|  |  |  |
| --- | --- | --- |
| **APPROVED BY:**  Director  Oil Refining Department  PJSC“Gazprom neft”  \_\_\_\_\_\_\_\_\_\_\_\_\_\_ M.L.Antonov  “\_\_\_” \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 20 | **APPROVEDBY:**  Vice President  for Oil Refining  PJSC “NK “Rosneft”  \_\_\_\_\_\_\_\_\_\_\_\_\_\_ А.А.Romanov  “\_\_\_”\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 20 | **CONFIRMED BY:**  General Director  Slavneft-YANOS PJSC  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ N.V.Karpov  «\_\_\_» \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 20 |

**TECHNICAL ENQUIRY FOR PREPARING TECHNICAL AND COMMERCIAL PROPOSAL FOR PROCESS SUBMISSION AND BASIC ENGINEERING DESIGN PACKAGE DEVELOPMENT FOR THE HYDROGEN PRODUCTION UNIT**

YAROSLAVL

2020

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# SECTION A – GENERAL INFORMATION

1. **INTRODUCTION**

# Slavneft-YANOS PJSC Refinery is located in the European part of the Russian Federation and processes Surgutskaya, Ukhtinskaya and East Siberian crude oils that come to the Refinery via different pipelines and are supplied in the mixed condition to the primary Crude Distillation Units.

# The development program of Slavneft-YANOS PJSC aims for the increase of oil refining efficiency, increase of “light” petroleum products yield, as well as production of motor fuels as per requirements of modern and potential European specifications and Technical Regulations of the Customs Union.

# The development program includes the construction of Bottom of the Barrel Processing Complex consisting of:

# 1) Delayed Coking Unit (DCU)

# 2) Diesel Fuel Hydrotreatment Unit (DFHU)

# 3) Hydrogen Production Unit (HPU)

# 4) Sulfur Production Unit (SPU)

# This project implementation envisages the elimination of low-margin fuel oil production at Slavneft-YANOS PJSC.

# The target of the present Technical Enquiry is to receive Technical and Commercial Proposals from the Licensors of the hydrogen production process for their comparative analysis and the selection of the most optimal process Slavneft-YANOS PJSC.

There are two cases of feed supply to the Hydrogen Production Unit that can be used:

Case 1. Natural gas, coming from the refinery – basic feed case.

Case 2. Liquefied hydrocarbon gas (blend from Hydrocracking unit and Gas Fraction unit) – reserve feed case (duration of operation on this type of feed – max 90 days/year).

Target product of Hydrogen Production unit is process hydrogen with concentration min 99.90 %vol. for the use in the processes of distillates hydrotreatment of Slavneft-YANOS PJSC process units.

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1. **DEFINITION AND INTERPRETATION OF TERMS**

In the given Technical Enquiry as herein after defined, the following capitalized words and expressions shall have the meanings assigned herein to them where the context permits.

CUSTOMER shall mean **Public Joint Stock Company “Slavneft-Yaroslavnefteorgsintez” (Slavneft-YANOS PJSC)** having its office in:

**The Russian Federation, 150023, Yaroslavl, Moskovsky prospect, bld. 130**

PROJECT shall mean Basic Engineering Design Package for the Hydrogen Production unit.

PROCESS means the process of hydrogen production by the method of hydrocarbons steam conversion.

LICENSOR shall mean the qualified Company which is able to perform all the SERVICES required for the development of Basic Engineering Design Package and which has all the required patent and license rights for the PROCESS.

SCOPE shall mean the scope, extent and limits of all SERVICES to be provided by LICENSOR or CUSTOMER as described in the current Technical Enquiry.

SERVICES shall mean all works to be done and services necessary to be supplied by LICENSOR.

PROPOSAL shall mean the Technical and Commercial Proposal given by LICENSOR to perform all SERVICES and which is prepared and submitted to CUSTOMER in accordance with the terms of Technical and Commercial Proposal submission.

CUSTOMER’s REPRESENTATIVE shall mean any person appointed by CUSTOMER to supervise and control the works of LICENSOR during execution stages and perform duties set by CUSTOMER.

LICENSOR’s REPRESENTATIVE shall mean any person nominated by LICENSOR and approved by CUSTOMER to perform the duties delegated by LICENSOR.

**SECTION В – DESIGN BASIS**

The following sections define the Design Basis which LICENSOR shall take into account. LICENSOR may define the additional requirements to the data which are given in the current Technical Enquiry.

LICENSOR shall forward Technical and Commercial Proposal for the Hydrogen Production Unit in compliance with the CUSTOMER’s data.

1. **PURPOSE OF THE UNIT**

The purpose of the Hydrogen Production unit is receiving hydrogen product with concentration min 99.90 %vol.

1. **CAPACITY**

Hydrogen Production unit targeted product capacity (hydrogen 99,90 %vol.) comprises 72.0 thousand tons 1st, 2nd and 3rd year, 60,0 thousand tons 4th year based on 7.320 operation hours (8.2 tons/hour).

Stable operation range of the Hydrogen Production unit: minimum possible capacity is defined by the LICENSOR – maximum capacity – 110% of capacity on hydrogen product.

Operation mode is continuous.

Turnaround cycle is 4 years.

Adsorbent life time is selected by the LICENSOR (taking into account continuous operation mode of Hydrogen Production unit – 4 years).

1. **PRODUCTS SPECIFICATIONS**

CUSTOMER requirements to the targeted product of the PROCESS are given in the Attachment 1.

1. **FEED SPECIFICATIONS AND COMPOSITION**

Amount and quality of the feed for the HPU are given in the Attachment 2.

1. **STANDARDS**

International standards shall be taken as a basis for construction and operation. At that, these standards shall be in compliance with the mandatory standards of the Russian Federation in the field of industrial safety, GOST, norms and regulations effective on the territory of the Russian Federation. In cases when the requirements of international standards and regulations are higher than the requirements of the Russian ones, the requirements of the international standards shall be used.

1. **BASIC REQUIREMENTS**

**6.1.** In order to achieve the best ratio on production (yield, %) of the targeted product, optimal capital expenditures for capital construction, operational expenses during the whole period of operation, fulfillment of the Russian legislation requirements in the spheres of labor protection, ecology, industrial safety and CUSTOMER’s special requirements (as per par. 7), the LICENSOR shall consider the following process sections within HPU in accordance with his process:

- Feed (charge) compression;

- Feed (charge) hydrogenation, hydrogen sulfide absorption (determined by the LICENSOR);

- Steam reforming of hydrocarbons (with pre-reforming section);

- CO high temperature conversion;

- Pressure Swing Absorption section;

- Flue gas heat disposal in order to generate steam;

- Preparation of feed water from demineralized water supplied to the batter limits from the refinery system to produce export steam and process steam from process steam condensate received at battery limits (heating, deaeration, reagent dosing);

- Preparation of fuel gas.

**6.2.**As the main fuel for the reforming heater tail gas shall be used. Natural gas is used during start-up and as a balance make-up during operation.

**6.3.**Consider:

- 2 systems of water steam production, export steam (goes outside battery limits) and process steam (used inside the unit).

- maximum production of medium pressure export steam (see parameters at par. 9.3.1)

- use of water steam process condensate within battery limits.

**6.4.Requirements to the processes automation:**

**6.4.1.** Provide maximum level of process automation including the operations on the start-up, and shutdown.

**6.4.2.** Provide the automated commercial record of incoming and outcoming mass flows including the utilities (steam, heating water, electrical energy, fuel gas, nitrogen, process air, recycle water, chemically treated water).

**6.4.3.** Provide the automated system of continuous control and record of the volume and/or weight and concentration of the harmful (polluting) substances emission with the flue gases of the stack. Harmful (polluting) substances which shall be monitored are as follows: suspended substances, sulfur dioxide, nitrogen oxide (summary of nitrogen and nitrogen dioxide), carbon oxide, hydrogen sulfide, ammonia.

**6.5. Requirements to the Basic Engineering Design documentation submission:**

**6.5.1.**Basic Engineering Design documents shall be submitted in the following form:

*Intermediate versions*–in electronic form, in PDF format in the Russian and English languages with possibility to search within the document.

*Final version:*

– two printed copies in the English language + one CD Rom (in case the LICENSOR is a foreign company);

– four printed copies in the Russian language + two CD Rom.

**6.5.2.** Requirements to the hard copy (paper version) of Basic Engineering Design documents final version: paper version shall be submitted in the hard file - folders.

**6.5.3.** Requirements to the electronic version of Basic Engineering Design documents final version:

* Electronic copy of the documents set shall be submitted on the CD-R disc (discs) in PDF format;
* Disc shall have the label stating the manufacturer, manufacturing date and the set description;
* Electronic copy of the text documents shall be submitted on the CD-R discs in the editable format “doc”;
* Electronic copy of the drawings shall be submitted on the CD-R discs in the editable format “dwg”;
* Root catalogue of the disc shall contain the text file with the content;
* Composition and content of the disc shall be in compliance with the documentation set;
* Each section of the set (volume, book, etc.)shall be submitted in a separate catalogue of the disc by the file (group of files) of the electronic document;
* Catalogue title shall comply to the section title.

**6.5.4.** The use of the files formats which differ from the standard formats shall be additionally agreed upon with the CUSTOMER.

**6.6. Other:**

**6.6.1.** The language of the correspondence, intermediate reports shall be English with translation to Russian.

**6.6.2.** Measurement system — SI system or technical units confirmed with the CUSTOMER.

**6.6.3.** The project team shall mandatorily include the Russian speaking representative.

**6.6.4.** The scope of information presented on the process flow diagrams shall be sufficient to prepare the mass balance for each of the vessel.

**6.6.5.** LICENSOR shall propose to visit the operating Units for getting familiar with the process. LICENSOR shall give the exact data for these Units such as:

1. Location
2. Capacity
3. The year of commissioning into operation. Turnaround cycle (in years).
4. **CUSTOMER SPECIAL REQUIREMENTS**

* During execution of the PROJECT the specification shall be developed that accounts the requirements for identifying the symbol of documentation, equipment, pipelines, instruments, as well as design requirements. This requirement is justified by the need to use a single approach (style) in the development of the PROJECT of one of the units included in a uniform Bottom of the Barrel Processing Complex of the CUSTOMER. The specified requirements of the CUSTOMER will be provided and recorded in the Data sheet on the process design of the LICENSOR during the kick-off meeting.
* The project should include the use of advanced achievements in the field of technology, energy efficiency, industrial safety and environmental protection, consistent with the principles of the best available technologies.
* The minimum energy consumption for production and the maximum possible yield of process hydrogen should be incorporated into the technological process.
* - The unit must comply with the best world values ​​for the indicators “Energy Efficiency Index EII” and “Process Losses” according to the Solomon methodology.

**8. OPTIONALITY OF THE PROPOSED DIAGRAMS:**

In case there are several options of the process and instrumental schemes it is required to provide all the options and perform the technical and economic comparisons (based on the table given in the Attachment 5). Provide the description of the changes in the process service and operation mode of the Unit.

**9 BATTERY LIMIT CONDITIONS:**

**9.1 Feed**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | **Pressure, MPa (g.)** | | **Temperature,** °C | |
| Min. | Max. | Min. | Max. |
| Case 1 | | | | |
| Natural Gas | 1.1 | 1.2 | 5 | 50 |
| Case 2 | | | | |
| Liquefied hydrocarbon gas for Gas Fraction unit | 2.40 | 2.50 | 35 | 35 |
| Liquefied hydrocarbon gas from Hydrocracking unit | 2.79 | 3.00 | 40 | 60 |

**Hydrogen rich gas**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Stream | **Pressure, MPa (g.)** | | **Temperature,** °C | |
| Min. | Max. | Min. | Max. |
| Hydrogen rich gas from refinery network | 4.0 | 5.1 | 40 | 120 |
| **Quality** | | | | |
| **Indicator** | **Units** | | **Average value** | |
| H2 | % vol. | | 90.05 (min 75) | |
| CH4 | % vol. | | 3.85 | |
| C2H6 | % vol. | | 2.97 | |
| C3H8 | % vol. | | 1.91 | |
| iC4H10 | % vol. | | 0.51 | |
| nC4H10 | % vol. | | 0.32 | |
| iC5H12 | % vol. | | 0.13 | |
| nC5H12 | % vol. | | 0.06 | |
| Summary C6H14 | % vol. | | 0.20 | |

**9.2 Products**

|  |  |  |
| --- | --- | --- |
| Product | **Pressure, MPa (g.)** | **Temperature,** °C |
| Hydrogen product | 2.00 | 40-45 |
| Export steam | 1.5 | 250 |

**9.3 UTILITIES**

**9.3.1 Water Steam (consumption for start-up period)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Stream | **Pressure, MPa (g.)** | | | **Temperature,** °C | | |
| Min.  (at the battery limit) | Operation  (near the source) | Design (max. near the source) | Min.  (at the battery limit) | Operation  (near the source) | Design (max. near the source) |
| High pressure steam | n/a | | | | | |
| Medium pressure steam | 1.00 | 1.20 | 1.50 | 189 | 250 | 280 |
| Low pressure steam | 0.20 | 0.30 | 0.60 | 133 | 143 | 250 |

**9.3.2 Water**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Stream** | **Pressure, MPa (g.)** | | **Temperature,** °C | |
| Min. | Max. | Min. | Max. |
| Direct cooling water 2 systems | 0.50 | 0.75 (near the source) | 25 | 50 (design) |
| Return cooling water 2 systems | 0.25 | 0.75 (near the source) | 35 | 50 (design) |
| Demineralized water | 0.70 | 1.19 | 20 | 40 |
| Feed water of export steam boilers/process steam | Defined by LICENSOR | Defined by LICENSOR | Defined by LICENSOR | Defined by Licensor |

**Quality of cooling water 2 systems (as per par. 2.5.2 of industry-specific process engineering guidance-97)**

|  |  |
| --- | --- |
| Parameter | Indicator value |
| Petroleum products, mg/l, max | 5 |
| Suspended substances, mg/l, max | 15 |
| Sulfates, mg/l SO4”, max | 500 |
| Chlorides, mg/l Cl´, max | 300 |
| General salt content, mg/l, max | 2000 |
| Carbonate liquid, mg-equ/L, max | 5 |
| Non-carbonate liquid, mg-equ/L, max | 15 |
| pH | 7,0÷8,5 |
| BODfull., mgО2/L, max | 25 |

**Quality of demineralized water**

|  |  |
| --- | --- |
| Parameter | Indicator value |
| Hardness, mkg-equ/dm3 | max 1 |
| Electric conductivity, µS/cm | max 2 |
| Silicic acid general (calculated for SiО2), mkg/dm3 | max 100 |
| Iron general, mkg/dm3 | max 100 |
| Snellen transparency, cm | min 40 |
| Chlorides, mg/dm3 | max 2 |
| Petroleum products, mg/dm3 | max1 |

Volume of necessity for demineralized water is defined by the LICENSOR.

Requirements to the quality of water involved into technological process, different from the stated in the tables shall be indicated buy the LICENSOR in Technical and Commercial Proposal.

**9.3.3Air**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Pressure, MPa (g.)** | | | **Temperature,** °C | | |
| Operating | | Design | Operating | | Design |
| Min | Max | Min | Max |
| Process air | 0.48 | 0.51 | 0.82 | Ambient | 40 | - 46/ 40 |
| Instrument air | 0.48 | 0.51 | 0.82 | Ambient | 40 | - 46/ 40 |
| Process, air, instrument air | Solid particles content – max 2 mg/m3 | | | | | |
| Size of solid particle – max 10 mkm | | | | | |
| Oil content (in liquid state) – absence | | | | | |
| Dew point = - 400С | | | | | |

**9.3.4Nitrogen**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Pressure, MPa (g.)** | | | **Temperature,** °C | | |
| Operating | | Design | Operating | | Design |
| Min | Max | Min | Max |
| Low pressure nitrogen | 0.60 | 0.65 | 0.82 | ambient | 40 | - 46/ 40 |
| High pressure nitrogen | 4.00 | 6.40 | 7.20 | ambient | 40 | - 46/ 40 |
| Composition | N2=99.6% vol, О2=0.4% vol. | | | | | |

**9.3.6Fuel**

|  |  |  |
| --- | --- | --- |
| **Natural gas (GOST 5542)** | | |
| **1. Pressure,MPa (g.)** | Min | Max |
| 1.1 | 1.2 |
| **2. Temperature,** °C | Min | Max |
| 5 | 50 |
| **3. Composition, % volume**  Methane  Ethane  Propane  n-Butane  i-Butane  n-Pentane  i-Pentane  neo-Pentane  Higher hexane  Nitrogen  Carbon dioxide  Oxygen  Hydrogen  Helium  Hydrogen sulfide, g/nm3  Mercaptan sulfur, g/nm3 | 98.582  0.694  0.158  0.0185  0.0185  0.0023  0.0034  0.0003  0.002  0.430  0.030  0.004  0.008  0.049  less than 0.01  less than 0.016 | |
| **4. Combustion heat, MJ/nm3 (kcal/nm3),**  **at 20 °С and 101.325 kPa, min** | 31.8 (7600) | |
| **5. Density at 20 °C, kg/nm3** | 0.678 | |

**9.3.7Electric power**

|  |  |  |
| --- | --- | --- |
| **Description** | **Voltage** | **Frequency** |
| Volt | Hz |
| **Electric power** |  |  |
| Average voltage | 6.000 | 50 |
| Low voltage | 380/220 | 50 |
| Special requirements | 1. For the motors with the capacity of≥200 kW – 6000 V, 50 Hz  2. For the motors with the capacity of<200 kW – 380 V, 50 Hz | |

**9.4. SITE CLIMATIC CONDITIONS**

| **Parameter** | **Measurement** | **Value** |
| --- | --- | --- |
| **Design temperatures:** | | |
| Absolute minimum | °С | - 46 |
| Air temperature of the coldest five days, availability of 0.98 | °С | - 34 |
| Air temperature of the coldest five days, availability of 0.92 | °С | - 31 |
| Absolute maximum | °С | + 37 |
| Average maximum of the hottest month | °С | + 23.2 |
| Annual average | °С | + 3.2 |
| Design temperature for ventilation (А parameter): |  |  |
| - summer | °С | + 20.8 |
| - winter | °С | - 31.0 |
| Design temperature for conditioning (B parameter): |  |  |
| - summer | °С | + 25 |
| - winter | °С | - 31.0 |
| Design temperature conditions for heating (B parameter) |  |  |
| - cold period | °С | - 31.0 |
| - average temperature of the heating period | °С | - 4.0 |
| Design temperature of the air coolers |  |  |
| - summer | °С | + 30.0 |
| - winter | °С | - 31.0 |
| **Duration of the heating period** | 24 hours | 221 |
| **Average relative moisture** | | |
| - of the coldest month | % | 83 |
| - of the hottest month | % | 74 |
| **Relative moisture for the air coolers process calculation** | | |
| - summer | % | 74 |
| - winter | % | 84 |
| **Wind** | | |
| Prevailing direction: |  |  |
| - in the cold period |  | southern |
| - in the hot period |  | northern |
| Average velocity - western | m/sec | 4.3 |
| Standard wind loading | kg/m2 | 23 |
| Correction factor "К" to the wind load depending on the height, up to: |  |  |
| 5 m |  | 0.5 |
| 10 m |  | 0.65 |
| 20 m |  | 0.85 |
| 40 m |  | 1.1 |
| 60 m |  | 1.3 |
| 80 m |  | 1.45 |
| 100 m |  | 1.6 |
| **Atmospheric residues:** | | |
| Precipitations per year | mm | 578 |
| Daily maximum | mm | 76 |
| Design snow load, as per SNiP 2.01.07-85 | kg/m2 | 240 |
| **Seismicity** | points | 5 |
| **Atmospheric pressure** | kPa | 101.325 |

**SECTIONС - PROPOSAL – TECHNICAL PART CONTENT**

# Proposals shall be forwarded both in the English and the Russian languages. LICENSOR’S TECHNICAL PROPOSAL shall include information about the process with account of quality of processed feed, indicated in Attachment 2.

1. **THE DESCRIPTION OF THE TECHNOLOGICAL PROCESS**

- Block diagram and process flow diagram with the design battery limits.

- Description of technological process, description of the know-how used in the process, description of the applied patents.

- Advantages of the proposed solutions.

- Input/output streams and their parameters.

- Operating conditions.

- Unit process operation parameters (as per the requirements of the tables to be filled – Attachment3).

- Sale products parameters (as per the requirements of the tables to be filled – Attachment 3).

- General arrangement diagram (optimal case of the layout solutions with the use of the best world practices): major sizes of the process sections and the required area.

- Description of the basic control principles, alarm and anti-emergency protection, equipping with the pressure safety valves units with the switching devices and with the discharge to flare.

- Possible integration with the existing Refinery scheme including the heat flows.

1. **TOTALMASSBALANCE, MASS BALANCE OF THE UNIT AND TECHNICAL REQUIREMENTS, EFFLUENTS**

- Total heat and mass balances with the products quality. Mass balance (as per the requirements of the tables to be filled – Attachment 3).

- Amount and quality of the effluents and discharges to atmosphere.

- Block diagram and process flow diagram.

- Operational limits and flexibility.

- Limitations on the feed and duty.

- Turnaround cycle.

1. **REQUIREMENTS TO THE CATALYSTS AND REAGENTS, VOLUMES AND CONSUMPTION VALUES**

- Demand for chemical reagents, auxiliary materials, their technical properties, safety passports, onetime loading and annual consumption rates.

- Life cycle of catalysts, adsorbents.

- Operating manual for catalysts, adsorbents.

- Possible suppliers of catalysts, adsorbents.

- Disposal methods.

1. **UTILITIES CONSUMPTION**

Utilities consumption as per the requirements of the tables to be completed – Attachment 3.

- Requirements to electric power, consumed capacity, etc.

- Steam, demineralized water, low and high pressure nitrogen, instrument air, process air.

1. **EQUIPMENT LIST**

- Complete equipment list with the parameters for the required capacity (as per the requirements of the tables to be completed – Attachment 3).

- List of critical and licensed equipment. Critical equipment – equipment with the long fabrication period. Licensed equipment is the patented equipment which is supplied only by the LICENSOR of LICENSOR’s affiliated company for following the terms of granting the guarantees for the PROCESS. For the licensed equipment it is required to provide the description including the monitoring of its status in the course of operation period. The cost of licensed equipment shall be indicated in Commercial part of the Proposal.

- Licensed and critical equipment shall be forwarded separately (with specification of the sizes, weight, transportation options and assembly).

- List and form of the documents released for the basic equipment (*reactors, compressors, heaters, Pressure Swing Absorption section, equipment internals).*

- Certified list of major process equipment vendors (specify minimum 3 vendors for each equipment item) with describing the possibility/lack of possibility to manufacture it by the Russian enterprises.

- Delivery dates of critical and licensed equipment.

- List of critical equipment which can be manufactured at the Russian enterprises.

- List of critical equipment manufacturers (minimum 3 for each equipment item).

- List of licensed equipment manufacturers.

- Within the scope of Technical and Commercial Proposal it is required to provide within the Basic Engineering Design scope the development of the extended technical designs for the heaters and reactors (if it is not included within the licensed equipment list).

1. **LIST OF THE WASTES REQUIREING THE TREATMENT**

* The list shall contain quantitative and qualitative characteristics of the wastes;
* Methods of their treatment and disposal.

1. **ESTIMATE SCHEDULE FOR EACH PROJECT STAGE.**

- Schedule of Basic Engineering Design development and the meetings for the intermediate and final acceptance of Basic Engineering Design.

- Evaluation schedule of the project in general, beginning from the development of Basic Engineering Design and including the unit commissioning into operation (with the following split into stages: basic engineering design, detailed engineering design, equipment procurement, construction and installation works, commissioning and start-up works).

1. **EVALUATING ESTIMATE OF THE INVESTMENTS, including:**

-All the license payments (intellectual property) (if the PROCESS is licensed).

-Development, procurement, cost of services for engineering supervision.

-Catalysts, adsorbents, reagents and other special additives.

-Cost of all equipment with a separate split of the licensed equipment cost which will be supplied by LICENSOR.

-Costs of additional services (man-hours), for instance, the supervision of the detailed design development, performing the installation and start-up works, test run and the operator’s training, etc.

- Cost of LICENSOR’s specialists participation in negotiations relating to HAZOP/SIL (cost for 1 session of HAZOP/SIL).

- PROJECT preparation schedule

- Capital expenditures, with division into design and survey work, equipment, construction and installation works and so on.

1. **EXPERIENCE**

- List of previous experience and Technology References.

- Number of the sold licenses during the last 15 years.

- List of the designed and operating units, start-up date and the capacity of all the units.

- Data on the similar units operation.

- Liquidated damages, maximum amount.

- Program of the catalyst/process improvement.

- Operation experience in this field with the Russian Design Institutes and manufacturing plants for the critical equipment fabrication.

- Information on qualification and experience of project manager and key participants, performing the project development.

1. **INFORMATION ON THE NECESSITY TO CONCLUDE**

- License Agreement (if PROCESS is licensed).

- Basic Engineering Design Agreement.

- Guarantee Agreement.

- Catalysts, Adsorbents Supply Agreement.

- Licensed Equipment Supply Agreement.

- Confidentiality Agreement.

If it is required to conclude any of the above Agreements, please, provide the draft of the corresponding Agreement.

1. **GUARANTEES**

- Limitations on the guarantees for engineering and process performance. Guarantees

Provision terms.

- Catalysts, adsorbents consumption rate / life cycle

- Unit capacity, stable operation range.

- Products quality parameters at the outlet from the unit.

- Energy Efficiency Index EII.

- Turnaround cycle.

- Other

1. **SOLUTIONS ON THE WORK SAFETY AND ENVIRONMENT PROTECTION**

- Liquid wastes (amount is based on the unit operation availability 8.760 hours per year).

- Solid wastes (amount is based on the unit operation availability 8.760 hours per year).

- Emissions to atmosphere (amount is based on the unit operation availability 8.760 hours per year), solutions to implement automatic monitoring of emissions.

- Effluents (amount is based on the unit operation availability 8.760 hours per year).

- Solving the issues of industrial work safety and environment protection.

- The ways of the generated effluents disposal with the use of advanced technologies in the sphere of environmental protection.

1. **TECHNICAL ASISTANCE AND ADDITIONAL SERVICES**

- The scope of works (in man-hours) on the technical assistance (supervision services)

- The scope of works (in man-hours) on the personnel training and commissioning and start-up (performing the test run).

1. **BASIC ENGINEERING DESIGN CONTENT**

Provide the content of the Basic Engineering Design. The recommended scope of the Basic Engineering Design is set forth in Attachment 4.

1. **MISCELLANEOUS**

Provide the summary table of the PROCESS technical and commercial parameters - Attachment5.

**Signature sheet**

**For the technical enquiry for preparing Technical and Commercial Proposal for PROCESS submission and Basic Engineering Design Package development for the**

**Hydrogen Production Unit**

**Slavneft-YANOS PJSC**

|  |  |  |
| --- | --- | --- |
| Chief Engineer |  | N.N.Vakhromov |
| Deputy Chief Engineer for Processes |  | A.V.Piskunov |
| Deputy Chief Engineer for Nature Protection and Safety |  | N.N.Leonov |
| Chief Process Engineer |  | E.V.Dutlov |
| Chief Power Engineer |  | S.L.Egorov |
| Chief Instrument Engineer |  | C.I.Kravets |
| Chief Mechanical Engineer |  | D.P.Kuchin |
| Head of the Project Office, Bottom of the Barrel Processing Complex |  | I.V.Dobrobolskiy |
| Head of Production Facilities, Bottom of the Barrel Processing Complex |  | V.E.Znaemov |
| Chief Engineer of Production Facilities, Bottom of the Barrel Processing Complex |  | A.V.Sobolev |
| Head of Production Operational Planning |  | A.E.Altufiev |
| Head of Research Laboratory |  | D.V.Borisanov |
| Deputy Head of Economic Department for Planning and Monitoring of the Investments Projects |  | О.V.Prikhodko |

ATTACHMENT 1 to the Technical Enquiry

for Technical and Commercial Proposal

**CUSTOME Requirements to target product of the PROCESS**

**(shall be confirmed by LICENSOR).**

|  |  |  |  |
| --- | --- | --- | --- |
| **Component/Indicator** | **Units** | **Process hydrogen** | **Determination method** |
| - Н2 | % vol. | min 99.90 |  |
| - С1 | % vol. | max 0.1 |  |
| - СО | ррm vol. | max 20 |  |
| - СО+СО2 | pрm vol. | max 50 |  |
| - Cl | pрm vol. | Absence |  |
| H2S | pрm vol. | Absence |  |

ATTACHMENT 2 to the Technical Enquiry

for Technical and Commercial Proposal

**Unit feed quality of Hydrogen Production unit**

**Case 1. Natural gas**

|  |  |  |
| --- | --- | --- |
| **Indicator:** | **Units** | **Value** |
| Methane | % vol. | 98.582 |
| Ethane | % vol. | 0.694 |
| Propane | % vol. | 0.158 |
| n-Butane | % vol. | 0.0185 |
| i-Butane | % vol. | 0.0185 |
| n-Pentane | % vol. | 0.0023 |
| i-Pentane | % vol. | 0.0034 |
| Neo-Pentane | % vol. | 0.0003 |
| Hexanes + higher | % vol. | 0.002 |
| Nitrogen | % vol. | 0.430 |
| Carbon dioxide | % vol. | 0.030 |
| Oxygen | % vol. | 0.004 |
| Hydrogen | % vol. | 0.008 |
| Helium | % vol. | 0.049 |
| Hydrogen sulfide | g/m3 | less than 0.01 |
| Mercaptan sulfur | g/m3 | less than 0.016 |

**Case 2. Liquefied Hydrocarbon Gas (blend from Hydrocracking unit (10%) and Gas Fraction unit (90%)**

Liquefied hydrocarbon gas from Hydrocracking unit

|  |  |  |
| --- | --- | --- |
| **Indicator** | **Units** | **Value** |
| Summary of hydrocarbonsС1-С2 | % vol. | 1.97 (max 4.0) |
| C3H8 | % vol. | 21.8 |
| C3H6 | % vol. | 0 |
| iC4H10 | % vol. | 36.7 |
| nC4H10 | % vol. | 39.4 |
| Summary C4H8 | % vol. | 0.039 |
| iC5H12 | % vol. | 0.02 |
| Summary C5 and higher | % vol. | 0.02 (max 3.0) |
| Summary of olefins | % vol. | 0.039 |
| H2S, ppmwt. | ppmwt. | 12.8 (max 70) |
| RSH, ppmwt. | ppmwt. | 6,8 |
| S, ppmwt. | ppmwt. | 19.6 |
| Density at 0°С, kg/m3 | kg/m3 | 576.4 |

Butane fraction from Gas Fraction unit (80%)

|  |  |  |
| --- | --- | --- |
| **Indicator** | **Units** | **Value** |
| C3H8 | wt.% | 0 |
| C3H6 | wt.% | 0 |
| iC4H10 | wt.% | 1.95 |
| nC4H10 | wt.% | 97.87 |
| Summary C4H8 | wt.% | 0.156 |
| iC5H12 | wt.% | 0.019 |
| nC5H12 | wt.% | 0 |
| H2S, ppmwt. | wt.% | less than 0.0002 |
| RSH, ppmwt. | wt.% | 0.0023 |

Butane fraction from Gas Fraction unit (20%)

|  |  |  |
| --- | --- | --- |
| **Indicator** | **Units** | **Value** |
| Summary of hydrocarbonsС1-С2 | wt.% | 1.52 (max 3.7) |
| C3H8 | wt.% | 98.24 |
| C3H6 | wt.% | 0 (max 0.2) |
| iC4H10 | wt.% | 0.19 |
| nC4H10 | wt.% | 0,04 |
| Summary C3 | wt.% | 98.24 (min 96.0) |
| Summary C4 | wt.% | 0.23 (max 0.5) |
| Summary C5 and higher | wt.% | absence |
| H2S | wt.% | 0.001 (max 0.003) |
| RSH | wt.% | 0.004 |
| Content of free water and caustic |  | absence |

ATTACHMENT 3 to the Technical Enquiry

for Technical and Commercial Proposal

**Tables for the completion by LICENSOR**

|  |  |  |
| --- | --- | --- |
| **Mass balance** | | |
| **Case 1. Natural gas** | | |
|  | tons/hour | wt.% |
| **Feed, received** |  |  |
| Naturalgas |  |  |
| **TOTAL:** |  | 100.00 |
| **Received** |  |  |
| Hydrogen product (99,90 % vol.) |  |  |
| Natural gas (used at the unit as fuel) |  |  |
| Tail gas (used at the unit as fuel) |  |  |
| Process losses |  |  |
| **TOTAL:** |  | 100.00 |
| **Case 2. Liquefied hydrocarbon gas blend** | | |
|  | tons/hour | wt.% |
| **Feed, received** |  |  |
| Blend, liquefied hydro carbon gas (LHG) |  |  |
| **TOTAL:** |  | 100.00 |
| **Received** |  |  |
| Hydrogen product (99,90 % vol.) |  |  |
| Natural gas (used at the unit as fuel) |  |  |
| Tail gas (used at the unit as fuel) |  |  |
| Process losses |  |  |
| **TOTAL:** |  | 100.00 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Quality of products** | | | | |
|  | **Units** | **Value** | **Testing methods used by LICENSOR** | **Slavneft-YANOS PJSC requirements** |
| **Process hydrogen** | | | | |
| Density at 20 °С | g/cm3 |  |  |  |
| - Н2 | % vol. |  |  | min99.90 |
| - С1 | % vol. |  |  | max 0.1 |
| - СО | pрm vol. |  |  | max 20 |
| - СО+СО2 | pрm vol. |  |  | max 50 |
| - H2S | % vol. |  |  | absence |
| - Cl | % vol. |  |  | absence |

|  |  |  |
| --- | --- | --- |
| **Process parameters** | | |
| **Parameter** | **Units** | **Value** |
| Case1. Natural gas flowrate to the unit (unit capacity): | tons/hour |  |
| Case 2: LHG flowrate to the unit (unit capacity): |  |  |
| Feed + fuel flow rate | tons/hour |  |
| Demineralized water flowrate | tons/hour |  |
| Export steam | tons/hour |  |
| **Reforming heater** |  |  |
| Convertedgastemperatureatheateroutlet | °С |  |
| Steam/gas | mole/mole |  |
| Residual content of СН4 (in dry gas) at heater outlet:cycle start/end | % vol. |  |
| Tail gas flowrate to heater | tons/hour |  |
| Tail gas pressure to heater | MPa (g.) |  |
| Natural gas flowrate to heater | tons/hour |  |
| Natural gas pressure to heater | MPa (g.) |  |
| **CO conversion reactor** |  |  |
| Temperature inlet/outlet cycle start/end | °С |  |
| Pressure inlet/outlet | MPa (g.) |  |
| СО residual content at outlet cycle start/end | % vol. |  |
| **Deaerator** |  |  |
| Top pressure | MPa (g.) |  |
| Flowrate of water steam for stripping | kg/hour |  |
| Temperature | °С |  |
| **Pressure Swing Absorption** |  |  |
| Quality of hydrogen product: |  |  |
| Density at 20 °С | g/cm3 |  |
| - Н2 | % vol. |  |
| - С1 | % vol. |  |
| - СО | pрm vol. |  |
| - СО+СО2 | pрm vol. |  |
| Hydrogen recovery efficiency | % |  |
|  |  |  |
| **Other basic and important parameters of unit operation according to the LICENSOR** |  |  |
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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Equipment list** | | | | | | | | | | | | | | |
| **Reactors** |  | |  |  |  |  |  |  |  | |  |  |  | |
| Name | D, mm | | Н, mm | Т operating  °С | Т design.  °С | Р operating, MPa (g) | Р design, MPa (g) | Wall thickness, mm | Material of construction | | Vessel weight, т | Nozzle standout, mm | Notes | |
|  |  | |  |  |  |  |  |  |  | |  |  |  | |
|  |  | |  |  |  |  |  |  |  | |  |  |  | |
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| **Columns** |  | |  |  |  |  |  |  |  | |  |  |  | |
| Name | Designation | | D, mm | Н, mm | Т operating.  °С | Т design °С | Р operating,MPa(g) | Р design, MPa (g) | Wall thickness, mm | | Material of construction | Quantity of trays, type | Notes | |
|  |  | |  |  |  |  |  |  |  | |  |  |  | |
|  |  | |  |  |  |  |  |  |  | |  |  |  | |
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| **Heat exchange/cooling equipment** | | | |  |  |  |  |  |  | |  |  |  | |
| Name | | Designation | Heat duty, kcal | Surface of heat exchanger, m2 | Т operating  °С | Т design °С | Р operating, MPa (g) | Р design, MPa (g) | Tube bundle material of construction | | Casing material of construction | Type (air cooled heat exchanger, shell and tube heat exchanger, etc.) | Notes | |
|  | |  |  |  |  |  |  |  |  | |  |  |  | |
|  | |  |  |  |  |  |  |  |  | |  |  |  | |
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| **Vessels** | |  |  |  |  |  |  |  |  | |  |  |  | |
| Name | | D, мм | Н, мм | Т operating  °С | Т design  °С | Р operating, MPa (g) | Р design, MPa (g) | Material of construction | | Horizontal/vertical | | | | Notes |
|  | |  |  |  |  |  |  |  | |  | | | |  |
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| **Heaters** | |  |  |  |  |  |  |  |  | |  |  |  | |
| Name | | Heat duty, kcal | Heater efficiency, % | Surface of heat exchanger, m2 | Т inlet °С | Т outlet °С | Р operating, MPa (g) | Product flowrate, tons/hour | Reaction pipes material of construction | | Quantity of burners | Recuperative heat exchanger availability / steam production | Notes | |
|  | |  |  |  |  |  |  |  |  | |  |  |  | |
|  | |  |  |  |  |  |  |  |  | |  |  |  | |
|  | |  |  |  |  |  |  |  |  | |  |  |  | |
| **Compressors** | |  |  |  |  |  |  |  |  | |  |  |  | |
| Name | | Designation | Flowrate, nm3/h | Flowrate, tons/hour | Рoperating, MPa (g) inlet for each stage | Рoperating, MPa (.) outlet for each stage | Quantity of compression stages | Тinlet  °С | Тoutlet  °С | | Compressor type | Shaft type | Power consumption | |
|  | |  |  |  |  |  |  |  |  | |  |  |  | |
|  | |  |  |  |  |  |  |  |  | |  |  |  | |
|  | |  |  |  |  |  |  |  |  | |  |  |  | |
| **Pumps** | |  |  |  |  |  |  |  |  | |  |  |  | |
| Name | | Designation | Flowrate, m3/hour | Flowrate, tons/hour | Рoperating, MPa (g) inlet | Рoperating, MPa (g) outlet | Т operating  .  °С | Pump type | Shaft type | | Power consumption | | | Notes |
|  | |  |  |  |  |  |  |  |  | |  | | |  |
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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Utilities consumption\*** | | | | | |  |  |  |  |  |  |
|  |  | **Hydrogen production** | | | **Notes** |  |  |  |  |  |  |
| **Consumption** | **Units** | **Normal operating mode** | **Start-up mode** | **Shutdown mode** |  |  |  |  |  |  |  |
| Fuel gas | Gcal/ton of feed |  |  |  |  |  |  |  |  |  |  |
| Electric energy | kWh/ton of feed |  |  |  |  |  |  |  |  |  |  |
| Incl.compressor shaft | kWh/ton of feed |  |  |  |  |  |  |  |  |  |  |
| Demineralized water | m3/hour |  |  |  |  |  |  |  |  |  |  |
| Cooling water 2 systems | m3/hour |  |  |  |  |  |  |  |  |  |  |
| High pressure nitrogen | nm3/hour |  |  |  |  |  |  |  |  |  |  |
| Low pressure nitrogen | nm3/hour |  |  |  |  |  |  |  |  |  |  |
| Instrument air | nm3/hour |  |  |  |  |  |  |  |  |  |  |
| Process air | nm3/hour |  |  |  |  |  |  |  |  |  |  |
| **Consumption from refinery network, incl.:** | Gcal/hour |  |  |  |  |  |  |  |  |  |  |
| Low pressure steam | Gcal/hour |  |  |  |  |  |  |  |  |  |  |
| Average pressure steam | Gcal/hour |  |  |  |  |  |  |  |  |  |  |
| **Own production, incl.:** | Gcal/hour |  |  |  |  |  |  |  |  |  |  |
| Low pressure steam (indicate temperature and pressure) | Gcal/hour |  |  |  |  |  |  |  |  |  |  |
| Average pressure steam (indicate temperature and pressure) | Gcal/hour |  |  |  |  |  |  |  |  |  |  |
| High pressure steam (indicate temperature and pressure) | Gcal/hour |  |  |  |  |  |  |  |  |  |  |
| **To the refinery network, incl.:** | Gcal/hour |  |  |  |  |  |  |  |  |  |  |
| Average pressure steam (indicate temperature and pressure) | Gcal/hour |  |  |  |  |  |  |  |  |  |  |
| Accept the following conditions for the calculation: |  |  |  |  |  |  |  |  |  |  |  |
| 1. Air temperature at inlet for air coolers plus 30 °С | |  |  |  |  |  |  |  |  |  |  |
| 2. Minimal temperature difference between air and cooling medium (outlet of process stream – air at inlet): 16 °С only for air cooling | | | | | | | | |  |  |  |
| 3. Minimal temperature difference between air and cooling medium (outlet of process stream – air at inlet): 20 °С for air cooling with subsequent water cooling | | | | | | | | | | | |
| 4. Temperature of cooling water: direct 25 °С, return - max 42 °С | |  |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Reagents consumption** | | |  |  |  |  |  |  |  |
| Reagents\* | tons/year | Notes |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| \*Indicate reagents used in the applied process, their designation and annual requirement, necessity to have reserve stock. | | | | | | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Continuous emissions** | | | |
|  | **Completed by PROJECT developer** | | **Notes** |
| **Flue gas from the stack** | | |  |
|  | **kg/hour** | **tons/year** |  |
| СО2 |  |  | Content of emissions and solid particles determine at calculation for dry substance |
| NH3 |  |  |
| H2S |  |  |
| NО2 |  |  |
| NО |  |  |
| СО |  |  |
| SО2 |  |  |
| N2 |  |  |
| CH4 |  |  |
| Hydrocarbons saturated С1-С5 (including methane) |  |  |
| Н2О |  |  |
| Suspended substances |  |  |
| Flue gases temperature, °С |  | |
| Flue gases velocity, m/s |  | |
| Flue gases flowrate, m3/c at normal conditions |  | |
| Other |  |  |

|  |  |  |
| --- | --- | --- |
| **Continuous effluents** | | |
| **Completed by PROJECT developer** | | **Notes** |
| **Effluent 1** | | |
| Flowrate, kg/hour |  |  |
| Effluent composition |  |  |
|  |  |  |
|  |  |  |
| **Effluent 2** | | |
| Flowrate, kg/hour |  |  |
| Effluent composition |  |  |
|  |  |  |
|  |  |  |
| **Effluent n** | | |
| Flowrate, kg/hour |  |  |
| Effluent composition |  |  |
|  |  |  |

ATTACHMENT 4 to the Technical Enquiry

for Technical and Commercial Proposal

**ATTACHMENT 4**

**Recommended scope of Basic Engineering Design documentation Package.**

**CONTENT OF THE BASIC DESIGN PACKAGE**

**1. DESIGN BASIS**

1.1. Engineering design basis

1.2. Feedstock and utilities specifications

1.3. Products specifications

1.4. Unit capacity

1.5. Battery limits conditions

1.6. Special requirements for the process, equipment, pipelines and instruments

**2. TECHNOLOGICAL PROCESS DESCRIPTION**

2.1. Operating parameters and technological process standards.

2.2. Process description

2.3. Chemical activity, physical and chemical basics of technological processes, including recycling

**3. MATERIAL (MASS) AND HEAT BALANCE**

3.1. Feedstock and product physical properties

3.2. Material (mass) balance. Product material (mass) balance

3.3. Heat and material (mass) balance for each number of process stream shall contain the following information:

- stream number;

- name and aggregate state of medium;

- stream composition;

- operating temperature and pressure;

- flowrates and stream characteristics (physical and/or chemical data is included);

- for streams with mixed phases, steam and liquid phase should be shown separately.

**4. UTILITIES BALANCE**

4.1. Summary tables of utilities consumption: fuel, steam, electrical power, boiled feed water, cooling water, demineralized water, high pressure nitrogen, low pressure nitrogen, instrument air, process air.

4.2. Tables of estimated electrical energy, cooling water, fuel, steam, demineralized water, high pressure nitrogen, low pressure nitrogen, instrument air, process air, etc. consumption.

**5. CATALYSTS AND REAGENTS**

5.1. Specifications for catalysts and reagents, safety passports.

5.2. Name of catalysts, loading diagrams, amount of catalyst for first loading.

5.3. Required amount of reagents for initial start-up and one year of normal operation

5.4. Recommended additional amounts to the reagents, specified for the initial start-up

5.5. Material safety data sheet (MSDS)

5.6. General recommendations on handling, storing and loading of catalysts

**6. PRODUCTIONWASTES**

6.1. Amount, composition and corrosive properties for each waste product or process emission that pollutes environment

6.2. Detailed specifications of the necessary actions, needed to prevent the pollution

6.3. All drain systems, except for storm water sewer system

6.4. Recommendations on environmental protection and waste disposal – liquid, gaseous, solid.

6.5. Points for organize automatic wastes monitoring

**7. PRINCIPLE TECHNOLOGICAL FLOW DIAGRAMS**

Diagrams will include minimum:

• process lines with process streams numbers in accordance with heat and material (mass)

balance;

• unit normal operation conditions, including flowrate, temperature and pressure values on

basic process streams;

• all process pipelines, needed for understanding of heat and material balance for each

equipment;

• material balance with hydrocarbon-group composition of the streams;

• operating temperature and pressure;

• streams flowrates and characteristics (physical and/or chemical data is included);

• basic control loops;

• compressor and pump types;

• heat exchanger types

• indication of streams at tube side and shell side of heat exchangers;

• loops of columns, vessels and reactors with indication of quantity of trays, filling with

catalyst, internals, position of basic nozzles

• gas streams enthalpy.

**8. LIST OF BASIC PROCESS EQUIPMENT**

**9. PROCESS SPECIFICATIONS OF ITEMIZED EQUIPMENT AND PACKAGE UNITS**

These specifications include all process data required for preparation of detailed purchase order specifications.

**9.1. Columns**

Process sketch which shows basic dimensions.

Arrangement and dimensions of process nozzles. Nozzles arrangement for instruments is also shown on the process sketch (liquid levels – normal, minimum, maximum, critical).

Design and operating conditions (temperature, pressure), materials and recommended corrosion allowance, heat treatment (if needed).

Isolation and heating requirements.

Apparatus height installation requirements.

Special requirements on process reasons

**9.2. Plates**

Steam and liquid load, flows characteristics and working conditions.

Recommended maximum flooding factor

Special process requirements (minimum efficiency, operating range, pressure drop, fluid communication in downpipe, etc.)

**9.3. Reactors and vessels**

Process sketch which shows general equipment; basic dimensions, required by the process; internal equipment (vortex breakers, distributors, knock out drums, etc.)

Position and dimensions of process nozzles

Position of instruments nozzles with indication on sketch of liquid levels (normal, minimum, maximum)

Operating and design conditions (temperature, pressure).

Recommended materials and corrosion allowances, heat treatment (if needed).

Heating and isolation requirements.

Special requirements including conditions needed for special operations.

**9.4. Heaters**

Process flow rates.

Operating and design parameters.

Basic dimensions and internals.

Physical and thermal-physical properties.

Consumed heat.

Permissible pressure drops.

Maximum heat streams.

Other special requirements on mechanical designing.

**9.5. Heat exchangers and air coolers**

Specifications include all data required for the heat transfer coefficient and choice of geometrical dimensions. The following data shall be specified:

• operating and design flow rates;

• compositions and conditions of streams (thermal properties, density, viscosity, etc.);

• operating and design conditions (temperature and pressure);

• heat duty, minimum contamination factor;

• permissible pressure drop;

• recommended materials and corrosion allowances for casings;

• data for conditions of mechanical designing and specific specifications (tube wall

thickness,

recommended tolerance between tubes, anti-freeze system, system of washing from salts for air cooled heat exchanger, control system, etc.);

• enthalpy diagrams (in case of change in phase);

• nozzle dimensions;

• heat exchanger type;

• isolation requirements.

**9.6. Pumps and compressors**

Specifications shall contain:

• operating conditions — pressure (inlet and outlet), temperature, flow rate, head;

• positive suction head of the system;

• composition and basic medium properties;

• recommended machine and motor type;

• special requirements to: sealings, lubricants, cooling, control system, compressor start on

nitrogen;

• materials of construction;

• anticipated capacity and efficiency;

• special requirements to designing and manufacturing of equipment.

**9.7. Other (if necessary)**

Electric furnaces

Cooling unit

Ejectors and injectors

Blending devices

Process filters

Others

Specifications shall contain all process data required by the supplier for mechanical design.

**10. MATERIAL OF CONSTRUCTION**

Report on material choice.

Materials and corrosion allowances for equipment and pipelines.

Anticorrosion measures and recommendations on material choice.

List of pipeline classes, where the properties of the class are indicated:

• design parameters (temperature and pressure);

• nominal PN pressure or series as per ASME B16.5;

• material of pipes, pipeline parts, valves with links to standards;

• corrosion allowance;

• sealing surface of flanges;

• types and properties of isolating valves;

• presence of additional requirements connected with corrosion active medium: heat

treatment of welded joints, hardness test against grain-boundary corrosion, etc.

**11. LIST OF PIPELINES**

Complete list of process and auxiliary pipelines shown on the process diagrams shall include:

• general regulations;

• pipeline numbering system;

• pipeline classes (medium assignment, material of construction, corrosion allowance)

• pipeline number;

• pipeline dimension;

• connection points;

• nature of product;

• operating and design conditions;

• heating and isolation, isolation designation;

• chemical, mechanical and thermal treatment before unit start-up, etc.

**12. PROCESS INSTRUMENTS AND CONTROL VALVES SPECIFICATIONS**

12.1. These specifications contain all process data for instruments and control valves design with consideration of inconsistent operations (shutdown, reduced capacity, start-up) and include:

• isolating valves

• control loops;

• control valves;

• flow rate, level, pressure and temperature devices;

• orifice plates;

• means of emergency alarms and trips;

• on-stream analyzers;

• local instruments (thermometer, pressure gauge, sight glass level gauge, level bridle with

electrical heat tracing, etc.);

• various devices.

12.2. List on input/output signals

**13. ELECTRICAL POWER SUPPLY**

13.1. List of electrical receivers indicating electrical characteristics (voltage, rated and consumed power, power factor, efficiency, etc.), operating mode (working / standby, permanent / periodic, etc.), requirements for reliability of power supply (first / second / third category of power supply, a special group of the first category of power supply), the average number of hours of work per year, etc.

13.2. Load calculations on voltage levels, consumption rates.

13.3. Requirements for the reliability of power supply of process electrical receivers. Critical Interruption Indicators

**14. SAFEGUARDS, FLARE AND FLARE SYSTEM**

14.1. Process specifications for pressure safety valves (PSV).

14.2. Table of discharges to flare system.

14.3. Properties of feed, auxiliary materials and completed products from safeguard, industrial sanitation and work safety point of view.

**15. PROCESS DIAGRAMS**

15.1. Specifications for legends

15.2. Process diagrams

These drawings shall be provided with detailed data required for design preparation. They will include at least the following:

• all itemized equipment, including standby equipment.

• process basic and auxiliary pipelines (required for normal operation and start-up conditions, shutdown and other actions) and their dimensions with indication of line number, specification, medium, heating and isolation requirement, recommended materials.

• process requirements for arrangement and altitude position of equipment, pipelines and any other requirements on arrangement related to the process.

• valves and fittings of process and any associated auxiliary pipelines, installation locations and position of spectacle blinds during normal operation mode;

• points of pipeline class change, requirements to necessity of pipe slopes, sample points, pockets or without them, drain, cold or hot washing, etc.;

• instruments required for control and management of process, as well as all control loops, required for measurement and automatic control of the process;

• instruments, control and isolation valves, safety devices shall be numbered;

• position of control and isolation valves in case of malfunction.

NOTES: Equipment for utilities production (e.g. steam production) built in process units shall be considered as process system.

15.3. Steam and condensate diagrams.

Summary documents reflecting all steam and condensate flows required for the start-up, normal operation, scheduled or emergency shutdown.

15.4. Utilities process diagrams.

Preliminary diagrams reflecting basic principles of utilities control.

15.5. List of alarms and trips with indication of set points.

15.6. Cause-and-effect diagram. Trips description,

**16. EQUIPMENT AND CONSTRUCTION ARRANGEMENT PLAN**

Preliminary equipment and construction arrangement drawing. Recommendations on most important process lines layout.

**17. BUILDINGS**

Materials of construction in case of specific process requirements.

Solutions of layout and dimensions of control buildings/facilities within battery limits.

**18. OPERATION MANUAL**

• Philosophy and parameters of process.

• Philosophy of process control.

• Initial and normal start-up (start-up after short-period shutdowns, cold start-up, start-up after emergency situations).

• Normal operation. (including operation of pump and compressor equipment).

• Normal shutdown (short-period shutdowns, hot shutdown and transfer of unit to circulation).

• Procedures of emergency shutdown (fire, blackout, malfunction of cooling water supply, malfunction of instrument air supply, etc.).

• Range of regulated parameter values.

• List of parameters, not allowed to be controlled in manual mode.

• List of trips, which can be switched off manually or automatically for start-up, shutdown or

change of unit’s operating modes.

• Special procedures:

- working with chemical reagents;

- related to work safety, work safety rules and environmental protection during operation

• Recommendations on safety.

• Basic industrial dangers, determined by: process features or performing certain production operations, used equipment features and conditions of its operation, safety rules violation by the personnel;

• Data on toxic properties of the feedstock, semi-finished products, products and waste products. Recommendations on individual protective gear of the personnel;

• Analytical testings recommended by LICENSOR;

- sampling points and safety procedure of sampling;

- frequency of testings as well as laboratory methods.

**19. ENERGY EFFICIENCY**

- initial data for design, design capacity and equipment composition.

- indicators characterizing specific values ​​of fuel and energy resources for the project;

- requirements for the selection of process solutions, architectural solutions, functional and technical, constructive and engineering solutions that affect the energy efficiency of the facility, incl. providing thermal protection of buildings and structures, solutions for heating and ventilation, insulation of equipment and pipelines to ensure energy efficiency of the project;

- justification of the choice of approved technical solutions of the project (based on a comparative analysis of energy intensity relative to alternative technical solutions) and a description of the decisions taken on energy conservation, including: technological solutions, decisions on the use of secondary energy resources, on the use of energy-efficient and energy-saving equipment and materials, etc.;

- justification of the choice of architectural and structural solutions that provide the necessary thermal protection of buildings and structures;

- requirements and degree of technical or commercial accounting of energy resources used at the designed facility;

- a list of energy efficiency requirements that the designed facility must comply with during commissioning and operation;

- a list of regulatory documents.

ATTACHMENT 5 to the Technical Enquiry

for Technical and Commercial Proposal

**Summary table of process technical and commercial parameters.**

**(for the completion by LICENSOR)**

| ***№*** | ***Technical and Commercial indicators*** |  |
| --- | --- | --- |
|  | *Hydrogen Production unit capacity on hydrogen (calculated for concentration of 99,90 %vol.), tons/hour* |  |
|  | *Ratio of stable operation, %* |  |
|  | *Turnaround cycle, years* |  |
|  | *Experience with Russian design institutes and manufactures for Hydrogen Production unit* |  |
|  | *Catalysts, adsorbents:*  *- volume of catalyst layer of feed hydrotreatment, m3*  *- volume of adsorbent H2S layer, m3*  *- volume of catalyst pre-reformer layer, m3*  *- volume of catalyst reformer layer, m3*  *- volume of CO conversion catalyst layer, m3*  *- volume of molecular PSA molecular sieve layer, m3*  *- catalyst loading method*  *- quantity of catalyst layers*  *- used catalyst type*  *- volume velocity of feed supply, hour-1*  *- catalyst life cycle, years*  *- volume of auxiliary material, m3* |  |
|  | *Content of impurities in products:*  *Hydrogen product*  *- Н2, volume ration, %*  *- СО+СО2, ppm vol.* |  |
|  | *Consumption/generation and properties of energy carriers:* |  |
| *- electrical energy, kW* |  |
| *- return water 2 systems, m3/hour* |  |
| *Tdirect/ treturn,ºС* |  |
| *- fuel, Gcal/hour* |  |
| *- demineralized water, tons/hour*  *- feed water for boilers, tons/hour* |
| *- average pressure steam generation, tons/hour* |
|  | *Guarantee indicators:* |  |
| *- target product yield (99,90 % vol. hydrogen), tons/hour*  *- quantity of export steam, tons/hour* |
|  | *Required space for construction, m2* |  |
|  | *Investment amount in US million dollars* |  |
|  | *PROJECT cost in US million dollars* |  |
|  | *License cost in US million dollars (is PROCESS is licensed)* |  |
|  | *Liability under guarantees, % of Basic Design cost* |  |
|  | *PROJECT preparation time, months* |  |
|  | *Total amount of operating units, which are built as per developed basic designs* |  |
| *- worldwide* |  |
| *- incl. in the Russian Federation* |  |
|  | *Amount of units as per developed PROJECTS, put into operation for the last 15 years* |  |
| *- worldwide* |  |
| *- incl. in the Russian Federation* |  |
|  | *Amount of units as per developed PROJECTS that are at stage of construction and installation works* |  |
| *- worldwide* |  |
| *- incl. in the Russian Federation* |  |