



## Residual Stress Experts



- Aerospace
- Conventional Power Generation
- Manufacturing
- Maritime
- Nuclear Power Generation
- Oil and Gas
- Rail and Transport

VEQTER is an engineering company providing excellence in the measurement, analysis and management of residual stresses. We are world leaders in our field and offer expertise on any aspect related to residual stresses in engineering components and structures.

### The Deep-Hole Drilling Technique

The Deep-Hole Drilling (DHD) residual stress measurement technique is a semi-invasive, mechanical strain relief technique (i.e. the strain of the component is measured during stress relief from the removal of a small amount of material). The technique has been successfully applied to a wide range of components and materials for measuring residual stresses.

The DHD technique is similar in principle to the ring core technique in which strain release is measured from the creation of a relatively stress free core of material by machining a ring (i.e. trepanning) around a central “strain gauge”. In this case however, the central strain gauge is a reference hole drilled deep into the component. The diameter of the drilled reference hole is measured, to an accuracy of 0.5µm, before and after trepanning and the difference used to calculate the original stress state. Upon completion of the trepanning process, a cylinder (i.e. core) of relatively stress free material containing the coaxial reference hole is extracted from the component.

VEQTER has a number of dedicated machines for carrying out the Deep-Hole Drilling technique anywhere in the world. At our laboratory facilities or on-site, we can measure residual stresses up to depths of 750mm.

To find out how VEQTER can help you, please contact us on +44 (0) 117 992 7970 or using [experts@veqter.co.uk](mailto:experts@veqter.co.uk)

## DHD Procedure:

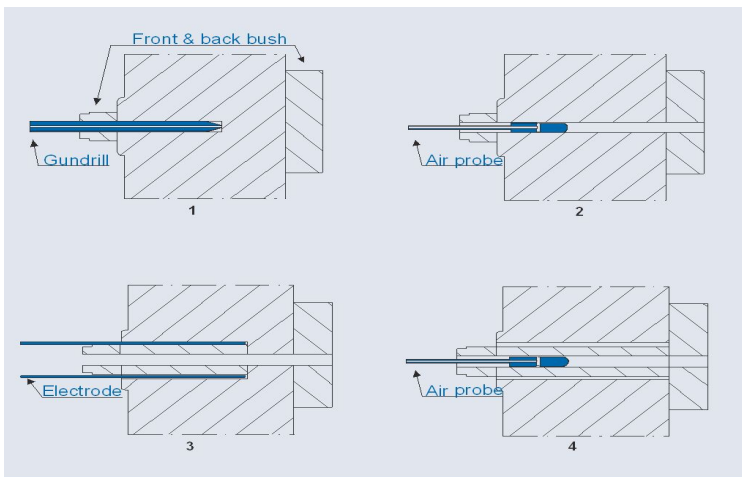
The procedure used for the DHD technique can be divided into 4 basic stages:

Stage 1 – a small diameter reference hole is gun drilled through the component and attached reference bushes ( $\varnothing 1.5\text{mm}$ ,  $\varnothing 3\text{mm}$  or  $\varnothing 5\text{mm}$ ).

Stage 2 – the diameter,  $\varnothing_0$ , of the reference hole is measured through the entire thickness of the component and reference bushes.

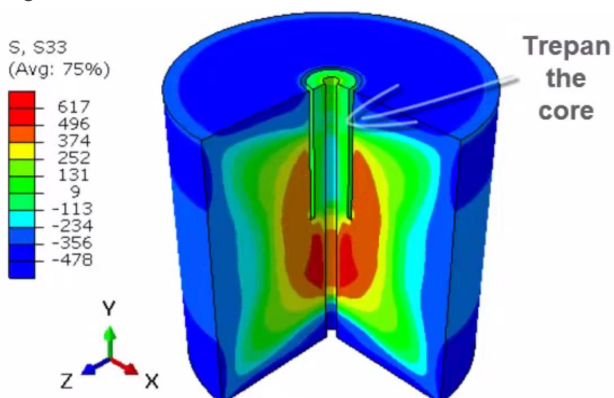
Stage 3 – a cylinder of material containing the reference hole along its axis is cut from the component, using an electro discharge machining ( $\varnothing 5\text{mm}$ ,  $\varnothing 10\text{mm}$  or  $\varnothing 16\text{mm}$ ).

Stage 4 – the diameter,  $\varnothing$ , of the reference hole is re-measured through the entire thickness of the cylinder and reference bushes.



Stages in the DHD TECHNIQUE

The diameter,  $\varnothing_0$ , of the reference hole measured in Stage 2 is the diameter when residual stresses are present. During Stage 3 the residual stresses are relieved, hence the diameter,  $\varnothing$ , of the reference hole measured in Stage 4 is the diameter when residual stresses are not present. Therefore, the differences between the measured diameters in Stages 2 and 4 enable the original residual stresses to be calculated.

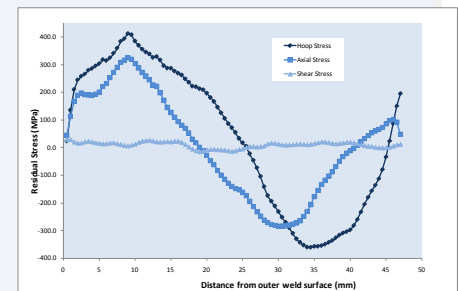


## Incremental Deep-Hole-Drilling (iDHD):

If high magnitude residual stresses ( $>60\%$  yield stress) are present in the component to be measured, then the DHD technique can be modified to account for plastic behaviour during the stress relief process.



Therefore, for iDHD, the procedure is changed to be performed incrementally, with the core being cut (trepanned) in several steps of increasing depth and diameter measurements being performed in between each step. The analysis then incorporates this sequence of incremental distortions for calculating the high magnitude residual stresses.



## Technique Specifications:

- ▲ Residual stresses can be measured at depths up to 750mm;
- ▲ Laboratory or “on-site” measurements;
- ▲ Bi-axial residual stress distribution measured (e.g.  $\sigma_{xx}$ ,  $\sigma_{yy}$  and  $\sigma_{xy}$ ), including stress gradients;
- ▲ Applicable to a wide range of materials;
- ▲ Indifferent to grain structure/texture of the component material;
- ▲ Nominal accuracy: 10MPa – Aluminium, 30MPa – Steel, 15MPa – Titanium;
- ▲ High magnitude residual stresses can be measured with iDHD
- ▲ Semi-invasive:
  - ▲ Enabling repeated residual stress measurements at many different stages in component life;
  - ▲ The resultant hole might need to be re-filled or a mock-up be provided
- ▲ Indifferent to surface finish of component;
- ▲ Not applicable through components of less than 6mm thick.

