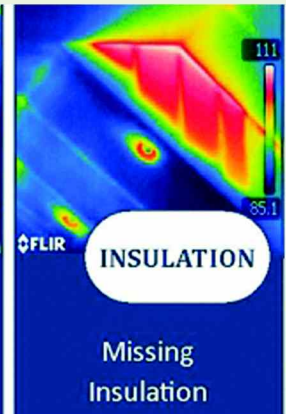
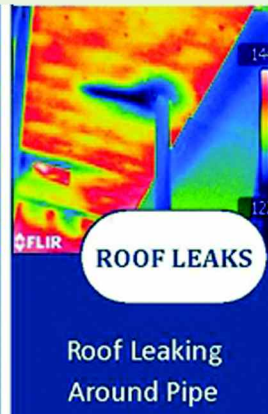
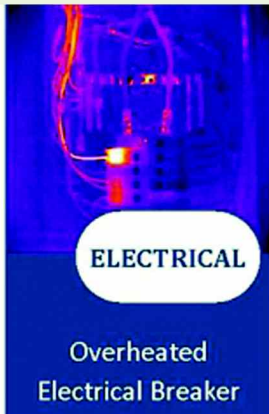
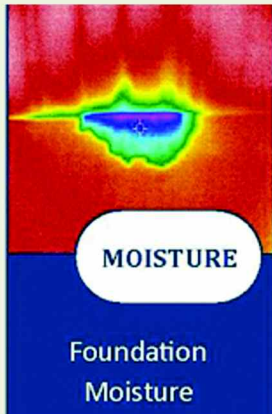
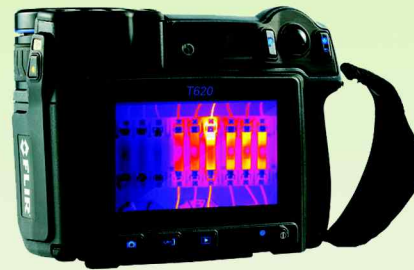




# Condition Based Maintenance

*(Leadership through Asset Management)*

Benefiting government, industry and the public through innovative science and technology



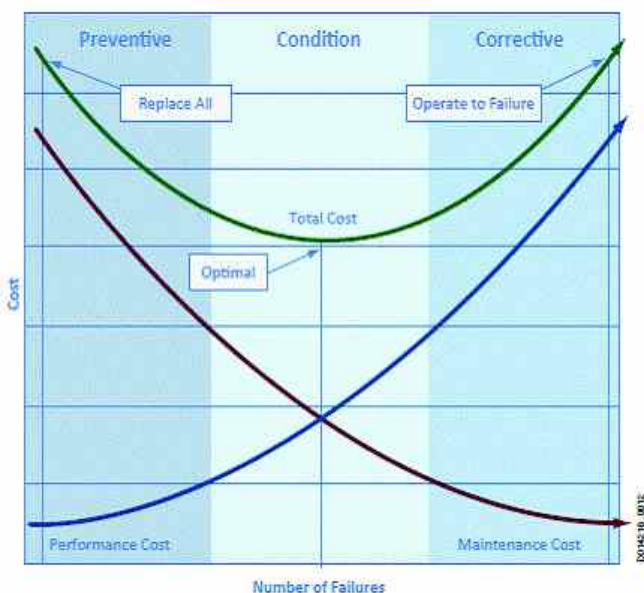
**Indian Institute for Production Management**  
 (Promoted by ICICI Bank, L&T, SAIL & Govt. of Odisha)  
 Kansbahal, Near Rourkela, Sundargarh, Odisha-770034  
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## About the Institute

Indian Institute for Production Management, Popularly known as **iiPM Kansbahal** is a distinguish corporate promoted Techno - Managerial Institute of the country, which has always set a new benchmarking in the field of Training, Education, Research and CBM which is only replicated by others. It is still leading in Training, Education and Research & CBM sectors through its unmatched expertise, experience for over three decades and dedicated team players. It's in early 80's when business and industry had just realized that **"Training is not a cost, it is an investment"** and education sector was feeling the germane of global standards, iiPM show its first light in a small, yet significant place called Kansbahal on 24 October 1983 in the landscape of mineral rich Sundargarh District, near Rourkela (Industrial capital of Odisha). The distinguished corporate houses along with the State Government are its promoters which includes ICICI Bank, Larsen and Turbo Limited (L&T). SAIL and Usha Martin have supported the ambition with full of their spirit. The campus is of 37 acres of lush green area and hilly view creates an ambience for vibrant learning environment.

The Institute has moved a long way imparting

***Interpreting the language of industrial machinery for over 35 years.***



***CBM optimizes costs between preventive and corrective maintenance.***

training to the foremen, techno-managerial solutions to the Industry and Business as a whole. The organization spreads its wing to a complete Training, Research (CBM) and Education hub and renamed as **Indian Institute for Production Management (iiPM)** in the year 1995. The institute has been transformed itself to the most preferred solution for up-keeping their Man & Machine since more than last three decades.

PRODUCTIVITY is a key strategy for each & every manufacturing companies to stay competitive in this continuously growing global market. Increased availability of production equipment is crucial for competitiveness and, to achieve increased availability, a good maintenance strategy is necessary. Good maintenance is achieved by having few corrective maintenance tasks performed while the preventive maintenance is kept to a minimum. Condition based maintenance is one possible way of achieving this. **Vibration Analysis, Thermographic Analysis, Oil Analysis and Wear Debris Analysis (WDA)** are few of the condition monitoring techniques those were followed by IIPM CBM team to decode the industrial machineries' health condition.

### **Asset Efficiency Optimization**

An integrated condition monitoring programmes is a critical component of Asset Efficiency Optimization (AEO), a proven iiPM methodology that combines a broad range of strategic and tactical tools to help you achieve maximum asset effectiveness and efficiency. A customized AEO programme can include everything from training and logistics, to a full predictive maintenance (PoM) service contract with qualified manpower and technology to help maintain your plant-even remotely. AEO methodology, combined with our unmatched credentials in the field of condition monitoring, makes iiPM a uniquely qualified partner in your ongoing drive to reduce total costs of ownership.

**C**ondition-Based Maintenance (CBM) is a maintenance philosophy used by industry to actively manage the health condition of assets in order to perform maintenance only when it is needed and at the most opportune times. CBM can drastically reduce operating costs and increase the safety of assets requiring maintenance.

Corrective/reactive maintenance can have severe performance costs, and preventive / scheduled maintenance replaces parts before the end of their useful life. CBM optimizes the tradeoff between maintenance costs and performance costs by increasing availability and reliability while eliminating unnecessary maintenance activities.

Indian Institute of Production Management (iiPM) develops and implements technologies that enable CBM, including data acquisition systems, management and tracking software, and condition monitoring algorithms.

## CBM Components

**CBM components are an optimized mix of :**

- Maintenance technologies (diagnostics, prognostics)
- Reliability-centred maintenance (RCM)-based processes
- Enablers (total asset visibility)

## CBM Features

- **Data acquisition may involve various types of information :**
  - Vibration                      - Temperature
  - Pressure                        - Speed
  - Voltage / Current           - Stress / strain / shock
  - Position                         - Particulates count
- **Feature extraction calculations may involve :**
  - Fast Fourier Transform
  - Data filtering / smoothing
  - Temperature / Pressure ratio
  - Efficiency                      - Mass flow
- Detection algorithms alert users to potential problems and otherwise unknown failures.

- Diagnostic algorithms isolate failures to specific components or subsystems.
- Prognostic algorithms estimate remaining useful life based on past and future operational profiles and physics of failure models.
- Supervisory reasoning algorithms reconcile conflicting information and provide recommendations such as :
  - inspections                      - Repairs
  - Parts ordering                  - Equipment shutdown

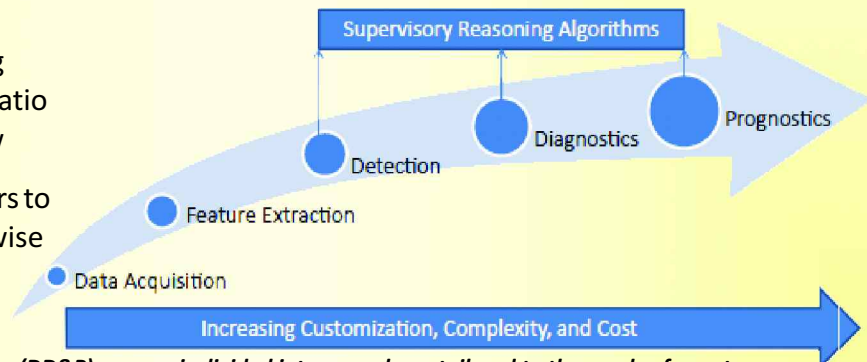
## CBM Implementation Vision

- Re-Define Equipment / Systems criticality in a holistic manner.
- Improve knowledge - develop skill-build up resources : Evolve own condition monitoring system as a gradual process.
- Re-cast your existing maintenance plan centering around MTBF-MTTR-FAILURE ANALYSIS-EFFECTIVE SOLUTION.
- Transit from Breakdown Maintenance - Minimise Scheduled Preventive Maintenance mode - Graduate to Condition Based Maintenance Mode.
- Find out ways for Horizontal deployment for your dept. plant as a whole.

## CBM Benefits

**The benefits of Implementing CBM include :**

- Increased system availability
- Increased system reliability
- Reduced Maintenance Costs & Efforts
- Reduced inventories
- Detects failure much in advance
- Ensures Quality & Safety
- Assess Imperfections & Improve system
- Assess Residual Life of Machines



*The Detection, Diagnostics and Prognostics (DD&P) process is divided into procedures tailored to the needs of a system.*

## OIL ANALYSIS & WDA

Operation problems in machines, engines and other components are often reflected in quality condition of the lubricant oil being used. Regularly scheduled lubricant analysis can identify mechanical problems before they impact the efficient running of machinery, avoiding costly headaches later on. Lubricants have to work under demanding conditions, exposed to constant high pressures, temperatures and other harmful factors, including water contamination, corrosion, raw fuel, and air ingested particles. Scheduled lubricant quality testing and expert advice can avoid and mitigate costly component or system failures and unscheduled maintenance.



A Powerful Technique which predicts the internal condition of the machine in a nonintrusive way by the study of worn particles. A small sample of lubricating oil or grease is needed to prepare a slide on a glass plate for examination under a powerful microscope with the help of various light conditions. The shape, size, texture, color and concentration indicate the machine as well as the oil status. Physical and chemical properties tests along with microscopic examination reveals the oil condition and its usability.

### WDA Benefits

<p><b>EXTEND THE LIFE OF LUBRICANT</b> Lubrication can be expensive and resource intensive to replace-especially in plant that is expected to operate 24/7. Extending the life of lubricants can reduce lubrication interventions and therefore decrease.</p>	<p><b>EXTEND SERVICE LIFE OF MACHINERY</b> By changing oil "on condition". You can ensure that the machines lubricant is always performing at its best to reduce wear in the moving parts and lengthen intervals between overhauls and end of useful life.</p>	<p><b>REDUCE DOWNTIME RISK</b> Many businesses use oil analysis to help avoid costly breakdowns by giving them a view of potential failures before they occur. Using this knowledge to schedule in corrective maintenance during scheduled downtime or non-peak running reduces your risk exposure to failures greatly.</p>
<p><b>EQUIPMENT FAILURE DETECTION AND PREDICTION</b> Oil analysis can show you what wear or damage is occurring inside your machines without strip downs or overhaul. It often allows you to see the rate of degradation (with a series of samples taken over time) and therefore decide what the optimum moment will be for intervention.</p>	<p><b>REDUCE MAINTENANCE</b> If you can "see" what wear is occurring inside your machines and determine where, you can target your maintenance accordingly rather than overhauling the whole machine. Oil analysis is a main component of an "on condition" maintenance regime.</p>	<p><b>RESOURCE OPTIMISATION</b> Using predictive and on-condition maintenance techniques such as oil analysis allows you to utilize your maintenance team better. They spend more of their time ensuring that machines keep running, rather than just reacting when they fail.</p>

### Why oil Analysis:

Oil analysis of lubricants, is a vital tool in avoiding costly failures and ensuring a long life for your machinery and equipment.

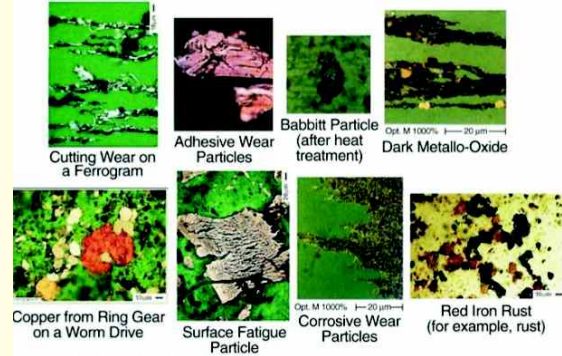
#### The four main components of condition monitoring are:

1. Analysis for wear metals to provide an indication of the mechanical condition of the unit and allow early detection of faults.

- Physical testing to detect the presence of contaminants which can indicate problems (e.g. Fuel or water in engine oil and/or cross contamination of lubricants). Test cleanliness of oils to ISO 4406 and NAS 1638.
- Assessment of the condition of the oil to estimate its remaining service life and allow cost effective top up rather than an unnecessary oil change.
- Analysis of the oil to ensure that the correct type and grade have been used and that the appropriate additives are present.

### Scope of WDA:

- ❖ DETERMINES WHEN ABNORMAL WEAR HAS BEGUN
- ❖ DETERMINES ROOT CAUSE OF WEAR/FAILURE
- ❖ DETERMINES WHICH COMPONENT IS FAILING
- ❖ DETERMINES REQUIREMENT OF LUBRICANT REPLACEMENT
- ❖ DETERMINES SUITABILITY OF LUBRICANT
- ❖ DETERMINES SEAL/FILTER CONDITION
- ❖ MACHINE CONDITION INDEX™



### Lubricant Tests Include :

- |   |  |  |
|---|--|--|
| <ul style="list-style-type: none"> <li>● Viscosity</li> <li>● Insolubles</li> <li>● Flashpoint</li> <li>● Water Content</li> <li>● Oxidation</li> <li>● Acid Number &amp; Base Numbers</li> </ul> | <ul style="list-style-type: none"> <li>● Wear Metal Elements</li> <li>● PQ Index</li> <li>● Foam Test</li> <li>● RPVOT</li> <li>● Fibre Count</li> <li>● Grease Analysis</li> <li>● Contamination Detection</li> </ul> | <ul style="list-style-type: none"> <li>● Oil Cleanliness</li> <li>● Trade Analysis</li> <li>● Unknowns Detection</li> <li>● Nitration</li> <li>● Sulfation</li> <li>● Air Release</li> <li>● Demulsification Test</li> </ul> |
|---|--|--|

## VIBRATION MONITORING / ANALYSIS & IN-SITU BALANCING

### WHAT IS VIBRATION DIAGNOSTICS ?

Vibration diagnostics is a major part of predictive machine maintenance programs. Vibration diagnostics has over the years proven to be the most effective method for checking “machinery health”.

Vibration diagnostics tools are here to help us to predict the machine failures. When predictive maintenance is applied and the machines are checked regularly, machine faults can be discovered at an early stage and appropriate action can be taken. By doing so you can avoid unexpected machine shutdowns and you can prevent replacement of parts which are still in good condition.

### HOW DOES IT WORK ?

Running machines generate vibrations, which contain a lot of information about their condition. A vibration meter or analyzer is used to measure this vibration. The sensor needs to be mounted on an appropriate point on the machine (e.g. bearing housing). The instrument measures the vibration signal, tells you the severity of the vibrations and also possible machine fault. The most frequent faults are bearing faults, unbalance, misalignment and looseness.

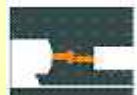
### Benefits of Vibration Analysis:

- ❖ M/c & component's health assessment and corrective maintenance planning at an early defect stage can be detected which will provide enormous scope for Reduction in maintenance effort & related cost.
- ❖ Elimination of secondary damages and reduction of energy losses are other significant gains.
- ❖ Reduces incidents of Human Accidents and catastrophic Failure. Enhances Safety and Precaution.

*Loose foot, unbalance*



*Misalignment*



*Rolling element bearing*



*Gears, Gear mesh, defective gear teeth*



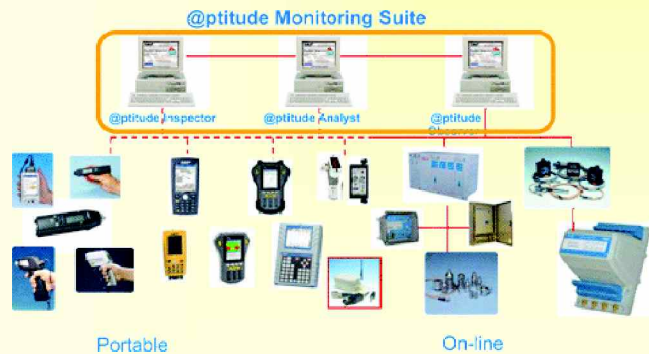
*Pumps eccentricity, cavitation*



- ❖ Creates Base Line Data (for major over-hauled Equipments or newly installed Plant & machinery)
- ❖ Offers Potential for huge cost Savings thru extended MTBF by detecting beginning wear/defects/faults.
- ❖ Optimize Maintenance Strategy (immediate/decision on outage time)
- ❖ Improvement in system reliability and availability, resulting increased production level.
- ❖ Helps establishing Bench Mark for Equipment Performance Standards for specific Plant.
- ❖ Offers enough potential for better Planning of Inventory to reduce Spare Parts consumption and inventory carrying costs.

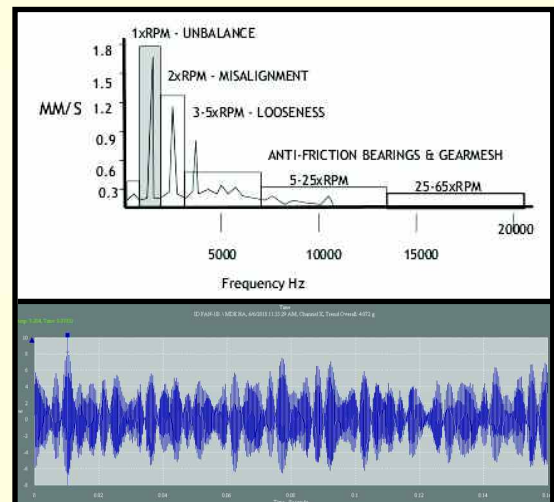
### INSTRUMENT & SOFTWARE:

- ❖ SKF CMXA 70 Microlog Data Collector/ FFT Analyzer cum Dynamic Balancer
- ❖ SKF Aptitude Analyst Software
- ❖ PRUFTECHNIK VIBEXPERT2 FFT Data collector /FFT Analyzer cum Dynamic Balancer
- ❖ Omnitrend Software for VibXpert
- ❖ Enpac 1200 Data Collector/ FFT Analyzer cum Dynamic Balancer with Emonitor Odyssey Software



### FAULTS/DEFECTS IDENTIFIED:

- ❖ Unbalance (Static, Couple, Overhung Rotor),
- ❖ Misalignment (Offset, Angular, Combination)
- ❖ Eccentric Rotor, Bent Shaft
- ❖ Mechanical Looseness, Structural Weakness, Soft Foot
- ❖ Resonance
- ❖ Mechanical Rubbing
- ❖ Problems Of Belt Driven Machines
- ❖ Journal Bearing Defects
- ❖ Antifriction Bearing Defects (Inner race, Outer race, Cage, Rolling Elements)
- ❖ Problems of Hydrodynamic & Aerodynamic Machines (Blade Or Vane, Flow turbulence, Cavitations)
- ❖ Gear Problems (Tooth wear, Tooth load, Gear eccentricity, Backlash, Gear misalignment, Cracked Or Broken Tooth)
- ❖ Electrical Problems of AC & DC Motor ( Variable Air Gap, Rotor Bar Defect)



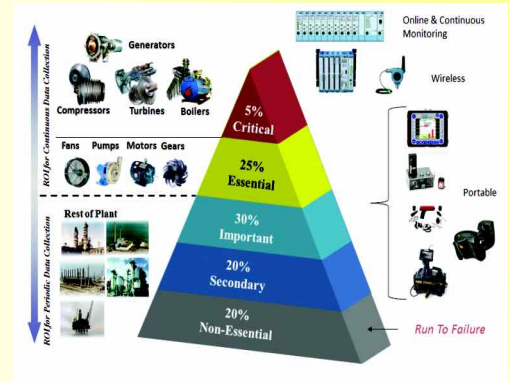
### Scope of Vibration Monitoring:

Industry	Equipment	
• Power	Fans	Pumps
• Cement	Blowers	Gearboxes
• Chemical	Compressors	Bearings
• Paper	Engines	Cement Mills
• Mining	Turbines	Electric Motors
• Food	Alternators	Press Machines
• Steel	CNC machines	AHU's



## OUR SERVICES INCLUDE:

- ❖ Routing in the Instrument, Data Logging, Spectrum Capturing, Vibration Analysis, Trending Data, Ascertaining Severity of Equipment Condition with Recommendation.
- ❖ Plant Survey and Determining Critical Equipments
- ❖ Condition Assessment, Trending of Overall Vibration levels as well trending of signatures in order to setup bench marks /base lines in old as well as in new plants
- ❖ In-situ balancing (Motors, Pumps & Fans)
- ❖ Root Cause Analysis (RCA)



## INFRARED THERMOGRAPHY ANALYSIS

Infrared Thermography is the process of using a thermal imager to detect infrared radiation (heat) that is emitted by an object. The technology allows operators to validate normal operations and, more importantly, locate thermal anomalies (abnormal patterns of heat invisible to the eye) which indicate possible faults, defects or inefficiencies within a system or machine asset.



In the infrared realm, even very cold objects emit infrared. Objects with higher temperatures emit higher levels of infrared radiation. Our experts use infrared thermography cameras to detect and measure heat levels in a range of equipment. Such testing is ideal for electrical wiring, furnaces, furnace tubes, bearings, batteries, motors, motor control centers and breakers, and more. IIPM has a proven track record in electrical surveys, insulation testing, and refractory testing for major clients such as Shell, Exxon Mobil, BP, Dow Chemical, Air Liquid, Folgers Coffee, and others.

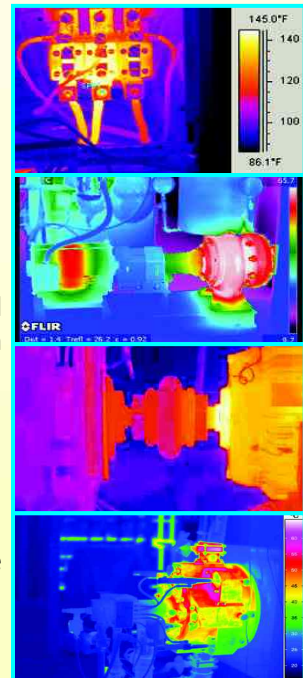
### Benefits of Infrared Thermography:

- Detect problems quickly, without interrupting service
- A large surface area can be scanned in a very short time
- Data can be stored for later image processing and analysis
- Assess priorities for corrective action
- Minimize preventive maintenance and troubleshooting time
- Comply with insurance company requirements

### Application:

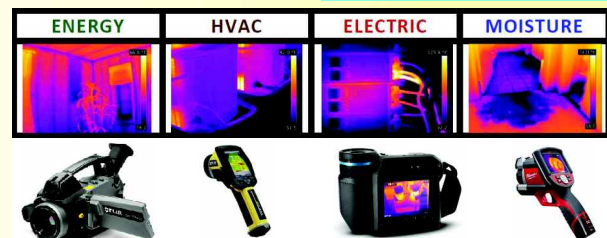
Thermography can be applied in any situation where a problem or condition can reveal itself by means of a thermal difference. For many situations, this is quite easy to apply; a thermal condition can be seen because the process involves release of thermal energy.

- **Electrical Systems:-** Switch yard equipments, Transmission line, Switch Gears, Electrical Panels entire Sub-station equipments.
- **Mechanical Systems:-** Motor, Pump, Compressor, Valves, Pulleys, Belts, Bearings, Gearboxes.
- **Boilers and Process Heaters:-** Refractory lining/Insulation deterioration, furnace tube evaluation for scaling and overheating. Steam system leaks, Piping insulation and leaks, Cold spot in rotary kiln.
- **Cooling Systems:** Cold storage tank insulation, Buildings inspection, Insulation.



### Instruments:

Thermography camera sets from FLIR systems with software. The instrument is capable of scanning surfaces in seconds and can store images. It has supporting latest software which enables customized report preparation indicating temperatures of area, spot, line, delta-T & thermal profile.



# OUR VALUABLE CUSTOMERS

 <p>ADGAS</p>	 <p>ADITYA BIRLA GROUP</p>	 <p>BHARATIYA RESERVE BANK NOTE MUDRAN (P) LTD.</p>	 <p>Bhushan POWER &amp; STEEL</p>	 <p>CAIRN Energy for India</p>	
 <p>CEAT</p>	 <p>Dalmia Bharat Cement</p>	 <p>DEEPAK FERTILISERS AND PETROCHEMICALS CORPORATION LIMITED</p>	 <p>DrukGreen Druk Green Power Corporation Limited A Royal Government of Bhutan Undertaking</p>	 <p>दामोदर घाटी निगम DAMODAR VALLEY CORPORATION</p>	
 <p>EMIRATES INDUSTRIAL LABORATORY Oilfield, Marine and Industrial Consultants</p>	 <p>EXIDE INDUSTRIES LIMITED</p>	 <p>गैल GAIL</p>	 <p>GIIB Engineered To Care</p>	 <p>इंडियनऑयल IndianOil</p>	
 <p>Indian Petrochemicals Corporation Limited</p>	 <p>ITC Limited</p>	 <p>Jayaswal Neco Industries Ltd. An ISO 9001:2008 Certified Company</p>	 <p>JINDAL STEEL &amp; POWER</p>	 <p>JSW Steel</p>	
 <p>GERDAU</p>	 <p>KALYANI</p>	 <p>L&amp;T Construction Skills Training Institute Work is Worship</p>	 <p>LANCO</p>	 <p>Mahanadi Coalfields Limited (A Subsidiary of Coal India Limited) A Mini Ratna Company</p>	 <p>MEA GOVERNMENT OF INDIA</p>
 <p>MRF</p>	 <p>नालको NALCO</p>	 <p>NAVAL DOCKYARD, MUMBAI</p>	 <p>Naval Dockyard Visakhapatnam</p>	 <p>NEPCO ECO-FRIENDLY. ANIMAL APPROVED.</p>	
 <p>Nestle</p>	 <p>एन एम डी सी NMDC</p>	 <p>एन पी टी आई NPTI प्रावीण्यं परोपवृत्तिश्च</p>	 <p>NUMALIGARH REFINERY LIMITED NRL</p>	 <p>एनटीपीसी NTPC A Maharatna Company</p>	
 <p>OCL INDIA LTD.</p>	 <p>ऑयल इंडिया लिमिटेड Oil India Limited</p>	 <p>ओ एन जी सी ONGC</p>	 <p>OPGC Power for Progress</p>	 <p>Paradeep Phosphates Limited</p>	
 <p>आर सी एफ Rashtriya Chemicals and Fertilizers Limited</p>	 <p>Reliance Industries Limited</p>	 <p>सेल SAIL</p>	 <p>SARDA SARDA ENERGY &amp; MINERALS LTD.</p>	 <p>TATA TATA STEEL</p>	
 <p>TATA TATA POWER</p>	 <p>vedanta</p>	 <p>vedanta</p>	 <p>VISA STEEL</p>	 <p>WBPDCL</p>	