THE FIFTEENTH U.S. - CHINA OIL AND GAS INDUSTRY FORUM

CHINA OIL AND GAS PIPELINE STANDARD SYSTEM



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Report outline

- **1. Establishment of Oil and Gas Pipeline Standard System**
- 2. Composition of Oil and Gas Pipeline Standard System
- 3. Development of Oil and Gas Pipeline Standard System

Introduction



- So far, China's onshore long-distance oil & gas pipelines has reached a total length of 120,000 km.
- In which, Petrochina is managing nearly 80,000 km of these pipelines in China.
- Natural Gas and Pipeline Company is currently managing 61,000 km of operating pipelines. Among which, 9,400 km are crude oil pipelines, 8700 km are refined oil pipelines and 43,000 km are natural gas pipelines.



1. History Review



In December 1958, China's first crude oil pipeline project, Karamay-Dushanzi pipeline finishes its building. Thereafter from early 1970s to early 1990s, a number of oil pipeline projects including Qing-Fu, Qing-Tie, Tie-Qin, and Tie-Da in northwest China, as well as Dong-Huang, Qin-Jing, Ren-Jing in north and east China, are completed. Based on these engineering practices, the first version of national standards entitled "Code for Design of Gas Transportation Pipeline Engineering" (GB 50251-94) and "Code for Design of Oil Transportation Pipeline Engineering" (GB 50253-94) were released in 1994. Their main references are Russian long-distance oil & gas pipeline design standards.

From 1990s to the early 21st century, with the completion of Petrochina projects such as, Shan-Jing pipeline, Shan-Jing Second pipeline, Ku-Shan pipeline, Lan-Cheng-Yu pipeline, as well as Sinopec Yong-Hui-Ning and Chang-Hang pipeline projects, oil & gas pipeline construction in China has gradually absorbed North American and European standards, the old standards are updated and reindexed to "GB50251-2003" and "GB50253-2003".

Over the past decade, China has experienced a period of its great pipeline development. During which, West-East Gas Second pipeline, Third pipeline, Shan-Jing Third pipeline and Sichuan-East Gas pipeline projects has been completed successively. These has enabled further revision of its pipeline standards with reference to North America, Europe, Russia, Japan, and international standards, and finally updated to current version of "GB50251-2015" and "GB 50253-2014", which are published as the core of its oil and gas pipeline standards.

Following the above three pipeline construction peak times, China oil and gas pipeline standards has experienced three major revisions in publishing year 1994, 2003 and 2014 (2015).

2. Standardization Administration Organizations



China exercises its standardization responsibilities by undertaking an unified administrative system with sub-division management responsibilities.

Standardization Administration of China (SAC) is an unified management agency for all national standards.

State Council departments, industry association standard bodies are in charge of their related division of industry standard. E.g., National Energy Administration is responsible for petroleum and petrochemical industry standard; Ministry of Housing and Urban-Rural Development is responsible for housing and construction industry standard.
 Local and regional standards are managed by local authorities in charge.





- National Energy Administration is in charge of centralized management of petroleum and petrochemical industry standards and its national standards.
- National Oil & Gas Standardization >Committee and Petroleum Industry Standardization Technical Committee are overall technical and standardization organizations.
- Other specific standardization sub committees cover subjects such as oil & gas storage and transportation, tubing, safety, project construction and other topics.



Petroleum Industry Standardization Technical Committee

*TC (Technical Committee) *SC (Standardization Committee)

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Over the years, Natural Gas and Pipeline Company has established effective communication and exchange mechanisms with standardization organizations such as the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), American Petroleum Institute (API), Institute of Petroleum (IP), American Society for Testing and Materials (ASTM), American Society of Mechanical Engineers (ASME) and National Association of Corrosion Engineers (NACE) etc., and actively participated in standardization research by tracking and adopting state-of-the-art international, national and industry standards.



| International / National Standardization Organization | | Domestic Counterpart Technical Unite | |
|---|--|---|--|
| ISO/TC193 | Natural gas | Natural Gas Research Institute of Southwest Oil & Gasfield Company | |
| ISO/TC193/SC1 | Natural gas / Analysis of natural gas | Natural Gas Research Institute of Southwest Oil & Gasfield Company | |
| ISO/TC193 /SC3 | Natural gas / Upstream area | Natural Gas Research Institute of Southwest Oil & Gasfield Company | |
| ISO/TC 67 | Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries | Standardization Research Institute of Petroleum Industry | |
| ISO/TC67/SC2 | Pipeline transportation systems | Tubular Goods Research Institute, BAOJI Petroleum Steel Pipe Co., Ltd., Petrochina Pipeline R&D Center | |
| ISO/TC67/SC6 | Processing equipment and systems | China Huanqiu Contracting & Engineering Corporation | |
| ISO/TC67/WG 10 | Liquefied Natural Gas installations and equipment | China National Offshore Oil Corporation | |
| ISO/TC 207/SC 4 | Environmental management/Environmental performance evaluation | Research Institute of Safety & Environment Technology | |
| ISO/TC 263 | Coalbed methane (CBM) | Coalbed Methane Co., Ltd. | |
| OIML/TC8 | International Organization of Legal Metrology /Instruments for Measuring Quantities of Fluids | National Petroleum & Natural Gas Mass Flowrate Calibration Station | |
| API | American Petroleum Institute | Standardization Research Institute of Petroleum Industry | |
| NACE | National Association of Corrosion Engineers | China Petroleum Planning and Engineering Institute | |



So far, we have established a series of national and industry standards that contain specifications of all subjects that cover whole life cycle pipeline stages.

It starts from pipeline design, procurement and construction, and extends to pipeline operation, maintenance and abandonments. These standards have technically supported pipeline construction and operation work in China.





- Completed software platform design, standard-based planning studies for selfdeveloped oil and gas pipeline SCADA system, and achieved initial system integration.
- Developed technical specifications of X80 and X90 high strength steel sheets and pipes for making high strength pipelines. Designed matched production process and techniques for elbow pipe and pipe fittings. Finished kilo-ton trial production, and applied these pipes to West-East Gas Third pipeline and China-Russia East Route Natural Gas pipeline projects.
- Established oil and gas pipeline integrity management system based on mandatory national standard entitled "oil and gas pipeline integrity management practices".
- Developed techniques and specifications for adding pour point depressant (PPD) and drag reducing agent (DRA) to oil and gas pipelines. Promoted safe and economic operation of the pipeline.
- Summarized a large number of experiences towards construction, maintenance and operation of mountain tunnels and water tunnels, developed industry standard entitled "Specification for maintaining of oil and gas pipeline aerial section and attaching installation".



By targeting key pipeline projects, quantities of technical bottlenecks are overcome to meet the needs of centralized large-scale pipeline construction.

 \succ At national and industry levels, comprehensive amendments were made towards improving pipeline design and construction standards, this has therefore enhanced overall pipeline construction technology. From 2011 to 2015, a total revision and publication of 12 national standards, 62 industry standards are made, which include:

- GB 50423-2013 "Code for design of oil and gas transportation pipeline crossing engineering"
- ●GB 50369-2014 "Code for construction and acceptance of ●GB 50251-2015 "Code for design of gas transmission oil and gas long-distance transmission pipeline engineering" pipeline engineering"
- GB/T 31032-2014 "Welding and acceptance standard for steel pipings and pipelines"
- pipeline"

 SY/T 4109-2013 "Nondestructive testing standard of oil and gas steel pipeline"

- SY/T 0086-2012 "Electrical isolation of cathodically protected pipelines"
- SY/T 6854-2012 "Technical standard of liquid epoxy external coating for buried steel pipeline"

- •GB 50253-2014 "Code for design of oil transportation pipeline engineering"
- SY/T 0452-2012 "Standard for welding procedure qualification of oil and gas metal pipeline"
- SY/T 4125-2013 "Welding specification for steel
 GB/T 50818-2013 "Mechanized ultrasonic testing technology specification for oil & gas construction pipeline project"
 - SY/T 0315-2013 "Technological specification of external fusion bonded epoxy coating for steel pipe"
 - GB/T 50698-2011 "Standard for AC interference mitigation of buried steel pipelines"



According to CDP document types, a six (projects) by six (document types) document structure has been formed with five-level document classification system, to comply with Petrochina knowledge base and its existing management system.







Petrochina Natural Gas and Pipeline Company has established a series of technical specifications and working standards towards subjects such as oil & gas storage project design, construction and project acceptance.

The published practice namely "Code for Design of Oil & Gas Storage and Transportation Project" (known as CDP), has incorporated serialization of design modules, design & construction management information platforms and databases. Shell—DEP

• "Designing & Engineering Practice" contains five types of documents including manuals, technical specifications, procedural specifications, procurement documents and sheets.

BP——ETP

• "Engineering Technology Practice" contains five types of documents including group practices, group supply instructions, instructive guidelines, references and specific procurement indexes.

Petrochina—CDP

• "Code for Design of Oil & Gas Storage and Transportation Project" contains six five types of documents including standard formats, standard lists, technical specifications, guideline documents, modularization documents and management procedures.



- > Actively adopt international standards and absorb advanced concepts.
 - "Petroleum and natural gas industries -- Pipeline transportation systems -- Reliability-based limit state methods" (ISO 16708-2013);
 - "Petroleum and natural gas industries -- Steel pipe for pipeline transportation systems" (ISO 3183-2012);
 - "Petroleum and natural gas industries -- Pipeline transportation systems"(ISO13623-2000) .
- > Participate development of international standards, expand international influence.
 - Drafting three ISO standards as principal developer entitled "Petroleum and natural gas industries --Pipeline integrity management specification -- Part 1: Full-life cycle integrity management for onshore pipeline", "Petroleum and natural gas industries -- Pipeline integrity management specification -- Part 2: Full-life cycle integrity management for offshore pipeline" and "Petroleum and natural gas industries -- Geological hazards risk management of oil and gas pipelines ";
 - Drafting two NACE standards entitled "Test Method for Measurement of Gouge Resistance of Coating Systems" and "Test Method for Measurement of Peel Strength of Pipeline Coating Systems".
- Carry out adoption and benchmarking work, especially on North America and Russian oil & gas pipeline construction and operation management standards. Setup multi-level technical exchanges with companies including NGT&S, UniversalPegasus, TransCanada, Spectra Energy and Enbridge etc.



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1. Oil and Gas Pipeline Standard System framework

Petrochina oil and gas pipeline standard system is divided into three levels. The first level consists of fundamentals and general standards; The second level contains twelve subjects including field pipeline management, pipeline traversing & crossing, utility system engineering etc.; The third level has 35 child subjects which are divided from upper level parent subjects.



At the level of national and industry standards, a total of 334 standards are oil and gas pipeline standards, which includes 272 published and currently effective standards and 62 other standards to be drafted and released.



standards among subjects

mandatory and voluntary



China aims to develop high grade steel, high-pressure, large-diameter, long distance, automation, digitalized and intelligent pipelines for its oil and gas pipeline construction. Over the years, it has launched a series of significant science & research projects and major field trials to preserve advanced technologies. Subjects such as pipeline design technology, high grade steel pipe manufacturing technology, pipeline welding technology, pipeline construction technology, quality inspection and control and other aspects of pipeline technologies has been drastically improved.

The above technology achievements have been recorded and converted in standardization process, and therefore produced/amended a total number of 170 relevant standards, of which 32 are Chinese national standards, 138 are industry standards.





Revised and published national standards including "Code for design of oil transportation pipeline engineering" (GB 50253-2014), "Code for design of gas transmission pipeline engineering" (GB 50251-2015), "Code for design of oil and gas transportation pipeline crossing engineering" (GB 50423-2013), etc.



(2) Standards for large diameter high grade steel pipe production

The fast development of oil and gas pipe production technology has promoted domestic high-grade steel pipe production standards to upgrade and comply with international standards.

- National standard "Petroleum and natural gas industries Steel pipe for pipeline transportation systems" (GB 9177-2011)
- Petrochina has independently developed large wall thickness and large diameter pipe induction heating manufacturing techniques, and has therefore published three national standards.

| Petrochina has independently develop and large diameter pipe induction techniques, and has therefore purstandards. | bed large wall heating manu plished three | thickness ifacturing national | 中华人民共和日 (#BG&T #/ILI-198-GI 石油天然气, 管线输送系统 | GB 3 国家标准 ^{CB/T 971-2011} ^{LT 971, 2-1977, dd T 971, 2-398} 工业 用钢管 |
|--|---|-------------------------------------|--|--|
| GB/T 29168.1- 2012Petroleum and natural gas industrie flanges for pipeline transportation s | s. Induction bends systems. Part 1:Inc | s, fittings and luction bends | Petroleum and natural gas Steel pipe for pipeline transpo (ISO 3183;2007,M | industries rtation systems OD2 |
| GB/T 29168.2- 2012Petroleum and natural gas industrie and flanges for pipeline transportat | s - Induction benc ion systems - Part | ls, fittings 2: Fittings | | |
| GB/T 29168.3- Petroleum and natural gas industrie 2012 and flanges for pipeline transportat | s—Induction ben ion systems—Part | ds, fittings 3:Flanges | 2011-12-30 裏布 中华人民共和国国家质量监督检 中国国家核准化管理 | 2012-06-01 实施 验检疫总局 发 布 委 员 会 |

The centralized large-scale pipeline construction has accelerated consistent improvement of welding operation mechanization and automation techniques, and therefore updated relevant standards on welding process and techniques to meet construction needs.

The establishment of standards on self-developed fullautomatic welding equipments has enabled automation of large-scale pipeline welding and construction work.

| GB/T 31032-2014 | Welding and acceptance standard for steel pipings and pipelines |
|-----------------|--|
| SY/T0452-2012 | Standard for welding procedure qualification of oil and gas metal pipeline |
| SY/T 4103-2006 | Welding specification for steel pipeline |



Double Torch Automatic Welding Equipment

Petrochina has carried out concentrated research on developing pipeline construction & engineering technologies and its equipments, to promote innovation standardization. It has revised and published a series of standards including core national standard entitled "Code for construction and acceptance of oil and gas long-distance transmission pipeline engineering" (GB 50369-2014), to meet construction needs for large diameter, high-grade steel pipe, large area and long distance pipelines.



- National standard "Code for construction and acceptance of oil and gas long-distance transmission pipeline engineering" (GB 50369-2014)
 First enacted in 2006. Revision version released in 2014 with reference to ASME B41.4 and ASME B31.8.
- Based on focused engineering practice and equipment research & development, standard entitled "Specifications for trenchless pipeline crossing engineering" has been published to regulate trenchless pipeline crossing processes.





Driven by the centralized large-scale pipeline construction projects, self-developed technologies such as full-automatic ultrasonic pipeline inspection tools and non-destructive pipeline testing equipments have been successfully applied in pipeline quality inspection and control process.

The published standards on these subjects are as follows:

| GB/T 50818- | Mechanized ultrasonic testing technology specification |
|----------------|---|
| 2013 | for oil & gas construction pipeline project |
| SY/T 4109-2013 | Nondestructive testing standard of oil and gas steel pipeline |



Non-destructive Testing



With the of China's oil and gas pipeline networks expands from east to west, north to south, and gradually to overseas, automation and informationization condition of pipeline operation management has gradually improved. Remarkable progress has been made on subjects such as process operation, integrity management, security & safety warning, emergency repair and oil & gas measurement etc., which collaboratively helps to establish a comprehensive oil and gas pipelines operation standard system.

At national and industry levels, a number of 116 standards regarding oil and gas pipelines operation have been published, in which 43 items are national standards, 73 items are industry standards.



• Standards for Oil and gas pipeline SCADA system

SCADA system implements centralized dispatching & control for oil and gas pipeline transportation. Its applications include sequential transportation, equipment monitoring, operation status monitoring of station control systems along pipelines, pipeline leak detection, pipeline operation software simulation and production safety protection etc.

Currently, SCADA system owns two national standards and four oil and industry standards, which are all converted from Petrochina enterprise standards

- Developed and published three industry standards regarding oil & gas pipelines operation, to enhance the level of pipelines operation standard.
- Developed and published family of standards for high pour point, high viscosity and high oil containing wax crude oil transportation.
 Subjects include heating, heat treatment and additive process, to develop to promote safe and economic operation of the pipeline.



PetroChina Beijing Oil & Gas Transportation Center 第15届中美油气工业论坛 25 Around the core mandatory national standard entitled "Oil and gas pipeline integrity management", an integrity management standards system has been established. At present, 45 standards have been published, which include one national standards and 44 industry standards. Subjects covering pipeline inspection and testing, risk assessment and other aspects of pipeline integrity managements.

National standard entitled " Oil and gas pipeline integrity management " (to be released) draws special attention from the State Administration of Production Safety Supervision and the State Administration of Quality Supervision, to make specific specification requirements.

Petrochina is also preparing and reserving for 33 items of its pipeline integrity enterprise standards to be upgraded to national standards and industry standards.





(3) Standards for safety warning and emergency repair

- Industry standard "Specifications for oil and gas pipeline safety warning system" (SY/T 6827-2011) regulates selection, installation, testing, inspection, transport and maintenance processes for fiber optic and acoustic pipeline safety warning systems and intelligent coating systems. These security systems can prevent third-party pipeline sabotages and locate alarm events.
- Industry standard "Specifications for maintaining of oil & gas pipeline aerial section and attaching installation" (SY/T 6068-2014), summaries experiences based on construction & operation of a large number of mountain tunnels and water tunnels in West Second, West Third and the China-Burma pipelines, and regulates maintenance and service procedures o f the aerial part of pipeline and its ancillary facilities.
- Industry standard "Specifications for steel oil and gas pipeline failure repair" (to be released), sums up the experiences from many emergency pipeline events and accidents, and regulates pipeline failures by referring to many international repair standards and practices.





The oil qualitative measurement and gas volumetric metering technology of China is currently reached an international advanced level with a complete set of standards. Natural gas energy metering technology under large-scale application, and has reserved a good number of technical standards.

The China oil and gas pipeline measurement standards system consists of 74 standard items, which include nine general standards, 36 of crude oil products measurement standards, fourteen natural gas measurement standards, two LNG measurement standards and two metrology and testing standards.

- Formulate and publish "Energy determination for natural gas" (GB / T 22723-2008)
- Initially established natural gas energy metering supporting technology and traceability system





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- With the development and application of oil and gas pipeline technologies such as construction, operation and management, relevant standard research work needs to follow up and update.
- Expedite the implementation of natural gas energy measurement standards on an national level.
- Increase investments and input into standard research to strengthen international standards adoption and benchmarking work.



- Improve tubular material and production standards for X80 and below grades steel pipes to develop standard series on high-strength and antideformation pipeline construction.
- Carry out high-strength steel pipe defects evaluation, repair and maintenance research, to develop repair and maintenance standards for high-pressure, large-diameter, high-grade steel pipes.
- Develop abandonment judgment and waste pipeline disposal technical specifications for oil and gas pipelines, to meet pipeline management needs.
- Implement the new national "Safety Production Law" and the "Environmental Protection Law", and develop series of pipeline safety and environmental protection standards ("Oil and gas pipeline safety management practices", "Specifications for water pollution prevention and oil and gas pipeline leak control" etc.), to provide basis for oil and gas pipeline safety operation.