Pre-Feasibility Report

Proposed 3 x 90 MW Petcoke based Captive Co-generation Power Plant (CCPP)

Prepared for

RELIANCE INDUSTRIES LIMITED,

DAHEJ MANUFACTURING DIVISION (DMD), DAHEJ, GUJARAT

June 2015

Contents

Annexures

1. Executive Summary:

Dahej Manufacturing Division (DMD) of Reliance Industries Limited (RIL) is located at village Dahej, in Vagra Taluka of Bharuch District in the State of Gujarat. It is a multi-product, fully integrated complex, manufacturing a wide range of petrochemicals, polymers, polyesters and polyester intermediates.

The power and steam required for the process plants at RIL-DMD are produced by existing gas-based captive power plant. But, due to uncertainty in availability and high cost of gas, a coal based Captive Cogeneration Power Plant (CCPP) of 3 X 90 MW (270 MW) capacity is being installed for which environmental clearance has been granted by SEIAA , Gujarat vide their letter SEIAA/GUJ/ EC/I(d) & 7(e) /96/2015 dated 2nd March 2015. This new coal based CCPP is to cater to the power and steam requirements for the complex. The existing gas-based generators will be preserved for exigencies. This will also enable black start, in case of any requirement.

It is proposed to use pet coke as a fuel for the above CCPP at DMD to be sourced from RIL Jamnagar refinery and imported. In case of any road transport, high capacity covered trucks will be used to avoid spillage. Pet coke requirement for the project will be about 1.47 MMTPA. The auxiliary fuel will be Natural Gas. Circulating Fluidized Bed Combustion (CFBC) boilers will be used in the upcoming CCPP instead of conventional Pulverized Fuel Combustion, which is capable of using wide variety of solid fuels and also has provision to control Sulphur Dioxide at source using lime stone injection. The limestone requirement, to reduce SO_2 emission, will be about 0.8 MMTPA.

Approx. 38 ha of land within the DMD complex is being utilised for setting up of the CCPP including storage and other facilities required for fuel storage & handling.

There will be no additional water requirement when the CCPP running on pet coke as fuel and the total water requirement for the purposes DM water and cooling tower make-up, will remain same at 1200 m^3/hr and wastewater discharges will be 33,419 m^3/day as approved for Coal based CCPP. No additional water will be drawn from source and it is with in approved quantity by Govt. of Gujarat. .The wastewater generated will be discharged through the existing marine disposal system with diffuser arrangement.

Two stacks of 220 metres each- one with three flues and another one with two flues are being established as per the standards prescribed by the CPCB for thermal power plants below 500 MW capacity. No change in stack design is envisaged due to Pet Coke fuel. Particulate matter emission will be controlled through electrostatic precipitator (ESP) to ensure it is limited to 50 mg/Nm^3. The fuel handling and transportation will be provided with bag filters to control fugitive emissions. Limestone will be continuously injected into furnace to reduce and control emission of SO_2 at source to the SEIAA approved maximum limit of 20 tons/day/boiler for coal firing. The furnace temperature in CFBC boilers will be maintained between 800-900^{0}C, limiting thermal NOx formation to maximum of 150 ppm, as approved by SEIAA. Continuous Emission Monitoring System (CEMS) are being installed in stack to continuously monitor the emissions of PM, SO_2 and NOx.

The noise standard but not more than 85 dB at 1 m from any equipment or sub-equipment will be observed from Steam Generator and auxiliaries. Noise attenuating enclosures will be provided, as necessary, on all noisy equipment to limit the noise level within permissible standards.

The ash handling system being established for Coal based CCPP will suffice in case of pet coke usage also as the ash % in pet coke is will be less than coal. The ash will be collected in dry form in silos for enhanced utilization. About 64 MT/hr of fly ash and 28 MT/hr of bed ash are expected to be generated, which will be utilised primarily in cement manufacturing industries. The silos will have capacity of 1 day ash storage.

2. Introduction of project:

Reliance Industries Limited (RIL) is currently implementing the coal-based Captive Cogeneration Power Plant (CCPP) at Dahej Manufacturing Division (DMD) in Gujarat. The objective of setting up of

this coal based CCPP is to meet the steam and power requirements economically and effectively due to shortage of natural gas. It is proposed to change fuel from coal to pet coke for which approval from MoEF is sought & the fuel is readily available at RIL Jamnagar

For the above CCPP, the conversion to pet coke as an alternative fuel is envisaged due to the following reasons:

1) Petroleum coke (Pet coke) is a carbonaceous solid derived from oil refinery coker units or other cracking processes. The chemical composition of petroleum coke is mostly elementary Carbon (usually over the 85% C dry) with high heating value and very little ash content (usually less than 1-2 %).
2) Petroleum coke is a fuel that has long been considered an ideal fuel for the circulating fluidized bed combustion technology.
3) Despite the low volatile content of pet coke, combustion efficiency is quite good in a circulating fluidised bed (CFB) (At least 2.5% higher than that of Coal fired CFB). Thus there is no need to redesign for higher temperatures to improve combustion efficiency.
4) Lower temperatures improve the emissions performance as well as reduce the potential for agglomeration and deposition. The recommended furnace design temperature should be typically in the range of 850 - 900°C. This will in-turn reduce the NOx emissions as well.
5) Compared to other low ash coals, pet coke has advantage in terms of bed material inventory. In spite of having low ash content, the bed material requirement is minimum, since limestone and its reacted products (gypsum) act as the bed material.

3. Project Description :

Dahej Manufacturing Division (DMD) of Reliance Industries Limited (RIL) is located at village Dahej in Vagra Taluka of Baruch District in the State of Gujarat. It is a multi-product, fully integrated complex manufacturing a wide range of petrochemicals, polymers, polyesters and polyester intermediates.

Due to uncertainty in availability and high cost of gas, A 270 MW coal based CCPP is being set up to meet the steam and power requirement of the process plant for which environmental clearance has been granted by SEIAA on 2nd March, 2015. The existing gas based generators will standby for exigency. Due to availability of surplus pet coke at RIL Jamnagar and other sources, it is now proposed to use pet coke as a fuel for the CCPP. The pet coke is proposed to be brought to DMD by sea route either at captive jetty and will be transferred to project site either by pipe conveyors or to nearby jetties and from there by road. In case of road transport, pet coke will be brought in high capacity covered trucks to avoid spillage.

Circulating Fluidized Bed Combustion (CFBC) technology used in the upcoming CCPP is capable of using wide variety of solid fuels and hence change of fuel to pet coke will not require any special construction or modification in the plant design. Pet coke requirement for the project will be about 1.47 MMTPA, while the corresponding limestone requirement, to control SO2 emission, will be about 0.8 MMTPA. Pet coke storage of 15 days and 5 days storage of lime stone is considered by providing covered storage yard.

The CCPP is coming up in 38 Ha of land within DMD complex. The location map of the project within DMD complex is attached at **Annexure-A**. No alternate site is considered due to the availability of land and required infrastructure at DMD as well as the power and steam to be produced are for captive use at DMD.

Process Description

CFBC Technology:

The depleting trend of coal quality and environmental considerations due to high sulphur and high ash content fuels, the technology of circulating fluidized bed combustion (CFBC) which got invented in 1980s has become popular . CFBC boiler consists of a boiler and a high-temperature cyclone as a solid separation device. A coarse fluidizing medium and char in the flue gas are collected by the high-temperature cyclone and recycled to the boiler. Recycling maintains the bed height and increases the denigration efficiency. To increase the thermal efficiency, a pre-heater for the fluidizing air and combustion air, and a boiler feed water heater, are installed. In CFBC boilers, combustion takes place at temperatures in the range of 800-900°C resulting in reduced NOx emissions compared with pulverized coal fired units or any other coal fired technologies. SO_2 emission is reduced by the injection of limestone in the combustion chamber.

Circulating beds use a higher fluidizing velocity, so the particles are constantly held in the flue gases, and pass through the main combustion chamber and enter into a cyclone, from which the larger particles are extracted and returned to the combustion chamber. Combustion conditions are relatively uniform through the combustor, although the bed is somewhat denser near the bottom of the combustion chamber. There is a great deal of mixing, and residence time during one pass is very short. The bed material is preferred either as crushed refractory or from the fuel ash or as sand in some cases. Due to the large heat capacity of the bed, combustion is stable and no supporting fuels are required, provided the fuel heating value is sufficient to raise the combustion air and the fuel itself above its ignition temperature. The intense turbulence ensures good mixing and combustion of the fuel. The schematic of a CFBC boiler is shown at **Annexure-B**

Limestone Feed and Control Mechanism

Sulphur capture in CFBC boilers happens by injecting Limestone along with fuel. The fuel and Lime mixture enters into combustion chamber through multiple feed points located in furnace front close to the bottom primary zone. Limestone undergoes decomposition by taking heat from the hot bed material (endothermic) and converts into Calcium Oxide (CaO).This process is called as Calcination. The calcined Limestone being porous in nature gets entrained in flue gas and enters the top section of furnace where the mixture of Oxygen and Sulphur Dioxide reacts with Calcium Oxide and converts into Calcium Sulfate ($CaSO_4$).This Process is called Sulfation. This process is an exothermic reaction. Thus, the Limestone converts gaseous SO_2 emission to solid Calcium Sulfate and gets removed from the system. Attributing higher particle residence time and recirculation, the Sulphur capture efficiency in CFBC boliers can be achieved to almost 95%.

Limestone injection control consists of Limestone variable speed rotary feeder. The amount of limestone that is required for a given amount of fuel depends on the sulphur content of coal. An increase in sulphur dioxide emissions will necessitate in an increase in the amount of limestone that is required for a given fuel flow to the furnace. The limestone demand is a function of the main fuel flow. An increase in fuel flow demand will result in a corresponding increase in the limestone demand to provide the demand signal to the Limestone Variable Rotary Feeder.

Technical Features of Main Plant & Equipment

The Coal/Pet coke based power plant consists of the following major equipment:

a) Four (3 operating +1 standby) steam generators, along with all ancillaries and auxiliaries, stack and duct work, damper, suction air filters along with controls and instrumentation, suitable for base load operation with Coal/ Pet coke as fuel.
b) 3 nos. steam turbine generators set (3 x 90 MW) with deaerator & feed heating equipment, steam condenser, CEP and feed water pumps with all piping systems.

c) Other auxiliary systems and major equipment needed, while operating on pet coke as fuel:
   - Limestone handling system
   - NG system

The power plants will be provided with the state-of-the-art Distributed Digital Control System (DCS), which will integrate various closed loop sub-systems, open loop sub-systems, monitoring and information sub-system covering the entire plant. The system will integrate the various proprietary control packages supplied by the main equipment suppliers for harmonious plant operation.

Fuel Quality:

Pet coke for the project will be available either from RIL Jamnagar refinery or can be imported through the proposed jetty or nearby jetties, as required. During road transport, pet coke will be brought in high capacity covered trucks. Pet coke requirement for the project will be about 1.47 MMTPA, while the corresponding limestone requirement, to reduce SO_2 emission, will be about 0.8 MMTPA. The proximate and ultimate analysis of pet coke, to be used for the power plant, is as follows:

Heating Values		
LHV	7672.4	kcal/kg
HHV	7895	kcal/kg
Ultimate Analysis (weight %)		
Moisture	5	%
Ash	0.2	%
Carbon	80.07	%
Hydrogen	3.71	%
Nitrogen	1.37	%
Chlorine	0.63	%
Sulfur	7.33	%
Oxygen	1.69	%
Total	100	%
Proximate Analysis (weight %)		
Moisture	5	%
Ash	0.2	%
Volatile Matter	14.22	%
Fixed Carbon	80.58	%
Total	100	%

Because of the extremely low ash (<0.2%) and high sulphur contents of pet coke 7.33%, limestone is used in the majority of bed materials of the CFBC boilers using pet coke. Limestone sizing is critical not only for efficient sulphur capture but also effective fluidization and fuel mixing there by uniform temperatures and heat transfer. Limestone of 80-90%, to be procured locally, will be used in CCPP.

Pet coke Handling Plant:

The pet coke handling will be done in the same system that of coal. In order to limit spread of dust, water sprinkling arrangements will be in place in the covered stockyard. Adequate dust extraction equipment will be installed at specific locations of high dust generation in transfer points.

Ash management:

The expected quantities of ash to be generated from the combustion of pet coke are, Fly ash: 64 TPH & Bed ash: 28 TPH. Only dry ash handling & management where in it is stored in silos. Ash in dry form is transferred from the hoppers to storage silos will be done through pneumatic conveying. The fly ash will be utilized for various purposes like brick making, additive to cement and additive to concrete. The bottom ash of CFBC boilers proposed will have minimum unburnt carbon and will prove suitable for use in cement manufacture as it will be clinkered to the required levels. Ash disposal will be carried out in closed type, top loaded, ash trucks.

4. Site Analysis:

Connectivity and land details:

RIL-DMD is located in the Dahej Industrial Area, notified by Gujarat Industrial Development Corporation at Dahej village near Dahej in Vagra Taluka of Baruch District. The Gazette notification declaring Dahej as notified industrial area is attached at **Annexure-C** and the plot plan showing the survey no. of the DMD complex is given on **Annexure-D**. The site is flanked by villages Ambheta, Jageshwar and Lakhigam. The far eastern and western side are surrounded by plains & coast line respectively. The proximity to port facilities off coast of Gulf of Khambhat are added advantages with respect to raw material unloading and product dispatches. The NH-8 connecting Ahmedabad & Mumbai is ~48 Km from the site. The nearest rail station is at Baruch situated ~48 km from the site. The CCPP is outside the CRZ area.

Climate of the area

At Dahej the climate is hot & humid, influenced by surrounding estuary and sea. The maximum temperature during summer and minimum temperature winter are 40^{o}C and 12^{o}C respectively. Predominant wind direction varied from South & South-West and North-East direction and average rainfall us about 1200 mm.

Soil Classification:

The soil at the project site can be classified as fine to medium fine i.e clayey. The clay content being in the range of 29.3-51.6%. The bulk density of the soil is between 1.14-1.26 gm/cm^3 and water holding capacity and porosity are in the range of 48.6-54.2% & 47.2-51.2% respectively. The pH of the soil is in the range of 8.40-8.88. The fertility status of the soil is poor.

5. Planning Brief:

The petrochemicals, polymers, polyesters and polyester intermediates plants at Dahej Manufacturing Division (DMD) of Reliance Industries Limited (RIL) require uninterrupted power and steam for their continuous manufacturing operations which is being provided by gas based captive cogeneration power plant. But due to uncertainty in availability of gas and cost, it is envisaged to generate steam & power by utilizing coal based generation in CCPP, which is under implementation. The present proposal is to convert fuel firing from Coal to Pet Coke.

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6. Proposed Infrastructure:

Approx. 38 ha of land within RIL-DMD complex is being utilised for setting up the CCPP. This includes plants and utilities, storage and administrative block. There is no residential area proposed. Conversion to pet coke as fuel will not require any additional construction redesigning of utilities than

those under implementation for the coal based plant. The RIL-DMD complex has a robust green belt and the same will be strengthened further in the CCPP area by planting native and tolerant species.

Fuel-Requirement, Availability & Transportation:

It is envisaged that pet coke required for the project will be imported through the jetty. Alternatively, it can also be brought the nearby jetties operating in the region. From the port, pet coke will be transferred to the site in closed conveyors. Pet coke may also be available from RIL Jamnagar refinery. During road transport pet coke will be brought in closed trucks. Limestone will also be brought in trucks.

Pet coke quantity:

Considering pet coke with gross calorific value (GCV) of 7895 kCal/kg and plant load factor of 100%, the annual pet coke requirement for Co-generation Plant works out to be about 1.47 Million Tonnes. The daily pet coke requirement with 100% PLF works out to about 4000 Tons for the capacity of 3 x 90 MW.

Other infrastructure facilities like access roads, housing facility for the construction staff with supply of water and electricity, community facilities viz. market, housing, construction power, health care etc. are already set up at DMD for other on-going operations.

7. Rehabilitation and Resettlement (R & R) Plan:

The CCPP project is coming up within the existing DMD complex area of Reliance Industries Limited in a vacant plot of land. There is no requirement of additional land and therefore no displacement of people involved.

8. Project Schedule & Cost Estimate:

The coal-based CCPP is under implementation at project site within DMD complex. No additional facilities required for the project to operate on pet coke as fuel.

9. Analysis of Proposal:

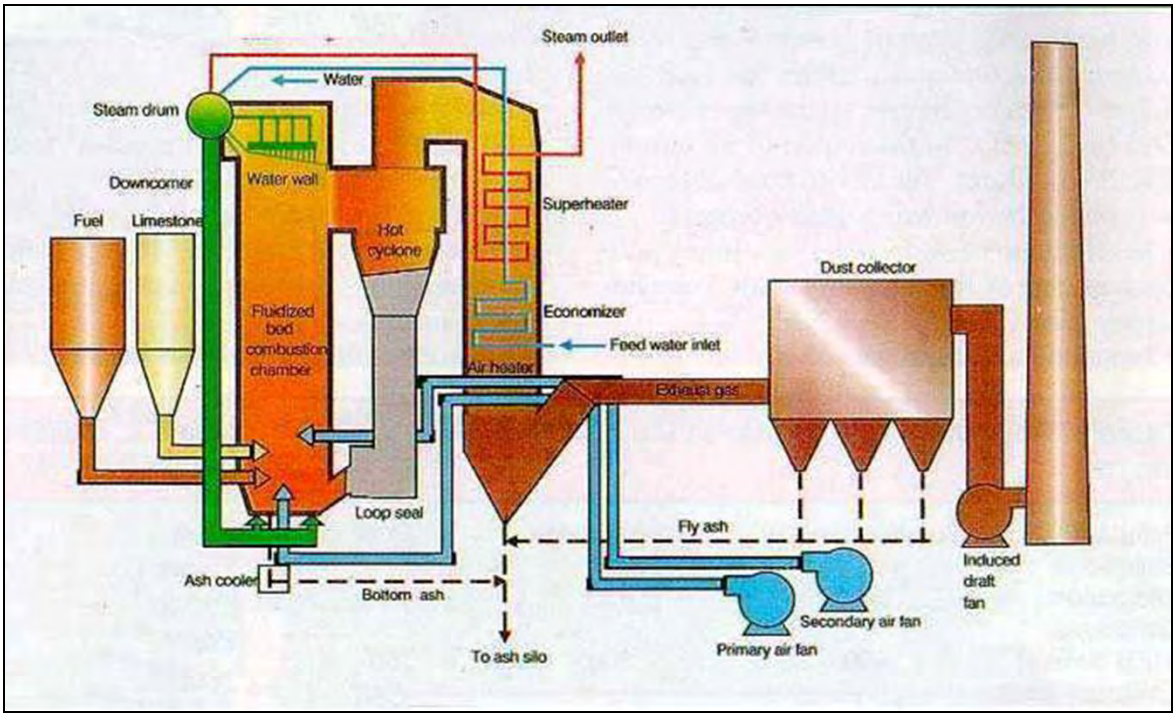
The pet coke based captive cogeneration power plant will ensure supply of power and steam at competitive cost, providing greater flexibility and viability to the Dahej Manufacturing operations in an environmentally responsive manner.

Annexure-A

Location of DMD plant

Annexure-B

Schematic of a CFBC boiler



Industrial Area Notification

Extra No. 209 REGISTERED No. G/GNR/2

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Separate paging is given to this Part in order that it may be filed as a Separate Compilation.

PART IV-B

Rules and Orders (Other than those published in Part I, I-A and I-L) made by the Government of Gujarat under the Gujarat Acts.

INDUSTRIES AND MINES DEPARTMENT

Notification

Sachivalaya, Gandhinagar, 9th June, 2009

Gujarat Special Investment Region Act, 2009.

No. GHU-17/SIR/112009/101492/I:—In exercise of the powers conferred by section 3 read with section 4 of the Gujarat Special Investment Region Act, 2009 (Guj. 2 of 2009), the Government of Gujarat hereby,--

(i) Declares the areas specified in column 4 of the villages and the talukas, as specified in column 3 and 2 of the Schedule appended to this notification, of the Bharuch district, as Special Investment Region which shall be known as "the Gujarat Petroleum, Chemicals and Petrochemicals Special Investment Region"; and

(ii) Determines the areas within the boundaries of revenue villages specified in column 4 of the said Schedule to be the geographical area of the said Special Investment Region, measuring 45298.59 Hectares in total.

SCHEDULE

Details of the areas, villages and talukas of the Bharuch district to be known as "The Gujarat Petroleum Chemical & Petrochemical Special Investment Region"

Sr. No.	Taluka	Village	Name of the Revenue Village			
1	2	3	4			
			Extent within PCPIR	Survey No.	Land Mark	Total Area of lands (in Ha.)
1	Vagra	Aragama	Partly	420-423 454-494 496-556 560	Boundary of Vilayat Estate	230.74
2	Vagra	Vorasamni	Partly	373-377 379-382 388-392	Boundary of Vilayat Estate	233.45

Sr. No.	Taluka	Village	Name of the Revenue Village			
1	2	3	4			
			Extent within PCPIR	Survey No.	Land Mark	Total Area of lands (in Ha.)
				403-404 408-499 500-599 600-661 820-833		
3	Vagra	Vilayat	Completely	All Survey Nos. 1-1239		1674.56
4	Vagra	Bhersam	Completely	All Survey Nos. 1-1014		1435.10
5	Vagra	Sayakha	Completely	All Survey Nos. 1-410		1567.71
6	Vagra	Kothia	Completely	All Survey Nos. 1-233		606.26
7	Vagra	Vahiyal	Partly	1-43 48 50-717 721-747	Survey numbers below Railway Line	1778.26
8	Vagra	Pipalia	Partly	1-69 83-320	Survey numbers below Railway Line	424.61
9	Vagra	Pakhajan	Partly	1-3 39-528	Survey numbers below Railway Line	1038.66
10	Vagra	Nadarkha	Partly	1-119 213-248	Survey numbers below Railway Line	306.42
11	Vagra	Sambheti	Partly	1-5 10 25-166	Survey numbers below Railway Line	226.58
12	Vagra	Janiadara	Partly	18-55 300-399 400-427 248-256 262-299	Survey numbers below Railway Line	311.79
13	Vagra	Akhod	Completely	All Survey Nos. 1-233		562.27
14	Vagra	Nandida	Completely	All Survey Nos. 1-604		1222.80
15	Vagra	Sadathala	Completely	All Survey Nos. 1-149		449.76
16	Vagra	Khojbal	Completely	All Survey Nos. 1-427		1222.53
17	Vagra	Bhensali	Completely	All Survey Nos. 1-265		563.47
18	Vagra	Atali	Completely	All Survey Nos. 1-384		1082.73
19	Vagra	Galenda	Completely	All Survey Nos. 1-259		579.18
20	Vagra	Samatpor	Completely	All Survey Nos. 1-138		293.05
21	Vagra	Vav	Partly	All Survey Nos. 1-247	Survey numbers below Railway line	321.34
22	Vagra	Jolva	Completely	All Survey Nos. 1-256		874.81
23	Vagra	Vadadla	Completely	All Survey Nos. 1-297		685.87
24	Vagra	Dahej	Completely	All Survey Nos. 1-994		3670.10
25	Vagra	Lakhigam	Completely	All Survey Nos. 1-775		1061.73
26	Vagra	Luvara	Completely	All Survey Nos. 1-290		895.81

Sr. No.	Taluka	Village	Name of the Revenue Village			
1	2	3	4			
			Extent within PCPIR	Survey No.	Land Mark	Total Area of lands (in Ha.)
27	Vagra	Jageshwar	Completely	All Survey Nos. 1-51		1272.32
28	Vagra	Ambheta	Completely	All Survey Nos. 1-544		3745.21
29	Vagra	Suva	Completely	All Survey Nos. 1-779		1431.58
30	Vagra	Rahiad	Completely	All Survey Nos. 1-951		1441.92
31	Vagra	Koliad	Completely	All Survey Nos. 1-235		3727.68
32	Vagra	Vengani	Completely	All Survey Nos. 1-160		441.87
33	Vagra	Kaladara	Completely	All Survey Nos. 1-443		1739.03
34	Bharuch	Amleshwar	Partly	1-797 850-894 934-966 968 984-987 1002-1006 1009-1062		1971.14
35	Bharuch	Bhuva	Completely	All Survey Nos. 1-315		348.42
36	Bharuch	Eksal	Completely	All Survey Nos.		793.04
37	Bharuch	Kesrol	Completely	All Survey Nos. 1-262		581.11
38	Bharuch	Navetha	Completely	All Survey Nos. 1-180		457.97
39	Bharuch	Manad	Completely	All Survey Nos. 1-239		1061.87
40	Bharuch	Mahegam	Completely	All Survey Nos. 1-157		560.82
41	Bharuch	Bhadbhut	Completely	All Survey Nos. 1-208		909.37
42	Bharuch	Kasva-Samni	Completely	All Survey Nos. 1-256		613.74
43	Bharuch	Vadva	Completely	All Survey Nos. 1-95		380.90
44	Bharuch	Sankhwad	Completely	All Survey Nos. 1-199		501.01
						45298.59

By order and in the name of the Governor of Gujarat,

MAHESHWAR SAHU,
Principal Secretary to Government.

Annexure-D

Map showing the GIDC plot Number of DMD