مركز المستشار الوطني للتدريب
National Consultant Centre For Training
YOUR GATE TO HANDS-ON TRAINING

5-Day Cement Industry Training Course
In

BALL AND VERTICAL MILLS MECHANICS

Dubai - UAE, 05 – 09 Jan. 2026

COURSE LEVEL: ADVANCED

COURSE OVERVIEW:

The mechanics of grinding systems are fundamental to the efficiency and productivity of cement manufacturing. This course defines the mechanical principles governing both ball mills and vertical roller mills (VRM), focusing on their design, structural integrity, and operational dynamics. By exploring the engineering behind these massive machines, participants will understand how to optimize the reduction of raw materials and clinker into fine powders.

The scope of this training is deeply technical, covering the components of the mill drive systems, including motors, gearboxes, and girth gears. It details the internal mechanics of ball mills, such as liner design and grinding media distribution, as well as the hydraulic systems and roller assemblies of vertical mills. The course also addresses the mechanical stresses, vibrations, and lubrication requirements that are critical for preventing equipment failure and extending the operational life of the machinery.

Coverage includes advanced diagnostic techniques for mechanical health monitoring, such as vibration analysis and thermography. Participants will learn about the maintenance of bearings, seals, and cooling systems, as well as the procedures for mill inspections and internal repairs. By the end of the course, attendees will be equipped with the knowledge to manage mill performance, minimize downtime, and execute precise mechanical adjustments to ensure continuous and efficient grinding operations.

COURSE OBJECTIVES:

After completion of this course, the participants will be able to:

- Explain the mechanical operating principles of ball mills and vertical roller mills.
- Identify and describe the function of all major mill components and assemblies.
- Analyze the load distribution and power transmission in large mill drives.
- Evaluate the design and wear patterns of mill liners and grinding media.
- Maintain and troubleshoot hydraulic systems used in vertical roller mills.
- Perform precision alignment of mill shafts, gearboxes, and couplings.
- Interpret vibration data to diagnose mechanical imbalances or bearing defects.
- Manage lubrication systems to ensure optimal performance of heavy-duty bearings.
- Implement effective preventive and predictive maintenance schedules for mills.
- Describe the procedures for safe internal mill inspections and liner replacement.
- Calculate mill efficiency based on mechanical inputs and material throughput.

- Solve complex mechanical issues related to mill vibration and heat generation.

TARGET AUDIENCE:

This course is designed for Mechanical Engineers, Maintenance Managers, Mill Supervisors, Reliability Engineers, and Senior Technicians responsible for the upkeep and optimization of grinding equipment.

TRAINING COURSE METHODOLOGY:

A highly interactive combination of lectures, discussion sessions, and case studies will be employed to maximize the transfer of information, knowledge, and experience. The course will be intensive, practical, and highly interactive. The sessions will start by raising the most relevant questions and motivating everybody to find the right answers. The attendants will also be encouraged to raise more of their questions and to share in developing the right answers using their analysis and experience. There will also be some indoor experiential activities to enhance the learning experience. Course material will be provided in PowerPoint, with necessary animations, learning videos, and general discussions.

The course participants shall be evaluated before, during, and at the end of the course.

COURSE CERTIFICATE:

National Consultant Centre for Training LLC (NCC) will issue an Attendance Certificate to all participants completing a minimum of 80% of the total attendance time requirement.

COURSE OUTLINE / COURSE CONTENT:

MODULE 1: PRINCIPLES OF COMMINUTION AND GRINDING

- Physics of size reduction: impact, attrition, and compression.
- Energy consumption and efficiency in different mill types.
- Comparing the mechanical advantages of ball mills versus VRMs.
- Material characteristics affecting grindability and wear.
- Overview of the grinding circuit and material flow.

MODULE 2: BALL MILL STRUCTURE AND COMPONENTS

- Design of the mill shell, head plates, and trunnions.
- Types of mill bearings: slide bearings versus anti-friction bearings.
- Drive arrangements: central drive, girth gear, and pinion systems.
- Diaphragm design and its role in material and gas flow.
- Sealing systems for preventing dust leakage and air ingress.

MODULE 3: BALL MILL INTERNALS: LINERS AND MEDIA

- Functions of lifting, classifying, and grinding liners.
- Materials and alloys used for high-wear resistance.
- Grinding media: ball size distribution and charging levels.
- Estimating liner wear rates and planning replacement cycles.

- Impact of mill speed (critical speed) on grinding mechanics.

MODULE 4: VERTICAL ROLLER MILL (VRM) MECHANICS

- Design of the grinding table and roller assemblies.
- The function of the rocker arm and pivot systems.
- Interaction between the roller and the material bed.
- Adjusting the dam ring height for optimal material retention.
- Mechanical design of the integrated high-efficiency classifier.

MODULE 5: HYDRAULIC AND TENSIONING SYSTEMS IN VRMS

- Components of the hydraulic power unit (HPU).
- Nitrogen accumulators and their role in shock absorption.
- Controlling the grinding pressure for different materials.
- Maintenance and troubleshooting of hydraulic cylinders and valves.
- Safety procedures for working with high-pressure hydraulic systems.

MODULE 6: MILL DRIVE SYSTEMS AND GEARBOXES

- Construction and maintenance of planetary and lateral gearboxes.
- Lubrication requirements for high-torque gear systems.
- Cooling systems for gearbox oil and motor windings.
- Auxiliary drives and their use during maintenance and start-up.
- Monitoring gearbox health through oil analysis and temperature.

MODULE 7: LUBRICATION TECHNOLOGY FOR GRINDING MILLS

- Properties of industrial lubricants: viscosity and additives.
- Centralized lubrication systems: operation and monitoring.
- High-pressure jacking oil systems for mill start-up.
- Managing oil contamination and filtration systems.
- Grease lubrication for open gears and girth gears.

MODULE 8: VIBRATION ANALYSIS AND CONDITION MONITORING

- Fundamental concepts of vibration in rotating machinery.
- Setting vibration limits and alarms for mills and fans.
- Identifying misalignment, unbalance, and looseness.
- Using ultrasonic testing for detecting bearing failures.
- Case studies on preventing catastrophic mill failures through monitoring.

MODULE 9: MECHANICAL ALIGNMENT AND TOLERANCES

- Tools and techniques for laser and dial indicator alignment.
- Managing thermal expansion in mill shafts and supports.
- Girth gear and pinion alignment and backlash adjustment.
- Leveling and grouting of mill foundations.
- Standards for mechanical tolerances in heavy machinery.

MODULE 10: MAINTENANCE PLANNING AND OVERHAULS

- Developing a preventive maintenance program for mills.
- Planning and executing a major liner or roller change-out.
- Tooling and lifting equipment required for mill maintenance.
- Spare parts management for critical mill components.
- Shutdown coordination between mechanical and process teams.

MODULE 11: TROUBLESHOOTING MECHANICAL FAILURES

- Root cause analysis (RCA) of bearing and gear failures.
- Solving issues of excessive mill vibration and noise.
- Addressing cracks in the mill shell or table.
- Dealing with lubrication leaks and seal failures.
- Best practices for emergency mechanical repairs.

MODULE 12: SAFETY AND FUTURE TRENDS IN MILLING

- Specific safety hazards: falling media and confined spaces.
- Innovations in wear-resistant materials and coatings.
- Remote monitoring and digital twins for mill maintenance.
- Energy-saving mechanical modifications for existing mills.
- Final review and certification of participants.