**PROJECT DESIGN DOCUMENT FORM
FOR CDM PROJECT ACTIVITIES (F-CDM-PDD)
VERSION 04.1**

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Efficiency Improvement by Boiler Rehabilitation in fossil fuel-fired (Natural Gas) Steam Boiler System
Version number of the PDD	6.0
Completion date of the PDD	08/07/2014
Project participant(s)	1. Al Jubail Fertilizer Company (Al Bayroni) 2. Saudi Basic Industries Corporation (SABIC)
Host Party(ies)	Kingdom of Saudi Arabia
Sectorial scope and selected methodology(ies)	Approved baseline and monitoring methodology AM0056 (version 1.0): "Efficiency improvement by boiler replacement or rehabilitation and optional fuel switch in fossil fuel-fired steam boiler systems"
Estimated amount of annual average GHG emission reductions	41831 tCO2e/yr

SECTION A. DESCRIPTION OF PROJECT ACTIVITY

A.1. Purpose and general description of project activity

AL Jubail Fertilizer Company (Al Bayroni), is a petrochemical complex in the business of manufacturing ammonia, urea, 2 Ethyl Hexanol and DOP. Al Bayroni is an affiliate of Saudi Basic Industries Corporation (SABIC) and a joint venture with Taiwan Fertilizer Company (TFC). Saudi Basic Industries Corporation (SABIC) is another project participant.

Al Bayroni currently operates three packaged boilers supplied by Mitsubishi Heavy Industries (MHI) with specifications as summarized in the table below. Steam from the boilers is utilized exclusively within Al Bayroni at the process plants. The purpose of this project is to enhance energy efficiency and reduce fuel consumption of these boilers whilst maintaining present steam quality and production rates. The project will involve modifications and installations as summarized below.

TABLE A.1 Boiler Rehabilitation Summary (Pre Project Implementation and Post Project Implementation Scenarios)

Boiler ID	2008-U	2008-UA	2052-U
Pre-Rehabilitation (Pre Project Implementation Scenario)			
Steam Production Rate (Name Plate Capacity)	129.25MT/H	129.25 MTH/H	129.00 MT/H
Steam delivery pressure	38.3 BarG	38.3 BarG	38.3 BarG
Steam Temperature	399 ^{O}C	399 ^{O}C	399^{O}C
Fuel	Natural Gas	Natural Gas	Natural Gas
Year of Commissioning	1983	1983	1995
Thermal Efficiency	83% (LHV)	83% (LHV)	85%(LHV)
Post Rehabilitation (Post Project Implementation Scenario)			
Steam production rate	No Change	No Change	No Change
Steam delivery pressure	No Change	No Change	No Change
Steam temperature	No Change	No Change	No Change
Reduction in Fuel Consumption	9.7%	9.7%	6.2%

The potential for energy savings and in turn reduction of GHG emissions have been evaluated through an independent study in 2007-2008 by M/S Mitsubishi, Japan and subsequently confirmed through a study by KBR during the same period. As a result, the following modifications and installations have been proposed to realize energy and GHG savings from the packaged boilers:

- New Economizer
- New modified super-heater
- Associated modifications in convection ducts

The new economizer unit will improve energy efficiency by heat recovery from the exhaust gases. Economizers are essentially (heat exchange) mechanical devices which utilize exhaust gases to preheat

boiler feed water thereby reducing overall heat demand and consequentially fuel consumption for steam production.

Super heater units proposed in the project will also improve energy efficiency by utilizing heat from flue gas to convert wet steam to dry steam. The super heater is placed in the path of flue gases from the combustion chamber allowing steam to be heated above its saturation temperature removing moisture at constant pressure.

Baseline Scenario

Please note that the Baseline Scenario is the same as Pre Project Scenario.

Project contribution to sustainable development

The Project will benefit local contractors whose participation will be required for the modification and commissioning phases thereby contributing to the local economy and communities in Jubail. The project will not cause an increase in pollutant emissions from the current situation hence no additional negative impacts will occur as result of implementing the project. Conversely, enhancing energy efficiency and reducing fuel consumption will contribute to reduction in GHG emissions (Table A.2 below).

TABLE A.2 POTENTIAL GHG REDUCTIONS AND TRADEABLE VOLUMES

Daily CO2 Emission Reductions	114 tCO2e
Annual CO2 Reduction	41831 tCO2e
Reduction over 10 years	418310 tCO2e

Project Timeline, Current Status and Monitoring

07/11/2010: The Project Idea Note was prepared. This is the date of official decision making.
25/08/2011: Start date of project activity. The contract with supplier was signed.
27/11/2011: Prior Consideration Note was submitted to UNFCCC.
27/11/2011: Board Resolution for project implementation was obtained. The Board confirmed approval for implementation budget.
05/12/2011: Prior Consideration Note was submitted to Saudi DNA.
10/05/2013: Modification of the first two boilers has been completed.
20/04/2013: Prior Consideration Form (Notification of Progress) submitted to UNFCC.
20/02/2014: Modification of third boiler has been completed.

The monitoring of the proposed project will be based on company's overall monitoring programme which is third party certified. All monitoring programmes including associated calibration are within the scope of the QMS and subjected to several audits and reviews including Internal Audits, SABIC Corporate Audits and Third Party (BSI) audits.

A.2 Location of the project activity:

The proposed project will be carried out inside Al Bayroni, in Jubail Industrial City, Eastern Province, Kingdom of Saudi Arabia (49° 33′ 27.98″ E and 27° 3′ 54.64″ N)

A.2.1 Host Party(ies):
Kingdom of Saudi Arabia

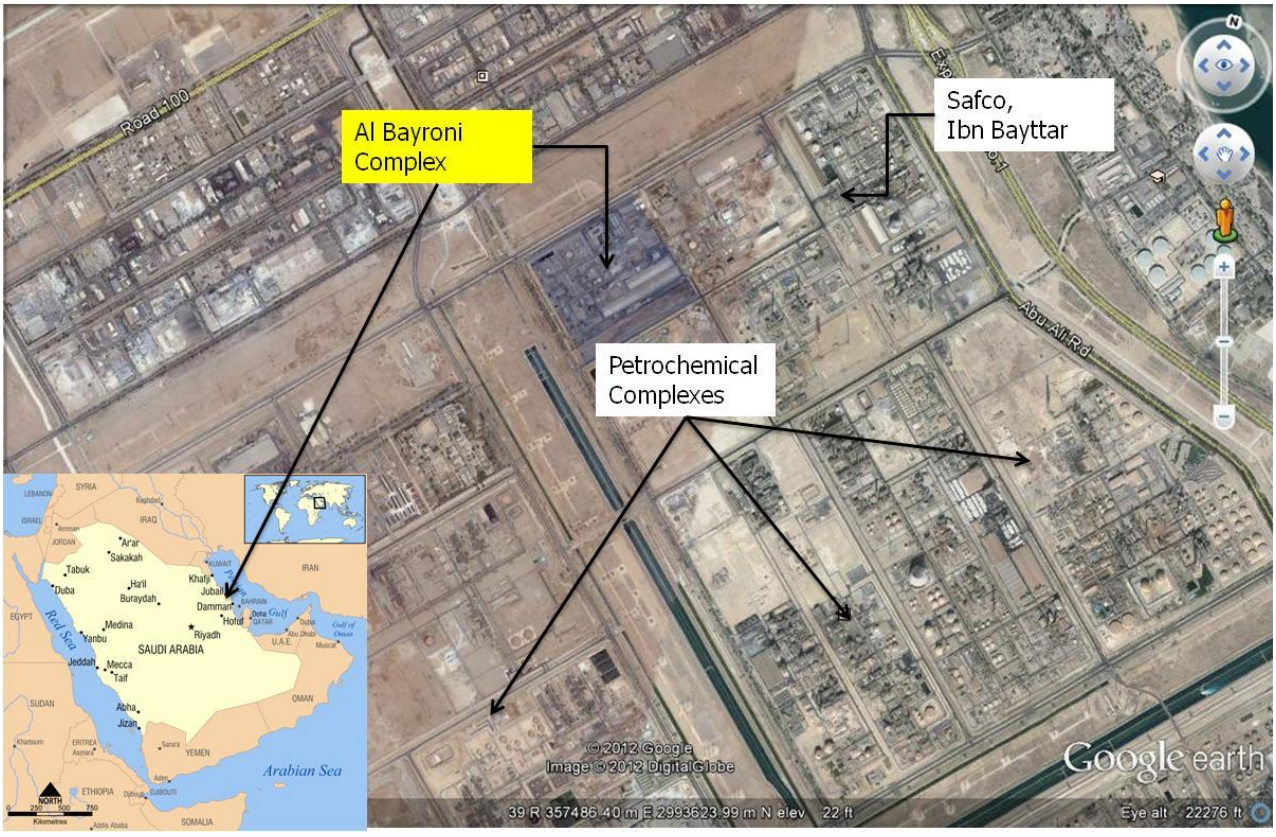
A.2.2. Region/State/Province etc.:
Eastern Province

A.2.3 City/Town/Community etc.:
Jubail Industrial City

A.2.4 Physical/ Geographical Location

The Jubail Industrial City, is managed by the Royal Commission for Jubail and Yanbu and specifically caters to the Petroleum and Petrochemical Sector and associated support industries. SABIC operates 3 facilities in the fertilizer sector in Jubail, namely Safco, Al Bayroni and Ibn Bayttar. See figure A-1 below for a map showing the location where the proposed project will be carried out. The proposed rehabilitation project will be within the Al Bayroni Complex. The nearest airport is the King Fahad International Airport in Jubail city located 80km south of the complex.

Figure A-1: Project Location and Surrounding Land Use



A.3 Technologies and Measures

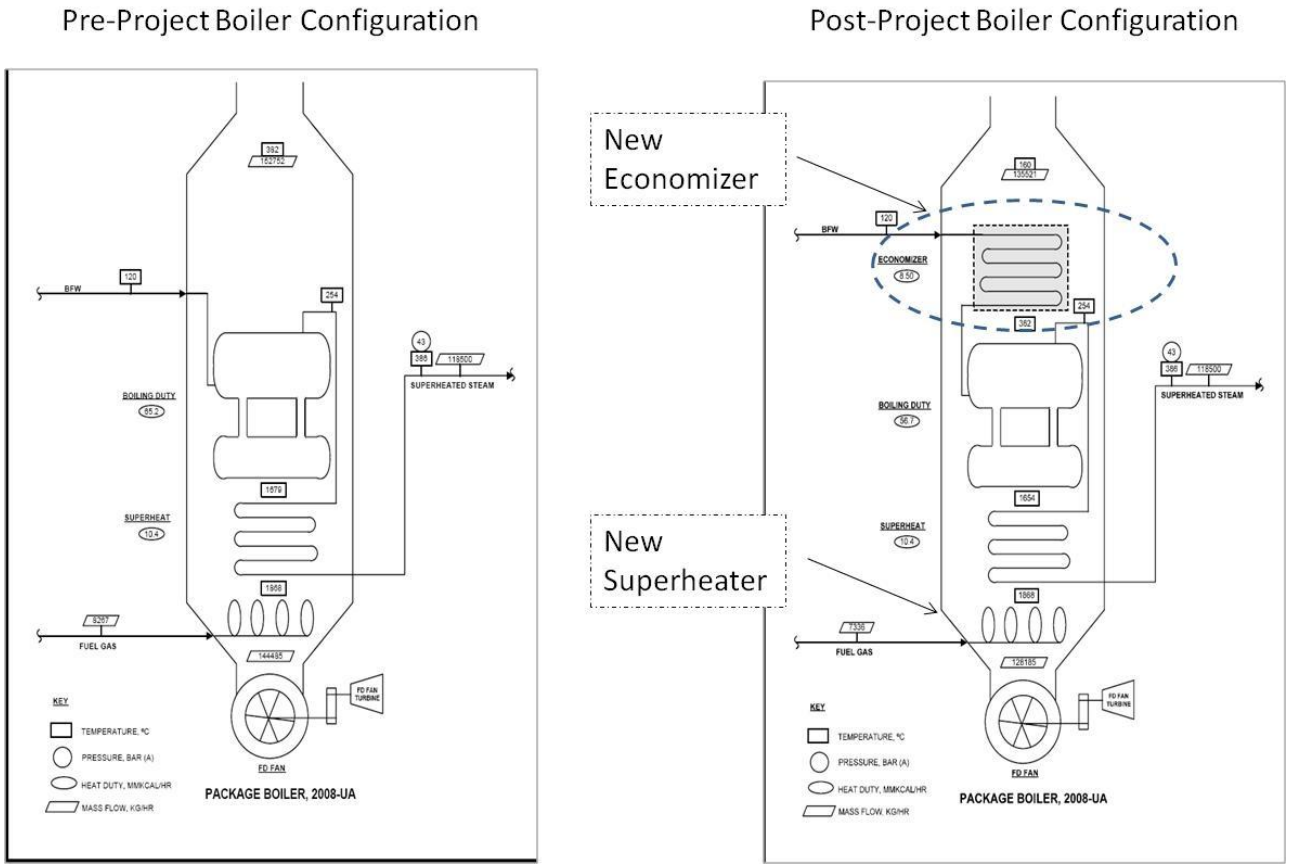
This project will involve the following modifications and installations to realize energy and GHG savings from the packaged boilers:

- New Economizer
- New modified super-heater
- Associated modifications in convection ducts

The new economizer unit will improve energy efficiency by heat recovery from the exhaust gases. Economizers are essentially (heat exchange) mechanical devices which utilize exhaust gases to preheat boiler feed water thereby reducing overall heat demand and consequentially fuel consumption for steam production.

Super heater units proposed in the project will also improve energy efficiency by utilizing heat from flue gas to convert wet steam to dry steam. The super heater is placed in the path of flue gases from the combustion chamber allowing steam to be heated above its saturation temperature removing moisture at constant pressure.

Figure A-2: Pre Modification and Post Modification Case



Source: KBR Energy Optimization Study (2008)

A.4. Project participants:

Name of Party involved (*) (host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Kingdom of Saudi Arabia (host)	Private: Al Jubail Fertilizer Company (Al Bayroni) a subsidiary of Saudi Basic Industries Corporation	No
Kingdom of Saudi Arabia	Private: Saudi Basic Industries Corporation (SABIC)	No

A.5. Public Funding of Project Activity

There is no source of public funding for the proposed Boiler Rehabilitation Project.

No Official Development Assistance (ODA) is involved in this project. It is 100% equity funded. Please see Appendix 2 (Al Bayroni's Declaration dated January 20, 2014).

SECTION B: Application of selected approved baseline and monitoring methodology

B.1. Reference Methodology

The Baseline and Monitoring method has been established for the proposed project following the approved methodology AM0056 (version 1.0) "***Efficiency improvement by boiler replacement or rehabilitation and optional fuel switch in fossil fuel-fired steam boiler systems***".

The following tools and guidelines have also been referred to:

1. Combined tool to identify the baseline scenario and demonstrate additionality (version 05.0.0 EB 70, Annex 9)
2. Guidelines on Additionality of First-Of-Its-Kind Project Activities (version 2.0, EB 69, Annex 7)
3. Guidelines for objective demonstration and assessment of barriers (EB-50, Annex 13 Version 01)
4. Paragraph 28/Decision 1/CMP 2 FCCC/KP/CMP/2006/10/Add.1 2 March 2007
5. Tool to calculate project or leakage CO2 emissions from fossil fuel combustion (Version 2, EB 41, Annex 11)

B.2. Applicability of Methodology

In the project activity, the large scale methodology, AM0056, version 1.0 has been applied and application of the methodology is as justified in Table B.1 below.

TABLE B.1: JUSTIFICATION FOR USE OF SELECTED METHODOLOGY

Applicable Criteria in AM0056 (version 1.0)	Justification
This methodology is applicable to project activities that in an existing facility: • Completely replace one or more boilers with some remaining lifetime; and/or • Implement fitting of additional new equipment to an existing steam generating system (retrofitting); and • Implement optional switch in fossil fuel	The proposed project l involves fitting existing boilers with additional new equipment, namely: • New Economizer • New modified super-heater • Soot blower • Associated modifications in convection ducts
Steam generation in the project activity is carried out through the use of fossil fuel fired steam boiler(s)	Steam generation in the project activity is carried out through three boilers, (namely 2008-U, 2008-UA and 2052-U) using only fossil fuel (natural gas).
National/local regulations do not require the replacement or retrofit of the existing equipment. The project participants shall demonstrate this through documented evidence (e.g. building code documents). These documents shall be submitted to a DOE at the time of validation	Al Bayroni complex being located within the industrial city of Jubail, is required to comply with the regulations of the Royal Commission for Jubail, Ras Al Khair and Yanbu specified in the Royal Commission Environmental Regulations (RCER, 2010). No requirements for replacement or retrofit of existing boilers has been prescribed in the RCER 2010.
There are no enforced national/local regulations/standards on minimum efficiency ratings for the boiler(s) included in the project	There are no requirements/standards in the RCER 2010 on minimum efficiency ratings for boilers.

boundary. The project participants shall confirm this through documented evidence (e.g. building code documents, industrial regulations, etc). These documents shall be submitted to a DOE at the time of validation	
National/local regulations/programmes do not constrain the facility from using the fossil fuel being used prior to fuel switching	The RCER 2010 does not specify any constraints or limits on the Al Bayroni complex on using fossil fuel. In addition, this condition is not applicable as the project activity does not include fuel switch.
Steam quality (i.e. pressure and temperature) is the same before and after the start of the implementation of the project activity	The quality as measured by temperature and pressure of steam prior to and post project implementation remains the same.
The existing steam generating system in the facility where the project activity is implemented may consist of more than one boiler	The project activity involves rehabilitation of three boilers (namely 2008-U, 2008-UA and 2052-U).
Only one type of fossil fuel is used in all boilers included in the project boundary. If the fossil fuel switch is implemented, it should involve all boilers in the project boundary. Small amounts of other start-up or auxiliary fuels can be used, provided that they do not account for more than 1% of total fuel use	All three boilers are fired utilizing only one type of fossil fuel - natural gas.
If the fossil fuel switch is implemented, only those project activities are eligible to use this methodology where both energy efficiency measures and fuel switch are additional.	This condition is not applicable as the project activity does not include fuel switch.

B.3 Project Boundary

The selected methodology, AM0056 (version 1.0) provides the following guidance for the project boundary:

> *The project boundary encompasses all equipment that is primarily used for the steam generating process (within the steam generation system), including auxiliary systems. The most relevant components of the steam generation system include the boiler(s), fuel supply, combustion air system, feed water system, including a condensate return system, and an exhaust gases venting system. In addition, all components that are required and predominantly used for steam generation are also part of the steam generation system.*
>
> *In order to ensure a common approach for determination of the project boundary as well as a common approach for determination of specific fuel consumption, international/national acknowledged norms and guidelines equivalent to ASME PTC 4-1998[1] have to be applied in conjunction with this methodology*.

[1] American Society of Mechanical Engineers: Performance Test Codes for Fired Steam Generators, ASME PTC 4-1998

Based on the guidelines above, the project boundary is the steam generation system comprising the three boiler units, namely Boiler 2008-U, Boiler 2008-UA and Boiler 2052-U and associated components as listed below and illustrated in Figure B-1 below:

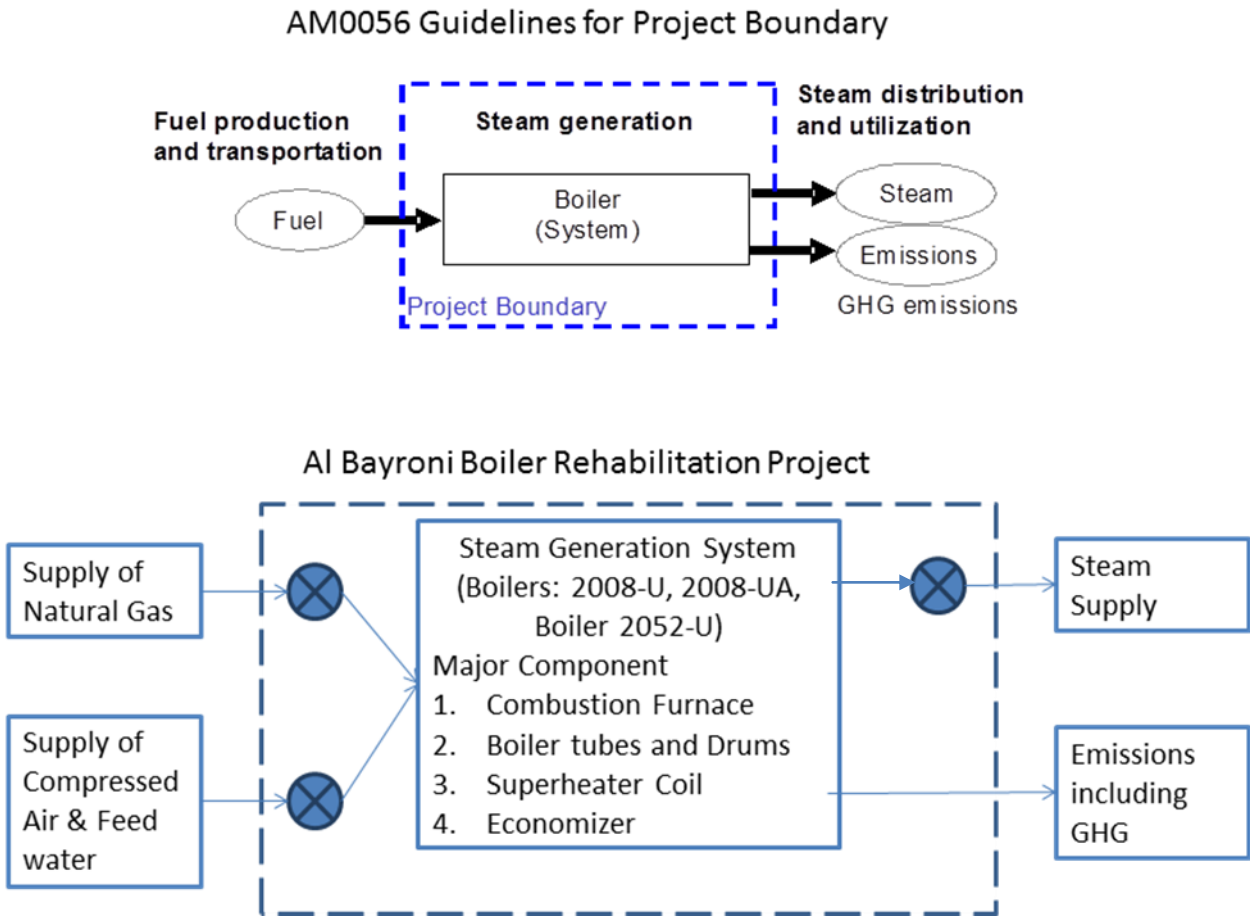
1. Inputs:
    a. Fuel supply
    b. Combustion air
    c. Feed water system
    d. Condensate return
2. Output
    a. Exhaust gases
    b. Greenhouse Gas Emissions
    c. Steam

Emission sources included in the baseline scenario and project activity are summarized in Table B-1 below.

TABLE B.2: EMISSION SOURCES INCLUDED IN OR EXCLUDED FROM PROJECT BOUNDARY

	Sources	**Gas**	**Included**	**Justification/Explanation**
Baseline	Fossil fuel consumption in the boilers	CO_2	YES	Main Source of GHG Emission
		CH_4	NO	Minor Source, Negligible
		N_2O	NO	Minor Source, Negligible
Project Activity	Fossil fuel consumption in the boilers	CO_2	YES	Main Source of GHG Emission
		CH_4	NO	Minor Source, Negligible
		N_2O	NO	Minor Source, Negligible

Figure B-1: Project Boundary following AM0056 (version 1.0)



The operational life time of all three boilers has been established to be at least 15 years from the modification completion date. This is supported by Internal Memorandums issued separately for each boiler after inspection and checks. Specifically:

1. Memorandum No RP&I/INSP/05/13 (dated 06/05/2013)
Issued for the Boiler 2008 – U

2. Memorandum No RP&I/INSP/06/13 (dated 06/05/2013)
Issued for the Boiler 2008 – UA

3. Memorandum No RP&I/INSP/04/14 (dated 25/02/2014)
Issued for the Boiler 2052 – U

In addition, AlBayroni is strictly adhering to regular maintenance practice as stipulated by Mechanical Integrity Program government by SABIC's Mechanical Integrity and Reliability Programme under the

SABIC's Safety, Health and Environmental Management System (SHEM) [2]. Operational manuals and records have been submitted to the auditors during their validation visit in January 2014.

B.4. Establishment and Description of Baseline Scenario

The version 05.0.0 of the "Combined tool to identify the baseline scenario and demonstrate additionality" has been used to identify the baseline scenario.

Step 0. Determination of whether the proposed project activity is the first-of-its-kind:

The "Guidelines on Additionality of First-Of-Its-Kind Project Activities" (version 2.0, EB 69, Annex 7) is used hereby to demonstrate that the project is "First-of-its-kind".

1. **Applicable Geographical Area:** The applicable geographic area is limited to industrial cities of Jubail, Yanbu and Ras Al Khair in the Kingdom of Saudi Arabia. The justification for the limitation is as follows: industrial cities of Jubail, Yanbu and Ras Al Khair are geographically distinct from the rest of the country because they are specially designated and developed as industrial centers. The entirety of these areas is managed by autonomously distinct authority - the Royal Commission (RCJY). The RCJY was established in 1975 as an autonomous organization (independent from other ministries and licensing agencies in the Kingdom) reporting directly to the Council of Ministers. It establishes policies, promotes investment, provides infrastructure, develops and enforces standards including environmental regulations specifically targeting petrochemical and high energy intensive industries (RCJY, 2014) in the above mentioned industrial cities

2. **Measure**: The Boiler Rehabilitation project involves energy efficiency improvement and therefore satisfies criteria 2(b) of EB 69 Annex 7.

3. **Output**: The output is steam. The output remains the same before and after post project implementation. There will be no change in steam quality or production rates as a result of the energy efficiency improvement.

4. **Application of Different Technology:** Technology proposed differs from other technologies by large scale energy efficiency. The Boiler rehabilitation project will realize energy savings of 203 GWH per year. This is over the 60GWH annually criteria stipulated for small installations in paragraph 28 of decision 1/CMP.2. Therefore the criteria of different technology apply through "large scale energy efficiency".

5. **Identification of first-of-its-kind project activity:** In accordance to the "Guidelines on Additionality of First-Of-Its-Kind Project Activities" (version 2.0, EB 69, Annex 7) the project is identified as first of its kind in the applicable geographical area because:

   (a) The project is the first in the applicable geographical area that applies a technology that is different from technologies that are implemented by any other project, which are able to deliver the same output and have started commercial operation in the applicable geographical area before the project design document (CDM-PDD) is published for global

[2] AL Bayroni' s adherence to SHEM is third party certified by 1) BSI QMS ISO 9001:2008 Certificate (attached) and 2) DNV Responsible Care: 14001:2008 and DNV ISO 14001:2008 Certificate (attached)

stakeholder consultation or before the start date of the proposed project activity, whichever is earlier;

There are no similar projects (both CDM and non CDM) implemented, being implemented or considered for implementation in applicable geographical area as confirmed by the Saudi Authorities (please refer to the attached statements issued by the Royal Commission dated 24 January 2014 and "first-of-its-kind" statement from Saudi DNA).

(b) The project implements one or more of the measures;

The proposed project involves energy efficiency improvement and therefore satisfies criteria 2(b) of EB 69 Annex 7.

(c) *The project participants selected a crediting period for the project activity that is "a maximum of 10 years with no option of renewal".*

The project participant selected a crediting period of 10 years with no option of renewal.

Outcome of Step 0 The proposed project is "First-Of-Its-Kind" in the applicable geographic region.

Step 1. Identification of alternative scenarios:

Step 1a. Define alternative scenarios to the proposed CDM project activity

The scenarios alternative to the proposed boiler rehabilitation project are listed in Table B-2 below and are based on guidelines provided in the Section 4.2.1 of the tool and AM0056 (version 1.0).

TABLE B-2: ALTERNATIVE SCENARIOS

Scenario	Scenario Description	Reference	Analysis	Baseline
S1	The proposed project activity undertaken without being registered as a CDM project activity	• Combined tool to identify the baseline scenario and demonstrate additionality • AM0056 (v.1.0)	• The proposed project is not common practice as demonstrated in Step 0 above. • Further, there are no regulatory benefits or financial incentives for the project to be implemented. No requirements have been specified in the RCER 2010[3] for upgrade of existing boiler utilities or for reduction of energy consumption.	No
S2	Where applicable, no investment is undertaken by the project	• Combined tool to identify the	• Third party investment providing the same output to users of the project activity,	No

[3] Royal Commission Environmental Regulations (http://rcjewt.org/regulations/regulationsrcer-2010%20volume%20iii%20penalty%20system%20.pdf)

Scenario	Scenario Description	Reference	Analysis	Baseline
	participants but third party(ies) undertake(s) investments or actions which provide the same output to users of the project activity	baseline scenario and demonstrate additionality	would require separate installation and assurance of reliable supply at desired steam quality and quantity. This is not a feasible scenario as the steam generation system is a core and integral component of the facility operations and production activities. Outsourcing to third parties risks reliability of supply and consequentially compromise downstream production	
S3	*Where applicable, the continuation of the current situation, not requiring any investment or expenses to maintain the current situation*	• *Combined tool to identify the baseline scenario and demonstrate additionality* • *AM0056 (v1.0)*	• Not feasible as continuation of the boiler in the current scenario will entail operational and maintenance expenses	*NO*
S4	Where applicable, continuation of current situation with investment	• Combined tool to identify the baseline scenario and demonstrate additionality	• Continuation of the current situation with expenses is a feasible scenario given the boiler has a lifetime of 15 years and extendable through regular maintenance. • Al Bayroni subscribes to and implements SABIC's Mechanical Integrity and Reliability Programme under the Safety, Health and Environmental Management System (SHEMS) [4] which in turn subjects all process equipment to inspection, preventive maintenance, planned and scheduled shut down and turn around to ensure	YES

[4] Al Bayroni' s adherence to SHEM is third party certified by 1) BSI QMS ISO 9001:2008 Certificate (attached) and 2) DNV Responsible Care: 14001:2008 and DNV ISO 14001:2008 Certificate (attached). Also attached is a "Rotating Equipment Program" standard which serves as an example of SHEM.

Scenario	Scenario Description	Reference	Analysis	Baseline
			reliability and longer life times.	
S5	Other plausible and credible alternative scenarios to the project activity scenario, including the common practices in the relevant sector, which deliver the same output, taking into account, where relevant, examples of scenarios identified in the underlying methodology	• Combined tool to identify the baseline scenario and demonstrate additionality • AM0056 (v1.0)	• Boiler rehabilitation to include modifications proposed in the project activity is not common practice as demonstrated in Step 0	No
S6	Where applicable, the "proposed project activity undertaken without being registered as a CDM project activity" to be implemented at a later point in time	• Combined tool to identify the baseline scenario and demonstrate additionality	• The proposed project activity being carried out without registration to CDM is unlikely as remaining life of the boiler is 15 years and can be further extended through regular maintenance.	No

Outcome of Step 1a: List of plausible alternative scenarios to the project activity
The plausible alternative scenario to the project activity, is
Scenario 4: Continuation of the current situation with expenses to maintain current situation

Step 1b. Consistency with mandatory applicable laws and regulations

Alternative Scenario S4 (**Continuation of the current situation with expenses to maintain current situation**) is in compliance to the applicable standards and limits prescribed in the RCER 2010.

Current boiler operations are subject to the RCER permitting and monitoring programmes. The boiler operation/steam generation system is permitted under the Environmental Permit to Operate (EPO) issued to Al Bayroni. As a result the boilers are required to comply with point source emission standards prescribed in the RCER for which Al Bayroni undertakes a third party stack monitoring programme to demonstrate compliance.

Outcome of Step 1b: **Scenario 4: Continuation of the current situation with expenses to maintain current situation –** is in compliance with mandatory applicable laws and regulations

Step 2. Barrier Analysis

The Barrier Analysis presented below is in accordance with the version 05.0.0 of the "Combined tool to identify the baseline scenario and demonstrate additionality".

Step 2a. Identify barriers that would prevent the implementation of alternative scenarios

In accordance with paragraph 23c (other barriers) the prevailing practice is identified as a barrier. The proposed project activity is the only such project in the distinct geographical area. There are no similar projects (both CDM and non CDM) implemented, being implemented or considered for implementation in applicable geographical area as confirmed by the Saudi Authorities (please refer to the attached statements issued by the Royal Commission dated 24 January 2014 and "first-of-its-kind" statement from Saudi DNA).

Outcome of Step 2a List of barriers that may prevent one or more alternative scenarios to occur:
1. Prevailing practice in the distinct geographical area is barrier which may prevent alternative scanrious to occur.

Step 2b. Eliminate alternative scenarios which are prevented by the identified barriers

The only scenario not prevented by the identified barrier (prevailing practice) is Scenario 4: Continuation of the current situation with expenses to maintain current situation. All other scenarios are eliminated due to prevailing practice.

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Outcome of Step 2b List of alternative scenarios to the project activity that are not prevented by any barrier
Alternative Scenario that is not prevented by barrier is Scenario 4: Continuation of the current situation with expenses to maintain current situation.

Outcome of Step 2
1. The Alternative Scenario not prevented by the Barrier is the Continuation of the current situation with expenses to maintain current situation (i.e. operate Boilers as per current design without rehabilitation). This Alternative Scenario therefore represents the baseline scenario.
2. The proposed Project (i.e. boiler rehabilitation) is the first-of-its-kind. Hence the Project is additional.

As the proposed project activity is first-of-its-kind and has been demonstrated to be additional, the remaining procedures of the "Combined tool to identify the baseline scenario and demonstrate additionality" (version 05.0.0) is not applicable.

B.5. Demonstration of Additionality

Chronology for Prior Consideration of the Project

- 07/11/2010: The Project Idea Note was prepared. This is the date of official decision making.
- 25/08/2011: Start date of project activity. The contract with supplier was signed.
- 27/11/2011: First Prior Consideration Note was submitted to UNFCCC.

  Please note that the project proponent (Al Bayroni) has submitted the Prior Consideration Note to UNFCCC with the original title of the project as "Energy Optimization of Packaged Boilers at Fertilizer Production".

- 20/04/2013: Second Prior Consideration Form (as Notification of Progress) submitted to UNFCCC.

  Please note that on 06/06/2012 the title of the project was renamed as "Efficiency Improvement by Boiler Rehabilitation in fossil fuel-fired (Natural Gas) Steam Boiler System". The second Prior Consideration Form (as Notification of Progress) submitted to UNFCCC on 20/04/2013 has the updated title of the project. Please note that the name of project proponent (Al Bayroni), description, authorized representative and exact location of the project in both forms are exactly the same which proves that this is the same project.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Baseline emissions were estimated following the steps and equations 1 to 7, prescribed in AM0056 (version 1.0), namely:

1. Step 1: Baseline capacity of the boilers were estimated based on results from actual measurements, independent third party technical assessments and upper range of boiler load class
2. Step 2: Load classes of the boilers were determined. In establishing the load classes, the baseline capacity as determined in Step 1 and boiler operating modes were determined
3. Step 3: Specific fuel consumption (SFC) and for each boiler in the system under each load class was determined. The SFC is a function of average fuel consumption for a load class and the average observed amount of steam produced within the load class. Using the net calorific value of the fuel, the specific energy consumption of the system was then determined for each load class.
4. Baseline emissions were then calculated using equation 7 in the methodology.

In calculating the Project Emissions, a net reduction of around 9.7% in fuel consumption was considered. Equation 7 in the methodology was considered in estimating the Project Emissions assuming a proportionate reduction in fuel consumption

For estimating leakages, since the facility will not utilize LNG, equation 8 of the assumes on fugitive upstream emissions of methane, which was calculated using equation 9 of AM00056. Since there is no change in the fuel source as a result of the project, the same upstream emission factors have been used. As required 21TCO2/TCH4 has been assumed for GWP for the 1st year

Net reductions have been estimated using equation 12 where Project emissions and leakages were reduced from the baseline estimation.

B.6.2. Data and Parameters fixed en ante

The following data and parameters have been considered in the baseline assessment but are not considered for monitoring in the crediting period as stated in the methodology. The Project Owner has extensive hourly data archived at the facility and which can be extracted. Monitoring data in excess of 3 months is available for validation.

Data / Parameter:	**CAP**
Data unit:	Tons/Hour (steam)
Description:	Maximum long term load (capacity) of the boiler or steam system (tonnes of steam output per hour at full load).
Source of data used:	Hourly Measurement Data
Value applied:	100-120Tons/Hour for each of the three boilers
Justification of the choice of data or description of measurement methods and procedures actually applied :	Boiler load classes have been selected based on review of third independent assessments of boiler performance, name plate capacity and historical data. All measurements shall comply with ASME PTC 4-1998
Any comment:	All Measurements are in compliance to ASME PTC 4-1998

Data / Parameter:	**Boiler load class, i and j**
Data unit:	Range Tons/Hour
Description:	Boiler load classes in the case of multi-boiler installations. For each boiler 'j' load classes 'i' are introduced.
Source of data used:	Hourly Measurement Data
Value applied:	See Section 6.3 (Table 1)
Justification of the choice of data or description of measurement methods and procedures actually applied :	The proposed methodology requires the project developer to choose at least two boiler load classes per boiler freely.
Comments	

Data/ Parameter	**System Load Class "K"**
Data Unit	(Tons/Hour) Tons/Annum
Description	System Load Classes
Source of data used	Hourly Measurement Data
Value applied	See Table B.6.5
Justification of the choice of data or description of measurement methods and procedures actually applied	Facility operates 24 hours continuously over the calendar year. Hence hourly measurements and annual totals are available
Comments	

Data/ Parameter	FC_{BLi}
Data Unit	M3/h
Description	Fuel Consumption in each load class (Data available hourly/annually)
Source of data used	Hourly Measurement Data
Value applied	See Table B.6.2
Justification of the choice of data or description of measurement methods and procedures actually applied	Information from steam system operator based on measurements following strictly international or national acknowledged norms and guidelines.
Comments	

Data/ Parameter	PB_{Li}
Data Unit	Tons/Hour (Tons/Annum)
Description	Average Hourly Steam Production in each load class
Source of data used	Hourly Measurement Data
Value applied	Tons/Hour
Justification of the choice of data or description of measurement methods and procedures actually applied	Information from steam system operator based on measurements following strictly international or national acknowledged norms and guidelines.
Comments	

Data/ Parameter	$NCV_{FF, BL}$
Data Unit	GJ/m3
Description	Net Calorific Value of Fossil Fuel Used (Natural Gas)
Source of data used	Analysis Report
Value applied	0.04 GJ/Nm3
Justification of the choice of data or description of measurement methods and procedures actually applied	Information from steam system operator based on measurements following strictly international or national acknowledged norms and guidelines.
Comments	

Data/ Parameter	EFC,FF,BL
Data Unit	tC/GJ
Description	Carbon Emission Factor for fuel used in the boiler system
Source of data used	IPCC
Value applied	0.056tCO2e/GJ
Justification of the choice of data or description of measurement methods and procedures actually	Regional/local emission factors are not available, hence IPCC factors have been used.

applied	
Comments	

Data/ Parameter	**OXIDFF,BL**
Data Unit	Fraction
Description	Oxidation factor for the fossil fuel used in the baseline boiler
Source of data used	IPCC/ Industry Practice
Value applied	1
Justification of the choice of data or description of measurement methods and procedures actually applied	Regional/local emission factors are not available
Comments	

Data/ Parameter	**PRESSBL,MIN**
Data Unit	bar
Description	Lowest measured pressure of the generated steam during determination of the specific energy consumption.
Source of data used	Measurement. Use test result for calculations.
Justification of the choice of data or description of measurement methods and procedures actually applied	Measurement strictly following international acknowledged norms and guidelines such as ASME PTC 4-1998 .
Comments	

Data/ Parameter	**$PRESS_{BL,MAX}$**
Data Unit	bar
Description	Highest measured pressure of the generated steam during determination of the specific energy consumption.
Source of data used	Measurement. Use test result for calculations.
Justification of the choice of data or description of measurement methods and procedures actually applied	Measurement strictly following international acknowledged norms and guidelines such as ASME PTC 4-1998 .
Comments	

Data/ Parameter	**$TEMP_{BLMIN}$**
Data Unit	K
Description	Lowest measured temperature of the generated steam during determination of the specific energy consumption.
Source of data used	Measurement. Use test result for calculations.
Justification of the choice of data or description of	Measurement strictly following international acknowledged norms and guidelines such as ASME PTC 4-1998 .

measurement methods and procedures actually applied	
Comments	

Data/ Parameter	**$TEMP_{BLMAX}$**
Data Unit	K
Description	Highest measured temperature of the generated steam during determination of the specific energy consumption.
Source of data used	Measurement. Use test result for calculations.
Justification of the choice of data or description of measurement methods and procedures actually applied	Measurement strictly following international acknowledged norms and guidelines such as ASME PTC 4-1998 .
Comments	

B.6.3. Ex-ante calculation of emission reductions:

Baseline Emission

Project emissions were calculated using the Approved baseline and monitoring methodology AM0056 (version 1.0).
Baseline emissions are calculated via the degree of efficiency of the overall steam generation system of the 3 boilers. The following detailed calculation procedures are based on the specific fuel consumption (SFC) for steam generation.

Step 1: Determination of the capacity of the baseline equipment
To determine the steam capacity of the boilers the following were considered:

- The name plate capacity for each boiler from the manufacture: 129.25 metric tonnes of steam per hour (MT /H)
- Technical analysis carried out by Kellog Brown Roots (KBR) for the modification of the boilers determined that the capacity of each boiler to be 120 MT/H
- Measurements carried out established an operating range for the boilers. The measurements methods have been reviewed and determined to be in accordance with the ASTM standards. The facility being a 24hour continuously operating petrochemical plant, the boilers are designed and maintained to operate at near constant loads. Hence based on the review of measurement data, the operating ranges were identified as summarized below:
  1. 2008-U: Operating Range: 100-120 Tons/hr
  2. 2008-UA: Operating Range: 100-120 Tons/hr
  3. 2052-U: Operating Range: 100-120 Tons/hr

From the above considerations, 100-120 Tons/hr was selected as the representative steam capacity for the boilers.

Step 2: Determination of the load classes of the boilers:
Based on hourly measurement data available at Al Bayroni, it has been observed that the facility operates at near constant load in the range of 100 - 120 Tons/hr. For representation purposes, however, a range of load classes have been evaluated and these are represented in the table below.

Table B.6.1: The selected boiler load classes

Boiler Load Class (Tons/hr)	2008-U Load Classes	2008-UA Load Classes	2052-U Load Classes
0-20	1	1	1
21-40	2	2	2
41-60	3	3	3
61-80	4	4	4
81-100	5	5	5
101-120	6	6	6
>120	7	7	7

Step 3: Determination of the specific fuel (energy) consumption of each boiler (per load class) within the steam system:

Step 3 b.1: Determination of the specific fuel consumption for each boiler 'j'per load class 'i' within the steam generation system

The specific fuel (energy) consumption of each boiler per load class within the steam system is determined using the following formula:

$$SFC_{i,j} = \left(\frac{FC_{BL,i,j,x}}{P_{BL,i,j,x}} \right)$$

Where

$SFC_{i,j}$ Specific fuel consumption within load class 'i' for each boiler 'j' as observed from performance tests (Nm³/tSteam)

$FC_{BL,i,j,x}$ Average observed fuel consumption for load x, using repeated performance test for that load, within load class 'i' for each boiler 'j' (Nm^3/hr)

$P_{BL,i,j,x}$ Average observed amount of produced steam for load x, using repeated performance test for that load, within load class 'i' for each boiler 'j' (T/hr)

Table B.6.2: SFC estimation per load class

Boilers	Load Class	Range (MT/H)	FCBL,i	PBL,i	SFCi,j
			Fuel (Nm3/Hour)	Steam(Tons/hr)	Nm3/Tsteam
2008-U	1	0-20	310.41	11.06	28.07
	2	21-40	3863.73	26.14	147.81
	3	41-60	4422.36	54.54	81.08
	4	61-80	6451.83	75	86.02
	5	81-100	7376.16	92.8	79.48
	6	101-120	9496.69	114.53	82.92
	7	>120	10269.65	129.27	79.44
2008-UA	1	0-20	637.49	7.42	85.92
	2	21-40	3054.14	39.99	76.37
	3	41-60	3592.46	50.59	71.01
	4	61-80	6819.45	70.51	96.72
	5	81-100	7930.26	92.15	86.06
	6	101-120	10183.06	114.15	89.21
	7	>120	10870.4	125.79	86.42
2052-U	1	0-20	Not Operational	Not Operational	Not Operational
	2	21-40	Not Operational	Not Operational	Not Operational
	3	41-60	Not Operational	Not Operational	Not Operational
	4	61-80	8070.34	77.26	104.46
	5	81-100	7600.61	96.35	78.89
	6	101-120	7725.27	108.45	71.23
	7	>120	Not Operational	Not Operational	Not Operational

Step 3 b.2: Determination of the specific energy consumption within the capacity of the boiler system for each boiler 'j' per load class 'i'

$SEC_{ij} = SFC_{ij} \cdot NCV_{BL,FF}$

Where

$SEC_{i,j}$ Lowest specific energy consumption within load class 'i' for each boiler 'j' (GJ/t)

$SFC_{i,j}$ Lowest possible specific fuel consumption within load class 'i' for each boiler 'j' (Nm³/t)

$NCV_{BL,FF}$ Net caloric value of fossil fuel used in the baseline boiler (GJ/m³): 0.039GJ/Nm3

Table B.6.3: SEC-Calculation

Boilers	Load Class	Range (MT/H)	FCBL,i	PBL,i	SFCi,j	Calorific Value	SEC
			Fuel (Nm3/Hour)	Steam(T/Hour)	Nm3/Tsteam	GJ/Nm3	GJ/T Steam
2008-U	1	0-20	310.41	11.06	28.07	0.039851562	1.12
	2	21-40	3863.73	26.14	147.81	0.039851562	5.89
	3	41-60	4422.36	54.54	81.08	0.039851562	3.23
	4	61-80	6451.83	75	86.02	0.039851562	3.43
	5	81-100	7376.16	92.8	79.48	0.039851562	3.17
	6	101-120	9496.69	114.53	82.92	0.039949238	3.31
	7	>120	10269.65	129.27	79.44	0.039951207	3.17
2008-UA	1	0-20	637.49	7.42	85.92	0.039851562	3.42
	2	21-40	3054.14	39.99	76.37	0.039851562	3.04
	3	41-60	3592.46	50.59	71.01	0.039851562	2.83
	4	61-80	6819.45	70.51	96.72	0.039851562	3.85
	5	81-100	7930.26	92.15	86.06	0.039851562	3.43
	6	101-120	10183.06	114.15	89.21	0.039931908	3.56
	7	>120	10870.4	125.79	86.42	0.040046125	3.46
2052-U	1	0-20	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational
	2	21-40	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational
	3	41-60	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational
	4	61-80	8070.34	77.26	104.46	0.039851562	4.16
	5	81-100	7600.61	96.35	78.89	0.039851562	3.14
	6	101-120	7725.27	108.45	71.23	0.039955145	2.85
	7	>120	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational

Step 3 b.3: Determination of the specific energy consumption of the steam generation system (per load class)

$SEC_{sys} = SEC_{ij} \cdot PB_{L,i}$

Where

SEC_{sys} Lowest of all calculated values of the specific energy consumption within each steam generation system's load class (GJ/hr).

$SEC_{ij,j}$ Lowest specific energy consumption within load class 'ij' of boiler 'j' (GJ/t) where 'i' corresponds to load class 'ij'

$P_{BL,i,j,x}$ Average observed amount of produced steam for load x, using repeated performance test for that load, within load class 'i' for each boiler 'j' (T/hr)

Table B.6.4: SEC of steam generation system calculation

Boilers	Load Class	Range (MT/H)	FCBL,i	PBL,i	SFCi,j	Calorific Value	SEC	SEC Sys
			Fuel (Nm3/Hour)	Steam(Tons/hr)	Nm3/Tsteam	GJ/Nm3	GJ/T Steam	GJ/hr
2008-U	1	0-20	310.41	11.06	28.07	0.039851562	1.12	12.37
	2	21-40	3863.73	26.14	147.81	0.039851562	5.89	153.98
	3	41-60	4422.36	54.54	81.08	0.039851562	3.23	176.24

	4	61-80	6451.83	75	86.02	0.039851562	3.43	257.12
	5	81-100	7376.16	92.8	79.48	0.039851562	3.17	293.95
	6	101-120	9496.69	114.53	82.92	0.039949238	3.31	379.39
	7	>120	10269.65	129.27	79.44	0.039951207	3.17	410.28
2008-UA	1	0-20	637.49	7.42	85.92	0.039851562	3.42	25.40
	2	21-40	3054.14	39.99	76.37	0.039851562	3.04	121.71
	3	41-60	3592.46	50.59	71.01	0.039851562	2.83	143.17
	4	61-80	6819.45	70.51	96.72	0.039851562	3.85	271.77
	5	81-100	7930.26	92.15	86.06	0.039851562	3.43	316.03
	6	101-120	10183.06	114.15	89.21	0.039931908	3.56	406.63
	7	>120	10870.4	125.79	86.42	0.040046125	3.46	435.32
2052-U	1	0-20	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational
	2	21-40	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational
	3	41-60	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational
	4	61-80	8070.34	77.26	104.46	0.039851562	4.16	321.62
	5	81-100	7600.61	96.35	78.89	0.039851562	3.14	302.90
	6	101-120	7725.27	108.45	71.23	0.039955145	2.85	308.66
	7	>120	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational	Not Operational

Step 4: Determination of the load classes of the steam system

The steam system load classes in Table B.6.5 below are the result of any possible combination of the boiler load classes given in Table B.6.1 above using the On-Off-Operation. Figure B.1-B.3 below present an analysis of the steam generation from the three boilers from which the following is evident:

1. Steam generation from all three boilers is largely within 100-120T/hour
2. Steam generation below 100 Tons/Hr is an occasional standalone occurrence and may represent downtime
3. Similarly steam generation above 120 Tons/hr is a rare occurrence and not sustained

Table B.6.5: Steam generation system load classes

System Load	2008U	2052U	2008UA
0-20	Rare Occurrence/ Possible Downtime	Rare Occurrence/ Possible Downtime	Rare Occurrence/ Possible Downtime
21-40	OFF	OFF	ON
41-60	ON	OFF	OFF
	ON	OFF	ON
	OFF	OFF	ON
61-80	ON	OFF	OFF
	OFF	ON	OFF
	OFF	OFF	ON
81-100	ON	OFF	OFF
	OFF	ON	OFF
	OFF	OFF	ON
	ON	ON	OFF
	OFF	ON	ON
	ON	OFF	ON
	OFF	ON	ON
101-120	ON	ON	OFF
	OFF	ON	ON
	ON	OFF	ON

System Load	2008U	2052U	2008UA
	OFF	ON	ON
121-140	ON	OFF	OFF
	OFF	ON	OFF
	OFF	OFF	ON
	ON	ON	OFF
	OFF	ON	ON
	ON	OFF	ON
	OFF	ON	ON
	ON	ON	ON
141-160	ON	ON	OFF
	OFF	ON	ON
	ON	OFF	ON
	ON	ON	ON
161-180	ON	ON	OFF
	OFF	ON	ON
	ON	OFF	ON
	ON	ON	ON
181-200	ON	ON	OFF
	OFF	ON	ON
	ON	OFF	ON
	ON	ON	ON
201-220	ON	ON	OFF
	OFF	ON	ON
	ON	OFF	ON
	OFF	ON	ON
	ON	ON	ON
221-240	ON	ON	OFF
	OFF	ON	ON
	ON	OFF	ON
	OFF	ON	ON
	ON	ON	ON
241-260	ON	ON	OFF
	OFF	ON	ON
	ON	OFF	ON
	OFF	ON	ON
	ON	ON	ON
261-280	ON	ON	ON
281-300	ON	ON	ON
301-320	ON	ON	ON
321-340	ON	ON	ON
340-360	ON	ON	ON
>360	ON	ON	ON

Figure B.1: Boiler Performance Analysis: 2008U

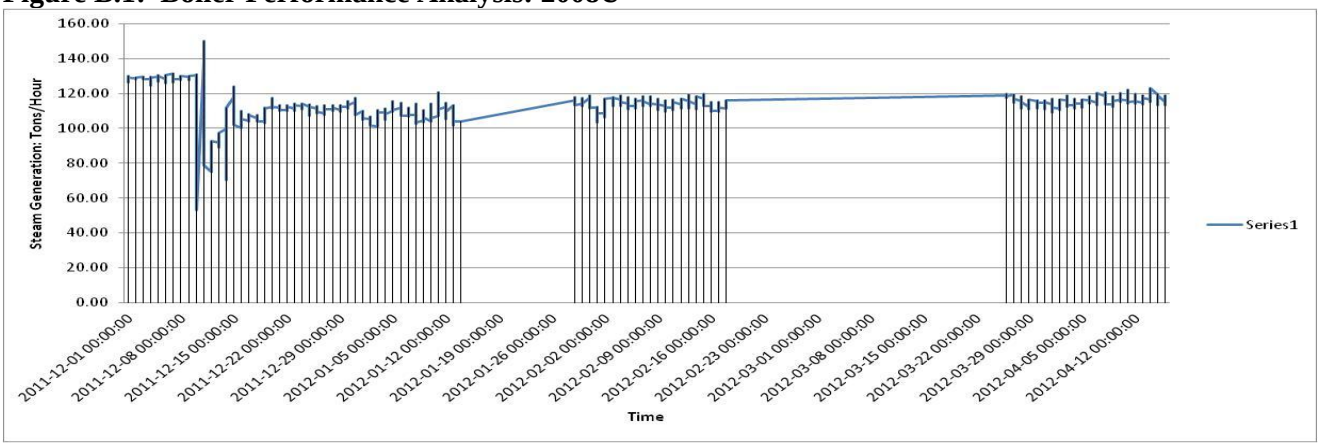


Figure B.2: Boiler Performance Analysis: 2008UA

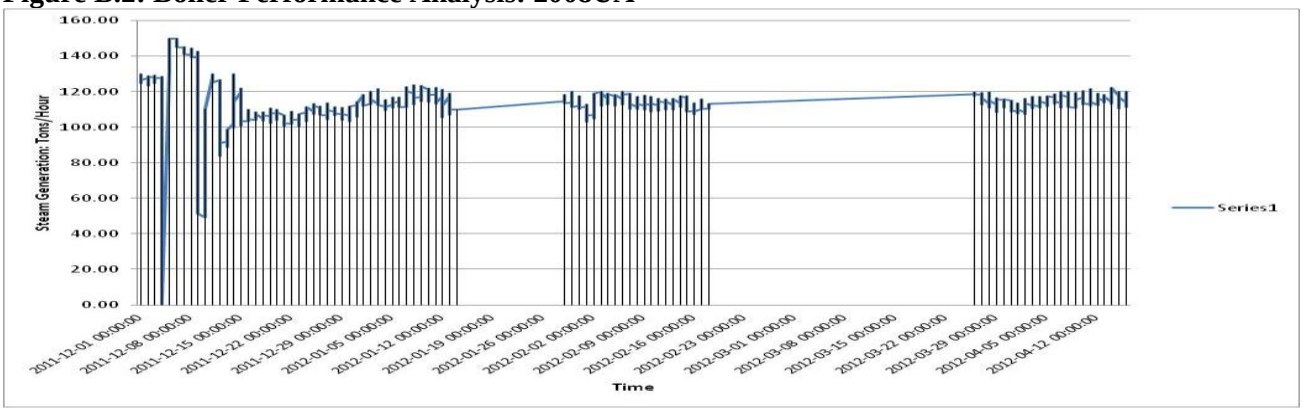
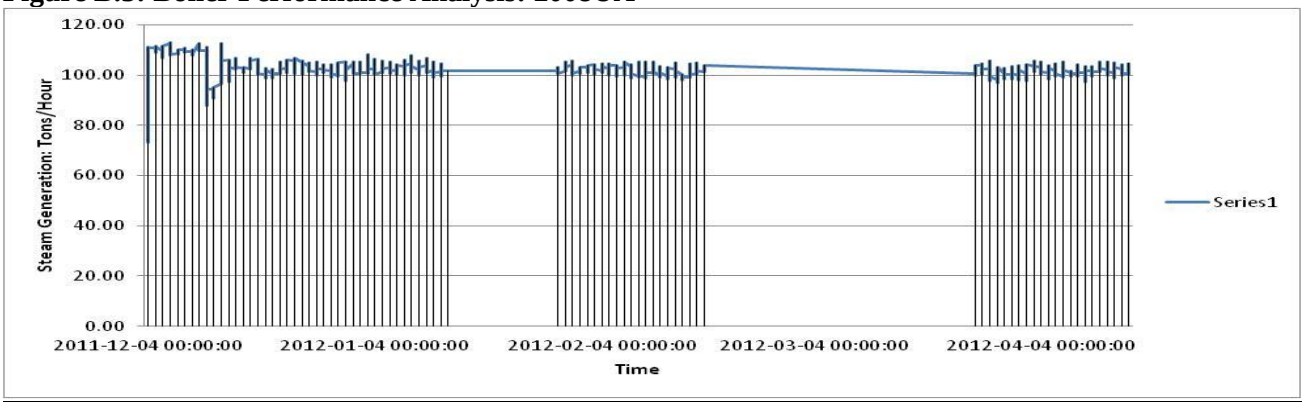


Figure B.3: Boiler Performance Analysis: 2008UA



Step 5: Determination of the specific fuel consumption of the steam system (per load class):

The specific fuel consumption of the steam system for different combinations is provided in the table below.

Table B.6.6: Specific Fuel Consumption & Energy Consumption

System Load Class	System Load	2008U	2052U	2008UA	Average Stem Production (Tons/hr)	Net Calorific Value of Fuel (GJ/m3)	NG Fuel (Nm3/h)	Specific Fuel Consumption (Nm3/T)	Specific Energy Consumption (SEC)(GJ/t of steam	Specific Energy Consumption System (SEC system)(GJ/hr)
1	0-21	Rare Occurrence/Possibly Downtime.								
2	21-40	OFF	OFF	ON	39.99	0.0399	3054	76.37	3.04	121.71
3	41-60	ON	OFF	OFF	54.54	0.0399	4422	81.08	3.23	176.24
		ON	OFF	ON	52.57	0.0399	4007	76.23	3.04	159.70
		OFF	OFF	ON	50.59	0.0399	3592	71.01	2.83	143.17
4	61-80	ON	OFF	OFF	75.00	0.0399	6452	86.02	3.43	257.12
		OFF	ON	OFF	77.26	0.0399	8070	104.46	4.16	321.62
		OFF	OFF	ON	70.51	0.0399	6819	96.72	3.85	271.77
5	81-100	ON	OFF	OFF	92.80	0.0399	7376.16	79.48	3.17	293.95
		OFF	ON	OFF	96.35	0.0399	7600.61	78.89	3.14	302.90
		OFF	OFF	ON	92.15	0.0399	7930.26	86.06	3.43	316.03
		ON	ON	OFF	94.58	0.0399	7488.39	79.18	3.16	298.42
		OFF	ON	ON	94.25	0.0399	7765.44	82.39	3.28	309.46
		ON	OFF	ON	92.48	0.0399	7653.21	82.76	3.30	304.99
		ON	ON	ON	93.77	0.04	7635.68	81.43	3.25	304.29
6	101-120	ON	OFF	OFF	114.53	0.0399	9496.69	82.92	3.31	379.39
		OFF	ON	OFF	108.45	0.0400	7725.27	71.23	2.85	308.66
		OFF	OFF	ON	114.15	0.0399	10183.06	89.21	3.56	406.63
		ON	ON	ON	112.38	0.04	9135.01	81.29	3.25	364.90
		ON	ON	OFF	111.49	0.0400	8610.98	77.24	3.09	344.03
		OFF	ON	ON	111.30	0.0399	8954.17	80.45	3.21	357.66
		ON	OFF	ON	114.34	0.0399	9839.88	86.06	3.44	393.01
7	121-135	ON	OFF	OFF	129.27	0.0400	10270	79.44	3.17	410.28
		OFF	ON	OFF	Not Operational	Not Operational	Not Operational			
		OFF	OFF	ON	125.79	0.0400	10870	86.42	3.46	435.32
		ON	ON	OFF	129.27	0.04	10269.65	79.44	3.17	410.28
		OFF	ON	ON	125.79	0.04	10870.40	86.42	3.46	435.32
		ON	OFF	ON	127.53	0.04	10570.03	82.88	3.32	422.79
		ON	ON	ON	127.53	0.04	10570.03	82.88	3.32	422.79
8	136-160	ON	ON	OFF	144.05	0.0399	21817	151.46	6.04	869.46
		OFF	ON	ON	154.02	0.0399	22672	147.20	5.87	903.51
		ON	OFF	ON	144.05	0.0399	21817	151.46	6.04	869.46

System Load Class	System Load	2008U	2052U	2008UA	Average Stem Production (Tons/hr)	Net Calorific Value of Fuel (GJ/m3)	NG Fuel (Nm3/h)	Specific Fuel Consumption (Nm3/T)	Specific Energy Consumption (SEC)(GJ/t of steam	Specific Energy Consumption System (SEC system)(GJ/hr)
		ON	ON	ON	Not Operational	Not Operational	Not Operational			
9	161-180	ON	ON	OFF	169.48	0.0399	14125	83.34	3.32	562.87
		OFF	ON	ON	174.94	0.0399	14239	81.40	3.24	567.44
		ON	OFF	ON	176.38	0.0399	14776	83.78	3.34	588.83
		ON	ON	ON	Not Operational	Not Operational	Not Operational			
10	181-200	ON	ON	OFF	189.80	0.0399	15086	79.48	3.17	601.16
		OFF	ON	ON	190.41	0.0399	15699	82.45	3.29	625.59
		ON	OFF	ON	187.77	0.0399	15352	81.76	3.26	611.77
		ON	ON	ON	Not Operational	Not Operational	Not Operational			
11	201-220	ON	ON	OFF	217.18	0.0400	16741.18	77.08	3.08	669.65
		OFF	ON	ON	216.43	0.0399	17331.79	80.08	3.19	690.85
		ON	OFF	ON	215.90	0.0398	18519.86	85.78	3.42	737.65
		ON	ON	ON	Not Operational	Not Operational	Not Operational			
12	221-240	ON	ON	OFF	225.28	0.0400	17240	76.53	3.06	688.93
		OFF	ON	ON	226.18	0.0400	18058	79.84	3.20	722.87
		ON	OFF	ON	231.33	0.0400	19926	86.14	3.44	796.45
		ON	ON	ON	Not Operational	Not Operational	Not Operational			
13	241-260	ON	ON	OFF	248.84	0.03985	19953	80.18	3.20	
		OFF	ON	ON	251.98	0.03985	16363	64.94	2.59	652.06
		ON	OFF	ON	245.03	0.04011	20753	84.70	3.40	832.41
		ON	ON	ON	252.91	0.0399	21187	83.77	3.34	844.31
14	261-280	ON	ON	ON	265.15	0.0396	21011	79.24	3.14	831.61
15	281-300	ON	ON	ON	286.79	0.0399	23171	80.79	3.22	923.37
16	301-320	ON	ON	ON	315.50	0.0398	25764	81.66	3.25	1025.39
17	321-340	ON	ON	ON	332.92	0.0399	26986	81.06	3.24	1077.56
18	340-360	ON	ON	ON	345.85	0.0400	27945	80.80	3.23	1118.65
19	>360	ON	ON	ON	395.99	0.0390	20087	50.73	1.98	783.38

Step 6: Calculation of baseline emissions

Baseline Emission for the system is calculated using the formula:

$$BE_y = 44/12 \cdot EF_{C,FF,BL} \cdot OXID_{FF,BL} \cdot SEC_{syst}$$

Where

$BE_{,y}$	Baseline emissions resulting from steam generation within the capacity of the baseline equipment in the year 'y' (tCO_2/yr)
SEC_{syst}	Specific energy consumption (GJ/t) of the multi boiler steam generation system
$EF_{C,FF,BL}$	Carbon emission factor of baseline fossil fuel (tC/GJ)
$OXID_{FF,BL}$	Oxidation factor of baseline fossil fuel
44/12	Ratio of the molecular weight of CO_2 to the molecular weight of carbon

Given the steam generation capacity for all three boilers has been determined to be 100-120Tons/hour and considering that boiler operations are predominantly within this load range, the following has been considered in estimating annual baseline emissions.

Table B.6.7: Annual Baseline Emissions Calculation

Steam Generation & Energy Consumptions	
Annual Steam Production (2011) (T/Annum) (from all load classes)	2860778
Boiler Load Classes considered for baseline emissions	100-120 (Individual Boilers)
Annual Steam Generation within selected load class - 2008U (Tons/Annum)	*867724.6383*
Annual Steam Generation within selected load class - 2052U (Tons/Annum)	*870759.8582*
Annual Steam Generation within selected load class - 2008-UA (Tons/Annum)	*915398.3884*
Total Steam Generation within selected load class (3 boilers) (Tons /Annum)	2653882.885
Average Fuel Consumption (Nm3/Ton)	81.17366021
Annual Fuel Consumption within representative load classes (Nm3/ annum)	215638525.4
Average Energy Consumption (GJ/Ton)	3.240419058
Annual Energy Consumption (GJ/Annum) (SECsyst)	8613546.002
Carbon Emission Factor (Fossil Fuel) (tc/GJ) ($EF_{C.FF.BL}$)	0.056
Oxidation Factor ($OXID_{FF.BL}$)	1
Baseline Emission (Tons/Annum)	482358.5761

Project Emissions

The proposed rehabilitation project is expected to achieve up to 9.7% savings in fuel consumption annually. Therefore the anticipated fuel consumption after implementation of project is expected to be 194721588.4 Nm3 per annum for the representative system load classes (100-120T/h).

To estimate the project emissions, the '**Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion' (version 2)** was used . The tool requires CO2 emissions to be calculated using equation 1 as stated below:

$$PE_{FC,JY} = \sum FC_{I,J} \text{ X } COEF_{I,Y}$$

Where,

$PE_{FC,JY}$ = Are the CO2 emissions from fossil fuel combustion in process j during the year 'y' (tCO2/year)

$\sum FC_{I,J}$ = Is the quantity of fuel type 'i' combusted in process 'j' during the year y (Mass or Volume Unit/year)

$COEF_{I,Y}$ = Is the CO2 emission coefficient of fuel type 'i' in year 'y' (tCO2/mass or volume unit)

i = are the fuel types

Two options have been provided in the tool to calculate the CO2 emission coefficient (COEFi,y). Option 2 (equation 4 below) (i.e. based on net calorific value and CO2 emission factor) has been used in estimating the emission coefficient.

COEFi,y = NCVi,y X EF CO2i,y

Where,
NCVi,y = Is the weighted average net calorific value of the fuel type i, in year y (GJ/Mass or Volume Unit)

EF CO2 i,y = Is the weighted average CO2 emission factor of fuel type i in year y (tCO2/GJ)

Project emissions have been estimated as presented in Table B.6.8 below.

Table B.6.8: Project Emission Calculations

Representative System Load Classes considered	100-120 (Individual Boilers)
Baseline Fuel Consumption within representative load classes (Nm3/annum)	215638525.4
Project Fuel Savings (%)	9.70%
Revised Fuel Consumption within representative load classes (Nm3/annum)	194721588.4
Average Calorific Value of Fuel (GJ/m3)	0.03992
Annual Energy Consumption (GJ/Annum) (Post Rehabilitation)	7773285.809
Project Emissions (Tons/Annum)	435304.0053

LEAKAGE

Emissions due to leakage have been calculated using equation 9 of the AM0056 (v 1.0):

$$LE_{CH4,y} = \left(FC_{PJ,y} \cdot NCV_{PJ,y} \cdot EF_{PJ,upstream,CH4} - FC_{BL,y} \cdot EF_{BL,upstream,CH4}\right) \cdot GWP_{CH4}$$

Quantity of fossil fuel combusted in the project plant during the year 'y' (t or m³), monitored as described in the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (FCpjy)	194721588.4
Average net calorific value of the fossil fuel combusted during the year 'y' (GJ/t or GJ/m³) monitored as described in the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (NCVpjy)	0.03992
Emission factor for upstream fugitive methane emissions of fossil fuel used in the project activity from production, transportation, distribution, and, in the case of LNG, liquefaction, transportation, re-gasification and compression into a transmission or distribution system, (t CH4 per GJ fuel supplied to final consumers) tCH4/GJ $_{(EFPJ, UPSTREAM CH4)}$	0.000296
Fossil fuel that would have been combusted in the absence of the project activity during the year 'y' (GJ) ($FC_{BL,Y}$)	8613546.002
Global warming potential of methane valid for the relevant commitment period.	21
Leakage (Tons/Annum)	-5223.057362

Note: There will no change in the source of fuel supply or mode of delivery as a result of the project. Therefore emission factor for upstream fugitive methane emissions remains same prior to and post project.

EMISSION REDUCTIONS

Emission reductions are calculated using equation 12 of AM0056 (version 1.0) as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Where

ER_y	Emissions reductions of the project activity during the year 'y' in tCO_2e
BE_y	Baseline emissions during the year 'y' in tCO_2e
PE_y	Project emissions during the year 'y' in tCO_2e
LE_y	Leakage emissions in the year 'y' in tCO_2e

Emission reductions from the above equation is 41831.51 MT/Annum

B.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Baseline emissions (t CO2e/annum)	Project Emissions (t CO2e/annum)	Leakage (t CO2 e/ annum)	Emission Reduction (t CO2 e/annum)
01/10/2014 – 30/09/2015	482358	435304	5223	41831
01/10/2015 – 30/09/2016	482358	435304	5223	41831
01/10/2016 – 30/09/2017	482358	435304	5223	41831
01/10/2017 – 30/09/2018	482358	435304	5223	41831
01/10/2018 – 30/09/2019	482358	435304	5223	41831
01/10/2019 – 30/09/2020	482358	435304	5223	41831
01/10/2020 – 30/09/2021	482358	435304	5223	41831
01/10/2021 – 30/09/2022	482358	435304	5223	41831
01/10/2022 – 30/09/2023	482358	435304	5223	41831
01/10/2023 – 30/09/2024	482358	435304	5223	41831
Total	4823580	4353040	52230	418310
Total No of Crediting Years			10	
Annual Average over the Crediting Period			41831 Tons/Annum	

B.7. Monitoring Plan

B.7.1 Data and parameters monitored:

Data/ Parameter	**$P_{PJ,i,y}$ (Individual Boilers)**
Data Unit	(Tons/Hour) Tons/Annum
Description	Generated steam in the year 'y' subdivided into load classes in the case of single

	boiler installations
Source of data used	Hourly Monitoring Data measured and archived at the Facility
Justification of the choice of data or description of measurement methods and procedures actually applied	Facility operates 24 hours continuously over the calendar year. Hence hourly measurements and annual totals are available
Monitoring Frequency	Hourly Data
QA/QC Procedures	(See Note 1)

Data/ Parameter	**$P_{PJ,k,y\ (System)}$**
Data Unit	(Tons/Hour) Tons/Annum
Description	Generated steam in the year 'y' subdivided into load classes in the case of Multi boiler installations
Source of data used	Hourly Monitoring Data measured and archived at the Facility
Justification of the choice of data or description of measurement methods and procedures actually applied	Facility operates 24 hours continuously over the calendar year. Hence hourly measurements and annual totals are available
Monitoring Frequency	Hourly Data
QA/QC Procedures	(See Note 1)

Data/ Parameter	**$PRESS_{BL,MAX}$**
Data Unit	bar
Description	Pressure of the generated steam
Source of data used	Measurement. Use test result for calculations.
Justification of the choice of data or description of measurement methods and procedures actually applied	Measurement following international acknowledged norms and guidelines such as ASME PTC 4-1998
Monitoring Frequency	Hourly
QA/QC Procedures	(See Note 1)

Data/ Parameter	**$TEMP_{PJ}$**
Data Unit	K
Description	Temperature of the generated steam
Source of data used	Measurement. Use test result for calculations.
Justification of the choice of data or description of measurement methods and procedures actually applied	Measurement following international acknowledged norms and guidelines such as ASME PTC 4-1998
Monitoring Frequency	Hourly
QA/QC Procedures	(See Note 1)

Note 1:
Al Bayroni's monitoring programme is integral to the company's third party certified (i.e. by British Standards Institute-BSI) ISO 9001:2008 compliant Quality Management System (QMS). All monitoring programmes including associated calibration is within the scope of the QMS and subjected to several audits and reviews including Internal Audits, SABIC Corporate Audits and Third Party (BSI) audits.

Further, Al Bayroni subscribes to SABIC corporate's Safety, Environment, Health & Security Management Systems (SHEMS) applicable to all Rotating equipment, Pressure Relief Devices, Instrument Devises, Tanks & Pressure vessels, Piping, Car seals and Blinds, Hoses, Critical Instruments & Devices by pass, and Cathodic protection program. As a result, any modifications/ changes, replacements and emergency response is governed by the SHEMS programme. Al Bayroni is also certified to the American Chemistry Council Technical Specification Responsible Care® RC 14001.

All the modified facilities have passed through safety review during the design stage (namely HAZOP review) to identify all potential hazards and appropriate mitigation were incorporated during design phase of the project." In addition, there are Standard Operating Procedures (SOPs) available with operating personnel to start, operate and shutdown the boiler safely that includes the emergency scenarios of failure also. These SOPs are facilitated by the online instrumentation, Distributed Control System and Emergency Shutdown System

Through the management systems, monitoring and measurements program, testing and calibration is achieved. Testing and calibration are scheduled through the SAP system and notified by the workflow system to the Instrument division through the SAP maintenance planner.

The equipment / tag for the boilers is marked in block diagrams Figure B.7.1 -7.3 below). The flow and temperature is continually monitoring through DCS log sheet (Table 7.1). The monitoring testing and its frequency with the management system procedure reference is also provided in Table 7.2.

Figure B.7.1: Packaged Boiler Block Diagram (Boiler 2052-U)

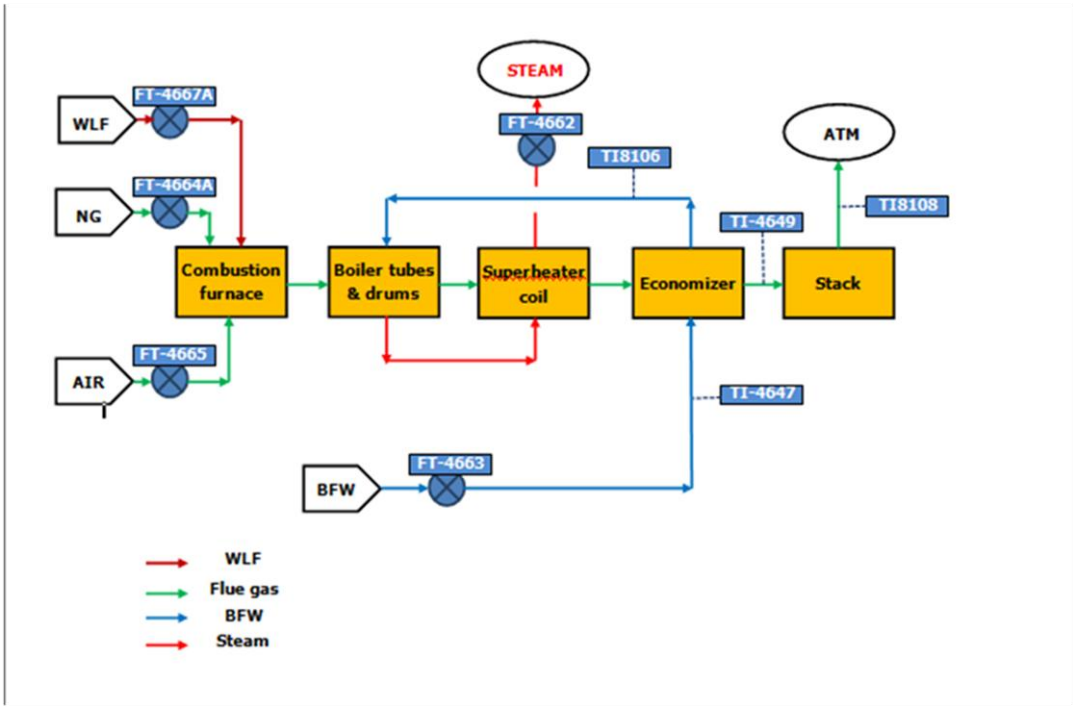


Figure B.7.2: Packaged Boiler Block Diagram (Boiler 2008-UA)

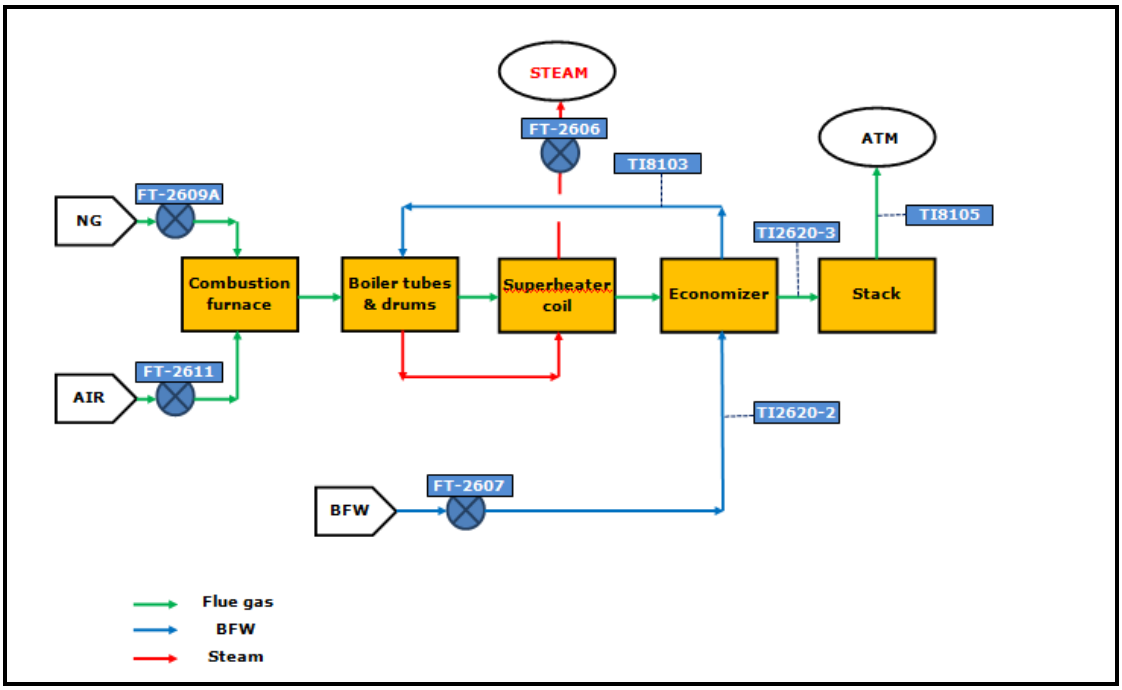


Figure B.7.3: Packaged Boiler Block Diagram (2008-U)

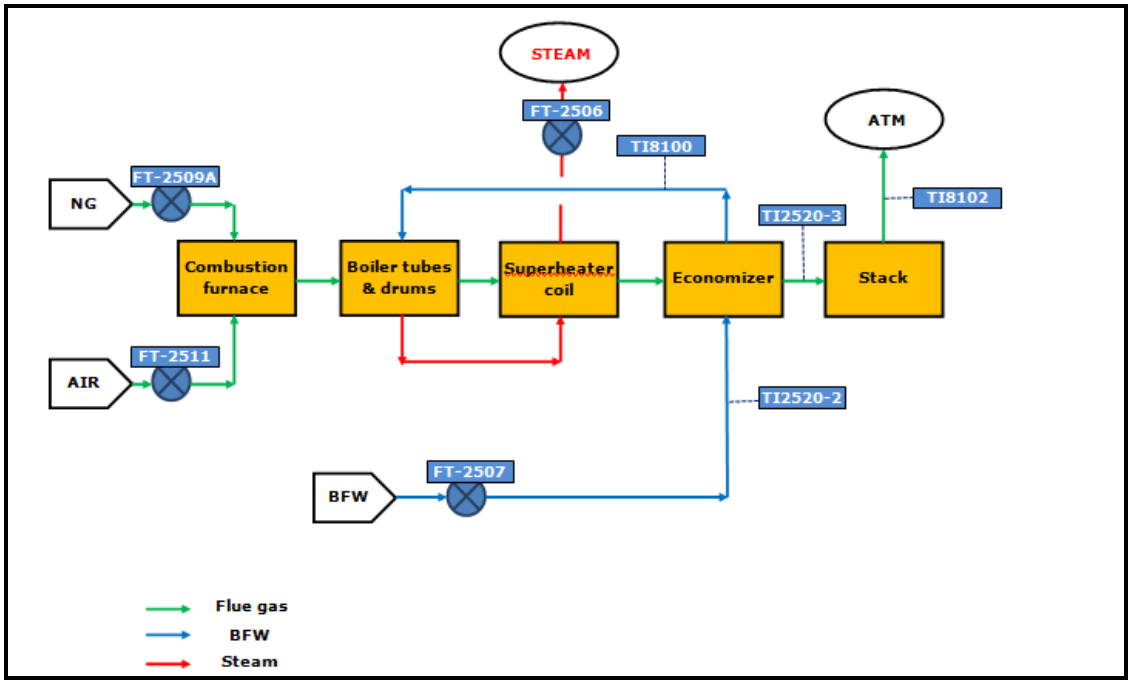


Table 7.1 Sample DCS Log Sheet

Log Items	STEAM SUPPLY			STEAM DRUM		BFW			CBD		FUEL GAS (NG)			
	Temp.	SH Stm Press.	Flow	Level (N)	Level (S)	Flow	Temp.	Econ. Out T.	Cond.	PH	Header Press.	Flow	Burner Press.	Flow Meter
	TI-2520-1	PI-2513	FIC-2506	LIC-2508	LI-2516	FIC-2507	TI-2520-2	TI-8100	CI-2517	AI-2518	PIC-2219	FIC-2509	PIC-2510	FI-2509A
	°C	BAR	T/H	MM	MM	M^3/H	°C	°C	µS/cm	pH	BAR	NM^3/H	BAR	NM^3
C. R.	360-410	37-43	<129	-25 ~+100	-25 ~+100	<135	105-125	160-190	<500	9.0-11	2.5-3.5	<12000	0.1-0.9	-
00/MV														
02:00														
04:00														
06:00														
08/MV														
10:00														
12:00														
14:00														
16/MV														
18:00														
20:00														
22:00														

Log Items	RATIO	COMBUSTION AIR							FLUE GAS					LOAD
	Fuel/Air Ratio	Flow	F.D.Fan Speed	2008-UJM	F.D.Fan Suc. T.	F.D.Fan Out Pres.	Windbox Pressure	Furnace Pressure	Furnace Draft Pr.	Econ. out Press	Outlet Temp.	Econ. out Temp	Excess O_2	MV Open
	HC-2511-1	FIC-2511	-	Selector mode	TI-2520-4	PI-2515-1	PI-2515-2	PI-2515-3	PI-2515-4	PI-8102	TI-2520-3	TI-8102	AI-2519	XMV 2505
	%	KNM^3/H	RPM	A .O .M	°C	mmH_2O	mmH_2O	mmH_2O	mmH_2O	mBar	°C	°C	%	%
C. R.	70-99	100-170	1600-1850	CP LP	4-55	230-330	220-330	80-150	-10 ~+10	-10 ~+10	320-400	144-205	1.0-3.5	<80

00/MV															
02:00															
04:00															
06:00															
08/MV															
10:00															
12:00															
14:00															
16/MV															
18:00															
20:00															
22:00															

REMARKS:

SIGNATURE BY:	**1ST SHIFT**	**2ND SHIFT**	**3RD SHIFT**
DCS BRD. OPERATOR:			
SHIFT SUPERVISOR:			

BQMS-UTL-LOG-12/06 V12 MAY 1, 2013

Boiler 2052 U				**Boiler 2008 U**				**Boiler 2008 U A**			
	Tag #	Calibration / Testing Frequency	Procedure#		Tag #	Calibration / Testing Frequency	Procedure#		Tag #	Calibration / Testing Frequency	Procedure#
1	Waste Liquid Fuel			**1**	Natural Gas			**1**	Natural Gas		
	FT 4667 A	Yearly	IMP-017		FT 2509 A	Yearly	IMP-017		FT 2609 A	Yearly	IMP-017
2	Natural Gas			**2**	Air			**2**	Air		
	FT 4664 A	Yearly	IMP-017		FT 2511	Yearly	IMP-017		FT 2611	Yearly	IMP-017

3	Air			**3**	Boiler Feed Water			**3**	Boiler Feed Water		
	FT 4665	Yearly	IMP-017		FT 2507	Yearly	IMP-017		FT 2607	Yearly	IMP-017
4	Boiler Feed Water			**4**	Steam			**4**	Steam		
	FT 4663	Yearly	IMP-017		FT 2506	Yearly	IMP-017		FT 2606	Yearly	IMP-017
5	Steam			**5**	Steam Temperature			**5**	Steam Temperature		
	FT 4662	Yearly	IMP-017		TI 8100	Yearly	IMP-024		TI 8103	Yearly	IMP-024
6	Steam Temperature			**6**	Flue Gas Temp			**6**	Flue Gas Temp		
	TI 8106	Yearly	IMP-024		TI 2520-3	Yearly	IMP-024		TI 2620-3	Yearly	IMP-024
7	Flue Gas Temp			**7**	Boiler Feed water temp			**7**	Boiler Feed water temp		
	TI 4649	Yearly	IMP-024		TI 2520-2	Yearly	IMP-024		TI 2620-2	Yearly	IMP-024
8	Boiler Feed water temp			**8**	Flue Gas Tem (Stack)			**8**	Flue Gas Tem (Stack)		
	TI 4647	Yearly	IMP-024		TI 8102	Yearly	IMP-024		TI 8105	Yearly	IMP-024
9	Flue Gas Tem (Stack)										
	TI 8108	Yearly	IMP-024								

Note: Instrument, Maint. Procedure -SHEM 03.02

B.7.2 Sampling Plan

No sampling is required as 100% of data will be monitored during the project scenario.

B.7.3 Other Elements of Monitoring Plan

Same as above.

SECTION C. DURATION AND CREDITING PERIOD

C.1. Duration of the project activity:

C.1.1. Start date of the project activity:

25/08/2011
The contract with supplier of goods and services for project implementation was signed on this data and therefore it is considered as a start date of the project activity.

C.1.2. Expected operational lifetime of the project activity:

Twenty years
As was demonstrated to the Validator during the validation visit, Al Bayroni is employs strict maintenance practice which allows to extend the operational life time of the project.

C.2. Crediting Period of Project Activity

C.2.1. Type of Crediting Period

Fixed (10 Years)

C.2.2. Starting date of the first crediting period:

01/10/2014

C.2.3.Length of the first crediting period:

10 Years

SECTION D. ENVIRONMENTAL IMPACTS

D.1. Analysis of Environmental Impacts:

The proposed boiler rehabilitation project is not expected to cause additional adverse impacts on the environment in comparison to the baseline scenario, as detailed below:

- Air Quality: This project is not expected to cause any additional emissions and affect ambient air quality from current levels caused by emissions from the existing boiler system.
- Soil and Groundwater: As the proposed project largely involves replacement within the boilers and

as no new construction and commissioning of facilities is required, no impact on soil and groundwater is expected from the project.

- Flora and Fauna: There will be no displacement of flora and fauna as the site for the project is already developed and accommodates the existing boiler system
- Socio-Economic: The local economy will be benefited through contracts to in Kingdom contractors for labour supply and logistical support to implement the rehabilitation.
- Noise: The proposed project is not expected to elevate noise levels above current levels.
- Energy Savings: There will be considerable energy savings from the project (estimated to be around 9.7%).

D.2. Environmental Impact Assessment

The Environmental Impact Assessment (EIA) is within the Environmental Permit Application process. As per RCER 2010 (section 1.3.7), a new or amended permit will be required only if production increases by 10% or more. Given that the proposed project activity will not result in an increase in production, no new or amended permit would be required, hence EIA is excluded.

SECTION E. LOCAL STAKEHODLER CONSULTATION

E.1. Solicitation of Comments from Local Stakeholders

Formal consultations with local stakeholders were held on September 30, 2013 at the Al Jubail Intercontinental Hotel, in Jubail Industrial City. An open invitation was issued to the public soliciting their participation in the consultation session in local newspaper "Arab News dated 8th September, 2013.

E.2. Summary of Comments received

In total 33 participants took part in the meeting representing various stakeholder groups:

- Royal Commission for Jubail (local government)
- ALBAYRONI Employees
- Employees of other companies
- Local residents
- DNA representatives
- Media representatives etc...

The meeting participants were requested to provide their feedback on the proposed CDM project through Stakeholder Consultation Feedback Form. They were asked to rate the quality of the project design, the adequacy of the information provided, project benefits, impact of the project, concerns, suggestions or criticism. The results of the survey are as follows:

- 22 respondents stated that they had received adequate information about proposed CDM project
- 1 respondent did not receive adequate information
- 14 rated the design of the project as excellent
- 6 rated the design as good
- Respondents stated that the project in their opinion would result in environmental (21), social (7) and economic (7) benefits
- 13 participants stated that the project impact would be significant

- 6 stated that impact would be fair

Table E.1 below presents concerns and criticisms about the project expressed by participants and the way they are addressed:

Table E.1: Summary of Comments Received from the Stakeholder Consultations

	Response
the monitoring processes of the project not very clear	The project will strictly follow monitoring procedures outlined by the applied methodology.
economic aspect of the project not very clear	Financial estimations (cash flow, IRR etc..) are currently being developed by team and will be explained in details in PDD
UNFCCC rules for CDM are over complicated	The team agrees with the concern however rules must be followed to complete CDM project
project being limited to only one SABIC Affiliate	Other companies within SABIC are currently investigating opportunities to implement CDM projects including the similar one (as part of PoA)
Proposed technologies not being the most advanced.	The project design is based on the tested technology.

In general, the comments were positive and supportive, recognizing the importance of sustainability agenda in the Kingdom of Saudi Arabia. Most comments urged the roll out of similar projects across entire SABIC (i.e. in other Affiliates) and other companies.

E.3. Report on how due account was taken of any comments received:

See Table E.1 above

SECTION F. APPROVAL AND AUTHORIZATION

The Letter of Approval was issued by National Committee for Clean Development Mechanism, Kingdom of Saudi Arabia (Saudi DNA) on 8th January, 2014.

Modalities of Communication (MoC) has been prepared and duly signed.

Appendix 1: Contact information of project participants

Organization name	AL-BAYRONI (Al-Jubail Fertilizer Company)
Street/P.O. Box	10046
Building	Main Building
City	Madinat Al-Jubail Sinaiyah
State/Region	
Postcode	31961
Country	Kingdom of Saudi Arabia
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Fax	+966 (3) 341 6100
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Contact person	Abdullah Al Shamrani
Title	President
Salutation	Mr
Last name	Al-Shamrani
Middle name	
First name	Abdullah
Department	
Mobile	
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Direct tel.	+966 (3) 340 6111
Personal e-mail	amshamrani@albayroni.sabic.com

Organization name	AL-BAYRONI (Al-Jubail Fertilizer Company)
Street/P.O. Box	10046
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State/Region	
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Fax	+966 (3) 340 6221
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Salutation	Mr
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Middle name	
First name	Ali
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Salutation	Mr
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Middle name	
First name	Ahmed
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Direct tel.	+966 (11) 225 9215
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State/Region	
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Website	www.sabic.com
Contact person	Zaour Israfilof
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Salutation	Mr
Last name	Israfilof
Middle name	
First name	Zaour
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Mobile	
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Direct tel.	+966 (11) 225 8346
Personal e-mail	israfilofzy@sabic.com

Appendix 2 Affirmation Regarding Public Funding

Below is the Declaration about ODA dated January 20th, 2014.

بسم الله الرحمن الرحيم

البيروني
albayroni

January 20, 2014
Jubail Industrial City, KSA

Declaration

To Whom It May Concern,

I hereby declare that no Official Development Assistance (ODA) funding has been used or will be used by Al Jubail Fertilizer Company (Al Bayroni) for its proposed CDM project titled "Efficiency Improvement by Boiler Rehabilitation in fossil fuel-fired (Natural Gas) Steam Boiler System".

The proposed CDM project is 100% equity funded.

Regards,

Khalid Abdullah Al-Omar
Senior Manager, Finance & Planning

شركة تابعة لسابك
A Sabic Affiliate

Albayroni
P. O. Box 10046
Madinat Al-Jubail Al-Sinaiyah 31961
Kingdom of Saudi Arabia
Tel 966 (0) 3 341 6488
Fax 966 (0) 3 341 7122

Al Jubail Fertilizer Company
Limited Liability Company
Authorized Capital: SR 700 Million
Paid Capital: SR 671.5 million
CR 2055000435

شركة الجبيل للأسمدة
شركة ذات مسؤولية محدودة
رأس المال المصرح به ٧٠٠ مليون ر.س
رأس المال المدفوع ٦٧١,٥ مليون ر.س
س.ت ٢٥٥٠٠٠٠٤٣٥

البيروني
صندوق بريد ١٠٠٤١
الجبيل الصناعية ٣١٩٦١
المملكة العربية السعودية
هاتف ٦٤٨٨ ٣٤١ (٠٣) ٩٦٦
فاكس ٧١٢٢ ٣٤١ (٠٣) ٩٦٦

Appendix 3 Applicability of Selected Methodology

Please refer to Section B.2.

Appendix 4 Further Background Information on ex ante calculation of emission reductions

Not Applicable.

Appendix 5 Further Background Information on Monitoring Plan

Please refer to Section B.7.

Appendix 6 Summary of Post Registration Changes

Not Applicable.

History of the document

Version	Date	Nature of revision
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).
03	EB 25, Annex 15 26 July 2006	
02	EB 14, Annex 06b 14 June 2004	
01	EB 05, Paragraph 12 03 August 2002	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		