

Critical review of present rescue practices in Indian mines: Suggestions for effecting a qualitative improvement in the existing scenario

In response to recent mine disasters and role of mine rescue services in Indian mines, Inspectorate at Directorate General of Mines Safety (DGMS, Dhanbad) conducted national workshop with mine emergency experts to investigate current needs and issues. Some of the issues include emergency response preparedness: competency of persons selected in rescue services, courses of instruction and practices prescribed for rescue trained person, fitness of persons selected for rescue training, scope of rescue and recovery in surface and opencast operations, rescue and recovery operation in case of persons engulfed in underground strata failure, caught between extremities, sudden influx of smoke & gases etc. – rapid transportation of injured miners to the surface, basic and advance firefighting skills in open and confined spaces, training for exploration and navigation in poor visibility and water hazards, first aid training and certification – refresher training in first aid and their periodicity, still water diving training, working over heights and training in dealing with huge boulders and debris, mine emergency response development drill programme for managers, control room members and rescue team members, establishment of safe haven in underground and mine rescue contests (zonal and all India). This paper undertakes a systematic review of the present rescue practices in India, in order to strengthen mine emergency rescue capabilities.

Keywords: Emergency preparedness, emergency plan, employee training

1. Introduction

When lives are in danger, mine emergency response systems must function rapidly and competently (S. B. Bealko et.al, 2010). The order of precedence of response actions in any mine emergency begins with the doctrine of self escape than with first responder and finally the mine rescue team (aided rescue). Mining industry is one of the high risk based industry due to its dynamic nature. If there is a breakdown in self escape and first responders are

not successful, then the deployment of mine rescue teams under the control of joint consultative committee on the surface is necessary for a safe rescue to be accomplished. An emergency preparedness, including developing crisis/disaster plans and training employees (OSHA, 2015), is essential for workplaces nowadays.

The mine rescue services in Indian mines play a very important role in management of emergency in a mine arising out of a disaster or a condition which is potentially disastrous. The rescuers are engaged during such emergencies for rescue of the person trapped belowground, emergency sealing of a mine or part thereof, locating problem site to control the situation and ascertaining causes, circumstances resulting in the accident/incident/unsafe condition and recovery of the mine or part thereof. The dilemma over the decision of deployment of rescuers and formation of a rescue team from amongst the rescue trained persons summoned at the surface of a mine, after a disaster is a difficult task for the officer-in-charge of the rescue operation. Aging workforce in Indian rescue services and its associated complications demands for review of the existing system in vogue. The discussion and deliberation supported by the safety perception survey during the workshop has provided motivation for evolving and framing suitable code(s) of assessment for rescue team emergency preparedness.

2. Mine emergency plan – legal issues

In exercise of the powers, conferred by clause (r) to (w) and clause (v) and (w) of section 58 of The Mines Act 1952, the Central Government made The Mines Rescue Rules, 1985. Regulation 199A of the Coal Mines Regulations 1957 and Regulation 190A of the Metalliferous Mines Regulations' 1961 stipulates of an emergency plan for every mine having working belowground for use in time of emergency. The emergency plan shall incorporate provision for mock rehearsals at regular intervals.

Recently, a DGMS (Tech.) (S&T) circular no.05 dated 2nd April; was also issued, detailing an integrated approach for development of safety management plan for coal and metalliferous mines and also underlining the concept of emergency exercise.

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3. Mine rescue services in Indian mines: issues and concern

No amount of technological advancement in emergency preparedness will pay dividend, unless we trained our emergency response experts, in standardized skills training for a wide range of mine emergency response and prepare individuals who are in good health and have adequate level of fitness. After reviewing to the recent mining disasters and the existing mine rescue legislation, a national workshop was conducted with all the stakeholders (representing Inspectors from DGMS, Head Safety, Rescue, Rescue Superintendents, active rescue trained persons from fields, researchers and academicians from ISM and CIMFR, Dhanbad) of the mining company on 22.04.2016 under the aegis of Directorate General of Mines safety, Science and Technology Division, DGMS, Dhanbad to investigate current needs and issues. Seventy eight participants of the workshop discussed and deliberated on some of the issues which includes amongst others emergency response preparedness, real-life training capabilities and training facilities, medical fitness standards of the rescue trained persons, training in first-aid, mine rescue contests etc. Some of the critical areas requiring immediate interventions are:

- There is a need to develop a structured protocol for conducting mine rescue practices.
- There is a general requirement for more emergency response preparedness training, mobilization of emergency assets.
- There is a need to develop protocol for selection and training of rescue personnel in Indian mines.
- There is a lack of communication between control room and rescue teams.
- Standardization of rescue skills and practices needs to be done.
- There is overall shortage of mine rescue training facilities.
- Fitness and medical standards of rescue team needs to be relooked at, as their work is unpredictable, occurring at extremely short notice, usually physically and psychologically demanding.
- There has to be a real-time triggering of information to incident management team. (Emergency initiation protocol, duties of manager and other competent persons in emergency to be re-defined.

4. Agenda for future - discussion and deliberation

- Competency of persons selected for emergency preparedness and response management.
- Courses of instruction and practices prescribed for rescue trained person.
- Fitness of persons selected for rescue training.
- Scope of rescue and recovery in surface and opencast operations e.g. slope failure, dump failure, fire-fighting, machine related emergencies, caught between extremities etc.
- Rescue and recovery operation in case of persons engulfed in underground strata failure, caught between extremities, sudden influx of smoke and gases etc. – rapid transportation of injured miners to the surface before arrival of aided rescue from surface (confined space rescue).
- Basic and advance firefighting skills in open and confined spaces. (In fire gallery and outdoor burn pad).
- Training for exploration and navigation in poor visibility and water hazards.
- First aid training and certification – refresher training in first aid and their periodicity.
- Still water diving is an important area of training to be considered for cases of drowning (dredging and pontoon operations).
- Working over heights and training in dealing with huge boulders and debris.
- Mine emergency response development drill programme for managers, control room members and rescue team members (managers duty in emergency).
- Establishment of safe haven in underground.
- Mine rescue contests (zonal and all India) should be made realistic (practical simulated exercise).

4.1 WITH THIS BACKDROPS FOLLOWING ARE THE COMPARATIVE STATEMENT REGARDING COMPETENCY OF THE PERSONS SELECTED FOR RESCUE TRAINING

	Parameters	Present criteria	International standards
1.	Entry age	21-30Yrs. – No exit age (extension given up to 35 yrs. By special order)	There is a definite entry and exit age for a mine rescuer (20 to 45 yrs.)
2.	Underground experience	Sufficient as certified by manager (1yr., 2 Yrs., 3Yrs.)	Minimum underground experience specified
3.	Medical fitness	As per standards laid down in schedule VI, certified by a doctor	Elaborate and exhaustive medical standard of fitness prescribed.
4.	Suitability for rescue work with breathing apparatus	After examination and interview by superintendent of rescue station.	After physical and psychological testing of person

4.2 COURSES OF INSTRUCTION AND PRACTICES GIVEN TO A RESCUE TRAINED PERSON

- 14 days of initial training (12 days with SCBA + 2 days with smoke helmet needs review to make a confident rescue trained person (RTP).
- Skills requirement for specific jobs needs to be prescribed (keeping in view application of rescue rule to surface and opencast operations).
- The training facilities shall have state-of-the art technology with projectors and animated films, videos, case studies of disasters/accidents/incidents etc.

4.3 FITNESS OF PERSONS SELECTED FOR RESCUE TRAINING

- In selecting members for a mine rescue team each individuals should, amongst other requirements, be:
 - ✓ In good health and physically fit
 - ✓ Have good vision and hearing
- Capable of performing long and arduous physical labour.

It is therefore important that each member is medically examined by a physician prior to commencing mine rescue training and annually thereafter (methodology to be developed).

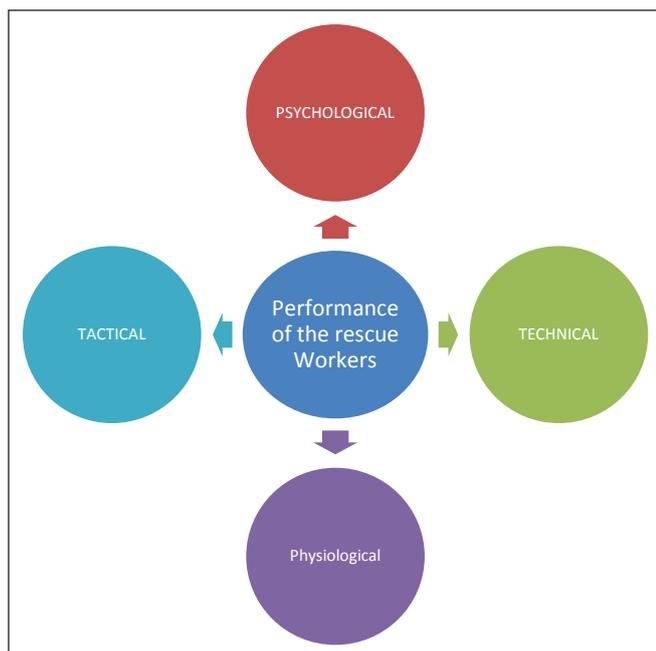


Fig. 1: The fitness component – mines rescue personnel

Technical and tactical component of the fitness may be covered by developed protocol

- There has to be developed a comprehensive protocol for medical examination of rescue personnel that may include amongst others:
 - ✓ Health assessment (assessment of cardiovascular variables, respiratory variables, gastrointestinal variables, renal variables, neurological variables,

hearing, vision, hematological indicators, endocrine indicators, musculoskeletal indicators, behavioral indicators)

- ✓ Physical fitness assessment (aerobic fitness, musculoskeletal fitness – To check both, exercise protocol may be developed)

4.4 SCOPE OF RECUE IN SURFACE AND OPENCAST OPERATIONS

- Scope of establishing fire gallery and fire suppression gallery to teach basic and advance fire-fighting skills in confined spaces, where mine rescue team can learn how to extinguish gaseous, liquid and solid fuel fire, evaluate fire-fighting tactics and handle fire extinguishers may be explored.
- Utilization of rescue training in the field of heavy object lifting and removal, vertical rope rescue training, rescue in confined space shall also be explored.

4.5 RESCUE AND RECOVERY OPERATION IN CASE OF PERSONS ENGULFED IN UNDERGROUND STRATA FAILURE, CAUGHT BETWEEN EXTREMITIES, SUDDEN INFLUX OF SMOKE AND GASES ETC. – RAPID TRANSPORTATION OF INJURED MINERS TO THE SURFACE BEFORE ARRIVAL OF AIDED RESCUE FROM SURFACE (CONFINED SPACE RESCUE).

- Scope of training multiple task force (MTF) (selected mine personnel) (Other than RTP'S) in the field of navigation and working under apparatus, with tools and tackles for short duration and in reduced visibility in cases of engulfment of mine personnel during strata failure, drowning, smoke/dust/gas, - their first aid and rapid transportation to surface may be explored.
- Issues relating to identification of MTF and compensation etc. may suitably be addressed.

4.6 FIRST AID TRAINING AND CERTIFICATION – REFRESHER TRAINING IN FIRST AID, TRAINING OF THE TRAINERS ETC.

- Initial training in rescue work should include courses for first aid training (covering courses as prescribed by St. Jones Ambulance Association)
- There has to be schedule for refresher training in first aid for all first aiders, so as to update their knowledge and skill in tune with the latest developments.
- Rescue trained personnel should be imparted specialized medical training (in the field of CPR, bleeding, and musculoskeletal injuries) and training in transportation of the injured miners.
- Training of the trainer in first-aid is also an important component of the first aid training programme.

4.7 STILL WATER DIVING IS AN IMPORTANT AREA OF TRAINING TO BE CONSIDERED FOR CASES OF DROWNING (DREDGING, PONTOON OPERATIONS AND SIMILAR TYPE OF OPERATIONS INVOLVING RISK OF DROWNING).

- Dredging and pontoon operations involving risk of drowning, needs personnel with water diving skills also cases of inundation requiring services of rescue

trained persons needs to be trained in water diving.

- There has to be made provision for still water training at the rescue stations. (Water pools with gallery situations).

4.8 MINE EMERGENCY RESPONSE DEVELOPMENT DRILL PROGRAMME FOR MANAGERS, CONTROL ROOM MEMBERS AND RESCUE TEAM MEMBERS (MANAGERS DUTY IN EMERGENCY)

- Mine emergency response development exercise serve a vital role in achieving the purpose of improvement and better understanding of the skill and knowledge needed for decision making and the mobilization of mine rescue team.
- These drills at regular intervals improve their performance during actual emergency situations.

4.9 APPLICATION OF REFUGE CHAMBER OR SAFE HAVENS IN UNDERGROUND COAL MINES.

- The basic principles of any emergency escape plan in an underground coal mine must be to seek to evacuate the mine with minimum complication and delay.
- As a part of above strategies use of safe havens (refuge stations/bays) and self-rescuers may be put in place (mustering point refuge chamber easy access to surface as the case may be).
- It is the need of the hour to establish a robust emergency survival strategy for use in large hot and gassy mines or where there are significant gradients

impeding passage out of the mine.

4.10 MINE RESCUE CONTESTS (ZONAL AND ALL INDIA MINE RESCUE COMPETITION)

- Mine rescue contests serve a vital role in achieving the purpose of improvement of safety and health of miners.
- These competitions have served to assure that mine rescue teams are well trained and capable of responding to mine emergencies.
- The competitions may be made a practical simulation exercise such as a fire or explosion drill in a model underground mines earmarked for the purpose.

5. Safety perception survey

A safety perception survey was conducted amongst the various participants of the workshop. The survey consists of two sets of questionnaire. First set of fifty one questions consists of questionnaires about current needs and issues of the rescue team emergency preparedness and the second set consists of 15 questionnaires asking views of the participants on the emergency preparedness based on risk management logic. The questionnaires were a set of likert-type scales multiple choice items (Tables 1 and 2) and were distributed to the participants individually. The result of the perception survey was broadly categorized into 15 different heads highlighting awareness and perception of the participants on the following fields.

TABLE. 1 PERCENTAGE RESPONDENTS DISTRIBUTION ON EMERGENCY RESPONSE PREPAREDNESS AND SAFETY MANAGEMENT PLAN

Heads	n	TD (%)	D (%)	NS (%)	A (%)	TA (%)
1. Present rescue services needs change.	72	1.5	3.6	4	25.9	65
2. There is a need to standardized rescue skills and practices.	72	3.4	12.2	17.2	22.4	44.8
3. There is a requirement for training of members of emergency control room.	72	4.1	9.3	5.1	32.5	49.0
4. There has to be developed and structured protocol for conducting mine rescue practice.	72	3.3	8.3	6.1	37.5	44.8
5. There has to be developed and structured protocol for selection and training of rescue personnel.	72	0	3.4	5.1	12.5	79.0
6. There has to be developed and structured protocol for fitness and medical standards of rescue team members.	72	0	0	0	14.7	85.3
7. There has to be developed and structured protocol for training in first aid, refresher training and training of trainers in first aid.	72	0	0	2.3	32.5	65.2
8. There has to be specialized training in the field of fire-fighting, ventilation effect of fire, vertical rope rescue, exploration in poor visibility, rapid transportation of injured, still water diving etc.	72	4.0	5.3	5.1	32.5	53.1
9. Risk assessment and scenario planning may be the basic criteria for emergency response.	72	0	1.9	3.1	22.5	72.5
10. Every mine should have incident management team to deal with emergency situation.	72	0	0	0	7.4	92.6
11. Every district should have adequate arrangement for first responder like trauma kits, airbags, wire nut cutters, small hydraulic jacks, power hammers, emergency medicines etc.	72	0	2.6	9.3	32.5	59.0
12. Incident management team should include incident controller, logistic controller, operation controller and technical service controller.	72	0	3.3	2.7	15.0	79.0
13. Safe havens/refuge chambers should be established in each underground mine for self escape.	72	4.1	9.3	5.1	32.5	49.0
14. There is a scope of rescue and recovery in surface and opencast operations.	72	0	0	5.1	22.5	72.4
15. A comprehensive guideline should be developed to deal with emergency situation in a mine.	72	0	0	4.7	14.5	80.8

TABLE 2 CHARACTERISTIC OF THE SAMPLE

Characteristic	Category	Frequency	Percentage
Rescue trained persons	1. Active	52	72.2
	2. Non active	20	27.8
Age	20-30	03	4.1
	31- 40	17	23.6
	41-50	33	45.8
	>50	19	26.5
Education	Field candidates	16	22.2
	Diploma	25	34.7
	Degree	31	43.1
Position	Workers	09	12.5
	Supervisors	07	9.7
	Managers and assistant managers	43	59.8
	Agents and general managers	13	18.0

6. Result and discussions

Analysis made on the perception towards present day mine rescue services in Indian mines and current needs and issues reveals that most of them are agreed that there is a general requirement to strengthen mine emergency rescue capabilities and a comprehensive guideline should be developed to deal with emergency situation by mine rescuers after summoned at the mine to avoid exposing rescuers to unacceptable levels of risk.

7. Conclusion and recommendations

Training in a real-life environment with opportunities for hand-on experience has been established as beneficial for mine rescue team. Most international mine rescue teams receive standardized skills training for a wide range of mine emergency responses. Preliminary findings suggests that defining active rescue trained persons by restricting their entry and exist age and increasing their capabilities may help mine rescue teams be better prepared for mine emergencies. Our rescue stations may develop some of the discussed training facilities to provide skills training. These facilities are structured to be systematic, efficient, self-contained and designed to provide realistic training.

Fitness standards of mine emergency experts needs review as no two rescues are the same. Performance limitations of the rescue workers affected by the biomechanical loads placed upon the body, high physiological costs (oxygen uptake in comparison with type of walking), reduced strength, decreased stability or balance and fatigue. Thus rescue personnel should be selected with the physiological demands of the task in mind. Aging workforce in rescue services and its associated complications, demands for review of the entry and exist age limits. Medical and physical fitness assessment

protocols are the need of the hours, that may be suitably incorporated at the later stage in the statute. Further studies are needed to more clearly define the mine rescue training, medical, physiological and psychological fitness needs and develop recommendations for improvement.

The ultimate goal is to ensure that the selection, coaching, mentoring and training of mine rescue personnel is adequate to protect team and prepare them for a mine emergency response to the fullest extent possible.

An introspection of the present emergency management practices in Indian mines reveals that

Recommendations made as above, if incorporated, would be instrumental in effecting a qualitative improvement in the current system in vogue.

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