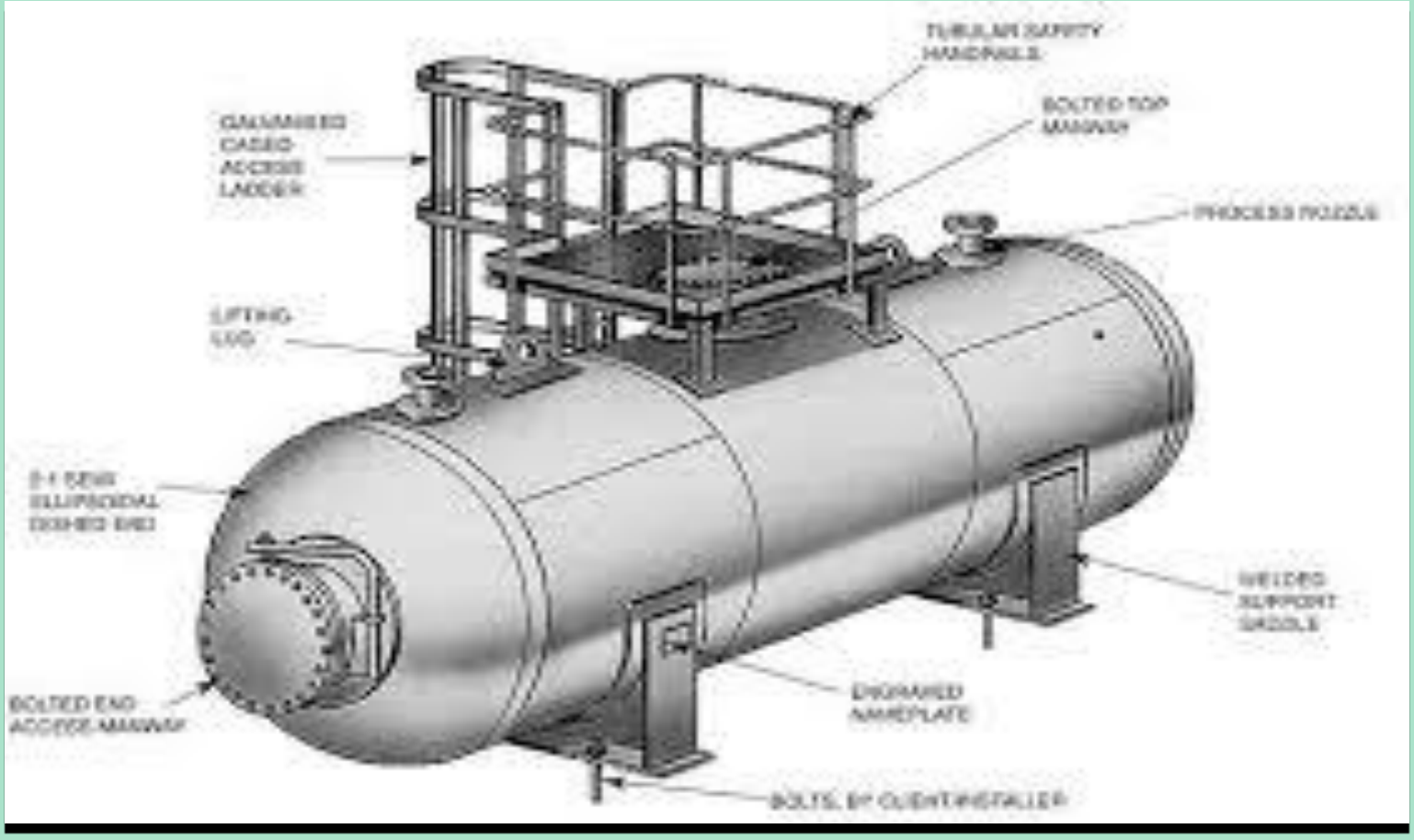
PRESSURE VESSEL SHOP FABRICATION & INSPECTION

By- Vishal Dhameliya (YouTube channel - Welding Knowledge)

https://www.youtube.com/channel/UClUgZeXcvTUaiRmQin1oCxQ



DESIGN & CONSTRUCTION CODE

- **ASME**
  - **Sec VIII Div I, II, III**
  - **Sec III**
  - **Sec I**
- **TEMA**
- **IBR**
- **PD (BS) 5500**
- **AD Merkblatt**

+

CUSTOMER SPECIFICATION

MATERIAL FOR CONSTRUCTION

- **CS**
- **LAS**
  - **C. Mn, C. Mo, Cr. Mo, Cr. Mo. V, Ni. Cr.Mo, Ni Steel**
- **Stainless Steel.**
  - **Austenitic, Ferritic, Martensitic, Duplex**
- **NF Metals & Alloys**
  - **Al, Cu, Brass, Bronze, Monel, Cupronickel, Inconel, Titanium**

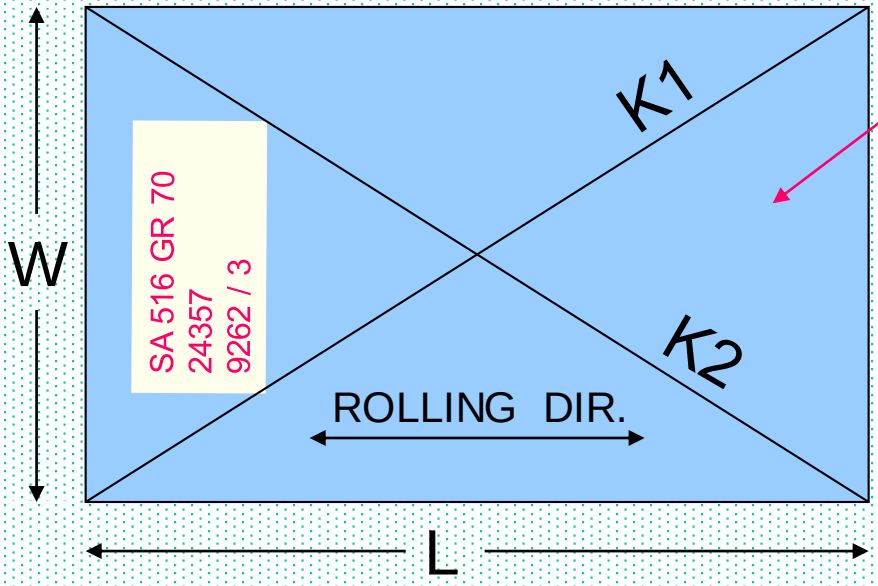
MATERIAL PRODUCT FORM

- Plate
- Forging
- Pipe
- Tube
- Casting

RAW MATERIAL IDENTIFICATION

- Material Quality, Thick. & Size -- Drawing
- Verify HT No., Plate No. & Isp. ID -- Material & TC
- Verify Properties Reported in TC – ASME Sec.II. Part A / B + ARM + Simulation HT
- Verify NDT (UT) Requirement
- Look For Pitting, Surface Damage / Defect on Both Sides

PROCEDURE FOR MARKING, CUTTING AND CHECKING OF SHELL PLATE



SHELL PLATE

No Hard Punching on

1) FM Below 6 mm thick

2) NFM Below 12 mm thick

TOLERANCE

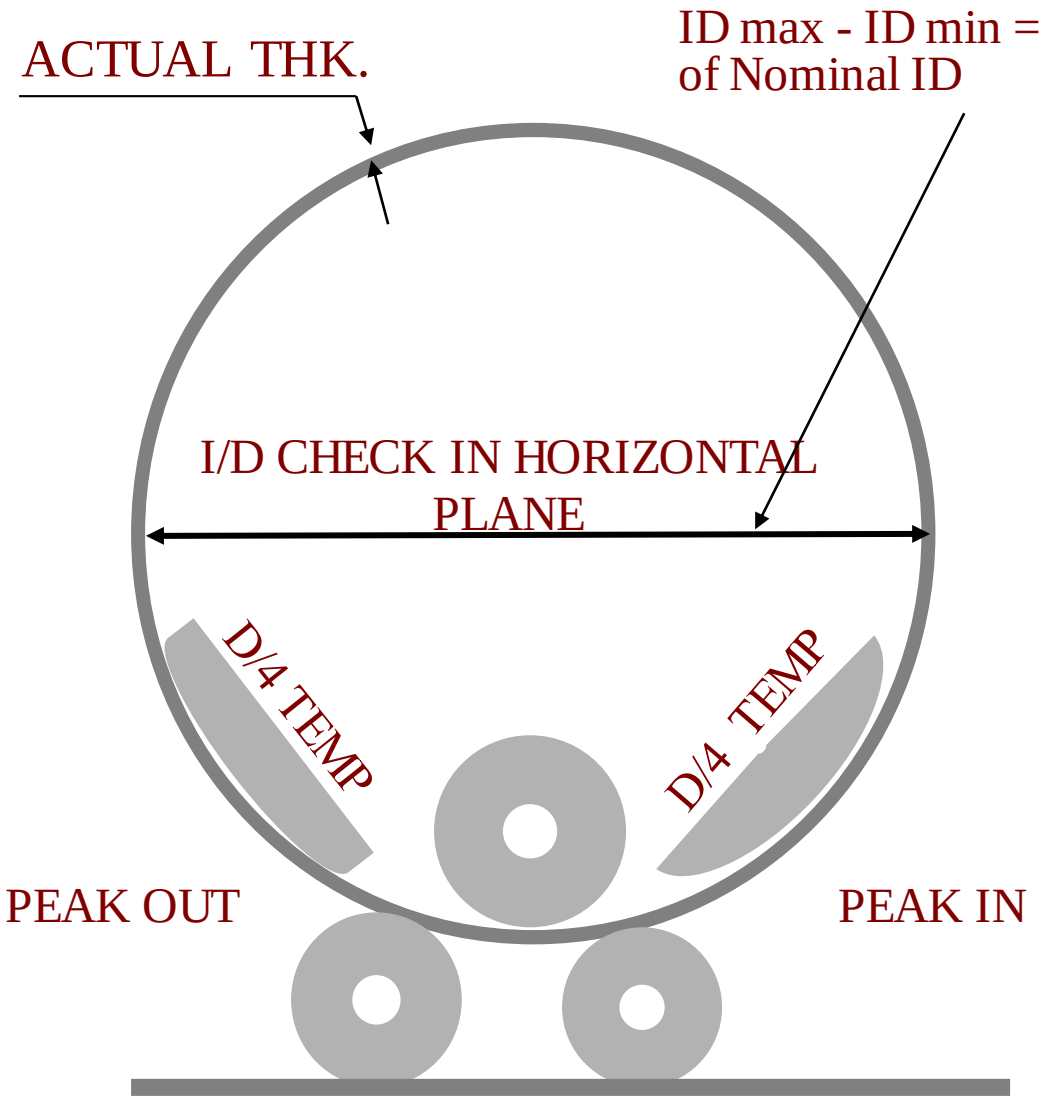
- **L & W - ± 1 mm / M, Max. ± 3 mm.**
- **K1 - K2 = ± 1 mm / M, Max. ± 5 mm**
- **IDENTIFICATION MARKING ⊥ TO ROLLING DIRECTION.**
- **L - NOMINAL CIRCUMFERENCE = MEAN DIA. X π**

π = 3.14159265358979323846264338327 92.....

LOADING OF PLATES FOR ROLLING

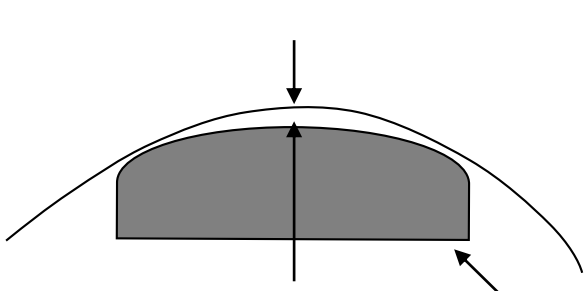
- Gas Cut Edges Free From Serrations
- All Corners Along the Edge Rounded Off
- Plate Loaded on M/c With ID Up side.
- Identification Marking On Bottom Side
- Rollers Across The Plate Length
- Edge Breaking Allowance Provided For Plates Above 75 mm Thick.

CHECKING SHELL PROFILE, OVALITY AND CIRCUMFERENCE



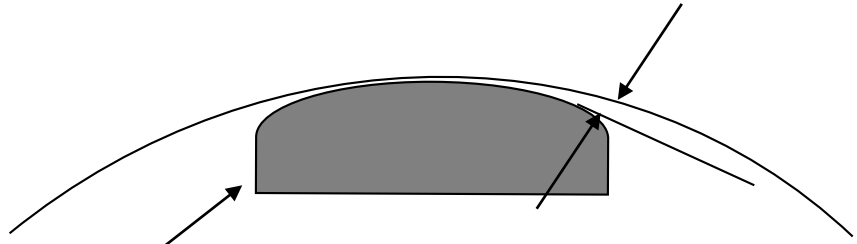
ID	Allowed gap Peak in / out
≤ 152	0.8 MM
≤ 305	1.2 MM
≤ 457	1.6 MM
≤ 610	2.4 MM
≤ 914	3.2 MM
≤ 1219	4.0 MM
≤ 1524	4.8 MM
≤ 1905	5.6 MM
≤ 2133	6.4 MM
≤ 2438	6.4 MM
≤ 2743	7.1 MM
≤ 3048	7.9 MM
>3048	**0.2% OF ID**

PROFILE CHECK BY TEMPLATE



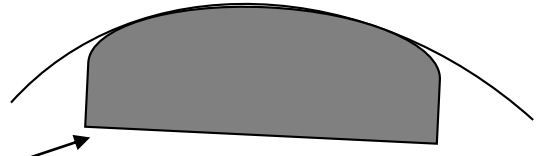
D/4 Template

Peak Out



D/4 Template

Peak In



D/4 Template

Matching Profile

MAXIMUM OFF SET IN BUTT WELD

Joint Thickness . "t"	Long Seam	Circ. Seam
13 mm & Below	$1/4^{th}$ t	$1/4^{th}$ t
Over 13 mm to 19 mm	3.2 mm	$1/4^{th}$ t
Over 19 mm to 38 mm	3.2 mm	4.8 mm
Over 38 mm to 51 mm	3.2 mm	$1/8^{th}$ t
Over 51 mm	$1/16^{th}$ t. Max. 10 mm	$1/8^{th}$ t. Max. 19mm

Aim For Half Of The Permissible Off Set At Set Up Stage

REINFORCEMENT LIMIT ON BUTT WELDS- UW 35

Material Thickness	Max. Reinforcement	
	Long Seam	Circ. Seam
Below 2.4 mm	0.8 mm	2.4 mm
2.4 to 4.8 mm	1.6 mm	3.2
Over 4.8 to 13 mm	2.4 mm	4 mm
Over 13 to 25 mm	2.4 mm	4.8 mm
Over 25 to 51 mm	3.2 mm	5 mm
Over 51 to 76 mm	4 mm	6mm
Over 76 to 127 mm	6 mm	6 mm
Over 127 mm	8 mm	8 mm

INSPECTION OF ROLLED / CYLINDRICAL SECTIONS

Shape	Checking Method
Profile	Template
Ovality (Out Of Roundness)	Diameter Measurement
Circularity	Swing Arm Method
Straightness	Stretching Twine

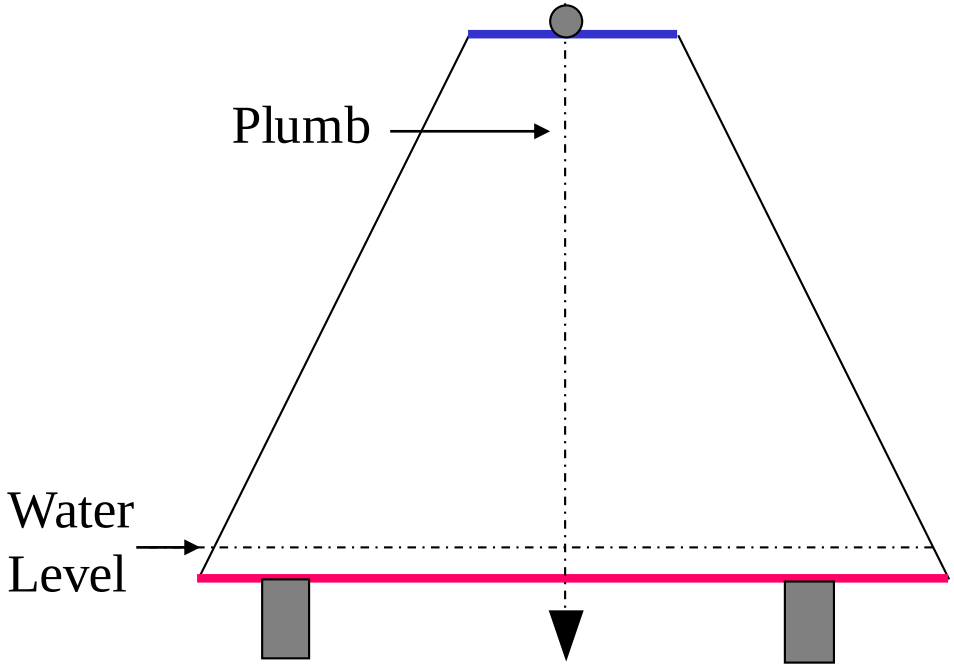
INSPECTION OF ROLLED / FORMED CONICAL SECTIONS

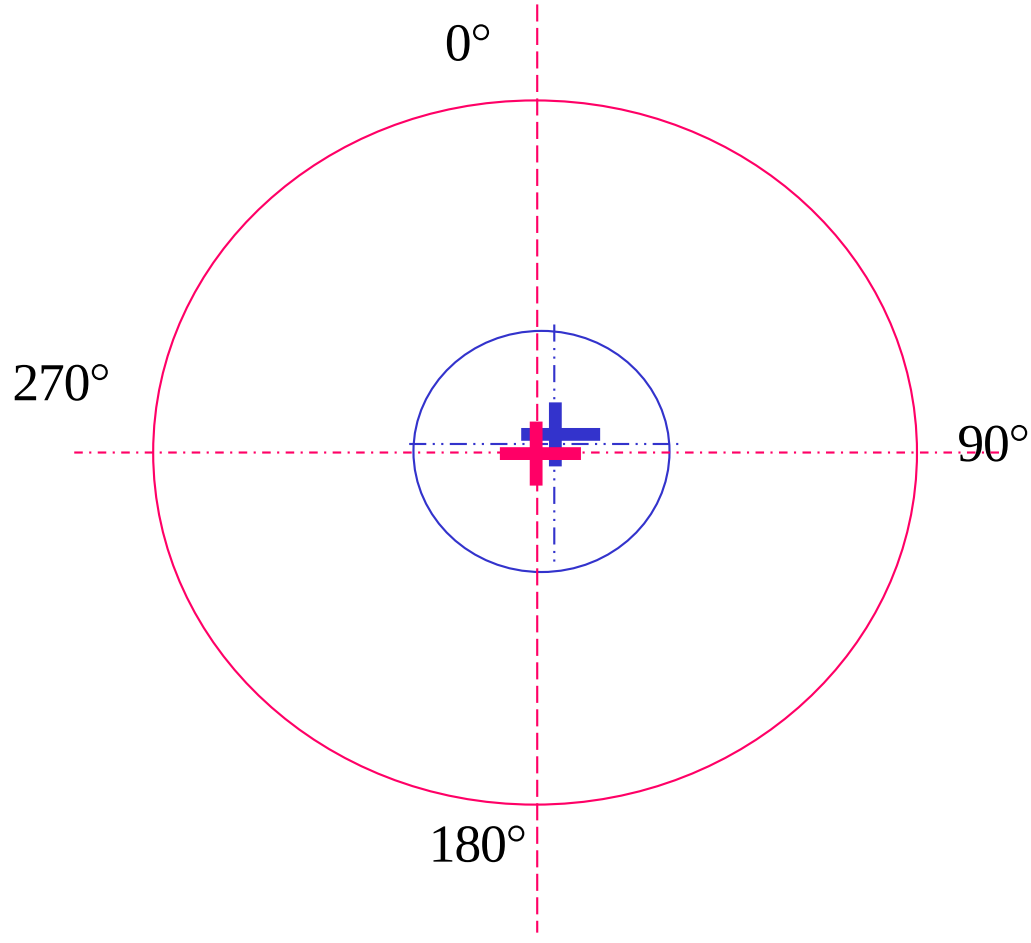
Shape	Checking Method
Profile At Open Ends	Template
Ovality (Out of Roundness)	Diameter Measurement
Circularity	Swing Arm Method
Concentricity	Leveling & Plumbing

PROFILE VERIFICATION OF SHELL SECTIONS UNDER EXTERNAL PRESSURE

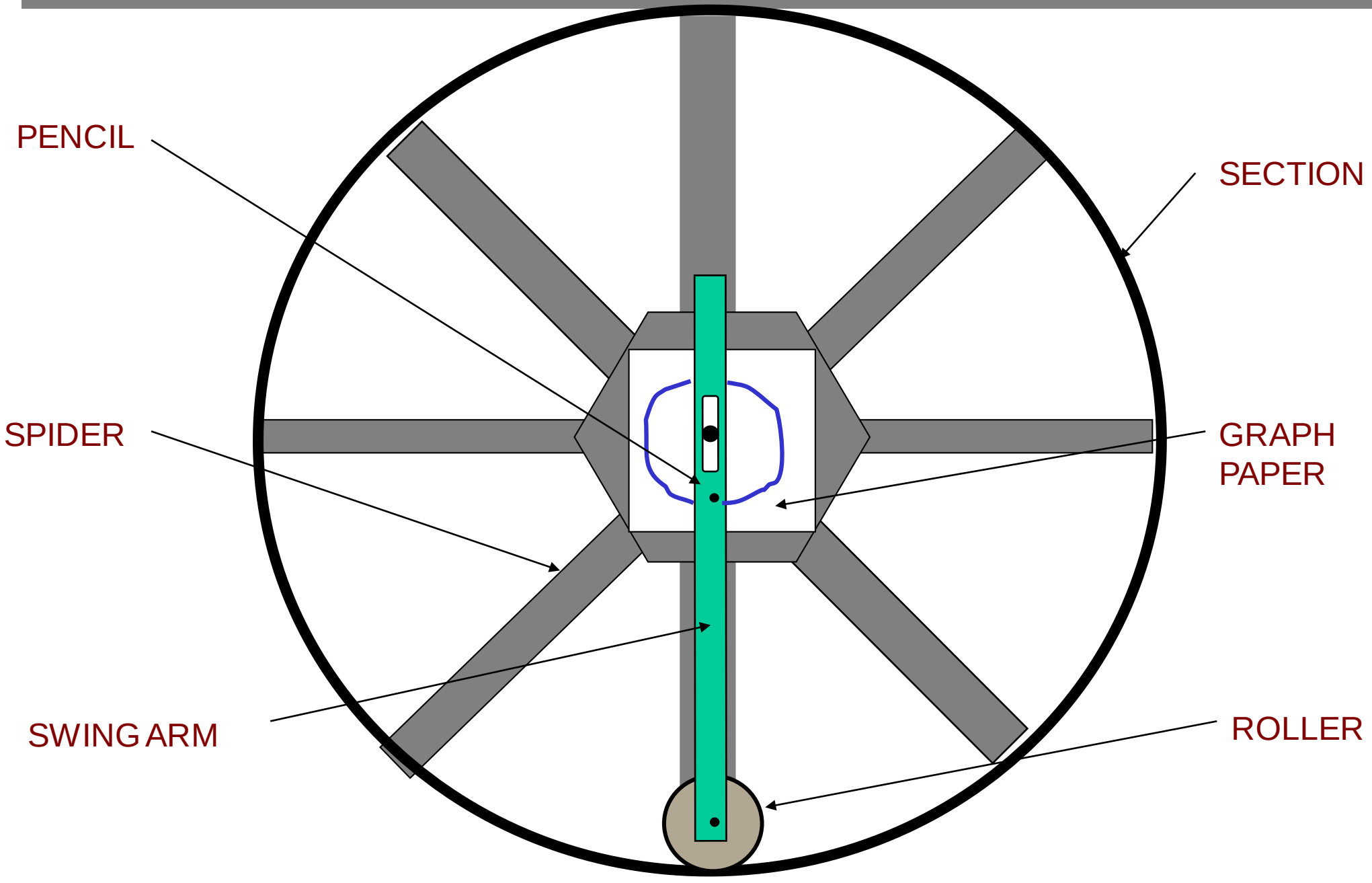
- Ovality Check – 0.5 Ø (1 % Ø Code Requirement)
- Template Check – UG 80 (b)
  - Chord Length of Template = 2 Times the Arc Length Obtained From UG 29.2 (Based on OD, Thickness & Length)
  - Vessel Length as Given in UG 28 & 28.1
  - Gap Permissible With the Template to be Obtained from UG 80.1
  - Hemispherical D/Es & Spherical Portion of Other D/Es, Template Check using L/D = 0.5

CONCENTRICITY CHECK OF CONES





CIRCULARITY CHECKING- SWING ARM METHOD



DERIVATION OF OUT OF CIRCULARITY

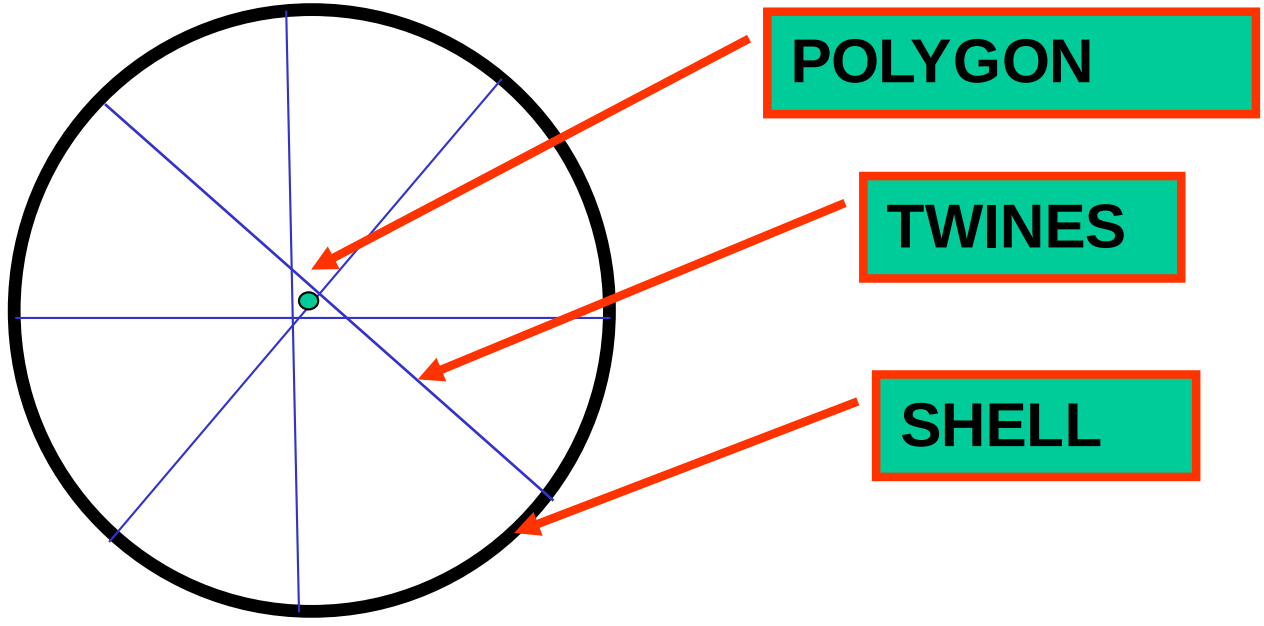
1. Measure the Area Encircled by the Curve From Graph
2. Calculate the Mean Diameter From The Area.

$$D = \sqrt{4A / \pi}$$

3. Mark Three Circles On A Transparent Paper
   - Circle With Mean Diameter D Derived
   - Circle With Mean Dia. D – (Tolerance in % D)
   - Circle With Mean Dia. D + (Tolerance in % D)
4. **SUPERIMPOSE THE CIRCLES IN TRANSPARENT PAPER ON CURVE OPTAINED ON GRAPH & DEMONSTRATE THAT THE CURVE IS WITHIN THE OUTER & INNER CIRCLES.**

CIRCULARITY CHECK BY TAPE OR TELESCOPIC GAUGE

1. FIND THE GEOMETRIC CENTRE OF THE SHELL-COURSE BY CROSSING 4 TWINES DIA , MARK THE CENTRE OF POLYGON



2. MEASURE THE RADIUS AT 48 LOCATIONS (R1 TO R48)

3. CALCULATE THEORATICAL RADIUS FROM Circumference

CIRCULARITY CHECK BY TAPE OR TELESCOPIC GAUGE

4 FIND THE MAXIMUM & MINIMUM RADIUS

5 CHECK THEY ARE WITHIN PEMISIBLE PERCENTAGE VARIATION

CIRC. SEAM SET UP & INSPECTION

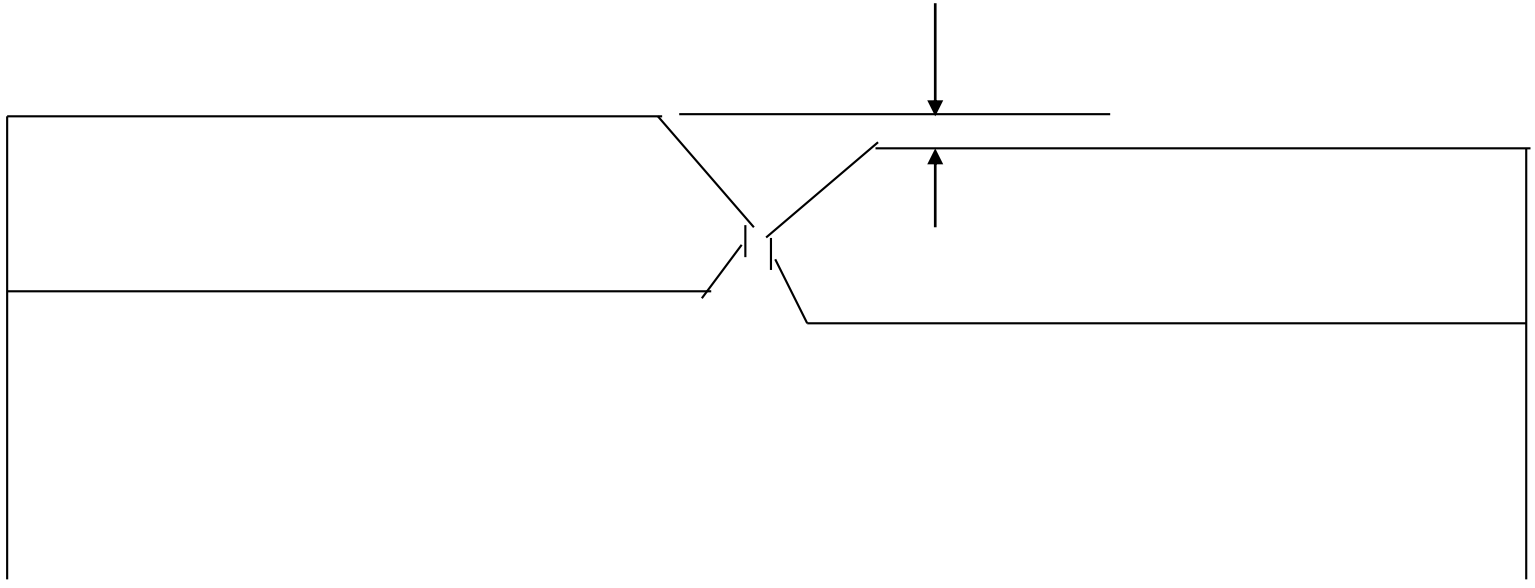
1. Ensure Following on Individual Shell Sections

1.1 Profile verification
1.2 Ovality Check
1.3 NDT of Long Seams
1.4 PTC Test results, if any
1.5 Orientation Marking & Verification
1.6 Weld edge preparation & PT / MT
1.7 Circumference difference of Butting ends
1.8 Theoretical Off Set on account of Circumference difference

CIRC. SEAM SET UP & INSPECTION

Theoretical Off Set

Difference in Circumference I 2 л



Set Up With the Off Set

CIRC. SEAM SET UP & INSPECTION

1. Align Two pairs of tank rotators – One of them Drive unit
2. Keep each shell section on tank rotators facing butting face together
3. Match orientations by rotating one shell section
4. Bring the sections closer to the required root gap by turn buckle / wedges
5. Lock 4 orientations keeping theoretical off set with wedges and tacks
6. Tack all 4 quadrants at every 300 mm apart keeping theoretical off set
7. Remove all external & internal cleats, dress and PT check

CIRC. SEAM SET UP & INSPECTION

1. Check Off Set on full circumference.
2. Check Surface Alignment at 4 orientations
3. Verify WEP, Root face & Root opening
4. Provide PTC, if required

INSPECTION OF DISHED ENDS

TYPE OF DISHED ENDS

- **Hemispherical**
- **Ellipsoidal**
- **Torispherical**

INSPECTION OF DISHED ENDS

TYPE OF CONSTRUCTION

- **Pressed From Single Blank**
  - **Without Any Weld Seam**
  - **With One Long Seam**
  - **With More Than One Long Seam**

- **Crown & Petal Construction**
  - **Single Tier**
  - **Multi Tier**

INSPECTION OF DISHED ENDS

FORMING TEMPERATURE

- **Cold Formed At Room Temperature**
- **Hot Formed At NR Temperature**
- **Cold Formed With Intermediate NR**
- **Cold Formed with Intermediate SR**

INSPECTION OF DISHED ENDS

FORMING METHOD

- **Single Pressing Using A pair of Die & Punch**
- **Progressive Forming By Repeated Point Pressing**
- **Progressive Forming For Crown Profile By point pressing & Knuckle Radius By Spinning**

INSPECTION OF DISHED ENDS

IDENTIFICATION MARKING

- Project No.
- Mtl. Specification
- Heat No. & Plate No.

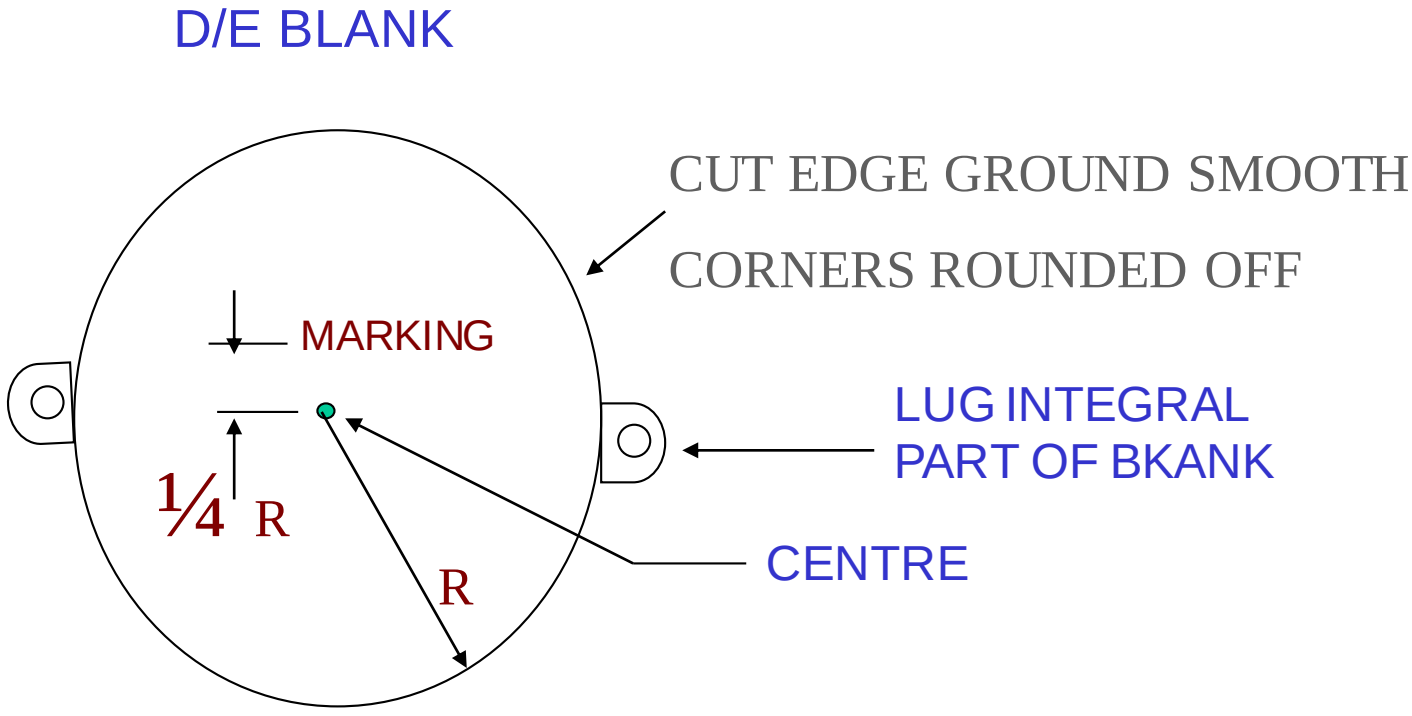
LOCATION OF MARKING

- Appx. ¼ th Radius of Single Disc Blank & Crown Disc
- Appx. At the Centre Of Blanks For Petals

INSPECTION OF DISHED ENDS

LIFTING LUGS ON BLANKS & PETALS

- **Provide Integral Lugs on Blanks & Petals For Handling.**



INSPECTION OF FORMED DISHED ENDS

Applicable For Single Piece & Crown + Petal Construction

1. **Circumference At Trimming line (Acceptance as per Tolerance Chart)**

2. **Knuckle Profile With 2D Full Size Template (No Gap At Center – End Gap max. 2mm**

3. **Height From Tan line (+ Half of 1¼ 🔔D/E Ø, – Half Of 5/8 🔔 D/E Ø)**

4. **Thickness At Crown, Knuckle & Edge (Above Minimum Specified In Drg.**

5. **Ovality On Open End (¼ Of 1% Of D/E Ø)**

INSPECTION OF FORMED DISHED ENDS

Applicable For Single Piece & Crown + Petal Construction

6 Check - Profile, Tan Line & Trimming Line With Full Size 2D Template. (Template radius – Open End, Crown & Knuckle - Less be 20 mm.) Template Shall Have Markings Of Tan Line, Trimming Line & Crown Centre. Deviation Permitted – Half of 1¼ 🔔D/E Ø in Plus & Half Of 5/8🔔 D/E Ø in Minus; No Abrupt Change In Profile. (Template To Be Verified On Lay Out)

7 Water Level 3 Points at 120° Apart On Trimming Line & Check Crown Center By A Plumb. (Deviation 5 mm per Meter Length Of D/E Ø Max. 20mm.(Not Applicable To Hemispherical D/E)

INSPECTION OF FORMED DISHED ENDS

Applicable For Single Piece & Crown + Petal Construction

8 Check – Straight Face (Tan Line To Trimming Line) With A Straight Edge of 1 Foot Scale. Minimum As Specified In Drawing. (Not Applicable To Hemispherical D/E)

9 All Press Marks On Out Side & Inside Shall Be Smoothly Ground / Merged.

10 PT Check Out Side Surface – No Linier Indication Permitted

INSPECTION OF FORMED DISHED ENDS

Applicable For Single Piece & Crown + Petal Construction

11 If Hot Formed, Check For MTC With Simulation Heat Treatment. (Not Applicable To Cold Formed D/E)

12 Blanks With Weld Joints Shall Be PT Checked & Radiographed Before & After Forming.

INSPECTION OF FORMED DISHED ENDS

Applicable For Only Crown + Petal Construction

1. Each Formed Petal Segment Shall Be Checked By A 3D Template From Inside. Profile Of Template Ribs To Be Verified. Maximum Gap Permissible At Any Location At The Rate Of 3mm / Mtr. Length Of Petal With Maximum Of 6mm.

2. Crown Segment Shall Be Checked By 2D Template. Gap Permissible 3mm / Mtr. Blank Dia.

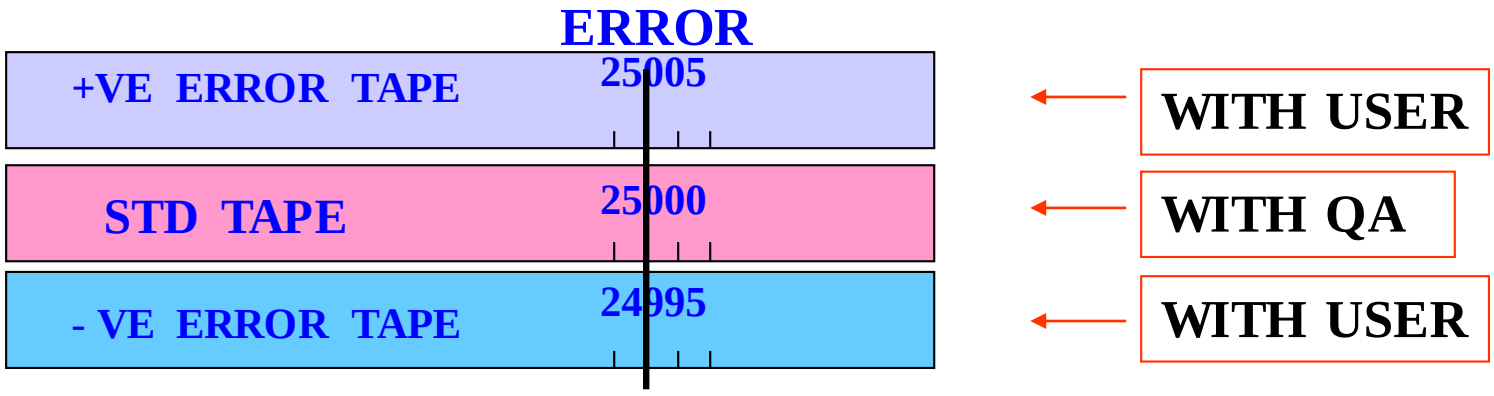
INSPECTION OF FORMED DISHED ENDS

Applicable For Only Crown + Petal Construction

3. Checks After Assembly

- **Off Set – Half Of Permissible As Per Code.**
- **Root Gap – (– 1mm , + 2mm)**
- **Root Face – (± 1mm)**
- **Serrations If Any On W E P, To Be Ground Smooth**
- **No Temporary Tacks On Groove**
- **No Defects On Tacks With External Cleats**
- **Petals To Be Numbered With D/E No.**
- **Match Marks On Adjacent Petals**

APPLICATION OF ERROR ON CALIBRATETAPE D TAPE



ERROR CORRECTION

TYPE OF ERROR	OPERATION	
	MARKING (ADD ERROR)	MEASURING (SUBTRACT ERROR)
+ VE	X + (+Y)	X -- (+Y)
-- VE	X + (--Y)	X -- (--Y)

NOTE :1. USE CALIBRATED TAPES ONLY

2. DO NOT USE TAPE HAVING ERROR MORE THEN $\pm$1 mm FOR CRITICAL JOBS.

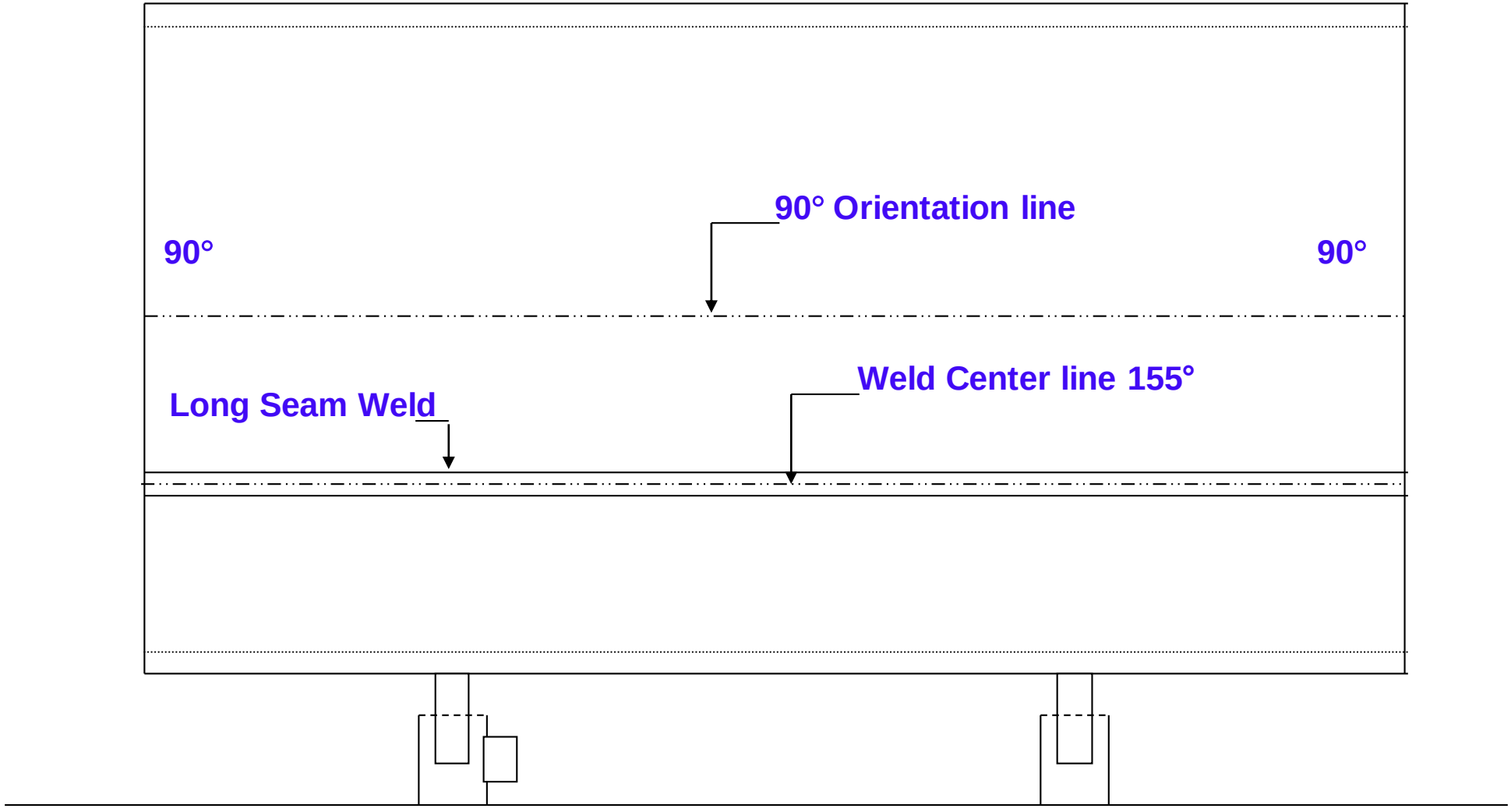
ORIENTATION MARKING ON CYLINDRICAL SHELLS

1. ROLLED SHELLS WITH ONE OR MORE LONG SEAMS

2. FORGED SHELLS WITHOUT ANY WELD SEAM

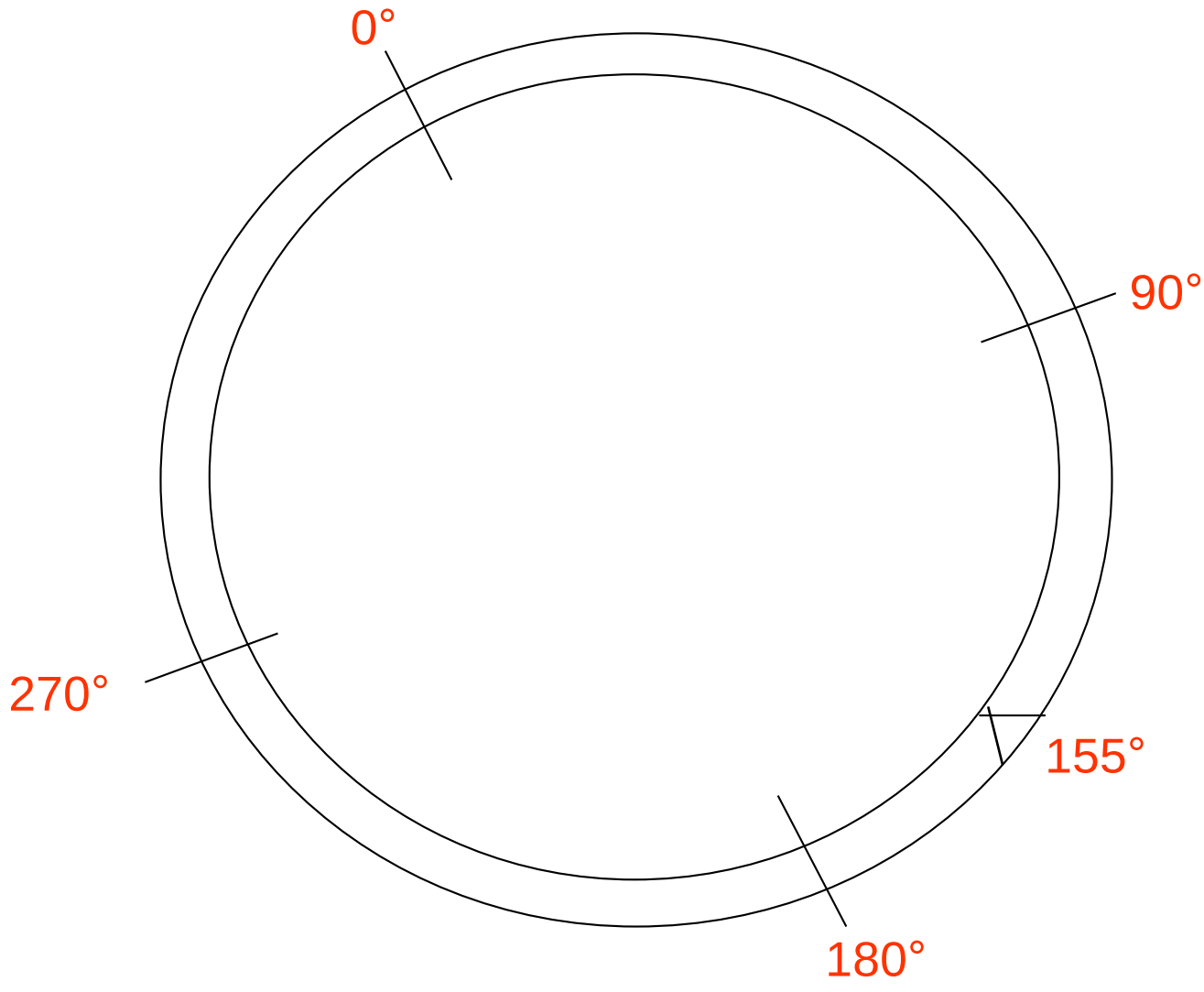
ORIENTATION MARKING ON ROLLED SHELLS

Shell With Weld Seam

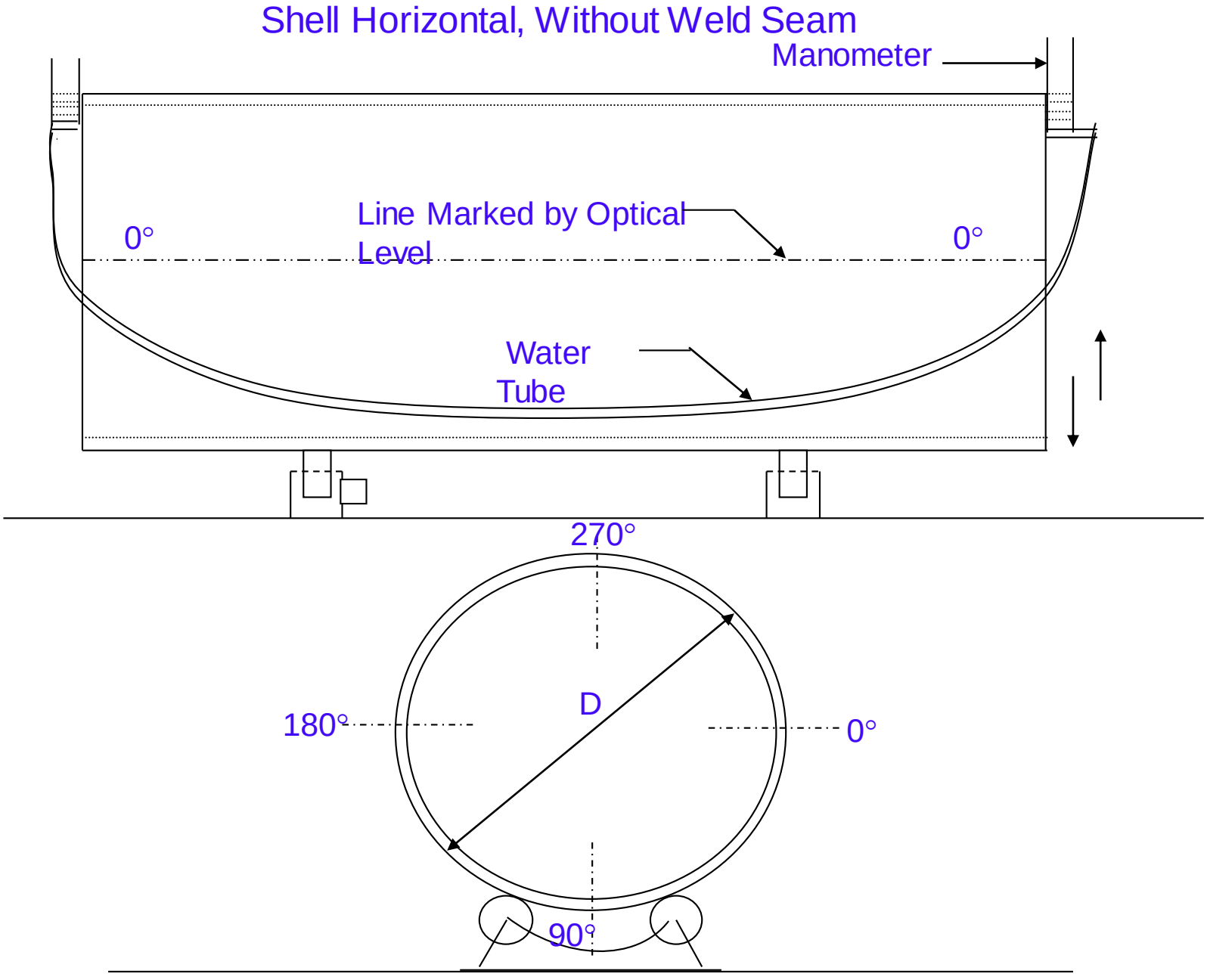


ORIENTATION MARKING ON ROLLED SHELLS

Shell With Long Seam

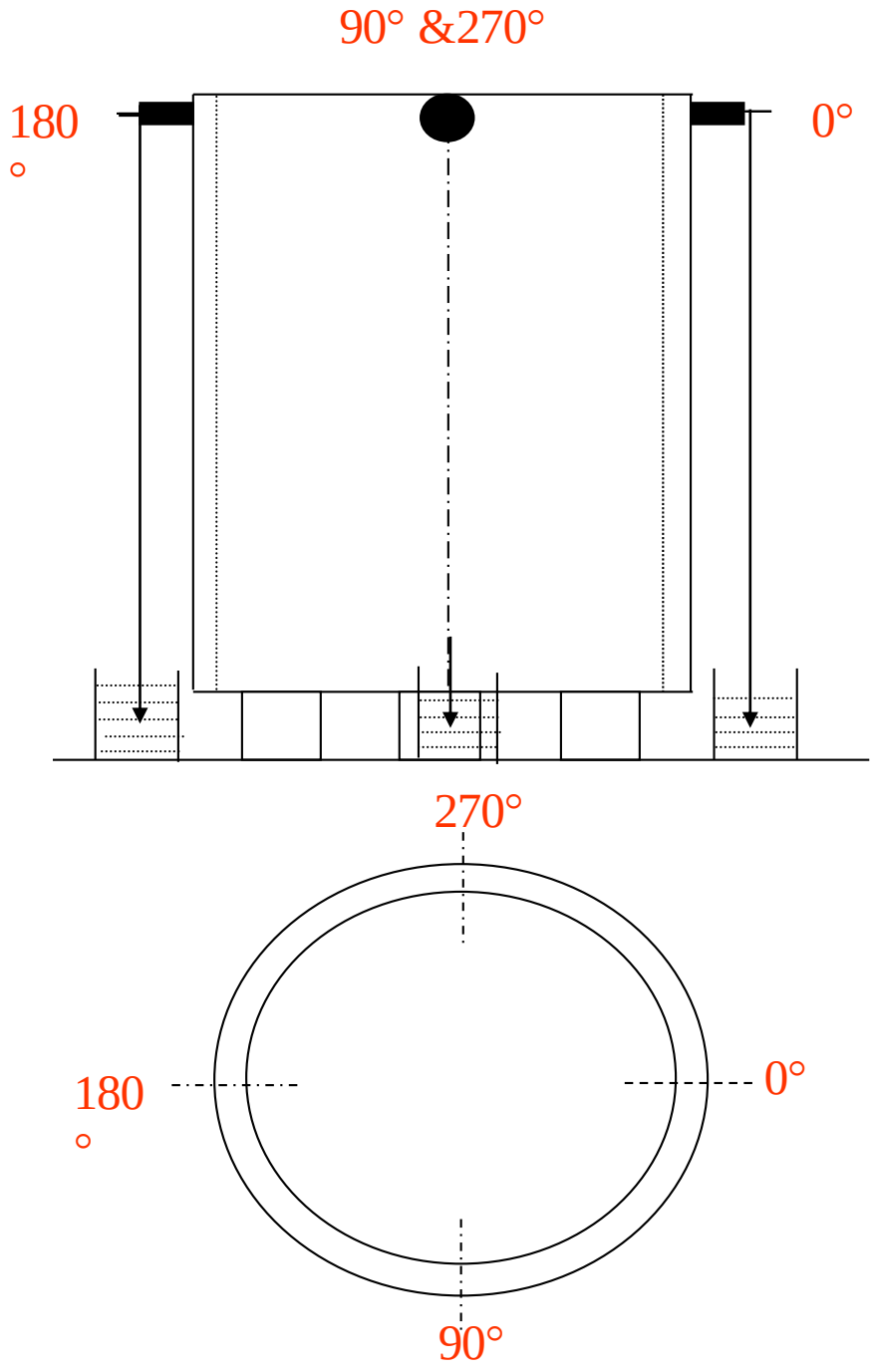


ORIENTATION MARKING ON FORGED SHELLS



ORIENTATION MARKING ON FORGED SHELLS

Shell Vertical Without Seam

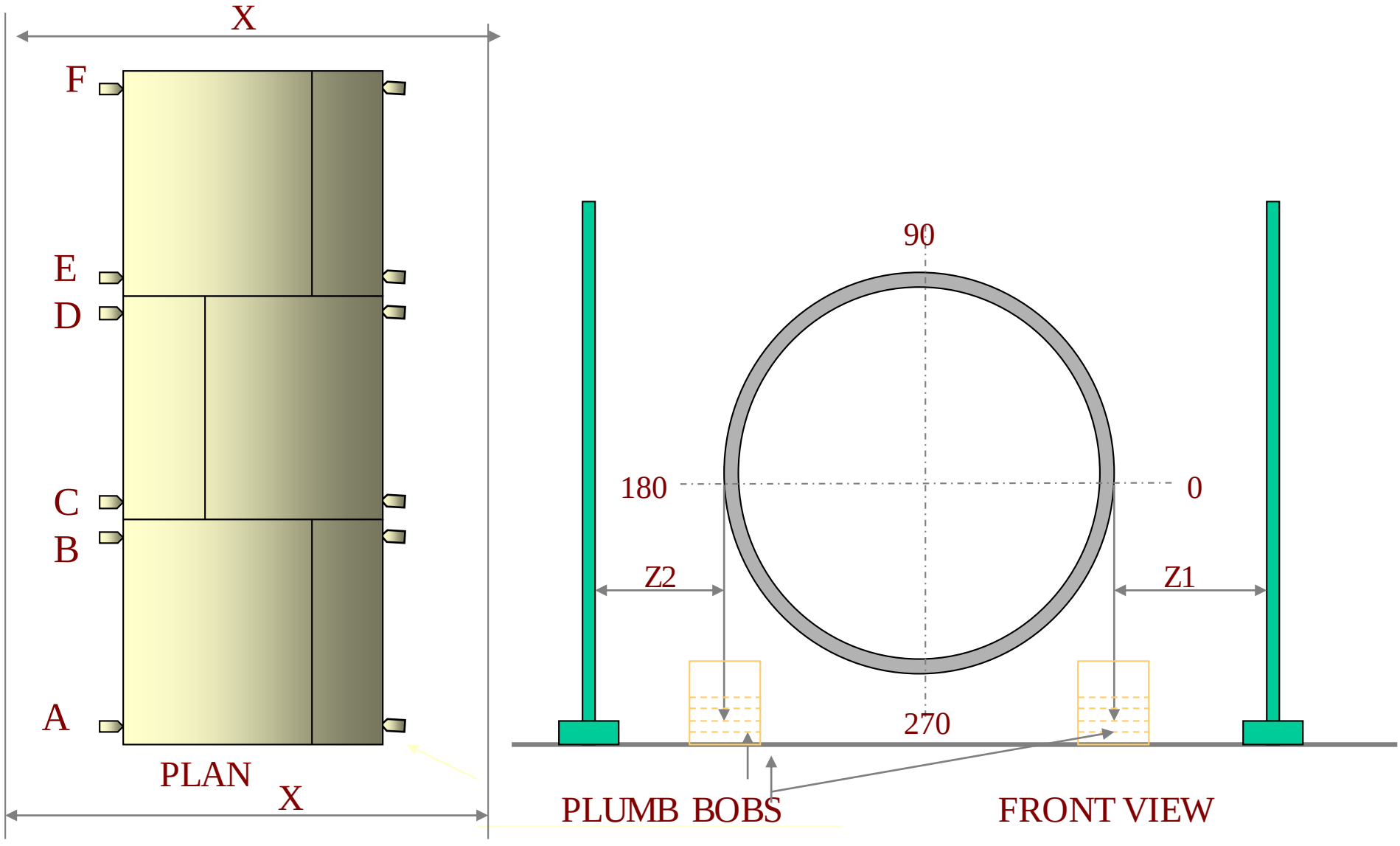


ALIGNMENT CHECK

1. AXIS ALIGNMENT

2. SURFACE ALIGNMENT

AXIS ALIGNMENT CHECK



AXIS ALIGNMENT CHECK

- MEASURE PERPENDICULAR DISTANCE BETWEEN PLUMB LINE AND HORIZONTAL TWINE & TABULATE READINGS AS SHOWN BELOW.

LOCATIONS	TWINE TO PLUMB DIST.		HALF DIFF (Z1- Z2 / 2) MM OF READING
	Z1 AT 0	Z2 AT 180	
A			
B			
C			
D			
E			
F			

AXIS ALIGNMENT CHECK

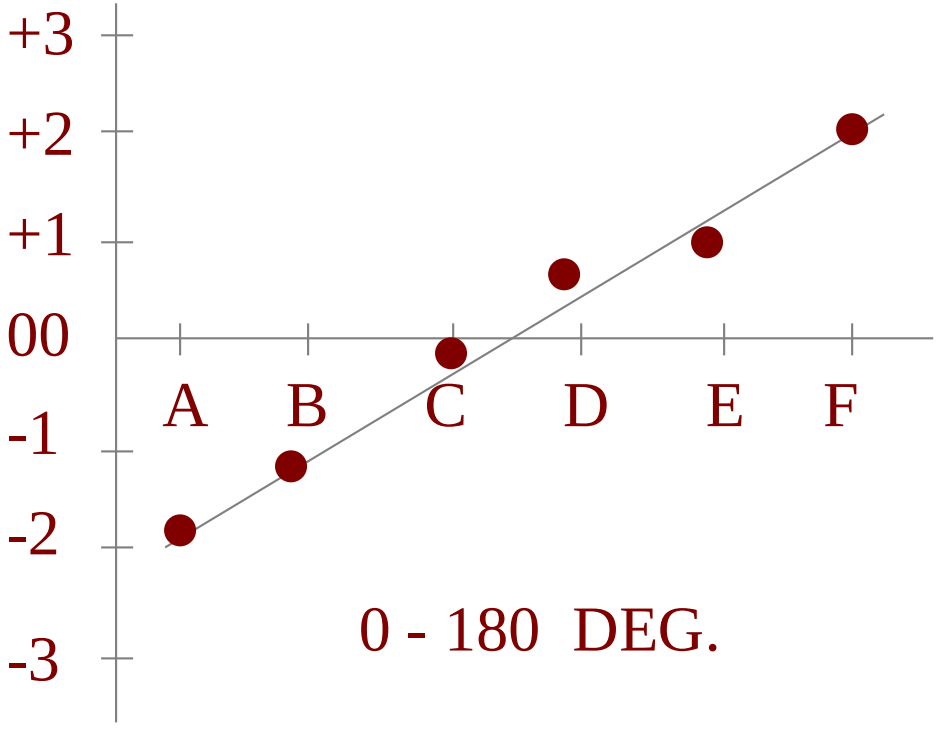
•REPEAT THIS EXERCISE FOR 90 / 270 ORIENTATIONS
BY ROTATING THE SHELL ASSEMBLY.

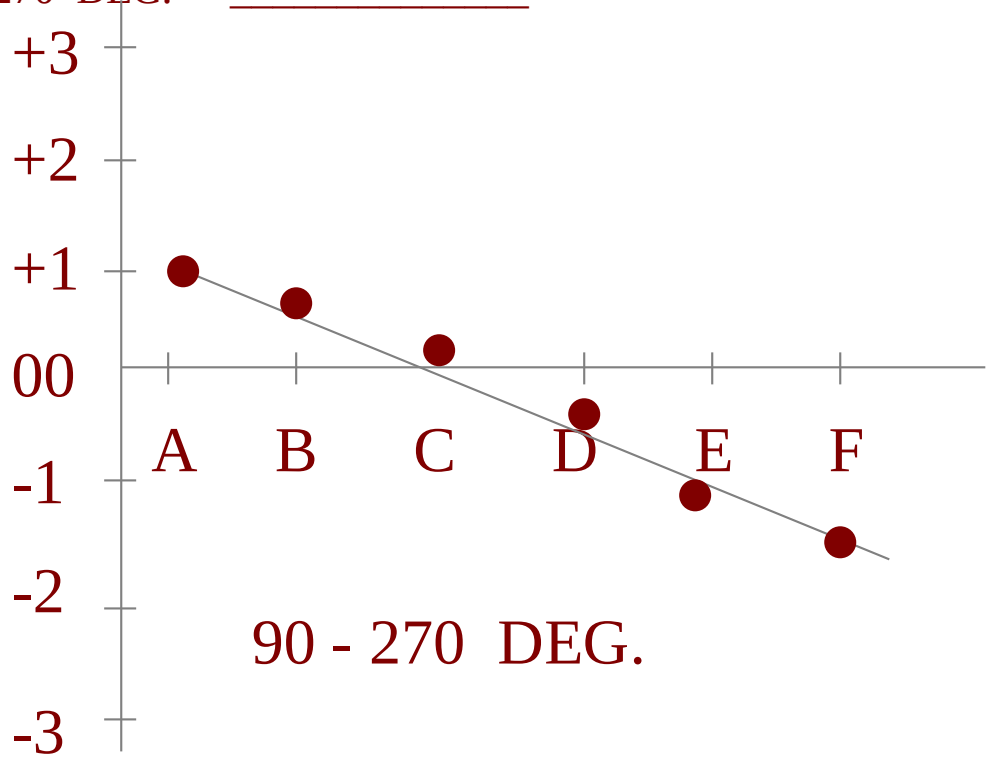
LOCATIONS ENTER DIM.	TWINE TO PLUMB DIST.		HALF DIFF (Z1-Z2 / 2) MM OF READING
	Z1 AT 90	Z2 AT 270	
ABCDE & F			

AXIS ALIGNMENT CHECK

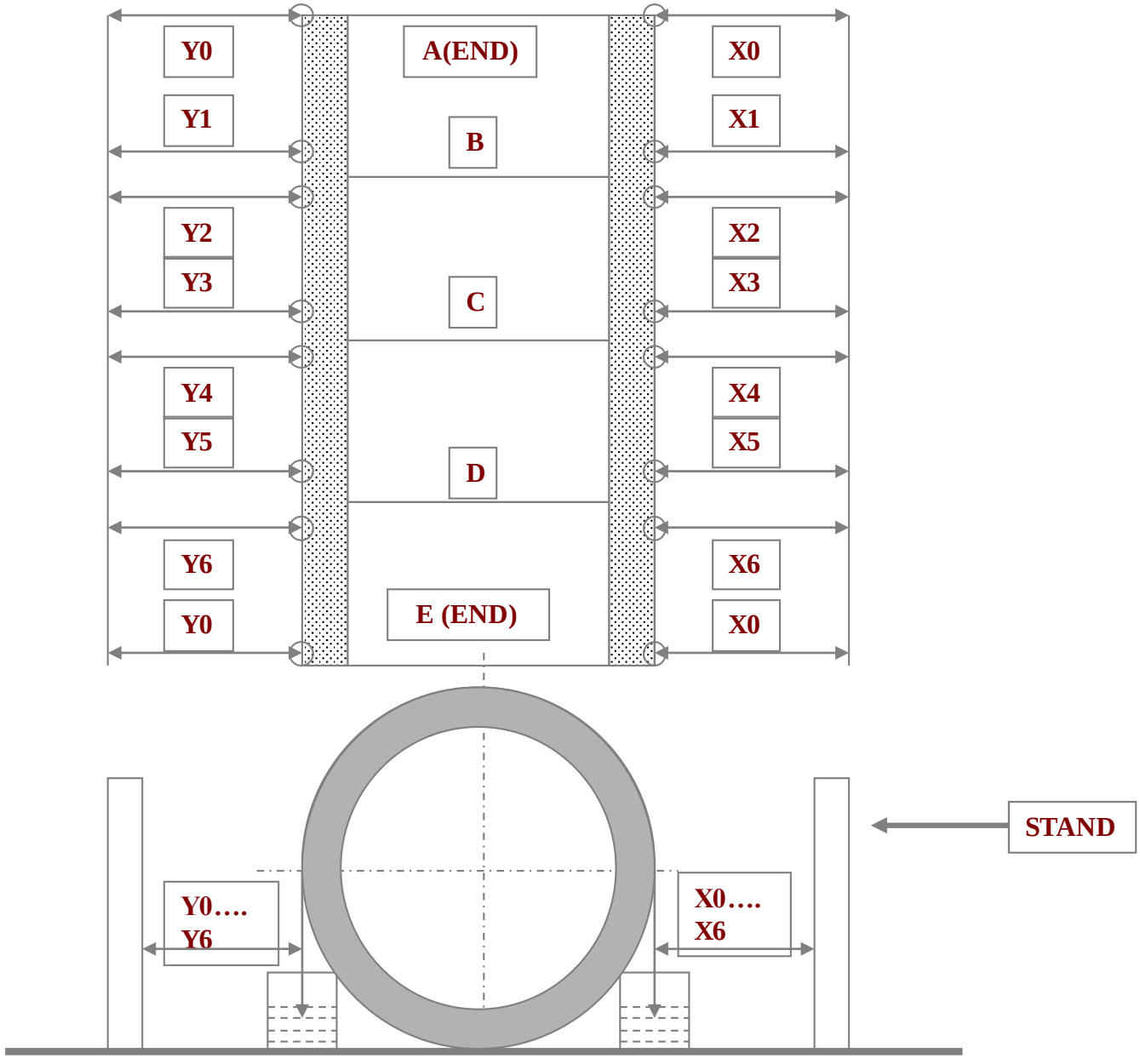
- PLOT THE POINTS ON A GRAPH PAPER WITH SUITABLE SCALE
- DRAW A BEST FIT LINE TO PASS THROUGH ALL POINTS
- THE MAXIMUM DISTANCE MEASURED FROM THE LINE IS THE MAXIMUM "OUT OF ALIGNMENT"
- FIND OUT MAX. OUT OF ALIGNMENT IN BOTH THE PLANES & NOTE AS

(A) 0 - 180 DEG. = _____ (B) 90 - 270 DEG. = _____





SURFACE ALIGNMENT CHECK

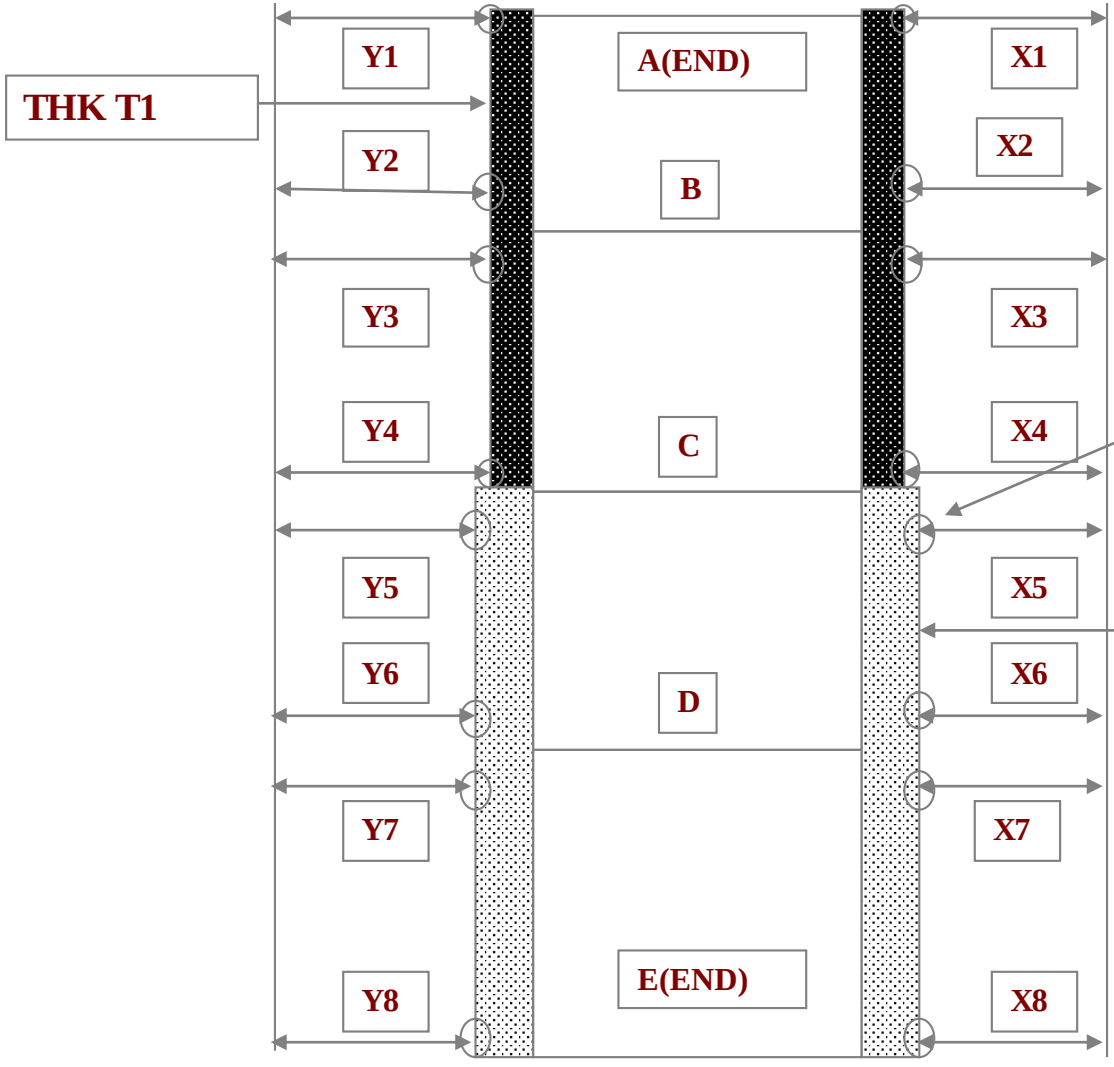


SURFACE ALIGNMENT CHECK

- LEVEL THE SHELL ORIENTATIONS (0 - 180 , 90-270) VERTICALLY / HORIZONTALLY
- DROP A PAIR OF PLUMBS NEAR EACH CIRC.SEAM AND ON ENDS
- PUT TWINES HORIZONTALLY ON BOTH SIDES OF SHELL.
- MAINTAIN EQUAL DISTANCE AT BOTH ENDS OF THE SECTIONS BETWEEN HORIZONTAL TWINES & PLUMB.
- MEASURE PERPENDICULAR DISTANCE BETWEEN OTHER PLUMBS AND HORIZONTAL TWINES AND RECORD THE READINGS IN THE TABLE BELOW.
- ROTATE THE JOB 90° AND REPEAT THE ABOVE MEASUREMENTS AT THE OTHER TWO ORIENTATIONS AND RECORD THEM.
- SURFACE MISALIGNMENT = **MAXIMUM READING - MINIMUM READING.**

SEAM NO	**ORIENTATION**			
	0	**90**	**180**	**270**
A (END)	**X0**		**Y0**	
B	**X1** **X2**		**Y1** **Y2**	
C	**X3** **X4**		**Y3** **Y4**	
D	**X5** **X6**		**Y5** **Y6**	
E (END)	**X0**		**Y0**	

SURFACE ALIGNMENT OF SECTIONS WITH DIFFERENT SHELL THICKNESS



X1 = X8 + (T2-T1)

IN CASES OF X2,X3,X4, ALIGNMENT IS DIFFERENCE OF THAT W.R.T X1

IN CASES OF X5,X6,X7, ALIGNMENT IS DIFFERENCE OF THAT W.R.T X8

SKETCH - 2

SURFACE ALIGNMENT OF SECTIONS WITH DIFFERENT SHELL THICKNESS

- THE DIMENSION SETTING AT ENDS (X0) ARE DECIDED TAKING IN TO CONSIDERATION OF SHELL COURSE THICKNESSES (REFER SKETCH 2)
- FOR REST SAME PROCEDURE IS TO BE ADOPTED.

NOTE:

THE SHELL OVALITY / SHAPE SHALL BE CONTROLLED WITHIN THE LIMIT IN ORDER TO GET BETTER ALIGNMENT.

TOLERANCES ON CIRC. OF SHELLS, D'ENDS , CONES & BELLOWS

- THE REQUIRED CIRCUMFERENCE SHALL BE COMPUTED BY THE FOLLOWING METHOD.

  REQUIRED CIRCUMFERENCE = (ID + 2T) × Л

  WHERE, I.D = INSIDE DIA. AS SPECIFIED IN DRAWINGS

  T = ACTUAL THICKNESS MEASURED AT ENDS

  PIE = VALUE OBTAINED FROM CALCULATOR

- MEASURE THE ACTUAL CIRCUMFERENCE ON THE JOB.
- ONLY CALIBRATED TAPES SHOULD BE USED FOR THE PURPOSE OF MEASUREMENT.
- COMPARE THESE TWO VALUES OF CIRCUMFERENCE AND CHECK THE ACCEPTABILITY BASED ON BELOW GIVEN TOLERANCE CHART.

TOLERANCE ON CIRCUMFERENCE

TOLERANCE ON CIRCUMFERENCE					
COMPONENTS	THICKNESS OF COMPONENTS IN MM				REMARKS
	UP TO 8	9 TO 18	19 TO 50	ABOVE 50	
ROLLED SHELLS AT L/S SET-UP STAGE	(+) 5 (-) 2	(+) 7 (-) 4	(+) 10 (-) 7	(+) 12 (-) 9	CIRCUM. TO BE CHECKED AT 3 LOCATIONS, 2 ENDS AND AT CENTRE
PRESSED / FORMED D'END, CONE & EXPANSION BELLOW AFTER COMPLETING WELD JOINT IF ANY	(+ / -) 5 (-0 / +10)**	(+ / -) 8 (-0 / +15)**	(+ / -) 10 (-0 / + 18)**	(+ / -)15 (-0 / + 25)**	IF COMPONENT IS IN SET-UP STAGE WITHOUT WELDING PER JOINT 3MM SHRINKAGE SHALL BE ADDED TO BASIC CIRCUMFERENCE.

NOTES:

- THE ABOVE LIMITS ARE APPLICABLE ONLY IF NO OTHERS STRINGENT TOLERANCE IS SPECIFIED.
- ** THIS TOLERANCE IS APPLICABLE ONLY WHEN ABUTTING SHELLS HAS HIGHER THICKNESS WITH OUTSIDE TAPER AND INSIDE FLUSH.

REFERENCE LINE MARKING PROCEDURE

1 OPTICAL METHOD **2 PIN METHOD**

DECIDING FACTORS

1 DIAMETER OF SHELL
2. THICKNESS OF SHELL
3. TOLERANCE ON TSR.

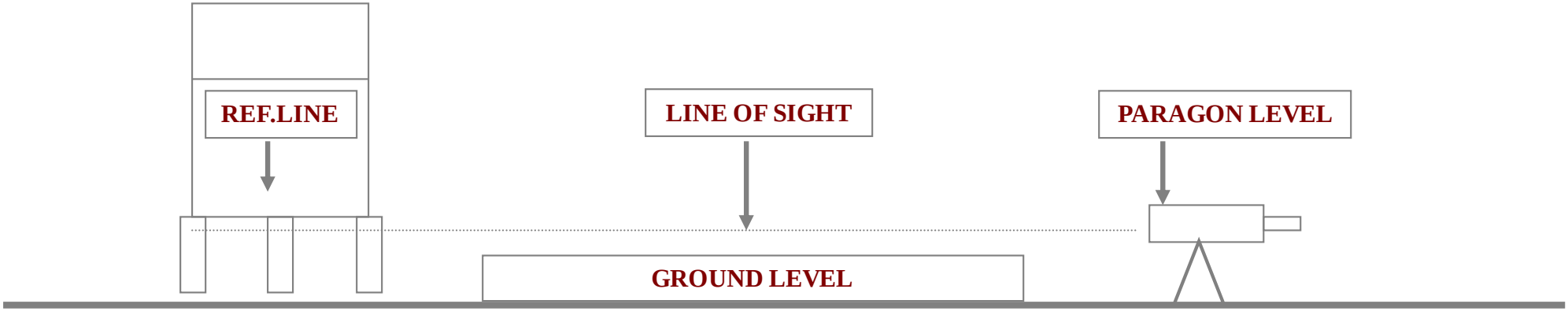
THE CHART BELOW RECOMMENDS THE METHOD (PIN OR OPTICS) TO BE FOLLOWED FOR MARKING THE REFERENCE LINE ON TOWERS WITH INTERNALS AS TSR

SHELL DIA	**UP TO 3500**		**3500-4500**		**>4500**	
**TOLERANCE ON TSR LEVEL WITHIN	>3	<,= 3	>3	<, = 3	>3	<, = 3
THICKNESS <, = 25	**P**	**O**	**O**	**O**	**O**	**O**
THICKNESS > 25	**P**	**O**	**P**	**O**	**O**	**O**

- **P** DENOTES PIN METHOD OF MARKING
- **O** DENOTE S OPTICAL METHOD OF MARKING / MARKING ON MACHINE BED WITH SHELL AXIS VERTICAL.
- **** TOLERANCE ON TSR WITHIN 3 mm MEANS THAT THE SPECIFIED TOLERANCE IS $\pm$ 1.5 mm
- ALL DIMENSIONS ARE IN mm

REFERENCE LINE MARKING / CHECKING WITH OPTICAL INSTRUMENTS.

- PLACE THE SHELL WITH THE AXIS VERTICAL.
- THE BOTTOM EDGE OF THE SHELL SHALL BE AT LEAST 1 MT ABOVE THE GROUND LEVEL.
- SHELL OVALITY TO BE CORRECTED WITHIN **0.25 %** OF **I/D** AT BOTH THE ENDS USING SPIDERS.
- THE ALIGNMENT OF THE SHELL SHALL BE WITHIN **2 MM**. THIS IS TO BE ASCERTAINED BY DROPPING PLUMBS AT FOUR ORIENTATIONS **90 DEG**. APART.
- THE MARKING / CHECKING SHALL BE DONE ON SHELL **O/D** AS WELL AS **I/D** BY KEEPING THE PARAGON LEVEL OUTSIDE THE SHELL AS SHOWN BELOW



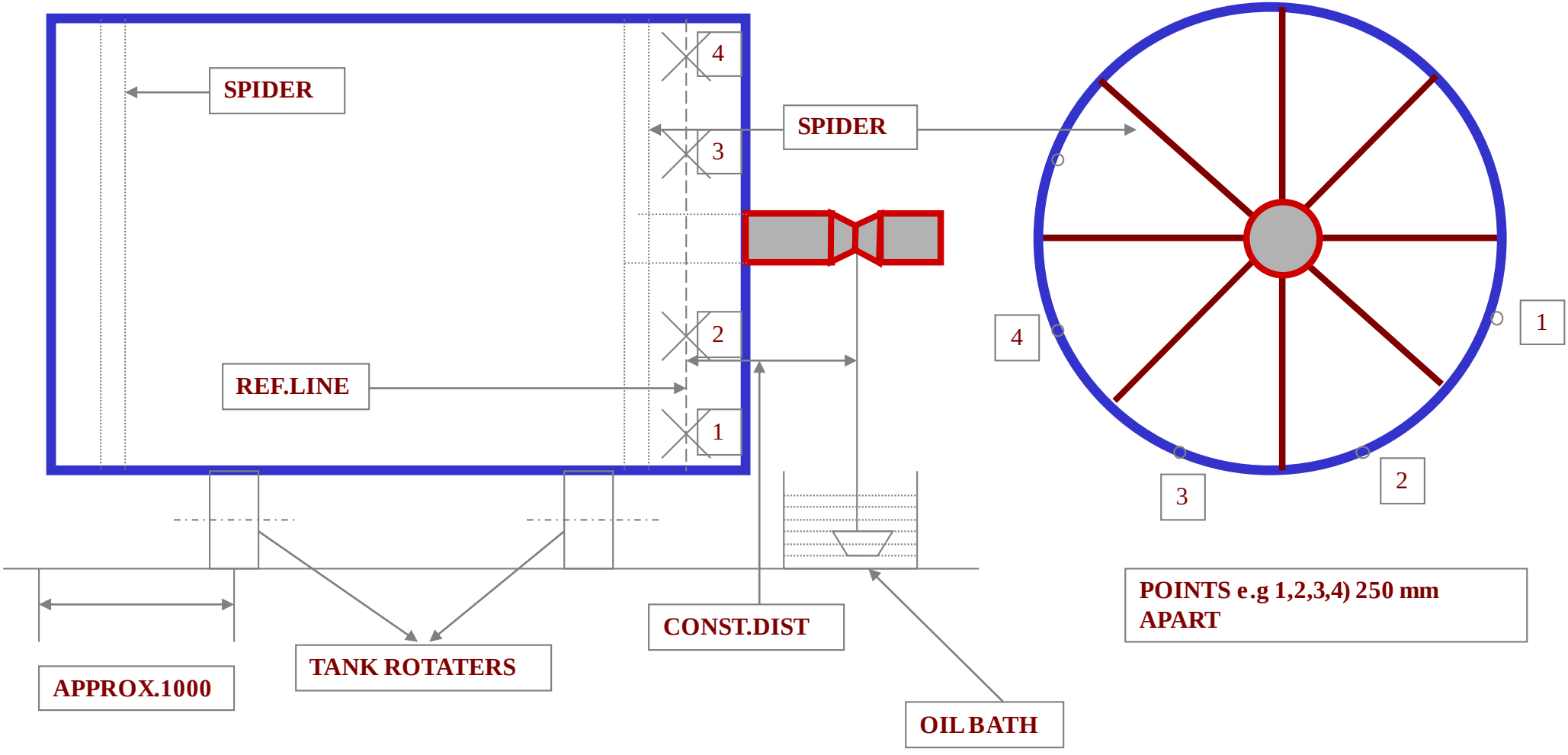
PROCEDURE FOR REFERENCE LINE MARKING BY PIN METHOD

- KEEP THE SHELL HORIZONTAL ON A PAIR OF TANK ROTATERS.
- CORRECT THE OVALITY TO 0.25 % BOTH ENDS.
- SPIDERS SHALL BE RIGID ENOUGH TO PREVENT BUCKLING.
- TACK WELD A PIN OF 10 DIA AT THE CENTRE OF THE SPIDER.
- THE PIN SHALL HAVE A MACHINED ‘V’ GROOVE FOR THE PLUMB.
- DROP A PLUMB ALONG THE GROOVE OF THE PIN.
- THE PLUMB IS TO BE SUSPENDED IN AN OIL BATH.

PROCEDURE FOR REFERENCE LINE MARKING BY PIN METHOD

- DIVIDE THE CIRCUMFERENCE OF SHALL APPROX. 250 mm APART ON **I/D** AND **O/D** AS SHOWN IN SKETCH.
- PUNCH MARK A CONSTANT DISTANCE FROM THE PLUMB ON **I/D** AND ON **O/D**
- JOIN THE PUNCH MARKS BY A FLEXIBLE STEEL RULE.
- MINIMUM **3 POINTS** ARE TO BE COVERED IN ONE SETTING OF SCALE
- ROTATE THE SHELL IN BOTH DIRECTIONS AND CONFIRM THE REFERENCE LINE MARKED **ON I/D & O/D**.
- WRITE THE REFERENCE LINE ELEVATION FROM **I/S & O/S** WITH PAINT.

PROCEDURE FOR REFERENCE LINE MARKING BY PIN METHOD



PROCEDURE FOR NOZZLE SET UP

- Mark nozzle location on the shell surface with the required elevation and orientation
- Mark cut out circle with the required diameter
- Make the cut out and the weld edge preparation
- Clear NDT on WEP (PT, MT, UT) if applicable
- Set up the nozzle with the required height & within the tilt permissible
- Bolt holes on the nozzle flange shall straddle with vessel centre line
- Provide three temporary supports at equidistance
- Tack weld the nozzle in the grooves – Tack length 8 times the electrode diameter – Welding parameters as per SWP

INSPECTION PROCEDURE FOR NOZZLE SET UP

- Check & confirm the nozzle forging material is identified
- Check & confirm the gasket seating finish is as per drawing and free from any damage
- Measure and confirm orientation & elevation of nozzle location
- Check projection & Tilt of nozzle flange
- Inspect the tacks in the groove and make sure that they are free from visible defect

PROCEDURE FOR MEASURING DCBB DIMENSIONS

- CHECK OVALITY OF SECTION AT FOLLOWING PLACES

  a) OPEN END.

  b) 100 mm ON BOTH SIDE OF THE CIRCS. SEAMS.

  c) MIDDLE OF EACH SHELL COURSE.

  (OVALITY SHALL BE WITHIN **0.5 %** OF THE NOMINAL DIAMETER.)

- INDIVIDUAL DCBB DIMENSIONS TO BE CONFORMED BEFORE S/U .

  a) DCBB WIDTH, HEIGHT & THICKNESS.

  b) HOLE DIA. & NO. OF HOLES.

  c) HOLE TO EDGES DISTANCES.

  d) HOLE TO HOLE DISTANCES.

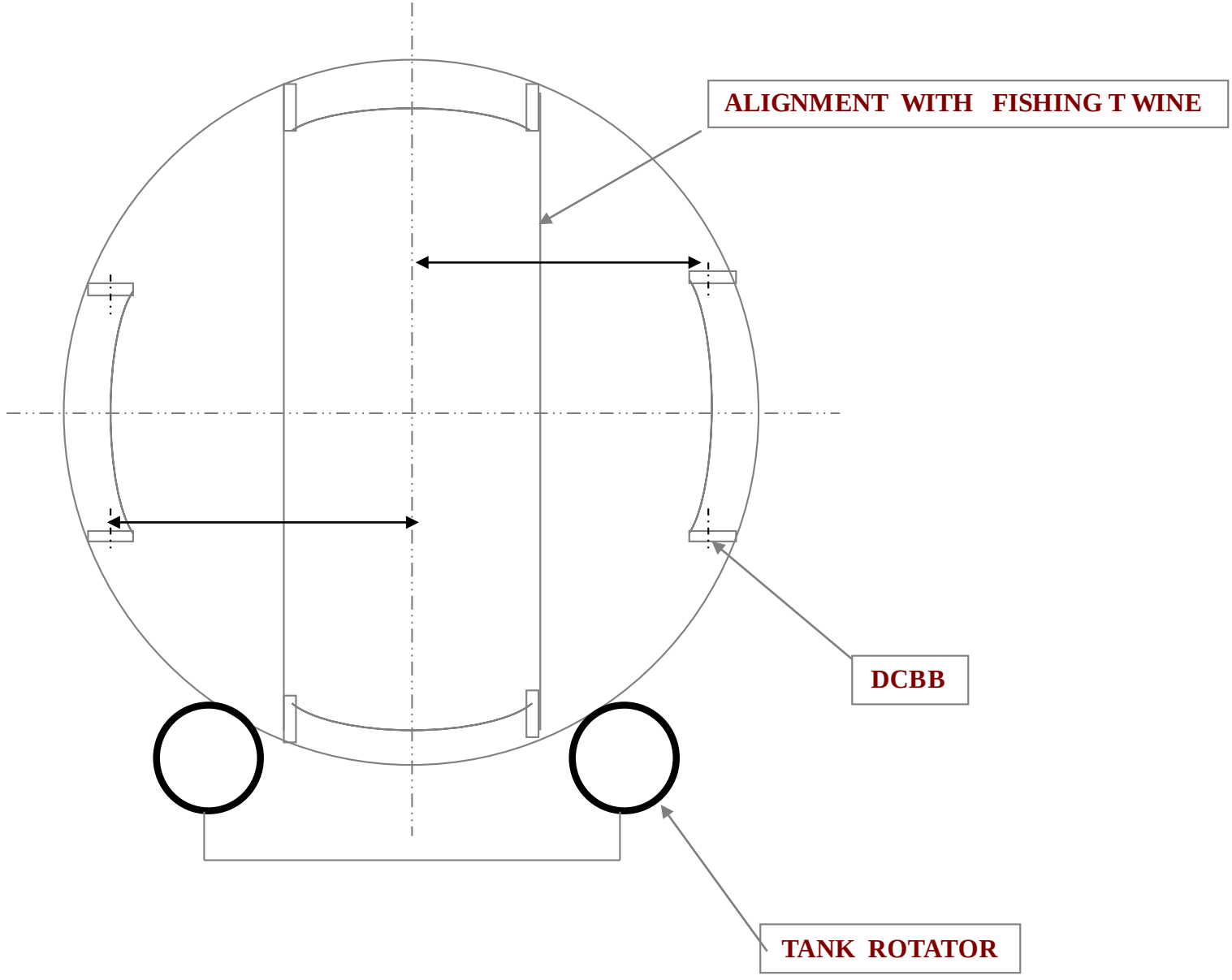
  e) DCBB ANGLE (IF APPLICABLE)

CHECK AND CONFORM TSR DIMENSIONS ARE WITHIN TOLERANCE.

PROCEDURE FOR MEASURING DCBB DIMENSIONS

- CHECK THE FILLET SIZE OF DCBB # SHELL & DCBB # TSR
- CHECK THE NDT OF DCBB # SHELL & DCBB # TSR
- CHECK THE CLEAN CORNER / NO WELD AREAS AS PER DRAWING
- CHECK ALL DRAWING DIMENSION OF DCBB AS SHOWN IN THE SKETCH.
- CHECK THE STRAIGHTNESS OF DCBB WITH 300mm LONG SCALE (IT SHALL BE WITHIN 1mm.)
- CHECK THE ALIGNMENT OF DCBB WITH FISHING TWINE AS PER SKETCH.

DCBB MEASUREMENT PROCEDURE



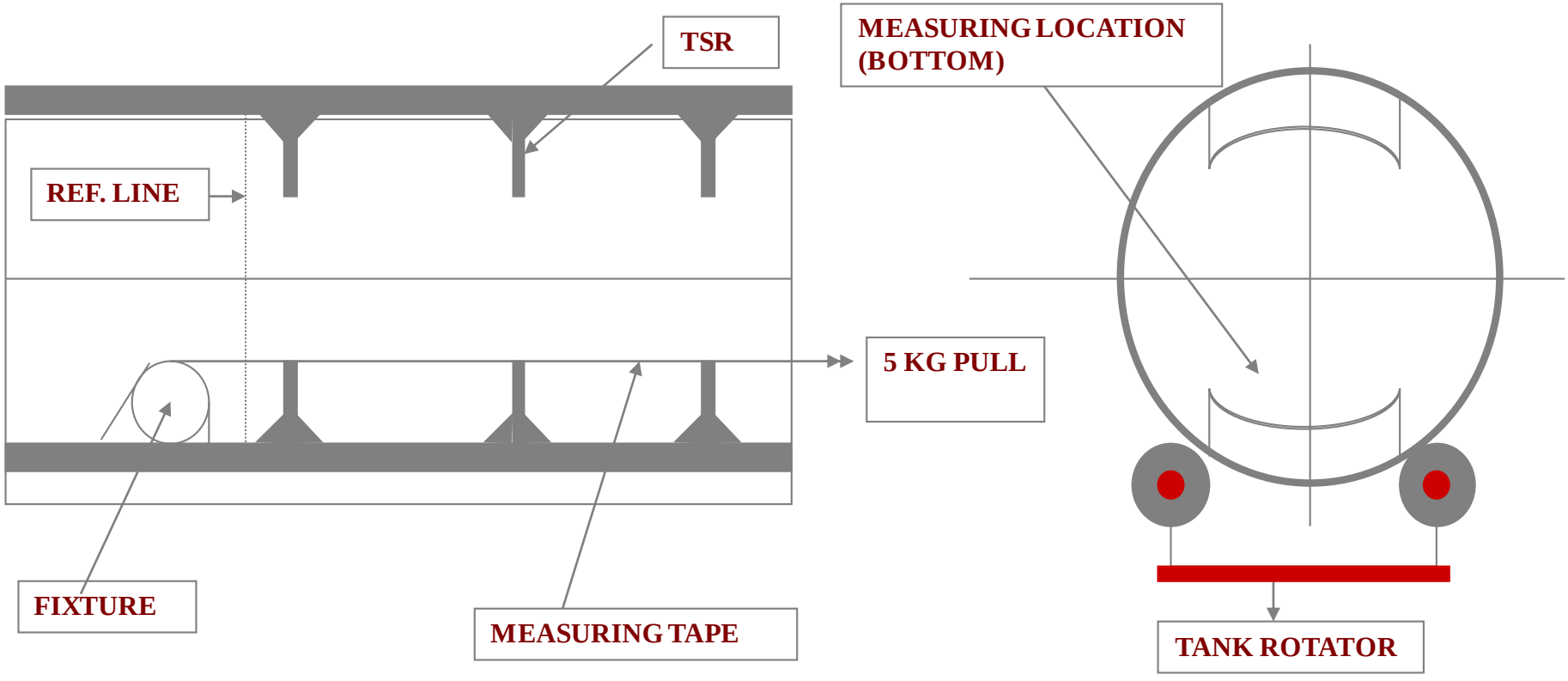
PROCEDURE FOR MEASURING TSR DIMENSIONS

- TAN LINE / REFERENCE SHELL BE CONFIRMED BY INSPECTION.
- VERIFY TAN LINE / REFERENCE LINE ELEVATION.
- CLEAR WELD VISUAL INSPECTION OF TSR # SHELL WELD.
- CHECK FILLET SIZE OF TSR # SHELL JOINT AS PER DRAWING.
- CLEAR NDT OF TSR # SHELL SEAM..
- BUTT WELDS, IF ANY ON TSR SHALL BE GROUND FLUSH.
- ANY DAMAGE ON TOP SURFACE OF TSR IS NOTICED, SAME SHALL BE WELD REPAIRED & FLUSH GROUND.
- CHECK THE TSR ELEVATION FROM TAN LINE / REFERENCE LINE
- USE ONLY CALIBRATED TAPE AND FIXTURE WITH SPRING BALANCE TO MEASURE

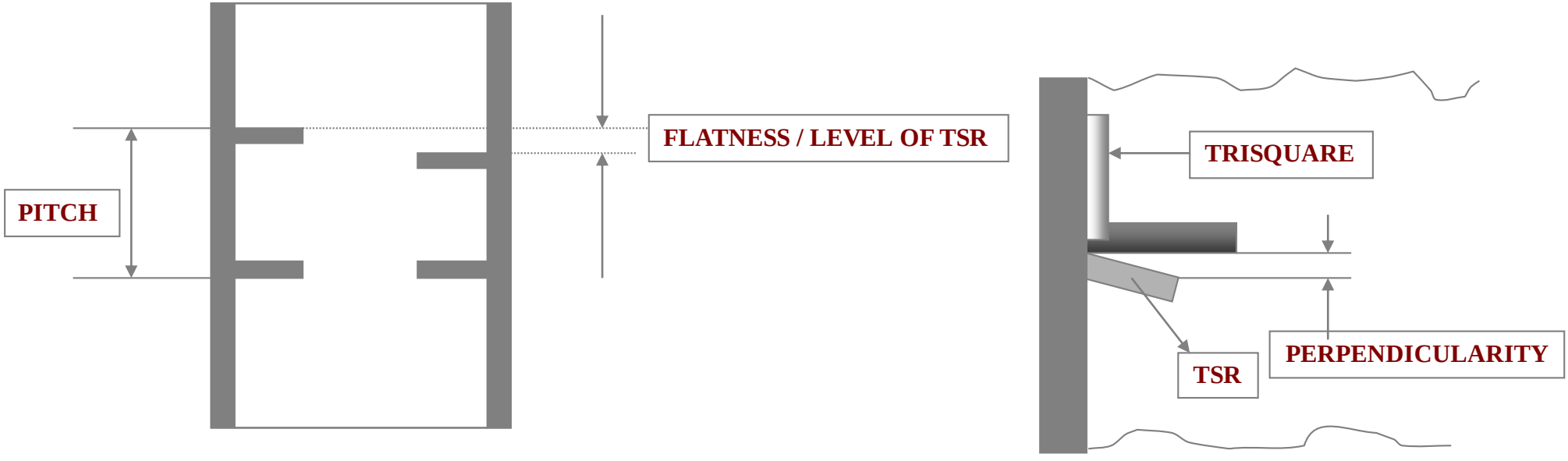
PROCEDURE FOR MEASURING TSR DIMENSIONS

- MEASURE THE TSR ELEVATION AT FOLLOWING PLACES
  a) MINIMUM TWO READINGS PER T.S.R. SEGMENT OF LENGTH < ONE METER
  b) FOR T.S.R. MORE THAN ONE METER MEASURE NEAR BOTH ENDS & EVERY ONE METER FROM OPEN END. (i.e. ONE PASS, TWO PASS, OR FOUR PASS TRAY)
- CHECK THE FLATNESS OF TSR - (MAX. - MIN. READING IN ELEVATION IS THE TSR FLATNESS)
- CHECK THE PITCH BETWEEN THE ADJACENT TSR
- CHECK THE PERPENDICULARITY OF TSR
- CHECK THE STRAIGHTNESS WITH 300 mm LONG SCALE AND IT SHALL BE WITHIN 1mm

PROCEDURE FOR MEASURING TSR DIMENSIONS



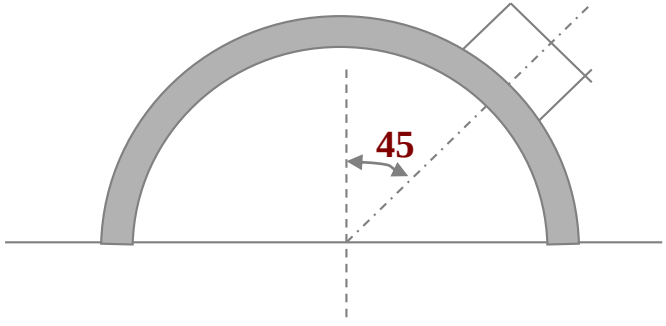
PROCEDURE FOR MEASURING TSR DIMENSIONS



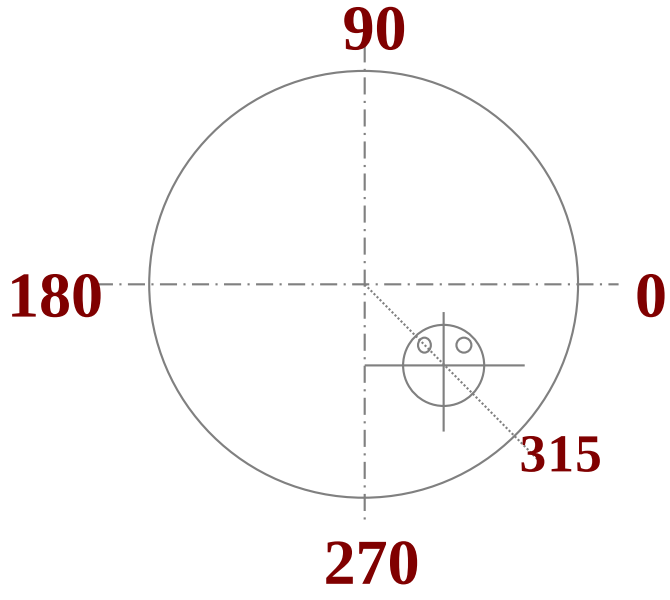
STRADDLING OF RADIAL NOZZLES ON D'ENDS

HYPOTHETICAL DATA FOR NOZZLE :

- NOZZLE INCLINED AT AN ANGLE OF 45 DEG. TO THE CENTRE LINE OF THE VESSEL (SEE SKETCH-1)
- ORIENTATION OF NOZZLE 315 DEGREES. (SEE SKETCH - 2)

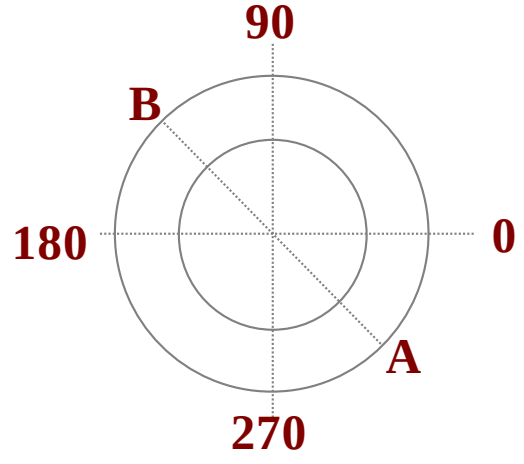


SKETCH 1



SKETCH 2

FLANGE FACE



SKETCH 3

STRADDLING OF RADIAL NOZZLES ON D'ENDS

PROCEDURE :

- MEASURE FOUR FOUR QUADRANTS OF THE FLANGE FACE ALSO MARK THE ORIENTATION LINES i.e. 0-90-180-270 ON THE FLANGE FACE.
- CHECK THE CENTRE-LINE MARKING OF THE D'ENDS
- CALCULATE THE VALUE OF CIRCUMFERENTIAL DISTANCE FOR 45 DEG.(i.e. 315-270 DEG.) BASED ON FLANGE OUTSIDE CIRCUMFERENCE.
- MARK POINT A ON FLANGE FACE AT A DISTANCE EQUAL TO CALCULATED CIRCUMFERENTIAL DISTANCE. (IN POINT NO.3, ABOVE) IN COUNTER-CLOCKWISE DIRECTION FROM 270 DEG. (SEE SKETCH 3)
- SIMILARLY MARK POINT B IN COUNTER-CLOCKWISE DIRECTION FROM 90 DEGREES.
- JOIN POINTS A AND B BY A STRAIGHT LINE.
- MATCH THIS LINE SO OBTAINED (LINE A-B) WITH THE ORIENTATION LINE OF 315 DEGREES MARKED ON THE D'END.

HYDROTEST

ENSURE FOLLOWING PRIOR TO WATER FILLING

1. COMPLETION OF WELDING ON PRESSURE PARTS
2. COMPLETION OF ALL NDT TO THE ACCEPTABLE STAGE
3. CLEARANCE OF ALL PENDING NCR / DCR, IF ANY.
4. FINAL CLEARANCE OF MATERIAL CLEARED PROVISIONALLY
5. TESTING OF P TC / MTC, IF ANY, TO THE ACCEPTABLE TEST RESULTS
6. ALL DIAMENSIONAL CHECK WITHIN THE ACCEPTABLE LIMIT

HYDROTEST

ENSURE FOLLOWING PRIOR TO WATER FILLING

7 VESSEL IS KEPT ON HYDRO TEST SADDLES IN THE SPECIFIED ORIENTATION AS PER THE DRG. ISSUED BY DESIGN DEPT.

8 ALL LONG SEAMS & CIRC. SEAMS ARE MADE VISIBLE FOR INSPECTION.

9 IF JOB IS PRIMER COATED, ALL PRESSURE WELD JOINTS ARE CLEANED FREE FROM PAINT.

10 GASKETS & GASKET SEATINGS ARE CHECKED FOR ANY DAMAGE

HYDROTEST

ENSURE FOLLOWING PRIOR TO WATER FILLING

11 INSIDE SURFACE IS CLEANED

12 AIR VENDING ARRANGEMENTS ARE DONE INSIDE WHEREVER REQUIRD

13 JOB HARDWARES & GASKETS SHOWN IN DRAWING ARE ASSEMBLED EXCEPT HARDWARES SPECIFIED FOR HYDROTEST.

14 ALL FASTENERS ARE TIGHTENED TO REQUIRED TORQUE

15 ALL OPENINGS ARE CLOSSED EXCEPT TOP ONE FOR FILLING WATER.

HYDROTEST

ENSURE FOLLOWING PRIOR TO WATER FILLING

16 ARRANGEMENT FOR PRESSURISING SHALL BE THROUGH ONE OF THE NOZZLES FROM BOTTOM

17 SQUARE BAR ARRANGEMENTS ON INLET AND OUT LET CONNECTIONS.

18 ARROW FOR DIRECTION OF WATER FLOW ON FITTINGS TO BE VERIFIED & CONFIRMED

19 TWO PRESSURE GAUGES OR ONE PRESSURE GAUGE AND ONE TRANSDUCER TO BE MADE AVAILABLE.

20 GRADUATIONS ON GAUGES - TWICE THE TEST PRESSURE (1.5 TO 4 TIMES THE TEST PRESSURE).

HYDROTEST

ENSURE FOLLOWING PRIOR TO WATER FILLING

21 GAUGES & TRANSDUCERS SHALL BE CALIBRATED WITH CALIBRATION STICKER

22 PPM REQUIREMENT OF TEST WATER SHALL BE VERIFIED AND CONFIRMED.

23 HYDROTEST PUMP (HIGH PRESSURE – LOW DISCHARGE OR LOW PRESSURE - HIGH DISCHARGE SHALL BE MADE AVAILABLE

24 HIGH DISCHARGE PUMPS SHALL NOT BE USED FOR VESSELS WITH VOLUM BELOW 10 CUB.MTR

HYDROTEST

WATER FILLING, PRESSURISING & INSPECTION

1. WATER SHALL BE FILLED FROM TOP NOZZLE AND CLOSSED WITH TEST BLANK.
2. TEST BLANK SHALL BE WITH NIPPLE, SQUARE BAR, PRESSURE GAUGE AND PIPE CONNECTION FOR VENDING.
3. INLET VALVE SHALL REMAIN CLOSSED TILL WATER FILLING
4. AFTER BLANKING THE TOP NOZZLE WITH GAUGE AND VEND PIPE, WATER SHALL BE PUMPED FROM BOTTOM

HYDROTEST

WATER FILLING, PRESSURISING & INSPECTION

5. VEND PIPE SHALL BE KEPT OPEN IN A BUCKET FULL OF WATER TO OBSERVE AIR BUBLES.
6. VENDING SHALL BE CONTINUED TILL THE AIR BUBLES IN THE BUCKET IS DISAPEARED.
7. CLOSE THE OUT LET VALVE ON TOP & CONNECT THE GAUGE TO LINE PRESSURE.
8. ISOLATE THE GAUGE AT THE BOTTOM FROM LINE PRESSURE AND PUMP THE WATER IN.
9. RAISE THE PRESSURE TILL 50% OF TEST PRESSURE.

HYDROTEST

WATER FILLING, PRESSURISING & INSPECTION

10. OPEN THE INLET GAUGE TO PRESSURE LINE AND VERIFY THE PRESSURE ON BOTH GAUGES.
11. INCRESE THE PRESSURE IN INCREMENTS OF 10% OF TEST PRESSURE
12. STOP PUMPING FOR 5 MINUTES AFTER EACH INCREMENT OF 10% OF RISE IN PRESSURE.
13. ISOLATE THE INLET PRESSURE GAUGE WHEN PUMP IN OPERATION.

HYDROTEST

WATER FILLING, PRESSURISING & INSPECTION

14. CONNECT THE INLET PRESSURE GAUGE TO LINE PRESSURE WHEN PUMP IS STOPED FOR PRESSURE VERIFICATION
15. WHEN TEST PRESSURE IS REACHED, STOP PUMPING, CONNECT INLET GAUGE TO PRESSURE LINE AND HOLD FOR 30 MIN (AS SPECIFIED IN SPEC) AND OBSERVE THE VESSEL FROM DISTANCE.

HYDROTEST

WATER FILLING, PRESSURISING & INSPECTION

16. REDUCE THE TEST PRESSURE TO ABOVE DESIGN PRESSURE AND INSPECT ALL CONNECTIONS FOR LEAKAGE

17. IF ANY LEAKAGE IS OBSERVED THROUGH GASKET CONNECTION, REPEAT THE TEST AFTER DEPRESSURISE THE VESSEL & TIGHTEN THE STUDS / NUTS.

18. IF ANY LEAKGE IS OBSERVED FROM WELD OR PARENT METAL, DRAIN THE WATER, REPAIR THE LEAK AND REPEAT THE TEST

19. TIME, TEMPERATURE & PRESSURE CHART WHEREVER SPECIFIED SHALL BE OBTAINED

HYDROTEST

IMPORTANT SAFETY POINTS IN HYDROTEST

- DRAIN THE VESSEL ONLY WHEN TOP OUT LET IS KEPT OPEN
- USE MINIMUM 2 GAUGES FOR ANY HYDROTEST
- NEVER USE HIGH DISCHARGE PUMPS FOR TESTING LOW VOLUM VESSELS. (VOLUM LESS THAN 10 M3).
- NEVER PRESSURISE ANY VESSEL ABOVE TEST PRESSURE

Thank You