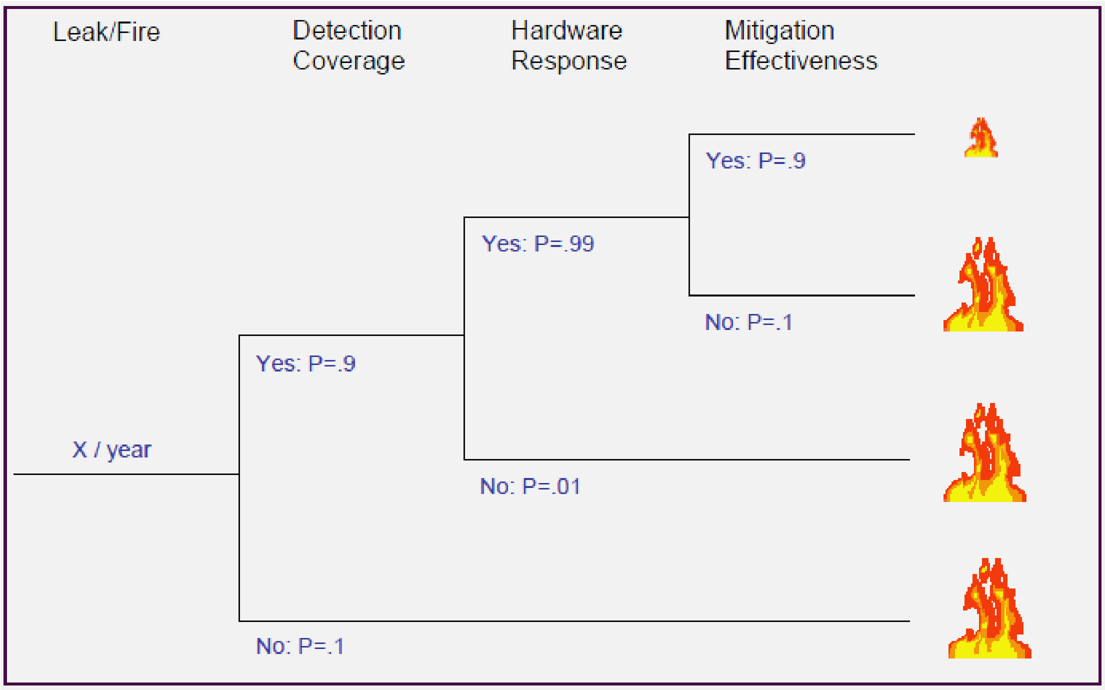
too much emphasis and importance is placed on the hardware of the system, which can encourage a false sense of security. To eliminate this false sense of security, many industry experts feel that a F&GS should not comply with the IEC 61508 / 61511 standards. Rather, a new performance standard should be developed specifically for F&GS and adequately address the issue of detector placement, coverage, and related issues.

The advocates for classifying a F&GS as a SIS claim that a system of gas and flame detectors is an effective mitigation layer of protection and should fall within the scope of IEC 61508 / 61511. A F&GS that automatically initiates process actions to prevent or mitigate a hazardous event and subsequently takes the process to a safe state can be considered a SIF or SIS. The F&GS would need to be composed of appropriate logic solver(s), sensor(s), and final element(s).

However, it is absolutely critical to ensure proper sensor (fire &gas detectors) placement in a plant. If there is incorrect placement of the gas or flame detectors, and hazardous gases and flames are not adequately detected, then the SIF / SIS will not be effective, regardless of the SIL capability of the system. Correct sensor placement is more important than deciding whether a F&GS should be SIL 2 or SIL 3. The F&GS system must be designed based on the unique requirements of each plant and application. Just purchasing a SIL 3 logic solver, a SIL 2 sensor, and SIL 2 final element, does not guarantee a SIL 2 system. To mitigate the inappropriate location of F & G devices, gas mapping studies and noise studies must be carried out. There islicensed software available to design the proper location of fire & gas devices with required coverage.



(Factors Effecting Fire and Gas System Performance)

PRESCRIPTIVE VERSUS PERFORMANCE BASED SAFETY STANDARDS

For example, EN-54 contains a large number of prescriptive requirements with respect to the design and installation of fire &gas detection systems. This includes requirements on initiating device circuit supervision, notification appliance circuit supervision, fire safety function circuit supervision, suppression system designs, etc. The concept of a safety instrumented fire & gas system requires implementing both the prescriptive requirements of a standard like EN-54, as well as the requirements of a performance based standard such as ANSI/ISA-84.00.01-2004.00.01-2004 in an attempt to design a system that has the best of both worlds.

FUNCTIONAL TESTING REQUIREMENTS

EN-54 does not specifically mandate functional testing of fire &gas detection systems based upon the architecture of the system and desired availability. SIS, on the other hand, has underscored the importance of functional testing and its relationship to overall probability of failure on demand calculations. This fundamental difference must be addressed for those intending to apply performance-based requirements to a fire &gas detection / mitigation system. By conducting a functional test of the system, you are attempting to identify any potential covert failures in the system. This results in a resetting of the PFD (Probability of Failure upon Demand) "clock" back down to a minimal PFD.

FIELD DEVICE WIRING DIFFERENCES

Traditional fire &gas systems utilize wiring schemes that allow many field devices to bedaisy chained together on a single circuit. For instance, this type of circuit typically usessome sort of end of line device to monitor the contact state of multiple sensors or it can evenuse an addressable network / bus scheme. SIS on the other hand,tends to have a single field device wired to a single I/O channel on the safety PLC. However, as per the latest developments, many industries prefer to have direct wiring of F & G device to F&GS system i.e. non-addressable type even for non process area (i.e. buildings) fire &gas detection. One shouldcarefully review the wiring schemes required by the safety instrumented F&GS to ensure the project's scope.

CURRENT MARKET TRENDS FOR FUNCTIONAL SAFETY FOR FIRE & GAS DETECTION SYSTEM

Since last couple of years, there has been much study done by the regulatory agencies to avoid or prevent the major accident in the industries by putting the regulations and laws mandatory to follow and imposing a heavy fine to the industries which are not complying to it. ARC Advisory Group's new "Fire and Gas Systems Global Market Research Study" provides a detailed analysis of this trend and forecasts the scenario in the coming years. The study focuses on providing suppliers with insights into the future of the fire and gas systems market.

End users become more proactive To comply the safety standard for F &GS according to the requirement mentioned in IEC 61508 & IEC 61511. Apart from IEC committee, ISA has also taken major initiative and provide the guidelines to the industries to design the F & GS according to standard ISA-84.00.01-2004.00.07. With all these development by IEC and ISA end user now become more familiar about the importance of safety requirement for F & GS system and is adhering the requirement while designing the F & GS.

A wide variety of fire and gas related sensors have had Failure Modes and Effects DiagnosticsAnalysis (FMEDA) performed. Many OEM like Det-tronics, Honeywell, Drager Safety, Autronica, MSA, General Monitors, MEDC, Emerson etc. is offering the fire & gas device with SIL-2 certified according to IEC 61508. This includes mainly the fire detectors and gas detectors. Also logic solvers are now available to SIL-3 certified according to IEC 61508 from many OEM like Honeywell, Foxboro, ABB, Emerson and so on. Several different OEM's have recognized the needto provide data for use in a performance-based safety instrumented system design. It is significant that sensor OEM's are beginning to provide data that could support the overallsafety concept of F&GS.

CONCLUSION

"Fire and gas systems are excluded" is often heard in discussions of the ISA standard on safety instrumented systems. This can be true, or not, depending upon the specific application in question. The exclusion that is often misquoted is

Distributed with permission of author(s) by ISA [insert current year]
Presented at [insert name of event here]; http://www.isadelhi.org

from paragraph 1.2.14, which reads:"Systems where operator action is the sole means required to return the process to a safe state are not covered by this standard (e.g., alarm systems, fire and gas monitoring systems, etc.)."

The key concept in this paragraph is that the exclusion applies to "systems where operator action is the sole means required to return the process to a safe state." This exclusion does not, therefore, address F&GS that automatically initiate process actions, but those that only monitor and generate alarms.

Another area of confusion surrounding the applicability of ISA-84.00.01-2004 to F&GS is whether the application of fire-mitigation materials should be a part of the SIF. This is not an issue that can be generally resolved, but instead requires case-by-case consideration. Just as you can review process-related SIFs to identify the actions required to achieve functional safety, you can similarly apply this identification of "safety critical actions" to an F&GS. If the successful initiation of fire mitigation achieves the risk reduction allocated to the F&GS, then these actions, along with the identified process actions, are safety critical.

The ISA/International Electro-technical Committee (IEC) standards for safety instrumented systems and the NFPA standards addressing F&GS developed in isolation, with the systems treated as separate and independent. However, the edges between these two types of systems are blurring, creating overlap between the system requirements. Many SIS have inputs from fire and gas detectors and generate outputs to process and fire-fighting equipment.

Thus, it appears that Safety-Instrumented fire &gas detection systems are gainingsignificant momentum and that can only benefit industry as a whole.

REFERENCES

1. ANSI/ISA-84.00.01-2004, *Application of Safety Instrumented Systems for the Process Industries*,

2. IEC 61508, *Functional Safety of Electrical/Electronic/Programmable Safety-relatedSystems, Part 1-7,*

3. IEC 61511, *Functional Safety: Safety Instrumented Systems for the Process IndustrySector, Parts 1-3,*

4. NFPA 72 *National Fire Alarm Code*,

5. Mike Scott & Bud Adler, "Industry Update: Safety Instrumented Fire & Gas Systems (SI- F&GS)". (http://www.aesolns.com/wp-content/uploads/2015/11/industry_update_safety_instrumented_fire_gas_systems_si_fgs.pdf)

6. DVC6000 SIS training Course -1 by Emerson. (http://instrumentationandcontrol.net/wp-content/uploads/2016/10/EMERSON-2005-Basic-Fundamentals-Of-Safety-Intrumented-Systems.pdf)

7. Article by General Monitors for SIL 102 (http://www.gmigasandflame.com/article_april2007.html)

8. Article by Paul Gruhn, PE, ICS Triplex SIL rating for Fire & Gas System Hardware (https://www.controlglobal.com/assets/14WPpdf/141023-Rockwell-ISATR84.pdf)

9. https://www.arcweb.com/market-studies/fire-and-gas-systems

BIOGRAPHIES

Sh. Hemant Patel wasborn in Surat, India in theyear 1977. He graduated in Instrumentation & Control engineering from Govt. Engineering College Gandhinagar, Gujarat University in 1998. At presenthe is working with Fluor Daniel India Pvt Ltd. since September-2013. He is also Certified Functional Safety Engineer (CFSE) from TUV-SUD*(TÜVSA/2017/FSC025/0001/0007/0004)*conducted by ISA-Delhi section in Nov-2017. He has thorough knowledge of SIS and also hands on experience of Exida software "exSILentia" for SIL verification.

STOCKYARD MANAGEMENT SYSTEM– Securing the value of Coal

Sameer Sharma
Additional General Manager
Project Engineering
(Control & Instrumentation)
NTPC Ltd
Engineering Office Complex,
Sec-24 Noida-201301
India

Ankur Tripathi
Manager
Project Engineering
(Control & Instrumentation)
NTPC Ltd
Engineering Office Complex,
Sec-24 Noida-201301
India

3D stockyard visualization, Material Tracking, Un-manned operation, Hotspot detection.

ABSTRACT

Thermal power plants contribute for about 60% of the power generation in India. Coal is the biggest cost component for these. Further, managing coal is complex, as issues vary from sourcing to logistic management, handling and yard management and maintaining an overall quality so that more power is produced with less quantity of coal.

Generally most of the stockyards in India are open type and face issues like spontaneous combustion during summer months, fugitive dust nuisance, erosion loses due to wind and rain, lump formation and other issues which mainly lead to losses in Gross Calorific Value (GCV). The issue aggravates as the process of detection of these hotspots and mitigation is mainly manual. Further, for most of the power generators the focus is generally on the timely delivery of Coal at their respective stations, which often takes away the attention from other considerations like managing proper yard layout and optimal use of stacker reclaimers so as to minimize long travel and save energy.

In Indian power plants lot of work has been done on improving efficiency and other parameters of main plant but this attention is generally lacking in the biggest and most challenging area of power plant, i.e, Material Handling plants. If the 3D-profile of coal in the yard is available to operator in remote location, Stacker/Reclaimer is operated Un-manned and there is Hot-spot detection of coal, linked to automatic operation of sprinklers to quench fire, there could be remarkable improvement in the operation of Coal Handling Plants.

This paper presents a system through which individual parts of coal stacking and reclaiming process can be optimized with a real time full terrain information of Stockyards with stock accounting and blending possibilities. The Un-manned operation of Stacker/Reclaimer

Copyright [2018] by ISA, DELHI SECTION
Presented at "ISA(D) Petroleum & Power Automation Meet 2018"

machines will result in safer operation and better stockpile management. Early detection of Hotspot and prevention of fire and losses and minimize emission of hazardous gases like methane and carbon monoxide.

This will lead to proper stockyard planning, material tracking, stock profiling and visualization in 3D, detection of Hotspot and Un-manned operation of Stacker/Reclaimer machines from Coal Handling plant control room through an integrated dash-board, thus ensuring safety of operator in field. It presents a combination of new technologies which will provide a paradigm shift from labor intensive and manual techniques to advanced data based analysis and early prediction techniques to prevent losses and enabling safer operation.

1.0 INTRODUCTION:

Generally most of the coal stockyards in India are open type and face issues like:

- Spontaneous combustion during summer months
- Sliding of coal on to stacker reclaimer rails due to improper stacking practices
- Difficulty in following First In First Out in Stacking/Reclaiming of coal
- Improper yard space management
- Fugitive dust nuisance
- Erosion loses due to wind and rain.
- Lump formation
- Improper height and orientation of Stockpile
- Difficulty in selective Stacking and Reclaiming

and many other issues which mainly lead to losses in Gross Calorific Value (GCV).

Most of the power producers have adopted the following practices in their maintenance schedule to minimize the losses due to the above challenges. This include:

- Orienting the stockpiles width wise
- Erecting boundary walls with proper drainage around periphery of Coal Stockyard
- Stacking good quality coal and bad quality separately
- Covering the stockpiles before start of monsoon with LDPE (low density polythene sheet)

All these techniques are quite labor and time intensive.

2.0 NEW TECHNIQUES IN STOCKYARD MANAGEMENT:

In recent years, market focus has been on the optimization of individual parts of the coal stacking and reclaiming process — such as stockyard planning, material movement and advanced automation solutions for seamless integration of all subsystems and providing to the operator the quintessential data in the most simplified way so that he can take a judicious decision. This system shall be referred as **Stockyard Management System (SYMS)**.

The SYMS shall provide Real Time Monitoring/operation of Stacker Reclaimer, Material tracking, Stock Profiling and visualization in 3D including coal quality management, detection of Hotspot and

Copyright [2018] by ISA, DELHI SECTION
Presented at "ISA(D) Petroleum & Power Automation Meet 2018"

automatic operation of Stockpile Sprinklers along with S/R ready for unmanned operation. SYMS system comprises following subsystems:

a. 3D coal stock pile mapping and visualization:

This stockpile visualization component of the SYMS offers a graphical representation of the stockpiles in the stock yard area. The view can be adjusted by operator at CHP Control Room from different viewpoints and the individual virtual piles can be selected for better managing of coal in these heaps. Slice or cut views can also be shown where the different material types and their respective properties are stored.

Stacker/ Reclaimer machines shall be equipped with suitable scanners (high quality Laser/Radar) enabling the system to map coal profiles in stockyard accurately. This system shall provide recording of material movement to and from stockpile, shape of the profile, distribution of material over profile as the machine moves for performing stacking or reclaiming operations. The data thus generated would provide exact information in form of a database.

b. Ready for Unmanned operation of Stacker / Relaimer :

The SYMS is fully automatic and also has the capability to perform unmanned operation of stacker/ reclaimer which will reduce requirement of the highly skilled manpower for S/R operation in hazardous area. This system will have the capability to operate the machines in man less mode while maintaining all the safety aspects in to consideration. To position the machine accurately and operate the machine remotely the SYMS shall use the RTK-GPS(Real time Kinematic GPS) system with anti-collision detection system. Once locked onto the phase signal these receivers mounted on the Stacker Reclaimer machines shall be able to provide accuracies in the range of +/- 2 cm both in the horizontal and vertical co-ordinates. This will prevent the cases of accidents/ collision happening in our stockyard and reduce the dependency of the CHP Control Room operator on the Stacker Reclaimer cabin operator.

c. Hot spot detection and Automatic Sprinkler Operation :

This subsystem of SYMS will provide Hot Spot Detection facility in coal stockyard and control the damages due to hotspot formation by automatic sprinkler operation in case of fire detection. In this system, thermal imaging and advanced thermography will provide the operator a thermal image of the complete stockyard all the time during day as well as in night. The operator can monitor the surface temperatures of the individual heaps and track the sudden rising temperature gradient due to spontaneous combustion and hotspots which are formed inside the heaps which are generally not visible to human eyes until fumes or flames start rising from the surface.

In this system, high resolution pan and tilt based Thermal Imaging cameras shall be

Copyright [2018] by ISA, DELHI SECTION

mounted on high masts (20-25 m) in and around stockyard. The number of cameras and location of these masts and cameras shall be decided such that, they offer no hindrance to movement of machine and material and also provide more than 90% coverage of all the coal piles.

On detection of hotspot, Automatic Sprinkler system is being envisaged to quench the fire in its earliest stage. The Stockyard is generally provided with Sprinklers for Dust Suppression during Stacking and reclaiming operations. Currently, these are manually operated. In this system, these are to be modified to Solenoids operated, so that they can operated automatically through PLC being envisaged in the Hotspot Detection system. In case of detection of hotspot in any area of Stockyard the respective Sprinkler can run in auto mode or manually by operator from CHP control room to suppress the fire instantaneously. The usage of water shall also be reduced/ optimized by automatic operation of sprinkler system instead of continuous manual sprinkling.

3.0 BENEFITS:

Major Benefits of adopting the Stockyard Management System comprising of 3D Stock Yard Modelling, Hotspot Detection and Automatic Sprinkler Operation are as follows:

- Real-time, full-terrain information of the stockyards and Material tracking with stock accounting and blending possibilities
- Uniform stockpile construction with a smooth surface in a trapezoidal form
- Enhancement of safety using un-manned operation of Stacker/Reclaimers
- Power plant coal requirements can be integrated into ERP through Pi-server leading to a more informed and judicious procurement of Coal and scheduling of wagons so that optimum levels of coal is always available at site
- Reduced labor cost, constant/ optimized belt load, optimized material throughput, energy savings by smooth and continuous operation through unmanned operation of stacker / Reclaimer
- Early detection of Hotspot and prevention of fire and losses due to spontaneous coal combustion in stockyards
- Minimizing emission of hazardous gases like methane/ carbon monoxide
- To nullify fire accidents and save huge amount of revenue and production loss in case of fire
- Automatic opening and closing operation of sprinklers leading to reduce wastage of water during hot summer months
- Improved equipment efficiency and reduced labor costs

4.0 CONSIDERATIONS DURING SYSTEM DESIGN:

Following considerations are to be kept while finalizing the system design:

- These system are state of the art and quite sophisticated. The operators available at field have to be trained and expertise is required to be

Copyright [2018] by ISA, DELHI SECTION

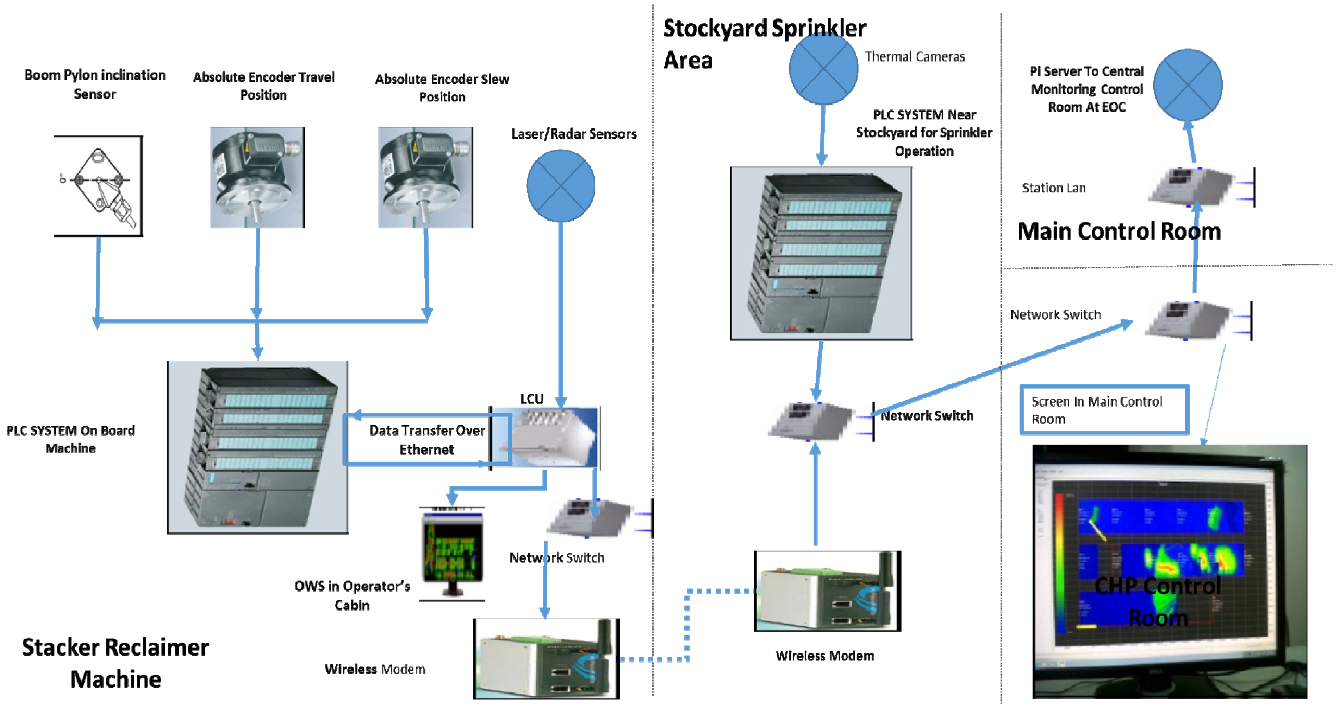
developed for properly handling and maintenance of the sensors and cameras.

• The location of the thermal cameras and poles for the same will have to be strategically erected so that movement of Stacker Reclaimer Machine, Dozer etc. is not hampered and maximum area of stockyard is covered.

• The inputs from scanner (laser /radar) selected has to be properly integrated with the software and the readings have to be co-related through local survey initially for proper tuning of scanners.

• The Global Positioning System has to be configured carefully as any error in predicting the machine position and scanner location would result in erroneous results.

Typical Architecture for Stockyard Management System



5.0 **CONCLUSION:**

These technologies are already in use in some of the ports and coal stockyards worldwide. In Indian context, it has been seen that mixed technologies have been used depending upon the individual plant/ process requirements.

Integration of individual systems into an effective Stockyard Management System will result in following benefits:

- Proper stacking of coal as per user requirement.

Copyright [2018] by ISA, DELHI SECTION

- Integrated information of 3D profile of stockpiles and hot spot detection in remote control room.
- Un-manned operation of Stacker/ Reclaimer from remote control room.
- Minimizing GCV losses due to heating.
- Reducing losses in erosion due to wind and drainage due to water.
- Proper Utilization of Stockyard with effective yard management techniques.
- Reduction in wear and tear of equipment.
- Prevention of Health hazards to our field operators.

The benefits will get enhanced when wind-barriers are used in the periphery of stockyards. NTPC being power technology leader has taken the opportunity to implement this holistic approach and take the benefit of this technology for optimization of coal and establish the trend of effective management of Stockyards in India.

5.0 ACKNOWLEDGEMENTS:

The authors are extremely grateful to Mr. Mr. G. Venu, Executive Director (Engg.), NTPC for his constant encouragement & support for exploring new technologies and Mr. A. K. Sinha, Ex(ED-Engg) NTPC for guidance in conceptualization of the system. The authors are grateful to Mr. M. K. Srivastava, GM (PE-C&I) NTPC for initiating this concept. The authors are also grateful to Mr. Vinay Kumar, GM (PE-Mech-MH) NTPC for supporting this concept.

BIOGRAPHIES:

Mr **Sameer Sharma** is an Additional General Manager in Project Engineering-C&I Dept of NTPC Ltd. in its engineering office, based in Noida.

His exclusive focus areas are Control System engineering, C&I of Coal Handling Plant, etc.

Mr Sameer Sharma has done B.E in Electronics from NIT, Raipur and M. Tech from IIT, Delhi.

Mr P.K. Gupta is an Additional General Manager in Project Engineering-C&I Dept of NTPC Ltd. in its engineering office, based in Noida.

Mr P.K.Gupta has done B.Tech in Electronics and Instrumentation from GSITS, Indore.

Mr Ankur Tripathi is a Manager in Project Engineering-C&I Dept of NTPC Ltd. in its engineering office, based in Noida.

Mr Ankur Tripathi has done B.Tech in Electronics and Communication from NIT, Allahabad.

Copyright [2018] by ISA, DELHI SECTION

Notes

Notes

Membership Enrollment Form

ISA-The International Society of Automation

Mail duly filled in form to ISA Delhi Section, B-45, Sector - 8, Noida 201301(U.P.) with Payment of Rs. 3000/-
Tel.no. 011-41759416, 9313384543

Cheque/DD should be in favor of "ISA Delhi Section"

Rewards for Recruiting Program:
ISA Sponsor Name ……………………………………………….
ISA Sponsor Membership ……………………………………..

1. Member Information

This Section must be completed in full.

☐ Mr. ☐ Ms. ☐ Dr.

Name Last/Family (Include suffix and /or professional designation) First/Given Middle

Company Position/Title

Business Address Information : This section must be completed to receive the FREE subscription to *Motion Control* magazine. (See section 4b.)

Street address/PO Box Mail Stop

City State/Province Postal Code

Country E-mail

Telephone include area code of country and city code Fax (include area code or country and city code)

Home Address Information :

Street address/PO Box Unit

City State/Province Postal Code

Country E-mail

Telephone (include area code of country and city code) Celular/Alernate Phone (include area code or country and city code)

Preferred Mailing Address (check one): ☐ Business ☐ Home

Preferred Billing Address (check one) : ☐ Business ☐ Home

Birth date (month/day/year)

Would you like information on senior Membership? ☐ Yes ☐ No

Have you ever been a member of ISA? ☐ Yes ☐ No

If yes, list last year of membership : ______________________

Highest degree earned : ☐ High School ☐ Associate/Vocational ☐ Bachelors ☐ Masters ☐ Doctorate

STUDENTS ONLY : ______________________
School

Required : Date of graduation (mm/yyyy)

2. Job Information

This section must be completed in full.

2A. Check your primary job function (choose only one)

- ☐ Control Systems Engineering (B)
- ☐ Education (N)
- ☐ Engineering Consulting (AG)
- ☐ Engineering Management (3)
- ☐ Environmental Control's (AI)
- ☐ General or Corporate Management (A)
- ☐ Marketing or Sales (C)
- ☐ Measurement, Testing, Quality or Standards Engineering (I)
- ☐ OEM Product/Systems Engineering (A2)
- ☐ Plant Information Systems (G)
- ☐ Product Design Engineering, Including applied R & D (1)
- ☐ Production Engineering (D)
- ☐ Research & Development (J)
- ☐ Safety, Systems Engineering (AJ)
- ☐ Software Engineering (F)
- ☐ Systems Design Engineering (S)
- ☐ Systems Integration (H)
- ☐ Technical or Engineering Support (K)
- ☐ Other (P) ______________________

2B. Check your Industry classification : (choose only one)

Manufacturing Industries

- ☐ Chemicals (2800)
- ☐ Electronic & Other Electric Equipment (3600)
- ☐ Food (2000)
- ☐ Industrial Machinery & Equipment, Including Computers (3500)
- ☐ Instrumentation, Measurement, Analysis & Control Apparatus (3800)
- ☐ Medical Instrumentation & Systems (3840)
- ☐ Petroleum Refining & Related Industries (2900)
- ☐ Pharmaceuticals (2830)
- ☐ Primary Metals (3300)
- ☐ Pulp, Paper & Allied Products (2600)
- ☐ Rubber & Miscellaneous Plastics (3000)
- ☐ Semiconductors & Electronic Components (3670)
- ☐ Stone, Clay, Glass and Concrete Products (3200)
- ☐ Textiles (2200)
- ☐ Tobacco Products (2100)
- ☐ Valves, Fittings, Fabricated Metal Products (3400)

Mining

- ☐ Metal Mining (1000)
- ☐ Oil and Gas Extraction (1300)

Transportation and Public Utilities

- ☐ Transportation – Aerospace (3760)
- ☐ Transportation – Aircraft (3720)
- ☐ Transportation – Automotive (3710)
- ☐ Transportation (3700)
- ☐ Utilities (4900)
- ☐ Utilities – Electrical (4910)
- ☐ Utilities – Natural Gas (4920)
- ☐ Utilities – Combination (Nuclear/Fossil Fuel, etc.) (4930)
- ☐ Utilities – Pipelines except Natural Gas (4600)
- ☐ Utilities – Water/Wastewater (4940)

Engineering & Other Services

- ☐ Communications/Data Distribution (4810)
- ☐ Construction (1700)
- ☐ Education (8200)
- ☐ Engineering Services (8710)
- ☐ Government (9100)
- ☐ Instrument & Control Apparatus Sales & Service (5000)
- ☐ Management Consulting (8740)
- ☐ Research, Development & Testing (8730)

SIGNATURE : This application cannot be processed without your signature

Signature Date :

IS MANAGING CRITICAL INDUSTRIAL APPLICATIONS YOUR DAILY CHALLANGE? THAT'S WHERE WE COME IN.

AC UPS & BATTERY CHARGERS TO MEET YOUR SPECIFIC INDUSTRIAL NEEDS.

Managing industrial environments is a huge responsibility but it doesn't have to be a huge challenge too. You need reliable, industrial-grade UPS systems, battery chargers, inverters, and rectifiers for heavy duty, industrial use. We provide configured or custom-made products to meet your specific industrial needs.

Liebert® HIPULSE-D
AC UPS System
5-160 kVA

Liebert® FP 30ZM
Modular AC UPS

Liebert® FP 60Z
AC UPS System
1-phase or 3-phase output

Liebert® UTILITYSURE
Industrial Modular Rectifier
Battery Charger-
110VDC & 220VDC

VERTIV™

YOUR VISION, OUR PASSION

Corporate Office : Plot C-20, Rd No.19, Wagle Ind Estate,
Thane (W), 400604. India

Explore solutions at **VertivCo.com/en-in**
Call Tollfree : **1-800-2096070**
E-mail : **marketing.india@vertivco.com**

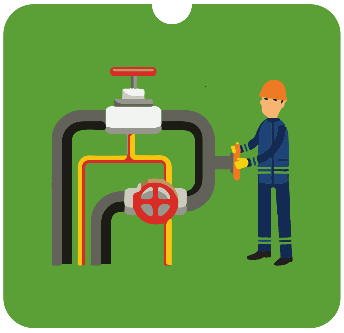
India's No.1
Commercial Enterprise
Highest
Highest sales turnover among corporates in India

Tops
Tops Indian Corporates in the prestigious *Fortune* 'Global 500' listing of the world's largest companies

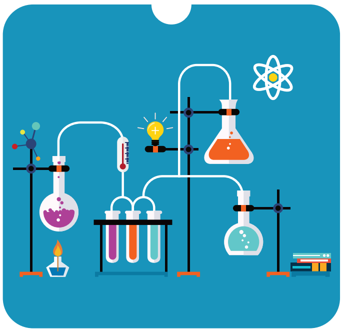
Biggest
Owns the biggest network of fuel stations in the country

Largest
Owns the largest combined refining capacity in the country

Widest
Owns the widest network of crude oil and petro-product pipelines



Most Advanced
Owns the most advanced R&D Centre in the downstream sector



On call
33,125 IndianOilPeople
to meet the energy demands in India and beyond

इंडियनऑयल
IndianOil
The Energy of India

Follows us On:
/IndianOilCorpLimited /IndianOilcl /IndianOilcorporationlimited /IndianOilcorp
www.iocl.com

Key Player
in petrochemicals and gas marketing

Most Profitable
India's most profitable public sector enterprise for the year 2016-17

Leader
Bagged the prestigious Platts Global Energy Award-2017 for Industry Leadership - Downstream

Best
Emerged as 'Best PSU Company to work For' in India