

# Required Training for Flexible Operation of Coal Fired Power Plants in India



Partner:

Supported by:

---

## **Imprint**

---

### **Commissioned by**

Excellence Enhancement Centre for Indian Power Sector (EEC)  
West Block - 2, First Floor  
Wing No. 5, Sector 1, R.K. Puram  
New Delhi 110066, India  
Email: [info@eecpowerindia.com](mailto:info@eecpowerindia.com)  
Website: [www.eecpowerindia.com](http://www.eecpowerindia.com)  
Tel.: +91 11 26164297 - 95

Indo-German Energy Forum Support Office  
c/o Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH  
1st Floor, B-5/2, Safdarjung Enclave  
New Delhi 110 029, India  
Email: [info@energyforum.in](mailto:info@energyforum.in)  
Website: [www.energyforum.in](http://www.energyforum.in)  
Tel.: +91 11 4949 5353

Project lead: O.P. Maken, Tobias Winter

### **Report by:**

KRAFTWERKSSCHULE E.V.  
Deilbachtal 199  
D-45257 Essen, Germany  
Website: [www.kraftwerksschule.de](http://www.kraftwerksschule.de)

### Contact:

Dr.-Ing. Dariush Hourfar, KWS Essen  
Dipl.-Ing. Hans-Werner Otte, KWS Essen

### **Version**

Essen, 09<sup>th</sup> June 2017; Rev. 1.2

All rights reserved. Any use is subject to consent by Indo-German Energy Forum Support Office (IGEF). All content has been prepared with the greatest possible care and is provided in good faith. IGEF provides no guarantee regarding the currency, accuracy and completeness of the information provided. IGEF accepts no liability for damages of a tangible or intangible nature caused directly or indirectly by the use of or failure to use the information provided, unless IGEF can be proven to have acted with intent or gross negligence.

## Content

<b>1</b>	<b>Preface .....</b>	<b>2</b>
<b>2</b>	<b>Concept and methods of training .....</b>	<b>3</b>
2.1	Operating personnel qualification requirements .....	3
2.2	Assessment of participants .....	4
2.3	Groups of training participants and general training objectives.....	5
2.3.1	Management personnel.....	5
2.3.2	Operating staff.....	5
2.3.3	Technical staff.....	6
2.3.4	Operations and grid coordinators and Maintenance Coordinators.....	6
2.4	The four components of implementation measures .....	7
2.4.1	Training .....	7
2.4.2	Follow-up.....	7
2.4.3	Qualification and Competence Development Programs.....	7
2.4.4	Lessons learnt for the future.....	7
2.5	Training and instruction methodology .....	12
2.5.1	Faculty training for Indian Trainers .....	12
2.6	Training objectives recommended for this project .....	13
2.7	Training materials - handouts.....	16
2.8	Proposal for the categorization of Indian power plants into four service groups .....	16
2.9	Learning tests .....	18
<b>3</b>	<b>Quality management system and methodology.....</b>	<b>20</b>
3.1	Conducting and Controlling.....	20
3.2	Quality Cycle.....	21
3.2.1	PDCA.....	21
3.3	Three Stage approach .....	22
3.3.1	Project Controlling (Stage 1) .....	23
3.3.2	Personnel Development Controlling (Stage 2) .....	24
3.3.3	Conduction and performance Controlling (Stage 3) .....	24
<b>4</b>	<b>Training Modules .....</b>	<b>26</b>
4.1	Preparation Modules .....	26
4.1.1	Boiler Design and Firing System .....	26
4.1.2	Design and Operation.....	28
4.1.3	Steam Turbine System .....	29
4.1.4	Electrical Systems .....	30
4.1.5	Renewable Energy Systems and feed-in behavior .....	36
4.1.6	Electricity Market and Generation Cost .....	38
4.2	Flexibility Modules.....	39
4.2.1	Boiler Operation .....	39
4.2.2	One Mill Operation .....	42
4.2.3	Electrical operations under extraordinary load and outage conditions .....	43
4.2.4	Maintenance Procedures and Strategies .....	47
4.3	Simulator Modules.....	49
4.4	Competency Modules .....	53
4.4.1	Maintenance Procedures and Strategies .....	53
4.4.2	Grid Coordination .....	55
4.4.3	Train the Trainer .....	57
4.4.4	Instruct the Trainer.....	58
<b>5</b>	<b>Recommendations, next Steps and way forward .....</b>	<b>60</b>
<b>6</b>	<b>List of Figures .....</b>	<b>61</b>
<b>7</b>	<b>Annex.....</b>	<b>64</b>