

## The Biggest Calibration Facility to be built For Actual Natural Gas in CHINA

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**ABSTRACT:** In order to meet the requirement of rapid development of natural gas industry, and to calibrate natural gas flowmeter used in the project of west-east natural gas transportation in China, a natural gas flow calibration station (facility) with high pressure and big diameter of pipe will be designed and built in Nanjing city. So far, the location of the calibration station, the design scheme and the process flow has been decided. The conceptual design for the facility has been completed. The main specifications of the facility are as follows: the maximum operating pressure is 5.5MPa, the maximum flowrate under actual working condition is 12000m<sup>3</sup>/h, the uncertainty of measurement is 0.5% and the maximum diameter of the test flowmeter is 400mm.

The facility is composed of the primary standard, transfer standard, working standard, check standard, calibration-test section, steady pressure and flow systems. The primary standard is mass (gravimetric)-time (Mt) primary standard. The transferring standard is sonic venturi nozzles. The high accuracy of turbine flowmeters in parallel is used as for working standard. The ultrasonic flow meters are used as check standard.

This paper describes and discusses particularly the location of the calibration station, design scheme, function, specification, components, process flow, transfer standard schematic diagram etc.

When the facility is built, its capability is the biggest in china, with features of bigger construction scale, multifunction, advanced equipment, higher pressure -stage, wider flowrate range, higher accuracy and steady performance.

**Key words:** China, natural gas, the project of west-east natural gas transportation, calibration facility.

### **1. Introduction**

In recent years, the production of natural gas has increased rapidly in China. It is  $183 \times 10^8 \text{Nm}^3/\text{a}$  in 2000,  $310 \times 10^8 \text{m}^3/\text{a}$  in 2002. When the Project of west-east natural gas transportation and the secondary natural gas transportation pipeline from Shanxi to Beijing etc are put into operation, the production of natural gas will be enhanced up to  $630 \times 10^8 \text{Nm}^3/\text{a}$  in 2005. Now, the feasibility study report on the natural gas transportation pipeline from Russian to China is started. The diameter of the pipeline is 1.5m, the pressure is 10MPa, the transporting volume of natural gas will be up to

$300 \times 10^8 \text{Nm}^3/\text{a}$  in 2010.

The transporting volume of natural gas will approach to  $1000 \times 10^8 \text{Nm}^3/\text{a}$  in 2010. So a lot of high-pressure and large flowrate gas flowmeters will require to be calibrated.

## **2. Outline of the project of west-east natural gas transportation**

So far, the Project of west-east natural gas transportation is one of the four biggest projects in China. It is a trans-country pipeline, started from Tarim basin in Xinjiang at west, and ended at Baihezhen in west suburb of Shanghai at east, crossing 9 provinces and regions from Xinjiang, Gansu, Ningxia, Shanxi, Henan, Anhui, Jiangsu to Shanghai. The trunk pipeline is 3900 km in total length with a design capacity for gas transferring of  $120 \times 10^8 \text{Nm}^3/\text{a}$  at a design pressure of 10.0MPa and pipe diameter of 1016mm. There are 42 high accuracy flowmeters used in the trunk pipeline. Its maximum diameter is DN300.

When the project of west-east pipeline has been completed, it is becoming more important for the calibration of flowmeter. At present, only the Daqing National Crude Oil Large Flowrate Measurement Station and the Chengdu verification branch station have the calibration facility for natural gas. But, whether the calibrating diameter and pressure scale or the flowrate range can not meet the needs of calibrating high pressure and large flowrate natural gas flowmeters used in the project of west-east pipeline. So it is very important for the Project to build the facility with high pressure and bigger bore of pipe

The calibration station will be constructed near the Nanjing Longtan distribution station; its area is about  $1.9 \times 10^4 \text{m}^2$ . It is composed of the calibrating workshop, the primary standard facility room, the compressor field, the gas composition analyzing room, pressure and temperature sensor testing room, instrument servicing room and offices etc.

## **3. Function of the facility**

(1) It can accomplish calibrations to evaluate the performance of all kinds of gas flowmeters, pressure sensors, temperature sensors and gas chromatographic instrument used in the project of west-east pipeline.

(2) It can accomplish test, calibration and study for the flowmeter with high pressure, middle pressure and low pressure and bigger bore of pipe.

(3) It can take part in comparison round robin test with some calibration facility at home and abroad.

## **4. The Main Specifications**

(1) The diameter of test flowmeter : 50~ 400mm.

(2) The maximum flowrate of gas : 12000 actual  $\text{m}^3/\text{h}$ .

- (3) The maximum operation pressure : 5.5MPa.
- (4) The operation temperature range : 10~ 30? .
- (5) Uncertainty of measurement of flowmeter :  $\pm 0.5\%$  .

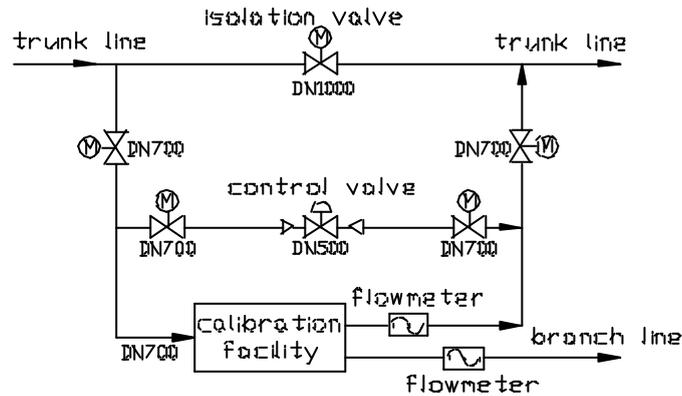
**5. The Design Scheme Determination**

The location of the calibration station is decided to be built near the Nanjing Longtan distribution station. It adopts a program of direct transferring by the differential pressure of gases between the high-pressure pipeline and the low-pressure pipeline; the gas with high pressure will directly discharge to the low-pressure pipeline.

When the meter with a high pressure and large flowrate (bigger than **3900 actual m<sup>3</sup>/h**) will be calibrated, it is necessary to get the flow gas from trunk line to trunk line, that is, while the isolation (block) valve on trunk line will be closed, the gas flowrate flowing through the calibration facility will be regulated by the control valve. After calibration, the gas used will be directly discharged back into the trunk line.

When the meter with a low pressure and small flowrate (smaller than **3900 actual m<sup>3</sup>/h**) will be calibrated, it is necessary to get the flow gas from trunk line to branch line. After calibration, the gas will be directly discharged into branch line. A schematic of the process flow is shown in figure 1.

In order to measure the used gas flowrate for the facility calibration, an ultrasonic flowmeter is separately fixed on the trunk line and branch line at the outlets of the facility.

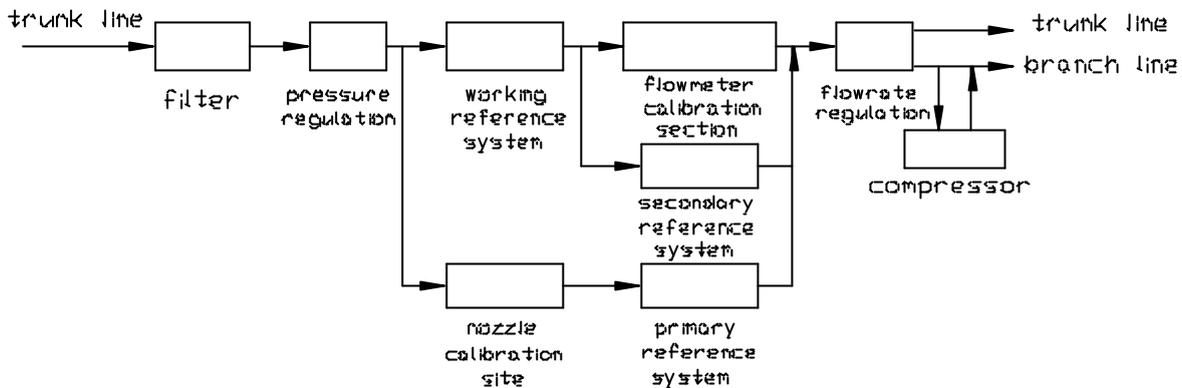


**Fig 1. Schematic of the calibration station (facility) gets/discharges natural gas**

**6. Components of the facility**

A schematic of the facility is shown in figure 2. The facility has eight main parts, that is filter, pressure regulation devices, working reference system, flowmeter calibration section, flowrate regulation devices, secondary reference system, nozzle calibration site, primary reference system and compressor etc.

First, the natural gas from Longtan trunk line is filtered by a filter, then the gas flows through pressure regulation section and flowrate regulation, finally the gas with a stabilized flow state entering the flowmeter calibration section.



**Fig 2. Schematic of the calibration facility basic component part**

The working reference system is used to calibrate the flowmeter. The working reference system consists of eight (8) parallel turbine flowmeters with a high accuracy. It can calibrate different diameter of flowmeter by the different combinations.

The secondary reference system consists of twelve (12) parallel sonic nozzles. The secondary reference system can be traced back to the primary reference system. When a sonic nozzle of the secondary reference needs to be calibrated or tested by the primary reference system, the sonic nozzle should be taken down and installed in the nozzle calibration site.

The eight parallel (8) pipelines are mounted in the facility to calibrate or test the flowmeters.

The calibration range of the flowmeter is 8~ 12000 actual m<sup>3</sup>/h, and the diameter of flowmeter is 50~ 400mm.

A compressor of smaller output is used in the facility outlet to exhaust the gas with low pressure into Wuhu branch line.

## **7. Brief introduction of all reference systems**

### **(1) The primary reference system**

The primary reference system (primary flow calibration system) is by means of the mass-time (Mt) method; during the test, the mass (M) of the gas jetted into a spherical tank is determined by direct weighing with a beam balance; at the same time, the time interval (t) is also determined. By the determined mass and time, the mass flowrate can be obtained. On the other hand, during the calibration, the mass of the gas flowing through the sonic nozzle into the tank is determined by direct weighing with the balance, the time interval is also determined; that is, the mass flowrate of the sonic nozzle can be calculated. So the mass and time are derived quantity, the two quantities

can trace back to the national standards.

The flowrate range of the primary reference facility is 8- 443 actual  $m^3/h$ , and the maximum operation pressure is 5.5MPa. The volume of spherical tank is about  $5m^3$ , and its weight is about 5t. At the maximum flowrate, the weight in the tank is about 165kg (kilograms). At the minimum flowrate, the weight in the tank is about 10kg by calculation. So the maximum scale of the beam balance is 5000kg, the weigh scale resolution is 2g (grams), and total measurement uncertainty of the scale is 4g.

## **(2) The secondary reference system etc**

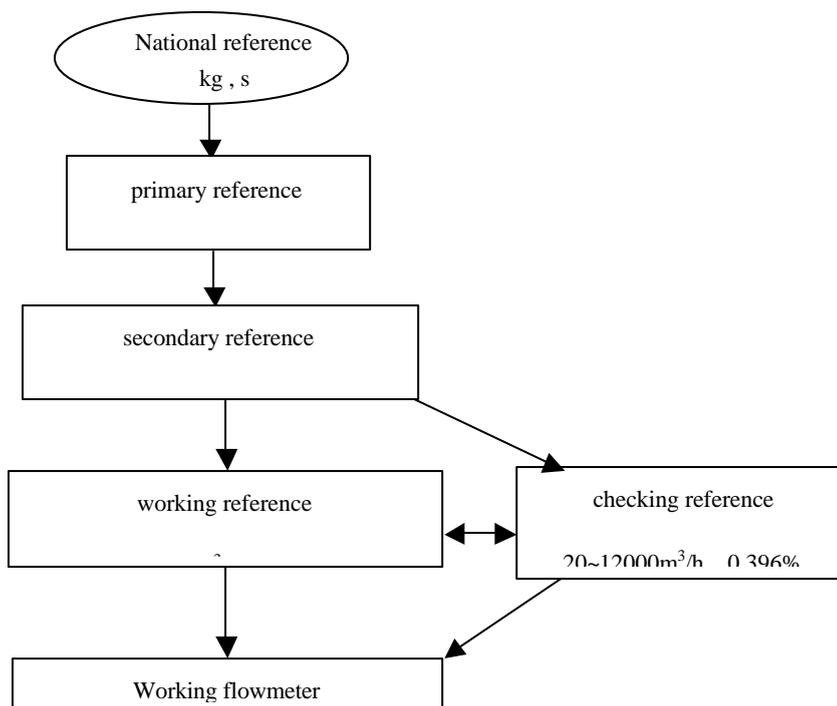
Twelve (12) parallel sonic nozzles are used in the secondary reference system, its flowrate range is 8- 3160 actual  $m^3/h$ .

Eleven (11) parallel turbine flowmeters are used in the working reference system, its flowrate range is 8- 12000 actual  $m^3/h$ . Several ultrasonic flowmeters with high accuracy are used to check the flowrate tested by the turbine meters.

## **8. The traceability schematic of the calibration facility**

The facility is consisting of the primary reference system, the secondary reference system, the working reference system and the checking reference system. The estimated uncertainties at each stage and the tractability schematic of the calibration facility are shown in figure 3.

The traceability schematic 3 shows that the facility is composed of four-stage traceability relationship. That is from the mass and time of national references to the primary reference, to the secondary reference, to the working reference, finally to the working flowmeter. The higher reference can trace to the lower reference.



**Fig 3. The traceability schematic of the calibration facility**

**9. Conclusions**

(1) The conceptual design for the calibration facility of the biggest project of west-east natural gas transportation in China has been completed. The facility can meet the requirements of calibrating and testing the flowmeters with high pressure and bigger bore of pipe for the natural gas industry in China.

(2) The facility is the biggest facility in China, with the features of a bigger construction scale, multifunction, advanced equipment, higher pressure-stage, wider flowrate range, higher accuracy and steady performance.

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