# Report

## Pressure Pulse Code Testing (PCT)

| | |
|---|---|
| **Report date:** | dd.mm.yyyy |
| **Testing package:** | Pressure Pulse Code Testing |
| **Tested wells** | **R1, R2, R3, R4, R5, R6, R7, R8** – oil producers |
| | **G** – gas injector |
| **Service company:** | Sofoil |

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TABLE OF CONTENT

## PCT STUDY BACKGROUND

This PCT study is part of the CCCS pilot Gas Injection study.

The Work Plan includes

RFA logging

- To conduct RFA during gas injection
- Determine injection profile for pulse test design
- Confirm no packer, tubing or behind casing annulus leaks

Pulse test design

- Test duration, pulse frequency and amplitude

Pulse test interpretation

- Cross-well connectivity, pressure response to injection pulsations

WI selection & conversion

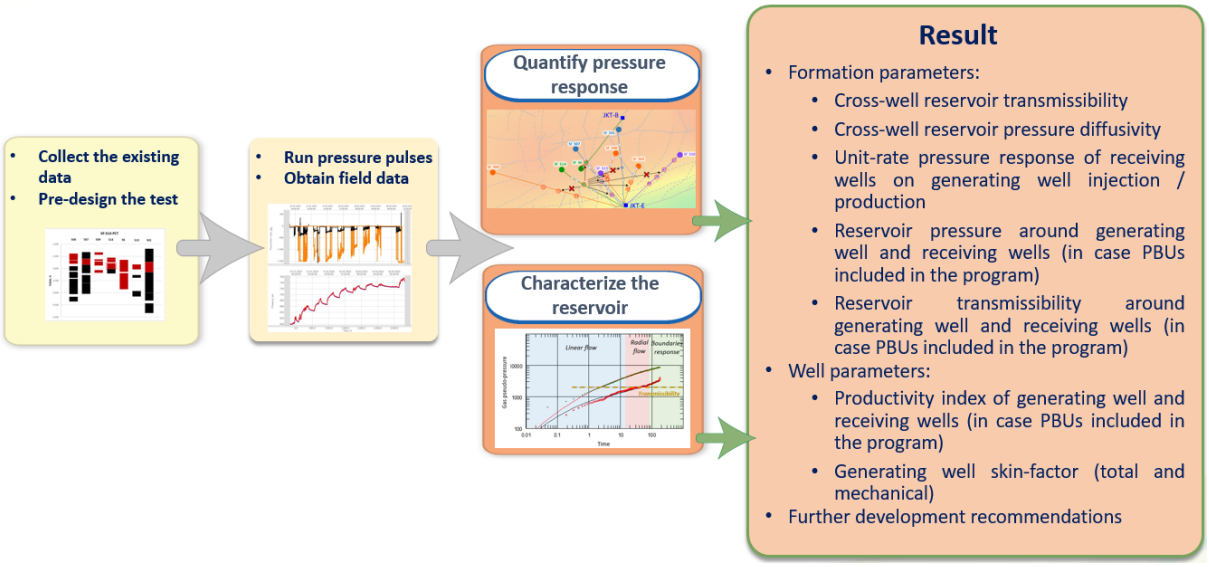
- Based on RFA logging and PCT analysis results

## PCT METHODOLOGY

- A new Pulse-Test design and interpretation methodology known as Pressure Pulse-Code Testing (PCT) is available from Sofoil. This enables cross-well connectivity estimation through coded pressure pulsing and interpreting the response on offset wells, without the need to shut-in producing wells, hence avoiding production deferral.
- PCT implements an advanced interpretation technique, called Pulse-Code Decomposition (PCD), which allows to distinguish the useful pressure response from the well/reservoir pressure noise basing on a complex correlation criteria.
- PCT calculates the pressure effect on receiving wells due to production/injection pulsation of a generating well. It also calculates the average cross-well transmissibility and pressure diffusivity in a cross-well interval.
- This makes it possible to directly see the communication quality, quantify and forecast the response to full-scale injection.

Note: Please see the following papers: **SPE-206493**, **SPE-201918**, **SPE-200542**, **SPE-196338**, **SPE-193712, SPE-187927** for full details of the PCT mathematical theory, workflow and case studies.

## PCT WORKFLOW AND RESULTS



## 1. GOALS & OBJECTIVES

The main objective of the PCT survey was to reduce the sub-surface uncertainty for infill well placement, mainly inter-well connectivity and existence of barriers or baffles, extend of the fault etc., using the Pressure Pulse Code Testing (PCT) technique.

### Goals

| | |
|---|---|
| 1 | Confirm and quantify connectivity between **G** and OP's |

### Objectives

| | |
|---|---|
| 1 | Evaluate connectivity between **G** and offset wells |
| 2 | Provide unit-rate response function to estimate offset wells' pressure / rate response to gas injection |

## 2. CONCLUSIONS & OBSERVATIONS

### Conclusions

| | |
|---|---|
| 1 | Gas injection into **G** clearly affects the offset producing wells and can bring additional oil production |

## 3. RESULTS

### 3.1. Inter-well connectivity evaluation

- G and some offset producing wells are communicating through zones open during PCT
- The injection provides substantial pressure support to producers R1, R2, R5, R8, and a slight support to R4
- No pressure response was seen on R6, which could be caused by lack of connectivity of the response is too weak to be detected with PCT due to absorption by several reservoirs open in the receiving well or sand build up in tubing.
- No pressure response was seen on R2 and R7, which could be caused by a lack of connectivity or a low response amplitude due to high distance to injector. R7 indicates a sporadic pressure build during the PCT, but it can't be correlated with the pulses created in G and is more likely a technological effect, e.g. smooth liquid level drop in a wellbore.
- The response travels faster towards R4 than towards R5, which is in the same direction and closer. That might mean that at least nearby R4 the pressure propagates via Z1, which has higher permeability

### 3.2. Reservoir characteristics / properties

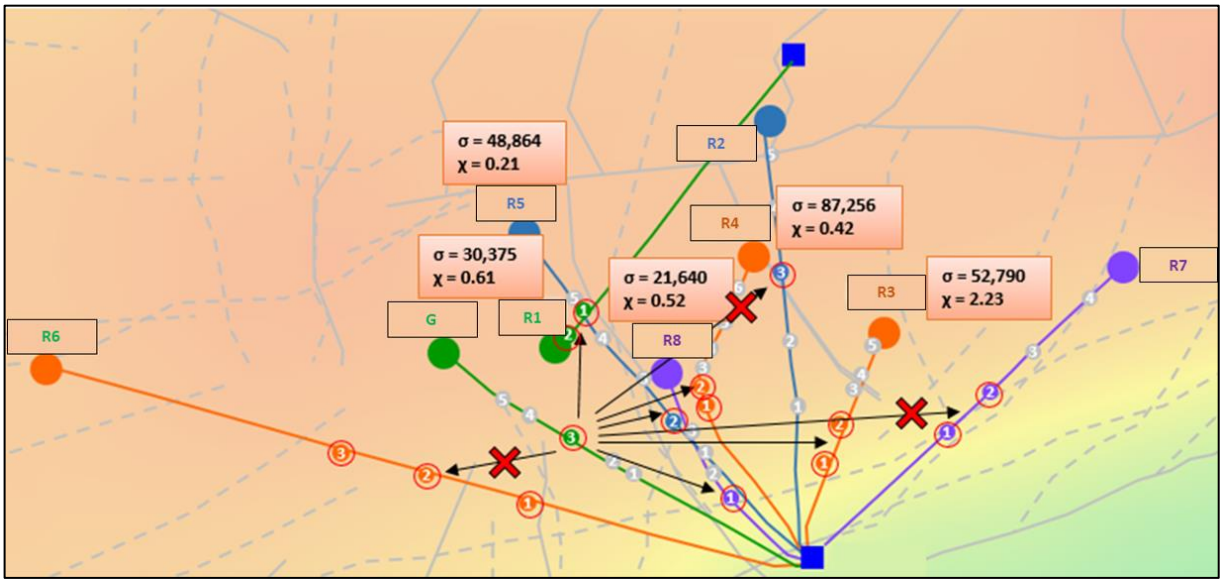
Apparent transmissibility and pressure diffusivity from PCT are presented in Table 3.2.1 and Fig. 3.2.1.

The Pulse-Code Decomposition algorithm computes σ (Transmissibility) and χ (Diffusivity) values based on the best model match to the actual pressure response so that the residual pressure (response-free pressure behavior) shows no correlation to the signal.

**Table 3.2.1.** Apparent transmissibility and pressure diffusivity from PCT

| # | Well | Property | PCT Value | Unit |
|---|---|---|---|---|
| 1 | R1 | σ | 30,375 | mD·ft/cP |
| | | χ | 0.61 | ·107 mD·psi/cP |
| 2 | R6 | σ | - | mD·ft/cP |
| | | χ | - | ·107 mD·psi/cP |
| 3 | R8 | σ | 21,640 | mD·ft/cP |
| | | χ | 0.52 | ·107 mD·psi/cP |
| 4 | R4 | σ | 87,256 | mD·ft/cP |
| | | χ | 0.42 | ·107 mD·psi/cP |
| 5 | R3 | σ | 52,790 | mD·ft/cP |
| | | χ | 2.23 | ·107 mD·psi/cP |
| 6 | R5 | σ | 48,864 | mD·ft/cP |
| | | χ | 0.21 | ·107 mD·psi/cP |
| 7 | R2 | σ | - | mD·ft/cP |

| | | | | |
|---|---|---|---|---|
| | | χ | - | ·107 mD·psi/cP |
| 8 | R7 | Σ | - | mD·ft/cP |
| | | χ | - | ·107 mD·psi/cP |




σ- Transmissibility, mD*ft/cP
χ – Pressure Diffusivity, * $10^7$ mD*psi/cP
**Fig. 3.2.1.** Transmissibility and pressure diffusivity from PCT

### 3.3. Pressure Transient Analysis

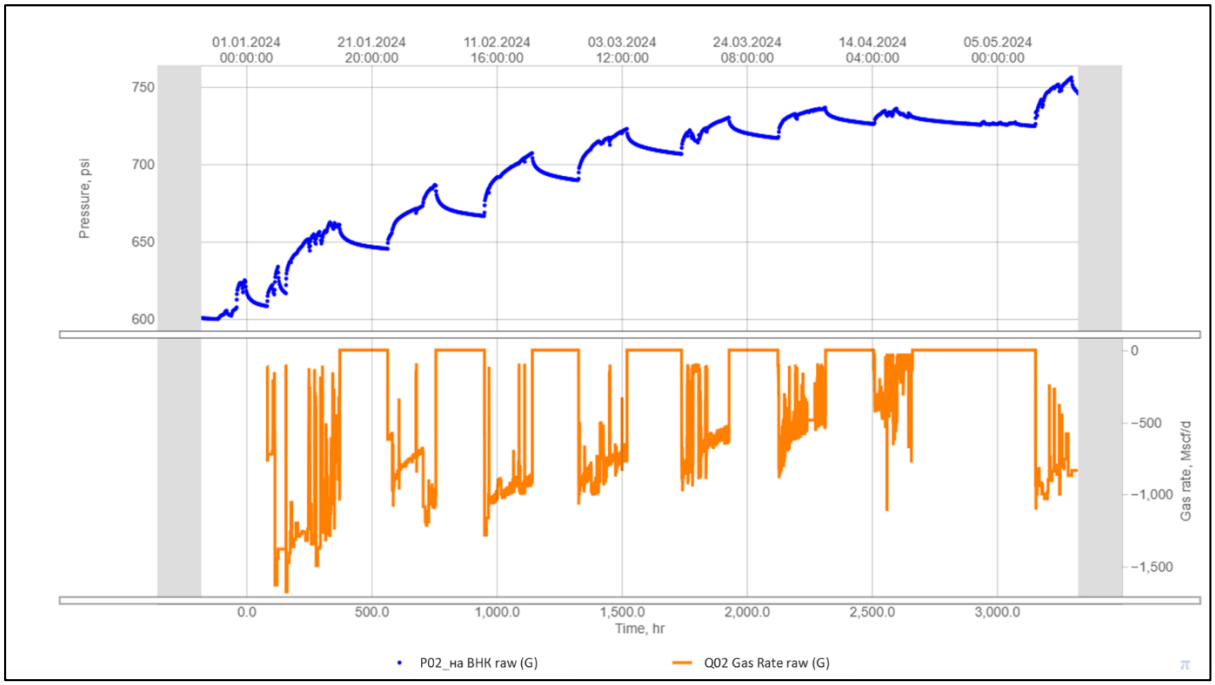



**Fig. 3.3.1.** Pressure Pulse History plot of **G**

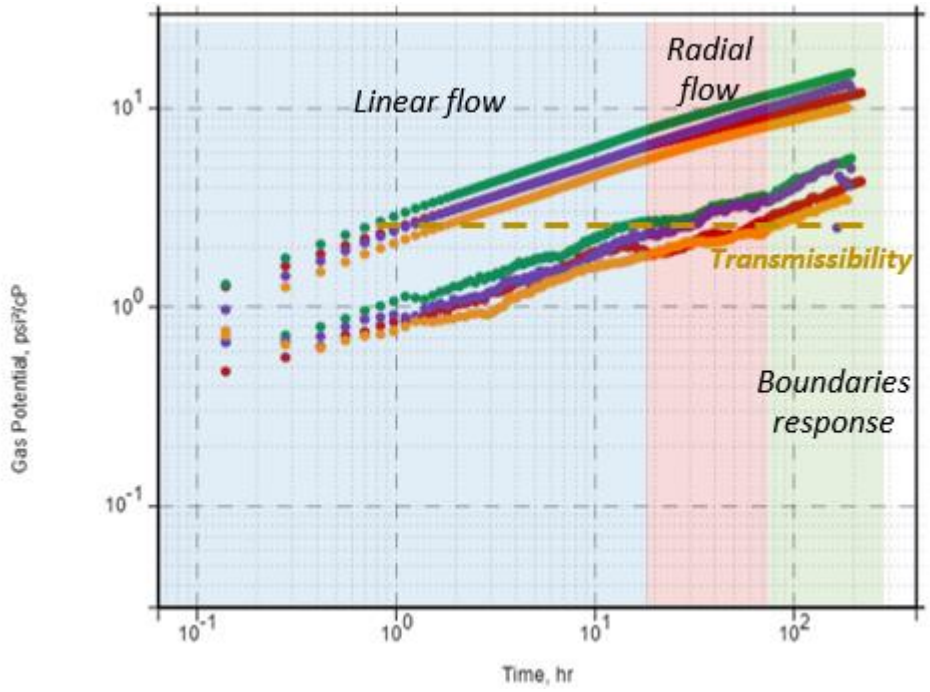



**Fig. 3.3.2.** PFO log-log plot of G

**Table 3.3.1.** Diffusion model summary on G

| Property | Abbreviation | PBU Value | OH Value | Unit |
|---|---|---|---|---|
| Net sand thickness | Hnet | | 55.1 | ft |
| Total Skin | ST | -5.3 | | |
| Permeability @ oil scenario | ko | 1810 | 56.3 | mD |
| Permeability @ gas scenario | Kg | 16.3 | | mD |
| Formation pressure (@DATUM 3000 ft) | Pe | 599 → 723 | | psi |
| Initial formation pressure (RFT@DATUM 3000 ft) | Pi | | 1349 | psi |

The values of permeabilities obtained using oil and gas scenario vary dramatically, but the actual permeability value lies between them.
That indicates that both gas and oil saturated thickness is taking the injected gas.
Also, the pressure build during the injection indicate a limited volume of the gas bubble around the well.

### 3.4. Evaluating the distance to the boundary

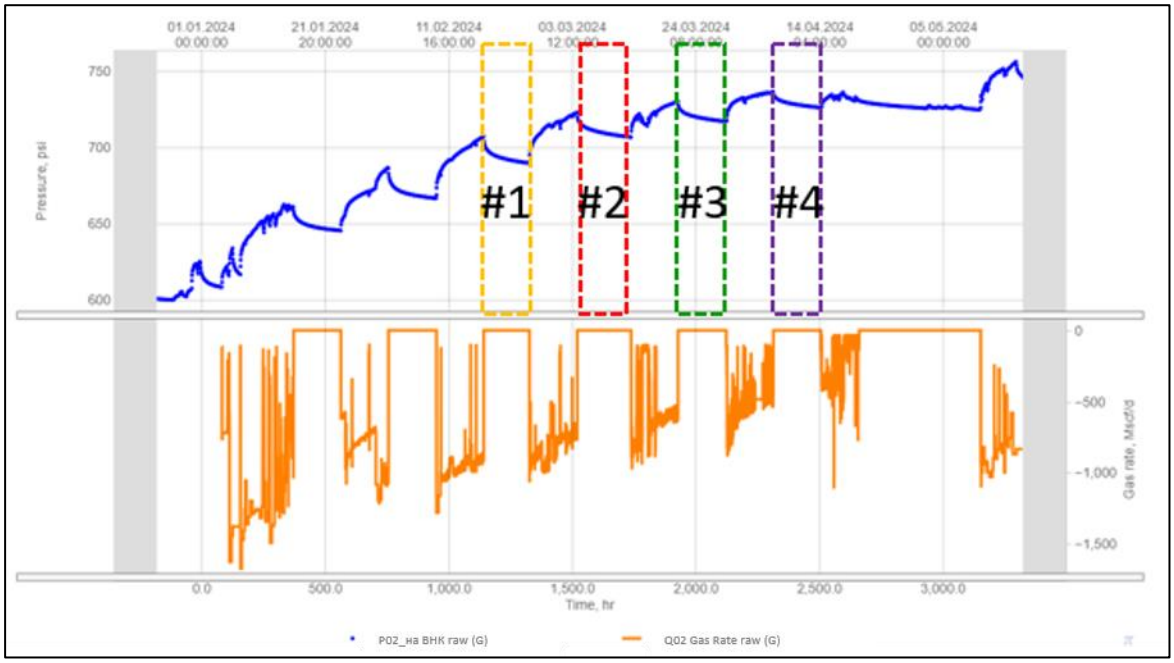



**Fig. 3.4.1.** Pressure Pulse History plot of G with build-ups

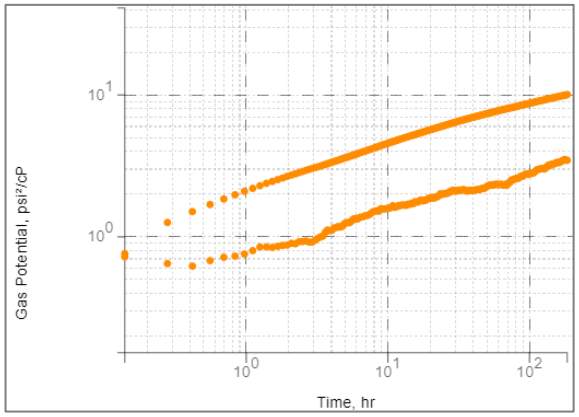



**Fig. 3.4.2a**. Build-up #1 diagnostic plot for well G

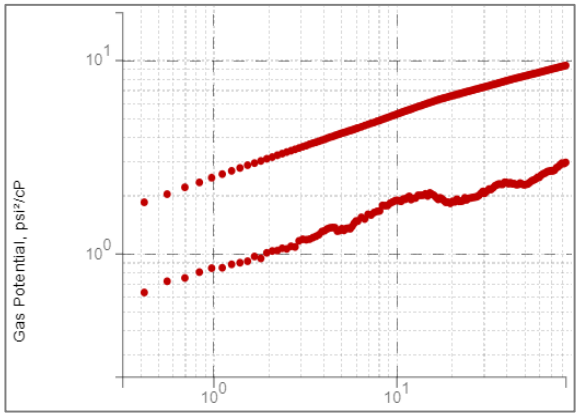



**Fig. 3.4.2b**. Build-up #2 diagnostic plot for well G

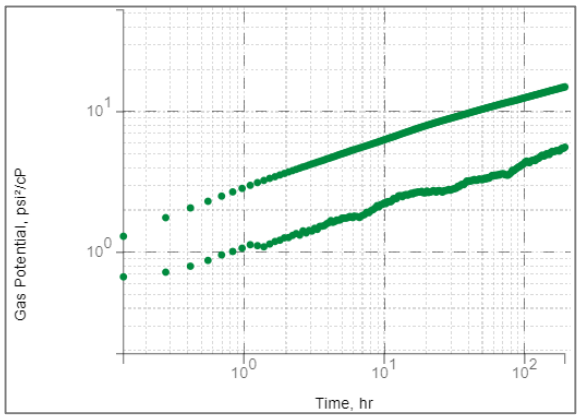



**Fig. 3.4.2c**. Build-up #3 diagnostic plot for well G

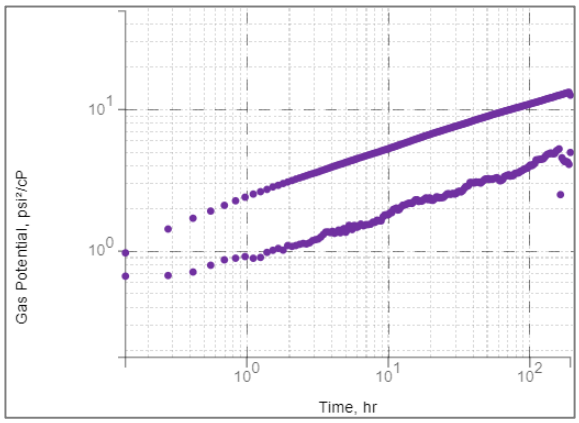



**Fig. 3.4.2d**. Build-up #4 diagnostic plot for well G

**Table 3.4.1.** Distance to the boundary

| Property | PBU# | Value | Unit |
|---|---|---|---|
| Distance to the parallel faults | 1 | 193; 385 | ft |
| Distance to the parallel faults | 2 | 184; 367 | ft |
| Distance to the parallel faults | 3 | 160; 321 | ft |
| Distance to the parallel faults | 4 | 162; 325 | ft |

The table clearly shows the limitations of analytical PTA in evaluating the exact distance to cross-phase boundaries, as the distance reduces with time. Though, the values of the distances and the shape of the bubble (elongated with two boundaries significantly closer than the other ones) could be considered as fair estimates.

## 4. PCT PLAN AND DESIGN

PCT is a methodology of evaluating the pressure response in receiving wells to coded rate sequence in offset generating wells. Map with wells included in the PCT program and inter-well distances are presented in Fig. 4.1 and Table 4.1 respectively.

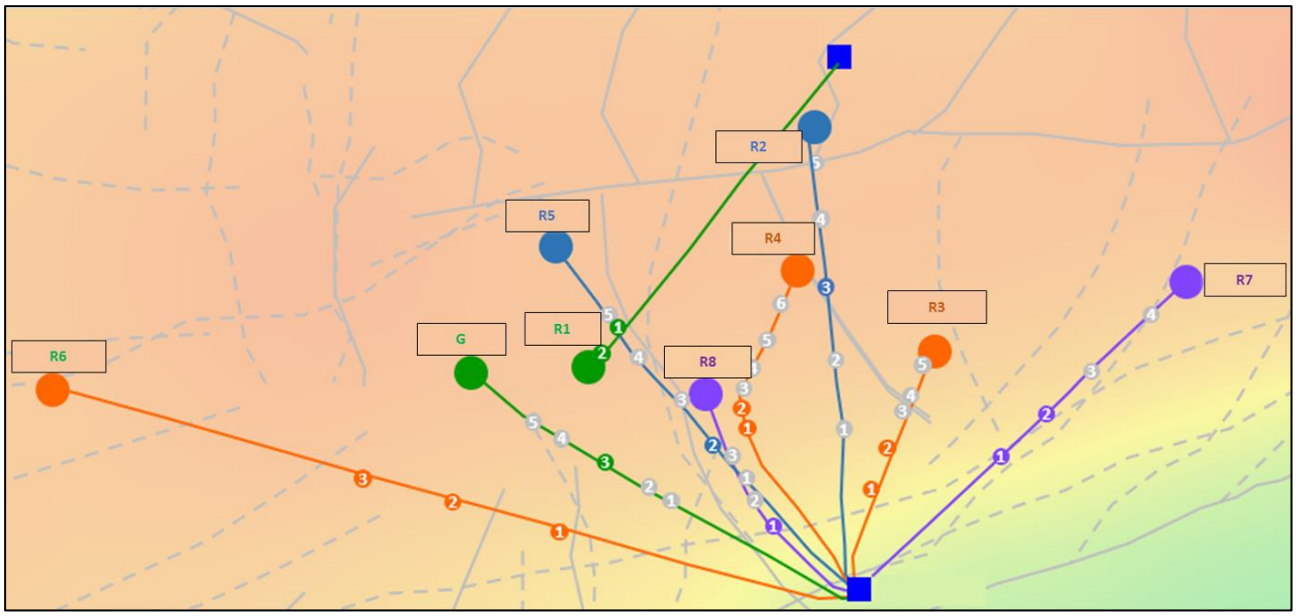



**Fig. 4.1.** PCT Investigation area map

**Table 4.1.** Inter-well distance

| # | Well | Zones | Type | Distance, ft | k = 25 mD |
|---|---|---|---|---|---|
| | | | | | Effective thickness, ft |
| 1 | R6 | 1+2+3 | Receiver | 1,225 | 184.1 |
| 2 | R1 | 1+2 | Receiver | 990 | 414.9 |
| 3 | R5 | 2 | Receiver | 885 | 152.6 |
| 4 | R8 | 1 | Receiver | 1,430 | 80.9 |
| 5 | R4 | 1+2 | Receiver | 1,180 | 104.8 |
| 6 | R2 | 3 | Receiver | 2,250 | 227.8 |
| 7 | R3 | 1+2 | Receiver | 2,233 | 203.8 |
| 8 | R7 | 1+2 | Receiver | 3,330 | 166.2 |
| 9 | G | 1+2+**3** | Generator | - | 55.1 |

Pressure pulse was generated in the generating well by changing the production rate, by means of flowing the well followed by shut-in, in a sequential manner.

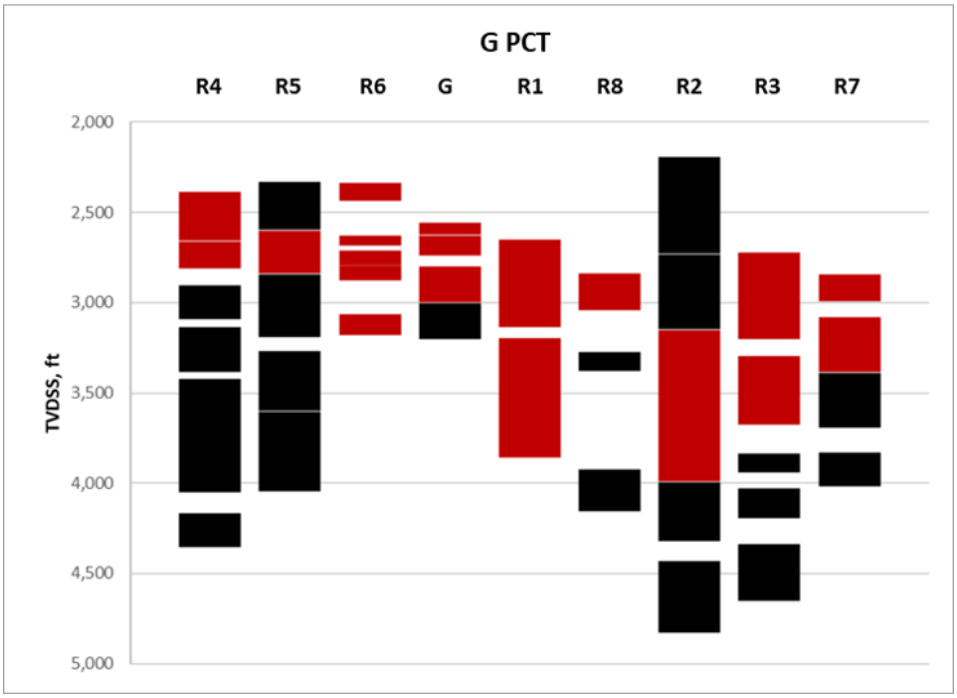



**Fig. 4.2.** Simplified cross-section, well locations (with other wells removed from the map) and PP properties used for the design

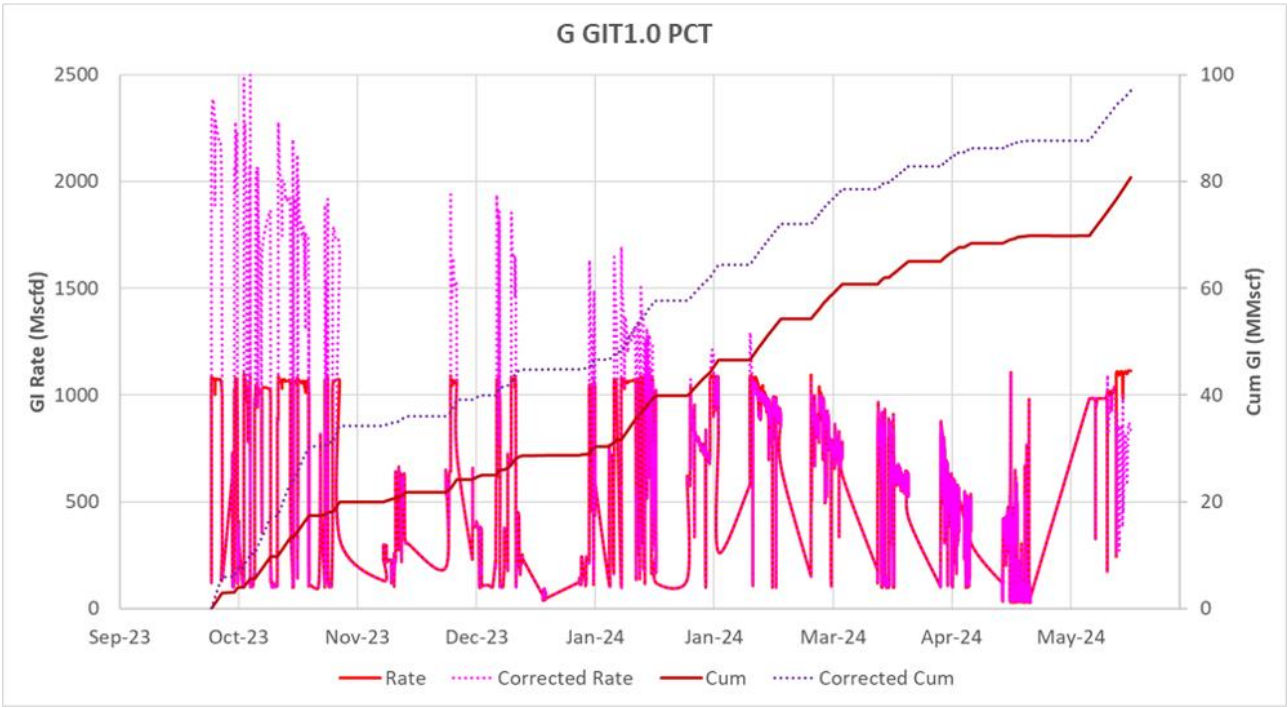



**Fig. 4.3.** Gas rate and cumulative injection: the surface measurement and corrected values with respect to a downhole flowmeter trend.

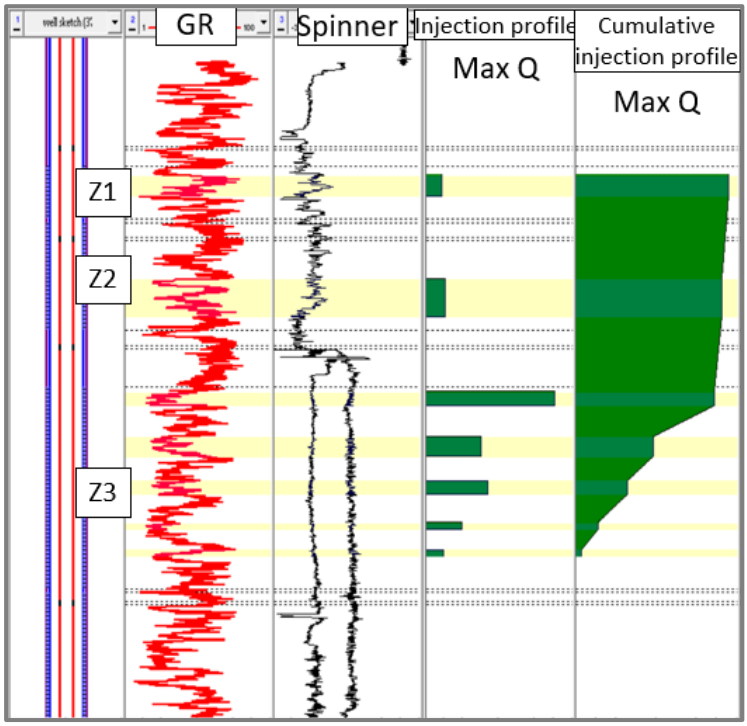



**Fig. 4.4.** Injection profile from RFA.

RFA has revealed that absolute most of the gas is going into Z3. It led to decision to run PCT with zones 1+2 open, assuming Z1+2 contribution to be negligible.

**Table 4.1.** Pressure recording design

| # | Well | Gauge used | Setting depth (MD), ft | Setting depth (TVDSS), ft |
|---|---|---|---|---|
| 1 | R6 | QMR+zPas | 5,124 | 2,892 |
| 2 | R1 | QMR+zPas | 4,719 | 3,273 |
| 3 | R5 | PDG | 2,572 | 2,253 |
| 4 | R8 | QMR+zPas | 2,746 | 2,649 |
| 5 | R4 | QMR+zPas | 3,499 | 2,885 |
| 6 | R2 | QMR+QMR | 4,575 | 3,693 |
| 7 | G | QMR | 3,490 | 2,622 |
| 8 | G | QMR | 3,915 | 2,897 |
| 9 | G | Flowmeter | 3,490 | 2,622 |
| 10 | R3 | PDG | 2,664 | 2,581 |
| 11 | R7 | PDG | 2,920 | 2,635 |

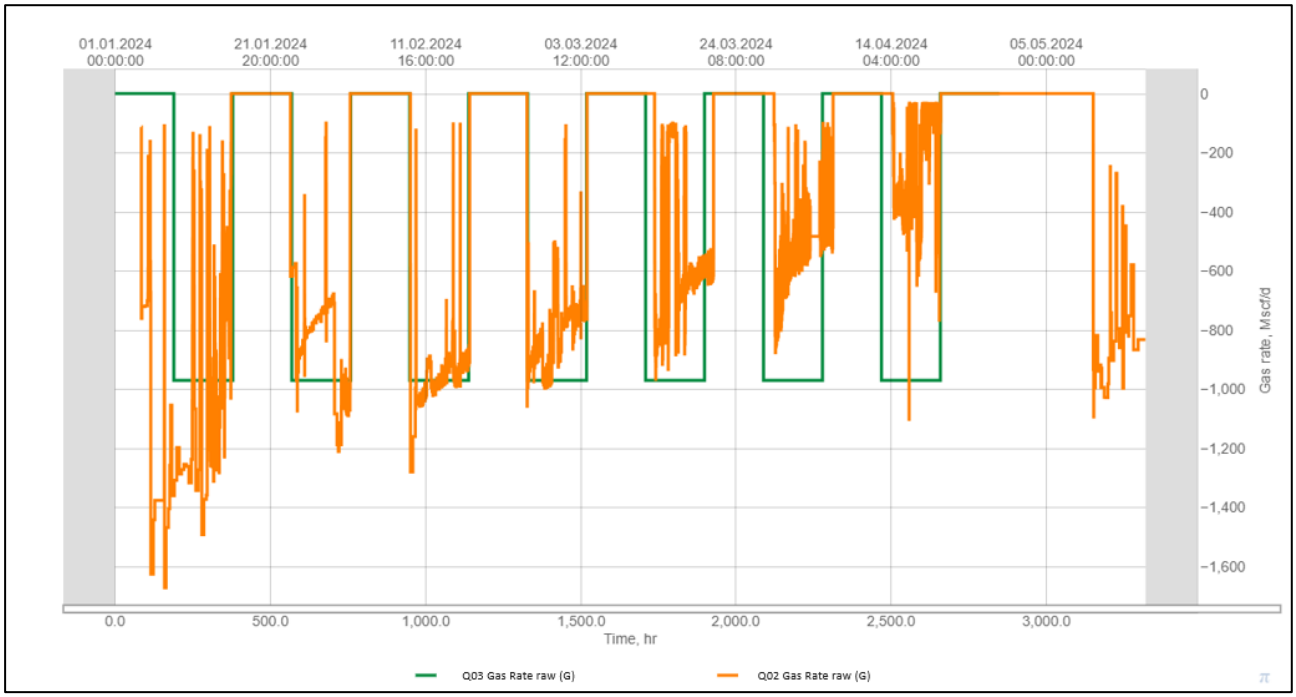



**Fig. 4.5.** PCT Design vs Field PCT

The initial design included 6 injection-shut-in pulses, the program was successfully completed according to the design

## 5. DATA ANALYSIS

### 5.1. Quality control and preprocessing

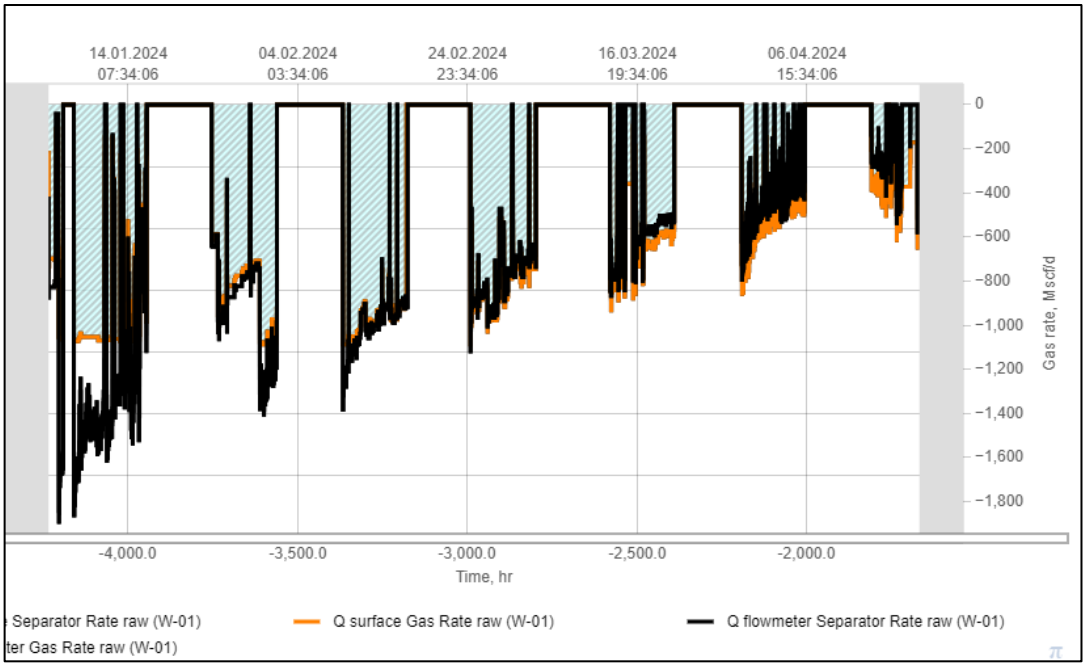



**Fig. 5.1.** Surface measurements and normalized flowmeter

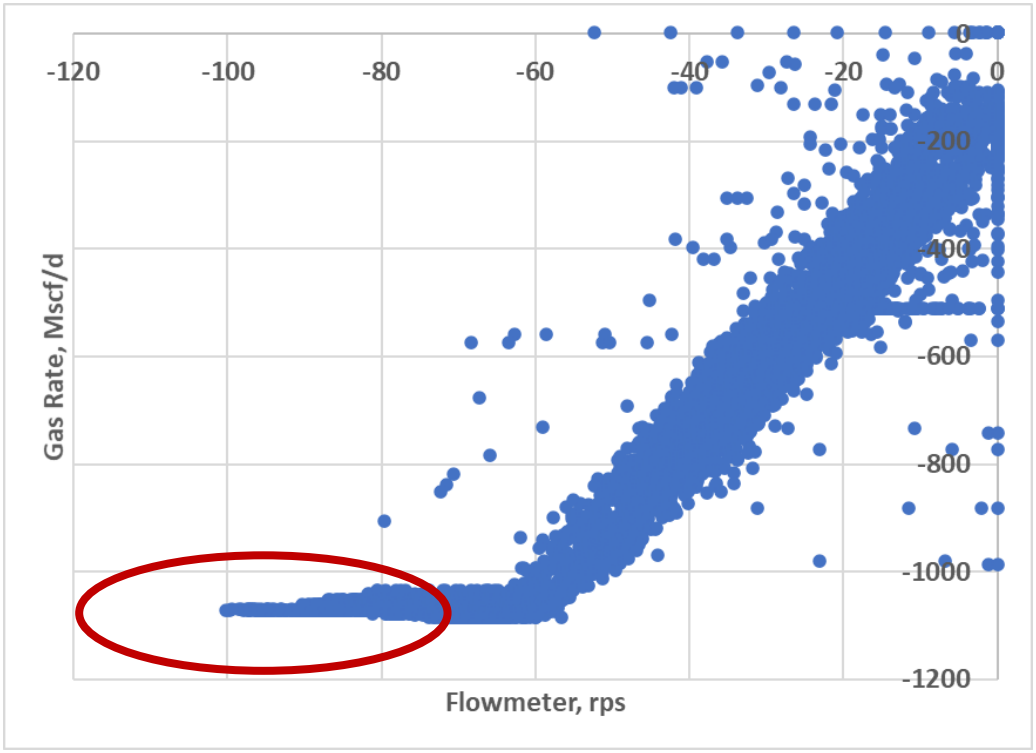



**Fig. 5.2 .** Surface measurements vs flowmeter

Flowmeter rate agrees with surface gas rate measurements. The cross-plot shows a close correlation except for the high injection rate values – more than 1 MMscfd.
The rate was corrected using the correlation between a flowmeter rps and gas rate measured on surface for rates lower than 1 MMscfd.


**Fig. 5.3a.** G quality control (pressure readings)

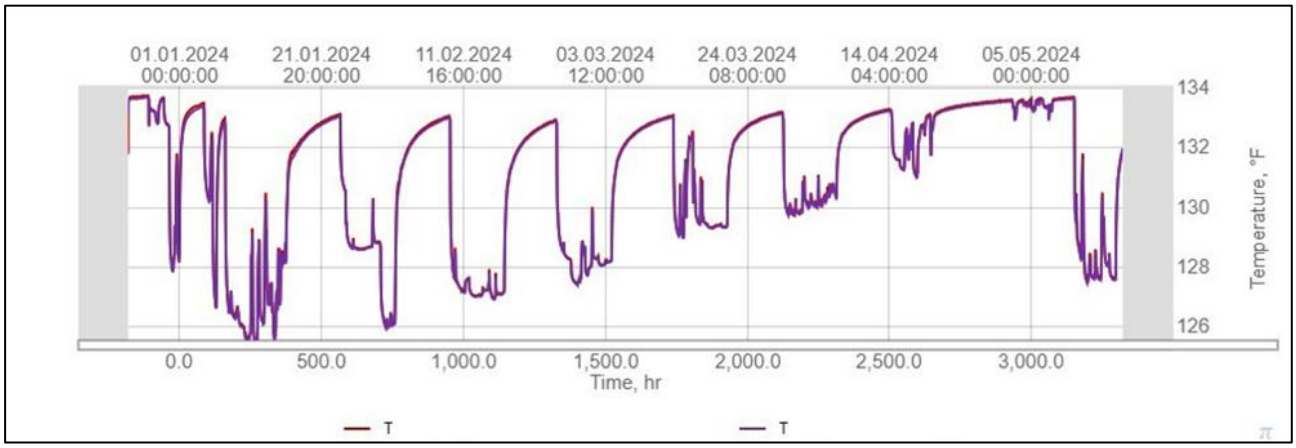



**Fig. 5.3b.** G quality control (temperature readings)

Both gauges recorded both pressure and temperature in the well for the whole PCT period. Pressure and temperature plots are showing almost perfect match despite the 275 ft TVDSS difference in setting depths.

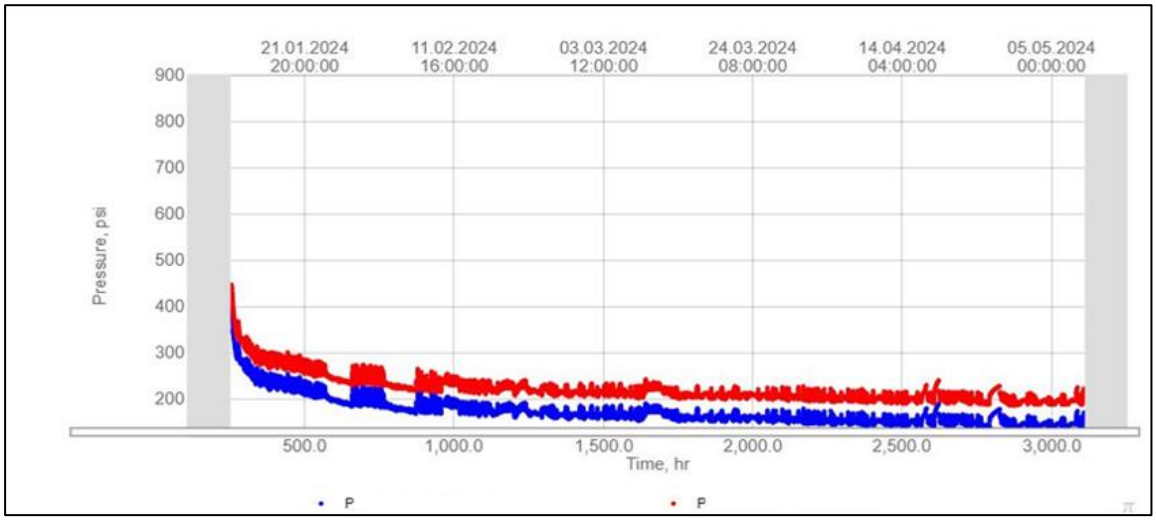



**Fig. 5.4a.** R1 quality control (pressure)

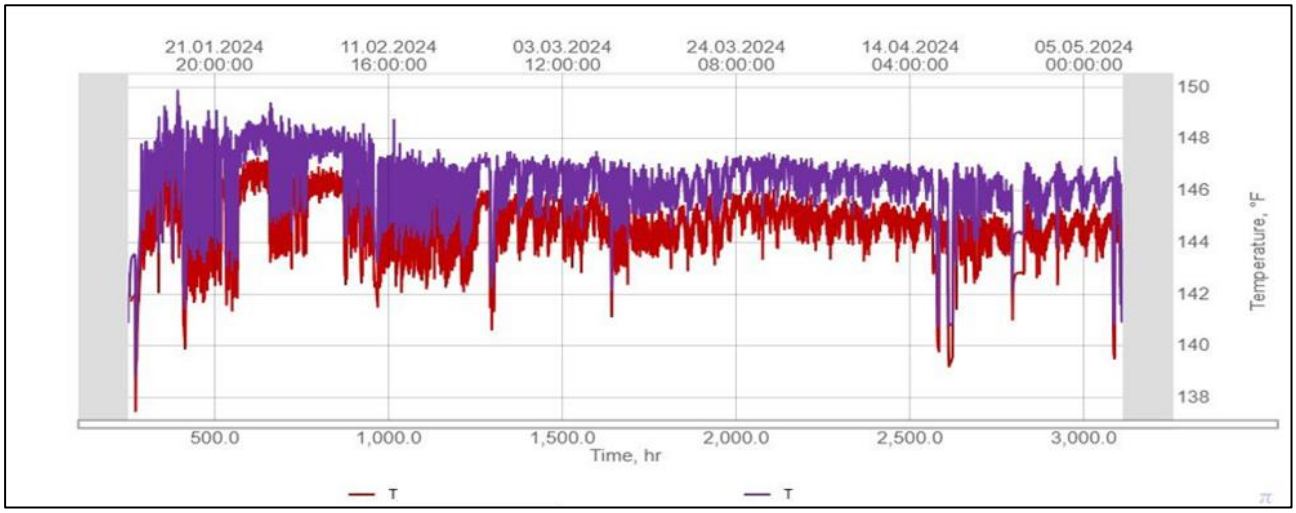



**Fig. 5.4b.** R1 quality control (temperature)

Both gauges recorded both pressure and temperature in the well for the whole PCT period. Pressure and temperature plots are showing a slight mismatch probably caused by different calibration, though linear pressure correction removes this mismatch completely.

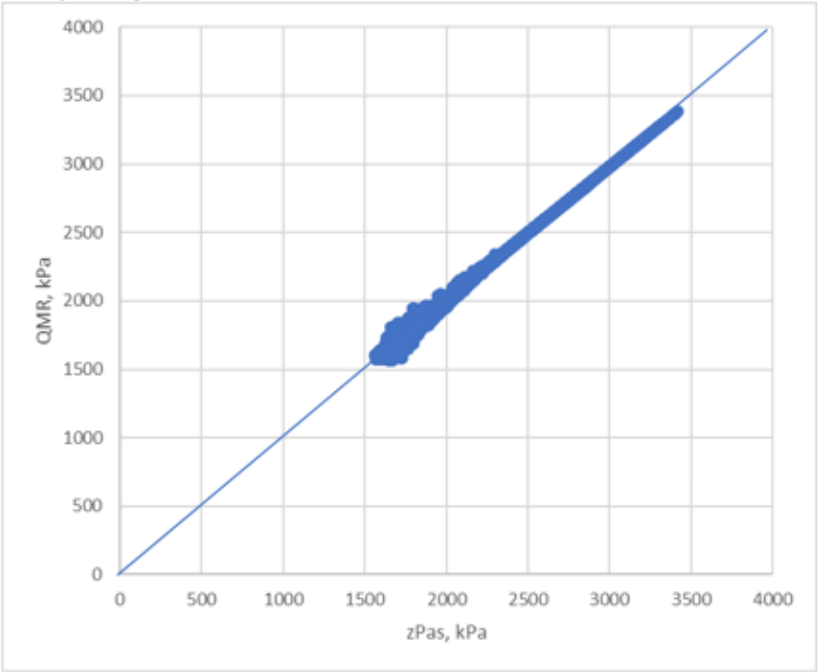



**Fig. 5.5.** R1 cross-correlation between gauges

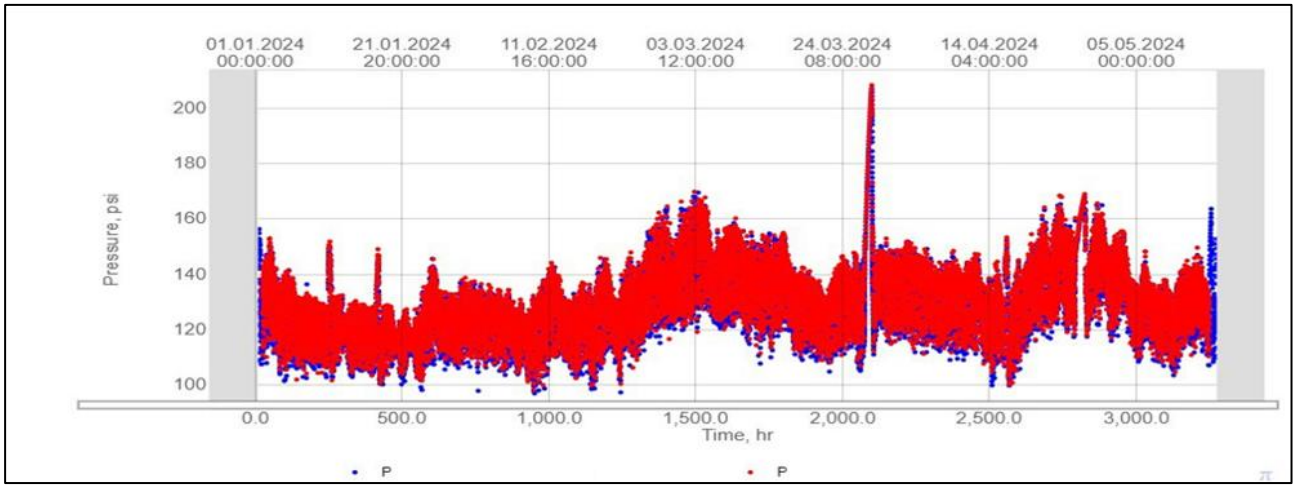



**Fig. 5.6a.** R2 quality control (pressure)

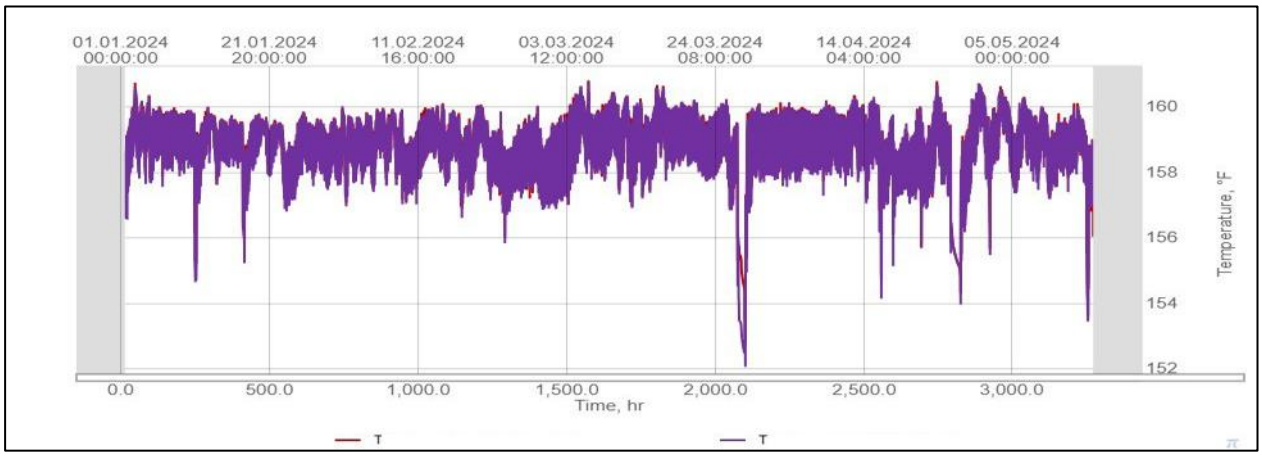



**Fig. 5.6b.** R2 quality control (temperature)

Both gauges recorded both pressure and temperature in the well for the whole PCT period. Pressure and temperature plots are showing almost perfect match.

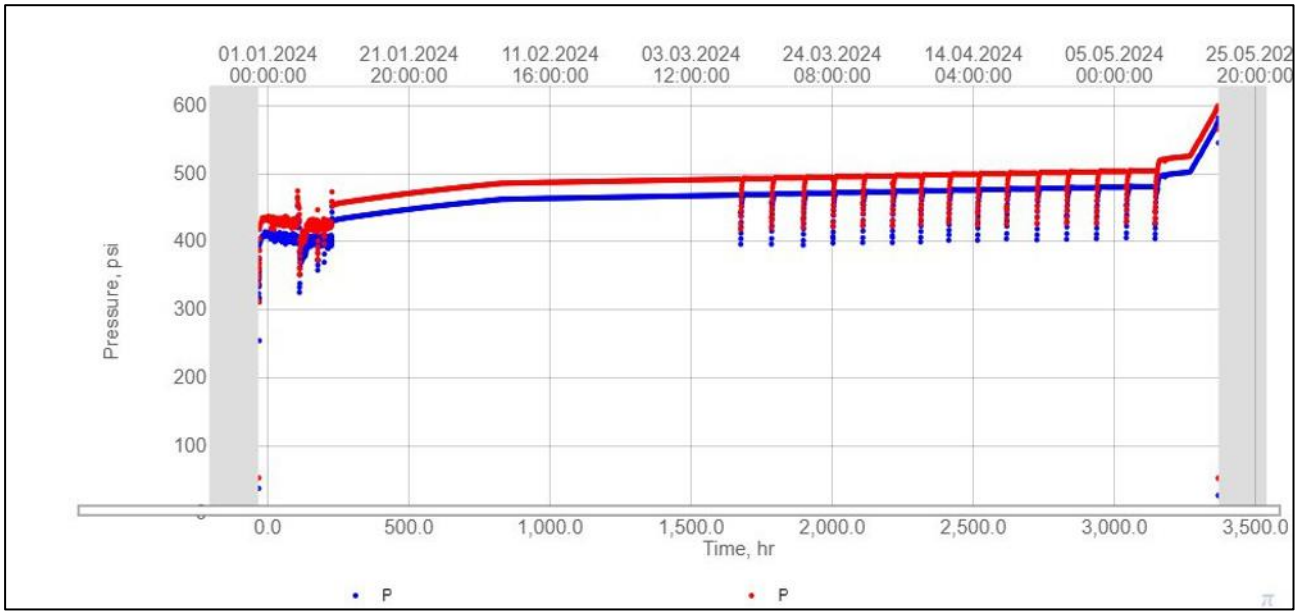



**Fig. 5.7a.** R4 quality control (pressure)

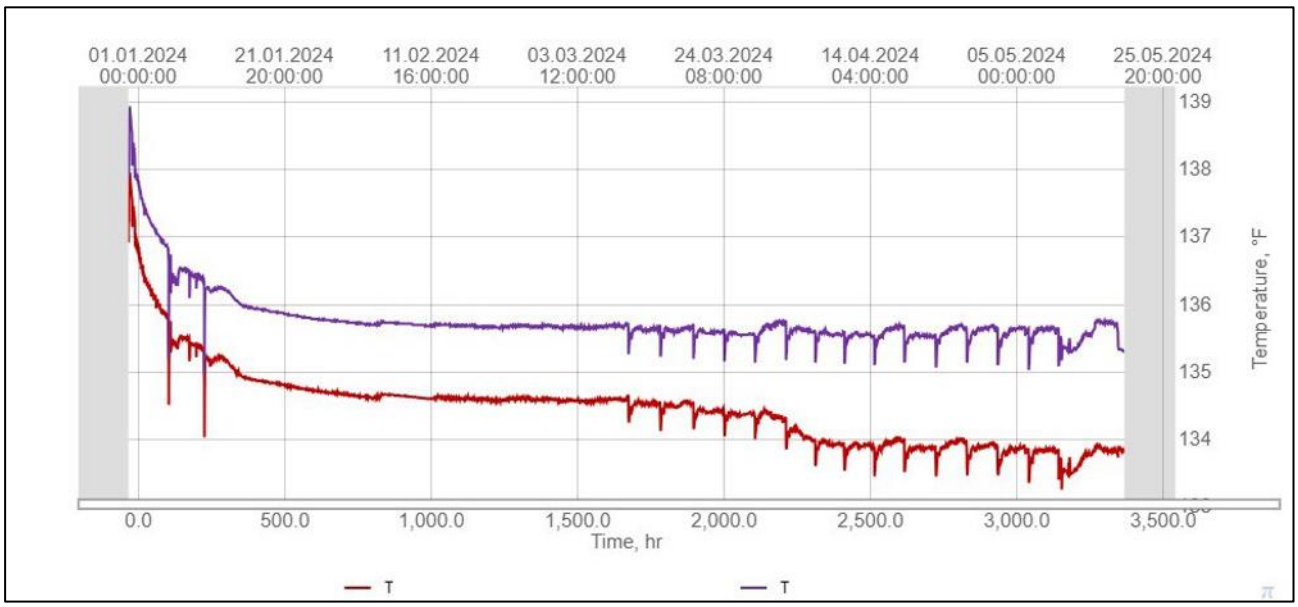



**Fig. 5.7b.** R4 quality control (temperature)

Both QMR and zPas gauges recorded both pressure and temperature in the well for the whole PCT period. Pressure and temperature plots are showing a slight mismatch probably caused by different calibration, though linear pressure correction removes this mismatch completely.

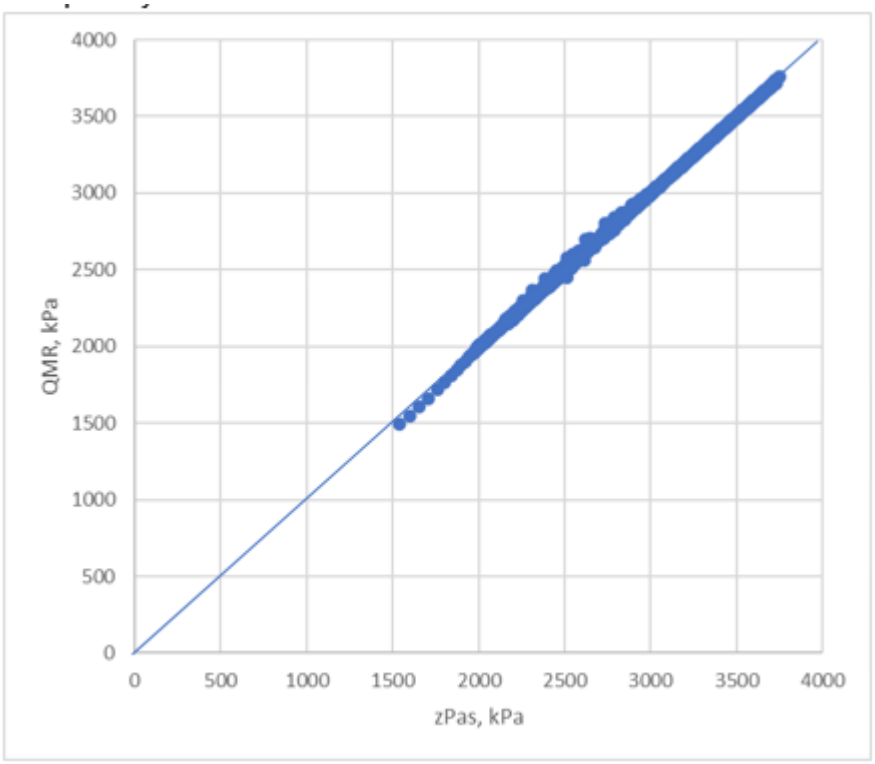



**Fig. 5.8.** R4 cross-correlation between gauges

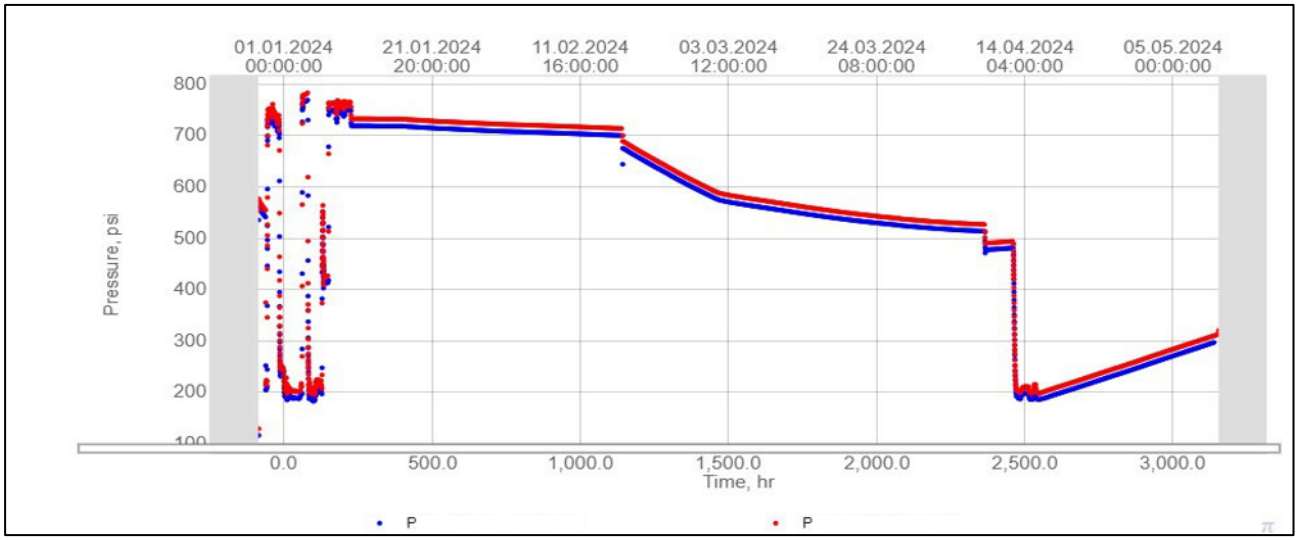



**Fig. 5.9a.** R8 quality control (pressure)


**Fig. 5.9b.** R8 quality control (temperature)

Both gauges recorded both pressure and temperature in the well for the whole PCT period. Pressure and temperature plots are showing a slight mismatch probably caused by different calibration, though linear pressure correction removes this mismatch completely.

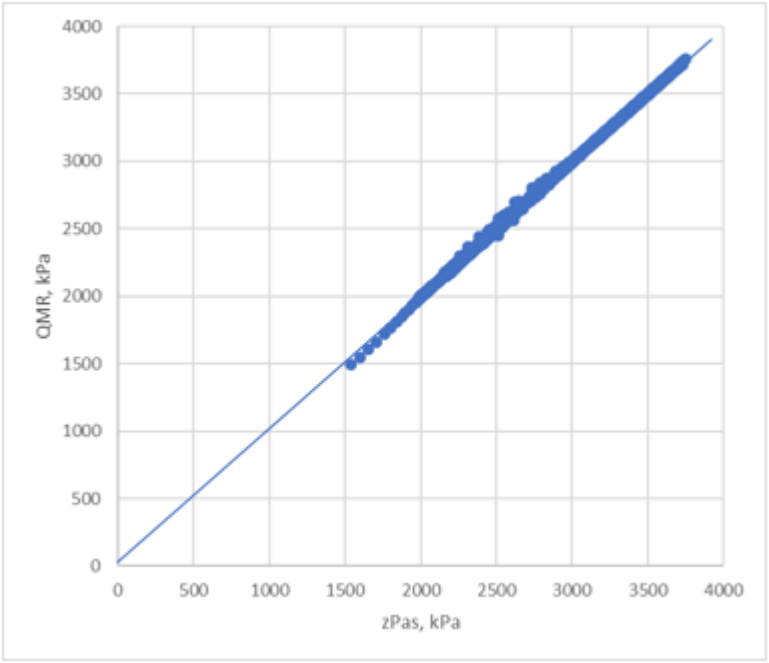



**Fig. 5.10.** R8 cross-correlation between gauges

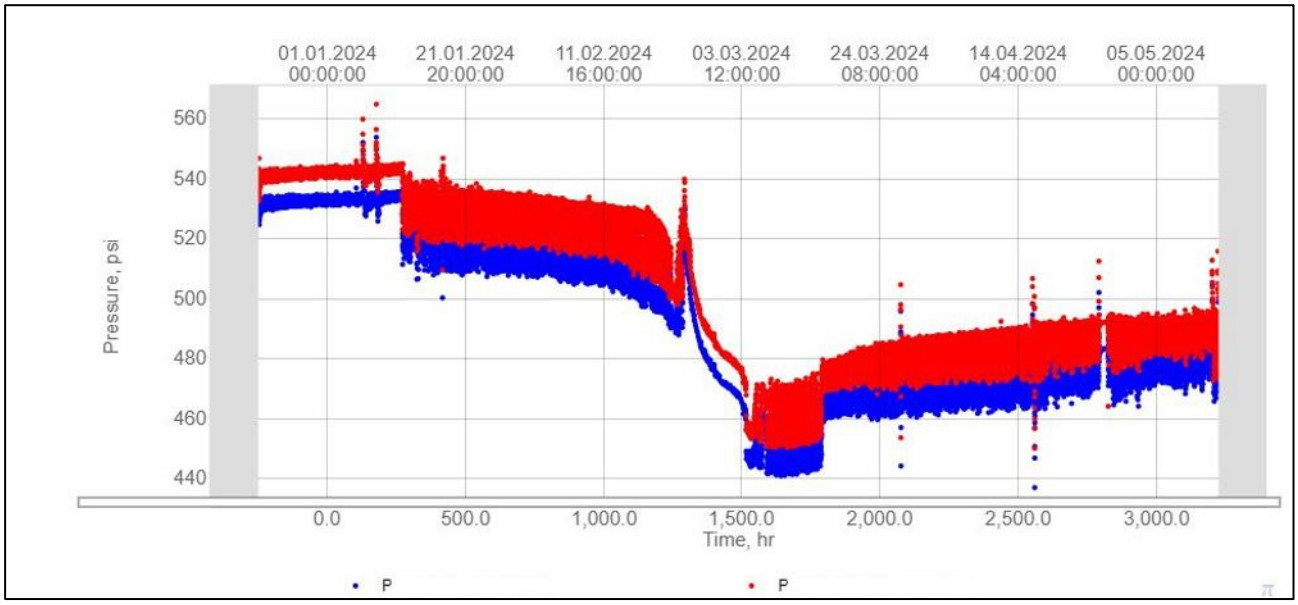



**Fig. 5.11a.** R6 quality control (pressure)

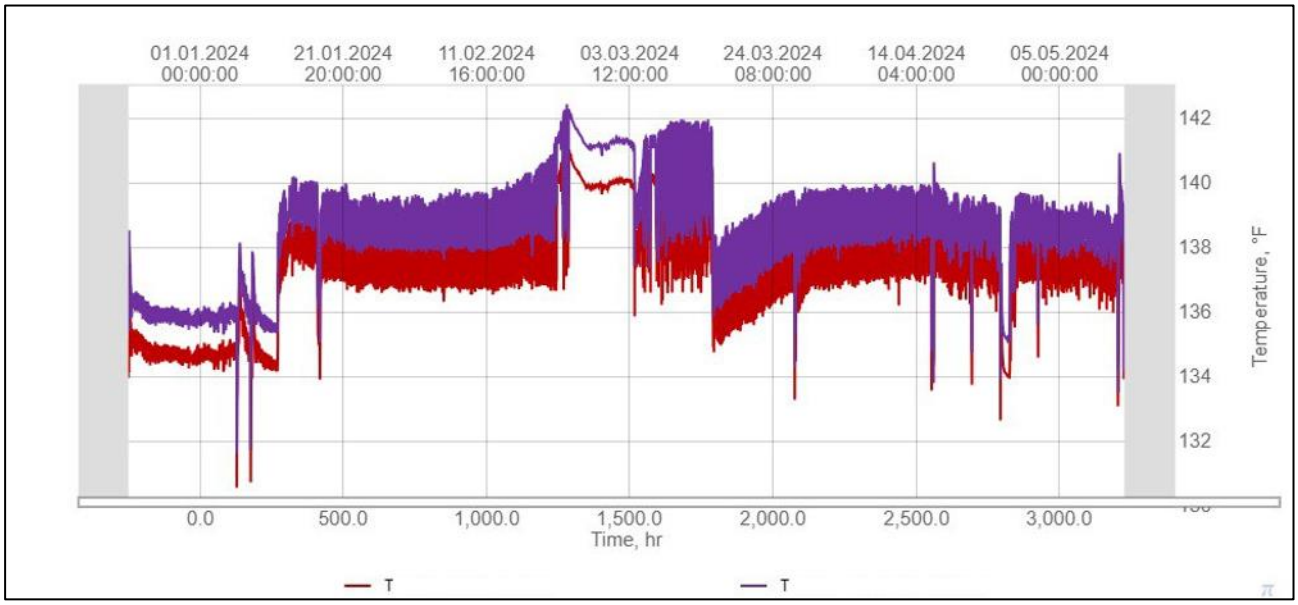



**Fig. 5.11b.** R6 quality control (temperature)

Both QMR and zPas gauges recorded both pressure and temperature in the well for the whole PCT period. Pressure and temperature plots are showing a slight mismatch probably caused by different calibration, though linear pressure correction removes this mismatch completely.

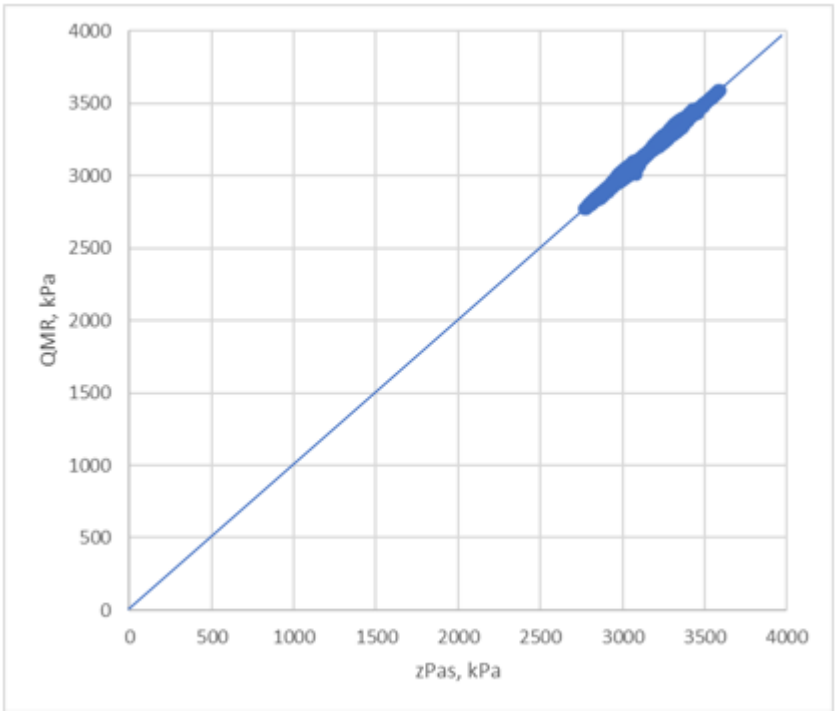



**Fig. 5.12.** R6 cross-correlation between gauges

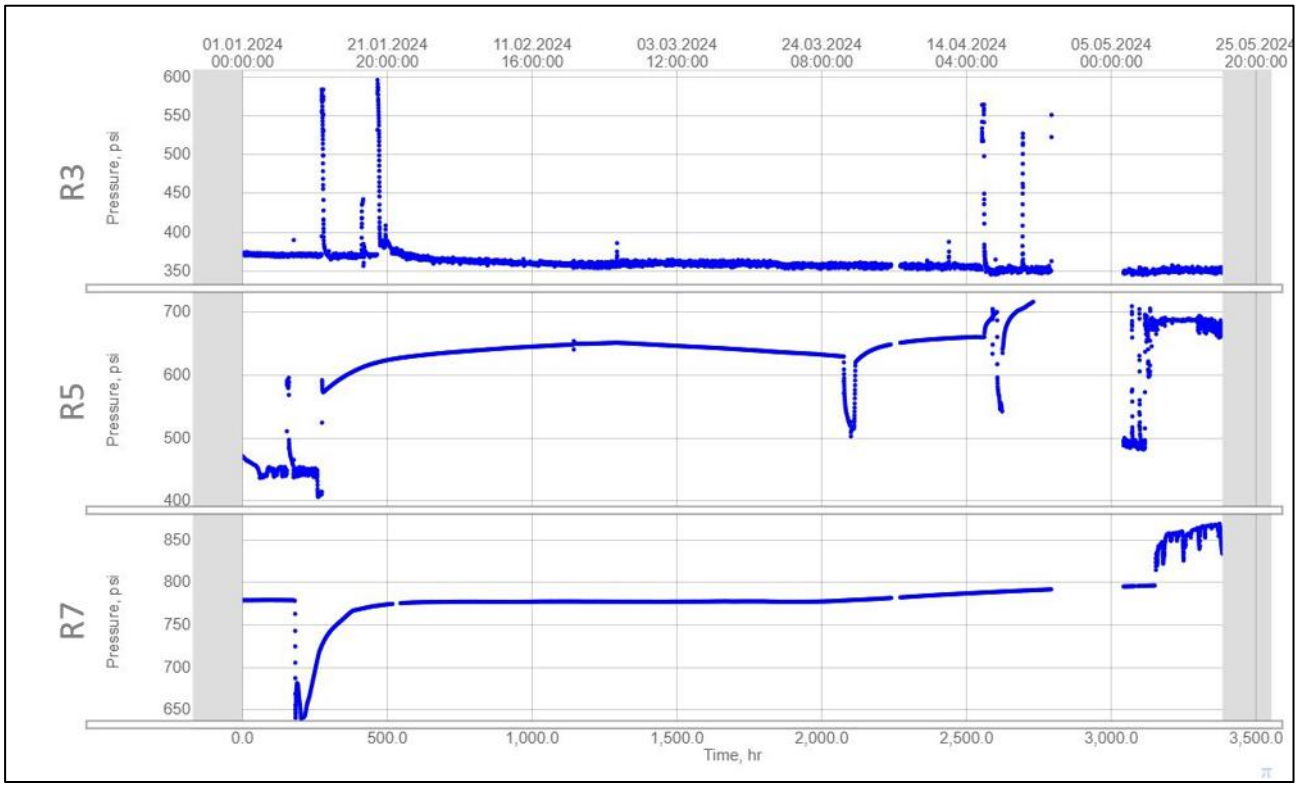



**Fig. 5.13.** R5 R3 R7 quality control

Permanent Downhole Gauges have recorded pressure in the wells for the whole PCT period.

### 5.2. PI analysis

The productivity of the receiving wells was calculated on surface conditions by the formula (1)

$$J = \frac{q_o}{P_e - P_{wf}}$$

$P_e$ – formation pressure,
$J$ – productivity index,
$P_{wf}$ – bottom hole pressure,

where, $q_o$ – oil rate, surface condition.

The productivity was calculated using the dynamic data during the test only, relying on fluctuations of rate, occasional build-ups and drawdowns, and should be considered as an estimate.

It was further used in calculating the potential production gain from the pressure response to gas injection.

### 5.3. Transient analysis

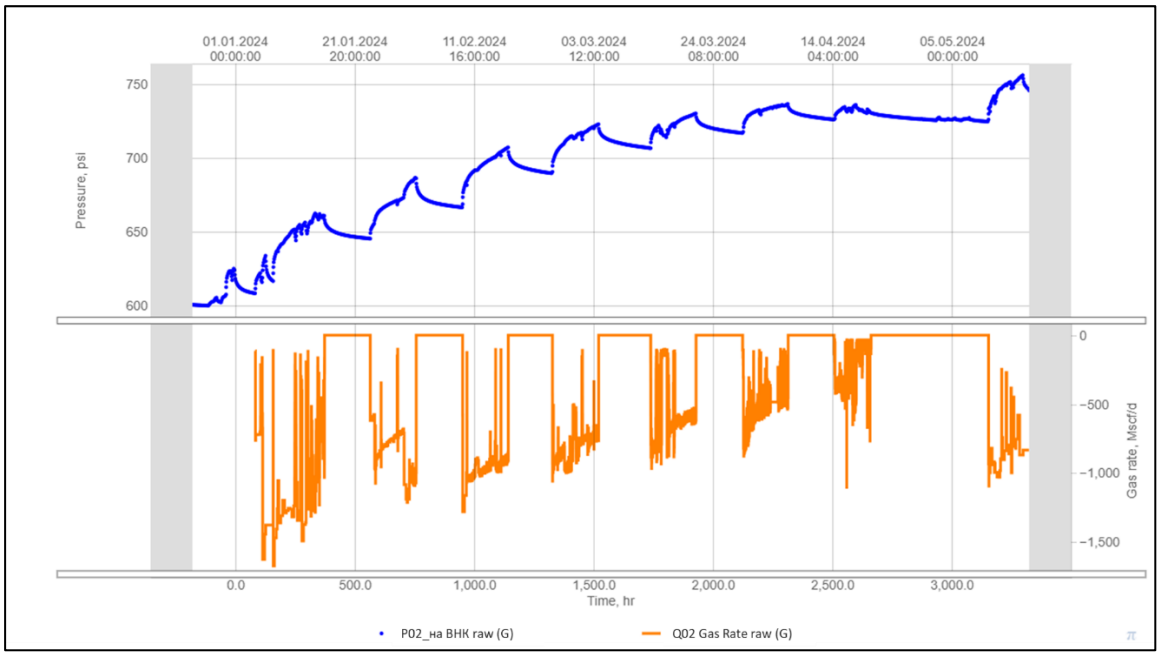



**Fig. 5.3.1.** History plot of G

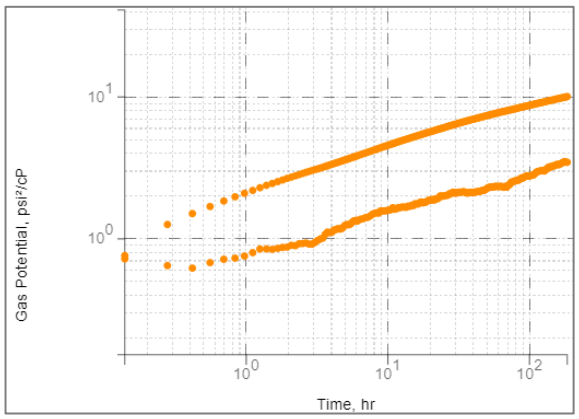



**Fig. 5.3.2a**. Build-up #1 diagnostic plot for well G

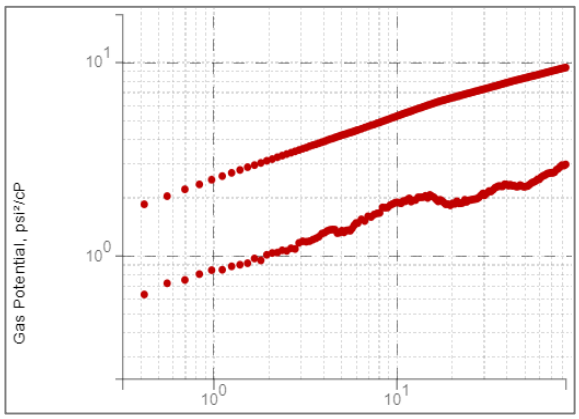



**Fig. 5.3.2b**. Build-up #2 diagnostic plot for well G

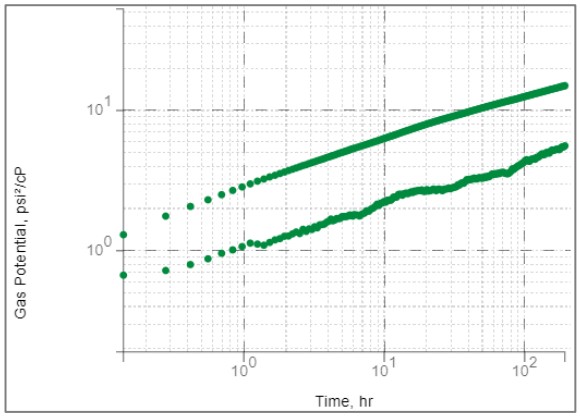



**Fig. 5.3.2c**. Build-up #3 diagnostic plot for well G

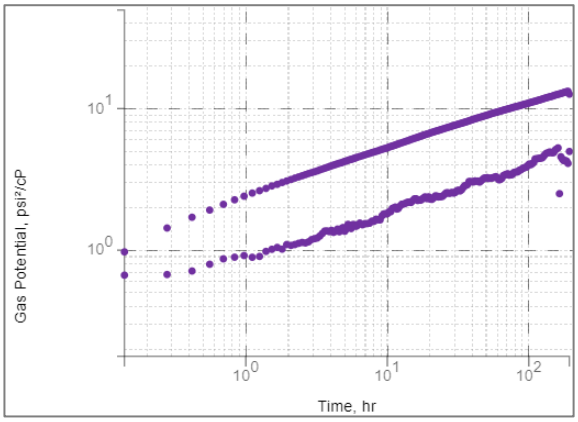



**Fig. 5.3.2d**. Build-up #4 diagnostic plot for well G

**Table 5.3.1.** Diffusion model summary on G

| Property | Abbreviation | PBU Value | OH Value | Unit |
|---|---|---|---|---|
| Net sand thickness | Hnet | | 55.1 | ft |
| Total Skin | ST | -5.3 | | |
| Permeability @ oil scenario | ko | 1810 | 56.3 | mD |
| Permeability @ gas scenario | Kg | 16.3 | | mD |
| Formation pressure (@DATUM 3000 ft) | Pe | 599 → 723 | | psi |
| Initial formation pressure (RFT@DATUM 3000 ft) | Pi | | 1349 | psi |

The values of permeabilities obtained using oil and gas scenario very dramatically, but the actual permeability value lies between them.
That indicates that both gas and oil saturated thickness is taking the injected gas.
Also, the pressure build during the injection indicate a limited volume of the gas bubble around the well.

### 5.4. PCT Results

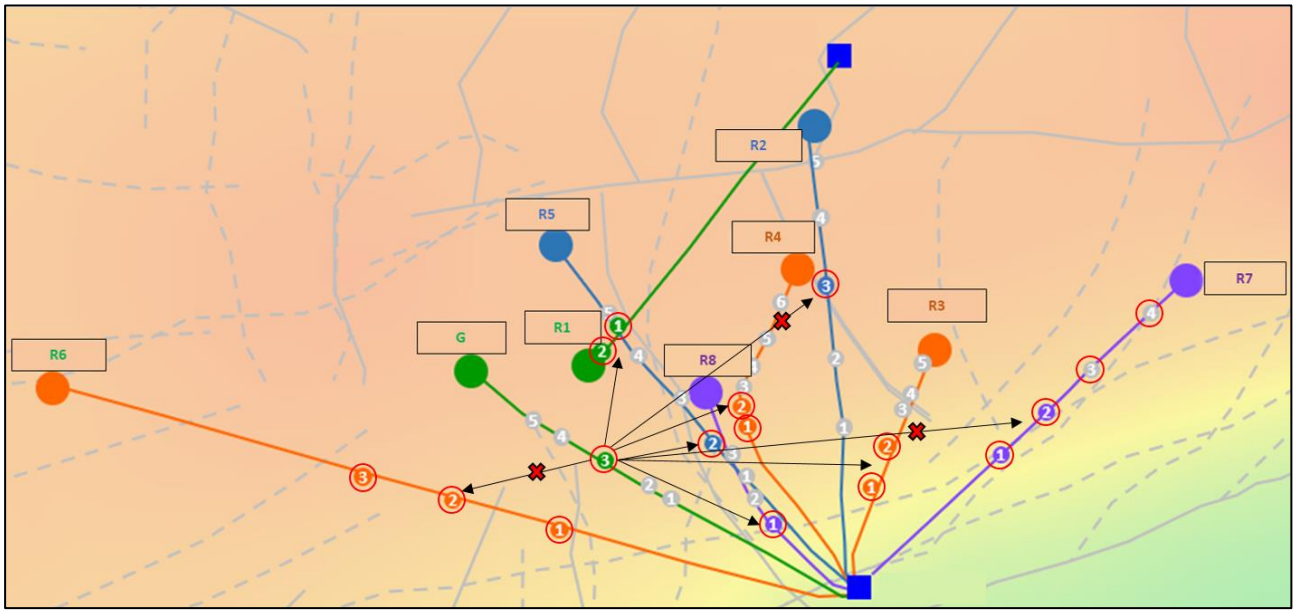



**Fig. 5.4.1.** PCT Investigation area map

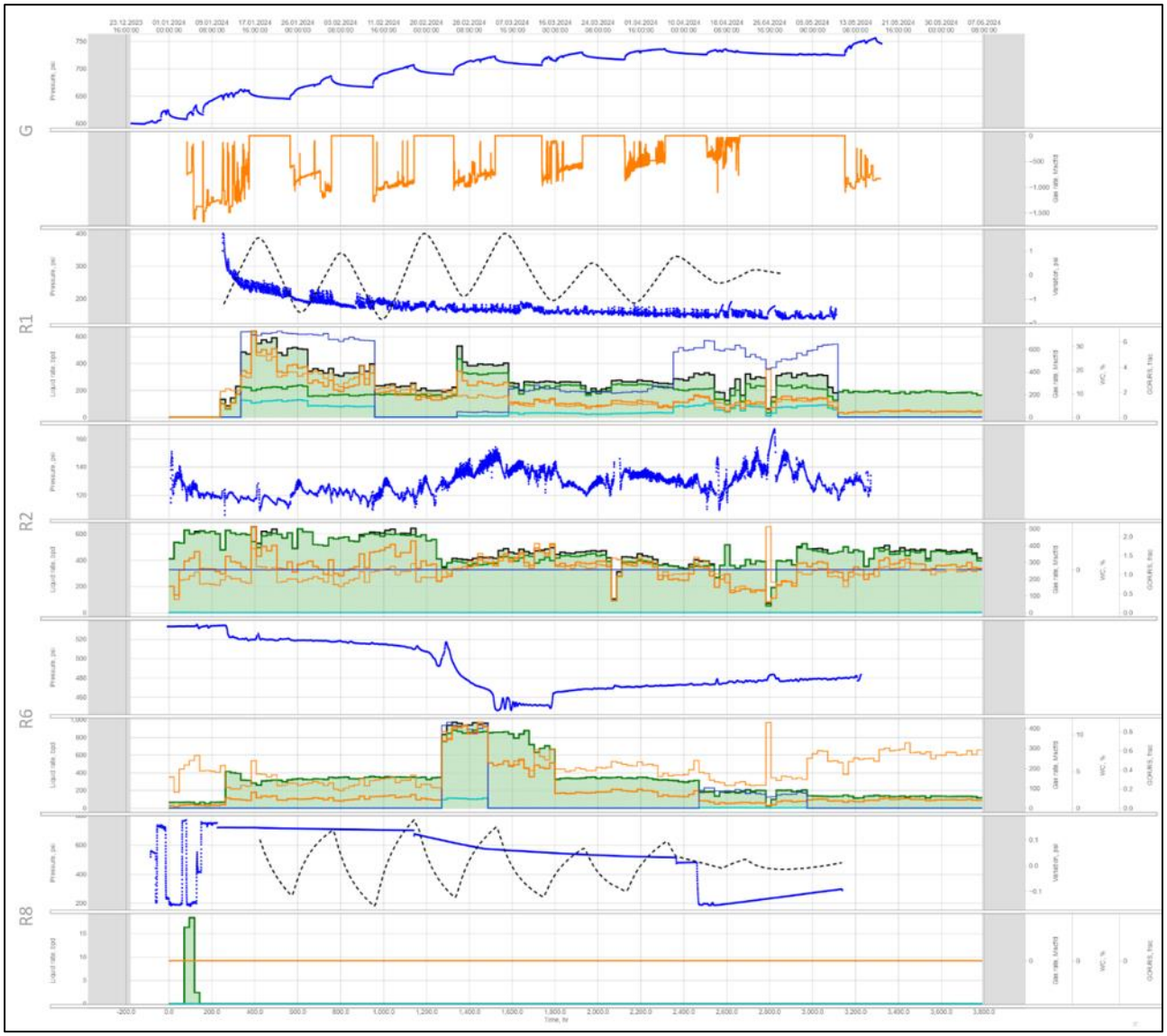



**Fig. 5.4.2.** PCT combined plot (**G – R1, R2, R6, R8**)

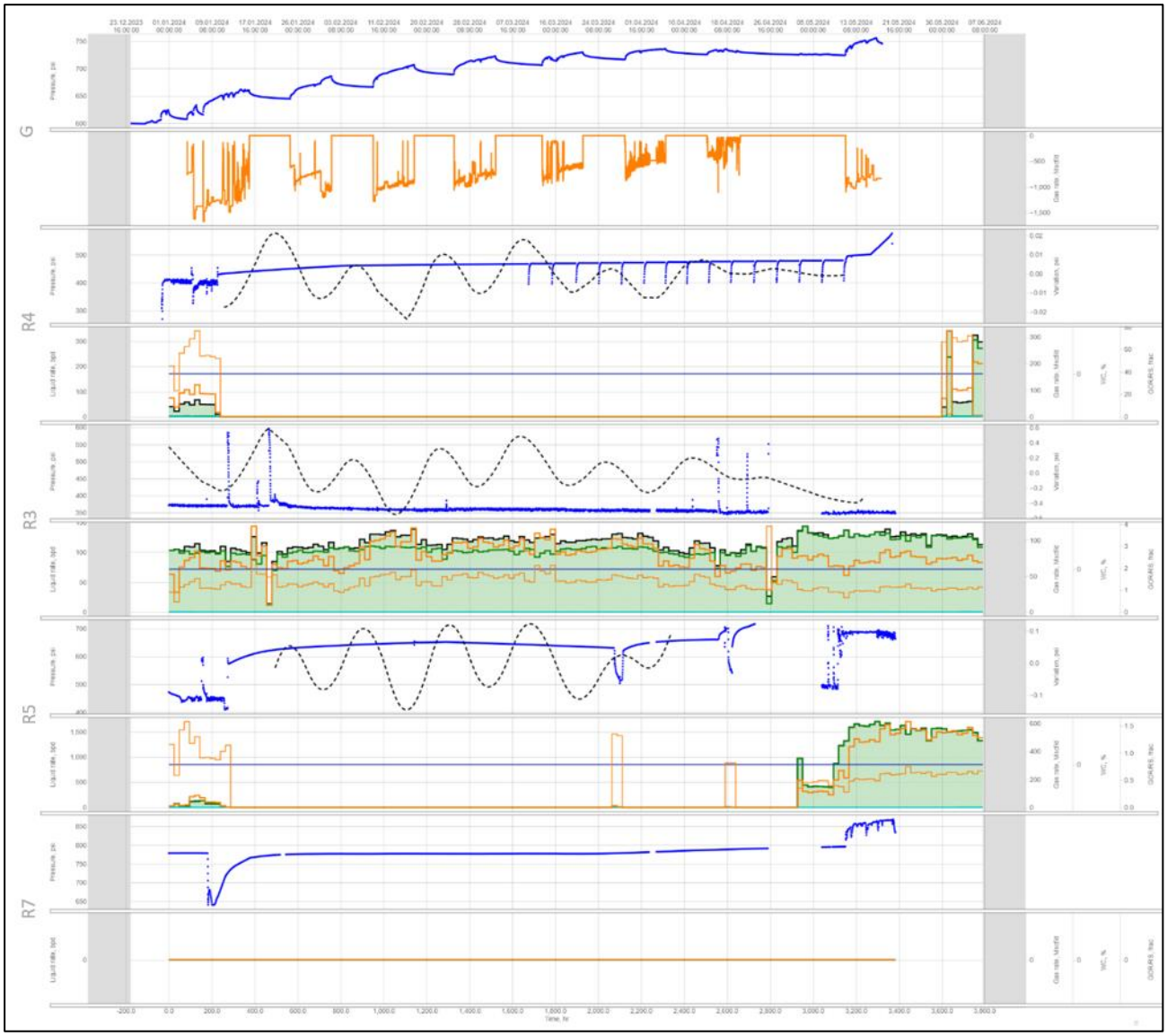



**Fig. 5.4.3.** PCT combined plot (**G – R4, R3, R5, R7**)

Fig. 5.4.2 and Fig. 5.4.3 show the recorded pressure (blue dots) and the decomposed pressure response for 5 wells where PCT was able to detect it (black dashed lines, right axis)

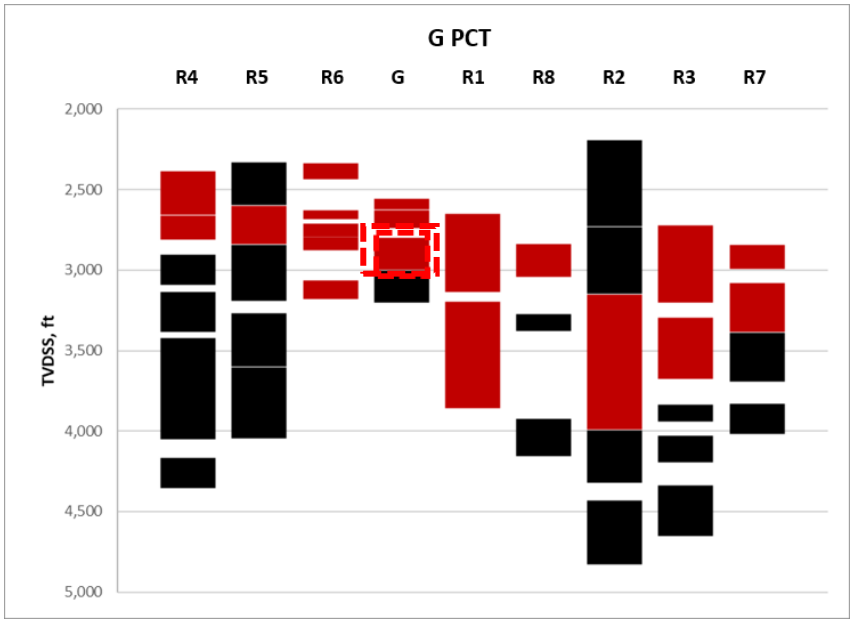



**Fig. 5.4.4.** Simplified cross-section, well locations (with other wells removed from the map) and PP properties used for the design

### 5.4.1 PCT cross-validation

**Table 5.4.1.** Results of X-Validation

| # | Receiver | Option | χ, ·10$^7$ mD·psi/cP | σ, mD·ft/cP | Result |
|---|---|---|---|---|---|
| 1 | R1 | Base | 0.61 | 30,375 | PASS |
| | | Cut 1 | 0.64 | 32,520 | |
| | | Cut 2 | 0.58 | 28,759 | |
| 2 | R6 | Base | 0.041 | 13.4 | FAIL |
| | | Cut 1 | 0.38 | 427.2 | |
| | | Cut 2 | 0.9 | 4,624 | |
| 3 | R8 | Base | 0.52 | 21,640 | PASS |
| | | Cut 1 | 0.5 | 19,210 | |
| | | Cut 2 | 0.53 | 22,384 | |
| 4 | R4 | Base | 0.42 | 87,256 | PASS |
| | | Cut 1 | 0.41 | 85,892 | |
| | | Cut 2 | 0.39 | 84,986 | |
| 5 | R3 | Base | 2.23 | 52,790 | PASS |
| | | Cut 1 | 2.19 | 49,633 | |
| | | Cut 2 | 2.2 | 50,836 | |
| 6 | R5 | Base | 0.21 | 48,864 | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | Cut 1 | 0.22 | 50,127 | |
| | | Cut 2 | 0.24 | 52,463 | |
| 7 | R7 | Base | 86 | 2,358,210 | FAIL |
| | | Cut 1 | 752 | 109,670,100 | |
| | | Cut 2 | 32 | 1,015,306 | |
| 8 | R2 | Base | 1.7 | 3,384 | FAIL |
| | | Cut 1 | 0.42 | 582 | |
| | | Cut 2 | 0.1 | 124.3 | |

**Table 5.4.2.** X-Validation of **R6 (supp. 1+2+3)**

| # | Receiver | Option | χ, ·10$^7$ mD·psi/cP | σ, mD·ft/cP | Result |
|---|---|---|---|---|---|
| 1 | R6 (supp. 1+2+3) | Base | 0.68 | 4378 | FAIL |
| | | Cut 1 | 1.09 | 98,642 | |

**Table 5.4.3.** X-Validation of **R6 (supp. 1+2)**

| # | Receiver | Option | χ, ·10$^7$ mD·psi/cP | σ, mD·ft/cP | Result |
|---|---|---|---|---|---|
| 2 | R6 (supp. 1+2) | Base | 0.17 | 729 | FAIL |
| | | Cut 1 | 0.92 | 52,066 | |

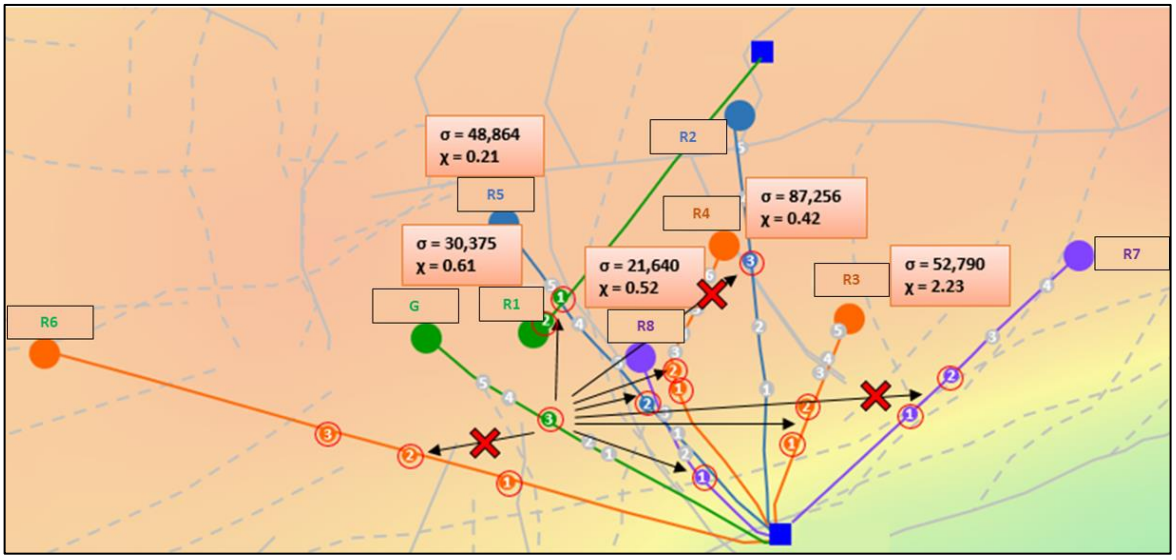
X-Validation is used to verify the results of a Pulse-Code Decomposition. We reduce the dataset and repeat the calculations in order to assess the robustness of the results.
The cross-well intervals with a low stability of **χ** and **σ** in different calculations, are disqualified. 5 intervals out of 8 have passed the X-Validation.

### 5.4.2. Apparent transmissibility and pressure diffusivity

**Table 5.4.2.** Transmissibility and pressure diffusivity comparison from PCT and design

| # | Well | Property | PCT Value | Design Value | Unit |
|---|---|---|---|---|---|
| 1 | R1 | σ | 30,375 | 326,079 | mD·ft/cP |
| | | χ | 0.61 | 6.03 | ·10$^7$ mD·psi/cP |
| 2 | R6 | σ | - | - | mD·ft/cP |
| | | χ | - | - | ·10$^7$ mD·psi/cP |
| 3 | R8 | σ | 21,640 | 38,217 | mD·ft/cP |
| | | χ | 0.52 | 2.67 | ·10$^7$ mD·psi/cP |
| 4 | R4 | σ | 87,256 | 98,099 | mD·ft/cP |
| | | χ | 0.42 | 4.82 | ·10$^7$ mD·psi/cP |

| | | | | | |
|---|---|---|---|---|---|
| 5 | R3 | σ | 52,790 | - | mD·ft/cP |
| | | χ | 2.23 | - | $\cdot 10^7$ mD·psi/cP |
| 6 | R5 | σ | 48,864 | 60,569 | mD·ft/cP |
| | | χ | 0.21 | 2.85 | $\cdot 10^7$ mD·psi/cP |
| 7 | R2 | σ | - | - | mD·ft/cP |
| | | χ | - | - | $\cdot 10^7$ mD·psi/cP |
| 8 | R7 | Σ | - | - | mD·ft/cP |
| | | χ | - | - | $\cdot 10^7$ mD·psi/cP |




σ- Transmissibility, mD*ft/cP
χ – Pressure Diffusivity, * $10^7$ mD*psi/cP
**Fig. 5.4.5.** Transmissibility and pressure diffusivity from PCT

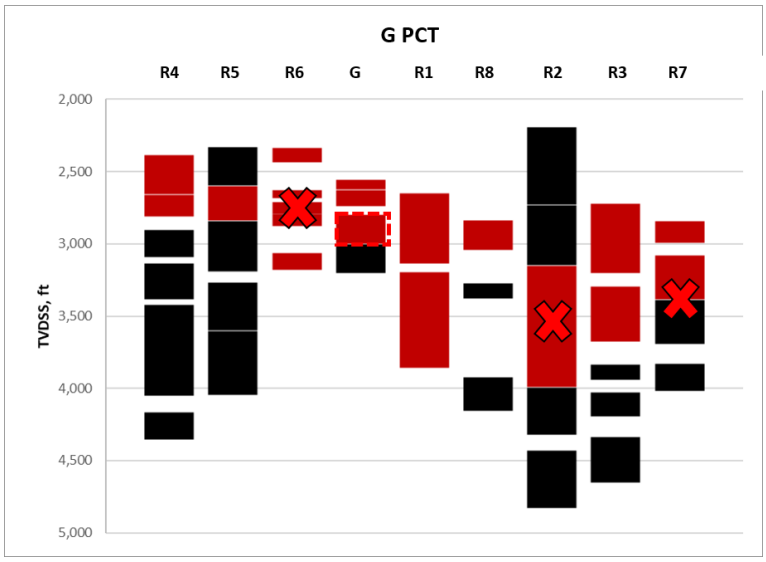
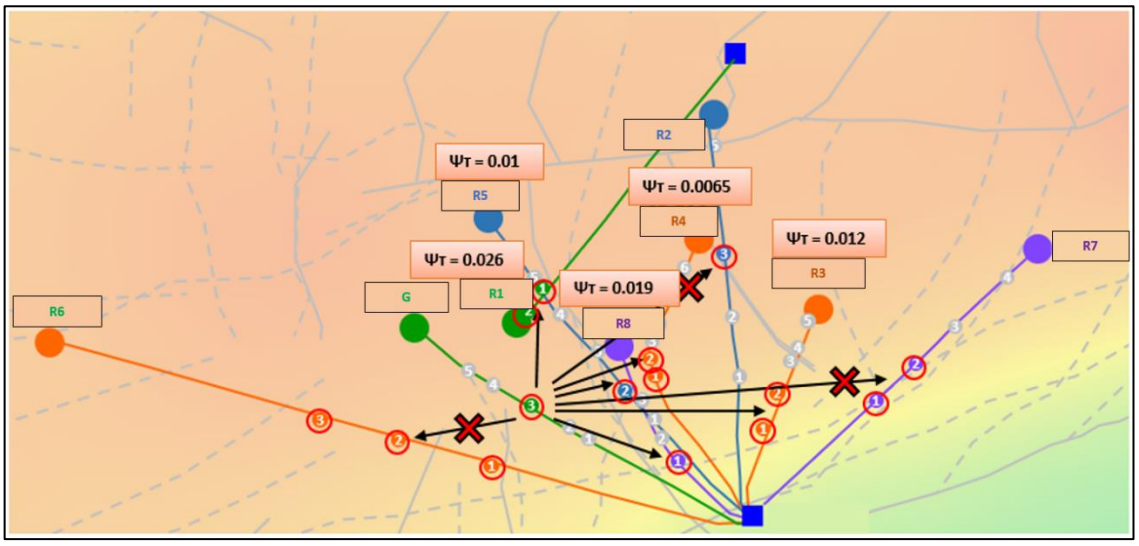



**Fig. 5.4.6.** Simplified cross-section, with indication of the wells where the response wasn't seen.

**Table 5.4.3.** Pressure amplitude and arrival time comparison from PCT and design

| # | Well | Property | PCT Value | Design Value | Unit |
|---|---|---|---|---|---|
| 1 | R1 | A | 1 | 0.039 | psi |
| | | t | 55 | 132 | hours |
| 2 | R6 | A | - | 0.036 | psi |
| | | t | - | 133 | hours |
| 3 | R8 | A | 0.125 | 0.007 | psi |
| | | t | 10 | 261 | hours |
| 4 | R4 | A | 0.015 | 0.026 | psi |
| | | t | 127 | 205 | hours |
| 5 | R3 | A | 0.3 | - | psi |
| | | t | 119 | - | hours |
| 6 | R5 | A | 0.075 | 0.094 | psi |
| | | t | 168 | 131 | hours |
| 7 | R2 | A | - | 0.0005 | psi |
| | | t | - | 110 | hours |
| 8 | R7 | A | - | - | psi |
| | | t | - | - | hours |

### 5.4.3. Cross-well interference




ΨT –Unit rate Pressure impact prediction @5 mnth, psi/bpd

**Fig. 5.4.7.** Pressure impact prediction

**Table 5.4.3.** Pressure impact prediction from PCT

| Interval | Gas flood support from G (@ 5mnth) | | |
|---|---|---|---|
| | Pressure Impact | | Oil Rate Impact |
| | Unit, psi/Mscf/d | Cumulative @1MMscf/d, psi | Cumulative @1MMscf/d, bpd |
| G → R1 | 0.026 | 26 | 20.8 (PI 0.8 bpd/psi) |
| G → R2 | - | - | |
| G → R6 | - | - | |
| G →R4 | 0.0065 | 6.5 | 0.33 (PI 0.05 bpd/psi) |
| G → R3 | 0.012 | 12 | 24 (PI 2.0 bpd/psi) |
| G → R5 | 0.01 | 10 | 7.4 (PI 0.74 bpd/psi) |
| G → R7 | - | - | |
| G → R8 | 0.019 | 19 | 0.76 (PI 0.04 bpd/psi) |

Oil rate increase was calculated using the wells' PI obtained from rate/pressure correlation immediately before or during the PCT. It considers 5 months of continuous gas injection @1mmscf/d. The calculation doesn't take into account the interference between the impacted wells.

### 5.4.4. Pressure / rate gain from gas injection during PCT

The following plot and table are showing the calculated pressure and rate response to gas injection pulses during PCT. It was obtained by convolving the actual injection rate history (including injection and fall-off cycles) with the unit pressure response found with PCD.

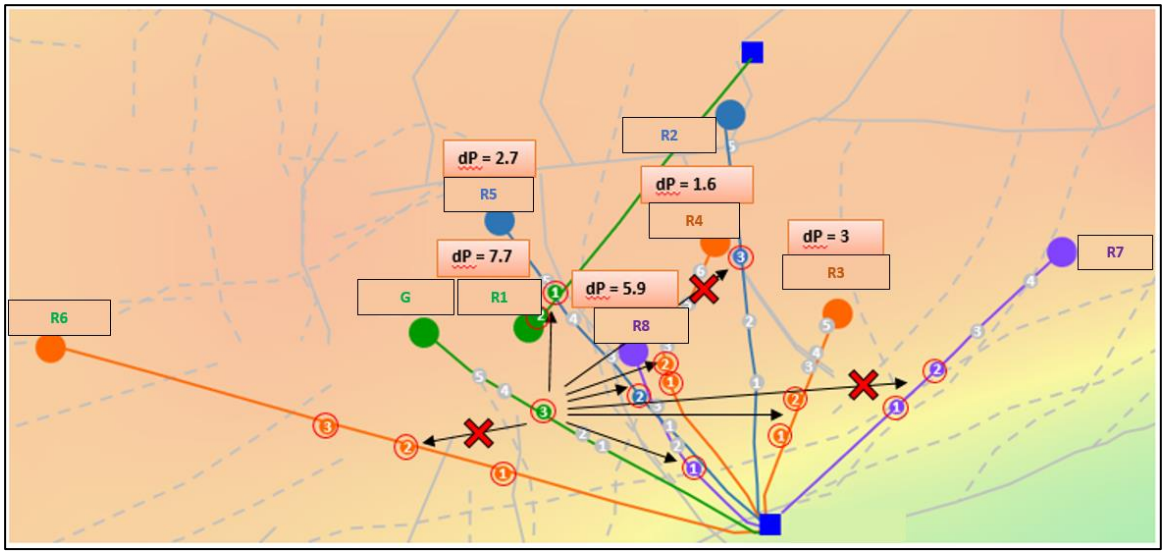



**Fig. 5.4.8.** Pressure gain from the injection during PCT

**Table 5.4.4.** Pressure / rate gain from the injection during PCT

| # | Well | Pressure increase, psi | Rate increase, bpd |
|---|---|---|---|
| 1 | R1 | 7.7 | 6.2 |
| 2 | R8 | 5.9 | 0.24 |
| 3 | R4 | 1.6 | 0.08 |
| 4 | R3 | 3 | 6 |
| 5 | R5 | 2.7 | 2 |

### 5.4.5. Pressure / rate gain from gas injection during PCT and pre-PCT injection

The following plot and table are showing the calculated pressure and rate response to gas injection pulses during PCT and pre-PCT injection. It was obtained by convolving the actual injection rate history (including injection and fall-off cycles) with the unit pressure response found with PCD.

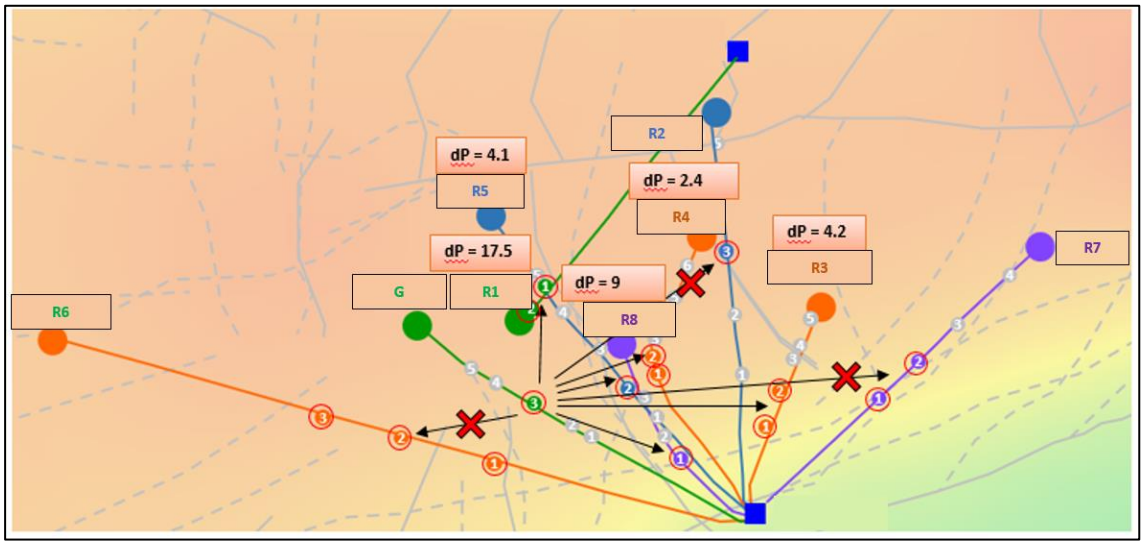



**Fig. 5.4.9.** Pressure gain from the injection during PCT + pre-PCT injection

**Table 5.4.5.** Pressure / rate gain from the injection during PCT + pre-PCT injection

| # | Well | Pressure increase, psi | Rate increase, bpd |
|---|---|---|---|
| 1 | R1 | 17.5 | 14 |
| 2 | R8 | 9 | 0.36 |
| 3 | R4 | 2.4 | 0.12 |
| 4 | R3 | 4.2 | 8.4 |
| 5 | R5 | 4.1 | 3 |

## 6. REFERENCES


1. PCT Workflow Regulations, Sofoil, 2024
2. PCT Report Template, Sofoil, 2024
3. PCT Case Book, Sofoil, 2024

## 7. NOMENCLATURE & ABBREVIATIONS

| | Abbreviation | Definition |
|---|---|---|
| 1 | PCT | Pressure Pulse-Code Testing |
| 2 | PTA | Pressure Transient Analysis |
| 3 | PCD | Pulse-Code Decomposition |
| 4 | DMC-PT | Dynamic Model Calibration based on Pressure Test |
| 5 | CTR | Cross-Well Transient Response |
| 6 | T | Initial reservoir temperature |
| 7 | $P_i$ | Initial reservoir pressure |
| 8 | Pe | Current reservoir pressure |
| 9 | $P_b$ | Pressure bubble point |
| 10 | $R_s$ | Gas-oil ratio |
| 11 | $\rho_o$ | Oil density |
| 12 | $c_o$ | Oil compressibility |
| 13 | $B_o$ | Formation volume factor |
| 14 | $\mu_o$ | Oil viscosity |
| 15 | $\rho_w$ | Water density |
| 16 | $c_w$ | Water compressibility |
| 17 | $\mu_w$ | Water viscosity |
| 18 | $Z_{top}$ | Average formation top |
| 19 | $Z_{OWC}$ | Oil-water contact |
| 20 | h | Thickness |
| 21 | $h_{eff}$ | Effective thickness |
| 22 | $\varphi$ | Porosity |
| 23 | $c_r$ | Rock compressibility |
| 24 | J | Productivity index |
| 25 | $\sigma$ | Transmissibility |
| 26 | $\chi$ | Pressure diffusivity |