Production stand-by of the Loppersum clusters for Security of Supply (waakvlam)

1 Background to the Capacity of the 5 Loppersum Clusters

Due to the historic development of the field, the cluster density is lower in the North of the field than in the South. At the same time, the reservoir thickness is increasing towards the North. This combination of low cluster density with high reservoir thickness (and good reservoir quality) make the Loppersum clusters among the most prolific in the field: together they provide some 30% of the total production capacity in the field.

For this capacity to be reliably and instantaneously available within stipulated gas quality requirements production clusters have to be maintained in a stand-by modus requiring a minimum production rate. This was also addressed in the interim judgement by the State Council on 14 April 2015, Figure 1. Small volumes of gas are allowed to be extracted from these clusters, solely to keep these open with a fast response time, so that they can meet exceptionally high demand for gas during cold spells or in case of problems and upsets in the gas supply or distribution system delivering the gas to the customer.

The Minister of Economic Affairs has adopted this State Council ruling in his decision making (e.g. Instemmingsbesluit Winningsplan Groningen 2016, Article 3.1)

> De voorzieningenrechter van de Afdeling bestuursrechtspraak van de Raad van State:
>
> I. bepaalt bij wijze van voorlopige voorziening dat gaswinning uit de clusters in en rond Loppersum ('t Zandt, Overschild, De Paauwen, Ten Post en Leermens), anders dan de hoeveelheid die nodig is om de clusters open te houden, uitsluitend is toegestaan als in de andere clusters dan wel regio's de daarvoor geldende productieplafonds nagenoeg zijn bereikt en uitsluitend indien dat vanuit een oogpunt van leveringszekerheid noodzakelijk is;

Figure 1 Article I from the 14/4/2015 State Council ruling.

NAM has made the following effort to minimize the produced volume by lowering the minimum required production rate in stand-by modus of the LOPPZ[1] clusters:

- Process control modification to maintain process equipment in its operational envelope in order to deliver gas according to the "Regeling van de Minister van Economische Zaken van 11 juli 2014, nr. WJZ/13196684, tot vaststelling van regels voor de gaskwaliteit (Regeling gaskwaliteit)".
- The compressors are running in recycling modus in order to allow for low flowrates. Compressed gas is looped back to the compressor inlet to keep the machine running in its operating envelope.
- Operational procedures were established to
    - guarantee reliability of LOPPZ clusters
    - relate the number of LOPPZ cluster running in stand-by to the expected chance of high demand (more clusters stand-by in low temperature conditions).

[1] The LOPPZ or Loppersum clusters constitute of **L**eermens, **O**verschild, De **P**aauwen, Ten **P**ost and 't **Z**andt

Result of above mentioned operational adjustments led to an actual annual produced volume in 2016[2] (with the relatively warm winter) below 1.0 Bcm.

An example of the LOPPZ security-of-supply provision in action occurred on 27/3/2015, when there was a major electrical power outage in North-Holland. As a result, the facilities in Den Helder were shut-in. Here the gas from offshore production is brought into the Dutch gas distribution network. At the call-off from GTS, the LOPPZ clusters were immediately brought into production[3], see Figure 2.

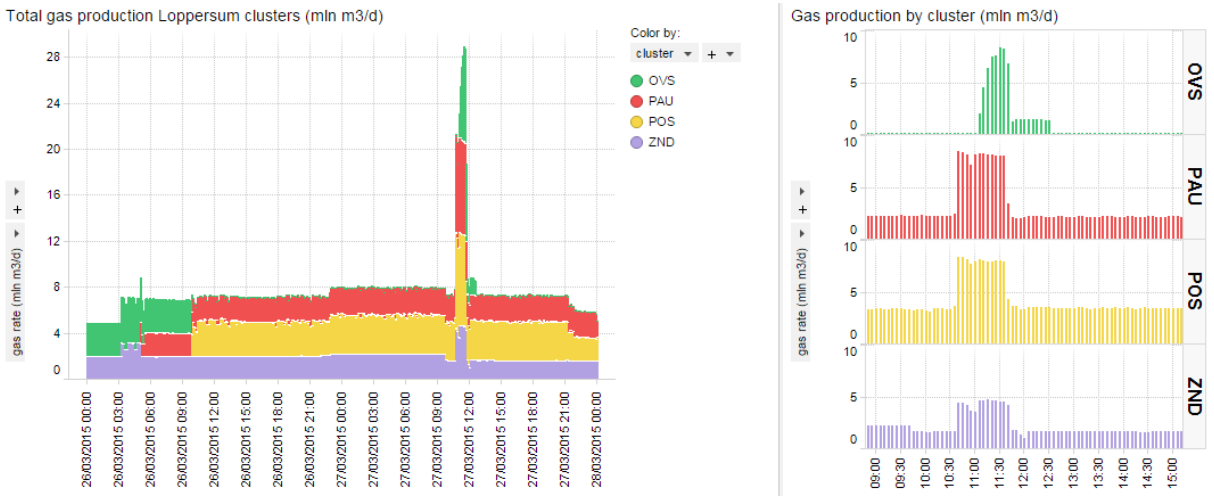

Figure 2 Ramp-up of LOPPZ clusters upon electricity power outage (Leermens cluster was not in production)

2 Technical lower bound for producing a location

The physical lower bound of production from a cluster in the Groningen field is zero; in principle, all production locations can be stopped producing. However, when a cluster has been stopped completely, the start-up period can be several hours up to several days, depending on the duration of the stop, the ambient temperature and the number of locations that are required to start producing at a certain production flow.

When a production cluster is required to be in a standby situation, to be able to ramp up quickly, the production cluster will need at least to be producing at a technical minimum flow. Figure 3 gives a schematic representation of the main components making up a production cluster. In a steady operation all components run within a certain pressure and temperature domain. The minimum rate of a production cluster depends on the ambient temperature: the colder it gets, the higher the required minimum flow to achieve a stable operating window across all system components. Currently, the lower bound of the flow is defined by the flow to prevent hydrates in an air cooler in the Low Temperature Separation (LTS) train, which is 1 mln Nm^3/d. However, at this flow rate the energy

[2] In gas year 2015-2016

[3] Note that the detailed split by cluster shows the following:

- NAM was able to ramp-up the hot stand-by clusters virtually immediately (within 5 minutes from 2-3 mln m3/d stand-by rate to 4-8 mln m3/d), while meeting the gas quality requirements.
- The Overschild/OVS cluster had been shut-in for 25 hours prior to the power outage, and was fortunately still relatively warm. NAM managed to start ramping-up the cluster only 30 minutes after the event, and within the next 30 minutes managed to ramp-up to 8 mln m3/d, while meeting the gas quality requirements.

efficiency is relatively low as well as the ramp-up speed is relatively slow. Based on these two considerations, the technical operational minimum flow is in practice 2 mln Nm^3/d for the non-LOPPZ locations and 1 mln Nm^3/d for the five LOPPZ locations.

When the ambient temperature drops below zero degrees Celsius, the minimum flow is defined by the flow to prevent freezing problems in the WACO system[4]. This technical minimum flow per location varies with the ambient temperature. When it is expected that the temperature drops below 0 degrees Celsius, the minimum flow for that day is in practice 3 mln Nm^3/d. At minus 10 degrees Celsius, the min flow is increased to 4 mln Nm^3/d. Table 1 shows the figures for minimum flow for a location when in stand by operating modus.

Ambient temperature T [degree Celsius]	Min Flow per location [mln Nm^3/d]
T > 0	2 (LOPPZ: 1)
0 > T > -10	3
-10 > T > -20	4
-20 > T	5

Table 1 Minimum required flow per location per ambient temperature regime.

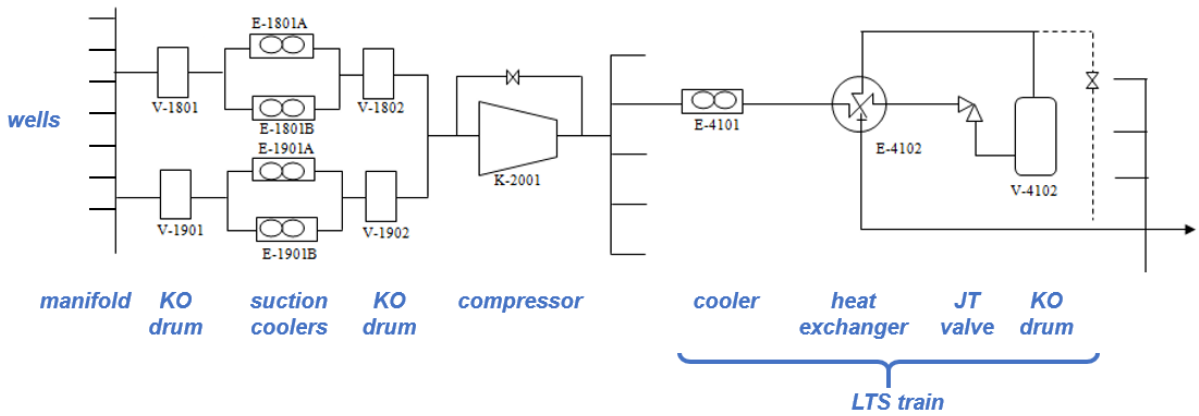

Figure 3 Simplified process diagram for the gas stream on a Groningen production cluster. Liquids are separated and collected from the Knock-Out drums.

[4] As part of the processing steps to bring the produced gas to spec for custody transfer, liquids (Water and Condensate) are separated from the produced gas.

Appendix A Information Page Loppersum Production