Project	Description
Heavy Oil Multi Phase Fiscal Measurement, North Slope, Alaska, USA	Two studies examined the measurement of Heavy Oil with a venturi based multi phase flow meter and dual energy gamma phase sensor (VDG*) for a 3rd party entrant to an existing production facility. The oil standard volume allocation uncertainty was required for regulatory approval and allocation tariffs: 1. Measurement of Heavy Oil with the VDG multi phase flow meter venturi flow element has additional uncertainty due to high viscosity resulting in low Rn (Reynolds Number) and consequently a decrease in the Cd (Coefficient of Discharge). Uncertainty in the viscosity used to calculate Rn and in the empirical curve fit of Cd to Rn combine to increase Cd uncertainty. The curve fit from an SPE paper on Heavy Oil was used and was validated by comparison with a Heavy Oil study by an operator and other recognised sources. The high viscosity was due to the Heavy Oil and a tight emulsion anticipated due to the use of downhole ESP's (Electrical Submersible Pump). A RSS (Root Sum Square) model of the VDG meter was developed using vendor's performance data to find the oil standard volume uncertainty for a range of GVF, WLR, liquid viscosity and flow rates for three sizes of meter encompassing the forecast production and fluid properties. 2. The VDG multiphase flow meter uncertainty model was updated to include an analytical model of the Dual Gamma Phase Detector to find the phase measurement based on physical characteristics of the sensors and fluids. Verifiable performance data could not be obtained necessitating this analytical approach. Due to the complexity of the phase sensor equations MCS (Monte Carlo Simulation) was used to find phase uncertainties and combined with the RSS uncertainty model of the VDG Venturi Flow Element and instrumentation. This hybrid RSS/MCS uncertainty model was used to find the oil standard volume uncertainty matrix for the forecast operating envelope and fluid properties. Regulatory approval was obtained and the uncertainty matrix used to calculate 3rd party tariff charges.
High GVF Multi-Phase Allocation Measurement, Gulf of Mexico, USA	Three studies examined the allocation options and uncertainty for a 3rd party sub-sea field development and impact on the allocation uncertainty exposure of the existing TLP (Tension Leg Platform) direct drilled well production. The 3rd party production forecast was for a GVF range of 70% increasing to over 99%: 1. 3rd party production measurement uncertainty was found for two topsides VDG meters prior to commingling with existing production upstream of the LP and HP separators. The 3rd party oil and gas allocation was found from the oil and gas phase measurements at standard volume after adjustment for vapour-liquid exchange in the process. The existing direct drilled oil and gas allocation uncertainty was found from the difference between fiscal oil and gas sales export quantities and the 3rd party allocation. Uncertainty was found for the forecast production including changes to the venturi flow element and differential pressure ranges to minimise the phase measurement uncertainty and allocation uncertainty.

Continued

	2. Due to differences in Royalty rates for each field the regulator required that production from both fields should be measured prior to commingling. Two additional topsides VDG meters were needed to measure the existing direct drilled LP and HP oil and gas production. The fiscal oil and gas export quantities are allocated to the production from each field after adjustment for vapour-liquid exchange. The meter phase uncertainty and allocation was found with a hybrid RSS/MCS model using the vendor's performance data. 3. Once the project received the go-ahead a venturi based multi phase flow meter with a tomographic phase detector (MPT*) was selected following a bid evaluation which found the meter was more suitable for the forecast high GVF. The study looked at the uncertainty of the MPT meter based on the verified vendor performance data with allocation by mass component removing the need to compensate for vapour-liquid exchange in the process. The project included witnessing and acceptance of the four MPT meters at the FAT (Factory Acceptance Test).
High GVF Multi Phase Allocation Configuration Study, North Sea, UK	Two studies estimated the uncertainty and bias utilising the SOLV VDG multi phase flow meter uncertainty model: 1. The phase measurement uncertainty was found at recent production rates for a meter configuration which had been in use for five years. 2. A revised configuration based on recent samples was used with the model to find the phase measurement uncertainty thereby demonstrating the reduction in uncertainty and bias achieved by use of a representative meter configuration.
Proposed Multi Phase Allocation Measurement, North Sea, Norway.	A 3rd party development over an existing platform proposed allocation with a dedicated 3-phase HP Separator, with measurement on each outlet, on a large skid located above the existing process equipment. The client proposed an alternative design using three MPT multi phase flow meter's on a small cellar deck skid that would save the project up to $30m and reduce additional platform loading by over 100 tonne. The study used the 20 year P50 production forecast with flowline simulation results for three years, when the flow regime changed, to estimate the steady state and slug flow rates, which were primarily liquid slug flow. These were used with verified MPT meter performance data to find the overall oil and gas flow measurement uncertainty for each forecast year.

For further information and downloads of papers and presentations visit www.solv.net or call or email us at the contacts listed below.

* Due to the terms of client and vendor confidentiality agreements company, project and product names are not shown.

Address: **SOLV Limited**, Glenafton House, Albyn Drive, Corpach, Fort William, Scotland, UK
Postal Code: PH33 7LW

Telephone: +44-(0)1397 773190
Mobile +44-(0)7884-314402
Facsimile: +44-(0)7884-613669
Email: contact@solv.net
Internet: www.solv.net
www.flowsolv.com