Fostering Systematic Research and Innovative Training Strategies for Ensuring Safety of Petroleum Installations in India

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***Abstract*— Managing accidents and reducing risk of disasters in the petroleum installations of our country is a sine-quo-non and has to be foster with a vision to ensure safety through systematic research and innovative training strategies for reducing number of fatal accidents, injuries leading to permanent disability. Practicing disaster risk management in a scientific manner will certainly develop a safety and injury free culture, which in turn will develop an accident free work place and would ensure zero accident to provide a safe and injury free work place where everyone can live and work together fearlessly from the present era of living and working dangerously. This calls for leapfrogging to emerging innovative training strategies and systematic research studies to develop the available human resources employed in this domain, there exists a need to understanding the role of Behavior Based Safety training applications. Therefore promoting strong safety culture through education and training of masses may be made as one of mandatory component of the vision 2030 document of training policy and must be highlighted in the CSR charter so as to achieve the benchmark of environmentally safe and accident free oil and gas operations on a 24 X 7 basis in India.**

***Keywords*—Accident Free Work Place, Behaviour Based Safety, Disaster Risk Reduction (DRR), Safety Culture, Zero Accident.**

I. INTRODUCTION

The Great Indian Forward Thinker, Late Shree C K Prahalad, In his Vision for India at the rate of seventy five i.e. For the year 2022 envisage that India shall build a skilled man power of 200 Million Graduates, and develop 500 Million Trained Technical Manpower and at least 10 Nobel Prize Winners for our country, so that India becomes the new moral force for people around the world [4] (www.india@75.in). In order to achieve the same we must foster it as a theme for next decade. The petroleum industrial organizations must understand the nature concept contents and process of developing safety culture for reducing risk of accidents and developing injury free work place for their employees, also to reach the goal of maintaining zero accident policy, and to achieve maximum number of accident free man hours in their respective organizations. The safety professionals and actively caring employees must correct, the at risk behaviour of others and encourage behavioural observations in an effective way to determine where exposure to risk is high and where to spend money to improve performance in an employee driven systems for disaster risk reduction through behavioural safety training and education of masses e.g. The use of PPEs, at work place, shall not be enforced, for the sake of merely complying the statutory regulations but be made mandatory for developing a strong safety culture and fostering the theme of safety for achieving excellence in oil and gas sector for disaster risk reduction in the next decade.

II. LITERATURES

To understand Behavioural Safety Training, theoretically, it is necessary to learn first about the learning concepts required for establishing safety process in the organization. In early days, B.F Skinner (1953) [25], was first to identify the types of consequences that can result from individual's behavior. i.e. Positive or Negative Reinforcement, Punishment and Extinction. He developed an operant conditioning model, later A.H.Maslow (1954) [19], came up with need theory of motivation. Kirkpatrick (1959) [18], in transforming learning to behavior describes four levels of training to improve performance, namely: Reaction, Learning, Behaviour, and Results. For managing change effectively, a seven step systematic approach has to be adopted, first need or desire for change environment has to be determined, then a tentative implementation plan has to be prepared and analysed for probable reactions, then a final decision has to be made by establishing a time table and communicating the change for its effective implementation (Kirkpatrick, D L 1959) [15]-[17]. Robert M Gagne, (1962) [9], has given the Integrative theory of learning based upon the behavioural approach, and Victor Vroom, (1964) [27], has described the cognitive process, responsible for deciding the best course of action for achieving the goal through one's mental ability. Later in the Year 1977, Albert Bandura, (1977) [1], developed the concepts of observational learning, which was known as Social Learning Theory. Then P. Balanchard, (1986) [21] , described the Behaviour Modeling Process, which was found useful for providing almost all types of skill trainings such as training in Interpersonal Skills, Sales Training, Interviewee and Interviewer Training, Safety Training, and for many other areas. This method was based on Albert Bandura's Social Learning Theory and was focused on developing behavioural skills only [1].

Its initial step reflects the cognitively oriented approach and later steps follow the Behaviorist and Reinforcement approaches (P.Balanchard, 1986) [21]. In recent years, E Scott Geller's (2000) [5] - [7], name is most popular one, who had described the concepts of Behaviour Based Safety (BBS) by understanding the Psychology of People responsible for ensuring safety in the organization. Later, Christopher A Janicak, (2002) [3], has described the tools and techniques for measuring the Safety Performance of an individual and of an organisation. A total safety culture mission requires a vision for behaviour management, and continual attention for improvement through actively caring people, which can target three factors, namely Person, Behaviour and Environment, responsible for influencing the safety culture of the organization (Geller E Scott, 2005) [8]. Behaviour Based Safety Training requires a visible presence and full management support with an open communication down the line for its effective launching in the organization (Kaila H L, 2006) [10]. The positive impact of training on intermediate results of knowledge scores, and on job skill evaluation scores has been consistently observed on the increased productivity and the business performance of the service industry, the positive impact of training on increase in learning of an individual in a training programme, while working in a learning organization can be significantly observed on business performance (Haque M I, 2007) [12]- [13]. Before launch of Behaviour Based Safety programme in organizations, training exposure to all employees is essentially envisaged, and an introductory workshop of two days duration should be called to include the following components of behavioural safety. Psychology of behavioural safety, its myths, its working, and its outcome, its implementations, its observations and feedback process, and the roles of managers in developing behavioural safety culture must be covered in detail (Kaila H L, 2009) [11]. Researcher Peter R Lewis (2010) [22], while describing Safety First Approach says, sometimes products can be used longer after they have been ruled dangerously as bad headlines due to defective products can almost gut a company and small failures, multiplied by the million, can make for an enormous financial hit. There are often warning signs in many failure cases, warning that are ignored at peril. Warnings of early failures must be heeded for prevention of disasters and product failure must be analysed by the unbiased and trained individuals, who are aware of their basic responsibility of ensuring safety and reliability (Peter R Lewis, 2010) [22]. Dr P T Shah (2010) [24], In his article, Safety Consciousness; A self Motivation for Productivity suggest that Expenditure in Safety is investment for production, Safety consciousness contribute towards safety assurance, which increases confidence and team building and motivate a person to produce more and faster. Over confidence may be disastrous as safety is not a onetime affair, it has to be reviewed constantly through inbuilt organizational system, and regular training of workman's may be one of the safe guards which can meet this need (P T Shah, 2010) [23].

III. INDIAN SCENARIO

Let us recall the infamous memories of midnight of 2nd December, 1994 of Bhopal tragedy, which had shaken the world and was an eye opener for Union Government and Union Carbide, who are still paying the compensations. Can all of us forget the recent Pink City Jaipur's IOCL POL terminal fire accident of 29th October, 2009, in which fire continued unabated for more than 11 days with loss of 11 lives and injury to 105 persons? Table 1 shows an example of the fatal accidents that have taken place in the same city repeatedly over the years and the very latest reoccurrences of same type of major fire accident at IOCL Hazira Depot in Surat on 05th. January 2013, in which 03 persons were killed.

TABLE-1

PINK CITY HYDROCARBON ACCIDENTS OF JAIPUR INVESTIGATED BY PESO

(Except Road Tankers and Retail Outlets Cases w. e. f: 11/10/2008 up to 13/12/2014)

Date	Place	District	State	Kill	Injury	Remarks
11/10/2008	Jaipur	Jaipur	RAJ	03	00	Iocl Alds Bleve Fire&Exp.
29/10/2009	Jaipur	Jaipur	RAJ	11	105	Jaipur ioclpol terminal fire continued unabated 11 day
28/05/2012	Jaipur	Jaipur	RAJ	01	01	Iocl bottP loading arm fire
13/12/2014	Jaipur	Jaipur	RAJ	12	12	Vce of butadiene containr

Source: Adapted from the official website of PESO; http://www.peso.gov.in accessed on 05-06-2016.

All of them were the result of personal failure on the part of the employees handling the hazards? It is now an established fact that, the human errors can be very well averted by imparting proper behavior based safety training to the employees. Therefore, instead of blaming them for endangering public safety and for playing with the life and properties of innocent citizens, we must train them on behavioural safety issues. We have yet not, learnt the lessons from both of the above cited major fire accidents occurred freshly involving petroleum installations in India, thus there is an immediate need to address the issue with the proven systems and systematic approaches to save our Nation from the inferno of future disasters, natural catastrophe arising due to earth quake, tsunami, thunder storm, rain, cloud bust, flood, lightening, etc. and we must not rule out any terrorist activity or enemy strikes to destabilize our country. Therefore Disaster Risk Reduction (DRR) Techniques has to be adopted for safety of petroleum installations in India.

Unfortunately, India has a very long history of petroleum installation accidents and manmade disasters, which mainly occurs due to lack of proper systematic research and by not adopting latest innovative training strategies for ensuring safety of petroleum installations, the details of some cases of

major disaster are cited here, the last 10 year details of the accidents occurred in India may be referred at Table-2 & 6.

For Example; Cochin refinery explosion 1983, HPCL Mumbai refinery accident 1987, BPCL Mehul refinery accident 1988, ONGC Hazira accident in 1998, devastating explosion and fire accident on 14th September,1997 at Vizag refinery, 1984 Shakur Basti's LPG bottling plant explosion accident of Old Delhi. Gas Cylinder Explosion at Madras refinery, Fire incident at IPCL Nagothane, Major Fire accidents at Gujarat Refinery Baroda on 17th Nov 2002, RIL Moti Khavdi Refinery on 25th Oct 2006 & on 01st Dec 2007 at EOL Vadinar Refinery at Jamnagar, Major Fire incidents at ONGC Oil Rig of Bombay High, Frequent on road collisions of transported petroleum and regular petroleum decantation fire at Retail Outlets and off course, the countless unreported Flash Fire Accidents occurring almost on daily basis in the Oil and Gas sector in India. The year wise details are shown in Table-2, for further elaborations on the subject with date and cause of accidents please refer the given Table-5 placed at the end of this research paper (www.peso.gov.in).

TABLE-2

YEAR WISE HYDROCARBON ACCIDENTS INVESTIGATED BY PESO

(Except Road Tankers and Retail Outlets Cases w. e. f: 30/06/2004 up to 16/01/2015)

Year	No. of Accidents	Persons Killed	Persons Injured	States Involved
2004	05	04	20	WB,UP,MS,GUJ,DNH.
2005	10	09	15	GUJ,UP,HR,MS.KRL.
2006	03	06	04	MS,HAR,GUJ.
2007	05	37	44	GUJ,UP, MS.
2008	06	05	06	DEL,GUJ,MS,RAJ,ASM.
2009	10	15	177	GJ,WB,KR.KT,AS,RJ,UP
2010	07	15	120	PUB,RAJ,MS,UP,GUJ.
2011	06	06	03	AP.ODS,GUJ,KRT,MS.
2012	08	16	54	AS,DL,KT,GJ,RJ,PB,MS
2013	11	42	19	GJ,PB,MS,ASM,AP,KRL
2014	13	138	34	GJ,CG,KT,P,AS,TN,W,R
2015	01(upto16/01 /2015)	01	00	DEL.

Source: Adapted from the official website of PESO; http://www.peso.gov.in accessed on 05-06-2016.

Are these cited examples of hydrocarbon disasters in India are not eye openers? Have we learnt any lessons out of it? What steps we have taken to stop the reoccurrences of such disasters? What pledges have been taken to reduce the risk of disaster? Are we ready for combating natural disasters like earth quacks, tsunami and cloud burst or flooding rains? Have we ever thought of enemy strike, terrorist assault or nuclear attack on our precious petroleum installations please? Let us have a Distress Look and "ACT" for the "SAFE" future, where ACT means (Action-Co-Operation & Training) and SAFE represents (Safe= Accident Free Environment). The available secondary data of fatal and non fatal injuries of reported industrial accidents for the year 2006, 2007 and 2008 are quite horrific with a total of 04,189 Fatalities and 1, 10,098 Non Fatal Injuries. India reported an average industrial accident frequency of 0.13 and average 4.53 rates of injuries per thousand workers from the year 2001 to 2005 and till 2007 as shown in Table-3 (www.dgfasli.nic.in).

TABLE-3

TOTAL NUMBER OF INDUSTRIAL INJURIES REPORTED IN FACTORIES

Year	Nos. of Fatal Injuries	Total Nos. of Injuries	Frequency rate of fatal Injuries/ Lac Man days Worked	Frequency rate of total Injuries/ Lac Man days Worked	Rate of Fatal Injuries / thousand Worker	Rate of Total Nos. of Injuries / thousand Worker
2001	627	28364	0.07	3.24	0.19	8.67
2002	540	20453	0.13	4.88	0.16	6.14
2003	525	16432	0.08	2.50	0.11	3.33
2004	562	15020	0.05	1.33	0.08	2.21
2005	501	10714	0.08	1.64	0.11	2.30
2006	1349	44200	NA	NA	NA	NA
2007	1453	32763	NA	NA	NA	NA
2008	1387	33135	NA	NA	NA	NA

Source: Adapted from the official website of DGFASLI; http://www.dgfasli.nic.in accessed on 01-02-2011.

On the basis of a study on Management of Safety by Objectives to analyze factors affecting, demand for making immediate and correct training decisions with respect to Operation and Maintenance (O&M) of the city gas distribution companies located in the state of Gujarat, it was noticed that the behavioural safety training was an important missing factor, and by imparting proper behavioural safety training to the respondents, targets of zero accident can be achieved in most of the petroleum installations, which are licensed under Manufacture, Storage, Import of Hazardous Chemical, (MSIHC) Rules 1989 and Petroleum Rules-2002. This calls for a need for leapfrogging to Behavior Based Safety (BBS) Training strategies and Systematic Research Studies in the area, from the Perspective of the Consumers Safety, Corporate Social Responsibility, and prevalent Disaster Risk Reduction practices in Indian context. Thus, in order to develop the available Human Resources Employed in this domain at various petroleum industries in India, there exists a need of understanding the role of Behavior Based Safety (BBS) Training Applications, which is required for capacity building, achieving safe working environment and developing an injury free work culture. Therefore by identifying this research gap, the researcher is of the opinion that further research study in this area has to be well supported by the Oil sector PSUs, Premium Petroleum Business Houses and Government Departmental Testing and Training Research Institutes for sustainable Disaster Risk Reduction in petroleum installations of our Country.

IV. OVERSEAS OUTCOMES

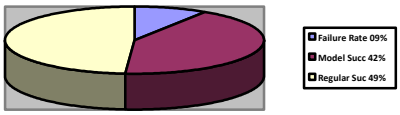
While studying the Innovative Overseas Implementation of Behaviour Based Safety Training Processes of Various

Industries during last ten years, i.e. from 1985 to 1994, Thomas R Krause [26], co-founder and CEO Behavioural Science Technology, Inc. Ojai, California and his associates found that rate of Failure was quite negligible and observed only in less than 10% Cases.

The demographic data was collected from the different Behaviour Based Safety, Training process implantation sites among the population of universe of 181 Industries situated in the area. The sample size of 86 industries were selected as population of interest and on statistical analysis of the data, 42 were rated with regular success, 36 were with model success and only 8 were reported with failure giving the overall success rate of 90% plus, as shown in Figure-1.

FIGURE-1

THE OVER ALL SUCSESS RATE IS OVER 90%



Source: Adapted from; The Behaviour Based Safety Process; Second Edition; Copyright 1997 by Thomas R Krause and "Reprinted with permission of John Wiley & Sons, Inc." New York (USA).

In the Year 1931 H.W Heinrich [14], estimated that 88% of all near hits and workplace injuries results from the unsafe act and later it was tested empirically and now known as "The Heinrich Triangle" It suggest that, the ratio between near miss incidents, minor injuries and major injuries as 300 : 29 : 1. Therefore it is important to investigate the near hits in order to reduce future minor and major injuries because of the fact that the 300:30 ratio of near miss to Injury is referred to as a "Heinrich- Law" (1980) [14]. Frank E. Bird (1997) [2], added that the ratio of 600: 30 : 10 : 1, between near hits, property damage, minor and major injuries on a wider scale as property damage is a physical trace of an accident and the precursor of an injury and remnant witness of the fatal inferno. The behavoiural act that contributed to a property damage incident was likely unintentional human error. Therefore failure to report such property damage incidents intentionally must be treated as highest degree of disregard to Safety.

Noted Researcher B F Skinner, A Bandura, R Gagne, W Edward Deming, Alfie Kohn,Terry McSween, E Scott Geller, Judith Komaki, Dan Petersen, John Hidley, Stan Hodson, Kim Sloat, Don Groover, Jim Spinger, Kristen Seymor, David Devieney, Larry Russell, Robert J McCorquodale, Christopher A. Janicak and many more safety professionals associated with American Society of Safety Engineers (ASSE) and National Safety Council (NSC) across the United State had privileged to work on the subject with their Vision and Perseverance for the Promoting Social Cause of an injury free culture and making "SAFETY FIRST" as Motto for organisational safety pertaining to the chemical and industrial organisations. The Behavior Based Safety (BBS) Training Process is successfully implemented at variety of US Industries in consultation with Professional Safety Leaders at Monsanto's Pensacola Florida, PPG Industries Inc, Eastman Chemical Company Texas, Shell Chemical Company.

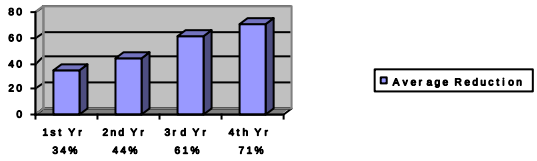
Similarly ARCO, ALCOA, Boise Cascade's De-Ridder Mill Louisiana, Rohn & Hass, Scott Paper, Georgia Gulf, Pillsbury, Hill's Pet Nutrition Richmond Indiana, SRUP Victoria British Columbia and Cheveron Pascagoula of Misssissippi USA, are the examples of same to name a few.

V. CONCLUSIONS

The Summary of major findings, with respect to Incident Rates and Workers Compensation Claims of some of the, Chemical companies, Electronic companies, Metal companies, Paper companies, and Petroleum companies were found to be highly significant and showed substantial Accident Reduction Rate over a period of four years of implementing BBS Training. The average reduction in incident frequency after implementation of BBS Training in first year was recorded as 34%, in second year as 44%, in third year as 61% and in fourth year it was found to have 71% reduction from pre implementation average, all outcomes were judged very significant, as can be seen in the Figure-2 showing average reduction, with compensation details mentioned in the Table-4.

FIGURE-2

THE AVERAGE REDUCTION IN INCIDENT FREQUENCIES THROUGH FOUR YEAR



Source: Adapted from; The Behaviour Based Safety Process; Second Edition; Copyright 1997 by Thomas R Krause and "Reprinted with permission of John Wiley & Sons, Inc." New York (USA).

TABLE-4

THE REDUCTION IN WORKER'S COMPENSATION

Company (Worker Comp)	Average Before	Average After	Percentage Reduction	Out Comes
Chemical Co. (Comps. Cost)	$240.4	$68.9	71%	Significant
Electronic Co. (No of Claims)	157	70	55%	Significant
Metal Co. (Claims Rate)	0.45	0.35	22%	Not Significant
Petroleum Co. (Dollars Spent)	$34800	$13700	61%	Significant

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While Reduction in rate of workers compensation's cost in term of dollars spent per employee is noticed as 71% for Chemical Company, 55% for Electronic Company, 22% for Metal Company, and 61% for the Petroleum Company. All the results were found very significant except for Metal Company, where the claim rates were high therefore the outcome was not found statistically significant [26].

In India too, it was very significantly noticed during the recently conducted research study on 318 respondents of 48 locations covering 6 districts during the month of July and August 2011 of Gujarat namely Ahmadabad, Baroda, Gandhi Nagar, Rajkot, Surat and Valsad in the Petro State Capital of India, that, M/s. IOCL, BPCL, HPCL, AEL, EOL, GGCL, GSPC, SGL, GAIL and CGSML all the 10 City Gas Distribution companies are getting quite positive results out of it (Ansari M I Z, 2013) [20]. However, it is a matter of great concern and still pains that India has a pool of only 41 numbers of Certified Safety Professionals (CSP) till 23rd Oct. 2016, on the last date of submission of this research paper (www.bcsp.org).

TABLE-5

HISTORY OF LAST 10 YEARS HYDROCARBON ACCIDENTS INVESTIGATED BY PESO

(Except Road Tankers and Retail Outlets Cases w. e. f: 30/06/2004 up to 16/01/2015)

Date	Place	District	State	Kill	Injury	Remarks
30/06/2004	Rajbundh	Burdawan	WB	00	00	Lightening stroke on MS floating roof tank Fire continued 3 days
30/06/2004	Baitalpur	Deoria	UP	01	02	Iocl 200KL MS leaked by water drain line got burnt
27/07/2004	Uran	Raigarh	MS	01	05	Ongc Installation low Aromatic naptha fire
03/08/2004	Silvasa	Daman	DNH	00	00	Full propane vessel got washed away in flood
29/10/2004	Koyali	Baroda	GUJ	02	13	Gujrat refinery FCC fire
13/02/2005	Gandhina gar	Gandhina gar	GUJ	00	04	static elec toluene fire
30/03/2005	Mathura	Mathura	UP	00	04	BPCL u/g Ethanol fire
27/04/2005	Gunnao	Kutchch	GUJ	00	00	Rupture of roof of 2 a/g FO Tanks due to heating
08/06/2005	Karnal	Karnal	HAR	00	03	Iocl lpg botteling plant fire
17/06/2005	Kurkumbh	Pune	MS	01	00	4 tank exploded in a mini refinery by gasket leak
19/06/2005	Willington I	Ernakulam	KRL	01	02	1580Kl a/g tank collapsed Brppl improper foundation
19/06/2005	Halol	Panchmahal	GUJ	04	00	Mini refinery oleum in sulphonator fire n explos.
28/12/2005	Panipat	Panipat	HAR	01	02	Panipat refinery fire in Ows line nr crude storage
29/12/2005	Mathura	Mathura	UP	01	00	Mathura Refinery fire in OWS line of AVDU
30/12/2005	Ambalam ugl	Ernakulam	KRL	01	00	Kochi refinery fire in DH-DS unit, H2S leaked in air
24/04/2006	Khalapur	Raigarh	MS	00	00	Class A A/g tank ruptured
14/05/2006	Hathin	Nuh	HAR	04	02	LPG Bottling plant fire during tanker decantation
25/10/2006	Motikhawdi	Jamnagar	GUJ	02	02	RIL refinery hydro treater Fire explo hot

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						gas leakage
01/02/2007	Vadinar	Jamnagar	GUJ	05	16	Eolrefinery fire napthaline
14/04/2007	Kandla	Kutchch	GUJ	01	02	Arcing while unloading Cyclo Hexane from ship
14/05/2007	Anand	Anand	GUJ	29	17	Lpg tanker pierced onroad
04/08/2007	Kosi	Mathura	UP	01	07	Lpg leaked in storage shed
15/12/2007	Mehul	Mumbai	MS	01	02	Bpcl refinery flares knock out drum in CRU Accdt.
29/01/2008	New Delhi	New Delhi	DEL	00	00	Fire during pipeline clean pigging due to NFLP fitmt
16/02/2008	Kandla	Kutchch	GUJ	00	00	632 MT Methanol a/g tank was on fire due to hotwork
23/02/2008	Vashi	Navi Mumbai	MS	02	05	Hpcl term filling gantry ex
20/09/2008	Sahar airport	Mumbai	MS	00	00	Iocl Afs hotwork in P'line
11/10/2008	Jaipur	Jaipur	RAJ	03	00	Iocl Alds Bleve Fire&Exp.
17/12/2008	Nainpurhajo	Kamrup	ASM	00	01	OIL crude oil pipeline fire
07/01/2009	Motikhawdi	Jamnagar	GUJ	02	02	RIL refinery hydrogen comp unit explods hot gas
09/01/2009	Kandla	Kutchch	GUJ	00	00	Iocl port terminal a/g tank was on fire due
						to hotwork
12/03/2009	Janaki	TAPI	GUJ	00	00	17.6 MT LPG fell through Rd.tanker in seasonal river
23/03/2009	Kai Khali	24 Pargana N	WB	00	00	ClA ingredient mixing fire
05/05/2009	Karumaloor	Ernakulam	KRL	00	00	Petronet Cck pipeline Hsd leak failure of ferrule joint
05/06/2009	Manglore	Karnataka	KRT	00	00	Refinery naptha vaporizer
28/08/2009	Digboi	Tinsukhia	ASM	02	01	Aod Refinery fire in DCU due to inferior qualty pipe
29/08/2009	Guwahati	Guwahati	ASM	00	00	Refinery crude oil fire hot work in drainage lines.
29/10/2009	Jaipur	Jaipur	RAJ	11	105	Jaipur ioclpol terminal fire continued unabated 11 day
17/11/2009	Noida	G B Nagar	UP	00	69	Factory Shed Co Leakage
24/03/2010	Janeria	Bhatinda	PJB	06	06	VCE due to leak of PetAB
19/06/2010	Salawas	Jodhpur	RAJ	00	01	filling gantry mix load fire
14/07/2010	Haji Bunder	Mumbai	MS	00	110	Gas leak at Mumbai port.
11/08/2010	Pune	Pune	MS	01	01	valve repaired in filling pt
25/09/2010	Mohgaon	Bhandara	MS	02	02	solvent extraction unit fire
28/09/2010	Hissainpir	Pilibhit	UP	06	00	LPG leaked and

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						exploded
19/11/2010	GothdaSavli	Vadodara	GUJ	00	00	solvent distilation unit fire
04/01/2011	Vdydhrpurm	Vijaywada	AP	00	00	Sulphide corrosion of cng.
09/04/2011	Raurkela	Sundergarh	ODS	03	02	DA filling plant accident
06/07/2011	Chatokara	Mathira	UP	01	00	NG pipeline in N2 purging
22/09/2011	Chokkahali	Banlore	KRT	01	01	Vessel busted in hydro test
04/10/2011	Vapi	Valsad	GUJ	01	00	Mini refinery DU crudeoil
24/11/2011	Mehul	Mumbai	MS	00	00	Hp refnery hexane loading
10/01/2012	Niinmati	Guwahati	ASM	00	13	Iocl refnery slope tk repair
16/01/2012	Vasant vihar	New Delhi	DEL	01	06	Alds degassing for hydroT
21/01/2012	Manglore	Manglore DK	KRT	01	05	Refinery hot work in SRU
02/05/2012	Kandla Port	Kutchch	GUJ	00	00	CC Pipeline pigging fireE
28/05/2012	Jaipur	Jaipur	RAJ	01	01	Iocl bottP loading arm fire
11/09/2012	Khanna	Ludhiana	PUN	10	08	Solvent Ext Plt hexane vce
16/11/2012	Vadval	Raigarh	MS	00	21	DA filling plant accident
04/12/2012	Rudatal	Ahmedabad	GUJ	03	00	Iocl crudeoil P'line flange
05/01/2013	Hazira	Surat	GUJ	03	00	Iocl termnal DD Fr Ms Tk
08/04/2013	Bhatinda	Bhatinda	PUN	00	00	Ref SWSII of S block fire
04/05/2013	Mankhurd	Govndi Mum	MS	01	16	VCE of 18mt Lpg bp
						tank
10/05/2013	Hirwaringar	Nagpur	MS	01	01	Sko depot decantation fire
13/05/2013	Numaligarh	Golaghat	ASM	00	00	shearing crud boostr pump
11/06/2013	Vadinar	Jamnagar	GUJ	00	00	lightning strike on rimseal
16/07/2013	Vadodara	Vadodara	GUJ	00	01	Fccu flare kod sump fire
03/08/2013	Guwahati	Guwahati	ASM	00	00	Iocl refnry clA decant Fire
23/08/2013	Vishkaptnm	Vishkaptnm	AP	37	00	Cooling water sump repair
30/09/2013	Kamrup	Guwahati	ASM	00	01	Iocl botling plant flash fire
16/10/2013	Ambalamugl	Ernakulam	KRL	00	00	Kochi Refnry rim seal fire
27/02/2014	Vadinar	Jamnager	GUJ	02	01	Inlet header P'line repair F
19/04/2014	Kathghora	Kathghora	CG	00	00	lightning strike on ldotank
03/06/2014	Manglore	Manglore DK	KRT	08	04	refinery naptha reflux line
26/06/2014	Bhatinda	Bhatinda	PUN	00	00	Ref VGO weld joint failur
27/06/2014	Godavari	East Godavri	KRT	100	12	GAIL ng P'line corosion
01/09/2014	Sibas Nagar	Sibas Nagar	ASM	07	03	NG line corroded ruptured
22/09/2014	Thiruvallur	Thiruvallur	TN	01	01	Hpcl install.petroleum fire
12/11/2014	Sibas Nagar	Sibas Nagar	ASM	00	00	EET burner fire of OIL
17/11/2014	Silvasa	Daman	DNH	08	00	Cl A transfer to plastic Brl
18/11/2014	Mahakar	Buldana	MS	00	00	Hpcl install.petroleum fire

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19/11/2014	24 Pargana	24 Pargana	WB	00	00	Toluene fire by nonflp mtr
13/12/2014	Jaipur	Jaipur	RAJ	12	12	Vce of butadien e containr
17/12/2014	Thane	Thane	MS	00	01	Process P'line of A Class
16/01/2015	New Delhi	New Delhi	DEL	01	00	NG line damage in drilling

Source: Adapted from the official website of PESO; http://www.peso.gov.in accessed on 05-06-2016.

It is therefore concluded that petroleum sector must educate the masse residing in the close vicinity of disaster prone area for disaster risk reduction, and develop a strong safety culture in order to provide a safe and injury free work place for their employees, accident free work culture for their organization and fulfill their social commitment of providing a safe, clean and accident free environment, where all the people can live and work together fearlessly from the present era of living and working dangerously.

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