# SPARKLE

# 2017

IpS ACADEMY

Institute of engIneerIng AnD sCIenCe

FIRE TECHNOLOGY & SAFETY ENGINEERING DEPARTMENT

***O Agni! Help us to gain prosperity by leading us***

***On the righteous path,***

***You know all our thoughts and actions.***

***Redeem us from all our sins and evil ways.***

***We bow before you with gratitude.***

***-Rigveda***

## DEDICATION

**A Fire and Safetyman is the member of that unselfish organization of men who hold devotion of duty above personal risk, who count sincerity of service above personal comfort and convenience, who strive, unceasingly to find better ways of protecting the homes of fellow citizens and property of the nation from the ravages of fire and other disasters. This journal is dedicated to all those who have sacrificed their lives in achieving this noble cause.**

# STUDENT CHAPTER

Department of Fire Technology & Safety Engineering established student chapter under Fire & Security Association of India (FSAI) in year 2016. Fire & Security Association of India (FSAI) is a non-profit organization representing the Fire Protection, Life Safety, Security, Building Automation, Loss Prevention and Risk Management domains. FSAI aims to work closely with the Government and all other stakeholders to enable the Indian fire and security industry to reach global pre-eminence with better regulatory framework.


Since its establishment the department has been running engineering career oriented Quality Improvement Programme (Q.I.P.) to render the best Fire & Safety professionals to the corporate world. These programmes includes basic fire-fighting training, first aid paramedics training, design of fixed fire-fighting installations and national seminar/workshops that impart best training to our students.

# Fire & Security Association of India (FSAI) MP Chapter

## Student Chapter Team

**PRESIDENT**

ADITYA SHARMA

**SECRETARY**

PUNEET RAJ

**TREASURER**

ABHINANDAN PAWAR

**CR FINAL YEAR**

PRACHI SHARMA

**CR THIRD YEAR**

SUMIT TRIVEDI

**CR SECOND YEAR**

PANKAJ SHUKLA

# President’s Message

*I have always believed that no doubt it is important to start new projects, undertake novel ventures, but more important is to insure that they do not remain one time wonders but become a continuous process, a habit, a tradition. Therefore it gives me great pleasure to see the periodic issue “SPARKLE”. I congratulate the editorial team of SPARKLE and wish them to success.*

*Achal K Choudhary,*

*President,*

*IPS Academy Indore (MP) India*

# Principal’s Message

*Technical Education is the most potential instrument for socio-economic change. Presently, the engineer is seen as a high-tech player in the global market. Distinct separation is visible in our education between concepts and applications. Most areas of technology now change so rapidly that there is a need for professional institutes to update the knowledge and competence.*

*Institute of Engineering and Science, IPS Academy is a leading, premium institution devoted to imparting quality engineering education since 1999. The sustained growth with constant academic brilliance achieved by IES is due to a greater commitment from management, dynamic leadership of the president, academically distinctive and experienced faculty, disciplined students and service oriented supporting staff.*

*The Institute is playing a key role in creating and ambiance for the creation of novel ideas, knowledge, and graduates who will be the leaders of tomorrow. The Institute is convinced that in order to achieve this objective, we will need to pursue a strategy that fosters creativity, supports interdisciplinary research and education. This will also provide the students with an understanding and appreciation not only of the process of knowledge creation, but also of the process by which technology and knowledge may be used to create wealth as well as achieve social economic goals.*

*I am delighted to note that the engineering graduates of this institute have been able to demonstrate their capable identities in different spheres of life and occupied prestigious position within the country and abroad. The excellence of any institute is a measure of achievements made by the students and faculty.*

*All the Best.*

*Dr. Archana Keerti Chowdhary*

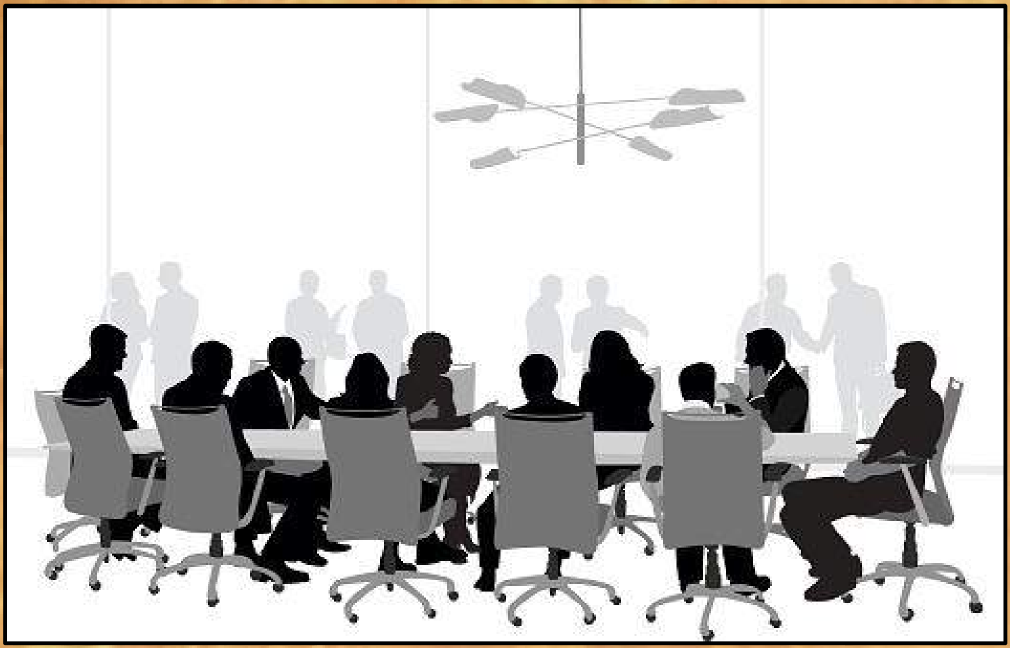
*Principal*

# HOD's Message

***In order to achieve the aims and objectives of the society we plan to undertake some useful activities like organizing seminars, workshops and conferences at national and international level and publication of relevant technical literature. In this process it has been decided to publish a technical magazine entitled "Sparkle". The magazine is covering area relating to Fire, Safety and Occupational health/ hygiene. The article and research paper being contributed by the student writers with a mission of spreading awareness about Fire Prevention and Protection, Industrial Safety and Occupational health/hygiene. This will also help in generating awareness and educating the common people, which in turn will help in reducing loss of life and property. The society will provide the National Forum to meet and discuss the various issues and developments in the field of fire protection and industrial safety. The technical magazine will have a wider circulation among leading consultants, organizations concerned with the Fire, Safety and Environment protection.***

***Dr. Praveen Patel***
***Head of Department***

# EDITORIAL BOARD






**PUBLISHED BY**

**IPS Academy, Indore**
**Institute of Engineering and Science**
**Fire Technology and Safety Engineering Department**

## CONTENTS

# PROGRAM EDUCATIONAL OBJECTIVES

**PEO 1:** To provide student with an academic environment aware of excellence, outstanding leadership, written, ethical codes and guidelines with moral values, and the life-long learning needed for a successful professional career.

**PEO 2:** To prepare students for job profile of Fire / Safety Officer with professional advancement in fire technology and safety engineering field through global education.

**PEO 3:** To provide students with basic foundation in mathematical, scientific and engineering fundamentals for solving complex problem in fire technology and safety engineering and to pursue higher studies.

**PEO 4:** To trained students with good scientific, engineering and life safety breadth so as to comprehend analyze, design and create novel products and solutions for the real life problem.

**PEO 5:** To inculcate in students professional and ethical attitude, effective communication skills, team work skills, multidisciplinary approach and ability to relate fire and safety engineering issues to broader and social context.

## PROGRAM OUTCOMES (POs)

The POs as recommended in National Board of Accreditation (NBA), New Delhi manual are as follows:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

# PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Ability to design solution for the complex major hazardous industries in terms of fixed fire-fighting installations and fire prevention that meet the specified needs.

2. Ability to describe the impact of safety engineering solutions in environmental, economic and societal context.

## Department Information

Department of Fire Technology & Safety Engineering was established in the year 1999. The Department became the first AICTE Approved Engineering Department for providing four years Bachelor degree of Engineering in Fire Technology & Safety Engineering.

Since its establishment the department has been running engineering career oriented quality improvement programme (Q.I.P.) to render the best Fire & Safety professionals to the corporate world. These programmes include basic fire-fighting training, first aid paramedics training, design of fixed fire-fighting installations and national seminar / workshops that impart best training to employee of Industries to gain skill.s

Department of Fire Technology & Safety Engineering is a leading department devoted to imparting quality Fire & Safety Engineering education. Apart from AICTE New Delhi, approval and affiliation with the Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal, department has also got approval from the Chief Factory Inspectorate Labor Department, Govt. of M.P. as per Gazette notification dated 29.05.2009.

**COURSES OFFERED:-**

1. UG – B.E. in Fire Technology & Safety Engineering

2. UG – B.E. in Safety and Fire Engineering

3. PG – M.Tech. in Industrial Safety Engineering

# VISION & MISSION OF THE DEPARTMENT

## Vision

To generate, develop and sustain a voluntary movement on Fire & Safety Engineering at the National Level aimed at educating and influencing society to adopt appropriate policies, practices and procedures that prevent and mitigate human suffering and economic loss arising from all types of accidents.

## Mission

1 To create and sustain a community of learning in which students acquire knowledge in fire, safety and hazard management and learn to apply it professionally with due consideration for ethical, human life & property safety issues.

2 To pursue research and development in fire safety engineering, hazard management and disseminate its findings.

3 To meet the challenges of today and tomorrow in the most effective, efficient and contemporary educational manner.

4 To help in building national capabilities in fire safety engineering, disaster management, hazard management, industrial safety education through practical training to ensure a fire safe nation.

# DEPARTMENT FACULTY DETAILS

| S. No. | Name of Faculty | Designation | Highest Qualification | Date of Joining |
|---|---|---|---|---|
| 1 | Dr. Praveen Patel | Asso. Professor | M.E. | 02.08.2004 |
| 2 | Dr R J Lalwani | Professor | Ph.D | 22.08.2016 |
| 3 | Dr. S.N. Varma | Professor | Ph.D | 04.01.2016 |
| 4 | Mr. Praveen Badodia | Assist. Prof | M.Tech | 04.03.2011 |
| 5 | Mr. Vineet Banodha | Assist. Prof | M.Tech | 17.08.2010 |
| 6 | Mr. Veerendra Suryavanshi | Assist. Prof | M.Tech | 01.01.2013 |
| 7 | Mr. Yashwant Buke | Assist. Prof | M.Tech | 08.10.2010 |
| 8 | Mr. Aashish Yadav | Assist. Prof | M.Tech | 12.01.2012 |
| 9 | Mr. Vijay Kr. Shankul | Assist. Prof | M.Tech | 13.03.2013 |
| 10 | Ms. Shalini Bhardwaj | Assist. Prof | ME | 08.08.2012 |
| 11 | Mr. Vijay Kahar | Assist. Prof | M.Tech | 01.08.2013 |
| 12 | Mr.Rajiv Premi | Assist. Prof | M.Tech | 20.10.2009 |
| 13 | Mr. Sandeep Yadav | Assist. Prof | M.Tech | 19.08.2010 |
| 14 | Mr. Abhishek Samvatsar | Assist. Prof | M.Tech | 01.08.2011 |
| 15 | Mr. Pankaj Solanki | Assist. Prof | M.Tech | 10.11.2008 |
| 16 | Ms. Sulochna Tiwari | Assist. Prof | M.Tech | 01.07.2014 |
| 17 | Mr. Puneet Bhawar | Assist. Prof | M.Tech. | 01.09.2016 |
| 18 | Ms. Kirti Vyas | Assist. Prof | M.Tech. | 01.08.2011 |
| 19 | Mr. B.N. Phadke | Assist. Prof | M.E. | 27.03.2010 |
| 20 | Mr. Manish Dubey | Assist. Prof | M.Tech | 14.06.2014 |
| 21 | Mr N K Jain | Asst. Professor | B.Tech | 09.02.2009 |
| 22 | Mr Jaiveer Singh | Assist. Prof | M.Tech | 01/05/2010 |

# Department Achievement

| S. No. | Detail | No. |
|---|---|---|
| 1 | Seminar Organized | 01 |
| 2 | Workshop Organized | 01 |
| 3 | Expert Lectures Organized | 13 |
| 4 | Industrial Visit Organized | 03 |
| 5 | Industrial Tour | 01 |
| 6 | Other Events Organized | 04 |

# Faculty Achievements

| S.No. | Topic | No. |
|---|---|---|
| 1 | Paper Published in Journals | 02 |
| 2 | Paper Presented in Seminar / Conferences | 01 |
| 3 | Seminar & Workshop Attended | 02 |
| 4 | SDP/FDP Attended | 01 |

# Students Achievements

| S.No. | Topic | No. |
|---|---|---|
| 1 | Special Awards | 01 |
| 2 | Received Vice Chancellor's Scholarship | 07 |
| 3 | Academic Awards | 07 |
| 4 | Paper Published in Journals | 02 |
| 5 | Paper Presented in Seminar | 12 |
| 6. | Workshop Attended | 02 |

## Participation in inter-institute events by students of the program of study

| S.No. | DATE | | Name of the Event | Awardees Name | Prize/ Certificate | Organized by |
|---|---|---|---|---|---|---|
| | From | To | | | | |
| 1 | 23/02/2017 | 25/02/2017 | Three Days Institute Annual Function Swaranjali 2017 | Aditya Sharma | Face of the crowd | IPS Academy, Institute of Engineering & Science. |
| 2 | 2016-17 | 2016-17 | Vice Chancellor Scholarship (2016-2017) | Mr. Ishwar Choudhary<br>Mr. Servesh Parmar<br>Mr. Pankaj Patidar<br>Mr. Deepak Ku. Singh<br>Mr. Rahul Singh<br>Mr. Vikash Barfa<br>Mr. Pankaj Patidar | Vice Chancellor Scholarship (2016-2017) | Rajiv Gandhi Technical University, Bhopal (M.P.) |
| 3 | 17/10/2016 | 21/10/2016 | Five Days Seminar on "An Overview of fire, Safety and Occupational Health in Present Scenario | Mr. Prabhat Jain<br>Mr. Nikhil Verma<br>Ms. Ankita Mahapatre<br>Mr. Mahendra Sattawat<br>Mr. Hari Om Sharma<br>Mr. Ayush Gupta | 1st position in Panel Discussion Competition | Fire Technology & Safety Engineering Department |
| 4 | 17/10/2016 | 21/10/2016 | Five Days Seminar on "An Overview of fire, Safety and Occupational Health in Present Scenario | Mr. Arpit Soni | 1st position in Quiz Competition | Fire Technology & Safety Engineering Department |
| 5 | 17/10/2016 | 21/10/2016 | Five Days Seminar on "An Overview of fire, Safety and Occupational Health in Present Scenario | Mr. Jay Parmar | 2nd position in Quiz Competition | Fire Technology & Safety Engineering Department |

| S.No. | Date | | Name of the Event | Awardees Name | Prize/ Certificate | Organized by |
|---|---|---|---|---|---|---|
| | From | To | | | | |
| 6 | 17/10/2016 | 21/10/2016 | Five Days Seminar on "An Overview of fire, Safety and Occupational Health in Present Scenario | Mr. Abhijeet Shrivastava | 1st position in Research Paper Presentation Competition | Fire Technology & Safety Engineering Department |
| 7 | 17/10/2016 | 21/10/2016 | Five Days Seminar on "An Overview of fire, Safety and Occupational Health in Present Scenario | Mr. Lucky Manoj Kothari<br>Ms. Dipti Moondra | 2nd position in Research Paper Presentation Competition | Fire Technology & Safety Engineering Department |
| 8 | 17/10/2016 | 21/10/2016 | Five Days Seminar on "An Overview of fire, Safety and Occupational Health in Present Scenario | Mr. Rajat Patwari | 1st position in Model Exhibition Competition | Fire Technology & Safety Engineering Department |
| 9 | 17/10/2016 | 21/10/2016 | Five Days Seminar on "An Overview of fire, Safety and Occupational Health in Present Scenario | Mr. Shubham Chandan<br>Mr. Shivam Gupta<br>Mr. Shivam Shukla | 2nd position in Model Exhibition Competition | Fire Technology & Safety Engineering Department |
| 10 | 2016-17 | 2016-17 | | Mr. Arihant Jain ,<br>Ms. Varsha Solanki | Gold Medal (2016-2017) | Rajiv Gandhi Technical University, Bhopal (M.P.) |
| 11 | 2016-17 | 2016-17 | | Appil Ora<br>Sakhi Jain | Silver Medal (2016-2017) | Rajiv Gandhi Technical University, Bhopal (M.P.) |

# Five Days Seminar
# On
# “An Overview of Fire, Safety and Occupational Health in Present Scenario”
## 17th Oct. to 21st Oct., 2016

## OBJECTIVE

The Seminar will provide unique opportunity for the participants to understand the fundamental and basic of Fire technology and safety engineering. The Seminar is intended to help the individuals for effectively communicating and enhancing the presenting skills so as to perform effectively in the arena of emergency situation.

## THEMES

- Risk Analysis
- Labeling, Classification and Transportation of Hazardous Material.
- Safety Consideration in Chemical Process.
- LNG Operations & Safety
- Construction Safety
- Disaster Mitigation & Management
- Hazard Identification & Risk Assessment.
- Principles of Safety Management
- Fire Dynamics.
- Fire Prevention & Protection.
- Water & Non Water Based Fire Fighting System.
- Occupational Health & Hygiene

## COORDINATORS

- **Mr. Manish Dubey**
  Associate Professor
  Fire Technology & Safety Engineering Department
  IES-IPS Academy, Indore

- **Mr. Rajiv Premi**
  Assistant Professor
  Fire Technology & Safety Engineering Department
  IES-IPS Academy, Indore

## REGISTRATION FEE

Student from IES-IPSA : Rs. 50/- per participant
Student from other Institute : Rs. 200/- per participant
Faculty members from other institute : Rs. 500/-per Participant

## CASH PRIZE:

| Name of Competition | Prize Amount |
|---|---|
| Panel Discussion | Rs 4000.00 |
| Research Paper-I | Rs 2500.00 |
| Research Paper-II | Rs 1500.00 |
| Quiz Competition-I | Rs 2500.00 |
| Quiz Competition-II | Rs 1500.00 |
| Model Exhibition-I | Rs 2500.00 |
| Model Exhibition-II | Rs 1500.00 |

Glimpses of Seminar

## WINNER & RUNNER-UP LIST

| S.No. | Date | Name of Competition | First Position | Second Position |
|---|---|---|---|---|
| 1. | 18.10.2016 | Research Paper Competition | (Improving the range of Fire Fighting Water Jet using flow conversion.)<br><br>1. Abhijeet Shrivastava | Evaluation & Simulation of hazard associated with LPG Transportation & Storage Facilities<br><br>1. Lucky Kothari<br>2. Dipti Moondra |
| 2. | 19.10.2016 | Panel Discussion Competition | US President Election 2016; Impact on India<br>1.Prabhat Jain<br>2. Nikhil Verma<br>3. Ankita Mahapatre<br>4. Mahendra Sattawat<br>5. Hari Om Sharma<br>6. Ayush Gupta | -- |
| 3. | 20.10.2016 | Quiz Competition | 1. Arpit Soni | 1. Jay Parmar |
| 4. | 20.10.2016 | Model Exhibition Competition | (NBC-IV Group A Occupancy )<br>1. Rajat Patwari | Fire & Safety in Hospital<br><br>1.Shubham Chandan<br>2. Shivam Gupta<br>3. Shivam Shukla |

## Research Papers Presented/Publication

**Paper Presented in Seminar/ Conference National**

| S No. | Name of Students | Title of Paper | Detail of Seminar/ Conference Proceeding and organized by |
|---|---|---|---|
| 1. | Arpit Soni, Aditya Sharma, Kamal Nagar, Vishal Kothare, Naman Chourasiya, Puneet Raj J Aayush Chorey, Arvind Verma, Shubham Gour Shubham Jain | Impact Assessment of Fire and Explosion using Source and Dispersion Modeling | Research Paper Competition in Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |
| 2. | Aashish Kumar Lakhan Bariya Kapil Bamniya Bhupendra Patidar Lucky Gupta Hitesh Sitlani Rohit Ginnare Shiv Pal Singh Shrawan Tripathi Shubham Chaurasia | Safety Review of the Steel Plant by Job Safety Analysis Method | Research Paper Competition in Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |
| 3. | Chetan Bhagvat Mahesh Dangi Devendra Singh PiyushRaghuvanhi Sanyam Jain Abhas Nagariya Rahul Singh Thakur Pranjal Gupta | Explosion Hazard and their Control Using Accident Model in Steel Industry | Research Paper Competition in Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |
| 4 | Piyush Sharma Sandeep Singh Narendra Gurjar Vinod Yadav Yogesh Yadav Sourabh Ku. Patel Sudhir Randhwa Praful Kumar Prakhar Parekh | Review of Chernobyl Nuclear Disaster and its causes | Research Paper Competition in Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |

| S No. | Name of Students | Title of Paper | Detail of Seminar/ Conference Proceeding and organized by |
|---|---|---|---|
| **5** | Kapil Dubey<br>Govind Singh<br>Nilesh Gupta<br>Rupesh Jaiswal<br>Sachin Porwal<br>Sarthak Alya<br>Shivam Khedekar<br>Vasudev Solanki | Recommendations of Fire Protection and Safety Policies Using Gap Analysis in IMC | Research Paper Competition in Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |
| 6 | Lucky Kothari<br>Dipti Moondra<br>Anshul Salvi<br>Fateh Ku. Sonekar<br>Karishma Jaiswal<br>Jitendra Sharma<br>Mayur Mahajan<br>Avadhesh Porwal<br>Ashish Pareekh | Estimation of Heat Flux in Pool Fire Using Different Mathematical Models | Research Paper Competition in Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |
| 7 | Rachit Tiwari<br>Prachi Sharma<br>Vikram Patidar<br>Shivam Gupta<br>Amit Raghuwanshi<br>Vijay Kaushal<br>Vikas Mourya<br>Vishwas Rathi<br>Shubham Doliya | Assessment of Occupational Health & Safety in Fertilizer Industry | Research Paper Competition in Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |
| 8 | Prabhat Jain<br>Nikhil Verma<br>Uttkarsh Agrawal<br>Rahul Kumar<br>Paranjay Najan<br>Pranav Saket<br>Manish Solanki<br>Mohd. Arshad | Hazard Identification and Risk Assessment of an LNG Plant Using FMECA and HAZOP Integrated Methodology | Research Paper Competition in Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |
| 9 | Akshay Nagwadiya<br>Akshay Patidar<br>Anand Kumawat<br>Anshul Kayast<br>Ashwint Pawar | Strategies in noise Reduction Using Engineering Controls in Thermal Power Plant | Research Paper Competition in Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |
| **10** | Chitvan Vyas<br>Kinshuk Sharma<br>Swapnil Kumare<br>Abhishek Boare<br>Gajendra Katkar<br>Piyush Pandey<br>Rajat Jaiswal | Design and Development of Smart LPG Gas Stove For Automatic Flame Control and Gas Leakage Detection System | Research Paper Competition in Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |

| S No. | Name of Students | Title of Paper | Detail of Seminar/ Conference Proceeding and organized by |
|---|---|---|---|
| 11 | Taher Sandalwala<br>Sawan Patidar<br>Saurabh Kumar<br>Rahul Choukikar<br>Rahul Kumar<br>Rahul Patidar<br>Sohan Pawar<br>Sourabh Gehlot<br>Shubham Roy<br>Umesh Ku.rathore | Hazop Study on Blow Out hazard in onshore Oil and Gas Industry | Research Paper Competition ( Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |
| 12 | Abhijit Shrivastava<br>Ashish Dharva<br>Kunal Patidar<br>Anuj Tiwari<br>Kaustubh Pawar<br>Narayan Patel<br>Narendra Tanwar<br>Nitin Sehrawat<br>Palash Yenkar | Design & Performance Analysisfor Improving the Range of fire-fighting water jet using flow conversion | Research Paper Competition ( Five Days Seminar on An Overview of Fire, Safety and Occupational Health in Present Scenario |

# "A Review Article of Smart LPG Stove System"

**1 Kshitij Gupta, 2 Mr.Veerendra Suryavanshi, M.Tech Student (Industrial Safety Engineering), Dept. of Fire tech. and Safety Engineering, IES, IPS Academy, Indore, 2 Asst. Professor, Dept. of Fire tech. and Safety Engineering, IES, IPS Academy, Indore**

**ABSTRACT**

Energy wastage is one of the most serious problems on the earth. LPG is the commonly used source of the energy for cooking in urban areas. In the present LPG system there are several disadvantages like most of the energy wasted when flame is greater than the vessel diameter, leakage of gas is one problems with current LPG cooking system, we don't have a option to set the ON period of the stove so that we can do other works during cooking process, overflow of food from vessel is unavoidable and we are least known about remaining gas in the cylinder. One of the major challenges at the present moment is the improvement of the current cooking system in urban areas where LPG is main source of cooking and to install LPG stoves in rural areas where LPG is less known. In proposed system we made use of a small 5 kg LPG cylinder which is portable and we have developed a cost effective Smart LPG Stove which is suitable for this economic world. This system can also be implemented to present 14 kg LPG cylinders. The system proposed consists of five major modules namely, automatic adjustment of flame size in accordance with vessel diameter, automatic turn OFF of system when given time has elapsed, automatic turn OFF of system when gas leakage is detected, gas level indicator module and overflow of food from the vessel is detected and wastage of food and LPG avoided. **Keywords**: Arduino mega 328 ,gas flow meter,MQ-6 gas sensor, LCD, stepper motor.

## 1. INTRODUCTION

LPG is the commonly used source of the energy for cooking in urban areas. In rural areas still people make use of naturally available resources such as Biomass and charcoal stove. These systems are not economically efficient and also leads to pollution. Also in present LPG system there are several disadvantages like most of the energy wasted when flame is greater than the vessel diameter, Leakage of gas is also one problem with current LPG cooking system. Because of this many people have died and the number of deaths per year is still growing. We need to think to reduce the number of deaths by alerting the people and turn off the stove when there is a leakage. In this busy world it is difficult to track entire cooking process but it is unavoidable since we don't have a option to set the on period of the stove so that we can do other work during cooking process. Overflow of food from vessel is also a problem where the flame will turn off while gas is flowing. That is also a kind of leakage. We are least known about remaining gas in the cylinder. One of the major challenges at the moment is to improvement of the current.

Gas sensors are employed in a wide range of applications in the fields of safety, health, instrumentation etc. Common examples are domestic/commercial alarms for explosive or toxic gases, or in automotive application as gas leakage detectors for LPG powered cars and exhausts detectors inside any fuel powered truck/car. Such sensors, nowadays, are found also in applications involving air quality control systems and pollution monitoring. Today’s sensors, while featuring a high sensitivity to a wide gases variety, are very compact in size and have significantly reduced their power consumption to better adapt to portable solutions. Building a system with a gas sensor is not as easy as it could appear. Despite the sensor could be treated, basically, as a variable resistor (which value depends on gas concentration in air) the practical implementation in a project should be done considering some design rules, especially if the final circuit is a device to be used in a field where reliability is strongly required (e.g. safety). As an example the internal elements of a sensor (heater and gas sensitive resistors) have to be constantly kept under control to avoid failures leading to a wrong alarm indication; furthermore, if the application needs to achieve a good measurement accuracy, factors like environment temperature, sensor life etc have to be taken into account. All those features and controls require introducing in the project a certain amount of external circuitry (including components like comparators, temperature sensor, spare logic etc[1].

## 2. ISSUE OF OLD ARTICLE

**1. GSM BASED ALERTING SYSTEM: Mr.Rahul Gachhe:** The primary objects of the this project is to provide a novel means for safely detecting any malfunction of a pressurized gas system in order to protect accumulation of combustible gases so that damage and explosion due to such an accumulation of gases is prevented. Another objective of the present invention is to provide a novel safety means for detecting the leakage of LPG gas into the area of an appliance when the appliance is suddenly shut down due to wind and any other reason. Yet another object of the present invention is to provide a novel gas detection and monitoring system for boats or the like which are normally dependent upon a stored supply of pressurized gas. Typical installation areas are gas yards (Bullets), gas banks with multi cylinders in manifold, utility areas like kitchens. This project is used to monitor the weight of LPG cylinder and send SMS through GSM. In our home we observe whenever LPG gas cylinder is empty, we give request for new gas cylinder at the office of service provider. Main reason behind this is delay in informing to the service or we inform the service provider at the last moment when the cylinder is empty. In home and hotels the main use of LPG gas is for cooking. But in industry sometimes LPG gas and some other combustible gas is used for some other purposes. In these places if the LPG gas inside gas cylinder is finished at that time request for new gas cylinder is sent to the storage department but, if there is shortage in stock then delay in providing new gas cylinder. This may cause dealy in process and intern delay in production.

**Hitendra Rawat:** Home security has been a major issue where crime is increasing and everybody wants to take proper measures to prevent intrusion. In addition there was a need to automate home so that user can take advantage of the technological The project is aimed at developing the security of Home against Intruders, Gas Leak and Fire. In any of the above three cases any one met while you are out of your home than the device sends SMS to the emergency no provided to it. The report consists of a background into the area of 8051 microcontroller and mobile communication, how they are interfaced to each other and AT commands set used in communication.

**Sujatha D:** The motivation for our project is the need to save fuel. LPG is a non-renewable source of energy, hence it is important that we need to use it judiciously. It is observed that a single household sometimes has multiple gas connections. This is simply because they are not aware of their fuel consumption rate. Our idea addresses this problem. The proposed idea aims to make the household consumer aware of their usage and thereby helping to reduce the LPG consumption. The number of deaths due to explosion of gas cylinders has been increasing in recent years. Thus there is need for a system to detect and also prevent leakage of LPG. The proposed project also implements leak detection and intimates the house owner of the same[3].

## 3. BASIC COMPONENT OF EMBEDDED SYSTEM:

**1. Microcontroller** An efficient and fast working controller is needed to continuously sense the LPG gas and its weight sensor output. Also a fast reply is desired when leakage is found. Along with this a system must possess capacity to store some information which can be used for further processing. Above operations require a very fast, single cycle execution rate microcontroller like ATmega328P. As shown in above figure 1, the microcontroller is the heart of the system. It has features like 32 KB flash memory. Thus the entire code can be stored in the microcontroller. The LCD module connected to port D and port B of ATmega328P is used to display the required messages. GSM module using AT commands connected to Rx and Tx pins of port B of ATmega328P are used to receive and transmit messages to desired family members and distributor. The weight sensor output taken from HX711 module is connected to pins of port A which is used to monitor gas level continuously.

**2. Gas Sensor** The gas sensor used is MQ6 which is highly sensitive to propane and butane which are the main constituents of LPG. The sensor can detect gas concentrations anywhere between 200 to 10000ppm. The material that is sensitive to LPG in MQ6 gas sensor is Tin di-oxide. As the concentration of target gas changes, the resistance of the sensitive component changes accordingly. This unit can be easily incorporated into an alarm circuit/unit, to sound an alarm.

**3. Weight Sensor**

The weight sensor used is a load cell which is basically a transducer which converts the mechanical force applied into an electrical signal. The load cell with required weighing capability is chosen for the continuous LPG consumption monitoring. Since the output of the load cell is in the range of millivolts, an instrumentation amplifier is used at the front end. HX711 breakout board is used for the purpose which has 24 bit precision.

**Display** For the purpose of user intimation, a 16x2 Liquid Crystal Display (LCD) is used to display the amount of LPG concentration in air and the amount of LPG remaining for user consumption. The operational voltage of 16X2 LCD is 5 volts and is operated in 4 bit mode[6].

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# "Design and Development of Smart LPG Gas Stove for Automatic Gas Control and Gas Leakage Detection System"

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## ABSTRACT

Energy wastage is one of the most serious problems on the earth. LPG is the commonly used source of the energy for cooking in urban areas. In the present LPG system there are several disadvantages like most of the energy wasted when flame is greater than the vessel diameter, leakage of gas is one problems with current LPG cooking system, we don't have an option to set the ON period of the stove so that we can do other works during cooking process, overflow of food from vessel is unavoidable and we are least known about remaining gas in the cylinder. One of the major challenges at the present moment is the improvement of the current cooking system in urban areas where LPG is main source of cooking and to install LPG stoves in rural areas where LPG is less known. In proposed system we made use of a small 5 kg LPG cylinder which is portable and we have developed a cost effective Smart LPG Stove which is suitable for this economic world. This system can also be implemented to present 14 kg LPG cylinders. The system proposed consists of five major modules namely, automatic adjustment of flame size in accordance with vessel diameter, automatic turn OFF of system when given time has elapsed, automatic turn OFF of system when gas leakage is detected, gas level indicator module and overflow of food from the vessel is detected and wastage of food and LPG avoided.

## INTRODUCTION

In cooking, a gas stove is a cooker / stove which uses natural gas, propane, butane, liquefied petroleum gas or other flammable gas as a fuel source. Prior to the advent of gas, cooking stoves relied on solid fuel such as coal or wood. The first gas stoves were developed in the 1820s, and a gas stove factory was established in England in 1836. This new cooking technology had the advantage that it was easily adjustable and could be turned off when not in use.

However the gas stove did not become a commercial success until the 1880s, by which time a supply of piped gas was available in large towns in Britain. The stoves became widespread on the European Continent and in the United States in the early 20th century.

Gas stoves became less unwieldy when the oven was integrated into the base and the size was reduced to fit in better with the rest of the kitchen furniture. By the 1910s, producers started to enamel their gas stoves for easier cleaning. Ignition of the gas was originally by match and this was followed by the more convenient pilot light. This had the disadvantage of a continual consumption of gas. The oven still needed to be lit by match, and accidentally turning on the gas without igniting it could lead to an explosion. To prevent these types of accidents, oven manufacturers developed and installed a safety valve called a flame failure device for gas hobs and ovens. Most modern gas stoves have electronic ignition, automatic timers for the oven and extractor hoods to remove fumes.

## LITERATURE REVIEW

### LPG Gas Leakage Detection & Control System

Hitendra Rawat, Ashish Kushwah, Khyati Asthana, Akanksha Shivhare Home security has been a major issue where crime is increasing and everybody wants to take proper measures to prevent intrusion. In addition there was a need to automate home so that user can take advantage of the technological the project is aimed at developing the security of Home against Intruders, Gas Leak and Fire. In any of the above three cases any one met while you are out of your home than the device sends SMS to the emergency no provided to it. The report consists of a background into the area of 8051 microcontroller and mobile communication, how they are interfaced to each other and AT commands set used in communication.

Apeh S.T, Erameh K.B and Iruansi U Design and Development of Kitchen Gas Leakage Detection and Automatic Gas Shut off System Gas leakages resulting into fatal inferno has become a serious problem in household and other areas where household gas is handled and used. Gas leakage leads to various accidents resulting in financial loss as well as human injuries and/or loss. The work aims at designing a system that detects gas leakage and alerts the subscriber through alarm and status display besides turning off the gas supply valve as a primary safety measure. The shutting off of the supply valve stops further gas flow to the cooker to prevent fire outbreak arising from attempt at igniting of the cooker. The system more like a first Aid, automatically uses a normally closed solenoid valve for the shutting off of the gas valve before calling for help via visual display and audible alarm to those within the environment. The system is an intelligent system, as it does not create a noise nuisance by continuously sounding alarm but the alarm stops beeping once the concentration of the gas in the atmosphere after leakage goes below the set point and opens the valve again for normal operations. This work will minimize injuries/losses occasioned by explosions due to gas leakages and improve safety of life and property while using domestic cooking gas.

**PROBLEM ENCOUNTERED DURING USAGE OF KITCHEN L.P.G. GAS STOVE:**

LPG is the commonly used source of the energy for cooking in urban areas. In rural areas still people make use of naturally available resources such as Biomass and charcoal stove. These systems are not economically efficient and also lead to pollution. Also in present LPG system there are several disadvantages like most of the energy wasted when flame is greater than the vessel diameter, Leakage of gas is also one problem with current LPG cooking system. Because of this many people have died and the number of deaths per year is still growing. We need to think to reduce the number of deaths by alerting the people and turn off the stove when there is a leakage. In this busy world it is difficult to track entire cooking process but it is unavoidable since we don't have an option to set the on period of the stove so that we can do other work during cooking process. Overflow of food from vessel is also a problem where the flame will turn off while gas is flowing. That is also a kind of leakage. We are least known about remaining gas in the cylinder. One of the major challenges at the moment is to improvement of the current cooking system in urban areas where LPG is installed and to install LPG stoves with smartness in rural areas where LPG is less known. In proposed system we make use of small 5 kg LPG cylinder which can easily portable. We have developed a cost effective smart LPG stove which is suitable for this economic world. This system can also be implemented to present 14 kg LPG cylinders. The system proposed consists of five major modules namely, automatic adjustment of flame size in accordance with vessel diameter, automatic turn off of system when given time has elapsed, automatic turn off of system when gas leakage is detected, gas level indicator module and overflow of food from the vessel is detected and wastage of food and LPG avoided

## CONCLUSION

It is expected that “Smart LPG Stove” gives user friendly and efficient output by varying flame according to vessel diameter. Also enables user to set time period for which gas should be in on state and gives the information about amount of remaining gas in the cylinder. The application of “Smart LPG stove” is in domestic purpose and in hotels. The system is expected to prevent hazardous caused by leakage of LPG gas. Also system detects the overflow of food and prevents wastage of food.

## SCOPE FOR FUTURE WORK

Most of the people use pressure cooker for cooking. The system can be further advanced by adding the feature of Whistle counter. So user can ask to enter number of Whistles after which stove has to turn off, a counter can implemented to count Whistles and turn off the stove. Gas leakage and gas cylinder emptiness can be informed to the user through messages using GSM technology.

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# "Hazard Identification and Risk Assessment of an LNG Plant Using FMECA and HAZOP Integrated Methodology"

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**ABSTRACT**

A safety analysis was performed to determine possible accidental events in the storage system used in the liquefied natural gas regasification plant using the integrated application of failure modes, effects and criticality analysis (FMECA) and hazard and operability analysis (HAZOP) methodologies. The goal of the FMECA technique is the estimation of component failure modes and their major effects, whereas HAZOP is a structured and systematic technique that provides an identification of the hazards and the operability problems using logical sequences of cause-deviation-consequence of process parameters. The proposed FMECA and HAZOP integrated analysis (FHIA) has been designed as a tool for the development of specific criteria for reliability and risk data organisation and to gain more recommendations than those typically provided by the application of a single methodology. This approach has been applied to the risk analysis of the LNG storage systems under construction in Porto Empedocle, Italy. The results showed that FHIA is a useful technique to better and more consistently identify the potential sources of human errors, causal factors in faults, multiple or common cause failures and correlation of cause-consequence of hazards during the various steps of the process.

Keywords: LNG Regasification terminals Risk analysis HAZOP FMECA Human errors Risk priority number

## 1. INTRODUCTION

By 2020, natural gas (NG) consumption in Europe will increase 22% to 26.5 trillion cubic feet per year (Licari and Weimer, 2011). At present 13 liquefied natural gas (LNG) receiving terminals are operational, and approximately 20 more are currently planned or under construction. However, the societal acceptability of LNG regasification facilities largely depends on safety standards which should result in low risk for both the population and the environment. For this purpose, appropriate and in-depth safety analyses should be perform taking into account the risks connected to new technologies used in these facilities (Bernatik et al., 2011; Pitblado and Woodward, 2011; Rathnayaka et al., 2012). Many techniques have been developed for hazard identification in the processing industry, but no single technique can identify all of the safety concerns. However, the process of risk assessment can be best achieved through a systematic approach using a combination of different techniques (Casamirra et al., 2009).

Detailed descriptions of the possible accident scenarios and component failures can be attained by applying well-known methods hazard and operability analysis (HAZOP) or failure modes, effects and criticality analysis (FMECA). A typical HAZOP provides an identification of accidental events (top events, TEs) and operability problems by using logical sequences of cause-deviation-consequence of process parameters. However, it doesn't lend itself to quantitative analysis, to rank the effects of failures and to study the relative effectiveness of the proposed corrective actions. The FMECA method focuses on individual components and their failure modes. Thus, each failure mode is only considered once, and all of its effects and controls are listed together. The criticality analysis is based on the risk priority number (RPN), a useful method for ranking the importance of each potential failure according to the failure rate, the severity of the failure consequence and the detection, which defines if the failure can be detected by the design controls or inspection procedures. However, it can be difficult for this technique to identify accident sequences and dependencies between equipment and human actions (Giardina et al., 2014).

## 2. OVERVIEW OF THE HAZARD IDENTIFICATION TECHNIQUES FOR LNG FACILITIES:

To help identify the hazards, there are several techniques employed in the LNG industry, and Hazard Identification (HAZID) is widely used during the early stages of design (Aronsson, 2012). The strengths of HAZID are flexibility (applicable to any type of installation or process), the use of the experience of the operating personnel as part of the team, and no repetitive consideration of deviations. The weaknesses are guide words require development at each installation, may omit some hazards and its benefits depend on the experience and knowledge of the team. Moreover, the accident scenarios defined as “atypical” (Paltrinieri et al., 2015) are not captured by conventional HAZID techniques because they deviate from normal expectations of unwanted events or worstcase reference scenarios. For these reasons, several European Directives have pushed the industry towards the development and extended use of the structured HAZID techniques, such as HAZOP analysis. Several extensive reviews of the available HAZID techniques have been conducted and can be found in the literature. For example, the review carried out by Glossop et al. (2000) describes more than 40 HAZID methods, but none of them appear to cover the issue of accident scenarios occurring outside the normal range of expectations of unwanted events in the HAZID process. A technique that is being increasingly used in the last 15 years is the LOPA methodology. It allows to evaluate the risk of individual hazard scenarios by combining initiating event frequencies with failure probabilities of protection layers. Commonly, it is used after process hazard analysis (e.g. HAZOP) which should provide the LOPA team a listing of hazard scenarios with associated consequence description and potential safeguards for consideration (Dowell and Williams, 2005, Baybutt, 2012a). The data needed to perform LOPA include information as follow: initiating events in enough detail to assess its frequency of occurrence; scenario consequence description and type in enough detail to assign an impact level; risk rankings that can be used in screening scenarios for LOPA (Baybutt, 2014).

**2.1 Observation and shortcomings:** The methodologies under review identify very important efforts and results in the development of guidelines for the assessment of accidents. Moreover, progress has been made in the development of specific hazard identification techniques. Nevertheless, some potential concerns are: - lack of a methodology that has been proven to be simple and versatile to support safety professionals in all steps of the risk assessment (often the choice of a particular hazard identification technique depends on the purpose for which the study is performed), - development of analysis techniques that more consistently assess the critical safety points, such as human error (Castiglia et al., 2008; Casamirra et al., 2009; Castiglia et al., 2014), failure modes, multiple or common cause failures, and correlation of the causes and consequences for each process unit and operation mode. These data are necessary for quantitative assessments of the occurrence probability of hazards, the characterisation of their consequences and the inclusion of these consequences in other units, - provide safety management tools that help the operators to plan safety and maintenance procedures, - if some processes are improved or equipment is replaced in a system, it is very important to ensure that the previously identified possible faults are still valid. This consists in applying, for example, “ad hoc” management of change (MOC) procedures that need of complete and accurate written information and data concerning process technology and process equipment.

### 3. DESCRIPTION OF THE PROPOSED SAFETY METHODOLOGY

To enhance the distinctive features of HAZOP and FMECA methodologies, the FHIA approach has been divided into three main steps. In the first step, the safety analysts and design experts must have an accurate description of the facility and the process (Baybutt, 2012b): process flow diagrams; piping and instrumentation diagrams (P&IDs); components reliability data; safety instrumented systems; operating instructions; safety shutdown procedures; process limits. The operational tasks (operating and maintenance procedures, inspection, etc.) that meet the operating goals and subgoals should also be examined. This scheme should allow the team to break up the system into a number of subsystems and to describe the various operational conditions for each subsystem. In the second step, the team compiles the FMECA worksheets for the components installed in each subsystem. This task should take into account the different operating conditions of the subsystem, which was previously examined in step 1. The team may also rank each failure according to the criticality of the failure effect and its probability of occurring using risk priority number (RPN). This amount of work isn't a long-term commitment, but an initial workload that should to be revised only if system repairs, equipment installations or changes are performed.

RPN uses three numerical values to describe each failure mode: occurrence index (O), which describes the probability that a particular accidental event will occur; severity index (S), which is a measure of the severity of consequences resulting from the undetected failure mode; and detection index (D), which describes the probability that the failure will be detected before the failure occurs. The product of these three numbers yields the RPN as follows:

Generally, the parameters O, S, and D are estimated by expert judgement. The specific rating descriptions and criteria can be defined by the organization or the analysis team to fit the products or processes that are being analysed (Stamatis, 1995a,b). The failures modes with higher RPN should be corrected with a higher priority than those with lower RPN. The O, S, and D used in the FHIA analysis are based on the ranking scales presented in Tables 1e3, which summarise some evaluation criteria used in many hazardous industrial processes (Stamatis, 1995a,b; McDermott et al., 1996; Dieter, 2000; Press, 2003; Davie, 2008; Giardina et al., 2014). The RPN rank is between 1 and 1000, and some users define priorities in the FMECA procedure as follows:

Very low if RPN < 5 (almost unnecessary to take the follow-up actions),

Low if 5 < RPN < 20 (minor priority to take the follow-up actions),

Medium if 20 < RPN < 200 (moderately priority to take the follow-up actions),

High if 200 < RPN < 500 (high priority to take the follow-up actions),

Very high if RPN > 500 (absolute necessary to take the follow-up actions, unacceptable).

Obviously, the threshold value at which the risk is acceptable can be modified taking into account the assigning value by experts on the basis of criticism collected against the severity levels. It should be noted that, in traditional FMECA applications, the RPN is unable to address human errors; therefore, this paper proposed the incorporation of human error into the occurrence parameter, O. The values reported in Table 1 are the occurrence rankings for the component failures and the human errors used in our analysis. In the third step, the team focuses on the specific points of each subsystem, called internal and external nodes. At each of these nodes, deviations in the process parameters are examined using the guide words (Dunjo et al., 2011a, 2011b ). To perform this task, the main causes that produce the performance deviations (i.e., failures or human errors), identified in step 2, can be easily used and added to the HAZOP worksheets (Fig. 1). For each TE, identified via the HAZOP procedure, the critical causes can be ranked using the RPN index. Obviously, the team can decide to set a cut-off value also for O and D indexes in order to improve knowledge-base of specific safety aspects.

**Safety analysis of LNG storage systems and results** : To classify the components in the RAD software, the name assigned to each component consists of three parts: the first is literal and allows us to define the type of component; the second is a numerical progression sequence to differentiate the components of the same type; the third part is the letter “a”, “b” or “c,” depending on whether the component belongs to tank TKa, tank TKb, or both, respectively (Fig. 3). Human error occurrence probabilities have been calculated using the fuzzy HEART (Human Error Reduction and Assessment Technique) methodology, a versatile tool to support safety studies in various industrial fields characterised by innovative systems (Castiglia and Giardina, 2011, 2013). The calculation has been performed taking into account the conditions that increase the errors, such as "shortage of time for error detection or correction", "information overloads", and "transfer knowledge from one task to another". Moreover, complex tasks that require a high level of comprehension and skill have been hypothesised in the management of the safety procedures

**Safety analysis of LNG storage systems**: The FMECA study of the devices operating in the storage system has led to the development of approximately 195 worksheets. The worksheets are divided into three categories to take into account whether the failure mode occurs during one or more of operating conditions, i.e.: "ship unloading" defined as "nominal phase", recirculation process activated to avoid stratification or high level problems, defined as "recirculation phase", additional operating phases ("ship unloading" and "recirculation phase"), defined as "more phases".

## CONCLUSIONS

As noted by Qi et al. (2012), although a large number of process industries have made progress in process safety, incidents continue to occur on a regular basis due to insufficient identification of hazards. It has been demonstrated that an extensive data collection scheme may be required to have a sufficient number of faults or human errors registered for the most reliable installations (Vinnem, 2010). Moreover, Dunjo et al. (2010) experience confirms that detailed failure modes and an exhaustive list of initiating events can easier facilitate the subsequent analysis for SIL needs for risk reduction. Therefore, it is important to provide a method that is able to support data gathering and systematic and comprehensive identification of hazards under different operating conditions and during the various steps of the processes of the plant. This is a very difficult task, especially in systems characterized by a large number of processes for the same subsystem. In this field, the proposed FMECA and HAZOP integrated analysis (FHIA) has been designed as a tool to develop specific criteria for reliability and risk data organization.

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# "Safety Review of the Steel Plant by Job Safety Analysis Method"

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**ABSTRACT**

The hazard identification is one of the most significant issues of the safety management process. Conventional approaches to hazard identification in a job safety analysis (JSA) tend to failure of identifying all the potential hazards involved in a work and can lead to accidents. How to identify the hazards thoroughly has becoming a challenge. The job safety analysis (JSA) method proposed in this paper, aimed to identify and assess all the potential hazards effectively by applying an analysis basis on energy sources. Through clarifying the energy sources in each sub step and identifying the corresponding potential hazards of each energy source respectively, the measures and solutions to eliminate or reduce the risks can be determined. The JSA method was applied in an offshore construction and installation project, and the total recordable incident rate (TRIR) result was reduced 50% when compared with another similar project using conventional JSA method. Additionally, JSA is a technique that can be fully applicable to many high risk construction and installation projects in shipyard.

**Keywords:** Safety Review, Job safety analysis, Hazard identification, Steel Plant.

## 1. INTRODUCTION

Identifying and assessing the hazards and risks is an essential step in safety management (Brown, 1976; Ophir et al., 2010). Job safety analysis (JSA) is currently one of the most important onsite risk management methodologies for high risk tasks using a simplified and structured team approach to identify hazards related to each step in a job or activity, and develops effective risk reducing measures to eliminate or minimizes the hazards. Hazards identification is the first and critical step in a systematic JSA process (Bahr, 1997). However, conventional JSA methods lack effective tools to identify all potential hazards (Nai-Wen et al., 2014; Sijie et al., 2015), which results in inadequate risk control measures. An appropriate combination of techniques throughout the process of hazards identification becomes an objective need (Hillson, 2002). Recently, some improved methods are put forward. Ale et al. (2008) developed and tested a tool for accident analysis based on a storybuilder method which improves investigation and categorization of accidents. Nai-Wen et al. (2014) suggested an accident causation method based text classification to assist job hazard analysis. However, how to identify all the potential hazards systematically is still a challenge. In this paper, the methodology of energy source based job safety analysis (ESBJSA) is introduced, which correlates the potential hazards with ten categories energy sources, aiming to identify all potential hazards in each sub step and make preventative solutions effectively. The structure of this paper is as follows: Firstly, literature reviews on risk assessment and risk management, project JSA application and energy source. Then, the proposed methodology for hazards identification, which contains three main sections and eleven sub steps, is introduced. Thirdly, two case studies are shown in constructing floating storage offloading (FSO) in northern China shipyard. Finally, the compared results between the two cases and related discussion are provided.

## 2. LITERATURE REVIEW

2.1. Risk management and risk assessment Risk is the likelihood of the hazard actually causing harm, and will depend on potential severity of the hazard, likelihood of harm occurring, and who might be affected by the undertaking tasks. Risk management is a system which aims to identify and quantify all risks to which the business or project is exposed so that a conscious decision can be taken on how to manage the risks (Flanagan and Norman, 1993; Chen, 2014). A systematic process of risk management is normally divided into: (1) risk identification and classification, (2) risk assessment, and (3) risk reduction (Brandsater, 2002; Duijne et al., 2008). Risk identification is the first step of risk management and it plays an important preliminary effort for taking preventive measures to risk reduction (Lee and Park, 1997; McCoy et al., 2006). Many researchers are trying to apply different methods to hazard identification, although many techniques are presented available to people for risk management (Susanne, 2013; Sijie et al., 2015; Rui et al., 2016). Risk assessment is an important process for organizations' safety, allowing them to demonstrate that hazards have been identified, existing risks to workers' health and safety have been assessed, and measures to reduce risks to a reasonably practicable level have been taken (CCPS, 2009; Fera and Macchiaroli, 2010). The federal Occupational Safety and Health Act (OSHA ACT of 1970) states that employers must furnish a place of employment free of recognized hazards that are causing or are likely to cause death or serious physical harm to employees. ANSI/AIHA Z10-2012 states that the organization shall establish and implement a process to set documented objectives, quantified where practicable, based on issues that offer the greatest opportunity for Occupational Health and Safety Management System improvement and risk reduction. Risk assessment has several objectives (Cooper et al., 2005)

## 3. THE PROPOSED METHODOLOGY

The proposed JSA methodology is designed in three main sections and eleven sub The planning phase decides what to do, the doing phase decides how to do and the checking and reviewing phase decides how it is doing and what can be improved.

3.1. Defining the job or task Normally higher risk, non-routine and no written procedure tasks or jobs that have a history of incidents or near misses need the JSA (Job Hazard Analysis, 2002). Appropriate level of detail is important, but the identified task must not be too broad like ‘‘opening the gas plant”, or too narrow like ‘‘turning on a switch”. There are some examples of appropriate level such as ‘‘removing a pump for maintenance”, ‘‘collecting an oil sample” and ‘‘loading pipe for transport”. You can break a complex job into two or more JSAs sometimes.

3.2. Organizing the JSA team The JSA must be undertaken by people who are performing the task. HSE members can help to facilitate the JSA team rather than being in charge of team alone.

3.3. Dividing the job into sub steps One job can be divided into a series of sub steps which begin with ‘‘action” words like remove, open, weld, etc.

According to the rules that not be too general or too detailed, the number of sub steps should ordinarily be no more than 10–12. But the correct sequence of job steps must be ensured.

3.4. Recognizing potential energy sources The potential energy sources in each specific step will be recognized by applying the ten categories energy source mentioned. This step plays a critical role for the entire ESBJSA and makes a big difference from the conventional JSA method.

3.5. Identifying potential hazards Potential hazards of each identified energy source among the ten categories will be identified from the perspective of safety, occupational health and environmental impacts. Try to be specific and avoid generalizations like pinch points, slips, trips, falls, etc.

## 4. RESULTS AND DISCUSSION

The two similar projects Bearing Sea project and Black Sea project were conducted the same period-thirteen months. And comparison results of. Bearing Sea project based on JSA occurred thirteen accidents totally, and eight of them weren't identified. However, the Black Sea project based on JSA only occurred six accidents, and only two accidents weren't identified. The accident numbers and the un identification numbers of the Bearing Sea project are more than twice as many as the Black Sea project. It is obvious that the proposed method have a better result for safety management.

The HSE targets and key performance indicators (KPIs) for the two projects are listed .We successfully implemented the JSA in the shipyard FSO conversion project. The compared result showed that the TRIR, one of the KPIs of HSE performances was improved 50% and LTIF and the number of Fires and Explosions both reached zero. The project HSE performance was improved apparently. Total Reportable Incident Rate in construction industry is still very high and the risk of shipyard industry is still far higher than other industries.

## 5. CONCLUSION

The construction industry is hazardous due to the diverse and complex nature of work tasks, trades and work environment. The risk of occupational accidents in the construction industry is far greater than others. The JSA is an effective method in risk management and the importance of Job Safety Analysis (JSA) is described, but the conventional JSA method tends to failure of identifying all the potential hazards and might lead to accidents. How to identify the hazards thoroughly has becoming a challenge. This study presents a new hazard identification methodology (JSA) based on in a job safety analysis.

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# “Explosion Hazard and their Control Using Accident Model in Process Industry”

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**ABSTRACT**

Accident modeling is a methodology used to relate the causes and effects of events that lead to accidents. This modeling effectively seeks to answer two main questions: (i) Why does an accident occur, and (ii) How does it occur. This paper presents a review of accident models that have been developed for the chemical process industry with in-depth analyses of a class of models known as dynamic sequential accident models (DSAMs). DSAMs are sequential models with a systematic procedure to utilize precursor data to estimate the posterior risk profile quantitatively. DSAM also offers updates on the failure probabilities of accident barriers and the prediction of future end states. Following a close scrutiny of these methodologies, several limitations are noted and discussed, and based on these insights, future work is suggested to enhance and improve this category of models further.

**Keywords:** Accident modeling Dynamic sequential accident models Dynamic risk assessment Precursor data

**1. Introduction** : The chemical process industry (CPI) is a highly complex system with diverse equipment, control schemes and operating procedures. It is also common for plants in this industry to utilise a variety of hazardous materials as raw materials and/or products. The interactions among these components, human factors, and management and organisational (M&O) issues make CPI susceptible to process deviations, which, in turn, may lead to failures if not properly managed (Khan and Abbasi, 1998c, Papazoglou et al., 1992). As illustrated by Fig. 1, when process failures occur, some may be recovered from, while others escalate into minor or major accidents and losses. To maintain the plant economy at desired levels, process plants are often equipped with a comprehensive process control system to ensure smoothness of operation and to prevent accidents. The system provides protection through varying degrees of automation, facilitated by human intervention and shielded by additional layers of protection as mitigating measures should the system fail. Nevertheless, despite all these measures, accidents still continue to happen. Examples of recent accidents in the CPI, along with some key information.

An efficient means of combating accidents is to formulate suitable preventive measures targeting the right plant components. However, this is difficult to realise unless accidents can be anticipated and are thoroughly understood, such that the failed component can be identified prior to the occurrence of an accident. Such efforts fall within the realm of accident modelling, which relates the causes and effects of events that lead to accidents. Effectively, accident modelling seeks to answer two main questions: (i) why does an accident occur, and (ii) how does it occur. The development of these methodologies can be traced back to 1941, when Heinrich introduced the domino theory.

Accident models can be classified in many ways. Qureshi (2007) has proposed a reasonably comprehensive classification by dividing the models into two broad categories, i.e., traditional and modern: the traditional approach is further categorised into sequential (SAMs) and epidemiological (EAMs), while the modern approach includes systematic (SyAMs) and formal (FAMs). This classification can be further extended by introducing a third category within the modern approach, called the dynamic sequential accident model (DSAM) (see Fig. 2). DSAM is a precursor-based technique that includes two modelling schemes: (i) process hazard prevention accident models (Kujath et al., 2010; Rathnayaka et al., 2011a); and (ii) dynamic risk assessment (DRA) models. Some of the most common accident models based on this categorization.

## 2. DYNAMIC SEQUENTIAL ACCIDENT MODEL (DSAM)

DSAM is a part of precursor-based dynamic risk analysis that uses common sequential models such as Fault Tree (FT) and Event Tree (ET) to represent accident scenarios and is often combined with other approaches to accommodate non-linear and complex interactions, as well as dynamic updating features, in one framework. To overcome uncertainty issues associated with failure data, an updating scheme based on precursor data was proposed as early as 1982

(Minarick and Kukielka, 1982). This study, which was carried out to estimate core damage failure probability in the nuclear industry, was echoed in many other efforts, leading to the development of methodologies that integrate the use of precursor data into reliability analysis. Some of these works include Modarres and Amico (1984); Lois (1985).

2.1. Process hazards prevention accident model (PHPAM) This family of accident models was recently introduced by Khan and co-workers, targeting applications in the CPI. To date, two models have been proposed, i.e., an off-shore oil and gas process industry accident model, and a system hazard identification, prevention and prediction (SHIPP) methodology. The offshore oil and gas process industry accident model developed by Kujath et al. (2010) is founded on the assumption that accidents in off-shore oil and gas facilities are initiated by hydrocarbon release, which then propagates into accidents. As a safety measure, five prevention barriers are installed along the accident propagation path to prevent and/or mitigate the impact of the release, as shown in Fig. 3. Within this modelling paradigm, the worst-case scenario occurs when all barriers fail, resulting in major or catastrophic accidents. Failures of prevention barriers are modelled using FT, while the resulting consequences are modelled using ET. Precursor data of end-state events in the ET are used to update the failure probabilities of the safety barriers using Bayesian theory. The model was successfully applied to the Piper Alpha (1988) and BP Texas City refinery (2005) accidents. However, the model has some limitations, including the following: (i) it only considers operational and technical failures as causes of accidents, and other contributing factors such as human and organisational errors are not reflected (Rathnayaka et al., 2011a); and (ii) it does not consider other initiating events that could lead to accidents, such as explosions or other forms of energy releases.

**2.2. Dynamic risk assessment (DRA) methodology** : DRA, which is also known as Dynamic Quantitative Risk Assessment (DQRA) methodology, is an extension of the QRA methodology to include updates of the failure probabilities of safety systems for a particular accident scenario using precursor data (Meel, 2007; Kalantarnia et al., 2009a). In a typical QRA methodology, four main steps are involved, i.e., hazard identification to identify plausible hazards, frequency evaluation to estimate the likelihood of occurrence, consequence analysis to assess the severity of the effect, and risk quantification to determine the risks associated with the hazards identified (CCPS, 2000). As shown in Fig. 5, the major difference between QRA and

DRA is that the latter provides additional steps in the likelihood estimation to include dynamic probability assessment by translating accident precursor data into a likelihood function and estimating the posterior failure probability. DRA methodology follows the following six steps:

(i) hazard identification,

(ii) scenario generation and prior probabilities estimation,

(iii) likelihood function formation,

(iv) posterior failure probabilities estimation,

(v) consequence analysis, and

(vi) posterior risk calculation (Meel, 2007; Kalantarnia et al., 2009a).

**2.2.1. Hazard identification:** Similar to QRA, the hazard identification step in a DRA involves the identification of potential hazards resulting from plausible failure scenarios and their consequences, such as injuries, fatalities, and property damages and other loses. At this stage, several hazard identification techniques can be used, as reviewed by (Glossop et al., 2000; Gould et al., 2005), including checklists, what if analysis, hazard and operability (HAZOP) analysis, and hazard identification and ranking (HIRA).

## 3. APPLICATION OF DSAMs

DSAMs that were initially introduced for use in the financial industry have been extended to be used in nuclear and CPI applications. These experiences have produced results that proved the adeptness of DSAMs in utilising precursor data to update risk profiles and have spurred interest to further improve the methodologies to enhance the updating procedures and produce more accurate estimations. In DSAM implementations, the intervals used between updates depend on the availability of precursor data, which vary from one field to another. As listed more applications are found in the CPIs, and most of these were in recent years.

## 4. FUTURE DEVELOPMENT DIRECTION

DSAMs have been proven useful in providing the necessary insights for better planning, as well as in responding to process safety needs. However, the current DSAMs need to be further refined to overcome some of their existing weaknesses and to improve their efficiency. In this section, some of the future research themes to complement some of the weaknesses and limitations of the methods are presented. The list is non-exhaustive, however, and it is certainly biased towards the interest of the authors.

## 5. CONCLUSIONS

This paper provides descriptions and analyses of accident models commonly used in the field of CPI. The models were classified based on Qureshi (2007) and extended to include a precursor-based category approach, known as DSAM. The capabilities of DSAMs and their implementation steps have been extensively discussed. Based on these analyses, it can be concluded that. These models have the capability to model CPI accidents caused by process hazards and human and organizational factors effectively with systematic procedures and quantitative outputs. These models can utilize precursor data (near-misses, mishaps, incidents, and accidents) to overcome the uncertainty associated with reliability data and to quantitatively estimate the dynamic risk profile that supports dynamic decision making.

Among DSAMs, the SHIPP model is the most promising for application in CPI as it takes into account the interactions between all process hazards, human faults, and management and organizational deficiencies. However, it has also been shown that there is a need to further improve the SHIPP model in the following aspects: Extend its framework by considering other highly contributing hazards. Overcome the dependency limitation of its ETs. Improve its predictive model by introducing another prediction approach with high sensitivity to track changes in the observed data.

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# PLACEMENT DETAILS