TECHNICAL PROPOSAL

FOR

R2R FLUE GAS TREATMENT PACKAGE

MATERIAL REQUISITION NO.: 2001-76-EP-ME-MR-4703-A3

01	Issued for Offer	M. H.	M. T.	M. SH.	23-Jan.-2024
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Contents

1- INTRODUCTION

This proposal is quoted in accordance with inquiry documents, specifications and standards listed in the received requisition no. "2001-76-EP-ME-MR-4703-A3" from the ODCC company.
The proposal is submitted in cooperation with "THERMO EUROPE S.r.l" & "PSE Engineering GMBH" as Hamoon Rah joint company for engineering, procurement, manufacturing and inspection services of one set "R2R FLUE GAS TREATMENT PACKAGE".

Latest technology is utilized for design of the package to providing optimized equipment, utility and chemical consumptions, safe and reliable operation to meeting client requisitions.

2- DEFINITIONS

Project: Esfahan Oil refinery Upgrading & Petrochemical

Employer: Sohrevardi Petrorefinery Safahan (SPRCO)

Contractor: Oil Design and Construction Company (ODCC)

Package Description: R2R FLUE GAS TREATMENT PACKAGE

3- APPLICABLE CODE & STANDARDS & DESIGN SOFTWARES

3-1- CODE & STANDARDS

Following international code and standards will be considered for design, fabrication and inspection, in addition to specific project requirements:

- ASME Sec. VIII, Div. 1
- ASME Sec. II
- ASME Sec. V
- ASME Sec. IX
- ASME B 31.3
- ASME B31.1
- ASME B 16.5 & B 16.47A
- ASME B 36.11
- API RP 520/521/526
- API RP 560
- API 614

- API 670
- API 673
- API 677
- API 660
- TEMA
- API RP 939-C
- ASME STS-1
- ASTM A380
- API RP 582
- API 611: Steam Turbine
- American Welding Society (AWS)
- ICAO Annex 14, Volume I
- API 620
- API 621
- UBC 97
- WRC 107/297
- IEC / ISA / CENELEC / NPCS / NFPA
- EN 10204-3.1 (for pressure parts) & EN 10204-2.2 (for non-pressure parts)

3-2- DESIGN SOFTWARE AND TOOLS

Following international software will be used for design, drafting and document preparing:

- ASPEN HYSYS & PLUS: Process simulation and modeling
- PV Elite, Cod. Calc., Nozzle Pro.: Mechanical design for pressure parts of vessels and exchangers
- AVEVA PDMS, NAVISWORK, AutoCad3D: Piping & 3D modeling
- CAESAR II: Stress analysis and support modeling
- AutoCAD: Drafting & drawing (2D or 3D)
- SAP 2000, SAFE & Tekla: Steel Structure Design & Calculation
- Microsoft Office: General Calculation & Document preparing
- Manufacturer design tools and software for sizing of special items

4- PACKAGE DESIGN DATA

4-1- GENERAL

R2R Flue gas treatment package consists of following equipment, piping, instrumentation will be designed to removal of solid particles, Co, NOx, SOx, H2S and NH3 from R2R flue gas streams

before venting to atmosphere. Also, HP steam will be produces by heat recovery from the combustion reaction heat.

- IN-76101 (Incinerator) including FA-76101A/B (Forced Draft Air Fan) and FA-76101A-ST (Steam Turbine for Forced Draft Air Fan) with F-76102 A/B (Air CO Incinerator Filter)
- ME-76107 (DE-NOX Filter)
- E-76102 (Flue Gas Cooler)
- SK-76101 (Flue Gas Scrubber)
- S-76101 (Stack)
- V-76114 (HP Steam Drum)

4-2- FEED CHARACTERISTICS

First feed characteristics to the incinerator (IN-76101) as first equipment of the R2R Flue gas treatment package is as table 1, 2 & 3:

Table 1- Flue Gas from First Regenerator (feed to incinerator)

Operating case		CO Min	Normal	CO Max (Design)
Gas analysis	mol %			
		N2 67.78	N2 67.78	N2 66.94
		H2O 15.62	H2O 15.62	H2O 15.43
		CO2 11.69	CO2 10.23	CO2 8.10
		CO 4.68	CO 6.14	CO 8.10
		SO2 0.10	SO2 0.10	SO2 0.10
		SO3 0.011	SO3 0.011	SO3 0.011
		H2S 0.083	H2S 0.083	H2S 0.083
		NO 0.016	NO 0.016	NO 0.016
		NH3 0.019	NH3 0.019	NH3 0.019
		H2 0.000	H2 0.000	H2 0.62
		CH4 0.000	CH4 0.000	CH4 0.36
		C2H6 0.000	C2H6 0.000	C2H6 0.18
		C3H8 0.000	C3H8 0.000	C3H8 0.09
		02 0.00	02 0.00	02 0.00
		TOTAL 100.00	TOTAL 100.00	TOTAL 100.00
Impurities (Wet base)	vol. ppm		Normal / Design	
			SOx 1115 / 1450	
			H2S 835 / 1086	
			NH3 195 / 213	
			NOx 164 / 254	
Molecular weight	kg/kmol	28.35	28.13	27.61
Mass rate	kg/h	372 772		
Volume rate (0°C - 1 atm)	Nm^3/h	296 990.8		

Table 2- Fines Content (Dry Base) in Flue Gas from First Regenerator (feed to incinerator)

Estimated Inlet Dust Loading	mg/Nm^3	1400
Particle size distribution	% wt	
0 – 5 microns		27.0
5 – 10 microns		25.0
10 – 20 microns		29.0
20 – 30 microns		12.0
30 – 40 microns		5.0
40 – 50 microns		2.0
50 – 60 microns		0.0

		TOTAL 100.00
Average particle size	µm	10.1

Table 3- Inlet Condition to Incinerator from First Regenerator

Pressure	bar abs	**0.912**
Normal Temperature	°C	***455***
Maxi Temperature	°C	**770**
Inlet Volume (Normal)	M^3/h	**879180**

Second feed characteristics to the outlet of incinerator (IN-76101) that to be mixed with incinerator outlet and routs to De-NOx section is as table 3 & 4:

Table 3- Flue Gas from Second Regenerator (feed to outlet of incinerator)

Operating case		Normal
Gas analysis	mol %	
		N2 73.83
		H2O 7.37
		CO2 16.77
		CO 0.00
		SO2 0.14
		SO3 0.016
		H2S 0.00
		NO 0.028
		NH3 0.00
		O2 1.85

		TOTAL 100.00

Impurities (Wet base)	vol. ppm	SOx 1599 H2S - NH3 - NOx 280
Molecular weight	kg/kmol	30.09
Mass rate	kg/h	193 261
Volume rate (0°C - 1 atm)	Nm^3/h	143 939.5

Table 4- Fines Content (Dry Base) in Flue Gas from Second Regenerator (feed to outlet of incinerator)

Estimated Inlet Dust Loading	mg/Nm^3	1400
Particle size distribution	% wt	
0 – 5 microns		27.0
5 – 10 microns		25.0
10 – 20 microns		29.0
20 – 30 microns		12.0
30 – 40 microns		5.0
40 – 50 microns		2.0
50 – 60 microns		0.0
		TOTAL 100.00
Average particle size	µm	10.1

Note 1: 10% overdesign will be considered on normal inlet flow rate of both feeds.

4-3- PRODUCT SPECIFICATION & PERFORMANCE GUARANTEE

Limitation for gas pollutant emissions from the R2R Flue gas treatment package is as following table:

Table 5- Limitation for gas pollutant emissions (from Stack of the R2R Flue gas treatment package)

Pollutant	Limit
Sulphur oxide	752 mg/Nm^3 (267 ppmv)
Particles	50 mg/Nm^3
Carbon Monoxide	150 ppmv (187.5mg/Nm^3)
Hydrogen sulphide	6 mg/Nm^3 (4 ppm)
Nitrogen Oxide	376 mg/Nm^3 (186 ppmv)
Hydrocarbons	20% opacity
Photochemical	20 mg/m^3
Nonphotochemical	300 mg/m^3

5- PROCESS DESCRIPTION

The R2R Flue gas treatment package consists of following sections to removal of solid particles, CO, NOx, SOx, H2S and NH3 from flue gas streams before venting to atmosphere. Also, recovery of waste heats to producing HP steam in the package is another aim.

5-1- Incineration (Combustion) Section

Combustion of the CO into CO2 and H2S into SO2 are realized in this section. The combustion effluents are mixed with flue gas from second regenerator in the incinerator chamber outlet before being introduced in the De NOx. The combustion reaction will be occurred in ~ 1050 oC and 0.08 barg

In case of emergency, the Incinerator can be by-passed while the unit is operated at full capacity.

The combustion will be accomplished by firing either fuel gas, clarified oil (filtered RFCC slurry) or fuel oil. Normal operating mode foreseen is Clarified Oil.

5-2- De-NOx Section

Aim of this section is to decrease the NOx content of the flue gas coming from the Incinerator section and the second regenerator in order to reach the environmental requirements. The NOx content at DE-NOx outlet will not exceed 183 ppm vol. dry basis (3% O2 excess). The De-NOx process considered in this package is a non-catalytic (thermal) process by using Urea Solution as reducing agent.

5-3- Flue Gas Cooler (Steam Generation) Section

The main objective of this section is to efficiently recover heat from the first and second regenerator flue gas and heat of combustion released by incineration section.

Maximum heat from the resultant products of combustion will be recovered in this section for the following services:

- Preheating of the boiler feed water being fed to the dedicated steam drum. The BFW preheated in the different sections is mixed with the circulating water prior to entry into the preheater coil
- Steam generation of FGC
- Superheating of the different steam productions of the main fractionator section as required

5-4- Flue Gas Scrubber Section

A wet scrubber will be used to remove particulate and SOx from the total flue gas produced by the R2R FCC unit. The particulate content at Scrubber outlet will not exceed 50 mg/Nm3 on dry basis at 3% O2 excess.

The SOx content at Scrubber outlet will not exceed 800 vol ppm on dry basis at 3% O2 excess.

Caustic Soda 53% w/w solution will be used as scrubbing agent in the scrubber tower.

5-5- Flue Gas Stack

Flue gas wet stack used to release flue gas at safe location in accordance with environmental regulation. Following cases will be considered in the stack sizing:

- 110% of normal operating case
- 45% of normal operating case
- Scrubber shutdown case
- CO incinerator bypass case
- Flue gas cooler bypass case
- Third stage separator bypass case

All required provisions for suitable installation and working of CEMS (Continuous Emission Monitoring System) such as nozzles (including spares), ladder and platform and any suitable internal and external support will be considered for the stack. Pollutant emissions of the gas outlet from the stack will be according to section 4-3 of this proposal.

6- UTILITY & CHEMICAL CONSUMPTION

Maximum required utilities and chemicals at design condition of the R2R Flue gas treatment package are described in table 6.

Table 6- Utility consumption at design condition

No.	Utility	Unit	Consumption	Specification
1	Fuel Oil (Clarified Oil)	kg/hr	6500	Supply Press.: acc. To project spec. Supply Temp.: acc. To project spec.
2	Instrument Air	Nm3/hr.	125	Supply Press.: 6.2 barg Supply Temp.: 40 ^{o}C
3	Electrical Power	kW	290	3ph, 50 Hz, 400 V

No.	Utility	Unit	Consumption	Specification
4	Electrical Power	kW	1750	3ph, 50 Hz, 6000 V
5	HBW	Kg/hr	295,000	Supply Press.: 57.6 barg Supply Temp.: 148 °C
6	Saturated Steam	Kg/hr	195,000	Supply Press.: 47 barg Supply Temp.: 264 °C
7	Process Water	Kg/hr	160,000	Supply Press.: 3.4 barg Supply Temp.: 40 °C
8	High Pressure Steam	Kg/hr	Hold	Supply Press.: 42 barg Supply Temp.: 360 °C
9	Caustic Soda (53% w/w)	Kg/hr	7000	Supply Press.: 3 barg Supply Temp.: Amb.
10	Urea (10% w/w)	Kg/hr	400	Supply Press.: 3 barg Supply Temp.: Amb.
11	Sodium Phosphate (5% w/w)	Kg/hr	30	Supply Press.: 55 barg Supply Temp.: Amb.

Note 2: All the consumptions are preliminary and will be finalized at detail engineering.

7- SCOPE OF SUPPLY

R2R Flue gas treatment package will be supplied according to following main characteristics for equipment and relevant instruments, valves, pipe, fitting, structure, etc.
Detailed table for scope of supply according to MR is attached.

7-1- EQUIPMENT

Preliminary equipment list for the R2R Flue gas treatment package is attached.

8-2- INSTRUMENT, CONTROL & ELECTRICAL DEVICES

Controlling of the R2R Flue gas treatment package is done via package control system (UCP), located at plant control room. All instrument and electrical devices as below items will be supplied according to project P&ID:

- Pressure and Differential Pressure Gauge & Transmitter
- Temperature Gauge & Transmitter
- Flow Orifice & Transmitter
- Analyzers
- Pressure Safety & Relief Valve
- Control Valve
- On/Off Valve
- Earthing Lugs & Cable
- Unit Control Panel (UCP) (Safe area)
- All bulk materials for construction work within the Package B.L. (Cable, Cable tray, Cable gland, Junction Boxes Supports and etc.)
- All Instrument process and pneumatic hook-up material (in SS316)
- JB (Separate junction boxes will be provided for each type of signals)

PLC shall be SIL-3 -FH

Note 3: EExia IIC T4 Zone2 (explosion proof enclosure) will be considered as Hazardous Area Classification.

Note 4: IP 55 & IP 65 will be considered for protection of electrical & instrument devices respectively. IP 42 will be considered for indoor control panel.

8-3- PIPING

All internal and interconnection piping and pipe supports material will be suppled according to project PMS (Piping Material Specification) and P&ID. The piping components are as below:

- Process Pipe
- Manual Valve
- Flange, Gasket, Bolt & Nut
- Pipe Fitting as Tee, Cap, Reducer, Restriction Orifice & etc.
- Piping Supports

The pipe size and pressure rating will be in accordance with the maximum flow rate and pressure encountered in the system. Particular care will be taken with the piping to provide

minimum restriction for equipment accessibility and minimize friction losses. The complete package with all piping system assembled will be functionally tested to ensure proper operation.

8-4- MISCELLANEOUS

8-4-1- SPARE PARTS FOR PRE-COMMISSIONING, COMMISSIONING AND START-UP

Spare parts for pre-commissioning, commissioning and start-up will be supplied according to following items:

- Bolts/ nuts/washer for doors, nozzle with blind, assembly of incinerator, burner mounting, (10% (Min. 2set))
- Gasket for access doors, nozzle with blind, burner and O-rings (100%)
- Refractory material (100% for refractory at site and 10% for refractory at shop)
- Fire bricks (20% for each type)
- Burner tile (5%)
- Mortar for burner tile (15%)
- Fuel gas tip (5% (Min. 1set))
- Pilot tip (5%, Min. 1set))
- Pilot ionization (10% (Min. 1set))
- Igniter transformer (2% (Min. 1set))
- Sight glass (10% (Min. 1set))
- Flexible hose for burners (10% (Min. 1set))
- Gasket, gland packing, O-ring for control valve & on-off valve (100%)
- Lamp, power-fuse (20%)
- Gasket and shaft seal for blower (100%)
- Filter elements of lube oil (100%)
- Filter elements of blower (100%)

8-4-2- SPARE PARTS FOR TWO YEARS OPERATION (OPTIONAL)

Spare parts for two years operation will be supplied as an option according to spare part procedure and requirements in attachment #3 of material requisition no. “2001-76-EP-ME-MR-4703-A3”.

8-4-3- CAPITAL SPARE PARTS (OPTIONAL)

Capital spare parts will be supplied as an option according to spare part procedure and following items:

- **Main Air Blower:**

NO.	Designation of Spare	Quantities
	CAPITAL SPARE PART	
1	complete Spare Rotor for Main Air Blower (Same size, type and material) which is balanced mechanically tested and horizontally packed. Preservation with purged container.	1 Set
2	complete spare rotor for steam turbine which is balanced mechanically tested and horizontally packed. Preservation with purged container	1 Set
3	Electronic Main Boards for each PLC	1 Set
4	Main Power Supply for each PLC	1 Set

- **CO Incinerator:**

NO.	Designation of Spare	Quantities
	CAPITAL SPARE PART	
1	complete Spare Rotor for Steam Turbine (Same size, type and material) which is balanced, mechanically tested and horizontally packed. Preservation with N2 purge.	1 EA
2	complete Spare Rotor for Gear box (Same size, type and material) which is balanced mechanically tested and horizontally packed.	1 EA
3	Electronic Boards for Electronic Governor (Same Type)	1 EA
4	Electronic Main Boards for PLC	1 EA

8-4-4- SPECIAL TOOLS (OPTIONAL)

Special tools list required for the R2R Flue gas treatment package will be provided in next steps.

9- SCOPE OF WORK

Engineering, procurement, fabrication, inspection & test and execution works needed for the R2R Flue gas treatment package is summarizes below.

Detailed table for scope of works according to MR is attached.

9-1- ENGINEERING AND DOCUMENTATION

The engineering will provide the detail design documents in general, process, mechanical, piping, electrical, instrument and structural divisions according to client requisition and agreed document list at job stage.

9-2- PROCUREMENT SERVICES

All required equipment, instruments, pipe & fitting, etc. for the packages proposed in section 8 of this proposal will be procured according to approved engineering documents and requisition.

9-3- INSPECTION & TEST

All packages will be inspected and tested according to project specifications & standards by Q.C. personnel and third party. The inspection and test will be executed in accordance with the project ITP including following items:

- Material Test Certificate (EN 10204 Type 3.1 & 2.2 for pressure & non-pressure parts respectively)
- Dimensional and Visual Inspection
- NDT According to Code & Standard
- Positive Material Identification (PMI) For Non-Carbon Steel Material
- Hydrostatic Test
- Sand Blast & Painting Inspection (where required)
- FAT & performance test for rotary equipment as burner, blower & pumps
- FAT & SAT for control system
- Instruments certificate and calibration check
- Deleted

Note 5: Preliminary ITP is attached.

9-4- PACKING, MARKING & SHIPPING

The following conditions are proposed for marking, packing & shipping of the packages:

- All equipment and packages will be clearly marked with their equipment number & name plate.

- Internal protection for equipment and piping of package will be done according to project specifications.
- Body of skid mounted packages will be loose for shipment.
- All fragile items and instruments will be removed and boxed for shipment.
- All individually shipped pieces will be tagged with identifying markings to assist in reassembly at site.
- All pieces will be clearly marked with proper shipping information in an insoluble manner. Purchaser should follow store procedures since the package is handed over to the Purchaser site store.
- Standard export packing with crate will be used for spare parts and other accessories.

9-5- SUPERVISION FOR INSTALLATION AND COMMISSIONING (OPTIONAL)

- Supervision at site for erection, installation, pre-commissioning and commissioning will be offered in commercial proposal separately and as Optional (Man per Day) item.

10- EXCLUSION ITEMS

Following items are excluded from Hamoon Rah scope of work and supply:

- Third Party Inspection
- Design & Supply for Fire & Gas System
- Installation of equipment, machinery, piping, instruments supplied in loose type
- Supply of instrumentation cables between FIELD (Local Control Panel, Junction Box, Instruments) and Control Room
- Fire proofing work and supply
- All building, civil work, concrete foundations, foundation design and grouting
- On-skid and Off-skid telephone and paging system design, lay-out and supply of material.
- Design and construction of civil and foundation works (foundation plan and loads will be submitted).
- Off-skid piping from PSV and drains to probable flare, vent and drain networks.
- Crane and handling devices
- Anchor Bolts
- CEMS Analyzers
- Turbo Expander TEX-76101
- Protective roof (canopy) for all electric motors
- MCC Panel
- Piperack “PR-7606”, “PR-7607” and Structure “STR-7612”, “STR-7613”

11- DELIVERY CONDITION

- The R2R Flue gas treatment package will be delivered in **24 months from order effective date**.

- Delivery point of the package is **Ex-Work, Hamoon Rah shop in Iran and Our sub-vendors shop for foreign equipment.**

12- DEVIATION

Deviate items from project MR are as below:

No.	Deviation	Description
1	No Deviation	-

13- ALTERNATIVE

Alternative cases for the project are as below:

No.	Alternative	Description
1	No Alternative	-

14- CLARIFICATION

Points need to clarification for the project are as below:

No.	Clarification	Description
1	No Clarification	-

15- GUARANTEE

Performance of the package and all of its components are guaranteed for a period of 12 months after start-up or 18 months after final delivery whichever comes earlier. The guarantee is only valid if the package is conveniently protected, Installed and commissioned according to our related documents and procedures. It covers faulty parts but not those damaged due to

negligence, lack of preventative maintenance according to our instructions, or bad operation, misapplication, abuse, improper installation by third parties. The guarantee of seller does not cover failures not reported to seller within the guarantee period specified above; also, it does not cover operation failures due to running above nominal capacities or improper handling, misuse or alternation of goods by personnel not authorized by seller, failures and damages due to the use of nonoriginal spare parts. We will not be liable in consequential damages, for loss of owner's anticipated products/income, fuel costs, penalties or fines imposed by third parties, loss by reason of plant shut down, non-operation, or increased expense of operation of other equipment, loss of product, or other consequential loss or damage of any nature arising from such defect.

16- ATTACHMENT

1. Scope of Work & Supply Table – Rev.01
2. Preliminary Sub-vendor List – Rev.01
3. Deviation/Clarification/Alternation Form – Rev.00
4. Hamoon Rah Catalog, Reference List & Certificate
5. PSE Reference List & Certificate
6. TERMO EUROPE S.r.l Reference List
7. TERMO EUROPE S.r.l Agreement
8. Split of Work Table
9. Preliminary Equipment List – Rev.00
10. Preliminary Datasheet & GAD for CO-INCINERATOR & DE-NOX – Rev.00
11. Preliminary GAD and Part List for FLUE GAS COOLER– Rev.00
12. Preliminary Datasheet for Fan – Rev.01
13. Preliminary Datasheet for Burner – Rev.01
14. Preliminary ITP – Rev.00
15. Sample Configuration Diagram for Unit Control Panel
16. Manufacturer Catalog for Fan & Burner
17. Filled Instrument TBA Table (Row No. IV-1 of TCL)