CFD sammenligning mot faktisk resultat

av Ole Kristian Våga – Emerson Daniel

En stiller ofte spørsmåltegn ved simuleringer gjort for alvorlige strømningsfortyrrelser som dobbelt bend ut av plan (DBOOP) inkl halvmåneplate oppstrøms en ultralyd gassmåler. Emerson – Daniel har nylig utført nettopp flere tester hos TCC for å se hvordan de teoretiske og faktiske målte profilene samsvarer. Standardene for testing utført er ISO 17089: 2010 og OIML 137 – 1&2: 2012 ettersom disse er nylig revidert og nye krav er lagt til. Full typegodkjenning er da utført ihht oppdatert krav:

OIML R137-1: 2006

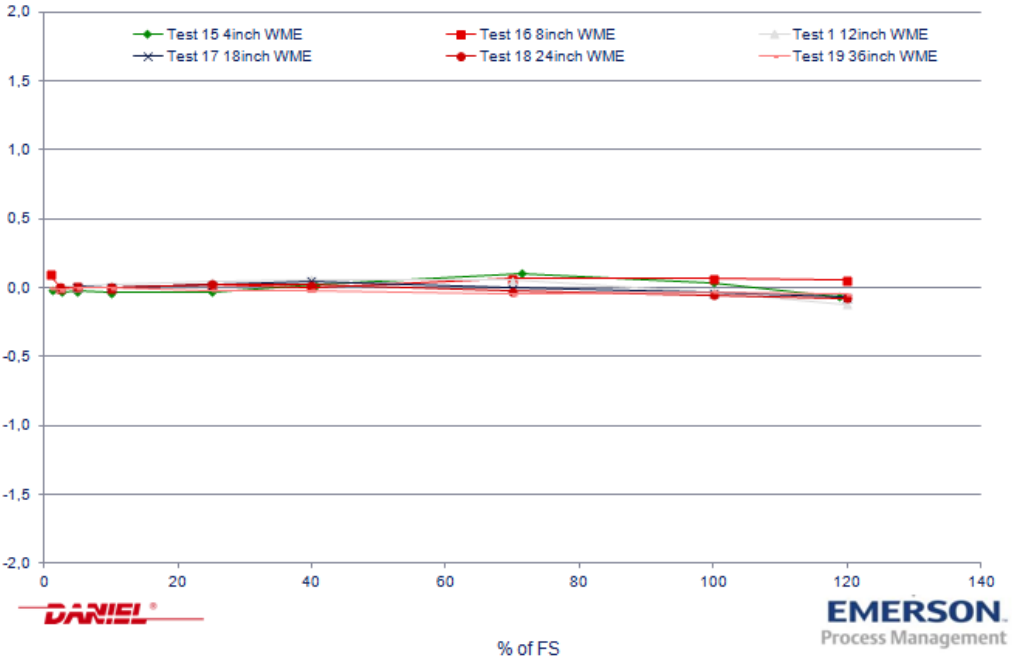
- Annex B
- B.2 Mild flow disturbances
  - DBOOP + expander
- B.3 Severe flow disturbances
  - DBOOP + HMP + Expander
  - Færre tester

OIML R137-1&2: 2012

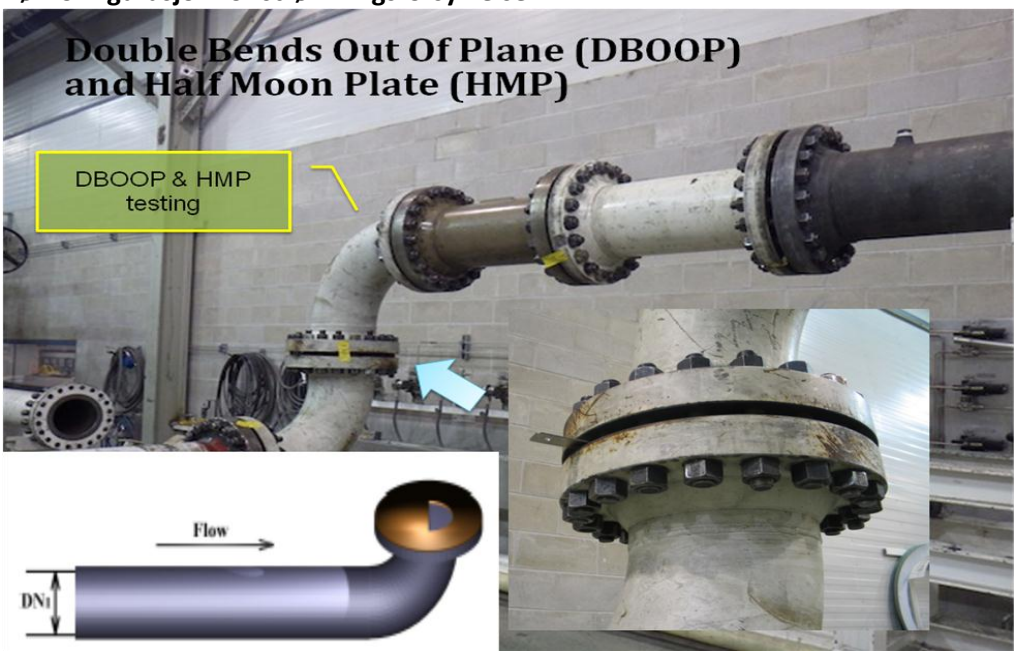
- Annex B
- B.2 Mild flow disturbances
  - DBOOP without expander
- B.3 Severe flow disturbances
  - DBOOP + HMP without expander
  - Flere tester

Før noen som helst testing med strømningsforstyrrelser ble utført kjørte vi en baseline for 4”, 8”, 12”, 18”, 24”og 36”. Kun 12” ble brukt for tester med strømningsforstyrrelser.

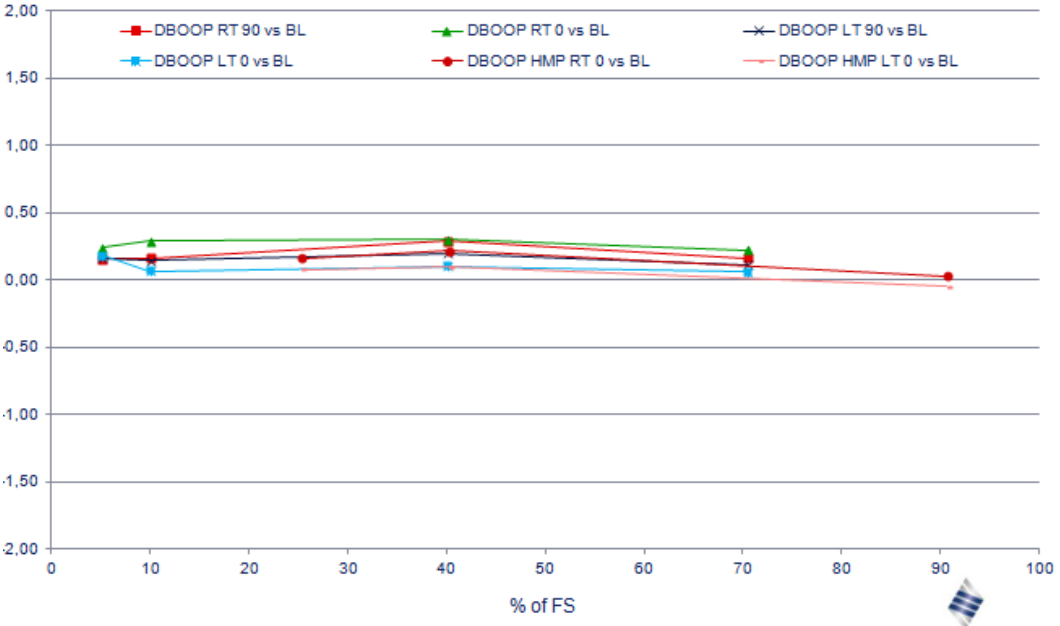
Baseline for alle størrelser:



Rørkonfigurasjon for strømningsforsyrrelser:



Resultater:



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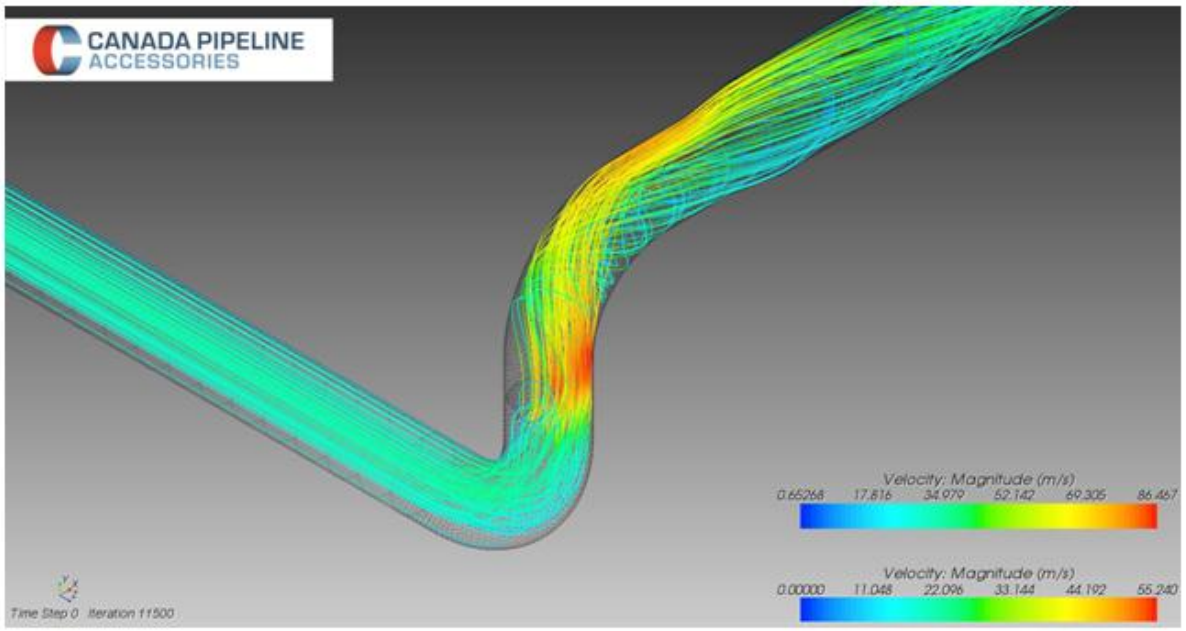
CFD mot faktisk resultat:



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R-137: DBOOP + HMP + 10D

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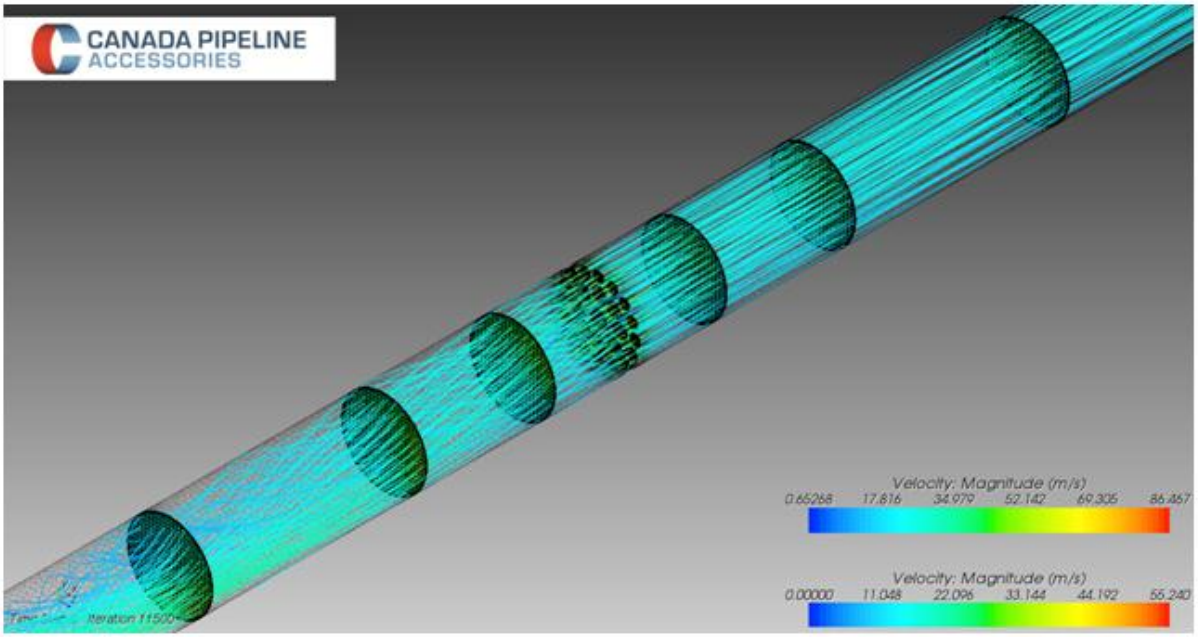

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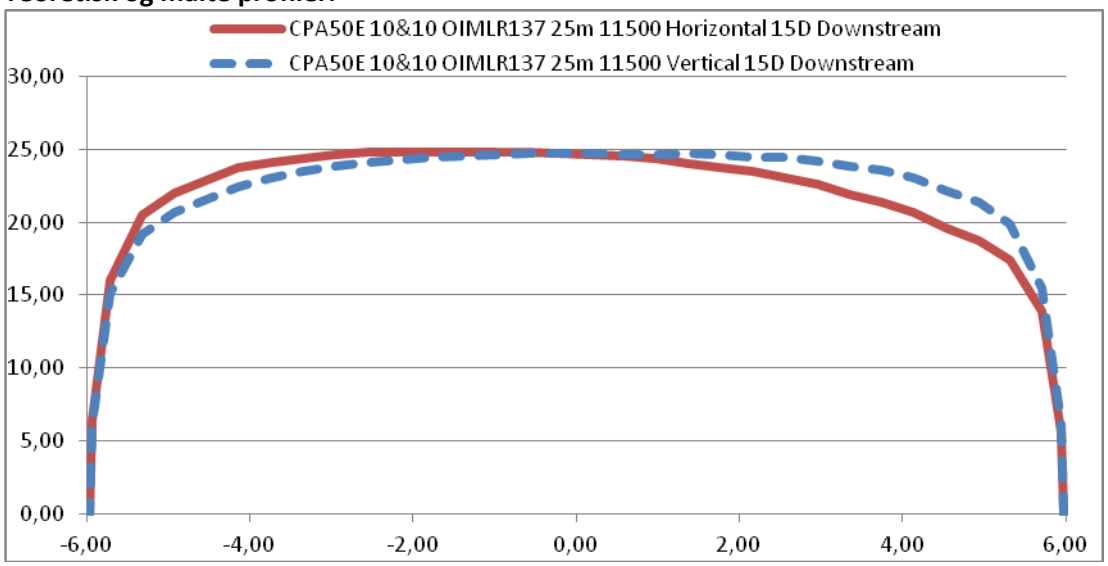
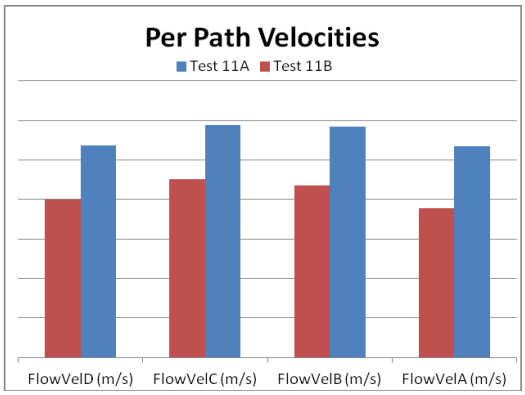
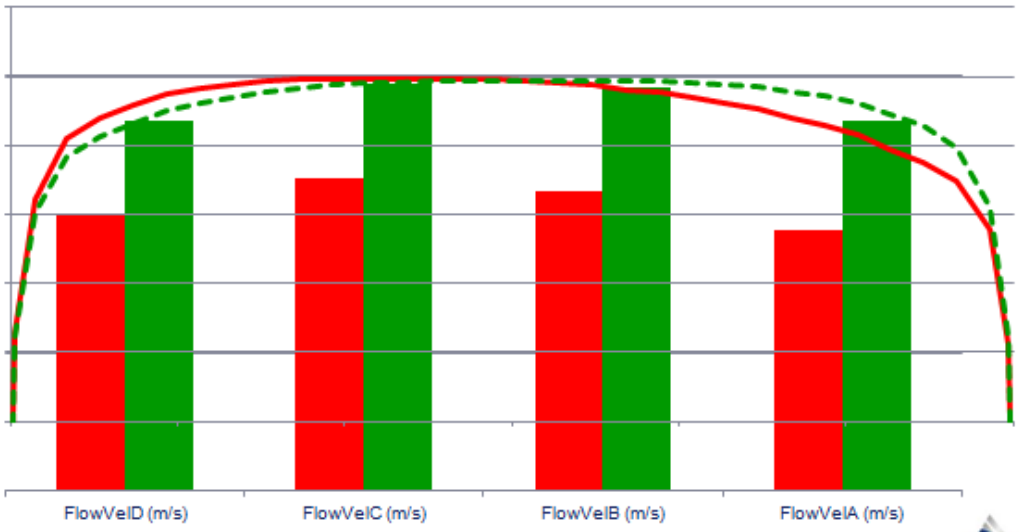
Teoretisk og målte profiler:







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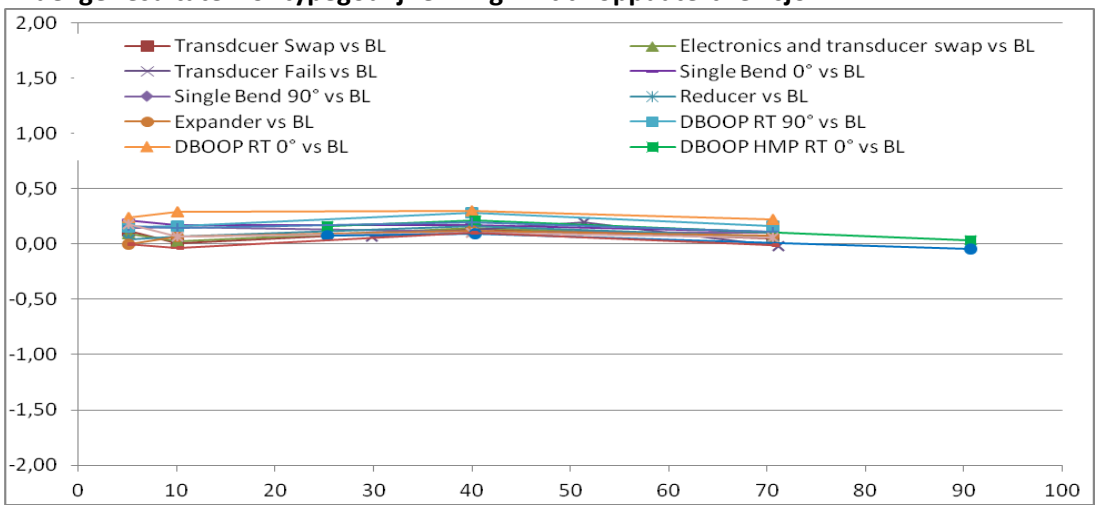
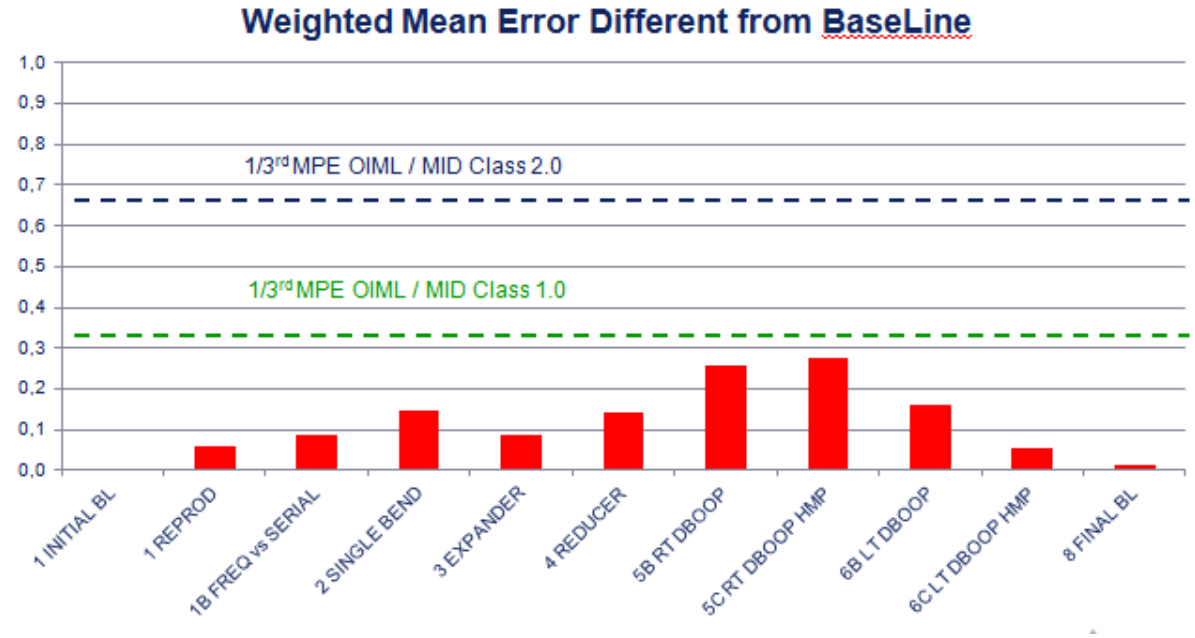
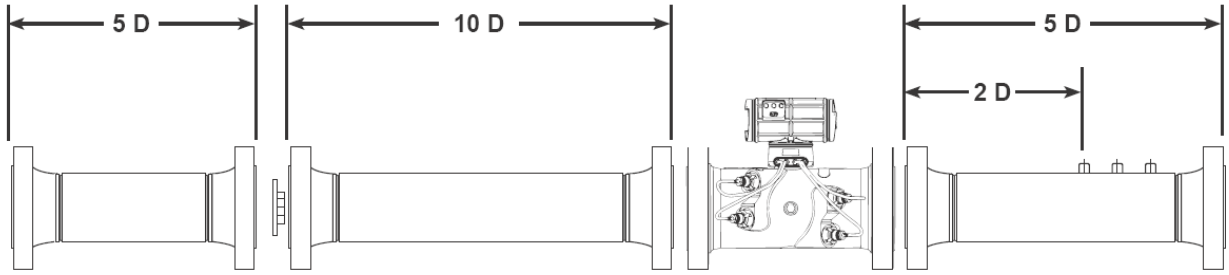
Endelige resultater for typegodkjhenning ihht til oppdatert revisjon:





Konklusjon:
OIML og ISO perturbation testing for typegodkjenning, selv om det er et kostbart og tidkrevende arbeid, bringer testresultater som hjelper oss å forstå og redusere effekten av strømningsforstyrrelser og dermed reduserer måleusikkerhet.

Resultatene av utført testing er godt innenfor OIML og MID Klasse 1,0% ved bruk av 5D - FC - 10D - USM - 5D, da de fleste er innenfor klasse 0,5%.



Ytterligere forbedring kan forventes med en mer effektiv flow conditioner og/eller lengre Lmin. Dual multipath meter (2 x 4, 1 x 8) vil også ytterligere hjelpe å redusere effektene strømningsforstyrrelser utgjør på måleusikkerheten.

OIML 137-1 & 2: 2012 er strengere i forhold til OIML 137-1: 2006

CFD samsvarer med faktisk reslutat.

Standarder brukt for typegodkjenning:

Table B.1 - Piping configurations for flow disturbances

Test		Test conditions	Remarks	Turbine	Ultrasonic	Thermal mass	Vortex
a		Reference conditions	approx. 80 D straight line		X	X	X
			approx. 10 D straight line (see Note)	X			
b		A single 90°-bend	radius elbow: 1.5 D	X	X	X	X
c		Double out-of-plane bend	rotating right; radius elbows: 1.5 D	X	X	X	X
d		Double out-of-plane bend	rotating left; radius elbows:1.5 D	X	X	X	X
e		Expander	one step difference of the pipe diameter is applied angle of expansion/reduction part : ≤ 15°		X	X	X
f		Reducer			X	X	X
g		Diameter step on the upstream flange	approx. +3% and – 3%	X	X		X
+		Half pipe area plate	image shows first bend in piping and mounting of half-moon plate.	X	X		

OIML 137 -&2: 2012

6.4.4 Installation conditions

For a standardized set of perturbations, the l_{min} of every perturbation shall be determined:

a) under reference flow conditions;

b) with a single 90° bend (radius of curvature of 1,5D):

   1) with the USM in normal position,

   2) with the USM rotated by 90°;

c) with two 90° bends in perpendicular planes (radius of curvature of 1,5D, without spacer between bends):

   1) with the USM in normal position,

   2) with the USM rotated by 90°;

d) an expander with a diameter increase of at least one pipe size [typically $2^{*1)}$];

e) a reducer with a diameter decrease of at least one pipe size [typically $2^{*1)}$];

f) a diameter step on the upstream flange of the USM with magnitude of +3 % and –3 % (or larger values if the manufacturer allows for larger steps);

g) a flow conditioner chosen and positioned by the manufacturer in combination with perturbations above.

The single tests shall be conducted for at least one flow rate below $q_{V,\,t}$ and for at least two different flow rates above $q_{V,\,t}$, according to 6.4.2. Relevant are the mean values of the three single measurements at each flow rate. Above $q_{V,\,t}$, all calculated mean additional errors shall be within 0,3 %.

Instead of the perturbation tests described in a) to g), similar tests with different perturbation-producing devices are allowed, such as perturbation plates (e.g. swirl generators). In that case, it shall be clearly shown that the velocity fields produced are similar to the perturbations presented in a) to g), for instance via the measurement of the three-dimensional velocity field.