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Technical Paper

From Tie Back to Allocation Business: A prerequisite is to understand the different methods and their Impacts for fair trade

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1. ABSTRACT

Flowrate measurements are essential to the oil and gas industry for quantifying and optimizing the production but also for taxation, custody transfer, allocation, reservoir management, well testing, environmental reporting purpose. A given flowrate measurement is entirely and correctly defined if, and only if, it is accompanied by its associated uncertainty.
The uncertainty is the degree of doubt about measurement, and it is related to a confidence interval to represent the likelihood that the real value of the measurement is within a specified interval.
A reported measurement should specify these 3 quantities: the reading, the associated uncertainty, and the confidence level, but this is far to be the standard practice in the oil and gas industry. Today with roughly 100million BOPD, this is a business value of roughly $6Bn per day, and an error of 0.1% leads to more than $2Bn revenue per year, which can be a gain or loss during the trading among the partners.
To trade successfully, companies must have a regulatory framework based on measurement confidence or uncertainty, but examples often are forgetting that allocation is also versus the quality of the produced fluids and final mixed product. A 30°API and 45°API oil have not the same value for a given volume, and this needs to be considered.
The paper is proposing thru simple examples to show the impact of the allocation for a given hypothetical field either based on proportional based allocation, uncertainty-based allocation, and by value adjustment. When the uncertainty in a measurement is adequately assessed and stated, the fitness for the measurement can be proven and judged, and the allocation process should reflect such effort in obtaining the lowest uncertainty value.
These scenarii will show how the production reconciliation can be drastically different for the different end-users and how important this should be understood clearly and applied adequately for fairness in business.

2. INTRODUCTION

Flowrate measurements are essential to the oil and gas industry for quantifying and optimizing the production for taxation, custody transfer, allocation, reservoir management, well testing, environmental reporting purpose. A given flowrate measurement is entirely and correctly defined if, and only if, its associated uncertainty goes with it.
The uncertainty is the degree of doubt about the associated measurement, and it is related to a confidence interval to represent the likelihood that the real value of the measurement is within a specified interval.
A reported measurement should specify these 3 quantities: the reading, the associated uncertainty, and the confidence level, but this is far to be the standard practice in the oil and gas industry.

To trade successfully, companies must have a regulatory framework based on measurement confidence or uncertainty, but examples often are forgetting that allocation is also versus the quality of the produced fluids and final mixed product; in this case, we are talking about Value Adjustment.
Indeed, a 30°API and 45°API oils have not the same value for a given volume, and this needs to be considered. They are mostly 4 different primary methods of allocation, thru some simple examples, it will be shown the impact of the allocation for a given hypothetical field either based on proportional based allocation, uncertainty-based allocation and by value adjustment. When the uncertainty in a measurement is assessed and stated correctly, the fitness for the measurement can be proven and judged, and the allocation process should reflect such effort in obtaining the lowest uncertainty value. The allocation technique not presented inside this paper is using the difference method, we believe this technique of allocation should be avoided and applied only if no other techniques could be applied either due to limitation from a technical point of view or high associated costs to implement it. For a reminder, this allocation system will be used for the next 20-40 years of the life of the field or well, and then the loss could be significantly high.
Multiple scenarii will show how the production reconciliation can be drastically different for the end-users and how important this should be understood clearly and applied adequately for fairness in business. It will be interesting to show that each producer could be interested in implementing either one technique of the others.

3. OVERVIEW

Usually, oil or gas production from various wells is commingled within a production line before being sold at the fiscal metering point. The allocation measurement is the technique used to correct the recorded production from the sum of the claimed production from the current flow metering devices against high accuracy (low uncertainty to be right) flowmeter or in other words, fiscal flow metering. Numerous documents exist about the techniques of allocation; there are also two primary standards which is presenting and referring to these techniques (Ref [2] [3]), namely the recommending practice of the ISO RP 85 (dedicated to subsea wet gas flowmeters) and the manual of petroleum measurement standards chapter 20.1, which is much more generic. The following chapters will be looking at the allocation from the volumetric flowrate point of view; however, it should be noted that this allocation could be done in mass or even better terms in energy (the last one being common for LNG, as an example). The variable Q, in this document, is standing for the volumetric flowrate of either oil, gas, and water. Often, we may refer to oil flowrate, but allocation can be done on all the fluid types for different purposes. Usually, there is an imbalance Δ between the sum of the flowrates from the upstream conditions and fiscal flowmeter, which is usually present at the export line. The imbalance production is used to equitably assigned a correction to the different flowrate from the upstream conditions.
We are assuming in this document that all the relevant analyses against fluid properties or equations of states and stability of the fluid have been done, is not the purpose of this document to make an inventory of the different processes and calculations to obtain such values.
Usually, the allocation is also needed by state or local authorities, being related to tax against oil and gas production. In some cases, the regulatory agency may stipulate the techniques of allocation and the frequency for such reporting.

We can evaluate the imbalance by:

$$\Delta\Big]_{Tier\_X} = Q_{Outflow}\Big]_{Tier\_X} - Q_{Inflow}\Big]_{Tier\_X} = \Delta = Q_{Out} - \sum_{k=1}^{n} Q_{in\_k} \quad (1)$$

The concept of a tier is presented in the section "Procedure to establish the allocation ". Qout stands for the flowrate leaving the current tiering section, and Qin_k is standing for the multiple productions coming inside the current tiering section.

3.1. Proportional-based allocation method

The proportionally based allocation method is the most straightforward technique which is based on the recording of the quantity measured for the different devices, (again this could be either oil, or gas, or water), and then using pro-rata of the production at the given device over the total production registered at the fiscal flowmeter. With such a technique of allocation, the quality of the measurement or the uncertainty associated with the flow metering device is not considered. There is no incentive in this case to keep the maintenance of the equipment used upstream in the best conditions.
It is possible to establish the coefficient α which is a correction that should be applied to each device upstream, as presented below for a given tier, with the subscripts "in" representing the flow coming inside this tiering section, and "out" the flow coming out of the same tiering:

$$\alpha_{in\_i} = \frac{Q_{in\_i}}{\sum_{k=1}^{n} Q_{in\_k}} \quad (2)$$

And, it can be verified that

$$\sum_{i=1}^{n} \alpha_{in\_i} = \frac{\sum_{i=1}^{n} Q_{in\_i}}{\sum_{k=1}^{n} Q_{in\_k}} = 1 \quad (3)$$

and the corrected flowrate for the given metering device "i" is then obtained by:

$$Q_{in\_i\_Correct} = Q_{in\_i} + \alpha_{in\_i} . \Delta \quad (4)$$

$$Q_{in\_i\_Correct} = Q_{out} \frac{Q_{in\_i}}{\sum_{k=1}^{n} Q_{in\_k}} = Q_{out} . \alpha_{in\_i} \quad (5)$$

3.2. Uncertainty-based allocation method

Uncertainty-based allocation (UBA) uses the uncertainty in the measurement through some equations to balance the difference between the entire claimed production and the export of fiscal flowmeters. This method, at the opposite of pro-rata allocation, promotes the use of the best flow metering devices (i.e., lower uncertainty); this will limit the impact of the imbalance on such high-quality system and, at contrary, underscoring equipment having a poor uncertainty will be more affected. The reader can refer to the reference [1] to see the mathematics, which is used to develop such an allocation technique.

The correction factor can be formulated in this case as presented below, and the equations (1) & (4) are still valid:

$$\tau_{in\_i} = \sigma_{in\_i} \cdot Q_{in\_i} \quad (6)$$

and $$\alpha_{in\_i} = \frac{\tau_{in\_i}^2}{\tau_{out}^2 + \sum_{j=1}^{n} \tau_{in\_j}^2} + \frac{Q_{in\_i}}{\sum_{j=1}^{n} Q_{in\_j}} \cdot \frac{\tau_{out}^2}{\tau_{out}^2 + \sum_{j=1}^{n} \tau_{in\_j}^2} \quad (7)$$

with $$Q_{in\_i\_Correct} = Q_{in\_i} + \alpha_{in\_i} . \Delta \quad (4)$$

Inside the formula (7) is highlighted in blue, the additional parameters which are used against the proportional allocation presented earlier (2). σ_i is standing for the relative uncertainty for a given device "i"; and τ_I is representing the absolute uncertainty in the same unit than the flowrates Q_{in}.

3.3. Value adjustment on Uncertainty-based allocation method

If the earlier techniques of allocation are purely based on volumetric flowrate (inside this paper) or energy or mass, the allocation could also be done from a revenue or value point of view associated with the production coming from each well. Said in different words, each oil has an associated API value, and when mixed together the value will be higher than some of the wells and lower for the others, by introducing the financial value of the production, it is possible to correct the volumetric flowrate allocated based on the difference in terms of price between the different produced oils. The value adjustment could be made on any type of allocation.
However, we believe that the interest of such a method should be used when a fair and equitable business has been proven between the different parties, which means, in this case, using the best allocation system (uncertainty-based allocation). The allocation, in this case, has two distinct steps, the first one based on a volumetric allocation and associated correction, the second proving the value of the mixed oil and corrected against the value of the oil for each well. For the first step, we had already:

$$Q_{in\_i\_Correct} = Q_{out} . \alpha_{in\_i} \quad (4)$$

This is corrected by the ratio of the value at the device "i" versus the outflow production value (i.e., quality of the mixture of fluids). The formula below is generic whatever is the allocation techniques used to set up the volumetric flowrate:

$$Q_{in\_i\_Correct\_VA} = Q_{in\_i\_Correct} \cdot \frac{ValueAPI_{in\_i}}{ValueAPI_{out}} = Q_{out} \cdot \frac{ValueAPI_{in\_i}}{ValueAPI_{out}} \cdot \alpha_{in\_i} = Q_{out} \cdot \beta_{in\_i} \cdot \alpha_{in\_i} \quad (8)$$

3.4. Procedure to establish the allocation

Whatever the techniques of allocation used, the process is the same and starts from the selling point of the terminal device measuring or the outflow of the field and goes against the flow direction up to the inflow condition of the wells. Usually, it will be necessary to split the process into different steps (also called "Tier"), which includes a commingled production systematically. Figure 2 below is showing 3 tiers. The process, in this case, will be to analyze first the Tier 1, then either the Tier#1-1 and Tier#1-2, it should be noted that we are not necessarily following the convention which is presented inside the API [3], we believe it is more comfortable in the complex allocation system to identify the path followed by the fluid research writing convention of Tier#x-y. The convention about the meaning of the number presented inside the boxes is explained in figure 1.

Figure 1: Pictogram used in this document to represent the wells or platforms with the performance and the associated uncertainty or corrected flowrates.

To report the production of the platform or from the subsea wells, we will be using such ideogram as presented figure 1, the name of the wells or platform, the production just below, the uncertainty associated with this measurement on the third line (left pictogram) or the corrected flowrates (right pictogram).

Figure 2 is presenting two producers whom both have three different units (for example, wells or platforms), which are producing in total 9,000 (for example, barrels per day of oil or any unit you wish to select). Each producer has a specific relative uncertainty, which is, for example, for unit#1 of the producer#1, ±3%. The three different producing units are commingled to one unit (unit#10 or #11), which is owned respectively by producer#1 and producer#2. The custody transfer is happening between these two units (#10 and #11), which are coming to another platform where fiscal metering system is in place before the total production is leaving the system (Fiscal#1).

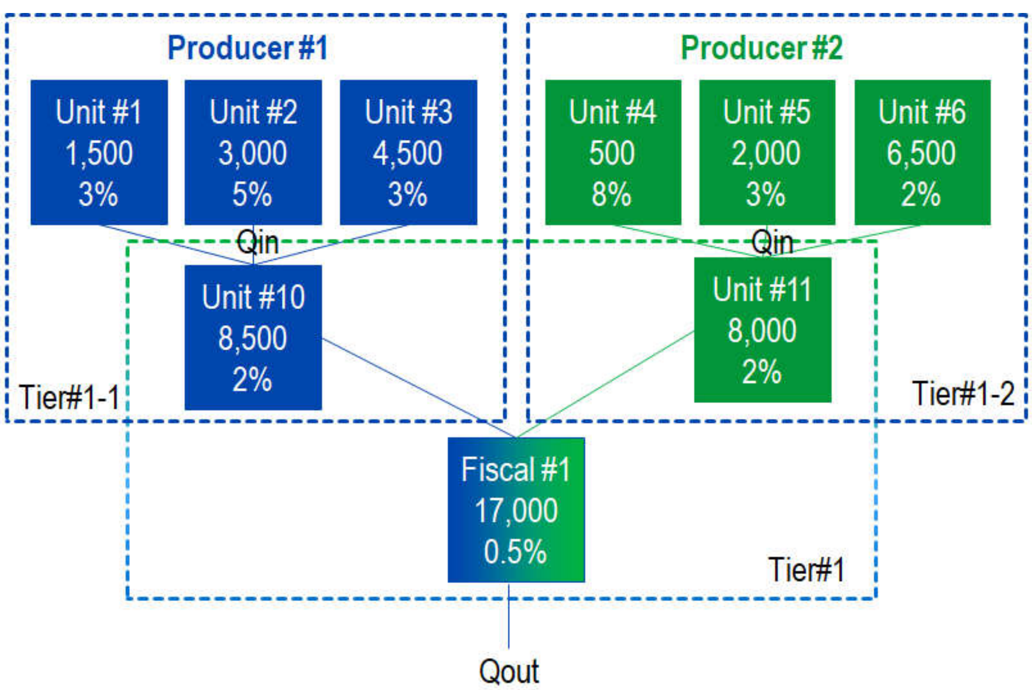

Figure 2: Typical way to establish the tiering process. The Analysis will start from the bottom of this graph and then goes up against the flow.

Fiscal#1 with Unit#10 and Unit#11 are representing the Tier#1; Unit#10 with Unit#1, Unit#2, Unit#3 (all blue) are representing the Tier#1-1; the same for the producer#2 with the Tier#1-2 (Unit#4, #5, #6, #11). The production of each unit is mentioned in the middle of the box (for example, Unit#1 produced 1,500). This is a convention that would be used in the next chapters.

4. INTRODUCTION TO ALLOCATION

To set up the allocation process correctly, it is necessary to have all flowrates at the same conditions and uncertainty stated with the same level of confidence; it is only after the review of this statement that the process of allocation can be done. It should be noted that proving the uncertainty of measurements can be the most challenging part and will be not discussed inside this paper. The reader can refer to the reference [4] to a better understanding of how to establish the uncertainty on the flow metering devices under pressure and temperature. A quick review is given below.

4.1. How to Establish the Uncertainty Measurement

The uncertainty of measurement shows the quality of the present measurement, and 3 numbers need to be specified:

- The actual value of the measurement or the quantity recorded (usually in the right of multiple measurements);
- The associated measurement of the uncertainty (which is associated with the standard deviation on the recorded measurements for the least);
- The level of confidence and the K factor, which in this case should be addressing 95% confidence interval.

The analyses of the measurement uncertainty can be reduced to a simple step-by-step procedure but quite demanding in terms of work and may often need the use of experts as presented below:

- Define the relationship between all the input parameters or measurements and the final output measurement;
- For each input parameter proven, a list of all the factors that can contribute to the uncertainty;
- For each uncertainty source identified, estimate the magnitude of the uncertainty. In case of any doubt, the estimation should take the most pessimistic case;
- Combine all the input uncertainties to obtain the overall uncertainty for the output measurement
- Express the overall uncertainty within, in our case, a 95% confidence interval, which defines the range where the expected new output measurement will be.
- Express the overall uncertainty on the average measurement value, which is associated with the duration of the recording and the acquisition frequency.

The guide to the expression of uncertainty in measurement (Ref [6]) is notifying the way to proceed to the calculation of the uncertainty. There are two recognized basic approaches to analyze the uncertainty of a system. The first is the analyze of

the statistical data (defined as type A). For type A analysis, a fair amount of data is collected, and then a statistical claim on the deviation is calculated. The second approach (type B), is a non-statistical assessment, and it is based on experience and expected professional judgment to establish a numerical limit on the uncertainty of this quantity, as shown earlier the most pessimistic case should be used.
In the multiphase and wet gas flow businesses, many variables or output parameters are calculated; however, most of them are based on some primary measurements, and therefore the uncertainty associated with these parameters should be calculated using the typical propagation of error based on the so-called root mean square deviation techniques.

4.2. Allocation with Two Producers

Our story starts with two producers having set up an allocation over the years between different fields. They have a fiscal measurement, not necessarily the best with ±0.5% uncertainty (see figure 3), but for some reasons, this was good enough. Both are producing the same claimed quantity but have a slight difference in the uncertainty for each platform, and the production is also split differently following the 3 associated units.

4.2.1. With Proportional Based Allocation

The analysis of the Proportional Based Allocation (PBA) provides the following outcome in figure 3. For example, for unit#1, the production claimed was 1,500, but based on the sales point (Fiscal#1) and the PBA method, it should be corrected to 1,460. This means that the production is -2.7% lower than claimed or measured, the correction factor is then 1-0.027=0.973, this number is outstanding, it should not be surprising to find number way lower than this in general. It can be noted that the correction is the same for each platform of the producer#1. Producer# 2, due to poorer reporting, is supporting a discount of -8.4%.

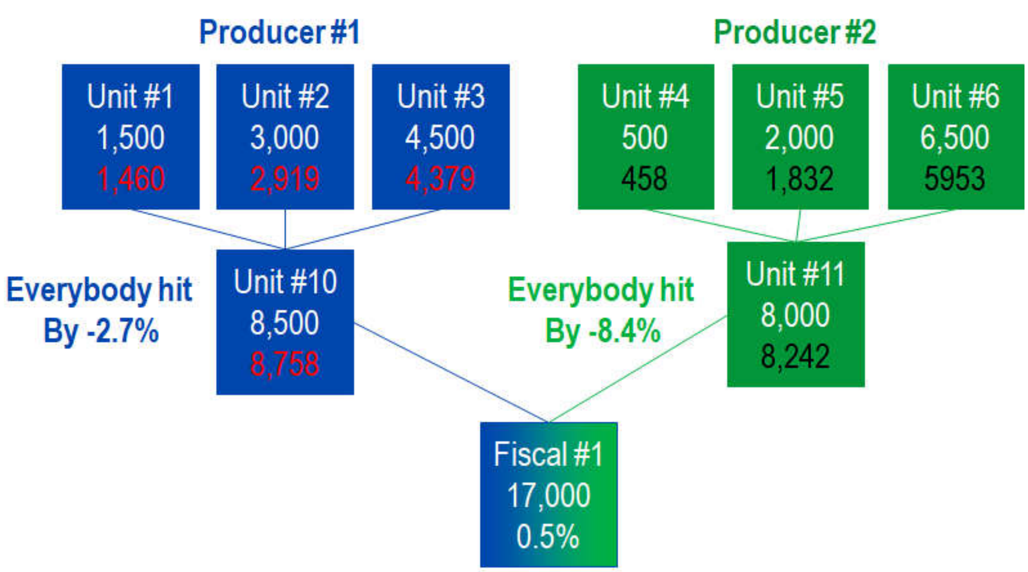

Figure 3: Typical PBA with two producers having both 3 platforms.

4.2.2. With Uncertainty-Based Allocation

Over the years, they have been looking for a better way to allocate the production, and they use on the recommendation of producer#1, who was spending a fair amount of money to support and calibrate equipment over the years the Uncertainty-Based Allocation (UBA) and the new split of production became as presented in figure 4. There is a significant improvement for the producer#1.

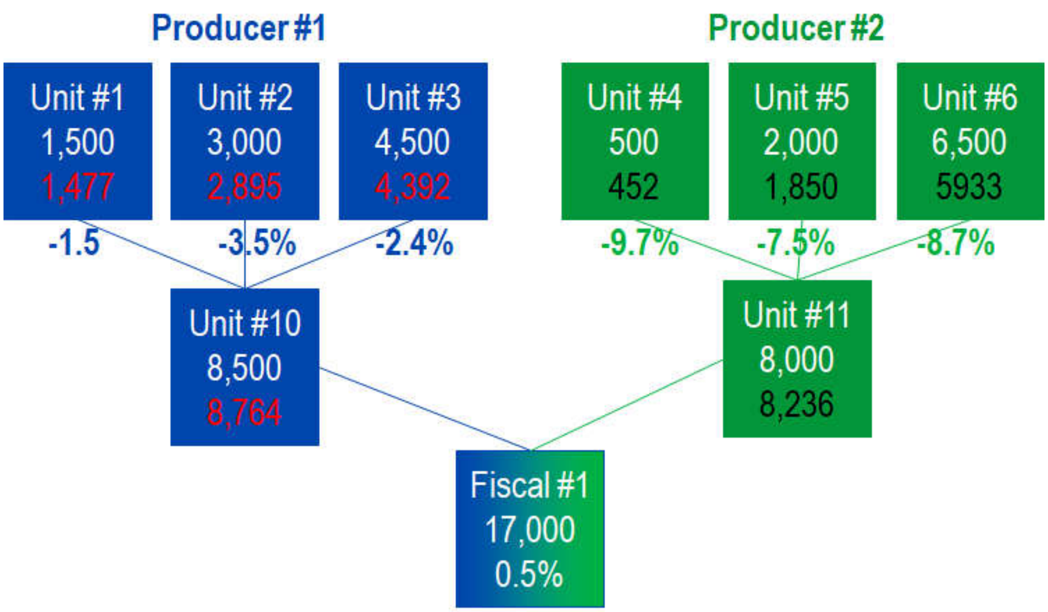

Figure 4: Typical UBA with two producers having both 3 platforms.

This UBA shows that working hard to keep uncertainty and equipment within the sweet spot is paying back. The improvement is modest in this case, 0.06% between PBA and UBA, but it should not be disregarded with the cumulative effect over time.

4.3. 3 Producers now with a PBA and UBA and Smallest Investment from Producer#3

A field was discovered nearby the installation owned by the producers#1 and #2, the depth and the expected production could not justify a specific development and a tie-back to the existing surface structure was agreed. The production of the subsea field is also of 9,000. However, due to the configuration, the claim on the uncertainty from the 3 wells is quite good for the subsea field. The entire CAPEX was quite high, and the producer#3 decided to avoid installing a metering solution to check the entire production from the subsea field, he was estimated that the solution with one subsea flowmeter per well would be good enough.
The producers#1 and #2 did not want to change the current allocation they agreed over the years but decided due to the newcomers and new fiscal flow metering solution available to have a new fiscal device before the production was flowing out of their hand. This fiscal equipment was rated 5 times better than the earlier one (±0.1%), which will stay in operation. The new topology is presented in figure 5. It can be noted that a discrepancy of 12.5% (27,000 claimed but only 24,000 sold) between the producing statements and the selling point.

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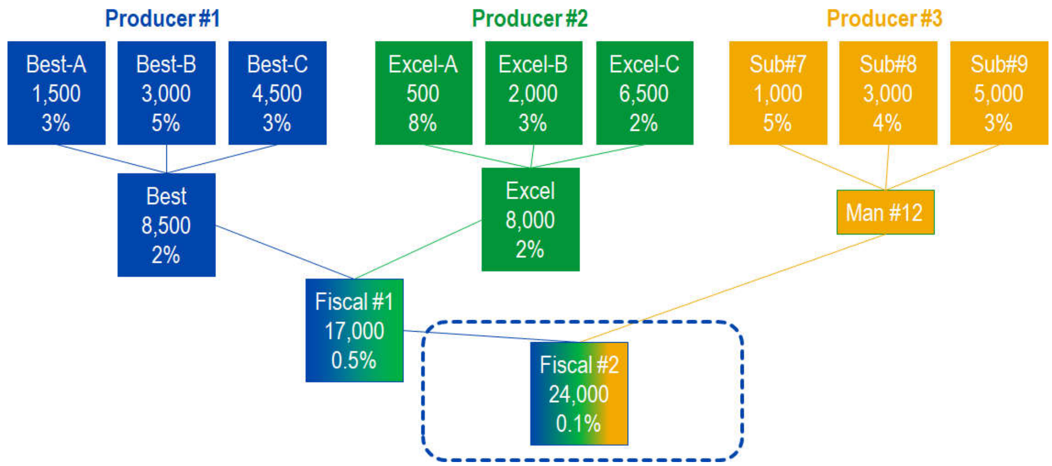

Figure 5: New scheme for the allocation of the 3 producers now with the tie-back of subsea installation and a new fiscal metering system in place.

4.3.1. PBA with the lowest investment from Producer#3

Time to produce was essential in this subsea project, and the Producer#3 decided to start an early production with no metering system at the gathering point from the subsea field on the host platform. The most straightforward allocation being the PBA, a first run, was made to analysis the benefit and the impact on the current production of the two earlier producers.
Note: In this simulation, we are not considering the possible effect due to the tie-back with some pressure effect and differ production from the fields of producer#1 and #2. We are assuming in this simplest case that the pressure could be in a way regulated. We are also simplifying the problem, and there is no storage in this allocation scheme. The purpose is to see the impact of a new producer irrespective of the other added problem, as presented in Figure 6.

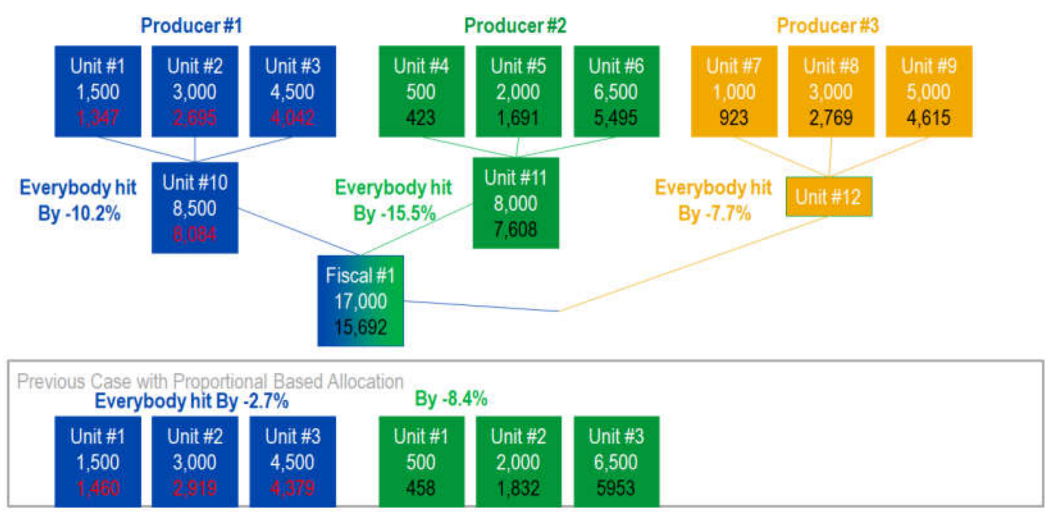

Figure 6: The upper part of the figure shows the allocation rate versus the first reading and the relative difference between both measurements. The lower part shows the difference against the production before the tie-back

The upper part of figure 6 shows the allocation rate for each unit versus the initial reading (above) and the relative difference between both measurements; for example the produced#1 get a -10.2% derating and his unit#1 is allocated 1,347 against 1,500; the producer#2 is reaching -15.5% and the producer#3 is only having -7.7%. The indication in the lower part of figure 6 shows the difference against the production without the tie-back of the subsea field. The calculation shows that the producer#1 loses now an added -9.0% = (1- (1,347/1,460)) of production with this tie-back and the producer#2 is -7.6%.
This is obviously not acceptable, and then the uncertainty-based allocation scheme was asked.

4.3.2. UBA with the lowest investment from Producer#3

The uncertainty-based allocation is presented in figure 7. The production for the Producer#1 is now much closer to the first claims (see red color) with 1,461 against 1,500, from the bottom line for the unit#1 it is mentioned a gain of 8.4% (= (1461/1347)-1) versus the PBA scheme presented in the earlier section. There is less than a 2.6% discrepancy between the claimed production and the reallocated one (1,461 and 1,500). The producer#2 is also gaining with this new UBA allocation. It can be noted that the producer#3 is penalized further in this process; this should not be surprised with no measurement of the commingled production; then the hit is more significant.

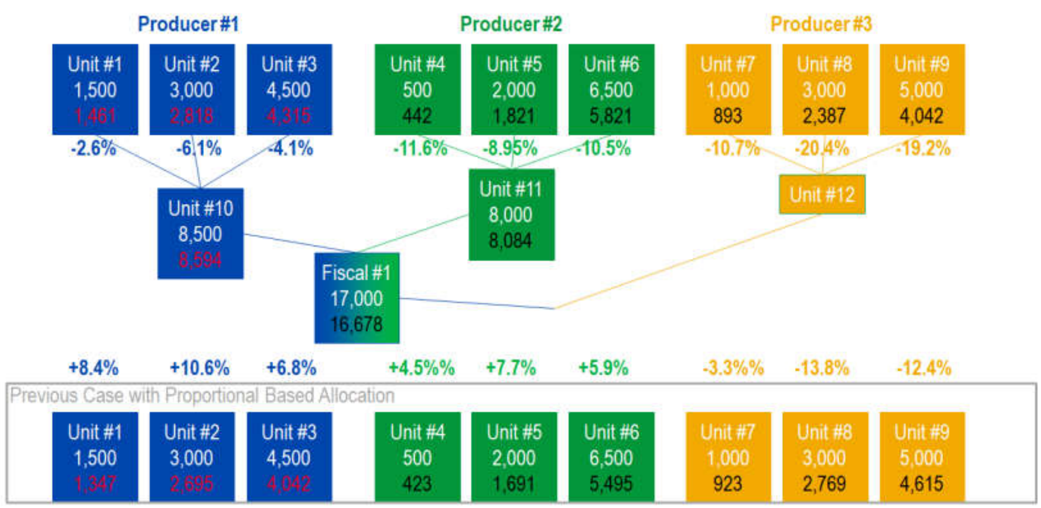

Figure 7: The upper part of the figure shows the UBA rate versus the first reading and the relative difference between both measurements. The lower part the difference against the PBA and UBA on the corrected flowrate.

4.4. 3 Producers now with a PBA and UBA and Largest Investment from Producer#3

The producer#3 had some concerns with such new schemes and the current configuration, and he decided to introduce as soon as possible a flow metering device on the receiving platform, due to limited place and issue with weight, the only solution was with a topside multiphase flowmeter. A fair investment was made to get a solution capable of being within ±3% on the oil rate for the given subsea conditions (figure 8).

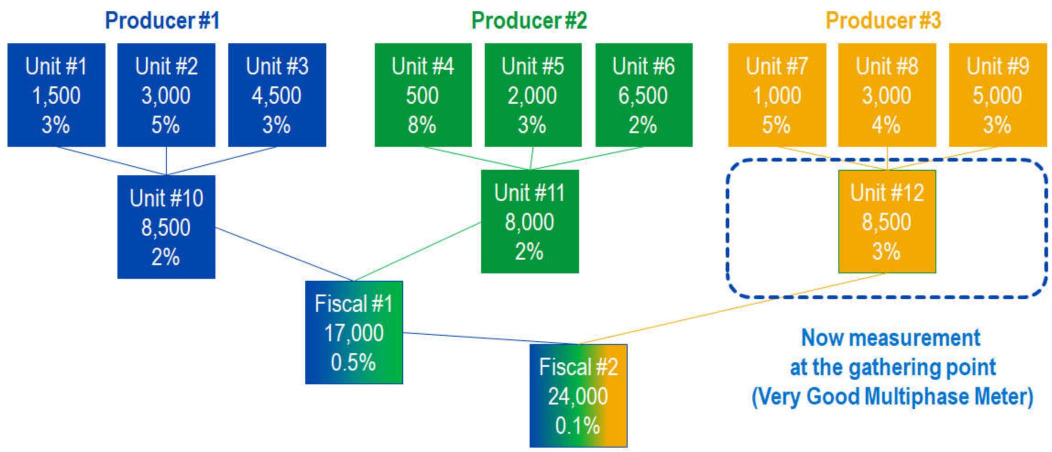

Figure 8: New configuration with an added MPFM for the commingled production coming from the subsea field development.

4.4.1. PBA with most significant investment from Producer#3

With such a new MPFM and an 8,500 production was reported for the 3 subsea well and similar to the one from Producer#1 and only -5.5% short of the entire subsea production claimed (1-8,500/9,000). Producer#3 proposed the PBA has the most straightforward mechanism for the revenue split. Figure 9 is showing the PBA with on the top the production and allocated figures, and the relative difference against the claimed production. The bottom part shows the conditions met before the installation of the new multiphase flowmeter by producer#3. The figure of 2.0% stands for the gain made versus the earlier configuration without the MPFM for the unit#1 (1-1,374/1,347) and so on.

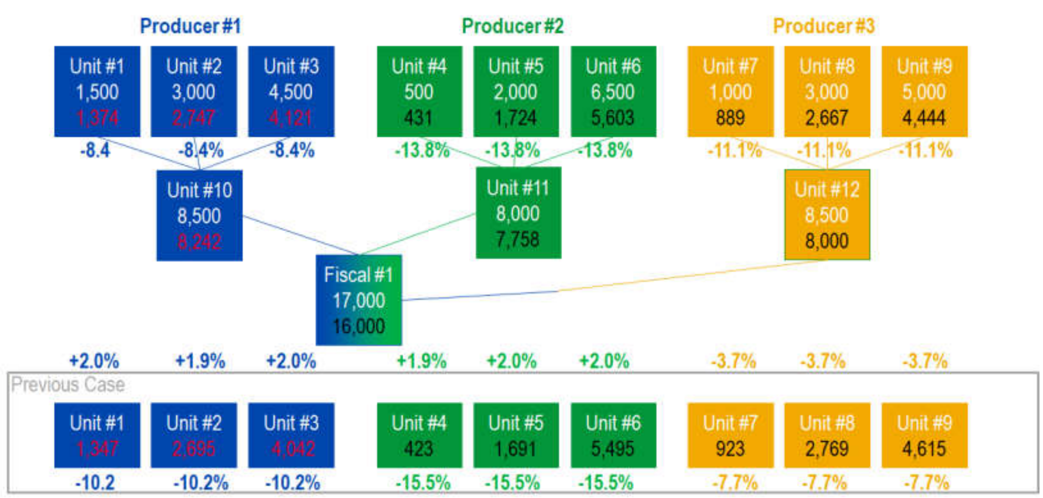

Figure 9: PBA scheme with the installation of a topside MPFM on the commingled production from the subsea field development (top numbers) versus the earlier PBA without this MPFM (bottom numbers).

It is remarkably interesting to note that Producer#3 was expecting with a new MPFM in place to be able to have a better allocation factor, but it is becoming worst with now some added expenditure for this high-class MPFM. He would have been better by taking no action. The production was derated by 1,000 (e.g., bopd) from the claimed production (9,000 bopd) against the final consolidation of the numbers (8,000 bopd).

4.4.2. UBA with most significant investment from Producer#3

With a global uncertainty for each flow metering device within 3-4% and losing more 11.1% (=1,000/9,000) versus the claimed production; the choice was for the producer#3 to propose the UBA. This was also supported by the two other producers that were losing significant values from the earlier allocation without the tie-back.
It should be noted immediately that referring to the description of the tiering process and with the UBA scheme, the MPFM (even if very good) will be "compared" against the fiscal metering#1, and there is a factor 6 (figure 10, 3%/0.5%) in terms of uncertainty performance.

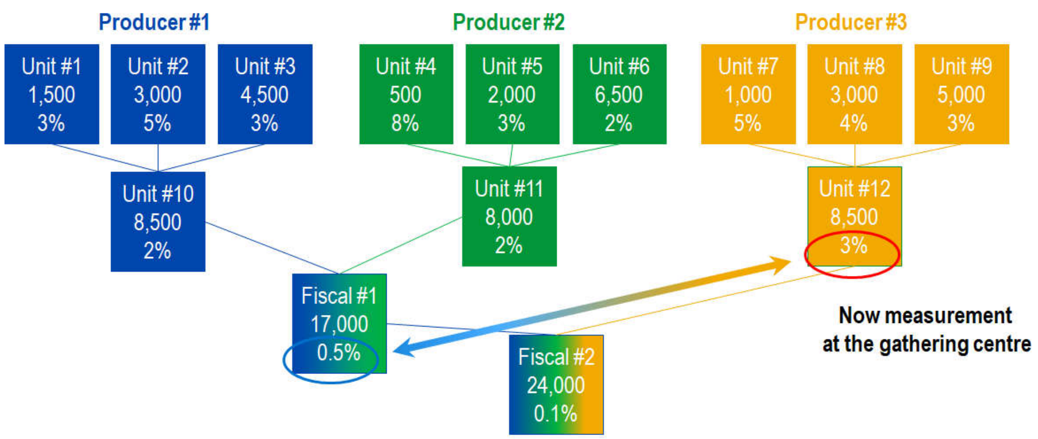

Figure 10: UBA scheme with high-class MPFM to check the commingled production coming from the subsea field development.

Figure 11 is showing the UBA with the same convention, as explained before. The bottom part shows the conditions met before the installation of the new multiphase flowmeter by producer#3. The company taking care of supporting equipment and having a tighten uncertainty is having less hit. Producer# 1 is, for sure, supporting such UBA scheme. It is interesting to see also that the producer#2 should follow the process of maintenance developed by the producer#1; they are 2 to 5 times hit more than producer#1. This is quite a drastic impact. Producer#3 was expecting with an MPFM and UBA in place to be able to have a better allocation factor, but it is becoming worst with the expenditure for this MPFM. It will have been better doing nothing in this configuration. Its production was derated by 1,843 (e.g. bopd and = 9,000-7,157) from the claimed one against the final consolidation. The message is then unambiguous; a significant effort should be spent to have high-quality measurements on the commingled subsea production being within ±3% is not good enough.

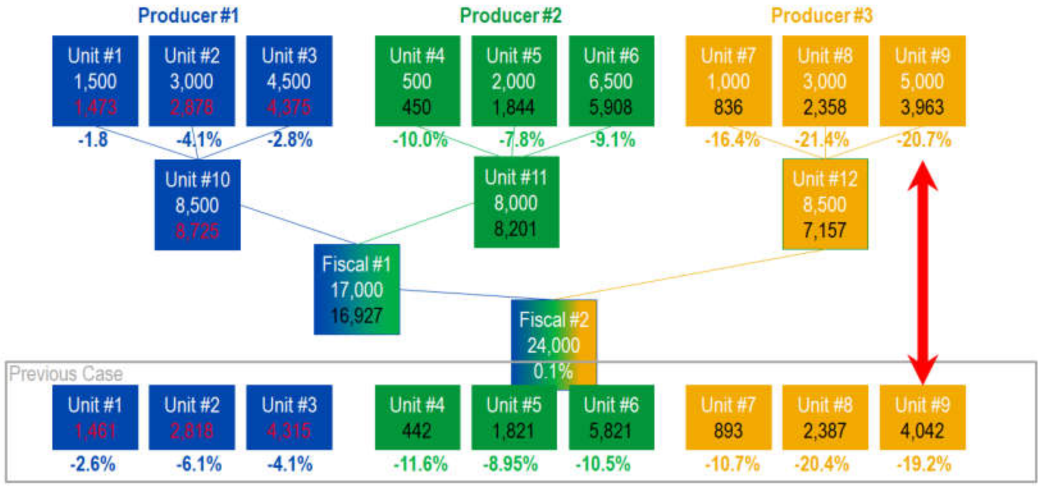

Figure 11: UBA scheme with the new configuration with an added measurement of the commingled production coming from the subsea field development (top) versus the earlier PBA without this MPFM (bottom).

As a conclusion, there is no incentive for the Producer#3 to buy equipment for the gathering point! He paid for it, and he is getting less on top of that!

4.5. Value Adjustment on Uncertainty Based Allocation

The value adjustment process is a way to allocate not only the flowrates but also the quality of the individual flow against the commingled one. The API is a good example. Higher is the API, and better is the quality of oil and higher is the price. This was the purpose of this scale at the origin, but this could also be valid for the gas against the BTU. The idea is to do a PBA or UBA first and then look at the value of the oil sold and then based on the API at each node that needs to be measured to do a second correction on the flowrate.

This should not be very mysterious for people, and a quick example should explain it if two producers are producing the same quantity of oi and one is API 10° and the other API 50°, the value of the second one in $ is much higher. However, the commingled production will be between API 10° and API 50°; let us assume API 35°, and then let us also assume that the allocation by the volumetric flowrate is the same for both producers, but the revenue (money) to get from the trading should not be 50-50%. This is what the value adjustment will do; by taking the value, then the second producer with high API value will get more mixed oil allocated than the first producer with low API. This should be seen as a financial way to address the problem, the physical production stays 50%-50%, and the reservoir engineers should use these flowrates from UBA or PBA, but the revenue is not, and this is highlighted by the VA process.

4.5.1. With the most significant investment from Producer#3

From our analysis above, the PBA is not the best method, and we did not develop the Value Adjustment on such allocation scheme. We concentrate only on the VA with UBA. Figure 12 is showing the quality of oil produced from the different fields and then the measurement of the API at each node of the system.

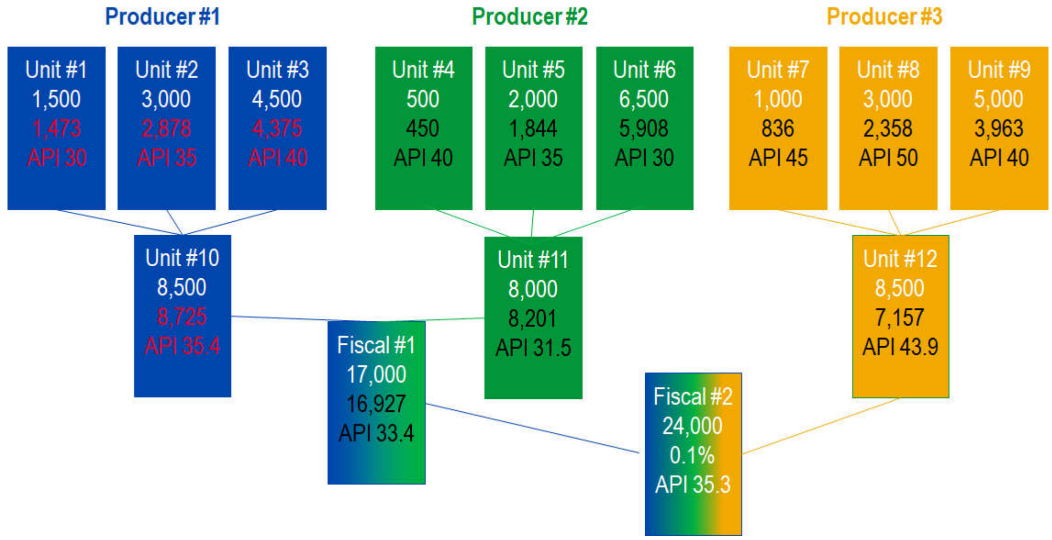

Figure 12: Quality of the oil from the different producers and at each node of the system. These numbers are coming from physical measurements.

The overall oil quality sold has a 35.3°API. Knowing the production on the outflow, it is possible to establish the generated revenue which is 1,516k$ at the fiscal flowmeter#2. Knowing the quality of oil of the inflow a prorate can be applied and reproduce along the production line up to the wellheads. The analysis will lead to the following corrected flowrates (figure 13).

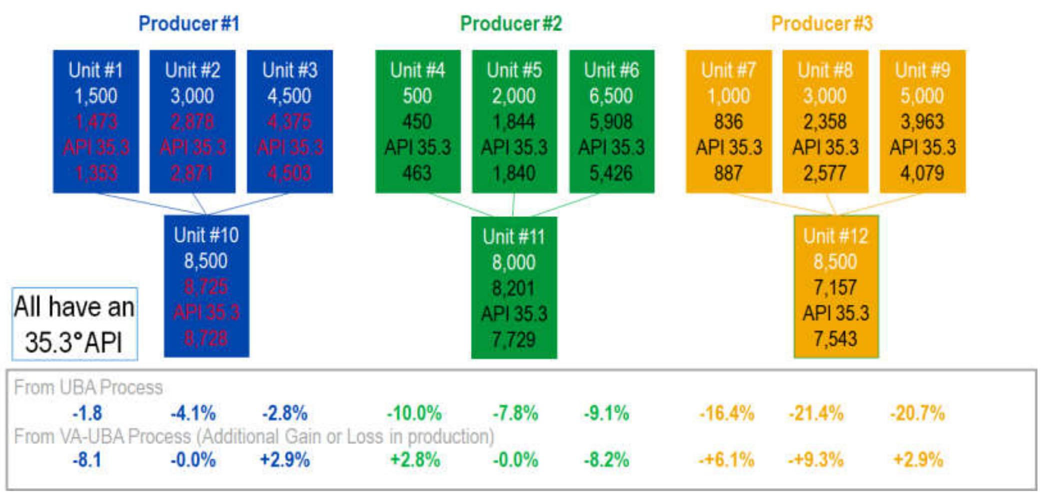

Figure 13: VA-UBA scheme with an MPFM on the commingled production coming from the subsea field development (top) versus the earlier UBA process (middle bottom). The last line of digits shows the added correction due to the quality of the oil.

By using such a scheme with VA, then the financial part is considered; however, it should not be considered that this is the physical production; this one is still best represented by the UBA on its own.

5. RESULTS SUMMARY

This paper has been written to provide an overview of the main type of allocations that the author has been facing. The purpose was to show that the impact of the allocation could be significant following the choice of the method. This is not something to take easy, it is a complete part of the flow metering and unfortunately sometimes decoupled in some companies. It should be a complete part of the metering department.
If getting the right value for the production is essential, this also affects the reservoir management and usually the modeling and the life of the reservoir over the next 20 to 40 years. Numerous times engineers are faced with a value expected from the reservoir model, which is not in line with the real production, but some of the errors or discrepancies can be spotted due to this allocation scheme and the fact that little care is taken to report number with a proper uncertainty.
To simplify the analysis, the work on allocation by difference (ABD) was not used, and this method is being the worst type of allocation and exposing the owner of this production to the claim and production at the fiscal point of the other producers. Today with such tools in place like virtual flow metering, this should be the minimum to use to have a better picture.

To simplify the comparison, we took an example with 3 companies having different drivers or policies or focus on the uncertainty and quality of the flow measurements. The first production was claimed to be 9,000 for each of the producers, but there is a significant difference in the end, whatever the techniques used. The best you care about the measurement and then less discount you will get on your claimed production.
Table 1 is presenting the overall results for these 3 producers, the claimed production is on the right side, and then the different allocations method are presented from the expected production when only the two producers were into business (line 5 and 7) and with the respective deviation (line 6 and 8) against the claimed production at the platforms or well site. Producer#1 has the best system in place with less than -3% deviation against producer#2 with -9%.

When producer#3 is tieing-back the production, a notable change happens to the two first producers when using the proportionally based allocation. The primary winner, in this case, is definitively producer#3 with no extra measurement. This shows that Producer#3 should not be the one to drive for better measurement quality.
Using the Uncertainty-Based Allocation, the numbers are significantly better for producer#1 and #2 without MPFM, producer#3 is hit 2 times more than inside the earlier scheme. However, it is by imposing to have a measurement of the entire production that the producer#1 and #2 can be back to the expected allocation and deviation between measurement as before the development of the subsea field. This is the goal that such companies with excellent equipment or fair maintenance program should aim for.
In this case, Producer#3 is facing reality, and the shortcut in the choice of the equipment subsea will affect his entire allocation for the next 20 to 40 years! Saving little bit on CAPEX or proper deployment of a metering solution has been detrimental for the entire production. It may be right that producer#3 is producing more, but the allocation will always be working against him. This should also show how critical is the selection of the multiphase or wet gas flowmeter either subsea or topside, there is still today not a significant focus on the impact on the flow conditions and sensitivity inside the selection, the test matrix on third party

facilities are limited to a simple exercise with often less than 20-30 data points. This should not be the case, and more extensive work should be put in place, and probably the two best-anticipated equipment should be tested in series to ensure they face the same conditions and provide a relevant report. It is still today to the procurement team the final decision, and they are purely looking at the current cost. If there is probably a bit of money saved when buying these MPFMs or WGFMs and some people could believe in having been working in a right way; for the future, the metering, allocation, and reservoir teams are left inside this organization struggling over the years about the right production and as indicated above may even affect the management of the reservoir and ultimately the recovery factor.
In any configuration, as presented in this case right now, there is a way for the subsea development to have a small correction on the claimed production. The idea of the tie-back was initially interesting, but there is a cost associated with this in terms of allocation. Even with initially all meters within ±3-5% uncertainty, which could be very good for reporting each phase subsea, there are by far away of high-quality against some top measurement, and it should be important to use some topside metering device with high quality to ensure the production is correctly allocated.

		Producer #1			Producer #2			Producer #3					
		Unit #1	Unit #2	Unit #3	Unit #4	Unit #5	Unit #6	Unit #7	Unit #5	Unit #9	Total	Total	Total
		bpd	bpd	bpd	bpd	bpd	bpd	bpd	bpd	bpd	bpd	bpd	bpd
1	UBA	1500	3000	4500	500	2000	6500	1000	3000	5000	9000	9000	9000
2	Unceetainty Metering	3%	5%	3%	8%	3%	2%	5%	4%	3%			
3	Commingled Uncertainty	2%			2%			None or 3%					
4	Commingled Uncertainty	0.5%						None or 3%					
5	PBA	1460	2919	4379	458	1832	5953				8758	8243	
6	Deviation	3%	3%	3%	8%	8%	8%				-3%	-8%	
7	UBA	1477	2895	4392	452	1850	5933				8764	8235	
8	Deviation	-2%	-4%	-2%	-10%	-8%	-9%				-3%	-9%	
9	PBA without MPFM	1347	2695	4042	423	1691	5495	923	2769	4615	8084	7609	8307
10	Deviation	-10%	-10%	-10%	-15%	-15%	-15%	-8%	-8%	-8%	-10%	-15%	-8%
11	PBA with MPFM	1374	2747	4121	431	1724	5603	889	2667	4444	8242	7758	8000
12	Deviation	-8%	-8%	-8%	-14%	-14%	-14%	-11%	-11%	-11%	-8%	-14%	-11%
13	UBA wihtout MPFM	1461	2818	4315	442	1821	5821	893	2387	4042	8594	8084	7322
14	Deviation	-3%	-6%	-4%	-12%	-9%	-10%	-11%	-20%	-19%	-5%	-10%	-19%
15	UBA with MPFM	1473	2878	4375	450	1844	5908	836	2358	3963	8726	8202	7157
16	Deviation	-2%	-4%	-3%	-10%	-8%	-9%	-16%	-21%	-21%	-3%	-9%	-20%
17	API	30°	35°	40°	40°	35°	30°	45°	50°	40°	35.11°	35.11°	35.11°
18	VA-UBA	1353	2871	4375	463	1840	5426	887	2577	4079	8599	7729	7543
19	Deviation	-10%	-4%	-3%	-7%	-8%	-17%	-11%	-14%	-18%	-4%	-14%	-16%

Table 1: results from the different allocation process

6. CONCLUSIONS

This paper has been written to provide an overview of the allocation processes and how the production can be largely affected. Cautions should always be in place when there is a tie-back of another field. A quick and straightforward deployment solution could lead to significant penalties over the next 20 to 40 years during the time the wells or the platforms will be in production.
Company following maintenance program with competent people or third party experts could have a good uncertainty on the measurements, and this needs to be acknowledged, and the best way to allocate is by proposing an Uncertainty-Based Allocation systematically; it requires a fair amount of work initially to establish the

real performance of each flow metering device, but this will be very beneficial in the long run.

The company expecting to tie-back with a light flow metering system in place needs to be ready to face penalties, the core of the solution is always to have a high-quality or low uncertainty flow metering device nearby the commingled point. This is where the entire effort should be spent (technical and financial); the allocation after inside the associate tier of this company will not be detrimental from a financial point of view, however as indicated earlier this could have an impact on the reservoir management and the associated recovery factor if the allocation number is far from the claimed flow measurement at the wellhead.

7. ACKNOWLEDGMENT

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8. REFERENCES

[1] P. STOCKTON, A. SPENCE; experiences in the use of uncertainty-based allocation in a North Sea offshore oil allocation system. Production and Upstream Flow Measurement Workshop, 2018.

[2] API RP 85, Use of subsea wet=gas flowmeters in the allocation measurement system, 2015.

[3] MPMS Chapter 20.1 production measurement and allocation system, 2019

[4] B. PINGUET, T. LEONARD; The Generic Way to Establish the True Statement about the Uncertainty of Facilities for MPFM/WGFM Validation, 37th North Sea Flow Measurement, 2019.