Thermowell, Thermocouple, RTD

- The thermowell may seem a fairly simple piece of equipment, designed to act as a barrier between temperature sensor and the process medium.
- Yet it is fundamental to the safety of the process; a faulty thermowell can jeopardize the whole operation.
- The main risk comes from vortices forming in the process medium around the thermowell, which can cause vibrations. The stresses caused around the stem of the thermowell by these vibrations can, over time, lead to failure.
- Incorrectly specifying pressure-retaining parts can have disastrous consequences, in the worst cases potentially leading to loss of life, loss of the plant and possible

Monju sodium leak and fire

An accident in December 1995, in which a sodium leak caused a major fire, forced a shutdown of a Nuclear Power Plant (MONJU) in Japan

- the reactor suffered a serious accident. Intense vibration caused a thermowell inside a pipe carrying sodium coolant to break, allowing several hundred kilograms of sodium to leak out onto the floor below the pipe.

- Upon contact with air, the liquid sodium reacted with oxygen and moisture in the air, filling the room with caustic fumes and producing temperatures of several hundred degrees Celsius.

Root Cause of Failure of Thermowell

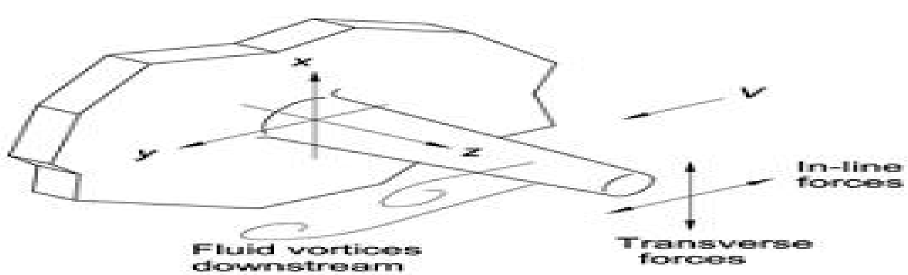
- Design Standard ASME PTC19.3, 1974

  -Failed to address in-line vibration,

  -Failed to assess oscillatory stress independent of steady state bending stresses.

  -Provided no fatigue factor for oscillatory stress or stress intensification factor for fatigue at the thermowell root, and Performed the installed natural frequency calculation in a very crude manner.

- After approximately five years of work, in July 2010, the ASME PTC 19.3TW (2010) standard was published and received ANSI approval



In-line forces were not considered by the 19.3 until the 19.3TW-2010 revision. Previous versions only took transverse resonance into account.

Changes done in new Standard

In most applications, 19.3TW is conservative

- Maximum allowable thermowell immersion lengths much shorter than previously allowed under the old 19.3 regime. This is due to consideration of in-line resonance and oscillating (dynamic) stress.
- Accommodating modern geometries, step-shanks, an unlimited velocity range, a predicted life cycle, rules regarding manufacturing tolerances, dimensional limitations and consideration of corrosion and erosion factors.
- For the first time, 19.3TW made clear that support structures such as velocity support collars are ill-advised and outside the scope of the standard primarily due to impracticalities regarding their manufacturing and installation.
- 19.3TW recognized that all thermowells are not equal in terms of their rigidity and susceptibility to vibration. Values such as the sensor mass, fluid mass and process connection design are incorporated into the calculation of the installed natural frequency of the thermowell.
- Most significant factor impacting thermowell design is the recognition of the need to avoid in-line resonance in most cases—the factor identified as the root cause of the MONJU failure.

How Conval handle Thermowell Calculation

Various views for different perspectives on the calculation are available. Thus the satisfying of the five limits of ASME PTC 19.3:2010 can be seen at a glance in the view 'Pass/Fail' by means of five colored tiles:

Dimensions	**Frequency**	**Steady-State**	**Dynamic**	**Hydrostatic Pressure**

Thermowell Stress Pass / Fail Analysis			
Identifier		0309.00 FKT011 W	
Flow velocity	u	17,27	m/s
Calculation standard		ASME PTC 19.3 TW-2010	
Type		Tapered thermowell	
Mounting type		As-welded	
Thermowell material class		B	
Material number		1.4401	
Elasticity modulus	E	196.250,0	N/mm²
Density of the thermowell material	ρm	7.980,8	kg/m³
Dimensional Limits			
Diameter at the root	A	27,0	mm
Diameter at the tip	B	15,0	mm