Intra-comparisons

What is the point?

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**Add value.
Inspire trust.**

Content

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Intercomparison Vs Intracomparison

Inter Vs Intra
Summary of what and why

- **Intercomparisons** are the gold Standard
    - They compare results between different laboratories
    - Commonly happen through coordinated round robins
    - Show transparency between multiple labs
    - Help identify systematic errors
    - Logistically challenging and time intensive
    - Can be difficult to cover full operating envelope all of labs involved
    - Often a requirement for accreditation

- **Intracomparisons** are completed internally within a lab
    - Used to check internal consistency and identify issues like operator bias
    - Quick and cheaper
    - Risk of correlation with same traceability chain overlaps
    - Possibility of hiding a whole lab systematic mistake
    - Offers confidence to users of lab when paired with intercomparisons

2

Key Technical Considerations

Technical Considerations

1. What is the measurement capability of the facilities? Mass, Volume or both?

2. How do you compare facilities with different operating conditions such as Temperature, Pressure, Viscosity?

3. Difference of uncertainty in measurement between the facilities

4. Transfer standard's history of repeatability and reproducibility

5. Facilities may have multiple references, it is important to ensure that a section of the facilities capabilities is not missed out

3

Case Study with Data Analysis Method

How to Complete an Intercomparison

Total expanded uncertainty calculation

- Baseline uncertainty of facility/lab/rig test is being completed in

$$U_{tot} = k\sqrt{u^2{}_{lab} + u^2{}_{rpt}}$$

- Uncertainty of the mean
  - Standard Deviation Approach
  - Not to be confused of API repeatability specification

Equivalence Calculation En

$$En_i = \frac{x_i - x_{ref}}{2\sqrt{u^2(x_i) - u^2(x_{ref})}}$$

Weighted Mean Average

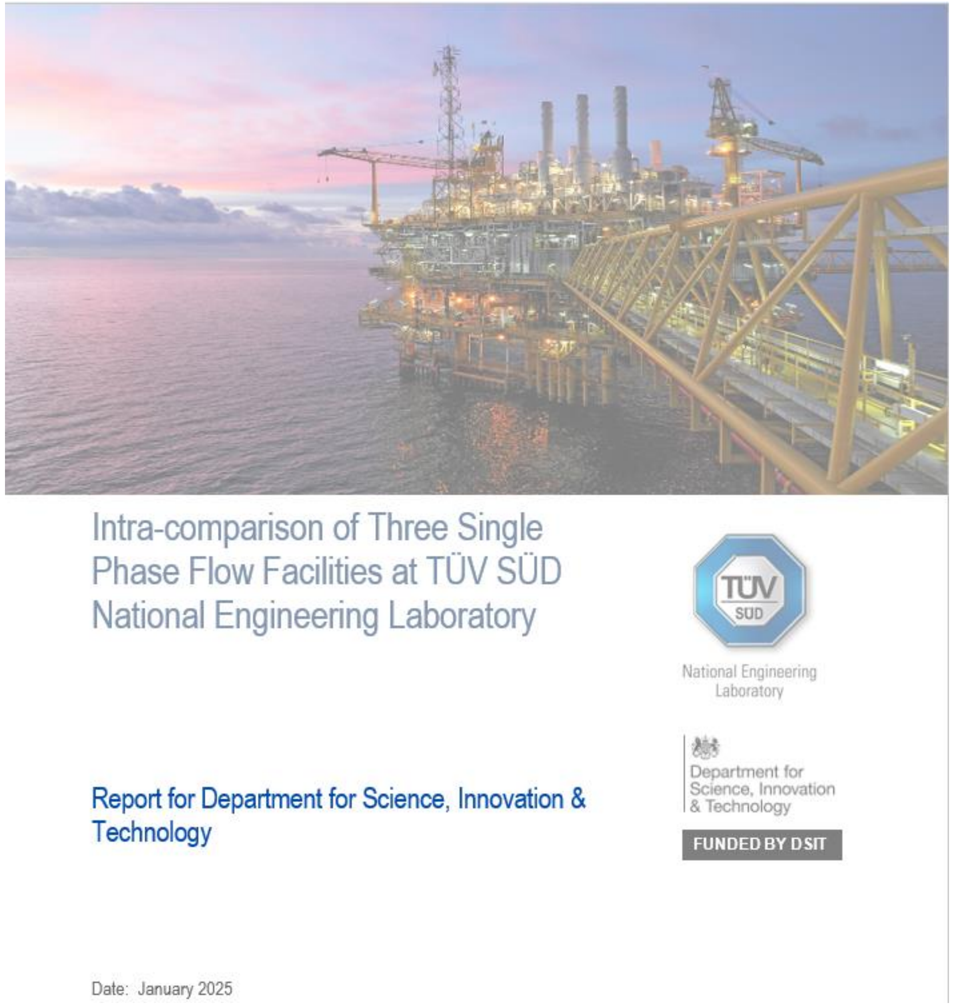
En<1 = GOOD

$$E_n = \frac{KF_x - KF_y}{\sqrt{U_x{}^2 + U_y{}^2}}$$

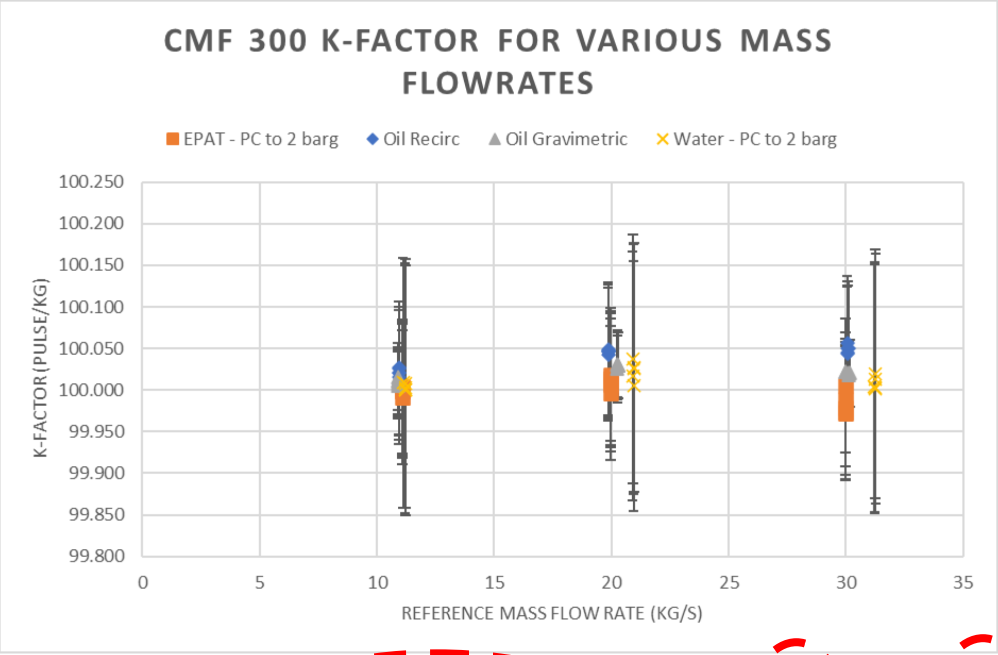
Direct Comparison

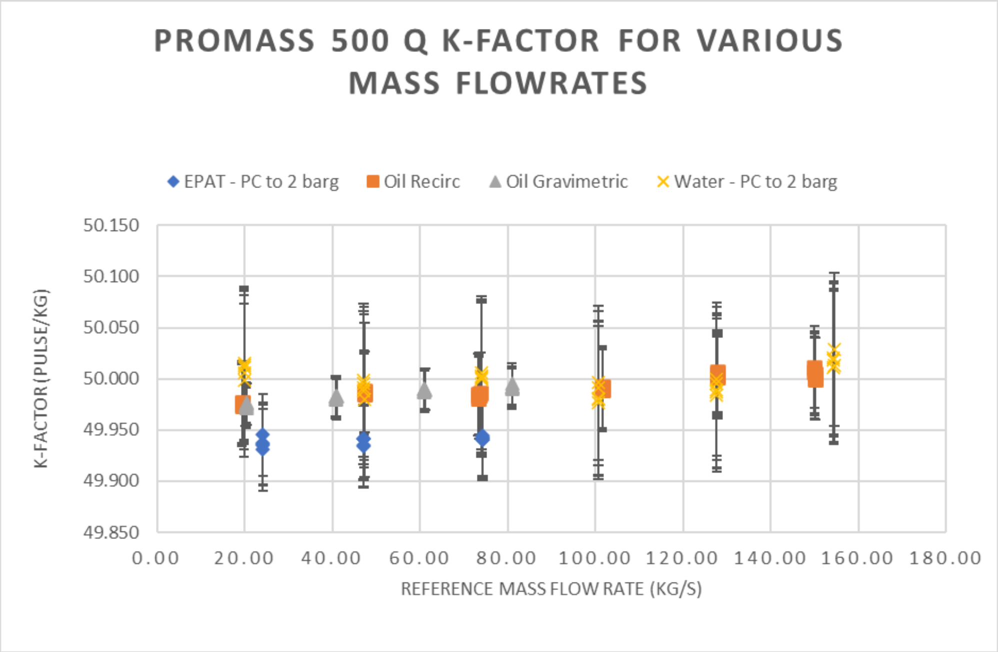
TUV SUD NEL Case Study

- We conduct intercomparisons annually and produce reports for DSIT and use them as evidence for UKAS accreditation.
- We use transfer standards of both mass and volume with extensive history from multiple manufacturers
- An example one completed in January 2025 used two Coriolis flow meters
  - 3” meter from Emerson
  - 6” Meter from Endress and Hauser
- Enabled the majority of the flow range to be assessed across three single phase liquid flow facilities
- All facilities are accredited to ISO/IEC 17025
- Provides confidence in the facility and transparency to industry



NEL Results





Mass Flow Rate (kg/s)	Oil Gravi. En	Water En	EPAT En	Oil Recirc. En	Weighted mean K.F (pulse/kg)	Weighted Mean Standard Absolute Uncertainty (pulse/kg)
11.03	0.00	0.04	0.15	0.16	100.010	0.016
20.26	0.02	0.04	0.26	0.25	100.028	0.016
30.35	0.08	0.07	0.48	0.41	100.019	0.016

Mass Flow Rate (kg/s)	Oil Gravi. En	Water En	EPAT En	Oil Recirc. En	Weighted mean K.F (pulse/kg)	Weighted Mean Standard Absolute Uncertainty (pulse/kg)
20.96	0.16	0.25	0.45	0.08	49.97	0.016
45.63	0.24	0.09	0.51	0.15	49.976	0.016
75.7	0.36	0.12	0.56	0.01	49.983	0.016
101.15	-	0.02	-	0.03	49.989	0.035
127.78	-	0.06	-	0.08	50.001	0.035
152.24	-	0.06	-	0.08	50.008	0.035

4

UKAS re-accreditation of Oil Facility

UK Primary Standard Oil Flow Facility

- First major upgrade to United Kingdom National Standard Oil Facility in almost 30 years
- Replacement of all electrical connections, Data Acquisition Hardware, Secondary Reference Flowmeters and Primary Reference
- Effectively we have a brand-new facility but the same operating measurement principles
- How do we go about gaining accreditation and more importantly how to reduce the time as much as possible whilst not reducing the standard?
- Intercomparison and history of multiple transfer standard devices!
- We received UKAS accreditation in few weeks instead of months and all through a desktop review!

UK Primary Standard Oil Flow Facility

Pre-upgrade	Post Upgrade
Gravimetric Uncertainty ±0.04 % (k=2) Secondary Reference Uncertainty ±0.08 % (k=2)	Gravimetric Uncertainty ±0.02 % (k=2) Secondary Reference uncertainty ±0.07 % (k=2)

Thank you

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Extra results – Oil Accreditation