SAVONIA

OPINNÄYTETYÖ - **AMMATTIKORKEAKOULUTUTKINTO**
TEKNIIKAN JA LIIKENTEEN ALA

ASME BASED QUALITY DOCUMENTATION GUIDE-LINES FOR POWER- AND RECOVERY BOILERS

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SAVONIA-AMMATTIKORKEAKOULU

OPINNÄYTETYÖ
Tiivistelmä

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Tiivistelmä

Opinnäytetyön tarkoituksena oli tehdä ohjeistus ASME-projektien laatudokumentoinnin läpivientiin voima- ja soodakattila projekteissa. Työn toimeksiantajana toimi suuri kansainvälinen voima- ja soodakattiloiden valmistaja. Opinnäytetyö sisältää suurelta osin selvitystä ASME-koodista ja koodin vaikutuksesta laatudokumentaatioon. Työssä vertailtiin laajasti ASMEen pohjautuvan dokumentaation eroavaisuuksia PED/EN projektien laatudokumentaatioon. Lisäksi ASMEsta on selvitettynä tärkeimmät kohdat, joita voima- ja soodakattilaprojektin ongelmattoman läpiviennin kannalta ovat tärkeitä. Opinnäytetyössä tehtävän ohjeistuksen on tarkoitus tulla ohjeeksi tuleviin ASME-projekteihin. Valmis ohjeistus tulee olemaan salainen ja on jätetty tästä opinnäytetyöstä pois.

Opinnäytetyö suoritettiin töiden ohella toimeksiantajan yrityksessä. Toimeksiantajalta löytyi kaikki tarvittava tieto ja materiaali, joita tarvittiin opinnäytetyön tekemiseen. Meneillään olevat projektit auttoivat osaltaan opinnäytetyön tekemistä. Meneillään olevista projekteista sai hyvän näkemyksen ASMEen pohjautuvan dokumentoinnin vaatimuksista esimerkkeineen ja ongelmakohtineen.

Opinnäytetyössä tehdyn ohjeistuksen on tarkoitus tulla käyttöön koko yritykselle. Ohjeistuksen on tarkoitus toimia tukemassa laatuinsinöörien työskentelyä ja antaa esimerkkejä verraten muihin käytössä oleviin standardeihin. Ohjeistus on tarkoitettu ensisijaisesti henkilöille, jotka eivät tunne ASMEa. Vastaava ohjeistus on toimeksiantajalla käytössä PED / EN projekteissa, joten ASME ohjeistus tulee PED / EN ohjeiden rinnalle tukemaan projektien läpivientiä ASME-projekteissa. Ohjeistus tulee helpottamaan vaaditun laatudokumentaation ymmärtämistä ja dokumenttien hallintaa ASME-projektin aikana.

Tärkein yksittäinen laatudokumentti ASME Boiler and Pressure Vessel Code tapauksessa on Manufacturer's Data Report, tässä dokumentissa valmistaja takaa tuotteensa ja tarkastaja hyväksyy tämän. MDR on avattu tässä opinnäytetyössä laajasti, kuten myös sen tärkeys. Myös kaikki muut vaaditut laatudokumentit on listattu ja niiden sisältöä avattu tässä opinnäytetyössä.

Avainsanat
AI, ASME, ASME BPVC, Laatu, Laatudokumentaatio, MDR, NoBo, PED, Standard, Soodakattila, Voimakattila

SAVONIA UNIVERSITY OF APPLIED SCIENCES

THESIS
Abstract

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Client Organisation /Partners			

Abstract

The goal of this thesis was to create ASME-based quality documentation guidelines for power- and recovery boilers. The client was a large international power- and recovery boiler manufacturer. The content of this thesis is mainly a report of ASME code and its effects on quality documentation. In thesis are widely compared ASME based quality documention differences between PED/EN projects quality documentation. Also ASMEs most important elements for power- and recovery boiler projects needs for trouble-free completion are figured out. Instruction made during thesis process is intended to be guidelines for upcoming ASME based projects. Instruction will be classified as secret and it is left out of this thesis report.

This thesis was done while working for the client. The Client provided all the knowledge and materials, needed for making this thesis. Also ongoing projects helped making of the thesis. Ongoing projects giva a good insight on ASME based documentation requirements with examples and problematics.

Instructions made in the thesis are aimed for use for whole company. Instructions should support quality engineers work and give examples of the other used standards. Instructions are intended primarily for those who don't have earlier experience of ASME. Similar instruction is used at the client organization in PED / EN projects, so ASME based instruction will come simultaneously to PED / EN instructions to support project completion. The instructions will help to understand needed quality documention and management of those documents during ASME project.

The most important single quality document in the case of ASME Boiler and Pressure Vessel Code is Manufacturer's Data Report on this document manufacturer assure own product and inspector approves it. This thesis clarifies those documents is discussed in this thesis.

Keywords
AI, ASME, ASME BPVC, MDR, PED, Power boiler, NoBo, Quality, Quality documentation, Recovery boiler, Standard

FOREWORDS

This thesis was made for a big international company and most of thesis is confidential. This report is only part of my final thesis. I want to thank for this opportunity to do my final thesis on such an interesting subject. On behalf of my school there were two supervisors for my thesis. Those supervisors were Jarmo Pyysalo and Ritva Käyhkö.

I want to thank especially Mr. Petteri Puranen for his help and guiding in my final thesis. I also want to thank Mr. Tuukka Starck for his help with my final thesis. Without those two I do not think that I would have managed to do my final thesis.

Varkaudessa 25.8.2015

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Tuomas Lappalainen

CONTENT

1 INTRODUCTION

Quality is nowadays more and more important for companies and they try to put more effort in their quality. The aim of final thesis was to make ASME based quality documentation guidelines for power- and recovery boilers for the company where I do my final thesis. The company has already guidelines for PED projects. That way final thesis fulfills the missing part of documentary guidelines of the company. ASME based quality documentation guidelines for power- and recovery boilers should be in use right after thesis is ready. Final thesis is classified as confidential so only some parts are shown in this report.

1.1 Abbreviations and definitions

AEI	Automation Electrification and Instrumentation.
AI	Authorized Inspector.
AIA	Authorized Inspection Agency (ASME).
ASME	American Society of Mechanical Engineer.
BFB	Bubbling Fluidized Bed. BFB is boiler type on power boilers.
BPVC	Boiler and Pressure vessels Code. Part of ASME.
DT	Destructive testing. Testing method on ASME and PED/EN.
EAM	European Appraisal for Materials
EN	Standard what has been approved on Europe.
ITP	Inspection and Test Plan. On use of both ASME and PED projects.
MDR	Manufacturer's Data Report. Used on ASME documentation.
MTR	Material Test Report. Material test reports issued by the material manufacturer. On EN this are called material certificates.
NB	National Board
NCR	Non Conformity Report.

NDE	Non-Destructive Examination. Testing method for pressure- and non-pressure vessels on ASME.
NDT	Non-Destructive testing. Testing method for pressure- and non-pressure vessels on PED/EN.
NoBo	Notified Body.
PED	Pressure Equipment Directive. PED can be fulfilled by using harmonized EN standards. PED is directive what guides manufacturing and design.
PMA	Particular Material Appraisal
PQR	Procedure Qualification Record. Used on ASME projects.
PWHT	Post Weld Heat Treatment.
SFS	Finish Standardisation Society.
WPQR	Welding Procedure Qualification Record. Used on EN projects.
WPS	Welding Procedure Specification.

2 POWER AND RECOVERY BOILERS

Power- and recovery boilers are one of the main products of the company where this thesis was done. Here is some basic knowledge of the power- and recovery boilers and general information about both boilers. (Pohto soodakattila peruskurssi, lecture material, read 3.6.2015)

In a normal process the fuel is burned in a high temperature and the burning process happens in furnace. It is important that furnace just like the boiler is designed for specific fuel or fuels. Normally there is one main fuel and secondary fuel. In this way are the best effectivity and efficiency received. On burning process it is important to make burning as complete as possible. Burning process frees flue gas and heat recovery happens in flue gases. It is important that there is possibility to control the power of burning. Boiler works like a giant water heater. (Pohto soodakattila peruskurssi, lecture material, read 3.6.2015)

In a main steam turbine plant the generated heat is transferred via heat delivery surface to the substance which is normally water. Pressurized steamed water is lead into steam turbine, where it expands and rotates turbine wings. (Pohto soodakattila peruskurssi, lecture material, read 3.6.2015)

2.1 Power boiler

Next it is focused on Bubbling Fluidized Bed (BFB) power boilers. Those types of boilers are designed to combust biomass. The capacity of the boiler is relatively large and they generate large amount of superheated steam with pretty high pressure for example 6, 5 MPa(g) and temperature of 500-550 °C. (Companys' Intranet Power boiler instruction read 15.7.2015)

Fuels can be for example wood-based biomass (natural wood chips, bark and branches) and palm kernel shells. The bubbling fluidized bed (BFB) power boilers usually need light fuel oil for boiler start-up and some cases for auxiliary fuel. Bubbling fluidized bed type of power boilers can use many kind of biomass fuels. (Companys' Intranet Power boiler instruction read 15.7.2015)

Bubbling fluidized bed (BFB) technology is a combustion technology for different biomass fuels. The fuel is combusted in and above the fluidized bed consisting of natural sand. The large heat capacity of the fluidized bed maintains combustion and evens out fluctuations caused by varying fuel quality. Low temperatures and efficient combustion result in low environmental emissions. (Companys' Intranet Power boiler instruction read 15.7.2015)

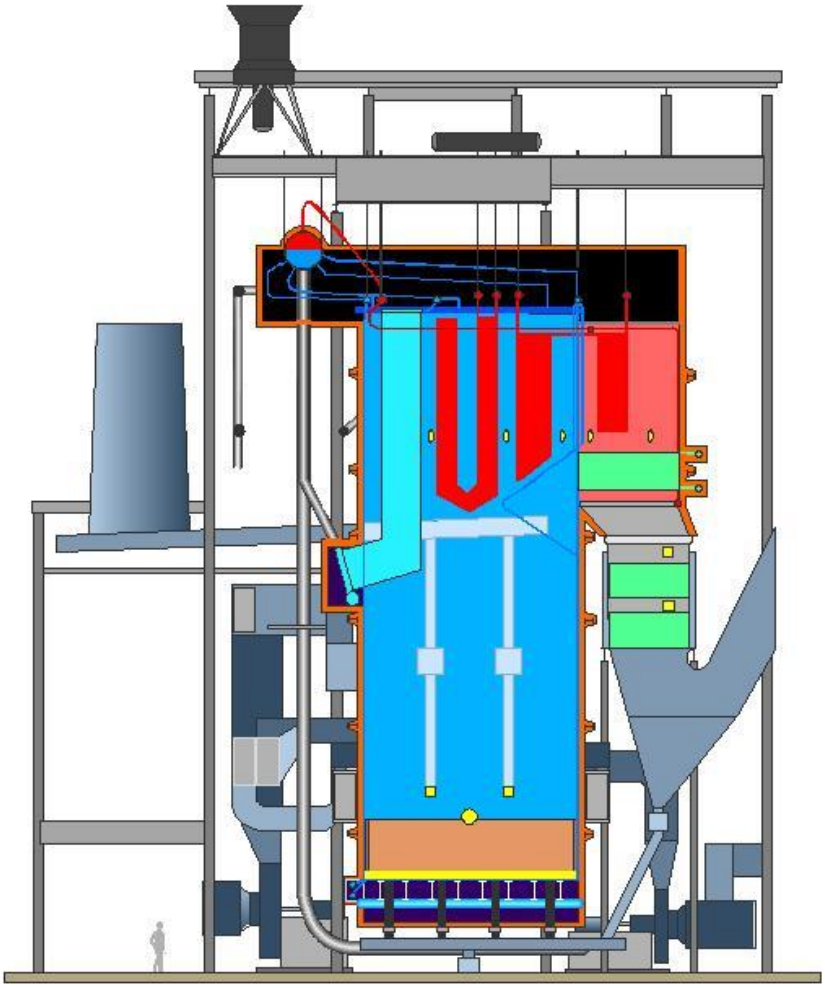
Bubbling Fluidized Bed Boiler (BFB) is a membrane walled natural circulation steam boiler supported from the bottom. The fluidizing grid structure with conservative boiler design allows effective utiliza-

tion of various fuels. The simple construction ensures reliable operation. (Companys' Intranet Power boiler instruction read 15.7.2015)

Bubbling fluidized bed boiler furnace walls, fluidizing grid as well as the second pass are of membrane wall construction and part of the evaporation circuit. Saturated steam is separated from saturated water in steam drum. (Companys' Intranet Power boiler instruction read 15.7.2015)

The superheater is divided into three stages located in boiler furnace and second pass. Steam temperature is controlled by spraying water between superheater stages. The economizers and air preheaters are located in the boilers third pass with plate enclosure walls for further heat recovery from the flue gases. The heat transfer surfaces are equipped with steam sootblowers. (Companys' Intranet Power boiler instruction read 15.7.2015)

The fuel is fed above the fluidized bed via air-cooled fuel feeding chutes. Combustion air is introduced as fluidizing air (primary air) into windbox below the grid, and into the furnace as combustion air, which is divided into secondary and tertiary air levels. The effective air staging and combustion control results in low NOx emissions. Solid particles are separated from flue gases in bag house filter. (Companys' Intranet Power boiler instruction read 15.7.2015)



Picture 1. Sideview of BFB boiler (Watson 2015)

2.2 Recovery boiler

Recovery boilers are part of sulphate pulp mill chemicals rotary. Black liquor is burned and in that way is generated heat. Heat is normally used to make electricity. Recovery boiler is natural circulation boiler and basic parts of recovery boiler are almost the same in steam generation boiler. (Pohto soodakattila peruskurssi, lecture material, read 29.3.2015)

Recovery boilers have two main tasks. These two tasks are pulping and chemical recovery and the content of the organic portion of the heat recovery. (Pohto soodakattila peruskurssi, lecture material, read 29.3.2015)

In a recovery boiler the concreated waste liquor will be prayed to the furnace from all walls. Liquor drops will dry on the way to the bottom of the furnace. When the liquor dries the sodium that is combined to the liquor will separate to sodium oxide, which will react on drying zone with gases mainly following ways:

$$Na_2O + CO_2 \Rightarrow Na_2CO_3$$
$$Na_2O + SO_2 + 1/2\ O_2 \Rightarrow Na_2SO_4$$

At the bottom of the furnace in loaf the following reactions happen:

- Organic burning materials gasify, burn partly and exit from the loaf.
- Sodium sulphate will reduce to sodium sulphide. Reduction happens in a close contact with chemicals and hot carbon under short air state mainly by following equations:

$$Na_2SO_4 + 2\ C \Rightarrow Na_2S + 2\ CO_2$$
$$Na_2SO_4 + 4\ CO \Rightarrow Na_2S + 4\ CO_2$$

To measure of the reduction can be defined in the following way:

$$\text{Reduction level (mole-\%)} = \frac{Na_2S}{Na_2S + Na_2SO} \times 100\ \%$$

- Recovered salts melt.

Molten chemical ash is poured out through the porous loaf to the bottom of furnace, where it is led by overflow via water cooled molten chutes to dissolving tank, where molten dissolves with the white liquor that can be from caustic zing plant or evaporation plant secondary condensate. The generated solution, green liquor, will be pumped to the caustic zing plant for additional treatment. (Pohto soodakattila peruskurssi, lecture material, read 29.3.2015)

Burning air of the lye will be bridged to the furnace by eight air register-levels. Primary air registers are located on all furnace walls. Primary-air's meaning is to maintain burning and enough high loaf

temperature. In this way the good reduction level is reached. (Pohto soodakattila peruskurssi, lecture material, read 29.3.2015)

Secondary air registers are located at the bottom of the lye nozzle on back- and front walls. Secondary air's meaning is to burn loaf area rising unburned gases and also prevent loaf growth over the maximum level. (Pohto soodakattila peruskurssi, lecture material, read 29.3.2015)

Tertiary air registers are located in the furnace back- and front walls. With tertiary air it is possible to make sure that the flammable gases will burn out completely. (Pohto soodakattila peruskurssi, lecture material, read 29.3.2015)

Actual recovery boiler's steam generation parts are almost the same as in any other kind of steam boiler. Recovery boiler is based on natural circulation boiler, one steam drum high duty- radiating boiler. The parts are the following:

- Two part economizer
- Pipe type furnace
- Three part superheater

In start-ups and shut-downs and also lye burners' malfunction cases recovery boiler is equipped with start-up and load burners, which use heavy fuel oil. (Pohto soodakattila peruskurssi, lecture material, read 29.3.2015)

2.2.1 Chemical recovery

Main part of chemical recovery is changing organic matter-bound sodium to the regenerated form of sodium carbonate (Na_2CO_3). On chemical recovery sodium (Na_2SO_4) reductions to sodium sulfide (Na_2S).

Changing the sulfur compounds to sulphide-form should be as complete as possible. Because the part that does not change to sulfide is it on closed cycle extra load and makes extra cost and extra difficulties.

Black liquor organic matter burning process generated heat is used to reactions, ash melting, as well as furnace sprayed thick waste liquor drying and also to steaming of water and superheating the steam. (Pohto soodakattila peruskurssi, lecture material, read 29.3.2015)

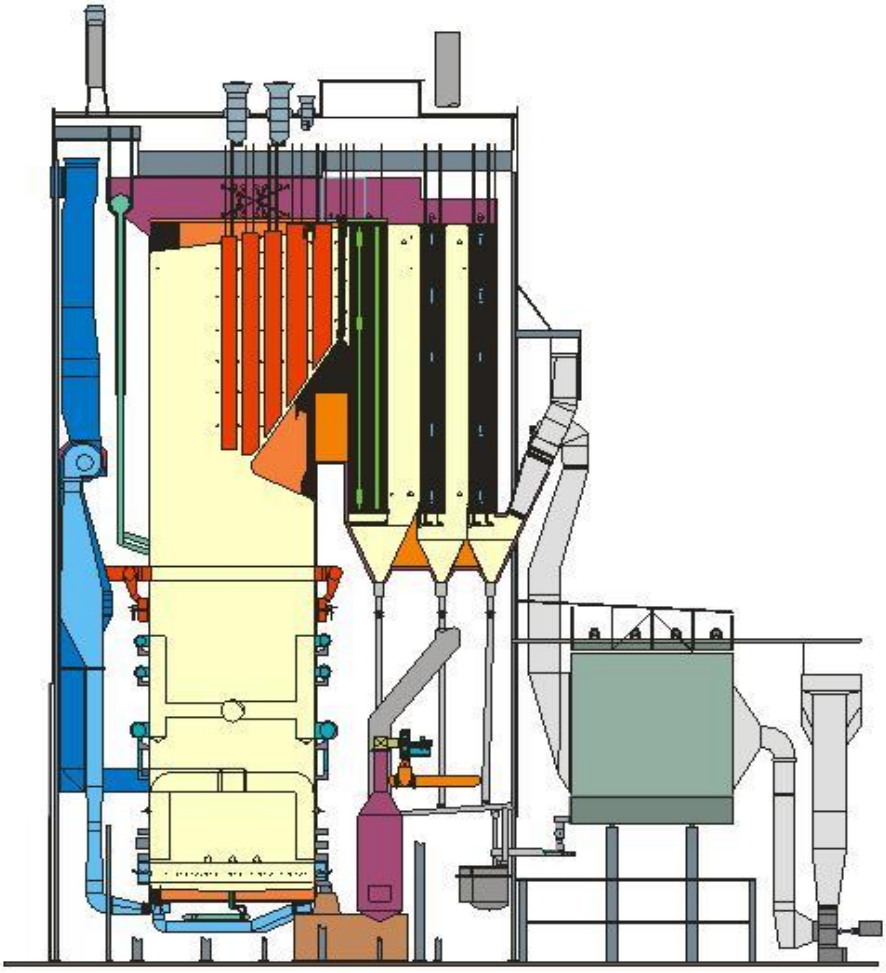
2.2.2 Heat recovery

In heat recovery the two main tasks of recovery boilers are following. Steam generating (generating of electric energy) is the first task. Part of the heat is used for furnace reactions is the second main task.

Manufacturing of bleached pulp also dissolves over half of wood material to the pulping liquor. Dissolved wood material energy content corresponds in this case to about 400 kg of fuel oil for every boiled mass tons. This is normal ratio in recovery boiler heat recovery. (Pohto soodakattila peruskurssi, lecture material, read 3.7.2015)

2.2.3 Protection of the environment

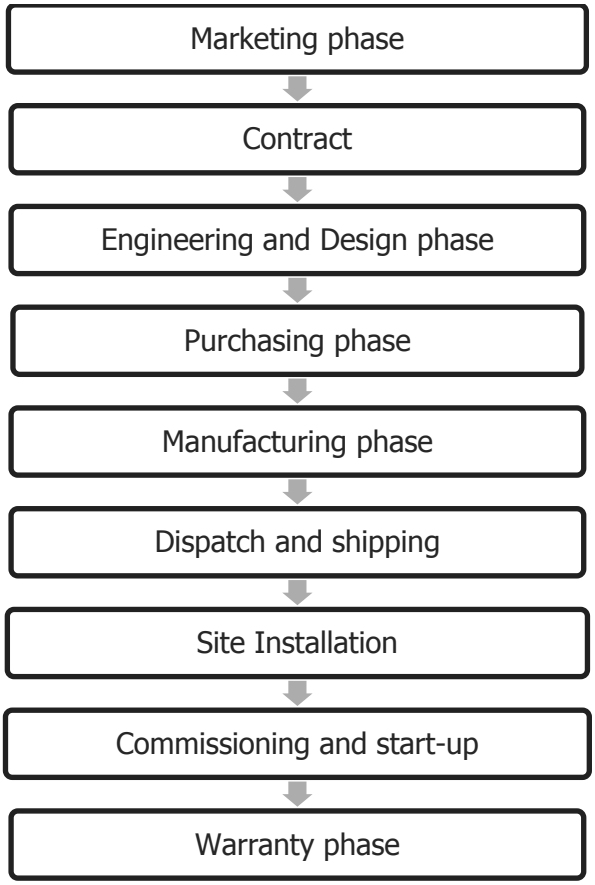
Protection of the nature is a part chemical cycle. In pulping process waste liquors are formed. This waste liquor consumes oxygen of the water. In chemical manufacturing of the pulp the load of the water system will be very severe unless we recover the waste liquor and destroy it by burning it in recovery boiler. (Pohto soodakattila peruskurssi, lecture material, read 3.7.2015)



Picture 2. Sideview of recovery boiler (Watson 2015)

3 PROJECT AND PROJECT PHASES

In boiler projects there are usually many different phases. Here is listed the normal order how the project goes from start to take over. There are only guidelines for normal projects. Every project has its own differences, but this is a frame how normally project phases goes. This kind of model is used specially in power- and recovery boiler projects, but this frame can also be used in other projects and even when manufacturing only a single vessel like some bigger tanks, preheaters or coolers. Project phases are shown in picture 3.



Picture 3. Project phases

Dividing a project into phases makes it easier to lead it to the best possible direction. Through this organisation into phases, the total workload of a project is divided into smaller components, and so making it easier to monitor and complete the project without any major problems. (Phases of project management, read 18.8.2015)

Normally in projects the project phases are ongoing simultaneously and linear segmentation is not possible. Some of the project phases happen at the same time and it is impossible to precisely say when one phase ends and an other begins. Also lengths of project phases are different and some phases are running almost during the entire project. Of course there are phases that are short and

this phase can be for example only signing of the contract. See table 1 timeline example of a project for more information about timelines.

Projects have some hold points that need to be completed before project can go to the next phase. Signing of contracts is a good example of a holdpoint. These holdpoints must be taken into account and these holdpoints can make lots of delays if something goes wrong. These delays can change timelines and cause more difficulties to the remaining phases. Some phases what is mentioned are not included in every project for example pre-engineering phase is this kind of phase. Project phases are different on different kind of projects and that's why also project holdpoints are in some cases different kind.

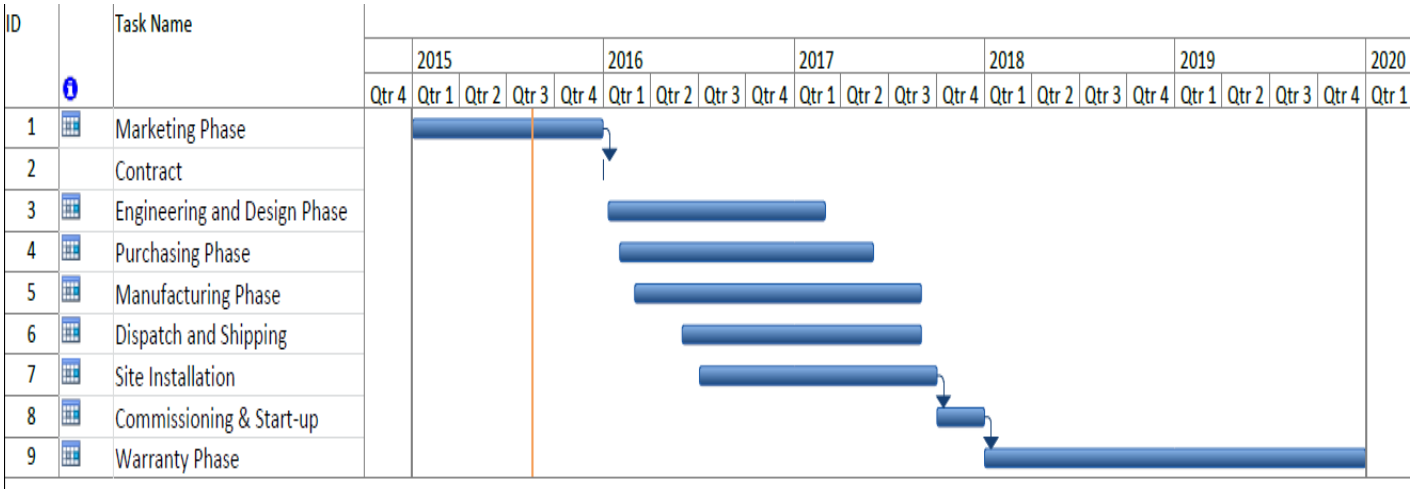


Table 1, Timeline example of a project.

According to the current laws and regulations health, safety and environmental issues are strongly taken care in every project. The health of every person who works in project is priority number one. Also near miss accidents are reported and informed so in the future accidents can be minimized.

4 ASME CODE AND STANDARDS

Standards facilitate everyday life. They increase safety and can be used to rationalize and harmonized operations. Standardization ensures that products, services and methods are appropriate for their intended use. It ensures that products and systems are compatible and interoperable.

PED is directive and therefore it has been taken into account in European countries own legistlation. PED can be follow by using harmonized EN standards or even with self created instructions, this is however extremely rare.

EN standards are based on earlier DIN (Germanys' national standard) and some other standards that were used before harmonized standards in the European area. EN standards are not as old as ASME code. In Finland there was SFS standard before EN standards.

A product manufactured according to standards is accepted in the international markets. Using the CE marking removes trade barriers.

ASME Boiler and Pressure Vessel Code was made because in the 19th century and early 20th century happens many steam boiler explosions were many people dies. Just one specific to be mentioned here was fatal explotion of the steam operated ship Sultana. At this fatal accident over 1200 people were killed. American Society of Mechanical Engineer introduced first ASME Boiler and Pressure Vessel Code in 1915. First code focused on manufacturing, engineering and use of pressure vessels or boilers. After that ASME has made many new versions of ASME Boiler and Pressure Vessel Code.

Standards and codes are marked to harmonize used practices. Primary meaning is to make manufactured goods to be safe to use. Standards are also made to keep production quality on between defined tolerances. In this way product is (almost) exactly the same all the time and those goods can be guaranteed to work as they are designed to do.

The standard gives us an international way to do business over national borders and standards are a way to speak useally the same language in multinational projects. With standards we can be sure that all regulations are fulfilled and authorities can also approve manufactured goods.

Without standards it is impossible to be sure that all manufacturers' can do and fulfill all requirements. Without standards it will be impossible to check all manufacturing methods are right for the materials.

ASME is an abbreviation and it comes from American Society of Mechanical Engineers. ASME is a code that is used in many different parts in the world and it is like standard but it is called a code. There are many similarities to PED standard and older DIN standard. ASME and PED are mostly used codes and standards in the world.

In this thesis focus is on ASME code for Boiler Pressure Vessel Code BPVC. It is made for power- and recovery boilers and must be followed in many countries when manufacturing any parts or vessels that will be in power- or recovery boiler.

Supplier of boiler has responsibility that pressure equipment is manufactured according to required code and that fulfil the requirements and is approved by authorities. After this the whole boiler can be handed over to the customer.

ASME manufacturers have a contract with their own AIA and they can use only that specific AI. In PED manufacturers can have their quality system based on single NoBos certificate, but they can also use different NoBo in different modules.

Also the boiler manufacturer has only one AI. In PED case the boiler manufacturer has one NoBo and that specific NoBo is responsible for whole boiler. Besides the main boiler parts there can be also CE-marked products with different NoBos approval.

4.1 Pressure Equipment Directive

PED is used in European countries and some other countries that want to use it. This is because not every country have standard or code for the pressure vessels and equipment. PED like other directives are laws that must be followed. Standard only gives guidelines on what is required. In PED orders and guidance are given to Notified Bodies and manufacturers on what needs to be followed. Notified bodies will make conformity assessment for pressure equipment. But of course inspectors are only humans and can make mistakes so it is good that customer is also aware of PED requirements. For more information about PED see attachment 3.

There is new version of PED (2014/68/EU) coming and it will replace old PED (97/23/EC) on 2016 July 19. Now there is transposition period ongoing and fluid group classification has been changed to correspond to the parts of new PED.

4.2 ASME Code

ASME Boiler and Pressure Vessel Code was first made in 1915. It was created to make boilers and pressure vessels manufacturing more harmonized and safe to use. ASME code also affects engineering of pressure vessels and boilers. (ASME Training material, Ojanpera, 2013)

Next are listed main parts of BPVC and also parts of outside ASME Boiler and Pressure Vessel Code. These pats have big effect to the BPVC (B31 piping and B16 pipe flanges and flange fittings); (ASME Training material, Ojanpera, 2013)

- Boilers
- Pressure Vessel
- Pipelines and Piping
- Pumps, Valves, Fittings, Flanges and Gaskets
- Bioprocessing Equipment
- Elevators and Escalators, Cranes and Hoist
- Geometric Dimensioning and Tolerance, Drawings and Terminology
- Nuclear Boiler

ASME has large amount of norms at the moment and numbers keep growing all the time. These norms are specifically for engineering, manufacturing and use of boilers and pressure vessels. Nowadays ASME Boiler and Pressure Vessels Code also covers nuclear boilers and large movable tanks.

ASME Boiler and Pressure Vessels Code is splitted into sections. Every section has different kind of purpose and every part is made according to some of this section. Section depends on purpose where part is coming. ASME and Boiler Pressure Vessel Code sections; (ASME Training material, Ojanpera, 2013)

- ASME I Rules for construction of power boilers.
- ASME II Materials
    - Part A – Ferrous material specifications
    - Part B – Nonferrous material specifications
    - Part C - Specifications for welding rods, Electrodes and filler materials
    - Part D – Properties
- ASME III Rules for construction of nuclear power plant components
    - Subsection NCA General requirements
    - Division 1 – Subsection NB Class 1 components. Rules for construction of nuclear facility components
    - Division 2 – Rules for construction of nuclear power plant component. Code for concrete reactor
    - Division 3 – Rules for construction of nuclear power plant components containment systems
- ASME IV Rules for construction of heating boilers
- ASME V Non-destructive examination
- ASME VI Recommended rules for care about operation of heating boilers
- ASME VII Recommended guidelines for the care of power boilers

- ASME VIII
    - Division 1 Rules for construction of pressure vessels
    - Division 2 Rules for construction of pressure vessels, alternative rules

- Division 3 Rules for construction of pressure, alternative rules of construction of high pressure vessels
- ASME IX Qualification standard for welding and brazing producers, welders, bracers and welding and brazing operators
- ASME X Fiber-reinforced plastic pressure vessels
- ASME XI Rules for in-service inspection of nuclear power plant components
- ASME XII Construction and continued service of transport

Every ASME section has own book and those books are different colored and that way can be easily founded. Color of these books changes, when new ASME BPVC comes out and replace the old one. Picture 4 has four different kinds of front pages ASME BPVC sections.

Picture 4, Front pages of different kind of ASME BPVC Sections, (ASME BPVC sections I, II, V and VIII covers 2013)

ASME code section is chosen by usage of the pressure equipment. Unlike in PED/EN there isn't any additional standard to be followed, but everything is found from ASME code sections. ASME code is updated every two years.

ASME piping code is called pressure piping B31 and it is spitted into more specific sections as follows; (ASME Training material, Ojanpera, 2013)

- ASME B31.1 Power Piping
- ASME B31.3 Process Piping
- ASME B31.4 Pressure Piping. Pipeline transportation system for liquor hydrocarbons and other liquids
- ASME B31.5 Refrigeration piping and heat transfer components
- ASME B31.8 Gas transmissions and distribution piping systems
- ASME B31.9 Building service piping
- ASME B31.11 Slurry transportation pipelines

There is a specific ASME pipe codes for all type of piping. This pressure piping B31 covers every piping that is needed in recovery and power boilers.

The following ASME code focuses on pipe flanges and flange fittings: (ASME Training material, Ojanpera, 2013)

- ASME B16.1 Cast iron pipe flanges and flanged fittings
- ASME B16.3 Malleable iron threaded fittings classes 150 and 300
- ASME B16.4 Gray iron threaded fittings classes 125 and 250
- ASME B16.5 Pipe flanges and flanged fittings
- ASME B16.9 Factory – made wrought butt-welding fittings
- ASME B16.10 Face-to-face-end dimensions of valves
- ASME B16.11 Forged fittings, socket-welding and threaded
- ASME B16.21 Nonmetallic flat gaskets for pipe flanges
- ASME B16.24 Cast copper alloy pipe flanges and flanged fittings
- ASME B16.34 Valves – Flanged, threaded and welding end
- ASME B16.42 Ductile iron pipe flanges and flanged fittings
- ASME B16.47 Large diameter steel flanges

4.2.1 Updating of ASME code

Started with the 2013 edition of the Code, ASME will shift from a three-year cycle to a two-year cycle. These changes eliminate annual addenda. (Verbal interview, Starck, 2015)

Before year 2013 ASME BPVC was in use for three year period and after three years a new version came and replaced the old one. There was a posibility that during that three years' period major changes were done on BPVC. These changes were called addenda. Addendas are new versions of the code and a new version was first shown six months before it became effective. It is always mentioned in manufacturing documentation which addenda was used in manufacturing the products. This can affect still older ongoing projects even the ASME BPVC is changed to two year-cycle and annual addenda is no longer in use.

Picture 5. Example of addenda mention in ASME BPVC 2010 Addenda 2011. (Ojanpera 2013)

Current BPVC are from 2013 and it is now the effective code. There might be years when no changes come to current BPVC. In these cases there won't be new addenda. In that case the newest addenda is used. Picture 5 gives example of what kind marking is used to separate ASME addendas.

4.2.2 Code Case

In ASME's code cases give instructions for issues that ASME BPVC does not cover. These code cases normally are so called temporary solutions and if code cases are done well these cases will be added to new version of ASME BPVC. If the code case is added to newest version of ASME BPVC the code case will be cancelled. All active code cases are listed and can be read on ASMEs' homepage.

4.2.3 ASME Certificate of Authorization

ASME BPVC will require Certificate of authorization for all manufacturers, who are following the ASME BPVC when making their products. This certificate is like approval of manufacturing ASME BPVC products. When talking about ASME manufacturer it means the physical manufacturer of the equipment. There is also possibility for design stamp. This stamp gives the designer possibility to design pressure equipment that is according to ASME BPVC.

ASME certification of authorization is expected also from those manufacturers, which manufacture pressure vessels parts by welding. Parts according to the code like pipes or material manufacturing do not need ASME certification of authorization.

Official ASME manufacturing demands that the company has the following: (ASME training material, Purje, 2013)

- ASME norms in use as that scope current production demands
- ASME quality manual, where it is described how company fulfills current demands of production. Quality manual must be in English.
- Contract between AIA (Authorized Inspection Agency) and manufacturer.
- Design Calculation must be available
- Assurance that QC is performed
- Assurance that examinations are performed as required by the Code
- Arrange inspection and free access of the Inspector
- Complying with all of the applicable requirements of the Code

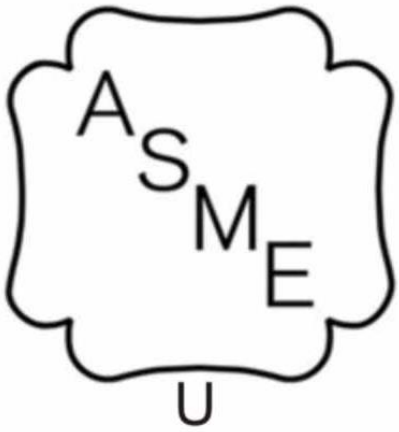
Of course only the ASME certification of authorization and the stamp is not enough for product safety. Final product will also be checked by AI. AI will check all manufactured pressure equipment. AI will do inspections also during manufacturing. AI will check the following things on final inspection:

- Visual inspections of the welds
- Pressure test

- Final checking of the documentation. This part includes materials and installation of the nameplate after AI has written the MDR.
- Product is designed according to specific ASME code for that product.
- Product is made according to ASME materials and ASME quality manual.
- Product will be checked according to ASME code.

If the product is accepted the products nameplate will be stamped with company's stamp see picture 6 and manufacturer will give written data report, that AI will accept and sign their own part of it.

Picture 6, ASME Stamp (Ojanpera 2013)



Picture 7, ASME Stamp with marking U (ASME stamp U)

It can be added under ASME stamp markings that indicates license scope. For example "U" can be used (in case of Pressure vessels Section VIII Division 1) see picture 7. It is possible that there is more than one marking under the ASME stamp. All markings are added under the previous marking or markings. Picture 8 gives information what kind of markings can be added under ASME stamp.

Picture 8, examples of old ASME stamps. (Ojanpera 2013)

4.2.4 Differences between ASME code and PED

The following table gives information on what kind of differences there are between ASME and PED in the manufacturing of pressure parts.

Table 2, ASME and PED differences.

	ASME	**PED**
Approved workshop	Needed (ASME Certificate of authority)	Not Needed
Quality Manual	Needed	Only on modules D, D1, E, E1, H, H1
Welding procedure and welders approval	Manufacturer According to ASME Section IX	3rd party inspector on categories' II, III and IV according to EN standards
NDE/NDT – inspectors approval	Manufacturer or NDE-company according to ASME code section V	3rd party inspector on categories' III, IV according to EN standard
Materials	ASME Section II or recertification	Harmonized product standard, PMA or EAM
Test reports / Material Certificates	Needed on plates. For many other material is needed only material norm based marking.	Needed EN10204 3.1 for pressure retaining parts on categories' II, III, IV other 2.2

There are significant differences between ASME and PED interpretation of materials. A list of the biggest differences between these two major standard and code is mentioned in table 3.

There is also a major difference between PED and ASME on standard units for use in equations and information. This can cause trouble when comparing the materials. For example temperature is indicated in ASME code in Fahrenheit and PED in degrees of Celsius.

Also a big difference that is good to realize between ASME and EN is way of marking material strength. In ASME the material strength is indicated as tensile strength, but in EN the yield strength is used. This kind of material strength indication is advantage for ASME materials, but closer look shows that the EN materials are normally better than ASME materials. The yield strength is more important to know than the tensile strength and the tensile strength is always higher than the yield strength.

There are also differences between PED and ASME BPVC hydrostatic test. On ASME section I the hydrostatic pressure test is done by 1, 5 *maximum allowed pressure this is done for all materials. On PED hydrostatic pressure test is done with higher of following two equations.
First option is 1, 43 * highest allowed pressure and second option is;

1, 25 * highest allowed pressure $*\frac{R_{p0,2\ 20}}{R_{p0,2\ t_C}}$. Normally this means posterior equation defines the PED boiler test pressure.

ASME Section I compared to EN12952 / PED on manufacturers' eyes is shown on table 4.

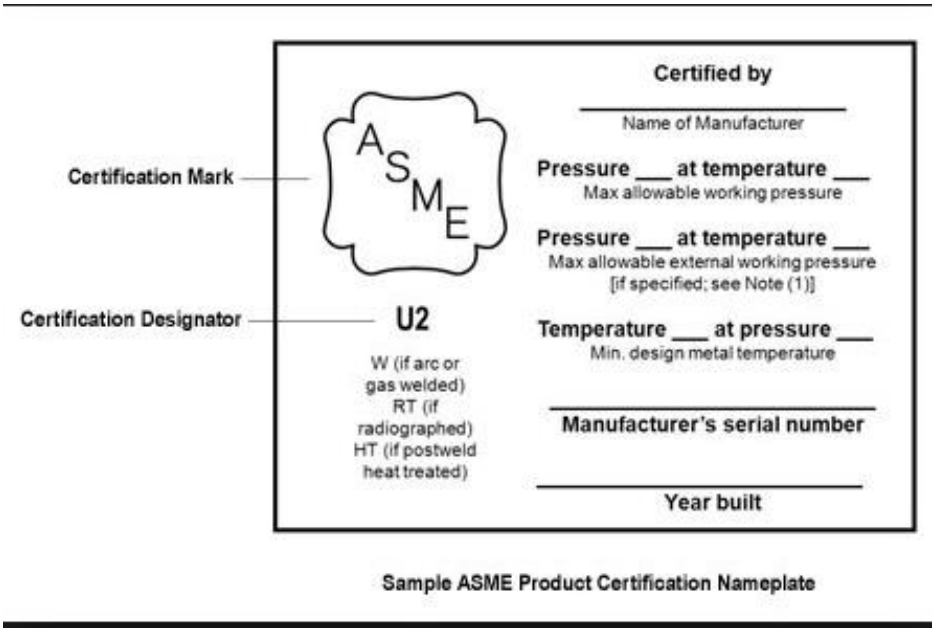
Table 3, ASME Section I compared EN12952 / PED on manufacturers' eyes.

	ASME Section I	**EN 12952**
Materials availability	Cheaper materials outside Europe. Chemical composition range can be wider.	According PED requirements (harmonized standard, PMA, EAM).
Materials range	Large selection of materials and better availability of steels (Not on European area)	More specified materials and tighter scope of materials
Quality manual / Quality system	Quality manual is needed for all manufactured products.	Quality manual is needed on specific modules.
Inspectors AI / NoBo	Specific (same) AI must be used on all workshop products.	More changes to choose notified bodies. Larger number of Notified Bodies.
Pressure Test	Simple pressure test. AI is involved.	More specific and tighter pressure test. NoBo is involved.
Weld qualification	Manufacturer is responsible for welders, welding methods and NDE inspectors Qualification.	Third party inspectors do NDT tests and approve welding methods. Welders are qualified with third party inspectors
Non-destructive examination / testing	Manufacturer can make own NDE test or subcontract NDE.	Third party isnpectors are involved on NDT tests.
NDE / NDT scope	Importance mainly on prefabrication and NDE scope is smaller	Focused on combination of manufacturing and NDT testing

4.2.5 ASME nameplate

ASME the nameplate is required for every pressure vessels just like PED. ASME has tight rules what kind nameplate shall be installed on pressure vessels and it is same kind on every pressure vessel. On PED nameplates there might be some extra information what is not required by PED. On ASME

nameplates there cannot be any extra information in the nameplate. In ASME AI will check the nameplate and in PED Notified Body does the inspection of it. Picture 9 shows an example of ASME nameplate and what information is required of pressure vessels nameplate.



Picture 9, Example of an ASME nameplate. (Purje 2013)

4.2.6 National Board of Boiler and Pressure Vessel Inspectors

National Board (NB) was established in 1919. The purpose of NB was to harmonize laws of manufacturing and inspecting the pressure vessels in America.

NB members are chief inspectors of various cities, USA states and Canadien provinces. Members of NB are in responsible of management and implementation of laws. NB has three main goals. Those goals are one code, one inspector and one stamp. (ASME Training material, Ojanpera, 2013)

In the USA and Canada registration of the pressure vessel is required. There are couple of exceptions, but normally all pressure vessels must be registered. If pressure vessel is meant to be used in USA or Canada it must be stamped correctly, manufactured and inspected by applicable part of BPVC section. Only in USA and Canada ASME stamp is required. Elsewhere ASME stamp can be used, but it is not required. Outside USA and Canada ASME Code can be used by applicable parts. This is allways marked in contract and area of usage is discussed with the customer.

4.3 Use of ASME

ASME can be used for all pressure vessels and parts from engineering to manufacturing. Before project starts it is very important to make sure what the ruling standards are and what need to be fulfilled in project. ASME Boiler and Pressure Vessel Code is used worldwide when manufacturing recovery or power boiler. ASME can be only ruled out when manufacturing boilers in Europe or Russia. Normally these codes and standards are not used on project simultaneously, but there have been a couple of special projects where customers wanted some parts to be manufactured with ASME and some with PED or EN standard.

In every project before the project starts it has been clear what standard or code must be fulfilled. Normally ASME is used mainly outside Europe and Russia. But ASME and PED can be used together in some cases. In this kind of cases it is very hard to draw a line where ASME code is used and where PED or EN standard is ruling. This should be done very precisely when doing the scope of equipment and power piping. If there are chances for misunderstandings they'll probably happen and make whole project more and more difficult and more expensive.

Normal cases PED and ASME are not used simultaneous and project has either one of PED or ASME. It cannot be said which one is better ASME BPVC or PED but ASME is used on larger geographic area. So these countries which are not so industrialized countries may use easier ASME BPVC than PED. Every country's own laws demand the use of a specific code or standard when manufacturing power- and recovery boilers.

4.4 ASME with stamp

ASME registration for power- or recovery boiler requires the following:

- Responsibilities for power- or recovery boiler manufacturer
    - Design documents including calculations, specifications and drawings must be reviewed and approved by AI. This review must be attested to by dated signatures in the design documents.
    - All pressure parts will be fabricated by subcontractors with Certificate of Authorization applicable to their scope of supply.
        - Manufacturer's Data Report
        - All Manufacturer's Data Reports to Boiler manufacturer's AI
    - The Master Data Report Form P-3A to boiler manufacturer's AI for his review and approved
        - AI shall sign the Master Data Report including his commission number and applicable endorsement

- Responsibily of erection company
    - Erection by contractor with Certification of Authorization to their scope of supply.
    - Erection Company AI must sign the Master Data Report including his commission number and appliance endorsement.

- Final ASME stamp
    - Boiler manufacturer and erection company stamp holder will stamp boiler name-plates

- Customer registrates the boiler to official ASME register

4.5 ASME Boiler and Pressure Vessel Code and the code objects for power- and recovery boilers

When using ASME Boiler and Vessel Code, the equipment where code is included listed below. Every one of following equipment needs to follow rules of ASME BPVC when these parts are under manufacturing or design. Next list shows only main parts that are according to ASME BPVC. There is also example after every equipment type. Equipment and vessels on power and recovery boilers are following:

- Boiler pressure parts, for example boiler walls
- Steam drum
- All tanks where pressure is higher than 1,0 bar. for example feed water tank
- Pipings
- Coolers, for example flue gas cooler
- Heat exchangers, for example primary air heat exchangers
- Valves and fittings, for example Safety valves
- Some AEI instruments, for example pressure indicators

In ASME BPVC all manufacturing and engineering should be tightly supervised. Every equipment that is mentioned above requires Manufacturer's Data Reports. Without MDR it is impossible to get final approval for boiler.

4.6 ASME Quality system requirements

ASME quality system for requires recovery- and power boiler documentation some specific requirements.

Final documentation, stamping and storing time of the documents requires the followings: (ASME Training material, Tolppanen, 2012)

- It must be described what is included in the final documentation
- Storing time of the final documentation must be defined
- Stamping procedures must be described
- Writing of Manufacturer's Data Reports
- There should be a log for AI

Co-operation with the AI affects in the following ways: (ASME Training material, Tolppanen, 2012)

- AI has to have access all time to the manufacturing workshop where the pressure parts are manufactured
- There shall be a written contract with AI and supplier
- Changes of ASME quality manual shall be approved with the AI
- AI must have access to final quality documentation all the time
- Before pressure vessel or part can be stamped there shall be AIs' permissions to do stamping
- AI will sign the Manufacturer's Data Report
- Placing the nameplate to the pressure vessel

There are specific duties that quality organization should fulfill when doing ASME projects. It is listed some of the duties. Most of the duties are responsibility of quality manager, quality assurance managers or in some cases quality engineers' duties: (ASME Training material, Tolppanen, 2012)

- ASME quality manual is updating and management
- Quality system training and introduction
- Ordering and organization of the ASME certification (National board and AI)
- ASME documentation management
- Making inspection and test plans for project
- Collecting of the Manufacturer's Data Reports from suppliers and writing own part of these
- Doing the stamping on nameplates
- Responsibility of preparation and presentation of the final documentation to the AI
- Communication with the AI
- ASME based quality manual actions year controlling with AI
- Audition with the organization
- Continuing the ASME certification every three years
- Controlling of the deviations, repair and preventing actions
- Monitoring actions that are demanded on ASME quality manual
- Monitoring of the suppliers and sub supplier

5 EFFECTS OF ASME ON QUALITY DOCUMENTATION COMPARED TO PED

ASME has effect on quality documentation and there are many similarities to PED requirements. Both ASME and PED have their own specialies. It is listed more specialties and effects to the quality documentation.

The biggest effect on quality documentation is MDR and especially AI's certificate of shop inspection. In ASME case certificate of shop inspection is in same documentation as MDR. There are also several types of MDRs. Selection of MDR depends on what is the vessel or pressure part's role and what kind work that part is doing. In PED Manufacturer's declaration and NoBo certificate of conformity are needed. These two documents can be compared to MDR on ASME case. PED requires two documents where as ASME requires only one document, which has more parts for needed information. In attachment 1 there is an empty MDR form that shall be filled with manufacturer.

Next are listed most important differences in MDR Forms. There is also the guidance of reading the MDR included in list below;

Form U in Manufacturer's Data Report is for pressure vessels like tank and pressurized heaters and coolers. Form P is for boiler pressure parts like economizers, high pressure piping and for the boiler. Form P can also be separate to different parts.

Manufacturer's Data Report has a part for certificate of shop inspection. In that part for certificate there is a spot for marking pp or s. S means pressure part and pp is for pressure piping. This certificate of shop inspection is all'ways written in ASME certified manufacturing workshop by AI after final inspections and pressure test.

ASME Manufacturer's Data Report can and will be written in sections. First the manufacturer write his own section where the product is specified and then sign the certificate of shop compliance and after that AI writes their section. This is different to PED where manufacturer writes his own declaration of conformity and Notified body will check the product and write their own certificate of conformity. Manufacturer declaration must have reference to notified body's certificate of conformity in case of PED.

This is the biggest difference between ASME code and PED. In ASME there is single Manufacturer's Data Report, what contains different sections and I PED there are normally two different certificates that are needed, but these requirements depend on what module is used. In PED there is also a wider range of what kind of manufacturer's declaration is written. Also every NoBos' has its own certificate forms. There are no any specific documents or certificates for these two PED required documents. PED only gives minimum requirements for information needed. Some manufacturers give some extra information on what are not requirements of PED and this is allowed. In ASME the MDR

is demand and there can be only one right report and manufacturers and AI cannot change it afterwards.

5.1 Manufacturer's Data Report

ASME gives demands on what is needed. The biggest difference is third party inspector's use in workshops when manufacturing PED standard or ASME code parts or vessels. PED gives here opportunity to choose more freely the inspector than ASME, because ASME has their own organization that trains AI. PED doesn't have specific organization for training and accredited NoBos train inspectors themselves. New PED defines more strictly duties of Notified bodies and this is a big improvement to old PED which allows the existence of unqualified NoBos.

MDR is the most important document in ASME projects, see attachment 1. It must always be written and without MDR it is impossible to get approval for pressure vessel of any kind. There are different kinds of MDRs' forms for different kind of pressure vessels. In ASME BPVC it is defined what kind of MDR form is used In specific pressure vessels. There is MDR specific information on what is needed on MDR. See attachment 1 for more information. In MDR form upper right corner there is a spot where AIs' markings like name and signature can be found. This is on every page of the MDR. MDR is two sided, but depending on form there might be more than two pages and this why it is important that AIs' signature is on every page of MDR. Manufacturer fulfills the important information of their product and also writes the required information in MDR. See attachment 1 for more examples of MDR. Customer's name must be mentioned in MDR. The idea is that without any other documents AI and customer can have important information just by looking at the MDR. This part includes for example dimensions of pressure vessel and traceability of the vessel (manufacturing number, year of built, drawing number for example). In MDR it is important that the ASME code used is mentioned and clearly marked in required field. In MDR there is a specific spot where the type of the pressure vessel is mentioned. There is specific information for vessel parts like the material used and locations of specific parts in vessels like flanges for example. It is important that MDR has a mention of pressure test. There are also spots for marking Manufacturer's Partial Data Reports that have an effect on the product of current MDR. In MDR there is a part for remarks where it is mentioned for example if there was any additional information that is not mentioned elsewhere in MDR. After this specific data of pressure vessels, there is a part for manufacturer's signatures and date where the manufacturer verifies that their product fulfills ASME's demands. This part of MDR is called Certificate of shop compliance. Next and last part that is fulfilled in workshop is Certificate of shop inspection. This part is completely written by AI and it is written after the pressure test and just before releasing the pressure vessel for shipping. in this part AI verifies that he or she has license to do inspection and that AI have approved the pressure vessel and that pressure vessel fulfills the requirements demanded in ASME BPVC. There is part in MDR form that is fulfilled on site when the pressure vessel is installed. Installer fulfills this part and verifies that field assembly is done propertly by signing the document. This part is called Certificate of filed assembly compliance.

The last part is called Certificate of field assembly inspection. This specific part is written last of MDR and it is written when AI comes and approves that field assembly for pressure vessel is done properly and pressure vessel works correctly on construction site. AI signs this document. After all these phases MDR is complete.

There are lots of different kinds of Manufacturer's Data Reports. Next it is listed forms on BPVC Section 1. MDRs that can be used on manufacturing the boiler or pressure parts: (ASME Manufacturer's Data Report forms, refer 29.7.0215)

- III-1A Certificate of Conformance for Reapplication of the Certification Mark
- P-2 Manufacturer's Data Report for Types of Boilers Except Watertube and Electric
- P-2A Manufacturer's Data Report for All Types of Electric Boilers
- P-2AM Manufacturer's Data Report for All Types of Electric Boilers Metric
- P-2B Manufacturer's Data Report for Electric Superheater and Reheaters
- P-2BM Manufacturer's Data Report for Electric Superheater and Reheaters Metric
- P-2M Manufacturer's Data Report for All Types of Boilers Except Watertube and Electric Metric
- P-3 Manufacturer's Data Report for Watertube Boilers, Superheaters, Waterwalls and Economizers
- P-3A Engineering-Contractor Data Report for a Complete Boilers Unit
- P-3AM Engineering-Contractor Data Report for Complete Boiler Unit Metric
- P-3M Manufacturer's Data Report for Watertube Boilers, Superheaters, Waterwalls and Economizers
- P-4 Manufacturer's Partial Data Report
- P-4A Manufacturer's Data Report for Fabricated Piping
- P-4AM Manufacturer's Data Report for Fabricated Piping Metric
- P-4B Manufacturer's Data Report for Field Installed Mechanically Assembled Piping
- P-4BM Manufacturer's Data Report for Field Installed Mechanically Assembled Piping Metric
- P-4M Manufacturer's Data Report Metric
- P-5 Summary Data Report for Process Steam Generators Revised
- P-6 Manufacturer's Data Report for Supplementary Sheet
- P-7 Manufacturer's Data Report for Safety Valves
- P-7M Manufacturer's Data Report for Safety Valves Metric
- P-8 Manufacturer's or Assembler's Certificate of Conformance for Pressure Relief Valves
- P-8M Manufacturer's or Assembler's Certificate of Conformance for Pressure Relief Valves Metric

Forms on BPVC Section VIII Division 1

- 26-1 Specification Sheet for ASME Section VIII. Div. 1 Appendix 26 Bellows Expansion Joints
- 26-1 Specification Sheet for ASME Section VIII. Div. 1 Appendix 26 Bellows Expansion Joints Metric

- QEXP-1 Tube Expanding Procedure Specification (TEPS)
- QEXP-2 Suggested Format for Tube-To-Tube sheet Expanding Procedure Qualification Record for Test Qualification (TEPQR)
- U-1 Manufacturer's Data Report for Pressure Vessels
- U-1A Manufacturer's Data Report for Pressure Vessels (Alternative Form for Single Chamber, Completely Shop- or Field-Fabricated Vessels Only)
- U-1B Manufacturer's Supplementary Data Report for Graphite Pressure Vessels
- U-2 Manufacturer's Partial Data Report
- U-2A Manufacturer's Data Partial Report (Alternative Form)
- U-3 Manufacturer's Certificate of Compliance
- U-3A Manufacturer's Certificate of Compliance (Alternative Form)
- U-4 Manufacturer's Data Report Supplementary Sheet
- U-5 Manufacturer's Data Report Supplementary Sheet Shell- and Tube Heat Exchangers
- UD-1 Manufacturer's Certificate of Conformance for Rupture Disk Devices
- U-DR-1 User's Design Requirements for Single- Chamber Pressure Vessels
- U-DR-2 User's Design Requirements for Multi- Chamber Pressure Vessels
- UV-1 Manufacturer's or Assembler's Certificate of Conformance for Pressure Relief Valves

5.2 Guidelines for the required documents

Guidelines for quality documentation are following the same frames on ASME projects as projects where PED is used. Even the frames have almost the same content. There are some differences in names of needed documents and documents forms.

The required documents are defined in purchasing phase. Different kind of parts require different documents. Always one document is required and that document is Manufacturer's Data Report. That document is important to the manufacturer of the whole boiler, because with that document part manufacturer liability starts and boiler manufacturer is not completely responsibilety of all boiler parts. Also document is important to AI. Without that document it is impossible to get authorities approval to current part or vessel. The content of MDR is more accurately specified in previous chapter General documentation requirements.

Next important document is certificate of shop inspection which is one section of MDR. In PED the similar document is Certificate of conformity which is written by NoBo. The manufacturer of the boiler has nothing to do with creating of this document. Both ASME and PED vessels which are under or equal to 1,0 bar on ASME and 0,5 bar in PED require only manufacturer's declaration.

The rest of the needed documents is not put in any order from important to less important. Next is listed rest of the documentation and briefly told content of those documents. All of the documents are important, but those mentioned next are less important than MDR.

In all projects the drawings need to be approved in ASME cases by AI and PED by Notified Bodies. In ASME case approving of the drawing is so called hold point before the drawings are approved by AI the project cannot continue and manufacturing of the products cannot start.

Welder's qualification is important and this is normally well reported and AIs and NoBos accept these documents. In pressure vessels there must always be welders who have qualification to do all welds. Without welders who have qualification it is impossible to get certificate of conformity from AI or in PED cases from Notified body.

Welders need to have WPS based on to PQR / WPQR to perform welding. These two documents are foundation of welding so AI / NoBo is interested in these documents.

Material test reports in ASME and material certificates in case of PED are needed for every part even parts without pressure. MTR are important because with those certificates it is possible to trace faulty material and avoid more possible faults. Every steel factory gives heat number and material test report or material certificate number for their products. Steel manufacturers have their own format to material test reports, but they should have the same information included anyway, because there isn't a common format, they can be hard to read sometimes. Material certificates are very important and after manufacturer's declaration and certificate of conformity in PED or ASME case Manufacturers Data Report including all its parts are the most important certificates. There can be material test report and material certificate in same material certificate on materials that fulfills the requirements of both ASME and PED/EN. More of material certificates in next chapter.

Next part is hot and cold forming. Hot and cold forming is extremely rarely reported when manufacturing pressure vessels. When manufacturing piping, hot and cold forming reports are more commonly used. These certificates are only needed when base material is changed enough. These certificates are only for metals. Both ASME and PED require this certificate when hot- and cold forming is used.

100% Visual inspection of welds is needed next. This is always needed in both ASME and PED. All welded parts need this kind of inspection. Normally welds in pressure parts need 100% visual inspection. AI needs to see these reports before writing the MDR. Notified Bodies are interested that these documents are found in pressure parts in case of PED.

Non-Destructive Examination called also NDE is important for some parts. For example tanks need non-destructive examination. These examinations are made by manufacturer or third party inspectors in ASME and in PED these non-destructive tests are done by third party inspectors.

Next is destructive testing. Destructive testing or DT is extremely rarely used in the case of ASME. PED/EN DT is sometimes demanded.

Post Weld Heat Treatments is used in specific metals. PWHT is required on thick alloyed materials. PWHT is used in both cases ASME and PED.

Dimensional inspection (functional as built to drawings) is used both in ASME based projects and PED projects. This demand is normally given by customer in normal pressure vessels and other parts that are under pressure. ASME or PED do not require this document for final approval for pressure vessels.

Surface treatment inspections are in use in both projects ASME and PED. This is not required for every part, but final customer and manufacturer of boiler are interested in these certificates. AI or Notified Body is not interested in these documents.

Hydrostatic testing is needed and AI and Notified Bodies need these test reports for final approval of boiler. These are really important documents. I get back to this in next chapter. Testing can be done for single vessels or larger groups for example parts of piping and tanks. This is always made by notified body in PED or AI in ASME case. On ASME case it is impossible to get pressure vessel to customer if the AI haven't witnessed the test and given approval.

Non-conformity reports are in demanded by both projects ASME and PED. This is needed every time when something does not go as planned and deviations need to be corrected. These reports need to show AI / NoBo for customers. It is optimal situation that there is not a single one of those in projects, but there will always be these for sure.

Final Inspection is needed for all pressure parts for both ASME and PED. This inspection is made with AI on ASME projects and Notified Body in case of PED. This is needed to get final approval for boiler.

Next are listed ASME BPVC requirements in boiler projects. First certificate of shop compliance is required for every pressure part manufactured and used in ASME based boiler projects. Certificate of shop compliance is a needed document for AIs final approval. Second important document in ASME based projects is certificate of shop inspection. That document is section on Data Report / Partial Data Report acc. ASME code (in case of Stamp). Completely filled MDR is most important for every pressure equipment in ASME projects. Without these it is impossible to get AI approval for whole boiler.

5.3 Document content and its importance for boiler manufacturer

ASME and PED both require only a few different documents; Manufacturer's Data Report on ASME and manufacturer declaration and Certification of conformity on PED. ASME doesn't like PED require manuals in target country's original language or some cases languages. Normally manuals are required also in English. In ASME case Manufacturer's Data Report is required and PED Manufactur-

er's declaration and certificate of conformity by Notified Body is required. With these documents the supplier fulfills the requirements of ASME and PED. Many big companies also require more documentation and these terms must be mentioned in the contract. Because those can't be demanded afterwards, or can but it will cost much more. Sometimes the manufacturer does not even deliver the needed "extra" documents if it is not on contract demands.

In the following there are all documents that are required to get for manufacturers in power- or recovery boiler projects. Next a stand is taken on ASME based demands and PED or EN similar demands only mentioned as general information.

First operation manuals are mentioned. This is not ASME based demand, but it is required by boiler manufacturer. In PED operation manuals are required even without mention in contract. These manuals are not included in quality documents and that's why these are not mentioned in earlier requirements.

The first required quality document is naturally Manufacturer's Data Report. There are no exceptions to that.

Next are listed demands for boiler manufacturer's documentation:

1. Manufacturer's Data Report and manufacturer's certification
   MDR is an important document of this section, but there are more certificates too. Like ITP (inspection and test plan) is a required document. Also authorized personnel's documents are required in this section. This means that inspectors and other members of personnel are informed by ITP how the testing is performed and certified. Those certificates are part of manufacturer's certification.

2. Certificate of shop inspection or Certification of conformity
   This part is included in MDR in ASME projects. Other documentation contains mainly in ASME BPVC projects type approval certificates and important photographs in manufacturer's nameplate with ASME stamp. PED requires also pictures of nameplate with CE-marking and other documents that refer to EC Directives.

3. List of drawings. This part of documentary contains lists of all necessary drawings for evaluation of the documentation. This demand is the same in PED / EN projects too. The demand comes only for the customer or manufacturer of the boiler. ASME or PED/EN does not demand these.

4. Next are test records for pressure and (or) tightness. These documents must be available for AI (boiler manufacturer) if the AI wants to look at these when trying to have approval for boiler. These MDR are of course AI approved earlier in manufacturing phase. Pressure and tightness test reports will be made in ASME projects by AI, but in PED / EN the test needs to be done by notified body. These are normally demanded in ASME projects and PED cases too these must be part of final documentation.

5. ITP or inspection and test plan are required in power- and recovery boiler projects. ITP must be completely filled out and this document must be included in final quality documentation. These demands are in both projects.

6. AS-Built drawings must be a part of final quality documentation. All drawings must be originals and if there had been any changes the changed drawings with red pen markings should be included. These are important documents and AI will approve all pressure part drawings in ASME projects. Notified Body is responsible for approval on PED projects.

7. Welding and laminations documentation contains all welding and heat treatment plans and reports, lists of WPS and PQRs' welders and also laminations and corresponding material certificates. These documents are inspected by customer and AI or PED cases notified bodies. Important when tracking the welding procedures and welders. In ASME there must be the same welders if some changes are made to the pressure vessel. This can be a problem if the welders are not good enough. But normally the product is checked and approved in workshop and there is no need to do any repairs or changes on site. If there is need to do those changes AI must be involved in this kind of actions. Of course site repairs or changes cost very much and therefore they are not done easily. Cost is about ten times compared to the workshop costs.

8. Material test reports or material certificates. Even though the material certificates are not in ASME or PED requirements, these certificates are always demanded by customer. It is possible to follow the faulty material with material test reports or material certificates. Material certificates are very important. In my opinion after ASME and PED required documents they are the most important documents. In normal cases these are not needed, but if something goes wrong material test reports or material certificates will become important. In ASME cases there is much information on materials, but shortly said ASME materials are not good as PED / EN required materials. In ASME materials are normally demanded on contract and material test reports must be according to the ASME Sec II.

   There should be also a list of the materials and also a list of filler materials and corresponding. Also the hot and cold forming reports and inspection records are part of material certificates. Hot and cold forming reports and inspection records are also important and part of Material certification section.

9. Non-destructive examination records contain all records of NDE examinations / NDT testing. Normally these tests are specified in ITP and more specific in welding and inspection plan. Non-destructive examinations are tests that do not break any material or harm the products. This NDE is according to ASME Sec V. There must be reports of every NDE. Also NDE inspectors' certificates are required. These inspectors need to be ASME qualified and approved.

10. Destructive testing record must be all records of destructive testing what are mentioned in ITP and contract if there are any. These DT are extremely rare. These are as important as NDE

records. Unlike NDE destructive testing will break materials. Also certificates for those who have done testing are needed.

11. Heat treatment plans & records contain all the heat treatment plans, records and charts. This covers test pieces too and are normally demanded by customer.

12. Dimensional and system inspection records. This section contains all protocols of dimensions and alignment checks, system inspection reports. These should be specified in ITP. Tests that are in this section are balancing- vibration- and performance test reports. These reports and certificates will be part of final quality documentation.

13. Surface treatment and corrosion protection records contain surface treatment and / or corrosion protective data sheets and thickness measurement records. This should be mentioned on ITP. These documents are part of final documentation. These are not always required in ASME or PED projects.

14. Non conformity reports or NCRs are made every time needed. Shortly every time something goes wrong there must be a NCR for that. These NCRs are checked by AI. It is normal that these NCRs are included in projects.

15. Record of final and system inspection records. These documents are a big part of final documentation. These are made with AI during final inspection. AI signs these final inspection documents and after signing these records cannot be questioned anymore. This same rule is in PED with Notified bodies.

16. Last but not least is the release note. Release note is a certificate that indicates that the manufacturer or representative has made needed inspections and released items for shipping to the site.

6 CONCLUSIONS

ASME code is a good choice for those countries that don't have their own pressure vessel standards. This is especially because ASME code can be used with applicable parts and it can be suited for a specific project just like the customer wants. ASME is also written in English and that will help. Even if ASME materials have better availability outside Europe it is safer to use similar EN materials because normally EN materials are better.

Many people think that ASME code is hard to use and some parts of ASME are oldfashioned and outdated. That is correct. If code or standard can be chosen, then it is better to use PED than ASME. PED/EN standards are more precise, it is easier to use better materials and there is a wider range of inspectors just a few facts to mention.

In multinational company it is good to have instructions for way of using ASME in quality documentation. That's now fulfilled and I hope that this thesis will help those who need guidance with ASME quality documentation.

There were lots of problems to keep this subject together. ASME based quality documentation guidelines for power- and recovery boilers is a huge subject and there are lots and lots of points that need to be taken into accont. However this final thesis is taking care of every important part of ASME effects on quality documents on power- and recovery boilers. In my opinion this thesis gives a relatively clear insight into the topic.

ASME is a really large subject and I had much work to figure out how I can clarify this subject to people who have never heard about how ASME effects on the quality documentation. That's why I have taken PED into this thesis to help understand ASME effects and what differences there are between these two major codes and directives. This thesis is easy to read even without earlier knowledge of PED

In my opinion this thesis gives very a thorough idea about quality documentation in power- and recovery boilers and also guidelines concerning power- and recovery boilers and progress of projects.

I really enjoyed doing this final thesis and I learned much more about ASME during the thesis process.

6.1 Consideration of the thesis

This thesis was very hard to do, because PED is used in Europe and therefore ASME is not so well-known. It helped me very much that I worked with ASME projects at the same time when this thesis was done and I got needed information for the ASME project. Biggest help to me were two ASME specialists Mr Petteri Puranen who was the supervisior of my thesis and Mr Tuukka Starck who gave

me a lot of important advice for my thesis. This report is only backround work of my real goal and rest of my final thesis is classified as confidental so not be shown on this report.

The thesis will give needed infomation for good quality documentation. The thesis also gives good content for final quality documentation. This thesis will give ASME based quality documentation guidelines for power- and recovery boilers.

The important part of my thesis was MDR. This document is the most important one in ASME projects and the importance of it can't be questioned.

I think that it will be easier to understand the content, if I enclose PED/EN to this thesis. I compare PED/EN and ASME to get a clear picture. Comparing also gives a wider basis for good quality documentation.

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ATTACHMENT 1: EXAMPLE OF MANUFACTURER'S DATA REPORT U-1

ATTACHMENT 2: EXAMPLE OF MANUFACTURER'S PARTIAL DATA REPORT U-2

ATTACHMENT 3: PRESSURE EQUIPMENT DIRECTIVE 2014/68/EU CLASSIFICATION AND CONFORMITY ASSESSMENT

ATTACHMENT 1

National Board Number: _____

Mfr. Representative: _____ Date: _____

Authorized Inspector: _____ Date: _____

FORM U-1 MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by _____
(Name and address of Manufacturer)

2. Manufactured for _____
(Name and address of Purchaser)

3. Location of installation _____
(Name and address)

4. Type _____ (Horizontal, vertical, or sphere) _____ (Tank, separator, jkt. vessel, heat exch., etc.) _____ (Manufacturer's serial number)

_____ (CRN) _____ (Drawing number) _____ (National Board number) _____ (Year built)

5. ASME Code, Section VIII, Div. 1 _____ [Edition and Addenda, if applicable (date)] _____ (Code Case number) _____ [Special service per UG-120(d)]

Items 6–11 incl. to be completed for single wall vessels, jackets of jacketed vessels, shell of heat exchangers, or chamber of multichamber vessels.

6. Shell: (a) Number of course(s) _____ (b) Overall length _____

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time

Body Flanges on Shells

									Bolting			
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material

7. Heads: (a) _____ (Material spec. number, grade or type) (H.T. — time and temp.) (b) _____ (Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)														
(b)														

Body Flanges on Heads

									Bolting			
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
(a)												
(b)												

8. Type of jacket _____ Jacket closure _____ (Describe as ogee and weld, bar, etc.)

If bar, give dimensions _____ If bolted, describe or sketch.

9. MAWP _____ (Internal) _____ (External) at max. temp. _____ (Internal) _____ (External) Min. design metal temp. _____ at _____.

10. Impact test _____ [Indicate *yes* or *no* and the component(s) impact tested] at test temperature of _____.

11. Hydro., pneu., or comb. test pressure _____ Proof test _____

Items 12 and 13 to be completed for tube sections.

12. Tubesheet _____ [Stationary (material spec. no.)] _____ [Diameter (subject to press.)] _____ (Nominal thickness) _____ (Corr. allow.) _____ [Attachment (welded or bolted)]

_____ [Floating (material spec. no.)] _____ (Diameter) _____ (Nominal thickness) _____ (Corr. allow.) _____ (Attachment)

13. Tubes _____ (Material spec. no., grade or type) _____ (O.D.) _____ (Nominal thickness) _____ (Number) _____ [Type (straight or U)]

National Board Number: _____

Mfr. Representative: _____ Date: _____

Authorized Inspector: _____ Date: _____

FORM U-1 (Cont'd)

Items 14–18 incl. to be completed for inner chambers of jacketed vessels or channels of heat exchangers.

14. Shell: (a) No. of course(s) _____ (b) Overall length _____

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time

Body Flanges on Shells												
									Bolting			
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material

15. Heads: (a) _____ (b) _____
(Material spec. number, grade, or type) (H.T. — time and temp.) (Material spec. number, grade, or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)														
(b)														

Body Flanges on Heads												
									Bolting			
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
(a)												
(b)												

16. MAWP _____ _____ at max. temp. _____ _____ Min. design metal temp. _____ at _____ .
(Internal) (External) (Internal) (External)

17. Impact test _____ at test temperature of _____ .
[Indicate *yes* or *no* and the component(s) impact tested]

18. Hydro., pneu., or comb. test pressure _____ Proof test _____

19. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	

20. Supports: Skirt _____ Lugs _____ Legs _____ Others _____ Attached _____
(Yes or no) (Number) (Number) (Describe) (Where and how)

21. Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report (list the name of part, item number, Manufacturer's name, and identifying number):

22. Remarks

National Board Number: _____

Mfr. Representative: _____ Date: _____

Authorized Inspector: _____ Date: _____

FORM U-1 (Cont'd)

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

U Certificate of Authorization Number _____ Expires _____

Date _____ Name _____ (Manufacturer) Signed _____ (Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by _____ of _____ have inspected the pressure vessel described in this Manufacturer's Data Report on _____, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ Signed _____ (Authorized Inspector) Commissions _____ (National Board (incl. endorsements))

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the statements in this report are correct and that the field assembly construction of all parts of this vessel conforms with the requirements of ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. U Certificate of Authorization Number _____ Expires _____ .

Date _____ Name _____ (Assembler) Signed _____ (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by _____ of _____, have compared the statements in this Manufacturer's Data Report with the described pressure vessel and state that parts referred to as data items _____, not included in the certificate of shop inspection, have been inspected by me and to the best of my knowledge and belief, the Manufacturer has constructed and assembled this pressure vessel in accordance with the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. The described vessel was inspected and subjected to a hydrostatic test of _____. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ Signed _____ (Authorized Inspector) Commissions _____ (National Board (incl. endorsements))

ATTACHMENT 2

National Board Number: _____

Mfr. Representative: _____ Date: _____

Authorized Inspector: _____ Date: _____

FORM U-2 MANUFACTURER'S PARTIAL DATA REPORT

A Part of a Pressure Vessel Fabricated by One Manufacturer for Another Manufacturer

As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by _____
(Name and address of Manufacturer)

2. Manufactured for _____
(Name and address of Purchaser)

3. Location of installation _____
(Name and address)

4. Type _____ _____ _____
[Description of vessel part (shell, two-piece head, tube bundle)] (Manufacturer's serial number) (CRN)

_____ _____ _____ _____
(National Board number) (Drawing number) (Drawing prepared by) (Year built)

5. ASME Code, Section VIII, Div. 1 _____ _____ _____
[Edition and Addenda, if applicable (date)] (Code Case number) [Special service per UG-120(d)]

Items 6–11 incl. to be completed for single wall vessels, jackets of jacketed vessels, shell of heat exchangers, or chamber of multichamber vessels.

6. Shell: (a) Number of course(s) _____ (b) Overall length _____

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time

Body Flanges on Shells												
									Bolting			
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material

7. Heads: (a) _____ (b) _____
(Material spec. number, grade or type) (H.T. — time and temp.) (Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)														
(b)														

Body Flanges on Heads												
									Bolting			
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
(a)												
(b)												

8. Type of jacket _____ Jacket closure _____
(Describe as ogee and weld, bar, etc.)

If bar, give dimensions _____ If bolted, describe or sketch.

9. MAWP _____ _____ at max. temp. _____ _____ Min. design metal temp. _____ at _____.
(Internal) (External) (Internal) (External)

10. Impact test _____ at test temperature of _____.
[Indicate *yes* or *no* and the component(s) impact tested]

11. Hydro., pneu., or comb. test pressure _____ Proof test _____

Items 12 and 13 to be completed for tube sections.

12. Tubesheet _____ _____ _____ _____ _____
[Stationary (material spec. no.)] [Diameter (subject to press.)] (Nominal thickness) (Corr. allow.) [Attachment (welded or bolted)]

_____ _____ _____ _____ _____
[Floating (material spec. no.)] (Diameter) (Nominal thickness) (Corr. allow.) (Attachment)

13. Tubes _____ _____ _____ _____ _____
(Material spec. no., grade or type) (O.D.) (Nominal thickness) (Number) [Type (straight or U)]

National Board Number: _____

Mfr. Representative: _____ Date: _____

Authorized Inspector: _____ Date: _____

FORM U-2 (Cont'd)

Items 14–18 incl. to be completed for inner chambers of jacketed vessels or channels of heat exchangers.

14. Shell: (a) No. of course(s) _____ (b) Overall length _____

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time

Body Flanges on Shells

									Bolting			
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material

15. Heads: (a) _____ (b) _____
(Material spec. number, grade, or type) (H.T. — time and temp.) (Material spec. number, grade, or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)														
(b)														

Body Flanges on Heads

									Bolting			
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
(a)												
(b)												

16. MAWP _____ (Internal) _____ (External) at max. temp. _____ (Internal) _____ (External) Min. design metal temp. _____ at _____ .

17. Impact test _____ at test temperature of _____ .
(Indicate *yes* or *no* and the component(s) impact tested)

18. Hydro., pneu., or comb. test pressure _____ Proof test _____

19. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	

20. Identification or part(s)

Name of Part	Quantity	Line No.	Mfr's. Identification No.	Mfr's. Drawing No.	CRN	National Board No.	Year Built

21. Supports: Skirt _____ (Yes or no) Lugs _____ (Number) Legs _____ (Number) Others _____ (Describe) Attached _____ (Where and how)

22. Remarks

National Board Number: _____

Mfr. Representative: _____ Date: _____

Authorized Inspector: _____ Date: _____

FORM U-2 (Cont'd)

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements in this report are correct and that all details of material, construction, and workmanship of this pressure vessel part conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

U Certificate of Authorization Number _____ Expires _____

Date _____ Name _____ (Manufacturer) Signed _____ (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by _____ of _____ have inspected the pressure vessel part described in this Manufacturer's Data Report on _____, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ Signed _____ (Authorized Inspector) Commissions _____ [National Board (incl. endorsements)]

(08/14)

ATTACHMENT 3

Lloyd's Register Energy

Working together for a safer world

Pressure Equipment Directive Category and Module Decision Flowchart

97/23/EC transitioning to 2014/68/EU

NOBO IDENTIFICATION NO.
0038

START → Maximum allowable pressure greater than 0.5 bar? Yes → Equipment excluded from PED: Art. 1.3? No → Determine type of Pressure Equipment

X, Y and Z are entry points for pressure accessories and/or assemblies

Maximum allowable pressure greater than 0.5 bar? No → PED does not apply

Equipment excluded from PED: Art. 1.3? Yes → PED does not apply

VESSEL
Determine state of fluid contents ← X
Gas → Determine fluid group* → Group 1: Table 1; Group 2: Table 2
Liquid → Determine fluid group* → Group 1: Table 3; Group 2: Table 4

(FIRE) HEATED PRESSURE EQUIPMENT
Table 5

PIPING
Determine state of fluid contents ← Y
Gas → Determine fluid group* → Group 1: Table 6; Group 2: Table 7
Liquid → Determine fluid group* → Group 1: Table 8; Group 2: Table 9

Determine maximum allowable pressure in bar and volume in liters

Determine maximum allowable pressure in bar and nominal size DN in mm

Use the table to determine the appropriate conformity assessment category

Choose a module from the category or a higher category ← Z

SAFETY ACCESSORIES
Manufactured for specific equipment
Yes → Classified in the same category as the equipment it protects
No → Choose a module from Category IV

PRESSURE ACCESSORIES
The volume is more appropriate than the nominal size DN? Yes → Go to point X
No → The nominal size DN is more appropriate than the volume? Yes → Go to point Y
No → The nominal size DN and the volume are equally appropriate
→ Compare the output category, starting from X, with that from Y, and take the highest category of these two
→ Go to point Z

ASSEMBLIES
Assemblies referred to in Article 3 (2) shall be subjected to a global conformity assessment procedure comprising:
↓
Assessment of each item of pressure equipment making up the assembly and referred to in Article 3 (1) which has not been previously subjected to a conformity assessment procedure and to a separate CE marking; the assessment procedure shall be determined by the category of each item of equipment;
↓
Assessment of the integration of the various components of the assembly as referred to in sections 2.3, 2.8 and 2.9 of Annex I, which shall be determined by the highest category applicable to the equipment concerned other than that applicable to any safety accessories;
↓
Assessment of the protection of an assembly against exceeding the permissible operating limits as referred to in sections 2.10 and 3.2.3 of Annex I, shall be conducted in the light of the highest category applicable to the items of equipment to be protected.
↓
Go to point Z

*__Fluid group:__ Reference is made to Regulation No. 1272/2008 for all pressure equipment subject to Directive 97/23/EC, placed on the market as of June 01 2015.
__Group 1:__ Hazardous substances and mixtures
__Group 2:__ Non-hazardous substances and mixtures

97/23/EC

Category	Module (Annex III PED)
SEP	Sound Engineering Practice
I	A
II	A1, D1, E1
III	B1+D, B1+F, B+E, B+C1, H
IV	B+D, B+F, G, H1

2014/68/EU

Category	Module (Annex III PED)
SEP	Sound Engineering Practice
I	A
II	A2, D1, E1
III	B (DT)+D, B (DT)+F, B (PT)+E, B (PT)+C2, H
IV	B (PT)+D, B (PT)+F, G, H1

DT=Design Type PT=Production Type

Modules D1, E1, D, E, H and H1 are quality procedures

REQUIRED DOCUMENTATION FROM MANUFACTURER TO NOTIFIED BODY

MANUFACTURER SHALL SUBMIT RELEVANT DOCUMENTATION TO NOTIFIED BODY FOR CONFORMITY ASSESSMENT

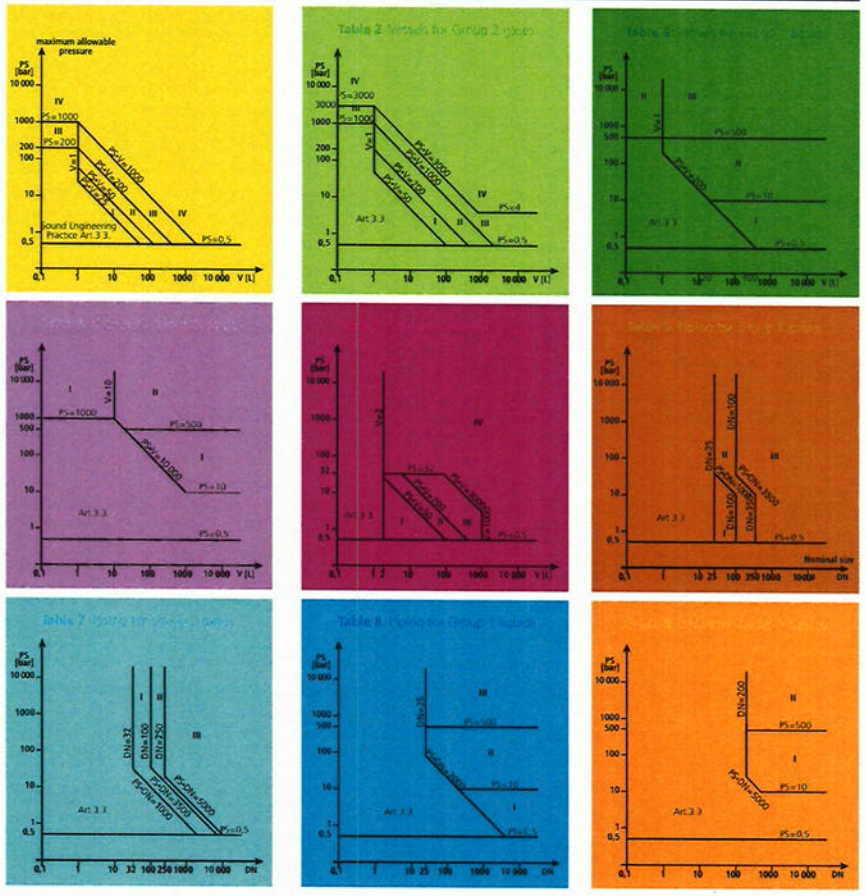
Following documents, where applicable, have to be present at Lloyd's Register prior to the Design Appraisal activities. **Please note: this list is not exhaustive. References to modules in 2014/68/EU are in (parentheses).**

PRESSURE EQUIPMENT (DESIGN APPRAISAL)	ASSEMBLIES (DESIGN APPRAISAL)
General description (application form)	General description of the Assembly
Drawings / isometrics	Piping & Instrumentation diagram (including safeguarded inlet pressure, temperatures, flow)
Parts list(s)	Line- and Equipment List (including at least PSmin, PSmax, TSmin, TSmax, PED fluid group, phase, table and PED category)
Result of the hazard analysis (as per Annex 1 of the PED 97/23/EC)	Result of the hazard analysis (as per Annex I of the PED 97/23/EC)
PMA's, in case of non-harmonized materials	Manual of the assembly
Calculations acc. chosen design code	Pump, compressor and turbine information (e.g. safeguarded supply pressure, temperature, flow)
B1: approved procedures for welding and NDE	Information relating to relieving safeguarding (e.g. case-determination and calculation)
	Information relating to instrumental safeguarding (e.g. Alarm & Trip-setting List, Cause and Effect Diagram).
Modules A1(A2), B1 (B DT), B (B PT), H1 and G	

Above listed and following documents, where applicable, have to be available during Inspection activities. Please note: this list is not exhaustive.

PRESSURE EQUIPMENT (INSPECTION)	ASSEMBLIES (INSPECTION)
Inspection test plan incl. material certificates	Inspection test plan
Result documents of tests and examinations as required by the design code, such as: Results of NDE, Results of the weld test plate examination, Approved procedures for welding and NDE activities, etc. (all NDE reports level II)	Approved procedures for welding and NDE activities
Manual of the pressure equipment	Declarations of Conformity of items used in the Assembly
Declaration of Conformity of the Pressure Equipment	Test reports of safety devices
	Copy of the certificate of the QA system (in case of module H)
	Qualification of personnel for permanent joints and NDE
	Manual of the items used in the Assembly
	Declaration of Conformity of the Assembly
Modules A1 (A2), C1 (C2), G	

Note: For exceptions regarding the tables 1, 2, 4, 5, 6, & 7, please check our PED App or refer to the PED text.



For help determining PED, categories and modules, download our PED Category Selection mobile app. Scan the QR code or visit pedapp.lr.org.

REVISING THE PRESSURE EQUIPMENT DIRECTIVE: TRANSITION FROM 97/23/EC TO 2014/68/EU

Manufacturers and other "economic operators" need to be aware of key dates in the transposition period for the new Pressure Equipment Directive (2014/68/EU):

- 1 June 2015: New fluid classification change takes effect
- From 19 July 2016: 2014/68/EU becomes legally binding

FLUID CLASSIFICATION CHANGE

As of 1 June 2015, economic operators must use the Classification, Labelling and Packaging (CLP) Regulation (EC 1272/2008) to determine whether their pressure equipment will be handling "dangerous" fluids. This applies to any equipment placed on the market after 1 June 2015. This means 2014/68/EU Art. 13 replaces 97/23/EC Art. 9 as of 1 June 2015.

For equipment to be placed on the market after 19 July 2016 the full directive, 2014/68/EU, will apply. For more in-depth discussion and a visual timeline of the revision, please visit www.lr.org/ped.

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