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Kinder Morgan

Proposal Title: Rio Vista

Proposal Number: [Redacted]

Proposal Description: [Redacted] Emission Control System to Reduce Emissions from Solar Saturn 10-1202 Turbines

Submitted by: [Redacted]

[Redacted] **Contact:** [Redacted]

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July 1, 2021

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Proposal #:	[REDACTED]
Project Name:	Rio Vista

James,

We are pleased to submit this proposal for an [REDACTED] **Emissions Control System** designed to reduce emissions for (2) Solar Saturn turbines.

The [REDACTED] **Emissions Control System** offered for this project is based on engine and emissions data provided by Kinder Morgan. The enclosed proposal details the price, scope of supply, warranty, commissioning and terms and conditions necessary to achieve the required emissions limits and long-term compliance.

Should you have any questions or comments, please do not hesitate to contact me.

THE [REDACTED] ADVANTAGE: COMPLIANCE AT A COMPETITIVE COST

[REDACTED] is an environmental engineering company supplying reliable exhaust after-treatment based emissions control systems to the North American market. Our strength is helping customers comply with federal and local emission regulations targeting process machines, marine vessels, offshore rigs, stationary diesel and natural gas engines and turbines. We specialize in reducing NOx using a comprehensive systems approach based on Selective Catalytic Reduction (SCR). Our SCR systems are then combined with oxidation catalysts or particulate filter technologies to reduce other regulated pollutant emissions, such as carbon monoxide (CO), hydrocarbons (HC), volatile organic compounds (VOC) and particulate matter (PM). We also offer an array of supporting component options, from urea storage tanks to air compressors to silencers, with the goal of providing everything necessary for a successful and near-turnkey installation.

Based in [REDACTED], [REDACTED] is a [REDACTED]. [REDACTED] leverages more than five decades of experience in environmental compliance, and draws upon the knowledge of over 1000 successful SCR systems in a wide variety of markets such as marine, power generation, oil and gas development, industrial and chemical processes.

Our structured engineering approach begins by comparing your project's emissions profile to the regulations, or to the project's unique requirements. We then design an emission control system tailored to your application. Our product manufacturing process is governed by exacting quality standards, and our systems are commissioned with the [REDACTED] Emissions Guarantee. To ensure compliance over the long-term, we provide support after the sale through extensive operator training, spare parts, and on-site maintenance.

TABLE OF CONTENTS

<u>I. QUOTATION</u>	<u>5</u>
1. SCOPE OF SUPPLY	5
2. PRICE	7
3. PAYMENT	7
4. SCHEDULING & DELIVERY	7
5. QUALITY STANDARD	7
6. OFFER VALIDITY	7
<u>II. TECHNICAL DESCRIPTION</u>	<u>8</u>
1. EXHAUST GAS DATA & EMISSION REQUIREMENTS	8
2. EMISSIONS GUARANTEE & WARRANTY	9
3. SCOPE OF SUPPLY	10
A. ENGINEERING (PER SITE)	10
B. TEMPERING AIR BLOWER (PER UNIT)	10
C. MIXING SECTION & INJECTION NOZZLE (PER UNIT)	10
D. CATALYST HOUSING (PER UNIT)	10
E. SILENCER (PER UNIT)	10
F. SCR CONTROL (PER UNIT)	11
G. REAGENT DOSING PANEL (PER UNIT)	11
H. AMMONIA PUMP STATION (PER SITE)	11
I. AMMONIA TANK AND END DEVICES (PER SITE)	11
<u>III. OPERATING PRINCIPLE</u>	<u>12</u>
<u>IV. SCR CATALYST IMPURITY TOLERANCE SPECIFICATION</u>	<u>15</u>

I. QUOTATION

PROPOSAL #: [REDACTED]

PROJECT: Rio Vista

DESCRIPTION: [REDACTED] Emission Control Systems to reduce emissions from Solar Saturn Natural-Gas Fired Turbines

1. SCOPE OF SUPPLY

ITEM	DESCRIPTION	EXT. PRICE (\$)
001	EMISSIONS CONTROL SYSTEM (2 x Saturn 10-1202) • 2 x Tempering Air Blower • 2 x Static Mixing Section with integrated Injection Lance • 2 x SCR Catalyst Housing containing: ○ SCR catalyst ○ Temperature and Differential Pressure Sensors • 2 x Silencer and Stack • 2 x Control System, Touch-screen PLC ○ NOx Sensor • 2 x Urea/Air Dosing Panel • 1 x Reagent Pump Station • 1 x Reagent Storage Tank • Engineering, Operation & Maintenance Documentation	\$1,170,000

Not included in the scope of supply:

- Load signal from the engine (4-20 mA)
- Fuel flow signal from the engine (4-20mA)
- Fuel composition (TCP/IP)
- Engine running signal (digital dry contact, closed when engine is running)
- Internet connection for remote PLC access and service support
- Structural and civil work necessary to complete the installation
- Expansion joints for provided exhaust components
- Aqueous Ammonia Solution
- Compressed Air, per ISO 1.3.4 requirements
- Heat tracing of Ammonia tank or Ammonia lines (available as an option)
- Provision for electricity and connection of the power supply to the enclosure
- System integration (design and engineering) with the building structure
- Platforms and other support structures
- Any 3rd party emission certification of stack test

2. PRICE

The given prices for the SCR Emissions Control System are net prices, DDP to customer location in NM, according to Incoterms 2010. All prices are in US dollars. Not included are taxes. Shipping based on standard ground, sea vessel and non-expedited shipping.

3. PAYMENT

30% of the order value upon initial order;

15% of the order value with submittal of engineering documents

50% of the order value with ready for shipment of the hardware

5% of the order value after successful commissioning, not to exceed six (6) months after delivery

All payments are to be paid within 30 days after each date of invoice, net.

4. SCHEDULING & DELIVERY

Delivery of the drawings and technical documents is approximately 12 weeks after receipt of a purchase order. Delivery of the hardware is approximately 20 weeks after approval of all technical details. Total estimated schedule (with a 4-week customer review period) is 36 weeks for receipt of material at each station.

5. QUALITY STANDARD

All drawings will be in both metric and English units. We reserve the right to adapt the technical design of the emission control system based on the results of the final engineering work, provided this does not impact the affect the guaranteed performance characteristics and is approved by the customer before production begins.

6. OFFER VALIDITY

This offer is valid 90 days from date on proposal.

II. TECHNICAL DESCRIPTION

1. EXHAUST GAS DATA & EMISSION REQUIREMENTS

Unit Data:

Parameter = 100% Load	Unit	Solar Saturn 10-1202*
Fuel	-	CQNG
Power	bhp	1,051
Exhaust Gas Flow Rate (wet)	lb/hr	37,652 95,398**
Exhaust Gas Moisture Content (actual, wet)	Vol. %	4.5
Oxygen Content (actual, wet)	Vol. %	15.6
Exhaust Temperature	°F	1190 850**

* From KM provided data

**With Tempering Air Added

Emission Control System Design Parameters:

Parameter	Unit	Saturn 10-1202
Aqueous Ammonia Solution	%	19
Aqueous Urea Solution Consumption Rate (at 100% engine load) approximately, per engine	gph	~5.8
Total Estimated Backpressure Contribution	inH ₂ O	6.5
Air Consumption, per engine (Based on 87 psi nominal, max 160 psi)	scfm	12**

**Typical dosing Type Z-Purge is ~4scfm with door open and <1scfm with door closed

2. EMISSIONS GUARANTEE & WARRANTY

Constituent	Current Engine Out	Required Stack Out**
NOx as NO ₂ *	150 ppmvd @15% O ₂	50 ppmvd @15% O ₂

** Based on 1 hour averaging with the engine operating at 100% load. Minimum temperature for SCR performance is 570F.*

***Based on a minimum 500F SCR outlet temperature with 19% NH3 and Maximum SCR inlet temperature of 950F*

Provided the engine is operating under stable operating conditions, guarantees the stack emissions (Based on % reduction) for a period of 16,000 hours of operation or 24 months after the initial engine performance test date, or 30 months after delivery, whichever comes first. All values are per EPA-approved measurement methods, with one-hour averaging while the engine is operating at 100% load. The mechanical warranty is 12 months after commissioning or 18 months after delivery, whichever comes first.

This guarantee is subject certain maintenance practices and engine operating conditions, as defined in the Terms & Conditions. The guarantee is also based on the emissions data provided to at the time of this quotation and defined in Section 1 of the Technical Description. reserves the right to modify Items 001 in the Scope of Supply and associated price once more accurate and complete emissions data are obtained in order to ensure the emission limits can be maintained as required.

3. SCOPE OF SUPPLY

A. Engineering (Per Site)

- Drawings
- System flow diagram
- Control of the SCR system
- Documentation

B. Tempering Air Blower (Per Unit)

Includes a single air tempering blower system to maintain constant temperature at the SCR elements. Designed to maintain ~850F temperature at the SCR inlet depending on the ambient conditions and unit load. Includes the motor VFD.

C. Mixing Section & Injection Nozzle (Per Unit)

Aqueous Ammonia solution is injected into the exhaust with a two-phase nozzle (air and Ammonia solution). An air atomization nozzle is integrated into the mixer to create small droplets such that complete evaporation of the water occurs without contacting the walls of the ductwork. The mixing section (SS304 housing/flanges) with integrated injection nozzle is coupled to a straight exhaust duct (included) to ensure complete conversion of aqueous Ammonia to ammonia gas.

D. Catalyst Housing (Per Unit)

The SCR catalysts are integrated into a single catalyst housing enclosure. The catalyst is loaded via service panels located on the side of the housing. With outlet temperature and differential pressure monitoring. Includes space for 1 additional layer of SCR elements and 1 layer of oxidation element. Note the SCR catalyst impurity tolerance specification in Section IV.

E. Silencer (Per Unit)

Based on the following:

- Carbon-steel, painted high temperature paint.
- Designed based on 100mph wind load
- Designed as base mounted, vertical
- With Stack for height from grade ~30ft
- Designed for 15-20 dBA noise reduction
- With 4 x 4in ANSI 150# test ports

F. SCR Control (Per Unit)

The SCR is controlled by a single PLC based control system housed in a control cabinet per unit. Includes an A-B MicroLogix PLC; 6in touch screen (A-B) control with menu-guided parameter inputs (without any program change); password protection; error message and clear readable display.

G. Reagent Dosing Panel (Per Unit)

All components for aqueous ammonia dosing are mounted on a steel back panel; includes steel dosing valve, magnetic valves and shut-off valves. (Pressure indicators related to reagent solution supply to the dosing panel are the customer's scope.)

H. Ammonia Pump Station (Per Site)

Pump station complete with auxiliary valves, filters; ships fully assembled and pretested from our factory. The pump station has been designed for 19% aqueous NH₃ for simultaneous operation of all units at the facility. The pump station also comes with one 100% backup pump.

I. Ammonia Tank and End Devices (Per Site)

Includes (1) horizontal, 12,000 USG, single-wall stainless-steel tank. 96in D x 32ft tangent to tangent length, made of 304 stainless steel, built to ASME Section VIII Division 1 Code, Design Parameters: 30 psig, 125°F with 1/16 in corrosion allowance. With the following end devices:

- (1) Ultrasonic level transmitter
- (1) Temperature transmitter
- (1) Pressure transmitter
- (1) Relief and Vacuum Valve
- (1) NH₃ leak detection sensor
- (1) Control panel for indication of level, pressure and temperature

III. OPERATING PRINCIPLE

Selective Catalytic Reduction Principle

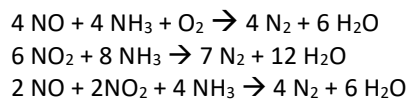
NO_x is a general term referring to Nitrogen Oxide (NO) and Nitrogen Dioxide (NO₂) gases. NO_x forms at the high temperatures of a combustion process, typical of internal combustion engines. NO_x is a precursor to smog and adversely affects health and the environment. As such, NO_x is increasingly regulated by both the US Environmental Protection Agency and by local authorities.

NO_x emissions are most efficiently removed from the exhaust by Selective Catalytic Reduction, often referred to as SCR. SCR works by promoting a chemical reaction between the NO_x and ammonia gas (NH₃), which is introduced upstream of the SCR catalysts. The ammonia can come from a variety of sources, including directly as a gas (known as anhydrous ammonia), or as an aqueous ammonia solution. It is more common to use aqueous urea solution. Urea is a widespread component of fertilizer, and water-based solutions made from urea are easier to handle than ammonia compounds. Moreover, aqueous urea solutions are readily available in different storage capacities and concentrations.

Commercially, aqueous urea solutions come in two concentrations, either 32.5% or 40%. The lower concentration, 32.5%, has the lowest freezing point of 12°F (-11°C), and is therefore used in colder climates where ambient temperatures can reach this point. The 40% concentration has a higher freezing temperature of 35°F (2°C), but requires less volume of solution to achieve the same degree of NO_x reduction. In either case, freezing is to be avoided since injection becomes problematic. When low temperatures are encountered in the application, it is customary to install an immersion heater in the urea storage tank, as well as heat-tracing the urea supply lines to the SCR System. This is true for both concentrations of urea solution.

When the engine is running and the catalyst has warmed up to its normal operating temperature, urea solution is injected into exhaust stream ahead of the SCR catalyst, in combination with high-pressure air, to assist in atomizing the spray. (The air also cools the urea injection nozzle and purges the injector when the engine is no longer running.) Chemically, the heat of the exhaust first vaporizes the water in the urea solution, resulting in the formation of small urea crystals. These crystals further breakdown in the exhaust stream into ammonia and carbon dioxide. Once ammonia is present, the chemical reactions shown below take place over the SCR catalyst, reducing NO_x to harmless nitrogen gas and water vapor.

Once ammonia gas is present, the chemical reactions shown below take place over the SCR catalyst, reducing NO_x to harmless nitrogen gas and water vapor:



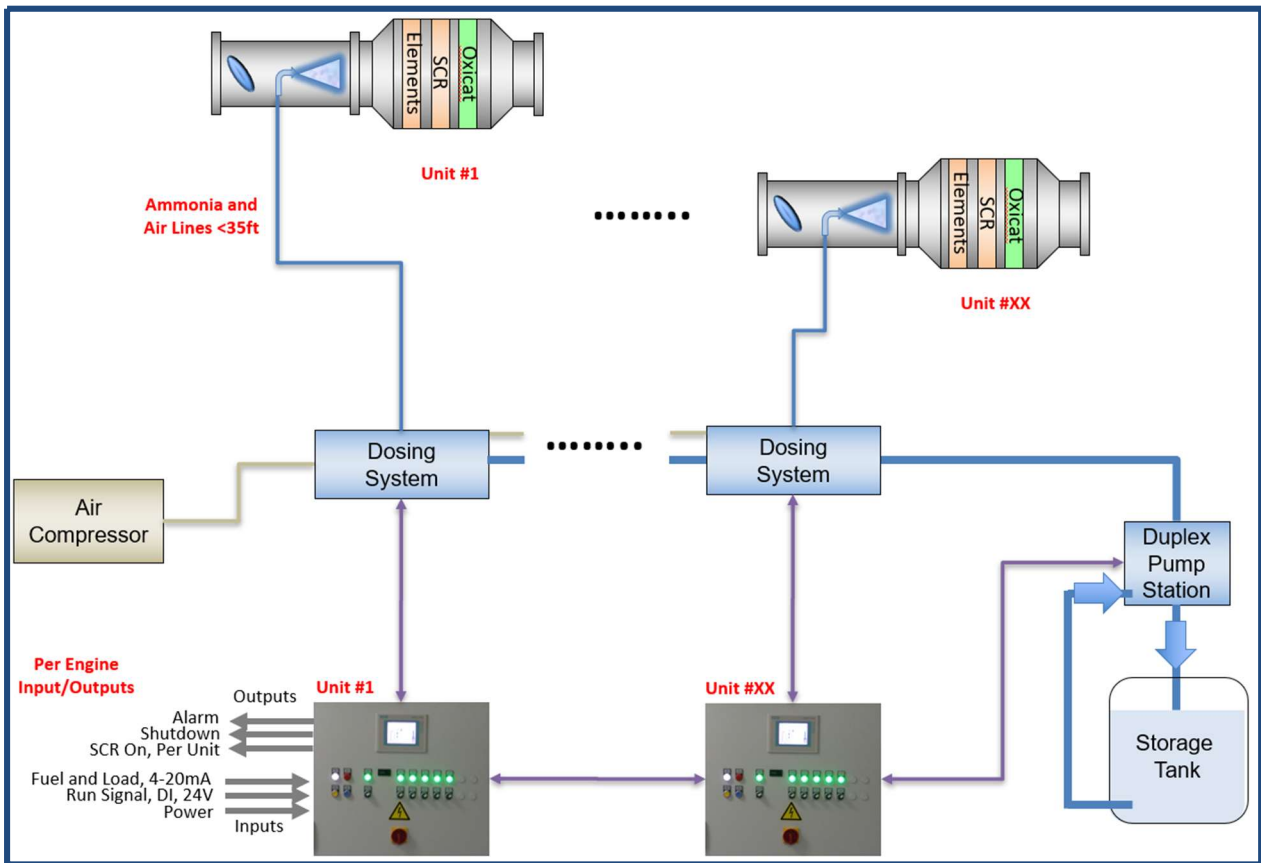
The SCR Catalyst Technology:

SCR catalysts generally fall into two categories, a vanadia-based catalyst embedded in an extruded ceramic substrate, or a zeolite-based technology coated onto the surface of a ceramic substrate. In the former, the catalyst is actually incorporated into the ceramic structure, and as a result the catalyst is generally more robust to thermal variation. In addition, vanadia-based technologies operate over a wide temperature range, and when combined with its strength advantages and lower cost, are used in many

industrial applications such as large-scale power plants and boiler systems. Vanadia-based catalysts have demonstrated NOx reduction capability of up to 98%, and can operate continuously to temperatures of 510°C (950°F).

Zeolite systems are ideal for higher temperature applications, for example above 510°C, and as such have found wide use in mobile diesel applications such as on-highway trucks. These systems have also demonstrated a capability for high NOx reduction.

The size of the SCR catalyst elements and how they are configured in a catalyst housing (e.g., number of catalyst layers) is determined by factors such as the required NOx reduction, allowable back pressure of the engine, and ammonia slip limits. High levels of NOx reduction (>80%) generally require 2-4 layers of catalyst.



Schematic of a representative Emission Control System.

Urea Injection Strategy:

Reducing NO_x to N₂ with high levels of chemical conversion efficiency without introducing excess ammonia into the exhaust (known as “ammonia slip”) requires precise control of the urea or ammonia injection process. The strategy for urea or ammonia injection depends on the degree of NO_x reduction, and the required ammonia slip limits.

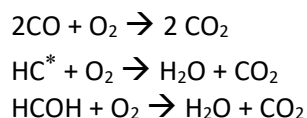
The simplest injection strategy links the engine to the SCR system through the engine load. NO_x emissions are measured as a function of engine load, creating a “NO_x vs. Engine Load” map. From this map, an injection algorithm determines the amount of urea or aqua ammonia necessary to reach the required NO_x level, and sends this signal to the dosing control system. Because the amount of urea or ammonia injected is based on the engine load and not on a direct measurement of NO_x, such an engine mapping strategy is often referred to as an “open-loop” control strategy. Such an injection strategy has been used successfully when NO_x reduction requirements are generally less than 90%. Moreover, the strategy has demonstrated that ammonia slip is minimal, generally far less than typical 10ppm regulatory requirements.

When higher levels of NO_x reduction are necessary, it is customary to add a NO_x analyzer to the SCR System to directly measure NO_x after the SCR catalyst. The signal from the analyzer is then sent to the SCR dosing control system, which then “trims” the injection volume up or down to ensure the required NO_x reduction level is reached, without overdosing that could lead to an increase in ammonia slip. As the NO_x is measured directly with the NO_x analyzer, and the signal is used to control the reagent dosing volume, this strategy is referred to as “closed-loop” control. This strategy has demonstrated up to 98% NO_x reduction, with very low levels of ammonia slip (as low as 5ppm in some applications).

Role of the Oxidation Catalyst:

By incorporating an oxidation catalyst into the system, it is possible to reduce carbon monoxide (CO), many hydrocarbon species (HC), volatile organic compounds (VOC) such as formaldehyde, and particulate matter. Placement of the oxidation catalyst depends on the application requirements, such as degree of CO reduction, but also on parameters such as the degree of NO_x reduction and maximum levels of ammonia slip. In many cases, the oxidation catalyst can be incorporated directly into the SCR catalyst housing, saving both space and the cost of a separate housing.

Oxidation catalysts are generally precious metals-based systems composed of platinum, or mixtures of platinum, palladium and other precious group metals (PGM). PGM catalysts are highly effective at utilizing the excess oxygen in the exhaust stream of lean-burning engines to convert CO, HC and formaldehyde to water vapor and carbon dioxide, as shown below:



Oxidation catalysts can be engineered to operate at temperatures similar to SCR catalysts, allowing for reduction of several pollutant emissions within the same system. Moreover, oxidation catalysts are highly effective, reducing emissions as much as 95%.

* The specific reaction depends on HC species, such as CH₄, C₂H₆ etc.

IV. SCR CATALYST IMPURITY TOLERANCE SPECIFICATION

SCR catalysts, like all catalyst materials, are susceptible to severe performance degradation if certain impurities in the exhaust stream exceed specific levels. These impurities derive from the use of improper or off-spec fuels, certain impurities in landfill or digester gases, lubrication oils, or other additives that could become part of the exhaust gas composition.

In order to maintain the warranty for the SCR quoted in this engineering document, the following impurities and impurity concentrations must be strictly adhered to. Any unexpected performance degradation of the SCR and/or Oxidation catalyst system will result in a chemical analysis of the catalyst system to determine if these impurity tolerances were exceeded.

Impurity	Max. Concentration Limit
Alkaline Metals	5 mg/Nm ³ (wet)
Alkaline Earth Metals	1 mg/Nm ³ (wet)
Hydrochloric Acid; Chloride Compounds	100 mg/Nm ³ (wet)
Hydrofluoric Acid; Fluoride Compounds*	1 mg/Nm ³ (wet)
P ₂ O ₅ ; Organic Phosphorous Compounds	0.05 mg/Nm ³ (wet)
Mercury & Zinc	0.1 mg/Nm ³ (wet)
Lead & Cadmium	0.1 mg/Nm ³ (wet)
Arsenic; Arsenic Compounds	0.005 mg/Nm ³ (wet)
Organic Silicon Compounds (e.g., Siloxanes); Silicon Halides	0.005 mg/Nm ³ (wet)

**Depending on exhaust gas composition and engine operating condition, a concentration of up to 20 mg/Nm³ may be acceptable. Please contact us for more information.*