MINISTRY FOR ENERGY AND WATER MANAGEMENT WSC, QORMI ROAD, LUQA, MALTA	techfem sps	CONTRACT N. CT 3108/2018	JOB 171001
	LOCATION MALTA & ITALY	DOC. 10-RX-E-0101	
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MELITA TRANSGAS PIPELINE

PROJECT OF COMMON INTEREST PCI 5.19

Co-financed by the European Union
Connecting Europe Facility

FEED BASIS OF DESIGN

7	IFA – Issued for Approval	F.Chiappetta P. Giuliani	C. Saltalamacchia	S. Belogi	04/06/2019
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1 INTRODUCTION

The main policy of the Maltese Government aims at reducing the cost of electricity generation and minimise the environmental impact of the generation of electricity in Malta by switching from liquid fuels to natural gas. To meet these objectives the government's policy is promoting independent investment in Malta's energy infrastructure in the form of new facilities, favouring the import of natural gas and new high efficiency generating plant at the site of Delimara Power Station.

The Studies performed in the previous phases clearly concluded that the most preferable solution in terms of feasibility under present market conditions, is to connect Malta to the European Gas Network by means of a Gas Pipeline. The option of linking Malta to Gela is preferred due to the existence of the required transmission infrastructure on the shoreline (see Fig. 1).

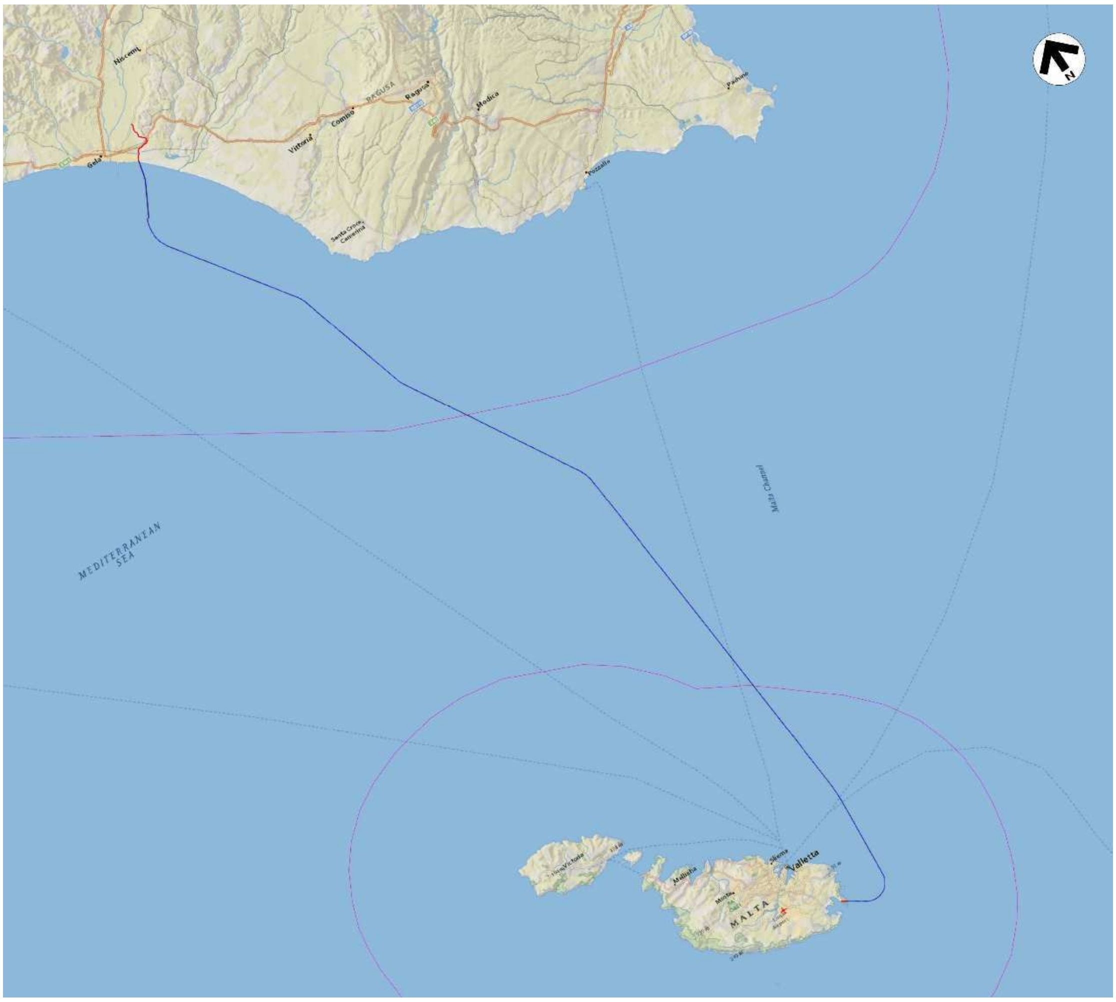

Figure 1. – Overall Pipeline Routing Map

The current phase of the project relates to the Front End engineering design study (FEED study).

1.1 Scope of the Document

The present document summarizes the basic data to be considered and the applicable codes for the design of the future pipeline system from Gela (Sicily) to Delimara (Malta).

In detail, the extended scope of this document is:

- to summarize the applicable codes and standards;
- to list the minimum functional design requirements;
- to collect the available design parameters;
- to highlight the missing information and data;
- to list the assumptions made for the design.

The report is to be considered as a live document which provides input to engineering studies and will be updated, as required, during the project execution. Additionally, the deliverables specified within this document are considered as explanatory to those specified in the ToRs and not replacing them.

1.2 Battery Limits

Battery limits for the development of the design activities are:

- Maltese side: Number 5 outlets are foreseen at Delimara Terminal Plant:
  - No. 3 outlets to be flanged inside the Terminal Plant for future connections;
  - No.1 outlet to be connected to the Regasification Unit outlet gas pipe;
  - No.1 outlet to be connected to DPS Unit D3.
- Italian side: Connection with Snam Rete Gas, Onshore plant at Gela (Sicily).

1.3 Definitions

In this document the following terms will be applied:

Client — (or **Contract Authority**) is the Maltese Ministry for Energy and Water Management

Contractor — is the JV Techfem/SPS, which is responsible for the execution of the Front End Engineering Design (FEED) of the Project.

PROJECT — is the Malta-Italy Gas Pipeline Interconnection (named: Melita Transgas Pipeline) from Gela (Italy) to Delimara (Malta) and the relevant plants/ancillaries.

1.4 Abbreviations

A.F.B.M.	Allowable Functional Bending Moment
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
AWTI	Above Water Tie-In
CBA	Cost Benefit Analysis
C.M.	Central Meridian
CP	Cathodic Protection
CWC	Concrete Weight Coating
D	Diameter
DCS	Distributed Control System
Dir	Direction
DPS	Delimara Power Station
Dr	Relative Density
EIA	Environmental and Social Impact Assessment
FEM	Finite Element Method
FSRU	Floating Storage Regasification Unit
GEBCO	General Bathymetric Chart of the Ocean
HAC	Hazardous Area Classification
HAT	Highest Astronomical Tide
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HFW	High-Frequency Welded Pipe
Hs	Significant Wave Height
HSE	Health Safety and Environment
HSS	Heat Shrinkable Sleeve
KP	Kilometre Point
ILI	In-Line Inspection

IRPA	Individual Risk Per Annum
LAT	Lowest Astronomical Tide
LLI	Long Lead Items
LPE	Layer Polyethylene
MAOP	Maximum Allowable Operating Pressure
MASW	Multichannel Analysis of Surface Waves
MHWN	Mean high water neap
MHWS	Mean high water spring
MLWN	Mean low water neap
MLWS	Mean low water spring
MSL	Mean Sea Level
MV	Medium Voltage
ND	Nominal Diameter (inches)
NG	Natural Gas
NVCC	Non Visible Combustion Chamber
PD	Design Period
PE	Polyethylene
P&IDs	Piping & Instruments Diagrams
PIM	Pipeline Integrity Management
PL	Pipeline
PMRS	Preliminary Marine Route Survey
PSHA	Probabilistic Seismic Hazard Analysis
QRA	Quantitative Risk Assessment
RAM	Reliability, Availability, Maintainability
RAO	Response Amplitude Operator
PP	Polypropylene
RP	Return Period
SAW	Submerged-Arc Welded Pipe
SCRZ	Sicily Channel Rift Zone
SIL	Safety Integrity System
SMTS	Specified Minimum Tensile Strength

SMYS	Specified Minimum Yield Strength
SRG IP	Snam Rete Gas Interconnection Point
SRT	Sicilian Receiving Terminal
SSRA	Site Seismic Response Analysis
STD	Standard
Su	Undrained Shear Strength, cohesive soils
TE	Tractebel Engineering
ToR	Terms of Reference
Ts	Significant Wave Period
UTM	Universal Transverse of Mercator
Vs	Shear-Wave Velocity
VS	Valve Station
WD	Water Depth
WDP	Water Dew Point
γ'	Submerged Unit Weight of Soil
ϕ	Angle of Friction, cohesionless soils

1.5 System of Measurement

International System (SI) units shall be used (Inches shall be used for pipeline nominal outside diameter).

The following units of measurement, and abbreviations, will be used in detailed design, together with accepted multiples and sub-multiples.

Dimensions	Inch (for pipe diameters, valve size, instrument tubing).	in (")
	Millimetres	mm
	Metres	m
	Kilometres	km
Weight	Kilogram	kg
	Metric ton	t
Gas flow	Standard cubic metre per hour	Sm^3/h

	Kilogram per hour	kg/h
Density	Kilogram per cubic metre	kg/m^3
Temperature	Degree Celsius	°C
Pressure	Bar (absolute)	bara
	Bar (gauge)	barg
Diff. pressure	Bar	bar
Viscosity	Millipascal second	mPa·s
Time	Day	d
	Hour	h
	Second	s
Force	Newton	N
Energy	Kilojoule	kJ
Power	Kilowatt	kW

2 CODES, STANDARDS AND REFERENCES

Should conflicting requirements be made by different rules, codes or standards, the most stringent one shall apply. In all cases Client shall be informed.

The codes, standards and specifications shall be the latest revision available at the time of order placement, unless otherwise stated and/or agreed.

2.1 Codes and Standards

[1]	AGA Report 08	Compressibility Factors of Natural Gas and other Related Hydrocarbon Gases
[2]	AGA Report 09	Measurement of Gas by Multipath Ultrasonic Flowmeters
[3]	AGA Report 10	Speed of Sound in Natural Gas and other Related Hydrocarbon Gas
[4]	OIML R 140	Measuring Systems for Gaseous Fuel
[5]	API Specification 5L	Specification for Line Pipe
[6]	API 6D	Specification of Pipeline Valves
[7]	API RP 14E	Recommended Practice for Design and Installation of Offshore Production Platform Piping System
[8]	API SPEC 16A	Specification for Drill-Through Equipment
[9]	API RP 17B	Recommended Practice for Flexible Pipe
[10]	API 505	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified ~s Class, Zone 0, Zone 1, and Zone 2
[11]	API 521	Pressure-relieving and De-pressuring Systems
[12]	API RP 551	Process Measurement Instrumentation
[13]	API RP 552	Transmission Systems
[14]	API RP 1111	Design, Construction, Operation and Maintenance of Offshore Hydrocarbon Pipelines
[15]	API RP 686	Recommended Practice for Machinery Installation and Installation Design
[16]	API RP 1102	Steel Pipelines Crossing Railways & Highways 2008
[17]	API RP 1110	Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas,

		Hazardous Liquids, Highly Volatile liquids or Carbon Dioxide
[18]	API STD 1104	Welding of Pipelines and related Facilities 2008
[19]	ASME B31.3	Process Piping
[20]	ASME B31.8	Gas Transmission and Distribution Piping Systems
[21]	ASME B16.5	Pipe Flanges and Flanged Fittings
[22]	ASME B16.9	Factory-Made Wrought Buttwelding Fittings
[23]	ASME B16.10	Face to face and end to end dimension of valves
[24]	ASME B16.11	Forged steel fittings, socket-welding and threaded
[25]	ASME B16.20	Metallic Gaskets for Pipe Flanges: Ring joint, spiral –wound and Jacketed
[26]	ASME B16.25	Buttwelding end
[27]	ASME B16.34	Valves-flanged, threaded and welding end
[28]	ASME B 16.47	Large diameter steel flanges
[29]	ASME B36.10M	Welded and Seamless Wrought Steel Pipe
[30]	ASME B36.19	Stainless steel pipe
[31]	ASME V	Non-destructive Examination
[32]	ASME VIII Div.1	Rules for Construction of Pressure Vessels
[33]	ASME IX	Welding, Brazing and Fusing Qualifications
[34]	ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
[35]	ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service
[36]	ASTM A516	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
[37]	BS 5760	Reliability of Systems, Equipment and Components
[38]	CIGRE	Technical Brochure 95 - Guide on the influence of high voltage AC power systems on metallic pipelines - Paris - 1995.

[39]	CIGRE	Technical Brochure 290 - AC corrosion on metallic pipelines due to interference from ac power lines - Paris - 2006.
[40]	DPR 6/06/2001 n.380	Testo unico delle disposizioni legislative e regolamentari in materia edilizia
[41]	Circol. 2/02/09 n. 617	Istruzioni per l'applicazione delle “Nuove norme tecniche per le costruzioni” di cui al D.M. 14/01/08.
[42]	DM 17/01/2018	Aggiornamento delle “Norme tecniche per le costruzioni”
[43]	DM 17/04/2008	Technical regulation for the design, construction, testing, operation and supervision of works and natural gas transportation systems with density not exceeding 0.8
[44]	DM 4/4/2014	Technical Standards for the crossings and the paralleling of pipelines liquids and gases with railways and other transportation lines
[45]	DM 24/04/2008	Modalità anche contabili e tariffe da applicare in relazione alle istruttorie e ai controlli previsti dal Decreto Legislativo 18 Febbraio 2005, N. 59
[46]	EI 15	Area Classification code for installations handling flammable fluids
[47]	EN 54	Fire detection and fire alarm systems
[48]	EN 1594	Gas infrastructure - Pipelines for maximum operating pressure over 16 bar -. Functional requirements
[49]	EN 1991 (latest version)	Eurocode 1: Actions on structures
[50]	EN 1992 (latest version)	Eurocode 2: Design of concrete structures
[51]	EN 1993 (latest version)	Eurocode 3: Design of steel structures
[52]	EN 1997 (latest version)	Eurocode 7: Geotechnical design
[53]	EN 1998 (latest version)	Eurocode 8 Design of structure for earthquake resistance
[54]	EN 10208-3	Steel pipes for pipelines for combustible fluids – Technical delivery conditions – Part 3: Pipes of requirements class C
[55]	EN 12186	Gas infrastructure - Gas pressure regulating stations for transmission and distribution - Functional requirements

[56]	EN 12285-2	Workshop fabricated steel tanks, Part 2: Horizontal cylindrical single skin and double skin tanks for the aboveground storage of flammable and nonflammable water polluting liquids
[57]	EN 12845	Standard, extinguisher appliances, water supplies for automatic systems
[58]	EN 12954	Cathodic protection of buried or immersed metallic structures. General principles and application for pipelines
[59]	EN 12732	Gas infrastructure. Welding steel pipework. Functional requirements
[60]	EN 13445	Unfired Pressure Vessels
[61]	EN 13942	Petroleum and natural gas industries -- Pipeline transportation systems - Pipeline valves
[62]	EN 14141	Valves for natural gas transportation in pipelines. Performance requirements and tests
[63]	EN 14161	Petroleum and natural gas industries. Pipeline transportation systems
[64]	EN 14870	Petroleum and natural gas industries. Induction bends, fittings and flanges for pipeline transportation systems
[65]	EN 14505	Cathodic protection of complex structures.
[66]	EN 21809-1&2	Petroleum and natural gas industries. External coatings for buried or submerged pipelines used in pipeline transportation systems. Part 1 -Polyolefin coatings (3-layer PE and 3-layer PP) – Part 2 Fusion-bonded epoxy coatings
[67]	EN 50443	Effects of electromagnetic interference on pipelines caused by high voltage A.C. electric traction systems and/or high voltage A.C. power supply systems.
[68]	CEI-EN 60079-10-1	Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres
[69]	EN 60751	Industrial platinum resistance thermometers and platinum temperature sensors
[70]	EN 61000	Electromagnetic compatibility
[71]	DNVGL-ST-F101	Submarine Pipeline Systems
[72]	DNVGL-RP-C203	Fatigue Design of Offshore Steel Structures

[73] DNVGL-RP-C205		Environmental Conditions and Environmental Loads
[74] DNVGL-RP-F105		Free Spanning Pipelines
[75] DNVGL-RP-F107		Risk Assessment of Pipeline Protection
[76] DNVGL-RP-F109		On-Bottom Stability Design Submarine Pipelines
[77] DNVGL-RP-F111		Interference Between Trawl Gear and Pipelines
[78] DNVGL-RP-F110		Global Buckling of submarine pipelines
[79] DNVGL-RP-F103		Cathodic protection of submarine pipelines
[80] EHS guidelines		EHS guidelines
[81] IEC 60331		Tests for electric cables under fire conditions
[82] IEC 60332		Tests on electric and optical fibre cables under fire conditions
[83] IEC 60364		Electrical Installations for Buildings
[84] IEC 60794		Optical fibres cables
[85] IEC 61882		Hazard and Operability Studies – Application Guide
[86] IEC 61936		Power installations exceeding 1 kV a.c. - Part 1: Common rules
[87] IEC 61508		Functional safety of electrical/electronic/programmable electronic safety-related systems –
[88] IEC 61511		Functional safety – Safety instrumented systems for the process industry sector –
[89] IP Research Report		Ignition Probability Review Model Development and Look-up Correlations, Energy Institute London, January 2006;
[90] ISA 5.1		Instrumentation Symbols and Identification
[91] ISA 5.3		Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems
[92] ISA 5.4		Instrument Loop Diagrams
[93] ISA 20		Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves
[94] ISA 75.01.01		Industrial – Process control valves – Part 2-1 Flow capacity sizing equations for Fluid Flow under installed conditions

[95]	EN ISO 12474	Cathodic Protection of Submarine Pipelines
[96]	ISO 13623	Petroleum and natural gas industries — Pipeline transportation systems
[97]	EN ISO 15589-1	Petroleum, petrochemical and natural gas industries -- Cathodic protection of pipeline systems - Part 1: On-land pipelines
[98]	EN ISO 15589-2	Petroleum and natural gas industries - Cathodic protection of pipeline transportation systems - Part 2: Offshore pipelines
[99]	ISO 15590	Petroleum and Natural Gas Industries – Induction Bends, Fittings and Flanges for Pipeline Transportation Systems
[100]	ISO 15664	Acoustics -- Noise control design procedures for open plant.
[101]	ISO 17089-1	Measurement of Fluid Flow in Closed Conduits – Ultrasonic Meters for Gas – Meters for Custody Transfer and Allocation Measurement
[102]	ISO 17776	Petroleum and natural gas industries – Offshore production installations – Guidelines on tools and techniques for hazard identification and risk assessment
[103]	ISO 3864-1	Safety colours and safety signs: design principles for safety signs in workplaces and public area;
[104]	ISO 3864-2	Safety colours and safety signs: design principles for product safety labels;
[105]	ISO 3864-3	Safety colours and safety signs: design principles for product safety signs;
[106]	ISO 7010	Graphical symbols -- Safety colours and safety signs -- Registered safety signs
[107]	ITU.T	Directives concerning the protection of telecommunication lines against harmful effects from electric power and electrified railway lines - ITU -1989 vol.II, vol.III.
[108]	ITU.T	Recommendation K.33 - Limits for people safety related to coupling into telecommunications system from a.c. electric power and a.c. electrified railway installations in fault conditions.
[109]	ITU.T	Recommendation K.68 - Management of electromagnetic interference

[110]	IEC/EN 60529	Classification of Degree of Protection Provided by Enclosures
[111]	IEC/EN 60584	Thermocouples
[112]	IEC/EN 60801	Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment
[113]	IEC 61131-1	Part 1 - 3
[114]	IEC 60870-5	Part 1 – 6
[115]	IEC 61000-4	Part 1 – 4
[116]	IEC 60870	Telecontrol equipment and systems
[117]	IEC 61511	Functional safety - Safety instrumented systems for the process industry sector
[118]	EN 61000	Electromagnetic compatibility
[119]	IETF RFC 3261	Session Initiation Protocol
[120]	ITU T	Series of Recommendations G, I, K, L, M, Q
[121]	ITU-T G.652	Characteristics of a single-mode optical fibre cable
[122]	ITU-T G.655	Characteristics of a non-zero dispersion shifted single-mode optical fibre cable
[123]	ITU-T L.10	Optical fibres cables for ducts and tunnel application
[124]	ITU-T K.25	Protection of optical fibres cables
[125]	OGP 434-4	Riser & Pipeline release frequencies
[126]	OGP 434-1	Process Release Frequencies
[127]	MSS SP44	Steel Pipeline Flanges
[128]	MSS SP75	Specification for High-Test, Wrought, Butt-Welding Fittings
[129]	NACE SP 0176	Corrosion Control of Submerged Areas of Permanently Installed Steel Offshore Structures Associated with Petroleum Production
[130]	NPFA 10	Standard for Portable fire extinguisher
[131]	NFPA 12	Standard on Carbon Dioxide Extinguishing Systems
[132]	NFPA 13	Standard for the Installation of Sprinkler Systems
[133]	NFPA 14	Standard for the Installation of Standpipe and Hose Systems

[134] NFPA 15 — Standard for Water Spray Fixed Systems for Fire Protection

[135] NFPA 24 — Standard for the Installation of Private Fire Service Mains and Their Appurtenances

[136] NFPA 70 — National Fire Protection Association – National Electrical Code

[137] NFPA 72 — National Fire Alarm and Signalling Code

[138] NFPA 90A — National Fire Protection Association – Installation of Air-Conditioning and Ventilating Systems

[139] NFPA 101 — Life safety Code

[140] OGP 434-4 — Riser & Pipeline release frequencies

[141] OGP 434-1 — Process Release Frequencies

[142] OSHA Occupational Safety and Health Administration

[143] Subsidiary Leg. 423.39 — Electrical Installation Regulation

[144] Subsidiary Leg. 513.02 — Avoidance of damage to third party Property Regulations

[145] Subsidiary Leg. 552.09 — Environmental management Construction site Regulations

[146] TIA/EIA 589 — Optical Fiber Cable Color Coding

[147] UNI 9795 — Sistemi fissi automatici di rivelazione e di segnalazione allarme d'incendio - Progettazione, installazione ed esercizio

2.2 Basic Design Documents

[148] P-008685-W1-000 — Basis of Design

[149] P-008685-W1-001 — Technical feasibility assessment for Malta landfall – Zone A

[150] P-008685-W1-002 — Malta Zone A - Offshore pipeline routing Alternative A1

[151] P-008685-W1-003 — Malta Zone A - Offshore pipeline routing Alternative A2

[152] P-008685-W1-004 — Malta Zone A - Offshore pipeline routing Alternative A3

[153] P-008685-W1-005 — Offshore Pipeline Route Selection Report

[154] P-008685-W1-006 — Offshore pipeline route drawing

[155] P-008685-W1-007 — Technical Feasibility Assessment for Malta Landfall Zone B

[156] P-008685-W1-008 Malta Terminal Layout Draft

[157] P-008685-W1-009 Offshore Pipeline Preliminary Design Report

[158] P-008685-W1-010 Offshore Pipeline Preliminary Construction Works

[159] P-008685-W1-011 Offshore Pipeline Preliminary Layability Assessment

[160] P-008685-W1-012 Onshore Route Selection Report (E1 Rerouting)

[161] P-008685-W1-013 Onshore Pipeline General Route – Italy Section

[162] P-008685-W1-014 Onshore Pipeline General Route – Malta Section

[163] P-008685-W1-015 Plan Ground Profile – Italy Section

[164] P-008685-W1-016 Plan Ground Profile – Malta Section

[165] P-008685-W1-017 Gela Terminal Preliminary Layout
Malta Terminal Preliminary Layout
Block Valve / Isolation Station Preliminary Layout

[166] P-008685-W1-018 Thermo-Hydraulic Analysis Report

[167] P-008685-W1-019 Overall Project Diagram

[168] P-008685-W1-020 Process Flow Diagram – Gela Terminal
Process Flow Diagram – Delimara Terminal

[169] P-008685-W1-021 P&ID

[170] P-008685-W1-022 Preliminary Spare Parts, Preliminary Material List, MTO/BOQ

[171] P-008685-W1-023 HSE Minimum Requirement

[172] P-008685-W1-024 HAZID ENVID Report

[173] P-008685-W1-025 Hazardous Area Classification Report

[174] P-008685-W1-026 Onshore Construction

[175] P-008685-W1-027 Environmental Risk Analysis

[176] P-008685-W1-028 Project Quality Assurance Plan

[177] P-008685-W1-029 HAZOP Report

[178] P-008685-W1-030 Gantt Chart

[179] P-008685-W1-031 RAM Analysis

[180] P-008685-W1-032 Investment Cost Estimate (Capex-Opex)

[181] P-008685-W1-033 Final Report

2.3 Technical Documents (Client provided data)

[182]	PEN-117251-001	Technical and Financial Feasibility Study for Connecting Malta to European Gas Network, 04/2015
[183]	PEN-117251-001/0012	Pipeline Route From Delimara to Gela
[184]	PEN-117251-001/0017	Indicative Constraints Map - Environmental Parameters
[185]	J1377–GI16/062	Ground Investigation Report, Solidbase Laboratory Ltd.
[186]	MEW001	Geophysical and Geotechnical Project Execution Plan

2.4 Other Documents

[187] LGTS Bathymorphological and geotechnical route characterisation and design parameters, Snamprogetti 2001

[188] Libya gas transmission system - Meteoceanographic Design Data, Snamprogetti 2001

[189] LA-E-71502 Technical Specification For a Bathymorphological Survey, 07/2002

[190] LF-E-70001 Feasibility Study Report Enemalta/eni, 08/2003

[191] British Admiralty Charts No. 36, 194, 974, 2123, 2124, 2538

[192] Istituto Idrografico della Marina – Carte Nautiche No. 263, 917

[193] Snam Rete Gas Sustainability Report 2014

[194] Gebco_2014 grid 30”, https://www.bodc.ac.uk/data/online_delivery/gebco/

[195] Geoportale Nazionale of Environmental Ministry, http://www.pcn.minambiente.it/GN/

[196] Carta Tecnica Territoriale (C.T.R. scale 1:10000), Sicily cartogrphic portal: http://www.sitr.regione.sicilia.it/

[197] Argnani A. (1990): The Strait of Sicily Rift Zone: foreland deformation related to the evolution of a back-arc basin; Journal of Geodynamics, 12, pp. 311-331.

[198] Ben-Avraham Z., Grasso M. (1990): Collisional zone segmentation in Sicily and surrounding areas in the Central Mediterranean; Annales Tectonicae, special issue - Vol. IV n. 2 (1990), pp. 131-139.

[199] Bishop, W.F., Debono, G., 1996. The hydrocarbon geology of southern offshore Malta and surrounding regions. Journal of Petroleum Geology 19,129-160.

[200] Boccaletti M., Cello G., Tortorici L. (1990): Strike-slip deformation as a fundamental process during the Neogene-Quaternary evolution of the

Tunisian-Pelagian area; Annales Tectonicae, special issue - Vol. IV n. 2 (1990), pp. 104-119.

[201] Finetti I. (1982): Structure, stratigraphy and evolution of Central Mediterranean; Boll. Geof. Teor. Appl., vol. 26, pp. 247-312.

[202] Finetti I. (1984): Geophysical study of the Sicily Channel rift zone; Boll. Geof. Teor. Appl., vol. 26, n. 101-102, pp. 3-28.

[203] Galea P. (2007): Seismic history of the Maltese islands and considerations on seismic risk, Annal of Geophysics, vol.50, No.6.

[204] Gardiner, W., Grasso, M., Sedgeley, D., 1995. Plio-Pleistocene fault movement as evidence for mega-block kinematics within the Hyblean-Malta Plateau, Central Mediterranean. Journal of Geodynamics 19, 35-51.

[205] Grasso M., Reuther C.D., Baumann H., Becker A. (1986): Shallow crustal stress and neotectonic framework of the Malta platform and the Southeastern Pantelleria rift (Central Mediterranean); Geologica Romana, vol. 25 (1986), pp. 191-212.

[206] Holland, C.W., Etiope, G., Milkov, A.V., Michelozzi, E., Favali, P., 2003. Mud volcanoes discovered offshore Sicily. Marine Geology 199,1-6.

[207] Illies, J.H. (1981): Graben formation: the Maltese islands, a case history, Tectonophysics, 73, 151-168.

[208] Jongsma, D., Van Hinte, J.E., Woodside, J.M., 1985. Geologic structure and neotectonics of the north African continental margin south of Sicily. Marine and Petroleum Geology 2, 156-177.

[209] Max, M.D., Kristensen, A., Michelozzi, E., 1993. Small scale Plio-Quaternary sequence stratigraphy and shallow geology of the west-central Malta Plateau. In: Max, M.D., Colantoni, P. (Eds.), UNESCO Technical Reports in Marine Science, Urbino, pp. 117-122.

[210] Micallef A., Berndt C., Debono G. (2011): Fluid flow systems of the Malta Plateau, Central Mediterranean Sea, Marine Geology, 284, pp.74-85.

[211] Minisini D., Trincardi F. (2009): Frequent failure of the continental slope: The Gela Basin (Sicily Channel), Journal of Geophysical Research, vol.114, F03014.

[212] Mouchel, L.G. And Partners, British Electricity International Limited (1990): Delimara power station Malta: seismic risk analysis, Rep. 26562, Enemalta Corporation, Malta.

[213] Panzera F., D'amico S., Lombardo G., Galea P., Akinci A.(2015): Overview of the seismic hazard in the Sicily channel archipelagos, Establishment of an Integrated Italy–Malta Cross–Border System of Civil Protection. Geophysical Aspects, pag. 31–45

[214] Reuther, C.D., Eisbacher, G.H., (1985). Pantelleria rift-crustal extension in a convergent intraplate setting. Geologische Rundschau 74, 585-597.

[215] Reuther C.D. (1990): Strike-slip generated rifting and recent tectonic stresses on the African foreland (Central Mediterranean region); Annales Tectonicae, special issue - Vol. IV n. 2 (1990), pp. 120-130

[216] Savini, A., Malinvemo, E, Etiope, G., Tessarolo, C., Corselli, C., 2009. Shallow seep- related seafloor features along the Malta Plateau (Sicily channel—Mediterranean Sea): morphologies and geo-environmental control of their distribution. Marine and Petroleum Geology 26,1831-1848

[217] Istituto Nazionale di Geofisica e Vulcanologia: Mappa di Pericolosità Sismica con Probabilità di Eccedenza del 10% in 50 Anni - OPCM 3519/2006.

[218] Malta-Italy Gas Pipeline Interconnection –Phase 1, PRJ-ENV215.

[219] A guide for to quantitative risk assessment for Offshore Installation

[220] Composizioni dei gas tipici immessi nella rete di trasporto Snam Rete Gas AT2017-2018 (from http://misura.snam.it/portmis)

[221] Codice di rete di Snam Rete Gas – Revisione LXVII

[222] Galdies C. (National Statistics Office, Malta, 2011): The climate of Malta: statistics, trends and analysis 1951-2010

[223] Aeronautica Militare – Servizio Metereologico: Tabelle climatiche 1971-2000 dall'Atlante Climatico

[224] https://www.seatemperature.org/europe/malta/marsaxlokk.htm

[225] https://www.seatemperature.org/europe/italy/licata.htm

[226] Specifiche tecniche per la predisposizione e la trasmissione della documentazione in formato digitale per le procedure di VAS e VIA ai sensi del D.Lgs.152/2006 e s.m.i. - Rev.4 del 3.12.2013

[227] Snam Rete Gas letter Prot. 1290 of 27/08/2015 "Identification of the best location of the interconnection point of the Malta-Sicily gas pipeline to Snam Rete Gas network in the area of Gela

3 COORDINATE SYSTEM AND FACILITIES LOCATION

3.1 Geodetic Data

The spheroid and projection parameters to be used are listed below (Ref.[186] and [226]):

Spheroid parameters:

Datum	WGS 84
Spheroid	WGS 84
Semi-major Axis	6 378 137.000 m
Semi-minor Axis	6 356 752.314 m
Inverse flattening (1/f)	1/298.257223563

Projection Parameters:

Projection Transverse Mercator

Grid	UTM Zone 33
Central Meridian (C.M.)	15° E
Latitude of Origin	0° N
False Easting	500 000 metres
False Northing	0
Scale Factor on C.M.	0.9996

3.2 Vertical Datum

Vertical reference for the onshore sections of the Project will be MSL, while for the offshore section the elevation will be referred to LAT in compliance with PMRS Contractor survey.

For the documents covered both offshore/onshore sections (i.e. shore approach dwg's and route profile for flow assurance calculations, etc.), LAT data from PMRS Contractor will be transformed by FEED Contractor in MSL in order to have a unique and common elevation profile.
The following values, taken from the admiralty charts, will been used to go from LAT to MSL:

- Gela: +0.15 m (Porto Empedocle)
- Malta: +0.63 m (Valletta)

For the offshore section, a weighted average will be calculated based on the distances from the above points. Therefore, close to shore the values to reduce from LAT to MSL are the same as the admiralty charts. Further offshore, the values applied are a function of the distance from both ports.

4 DESIGN DATA

4.1 Design Lifetime

According to previous design phases (Ref. [148]) all equipment, facilities and pipelines will be designed for a minimum operational life of 35 years (from the start of operation, i.e. the gas-in of the pipeline).

To achieve this target proper materials selection (with any corrosion allowance), pipeline route selection, maintenance and inspection requirements, will be defined during the Project execution.

4.2 Pipeline Data

4.2.1 Geometrical and Mechanical Data

The main applied design codes are:

Location	Main Design Codes
Onshore (Italy)	D.M. 17/04/2008 ASME B 31.8 (1) ISO 13623 (1)
Offshore	DNVGL ST-F101 D.M. 17/04/2008 (Only within Italian national water) ISO 13623
Onshore (Malta)	EN 1594 ASME B 31.8 ISO 13623

Notes:
(1) Applicable for the aspects not covered or in contrast with D.M. 17/04/2008 (e.g. Stress Analysis verification)

Table 4-1 – Main Design Codes

The following table summarizes the geometrical and mechanical data relevant to the pipeline, based on previous Basic design phase

Description	Unit	Value
Input External Diameter (constant)	mm / inch	559 / 22 (1)
Steel Grade / SMYS [MPa]	ISO 3183 L450, X65 (2)	
Steel Density	kg/m^3	7850

Description	Unit	Value
Modulus of Elasticity	MPa	207000
Poisson's Ratio	-	0.3
Coefficient of Thermal Expansion	(°C^{-1})	1.16E^{-5}

Notes:
(2) 22'' is the diameter selected during Basic Design. Final Diameter will be selected during FEED within standard commercial values (see also 6.2.2).
(3) Value taken from previous design phase; steel grade will be finally selected within the mechanical sizing report.

Table 4-2 – Geometrical and Mechanical Data

4.3 Process Data

4.3.1 Design Data

The following table summarizes the data for the design of the pipeline system, based on previous Basic Design phase:

Design Pressure (1)	90 barg
Hydrotest Pressure (2)(3)	126 barg
Design Temperature (min/max)	-10°C / +60°C
Maximum Fluid Velocity	According to Ref. [221](4)

(1) Design pressure shall be finalised based on flow assurance analyses.
(2) 1.4 x Design Pressure. The coefficient 1.4 was defined during Basic Design (see Ref. [148]) and assumed as a Project requirement. According to DM 17/04/08, the Hydraulic Test shall be done at a pressure 1.3 times the maximum operating pressure (MAOP). According to DNVGL-ST-F101, the Hydraulic Test shall be done at a pressure 1.15 times the design pressure. According to ISO13623, the Hydraulic Test shall be done at a pressure 1.25 times the maximum operating pressure.
(3) If different design standards are applied to the different pipeline sections, these will be tested according to the respective design standard. If a hydrotest is conducted for the complete pipeline which has been designed using different standards, the test pressure will have to be agreed upon between the Client and the Contractor. Alternatively, if the pipeline will be designed to a one single standard (which proves to be the most rigorous) then hydrotest will need to be conducted in line with this standard.
(4) Pipe sizing will be done considering the maximum allowable velocity according to "Codice di Rete", that is 25-30 m/s, depending on plant section (Ref. [221]).

Table 4-3 – Process design parameters

The operating conditions reported in the following table will be considered for the two project phases:

Project Phase	Phase 1	Phase 2
Flow from (Inlet)	Gela	Delimara
Flow to (Outlet)	Delimara Power Plant	Gela Delimara Power Plant
Conveyed Fluid	Natural Gas from Gas Grid	Natural Gas from FSRU
Fluid Density [kg/Sm^3]	0.795 @ STD conditions (1) (1.013 bar, 15°C)	0.737 @ STD conditions (1.013 bar, 15°C)
Actual Max Flowrate [Sm^3/h]	70000 (2)	-
Max Flowrate [Sm^3/h]	218752	To Gela: 232000 To Power Plant: 70000
Min Flowrate [Sm^3/h]	3530 (2)	To Gela: 21000 To Power Plant: 3530 (2)
Outlet Pressure [barg]	38 (5)	Italy: 75 (6) Power Plant: 38 (5)
Inlet Temperature [°C]	15 (4)	15 (4)
Min/Max Acceptable Outlet Temperature [°C]	0 / 50 (4)	Gela: Min > 3 / Max < 50 (3) Power Plant: 0 / 50 (4)

(1) Data provided by Snam Rete Gas for the Libyan Gas, Year 2017-2018 (see Ref. [220]).
(2) Data provided by Client (see Annex 1 - Minimum Gas Flows through the Malta-Italy Gas Pipeline).
(3) Data take from "Codice di Rete di Snam Rete Gas" (see Ref. [221]).
(4) Contractor assumption.
(5) Pressure outlet of the Regassification Plant is ranging 36.5 to 39.5. The control system at Gas Turbine is controlling the pressure at 31.5 barg (see Annex 2).
(6) Minimum contractual pressure at SRG Entry Point according to Ref. [227].

Table 4-4 – Operating conditions

4.3.2 Fluid Composition

Data provided by Snam Rete Gas for the Libyan Gas (Year 2017-2018), will be considered for the dry gas composition of Phase 1 (see Ref. [220]).

Component	% Mole
Methane	85.306
Ethane	6.486
Propane	2.058
Isobutane	0.280
Normal Butane	0.437
Isopentane	0.099
Normal Pentane	0.063
Hexanes +	0.015
Nitrogen	3.882
Carbon Dioxide	1.268
Helium	0.106

Table 4-5 – Dry gas composition for Phase 1

In particular, the following saturated gas composition will be used for flow assurance analyses relevant to Phase 1, considering that, according to “Codice di Rete di Snam Rete Gas” (Ref. [221]), water dew point shall be lower or equal to -5°C at a pressure of 70 barg:

Component	% Mole
Methane	85.300
Ethane	6.486
Propane	2.058
Isobutane	0.280
Normal Butane	0.437
Isopentane	0.099
Normal Pentane	0.063
Hexanes +	0.015
Nitrogen	3.882
Carbon Dioxide	1.268
Helium	0.106
Water	0.006

Table 4-6 – Saturated gas composition for Phase 1 (WDP=-5°C at 70barg)

The following dry fluid composition, taken from the previous Basic design phase, will be considered for flow assurance analyses relevant to Phase 2, since water content in natural gas obtained from LNG regasification is normally lower than 0.1 ppm (mole):

Component	% Mole
Methane	91.071
Ethane	7.551
Propane	0.764
Isobutane	0.005
Normal Butane	0.001
Nitrogen	0.608

Table 4-7 – Dry gas composition for Phase 2

However, it has to be highlighted that pipeline system design will take into account, if required (for example, for corrosion assessment), alternative gas compositions, according to the following gas components acceptability limits, reported in “Codice di Rete di Snam Rete Gas” (Ref. [221]):

Component	Max. Allowed Content
Oxygen	0.6 %mol
Carbon Dioxide	3.0 %mol
Hydrogen Sulphide	6.6 mg/Sm^3
Mercaptan Sulphur	15.5 mg/Sm^3
Total Sulphur[1]	150 mg/Sm^3

Table 4-8 – Gas components acceptability limits

4.4 Environmental Data

4.4.1 Site Ambient Conditions at Malta

The air temperature data recorded by the Malta Airport MetOffice for the period 1947-2010 (see table below, Ref. [222]), can be considered for DPS, that is about 6km distant from the Luqa Airport.

[1] Inclusive of all Sulphur compounds.

Month	Record Max	Average Max	Record Min	Average Min	Average
	[°C]	[°C]	[°C]	[°C]	[°C]
Jan	22.2	18.7	**1.4**	5.0	11.8
Feb	26.7	19.4	1.7	4.8	12.1
Mar	33.5	22.0	2.2	5.9	13.9
Apr	30.7	24.7	4.4	7.9	16.3
May	35.3	29.3	8.0	11.3	20.3
Jun	40.1	33.6	12.6	15.2	24.4
Jul	42.7	36.4	15.5	18.5	27.4
Aug	**43.8**	35.8	15.9	19.2	27.5
Sep	37.4	32.4	13.2	16.5	24.5
Oct	34.5	28.6	8.0	12.9	20.8
Nov	28.2	24.4	5.0	9.0	16.7
Dec	24.3	20.4	3.6	6.5	13.5

Table 4-9 – Ambient air temperature at Luqa Airport

Moreover, the following environmental data are considered (Ref. [222], [224]):

- Relative humidity (average min/max): 54% / 89%
- Seawater temperature (average min/max): 14°C / 28°C

Based on the above, the following ambient data will be used for the Project at Malta:

- Maximum Ambient Temperature — 45 °C
- Minimum Ambient Temperature — 0 °C
- Maximum Ambient Temperature to be used for electrical equip. — 45 °C
- Expected minimum Temperature for piping erection — 10 °C
- Design thermal variation (ΔT) for structural calculations — 45 °C
- Maximum Seawater Temperature — 30 °C
- Minimum Seawater Temperature — 12 °C
- Relative humidity — 100 %

The site is situated at about 7 m above mean sea level and is in a humid semi-tropical climate. Moreover, the site is subject to periods where the atmosphere is laden with dust and sea water spray.

4.4.2 Site Ambient Conditions at Gela

The air temperature data recorded at Gela station by the Military Aeronautics for the period 1971-2000 are reported in the table below (Ref. [223]).

Month	Record Max	Average Max	Record Min	Average Min	Average
	[°C]	[°C]	[°C]	[°C]	[°C]
Jan	24.0	15.0	0.8	8.8	11.9
Feb	21.6	15.0	2.0	8.5	11.8
Mar	25.0	15.9	**0.0**	9.3	12.6
Apr	27.4	17.8	4.6	11.1	14.5
May	33.4	21.3	7.4	14.9	18.1
Jun	36.2	24.5	12.2	18.5	21.5
Jul	**41.4**	26.4	14.8	20.7	23.5
Aug	40.0	27.4	15.6	21.7	24.6
Sep	34.4	26.1	12.4	20.1	23.1
Oct	32.2	22.9	9.0	16.7	19.8
Nov	26.2	19.3	2.4	13.0	16.1
Dec	23.6	16.3	2.6	10.2	13.3

Table 4-10 – Ambient air temperature at Gela

Moreover, the following environmental data will be considered (Ref. [223], [225]):

- Relative humidity (average min/max): 53% / 90%
- Seawater temperature (average min/max): 14°C / 28°C

Based on the above, the following ambient data will be used for the Project at Malta:

- Maximum Ambient Temperature 45 °C
- Minimum Ambient Temperature 0 °C
- Maximum Ambient Temperature to be used for electrical equip. 45 °C
- Expected minimum Temperature for piping erection 10 °C
- Design thermal variation (ΔT) for structural calculations 45 °C
- Maximum Seawater Temperature 30 °C
- Minimum Seawater Temperature 12 °C
- Relative humidity 100 %

The site is situated at about 6 to 70 m above mean sea level and is in a humid semi-tropical climate.

4.4.3 Wind conditions at Malta

The wind rose elaborated by the Malta Airport MetOffice for the period 1997-2006 with the indication of the wind directions and the relevant speed is reported in the figure below (Ref. [222]).

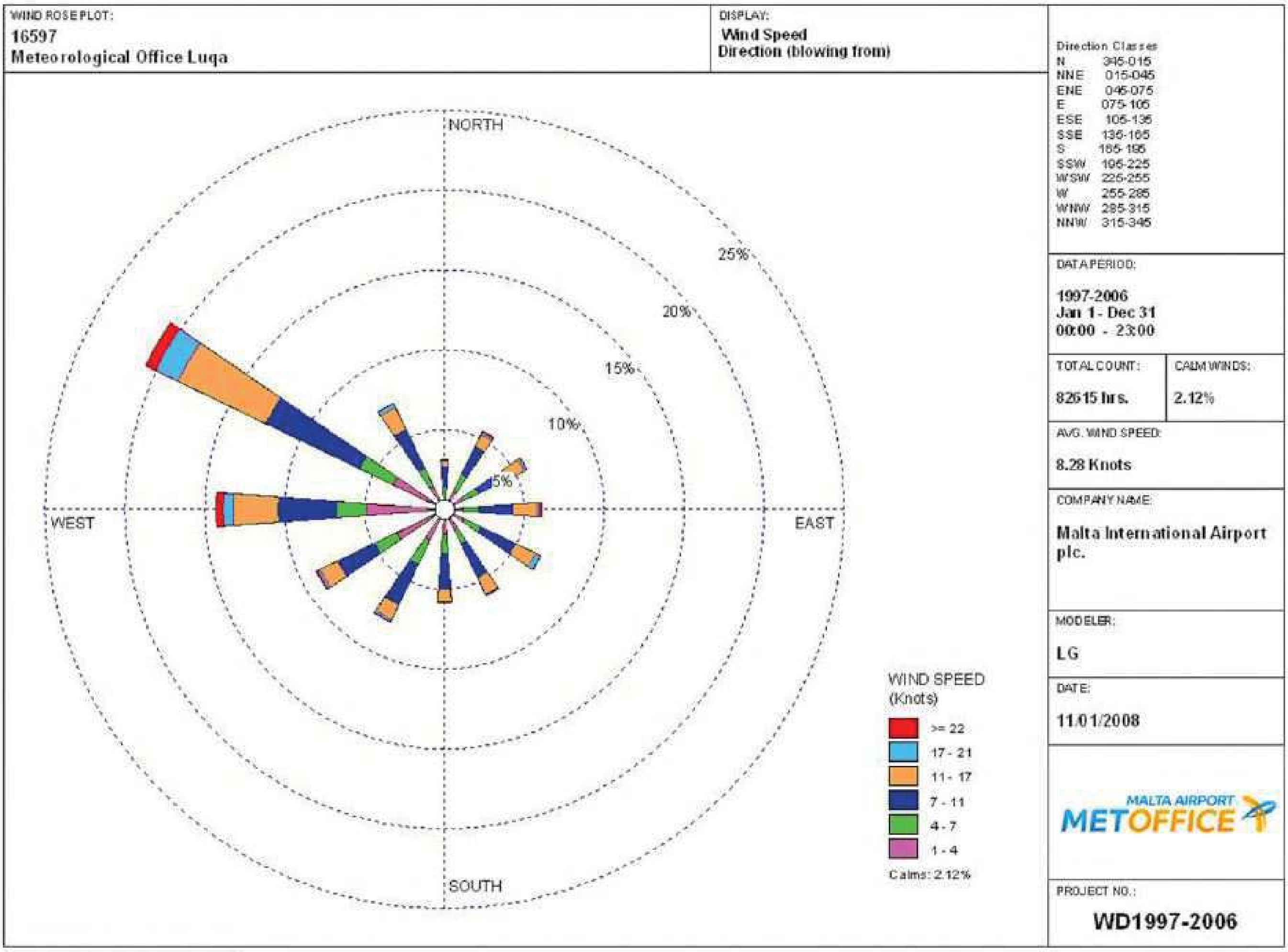

Figure 1 – Wind Rose by the Malta Airport MetOffice for the period 1997-2006

The prevailing wind direction is NW-W.

The same report (Ref. [222]) shows the highest average wind gust with a speed of 47 knots (24.2 m/s) but there is not a specific design value for wind action on civil structures. For this reason, the wind speed used for structural calculations will be 31 m/s according to Ref. [42], which is applicable for Italian Islands (i.e. Lampedusa).

4.4.4 Wind conditions at Gela

The wind rose at Gela has been elaborated using the data of the Military Aeronautics station for the period 1971-2000 (Ref. [223]).

The prevailing wind direction is W-SW

The wind speed used for structural calculations will be 28 m/s according to Ref. [42]

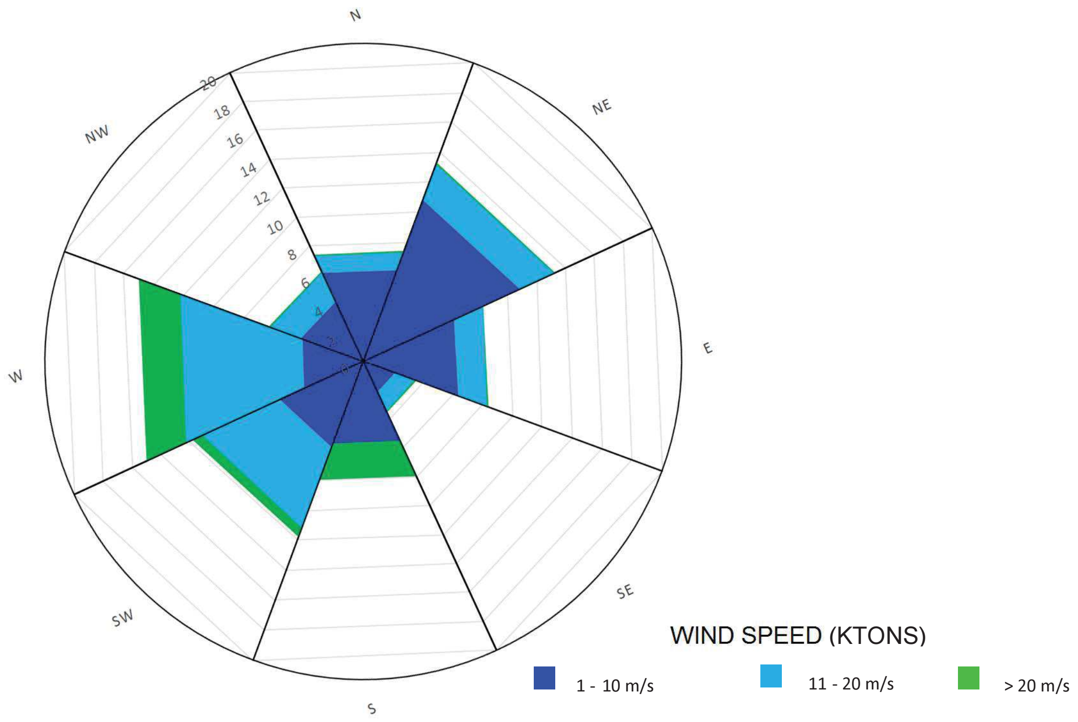

Figure 2 – Wind Rose for the period 1971-2000 (elaborated from Gela Station of Military Aeronautics)

4.4.5 Meteoceanic data

HOLD – data to be provided by Client after PMRS.

4.5 Topography and geotechnical data

Topographical and geotechnical data will be available after surveys completion; for the onshore sections, surveys will be performed by CONTRACTOR while for the offshore section data will be provided by Client after PMRS.

HOLD for offshore section– data to be provided by Client after PMRS.

4.5.1 Bathymetric Data

HOLD – data to be provided by Client after PMRS.

4.6 Seabed Morphology

HOLD – data to be provided by Client after PMRS.

4.7 Seabed Geotechnical Data

HOLD – data to be provided by Client after PMRS.

4.7.1 Seismic data

Onshore

All buildings, structures including stacks and foundations shall be designed to withstand earthquakes and seismic shocks as relevant to the Maltese Islands as per international codes and to at least one higher grade as appropriate to this type of development.

Plant and structures shall be designed to withstand an earthquake with a peak ground acceleration of 15% gravity. The design base shear is to be determined according to the following codes:

	EC8-2013	**IBC 2015**	**UBC 1997**
Seismic zone & intensity	Third $a_g = 0.15\ g$	$Ss = 0.4\ g$, $S_1 = 0.095\ g$ Design category C	2A $Z = 0.15\ g$

For the Italian part all buildings, structures including stacks and foundations shall be designed following the D.M. 17/1/2018 Ref[42], in particular plant and structures shall to withstand a design earthquake with a peak ground acceleration of 10% gravity, therefore should be used a zone factor of 0.1; however also for the Italian part can be considered a zone factor 0.15 with a peak ground acceleration of 15% gravity to have the same factor for the whole project.

The parameters before indicated shall be considered as minimum requirements, but the specific parameters related to the site will be provided after the geotechnical survey, in particular for the Italian section the Vs will be investigated by geophysical investigation MASW type.

Offshore

HOLD – data to be provided by Client after PMRS

Input Data available from public sources (i.e. not within the PMRS SOW) will be gathered during FEED and reported in the relevant documents (see dedicated sections of the present report).

5 METHODOLOGIES AND CRITERIA

5.1 General Design Methodology and Criteria

The following general design methodology criteria will be applied both to the Onshore and Offshore sections.

5.1.1 Corrosion Allowance

The fluid composition reported in Sec. 4.3.2, indicates that the transported fluid contains CO_2; however, since there is no free water (even considering the maximum water dew point of -5°C at 70 bar), no corrosion mechanism is expected and no corrosion allowance is foreseen for onshore/offshore pipeline. However, the detailed material selection (doc. 10-RM-E-3000) foreseen during FEED activities will define further the matter of corrosion allowance and external/internal coatings.

According to the information available at this stage, sour service requirements are excluded.

During the future project phases, above considerations shall be deeply investigated and updated on the basis of future available data such as more detailed fluid composition, corrosion studies, etc.

5.1.2 Coatings

Final coatings will be selected during FEED. However, the following external coatings were selected in the previous Basic Design phase:

Coating Layer	Description
External Anti-Corrosion Coating	3LPE, thickness 3.5mm
Internal Flow Coating	Liquid epoxy paint thickness 60/90 µm
Concrete Coating	CWC, thickness ranging from 40mm to 140mm

Table 5-1 – Coating Data from Basic Design

External Anti-Corrosion Coating is necessary for protection from external corrosive environment (seawater/soil), together with specific cathodic protection systems for both offshore and onshore. Typical value of 3LPE coating is 950kg/m^3 (ref [66]).

Internal coating is applied as flow improver and internal cleanness but not for corrosion protection purposes being the transported fluid dry-sweet gas (see also point 5.1.1).

Concrete Coating will be selected for vertical/lateral pipeline stability and, eventually, for protection purposes. Concrete material with density 2400 kg/m^3 and 3040 kg/m^3 will be considered during FEED phase.

5.1.3 Burial Requirement

According to previous Basic Design, the pipeline shall be buried in the onshore sections with a minimum cover at the top of pipe of 2.0 m. The burial depth shall be determined along the route during the FEED Design according to the requirements of the applicable codes and of the infrastructures/services owners.

The pipeline burial in offshore section will be evaluated during FEED based on lateral stability, global buckling and protection requirements. Moreover, the offshore pipeline buried depth shall be subject to "Risk Assessment of Pipeline Protection" and shall be defined during FEED activities.

Location	Pipeline Burial Depth (from the pipeline top)
Onshore Sections	2.0 m
Offshore Sections	To be defined during FEED activities based on protection requirements

Table 5-2 – Pipeline Minimum Burial Depth

5.2 Onshore Design Methodology and Criteria

5.2.1 Onshore Route Selection

The following general considerations shall be assessed for onshore route selection:

- Minimize the total Pipeline length and number of direction changes / bends
- Avoid the Pipeline routes through critical areas, such as oil / gas fields, plants, unstable seabed zones and seismically active areas, Populated locations etc.
- Avoid inclinations that would make pipeline pigging impossible;
- Avoid as much as possible areas with environmental constraints (i.e. natural protected areas, protected habitats according to Natura 2000 directive, etc.);
- Minimize the number of crossings of rivers, roads, railways, other pipelines and utilities.
- Route the pipeline through an existing corridor(s) requiring minimum safety distance from the existing lines

For the onshore pipeline on the Italian side, the following shall be considered too:

- Block valve stations, using remote controlled Valves, are requested to sectionalise the pipeline in case of railway crossing according to Italian laws, "D.M. 04/04 2014 (Ref. [44]); number two railway crossings are foreseen along the pipeline route, therefore the installation of number three VS shall be necessary along the onshore route.
- The direct interference with habitat 92D0 will be avoided.

- The interference with the river/watercourse safeguarding buffer area (150m from the riverbed) of "Canale Priolo" will be minimised.
- With reference "Landscape Plan of the areas 6, 7, 10, 11,12 and 15 falling within the Province of Caltanissetta" the interference with designated area as "Tutela 2" shall be minimised, while direct interference with designated area as "Tutela 3" shall be avoided.

For the pipeline on the Malta end, the following shall be considered too:

- The typology of shore approach will be trenchless methodology to arrive directly in to the plant area, anyway the onshore pipeline route design will follow the general consideration above mentioned.

5.2.2 Main Onshore Crossings

The Italian portion of the onshore pipeline will interfere the following main infrastructures/services:

- Provincial Road N° 82
- N.14 Municipal Roads (paved and unpaved)
- Railway Gela – Catania
- Oil Pipeline ENIMED ND 200 (8")
- Canale Priolo
- State Highway N° 115
- N.7 Water supply pipes
- Provincial Road N° 51
- Railway Canicattì – Siracusa
- N.2 Ethylene Pipelines Gela-Ragusa
- SRG Pipeline "All. Le Serre" of Gela ND 150 (6")

Upstream and downstream the railway crossings the installation of block valve stations have been foreseen.

5.2.3 Onshore Crossings

The crossing of existing buried pipelines, cables, power lines or underground utilities will be (if possible) made at an angle between 60 and 90 degrees with a minimum clearance of 1 m. Highway and railway crossings will be made at an angle about 90 degrees to the road or rail center line by a thrust boring machine method, using casing pipe to ensure integrity of the pipeline under the loads due to the traffic. The minimum depth of cover will be 2.0 m below surface of the paved roads. Track and minor road crossings will be crossed using open cut methods.

Crossings of rivers, canals and streams will be designed to ensure integrity of the pipeline under all conditions of the water flow. The minimum depth of cover shall be 2 m below the river bed.

At the end of the Italian section, close to the beach, will be located the golden weld connecting between the onshore and the offshore pipeline.

5.2.4 Onshore plants

Onshore plants will be foreseen at the ends of the pipeline. Suitable scraper launcher and receiver traps (bi-directional type) will be provided at the plants for the internal cleaning/inspection of the pipeline, together with metering and pressure regulation units. The metering unit at Delimara will be Fiscal type, while at Gela the Fiscal Metering will be inside the Snam Rete Gas Terminal.

Scraper launcher and receiver traps will be provided suitable for the running of intelligent pigs for corrosion detection or maintenance operations.

The pipeline will be suitable to allow pigging operations for internal inspection using an intelligent pig, as well as cleaning pigs for the removal of any debris in the pipeline. The variation in internal diameter along each pipeline will be minimized, in order to minimize obstructing the passage of cleaning pigs and intelligent pigs.

Each plant will be located inside fence panels.

According to Client instruction, the outlet at Malta Terminal will have at least 5 outlets:

1. one for DPS Unit D4 (with fiscal meter between 0 and 50,000 Sm3/h,
2. one for DPS Unit D3 with fiscal meter between 0 and 50,000 Sm3/h (for D3 connection it is necessary an additional gas pipe to be routed adjacent to the D3 plant),
3. one for future Power Plant additional connection (fiscal meter to be left flanged to ensure that future connection will not require pipeline stoppage),
4. two for future gas distribution connection (fiscal meter to be left flanged to ensure that future connection will not require pipeline stoppage).

The line for DPS Unit D4 and D3 (points 1 and 2 above) will be connected at the outlet in order to have also the possibility to feed DPS Units at 100,000 Sm3/h.

Furthermore, given the sensitivity of the Delimara Terminal Plant next to the operating plant (and gasoil tanks) and adjacent to a touristic village, and knowing the fact that this was an issue during the Authorization Process for the Regassification Plant, it is envisaged that instead of a cold vent, at DPS, shall be installed a NVCC. During the FEED studies it will be also verified and confirmed the philosophy to be followed in Gela.

5.2.5 Block Valve Stations

The block valve station shall be provided with de-pressurizing vent for pipeline venting to atmosphere.

Block valve assemblies shall be equipped with instrument connections to permit the attachment of pressure gauges and pressure transmitters. Connections will be valved so that equipment may be connected or disconnected on-line without depressurizing the pipeline.

Valves shall be provided with remote control, to be operated directly to the control room and all block valves will be provided with by-pass line sized to equalize pressure on either side of the valve.

Each VS will be located inside fence panels.

5.2.6 Cathodic Protection Systems – Onshore

To protect the buried sections of the onshore pipeline from external corrosion, an adequate external coating (Sec. 4.2.5), suitable for cathodic protection application, plus a suitable impressed current cathodic protection system is foreseen while, for the above-ground part, an appropriate painting system will be selected and specified.

The cathodic protection system will be designed to guarantee a minimum protection potential selected as a function of soil resistivity conditions and of anticorrosion coating, in accordance with EN ISO 15589-1. A maximum protection potential not more than -1.2V (i.e. IR-free condition) versus Cu/CuSO4 saturated half-cell reference electrode will be assured to prevent disbondment and/or blistering of the coating. Alternatively, a minimum of 100 mV of polarization as measured between the structure surface and a stable reference electrode contacting the electrolyte can also be considered as a protection criterion. Formation or decay of polarization shall be measured to satisfy this criterion. This method is most commonly used for structures that are bare, poorly coated or in contact with earthing systems where it is difficult to achieve the IR-free potential criterion.

Cathodic protection current density values will be selected according to EN ISO 15589-1 for the onshore pipeline section, and according to EN 14505 for buried metallic structures (i.e. piping, rebars in concrete and earthing system) in Gela and Delimara plants.

Insulating joints will be foreseen at both terminal plants inlet/outlets and Sicily shore approach (at Malta shore approach is not foreseen any insulating joint because is practically the plant inlet). At least n.7 insulating joints are envisaged for the Project.

An impressed current cathodic protection system will be considered feeding shallow groundbeds at Gela and Delimara plants, and a deepwell vertical groundbed for the Italian onshore pipeline section. Anodes alloy will be selected according to soil conditions. A monitoring system is foreseen at the terminal stations.

5.2.7 Onshore Wall Thickness Selection

The minimum required wall thickness will be assessed according to the following criteria, stated in D.M. 17/04/2008 (Ref.[43]), D.M. 04/04/2014 (Ref.[44]), ASME B31.8 (Ref.[20]) and ISO 13623 (Ref.[96]):

- Internal pressure containment;
- Class location;
- Main Road and Railway Crossings.

The effect of combination of external loads in addition to internal pressure will be considered in other specific analysis and relevant report (i.e. railways and road crossings).

The selected pipe wall thicknesses will be considered in subsequent analyses so that the final value can be increased if required, in particular from:

- Stress Analysis calculations
- Bending requirements (field and prefabricated bends)

5.3 Offshore Design Methodology and Criteria

5.3.1 Offshore Route Selection

The new pipeline from Gela (Sicily) to Delimara (Malta) shall be designed according to the criteria and methodology of ISO 13623 and DNVGL-ST-F101.

Criteria and methodology relevant to each offshore pipeline design activity will be described in detail in the relevant project documentation.

A short description of the methodology relevant to the main design activities of the pipeline is reported in the following sections.

The pipeline route will be defined basing on the previous project phases and the results provided by PMRS Contractor.

Route corridor selection will be performed considering the following:

- minimize route length;
- the route shall lie within the route corridor identified;
- the horizontal radius at turn points along the route shall be selected on the basis of layability and of curve lateral stability;
- risks related to on bottom obstructions, seabed features and geohazards shall be avoided/minimized;
- presence of environmentally or cultural heritage sensitive areas;
- seabed lithology;
- requirements from Third Parties and Authorities;
- the crossing area shall be minimized and crossing constraints shall be regarded;
- the lay-out at the shore approaches shall take into account the installation phases and the more probable procedures for the construction/installation works;
- any other constraint along the route (existing and planned) with potential impact on constructability, safe operation and accessibility.

5.3.2 Offshore Wall Thickness Selection

The minimum required wall thickness will be assessed according to the following criteria, stated in DNVGL ST F101 (Ref.[71]):

- Internal pressure containment;
- External pressure collapse

- Propagation buckling.

In addition, within Italian territorial water, the requirements of D.M. 17/04/2008 (Ref.[43]) will be considered.

Effect of temperature will be considered in this calculation only for decrease in steel properties (SMYS derating) considering the curves suggested in DNVGL ST F101 (Ref.[71]). The effect of combination of external loads in addition to internal/external pressure will be considered in other specific analysis and relevant report.

The wall thickness selection takes into account the results of structural integrity analyses in the following conditions:

- Empty pipe;
- Hydrotest;
- Operating;
- Shut down.

The selected pipe wall thicknesses will be considered in subsequent analyses so that the final value can be increased if required (as detailed in other sections of the present document), in particular from:

- On bottom stability requirement
- Bottom roughness, free-spans, crossings, global buckling analyses
- Integrity during installation
- Protection purposes (trawl gear, dropped object, sinking)

5.3.3 On Bottom Stability

The scope of this analysis is to define the minimum pipe submerged weight necessary to guarantee the lateral and vertical stability of the system subject to hydrodynamic forces due to the action of the waves and currents. The analysis will be carried out through analytical calculations by means of an in-house software in accordance with DNV RP F109 Ref.[76].

Corrosion will be treated as follows:

- In temporary condition, the pipeline is considered not corroded;
- in operating condition, the loss in weight of only half of the corrosion allowance (if any) will be considered, since the corrosion is never homogeneously distributed on the internal surface.

If the steel pipe will be found to be unsuitable for stability, the main solution will be adding CWC thickness to the pipe. However, also other remedies will be evaluated: increase of steel wall thickness, consider additional stabilizing systems (mattresses, counteracts), trenching/burial.

Wave and current directionality will be considered for each change of pipeline direction along the route. If required, seasonality will be considered (only in temporary condition).

A 2% water absorption in concrete weight will be considered in both temporary and operating phase, since for stability the assumption is conservative because a lower weight makes the pipeline unstable.

Stability due to seismic events (e.g. soil liquefaction) will be also investigated.

Density of 2400 kg/m^3 and 3040 kg/m^3 will be considered.

5.3.4 Pipeline Bottom Roughness Stress Analysis

This is a static analysis aimed to determine the configuration of the pipeline laid on the seabed profile along the route, for the different conditions during its design life. The scope is to identify:

- The state of stress of the pipeline: the main criterion considered will be the Local Buckling Unity Check – Load Controlled of DNVGL ST F101 (Ref.[71]). Locations where allowable code check will exceed limits (if any) will be identified and a further analysis will be performed considering specific intervention works (presented as separate report).
- The length and height of the free span along the final route, which will be compared to the allowable values given from the criteria of DNV RP F105 [74], (calculated in a separate report).

The following conditions apply:

- As-Laid (Empty)
- Flooded (filled with water)
- Hydrotest;
- Operating;

The pipeline bending stiffness will be calculated considering the uncorroded nominal steel thickness and the stiffening effect of concrete, while for the mechanical strength only the pipe steel (full corroded) will be considered.

A 5% water absorption in concrete weight will be considered in both temporary and operating phases, since for stress the assumption is conservative because a higher weight increases pipeline stresses.

The static free span analysis is included in this activity and will be performed by means of a dedicated commercial FEM software. (Sage Profile 3.1). The roughness analysis will be performed using by DTM (Digital Terrain Model) file, based on 3D survey data.

5.3.5 Pipeline Expansion Analysis and Global Buckling Susceptibility Analysis

The objective of the analysis is to assess the propensity of the pipeline to develop global buckling under operating conditions.

Global buckling (upheaval or lateral) will be analysed by means of a 3D FEM Software which takes into account the real sea bottom data along the route and pipeline condition (e.g. buried sections).

If the pipeline will be found to be susceptible to global buckling occurrence, mitigation measures will be considered.

In particular

- For buried sections of pipeline subjected to upheaval (vertical) buckling the backfilling requirement counteracting the phenomenon (if any) will be determined.
- For the pipeline laid on seabed pipe stress in the post-buckling shape will be evaluated and if found to be unacceptable remedial actions will be considered (e.g. trenching, buckling triggers, snake lay).

Reference will be made to DNVGL RP F110 (Ref.[78]):

Please note that lateral bucking triggered by trawling loads will be analysed in a separate report as detailed in a dedicated section of the present report.

The lateral buckling will be studied in the following steps:

1- Analytical global buckling susceptibility check will be done in accordance with methodology outlined in DNVGL-RP-F110. Hobbs formulation will be used to validate the critical buckling force;

2- The global buckling FE analysis to verify the post-buckling configuration (if any).

The global buckling will be performed using by DTM (Digital Terrain Model) file, based on 3D survey data, by the software Sage Profile 3.1.

5.3.6 Cathodic Protection Design Offshore

The pipeline protection against corrosion will be ensured by a combination of coating and Cathodic Protection provided by sacrificial anodes Indium-activated Aluminium alloy, which is the commonly used material for offshore pipelines. For the purpose of the project half-shell bracelet type sacrificial anodes will be selected; anodes size and spacing will be provided.

Bracelet anodes to be installed on pipes with CWC will be “squared type”, considering that the maximum anode external diameter shall not exceed the outer concrete diameter. Different anodes geometries will be considered in order to match with the different CWC thickness that will be selected (if applicable). For sections where CWC is not required (if any), anodes with tapered edges will be considered.

Analysis during Design phase will be performed according to Refs. [79] and [98].

Material specifications covering anodes manufacturing and anodes installation will be provided.

5.3.7 Pipeline/Soil Interaction Study

The study will include the analysis of soil type along the route and relevant design parameters, such as initial pipeline embedment, friction factors, axial and lateral soil resistance and soil spring stiffness values.

5.3.8 Geohazards

The following activities related to the interaction of the pipeline with geohazard causes will be carried out:

- PSHA study:

The definition of seismic design data (profiles of Peak Ground Acceleration-PGA, Peak Ground Velocity-PGV and Uniform Hazard Spectra-UHS) will be evaluated through a complete PSHA study at design return period (e.g. 100 and 10000 years according to Ref. [71]). The PSHA will be carried out following the Cornell (1968) approach and will be based on a logic tree structure to evaluate the worst scenario.

- SSRA study:

A seismic site response analysis will be carried out to evaluate the acceleration at the seabed. The acceleration obtained from the PSHA will be used as an input for this study, the geotechnical data gathered by PMRS will be then used to build a model of the sediments overlaying the bedrock in order to evaluate the possible amplification of the bedrock acceleration toward the seabed.

- Active fault crossing assessment and design:

The active faults capable of generating earthquake will be identified basing on the review of scientific literature regarding the geological and tectonic framework of the area of interest and on the interpretation of geological and geophysical survey results. The expected fault displacement and sense of movement will be established in order to define appropriate pipeline design.

- Soil liquefaction assessment under seismic and wave loads:

From the results of the PMRS, route sections with potentially liquefiable soils will be identified.

For these sections, Contractor will assess the potential for seismic induced liquefaction for relevant earthquake return periods.

The potential for wave-induced liquefaction will be evaluated for relevant storm return periods, based on soil characteristics and water depth.

The study will be carried out in those sections where the waves characteristics allow a possible interference with the seabed. At the landfalls the study will not be carried out in case of HDD or micro tunnelling methodologies will be selected during the route selection process.

- Pipeline Seismic Shaking Assessment:

Based on the results of the PSHA, SSRA studies and soil characteristics along the route, the effects of strains induced on the pipeline by travelling seismic waves will be evaluated and combined with the operating strains.

The resultant strains will be checked against the allowable limits stated by relevant codes.

- Slope stability analysis (onshore and offshore):

Potentially unstable slopes along the route will be identified and categorized basing on their criticality for the pipeline.

Slope stability will be assessed for both static and seismic condition, considering the relevant earthquake return period.

- Metocean Study Review / Update:

The metocean design parameters provided by PMRS Contractor will be reviewed and updated, if required.

- Sediment Transport/Seabed Scouring and Coastal Evolution Studies shall be performed for Gela landfall.

The maximum seabed variations expected during the pipeline lifetime as well as the expected shoreline evolution trend (erosion/deposition) will be defined in order to define a proper design beach profile.

This study will be carried out only in case that the open trench is the installation method selected at Gela landfall or in case some additional trenching is still required at the HDD exit.

5.3.9 Layability Analysis

Results of the preliminary static lay analyses at the maximum water depth for each relevant combination of pipe wall thickness and concrete coating thickness will be presented. Since at the present phase the actual lay vessel and respective RAO's are unknown, dynamic analysis is excluded and shall be performed by the EPC Contractor considering actual lay data and weather installation window.

Moreover, a bend stability check will be performed in order to identify the minimum stable bending radius along the route for the relevant section.

Lay vessel properties in terms of tensioner capacity, stinger/ramp length and radius, supports maximum loads will be provided.

The installation strategy/procedure will be defined in terms of number of involved Lay-Barges/Lay-Vessels and location of AWTI.

Minimum operational draft will be identified for different scenarios, based on the selected lay, shore approach and AWTI installation procedure.

A pull in analysis will be carried out based on the final installation procedure chosen at the shore approaches.

The most promising area for the AWTI will be identified and preliminary analysis performed; the main scope will be to provide requirements in terms of davits number, layout and capacity.

The following assessments will be carried out during FEED phase:

- Contingency cases such as wet buckle;
- Installation Laybarge dead band identification (lower and upper bound lay tension sensitivity);
- Optimization of the lay barge ramp (based on ramp/stinger curvature radius);
- All analyses necessary to define the shore approach layout and the sizing of the marine spread/equipment will be investigated.

The main criterion considered for the state of stress of the pipeline will be based on DNVGL ST F101 (Ref.[71]).

The pipeline bending stiffness will be calculated considering the uncorroded nominal steel thickness and the stiffening effect of concrete

A 5% water absorption in concrete weight will be considered in the pipe section below water level, since for stress the assumption is conservative.

Analysis will be performed by means of a dedicated commercial FEM software.

5.3.10 Free Span Analysis

The static analysis of the free spans along the pipeline route is already included in the bottom roughness analysis as described in the above sections, while the free span analysis against dynamic loads will be carried out according to Screening Criterion of DNV RP F105 Ref.[74], which provide a fatigue life in excess of 50 years.

The actual pipeline free spans length along the route profile (identified through the bottom roughness analysis, see previous sections) will be checked to comply with the screening criteria of; where acceptance criteria are not fulfilled, proper pre/post-lay intervention works will be defined.

Where the screening criterion is not applicable, a response model fatigue approach will be followed according to DNV RP F105 Ref.[74].

Limit bending moment with respect to yielding / local buckling limit states will be provided in both permanent and temporary phases.

5.3.11 Fishing Gear Interaction and Protection Study

The analyses will be performed as per Ref. [75]and Ref.[77] with respect to:

- Dropped object analysis;
- Indentation due to trawl interaction;
- Hooking analysis;
- Pullover analysis (including analysis of lateral buckling triggered by trawling loads, if any).

5.3.12 Intervention Works Design

Intervention works (if any) due to free span length reduction, pipeline protection, crossing, stability, etc will be considered in the design both before and after laying.

5.3.13 Crossing Assessment

The following crossings are highlighted along the route, based on previous design phase:

Crossing °N	Crossing ID	Crossing Type	Crossing KP	East (m)	North (m)	Crossing Angle (deg)
1	SEA-ME-WE-3	pipe on cable	35.096	446084.9	4068591.7	49.8
2	SEA-ME-WE-4	pipe on cable	38.300	446926.5	4065599.3	75.0
3	AAE-1	pipe on cable	45.800	448988.1	4058268.8	70.0
4	MINERVA	pipe on cable	62.277	456500.5	4043703.0	30.4
5	MaSi	pipe on cable	62.547	456634.3	4043470.0	29.9
6	SEA-ME-WE-5	pipe on cable	79.487	463857.9	4028368.7	57.2
7	MELITA-1	pipe on cable	86.737	464383.2	4021137.8	30.9
8	LEV	pipe on cable	91.939	464760.1	4015948.8	53.7
9	MENA	pipe on cable	93.604	464880.7	4014288.7	56.2
10	ALEXANDROS	pipe on cable	103.873	465624.6	4004046.5	53.2
11	HAWK	pipe on cable	106.348	465804.0	4001577.6	53.1
12	I-ME-WE	pipe on cable	106.393	465807.2	4001532.9	53.1
13	SEACOM	pipe on cable	118.348	466673.3	3989609.0	53.1
14	GO-1	pipe on cable	122.861	467000.3	3985107.8	69.8
15	VMSCS	pipe on cable	128.794	467430.1	3979191.0	75.1

Crossings will be updated after PMRS.

A minimum vertical separation of 500mm and a minimum angle of 30° will be considered in the design.

Crossing Design will be performed considering also the allowable free span length derived by VIV analysis.

5.3.14 Shipping and Marine Traffic Assessment

The scope of this report is:

- To provide information relevant to marine traffic activities in the project area from available fishing studies, statistics, literature data, port authority data, monitoring on the area, marine data repository;
- To define vessel size and frequency of possible interaction along the pipeline corridor;
- To show and discuss the results of the AIS data pre-processing activities performed on the available AIS data.

The information relevant to fishing activities will be used as input data for the “Fishing Gear Interaction Report”.

5.4 Landfall Construction Methodology

Pipeline installation with conventional methodology of the open trench has been assessed during Basic Design study at Gela landfall. This methodology implies an excavation of a trench and the backfilling with the excavated material causing an unavoidable disturbance to the archaeological areas crossed in proximity of the shore. For this reason, and as highlighted by Client, at Gela a trenchless solution will be studied as a preferable option.

At Malta, on the base of the preliminary geotechnical survey, it is confirmed the preliminary feasibility of an HDD.

In light of the above, the scope of this activity is to assess the feasibility of the pipeline shore approach with an HDD methodology at both Malta and Gela landfall, on the basis of survey data (onshore and offshore).

The construction and installation activities required for the complete execution of the work, including the onshore site preparation, offshore pre-trenching, pipe string preparation and Horizontal Directional Drilling will be identified.

The minimum requirements for the HDD profile and for the seabed transition at the near shore section will be defined and the pipeline integrity will be checked in accordance with DNVGL ST F101 [71].

5.5 PIPING DESIGN CRITERIA

5.5.1 Piping Philosophy

The following piping design philosophy will be applied during FEED:

- Piping considered with break flanges but only when strictly necessary so that equipment or part equipment that requires maintenance (exchangers, tube bundles, pumps, etc. can be removed without removing block valves or all the lines connected to the equipment.).
- Pipes will be designed in order to avoid liquid or gas pockets; a vent for gas pockets and a drain for liquid pockets shall be provided.
- Branches from liquid product headers will be generally made on the bottom of pipes.
- The use of flanges on pipes will be minimized and anyway limited to:
    - connecting lines to equipment
    - connecting flanged elements installed on line
    - on pipes which have to be removed for particular service and maintenance.
- Whenever possible and as per safety studies, plant areas where are located flanged connection shall be equipped with gas detectors.

5.5.2 Piping Class Specification

Piping class specification will be produced according to ASME B31.3 (Ref. [19]), ASME B31.8 (Ref. [20]) and process data (see Sec. 4.3).

5.6 Civil Works General Design Criteria

The part of the FEED for the Malta/ Sicily Gas Pipeline Interconnection, relative to civil works, include two terminal stations, three block valve stations, and other related items onshore pipeline.

The following main codes and standards will apply for the civil design in the project activities. Other international and local standards/codes may be added during project execution.

For Italy Gela Terminal and Italy Block Valve Station:

D.P.R. 6/06/2001 n.380: Testo unico delle disposizioni legislative e regolamentari in materia edilizia

Circolare 2/02/2009 n. 617: Istruzioni per l'applicazione delle “Nuove norme

tecniche per le costruzioni” di cui al D.M. 14/01/08.

D.M. 17/01/2018:” Aggiornamento delle Norme tecniche per le costruzioni”

For Malta Delimara Terminal:

Eurocode 0: Basis of structural design

Eurocode 1: Actions on structures - General actions

Eurocode 2: Design of concrete structures

Eurocode 3 Design of steel structures

Eurocode 7 Geotechnical design

Eurocode 8 Design of structure for earthquake resistance

Subsidiary legislation 513.02 “Avoidance of damage to third party Property regulations”

Subsidiary legislation 552.09 “Environmental management Construction site regulations”

5.6.1 Concrete works

Concrete items will be calculated and carried out according to Eurocodes / NTC 2018 and shall be made with minimum concrete compressive strength class C30/37, for reinforced concrete and C12/15 for lean concrete.

Steel bars for concrete reinforcements shall be made of B450C steel or equivalent.

All general procedures and criteria will be indicated in the Doc. “Design specification and criteria for civil works”.

5.6.2 Steel Structures

Steel structures will be calculated and carried out according to Eurocode / NTC 2018.

Steel shall have minimum yield strength fy = 275 N/mm^2.

5.7 Electrical Design Criteria

Electrical Design activities performed during the Basic Design are limited and only general requirements have been found. Therefore, Contractor will develop the design of the electrical system according to the applicable standards/code following the criteria reported in the following sections.

5.7.1 Electrical Systems Design Scope of Work

The scope of work for the electrical systems includes: the analysis of the power supply and distribution installations under normal and emergency conditions; the definition of electrical components; the electrical installation systems; including cables, lighting, earthing and cables routing.

The electrical power supply for the Terminal and Block Valve Stations in Italy shall be request to Grid Operator of Distribution Energy in Low Voltage. The power supply will be connected to LV switchgear into the Control building.

This building contains all electrical and instrumentation switchboards.

The electrical switchgears to be installed will be: LV switchgear, rectifier (usually included in LV switchgear), UPS, diesel generator panel (and instrumentation panel).

The electrical feeding system at Delimara Terminal in Malta will be similar, but the electrical power supply shall be furnished by the near Power Plant. For this purpose, the required power at Terminal Station will be calculated (KVA/MVA) and the power availability verified with the Power Plant (connection will be from circuit breaker provided by Enemalta up to terminal including any required transformers). Client will give assistance to get the existing cable routing and relevant information on the available power source from the Power Station.

Diesel generator is foreseen at terminal stations for power back-up purposes. At BVS only UPS are foreseen due to the very low power loads expected.

The Basic Design has foreseen at Delimara Terminal provisions for the connection to electrical heaters needed for the 2nd phase of the project (gas from Malta to Italy). Contractor highlights that also for the 1st phase it is envisaged the needed of heating for some particular operating conditions. During the FEED activities the selection of the heaters will be evaluated considering the two phases duties in order to minimise the orders/installations and avoid any plant stoppage in future.

All diesel tanks, transformer oil tanks, etc., shall be enclosed in a bund (or alternative methods) to avoid land contamination in case of leaks. Bunds shall have a capacity of 110% compared to the tank size.

5.7.2 Electrical Standards and Regulations

This design criteria refers to the latest edition of the International Electrotechnical Commission (IEC) Codes standards and to latest edition of the applicable documents issued by the European Committee for Electrotechnical Standardisation (CENELEC).

The design of the electrical installations and the selection of the materials shall comply also with the Local Certification Authorities.

Electrical equipment and materials shall be selected in accordance to the minimum requirements stated, in specific project's documentation (i.e. technical/supply specifications, technical data sheets, etc.) and in the relevant Client's standards (if any).

In particular the following main European Directive will be followed:

- Low Voltage Directive (LVD) "Directive 2014/35/EU relating to electrical equipment designed for use within certain voltage limits"
- ATEX Directive (ATEX) "Directive 2014/34/EU relating to equipment and protective systems intended for use in potentially explosive atmospheres"
- EMC Directive (EMC) "Directive 2014/30/EU relating to electromagnetic compatibility"
- Construction Products Regulation (CPR) "Regulation (EU) No 305/2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC"

In addition, the Supply for Italian installations shall comply with Italian Government Rules and Regulations relevant to Health, Safety and Environment, whereas the supply for Maltese Installation shall comply with Subsidiary legislation 423.39 - Electrical installations regulations.

5.8 Instrumentation and Automation Design Criteria

The gas pipeline will be operated under control of a dedicated SCADA system which will be connected with the Pipeline DCS at the Main Control Room located in Delimara Terminal Station.

Pipeline DCS will in turn be connected to Delimara Power Plant DCS.

Delimara Terminal will be directly monitored and controlled by the Pipeline DCS while Gela Terminal and Block Valve Stations (BVS) will be monitored and controlled as remote operating facilities.

BVS will be provided with RTU's for the interface with the Master Terminal Unit (MTU) in Gela Terminal which will be connected to Delimara Terminal.

5.8.1 SCADA

SCADA will gather all the peripheral signals in order to monitor the operating parameters of the off-site facilities. Operational data will be stored for retrieval and particularly alarm signals which will involve emergency operations will be displayed to the operators via DCS console.

All emergency procedures will be actuated from off-site facilities either in automatic or under manual control and monitored by the SCADA system.

SCADA will exchange real time information as well as historical data with DCS.

SCADA will collect data through the TLC systems provided for the following connections:

- Delimara Terminal and Gela Terminal
- Gela Terminal and onshore BVSs

5.8.2 Delimara Terminal Station

The following main equipment will be installed in the Delimara Terminal:

- n° 1 Pipeline DCS
- n° 2 Pressure Regulating System SKIDs
- n° 2 Fiscal Metering System SKIDs with Ultrasonic Flow Meters
- n° 1 Fiscal Metering System SKID with Turbine Flow Meter for Fuel Gas feeding NVCC pilot system
- n° 2 Gas Analyzer Cabinet
- n° 4 ESD valves
- field instrumentation (mainly pressure transmitters, differential pressure transmitters, pig signallers, level switches)
- on-off valves
- telephone system
- CCTV System
- main and back-up telecommunication systems
- n° 1 Control Room with 1 or 2 monitors (Main Control Centre)
- gas detection and fire-fighting system (as required according to the HSE studies)

5.8.3 Gela Terminal Station

The following main equipment will be installed in the Gela Terminal:

- n° 1 Main Terminal Unit (MTU)
- n° 1 Pressure Regulating System SKIDs
- n° 1 Fiscal Metering System SKIDs with Ultrasonic Flow Meters
- n° 1 Gas Analyzer Cabinet
- n° 2 ESD valves
- field instrumentation (mainly pressure transmitters, differential pressure transmitters, pig signallers, level switches)

- on-off valves
- telephone system
- CCTV System
- main and back-up telecommunication systems
- gas detection and fire-fighting system (as required according to the HSE studies)

5.8.4 Block Valve Stations (BVS)

The following main equipment will be installed in each of the n°3 BVS:

- n° 1 Remote Terminal Unit (RTU)
- n° 1 Block Valve
- field instrumentation (mainly pressure transmitters)
- telephone system
- CCTV System
- main and back-up telecommunication systems
- gas detection and fire-fighting system (as required according to the HSE studies)

5.9 Telecommunication Design Criteria

5.9.1 Telecommunication Between Delimara Terminal Station and Gela Terminal Station

Contractor plans to use FO cable as the main communication medium between Gela Terminal, BVSs and Delimara Terminal. Contractor shall identify and design any further infrastructure needed in order to connect the Gela Terminal station, the Block valve stations, and the Delimara Terminal stations to the existing communication infrastructure in order to provide a reliable source of communication.

The telecommunication link and relevant data transmission between Gela Terminal Station and Malta Terminal Station will be studied and defined during the FEED activities (i.e new Fiber Optica Cable, existing cables, etc.).

Also an alternative system as stand-by will be evaluated. That is, in order to allow emergency operation in case of disruption of fibre optics cable or failure, a back-up system dedicated to emergency communication shall be defined.

5.9.2 Telecommunication Gela Terminal Station and Block Valve Stations (BVS)

The telecommunication system (TLC) connecting Gela Terminal Station with the BVSs will be based on a new of Optical Fibre Cable (OFC) laid along the onshore pipeline.

In order to allow emergency operation in case of disruption of fibre optics cable or failure, a wireless (ex: GSM/GPRS) back-up system will be foreseen in the project.

6 MATERIAL SELECTION AND SPECIFICATIONS

6.1 Material Selection

Material selection will be carried out to enable pipeline, piping and equipment to meet the design life according to the established operating conditions.

Material selection will be according to NORSOK M-001 combined with experience and engineering judgement. However, as above stated, no free liquid water will be present and no corrosion mechanism is expected. Therefore, no corrosion allowance is expected for onshore/offshore pipeline. However, Corrosion rate and relevant corrosion allowance will be verified during FEED according to Norsok requirements.

Material selection will include general requirements on painting and external coating, which will be then treated in detail in the relevant FEED Documents (i.e. painting specification and pipeline anti-corrosion coating).

6.2 Material Specification

6.2.1 Pig Launcher/Receiver Trap

Equipment shall be designed according to the applicable codes (Ref. [20] and [43]) and to the instructions included in the technical documentation issued for the Project (the most conservative parameters will be applied for both pig traps).

In particular the end closure for pipeline launchers and receivers (pig traps) shall be designed according to ASME VIII, DIV. 1.

Pig traps for the natural gas pipeline shall be designed to accommodate In-Line Inspection (ILI) tools and other devices without interrupting the gas flow and the ongoing operation.

The internal diameter of pig trap barrels will be sized larger than the pipeline to which they are attached to facilitate insertion and removal of inspection and cleaning tools. The length of the pig trap barrels shall be sufficient to accept the longest expected ILI tool in the industries for the particular pipeline size to which the pig trap is attached. Pressure gauges and pig signallers shall be installed on all pig launchers and receivers.

An equalising line will be installed on the launcher / receiver barrel to ensure the safe pigging operations.

6.2.2 Line Pipes

During FEED activities, the confirmation of the pipeline diameter size selected in the Basic design phase (ND 22'') shall be deeply investigated and different type of line pipe (seamless, HFW and SAW) shall be compared in terms of cost, pros and cons.

Moreover, the advantage to use the same type of linepipe for the offshore and onshore section will be verified.

6.2.3 Bends

In order to accommodate changes in vertical or horizontal alignment in the onshore sections, pipeline bends will be made in the pipeline. Bends with a radius of 40D curvature may be accommodated by cold field bending of the pipe, bends with 5D radius of curvature (according to ISO 15590 standard) will be made using a qualified induction heating process. Bends smaller than 5D will not be allowed for installation in the pipeline. The designed bends will allow pipeline intelligent pigs to pass through.

The deviation along the offshore section will be done with elastic bends; the use of 5D induction bends will be avoided/minimised.

6.2.4 All Other Main Mechanical Items

For all the following main mechanical items, specification and data sheet will be issued considering good international engineering practice and according to the relevant codes and standards:

- pipeline main block valves (API 6D)
- barred tees (ASME B31.8)
- insulating joints (ASME VIII, Div. 1, App. 2 and ASME B16.5)
- filters (ASME VIII, Div. 1, EN 13445)
- pressure regulation skids (EN 12186)
- metering skids (ISO 17089-1, AGA 09, AGA 10, OIML R140)
- heaters (IEC 60364, EN 13445)
- vents (EN 13445)
- vessels (ASME VIII, Div. 1, EN 13445)
- diesel pumps (for fight fighting) (EN 12845)

7 HEALTH, SAFETY AND ENVIRONMENT (HSE)

HSE studies and workshops are foreseen during the FEED design activities in order to identify potential hazards and reduce the associated residual risk to ALARP (As Low As Reasonable Practice).

7.1 Safety Workshops

<u>HAZID/ENVID Study</u>

The HAZID/ENVID workshop shall be carried out to identify potential safety and environmental hazards and adequate safeguards to prevent or mitigate them.

The HAZID/ENVID workshop shall be led by a third -party Chairman, who has the responsibility of the correct application of HAZID/ENVID methodology (brainstorming approach based on standard set of guidewords).

<u>HAZOP Study</u>

The HAZOP study shall be performed by expert's team to identify potential hazard and operability problems and appropriate protection measures, according to last revision of P&IDs.

The workshop shall be led by a third-party Chairman, who has the responsibility of the correct application of HAZOP methodology, developed according to IEC 61882, ref. [85].

<u>SIL Assessment Study</u>

The SIL assessment study aims to identify the integrity level (probability of failure on demand) of safety functions to avoid safety, environmental and asset hazards. The SIL workshop will be carried out at the end of HAZOP study in the same session. It shall be led by a third-party Chairman who has the responsibility of the correct application of SIL methodology, developed according to IEC 61508/ IEC 61511, [87] and [88].

7.2 Safety Study

The HSE philosophy shall give the guidelines for all HSE studies and workshops, according to the National and International Standards and Good Engineering Best practice.

An independent philosophy will be developed for

- Fire & Gas Detection System, according to International Standards [130] and [131].
- Fire protection System, according the International Standards [130], [131] and [134]. Specific requirements from Authorities will be also considered.
- Noise and Vibration Control study, according to International Standards [100].

The Thermal Radiation and Gas dispersion Analysis shall be performed to identify the sterile area for the Cold vent and/or NVCC, according to API 521, ref. [11].

The Hazardous Area Classification shall be performed to identify the areas potentially affected by explosive atmospheres both in terms of probability (type of Zone) and extension of the Zones themselves, according to IEC 60079-10 and API 505.

The escape routes and safety signs layouts shall be developed for the GELA Terminal, Malta Terminal and each Italian block valve stations, according to the international standards [103], [104], [105] and [139].

The Quantitative Risk Assessment (QRA) for onshore and offshore pipeline sections and related facilities shall be developed to identify the Individual Risk per Annum (IRPA) and the Local Social Individual Risk (LSIR). The methodology shall be assessed in the HSE philosophy, where the requirements for the frequency assessment and the human vulnerability will be declared, according to [136], [137][141], [138], [89] and [219].

The Reliability, Availability and Maintainability (RAM) analysis shall be carried out according to BS 5760, ref. [37], in order to meet the minimum PROJECT Operational Availability, considering the equipment design and configurations, current sparing and maintenance philosophy.

All the recommendations raised from HSE studies and workshops shall be collected in the HSE Register, used for track and follow-up activities.

8 ANNEXES

8.1 Annex 1 - Minimum Gas Flows through the Malta-Italy Gas Pipeline

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THE ENERGY & WATER AGENCY

Minimum Gas Flows through the Malta-Italy Gas Pipeline

The gas fired generating plant at Delimara Power station is composed of the following:

- D3 - consisting of a Diesel Engine Combined Cycle plant rated at 146MWe. It is composed from eight (8) Wartsila 18-cylinder engines with 4 of them being the 50DF model (dual fired natural gas and gasoil) and 4SG models operating solely on natural gas.
- D4 - A 205MWe rated Combined cycle gas turbine plant consisting of three (3) Siemens SGT800 gas turbines, each with its own steam generator and the steam being fed into one steam turbine.

The operation of the above two plants depend on a number of factors. However, there have been a number of times when the combined cycle plant would be shut down and the electricity load demand on the power plant would be so low that only one diesel engine would be operating at 14MWe output. This would entail a gas demand of approximately 35MWth (conversion efficiency of the diesel engine at 40%). Such an operating period would normally occur during the night hours and would last for approximately 4 to 8 hours per night.

Assuming the following (Libya natural gas calorific value (CV) - SNAM 2015 report):

(Please note that British numerical notation is used in this paper.)

Gas gross CV – 39.522 MJ/Sm^3
Gas net CV – 35.719 MJ/Sm^3

This would result that during the period mentioned above, the expected gas flow through the pipeline would be 3,530 Sm^3/hr.

With the above figures, the Energy and Water Agency has the following requirements:

- To design the pipeline flow, fiscal meters and pressure control systems to cater for the flows between 218,752 Sm^3/hr (full pipeline flow Gela-Malta) and 3,530 Sm^3/hr (minimum pipeline flow Gela-Malta).
- To ensure that during start-up the pressure control systems can control lower flows and ramp-up to 3,530 Sm^3/hr at the rate of 250 Sm^3/min.
- The fiscal flow meters should be capable of operating on such a range within their certified accuracy limits.
- To note that current installed capacity will take a maximum of 70,000 Sm^3/hr.