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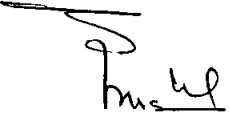
June 4, 2021

Chief Executive Officer K-Electric Limited (KEL) KE House, Punjab Chowrangi, 39 – B, Sunset Boulevard, Phase-II Defence Housing Authority Karachi.	Chief Executive Officer Sindh Nooriabad Power Company (Pvt.) Ltd. (SNPCL-II) # 23-A/II, Mohammad Ali Jauhar Memorial Cooperative Housing Society, Karachi Tele: 021 – 3454 0235, 3454 0236 Cell # 0323 – 855 7744
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Subject: **Order of the Authority in the matter of Approval of Capacity and Heat Rate for Sindh Nooriabad Power Company Ltd. (SNPCL-II)**

Enclosed please find herewith the subject Order of the Authority (07 Pages) in the matter of Approval of Capacity and Heat Rate for Sindh Nooriabad Power Company Ltd. (SNPCL-II) for information, record and further necessary action.

Encl: As above


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(Syed Safer Hussain)

**ORDER of the Authority in the matter of Approval of Capacity and Heat Rate for Sindh
Nooriabad Power Company Ltd. SNPCL-II**

Introduction:

SNPCL-II is a generation facility having approximately 50MW capacity at Nooriabad, Sindh Province, Pakistan. The facility sells power to K-Electric. The power plant comprises 5 Wartsilla W20V34SG gas fired engines having capacity of app. 9.73MW each and a Steam Turbine of 3.44MW capacity.

Background:

2. The Authority in the matter of review motion filed by SNPC-II decided as follows: (Paragraph – ORDER 8.A)

All the relevant tariff components shall be adjusted at the time of COD based upon the Initial Dependable Capacity Test to be carried out for determination of net dependable capacity in case the capacity is established higher than 50.5312 MW; however, no adjustment shall be made if the capacity comes out less than 50.5312 MW

The allowed tariff has been worked out on the basis of minimum net efficiency of 43.66% (net HHV at mean site conditions). Based upon the test of the complex to be carried out at the time of COD by an Independent Engineer in presence of NEPRA officials, the reference fuel cost component of tariff shall be adjusted, provided that the combined auxiliary and transformer losses are lower or equal to 3% [Ref: Decision dtd. August 4, 2017 - Paragraph Order 8.A)

Objective of Performance (Capacity and Heat Rate) Test:

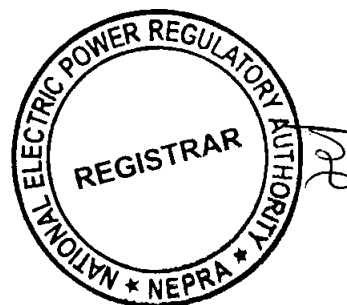
3. The main objective of this test as required by NEPRA was to evaluate the thermal performance (heat rate/thermal efficiency) and capacity of the plant on HHV and LHV as per ASME PTC-46 and other applicable standards in the following plant configurations:

- i. Combined Cycle Mode
- ii. Open cycle Mode

Miscellaneous Additional Scope:

4. As communicated by NEPRA to SNPC vide its letter dated Nov 14, 2019 and subsequent meetings, the detailed test results/report, was required to include clear observations, analysis, conclusion and useful recommendations by IE.

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Test Standards:

5. The guidelines of following applicable standards were followed while preparing test procedure, conducting and evaluating the Heat Rate and Capacity test:

- ASME PTC 46
- ISO- 15550
- ISO 30456-1
- ISO 3046-3

Performance (Capacity and Heat Rate) Tests (October 22 & 23, 2020):

6. Pursuant to approved test procedure, the performance tests in different plant configuration were conducted on October 22 (Simple cycle) and October 23, 2020 (combined cycle).

7. For the performance test, the readings were recorded manually at 15 minute intervals to be used for calculations.

Calculations of Calorific Values (LHV/HHV) of Gas fuel by IE:

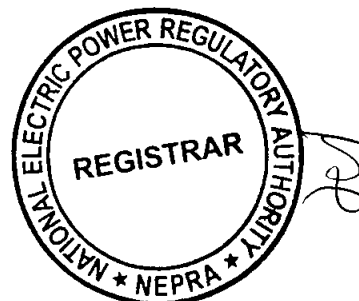
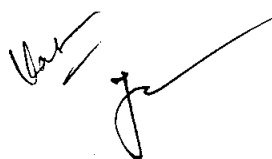
8. LHV and HHV values for the gas was taken from SSGC chromatograph. Additionally, the gas samples were also taken by Independent party for analysis. IE has submitted the values and analysis in its report.

Simple Cycle Test (22.10.2020)

	Average Value during test period (BTU/ft ³ @ 14.65 psia and 60°F)	Third party analysis result (BTU/ft ³ @ 14.65 psia and 60°F)
LHV	996.9	985.8
HHV	900.4	889.4

Combined Cycle Test (23.10.2020)

	Average Value during test period (BTU/ft ³ @ 14.65 psia and 60°F)	Third party analysis result (BTU/ft ³ @ 14.65 psia and 60°F)
LHV	996.1	986.5
HHV	899.7	890.7



Test Results:

9. Following are the results of test regarding capacity and heat rate of SNPC-II as prepared by the IE and forwarded by SNPC-II to NEPRA, dated Jan 29, 2021 (results representing test day).

Results (Capacity and Heat Rate) of Performance Test:

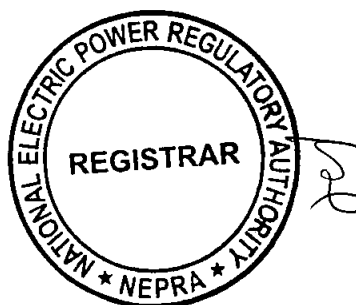
Simple Cycle

Sindh Nooriabad Power Co. II (SNPC-II)			
P_{net}	Net Electrical Capacity during test	48 039	kW
P_{gross}	Gross Electrical Capacity during test	48 589	kW
η_1	Heat rate at net energy dispatch (HHV)	8 754	Btu/kWh
η_2	Heat rate at net energy dispatch (LHV)	7 907	Btu/kWh
η_3	Heat rate at gross energy generation (HHV)	8 655	Btu/kWh
η_4	Heat rate at gross energy generation (LHV)	7 818	Btu/kWh
η_1	Net Specific fuel consumption rx1	2.57	kWh/kWhe
η_2	Net Specific fuel consumption rx2	2.32	kWh/kWhe
η_3	Net Specific fuel consumption rx3	2.54	kWh/kWhe
η_4	Net Specific fuel consumption rx4	2.29	kWh/kWhe

Combined Cycle

Sindh Nooriabad Power Co. II (SNPC(II))			
P_{net}	Net Electrical Capacity during test	51 216	kW
P_{gross}	Gross Electrical Capacity during test	51 952	kW
η_1	Heat rate at net energy dispatch (HHV)	8 216	Btu/kWh
η_2	Heat rate at net energy dispatch (LHV)	7 420	Btu/kWh
η_3	Heat rate at gross energy generation (HHV)	8 100	Btu/kWh
η_4	Heat rate at gross energy generation (LHV)	7 315	Btu/kWh
η_1	Net Specific fuel consumption rx1	2.41	kWh/kWhe
η_2	Net Specific fuel consumption rx2	2.17	kWh/kWhe
η_3	Net Specific fuel consumption rx3	2.37	kWh/kWhe
η_4	Net Specific fuel consumption rx4	2.14	kWh/kWhe

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Analysis:

10. Pursuant to the instructions of the Authority, the IE carried out the performance (capacity and heat rate) tests of SNPC-II as per ASME PTC 46 and other relevant standards / code - these were also witnessed by the NEPRA representatives. It may be noted that earlier NEPRA approved capacity and heat rates/efficiency for SNPC-II, which were 50.5312MW and efficiency of 43.66% (net HHV) were provisional (to be trued up at COD on basis of certain conditions)

11. SNPC-II submitted IE's report to NEPRA dtd. Jan 29, 2021. The Authority noted that the SNPC-II plant achieved COD in Jan. 2018, however, the test was conducted in October 2020. Therefore, pursuant to earlier directions of the Authority [August 2017], IE was directed to use the results of the current test and to evaluate / derive the numbers in respect of Heat Rate and capacity at COD of the plant. Further, IE was required to provide loss & auxiliary calculations, true reflection of Operating Hours in degradation curves, etc. IE fulfilled the requirements, and provided NEPRA with the required analysis vide correspondence dated April 6, 2021.

Capacity:

12. IE in its report has evaluated a net capacity of 51.216MW on test day. Further, IE has reported an avg. operating hours of 22,000 on test day. Correspondingly, using IE's degradation curve and the evaluated net capacity determined in the test - the net capacity of the plant (SNPC-II) at COD is analysed as 51.526MW against the provisionally determined net dependable capacity of 50.5312MW.

Net Capacity for SNPC-II at COD	51.526MW
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Heat Rate:

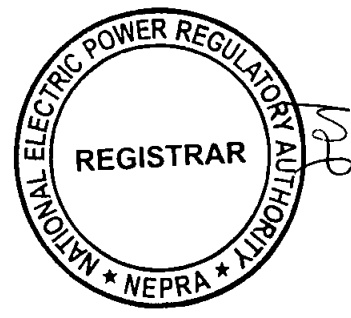
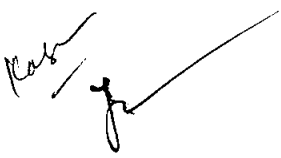
13. The results of the test are as follows:

HR (HHV) as evaluated by IE: 8216 BTU/kWh (41.53%).

14. IE was further required to provide its opinion about efficiency/ Heat Rate corresponding to COD on the basis of tested results. IE in response dated April 2021 stated as follows:

1. With respect to Heat rate, the correction curves against ageing dictate the maximum deviation in Heat Rate that could occur at specific operating hours. With reference to correction curves presented in appendix C, the evaluated heat rate for current test can be reflected for COD anywhere between;

- 7420 Btu/kWh ~ 7355.3 Btu/kWh for SNPC-II – Net Heat rate at LHV
- 8216 Btu/kWh ~ 8144.3 Btu/kWh for SNPC-II – Net Heat rate at HHV



Average Operating hours on test date: 22000 hrs
Maximum Permanent degradation till test date: 0.5 %
Maximum Recoverable degradation on Test date: 0.38 %

Above ranges are based on the maximum degradation that could occur over the period of 22,000 RHRs. However, in practice the actual degradation for the new engines usually remain below this maximum limit. As test results for Jan 2018 are in accordance with above range, hence can be considered as COD results which are as under:

- 7400 Btu/kWh for SNPC-II – Net Heat rate at LHV
- 8196 Btu/kWh for SNPC-II – Net Heat rate at HHV

15. The Authority noted that the test was conducted in October 2020; however, the COD of the plant was in Jan. 2018. Therefore, adjustment needs to be made for evaluating Heat Rate at the time of COD. Using Heat Rate number vis-a-vis Operating hours and degradation curve the Heat Rate at the time of COD is evaluated as 8143.699 corresponding to 41.90% efficiency.

16. It is noted that the above analysis of IE also corroborates the Heat Rate number as evaluated by the Authority.

Degradation and Part Load Adjustment:

17. The earlier direction of the Authority [decision dated August 2017] on compensation for degradation and part load adjustment was as follows:

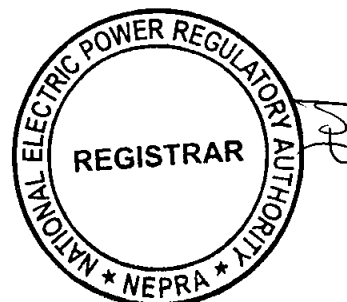
The compensation of degradation and part load adjustment shall be allowed at the time of COD on submission of such curves as provided by Original Equipment Manufacturer ("OEM") [Ref: Decision dtd. August 4, 2017 - Paragraph Order 8.A)

18. In view of compensation for degradation, the Authority notes that IE has confirmed that *"degradation curves are based on standard data/information as provided by OEM"*. In this regard and in view of the above direction of the Authority [Aug. 2017] on the matter, the degradation curves are allowed. Regarding part load, the Authority notes that the subject plant occupies a priority dispatch position in economic merit order and further that its actual annual utilization in last two years is around 7700-7900 running hours RHRs. Further that the plant comprises small size engine sets of around 9MW capacity, therefore, in view of Authority, it is not practicable / expedient to allow part load adjustment.

19. It is highlighted that the Authority while allowing an efficiency of 43.66% (net HHV) in its decision dated August 2017 also made it conditional that downward adjustment will only be allowed *'provided that the combined auxiliary and transformer losses are lower or equal to 3%.'*

20. Regarding auxiliary and transformer losses, IE has evaluated the same as:

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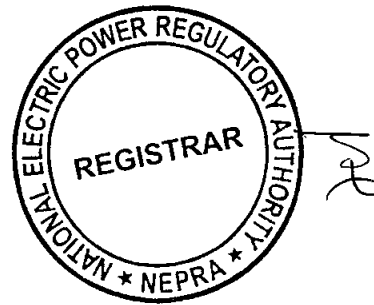
SINDH NOORIABAD POWER CO. II (SNPC-II)

Combined Cycle test results

P_{net}	Net Electrical Capacity during test	51 216	kW
P_{gross}	Gross Electrical Capacity during test	51 952	kW
	Auxiliary + Transformer losses	736	kW
	Auxiliary + Transformer losses as percentage of P_{gross}	1.42	%

20. Since the combined auxiliary and transformer losses have been noted to be less than 3%, therefore the Heat Rate as worked out for COD (on the basis of the test) is acceptable.

Recommended Heat Rate net HHV - (Btu / kWh)	Corresponding Efficiency (%)
8143.699	41.90%



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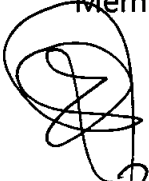
DECISION OF THE AUTHORITY:

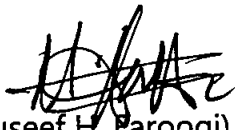
Based on the Heat Rate tests conducted by the Independent Engineer for SNPC-II, the Authority decides as following:

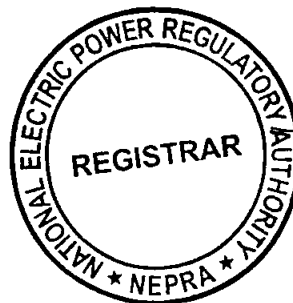
- i. The net capacity corresponding to COD for SNPC-II as **51.526MW**.
- ii. The Heat Rate corresponding to COD as **8143.699** Btu/kWh - net HHV equivalent to 41.90% efficiency. This heat rate will be applicable along with the degradation curve based on operating Hours (OHs), without any additional adjustment for other parameters.
- iii. SNPC-II is required to conduct maintenance including Major Overhaul of its plants / units as per prudent utility practices and recommendations of OEM.

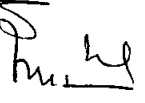

(Engr. Madsood Anwar Khan)
Member


(Rafique Ahmed Shaikh)
Member


(Rehmatullah Baloch)
Member
22/6/21


(Tauseef H. Parooqi)
Chairman




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