16.1, sketch (w-2) for limitations.

(3) If $L < 2.5t_x$, use sketch (e-1); if $L \geq 2.5t_x$, use sketch (e-2).



Nozzle Graphics Noz N1 Fr10
8.1788
25.462
10.000
4.000
6.000
12.000
Units : mm.
Print
Close
th : 6
D : 4
4.243
ds, multiply A5 by 0.75 per UC
Weld Leg : 10
5.
Weld Leg : 0
eld Depth : 6
eld Type : None
Weld Strength OK
erial : SA-105
ade : 150
GR 1.1
ype : Weld Neck
eas : None
oss : 0
Eff. : 1
1
r Tr : 0
0
?:
Manway/Acs
gue Curve: Table 3.F.1
Piping Attache
ailed]
Plot...

Notes about opening

- ❖ The Vessels 18" to 36" I. D. must have a manhole or at least 2 hand holes or two threaded openings
- ❖ All vessels over 36" I. D. must have a manhole
- ❖ When inspection openings are required, they must meet the following
- ✓ An elliptical manhole shall not be less than 12" X 16"
- ✓ A circular manhole shall not be less than 16"
- ✓ A handhole shall not be less than 2"x 3"

- ❑ Ref. ASME Continuing education institute booklet

UG-41 (STRENGTH OF REINFORCEMENT)

- (a) Material used for reinforcement shall have an allowable stress value equal to or greater than that of the material in the vessel wall.

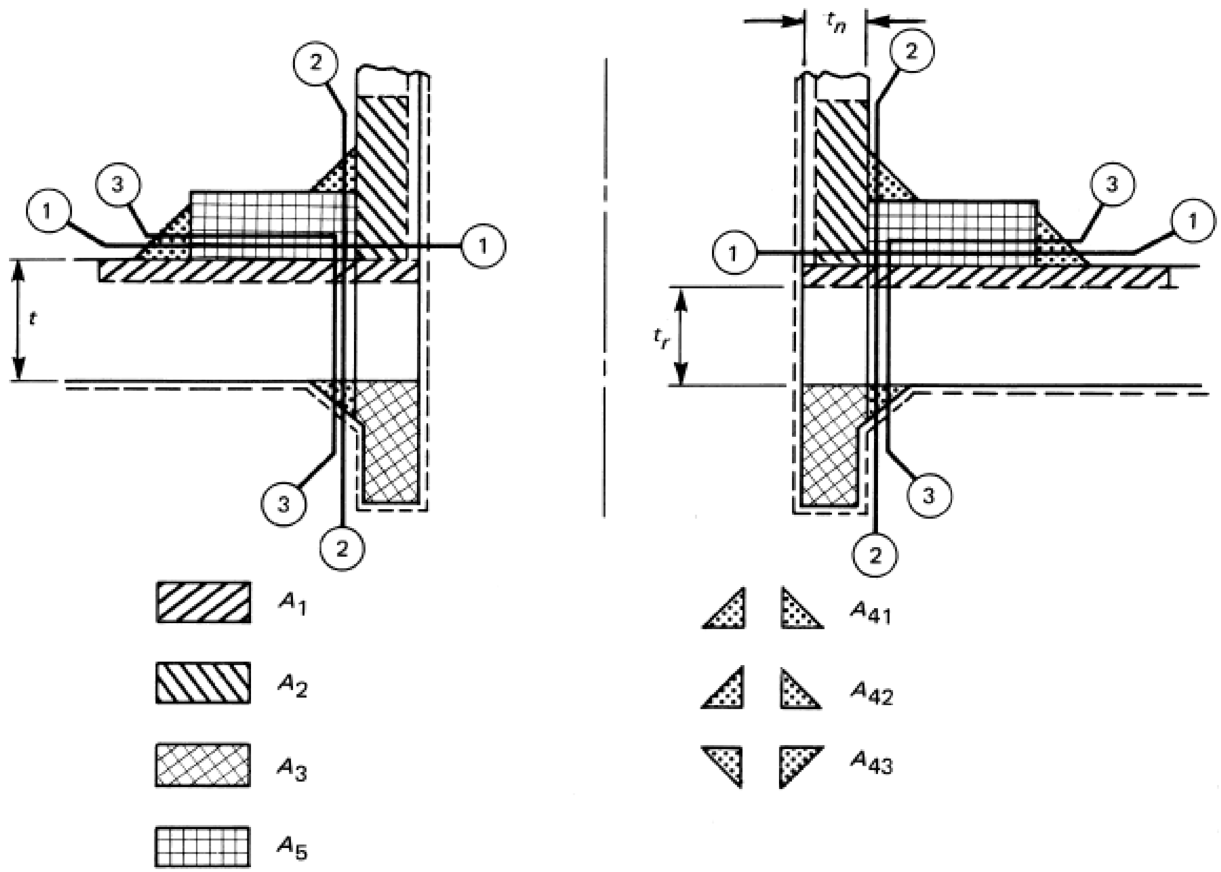
- IF SUCH MATERIAL IS NOT AVAILABLE ?!

- Lower strength material may be used, provided the area of reinforcement is increased in inverse proportion to the ratio of the allowable stress values of the two materials to compensate for the lower allowable stress value of the reinforcement.

UG-41 (STRENGTH OF REINFORCEMENT)

- No credit may be taken for the additional strength of any reinforcement having a higher allowable stress value than that of the vessel wall.
- weld metal outside of either the vessel wall or any reinforcing pad used as reinforcement shall be credited with an allowable stress value equivalent to the weaker of the materials connected by the weld.

Figure UG-41.1
Nozzle Attachment Weld Loads and Weld Strength Paths to Be Considered



W = total weld load [UG-41(b)(2)]
$= [A - A_1 + 2t_n f_{r1}(E_1 t - F t_r)]S_v$
$W_{1\text{-}1}$ = weld load for strength path 1-1 [UG-41(b)(1)]
$= (A_2 + A_5 + A_{41} + A_{42})S_v$
$W_{2\text{-}2}$ = weld load for strength path 2-2 [UG-41(b)(1)]
$= (A_2 + A_3 + A_{41} + A_{43} + 2t_n t f_{r1})S_v$
$W_{3\text{-}3}$ = weld load for strength path 3-3 [UG-41(b)(1)]
$= (A_2 + A_3 + A_5 + A_{41} + A_{42} + A_{43} + 2t_n t f_{r1})S_v$

(a) Depicts Typical Nozzle Detail With Neck Inserted Through the Vessel Wall

UG-42 (Reinforcement of Multiple Openings)

- When the spacing between two openings is less than two times their average diameter, the reinforcement must satisfy the requirements for multiple openings. There are three general procedures for reinforcing multiple openings. They are:

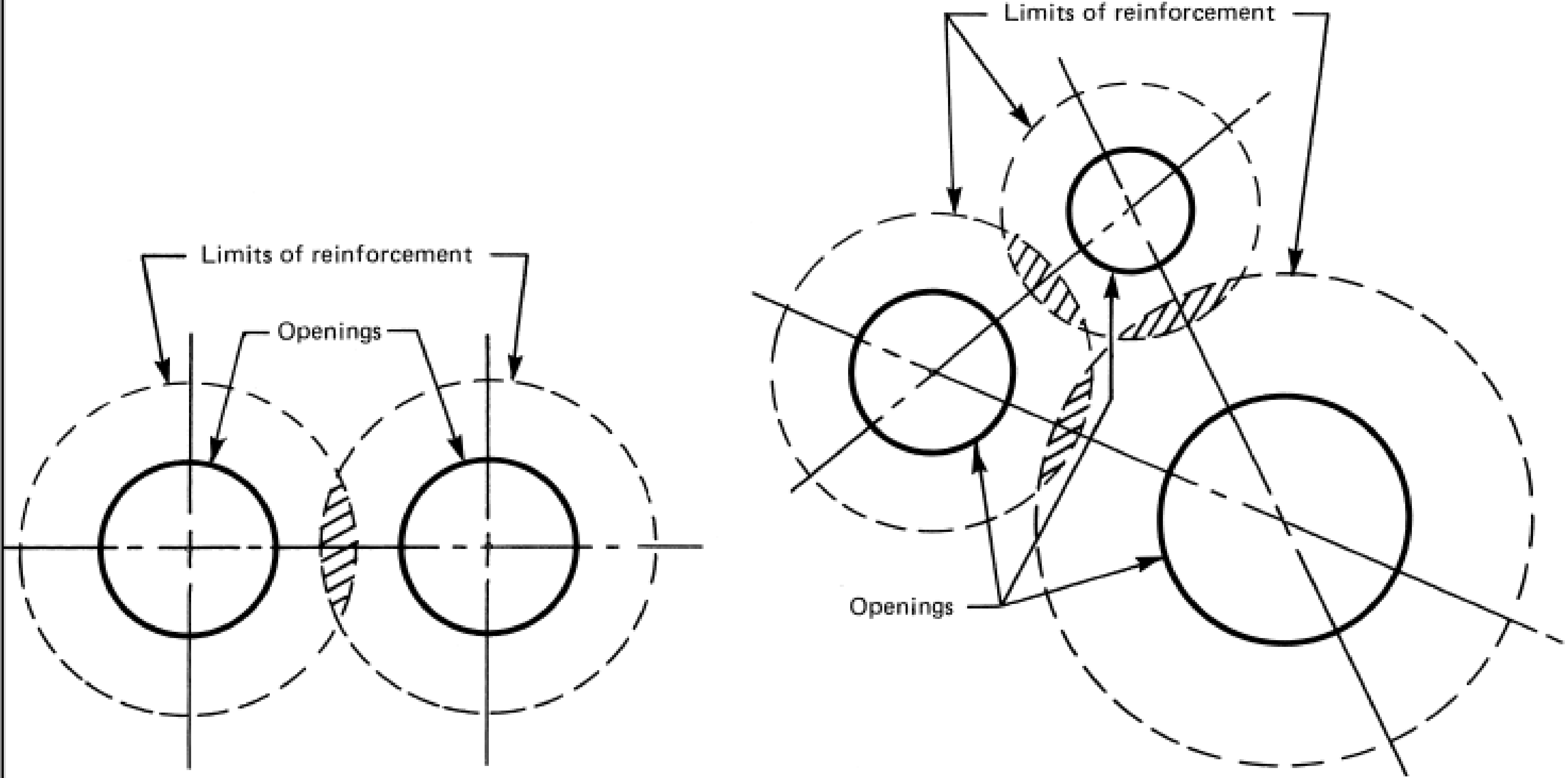
❖ (1) standard reinforcement practice with restrictions on the distribution of the reinforcement,

❖ (2) reinforcement based on a large opening that encompasses the multiple openings

❖ (3) the ligaments rules of UG-53.

Ref. : *CASTI Guidebook*

Figure UG-42
Examples of Multiple Openings

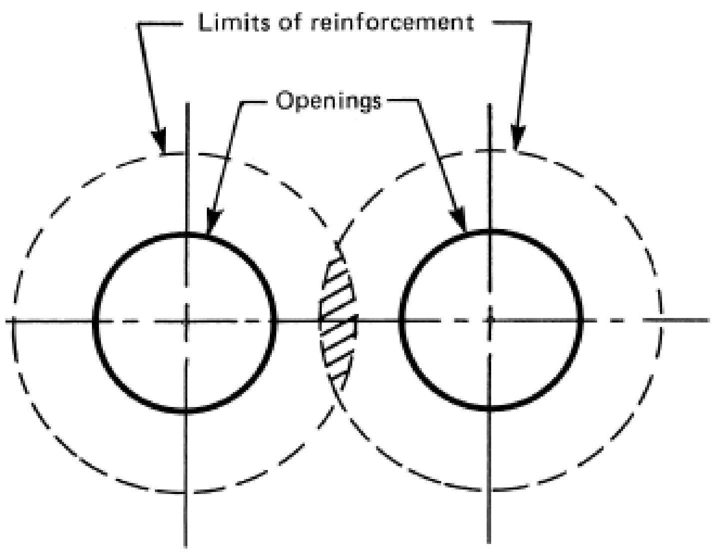


(a) Two Openings Spaced With Limits of Reinforcement Overlapping

(b) More Than Two Openings Spaced With Limits of Reinforcement Overlapping

UG-42 (Reinforcement of Multiple Openings)

- When any two openings are spaced such that their reinforcement overlaps, the reinforcement in the plane connecting the centers of the two openings must be equal to or greater than the sum of the area required for each opening and must satisfy all standard reinforcement requirements (UG-37, 38, 40, and 41).
- (1) The overlap area shall be proportioned between the two openings by the ratio of their diameters.
- (2) For cylinders and cones, if the area of reinforcement between the two openings is less than 50% of the total required for the two openings, the supplemental rules of 1-7(a) and 1-7(c) shall be used.



(a) Two Openings Spaced With
Limits of Reinforcement Overlapping

UG-42 (Reinforcement of Multiple Openings)

- (b) When more than two openings are spaced as in (a) above [see Figure UG-42 sketch (b)], and are to be provided with a combined reinforcement, the minimum distance between centers of any two of these openings shall be 11/3 times their average diameter, and the area of reinforcement between any two openings shall be at least equal to 50% of the total required for the two openings. If the distance between centers of two such openings is less than 11/3 times their average diameter, no credit for reinforcement shall be taken for any of the material between these openings. Such openings must be reinforced as described in (c) below.

UG-42 (Reinforcement of Multiple Openings)

- (C) Alternatively, any number of adjacent openings, in any arrangement, may be reinforced by using an assumed opening enclosing all such openings. The limits for reinforcement of the assumed opening shall be those given in UG-40(b)(1) and UG-40(c)(1). The nozzle walls of the actual openings shall not be considered to have reinforcing value. For cylinders and cones, when the diameter of the assumed opening exceeds the limit is in UG-36(b)(1), the supplemental rules of 1-7(a) and 1-7(c) shall also be used.

UG-43 (Methods Of Attachment Of Pipe And Nozzle Necks To Vessel Walls)

(a) General:

- Nozzles may be attached to the shell or head of a vessel by any of the methods of attachment given in this paragraph, except as limited in UG-36.

(b) Welded Connections :

- Attachment by welding shall be in accordance with the requirements of UW-15 and UW-16.

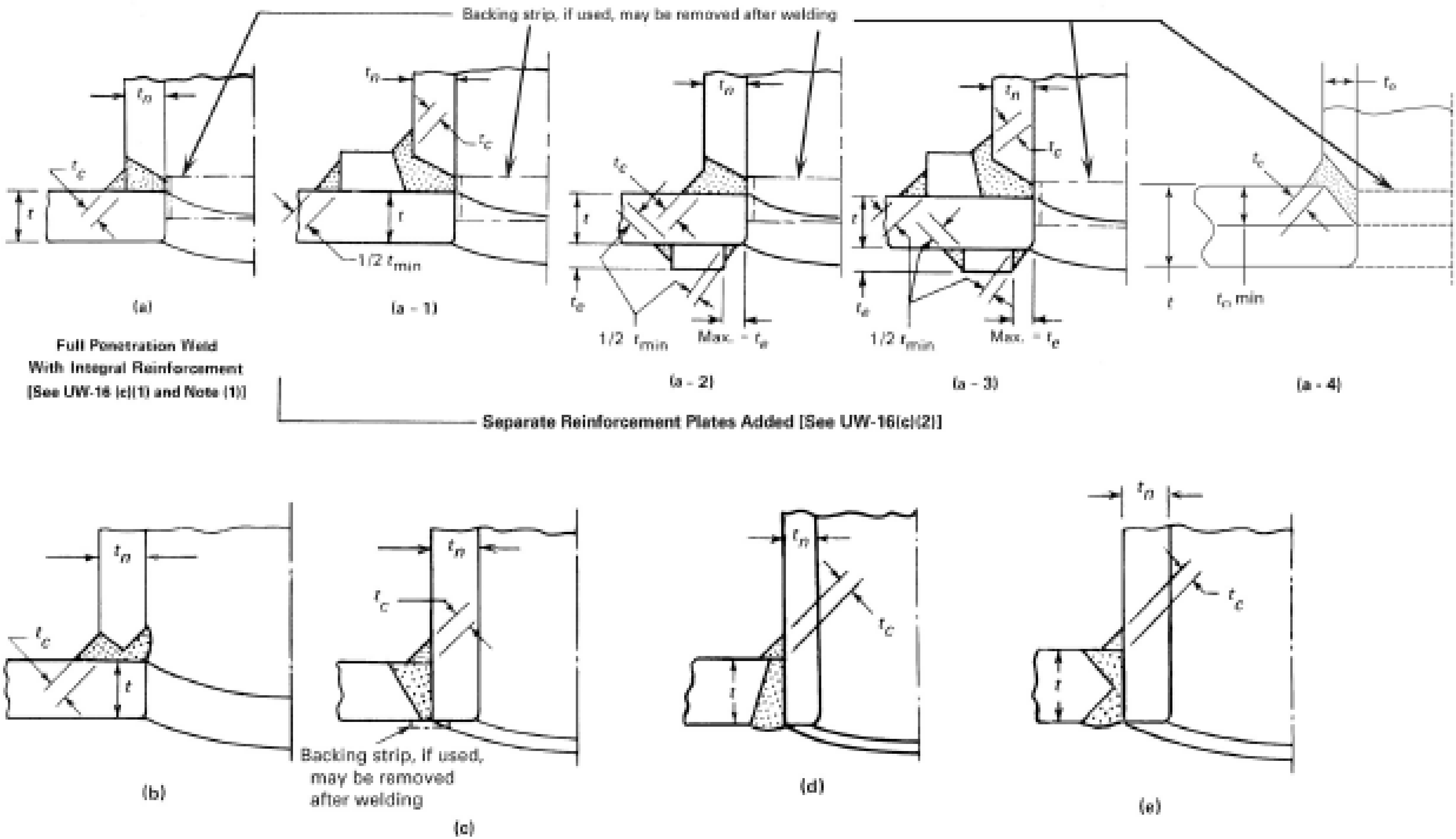
UW-16 (Minimum requirements for attachment welds at openings)

- Do = outside diameter of neck or tube attached by welding on inside of vessel shell only
- G = radial clearance between hole in vessel wall and outside diameter of nozzle neck or tube
- r1 = minimum inside corner radius, the lesser of 1/4t or 1/8 in. (3 mm)

Radius = 1/8 in. (3 mm) minimum blend radius

- t = nominal thickness of vessel shell or head,
- t1 or t2 = not less than the smaller of 1/4 in. (6 mm) or 0.7tmin
- t c = not less than the smaller of 1/4 in. (6 mm) or 0.7t min (inside corner welds may be further limited by a lesser length of projection of the nozzle wall beyond the inside face of the vessel wall)
- t e = thickness of reinforcing plate, as defined in G-40

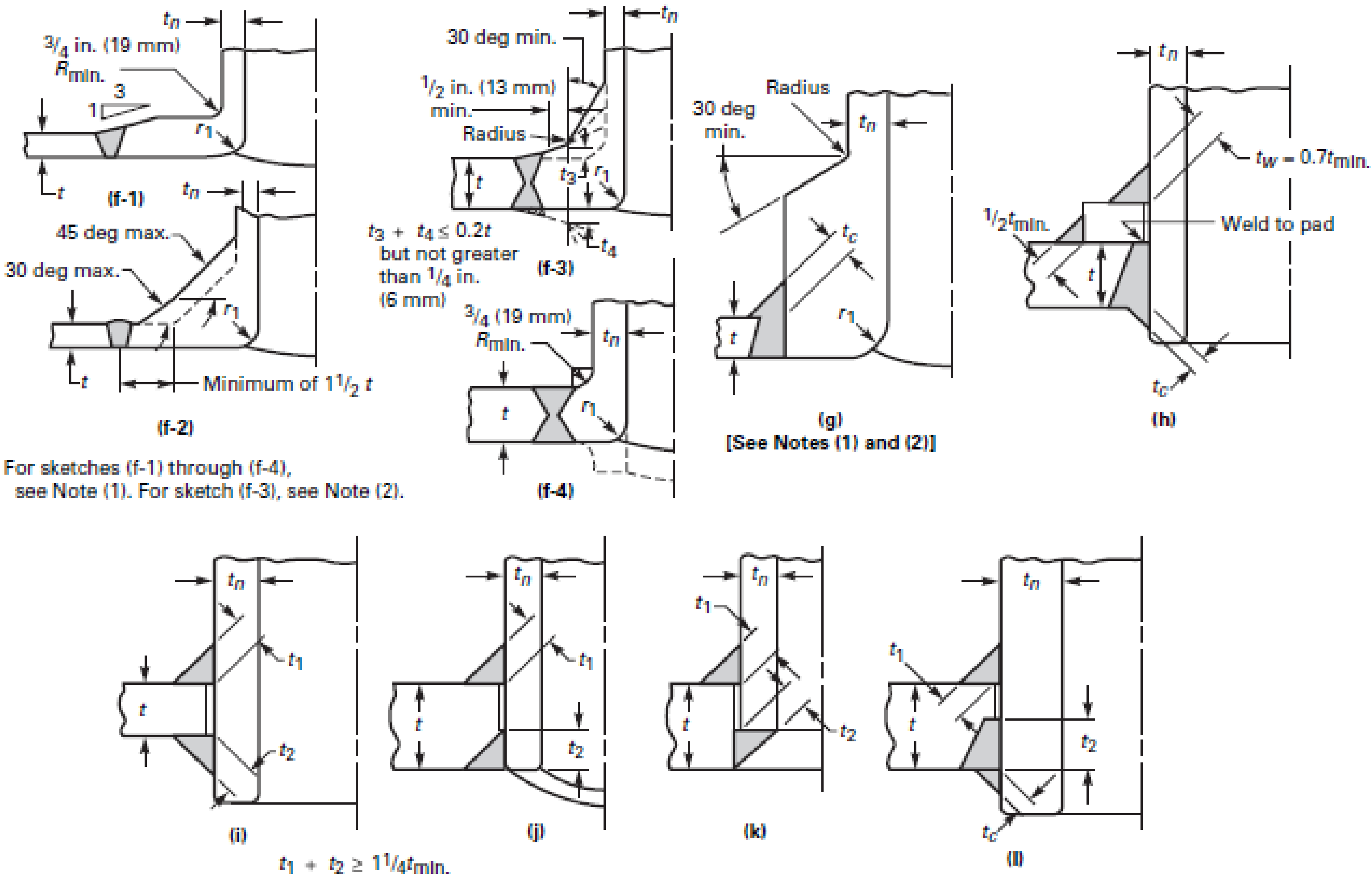
Figure UW-16.1
Some Acceptable Types of Welded Nozzles and Other Connections to Shells, Heads, etc.



Full Penetration Welds to Which Separate Reinforcement Plates May Be Added [See UW-16(c)(2) and Note (1)]

Notes follow on last page of this Figure.

Figure UW-16.1
Some Acceptable Types of Welded Nozzles and Other Connections to Shells, Heads, etc. (Cont'd)



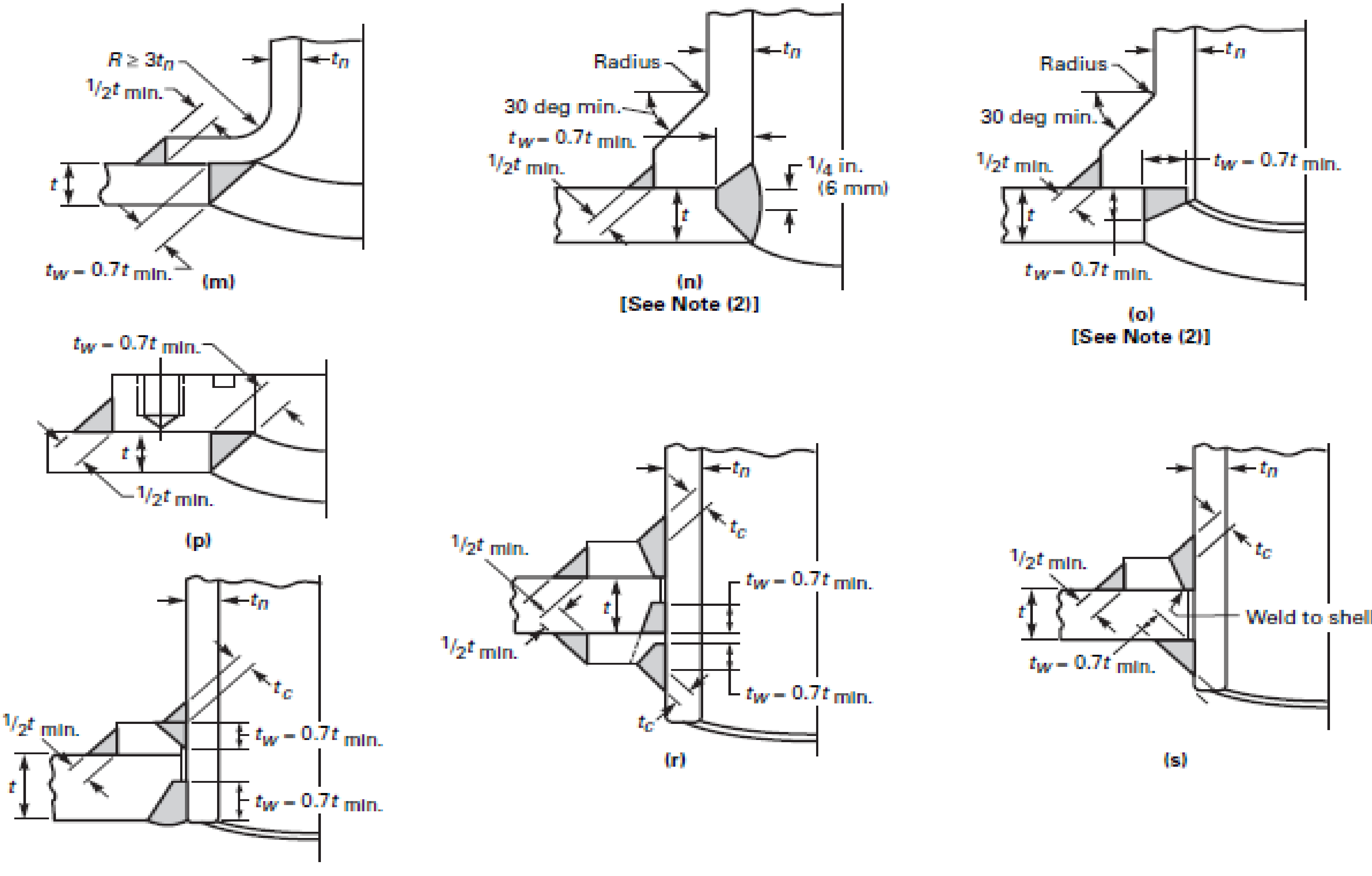
$t_3 + t_4 \le 0.2t$ but not greater than $^1/_4$ in. (6 mm)

For sketches (f-1) through (f-4), see Note (1). For sketch (f-3), see Note (2).

$t_1 + t_2 \ge 1^1/_4t_{min.}$
t_1 or t_2 not less than the smaller of $^1/_4$ in. (6 mm) or $0.7t_{min.}$

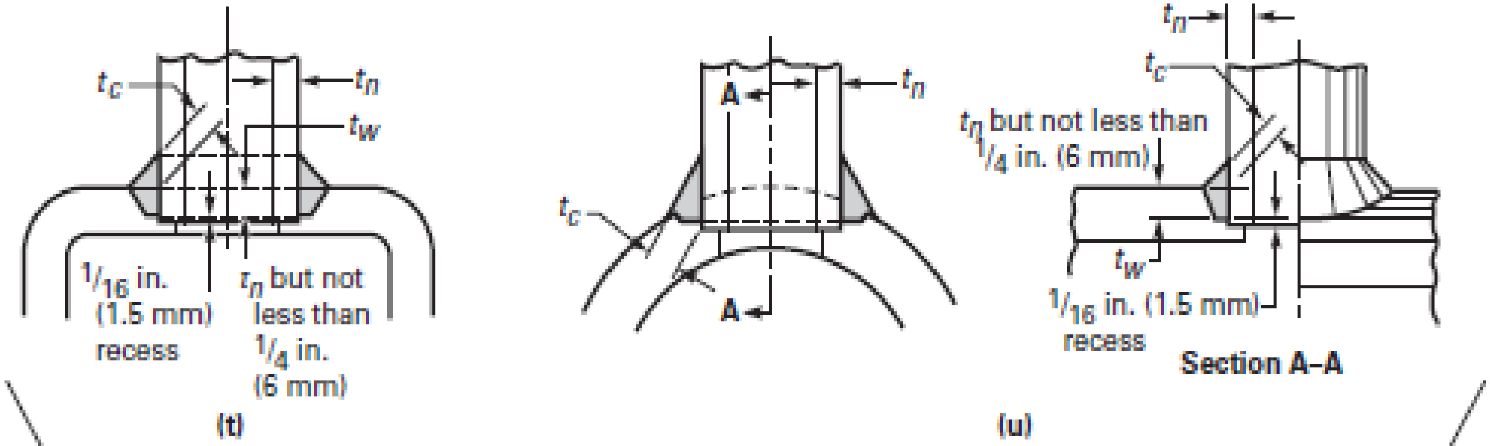
Notes follow on last page of this Figure

Figure UW-16.1
Some Acceptable Types of Welded Nozzles and Other Connections to Shells, Heads, etc. (Cont'd)



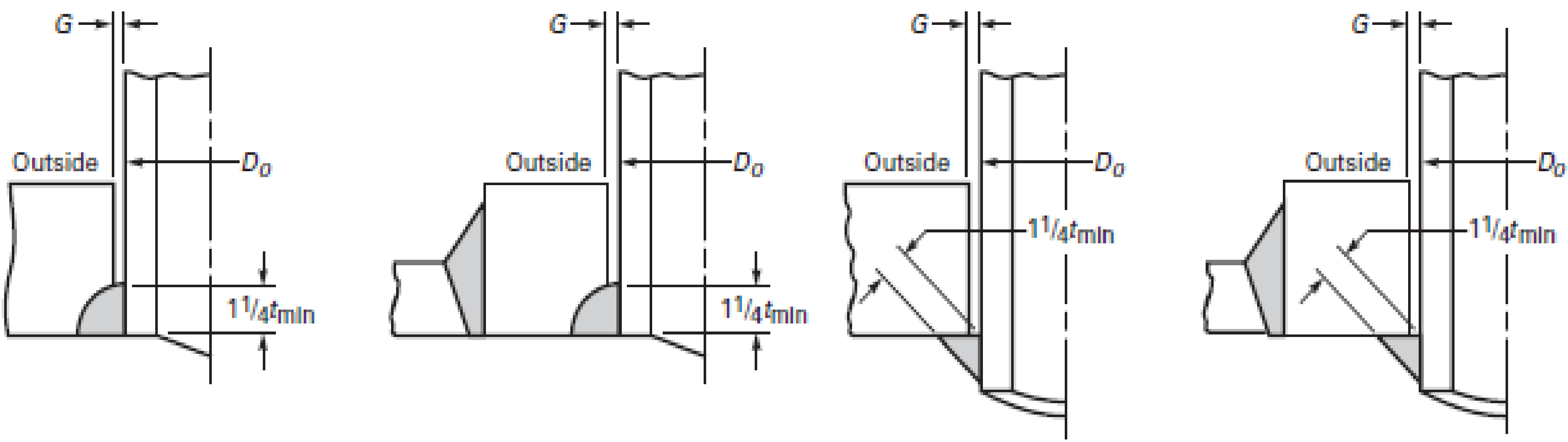
Notes follow on last page of this Figure

Figure UW-16.1
Some Acceptable Types of Welded Nozzles and Other Connections to Shells, Heads, etc. (Cont'd)



Typical Tube Connections

(When used for other than square, round, or oval headers, round off corners)



(v-1) [See Note (3)]

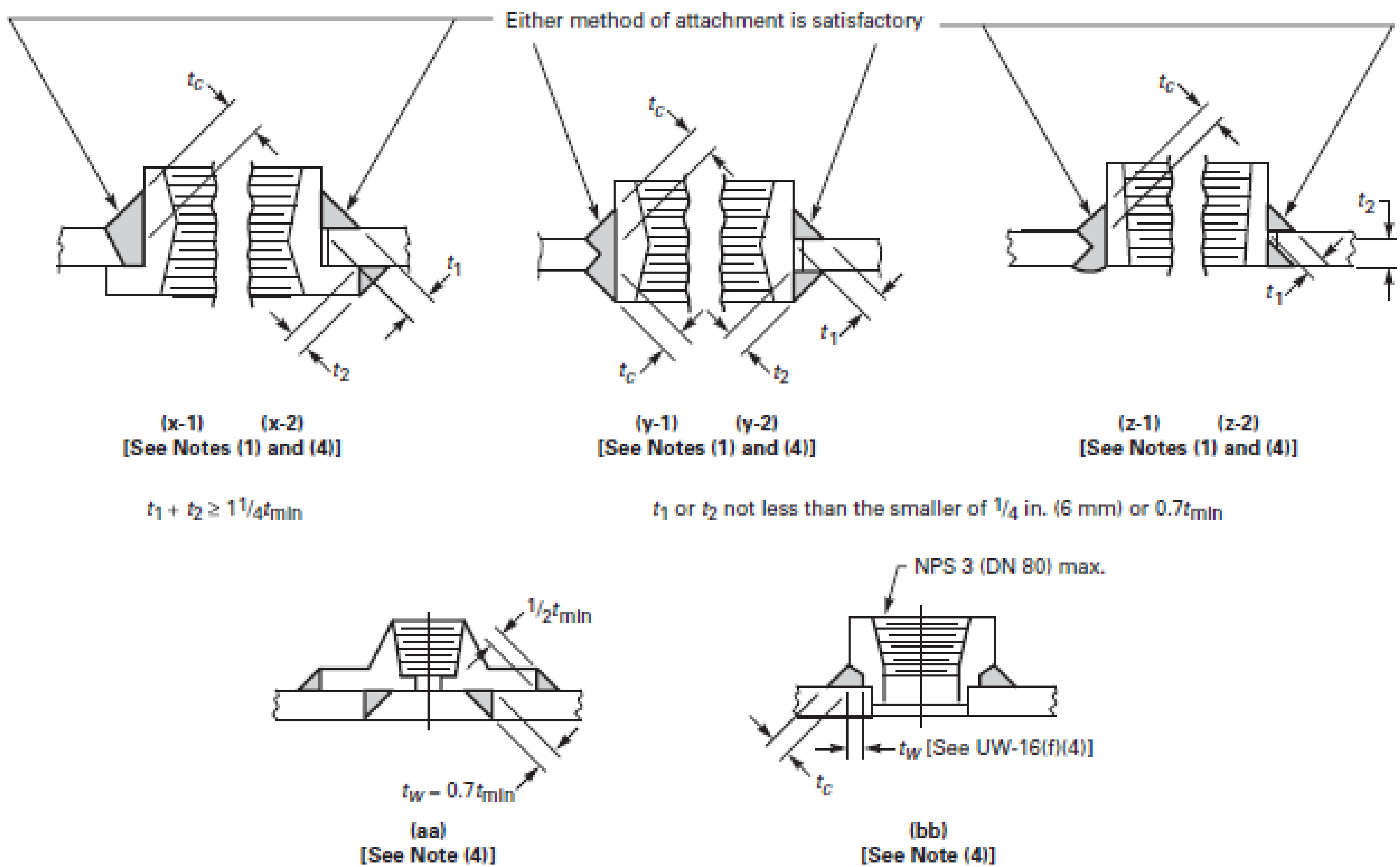
(v-2) [See Note (3)]

(w-1) [See Note (3)]

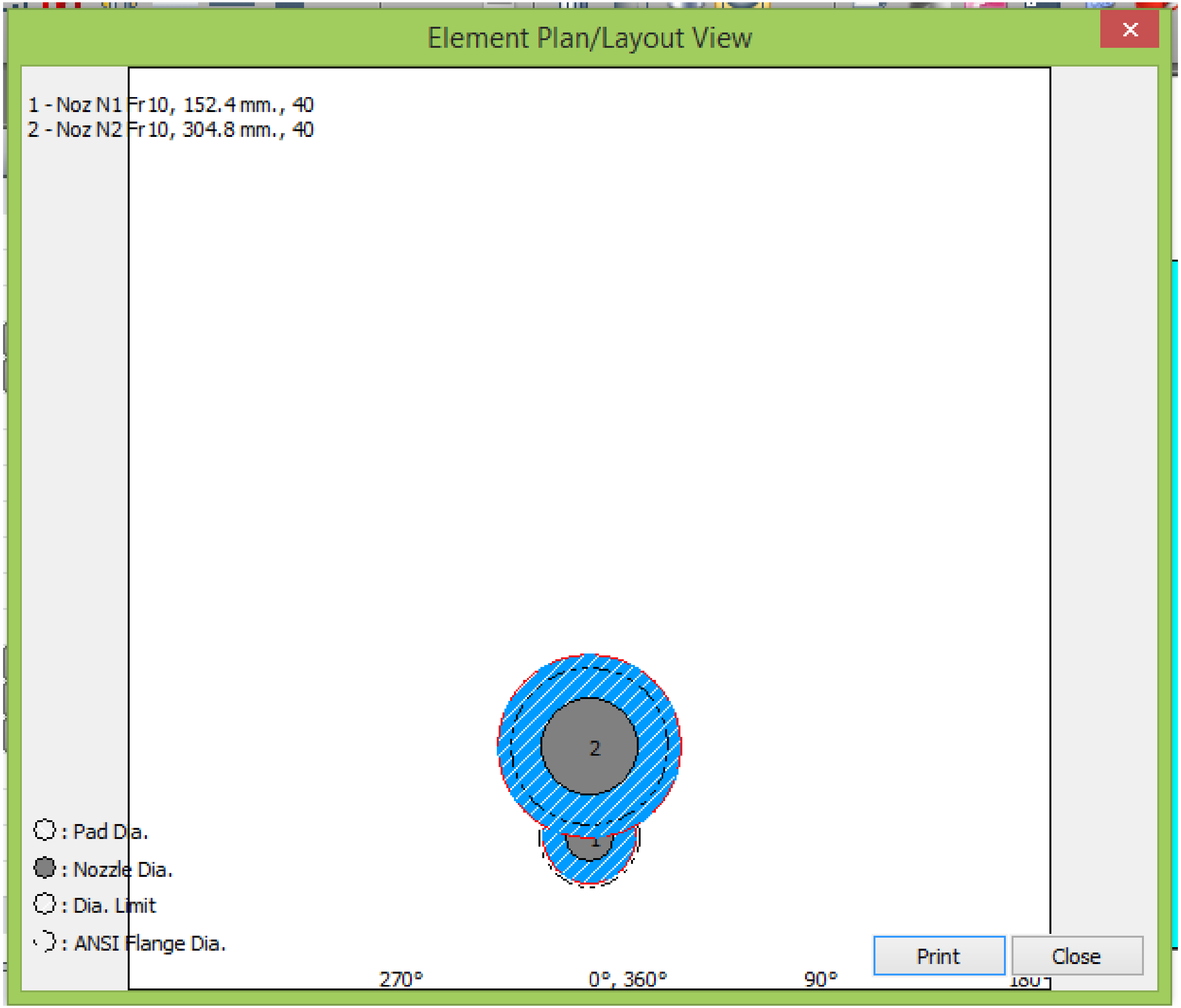
(w-2) [See Note (3)]

Notes follow on last page of this Figure.

Figure UW-16.1
Some Acceptable Types of Welded Nozzles and Other Connections to Shells, Heads, etc. (Cont'd)



NOTES:
(1) Sketches (a), (b), (c), (d), (e), (f-1) through (f-4), (g), (x-1), (y-1), and (z-1) are examples of nozzles with integral reinforcement.
(2) Where the term *Radius* appears, provide a $\frac{1}{8}$ in. (3 mm) minimum blend radius.
(3) For sketches (v-1) through (w-2):
  (a) For applications where there are no external loads, $G = \frac{1}{8}$ in. (3 mm) max.
  (b) With external loads
  $G = 0.005$ for $D_o \le 1$ in. (25 mm); $G = 0.010$ for 1 in. (25 mm) < $D_o \le 4$ in. (100 mm); $G = 0.015$ for 4 in. (100 mm) < $D_o \le 6\frac{5}{8}$ in. (170 mm)
(4) For NPS 3 (DN 80) and smaller, see exemptions in UW-16(f)(2).

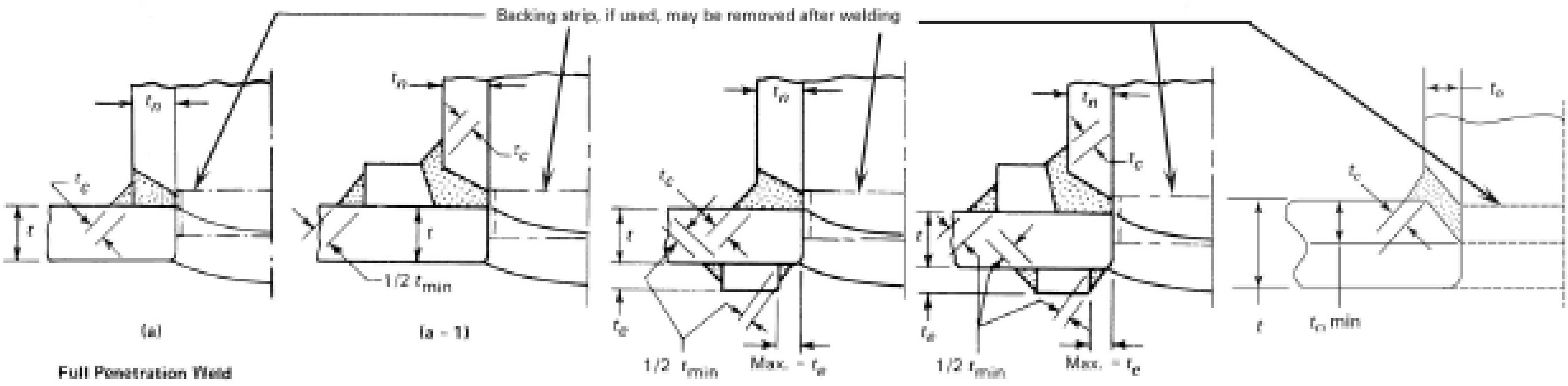

Element Plan/Layout View
1 - Noz N1 Fr10, 152.4 mm., 40
2 - Noz N2 Fr10, 304.8 mm., 40
2
1
: Pad Dia.
: Nozzle Dia.
: Dia. Limit
: ANSI Flange Dia.
Print
Close
270°
0°, 360°
90°

UW-16 (Minimum Requirements For Attachment Welds At Openings)

(c) Necks Attached by a Full Penetration Weld.

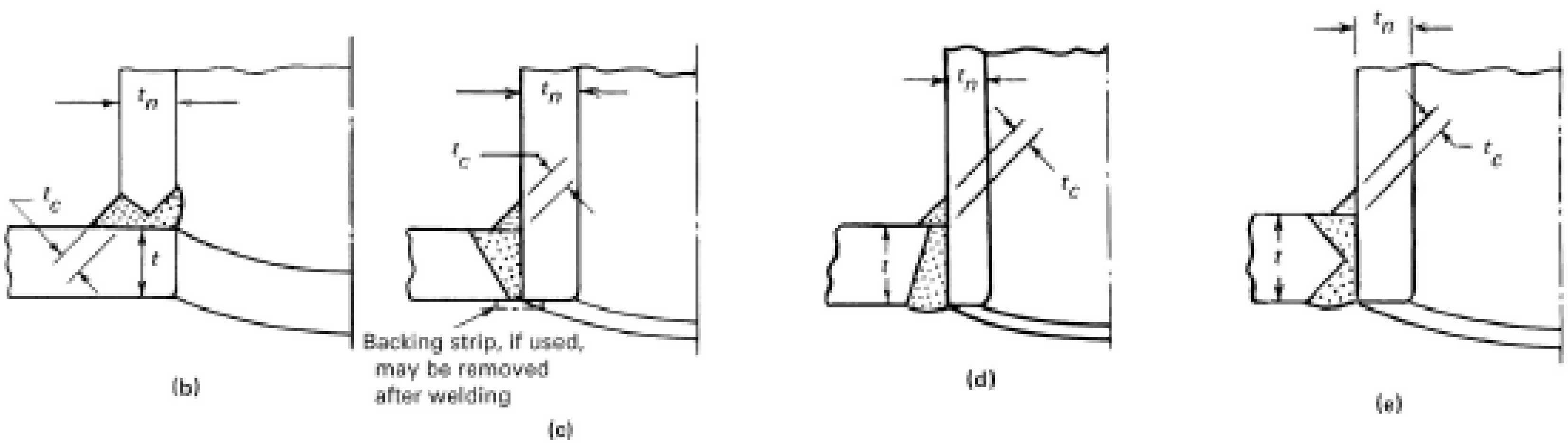
- ❖ Necks abutting a vessel wall shall be attached by a full penetration groove weld.(See Figure UW-16.1 sketches (a) and(b) for examples)
- ❖ Necks inserted through the vessel wall may be attached by a full penetration groove weld. See Figure UW-16.1 sketches (c), (d), and (e).
- ❖ When complete joint penetration cannot be verified by visual inspection or other means permitted in this Division, backing strips or equivalent shall be used with full penetration welds deposited from one side.
- ❖ If additional reinforcement is required it shall be provided as integral reinforcement or by the addition of separate reinforcement elements (plates) attached by welding.

Figure UW-16.1
Some Acceptable Types of Welded Nozzles and Other Connections to Shells, Heads, etc.



Full Penetration Weld With Integral Reinforcement [See UW-16 (c)(1) and Note (1)]

Separate Reinforcement Plates Added [See UW-16(c)(2)]

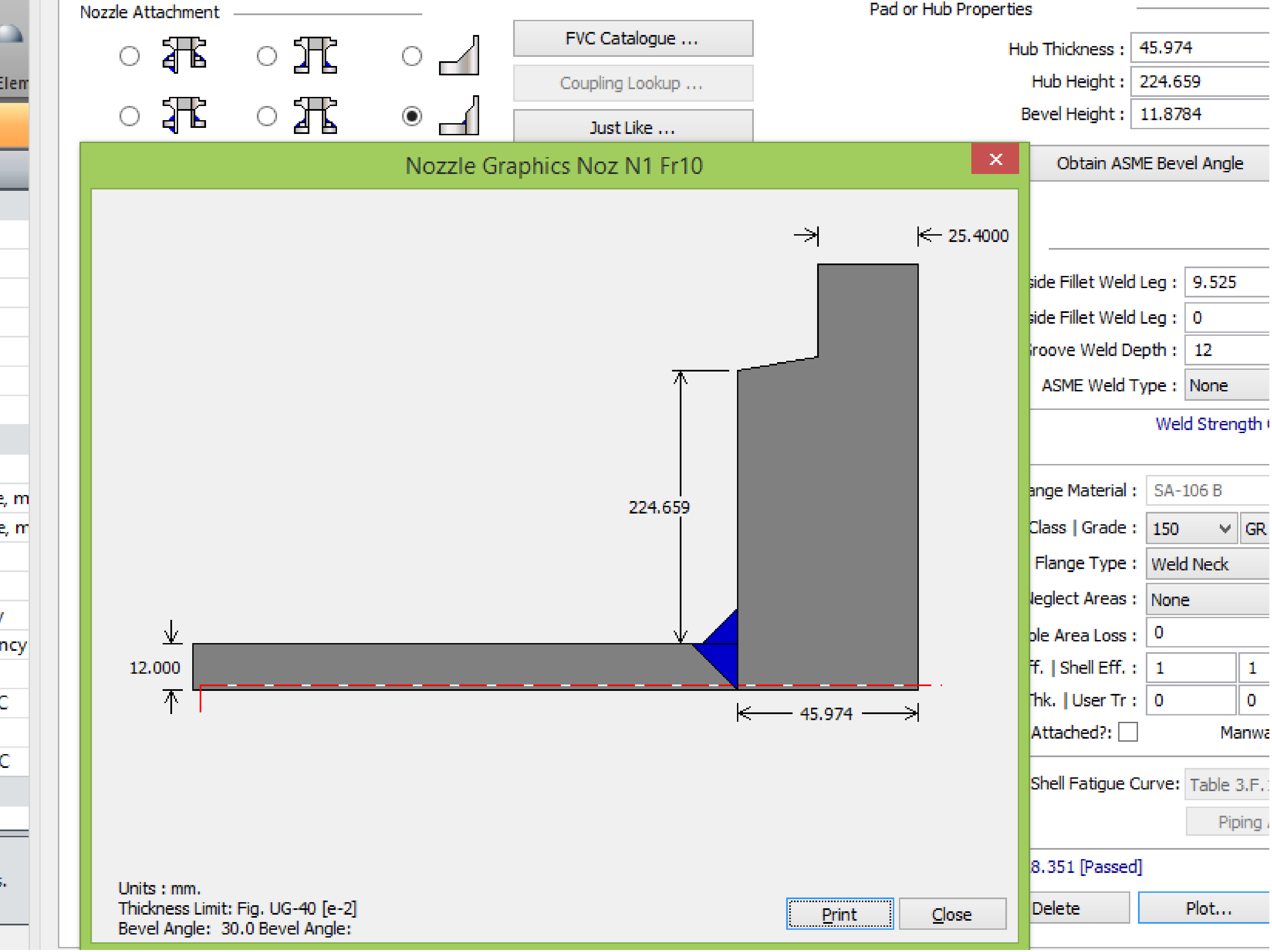


Full Penetration Welds to Which Separate Reinforcement Plates May Be Added [See UW-16(c)(2) and Note (1)]

Notes follow on last page of this Figure.

UW-16 (Integral Reinforcement)

- Integral reinforcement is that reinforcement provided in the form of extended or thickened necks, thickened shell plates, forging type inserts, or weld buildup which is an integral part of the shell or nozzle wall and, where required, is attached by full penetration welds. See Figure UW-16.1 sketches (a), (b), (c), (d), (e), (f-1), (f-2), (f-3), (f-4), (g), (x-1), (y-1), and (z-1) for examples of nozzles with integral reinforcement where the F factor in Figure UG-37 may be used.


Nozzle Attachment
FVC Catalogue ...
Coupling Lookup ...
Just Like ...
Pad or Hub Properties
Hub Thickness : 45.974
Hub Height : 224.659
Bevel Height : 11.8784
Obtain ASME Bevel Angle
Nozzle Graphics Noz N1 Fr10
25.4000
224.659
12.000
45.974
Units : mm.
Thickness Limit: Fig. UG-40 [e-2]
Bevel Angle: 30.0 Bevel Angle:
Print
Close
side Fillet Weld Leg : 9.525
side Fillet Weld Leg : 0
roove Weld Depth : 12
ASME Weld Type : None
Weld Strength
ange Material : SA-106 B
Class | Grade : 150 GR
Flange Type : Weld Neck
Neglect Areas : None
ole Area Loss : 0
f. | Shell Eff. : 1 1
hk. | User Tr : 0 0
Attached?:
Shell Fatigue Curve: Table 3.F.
Piping
8.351 [Passed]
Delete
Plot...

UW-16 (Integral Reinforcement)

(d) Neck Attached by Fillet or Partial Penetration Welds

- (1) Necks inserted into or through the vessel wall may be attached by fillet or partial penetration welds, one on each face of the vessel wall. The welds may be any desired combination of fillet, single-bevel, and single-J welds. The dimension of t 1 or t 2 for each weld shall be not less than the smaller of 1/4 in. (6 mm) or 0.7tmin, and their sum shall be not less than 11/4tmin. See Figure UW-16.1 sketches (i), (j), (k), and (l).

UW-16 (Integral Reinforcement)

If additional reinforcement is required, it may be provided in the form of extended or thickened necks, thickened shell plates, forgings, and/or separate reinforcement elements (plates) attached by welding. Weld requirements shall be the same as given in (c)(2) above, except as follows. The welds attaching the neck to the vessel wall or to the reinforcement plate shall consist of one of the following:

- (-a) a single-bevel or single-J weld in the shell plate, and a single-bevel or single-J weld in each reinforcement plate. The dimension tw of each weld shall be not less than 0.7t min. See Figure UW-16.1 sketches (q) and (r).
- (-b) a full penetration groove weld in each reinforcement plate, and a fillet, single-bevel, or single-J weld with a weld dimension tw not less than 0.7tmin in the shell plate. See Figure UW-16.1 sketch (s).

UW-16 (Integral Reinforcement)

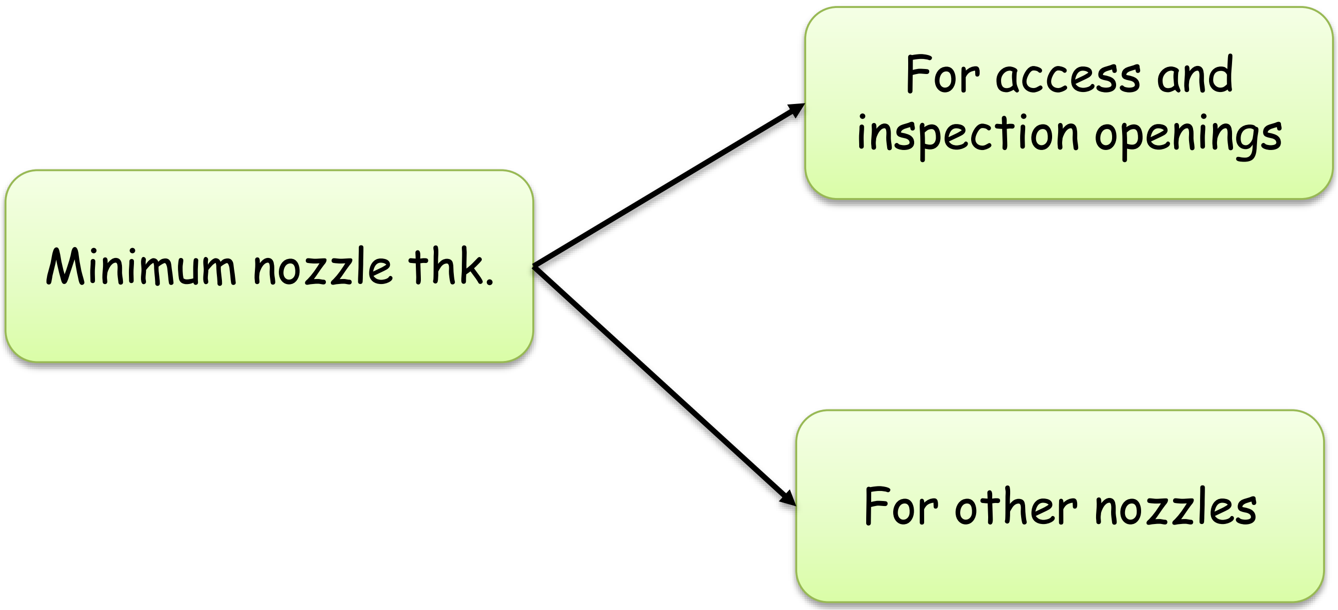
- (2) Nozzle necks, flared necks, and studding outlet type flanges may be attached by fillet welds or partial penetration welds between the outside diameter or the attachment and the outside surface of the shell and at the inside of the opening in the shell. The throat dimension of the outer attachment weld shall not be less than 1/2tmin. The dimension tw of the weld at the inside of the shell cutout shall not be less than 0.7t min. See Figure UW-16.1 sketches (m), (n), (o), and (p).

UW-16 (Integral Reinforcement)

- (f) Standard Fittings: ASME/ANSI or Manufacturer's Standard. The attachment of standard fittings shall meet the following requirements; see (g) for the attachment of bolting pads:
- fittings shall be attached by a full penetration groove weld or by two fillet or partial penetration welds, one on each face of the vessel wall. The minimum weld dimensions shall be as shown in Figure UW-16.1 sketches (x), (y), (z), and (aa).

- Exemptions:
- Fittings not exceeding NPS 3 (sketches (x), (y), (z), (aa), and (bb)) –see UW-16 (3) and (4)
- Flange-type fittings not exceeding NPS 2

- The minimum wall thickness of nozzle necks shall be determined as given below.



UG-45 (NOZZLE NECK THICKNESS)

- For access openings and openings used only for inspection:

$$t_{\text{UG-45}} = t_a$$

- For other nozzles:

Determine t_b.

$$t_b = \min\left[t_{b3},\ \max\left(t_{b1},\ t_{b2}\right)\right]$$

$$t_{\text{UG-45}} = \max\left(t_a,\ t_b\right)$$

UG-45 (NOZZLE NECK THICKNESS)

where

t_a = minimum neck thickness required for internal and external pressure using UG-27 and UG-28 (plus corrosion and threading allowance), as applicable. The effects of external forces and moments from supplemental loads (see UG-22) shall be considered. Shear stresses caused by UG-22 loadings shall not exceed 70% of the allowable tensile stress for the nozzle material.

t_{b1} = for vessels under internal pressure, the thickness (plus corrosion allowance) required for pressure (assuming E = 1.0) for the shell or head at the location where the nozzle neck or other connection attaches to the vessel but in no case less than the minimum thickness specified for the material in UG-16(b).

t_{b2} = for vessels under external pressure, the thickness (plus corrosion allowance) obtained by using the external design pressure as an equivalent internal design pressure (assuming E = 1.0) in the formula for the shell or head at the location where the nozzle neck or other connection attaches to the vessel but in no case less than the minimum thickness specified for the material in UG-16(b).

t_{b3} = the thickness given in Table UG-45 plus the thickness added for corrosion allowance.

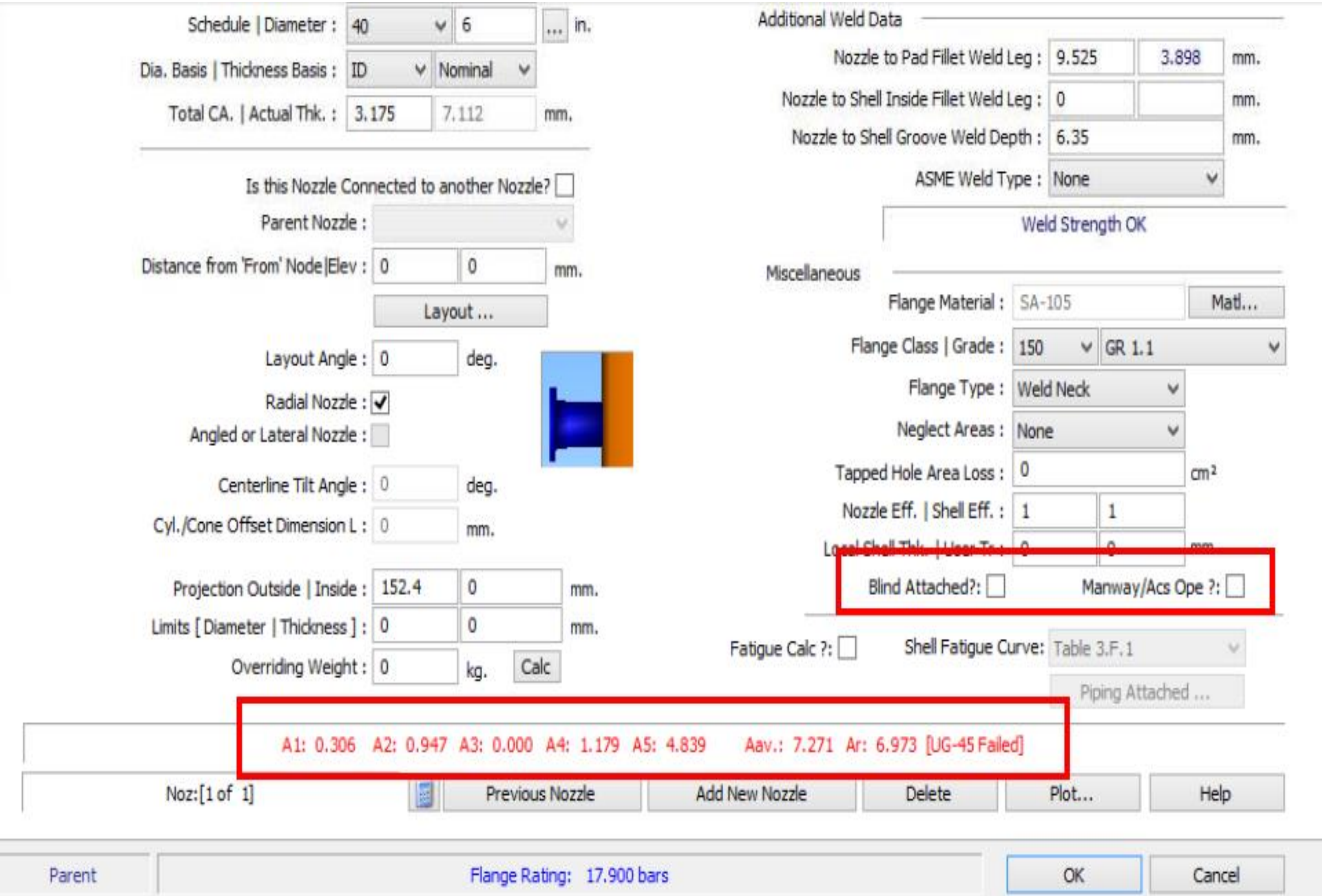
$t_{UG\text{-}45}$ = minimum wall thickness of nozzle necks

UG-45 (NOZZLE NECK THICKNESS)

Table UG-45
Nozzle Minimum Thickness Requirements

Nominal Size	Minimum Wall Thickness [See UG-16(d)] in.	mm
NPS 1/8 (DN 6)	0.060	1.51
NPS 1/4 (DN 8)	0.077	1.96
NPS 3/8 (DN 10)	0.080	2.02
NPS 1/2 (DN 15)	0.095	2.42
NPS 3/4 (DN 20)	0.099	2.51
NPS 1 (DN 25)	0.116	2.96
NPS 11/4 (DN 32)	0.123	3.12
NPS 11/2 (DN 40)	0.127	3.22
NPS 2 (DN 50)	0.135	3.42
NPS 21/2 (DN 65)	0.178	4.52
NPS 3 (DN 80)	0.189	4.80
NPS 31/2 (DN 90)	0.198	5.02
NPS 4 (DN 100)	0.207	5.27
NPS 5 (DN 125)	0.226	5.73
NPS 6(DN 150)	0.245	6.22
NPS 8 (DN 200)	0.282	7.16
NPS 10 (DN 250)	0.319	8.11
≥ NPS 12 (DN 300)	0.328	8.34

GENERAL NOTE: For nozzles having a specified outside diameter not equal to the outside diameter of an equivalent standard NPS (DN) size, the NPS (DN) size chosen from the table shall be one having an equivalent outside diameter larger than the nozzle outside diameter.


Schedule | Diameter : 40 6 ... in.
Dia. Basis | Thickness Basis : ID Nominal
Total CA. | Actual Thk. : 3.175 7.112 mm.
Is this Nozzle Connected to another Nozzle?
Parent Nozzle :
Distance from 'From' Node|Elev : 0 0 mm.
Layout ...
Layout Angle : 0 deg.
Radial Nozzle :
Angled or Lateral Nozzle :
Centerline Tilt Angle : 0 deg.
Cyl./Cone Offset Dimension L : 0 mm.
Projection Outside | Inside : 152.4 0 mm.
Limits [Diameter | Thickness] : 0 0 mm.
Overriding Weight : 0 kg. Calc
Additional Weld Data
Nozzle to Pad Fillet Weld Leg : 9.525 3.898 mm.
Nozzle to Shell Inside Fillet Weld Leg : 0 mm.
Nozzle to Shell Groove Weld Depth : 6.35 mm.
ASME Weld Type : None
Weld Strength OK
Miscellaneous
Flange Material : SA-105 Matl...
Flange Class | Grade : 150 GR 1.1
Flange Type : Weld Neck
Neglect Areas : None
Tapped Hole Area Loss : 0 cm²
Nozzle Eff. | Shell Eff. : 1 1
Blind Attached?: Manway/Acs Ope ?:
Fatigue Calc ?: Shell Fatigue Curve: Table 3.F.1
Piping Attached ...
A1: 0.306 A2: 0.947 A3: 0.000 A4: 1.179 A5: 4.839 Aav.: 7.271 Ar: 6.973 [UG-45 Failed]
Noz:[1 of 1] Previous Nozzle Add New Nozzle Delete Plot... Help
Parent Flange Rating: 17.900 bars OK Cancel

UG-46 (INSPECTION OPENINGS)

- (a) All pressure vessels for use with:

❖ compressed air

❖ subject to internal corrosion

❖ having parts subject to erosion or mechanical abrasion

shall be provided with suitable:

✓ Manhole

✓ Handhole

✓ inspection openings for examination and cleaning.

UG-46 (INSPECTION OPENINGS)

(a) All pressure vessels for use with:

- compressed air
- subject to internal corrosion
- having parts subject to erosion or mechanical abrasion

shall be provided with suitable:

- ✓ Manhole
- ✓ Handhole
- ✓ inspection openings for examination and cleaning.

UG-46 (INSPECTION OPENINGS)

- (c) Vessels over 12 in. (300 mm) I.D. under air pressure:

that also contain, substances that will prevent corrosion need not have openings for inspection only, provided the vessel contains suitable openings through which inspection can be made conveniently, and provided such openings are equivalent in size and number to the requirements for inspection openings in (f) below.

- (d) For vessels 12 in. (300 mm) or less in inside diameter:

openings for inspection only may be omitted if there are at least two removable pipe connections not less than NPS 3/4 (DN 20).

UG-46 (INSPECTION OPENINGS)

- (e) Vessels less than 16 in. (400 mm) and over 12 in. (300 mm) I.D. :

➢ shall have at least two handholes

➢ or two threaded pipe plug inspection openings of not less than NPS 11/2 (DN 40)

➢ except as permitted by the following:

- when vessels to be installed so that inspection cannot be made without removing the vessel from the assembly, openings for inspection only may be omitted provided there are at least two removable pipe connections of not less than NPS 11/2 (DN 40).

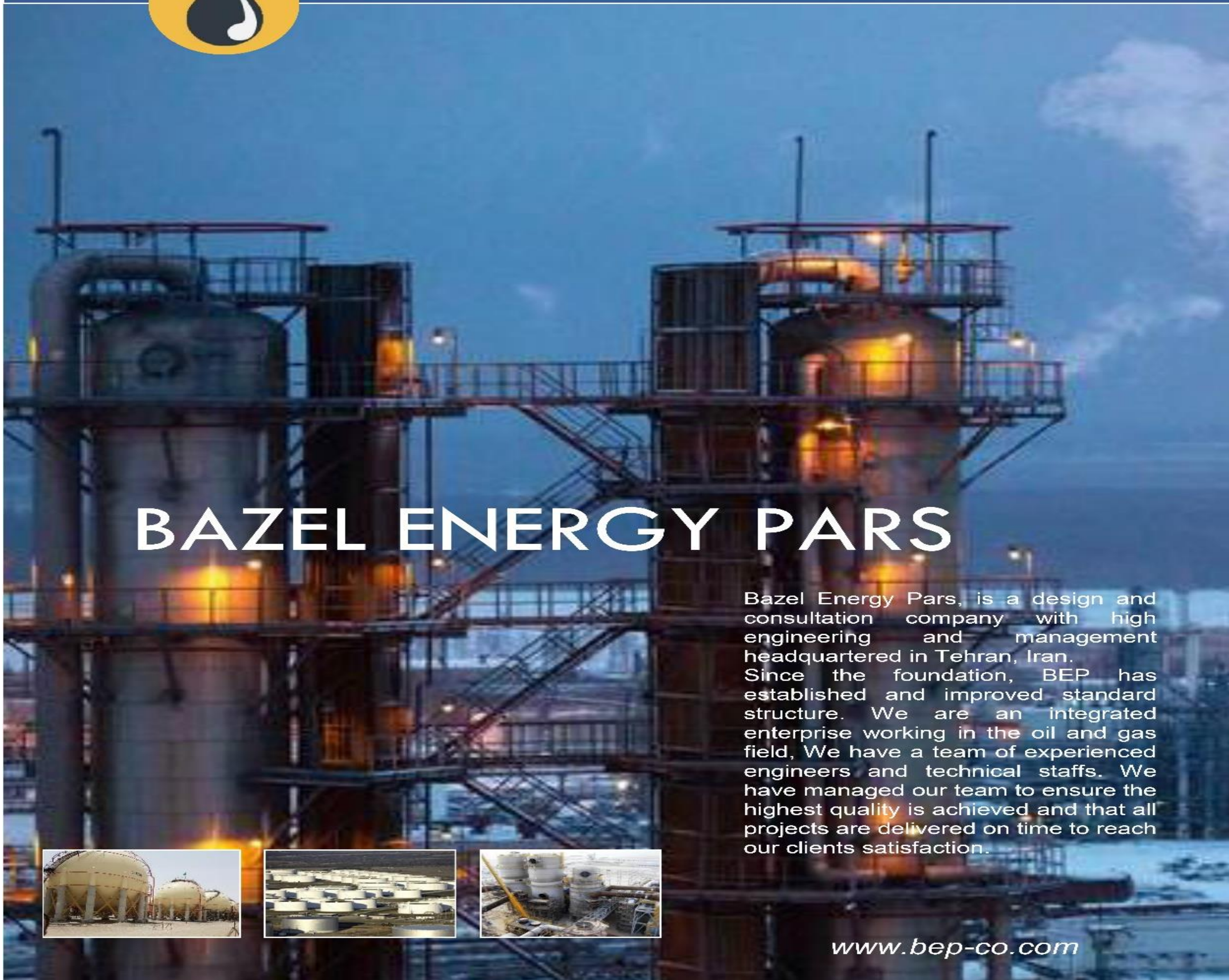
UG-46 (INSPECTION OPENINGS)

- (f) Vessels that require access or inspection openings shall be equipped as follows.
- (1) All vessels less than 18 in. (450 mm) and over 12 in. (300 mm) I.D. shall have at least two handholes or two plugged, threaded inspection openings of not less than NPS 11/2 (DN 40).
- (2) All vessels 18 in. (450 mm) to 36 in. (900 mm), inclusive, I.D. shall have a manhole or at least two handholes or two plugged, threaded inspection openings of not less than NPS 2 (DN 50).
- (3) All vessels over 36 in. (900 mm) I.D. shall have a manhole, except that those whose shape or use makes one impracticable shall have at least two handholes 4 in. × 6 in. (100 mm × 150 mm) or two equal openings of equivalent area.

UG-46 (INSPECTION OPENINGS)

- (g) When inspection or access openings are required, they shall comply at least with the following requirements:
- (1) An elliptical or obround manhole shall be not less than 12 in. × 16 in. (300 mm × 400 mm). A circular manhole shall be not less than 16 in. (400 mm) I.D.
- (2) A handhole opening shall be not less than 2 in. × 3 in. (50 mm × 75 mm), but should be as large as is consistent with the size of the vessel and the location of the opening.

OIL & GAS TECHNOLOGIES



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Summary of openings Error and warnings

- 1- Rating of flange has been failed
- 2- Nozzles have clash and do not distanced as per limit of reinforcement
- 3- UG-37 failed
- 4- UG-45 Failed
- 5- WRC at nozzle or pad has been failed

UG-46 (INSPECTION OPENINGS)

(a) All pressure vessels for use with:

- compressed air
- subject to internal corrosion
- having parts subject to erosion or mechanical abrasion

shall be provided with suitable:

- ✓ Manhole
- ✓ Handhole
- ✓ inspection openings for examination and cleaning.

UG-46 (INSPECTION OPENINGS)

- (c) Vessels over 12 in. (300 mm) I.D. under air pressure:

that also contain, substances that will prevent corrosion need not have openings for inspection only, provided the vessel contains suitable openings through which inspection can be made conveniently, and provided such openings are equivalent in size and number to the requirements for inspection openings in (f) below.

- (d) For vessels 12 in. (300 mm) or less in inside diameter:

openings for inspection only may be omitted if there are at least two removable pipe connections not less than NPS 3/4 (DN 20).

UG-46 (INSPECTION OPENINGS)

- (e) Vessels less than 16 in. (400 mm) and over 12 in. (300 mm) I.D. :

➢ shall have at least two handholes

➢ or two threaded pipe plug inspection openings of not less than NPS 11/2 (DN 40)

➢ except as permitted by the following:

- when vessels to be installed so that inspection cannot be made without removing the vessel from the assembly, openings for inspection only may be omitted provided there are at least two removable pipe connections of not less than NPS 11/2 (DN 40).

UG-46 (INSPECTION OPENINGS)

- (f) Vessels that require access or inspection openings shall be equipped as follows.
- (1) All vessels less than 18 in. (450 mm) and over 12 in. (300 mm) I.D. shall have at least two handholes or two plugged, threaded inspection openings of not less than NPS 11/2 (DN 40).
- (2) All vessels 18 in. (450 mm) to 36 in. (900 mm), inclusive, I.D. shall have a manhole or at least two handholes or two plugged, threaded inspection openings of not less than NPS 2 (DN 50).
- (3) All vessels over 36 in. (900 mm) I.D. shall have a manhole, except that those whose shape or use makes one impracticable shall have at least two handholes 4 in. × 6 in. (100 mm × 150 mm) or two equal openings of equivalent area.

UG-46 (INSPECTION OPENINGS)

- (g) When inspection or access openings are required, they shall comply at least with the following requirements:
- (1) An elliptical or obround manhole shall be not less than 12 in. × 16 in. (300 mm × 400 mm). A circular manhole shall be not less than 16 in. (400 mm) I.D.
- (2) A handhole opening shall be not less than 2 in. × 3 in. (50 mm × 75 mm), but should be as large as is consistent with the size of the vessel and the location of the opening.

UG-46 (Summary Size of opening)

Size of Opening

- NS < 12" = two removable pipe connections
- 12"< NS <18" = two handhole
- 18"< NS = one manhole or two handhole

1-7 Large openings in cylindrical and conical shells

(a) Reinforcement shall complies with the following rules:

- Two-thirds of the required reinforcement shall be within the following limits:

(1) parallel to vessel wall: the larger of three-fourths times the limit in UG-40(b)(1), or equal to the limit in UG-40(b)(2);

(2) normal to vessel wall: the smaller of the limit in UG-40(c)(1), or in UG-40(c)(2).

(b) In addition to above condition :

- openings for radial nozzles and with below condition:

- (-a) vessel diameters greater than 60 in. (1 520 mm) I.D.;
- (-b) nozzle diameters that exceed 40 in. (1 020 mm) I.D. and also exceed $3.4\sqrt{Rt}$
- (-c) the ratio Rn/R does not exceed 0.7

- Membrane stress Sm shall not exceed S
- The maximum combined membrane stress Sm and bending stress Sb shall not exceed 1.5S at design conditions.

Case A (see Figure 1-7-1)

$$S_m = P\left(\frac{R(R_n + t_n + \sqrt{R_m t}) + R_n(t + t_e + \sqrt{R_{nm} t_n})}{A_s}\right) \quad (1)$$

Case B (see Figure 1-7-1)

$$S_m = P\left(\frac{R(R_n + t_n + \sqrt{R_m t}) + R_n(t + \sqrt{R_{nm} t_n})}{A_s}\right) \quad (2)$$

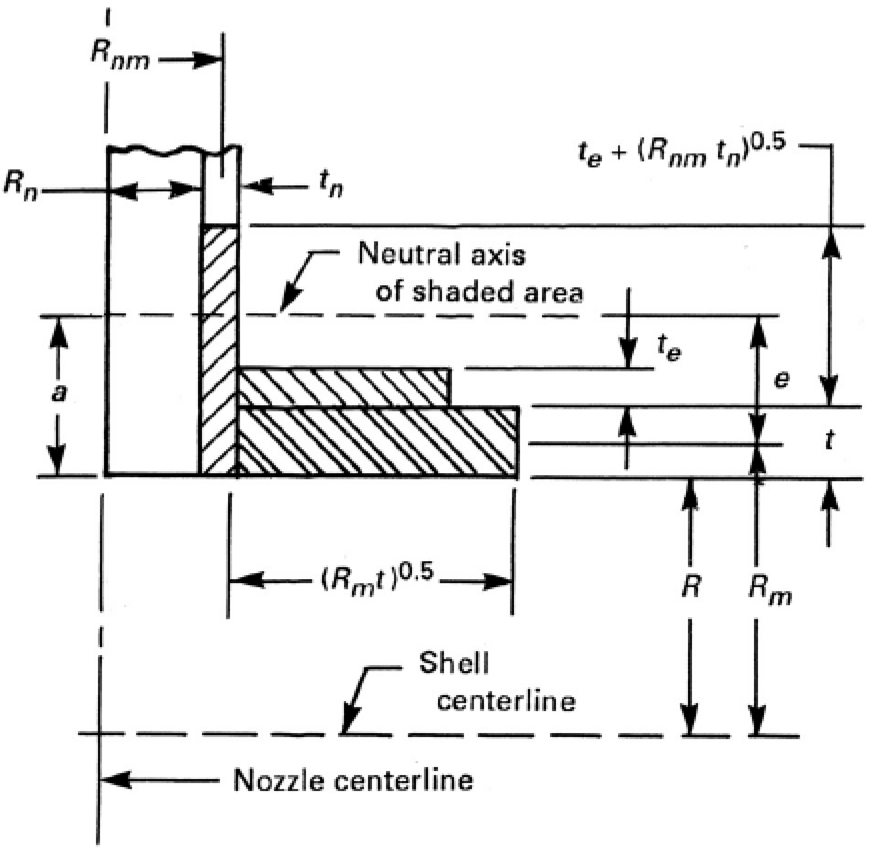
Cases A and B (See Figure 1-7-1 or Figure 1-7-2)

$$M = \left(\frac{R_n^3}{6} + R R_n e\right) P \quad (3)$$

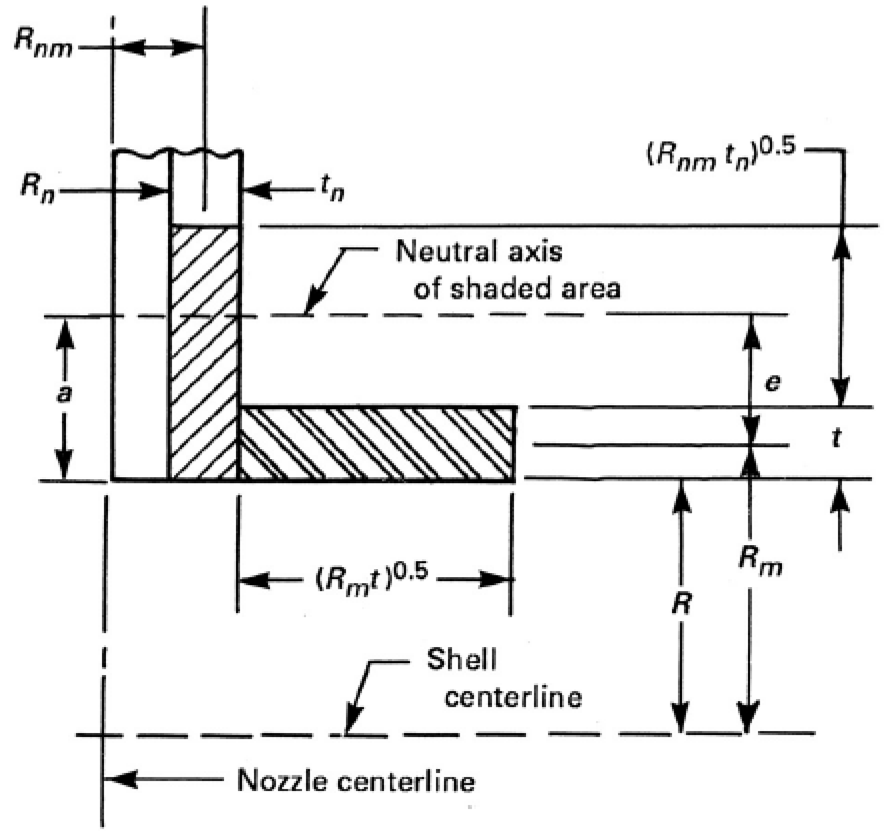
$$a = e + t/2 \quad (4)$$

$$S_b = \frac{Ma}{I} \quad (5)$$

Figure 1-7-1

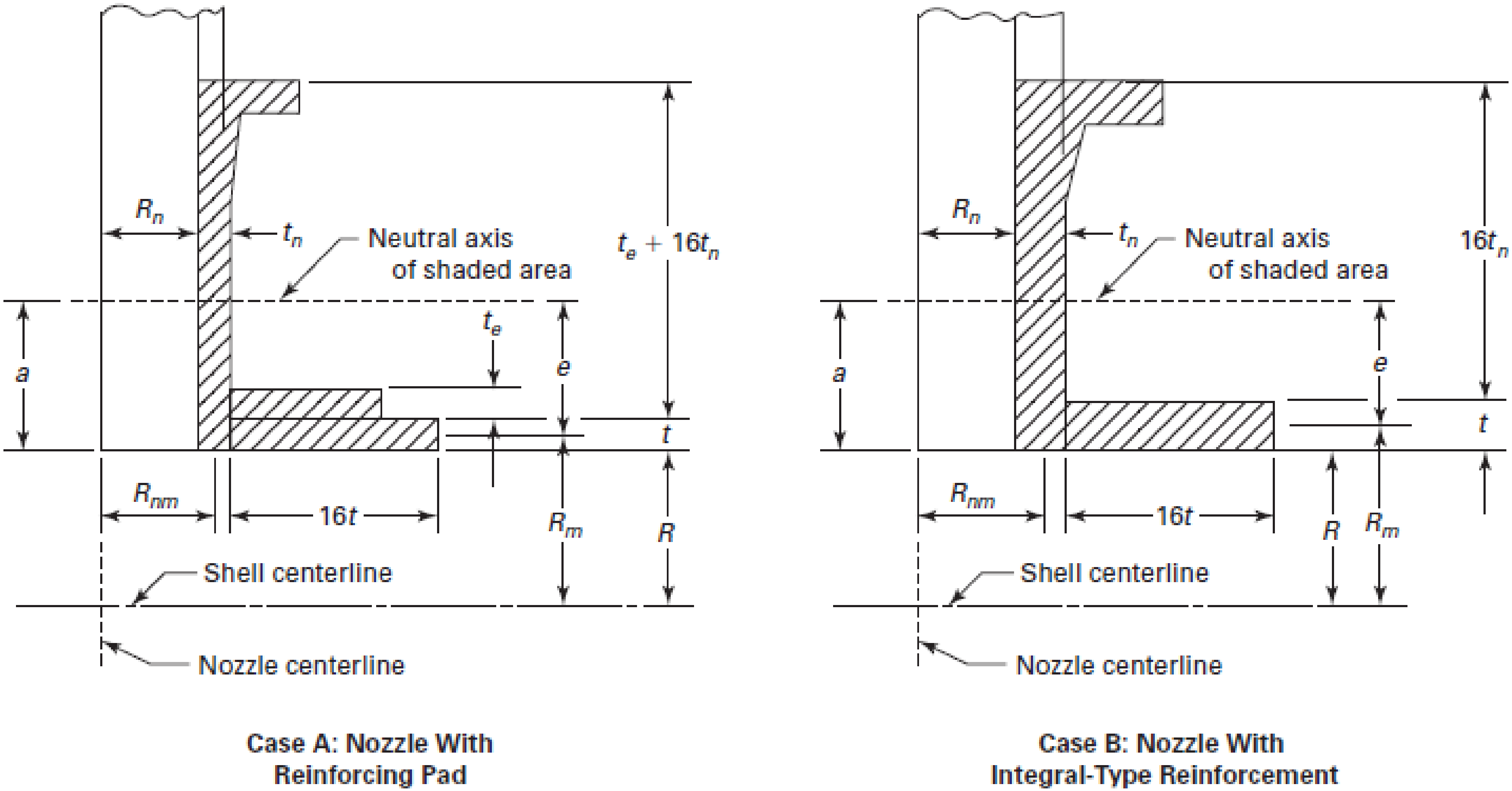


Case A: Nozzle With Reinforcing Pad



Case B: Nozzle With Integral-Type Reinforcement

Figure 1-7-2

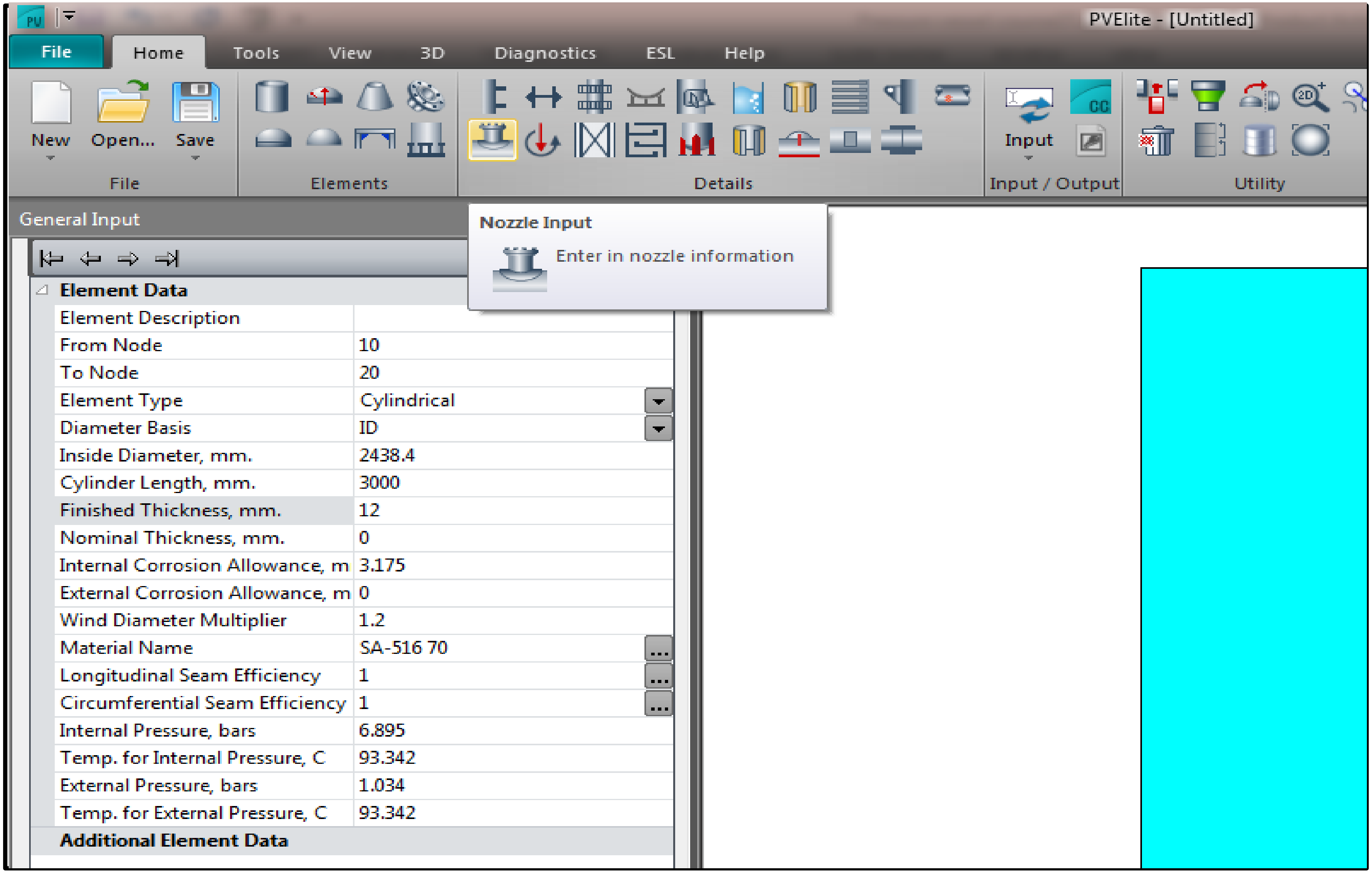


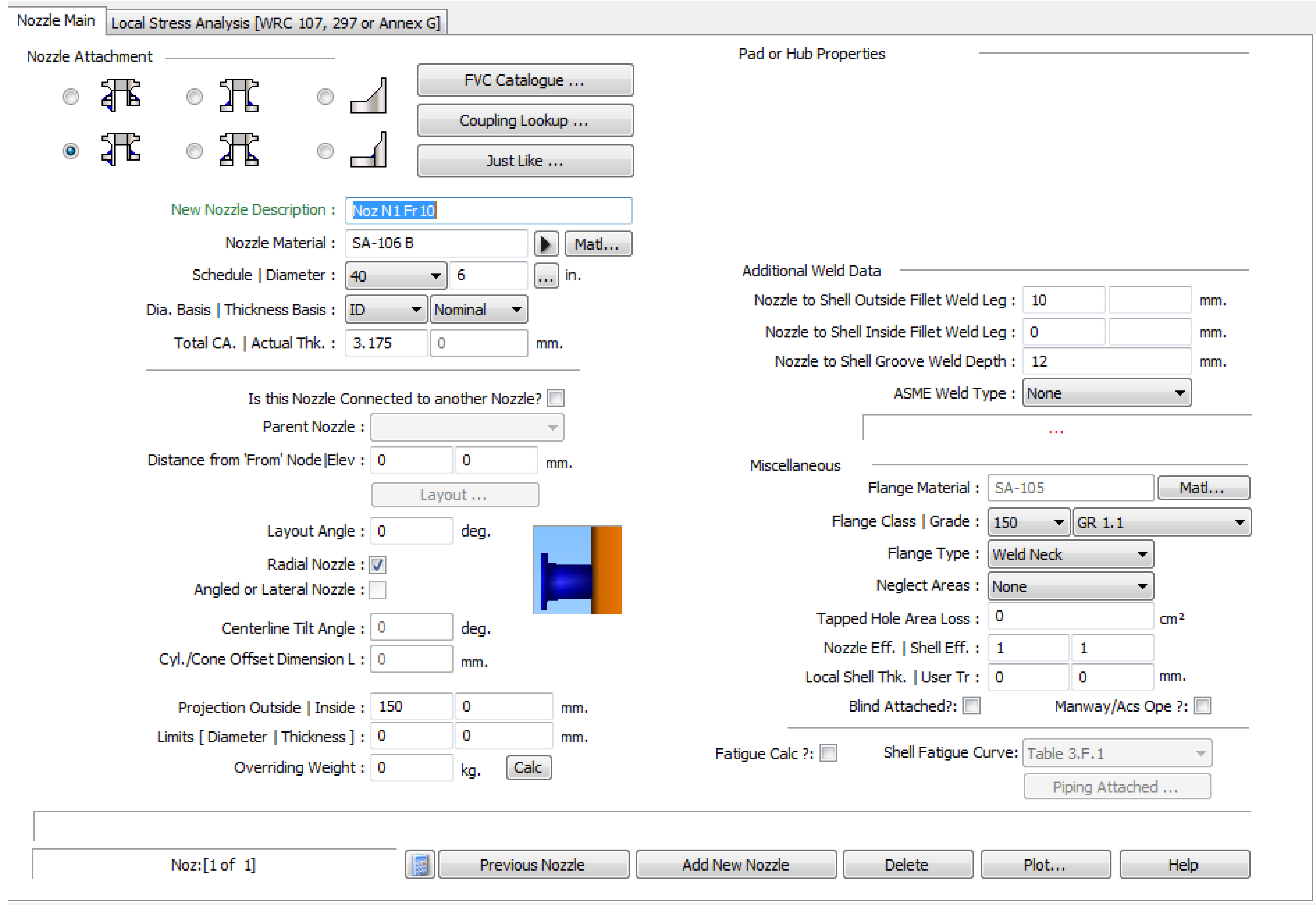
GENERAL NOTE: When any part of a flange is located within the greater of the $\sqrt{R_{nm}t_n} + t_e$ or $16t_n + t_e$ limit as indicated in Figure 1-7-1 or Figure 1-7-2 Case A, or the greater of $\sqrt{R_{nm}t_n}$ or $16t_n$ for Figure 1-7-1 or Figure 1-7-2 Case B, the flange may be included as part of the section that resists bending moment.

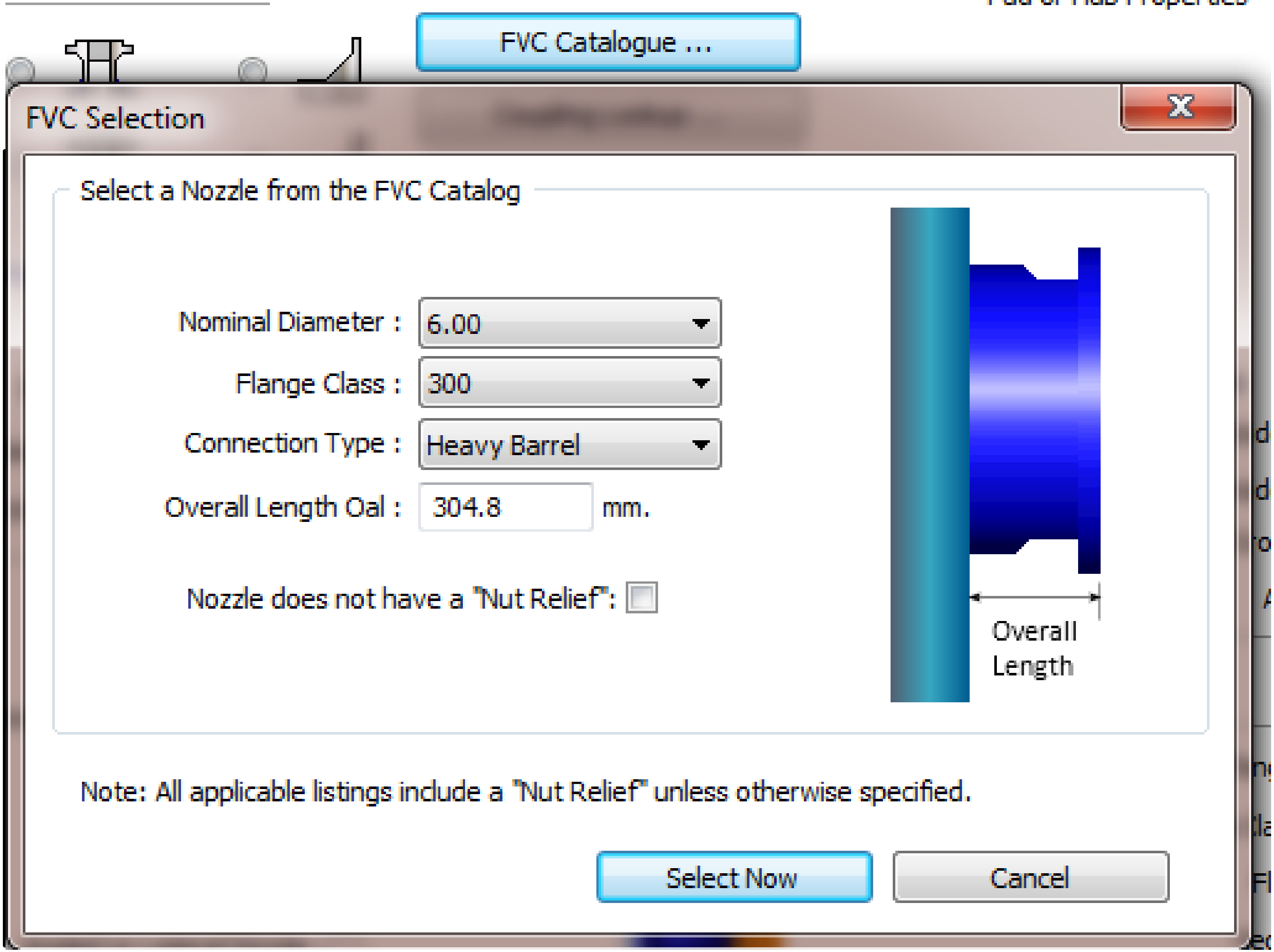
Summary of openings Error and warnings

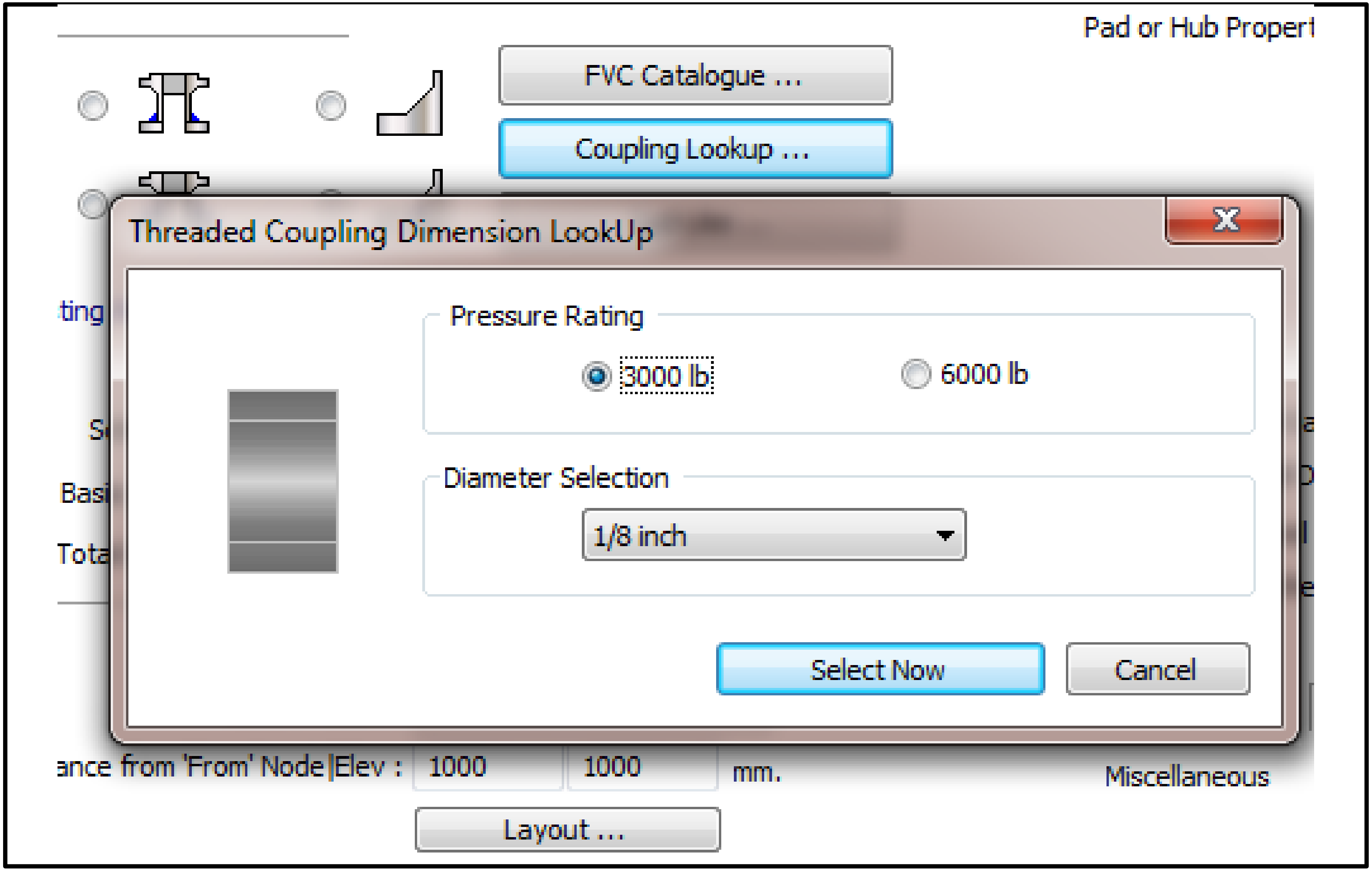
- 1- Rating of flange has been failed
- 2- Nozzles have clash and do not distanced as per limit of reinforcement
- 3- UG-37 failed
- 4- UG-45 Failed
- 5- WRC at nozzle or pad has been failed

Nozzle design

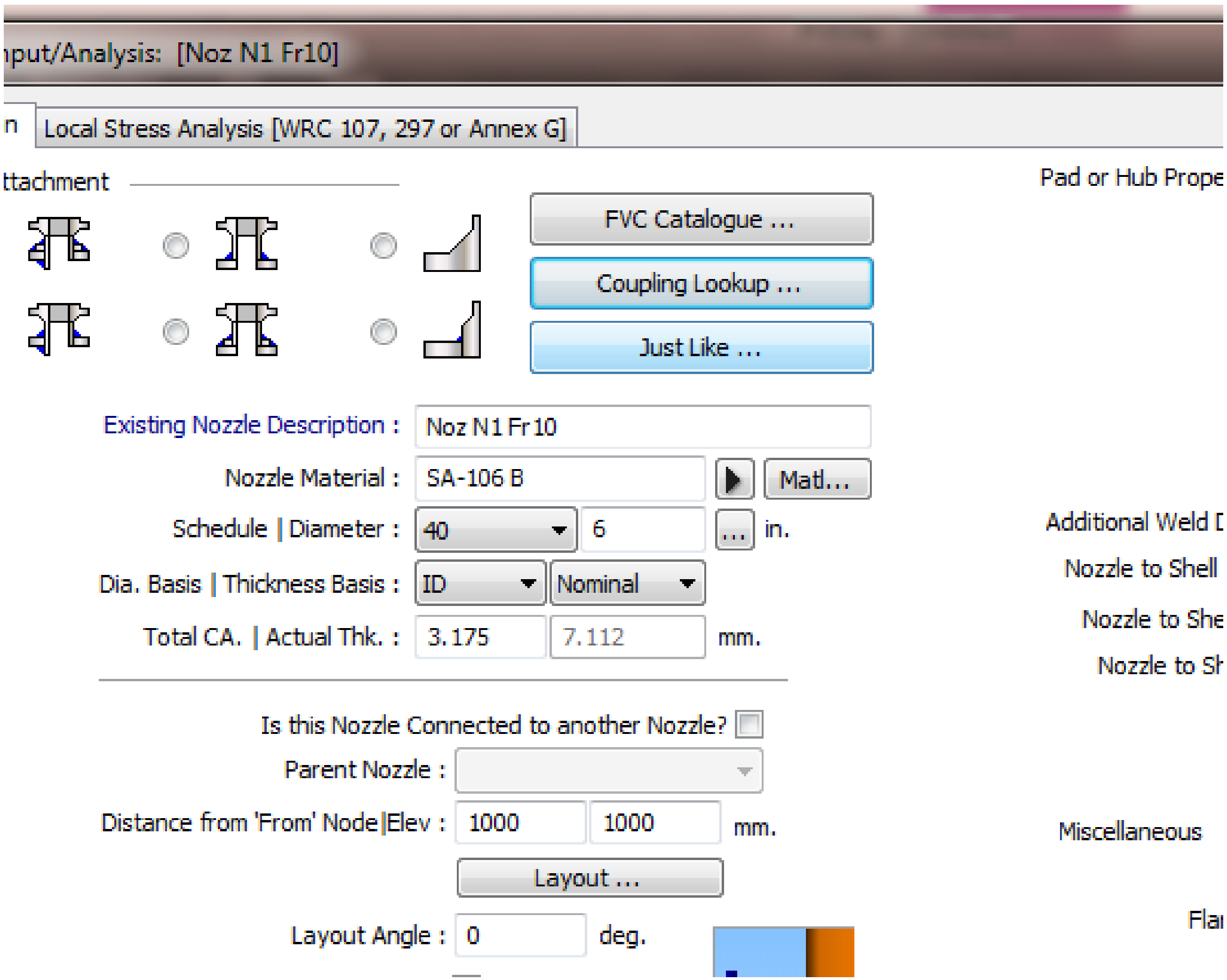



Nozzle Main
Local Stress Analysis [WRC 107, 297 or Annex G]
Nozzle Attachment
FVC Catalogue ...
Coupling Lookup ...
Just Like ...
New Nozzle Description :
Noz N1 Fr 10
Nozzle Material :
SA-106 B
Matl...
Schedule | Diameter :
40
6
in.
Dia. Basis | Thickness Basis :
ID
Nominal
Total CA. | Actual Thk. :
3.175
0
mm.
Is this Nozzle Connected to another Nozzle?
Parent Nozzle :
Distance from 'From' Node|Elev :
0
0
mm.
Layout ...
Layout Angle :
0
deg.
Radial Nozzle :
Angled or Lateral Nozzle :
Centerline Tilt Angle :
0
deg.
Cyl./Cone Offset Dimension L :
0
mm.
Projection Outside | Inside :
150
0
mm.
Limits [Diameter | Thickness] :
0
0
mm.
Overriding Weight :
0
kg.
Calc
Pad or Hub Properties
Additional Weld Data
Nozzle to Shell Outside Fillet Weld Leg :
10
mm.
Nozzle to Shell Inside Fillet Weld Leg :
0
mm.
Nozzle to Shell Groove Weld Depth :
12
mm.
ASME Weld Type :
None
...
Miscellaneous
Flange Material :
SA-105
Matl...
Flange Class | Grade :
150
GR 1.1
Flange Type :
Weld Neck
Neglect Areas :
None
Tapped Hole Area Loss :
0
cm²
Nozzle Eff. | Shell Eff. :
1
1
Local Shell Thk. | User Tr :
0
0
mm.
Blind Attached?:
Manway/Acs Ope ?:
Fatigue Calc ?:
Shell Fatigue Curve:
Table 3.F.1
Piping Attached ...
Noz:[1 of 1]
Previous Nozzle
Add New Nozzle
Delete
Plot...
Help

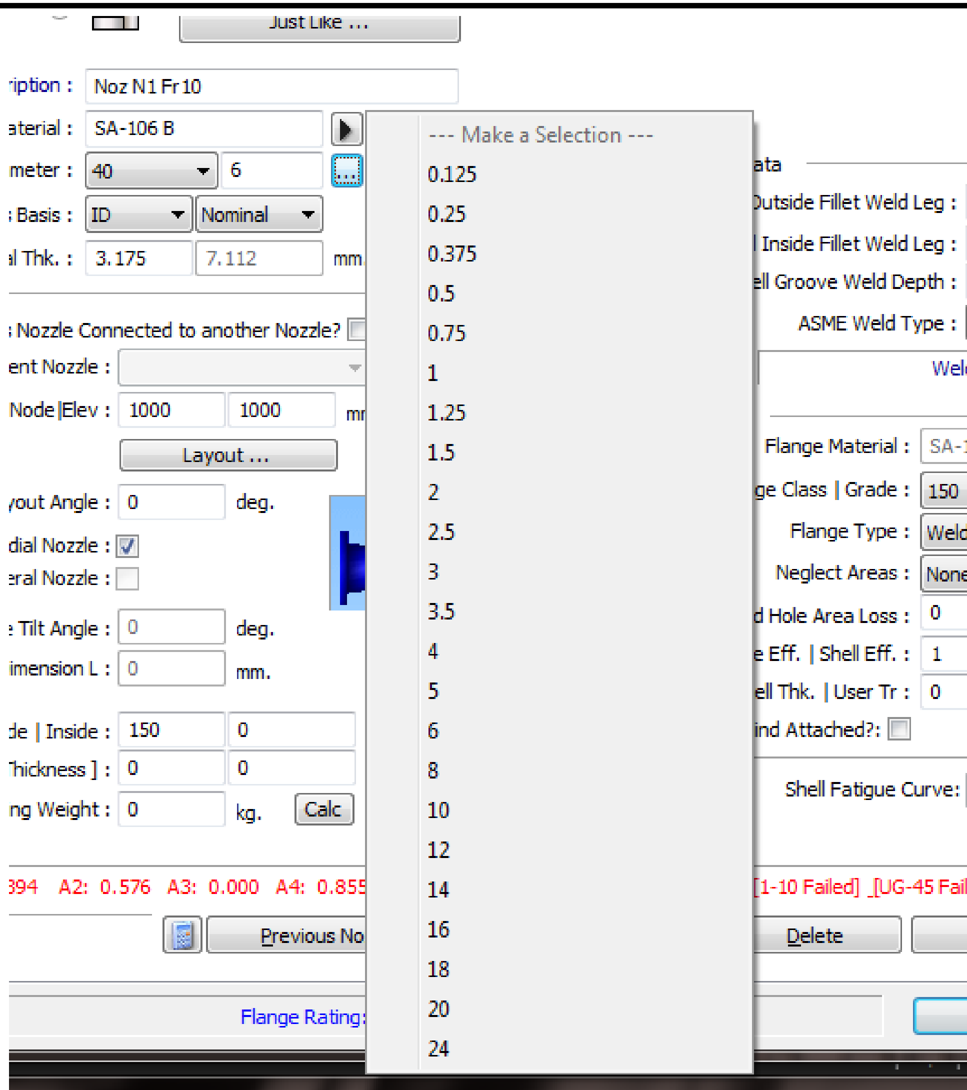

FVC Catalogue ...
FVC Selection
Select a Nozzle from the FVC Catalog
Nominal Diameter :
6.00
Flange Class :
300
Connection Type :
Heavy Barrel
Overall Length Oal :
304.8
mm.
Nozzle does not have a "Nut Relief":
Overall Length
Note: All applicable listings include a "Nut Relief" unless otherwise specified.
Select Now
Cancel


Pad or Hub Propert
FVC Catalogue ...
Coupling Lookup ...
Threaded Coupling Dimension LookUp
Pressure Rating
3000 lb
6000 lb
Diameter Selection
1/8 inch
Select Now
Cancel
ting
Basi
Tota
ance from 'From' Node|Elev :
1000
1000
mm.
Miscellaneous
Layout ...

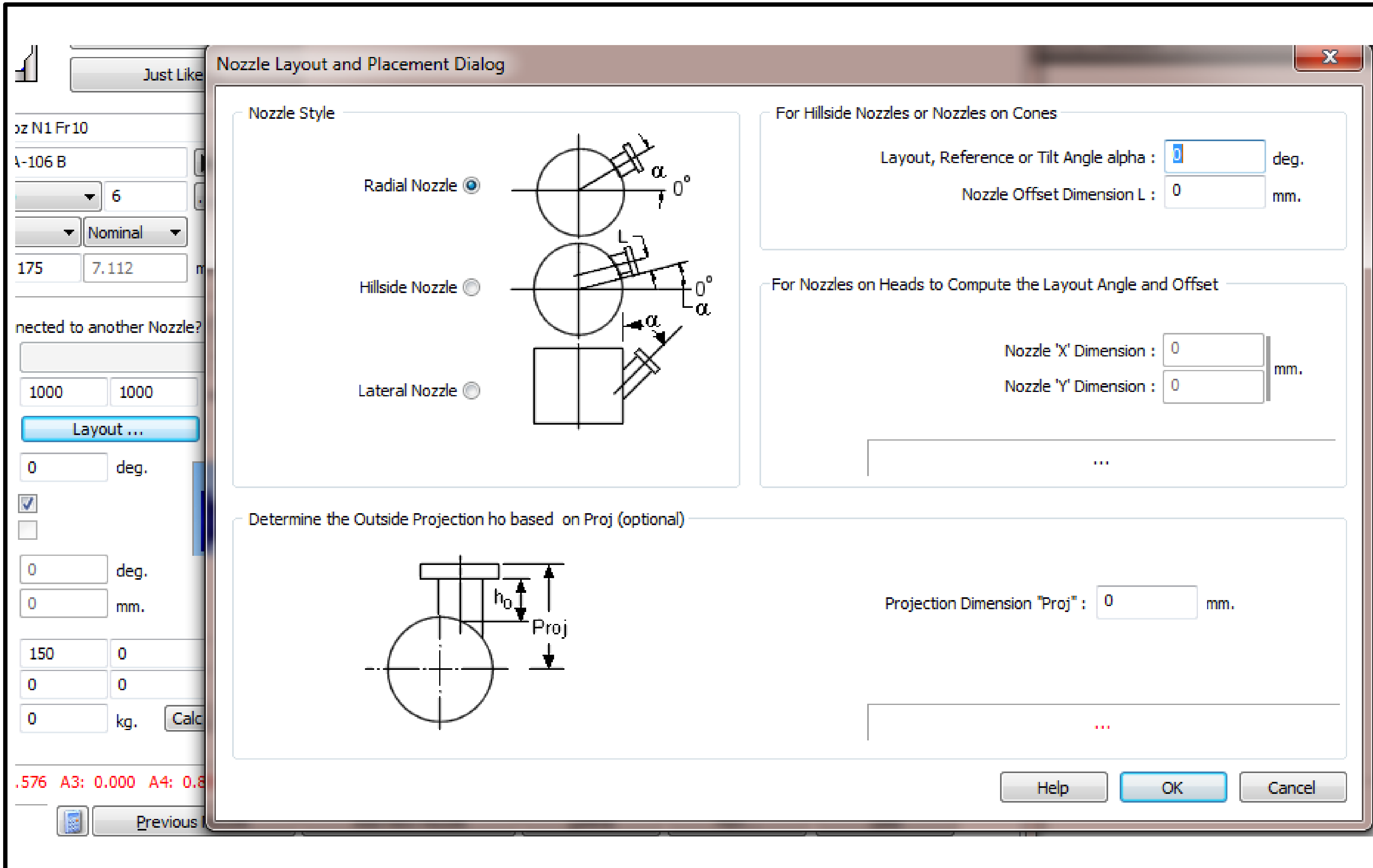
Nozzle design



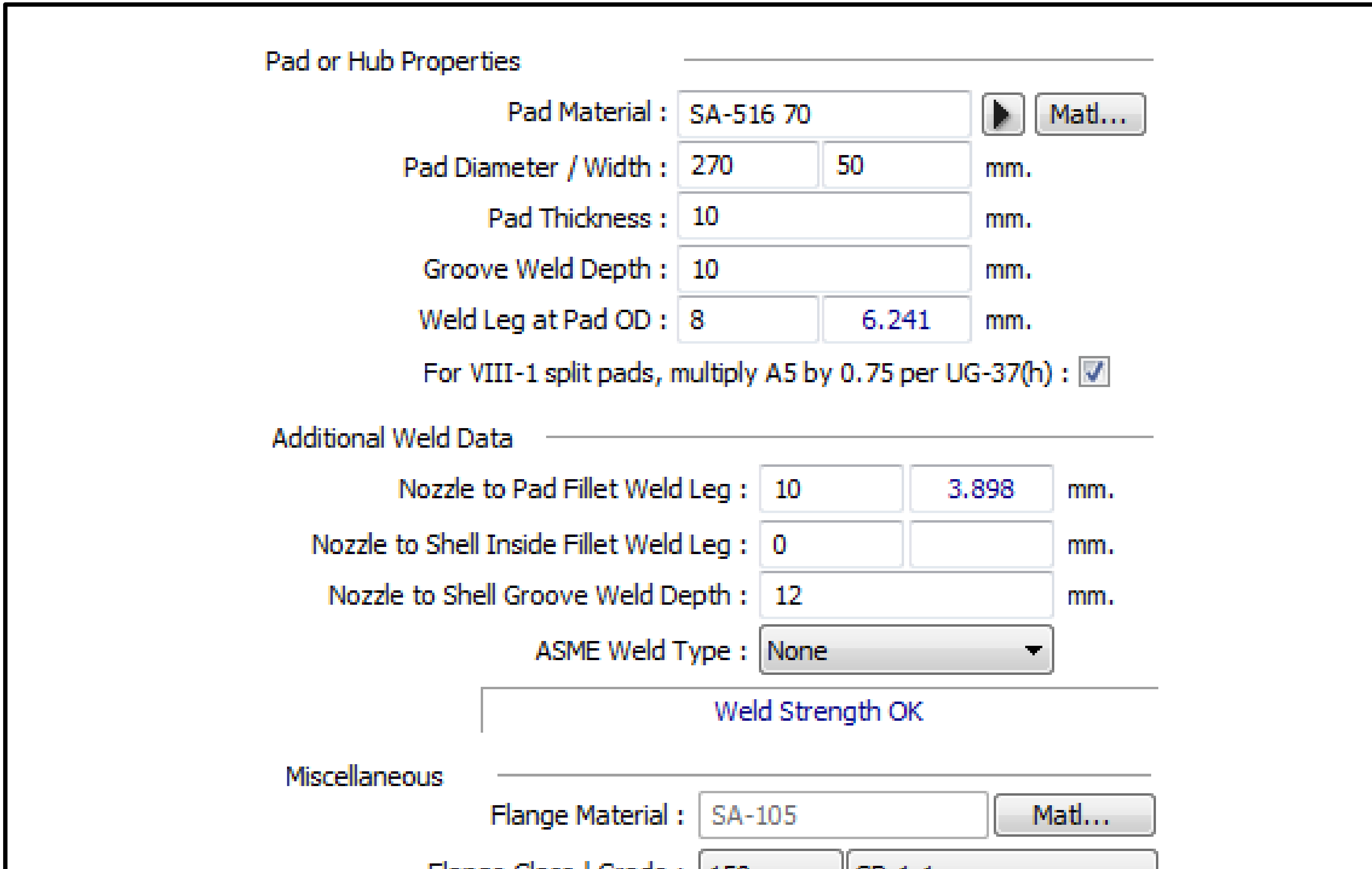
Nozzle design

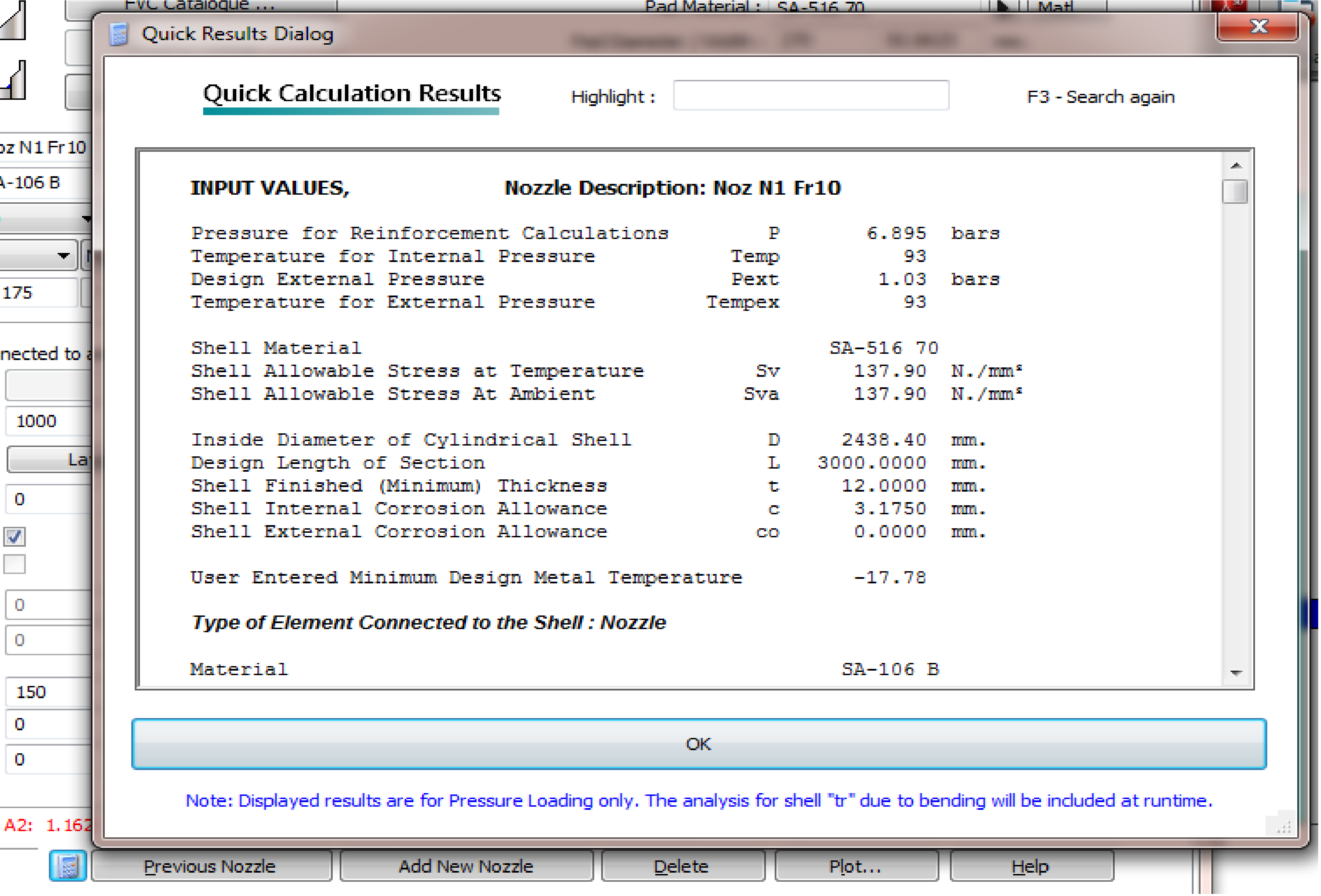


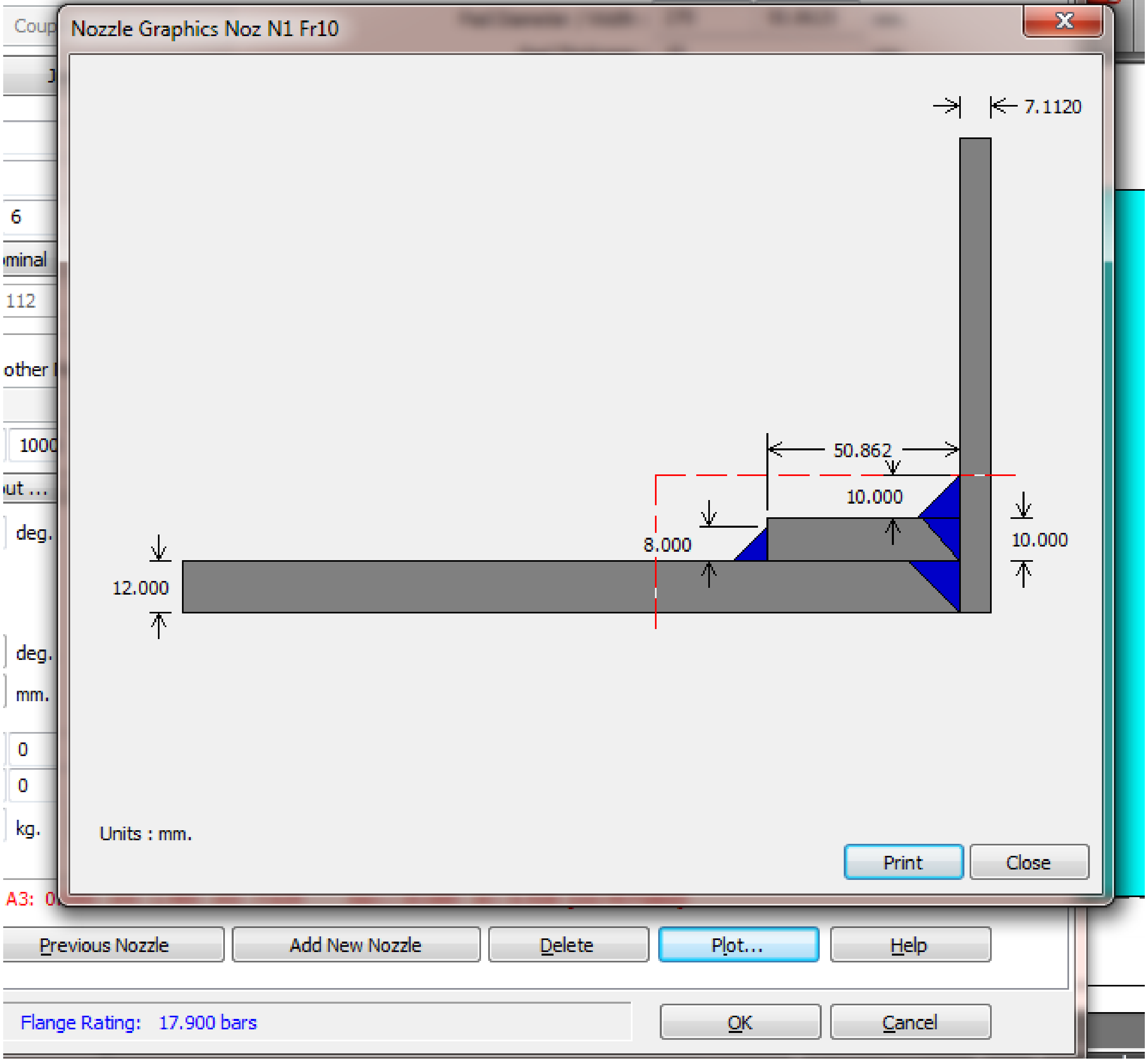
Nozzle design

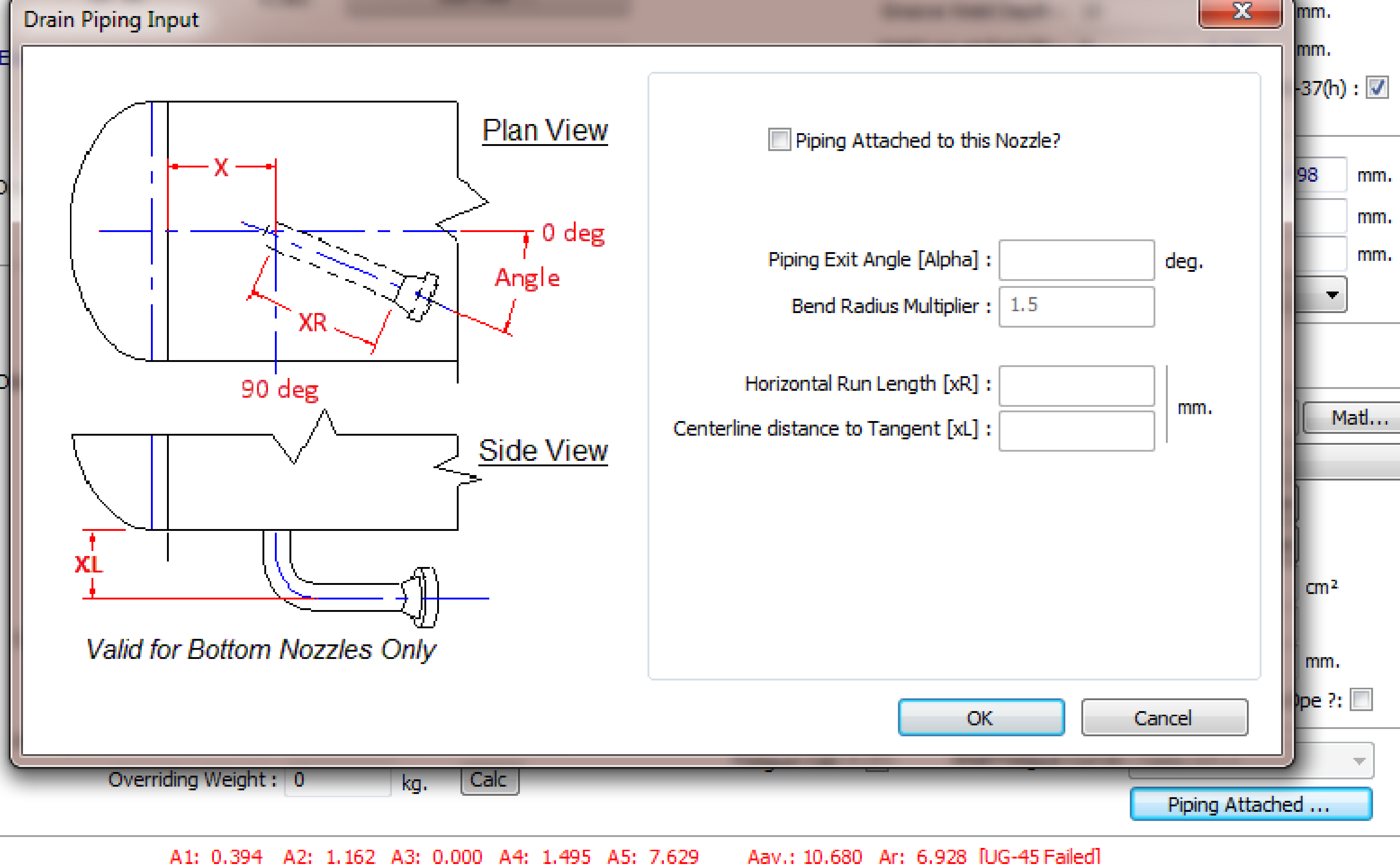


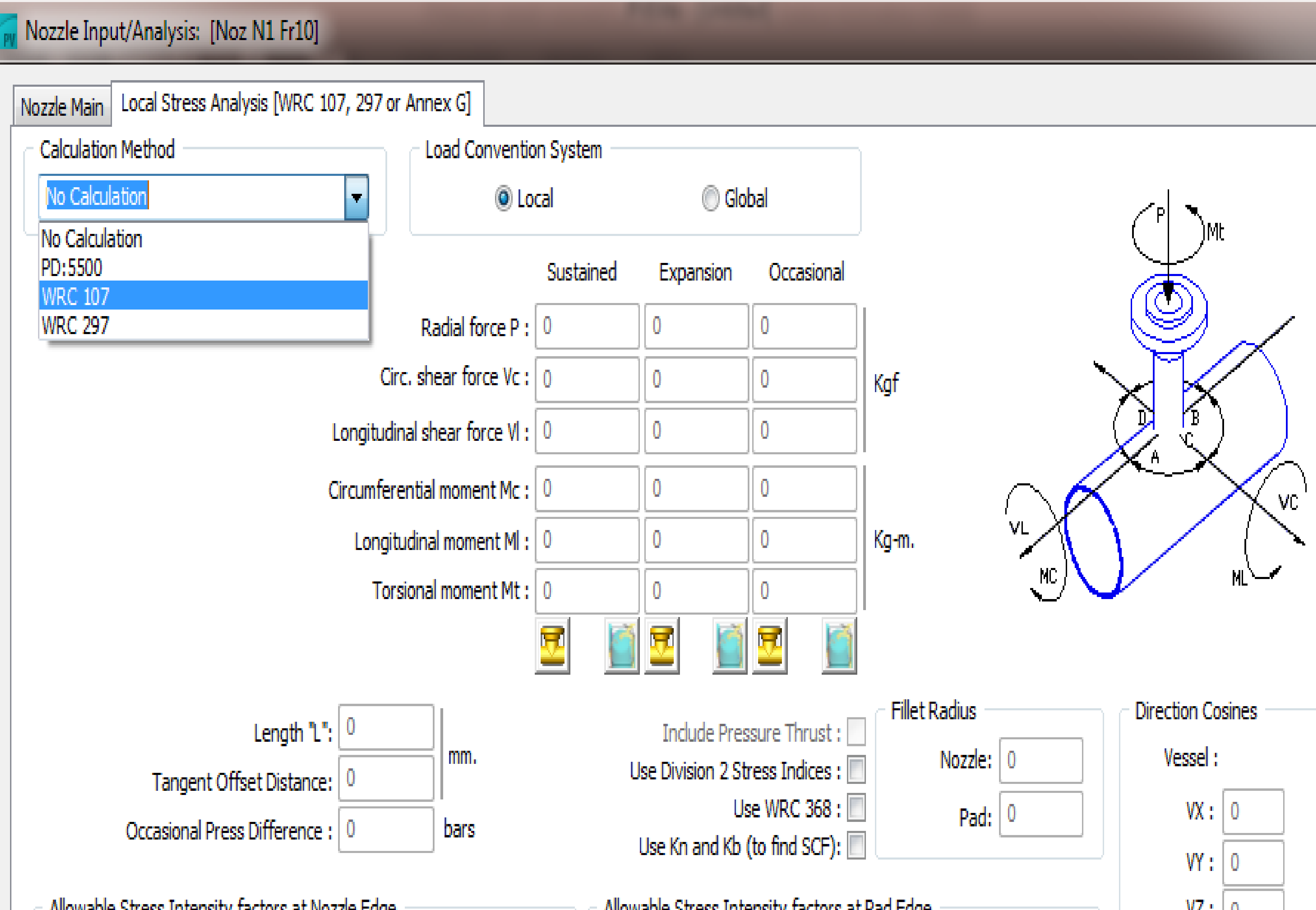
Nozzle design

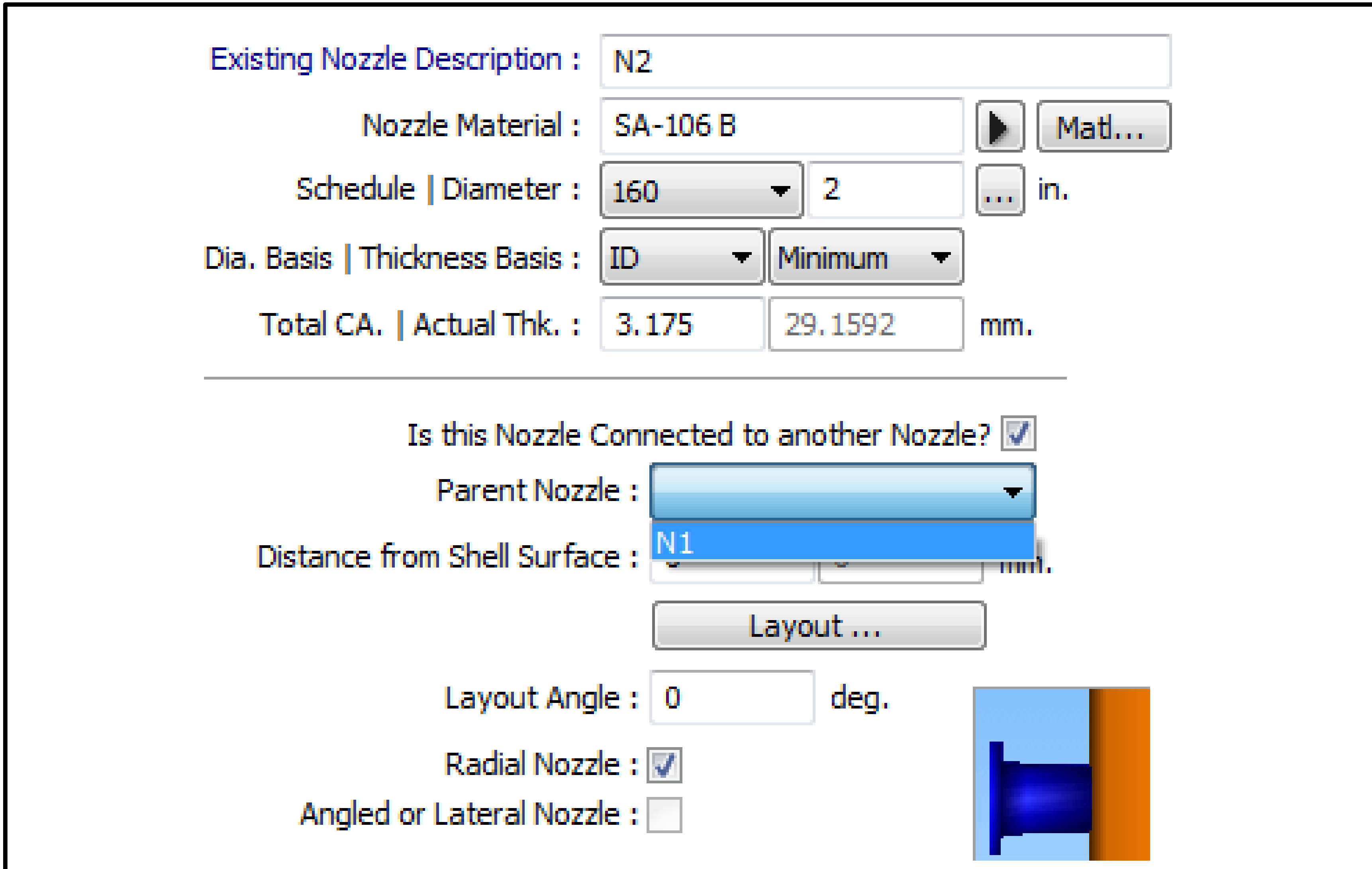



Quick Results Dialog
Quick Calculation Results
Highlight :
F3 - Search again
INPUT VALUES, Nozzle Description: Noz N1 Fr10
Pressure for Reinforcement Calculations P 6.895 bars
Temperature for Internal Pressure Temp 93
Design External Pressure Pext 1.03 bars
Temperature for External Pressure Tempex 93
Shell Material SA-516 70
Shell Allowable Stress at Temperature Sv 137.90 N./mm²
Shell Allowable Stress At Ambient Sva 137.90 N./mm²
Inside Diameter of Cylindrical Shell D 2438.40 mm.
Design Length of Section L 3000.0000 mm.
Shell Finished (Minimum) Thickness t 12.0000 mm.
Shell Internal Corrosion Allowance c 3.1750 mm.
Shell External Corrosion Allowance co 0.0000 mm.
User Entered Minimum Design Metal Temperature -17.78
Type of Element Connected to the Shell : Nozzle
Material SA-106 B
OK
Note: Displayed results are for Pressure Loading only. The analysis for shell "tr" due to bending will be included at runtime.
Previous Nozzle
Add New Nozzle
Delete
Plot...
Help

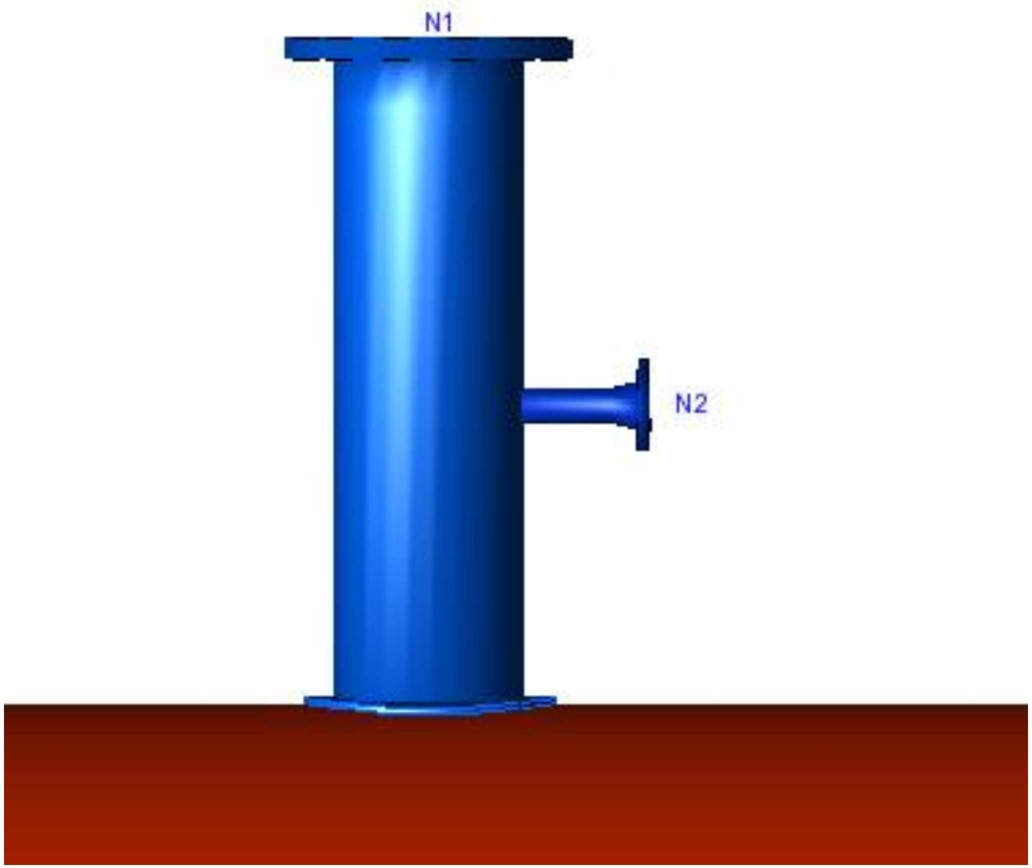

Nozzle Graphics Noz N1 Fr10
7.1120
50.862
10.000
8.000
10.000
12.000
Units : mm.
Print
Close
Coup
6
minal
112
other
1000
ut ...
deg.
deg.
mm.
0
0
kg.
A3:
Previous Nozzle
Add New Nozzle
Delete
Plot...
Help
Flange Rating: 17.900 bars
OK
Cancel


Drain Piping Input
Plan View
X
0 deg
Angle
XR
90 deg
Side View
XL
Valid for Bottom Nozzles Only
Piping Attached to this Nozzle?
Piping Exit Angle [Alpha] :
deg.
Bend Radius Multiplier :
1.5
Horizontal Run Length [xR] :
Centerline distance to Tangent [xL] :
mm.
OK
Cancel
Overriding Weight : 0
kg.
Calc
Piping Attached ...
A1: 0.394 A2: 1.162 A3: 0.000 A4: 1.495 A5: 7.629 Aav.: 10.680 Ar: 6.928 [UG-45 Failed]

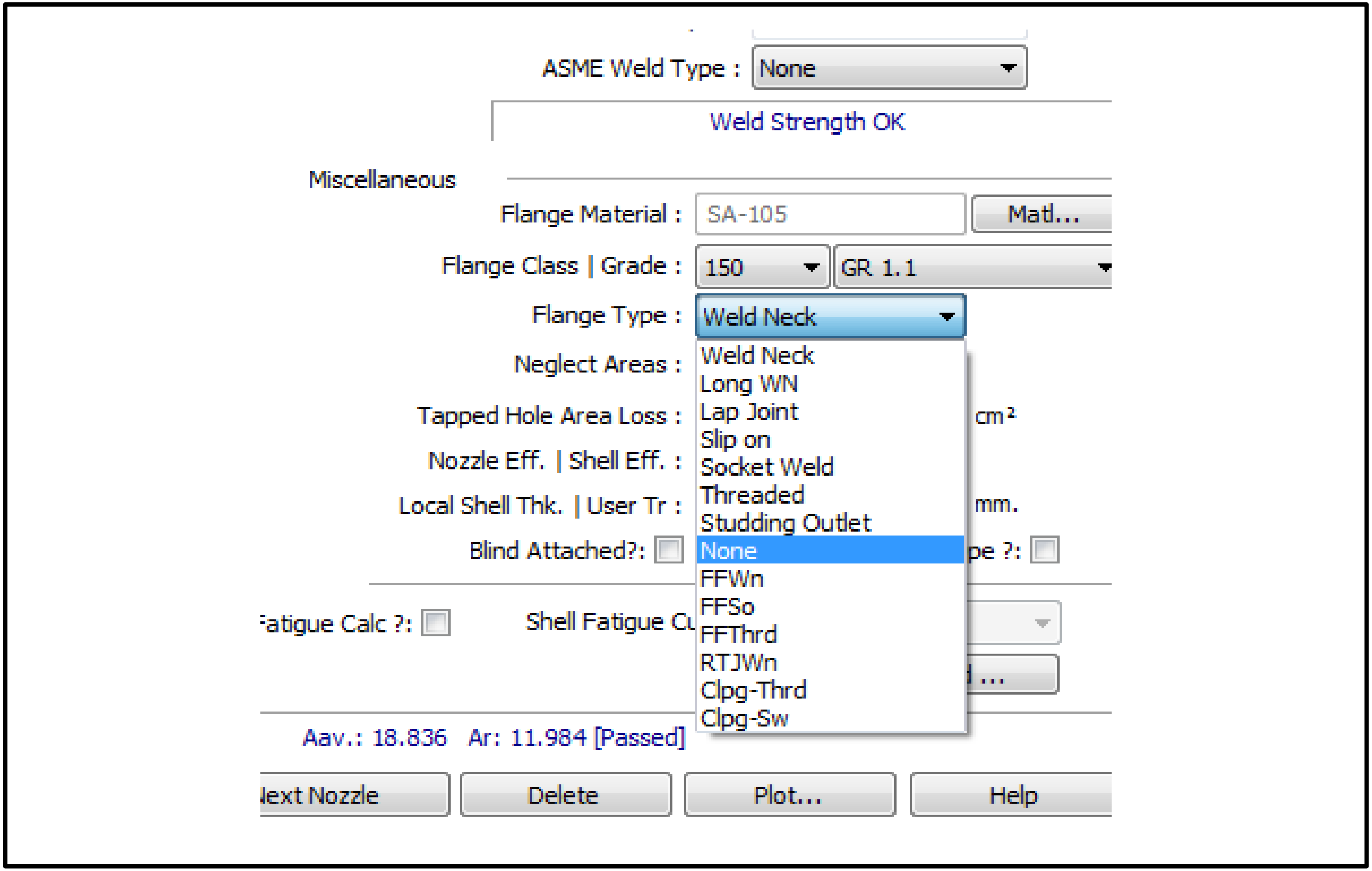

Nozzle Input/Analysis: [Noz N1 Fr10]
Nozzle Main
Local Stress Analysis [WRC 107, 297 or Annex G]
Calculation Method
No Calculation
No Calculation
PD:5500
WRC 107
WRC 297
Load Convention System
Local
Global
Sustained
Expansion
Occasional
Radial force P :
Circ. shear force Vc :
Longitudinal shear force Vl :
Kgf
Circumferential moment Mc :
Longitudinal moment Ml :
Torsional moment Mt :
Kg-m.
Length "L":
Tangent Offset Distance:
mm.
Occasional Press Difference :
bars
Include Pressure Thrust :
Use Division 2 Stress Indices :
Use WRC 368 :
Use Kn and Kb (to find SCF):
Fillet Radius
Nozzle:
Pad:
Direction Cosines
Vessel :
VX :
VY :
VZ :
Allowable Stress Intensity factors at Nozzle Edge
Allowable Stress Intensity factors at Pad Edge
P
Mt
D
B
C
A
VL
VC
MC
ML


Existing Nozzle Description : N2
Nozzle Material : SA-106 B
Matl...
Schedule | Diameter : 160 2 ... in.
Dia. Basis | Thickness Basis : ID Minimum
Total CA. | Actual Thk. : 3.175 29.1592 mm.
Is this Nozzle Connected to another Nozzle?
Parent Nozzle :
N1
Distance from Shell Surface :
Layout ...
Layout Angle : 0 deg.
Radial Nozzle :
Angled or Lateral Nozzle :

Nozzle design



Nozzle design

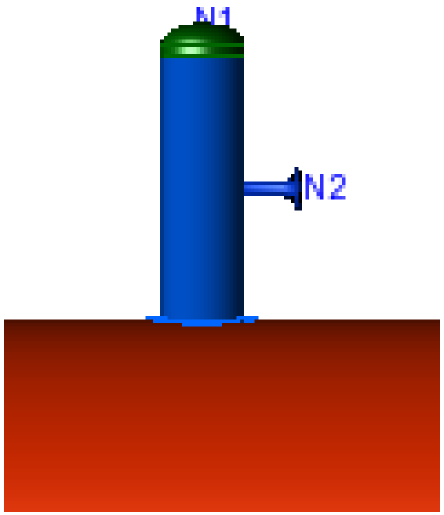


External Pressure, bars	1.034
Temp. for External Pressure, C	93.342
Additional Element Data	
Head Factor	2
Inside Head Depth, mm.	609.6
Sump Head	✔
Parent Nozzle	N1
Head is Cold Spun (EN-13445)?	

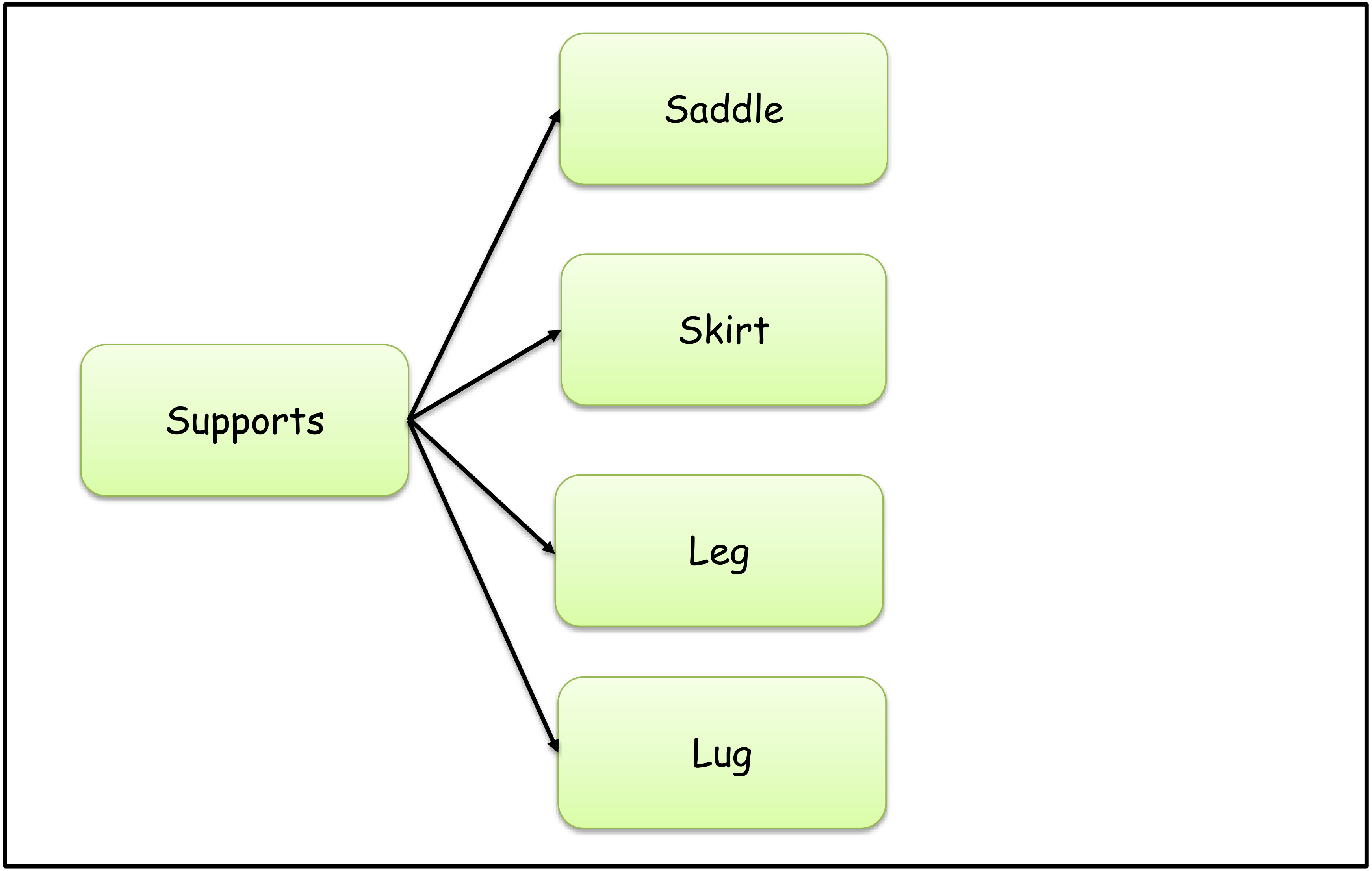
Parent Nozzle

Select the nozzle that that this head is attached to.

[10]



Vessel Supports!



4.15.3 SADDLE SUPPORTS FOR HORIZONTAL VESSELS

4.15.3.1 Application of Rules.

(a) Design Method - The design method in this paragraph is based on an analysis of the longitudinal stresses exerted within the cylindrical shell by the overall bending of the vessel, considered as a beam on two single supports, the shear stresses generated by the transmission of the loads on the supports, and the circumferential stresses within the cylindrical shell, the head shear and additional tensile stress in the head, and the possible stiffening rings of this shell, by this transmission of the loads on the supports. The stress calculation method is based on linear elastic mechanics and covers modes of failure by excessive deformation and elastic instability. Alternatively, saddle supports may be designed in accordance with Part 5.

(b) Geometry - A typical horizontal vessel geometry is shown in Figure 4.15.1. Saddle supports for horizontal vessels shall be configured to provide continuous support for at least one-third of the shell circumference, or $\theta \geq 120$ deg.

(c) Reinforcing Plates - If a reinforcing plate is included in the design to reduce the stresses in the cylindrical shell at the saddle support, then the width of the reinforcing plate, b_1, shall satisfy Equation (4.15.1) and provide a supporting arc length that satisfies eq. (4.15.2). A typical reinforcing plate arrangement is shown in Figure 4.15.2.

$$b_1 = \min\left[\left(b + 1.56\sqrt{R_m t}\right),\ 2a\right] \tag{4.15.1}$$

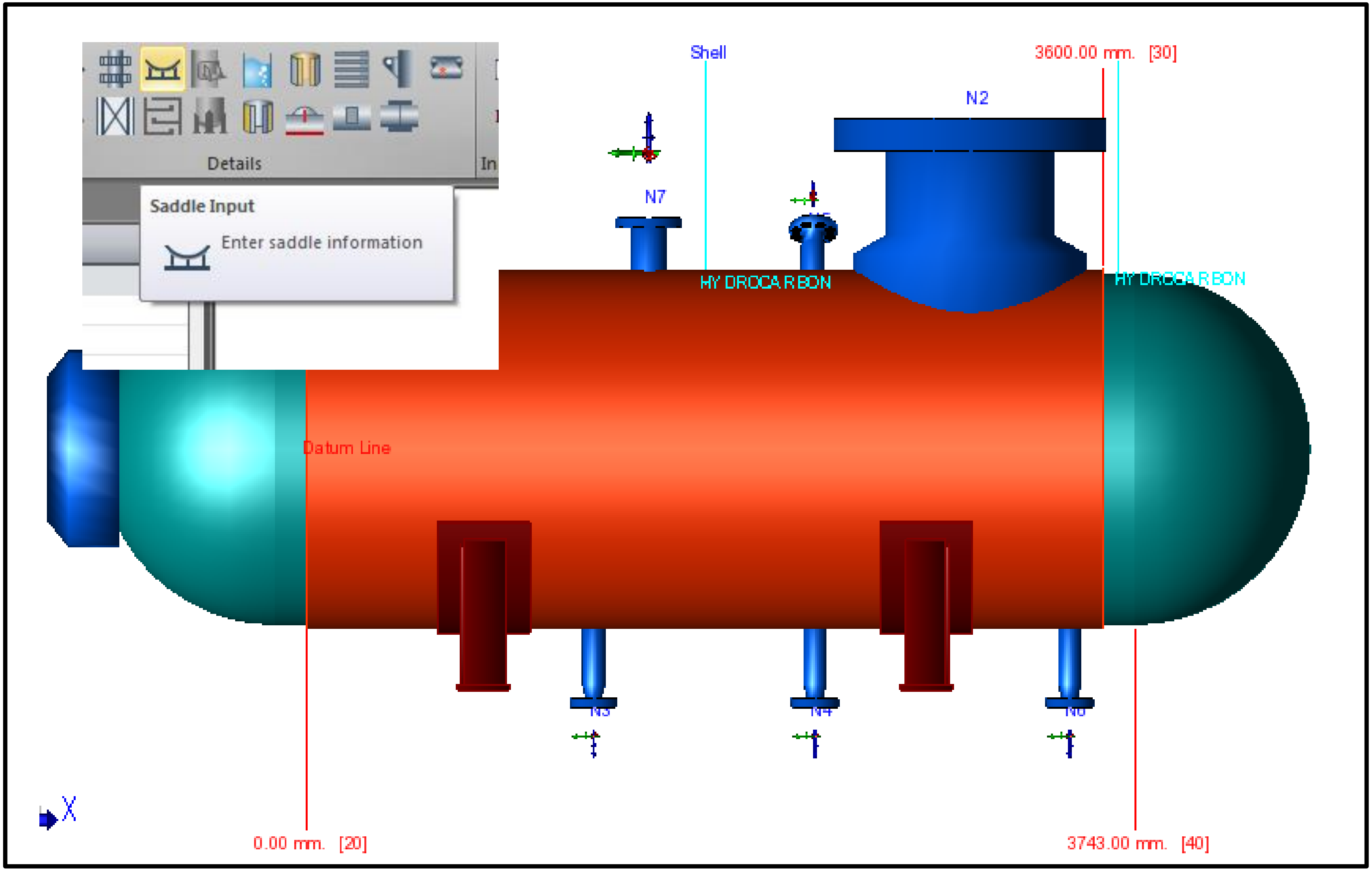
$$\theta_1 = \theta + \frac{\theta}{12} \tag{4.15.2}$$

(d) Stiffening Rings - Stiffening rings may be used at the saddle support location, on either the inside or outside of the cylindrical shell. The stiffening rings may be mounted in the plane of the saddle (see Figure 4.15.3) or two stiffening rings may be mounted on each side of the saddle support equidistant from the saddle support (see Figure 4.15.4). In the later case, the spacing between the two stiffening rings, h, as shown in Figure 4.15.4 shall not be greater than R_m. If $h \leq 1.56\sqrt{R_m t}$ as shown in Figure 4.15.3 Sketch (c), then both of the stiffening rings shall be considered as a single stiffening ring situated in the plane of the saddle in the stress calculations.

4.15.3.2 Moment and Shear Force.

(a) If the vessel is composed of a cylindrical shell with a formed head (i.e. torispherical, elliptical, or hemispherical) at each end that is supported by two saddle supports equally spaced and with $a \leq 0.25L$, then the moment at the saddle, M_1, the moment at the center of the vessel, M_1, and the shear force at the saddle, T, may be computed using the following equations.

SADDLE



Details
In
Saddle Input
Enter saddle information
Shell
3600.00 mm. [30]
N2
N7
HYDROCARBON
HYDROCARBON
Datum Line
X
0.00 mm. [20]
3743.00 mm. [40]

From Node : 20

Detail Description : Fixed

Distance from "From" Node : 800 mm.

Saddle Width | Dimension a : 210 | 154 mm.

Centerline Dimension B : 1000 mm.

Saddle Contact Angle : 120 deg.

Wear Plate Width | Thickness : 420 | 20 mm.

Wear Plate Contact Angle : 132 deg.

Height of Section Ring : 0 mm.

Friction Coefficient Mu : 0

Moment Factor, Ftr : 3

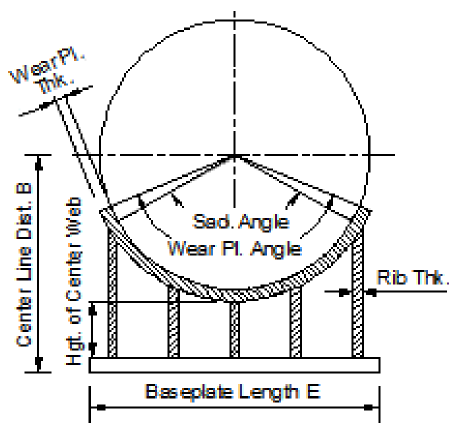
Dimension E at Base (optional) : 0 mm.

Tangent to Tangent Distance (optional) : 0 mm.

Circumferential Eff. Over Saddle | At Midspan : 1 | 1

Wear Plate and Shell Materials are the Same ? ☐

Is this Saddle Welded to the Shell ? ☑



Add Saddle Ring ... | Select Saddle ... | Same as First

Sadl:[1 of 2]

Previous Saddle | Goto Next Saddle

☑ Perform Saddle Check ?

Saddle Allowable Stress : 137.9 N./mm² [Matl...]

Material Yield Stress : 262.01 N./mm²

E for Plates : 1.99943e+008 KPa.

Baseplate Length | Thickness : 1350 | 26 mm.

Baseplate Width : 210 mm.

Number of Ribs : 4

Rib Thickness | Web Thickness : 15 | 15 mm.

Height of Web at Center : 228 mm.

Web Location : Side - Left

☑ Perform Anchor Bolt Calculations ?

☐ Saddle Bolted to Steel Foundation?

Number of Bolts : 2

Num of Bolts in Tension : 1

Edge Distance : 145.009 mm.

Bolt Corrosion Allowance : 0 mm.

Bolt Material : SA-193 B7 [Matl:]

Bolt Allowable Stress : 145 N./mm²

Thread Series : Tema Metric

Bolt Nominal Diameter : 48 mm. [...]

Bolt Root Area : cm²

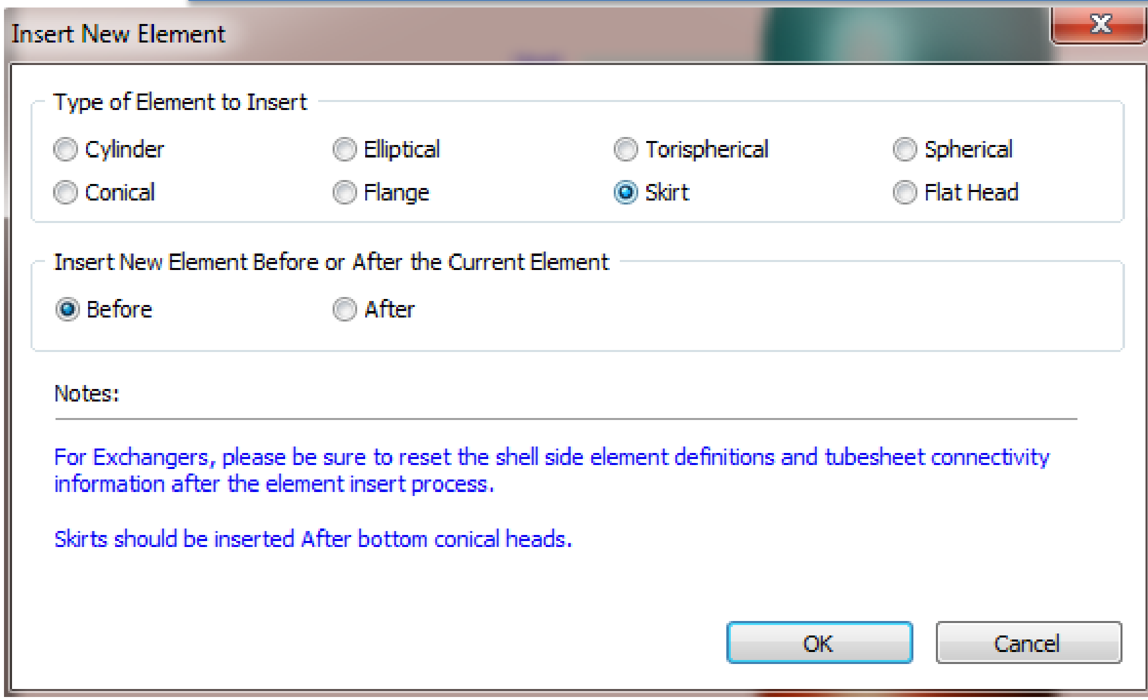
Optional Moments for Saddle Analysis

	Operating	Test	
Moment M1 or M3 (optional) :	0	0	Kg-m.
Moment M2 or M4 (optional) :	0	0	

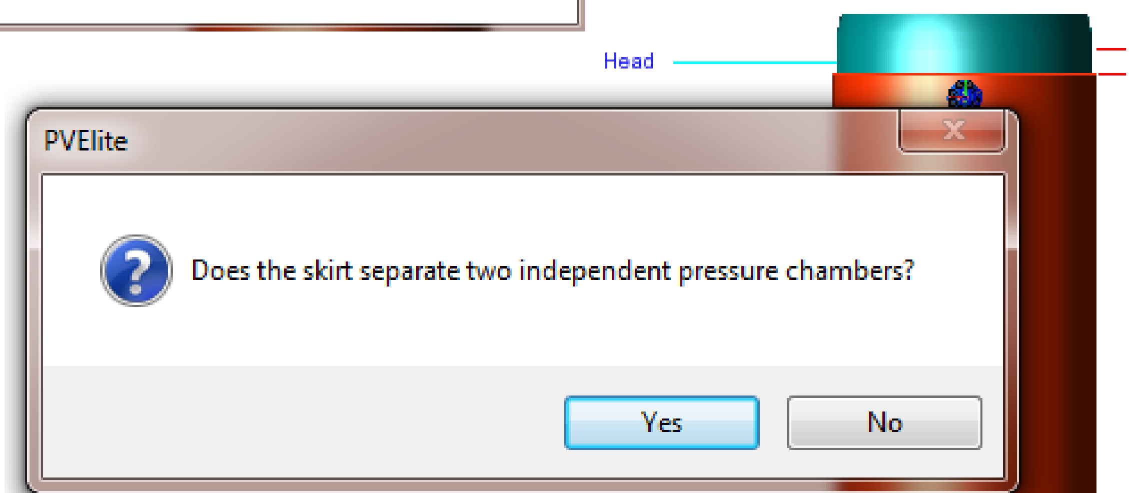
...

Delete | OK | Cancel | Help

SKIRT



Insert New Element
Type of Element to Insert
Cylinder
Elliptical
Torispherical
Spherical
Conical
Flange
Skirt
Flat Head
Insert New Element Before or After the Current Element
Before
After
Notes:
For Exchangers, please be sure to reset the shell side element definitions and tubesheet connectivity information after the element insert process.
Skirts should be inserted After bottom conical heads.
OK
Cancel

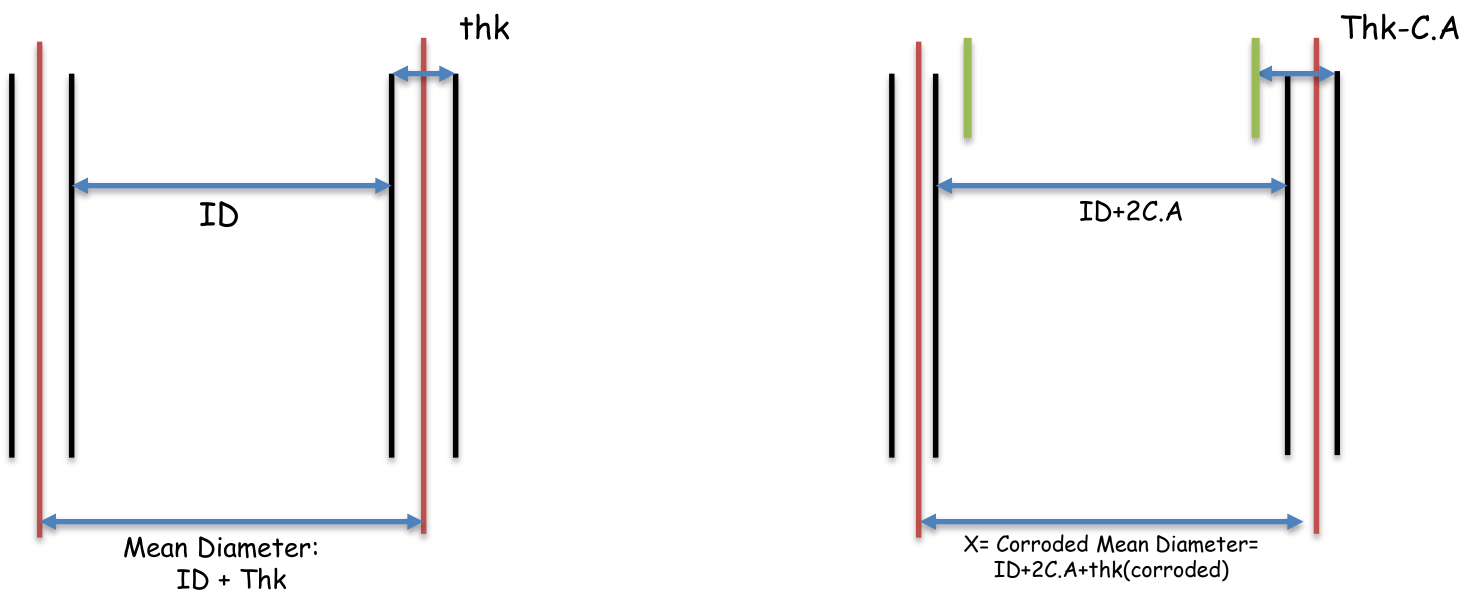


Head
PVElite
Does the skirt separate two independent pressure chambers?
Yes
No

SKIRT

- Material Consideration
- Skirt length
- Skirt alignment
- Skirt Thickness
- Skirt corrosion and JE
- Base ring Design

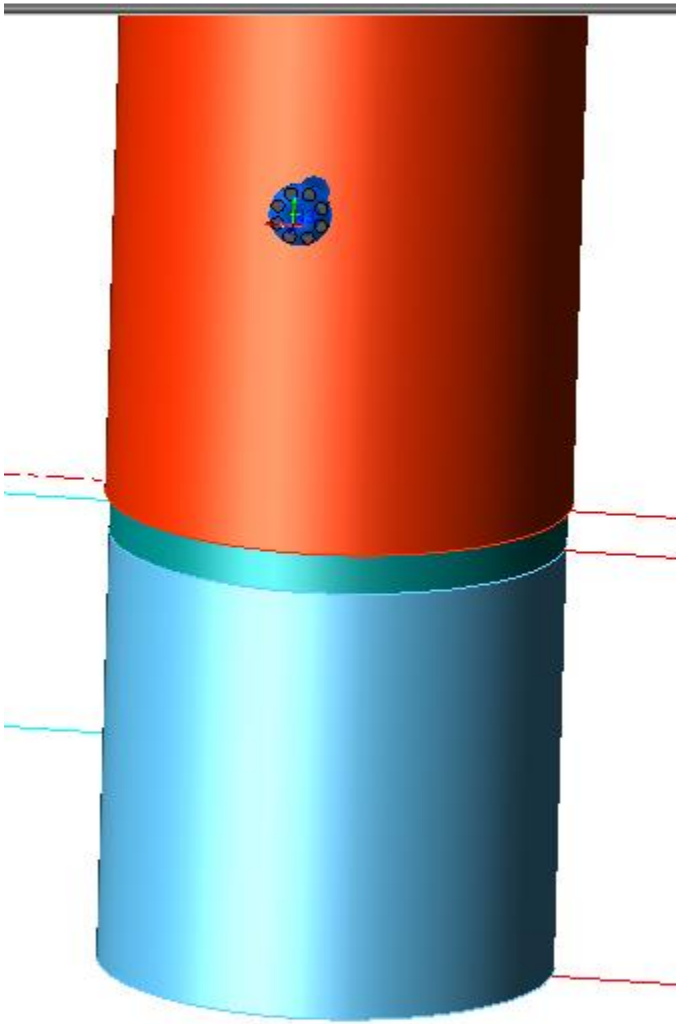
SKIRT

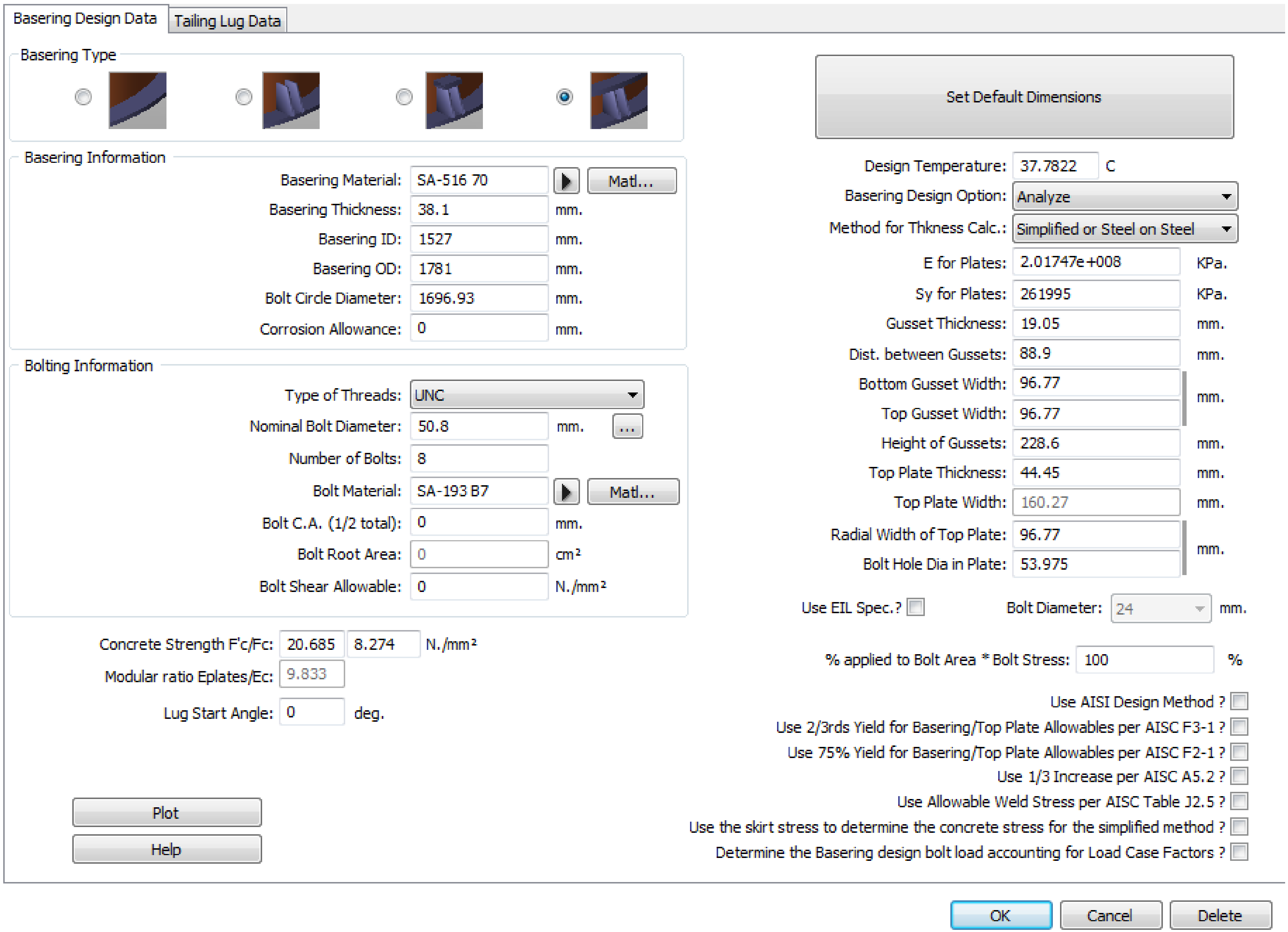


- If Skirt Thk = Shell Course Thk , Then: OD of skirt and shell course should be equal
- If Skirt Thk > Shell Course Thk , Then: OD of skirt and shell course should be equal
- If Skirt Thk < Shell Course Thk , Then: Mean Diameter of skirt and Mean Diameter of shell course should be equal (Corroded Condition)>>>>>>>>Skirt ID (in corroded Condition) = X - Thk

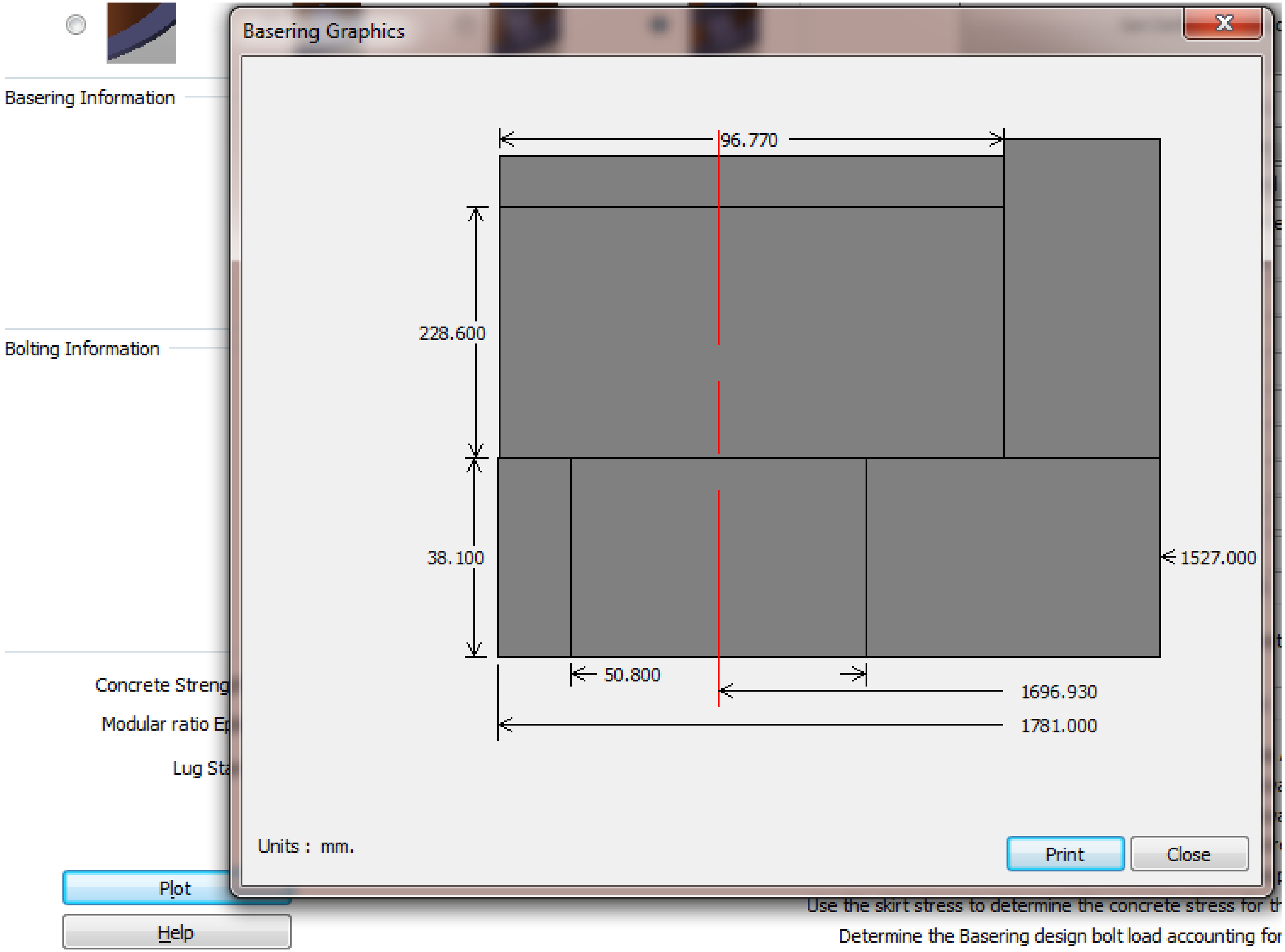
SKIRT

neral Input	
From Node	10
To Node	20
Element Type	Skirt
Diameter Basis	ID
Inside Diameter, mm.	1527
Skirt Length, mm.	1524
Finished Thickness, mm.	30.23
Nominal Thickness, mm.	35
Internal Corrosion Allowance, m	1.6
External Corrosion Allowance, m	0
Wind Diameter Multiplier	1.3
Material Name	SA-516 70
Longitudinal Seam Efficiency	1
Circumferential Seam Efficiency	1
Internal Pressure, bars	0
Temp. for Internal Pressure, C	86
External Pressure, bars	0
Temp. for External Pressure, C	155
Additional Element Data	
Skirt Diameter at Base, mm.	1527
Perform Basering Analysis	☑
Evaluate Holes in Skirt	




Basering Design Data
Tailing Lug Data
Basering Type
Basering Information
Basering Material: SA-516 70
Matl...
Basering Thickness: 38.1 mm.
Basering ID: 1527 mm.
Basering OD: 1781 mm.
Bolt Circle Diameter: 1696.93 mm.
Corrosion Allowance: 0 mm.
Bolting Information
Type of Threads: UNC
Nominal Bolt Diameter: 50.8 mm.
Number of Bolts: 8
Bolt Material: SA-193 B7
Matl...
Bolt C.A. (1/2 total): 0 mm.
Bolt Root Area: 0 cm²
Bolt Shear Allowable: 0 N./mm²
Concrete Strength F'c/Fc: 20.685 8.274 N./mm²
Modular ratio Eplates/Ec: 9.833
Lug Start Angle: 0 deg.
Plot
Help
Set Default Dimensions
Design Temperature: 37.7822 C
Basering Design Option: Analyze
Method for Thkness Calc.: Simplified or Steel on Steel
E for Plates: 2.01747e+008 KPa.
Sy for Plates: 261995 KPa.
Gusset Thickness: 19.05 mm.
Dist. between Gussets: 88.9 mm.
Bottom Gusset Width: 96.77 mm.
Top Gusset Width: 96.77
Height of Gussets: 228.6 mm.
Top Plate Thickness: 44.45 mm.
Top Plate Width: 160.27 mm.
Radial Width of Top Plate: 96.77 mm.
Bolt Hole Dia in Plate: 53.975
Use EIL Spec.?
Bolt Diameter: 24 mm.
% applied to Bolt Area * Bolt Stress: 100 %
Use AISI Design Method ?
Use 2/3rds Yield for Basering/Top Plate Allowables per AISC F3-1 ?
Use 75% Yield for Basering/Top Plate Allowables per AISC F2-1 ?
Use 1/3 Increase per AISC A5.2 ?
Use Allowable Weld Stress per AISC Table J2.5 ?
Use the skirt stress to determine the concrete stress for the simplified method ?
Determine the Basering design bolt load accounting for Load Case Factors ?
OK
Cancel
Delete

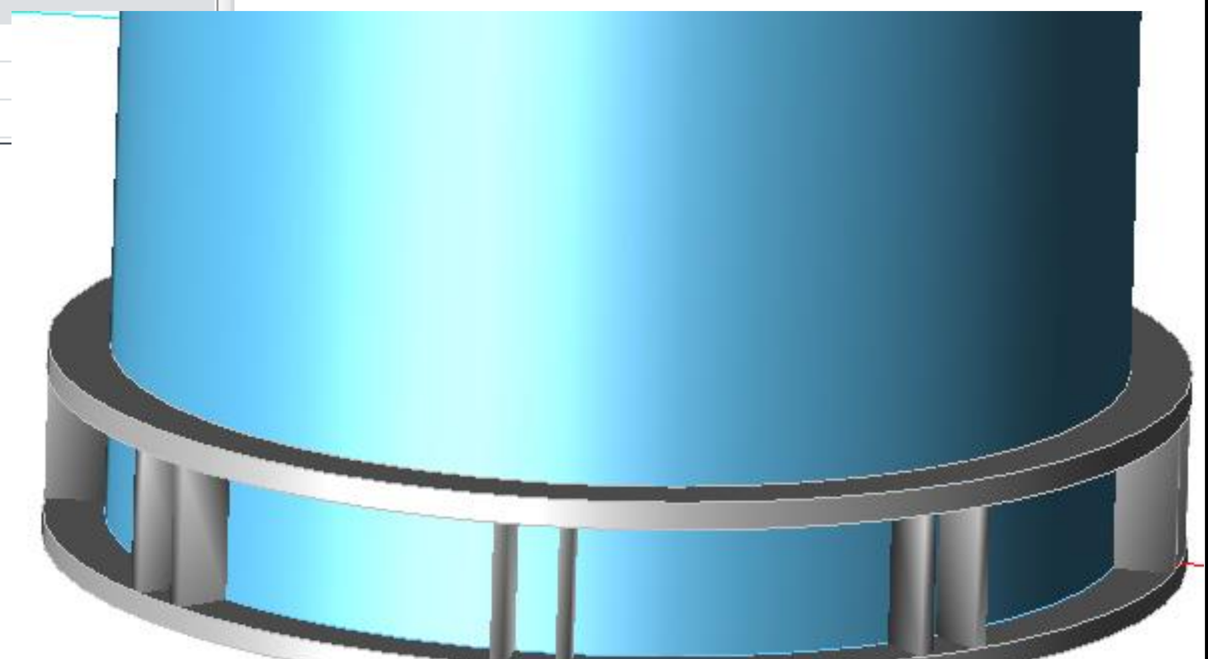
SKIRT



Basering Information
Bolting Information
Concrete Streng
Modular ratio Ep
Lug Sta
Plot
Help
Basering Graphics
96.770
228.600
38.100
1527.000
50.800
1696.930
1781.000
Units : mm.
Print
Close
Use the skirt stress to determine the concrete stress for th
Determine the Basering design bolt load accounting for

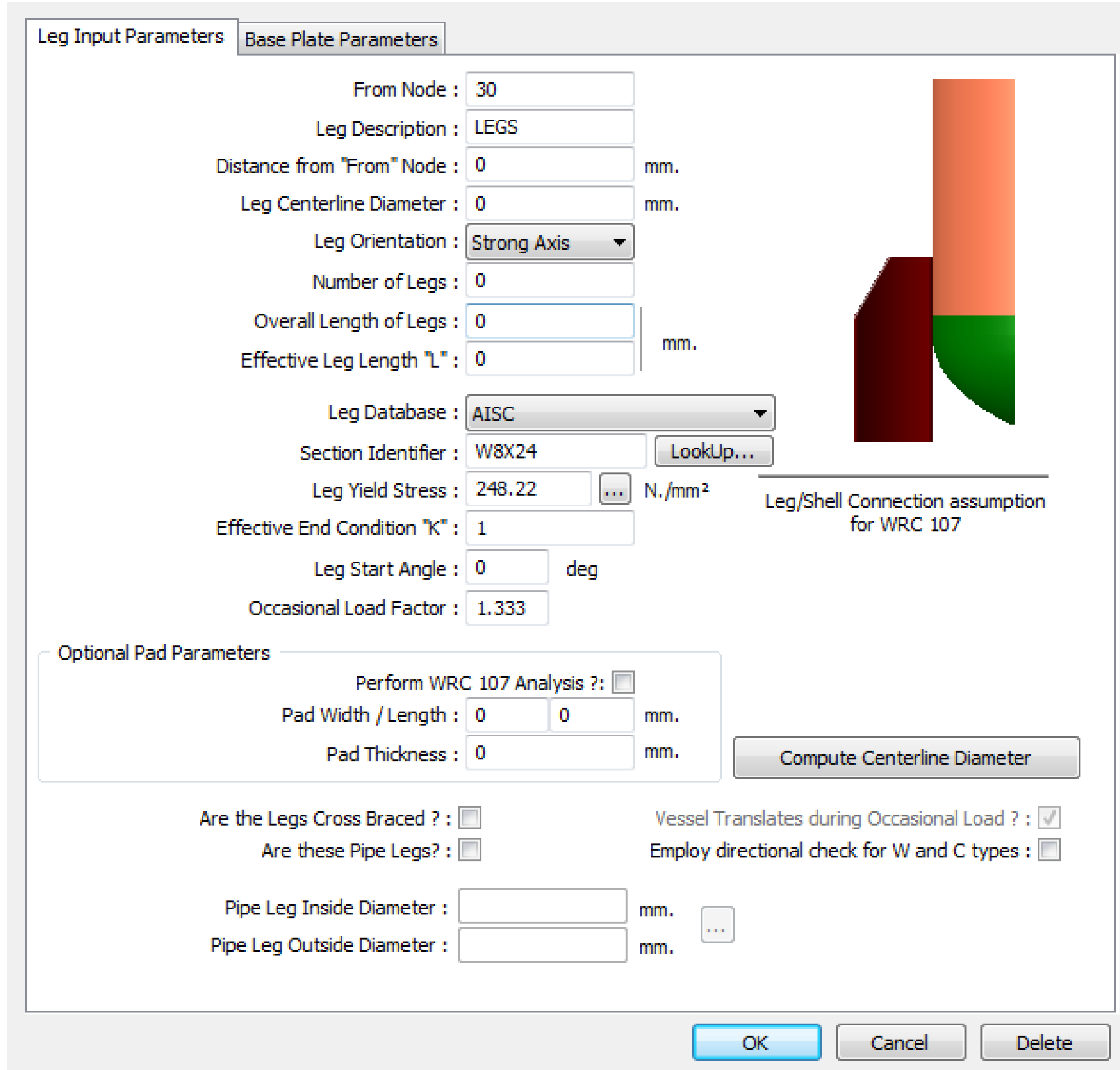
SKIRT

Nominal Thickness, mm.	35
Internal Corrosion Allowance, mı	1.6
External Corrosion Allowance, m	0
Wind Diameter Multiplier	1.3
Material Name	SA-516 70
Longitudinal Seam Efficiency	1
Circumferential Seam Efficiency	1
Internal Pressure, bars	0
Temp. for Internal Pressure, C	86
External Pressure, bars	0
Temp. for External Pressure, C	155
Additional Element Data	
Skirt Diameter at Base, mm.	1527
Perform Basering Analysis	✔
Evaluate Holes in Skirt	☐



LEG

Details
Leg Input
Enter leg information

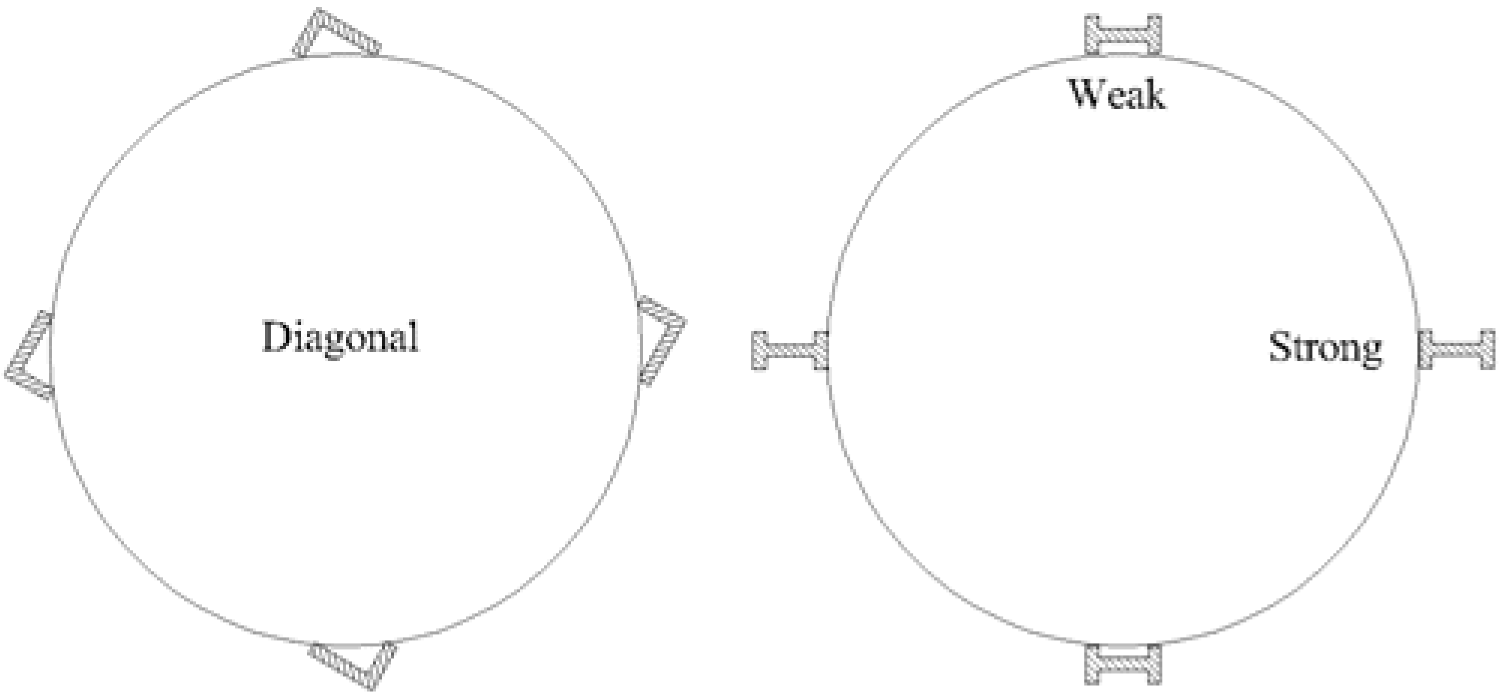


Leg Input Parameters
Base Plate Parameters
From Node : 30
Leg Description : LEGS
Distance from "From" Node : 0 mm.
Leg Centerline Diameter : 0 mm.
Leg Orientation : Strong Axis
Number of Legs : 0
Overall Length of Legs : 0
Effective Leg Length "L" : 0
mm.
Leg Database : AISC
Section Identifier : W8X24
LookUp...
Leg Yield Stress : 248.22 N./mm²
Effective End Condition "K" : 1
Leg Start Angle : 0 deg
Occasional Load Factor : 1.333
Leg/Shell Connection assumption for WRC 107
Optional Pad Parameters
Perform WRC 107 Analysis ?:
Pad Width / Length : 0 0 mm.
Pad Thickness : 0 mm.
Compute Centerline Diameter
Are the Legs Cross Braced ? :
Are these Pipe Legs? :
Vessel Translates during Occasional Load ? :
Employ directional check for W and C types :
Pipe Leg Inside Diameter : mm.
Pipe Leg Outside Diameter : mm.
OK
Cancel
Delete

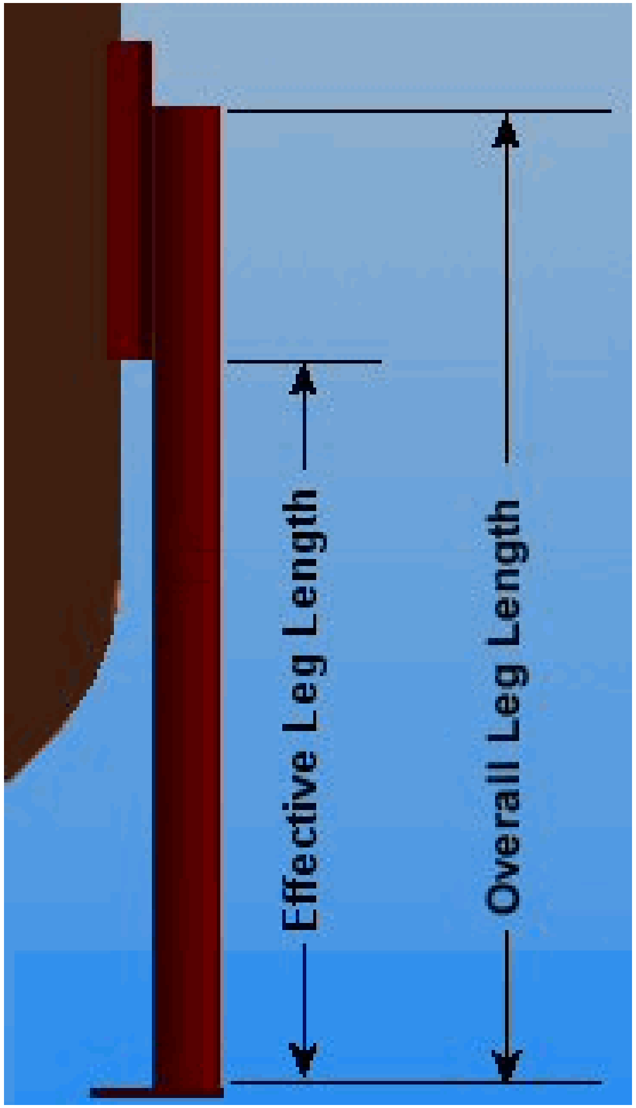
Leg Orientation

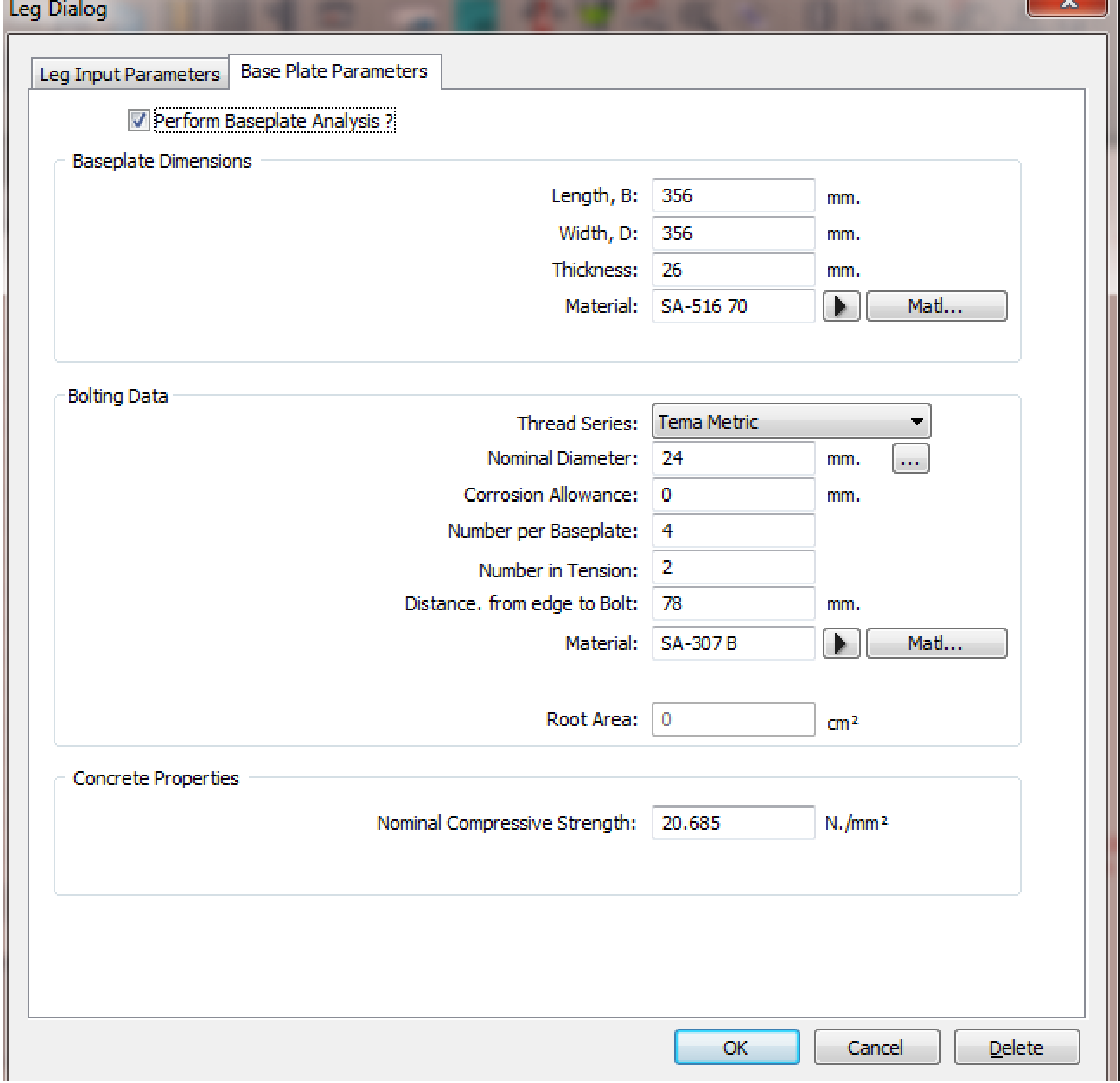
Select the orientation of the leg cross-section with respect to the centerline. Select:

- **Strong Axis** - The strong axis is perpendicular to the vessel.
- **Weak Axis** - The weak axis is perpendicular to the vessel.
- **Diagonal** - The strong axis is diagonal to the vessel.

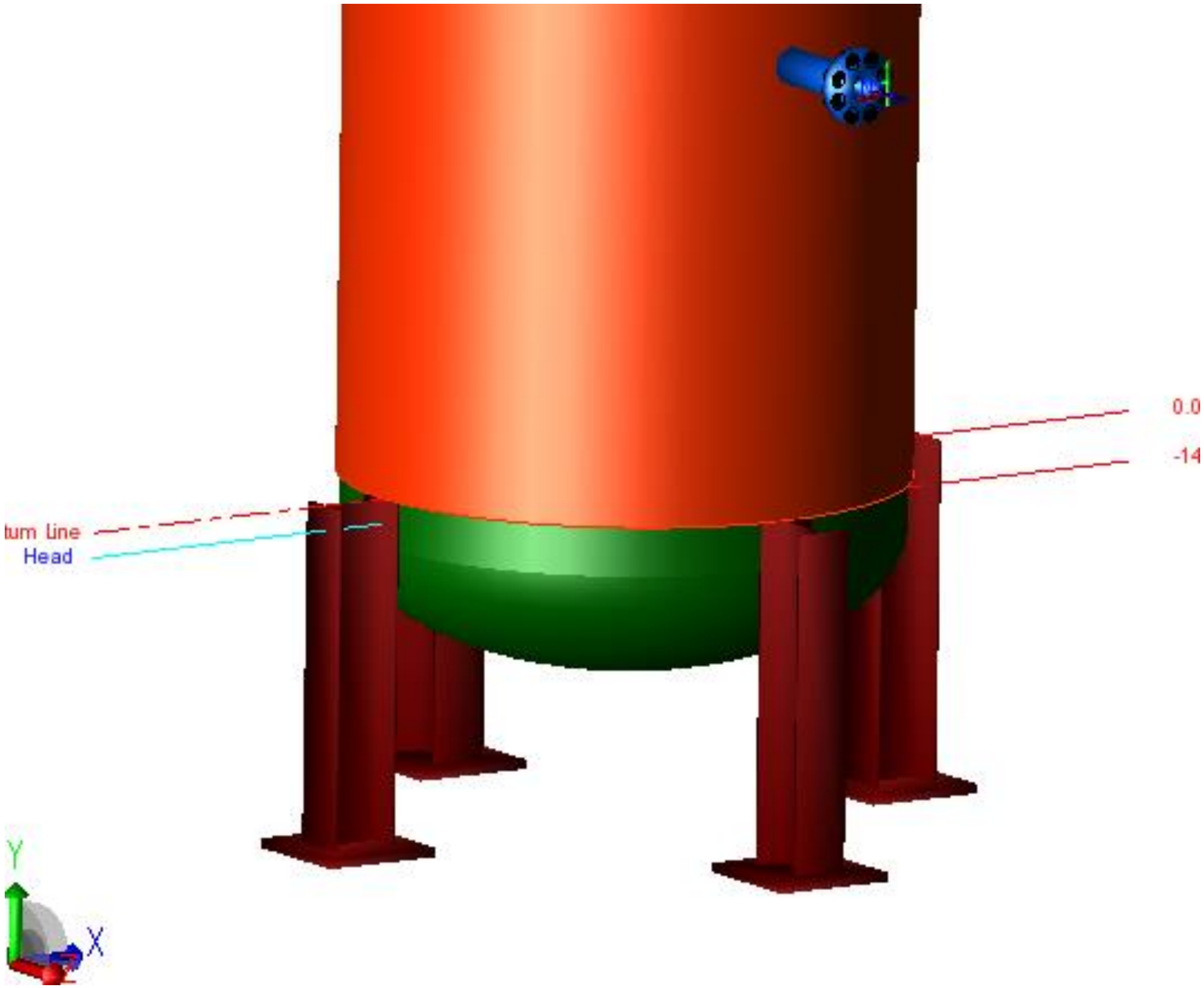


LEG

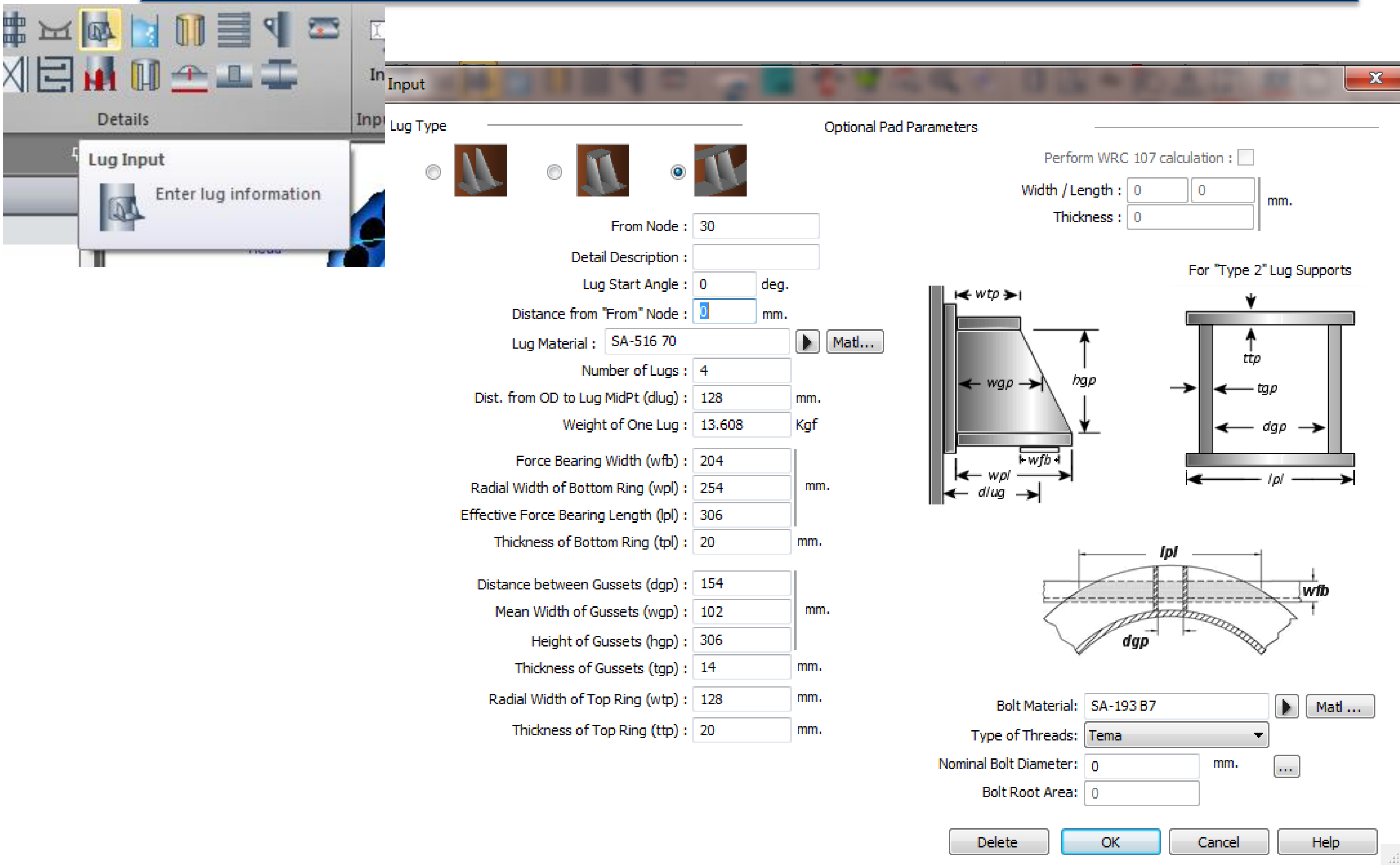



Leg Dialog
Leg Input Parameters
Base Plate Parameters
Perform Baseplate Analysis ?
Baseplate Dimensions
Length, B: 356 mm.
Width, D: 356 mm.
Thickness: 26 mm.
Material: SA-516 70 Matl...
Bolting Data
Thread Series: Tema Metric
Nominal Diameter: 24 mm. ...
Corrosion Allowance: 0 mm.
Number per Baseplate: 4
Number in Tension: 2
Distance. from edge to Bolt: 78 mm.
Material: SA-307 B Matl...
Root Area: 0 cm²
Concrete Properties
Nominal Compressive Strength: 20.685 N./mm²
OK
Cancel
Delete

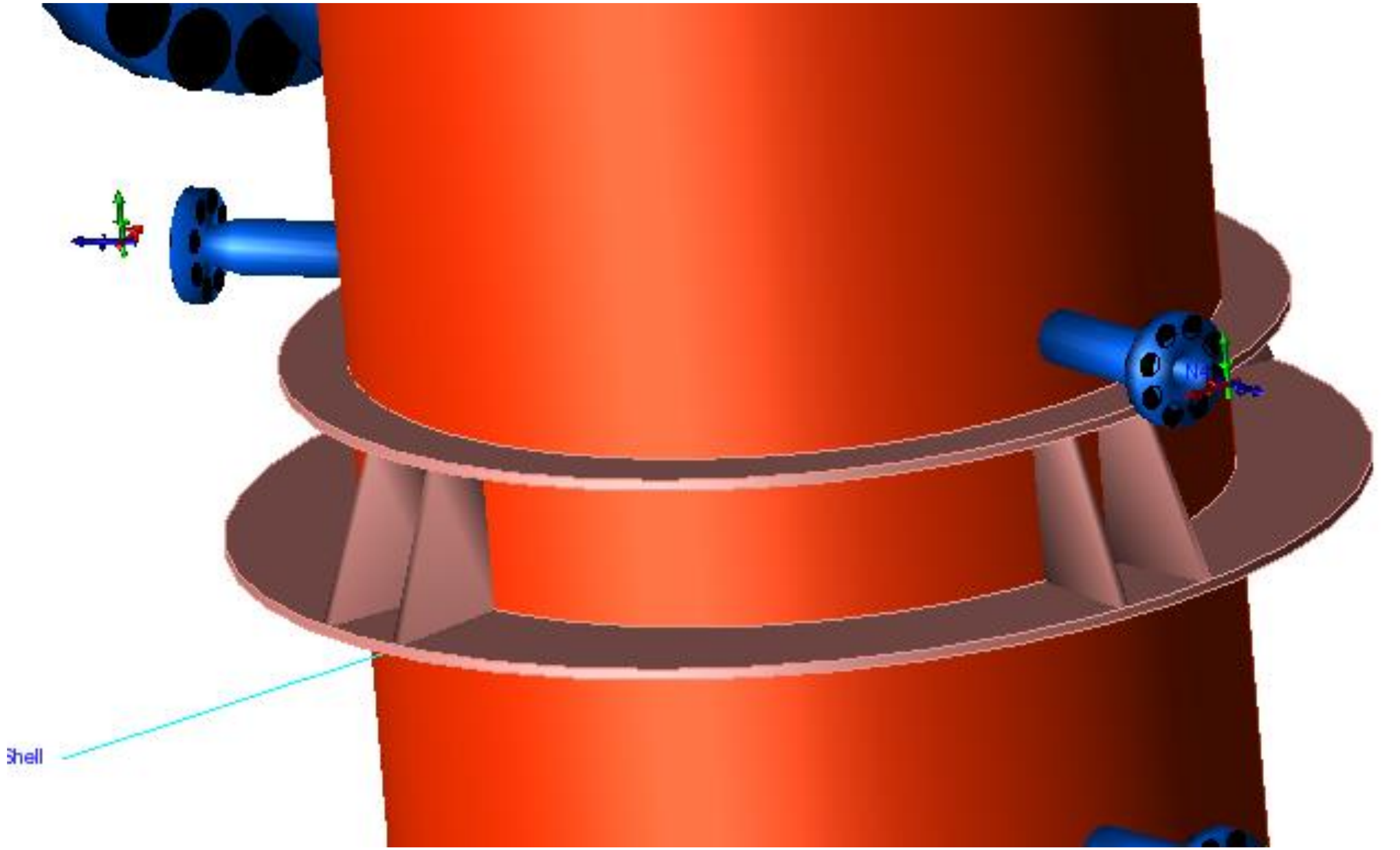
LEG



LUG


Details
Lug Input
Enter lug information
Input
Lug Type
From Node : 30
Detail Description :
Lug Start Angle : 0 deg.
Distance from "From" Node : 0 mm.
Lug Material : SA-516 70
Matl...
Number of Lugs : 4
Dist. from OD to Lug MidPt (dlug) : 128 mm.
Weight of One Lug : 13.608 Kgf
Force Bearing Width (wfb) : 204
Radial Width of Bottom Ring (wpl) : 254
Effective Force Bearing Length (lpl) : 306
mm.
Thickness of Bottom Ring (tpl) : 20 mm.
Distance between Gussets (dgp) : 154
Mean Width of Gussets (wgp) : 102
Height of Gussets (hgp) : 306
mm.
Thickness of Gussets (tgp) : 14 mm.
Radial Width of Top Ring (wtp) : 128 mm.
Thickness of Top Ring (ttp) : 20 mm.
Optional Pad Parameters
Perform WRC 107 calculation :
Width / Length : 0 0 mm.
Thickness : 0
For "Type 2" Lug Supports
wtp
wgp
hgp
wfb
wpl
dlug
ttp
tgp
dgp
lpl
lpl
wfb
dgp
Bolt Material: SA-193 B7
Matl ...
Type of Threads: Tema
Nominal Bolt Diameter: 0 mm.
Bolt Root Area: 0
Delete
OK
Cancel
Help

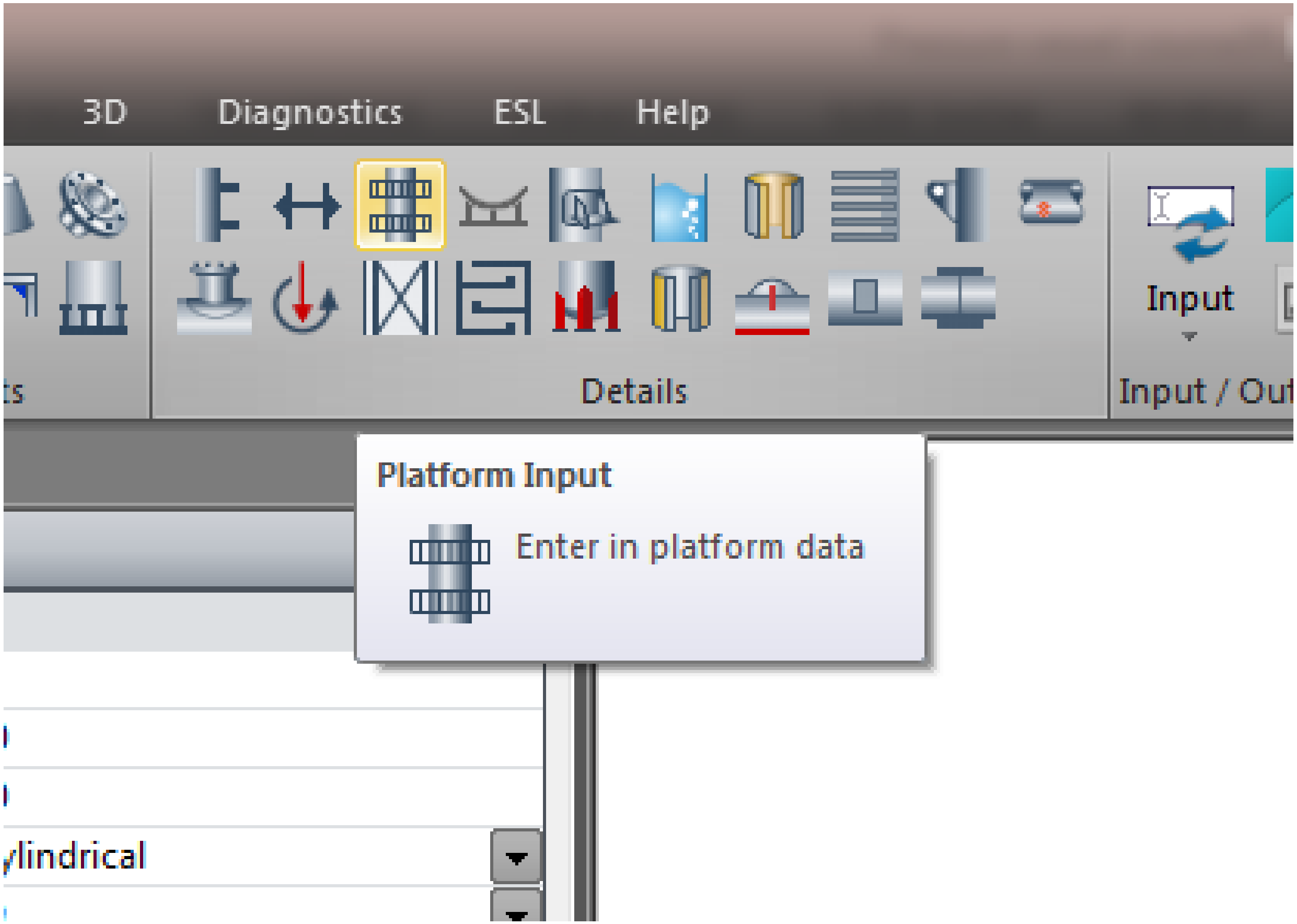
LUG



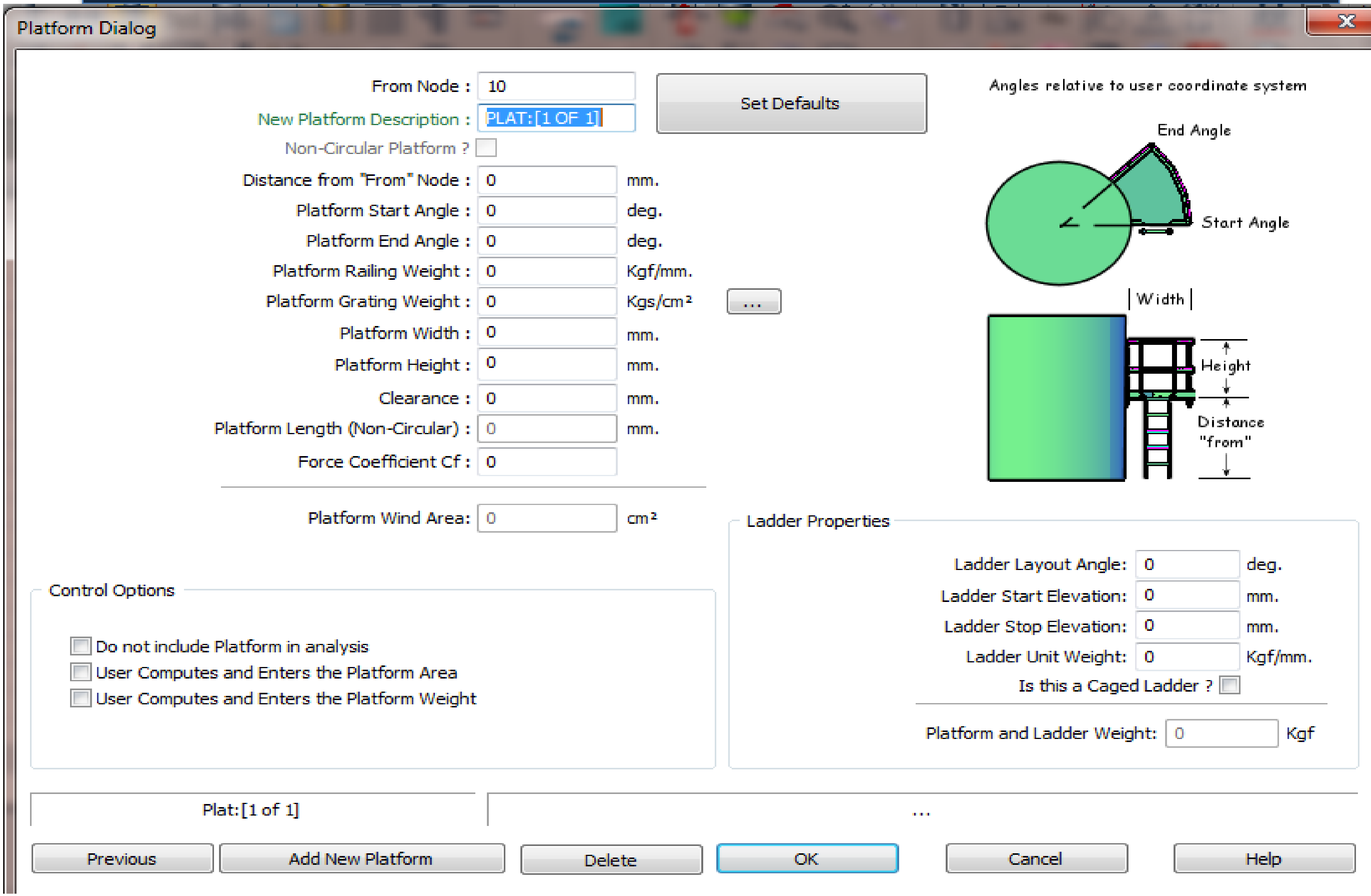
Support Design Errors

Support Design Errors		
TYPE OF SUPPORTS	Common Errors	Solution
SADDLE	Horn of saddle	saddle contact angle Thk of wear plate Thk of shell width of saddle and wear plate close to head
	head as a stiffner	take distance of head
	tip off saddle	width of saddle
	tip of wear plate	width of wear plate
	Bolt area	Qty. and Size
	Unity check	increase thicknesses
SKIRT	gusset Thickness	increase thicknesses
	Top plate Thk	increase thicknesses
	Base plate Thk	increase thicknesses
	Concrete	increase width of base ring
	Bolt area	Qty. and Size
Leg	Unity check	increase thicknesses
	Bolt area	Qty. and Size
	WRC failed	pad dim. And thk
Lug	Unity check	increase thicknesses
	Bolt area	Qty. and Size
	WRC failed	pad dim. And thk
	Component thk	increase thicknesses

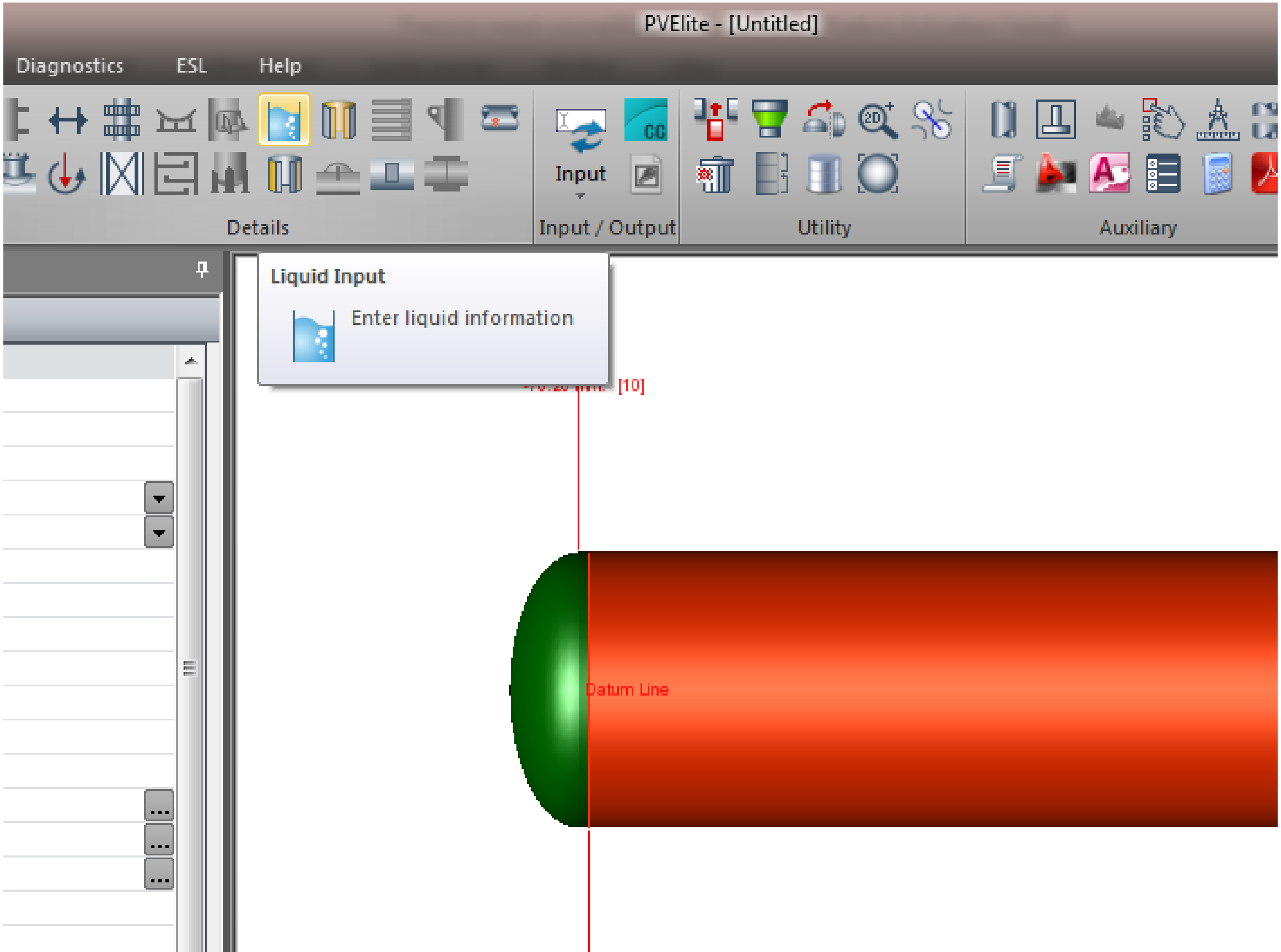
Ladder and Platform



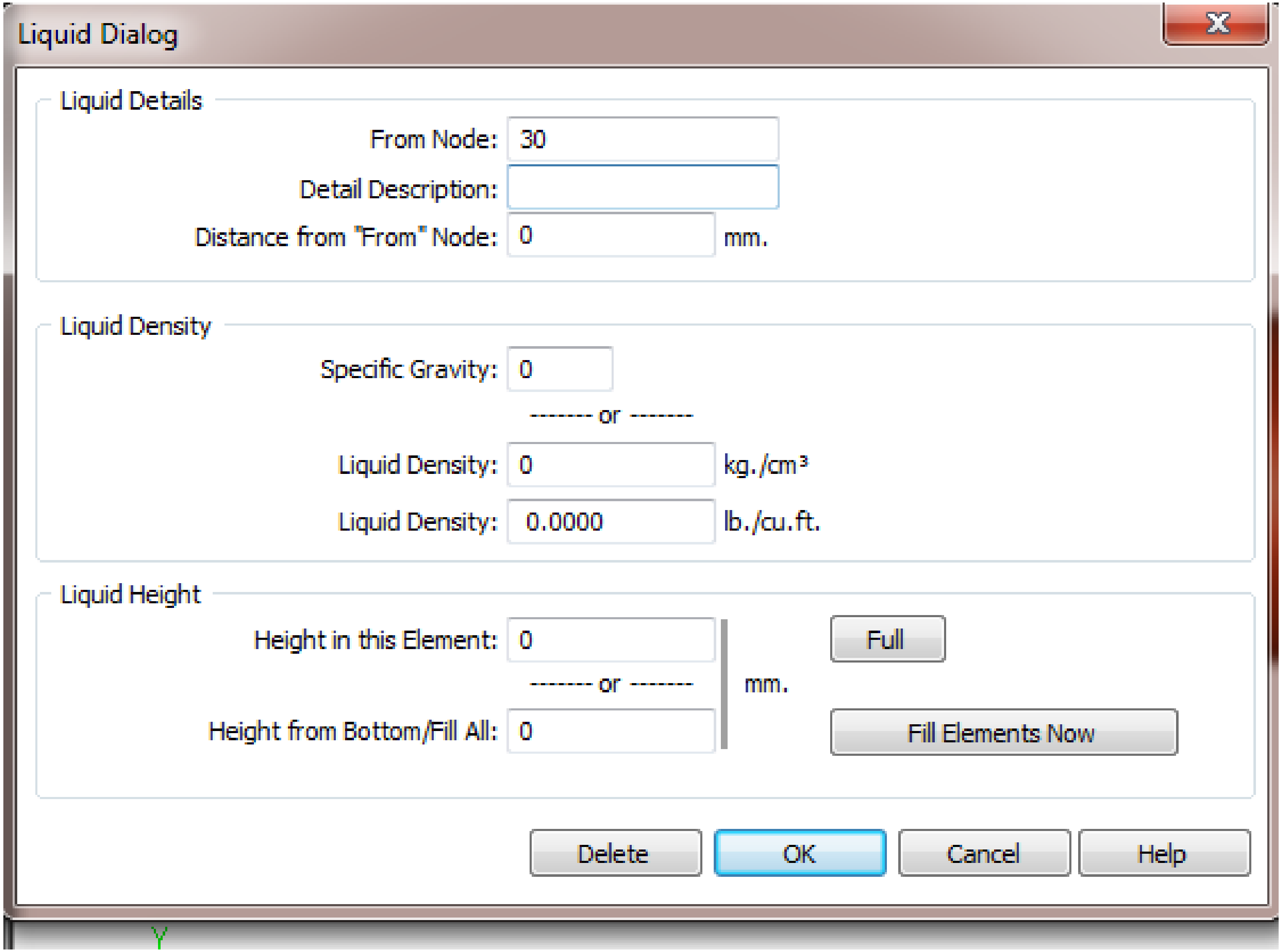
Ladder and Platform



Liquid

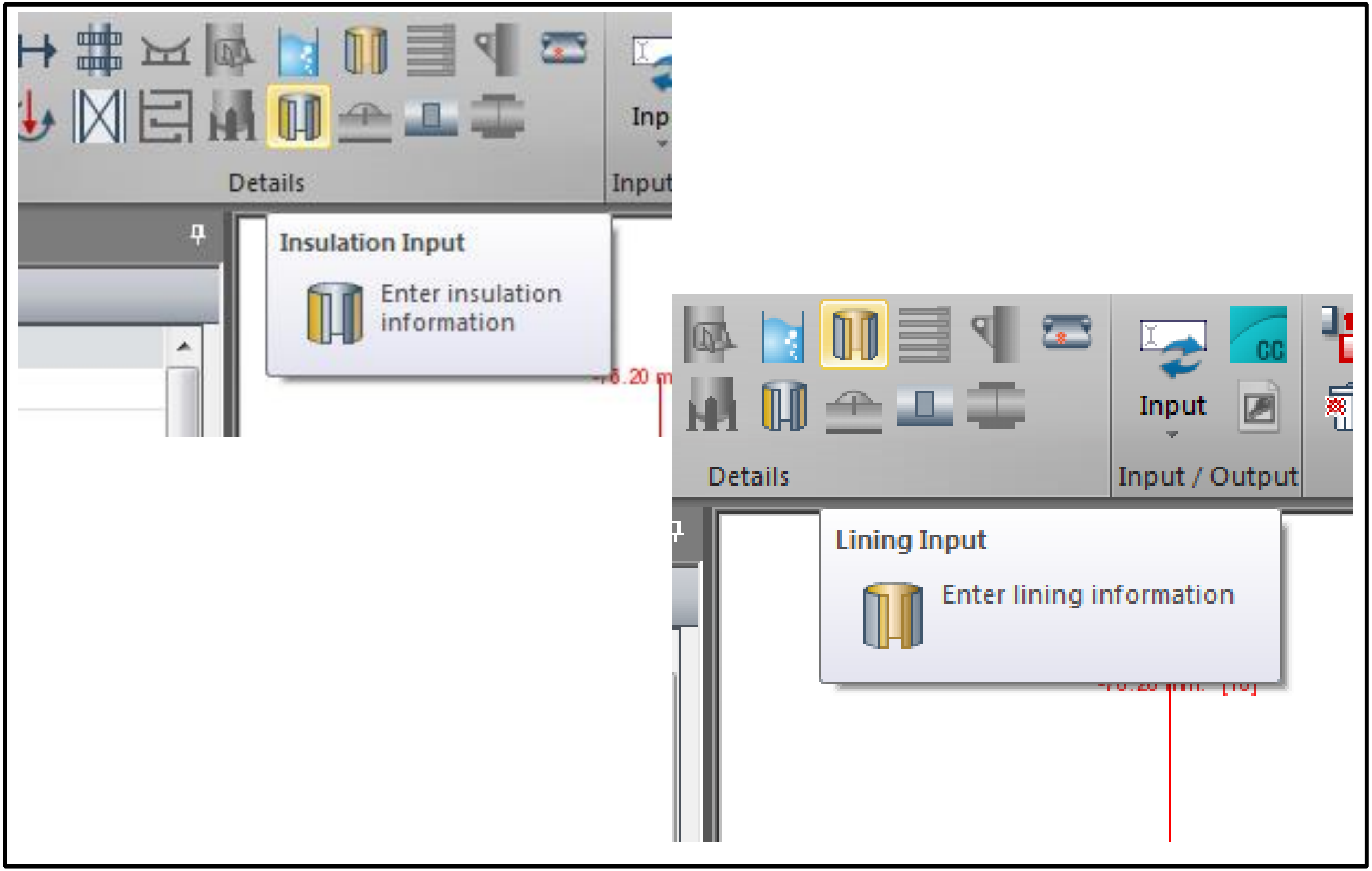

PVElite - [Untitled]
Diagnostics
ESL
Help
Input
Details
Input / Output
Utility
Auxiliary
Liquid Input
Enter liquid information
[10]
Datum Line

Liquid

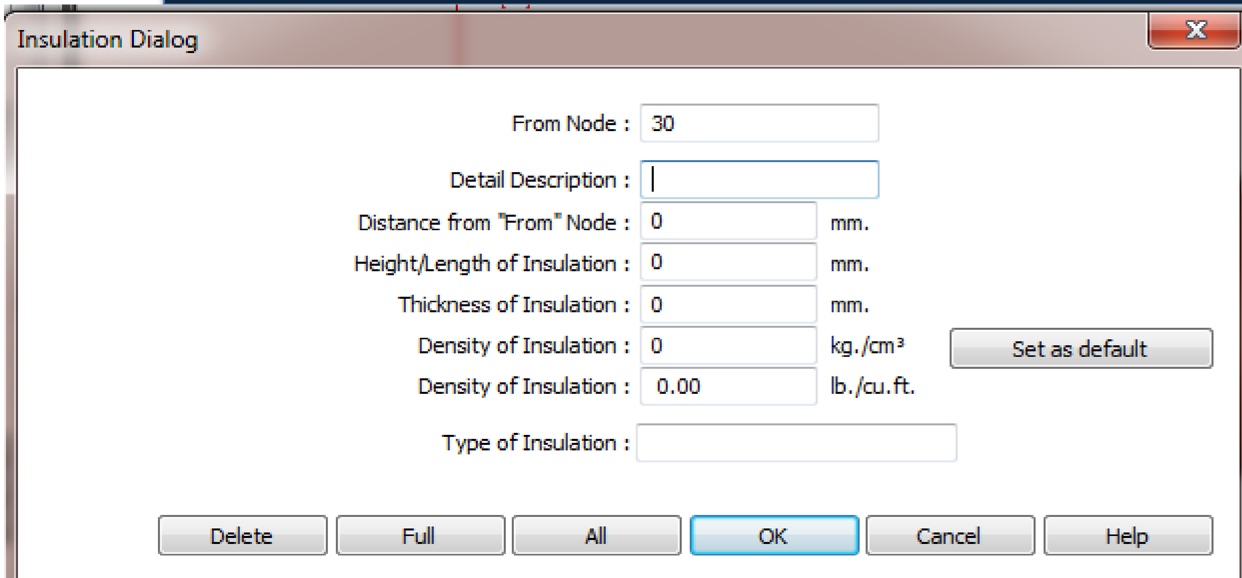


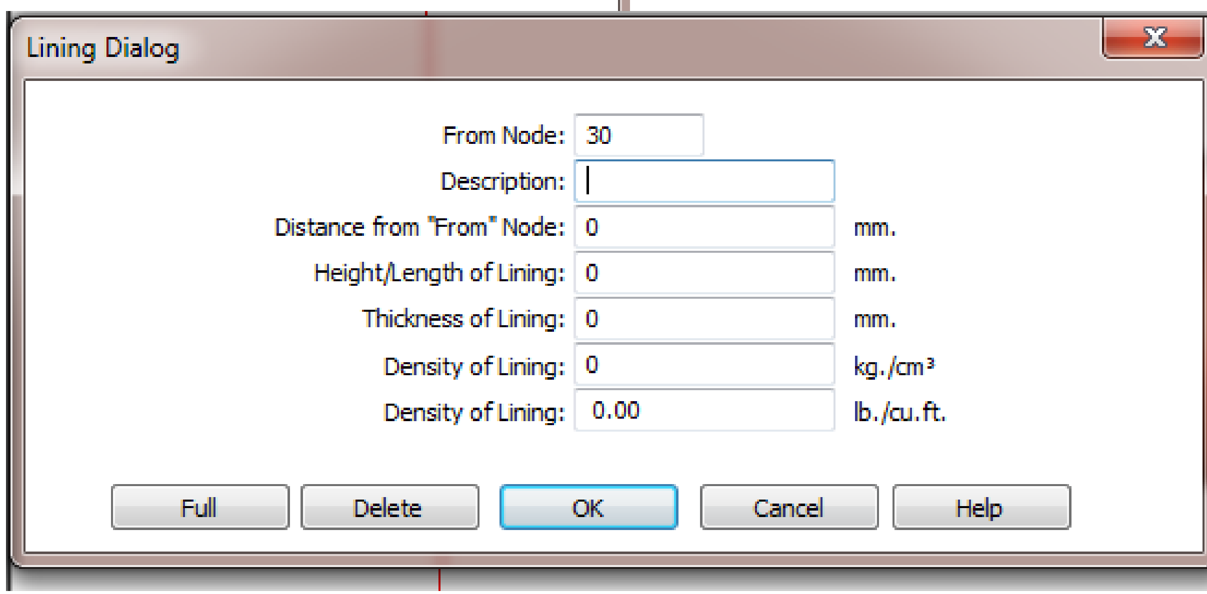
Liquid Dialog
Liquid Details
From Node: 30
Detail Description:
Distance from "From" Node: 0 mm.
Liquid Density
Specific Gravity: 0
------- or -------
Liquid Density: 0 kg./cm³
Liquid Density: 0.0000 lb./cu.ft.
Liquid Height
Height in this Element: 0
------- or -------
Height from Bottom/Fill All: 0
mm.
Full
Fill Elements Now
Delete
OK
Cancel
Help

Insulation & Lining

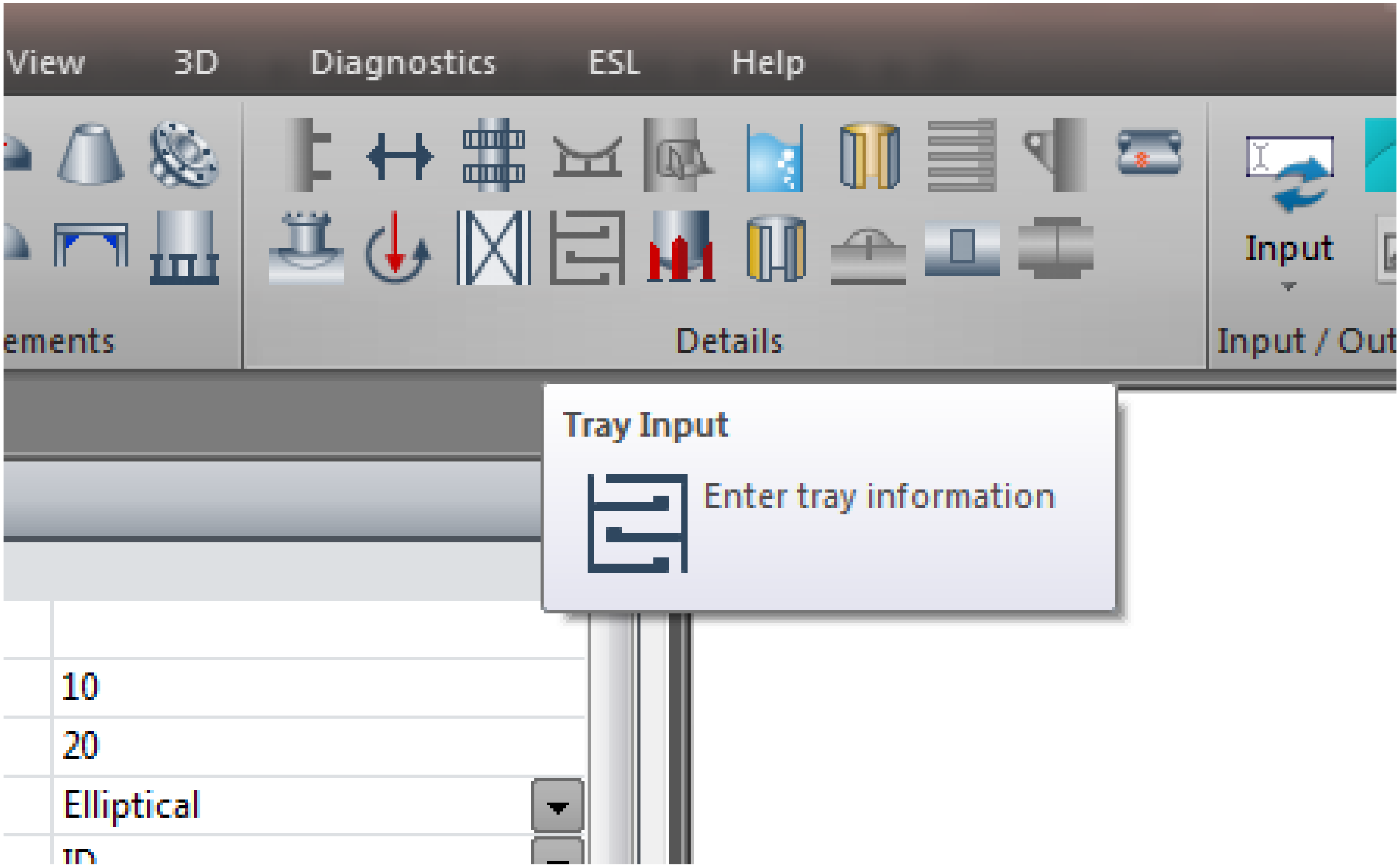


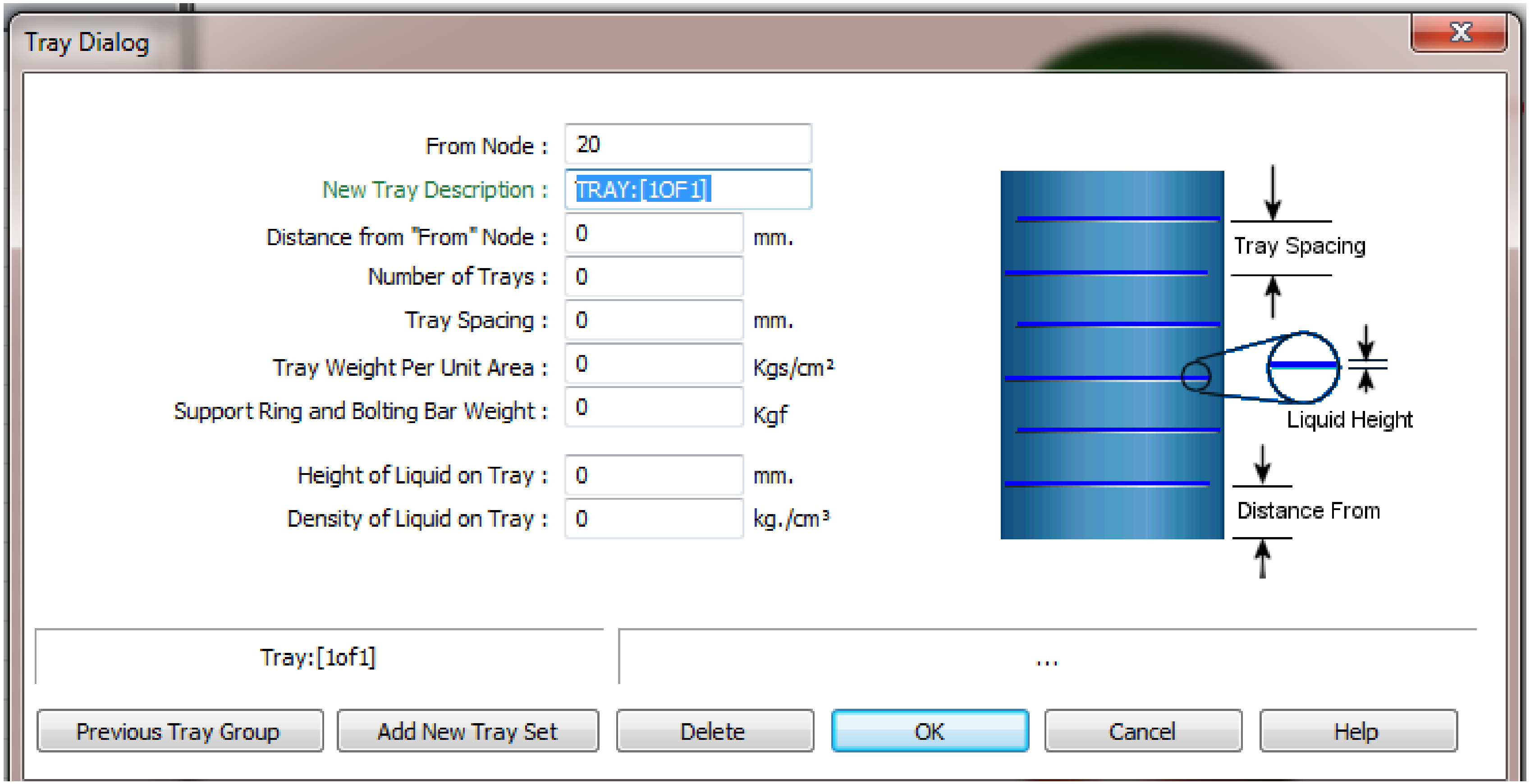
Insulation & Lining



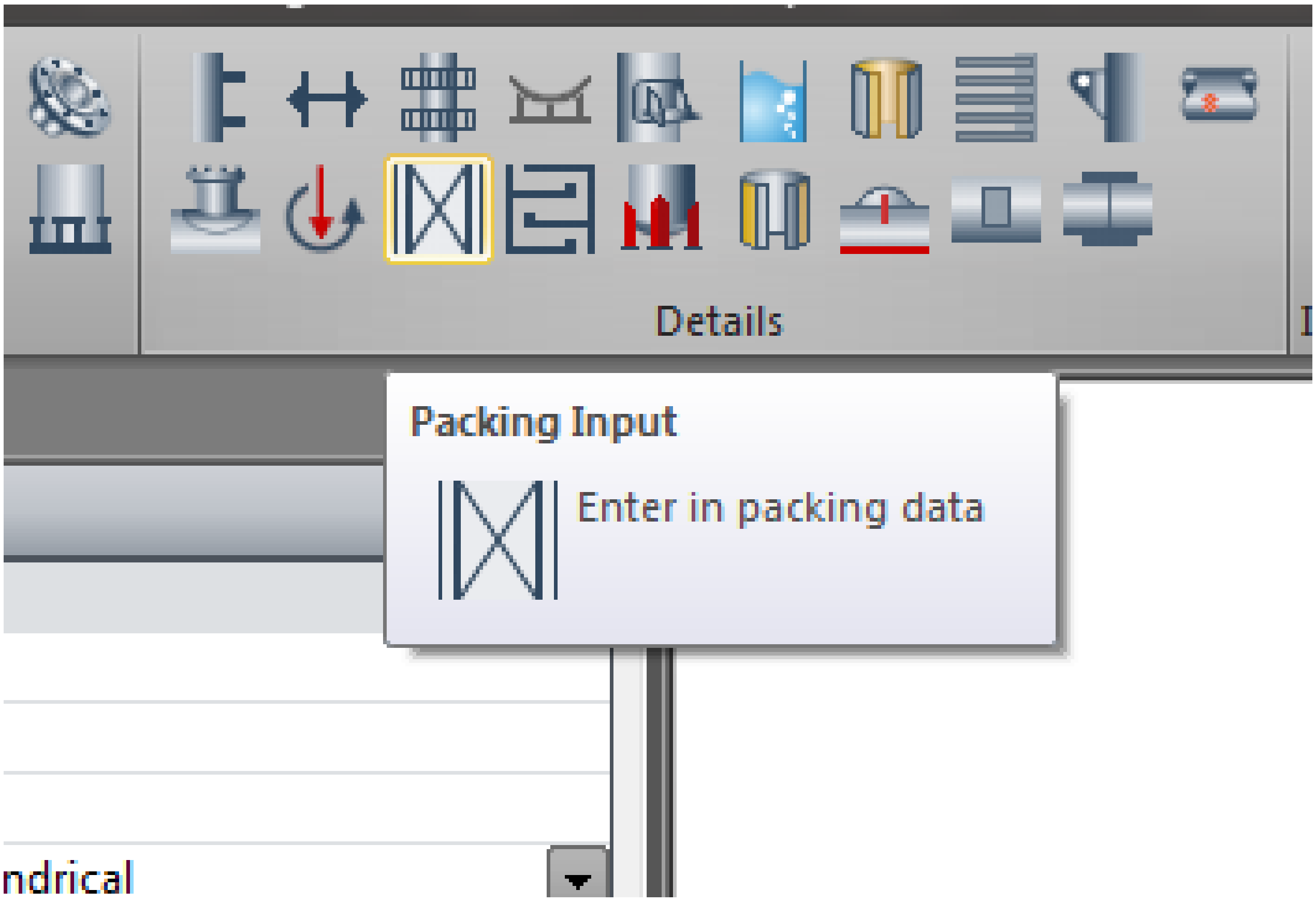


Tray

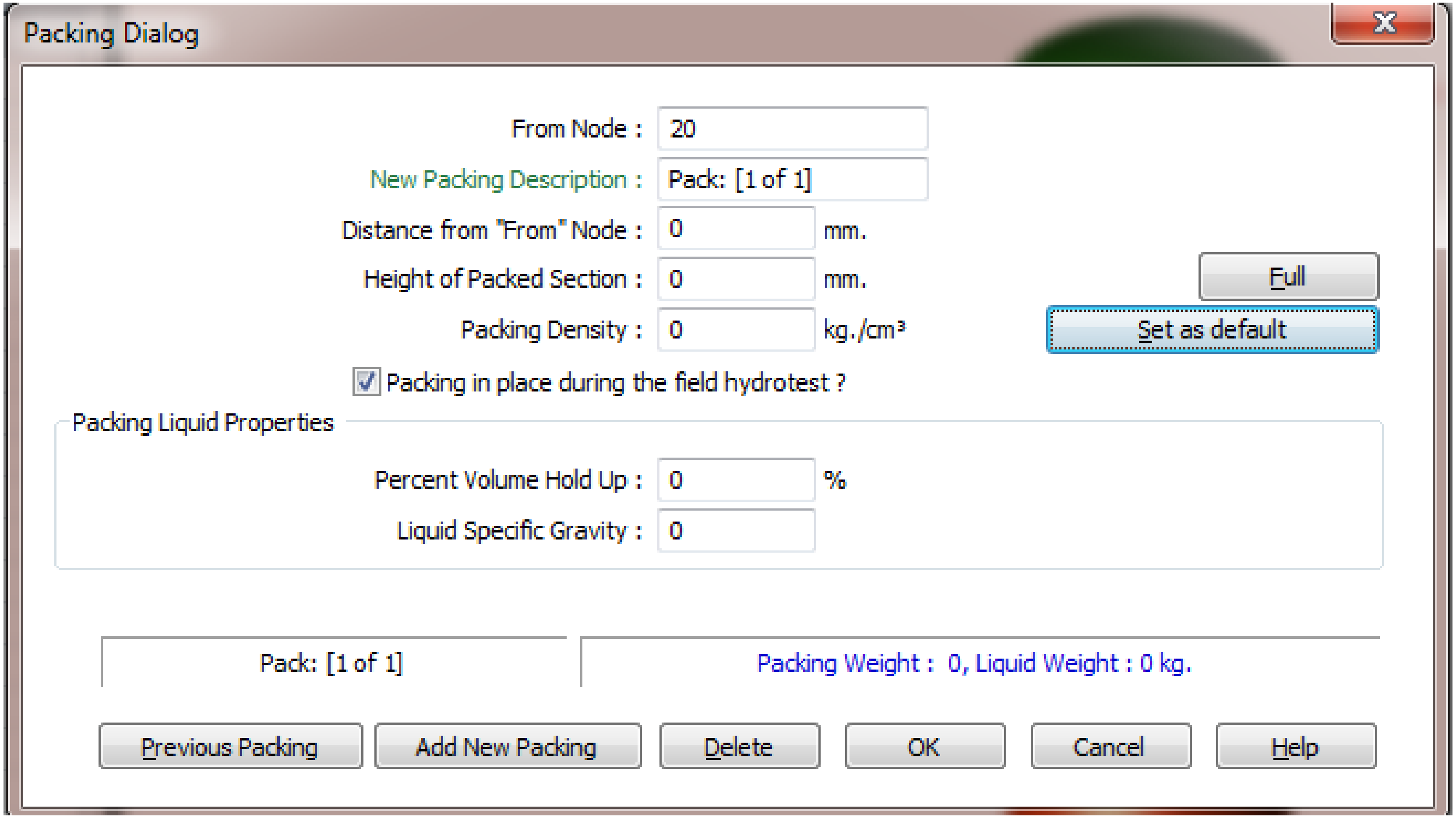

View
3D
Diagnostics
ESL
Help
ements
Details
Input
Input / Out
Tray Input
Enter tray information
10
20
Elliptical


Tray Dialog
From Node : 20
New Tray Description : TRAY:[1OF1]
Distance from "From" Node : 0 mm.
Number of Trays : 0
Tray Spacing : 0 mm.
Tray Weight Per Unit Area : 0 Kgs/cm²
Support Ring and Bolting Bar Weight : 0 Kgf
Height of Liquid on Tray : 0 mm.
Density of Liquid on Tray : 0 kg./cm³
Tray Spacing
Liquid Height
Distance From
Tray:[1of1]
...
Previous Tray Group
Add New Tray Set
Delete
OK
Cancel
Help

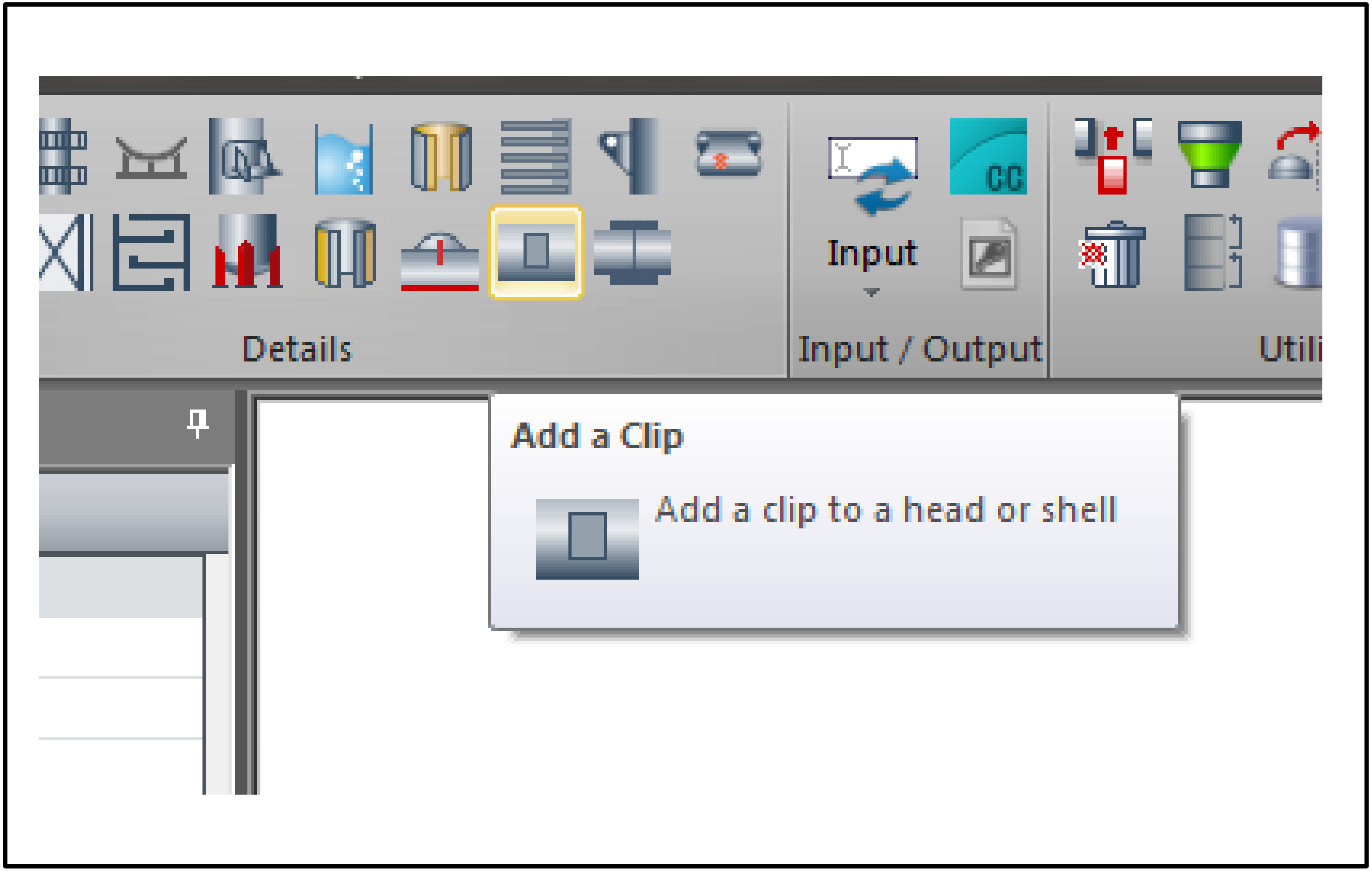
Packing



Packing

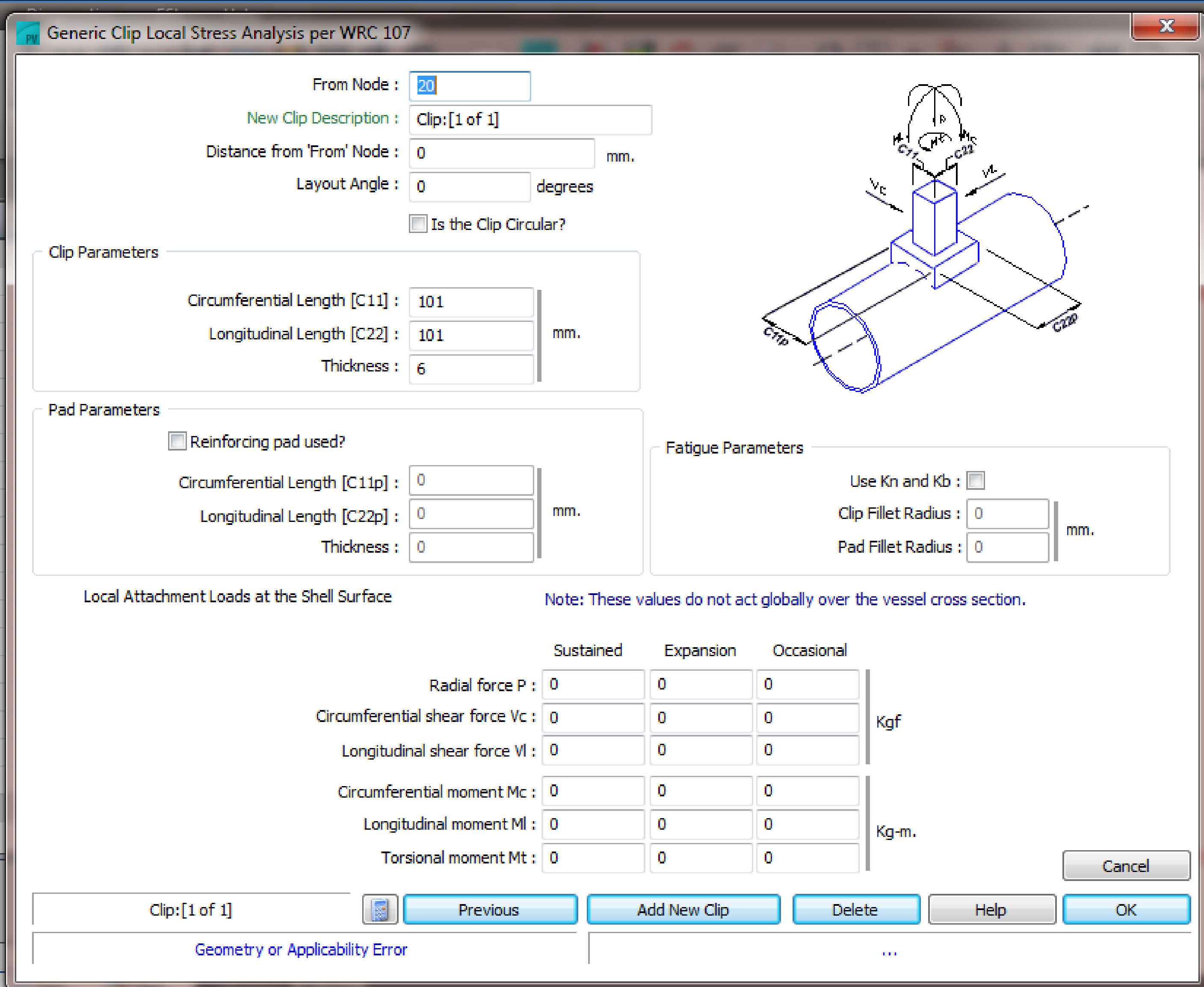

Packing Dialog
From Node :
20
New Packing Description :
Pack: [1 of 1]
Distance from "From" Node :
0
mm.
Height of Packed Section :
0
mm.
Packing Density :
0
kg./cm³
Full
Set as default
Packing in place during the field hydrotest ?
Packing Liquid Properties
Percent Volume Hold Up :
0
%
Liquid Specific Gravity :
0
Pack: [1 of 1]
Packing Weight : 0, Liquid Weight : 0 kg.
Previous Packing
Add New Packing
Delete
OK
Cancel
Help

Clip



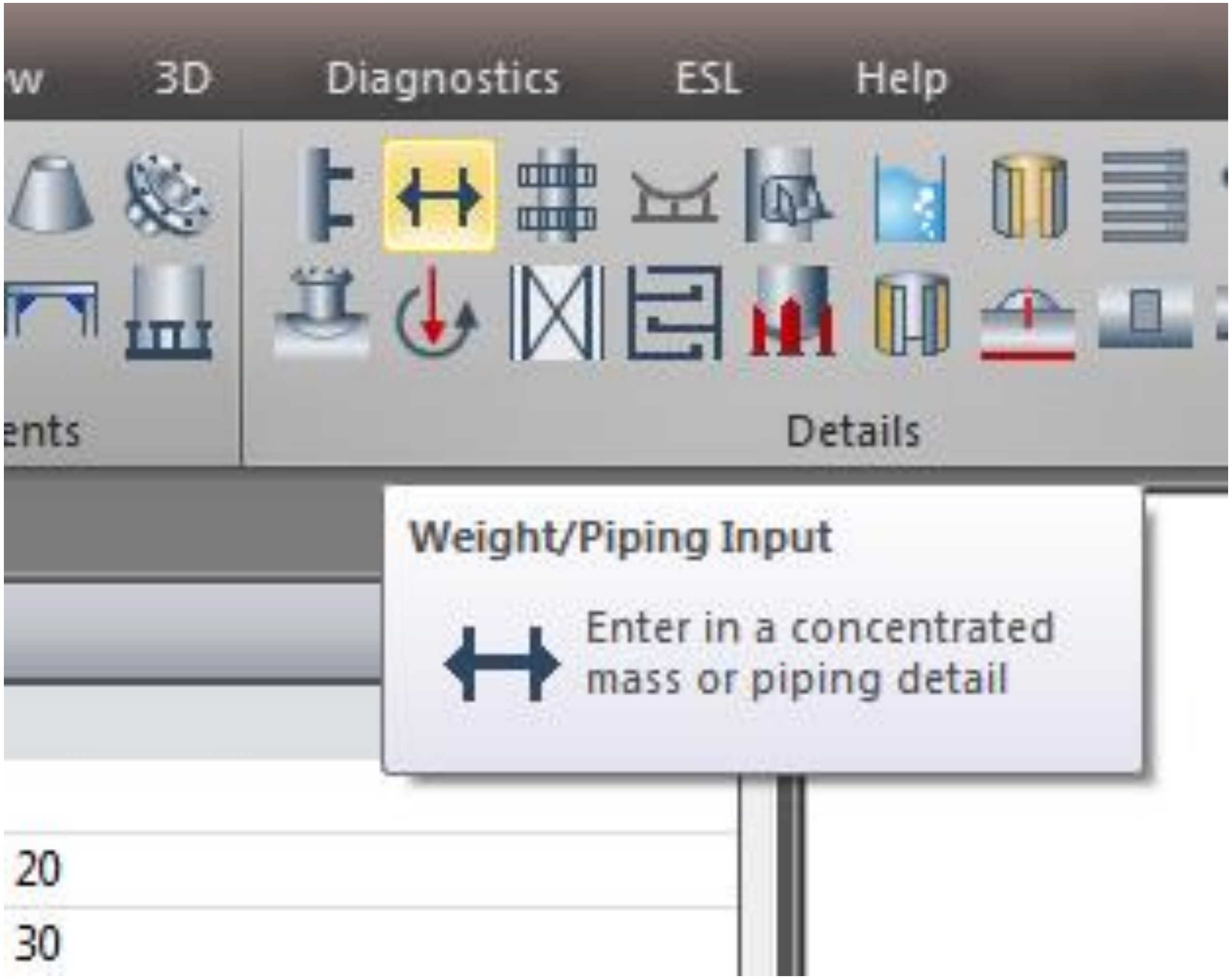
Input
Details
Input / Output
Utili
Add a Clip
Add a clip to a head or shell

Clip

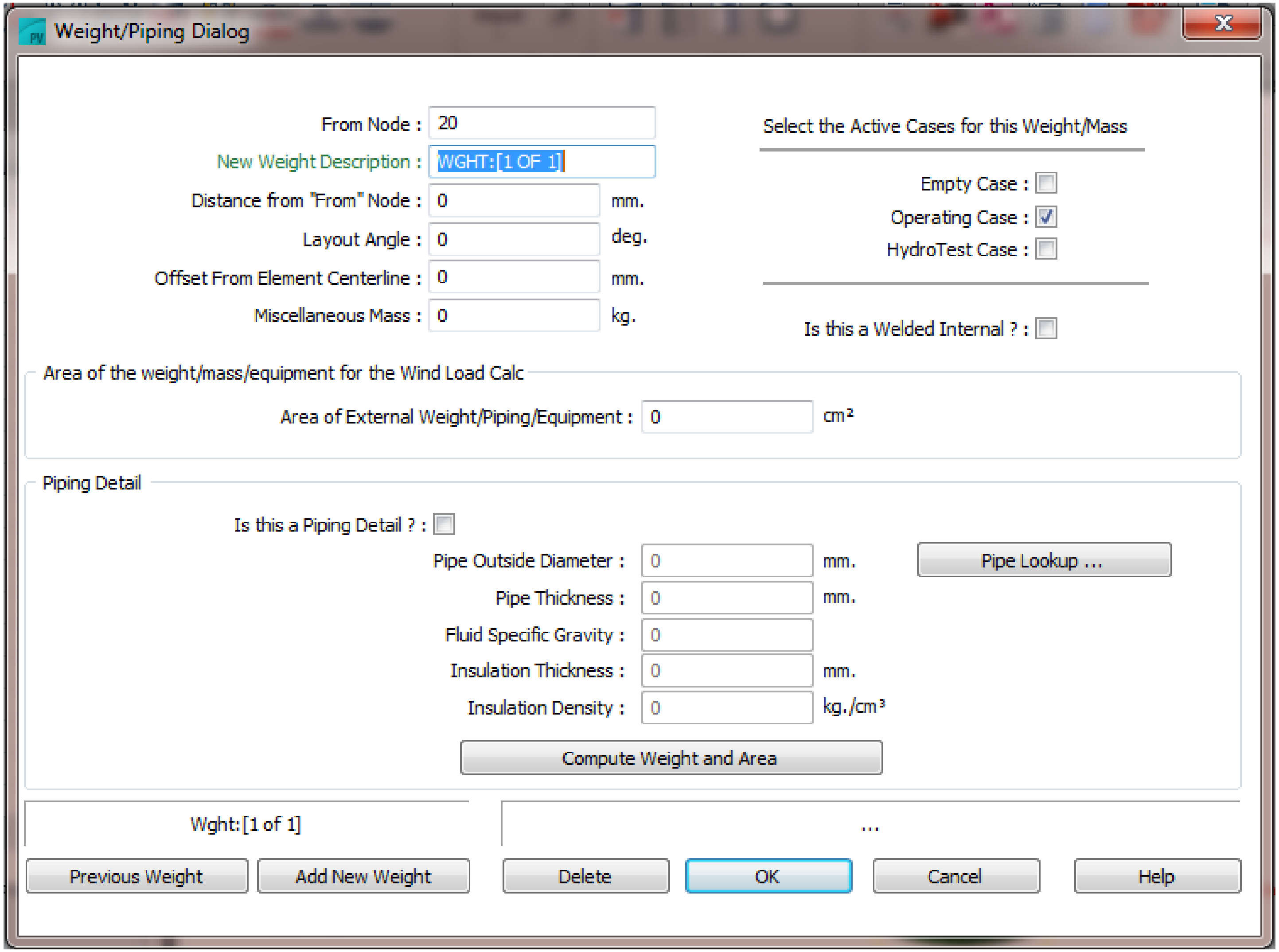


Generic Clip Local Stress Analysis per WRC 107
From Node : 20
New Clip Description : Clip:[1 of 1]
Distance from 'From' Node : 0 mm.
Layout Angle : 0 degrees
Is the Clip Circular?
Clip Parameters
Circumferential Length [C11] : 101
Longitudinal Length [C22] : 101
Thickness : 6
mm.
Pad Parameters
Reinforcing pad used?
Circumferential Length [C11p] : 0
Longitudinal Length [C22p] : 0
Thickness : 0
mm.
Fatigue Parameters
Use Kn and Kb :
Clip Fillet Radius : 0
Pad Fillet Radius : 0
mm.
Local Attachment Loads at the Shell Surface
Note: These values do not act globally over the vessel cross section.
Sustained Expansion Occasional
Radial force P : 0 0 0
Circumferential shear force Vc : 0 0 0
Longitudinal shear force Vl : 0 0 0
Kgf
Circumferential moment Mc : 0 0 0
Longitudinal moment Ml : 0 0 0
Torsional moment Mt : 0 0 0
Kg-m.
Cancel
Clip:[1 of 1]
Previous
Add New Clip
Delete
Help
OK
Geometry or Applicability Error
...

Weight

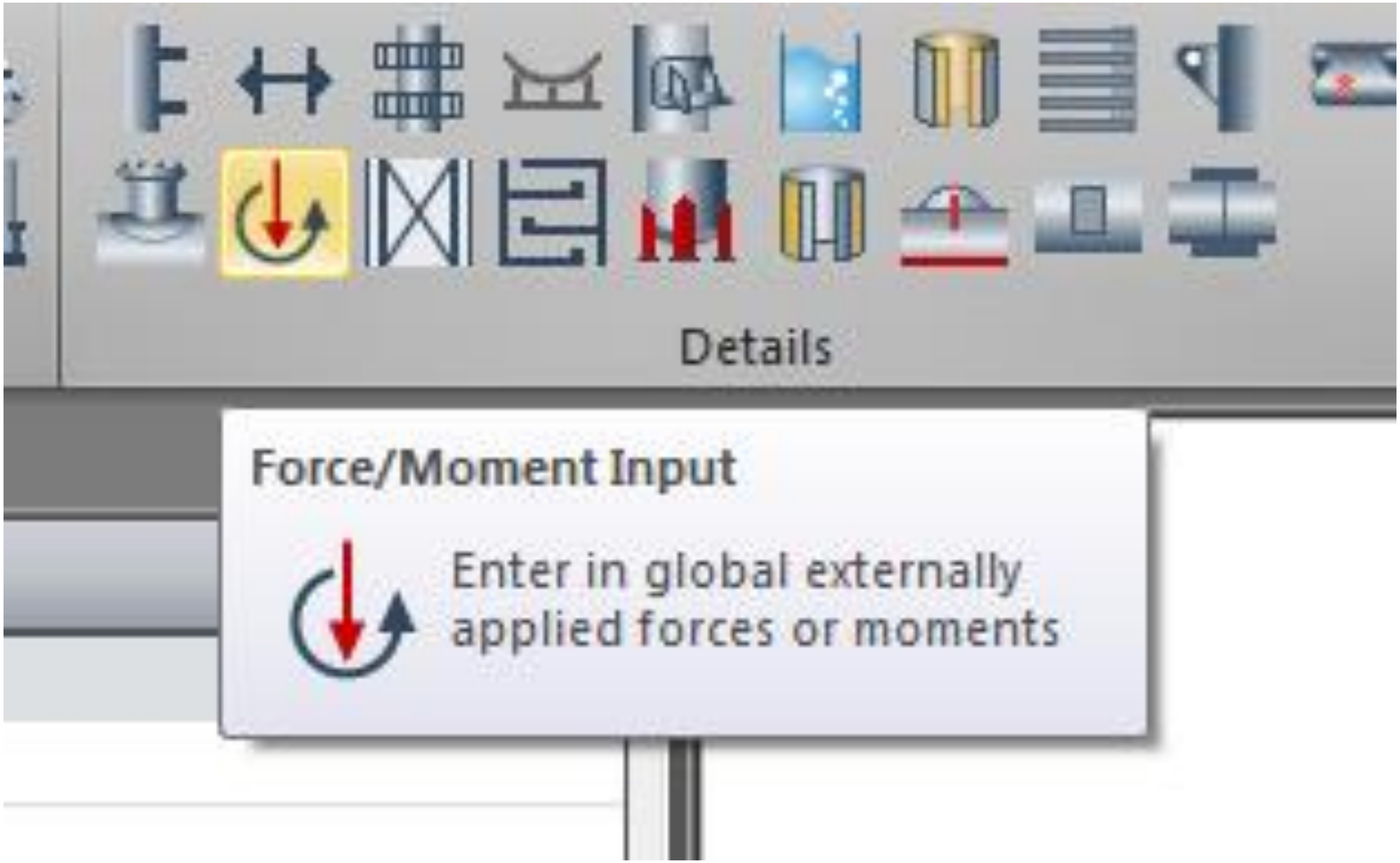

w
3D
Diagnostics
ESL
Help
ents
Details
Weight/Piping Input
Enter in a concentrated mass or piping detail
20
30

Weight

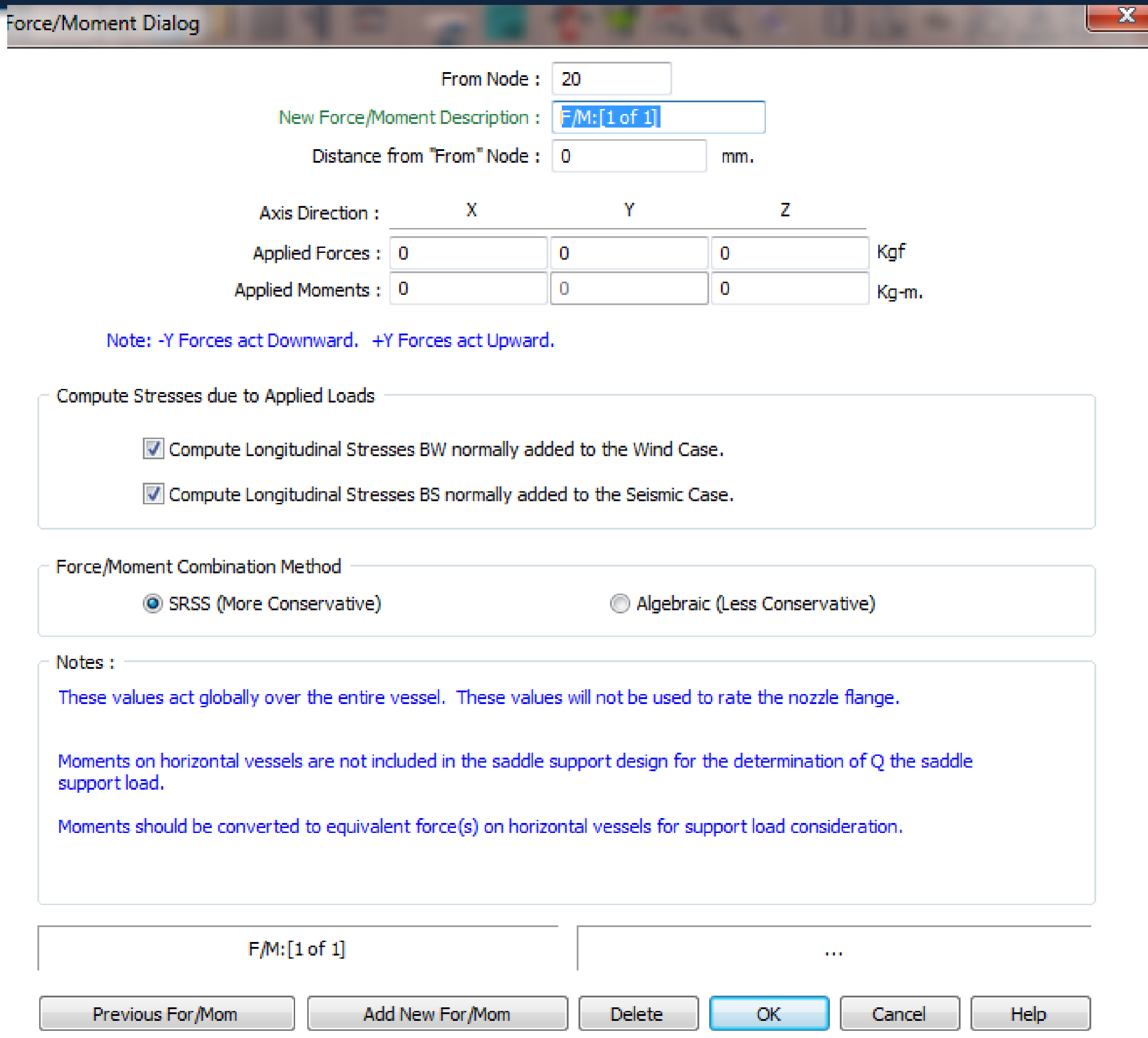


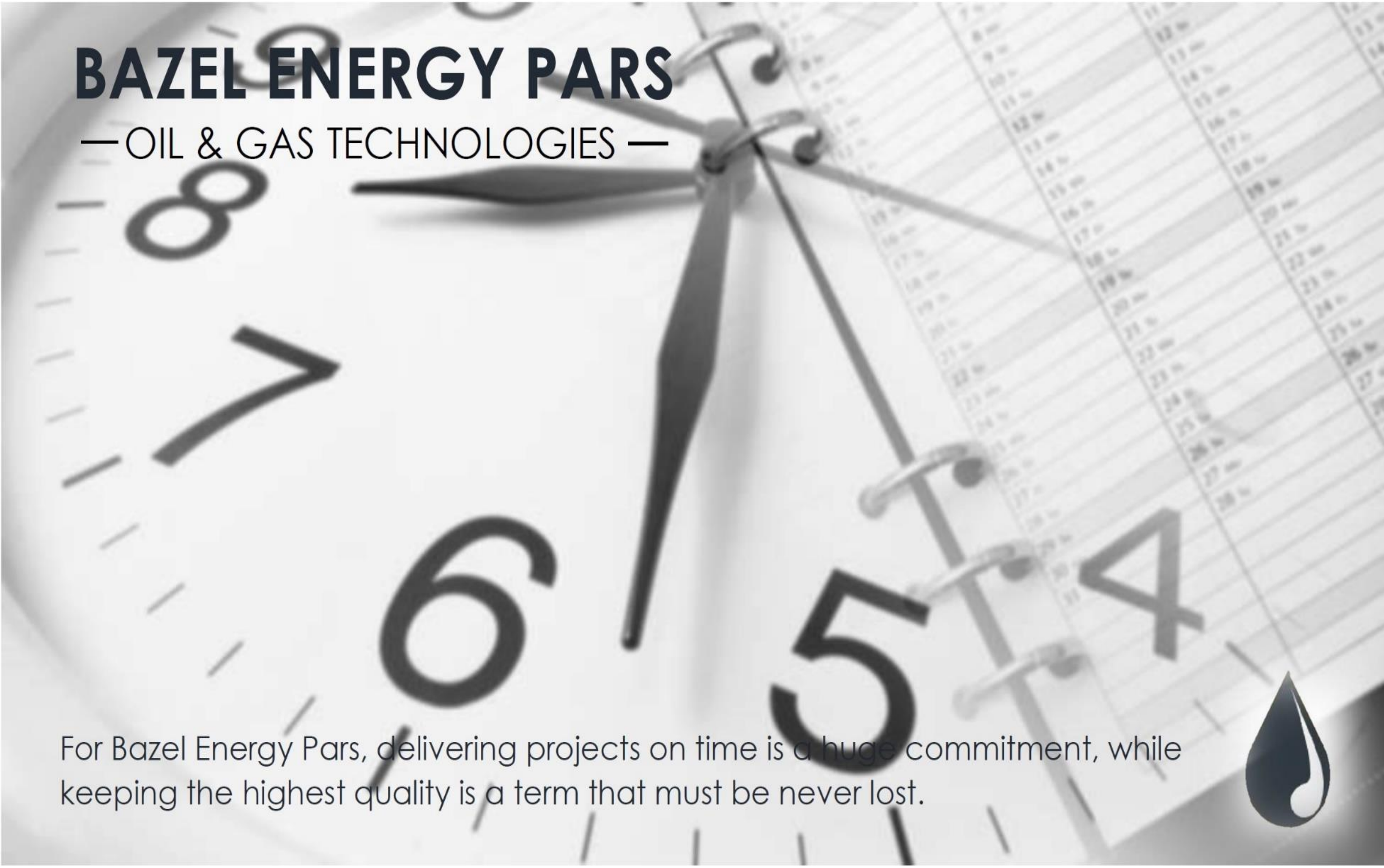
Weight/Piping Dialog
From Node : 20
New Weight Description : WGHT:[1 OF 1]
Distance from "From" Node : 0 mm.
Layout Angle : 0 deg.
Offset From Element Centerline : 0 mm.
Miscellaneous Mass : 0 kg.
Select the Active Cases for this Weight/Mass
Empty Case :
Operating Case :
HydroTest Case :
Is this a Welded Internal ? :
Area of the weight/mass/equipment for the Wind Load Calc
Area of External Weight/Piping/Equipment : 0 cm²
Piping Detail
Is this a Piping Detail ? :
Pipe Outside Diameter : 0 mm.
Pipe Lookup ...
Pipe Thickness : 0 mm.
Fluid Specific Gravity : 0
Insulation Thickness : 0 mm.
Insulation Density : 0 kg./cm³
Compute Weight and Area
Wght:[1 of 1]
...
Previous Weight
Add New Weight
Delete
OK
Cancel
Help

Force and Moment



Force and Moment




BAZEL ENERGY PARS
— OIL & GAS TECHNOLOGIES —
For Bazel Energy Pars, delivering projects on time is a huge commitment, while keeping the highest quality is a term that must be never lost.