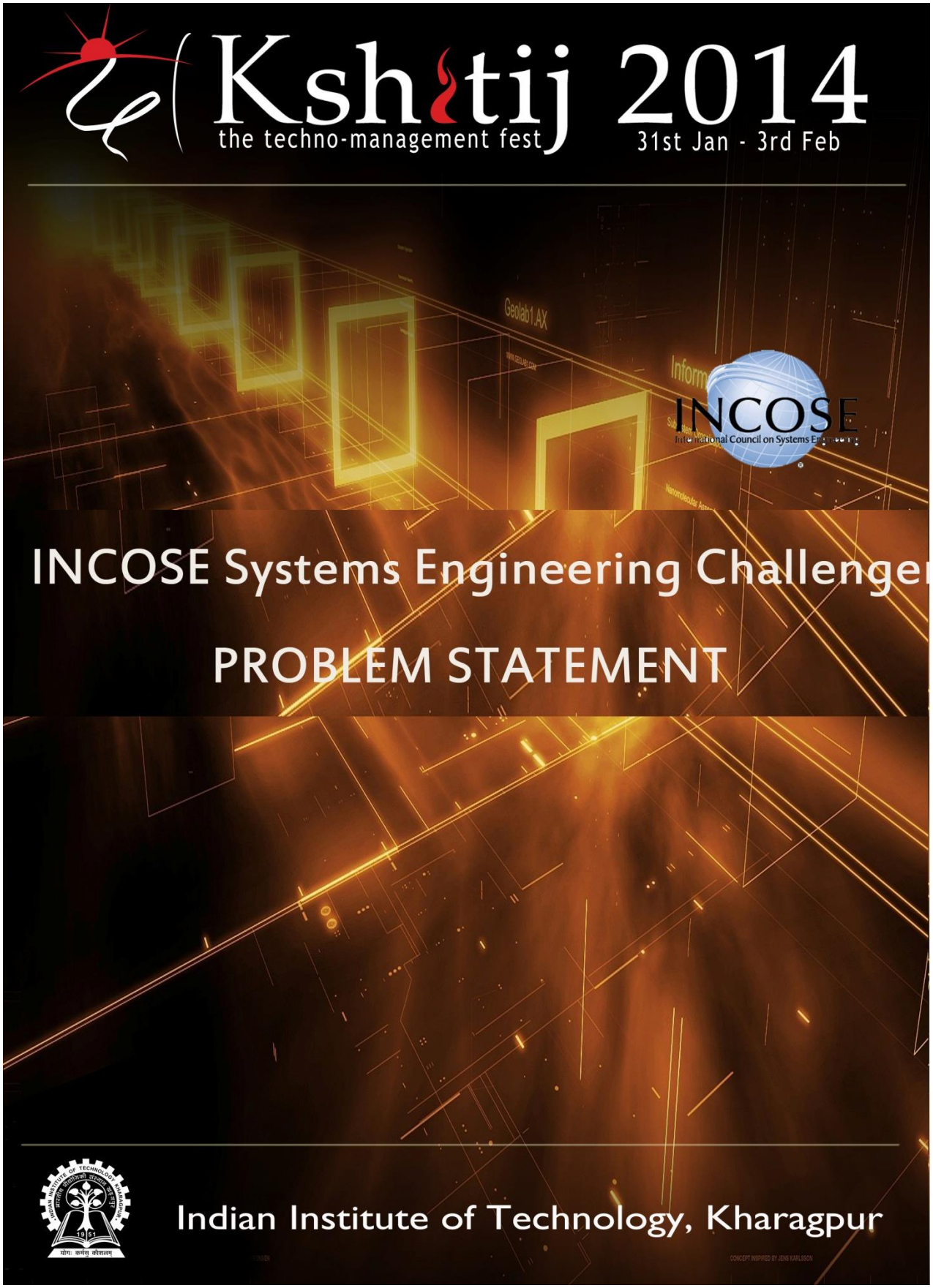
Kshitij 2014
the techno-management fest
31st Jan - 3rd Feb
INCOSE
International Council on Systems Engineering
INCOSE Systems Engineering Challenge
PROBLEM STATEMENT
Indian Institute of Technology, Kharagpur

INCOSE SYSTEMS ENGINEERING CHALLENGE (INCOSE SEC)

PROBLEM STATEMENT:

(On development of a prototype for the system engineering international standards and system tools for VSEs)

a) Background:

- INCOSE Systems Engineering Handbook provides a good description of the key activities performed by a systems engineer.
- As majority of organizations in the world are VSEs (Very Small Enterprises) employing 25-50 people, they have greater impact on the quality and standardization of the final product in the market.
- Since most of the international standards are defined on the basis of the profile of big companies / manufacturers these VSEs face a major problem in implementing them due to lack of resources and infrastructure.
- Also we need to take care of the business models , objectives , situational & demographic factors and risk levels of different VSEs who are either not following the standards or following a small portion of the standardization process due to discrepancies in the existing standards which need to be reviewed and modified.
- So we need to inspect the existing standards in context with these VSEs and work on the problems faced by these VSEs as recorded by INCOSE in various past surveys.
- Hence we need to review those standards for the development of a future prototype for easy reference to these VSEs.

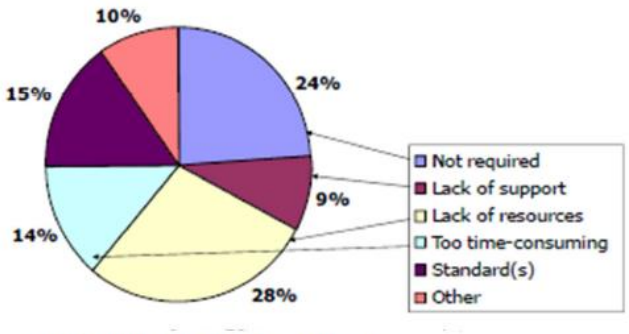

FIGURE: Why don't VSE use standards?

b) Virtual Case:

A group of companies commenced its business operations with incorporation of its very first company GT Cylinders Pvt. Ltd in year 1990. Since then, the company diversified and expanded business operations catering into various business sectors. The company is a privately owned ISO certified Very small Enterprise (VSE) situated in the Greater Noida, Gautam Budh Nagar district of Uttar Pradesh. It currently manufactures Gas Cylinders and their Valves and Regulators for Oil Companies, Steel Wire Ropes for construction companies and Steel Pipes and tubes for different uses.

Consistently, the company is facing problems in full implementation of the ISO standards defined because of the following factors:

- ✓ Lack of resources.
- ✓ Some Standards are not really required.
- ✓ The standards are difficult and bureaucratic and do not provide adequate guidance for use in a small business environment.

Profile of Group Companies

S.NO.	Name of the Company	Nature of Business Activity
1.	GT Cylinders Pvt. Ltd.	Manufacturing of LPG cylinders for PSUs, Manufacturing of LPG Valves and Regulators
2.	GT Steel Wires Pvt. Ltd.	Manufacturing of Steel Wire Ropes for bridge construction and heavy machinery companies.
3.	GT Fittings Pvt. Ltd.	Manufactures Steel Pipes and Tubes by various drawing operations and supplies to PSUs for water, sewage, transportation systems, oil and steel industries.

The different groups (each a VSE) follow a set of ISO Standards which are listed along with this problem statement. But due to lack of resources and infrastructure it is not able to accomplish the standards up to the mark.

c) Guidelines for Abstract submission :

- ✓ Teams would need to develop a prototype system, which needs to encompass a brief overview of the ISO Standards used for a particular VSE, difficulty in implementations, modifications, reviews etc. (bringing in the multi-disciplinary perspective).
- ✓ First of all, teams would need to go through the SE Handbook provided along with this problem statement in order to follow the essence/intent of the processes & activities described in INCOSE SE Handbook towards developing the prototype system.
- ✓ Teams would then need to apply their understanding (based on compatibility and implementation issues for given VSE profile) and share lessons learnt /best practices /suggestions for improvement.
- ✓ After that teams are required to go through the various ISO Standards (provided along with this problem statement) being used in context with the Virtual company described in the problem statement .
- ✓ Teams need to consider only those ISO Standards which are enclosed with the problem statement for any reviews and suggestions (for improvement in context with the given VSE profile) and reference for different processes of system engineering. They should identify standards to be applied with modifications.
- ✓ The scope and details of any process need to be linked and shown through a proper flow diagram. An instance of a process model through flow diagram can be seen in the INCOSE SE Handbook provided along with this problem statement .
  (Please refer page no. 19 of the Handbook provided).

d) General Layout of the Prototype:

The prototype should have the following components:

1. A Brief overview of the present scenario of the GT Group of Companies.
2. Then the teams need to consider one group of company at a time and describe the following :

- ✓ They need to consider the various manufacturing processes involved in all the three groups of GT and briefly give a description through linked flow diagram.
- ✓ At each manufacturing process for each group of companies, specify the ISO standards (whether to modify, keep unchanged, discard or use that standard) that need to be reviewed.
- ✓ Then describe the feasibility, adaptability and accessibility of the individual prototypes defined in context with that particular group of GT.For example- if any standard is

reviewed for GT Fittings Pvt. Ltd. then explain the reason in context with a general pipe & tube making company (how it can affect the investment, risk factor and complements with the situational and demographic factors of the company). Be brief and precise.

3. After giving suggestions and reviews for improvement in the ISO Standards (in context with each of the three groups of GT) try to figure out how the three groups of GT would achieve better cost-effective implementation and quality control through your reviewed ISO Standards (a comparison in tabular form) and give justifications behind that.
4. A brief Conclusion and Future Work that need to be done for implementation of standards in similar VSEs.

NOTE: Only those ISO Standards which are provided along with this problem statement need to be considered for any modifications, reference or analysis of the processes. No other standards are to be used.Also be brief and precise while considering any ISO standard for review as we want the qualitative evaluation of standards based on your views and ideas .

e) Event Rules and Regulations :

1) The event consists of two stages :

STAGE 1:

- ✓ Online Abstract Submission (in pdf file format) before the specified deadline.
- ✓ The abstract submitted should include a general layout of the prototype developed.
- ✓ For this, the teams are required go through the INCOSE Systems Engineering Handbook along with the guidelines and the general prototype layout as specified here.
- ✓ Teams need to be brief and specific in the abstract and strictly adhere to the guidelines mentioned in the problem statement.
- ✓ Based on the abstract, shortlisted teams will be called for the next round of the event.

STAGE 2:

- ✓ In this round, teams need to give a powerpoint presentation on their developed prototype.
- ✓ Presentation should cover details and salient features of the abstract.
- ✓ Through the virtual case provided, participants need to show the problems faced by similar VSEs in implementing standards and suggest ways to overcome the same.

- ✓ The teams should present their own views on the given problem and discuss the future scope of study.

f) Marking Scheme:

Marking will be done (both for abstract and presentation) based on certain crucial points that must be included.

1. **Brief Overview of the problems faced by the VSE due to its inconsistencies in existing ISO Standards.**
2. **Process Description for each group of companies through flow diagram.**
3. **Explanation behind the discrepancies observed in ISO standards provided and reviews and improvements suggested thereby.**
4. **The prototype feasibility, adaptability and accessibility by VSEs in future.**
5. **Creativity and Analysis: depending on how the team has figured out the virtual case on the basis of cost effective implementation and Quality Control parameters.**
6. **Conclusion and future work (ground work) that need to be done to have real-time implementations.**
7. **Q&A session (for presentation round only)**

SETS OF ISO STANDARDS:

For GT Cylinders Pvt. Ltd.:

1. ISO 4706:2008

Gas cylinders -- Refillable welded steel cylinders -- Test pressure 60 bar and below

ISO 4706:2008 specifies the minimum requirements concerning material selection, design, construction and workmanship, procedure and test at manufacture of refillable welded-steel gas cylinders of a test pressure not greater than 60 bar, and of water capacities from 0.5 l up to and including 500 l exposed to extreme worldwide temperatures (-50 °C to +65 °C) used for compressed, liquefied or dissolved gases.

Transportable large cylinders of water capacity above 150 l and up to 500 l may be manufactured and certified to ISO 4706 provided handling facilities are provided.

ISO 4706 is primarily intended to be used for industrial gases other than Liquefied Petroleum Gas (LPG), but may also be applied for LPG.

2. ISO 5145:2004

Cylinder valve outlets for gases and gas mixtures -- Selection and dimensioning

ISO 5145:2004 establishes practical criteria for determining valve outlet connections for gas cylinders.

It applies to the selection of gas cylinder valve outlet connections and specifies the dimensions of a number of them.

ISO 5145:2004 does not apply to connections used for cryogenic gas withdrawal or gases for breathing equipment which are the subject of other International Standards.

3. ISO 6406:2005

Gas cylinders -- Seamless steel gas cylinders -- Periodic inspection and testing

ISO 6406:2005 deals with seamless steel transportable gas cylinders (single or those that comprise a bundle) intended for compressed and liquefied gases under pressure, of water capacity from 0.5 l up to 150 l; it also applies, as far as practical, to cylinders of less than 0.5 l water capacity.

ISO 6406:2005 specifies the requirements for periodic inspection and testing to verify the integrity of such gas cylinders to be re-introduced into service for a further period of time.

4. ISO/TR 7470:1988

Valve outlets for gas cylinders -- List of provisions which are either standardized or in use

It specifies details for types of threads and thread sizes. Tabulates nominal diameters from 9.73 mm up to and including 30 mm together with the corresponding pitches and designations, refers to the national standards of concern. Valve outlets for toxic gases, valve outlets for flammable gases, valve outlets for oxidizing gases, and valve outlets for inert gases are also specified

5. ISO 10464:2004

Gas cylinders -- Refillable welded steel cylinders for liquefied petroleum gas (LPG) -- Periodic inspection and testing

ISO 10464:2004 specifies the intervals and inspection and testing procedures for the periodic inspection of refillable welded steel dedicated LPG cylinders of water capacity from 0.5 l up to and including 150 l.

It applies to cylinders protected by a system to prevent external corrosion and designed and manufactured in accordance with ISO 4706, ISO 22991 or an equivalent design and construction standard. ISO 10464 may also apply to other refillable welded steel cylinder designs for LPG with the approval of the national authority. Cylinders for the on-board storage of LPG as a fuel for vehicles are excluded from the standard, except cylinders used for fork-lift truck applications.

6. ISO 10691:2004

Gas cylinders -- Refillable welded steel cylinders for liquified petroleum gas (LPG) -- Procedures for checking before, during and after filling

ISO 10691:2004 specifies the procedures to be adopted when checking transportable refillable welded steel LPG cylinders before, during and after filling.

It applies to transportable refillable welded steel LPG cylinders of water capacity from 0.5 l up to and including 150 l.

It does not apply to cylinders permanently installed in vehicles, or to plant and filling equipment.

7. ISO 11114-1:2012

Gas cylinders -- Compatibility of cylinder and valve materials with gas contents -- Part 1: Metallic materials

ISO 11114-1:2012 provides requirements for the selection of safe combinations of metallic cylinder and valve materials and cylinder gas content.

The compatibility data given is related to single gases and to gas mixtures.

Seamless metallic, welded metallic and composite gas cylinders and their valves, used to contain compressed, liquefied and dissolved gases, are considered.

Aspects such as the quality of delivered gas product are not considered.

8. ISO 11114-2:2013

Gas cylinders -- Compatibility of cylinder and valve materials with gas contents -- Part 2: Non-metallic materials

ISO 11114-2:2013 gives guidance in the selection and evaluation of compatibility between non-metallic materials for gas cylinders and valves and the gas contents. It also covers bundles, tubes and pressure drums.

ISO 11114-2:2013 can be helpful for composite and laminated materials used for gas cylinders.

It does not cover the subject completely and is intended to give guidance only in evaluating the compatibility of gas/material combinations.

Only the influence of the gas in changing the material and mechanical properties is considered (for example chemical reaction or change in physical state). The basic properties of the materials, such as mechanical properties, required for design purposes are normally available from the materials' supplier and are not considered.

The compatibility data given are related to single component gases but can be used to some extent for gas mixtures. Ceramics, glasses, and adhesives are not covered.

Other aspects such as quality of delivered gas are not considered.

ISO 11114-2:2013 is not intended to be used for cryogenic fluids.

9. ISO 11114-3:2010

Gas cylinders -- Compatibility of cylinder and valve materials with gas contents -- Part 3: Autogenous ignition test for non-metallic materials in oxygen atmosphere

ISO 11114-3:2010 specifies a test method to determine the autogenous ignition temperature of non-metallic materials in pressurized gaseous oxygen.

The autogenous ignition temperature is one criterion for ranking materials, and can be used to assist with the choice of materials used in the presence of gaseous oxygen.

It is intended that ISO 11114-3:2010 be used for the selection of non-metallic materials for gas cylinders and accessories, for example to select the materials in order to meet the requirement for type testing for oxygen compatibility of all cylinder valves for highly oxidizing gases as specified in ISO 10297.

For GT Steel Wires Pvt. Ltd.:

1. ISO 2408:2004

Steel wire ropes for general purposes -- Minimum requirements

ISO 2408:2004 specifies minimum requirements for the manufacture and testing of stranded steel wire ropes for general purposes, including lifting equipment such as cranes and hoists. Ropes for slings are also dealt with, and tables giving minimum breaking forces for the more common sizes, grades and constructions of stranded rope presented. It is applicable to single-layer, rotation-resistant and parallel-closed ropes made from wires of uncoated (bright), zinc-coated and zinc-alloy coated finish in rope diameters of up to 60 mm, supplied as bulk manufacture. It is not applicable to ropes for mining purposes, aircraft control, the petroleum and natural gas industries, aerial ropeways and funiculars, lifts or for fishing purposes.

2. ISO 2262:1984

General purpose thimbles for use with steel wire ropes -- Specification

Cancels and replaces the first edition (i.e. ISO 2262:1972). Applies to thimbles suitable for use with steel wire ropes complying with ISO 2408, having a maximum tensile grade of 1770 MPa with diameters from 4 to 60 mm. Does not apply to thimbles for use with fibre ropes. Reeving thimbles and solid thimbles are not included.

3. ISO 3108:1974

Steel wire ropes for general purposes -- Determination of actual breaking load

Describes a method of tensile test to destruction. May be used for steel wire ropes for general purposes (see ISO 2408) or other ropes, unless the standard concerned specifically excludes its use, or gives another method. Specifies test piece including test length, testing and test report.

4. ISO 3189-1:1985

Sockets for wire ropes for general purposes -- Part 1: General characteristics and conditions of acceptance

Lays down the dimensions necessary for interchangeability, prototype test requirements and quality control of steel sockets for steel wire ropes within the nominal diameter range of 8 to 60 mm. Applies to forged, or machined sockets from solid or to cast sockets. These sockets are not suitable for use in conjunction with locked coil and spiral strands.

5. ISO 4346:1977

Steel wire ropes for general purposes -- Lubricants -- Basic requirements

Specifies the nature and properties of lubricants used in the manufacture of wire ropes for general purposes. Service dressings and fibre core lubricants are excluded. Includes general and special requirements, qualification tests and quality control.

6. ISO 7531:1987

Wire rope slings for general purposes -- Characteristics and specifications

Specifies the type of sling, the working load limit, and the manufacture of slings and sling assemblies. The multi-legged slings are constructed with legs of equal nominal length. Slings of

unequal leg length may also be constructed, but the rating of such slings requires special consideration by a competent person.

7. ISO 8792:1986

Wire rope slings -- Safety criteria and inspection procedures for use

Applies to the regular use of wire sling ropes. The use of wire rope slings is frequently covered by national regulations; these would take precedence over ISO 8792.

8. ISO 10425:2003

Steel wire ropes for the petroleum and natural gas industries -- Minimum requirements and terms of acceptance

ISO 10425:2003 specifies the minimum requirements and terms of acceptance for the manufacture and testing of steel wire ropes not exceeding rope grade 2 160 for the petroleum and natural gas industries.

9. ISO 4101:1983

Drawn steel wire for elevator ropes -- Specifications

Gives specifications (concerning diameter, ovality, tensile strength, tests, and acceptance conditions) for steel wire to be used for elevator ropes only. Applies to new steel wire of between 0.25 and 1.8 mm diameter, used solely for manufacture of elevator ropes. Does not apply to steel wires taken from a rope.

For GT Fittings Pvt. Ltd.:

1. ISO 559:1991

Steel tubes for water and sewage

Specifies the technical conditions for delivery of seamless and welded steel tubes for the conveyance of water and sewage at temperatures between - 10 °C and 120 °C. Does not apply to steel tubes in accordance with ISO 65 and similar plain end tubes. Contains references, definitions, informations to be supplied by the purchaser, and data relating to manufacturing process, chemical composition, mechanical properties and weldability, dimensions, masses and tolerances, appearance and soundness, inspection and testing, marking, lining or coating and documents.

2. ISO 1129:1980

Steel tubes for boilers, superheaters and heat exchangers -- Dimensions, tolerances and conventional masses per unit length

Specifies the diameters, thicknesses, tolerances and masses per unit length of fired tubes, including superheater and heat exchanger tubes. It does not apply for tubes according to ISO 6758 and ISO 6759. Tabulates the data for carbon and alloy steel tubes , austenitic stainless steel tubes & ferritic and martensitic steel tubes.

3. ISO 2937:1974

Plain end seamless steel tubes for mechanical application

Specifies the characteristics of hot-finished tubes intended for use with or without subsequent machining operations. Cowers outside diameters from 33.7 mm up to and including 406.4 mm with thicknesses from 3.2 mm up to and including 65 mm. Lays down chemical composition as well as mechanical and technical properties of material.

4. ISO 3183:2012

Petroleum and natural gas industries -- Steel pipe for pipeline transportation systems

ISO 3183:2012 specifies requirements for the manufacture of two product specification levels (PSL 1 and PSL 2) of seamless and welded steel pipes for use in pipeline transportation systems in the petroleum and natural gas industries.

5. ISO 2531:2009

Ductile iron pipes, fittings, accessories and their joints for water applications

ISO 2531:2009 specifies the requirements and test methods applicable to ductile iron pipes, fittings, accessories and their joints for the construction of pipelines:

- to convey water (e.g. for human consumption and raw water),
- operated with or without pressure, and
- Installed below or above ground.

It specifies materials, dimensions and tolerances, mechanical properties and standard coatings of pipes, fittings and accessories. It also gives performance requirements for all components including joints.

ISO 2531:2009 applies to pipes, fittings and accessories cast by any type of foundry process or manufactured by fabrication of cast components, as well as corresponding joints in the size range DN 40 to DN 2600 inclusive.

6. ISO 6758:1980

Welded steel tubes for heat exchangers

Specifies the characteristics of plain end tubes manufactured from unalloyed and alloyed steels (including austenitic stainless steels). It does not apply to steel tubes intended for exposure to flame.

7. ISO 6759:1980

Seamless steel tubes for heat exchangers

Specifies the characteristics of plain end tubes manufactured from unalloyed and alloyed steels (including austenitic and ferritic stainless steels). It does not apply to steel tubes indended for exposure to flame.

8. ISO 11960:2011

Petroleum and natural gas industries -- Steel pipes for use as casing or tubing for wells

ISO 11960:2010 specifies the technical delivery conditions for steel pipes (casing, tubing and pup joints), coupling stock, coupling material and accessory material and establishes requirements for three product specification levels (PSL-1, PSL-2, PSL-3). The requirements for PSL-1 are the basis of ISO 11960:2010. For pipes covered by ISO 11960:2010, the sizes, masses and wall thicknesses as well as grades and applicable end-finishes are listed.

By agreement between the purchaser and manufacturer, ISO 11960:2010 can also be applied to other plain-end pipe sizes and wall thicknesses.

ISO 11960:2010 is applicable to the following connections in accordance with API Spec 5B: short round thread casing (SC), long round thread casing (LC), buttress thread casing (BC), non-upset tubing (NU), external upset tubing (EU) and integral tubing connections (IJ).

For such connections, ISO 11960:2010 specifies the technical delivery conditions for couplings and thread protection. Supplementary requirements that can optionally be agreed for enhanced leak resistance connections (LC) are given.

ISO 11960:2010 can also be applied to tubular with connections not covered by ISO/API standards.

The four groups of products to which ISO 11960:2010 is applicable include the following grades of pipe: group 1, including all casing and tubing in grades H, J, K, N and R; group 2, including all casing and tubing in grades C, L, M and T; group 3, including all casing and tubing in grade P; and group 4, including all casing in grade Q.

Casing sizes larger than label 1: 4-1/2 but smaller than label 1: 10-3/4 can be specified by the purchaser for use in tubing service.

Supplementary requirements that can optionally be agreed between purchaser and manufacturer for non-destructive examination, fully machined coupling blanks, upset casing, electric-welded casing, tubing and pup joints, impact testing, seal ring couplings, test certificates, tensile testing and sulfide stress cracking testing are given. ISO 11960:2010 is not applicable to threading requirements.

9. ISO 11961:2008

Petroleum and natural gas industries -- Steel drill pipe

ISO 11961:2008 specifies the technical delivery conditions for steel drill pipes with upset pipe body ends and weld-on tool joints for use in drilling and production operations in petroleum and natural gas industries for three product specification levels (PSL-1, PSL-2 and PSL-3). The requirements for PSL-1 form the basis of this ISO 11961:2008 but those that define different levels of standard technical requirements for PSL-2 and PSL-3 are also given.

ISO 11961:2008 covers grade E drill pipe and the high-strength grades X, G and S.

A typical drill pipe configuration is given, showing main elements and lengths. The main dimensions and masses of the grades of drill pipe are given in both SI units and in USC units.

ISO 11961:2008 can also be used for drill pipe with tool joints not specified by ISO or API standards.

By agreement between purchaser and manufacturer, ISO 11961:2008 can also be applied to other drill-pipe body and/or tool-joint dimensions. ISO 11961:2008 lists supplementary requirements that can optionally be agreed between purchaser and manufacturer, for testing, performance verification and non-destructive examination.

ISO 11961:2008 does not consider performance properties.

10. ISO 9349:2004

Pre-insulated ductile iron pipeline systems

ISO 9349:2004 specifies the requirements and test methods applicable to pre-insulated ductile iron pipes, fittings, accessories and their joints for the construction of pipelines (or parts thereof) to convey water (e.g. potable water), wastewater and other liquids, to be operated with or without pressure, to be installed below or above ground, to limit temperature variations of the conveyed fluids.

ISO 9349:2004 gives, in addition to the specifications of the existing ISO standards for the conveying ductile iron pipes and fittings, specifications for materials, dimensions and tolerances, mechanical and thermal properties of the thermal insulation layer and external casing of pre-insulated ductile iron pipes, fittings and accessories.

ISO 9349:2004 covers pre-insulated ductile iron pipes, fittings and accessories of a size range extending from DN 60 to DN 600 inclusive, which are manufactured with socketed, flanged or spigot ends for jointing by means of various types of gaskets which are not within the scope of this International Standard; pre-insulated in the works (excluding on-site application of the insulation layer and/or the casing); normally delivered internally and externally coated; intended for fluid temperatures from 0 °C to 50 °C excluding frost.