सत्यमेव जयते

SUPPORTED BY
DEPTT. OF SCIENCE & TECHNOLOGY,
GOVT. OF INDIA

The International Society of Automation

ISA Delhi Section

ISA Delhi Section

POWAT – 2012

Automation – Innovating for Evolving Challenges

POWER AUTOMATION TECHNOLOGY EVENT
(Conference and Exhibition)

पावरग्रिड

एनपीसीआईएल NPCIL

बी एच ई एल BHEL

एनटीपीसी NTPC A Maharatna Company

PDIL पी डी आई एल ENGINEERING THE FUTURE

13th & 14th January 2012 *at* **The Grand**
Vasant Kunj - Phase II,
Nelson Mandela Road, New Delhi

BSL Engineering Services Limited

(TOTAL ENGINEERING SOLUTIONS)

BSL Engineering Services Limited is a diversified global conglomerate providing Engineering & Construction services in Power, Mining, Oil & Gas and with interests in Construction, Infrastructure and Aviation sectors.

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BSL Engineering Services Limited

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Telephones: +91-120-2490365-67, Fax: +91-120-2490368

Web site: http://www.bslengg.com/www.bslgroupco.com Email-contact@bslengg.com

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**13th & 14th
January 2012**

at

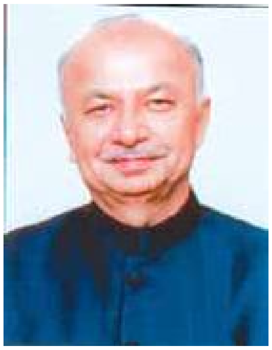
**The Grand
Vasant Kunj - Phase II,
Nelson Mandela Road, New Delhi**

विद्युत मंत्री
भारत सरकार
नई दिल्ली-110 001

सत्यमेव जयते

सुशीलकुमार शिंदे
SUSHILKUMAR SHINDE

Do MoP/VIP/245/2012
MINISTER OF POWER
GOVERNMENT OF INDIA
NEW DELHI - 110 001



11/1/2012

MESSAGE

It gives me immense pleasure to learn that ISA Delhi Section is organizing Power Automation Technology Event "POWAT-2012" focusing on Control & Automation in the Power Sector. I learn that ISA promotes the establishment of standards & operational guidelines in the field of Automation & Control and provides a platform to stake holders for knowledge sharing and learning.

In fact, ISA needs to take initiatives to develop state-of-the art technologies in Control & Automation so as to make India a global leader in the sector. Towards this end, the compendium of technical papers being published by ISA would be a very good reference material, to start with. I am sure that this conference will provide an opportunity for not only sharing knowledge and learning from both Indian and international experts but also help India build world leadership in the sector.

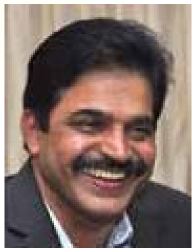
I wish the conference all success.

(SUSHILKUMAR SHINDE)

विद्युत राज्य मंत्री
भारत सरकार

सत्यमेव जयते

MINISTER OF STATE FOR POWER
GOVERNMENT OF INDIA



के. सी. वेणुगोपाल
K. C. VENUGOPAL

11th January, 2012

MESSAGE

Indian Power sector is in a rapid growth trajectory. Thanks to the efforts made by all stakeholders connected with the sector. Control and Automation plays a crucial role in Power Generation, Transmission and Distribution. Today, with the help of state of the art control systems, we have established a robust integrated Power system in the country.

It gives me immense pleasure to learn that ISA Delhi Section is organizing POWAT-2012 conference, focusing on the important aspect of Control & Automation in the Power Sector. I am happy to learn that ISA promotes the establishment of standards & operational guidelines in the field of Automation & Control in all industries and provides a common platform to all stake holders of automation community for knowledge sharing and learning from peer groups.

At a time when our country is making serious efforts in implementation of smart grid concept, I hope that this conference will provide a fruitful exchange of knowledge & learning for both Indian and international experts in the field of automation and control in all aspects of power Generation and distribution.

I wish all success to this conference.

(K.C.Venugopal)

RIGHT TO INFORMATION

श्रम शक्ति भवन, रफी मार्ग, नई दिल्ली-110001 फोन : 011-23723700, 23705903 फैक्स : 23705902
Shram Shakti Bhawan, Rafi Marg, New Delhi-110 001 Ph. : 011-23723700, 23705903 Fax : 23705902

अरुप रॉय चौधरी
अध्यक्ष एवं प्रबन्ध निदेशक

Arup Roy Choudhury
Chairman & Managing Director

एनटीपीसी लिमिटेड
(भारत सरकार का उद्यम)
NTPC Limited
(A Govt. of India Enterprise)

केन्द्रीय कार्यालय/Corporate Centre

MESSAGE

I am glad to note that the International Society of Automation (ISA) has been making immense contribution worldwide in the very important and dynamic field of process automation across the industries. It is praiseworthy indeed that Delhi Section of ISA is organizing Power Automation Technology (POWAT) Conference 2012 which will address the process automation issues specific to the power industry.

I gather that the event will cover all the segments of the power value chain. Automation being the veritable nerve centre of power stations, transmission and distribution systems and, at the same time, this being a rapidly developing area with fast obsolescence, the challenges before the professionals working in the automation space are indeed exciting as well as daunting. From operating ultra super critical power stations to building and managing smart grids, automation will hold the key to the business.

In this context, the conference assumes high significance. I am sure that this well conceived event will help the professionals and the entire power industry know about innovative solutions and will also help in enhancing the productivity of the industry.

I wish this significant event all success in its objectives.

(ARUP ROY CHOUDHURY)

एनटीपीसी भवन, स्कोप काम्पलेक्स, 7 इन्स्टीट्यूशनल एरिया, लोधी रोड, नई दिल्ली–110 003 टेल / Tel. : (O) +91-11-24361199, 24360044 फैक्स / Fax : +91-11-24363050
NTPC Bhawan, SCOPE Complex, 7 Institutional Area, Lodhi Road, New Delhi-110 003 E-mail : cmd@ntpc.co.in वेबसाइट / Website : www.ntpc.co.in

वाई.एस. मय्या
Y.S. MAYYA
उत्कृष्ट वैज्ञानिक, अध्यक्ष एवं प्रबन्ध निदेशक
Outstanding Scientist,
Chairman & Managing Director

इलेक्ट्रानिक्स कारपोरेशन आफ इंडिया लिमिटेड
Electronics Corporation of India Limited
A Government of India (Dept. of Atomic Energy) Enterprise
ECIL P.O., Hyderabad - 500 062. A.P. INDIA
Phone : (O) +91-40-27121055
Fax : +91-40-27122535
E-mail : cmd@ecil.co.in

December 3, 2011

MESSAGE

I am very glad to know that ISA Delhi Section is organizing POWAT-2012 Conference during 13-14 Jan 2012 focused on I&C applications in Power sector.

I am aware and highly appreciate the immense contribution by ISA in promoting the establishment of Standards and Operational guidelines in the field of Automation and Control.

I am very confident that the conference meet would serve the purpose of serving as an excellent forum to promote knowledge sharing on the focused subjects in Automation and Control among automation professionals, academia and the industry.

I extend my best wishes and full support for the grand success of the event.

(Y.S. Mayya)
Chairman & Managing Director

प्रोजेक्ट्स एण्ड डेवलपमेंट इण्डिया लिमिटेड
(भारत सरकार का उपक्रम)
Projects & Development India Ltd.
(Govt. of India Undertaking, Dept. of Fertilizers)
A-14, Sector-1, NOIDA-201301

PDIL
पी डी आई एल
ENGINEERING THE FUTURE

Dr. M RAVI KANTH, Ex. IAS
M.A. (Eco), LLB, MBA, Ph.D
Chairman & Managing Director

Message

I am glad to know that ISA (D) POWAT–2012, 4th Power Automation Technology event is being held on 13-14 January 2012 in Delhi, and I congratulate ISA-Delhi Section for organizing such event, which gives opportunities to suppliers, technology developers, and consultants from power sector for understanding the challenges in the sector better.

It is heartening to note that the ISA (D) POWAT–2012 is focussing the key issues of concern in the power sector and the event is supported by Department of Science and Technology and all power majors, with the participation of several leading manufacturers/suppliers, users and consultants engaged in the control & automation systems.

I wish the event a grand success and as CMD of PDIL, I believe many more such major events in the field of control and automation will be organized by ISA-Delhi in future as well. Best wishes,

Dr. M Ravi Kanth
Chairman & Managing Director
Projects & Development India Limited

PHONE : (O) 0120-2529809 FAX : 0120-2541045
E-mail : ravi86ias@gmail.com
Other Offices : Sindri, Baroda, Mumbai, Kolkata, Chennai, Hyderabad & Visakhapatnam
Visit us at : www.pdilin.com

ISO 9001:2008 Company

एनटीपीसी
NTPC

डी. के. जैन
निदेशक (तकनीकी)

D. K. JAIN
Director (Technical)

एनटीपीसी लिमिटेड
भारत सरकार का उद्यम
NTPC Limited
A Govt. of India Enterprise
(Formerly National Thermal Power Corporation Ltd.)

केन्द्रीय कार्यालय / Corporate Centre

Message

I am happy to learn that ISA - Delhi Section is bringing out a compendium of all the technical papers in the POWAT-2012 Conference, for wide circulation. I wish to congratulate the ISA Delhi team for this endeavor.

I understand that the ISA Delhi Section is a part of the ISA international which is a family of more than thirty thousand experts in the field of automation and control across the entire spectrum of industry. It is commendable that as a part of their international effort of "knowledge building through knowledge sharing", ISA Delhi Section has organized this conference focusing on the challenges of automation and control in the power sector. This conference is very relevant in the light of evolving changes in the technology spectrum and increased concern for the environment as the country moves ahead to add substantial power generation and distribution capacity. I am sure that this compendium of technical knowledge will be very useful to all practitioners of instrumentation, control and automation in the power sector.

I wish a grand success to ISA(Delhi) POWAT-2012.

(D.K. JAIN)

एनटीपीसी भवन, स्कोप कम्पलैक्स, 7 इन्स्टीट्यूशनल एरिया, लोधी रोड, नई दिल्ली–110003 / Tel. : 91-11-24361536, 24362050
NTPC BHAVAN, SCOPE COMPLEX, 7, INSTITUTIONAL AREA, LODHI ROAD, NEW DELHI-110003 Fax : 91-11-24362421 Website : www.ntpc.co.in

न्यूक्लियर पावर कॉर्पोरेशन
ऑफ इण्डिया लिमिटेड
(भारत सरकार का उद्यम)
NUCLEAR POWER CORPORATION OF INDIA LIMITED
(A Govt. of India Enterprise)

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C-2-04, Nabhikiya Urja Bhavan, Anushaktinagar, Mumbai-400 094.

दूरभाष/Phone : 022-2599 5070
टेलीफैक्स/Telefax : 022-2550 4212
निवास/Resi. : 022-2556 8052
ई-मेल/E-mail : akchandra@npcil.co.in

ए. के. चंद्रा
अधिशासी निदेशक (सी एंड आई, इलेक्ट्रीक एंड आर एंड डी-ईएस)
A. K. CHANDRA
Executive Director (C & I, Elect. & R&D-ES)

MESSAGE

I am happy to learn that the "The International Society of Automation" ISA Delhi Section is organizing Power Automation Technology Event on January 13-14, 2012 focused on I&C applications for the Power Sector.

India has been experiencing a very high growth rate and to maintain this rate it is necessary to enhance the infrastructure substantially. The availability of power is crucial for industry and is also very important to improve our quality of life.

Presently a major share of power is produced using fossil fuels which are depleting rapidly and are also adversely affecting the environment. It is important to pursue the use of clean fuels, including nuclear, which are environment friendly and also economically viable.

The role of I&C in generating power safely and economically is crucial. A meeting of automation professionals under the auspices of ISA Delhi will provide a good opportunity for exchange of information and updating of knowledge.

I wish the POWAT-2012 all success in the endeavour to achieve adoption of latest I&C technologies to achieve safe and efficient power availability in the country.

AKChandra

(A.K. Chandra)
Distinguished Scientist

LANCO
Always Inspiring

Message

I congratulate ISA-Delhi section having taken such initiative in organizing Mega Automation Event, POWAT-2012 which provides a common platform for all the stakeholders of control and automation community.

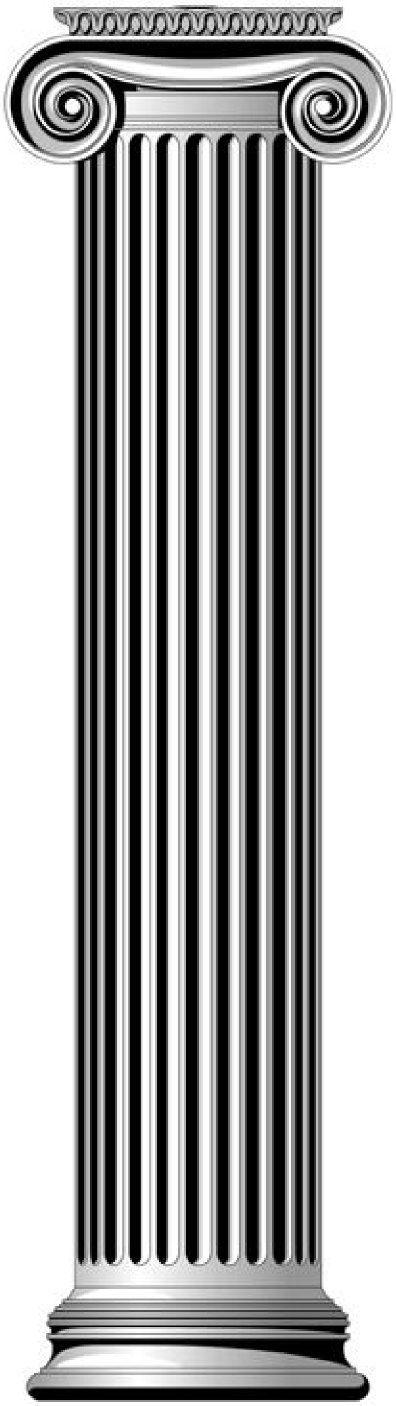
The formation of such forum is very apt and encouraging which will engage the automation professionals and drive towards safe, reliable, efficient and environment friendly power availability in the country. I am very much delighted over the mission and vision statement of POWAT-2012 "Automation – Innovating for Evolving Challenges" which is really the need of the hour to meet the future challenges.

I wish this event a grand success and believe this will be a land mark event in the years to come.

S. C. Manocha
CEO & Whole Time Director

Lanco Infratech Limited
Office: EPC Division, Plot # 404-405, Udyog Vihar, Phase-3, Gurgaon-122 016, Haryana, India.
T+91-124-672 5200/672 6800 **F**+91-124-672 6900
Corporate Office: Lanco House, Plot # 397, Udyog Vihar, Phase-3, Gurgaon-122 016, Haryana, India.
T+91-124-474 1000 **F**+91-124-474 1088
Registered Office : Lanco House, Plot No.4, Software Units Layout, HITEC City, Madhapur, Hyderabad-500 081, A.P., India

ISA Delhi Section



The International Society of Automation (ISA)

Founded in 1945, the International Society of Automation (ISA) is a leading, global, nonprofit organization that is setting the standard for automation by helping over 30,000 worldwide members and other professionals to meet, interact and share their knowledge. Based in Research Triangle Park, North Carolina, ISA is organised into 14 districts and hundreds of sections across the world. The South East Asia region is designated as District-14 and within this district, the Delhi Section is an active organization drawing members from the entire spectrum of automation Engineers across Power, Oil & Gas, Consultants, Automation system & component Manufacturers, system integrators and many other industries.

ISA has been involved in promoting emerging technologies across the globe by a variety of ways such as:

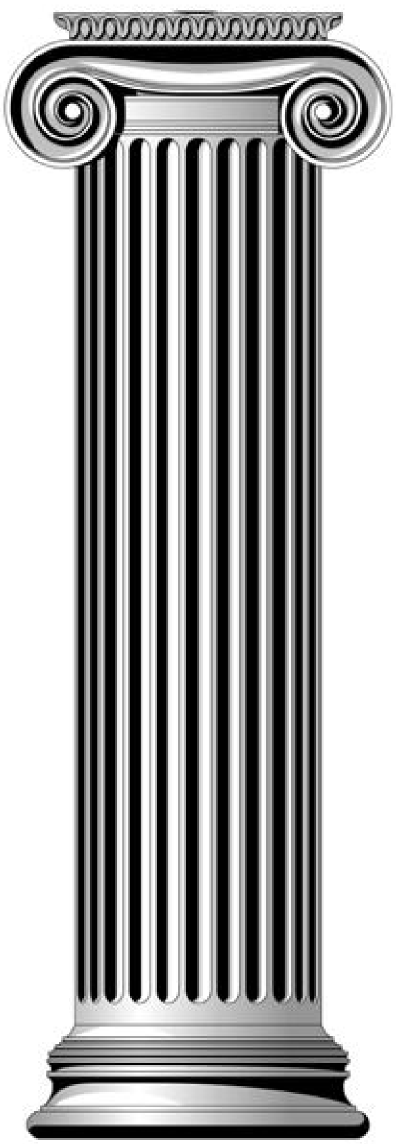
- Developing and updating standards for existing & evolving technologies in automation related fields ;
- Publication of Text-books, hand-books, journals, proceedings etc. on a wide array of automation related subjects from primary field sensors to integrated automation and management systems for various kinds of plants & processes;
- Facilitating Interface & interaction with other agencies like IEC, IEEE, EPRI, ASME and others to develop and maintain automation related standards with regular updations, keeping pace with the march of technology in various fields;
- Organising of Training seminars/workshops, webinars and Exhibitions like ISA-Expo held regularly in the USA for knowledge dissemination;
- Carrying out certification programs for technicians, engineers and senior professionals.
- Recognizing the talented and the dedicated professionals in the field of Automation through various honours and awards
- Enabling Interaction with Student members, formation of student section and annual scholarships, competitions etc. are many interesting student programs of the ISA.

The ISA Delhi Section - ISA(D)

ISA Delhi Section had been formed almost a decade back and has progressed well since then with a membership of more than 350 and growing. ISA Delhi Section had taken many initiatives in the past including organizing two exhibitions ISA (D) EXPO' 05 & '07, a large number of seminars and workshops on emerging technologies. Regular Monthly technical exchanges on diverse topics are organised for the benefit of all members of ISA(D), thereby increasing the knowledgebase & technical capabilities of members.

ISA Delhi Section has taken quite a few initiatives in the recent past to better address the need for knowledge sharing among industry specific groups of Automation Engineers. Notably, within the overall ambit of ISA(D), two industry specific interest groups have already been created, one for the Power Industry namely Power Automation Group or POWAT and one for the Oil & Gas Industry called Petroleum & Natural Gas Industries Automation Domain or PNID. ISA(D) is also encouraging the

ISA Delhi Section



formation of a systems Integrators forum, so as to share the vast scattered knowledge base resources of systems integrators community.

ISA(D) Power Industry Automation Technology Group (POWAT)

POWAT is an initiative taken by ISA-Delhi section to provide a common platform to all stakeholders of the Power Sector Automation community including users, power equipment suppliers, Automation system suppliers, system integrators, consultants, R&D establishments, academicians, independent experts and students for sharing of knowledge and experiences. The purpose of this forum is to enable learning from peers and industry experts and their experiences in the field of Power sector automation, so as to promote sustainable development of power sector automation solutions.

The vision of the ISA (D) - POWAT is :

"Take the automation in the Indian power sector to global heights and acquire numero-uno position.''

The mission of the ISA (D) – POWAT is :

"Engage all stake holders of power sector in adopting the latest instrumentation and automation standards, there-by achieving safe, reliable, efficient and environment friendly power availability in country.''

To realize the above vision and to execute the mission, the various long term and short term activities being carried out by ISA(D) - POWAT are :

- Enable knowledge sharing among power sector automation fraternity including utilities, consultants, equipment manufacturers, suppliers and academicians.
- Facilitate through integrated automation, the realisation of a world class power plants in India with green, clean and lean visualization, there-by establishing global benchmarks in power generation in terms of reliable & quality power, at a competitive cost.
- Provide an opportunity for Indian power sector automation experts to get an exposure to the global developments in automation and there by providing an opportunity to seek & implement latest state-of-the-art global solutions best adapted for India Specific conditions.
- Provide an interface for the automation fraternity with the policy markers and regulators

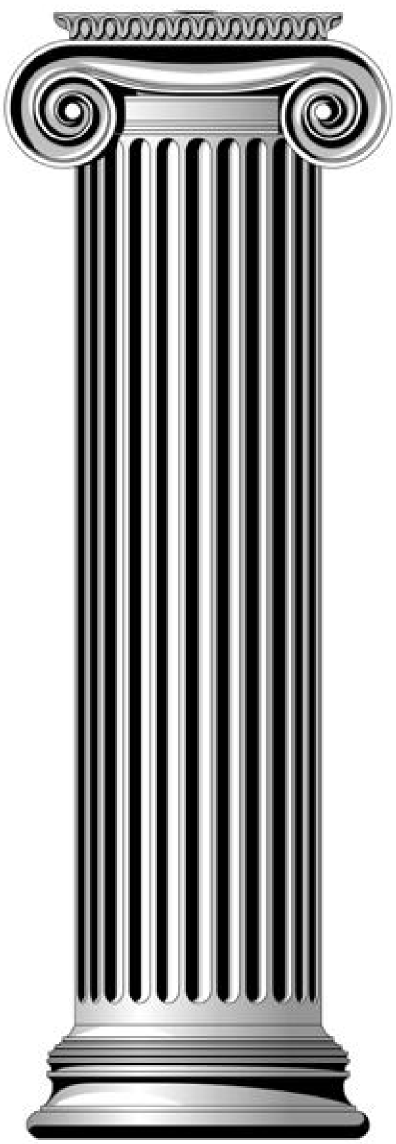
We believe that the engagement and involvement of various stake holders including technology providers and developers would certainly help in achieving the roadmap for implementing strategies for level-4 automation so essential for a worldclass power utility.

POWAT-2012

After the successful conclusion of POWID-INDIA-2009 organized in Delhi on 24-25 April-2009 and POWID-INDIA 2010 organised in Mumbai on 28-29, ISA Delhi Section Proudly announces the largest focused Power Sector Automation Show POWAT-2012 on 13-14 January 2012, at the Grand Hotel, Nelson Mandela Road, Vasant Kunj, New Delhi.

The two day conference and exhibition seeks to engage all stakeholders & players in the field of Power Sector Automation. The Symposium intends to engage automa-

ISA Delhi Section



tion experts from Thermal Power, Nuclear Power, Hydro Power, Renewable Energy, Transmission & Distribution, Automation Providers/manufacturers, system integrators, consultants, R&D Organisations, academicians and others for an invigorating exchange of knowledge. We attempt to bring on stage, the key technology issues before a well represented audience from the full spectrum of the Indian Power Sector.

It is our Endeavour to develop a technology road map through continual efforts and various programs of POWAT, so that Indian power industry can develop a vision of being world class, by retaining the leadership through the management of Innovation, R&D, technology and talent. This calls for the involvement of not only the technocrats, scientists' academicians, IT and management professionals, but also the senior policy and decision makers and doyens of industry to influence future course of power industry in India. Over and above, it also necessitates the continuous engagements of leaders and stalwarts, not only from the fields of automation and it but also from diversified disciplines like project Management, Finance, Power Generation / transmission/ Distribution, Administration, Macro Planning, Manufacturing, Environment Planning/Engineering, Government, Quality and host of other domains, sectors divisions.

This is meant to be a continuing endeavor ever pushing the power industry to the forefront of technology and performance leadership.

A power packed, two days program with event theme as **"Automation – Innovating for Evolving Challenges"** is being planned to satiate the ever-increasing demand of knowledge sharing among automation professionals of Power industry.

2011-2012 ISA Section Leaders Report Form

FAX TO MEMBER SERVICES AT 919-549-8288
DUE BY 01 May 2011

Name of Section: ISA DELHI SECTION **District #:** 14

Person Completing Form: Alok Shrivastava **Position:** President

Effective Date Leaders Take Office: 01/05/2011

Positions were confirmed by: Outgoing President ! Incoming President !

Position	Name	Mem. #	E-mail Address
President (3130)	Alok Shrivastava	32247966	alok@ntpceoc.co.in
President-elect (3150)	Atish Chakraborty	32899583	chakrabartya@iocl.co.in
Vice President (3390)	S K Dhawan	33187323	sk.dhawan@eil.co.in
Secretary (3250)	Anil Mishra	32972095	anil.mishra@cadtechindia.com
Treasurer (3350)	Anil Chaudhary	32247401	anil@elconsys.in
Delegate (1370)	S Verma	32154992	sureverma@hotmail.com
Alt. Delegate (0030)	R Goyal	32180883	eipenviro@gmail.com
Program Chair (0950)	P P Patil	33137157	pppatil@ntpceoc.co.in
Education Chair (1350)	R K Bassi	32941231	rkbassi@yahoo.com
Membership Chair (0790)	Arun Gupta	32929694	arung@indure.com
Newsletter Editor (2970)	S S Garuryar	32929692	ssgaruryar@yahoo.co.in
WebMaster (3420)	Parag Tyagi	33129449	paraag@wissenautomation.com
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Marketing Chair (1010)	Akash Sharma	33129424	asharma@provibtech.com
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Honors & Awards (0510)	N K Pande	04117201	pande.nk@gmail.com
Historian (1990)	S Suderson Rao	33117790	ssrao46@gmail.com
Student Section Liaison (2870)	S Bhattacharya	33146690	soumitra@ntpceoc.co.in
Section-Division Liaison (2850)	S Mahesh Kumar	32978456	s.mahesh.kumar@eil.co.in
Standards & Practices (1150)	S Samanta	33137156	ssamanta@ntpceoc.co.in
Past Section President (3090)	Prasenjit Pal	32156518	prasenjit@ntpceoc.co.in
Other (2950) Sr. Advisor	M P Singh	32046378	mp1.singh@jalindia.co.in
Other (2950) Sr. Advisor	N K Pande	04117201	pande.nk@gmail.com
Other (2950) Sr. Advisor	R G Dhalwani	32205732	rdhalwani@deseinindure.com
Other (2950) Sr. Advisor	Mrs. Arundhati Bhattacharya	32972094	arundhati@ntpceoc.co.in
Other (2950) Sr. Advisor	Rajiv Gupta	33158320	rajiv.gupta@eil.co.in
Other (2950) Sr. Advisor	Naveen Sharma	33195630	naveen.sharma@lancogroup.com

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	Y. K. Sehgal, ED(Smart Grid) PGCIL
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	Shri Sankar Chattopadhyay, Reliance Infra Limited
	Sh R G Dhalwani-Senior Consultant Desein
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	Sh S Samantha
	Sh Prasenjit Pal
B)Program execution and logistics	**Sh Anil Choudhary**
	Sh Arun Gupta
	Sh Akash Sharma
	Sh Parag Tyagi
	Sh Prashant Patil
	Sh Anil Mishra
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	Sh Neeraj Kumar
	Sh Manish Mumar
	Sh Raja Shekhar Gudipaty
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	Sh. Akash Sharma
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	Sh. Radheyshyam Tiwari
D)Venue seclection and Survey	**Sh Ravinder Goyal**
	Sh Akash Sharma
	Sh Anil Mishra
F)VIP follow up and protocol handling	**Sh. Prasenjit Pal**
	Alok Shrivastava
	Sh. Surendra Verma
E)Delegates follow up.	**Sh N.K. Pande**
	Sh Anil Mishra
	Sh Parashant Patil

Team ISA Delhi (2011-12)

Sh Prasenjit Pal
Convener POWID

Sh Rohit Bhardwaj
Chief Patron

Sh Atish Chakrabarty
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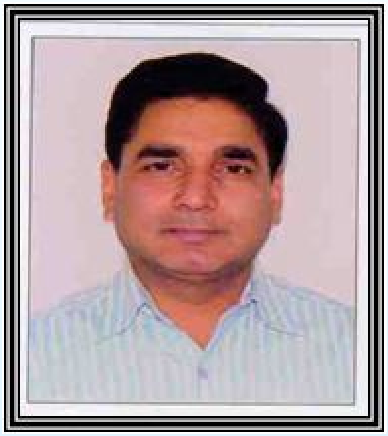

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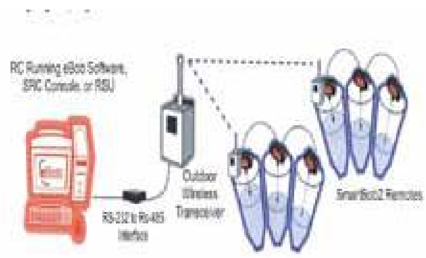

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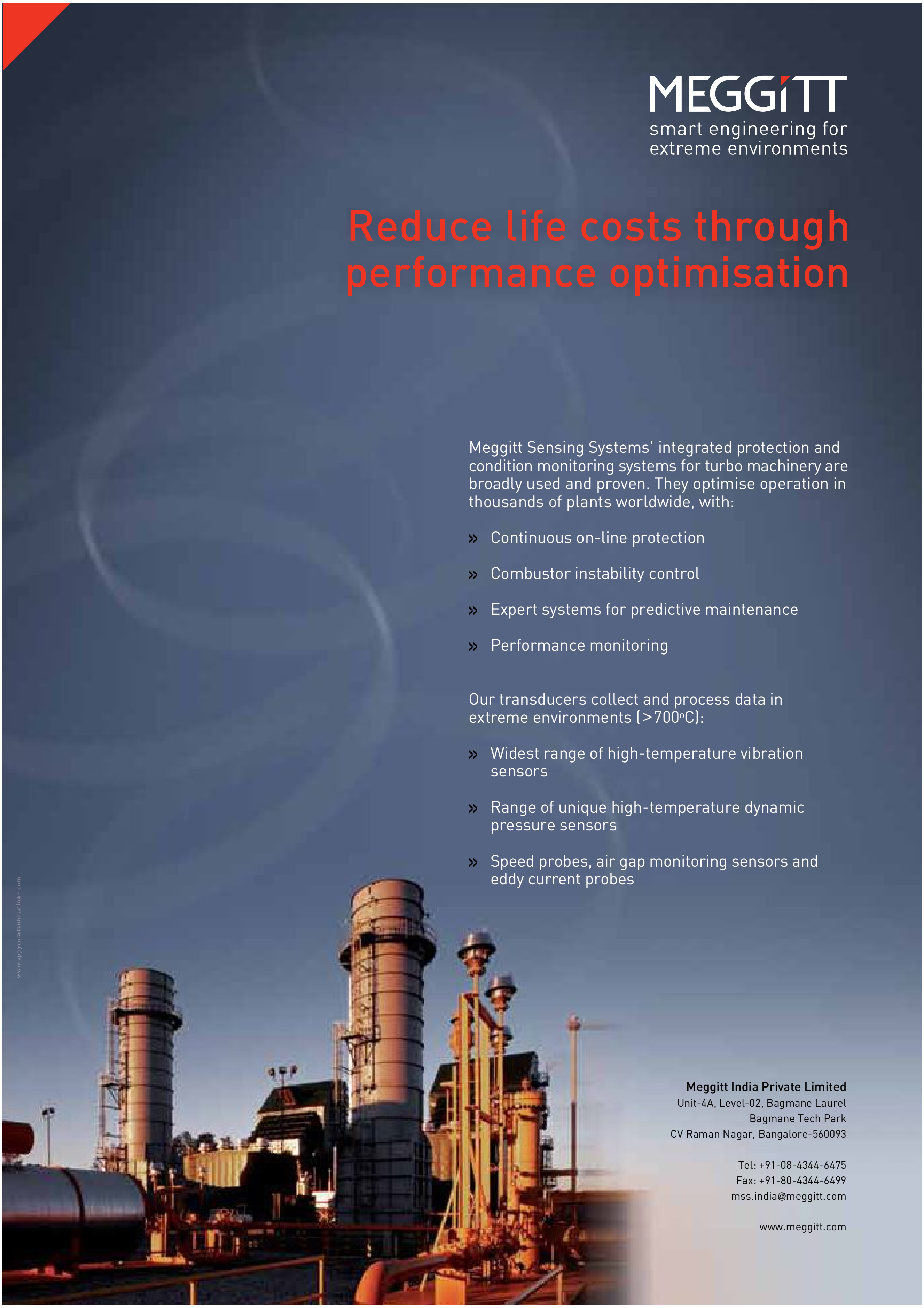
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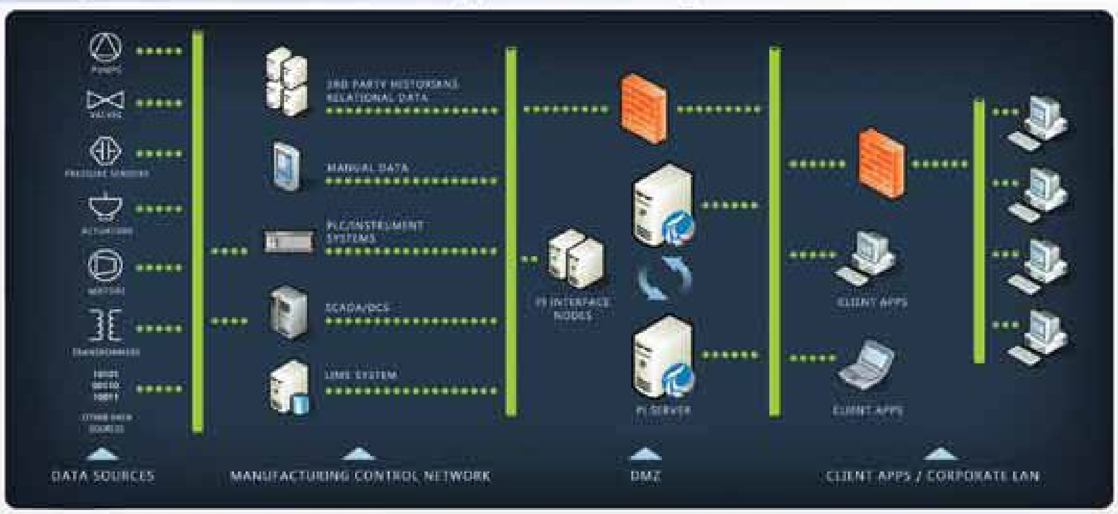

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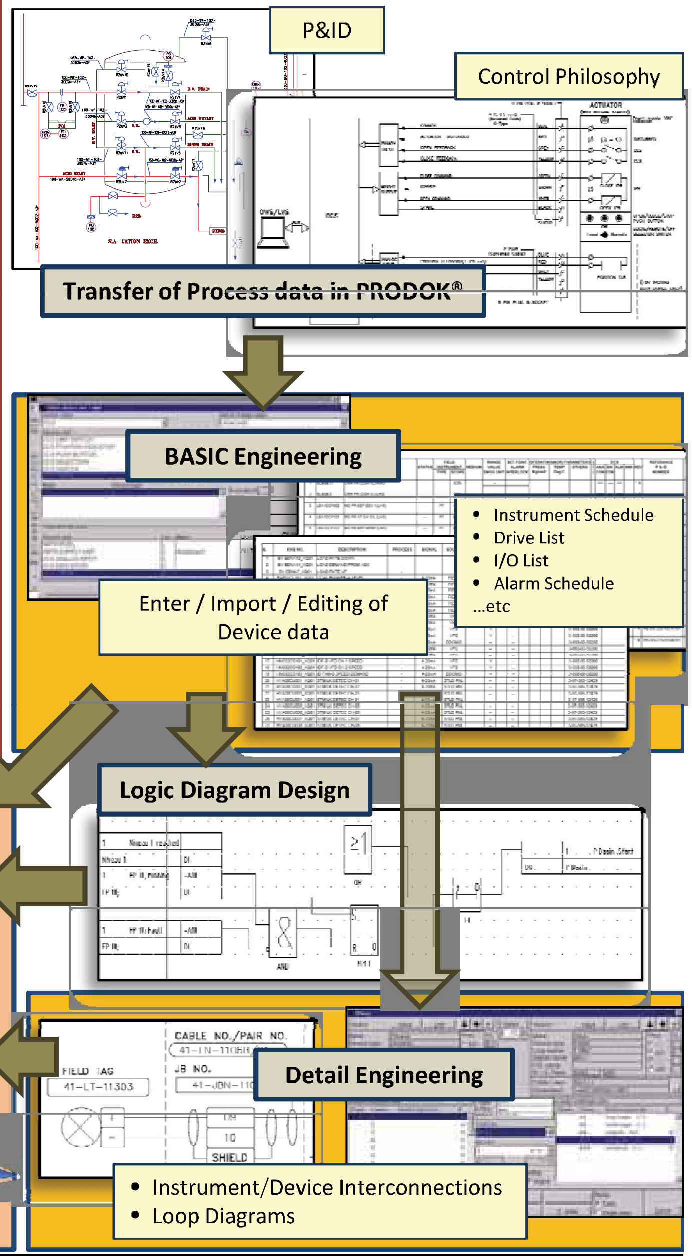

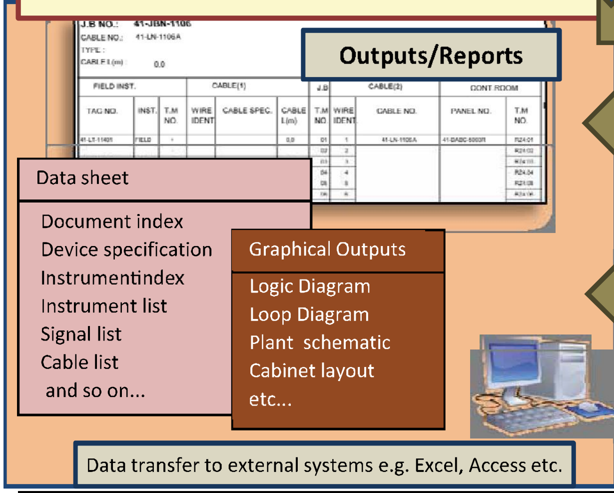

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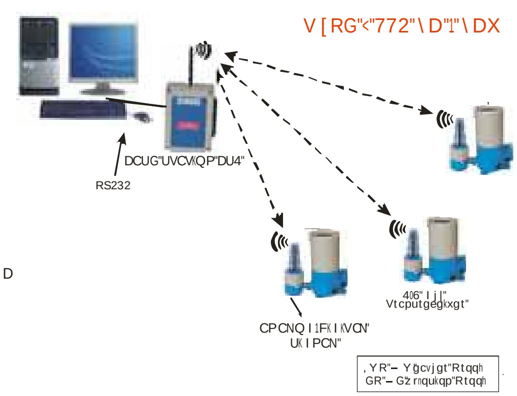

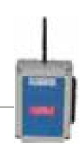

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"Challenges of Control and Instrumentation System in Indian Electric Power Industry"

By Soumitra Bhattacharyya

As per the Integrated Energy Policy developed by planning commission of Govt. of India, by 2031-32 power generation capacity must increase to nearly 8, 00,000 MW from the present level of approximately 185496 MW (As on 30.11.2011) .Power requirements by 2017 would be about 300000 MW.

Meeting the energy challenge is of fundamental importance to India's economic growth targets and its efforts to raise its level of human development. The broad vision behind the energy policy is to reliably meet the demand for energy services of all sectors at competitive prices. The demand must be met through safe, clean and convenient forms of energy at the least cost in a technically efficient, economically viable and environmentally sustainable manner. Considering the shocks and disruptions that can be reasonably expected, assured supply of such energy and technologies at all times is essential to providing energy security for all. Meeting this vision requires that India pursues all available fuel options and forms of energy, both conventional and non-conventional. Further, India must seek to expand its energy resource base and seek new and emerging energy sources. Finally, and most importantly, India must pursue technologies that maximize energy efficiency and conservation. Coal shall remain India's most important energy source till 2031-32 and possibly beyond. Thus, India must seek clean coal technologies and, given the growing demand for coal, also pursue new coal extraction technologies such as in-situ gasification to tap its vast coal reserves that are difficult to extract economically using conventional technologies.

As already mentioned, in order to achieve reasonable energy security and to insulate the energy supply from reasonably expected supply disruptions and shocks, electricity generation through diverse fuel options and forms of energy, both conventional and non-conventional should be explored. Pursuing diverse fuel options will not only enhance energy security but also reduce carbon intensity of our power generation fleet, establishing the company's image as a clean company.

Coal has been undisputedly recognized as the most important energy source till 2031-32 and possibly beyond. While exploring technological solutions, India is therefore, concentrating on reducing environmental impact and increasing the efficiency of coal based generation, so as to optimally use this perishable resource. Clean coal technologies such as Supercritical and Ultra Supercritical technologies, SOx / NOx / Mercury / SPM/ RSPM reduction technologies, and development of IGCC is the key focus areas in our plans.

Meeting the energy needs of the future requires rapid capacity addition using all the possible energy options including coal, hydro, nuclear, and renewable resources. In addition to this the available fuel options should be utilized in the most efficient way so as to meet the environmental and economical challenges. Supply-chain management, Life cycle optimization, and advanced process automation to operate most efficiently are essential to build the energy infrastructure of the future so as to meet the rapidly increasing demand in safe, efficient, environmentally clean and economical ways.

Meeting these challenges will create new opportunities in building innovative solutions for project planning, management, construction, operation, and R&M encompassing the three dimensions of lifecycle optimization, automation, and the chain management from customers to suppliers.

Control & instrumentation systems for the power industry:-

Control & Instrumentation systems are the prime movers behind the successful functioning of power plant equipment & rightfully, termed as brain and the nervous system of the power plant. The key demands from Control & Instrumentation systems for the power industry are :

- **Improvement in Plant Availability :**
- **Reliability:**
- **Efficiency:**
- **Asset management:**
- **Environmental norms:**

- **Safety:**
- **Security:**

These parameters are very vital for power plant & by proper designing of the control & instrumentation systems, these can be improved upon.

C&I technologies of the future:

The power industry have a come a long way in the field of control & instrumentation systems; from relay based systems to solid state, to microprocessor based DDCMIS with advanced software. Based on continuous learning and experience gained over the years, the C&I engineers have adopted proven state of the art technologies, and embarked on study on new vistas of technology.

Some of the latest technologies generally adopted include

- Smart positioners for control valves resulting in reduced commissioning and improved diagnostics;
- Temperature transmitters adoption for improved availability, reduced inventory, improved diagnostics and reduced cabling for on going projects;
- Selectively introduced Wire-less communication technology for having operation of the most remote location of power plant without using expensive cables.
- Latest instruments, based on Radar/Ultrasonic principle
- Large video Screen (LVS) based operation, Boiler Flame and CCTV integration on main plant LVS screen for improving the overall operation and maintenance of power plants.
- Field Bus for selected areas to avail of its benefits
- Several innovative concepts have been adopted like introduction of combined control room for main power plant as well as off site areas, adoption of DCS based unified hardware for main plant as well as off site areas, Plant wide integration of all auxiliary plants for monitoring and control through integrated station wide LAN
- A state of the art integrated simulator for 660 MW /800MW
- DCS network architecture designed for better security while ensuring connectivity with ERP systems

Some of the challenges & end user concerns are:-

• Obsolescence-

Suitable solutions needs to be devised so that effect of obsolesce is not felt at the end user level. At the same time, end user should also not be deprived of the latest technology/ offering.

• Interoperability of the automation systems:-

One particular requirement of interoperability is the operation of control system of one DCS with HMI of another so that the power plant operator can be presented with a single unified user interface.

• Skill development and domain expertise:-

Power plant being a very specialized area, domain expertise is required for automation professionals. Training facilities matching these requirements needs to be developed.

Effective tools for analysis & operator training: There is always a increasing demand for more facilities & suppliers should aim at bridging this gap as much as possible.

Conclusion

In spite of the challenges ahead, we the C&I engineers irrespective of belongingness to public sector of private sector, we need to gear up so that control and monitoring of the main equipments come to the optimum level. Thus, the older station will come to the level to new power station after renovation while the new power station shall exhibit highest efficiency along with full reliability.

Soumitra Bhattacharyya: Soumitra Bhattacharyya graduated in Electrical Engineering from NIT, Durgapur and a post graduate from IIT, Delhi. He has 31 years of experience Maintennace and Design / Engineering activity of fertilizer plants, Thermal Power Plants including combined cycle projects of various sizes. He is the head of the Technical Committee and the technical coordinator of POWAT 2012

सत्यमेव जयते

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ISA DELHI SECTION

POWAT-2012

Programme Details

Date-13th-14th Jan-2012

HOTEL **The Grand**
Vasant Kunj - Phase II, Nelson Mandela Road,
NEW DELHI

ISA Delhi Section

DAY-1	13-Jan-12	
	Time From	Time To
Registration	**9:00 AM**	**9:45 AM**
Inauguration Session		
Arrival of Chief Guest Sh. Arup Roy Choudhury	10:00 AM	
Welcome of Dignitaries with Bouquet	10:05 AM	
Lamp Lighting	10:10 AM	
Welcome address by ISA-D president	10:15 AM	
Key Note Address By Sh Ravi Kapoor Head EPC -Thermal, Lanco Infratech	10:25 AM	
"Adress By Chief Patron ISA(D) POWAT Sh D.K Jain Director(Technical) NTPC"	10:35 AM	
"Address by Guest of Honour, CMD PDIL Dr M Ravi Kanth"	10:45 AM	
"Address by Guest of Honor, CMD ECIL Sh Y S Mayya"	10:55 AM	
"Address by Chief Guest, CMD NTPC Sh Arup Roy Choudhury "	11:05 AM	
Release of Souvenir by Chief Guest	11:20 AM	
Vote of Thanks by Convener-ISA(D) POWAT-2012	11:25 AM	
Inauguration of Exhibition by Chief Guest and Dignitories	11:30 AM	
Tea Break	**11:50 AM**	**12:20 PM**
"Session-1 "INVITED PAPERS - POWER SPECTRUM"	**12:30 PM**	**1:30 PM**
Session Chair : Sh Sharad Anand ED-Engg NTPC Limited*	**"Session Co Chair : Sh G Ganpatiraman, ED-BHEL-EDN**	
Invited Paper on Automation in Nuclear Power Generation	"Mr. A. K. Chandra ED (C&I, E, R&D-ES),	NPCIL, Mumbai
Invited Paper on automaion in T&D - Smart Grid	"Y. K. Sehgal, ED(Smart Grid)"	PGCIL, Gurgaon

Invited Paper on Automation in Power Generation(Thermal)	"Mr. Sai Kumar, DGM "	BHEL-EDN, Bangalore
*Requested		
Networking Lunch Break	1:30 PM	2:30 PM
"Session-2 "Automation in Thermal Power plants "	**3:00 PM**	**4:30 PM**
Session Chair : Sh Vinod Sharma CEO Meja Urja Nigam Pvt limited*"	**"Session Co Chair : Mr. K R Bhardwaj AGM -HOD -C&I PEM BHEL "**	
Volume measurement using 3D technology	Mr Motti Holller	P.M Automation Solutions Ltd.,Tel Aviv, Israel
Microwave Blade Tip Sensing: Capabilities for Turbine Operators	Scott Billington, Michael Hafner, Tom Holst.	Meggitt Sensing Systems,Route de Moncor 4 Fribourg, Switzerland
Hazardous Area Classification and methods of preventing fire and explosion hazards in Gas & Coal based Thermal Power Plants.	Ashok Kumar Panda, Nikhilesh Kumar & Soumya.	Lanco Infratech Ltd
PARTICULATE EMISSION MONITORING BY USING TRIBOELECTRIC TECHNOLOGY	Karl Ehrström; CEO; Finland;Vikram Singh	"Sintrol Oy; Helsinki; Area Sales Manager; Sintrol Oy; New Delhi; India "
*Requested		
Tea Break	4:30 PM	5:00 PM
Session-3 "Automation Solution in Combined Cycle Power Plants"	5:15 PM	6:45 PM
Session Chair : Mrs Arundhati Bhattacharya, GM PE-C&I, N T P C limited	**"Session Co Chair : Sh Siddharth Ghoshal, Director GE Energy"**	
Remote Operations and Monitoring of Origin Power Station and Managing Security of control systems.	"Ravi Malik, I & C Lead - Generation "	"Origin Energy, Australia "
Output Loss Analysis – A tool to monitor Real time performance losses of a CCGT power station	Diwakar Kaushik& Vinay Pratap Singh	NTPC ERP
REDUCING UNCERTAINTY IN FUEL GAS MEASUREMENT BY MASS SPECTROMETRY	Peter J Traynor ;Dr. Robert G Wright	"Thermo Fisher Scientific, Sugar Land, TX; Thermo Fisher Scientific, Winsford, Cheshire, UK"
GREENHOUSE GAS EMISSIONS REPORTING – COMBINED CYCLE POWER PLANT	"V V V Prakash, Kalluri Anjaneyulu"	Bechtel India Pvt.Ltd, New Delhi
Power Quiz & LUCKY DIP	**7:00 PM**	**8:00 PM**
Quiz Masters : Prasenjit Pal & P. Sengupta		

Bon Fire -Lohri & Networking Dinner	8:00 PM	
Day-2	**14-Jan-12**	
	Time From	Time To
Session-4 Automation in Nuclear Power plants	9:30 AM	11:00 AM
Session Chair: **Sh A K Chandra - ED (C&I, E, R&D-ES), NPCIL, Mumbai**	**Session Co Chair-** **Sh Ajit Kumar - GM Nuclear NTPC**	
Radiation Monitoring System in Indian Nuclear Power Plants	Vinayak B,N P Panchal, N S Kaintura	NPCIL
Fuel Handling Controls in Pressurised Heavy Water Reactors	Nitin Rimza, S Bandyopadhyay, Joe Peter K,P Nagabhushana, M Bharathkumar, K Agiladaeswari	NPCIL
Power Control Requirements, Instruments and Techniques for Indian PHWRs	S Thangapandi, Sujit Chattopadhyay R Balasubramanian,	NPCIL
Reactor Control and Protection System of VVER-1000	Kamlesh Nathani, Mrs Nabanita Pyne, S K Sen	NPCIL
Networking Tea Break	11:00 AM	11:30 AM
Session-5 **Automation advancement in Various Fields including Transmission and Distribution**	**11:45 AM**	**1:15 PM**
Session Chair:- **Sh Y K Sehgal, ED Power Grid Coorporation**	**Session Co Chair-** **Sh N K Kothari, GM NTPC Badarpur**	
EDIFYING THE SMART FUTURE OF POWER UTILITIES BY ANALYSING THE CONCEPT OF GENERATION SIDE VIRTUAL POWER	Saroj Chelluri DGM (PE-Elect) NTPC Ltd, Amit Kulsheshtra DGM (PE-Mech) and Prasenjit Pal DGM & STA to Director (Tech), NTPC Ltd	NTPC Ltd
Application of Foundation Fieldbus and DART Technology in Power Plants	Arasu Thanigai	Business Development Manager;Pepperl+Fuchs Pte Ltd;Singapore
Power to control the process control	Ms Anuja Thukral	PHOENIX CONTACT (INDIA) PVT. LTD.A-58/2, Okhla Industrial Area, Phase- II,New Delhi - 110020, India
Implementation of BOP PLC Standardization and BOP Network at Rosa Power Plant.	Viswanathan Kumar	Reliance Infrastructure Limited, Noida.
* Requested		
Networking Lunch Break	1:15 PM	2:15 PM

Session-6 **Plant Asset Management**	**2:15 PM**	**4:00 PM**
Session Chair : **Sh N K Shrivastava - GM R&M ,NTPC Limied**	**Session Co Chair** **Sh Pankaj Bhartiya , GM Cen-PEEP,NTPC Limted**	
Fleet Optimization through realtime enterprise integration	Mr. David Thomason	OSI soft
Effective Planning of Resources and Monitoring Overhaul Preparedness through ERP	Mr Anand Prakash & Mr Vinay Pratap Singh	NTPC ERP
Development of automation mechanism for inspection of power plant components in critical areas	Kishore Aggarwal, Badri Vishal Gupta and Rakesh Kumar Chakraborty	NTPC NETRA
" ADVANCE VIBRATION ANALYSIS & DIAGNOSIS SYSTEM FOR POWER PLANT ROTARY MACHINE – IT SAVES COST AND INCREASES UP TIME. "	MUKESH VYAS	Division Head – IndiaForbes Marshall P Ltd Shinkawa VMS Systems
"Monitoring plant assets using optimum selection of "Technology & Methodology "	"Pankajkumar Sharma Sr. Services Manager, Machinery Diagnostics Services"	GE India Industrial Private Ltd. (Div. Bently Nevada),
	4:00 PM	4:30 PM
GM R&M ,NTPC Limied		
Session-7 **Automation in Hydro power and renewable power solution**	**4:30 PM**	**5:30 PM**
Session Chair: **Sh AK Gupta, GM (Buisness Development) NTPC Limited**	**Session Co Chair-** **Sh Ramani Iyer, Forbes Marshall Limited**	
Latest Technologies of Field Instrumentation, Data Collection and Reporting for Dams and Related Structures	V K Rastogi	Encardio-rite Electronics Private Limited, Lucknow, India
Two axis Solar Tracking System	S.P.S. Pundir, Rakesh Swami, Vishal Singh	NTPC Netra
Solar Thermal Power Plants – An Overview of Automation	R C Kamath	ABB India
Session-8: **Panel Discussion on Challenges of rapid obsolescence in Automation System and Valedictory session.**	**5:45 PM**	**7:30 PM**
Sh S.P Singh Dir(HR) NTPC limited session Chairman		
Sh S.C. Pandey ,RED(WR-1) NTPC Limted *		
Sh Ravi Kapoor Head EPC Th-Lanco Infratech*		
Sh Shirsh Chandra Yukogawa India Limited		

Sh Rajeev Sharma ,Alstom Power*		
Panel Secretary-S Soumitra Bhattachrya (Technical coordinator POW-AT-2012)		
*Requested		
Networking Dinner	**7:30 PM**	
Note:-The programe contents may change depeneding on final paper scrutinity by the High Power Technical Committee of the technical Papers		

Invited Papers Power Spectrum

I&C for Safety of Nuclear Power Plants

A. K. Chandra
ED (C&I, E, R&D-ES), NPCIL, Mumbai

The Instrumentation & Control (I&C) systems in a nuclear power plant monitor the health of the plant and are designed to maintain the plant in a safe state. The systems carry out several important functions including protection, control, and monitoring and provide all information to the operator.

The main safety objective in NPPs is to prevent release of radioactive products in the environment beyond acceptable limits. Safety considerations are critical in the design and operation of I&C systems. Safety is achieved by application of the principle of defence in depth i.e. by providing several layers of protection. Thus, control systems maintain relevant plant parameters within their operational limits. If any parameters cross their operational limits, the control systems reduce the reactor power till the parameters return to within limits. If any parameters exceed the safety limits, the reactor shutdown systems activate and shut-down the reactor to prevent any accident.

I&C systems which ensure plant safety are classified as Ia systems and are designed to meet stringent safety requirements. Such systems are physically, functionally and electrically isolated from other systems. I&C systems which ensure plant safety by maintaining the plant parameters within the safety envelope or monitor the health of Ia safety systems, are classified as Ib systems. I&C systems which carry out surveillance and contribute indirectly to reduction of possibility of safety being challenged are classified as Ic systems. The stringency of qualification requirements to be met by Ib and Ic systems are progressively reduced.

The safety life cycle of a Digital I&C System consists of the entire period from defining the requirements through development and installation and commissioning to the operation of the system. The development of such systems is carried out using engineering procedures which helps achieve quality. The procedures define the standard work methods for carrying out each phase of the life cycle, viz. design, development and testing. The procedures identify the documents to be prepared at various stages of the life cycle and also describe the nature and structure of information content of the same.

The Safety Case includes documentary evidence to demonstrate that the system has been developed complying with regulatory requirements, has been subjected to Verification &Validation, and meets safety and reliability goals. The Regulatory Requirements include need to provide evidence of the Safety Case and the general design requirements including conformance to applicable guides.

OPTIMISATION FOR THERMAL POWER PLANTS

Mr. Sai Kumar
DGM , BHEL EDN

SYNOPSIS

In order to optimize the operation of Thermal Power Plant and thereby increase its economic efficiency, the plant is to be operated on the basis of a continuous performance evaluation of the units as well as all their major components and process parameters. Hence, it is essential that power is generated with the least possible input cost as well as to ensure better availability of the plant assets, least downtime and monitoring of key parameters of the plant on 24 X 7 basis.

BACKGROUND

PADO (Performance, Analysis, Diagnostics and Optimisation) is a software-based solution for overall power plant performance improvement. In a modern thermal power plant the control hierarchy the bottom most level is the overall plant Distributed Control System (DCS) for the SG, TG and Balance of Plant (BOP) controls. DCS interacts and controls the overall plant equipments with Human Machine Interface platform (HMI) residing at one level higher than DCS for Video Process Control through operator interface.

PADO is topmost level in the control hierarchy . This is a very powerful software tool, which enables the power plant operator to run the plant in the most optimised manner, helps him in analysing the plant operating parameters for better control, diagnosis and availability. All these eventually lead to a marked improvement in bottom line for the Utilities.

PADO is unique software package developed on multi-faceted technologies as mentioned below encompassing all the facets of a power plant is offered by BHEL in one platform in a fully integrated manner for informed decision making for the operators leading to improved operation efficiency and availability of the plant.

- **Data acquisition :**

Collection measurement data

- **Data Validation :**

To check the measurement values, replace the bad data by plausible one by Kohonen neural networks which when one or two data points fails out of a set of some twenty, the Kohonen chart generates plausible replacement.

- **Data reconciliation :**

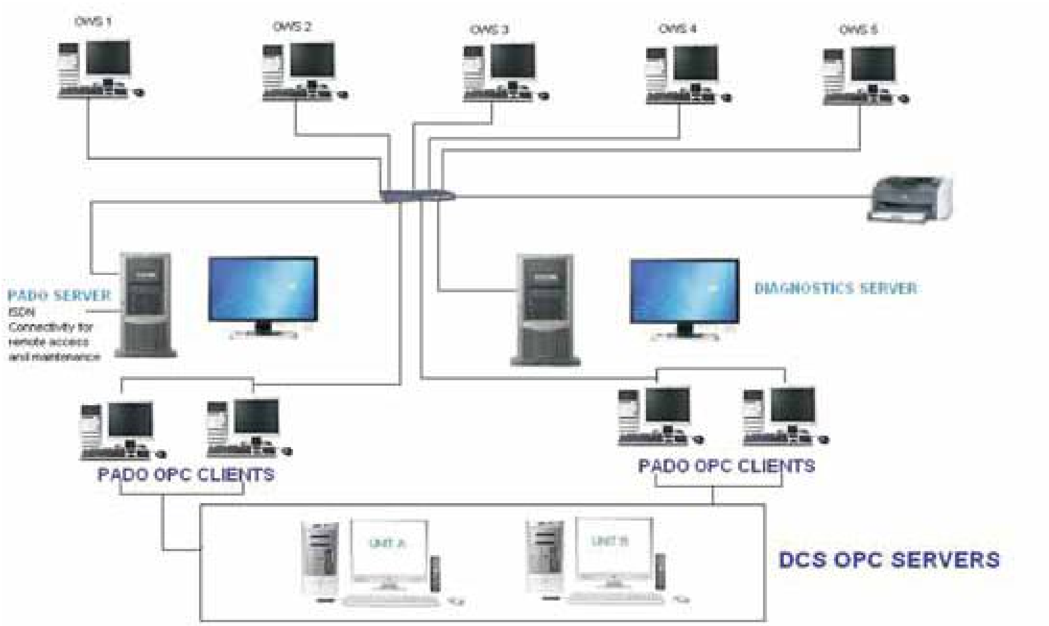
The method which is based on the mathematical algorithm and delivers set of reconciled measurement values with improved accuracy.

- Performance analysis and monitoring of system components
- Boiler performance optimisation
- Regenerative cycle performance optimization
- System performance optimization viz., Heat rate optimization and soot Blowing optimization
- Boiler stress condition analyser
- System performance Diagnostics
- Inter active water chemistry

This product has been supplied and installed first time by BHEL in the country in 500MW Thermal Power Plants for NTPC at Simhadri stage I

CONFIGURATION OF PADO SYSTEM

The PADO system hardware component consists of Servers, workstations, associated network and printer. High end Servers are provided for Optimization and Diagnostics functions separately. These servers acquire live data required for calculations through a suitable interface from Plant DCS. Several workstations are connected to these servers in LAN to display / view various PADO display screens. Reliable ISDN connectivity to PADO server is required on 24X7 basis for remote connectivity for installation of PADO softwares, remote monitoring, and accessing live / archived data for analysis, fine tuning and site adoption. Typical PADO system hardware configuration is shown in Figure – II.



PADO FUNCTIONALITIES:

1. PERFORMANCE ANALYSIS AND MONITORING OF SYSTEMS AND COMPONENTS:

This module displays the visulisation screens related to plant equipment efficiencies and performance parameters like heat rate and evaluation of controllable losses. Operator / Shift in charge gets an idea about the present working condition of the plant for optimisation of cost.

2. EMISSION ANALYSIS AND MONITORING:

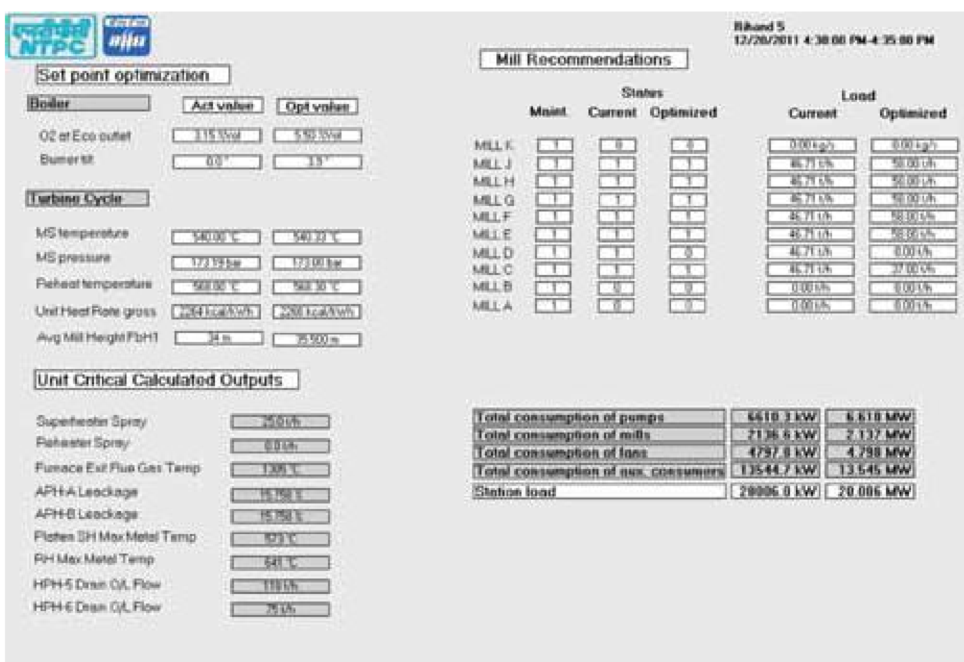
This module carries out emission monitoring of SOX, CO, NOX and Opacity.

3. SYSTEM AND PERFORMANCE DIAGNOSIS:

Used for detection of abnormalities in the process and warns operating personal to take corrective action by root cause analysis method. Primarily Equipment health Diagnosis for HIGH & LOW pressures, temperatures, level and vibration are carried out. In addition to this, Plant performance diagnosis for boiler, turbine, condenser, feed water and regenerative heating system are carried out.

4. SET POINT OPTIMIZATION:

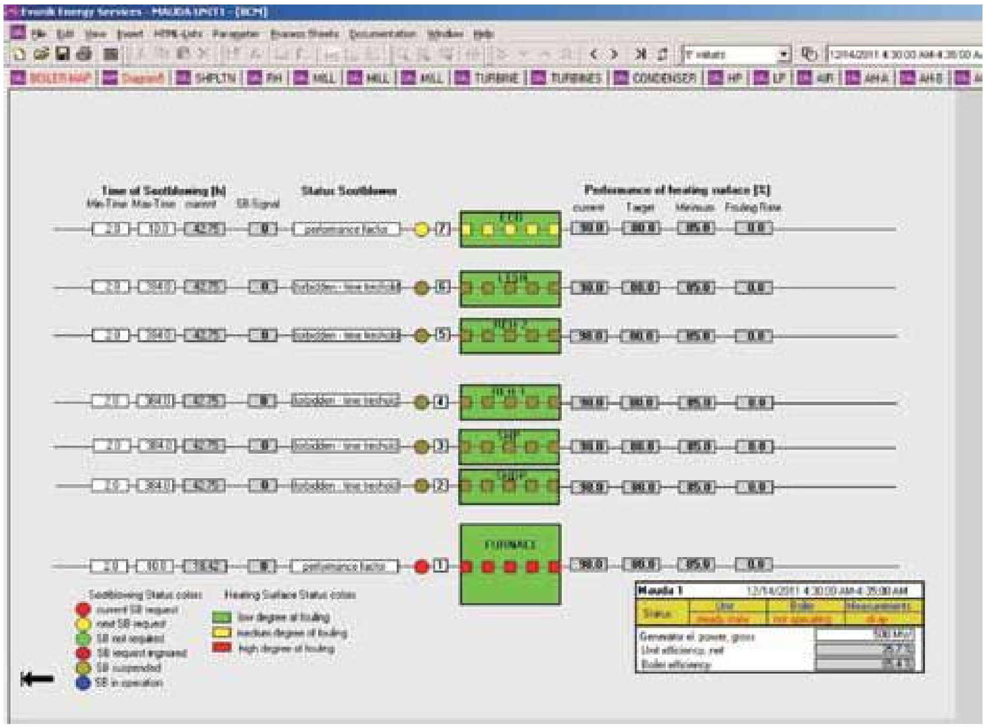
Set Point optimization indicating actual & optimum values for important plant operational parameters like Excess air, Burner tilt, MS temperature etc is carried out with the help of this module.



5. BOILER PERFORMANCE OPTIMIZATION INCLUDING OPTIMIZED OPERATION OF SOOT BLOWER SYSTEM:

Various boiler related calculations on Backward & Forward calculation, Zonal heat absorption, Fouling factor of heat transfer surfaces, Metal temperature calculation, Pulveriser performance evaluation, WHAT-IF Capability and Soot blowing optimization are carried out with the help of this module.

SAMPLE SCREEN SHOT OF BCM



6. BOILER STRESS CONDITION ANALYSIS:

This module continuously acquires operating temperature and pressures for thick walled components and calculates the resulting contributions from creep & fatigue as well as carries out lifetime monitoring for these plant components.

7. INTERACTIVE WATER & STEAM CHEMISTRY MANAGEMENT SYSTEM:

This module mainly carries out diagnosis for conductivity of DM Makeup water cation, feed water cation, condensate cation, saturated steam cation, main steam cation and pH value of condensate feed water, saturated steam, main steam and drum water .

8. REGENERATIVE CYCLE PERFORMANCE OPTIMISATION:

With the help of this module deviation of performance of the turbine cycle is examined by the deviation of important parameters of the turbine cycle. Actual efficiency of individual stages of turbine, evaluation of LPH and HPH performance by comparing current values of TTD / DCA to the reference values as well as Heater level evaluation are also carried out.

9. COOLING TOWER OPTIMISATION :

The evaluation of wet cooling towers is made in PADO system by the special module fully integrated in the evaluation of the overall water steam cycle of the plant.

10. FLEXIBILTY TO INTERFACE FOR ANY TYPE OF DCS SYSTEM

PADO system has an excellent capability to interface with any type of DCS system like maxDNA, ABB ,Honeywel ,Invensys and Emerson .The interfacing tests were done with help of NTPC and various DCS suppliers.

11. WRITING BACK PADO RESULTS TO maxDNA SYSTEM.

PADO system has an ability to write back the PADO results to maxDNA system which helps

SEAMLESS INTEGRATION OF PADO RESULTS AND RECOMMENDATIONS IN DCS HMI SCREENS

KEY BENEFITS OF PADO:

- This is an excellent software tool aiding the plant personnel with advisory guidance message on how to operate the plant in the most optimized manner eventually leading to overall improvement in plant performance, reduced heat rate and thereby ensuring control over generation cost.
- Keeps a close watch on various controllable losses resulting in improvement in plant performance.
- Improved combustion optimisation while not sacrificing on emission limits.
- Root cause analysis leading to quick identification of operational problem, which results in saving of valuable time and effort.
- Lifetime monitoring of critical boiler components.
- Helps in live on line reporting to top management about key performance parameters and healthiness of the plant thereby aiding in informed decision making.
- Representation of components in Traffic light system like Red, Green and yellow.

(f) PADO PROJECTS IMPLEMENTATION BY BHEL:

Following are the experience of BHEL in implementing total PADO for various ratings and different customer base

UNIT RATING	NO OF SETS	CUSTOMERS
490/500	46	NTPC, KPCL, MAHAGHENCO, GEB, CSEB
525	4	TATA POWER, HNPL
600	5	TNEB, MPEB, APGENCO
195/250	9	NTPC
660, 700 (Super critical)	3	NTPC, KPCL

(g) PADO PROJECTS UPGRADES AND CUSTOMER SUPPORT :

PADO remote connectivity center is established at BHEL EDN, Bangalore for accessing the PADO servers situated at various sites for remote installation of software, on line accessing of data / calculation results, carrying out analysis and providing customer support.

This facility will also be extended for other power plants' PADO system in due course of time.

CONCLUSION

We all know information is power. More significantly, when information is converted into meaningful data, it empowers the user to derive maximum benefit out of it. PADO does exactly this. It empowers the power plant utility with the most valuable data available to make quick business decisions.

BIOGRAPHIES

Sri Saikumar Graduated in Electrical and Electronics from JNTU Hyedarabad. Working in the field of DCS for last twenty years with specilisation in Human Machine interfaces and being one of the pioneers to introduce PADO in India. At Present he is Deputy General Manager at BHEL Elctronics Division Bangalore

Sri Ananda C Graduated in Electronics and Communications from Mysore University and MBA from IGNOU. Working in the field of DCS for last Twenty Five years with specialization in Boiler Protection and controls. At Present he is Additional General Manager at BHEL Electronics Division Bangalore.

Automation in Thermal Power Plants

Volume measurement using 3D technology

Mr. Ofir Perl
CEO
A.P.M Automation Solutions Ltd.
Tel Aviv, Israel
Mob: +972-54-6526717
Email:ofir@apm-solutions.com

KEYWORDS

Coal fired power, ESP, Volume measurement, bulk solids, Instrumentation, 3D profiling, acoustics, array of antennas

ABSTRACT

Large-scale manufacturing industries ranging from power industry to cement to steel, plastics and others must overcome challenges of accurately assessing and controlling inventory in order to successfully manage the entire production process. Hundreds of different kinds of storage bins and silos around the globe of different shapes and sizes store materials with widely varying basic characteristics – dielectric constants, particle size, particle type, chemical make-up of particles, and more. Conditions inside bins and silos are often harsh: they are dusty, impacted by extreme temperatures, and subject to anomalies of irregular surfaces and unbalanced filling and emptying. To name some of them are ESP Hoppers, Coal, Limestone, Cement and Fly Ash Silos. They all present a great Challenge in knowing the its true level and volume, thus challenging the management in assessing and controlling it inventory, improve efficiency and preventing over spilling.

In this paper we will introduce a technology which employs an array of low frequency transducers to measure and map the entire surface area, and a patented algorithm that processes the information to generate a 3-dimensional map. The technology enables to measure the volume and mass of materials in new applications that other technologies cannot reach. It enables measuring practically any kind of material stored in an almost unlimited variety of containers, including large open bins, bulk solid storage rooms and warehouses. It enables mapping loads that randomly form over time inside silos, and many other previously inaccessible applications.

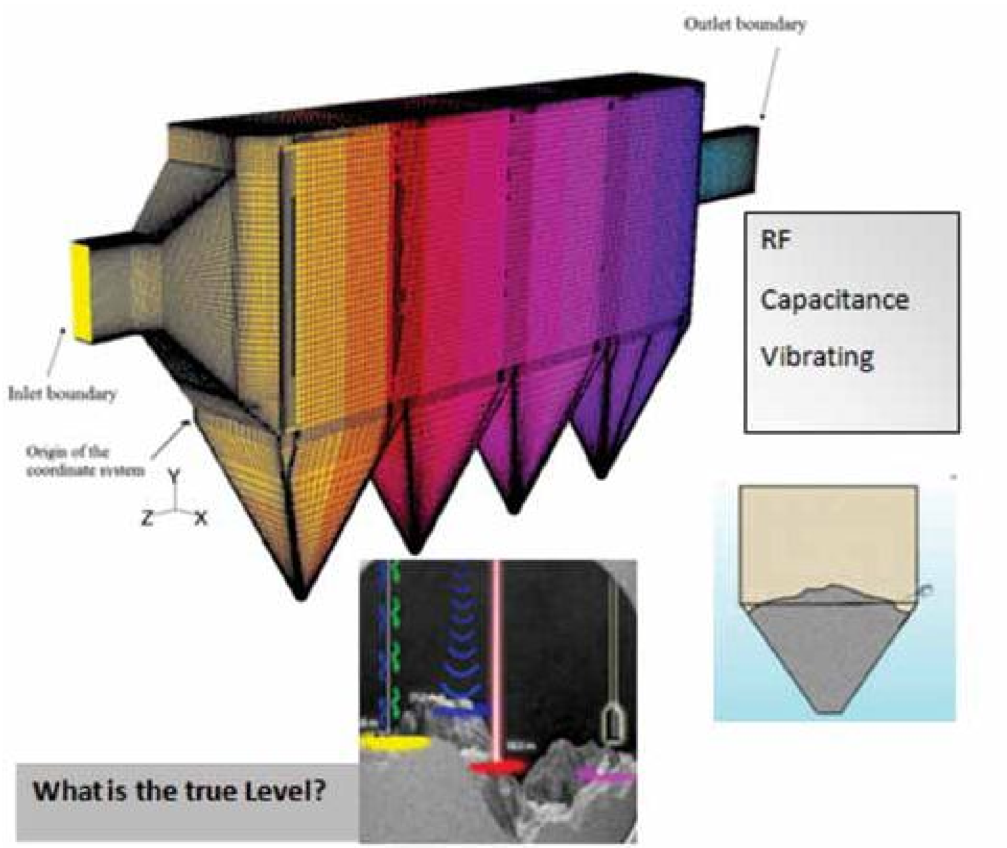
Providing much greater accuracy in its measurements and significantly enhanced overall performance, the technology represents very attractive solutions to continuous level & volume measurement challenges. The technology translates into major cost savings and faster returns on investment, and allows managers to make informed decisions that go right to the bottom line throughout the entire supply chain

INTRODUCTION:

The technology relates to monitoring of inventory and to process measurement, and, more particularly, to a system and method for measuring the content of a bin. The monitoring of liquid inventory generally is straightforward. By contrast, the monitoring of bulk solid inventory that consists of particulates piled up inside a bin such as a silo often is very difficult. Examples of such bulk solid inventory include cement, coal, fly ash, etc. The measurement of the level of bulk materials inside a bin is a problem that has not yet been solved adequately. The conditions inside bins typically are unfavorable (dust, extreme temperatures, etc.) and the contents of the bulk material stored in the bins often do not have a flat surface and are not always isotropic. Other difficulties arise from the wide variety of bin shapes in use and from the explosive atmospheres inside some bins.

The scope of the term “bin” as used herein includes any storage container, for bulk particulate solids, whose structure defines an interior volume for receiving and storing the solids. Such a bin may be closed above, below and on all sides, as is the case when the bin is a silo, vessel or tank, or may be open above or on one or more sides. The example of a “bin” that is used in the detailed description of the present technology below is a silo; but it will be obvious to those skilled in the art how to apply the principles of the present technology to any type of bin.

Four principal methods are known for continuous measurement of the content of a bin such as a ESP Hopper.



(1) An electromechanical (yo-yo) level sensor consists essentially of a weight at one end of a reel of tape. The weight is allowed to descend in the silo to the depth at which the top surface of the content is situated. When the weight settles on top of the content, the tension in the tape slackens. The weight then is retracted to the top set point. The height of the content is inferred from the time required to retract the weight or from the measured tape length. Mechanical devices such as yo-yo sensors are unreliable. They tend to get clogged by dust and to get stuck on obstacles such as pumps and rods inside the silos.

(2) Ultrasonic level sensors work on the principle of sound wave transmission and reception. High frequency sound waves from a transmitter are reflected by the top surface of the content to a receiver. The height of the content is inferred from the round-trip travel time. Such sensors have limited range and work poorly in the presence of dust. In addition, such devices need to be custom-designed for different types of silo.

(3) Radar level sensors work on the principle of electromagnetic wave transmission and reception. Electromagnetic waves from a transmitter are reflected by the top surface of the content to a receiver. The height of the content is inferred from the round-trip travel time. Such sensors are still based on a single continuous sample point and are therefore not accurate enough for bulk solid applications.

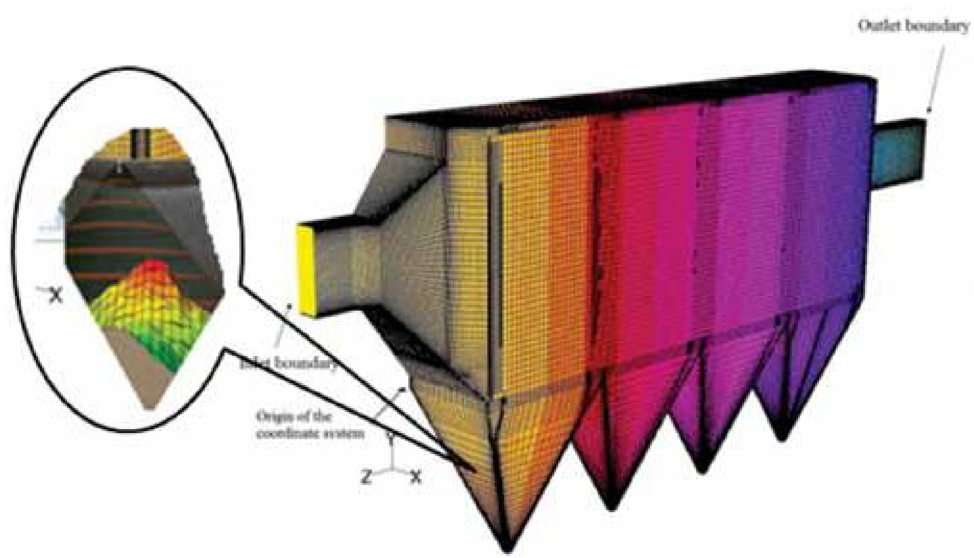
(4) Capacitance sensors measure the capacitance between two metallic rods or between a metallic rod and the ground. Because the silo content has a different dielectric constant than air, the capacitance changes according to the level of the top surface of the content between the two rods or between a rod and the ground. Such sensors tend to be inaccurate and are sensitive to humidity and to type of material stored in the silo.

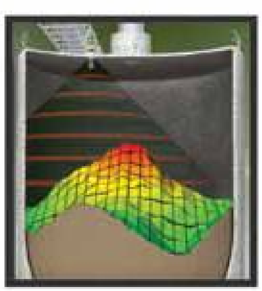
All the prior art sensors discussed above are insensitive to the shape of the contents, and so are inaccurate in the presence of a common phenomenon called “coning” that occurs as bulk particulate solids are withdrawn via the base of a bin: an inverted conical hole, whose apex is directly above the point of withdrawal, tends to form in the bulk particulate solids. A similar phenomenon occurs as bulk particulate solids are added to a bin from the top: the solids tend to pile up in a cone whose apex is directly below the point of insertion of the solids. These sensors also work poorly in bins with complicated geometries and in the presence of obstacles.

There is thus a widely recognized need for, and it would be highly advantageous to have, a method and a technology of measuring the content of a bin such as a silo that would overcome the disadvantages of presently known methods as described above. In particular, it is not known in the prior art to map the upper surface of the bin contents in three dimensions.

METHODOLOGY/SUMMARY OF THE INNOVATIVE TECHNOLOGY – VOLUME MEASUREMENT

The technology employs a 2-dimensional array beamformer to send low frequency pulses and receive echoes of the pulses from the contents of the silo, bin or other container. The device's Digital Signal Processor samples and analyzes the received signals. From the estimated times of arrival and directions of received echoes, the processor generates a 3-dimensional image of the surface that can be displayed on a remote screen.





The 3DLevelScanner is unaffected by the type of materials being stored, avoiding the need for special calibration, or by environmental conditions, such as dust, filling "noise", humidity, or temperature.

Three factors combine to make the technology an innovative one and the best-of-class solution for accurate measurement of bulk solids, particularly those in dusty environments:

1. Low frequency of transmitted signals (under 4 kHz)
2. A 3-antenna system that measures not only elapsed time between transmission and receipt of acoustic echoes but also the phase between the echoes
3. Proprietary algorithms enabling precise 3-D mapping of the contents inside the silo or storage bin

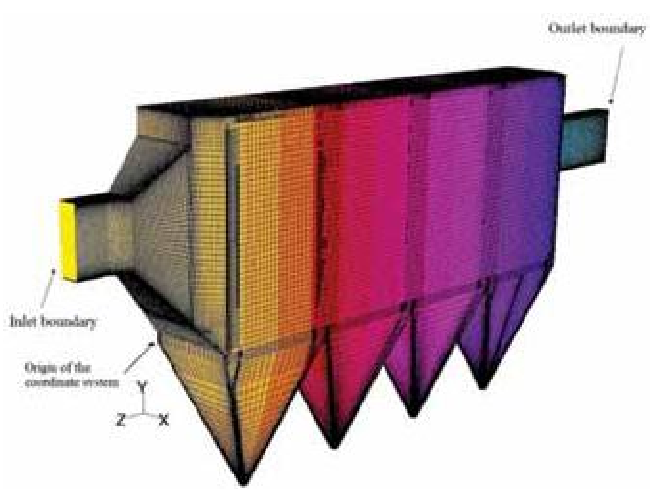
TYPICAL APPLICATION:FLY ASH LEVEL DETECTION IN ELECTROSTATIC PRECIPITATORS (ESP) HOPPERS

In recent years the particle emissions from process industries have been attracting more attention because of the anticipation of upcoming strict U.S. Environmental Protection Agency (EPA) regulations. Although electrostatic precipitators generally capture 99.5% of the particles from the flue gas in terms of mass volumes, the anticipated regulations on PM2.5 (particulate matter with particle sizes of 2.5 microns and less) have led power stations to explore improvement options to control the emissions of the fine particulate at a minimal cost.

Electrostatic precipitators (ESPs) are the most commonly used, effective, and reliable particulate control devices (System); they are employed mostly in (coal based) power plants and other process industries. The particle-laden flue gas from the boiler flows through the ESP before it enters the environment (thru stack). The ESP works as a cleaning device, using electrical forces to separate the dust particles from the flue gas.

A set of discharge electrodes is suspended vertically between two collection electrodes in a typical wire-plate ESP channel. While the flue gas flows through the collection area, electrostatic precipitators accomplish particle separation through the use of an electric field in the following three steps. The electrical field does the following:

- Imparts a positive or negative charge to the particles by means of discharge electrodes
- Attracts the charged particles to oppositely charged or grounded collection electrodes
- Removes the collected particles by vibrating or rapping the collection electrodes or spraying them with liquid (applicable only in wet ESP)



That large portion of the Fly-ash (dust) particles (which could not be trapped in the Economizer) are collected in the ESP Hoppers below the Electrostatic Precipitators (ESP) having high peak voltage of 71 KV on the collecting plates to polarize the Fly-Ash (dust) Particles.

To prevent over-spilling of Fly-ash (dust) from these hoppers, de-ashing (de-dusting) is performed after a fixed time interval (even if the hopper is not filled completely with Fly-ash (dust)).

This results in:

- High power consumption as many times as the de-ashing (de-dusting) operation takes place.
- A lot of wear & tear due to moving parts of the de-ashing (de-dusting) system.
- Build-up of the ash particles in the portion of the High Voltage Plates could cause a short-circuit between the collecting plate and the electrode (especially under Humid conditions) thus destroying the plate arrangement and the electrical equipment.

This calls for an Automatic Level Detection System to control the High and Low Level of Fly-ash in the ESP Hoppers and start the emptying process only when the pre-set maximum level is reached.

Fly Ash (dust) Level Control & Detection in Hoppers remains a difficult problem in the industry, presenting the following main challenges of dealing with Fly Ash:

- Has very low density, hard to sense (false alarms)
- Tends to stick to everything particularly when moist. (creates rat holing)
- Has a very low dielectric constant.
- Carries static charge.
- Is at high temperature (Approx. 200 deg. C.).
- Is abrasive in nature.

Due of the above mentioned difficulties, current solutions (such as high and low level alarm switches and other technologies) present lots of operational issues.

Users are looking for a non contact solution that will profile the material and measure the volume continuously and therefore save energy (money), maintenance (wear and tear). Once user gets material profile he can easily:

- Detect **rat holes** at a very early stage
- Detect buildups so user can clean the hoppers in time
- Prevent false alarms due to build ups
- Prevent damage to the plates due to absence of alarms

And eventually:

- Reduce pollution and allow compliance with the strict EPA regulations.

The solution: Continuous volume measurement, using a 3D Scanner, with real time visualization of the material inside the hopper.

The ability to visualize material surface on line, will provide better monitoring and will **reduce the number of failures.**

The ability to empty the hopper on time result in **less pollution** (conformity with EPA regulations) and less **short circuiting, hence longer** plates life (less expenses and higher efficiency). (Customer quote: "…. no more shut down of plant / generation")

METHODOLOGY/SUMMARY OF THE INNOVATIVE TECHNOLOGY – VOLUME MEASUREMENT

3DLevelScanner's technology actually takes advantage of the large 70-degree beam angle (that results from working at a very low frequency), by using a three-antenna system with proprietary algorithms to add another important dimension, **direction**. The result is that every 5 seconds the 3DLevelScanner receives a matrix of x-y-z position coordinates that represent the echoes from the surface of the contents in the silo. Connecting these points together generates a highly accurate profile of the surface area, which in turn yields more precise measurement of the amount of materials being stored.

Method of Algorithm: How to find and detect the direction from which the echoes are coming from:

Step1: Every echo reflected back goes through classification algorithm.

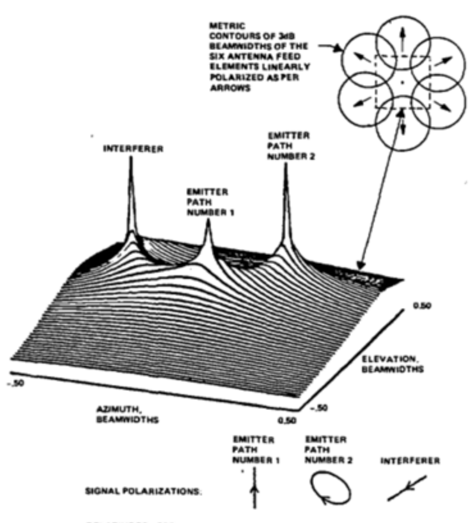
The MUSIC (MUltiple SIgnal Clasification) algorithm: is a linear subspace algorithm that achieves performance close to Shanon limit with relatively low complexity cost. MUSIC estimates the frequency content of a signal or autocorrelation matrix using an Eigen space method. This method assumes that a signal, x(n), consists of p complex exponentials in the presence of Gaussian white noise. Given an $M \times M$ autocorrelation matrix, R_x, if the Eigen values are sorted in decreasing order, the eigenvectors corresponding to the p largest Eigen values spanning the signal subspace. Note that for M = p + 1, MUSIC is identical to Pisarenko's method. The general idea is to use averaging to improve the performance of the Pisarenko's estimator. The frequency estimation function for MUSIC is

$$\hat{P}_{MU}(e^{j\omega}) = \frac{1}{\sum_{i=p+1}^{M} |\mathbf{e}^H \mathbf{v}_i|^2}$$

Where V_i are the noise eigenvectors and

$$e = \begin{bmatrix} 1 & e^{j\omega} & e^{j2\omega} & \cdots & e^{j(M-1)\omega} \end{bmatrix}^T$$

Example of Music algorithm result with 2- dimensional array



The algorithm records the exact time that every pulse is transmitted and the exact time every adjacent echo is received. The difference between these times is the time of flight of signal. The distance is the time of flight multiplayer by half the propagation speed (half because the signal travels forth and back).

The Speed of sound is given by

$$331.3\sqrt{1+\frac{T^{\circ}}{273.15}}$$

T is the measured temperature in Celsius.

For every direction of echo there is a specific set of relative phases induced on the scanner array. However there are some directions that create the same phases on the array even though the directions are not the same.

That effect can be avoided if the spacing between array elements is not more than half wavelength.

Step 2: Angle Calculation

When the spacing between array elements is larger than half wave length there are some different pairs of angles ($\theta 1,\phi 1$) and ($\theta 2,\phi 2$) that cannot be distinguished physically by the array. The smallest angle $\theta 0$, such that for every pair of spherical angles that fulfill $\theta 1 <= \theta 0$ and $\Theta 2 <= \theta 0$, the directions ($\theta 1,\phi 1$) and ($\theta 2,\phi 2$) induce different relative phases on the array (thus every two directions with smaller θ can be distinguished) is the maximal angle at which the array can figure direction without aliasing mistake. In triangular array this angle is given by:

$$\theta_0 = a\sin\left(\frac{C}{\sqrt{3}\cdot f\cdot D}\right)$$

Where:

D is the spacing between antenna elements.

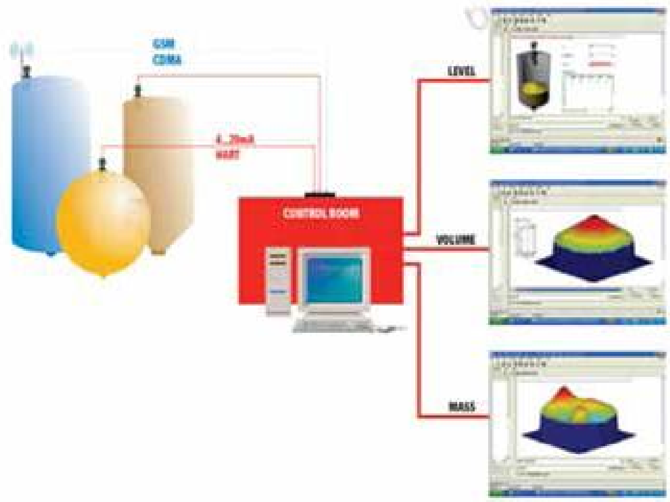
C the propagation speed

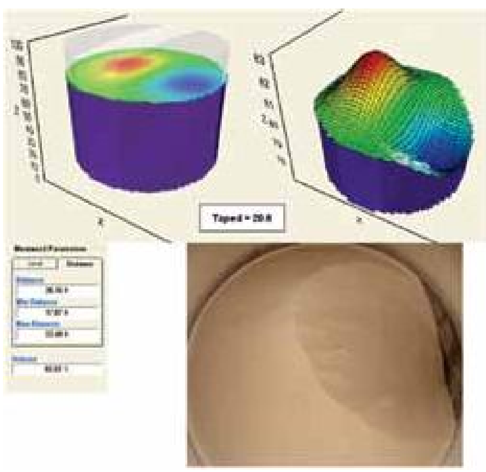
F pulse carrier frequency

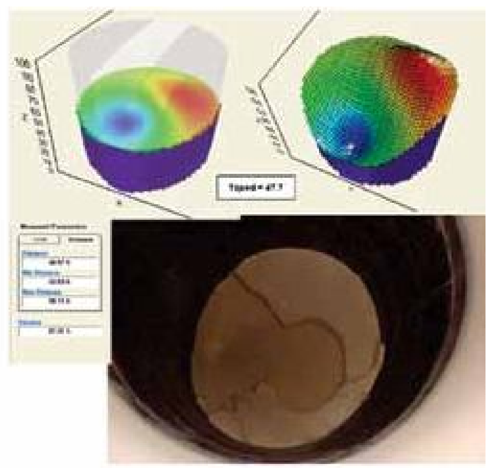
RESULTS

Using the described technology results:

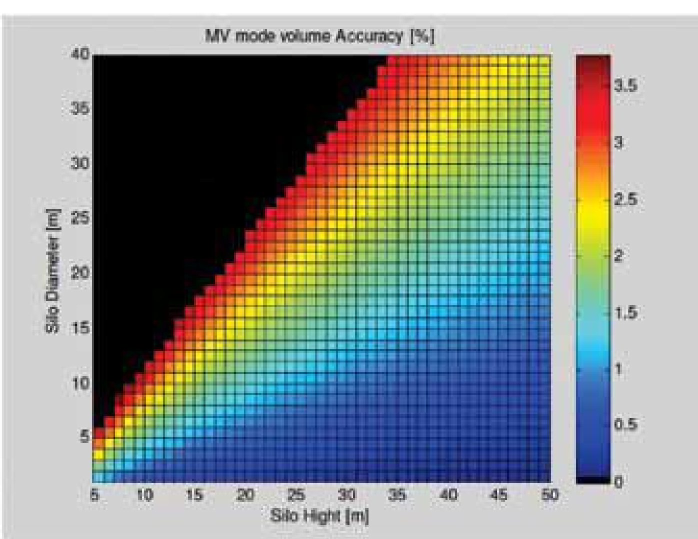
(1) In the ability to profile bulk solid materials in silos such as the below examples:







(2) The ability to reach unprecedented volume accuracy. The accuracy reached with the described technology:



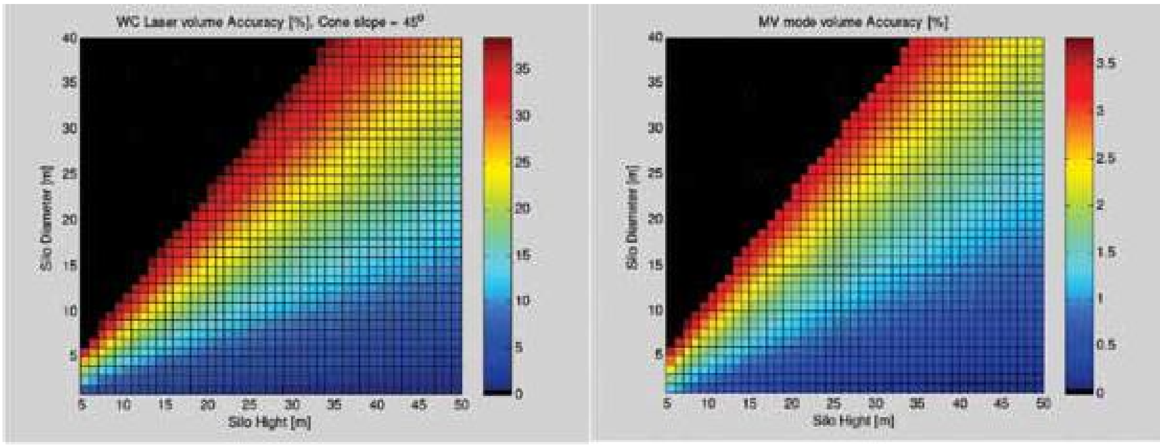
Example:

(1) In a 25 meters high silo and 15 meters wide, it is possible to receive volume accuracy of 1.5% - 2%.

(2) In a 25 meters high silo and 10 meters wide, it is possible to receive volume accuracy of 1%.

CONCLUSION

The results show a great improvement in the accuracy of measurement in bulk solid applications



Comparing today's technologies with the described technology shows an improvement in the volume accuracy by an order of magnitude.

In other words, in applications where the described technology would provide 1% accuracy, an existing technology (yo-yo, ultrasonic, radar) would give 10% accuracy.

Therefore, it is advisable for customers from a variety of industries (steel, power, cement, food, chemicals) who wish to asses more accurately the amount of materials they have in their silos for inventory purposes and optimization of manufacturing process to use the suggested technology.

Providing much greater accuracy in its measurements and significantly enhanced overall performance, the technology represents a revolution to continuous level & volume measurement challenges. This translates into major cost savings and faster returns on investment, and allows managers to make informed decisions that go right to the bottom line throughout the entire supply chain of their plant.

PARTICULATE EMISSION MONITORING BY USING TRIBOELECTRIC TECHNOLOGY

Karl Ehrström; CEO; Sintrol Oy; Helsinki; Finland

Vikram Singh, Area Sales Manager (India); Sintrol Oy; New Delhi; India

ABSTRACT

With stricter emissions regulations in industry, the demand for dust monitors is expected to increase rapidly in the near future. This increase in demand has also created greater expectations and demands in terms of what users expect from a dust measurement system. To fullfill customer needs in heavy and different industrial applications, instruments for dust measurements need to be reliable, accurate and robust while remaining easy to use for the end user.

KEYWORDS: particulate, triboelectric, emission measurement, sensor

INTRODUCTION

Emission measurements are a natural and important part of today's power plant operation. In the future, as environmental regulations become stricter, the importance of emissions measurements will continue to increase. Combined with the increasing needs of dust monitoring solutions, the overall demand for solutions will rise. This prospect of larger need for dust monitoring and more innovative solutions to existing options has created huge possibilities and challenges at the same time.

The most used technique globally in particulate emissions measurements is based on optical technology. This technology is widely known and accepted. At the same time, the difficult conditions in industrial environment can create many problems to the measurement. Since these issues are unique to the technology itself, it has been noticed that new competitive technology for emission control measurements are needed. The purpose of this paper is to describe triboelectric technology as an optional technology for emission measurements and describe its benefits compared to the optical method.

TRIBOELECTRIC PHENOMENON AND PARTICULATE MEASUREMENTS

Triboelectricity is a physical phenomenon that has been known since antiquity. The word tribo is even derived from the Hellenic word "tribein" which means rubbing. The physical definition of the triboelectric phenomenon can be described as a process where two material surfaces are first contacted and then loosened from each other. The result of this is that both surfaces become electrically charged. Alternative phrases such as "contact charging" or "friction charging" describe the phenomenon well also. It can also be assumed that some kind of chafe is present in all triboelectric processes. Basically when two surfaces are contacted the transfer of charges between them occurs at the same time. When surfaces are then detached it is natural that other material has deficit and other has excess of charges. Amount of charge transfer is affected by various physical properties. In particulate measurements triboelectric phenomenon happens between the metal probe and the particles that flow in the channel. Movement of these particles will create the triboelectric effect to the metal probe, which is then converted to a signal. This signal is then amplified and converted to the proper form for the user. Basic triboelectric measurement situation is described in picture 1.

Picture 1. Triboelectric dust measurement principle. (Sintrol Oy)

In triboelectric dust measurement, the isolated metal sensor is placed inside the channel where particulate flow occurs. Particles naturally carry a charge, which they give off when they interact with the sensor. The pure mechanical impact between dust particles and sensor rod affects the DC current which is then proposal to the dust concentration in channel. Part of the current is formed through induction when particles pass near the probe. The current which is formed due to the particle movement is the AC current.

TRIBOELECTRIC TECHNOLOGY IN EMISSION MEASUREMENTS

Earlier triboelectric methods have been used primarily for process control solutions and filter leak detection. The main reasons for this have been easy maintenance, robust design and relatively low costs compared to the optical dust monitors. Historically, this has held true largely due to technological limitations of triboelectric dust monitor measurement techniques.

Today the advancements in technology have changed the dynamic and made the triboelectric measurement principle a viable alternative to the optical method for emission measurements as well. One main improvement is that, in the past, triboelectric monitors generated their signals based on the DC current only. Today, however, the advanced models provide an output based on both the AC and DC components. When taking both components into account, the measurement is much more sensitive and accurate. These significal technical improvements enable the use of triboelectric dust monitors in official emissions measurements today. Triboelectric dust monitors have also been recognized by third party certification bodies as an emissions measurement too. TÜV Rheinland, the German based, globally recognized organization, has approved triboelectric dust monitors to meet the European standards for official emissions measurements. These third party approvals validate that the triboelectric measurement principle is a functional and viable method to meet the demands and expectations of emissions measurements.

The technological advancements described above provide insight into how the measurement principle is suitable for emissions measurements. There are also some practical reasons which make it a suitable option for this application. The robust design of the triboelectric dust monitors, it can help alleviate some of the problems that are commonly faced when using the optical emissions monitors.

One of the most important benefits of triboelectric monitors is easy installation. Picture 2 below shows a typical installation for a triboelectric dust monitor. As can be seen in the image, the installation only requires a hole in the channel where the measurement will take place. From there, it is mounted using the installation socket which is welded over a hole. Once completed, the mechanical installation is ready and measurements can begin.

Picture 2. Installed triboelectric monitor (Sintrol Oy)

One major problem for optical systems has been the effect of vibration, which is present in many industrial applications. For triboelectric monitors, the design allows the device to withstand high levels of vibration in the industrial process. An integral part of this is the use of a SS 316L stainless steel probe. An additional benefit of using this probe is that it also enables the dust monitors to be used in corrosive environments. Steel probes are also easy to coat for applications with special conditions. In cases with high relative humidity there is the possibility to use a probe coated with teflon to avoid problems caused by condensing water. Also other types of coatings are easy to manufacture based on user demands. This coating possibility makes triboelectric monitors easy to modify to better fullfill user's expectations in different measurement conditions.

A significant benefit of triboelectric monitors compared to the optical measurement is the ease of maintenance. Unlike optical monitors, which may require maintenance as often as once a week, the triboelectric monitor requires maintenance typically only on an annual basis. With the stainless steel probe, as described above, the triboelectric dust monitor's strong design allows maintenance sessions to be easy and quick. With installation locations often times in a difficult to reach place, this can create a great deal of convenience and cost savings to the end user. Ease of maintenance is one of the key benefits for industry users since emissions measurements need to be done continiously and significant stoppages in measurements are not allowed.

Since triboelectric technique is used in process control, it can also stand much heavier dust loads compared to the optical method without maintenance. In situations with extremely heavy conditions there is also the option to purge air along the probe surface which helps to keep sensor clean and increase intervals between the maintenance periods.

CONCLUSIONS

Triboelectric technology opens new possibilities for users who are working with emissions measurements today. The technology has made advancements to the level that it offers solutions for emission measurements and certified emissions instruments as well. With these technological improvements, it has also been able to maintain many of the advantages of the traditional triboelectric monitor, such as the ease of use, low maintenance requirements and operation in difficult conditions.

ACRONYMS

SS 316 L — Acid resisting stainless steel

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Hazardous Area Classification and methods of preventing fire and explosion hazards in Gas & Coal based Thermal Power Plants

BY

Ashok Kumar Panda
HOD, Control & Instrumentation,
Lanco EPC, Gurgaon

Nikhilesh Kumar
Lead for Control & Instrumentation,
Solar Projects, Lanco EPC, Gurgaon

Soumya
Research Intern at Lanco
EPC, Gurgaon

Abstract

This working is intended to give an overview of the concepts and principles that define a Hazardous Location and the guidelines to classify these locations. It is framed categorically and lucidly to help in carrying on a conversation about this subject without becoming an expert.

To place a product into a hazardous area, it must be designed and certified specifically for that area classification. Gas and Thermal power plant have many areas which are hazardous in nature and cause accidents and fire as a result of wrong selection of equipment and instruments with respect to the classified area. And hence focus has been given to understand the theory of the available protection techniques and how they are implemented in these zones across industries.

Key Words

Explosion Triangle, Lower Explosive Limit, Upper Explosive Limit, Flash Point, Combustible liquid, Flammable liquid. Explosion tree, Hazardous Area Classification, Self Ignition Temperature, Zone Classification, Auto Ignition Temperature, Maximum Experimental Spark Gap, Minimum Ignition Current, methods of protections, Flame proof, Intrinsically Safe, Safety Barriers.

1.0 Introduction

Coal and gas based power plants utilize flammable or combustible solids, liquids and gases that pose fire or explosion hazards. It is essential to know the characteristics of all of the hazardous materials used in the power plant, define their locations and potential sources of leaks, and determine the extent of the Hazardous Area associated with each leak source. Each Hazardous Area should be classified according to applicable industry codes and standards. Such Area Classifications are used in the selection and installation of suitable electrical equipment, wiring devices, and wiring methods that prevent the ignition of flammable or explosion mixtures.

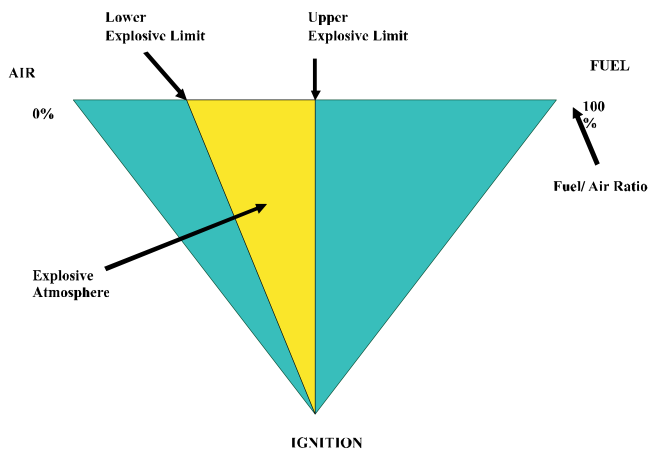
This paper describes the approach, proposed to be used by Lanco Infratech Limited, in the classification of Hazardous Areas for a typical power plants and guidelines to be followed for prevention of these hazards especially to Instrumentation and Electrical domain. It describes basic nature of fire & explosion, parameters which affect the intensity of these hazards and then explore various codes and standards being referred across the industry. An insight is also given to how modern electrical and instrumentation system have been developed in order to tackle with these hazards. Identified areas such as Fuel Gas System, Ignition Gas System, Fuel Oil System, Hydrogen Gas for Generator Cooling System, Plant Battery System, and Ammonia System etc have been analyzed with respect to potential hazards. Exercises have been done which identify combustible materials in these systems and then classify them as per the industry codes and standards and propose methods to mitigate these hazards. With an attempt to explain details of various methods used widely in similar industries, details of associated devices, wiring methods and field instruments have been presented in this paper. Others may find this paper useful in developing their own guidelines for classifying Hazardous Areas in power plants.

2.0 DESIGN BASICS

The National Electrical Code (NEC), IEC, NFPA 70, defines Hazardous (Classified) Locations as those where fire or explosion hazards may exist due to the presence of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings.

Electrical Area Classification is the process of determining the existence and extent of Hazardous (Classified)

Locations in a facility handling any of 2.01 Explosion Triangle

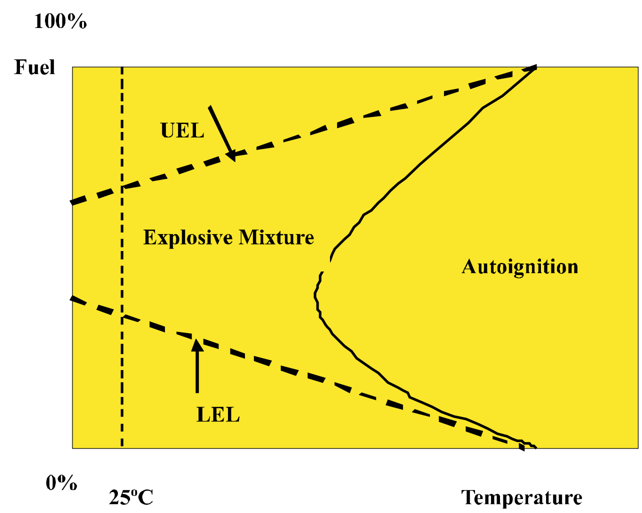


The above conditions constitute the well-known "fire triangle." Within the context of Electrical Area Classification, the source of energy is understood to be within the electrical system of the facility.

The Fuel (in the form of a gas, vapour mist or dust) and the air together form a potentially explosive atmosphere. When the proportion of the fuel and air is between certain limits they form an explosive atmosphere which can be ignited by an ignition source. Outside the limits, the mixture will not ignite but has the potential to do so if the proportion can change. Ignition occurs as a result of the combination of three ingredients; fuel, air and source of ignition. If any one of these ingredients is diluted beyond known limits or is completely eradicated then ignition cannot take place. Explosion protection techniques operate by ensuring that either: The ingredients of the triangle do not come together at the same time, or the resultant ignition that occurs if the ingredients do come together is adequately controlled so as not to ignite a larger supply of fuel.

2.02 LEL and UEL

The Lower Explosive Limit (LEL) is also known as the Lower Flammable Limit(LFL) in some parts of the world. A similar labeling exists for the Upper Explosive Limit (UEL.) The LEL and UEL are different for each gas or vapour. The LEL of a combustible gas is defined as the smallest amount of the gas that will support a self-propagating flame when mixed with air (or oxygen) and ignited. In gas detection systems, the amount of gas present is specified in terms of %LEL: 0% being a combustible gas-free atmosphere and 100%LEL being an atmosphere in which the gas is at its lower flammable limit.



The LEL of a gas is not significantly affected by the humidity fluctuations normally encountered in the operation of a gas-detecting system.

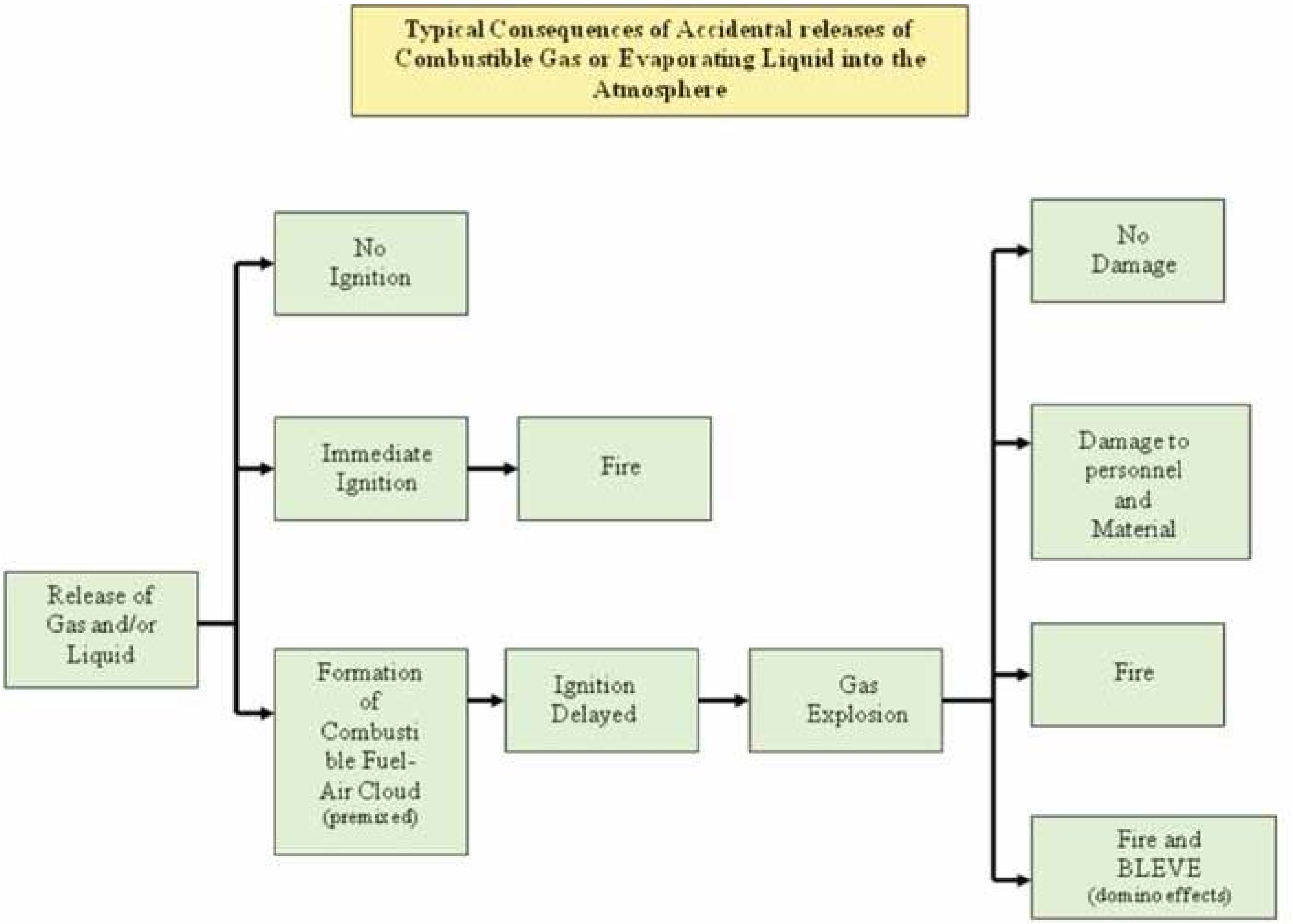
2.03. Relevant Definitions:

Flash Points: The minimum temperature at which a liquid gives off vapour within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid. The flash point is normally an indication of susceptibility to ignition. The expression "low flash-high hazard" applies.

Combustible Liquid: Any liquid having a flash point at or above 100°F (37.8°C.)

Flammable Liquid: Any liquid having a flash point below 100°F (37.8°C) or higher , the total of which make up 99% or more the total volume of the mixture.

Vapour Pressure: Measure of a liquid's propensity to evaporate. The higher the vapour pressure, the more volatile the liquid and, thus, the more readily the liquid gives off vapours. The vapour pressure increases exponentially as temperature rises. In the gas phase above a liquid there is always some vapour of the liquid. The pressure exercised by this vapour onto the walls of a closed vessel is called the vapour pressure. When the vapour pressure is equal to or greater than the ambient pressure, the liquid boils.



2.04 Explosion Tree

This chart shows what can happen if combustible gas or evaporating liquid is accidentally released into the atmosphere. If the gas cloud, formed from the release, is not within the flammability limits or if the ignition source is lacking, the gas cloud may be diluted and disappear. Ignition may occur immediately, or may be delayed by up to tens of minutes, all depending on the circumstances. In case of an immediate ignition (i.e. before mixing with air or oxidizer has occurred) a fire will occur.

The most dangerous situation will occur if a large combustible premixed fuel-air cloud is formed and ignites. The time from release start to ignition can be from a few seconds up to tens of minutes. The amount of fuel can be from a few kilograms up to several tons.

The pressure generated by the combustion wave will depend on how fast the flame propagates and how the pressure can expand away from the gas cloud (governed by confinement.) The consequences of gas explosions range from no damage to total destruction. The pressure build-up due to the gas explosion can damage personnel and material or it can lead to accidents such as fires and BLEVE's, Boiling Liquid Expanding Vapour Explosions (domino effects.) Fires are very common events after gas explosions.

3.01. Area Classification.

Hazardous Location: Hazardous location means premises, buildings, or parts thereof in which there exists the hazard of fire or explosion. In both Canada and the United States, there are three classes of hazardous locations. They are as follows:

Class I- A location where there is a danger of explosion due to the presence of a flammable gas or vapour.

Class II- A location where there is a danger of explosion due to the presence of a flammable dust.

Class III- A location where there is a danger of explosion or flash fire due to the presence of flammable fibres or flyings.

In both Canada and the United States, there are three classes of hazardous locations: Flammable gas or vapour, Flammable dust and Flammable fibres or flyings. Outside of North America there exists another system of area classification for gases or vapours. This is the system developed by the International Electrotechnical Commission (IEC.) North America is well ahead of the rest of the world in the classification of dusts. Codes recognize that not all gases, vapours, and dusts are the same. There are many differences between flammable gases and vapours, which make it impossible to use the same degree of protection for every compound.

3.02 Hazardous Dust Area Classification

3.02a: North American (NEC): North America has subdivided Combustible Dust (Class II) and Ignitable Fibres and Flyings (Class III) into two Divisions. Combustible Dust contains Groups E, F, and G, however, Class III contains no Groups. Combustible Dust uses Temperature Codes T1 to T6. Ignitable Fibres and Flyings has temperature Codes T3B to T6. The U.S. National Electrical Code limits the maximum Temperature Codes for Class III equipment to 165°C for equipment not subject to overloading and to 120°C for equipment that may be overloaded.

The classification of areas containing dusts, fibres, and flyings is somewhat different from that for gases and vapours. In North America the classification for Hazardous Dust, Class II, and Hazardous Fibres, Class III, is further divided into two Divisions.

Table A: Classification

Material	Category
Metal Dust	Class II, Group E
Coal Dust	Class II, Group F
Grain and Plastic Dust	Class II, Group G
Fibres and Flyings	Class III

Table B: Divisions

Conditions	Classification
Dust or Fibres and Flyings in Suspension	Division 1
Metal Dust in Suspension or Settled on Surfaces	Division 1
Other Dusts or Fibres and Flyings Settled on Horizontal Surfaces	Division 2

3.02b European

Europe is developing their system for classifying Hazardous Dust. They have elected to use the Zone system and have created three Zones, unlike the North American system. Zone 20 is a new concept for us in North America.

Zone21: An area not classified as Zone 20 in which combustible dust, as a cloud, is likely to occur during normal operation, in sufficient quantities to be capable of producing an explosive concentration of combustible dust in mixture with air

Zone 22: An area not classified as Zone 21 in which combustible dust, as a cloud, can occur infrequently, and persist only for short period, or in which accumulations or layers of combustible dust can give rise to an explosive concentration of combustible dust in mixture with air.

Zones 21 and 22 are very similar to our Division 1 and 2, respectively, and Zone 20 is like Zone 0 for gases and vapours. The new Zone 20 is intended to cover locations such as the inside of hoppers, silos, cyclones, filters, dust transport systems, blenders, mills, dryers, and bagging equipment; areas in which a dust cloud is almost always present.

3.03 SIT

Self Ignition Temperature is the temperature at which combustible materials ignite spontaneously in air. Looking at common Dust characteristics for the three different Groups, one will notice that there are two spontaneous Ignition temperatures for Hazardous Dust; a Cloud Temperature and a Layer Temperature. The Cloud SIT could be higher or lower than the Layer SIT depending on the Hazardous Dust. The SIT could be a lot lower than the Hazardous Gases (e.g. Uranium.).

There are different classifications of Coal, depending on location of the Coal, and each Coal type has a different SIT. Coal certification usually requires a Coal-Blanketing test and is usually certified by a different Authority in each country, one responsible for Mining.

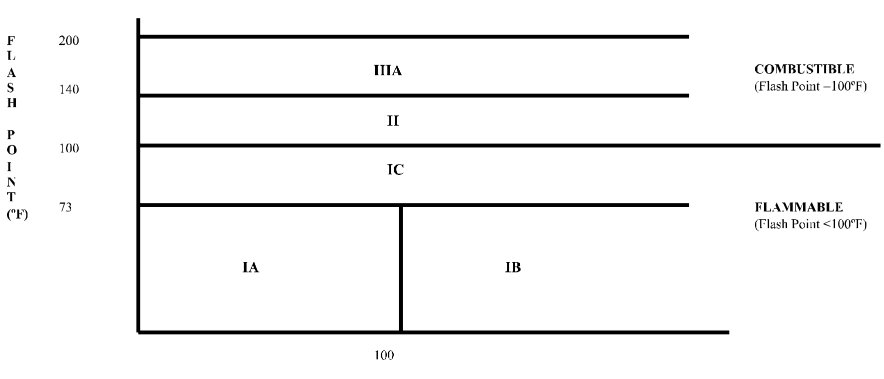
Group	Dust	Cloud SIT (°C)	Layer SIT (°C)
E	Aluminium	650	760
E	Magnesium	620	490
F	Coal Pitts	610	180
F	Coal DOM (NS)		160
F	Coal Lit (Sask)		160
F	Coal Dip (AB)		180
F	Coal Cau (AB)		200
G	Alfalfa	460	200
G	Coffee	410	220
G	Wheat	480	220
G	Polyurethane	550	390

Table C: Common Dust Characteristics and their corresponding SIT illustrated in the above table

3.04: Hazardous Area Liquid Classification:

Here one sees how the United States uses the Boiling point and Flash Point to Classify Liquids. Different requirements exist for each class. One should not get confused between a Hazardous Location classification and a Combustible Liquid Classification.

Classes of Flammable and Combustible Liquids as Defined in United States



3.04a: Flash Point of a Few Common Liquids

Liquid	Flash Point (°C)
Propane	-104
Butane	-60
Ethyl Ether	-45
Gasoline	-43
Carbon Disulphide	-30
Acetone	-18
Benzene	-11
Methyl Ethyl Keytone (MEK)	-9
Heptane	-4
Toluene	4
Methyl Alcohol	11
Ethyl Alcohol	12
Propyl Alcohol	15
Jet Fuel (JP4)	18
Turpentine	35
Polyester Resin	38
Diesel Fuel	40
Kerosene	51.6
Fuel Oil	80
Ethyl Glycol	111
Lubricating Oil	149
Corn Oil	254

Combustible Liquid: Any liquid having a flash point at or above 100°F (37.8°C.)

Flammable Liquid: Any liquid having a flash point below 100°F (37.8°C)

National Fire Protection Association Guidelines: It applies to the handling , storage, and use of flammable and combustible liquids with a flash point below 200°F. Two primary hazards associated with flammable and combustible liquids are explosion and fire. Standards addresses primary concerns of design and construction, ventilation, ignition sources and storage

3.05 Hazardous Area Gas Classification

The hazardous gas classification was further broken down in both North America and Europe. North America created two Divisions; one for continuously and periodically hazardous locations and another one for occasionally hazardous locations. The IEC system created three Zones; one for continuously hazardous areas, one for periodically hazardous areas and the last one for occasionally hazardous areas. The North American system creates a situation where an area may be classed either as too stringent or too loose.

Many countries are trying to harmonize to the IEC system. Both Canada and the United States have created a parallel set of standards based on the IEC system. Manufacturers can dual certify to both systems. Canada has taken the position that any new location will be classified using the IEC system and Business has the option of changing existing Division classified areas to the Zone system. The United States has made either system an option for Businesses.

Table D

CEC/NEC Division Classification	IEC Zone Classification
Class I, Division 1: Where ignitable concentrations can exist under normal operating conditions; may exist frequently because of repair, maintenance or leakage; or may exist due to breakdown of equipment in conjunction with an electrical failure.	Class I, Zone 0: Where ignitable concentrations are present continuously or for long periods of time. Class I, Zone 1: Where ignitable concentrations are likely to exist under normal operations; may exist frequently because of repair, maintenance or leakage; may exists due to breakdown of equipment in conjunction with an electrical failure; or adjacent to Class I, Zone 0 locations.
Class I, Division 2: Where volatile flammable liquids are stored, etc. in closed containers; where ignitable concentrations are normally prevented by positive pressure ventilation; or adjacent to Class I, Division 1 locations.	Class I, Zone 2: Where ignitable concentrations are not likely to exist in normal operation or may exist for a short time only; where volatile flammable liquids are stored, etc. in closed containers; where ignitable concentrations are normally prevented by positive pressure ventilation; or adjacent to Class I, Zone 1 locations.

There are many differences between flammable gases and vapours, which make it impossible to use the same degree of protection for every compound. Some of the factors separating the various gases or vapors are the MESG (Maximum Experimental Spark Gap), MIC (Minimum Ignition Current). It is evident that there are some natural groupings for gases and vapors based on similarity of some of these factors. In practice, all gases are classified into just a few groups according to their ease of ignition, and a common and easily reproducible test gas typifies each group. The North American and IEC systems call the gas groups by different characters.

Table E

Gas	CEC/NEC Code	IEC Code
Acetylene	Group A	Group IIC
Hydrogen	Group B	Group IIB + H2
Ethylene	Group C	Group IIB
Propane	Group D	Group IIA
Coal Mines	Gaseous Mines	Group I

3.06 AIT (Auto Ignition Temperature)

It was recognized that there was no relationship between gas, vapour, and dust groups and the Auto-Ignition Temperatures (AIT) of various compounds. The AIT is the temperature at which a gas, vapour, or dust will ignite spontaneously without any other source of ignition. Because these temperatures did not correspond with the Gas Groups, Temperature Codes were established for equipment used in hazardous locations. Maximum Temperatures were assigned to each group, but this was problematic. North America decided to devise a temperature code similar to the IEC Code, but with more groups. As an alternative to the temperature codes, the actual maximum temperature that the device can attain, under normal or overload conditions, may be shown on the product. In North America a temperature code is not required to be marked on the equipment if its temperature is less than 100°C. It must be marked for other countries. The ambient temperature must also be identified.

Table F: Temperature codes used by IEC and North American Code.

IEC Temperature Code	Temperature, ˚C	North America Temperature Code
T1	450	T1
T2	300	T2
	280	T2A
	260	T2B
	230	T2C
	215	T2D
T3	200	T3
	180	T3A
	165	T3B
	160	T3C
T4	135	T4
	120	T4A
T5	100	T5
T6	85	T6

Table G: The below table depicts LEL/UEL/AIT of popular gases.

Group	Gas or Vapour	LEL (%)	UEL (%)	AIT (°C)
A	Acetylene	2.5	80	299
B	Hydrogen	4	75	550
C	Diethyl ether	1.9	48	160
C	Ethylene	3.1	32	435
C	Hydrogen Sulphide	4.3	45	260
D	Ammonia	15	28	651
D	Butane	1.9	8.5	372
D	Gasoline	1.4	7.6	215
D	Methane	5.3	15	537
D	Carbon Monoxide	12.5	74.2	605
D	Propane	2.2	9.5	493

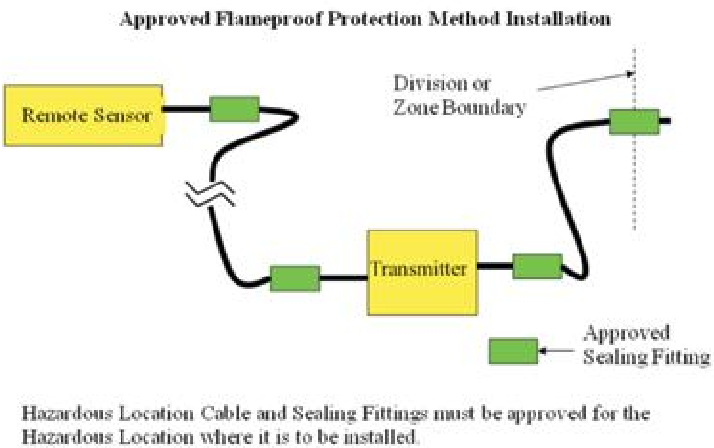
Looking at the LEL, UEL, Gas Group and Auto Ignition Temperature (AIT) of some common gases, one will notice that the LEL and UEL are different for each gas. The AIT for diethyl ether is 160°C. It is the gas with the lowest AIT and is a Temperature Code of T3C. A product with a Temperature Code of T3C is safe in a hydrogen sulfide (260°C) environment or an acetylene (299°C) environment, although some buyers may demand lower Temperature Codes such as T6 because that's what your competitor's product meets. Unless there is something in the same location, e.g. hazardous dust, which requires a lower Temperature Code then T3C, then a lower Code is not necessary.

4.00 Methods of prevention/protection

There are 10 different types of protection methods used in hazardous locations. However, they are restricted in terms of where they are allowed to be used. This will restrict the certified uses of the electrical equipment. These protection methods can be identified by approach used. There are four approaches for segregation of the hazard; Oil Immersion, Pressurization, Powder filing,, and Encapsulation. The two approaches of Refined Mechanical Design are Increased Safety and Non-incendive. Intrinsic Safety is an approach to limiting the energy (2-fault and 1-fault.) The other approach is containment of the explosion. In North America this is called Explosion-proof whereas in the rest of the world it is known as flameproof protection. The final type is known as Special protection. It is usually a combination of the other techniques that are considered acceptable by a Notified Body, allowing the products to be used in the desired location. The criteria to certify a piece of electrical equipment to a particular protection technique may vary in each country.

Type of Protection	Identification
Flameproof (Explosion-Proof)	d
Intrinsic Safety (2-fault)	ia
Intrinsic Safety (1-fault)	ib
Pressurization	p
Increased Safety	e
Oil Immersed	o
Powder Filled	q
Encapsulated	m
Zone 2 Apparatus	n
Special Protection	s

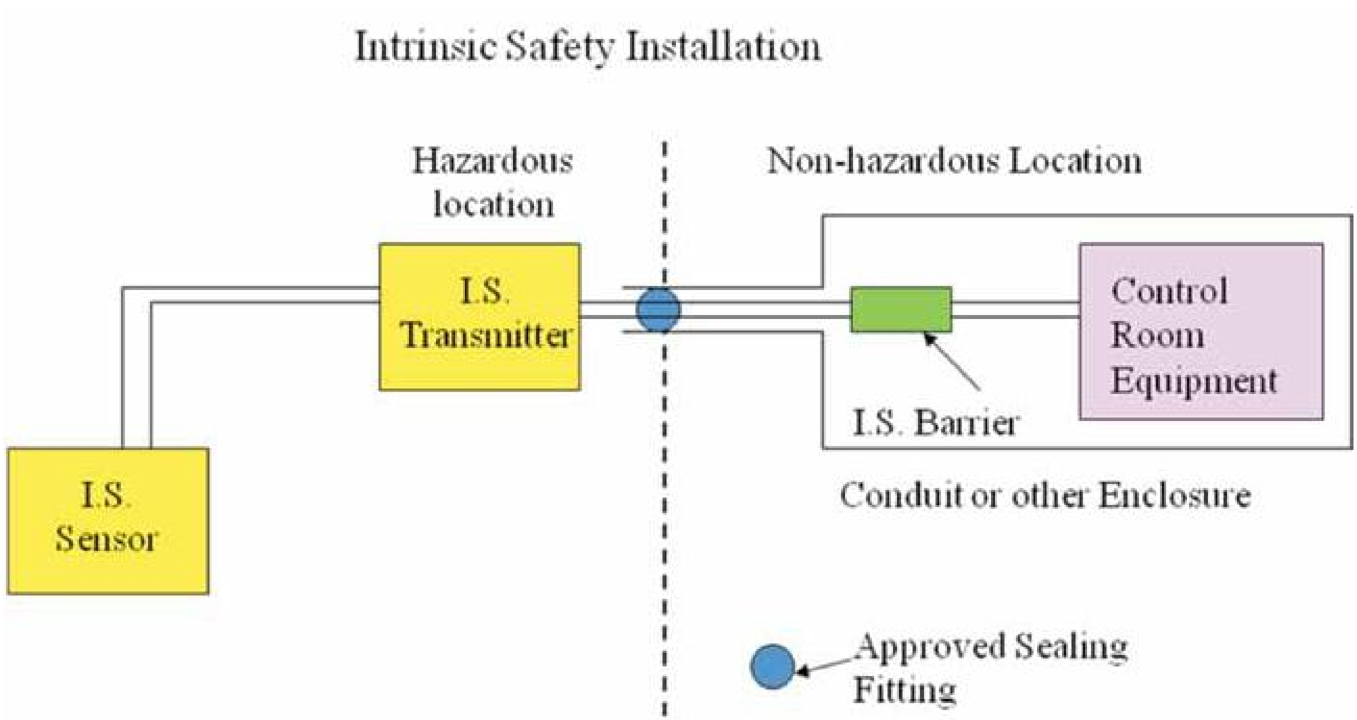
4.01 Flame Proof Method



A Typical Wiring & Installation Arrangement for Flameproof method of protection

Flameproof protection used to contain an explosion requires the use of approved Sealing Fittings and approved Conduit or Cable to prevent the effects of pressure piling. The approved Sealing Fittings are required at the crossing of Division or Zone Boundaries and within 18 inches (450 mm) of any enclosure that contains an arcing device (including Wire Junction Boxes.)The problem with Sealing Fittings is that Installers tend to install a lot of them at once and then go around to place the required Epoxy correctly into them. Each Sealing fitting must contain the epoxy that it was certified with in order to work. It must not use another manufacturer's epoxy. Therefore an Installer must be careful and ensure the correct epoxy is used with each device. Another problem is that the epoxies used in the Sealing Fittings are water-based. This is not good in cold temperature climates, where an epoxy may not cure correctly or it was forgotten to be poured in winter. To perform work on flameproof installations, unlike Intrinsically Safe Systems, requires a "Hot Permit" to be shut down the system.

4.02 Intrinsically Safe Method



This Intrinsic safety system is based on limiting of the "ignition source." By design, the electrical energy released in a circuit can be limited or clamped to such a level that it is incapable of igniting the explosive mixture. An advantage of this type of system is the fact that there is no explosion-proof enclosure required and no special wiring requirements except the equivalent requirements for that type of circuit in an ordinary location. Maintenance can be performed on the equipment while it is live.

The safety of the circuit is difficult to defeat and no Sealing Fittings are required except where the circuits passes from a hazardous to a non-hazardous location. However, Intrinsic safety can only be used for low power circuits and requires care in selecting components. Field wiring must be kept separate from all other wiring and there are some limitations on the capacitance and inductance of the field wiring.

There are two types of Intrinsic safety circuits; Ex ia (2-fault) and Ex ib (1-fault.) To protect the Intrinsic Safety approved equipment from faults originating from a Non-hazardous location an I.S. Barrier is normally required. An I.S. Barrier acts like a fuse, limiting the energy and controlling fault currents and voltages.

Table H: Protection Techniques Vs Zones and Divisions for Class I (Gases and Vapours) Equipment

CSA/UL/IEC Standard Permissible Protection Techniques	CSA/UL National Standard Permissible Protection Techniques
Zone 0: Ex ia (Intrinsic Safety, 2-fault)	Division 1: Intrinsic Safety (Ex ia)
Zone 1: Ex ib (Intrinsic Safety, 1-fault) Ex d (Flameproof) Ex e (Increased Safety) Ex o (Oil Immersed) Ex p (Purged and Pressurized) Ex q (Power Filled) Ex m (Encapsulated)	Explosion-Proof Purged and Pressurized Note: Equipment suitable for Division 1 is also suitable for Division 2.
Zone 2: Ex n (non-sparking/non-ignition-capable) Those permitted for Division 2. Note: Equipment suitable for Zone 0 is also suitable for Zone 1 and Zone 2; similarly Zone 1 is suitable for Zone 2.	Division 2: Non-ignition-capable arcing parts Non-ignition-capable heating parts Non-incendive Those permitted for Zone 1 and 2,

5.0 Fire and Explosion risk systems and equipment in Power Plant [1]

The main components and systems in a power plant that pose fire or explosion risks are as follows:

a) Fuel Gas System - Includes gas receiving station, gas analyzer system, gas compressor station, main shut-off valve, gas relief points, filter and scrubber station, gas pre-heater, gas control valve block, gas safety relief valve, gas flow metering, gas distribution piping, and turbine auxiliaries equipment/compartment.

b) Ignition Gas System - Includes propane gas cylinders, piping to ignition burner and combustor, and gas relief points.

c) Fuel Oil System -Includes fuel oil tanks, fuel oil unloading and forwarding pump station, fuel oil treatment system, fuel oil metering, fuel oil booster pump and leakage tank, fuel oil control valve block, and fuel oil piping to burners. The fuel oil becomes flammable when heated above its flash point.

d) Hydrogen Gas for Generator Cooling System - Includes hydrogen generation plant, hydrogen gas cylinder station, gas unit, seal oil unit, control cubicle, and piping.

e) Plant Battery System - Includes battery rooms.

f) Ammonia System - Includes storage tanks, pumps, and diked areas.

Potential Leak Sources

The following are some of the most common potential leak sources in the fuel gas, propane gas (ignition), fuel oil, hydrogen gas, and ammonia gas systems. Some of these leak sources are identified by the CTG equipment vendor.

(a) Fuel Gas System

- Flange gasket connection points on local piping, tubing, or at equipment
- Flange gaskets or screwed connections in main headers
- Seals (unless seal-less) at pumps and control valves
- Pressure relief devices due to overpressure in the system
- Gas relief points located in the open air above the turbine building roof for equipment located within the turbine area.

(b) Propane Gas (Ignition) System

- Ignition gas cabinet at the turbine auxiliary equipment area with screwed couplings and glands
- Gas relief points above the turbine building roof.

(c) Fuel Oil System

- Fuel oil transfer pipe joints and coupling in the fuel oil unloading area and forwarding pump stations
- Fuel oil tanks piping, pump blocks, filling and suction valve blocks, vents, indicators, alarm switches, oil piping outdoor and at combustor, burners, and heaters
- Open process points, sample points, and sumps.

(d) Hydrogen Gas (H2) System

- H2 gas storage cylinders
- H2 cooling unit and separator
- H2 cooled generator
- Battery rooms - Hydrogen gas is released from lead-acid flooded cell batteries during battery charging operations.

(e) Anhydrous Ammonia System

- Storage tanks, vaporizer, and diked areas.

6.0 BOUNDARIES OF HAZARDOUS CLASSIFIED LOCATIONS

Using the references listed above, the extent of the followed, especially if they are more stringent than Classified Area is established for each type of leak the guidelines provided in Table I source as shown in Table I. When there is more than one leakage source in an These guidelines should be used as a minimum area, such as in the case of a manifold having several requirement for Classification of Electrical Areas instruments, valves, and flanges, or if there are where such materials are located and processes are several pieces of equipment with potential leak performed. Table I is giving an over-view analysis of hazardous areas which are found in Thermal and Gas based power Plants with their identification, and extent of classified area.

Table I: Hazardous area in Thermal and Gas based power Plants. [1]

Hazardous Material	Process Equipment	Location/ Ventilation	Source of Leakage	Area class/ Division/Group/ AIT	Extent of Classified Area from Leakage Source (NFPA 497)
Fuel Gas (Natural Gas)	Gas Receiving Station	Outdoor / Natural	Possible release due to failure at meters, flange gaskets, or valve seal	I/2/D/457 C	Within 15 ft in all directions from leakage point

Fuel Gas (Natural Gas)	Gas Compressor Station	If not enclosed/ Natural & If enclosed/ Artificial Forced	Possible release due to failure at meters, flange gaskets, or valve seal	I/2/D/ 457 C	Within 15 ft in all directions & Entire Enclosure
Fuel Gas (Natural Gas)	Safety Valve Gas Relief Point(s)	Outdoor / Natural	Possible release due to overpressure in the system (abnormal) (Note 2)	I/1/D/ 457 C & I/2/D/ 457 C	Within 15 ft in all directions from a release point
Fuel Gas (Natural Gas)	Gas Filter/ Separator & Preheater Station	Outdoor / Natural	Possible release due to failure at meters, flange gaskets, or valve seals	I/2/D/ 457 C	Within 15 ft in all directions from leakage point
Fuel Gas (Natural Gas)	Gas Control Valve Module	Packaged Enclosure or Building/ Adequately Ventilated (Note 1)	Possible release due to failure at meters, flange gaskets, or valve seal, or door seals (abnormal)	I/2/D/ 457 C	Entire Enclosure or Building
Fuel Gas (Natural Gas)	Gas Control Valve Module Relief Point	Gas Turbine Building/ Enclosure Roof	Exhaust Vent	I/1/D/457 C	Within 18 ft radius from vent and 3 ft vertical from vent
Fuel Gas (Natural Gas)	Heat Recovery Steam Generator (HRSG) Supplemental Gas-Firing Duct Burner System	Outdoor / Natural	Possible release due to failure at flange gaskets or valve seal (abnormal)	I/1/D/457 C	15 ft radius from burner front, valve, and connections to burner grids
Fuel Gas (Natural Gas)	Fuel Gas Drain Tank	Outdoor / Natural (Above Ground)	Possible release due to failure at valve seal (abnormal)	I/1/D/457 C & I/2/D/ 457 C	Within 5 ft radius from relief valve and 10 ft radius from vent or relief valve
Fuel Gas (Natural Gas)	Fuel Gas Drain Tank	Outdoor / Natural (Under Ground)	Possible release due to failure at instruments, flange gaskets, or valve seal	I/1/D/ 457 C & I/2/D/ 457 C	Within 5 ft radius from relief valve and 15 ft radius all around
Ignition Gas (Propane Gas)	Ignition Gas Cabinet	Turbine Auxiliary Equipment Area	Possible release due to failure at valve seal (abnormal)	I/2/D/ 450 C	Entire Cabinet

Fuel Oil	Fuel Oil Unloading & Pump Station	Outdoor Oil Unloading Shelter/ Natural	Possible release due to failure at oil transfer pipe coupling at the oil delivery truck	I/2/D/ 257 C	3 ft from the edge of the device extending in all directions and up to 18 inches above floor or grade level extending to a distance of 10 ft horizontally
Fuel Oil	Fuel Oil Tank	Outdoor Oil Tank Farm / Natural	Possible release of gas vapor from vent and sample points	I/1/D/ 257 C & I/2/D/ 257 C	Inside tank and within 5 ft in all directions from a point of discharge Beyond 5 ft but within 10 ft in all directions from a point of discharge
Fuel Oil	Fuel Oil Forwarding Station	Oil Tank Farm Area/ Adequately Ventilated (Note 1)	Possible release due to failure at valve seal (abnormal)	Non-classified if handled at less than the flash point temperature & I/2/D if handled at greater than the flash point temperature	Entire Compartment / Enclosure
Fuel Oil	Fuel Oil Control Valve Block	Turbine Auxiliary Equipment Compartment / Adequately Ventilated (Note 1)	Possible release due to failure at valve seal (abnormal)	Non-classified if handled at less than the flash point temperature & I/2/D if handled at greater than the flash point temperature	Entire Compartment / Enclosure
Hydrogen Gas	Hydrogen Plant	Electrolyzer, Liquid separator, Purifier and Drier / Enclosed Roof (Forced ventilation)	Possible release due to failure of valve seal, gaskets, vents and sample point.	I/2/B/520 C	Within 15 ft in all directions from a point of discharge

Hydrogen Gas	Hydrogen Gas Storage Cylinders	Outdoors / Natural	Possible release from valve packing, flange gasket, and relief valves vented or system overpressure (abnormal) (Note 2)	I/2/B/520 C	Within 15 ft in all directions from a point of discharge
Hydrogen Gas	Hydrogen Manifold Equipment	Under Turbine Generator (TG) Pedestal – Open Bay / Adequately Ventilated (Note 1)	Possible release due to leaks in screwed joints	I/2/B/520 C	15 ft horizontal and vertical radius from leak source
Hydrogen Gas	Hydrogen Cooled Generator	Turbine Building /Adequately Ventilated (Note 1)	Hydrogen oil seals	I/2/B/520 C	Within 5 ft in all directions from a point of Leakage source
Hydrogen Gas	Hydrogen Seal Oil Unit	Turbine Building /Adequately Ventilated (Note 1)	Possible release due to failure at meters, flange gaskets, or valve seals	I/2/B/520 C	Within 5 ft in all directions from a point of Leakage source
Hydrogen Gas	Hydrogen Gas Relief Points/ Seal Units	Outdoor Above TG Building Roof	Gas Vents	I/1/B/520 C	Within 1\5 ft in all directions from a point of Leakage source
Hydrogen Gas	Plant Direct Current System Batteries	Battery Room/ Adequately ventilated	Hydrogen gas during battery charging cycle. Failure of continuously operated Exhaust Fan	Non-Classified	See Note 3
Anhydrous Ammonia	Tank and Vaporizer	Outdoor Storage Tank and Diked Area	Ammonia concentration in air are not likely to exceed 16% by volume	Non-Classified	See Note 4

Note 1: Adequately ventilated per NFPA 497: A ventilation rate that affords either 6 air changes per hour, or 1 cfm per square foot of floor area, or other similar criterion that prevents the accumulation of significant quantities of vapor-air concentrations from exceeding 25% of the lower flammable limit.

Note 2: If vent pipes are being discharged in an otherwise non-hazardous area, they should be discharged outdoors at a minimum distance of 10 feet (for natural gas) and 15 feet (for hydrogen) from any electrical equipment, light fixture, etc.

Note 3: A continuously operated exhaust fan in the battery room is required to remove the hydrogen gas discharged from the batteries. The exhaust fan will prevent accumulation of the hydrogen gas explosive mixture. Loss of electrical power to the fan should be alarmed in the Plant Control Room.

Note 4: Ammonia detectors should be installed around the diked area that sends a signal to the Plant DCS. A deluge water spray system should be installed for automatic/manual actuation and an alarm signal should be sent to the Fire Alarm Panel located in the Plant Control Room.

7.0 Application and Implementation:

The objective of this paper is to understand the theory and methods which are practiced across the industry for classifying the various categories for explosion hazards present in industry. Power plants in India still have scope for addressing these hazards and mitigating them by implementing these methods of protection right from the design stage.

An attempt has been done to use rich practice of Oil & Gas sector in implementing these protection methods in gas and thermal power plants. Lanco has completely implemented these proposed methods in Lanco Solar Polysilicon manufacturing plant, right from the design stages. Although this facility has more relevance to refinery but similarity with some areas of gas and thermal power plant compelled us to explore associated hazard and propose scope of implementation.

References

[1] "Practical Guidelines for Electrical Area Classification in Combustion Turbine-Generator Power Plants" – by Ram K. Saini, P.E. Principal Engineer & Chuck Emma, P.E.Principal Engineer, Burns and Roe Enterprises, Inc.

[2] NEC Article 500, NEC Article 505

[3] National Fire Protection Association (NFPA) Recommended Practices 499

[4] NFPA 497-1997 Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

[5] NFPA 30-2003 Flammable and Combustible Liquids Code

[6] NFPA 50A-1999 Standard for Gaseous Hydrogen Systems at Consumer Sites

[7] NFPA 70-2005 National Electrical Code (Chapter 5)

[8] IEC 79-10 (Part 10) Classification of Hazardous Areas

[9] IEC 79-14 (Part 14) Electrical Installations in Explosive Gas Atmospheres

[10] CSA standard C22.2 No. 213 sealed component test for Flame proof application.

[11] ANSI/ISA RP12.06.01 Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation

BIOGRAPHIES

Ashok Kumar Panda: Ashok Kumar Panda graduated in Electronics and Telecommunication Engineering from NIT, Silchar and a post graduate from IIT, Delhi. He joined NTPC in 1991 and has worked in areas of O&M, Engineering and had been involved in several optimization projects. He joined Lanco EPC division as HOD C&I engineering in 2008 and has been dealing the thermal, combined cycle and solar power projects.

Soumya: Soumya is a final year student at R V College of engineering, Bangalore and is pursuing bachelors in Instrumentation engineering. She has been involved in Industrial project at Lanco EPC C&I division. She was involved in C&I of Solar projects with perspective of understanding the criticality, safety issues and related codes & Standards, then to implement this learning into Thermal and Gas power plant.

Nikhilesh Kumar: Nikhilesh Kumar graduated in Instrumentation engineering from IIT Kharagpur in 2007. He has worked in projects, plant commissioning, design & engineering at Sterlite and Johnson Matthey. He joined Lanco and has been dealing C&I engineering for solar projects. He has participated into HAZOP studies, SIL study, HAZID and Area Classifications during his career in design engineering.