



Health and Safety Manual for the Malawi Road Sector



Environmental and Social Management Unit

October 2007

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Acknowledgement

The Roads Authority would like to thank in particular the Ministry of Labour and Vocational Training, all Contractors and Consultants, RA Staff and Engineers who participated in the preparation of these guidelines, for their efforts and invaluable contributions.

Environmental Policy Statement

NRA VISION

By the year 2020, the Malawi and maintained up to a standard motorized traffic reach every adequate, safe, reliable, efficient, economic and in an environmental friendly manner at all times of the year.



public road network be developed where all motorized and non-society in the country in an

NRA's Mission Statement

Develop and maintain public road network infrastructure investment in a cost effective manner with a view to providing accessible, reliable, efficient, safe, sustainable and most economic transport system.

RA's Environmental Policy Statement

To achieve the Vision and fulfill the Mission Statement NRA endeavours to:

- Comply with the relevant health, safety legislation in accordance with Section 13(d) of the Malawi Constitution and adherence to the environmental best practices for the roads sector;
- Prevent adverse environmental effects of road construction and ensuring that the infrastructure itself is environmental friendly through;
 - The inclusion of EIA in the planning of the construction of roads and energy conservation;
 - Promotion of environmental protection and resource conservation;
 - Ensuring that roads do not impede drainage and cause water stagnation resulting in water pools that may become breeding places for disease vectors and pathogens;
 - Ensuring that drainage outlets do not become the primary sources of erosion;
 - Promoting the use of more energy-efficient and less polluting modes of transport
- Enforce environmental standards and specifications in line with MBS - ISO 14,000 series;

- Carry out on-site supervision on sites with consultants and contractors to ensure environmental due diligence; and that agreed environmental; health and safety standards designed to reduce associated risks during construction and operation, are being followed;
- Report on the compliance with environmental commitments, the status of the mitigation measures and the results of the monitoring programmes to consultants, contractors, stakeholder and members of the public; and get feedback on the requisite environmental performance information;
- Develop specified performance indicators to enhance the review of progress in implementing mitigation measures; and where necessary recommending remedial measures;
- Conduct training in EIA and in safe and practical and efficient work procedures to minimize the negative impacts and enhance positive impacts by adopting the precautionary principle; the polluter pays principle and best available technology that entails the least environmental cost (BATNEEC)
- Prepare and implement environmental risk management and road safety plans;
- Prepare environmental guidelines and best practices for road construction, maintenance and environmental management for use in the sector.
- Compliment activities and endeavours of partners in the Transport Sector like Rail, Aviation and Marine Transport Systems.

Foreword

It is a requirement by the Occupation Safety, Health and welfare Act, 1997 that every employer should ensure the safety, health and welfare at work of all employees.

The matters to which that duty extends includes in particular: a) Provision and maintenance of plant and systems of work that are safe and without risks to health, b) Arrangements for ensuring safety and absence of risk to health in connection with the use, handling, storage and transportation of articles and substances, c) The provision of information, instruction, training and supervision in to ensure and health and safety of workers; d) The provision of maintenance in a manner that is safe and without risk to health, and the provision of maintenance in a manner that is safe and without risk to health, and provision and maintenance of means of access to and egress from it that are safe and without such risks; e) The provision of maintenance of a working environment for his employees that is safe, without risk to health, and adequate as regards facilities and arrangements for their welfare at work

It is also the duty of every person having control of any premises to use the best practicable means for preventing the emissions into the atmosphere from the premises of noxious or offensive substances, and for rendering harmless and inoffensive such substances as may be so emitted It is the responsibility of the Ministry of Labour and Vocational Training, by order published in the Gazette, may prescribe any substance to be noxious or offensive and arrangements with regards the manner in which the plant being used and supervision of any operation involving the emission of these noxious and offensive substances.

The Roads Authority Act in collaboration with the Ministry of labour and Vocational Training have prepared this Health and Safety Manual to ensure that contractors and consultants involved in road construction and maintenance activities comply to the ILO Code of Practice in the Work place and the Health and Safety requirements stipulated in the Malawi Constitution an the Occupation Safety, Health and welfare Act, 1997

It is envisaged that this Health and Safety Manual will compliment health and safety arrangements and endeavors actors in the road sector have put in place to ensure continued health and safety for employers and employees and thus contributing to overall National Development of Malawi.

P.J. Kulemeka
Chief Executive Officer
Roads Authority

Acronyms

| | | |
|-------|---|---|
| BS | : | British Standard |
| CCTV | : | |
| ESCOM | : | Electricity Supply Commission of Malawi |
| FOPS | : | Falling Objects Protective Structures |
| HVAC | : | High Velocity Air Conditioning System |
| PPE | : | Personal Protective Equipment |
| ppm | : | parts per million |

4.1 *Planning and selecting the right equipment for the job* 28

4.2 Roles of Site agent and foremen 28

The site agent should consider how they will manage the site to ensure that it is kept in good order by: 29

4.4.1 Role of site workers in ensuring health and safety 29

Everyone on site including workers needs to play their part by: 29

The main causes of injury continue to be: 30

The main causes of occupational ill health continue to be: 30

When lighting burners, please follow the procedures below: 52

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1.0 Site Induction

The importance of site induction training cannot be over emphasized. It has also been found that new arrivals are statistically the most likely to be injured, and soon after starting work.

Typically, site induction training takes approximately one hour and should be carried out by the Site Manager/Foreman, depending upon the management structure of the organization. It should be properly planned and organized by the use of checklists. Induction Training should be recorded in a register.

1.1 Site Induction Format And Checklist

Every employee must go through a Health and Safety Induction process before they are allowed to commence work on site. This induction training, should concentrate on site specific Health & Safety issues.

The training will be conducted by site management and will include as a minimum the points below.

- Project Description
- Key members of the Site Management Team
- Site layout - boundaries, security, notice boards, parking etc
- Major Risks and Project Standards
- Conditions & Substances affecting Health
- Major Causes of Accidents
- Health & Safety Targets
- Employers & Individuals responsibilities
- Personal protective equipment
- Accident reporting and First Aid
- Fire and Emergency Procedures
- Fire Extinguishers
- Welfare

Canteen
Toilets
Changing/Drying Rooms

- Environmental issues
- Communications
- Method Statements/Risk Assessments
- Toolbox Talks

1.2 Induction Procedure

Induction is very vital to make sure employees safety at sites. The employees Should thoroughly know:

- The site safety rules
- What the contractor is doing and who is involved
- Safety procedures and layout for the site
- The risks on this project
- Accident causes and reporting procedures
- Health and Safety Targets
- Health and Safety duties
- Minimum Personal Protective Equipment
- Where the welfare and First Aid facilities are located

1.3 Site Layout

Employees should be familiar with the site and facilities below:

- Parking
- Access
- Entry - security, booking and pass systems (if any)
- Hours of work
- Keeping vehicles and machines separate from people
- Parts of the site which are prohibited or sensitive

1.4 Employees Health

Employees need to be taught conditions and substances that can affect may or will affect their health and safety. These include but not limited to:

- Manual handling
- Dust
- Asbestos

- Concrete
- Noise and vibration
- Radiography (welding/lasers)

1.5 Personal Protective Equipment

Wearing the correct PPE and personal hygiene are essential to avoid health problems

1.6 Precautions and Control Measures

Precautions and control measures include:

- Site investigations
- Barriers and signs
- Permits to work that apply on this site
- Personal protective equipment
- Health checks

1.7 Contractors Responsibility

To make sure that they provide a safe place and system of work all employees
 Assessing the risks and making a plan (method statement) to remove or control the
 risks so that you can do the work safely
 Explaining the method statement to you before work starts

1.8 Employees Responsibilities -

- To follow the safe systems of work and site rules
- To work safely
- To follow the site rules
- To wear the correct PPE
- Not to interfere with safety equipment

1.9 Personal Protective Clothing

Employees should be taught that essential protection is:

- Safety helmet
- Safety footwear with steel toecaps and mid sole insert
- High visibility vests (if appropriate)
- ALL PPE MUST BE WORN BY LAW

- Eye protection if there is a danger of eyes being damaged
- Gloves to protect hands
- Safety harness - if there is a danger of falling
- Ear protection, when working in noisy areas
- Face mask, if the environment is dusty

1.10 Accident Reporting

Accident reporting procedures are discussed in annex 6 of this manual.

1.11 Fire And Emergency

Employees should be taught that if there is a fire or other emergency the alarm will be raised. They should **MAKE SURE** they **KNOW** where **THE EXITS ARE** located.

They should

- Make your work safe and then go to their assembly point
- Do not return to work until you are told it is safe to do so

1.12 Employees' Welfare

The Employees should know where the facilities listed below are situated:

- Canteen
- Toilet and wash room
- Site office
- Changing rooms and drying rooms

1.13 Method Statement etc.

- The supervisor should explain method statements before work start
- Each week the employee should receive a toolbox talk on a safety topic

2.0 Plant and Vehicle Safety on Road Construction sites

Key elements needed to be addressed when planning for plant and vehicle safety when carrying out road construction activities.

- Ensuring a safe workplace
- Ensuring safe driving and work practice
- Ensuring safe vehicles

2.1 Ensuring a safe workplace

Identifying any hazards in the areas in which vehicles are to operate and assessing and controlling the potential risk associated with these hazards to ensure a safe workplace. It is important that while carrying out this exercise, the potential of vehicles to cause harm to others must be evaluated. Particular attention should be given to the following:

2.1.1 Traffic Routes

- Must be well planned and correctly marked; and, appropriate signage should be used
- Routes including one way systems are preferred
- The needs of drivers unfamiliar with the site need to be addressed (i.e. clear directions, systems, etc.)

2.1.2 Pedestrian safety

- Pedestrians must be separated from vehicles as much as possible, particularly where vehicles are reversed, loaded, unloaded, etc.
- Designated pedestrian routes and areas should be established
- Where both vehicles and pedestrians cannot be separated the provision of high visibility clothing, adequate lighting and reversing aids for drivers is essential. All pedestrians must be alerted to the potential risk.
- A member of staff should accompany visitors who are unfamiliar with the site if they are required to walk around it.

2.1.3 Public Safety

- Any visitors to the site should be clearly directed to public parking areas and a procedure should be put in place to ensure that there is no interaction with site traffic
- Non-site vehicles should be discouraged from entering the site
- If anyone driving on site must leave their vehicle, they must be wearing the appropriate Personal Protective Equipment, (this is particularly important for delivery truck drivers)

2.2 Overhead Power Lines

Overhead power lines pose a significant risk for any machinery operating below them. Vehicles don't actually need to strike overhead power-lines for injury to occur as electricity can arc a surprising distance depending on voltage and conditions. If possible, lines should be diverted prior to work commencing in their vicinity.

Applications for diversion should be made in good time during the design stage of a construction project to bring about prompt diversion, prior to other works commencing on site. If it is not reasonably practicable, then it is vital that precautions are put in place if vehicles have to operate or pass under or near power lines. These precautions include:

- The avoidance of work under or near power-lines where possible.
- The use of 'goalposts' to restrict access above a certain height and to enforce the lowering of all appendages to a safe level
- Barriers and bunting should be used to alert drivers and to ensure that the only access to the danger zone is through the 'goalposts'.
- Tipping areas must be assessed to make sure they remain risk free during unloading
- Appropriate signage must be put in place and all drivers made aware of the potential risk
- If work must be carried out below power-lines and it is possible that cranes, excavators and other vehicles can reach the danger zone the lines should be isolated and earthed before work begins. If this is not possible physical safeguards (such as chains on the boom) may be required to prevent vehicles reaching into the danger area.
- Guidance should be sought from the ESCOM when working under or near electricity
- All drivers must be made aware of procedures to be carried out in the event of their vehicle coming into contact with electrical current.

2.3 "Goal posts" Distance from the Power lines

Goal post should ideally be located at the entrance to site or, if there is equipment such as cranes, telehandlers or dump trucks on site, at either side of the danger zone. If power lines lie directly across a road, goal posts should be located at least 6 meters on either side of the lines if made of rigid non-conducting material. If the posts are made of elastic or other flexible materials then they must be located 12 meters from the power lines on either side.

2.4 Vehicle practices need to be in place to ensure site safety

Safe practices need to be developed for the different aspects of the vehicles Operators job if safety is to be maintained. Practices should be in place to:

- Ensure the selection of competent drivers
- Ensure systems are in place (through CCTV, banks men, signalers, etc.) to pass signals to the driver from outside the vehicle if the driver's view is impaired
- Ensure drivers are not exposed to excessive noise, vibration or dust
- Set, maintain and enforce speed limits
- Ensure all signs are clear and legible
- Ensure the need for reversing is minimized (by the use of one way systems, etc.)
- Ensure adequate visibility for the driver is provided and maintained
- Provide adequate supervision and training where necessary
- Ensure that all loading, unloading, servicing, refueling of both site and road vehicles can be done so safely. Road vehicles may need extra precautions due to the way they are used on site or the conditions they are used in
- The carrying of passengers should never be permitted unless there is a passenger seat in the vehicle to facilitate this;
- Plant and Vehicles should be fitted with CCTV cameras and other reversing aids (refer to Annex 2: Fitting CCTV cameras and Reversing aids)

2.5 Factors needed to be considered when evaluating the safety of a vehicle

Vehicles must be suitable for the place in which they are to be used and for the work they undertake. The selection of suitable work equipment can reduce or eliminate many risks. The following are important factors to consider when choosing a vehicle:

- The effectiveness of the braking system, bearing in mind the slopes it is expected to operate on;
- Adequate all round visibility for the driver;
- Stability under all foreseeable operating conditions;
- Protection for the driver and any passengers from falling objects (falling object protective structure) and overturning (roll-over protective structures and restraining devices);
- Safe access to and from the cab and other areas to which access may be required;
- Lights, windscreen wipers, horn and other warning devices;
- Guarding for dangerous parts during use or maintenance work;
- Protection for the drivers and any passengers from rain, high or low temperatures, noise, dust or vibration;
- Suitable seating for the driver and any passengers; and
- Adequate seatbelts or restraining devices for drivers and passengers.

2.6 Training should be given to mobile plant operators

All employees need to be given adequate safety training to carry out their jobs without presenting a risk to themselves or to others. All employees need to be given site specific training relevant to their job and work area.

This training should include

- emergency procedures
- site vehicle safety rules
- the use of PPE (personal protective equipment)
- the location of overhead power-lines on site
- how to inspect and test their vehicle before work
- any other relevant safety information relating to the persons job which is contained in the safety statement
- the duties placed upon them by the Safety, Health and Welfare at work Act 1997
- contact details of the safety representative

This training should be given before the commencement of work, in the form of induction training.

2.7 Vehicle Safety Rules should be in place on site

“If work equipment is moving around in a work area, appropriate traffic rules shall be drawn up and followed.”

As such vehicle safety rules need to be drawn up which cover the following:

- Driver selection, training, assessment and authorization;
- Security arrangements, including control of keys;
- Restrictions on where vehicles may be used, due to height, width, gradient of roads;
- Any restrictions on reversing, extent of one-way systems;
- Speed limits;
- Daily check sheets, reporting of defects;
- Pedestrian safety, segregation, parking areas;
- Fitting and use of safety devices, e.g. seat belts and visibility aids;
- Use of vehicles in adverse conditions, e.g. fog, rain, mud, ice, etc.;
- Precautions where vehicles or trailers with tipping bodies or tipping gear are loaded, unloaded or sheeted;
- Instructions to drivers concerning the reporting of defects;
- Relevant cross-references to the scheme for inspection and maintenance of plant;
- The wearing of seat belts.

Some rules will only apply to certain areas or work activities but there should be no ambiguity as to which rules apply and where. These rules should be clearly set out in the contractor's safety statement and/or the safety and health plan for the project, and all persons (including sub-contractors) working on the site should be made aware of them and must adhere to them in full.

Precautions on Working sites

The general precautions that need to be taken when operating vehicles and machinery on a construction site include:

- Follow all safety instructions
- Including signs on machine and manufacturers' instructions
- Replace and maintain signs on machine as necessary
- Learn how to operate machine and controls safely
- Allow only trained, qualified, authorized personnel to operate machine
- Ensure regular maintenance and servicing
- There should be no unauthorized modifications made to the machine

2.8 Emergency Preparedness

It is necessary at all times that employees:

- Be prepared for the occurrence of fire or accidents
- Have a first aid kit and extinguisher on hand (and know how to use it correctly)
- Establish emergency procedures
- Have emergency contact numbers on hand

2.9.1 Protective Clothing

- You may need hard hats, steel toe capped boots, safety goggles, face shields, heavy gloves, hearing protection, wet weather gear, respiratory or filter masks, depending on the situation
- Avoid wearing loose clothing, jewellery, or other items that can catch on control lever or other parts of the machine.
- Operating machinery requires the full attention of the operator. Do not wear radio or music headphones while operating the machine.

2.9.2 Protect against noise

- Prolonged exposure to noise can cause impairment or hearing loss and earmuffs or earplugs may be required

2.9.3 Inspect machine

- A walk around inspection of the machine should be carried out at the start of each day and shift.

2.9.4 Use handholds and steps

- Getting on and off the machine; always face the machine and maintain three point contact with the steps and handrails
- Do not use any controls as hand-hold
- Never mount or dismount a moving machine
- Be careful of slippery conditions on platforms, steps and handrails

2.9.5 Adjust the operator's seat

- A poorly adjusted seat may quickly fatigue the operator leading to mis-operations and potential back problems for the operator
- The operator should be able to fully depress the pedals and to correctly operate the control levers with his back against the seat

2.9.6 Fasten your seatbelt

- Prior to operating the machine, thoroughly examine webbing, buckle and attaching hardware. If any item is damaged or worn, replace the seat belt or component before operating the machine.
- It is recommended that seat belts be replaced every three years regardless of its apparent condition

Move and Operate Safely

- Confirm location of bystanders before moving, swinging or operating machine
- Always keep the alarms and safety devices in good working order and in use
- Use a signal person when moving, swinging or operating in congested areas. Coordinate hand signals before starting the machine

2.9.7 Operate only from the operator's seat

- Inappropriate engine starting procedures may cause the machine to runaway, possibly resulting in serious injury or death

2.9.8 Passengers

- Passengers should never be carried on vehicles and machinery unless there are suitable passenger seats and safety restraints in place

2.9.9 Investigate the job site beforehand

- Investigate the ground conditions of the job site beforehand to prevent the machine from falling and to prevent the ground, stockpiles, or banks from collapsing
- Make a work plan. Use machines appropriate to the work and job site
- Reinforce the ground, edges and road shoulders if necessary. Keep the machine well back from the edges of excavations and road shoulders.
- When working on an incline or on a road shoulder, employ a signal person if necessary
- If working in an area where there is a possibility of falling stones or debris ensure cab has been equipped with FOPS (falling object protective structures)
- When footing is weak, re-enforce the ground before starting work
- When working on frozen ground, be extremely alert. As ambient temperatures rise, footing becomes loose and slippery

2.9.10 Park the machine safely

- Park machine on firm, level surface
- Lower bucket or any raised parts to the ground
- Run engine at slow idle speed without load for 5 minutes
- If parking must be carried out on an incline, block both tracks or wheels and if working with an excavator, thrust the bucket teeth into the ground
- Turn key switch to OFF to stop engine
- Remove the key from the key switch
- Pull the pilot control shut-off lever to the LOCK position
- Close windows, roof vent and cab door
- Lock all access doors and compartments

2.10 Precautions to be taken when loading or unloading a machine

The transport of site machinery can involve numerous hazards and the following precautions should be taken at all times:

- Loads carried must be adequately secured so there is no likelihood of them moving or falling off
- Particular attention should be paid to the dangers of high loads
- The design and construction of the vehicle should be suitable for the load
- The maximum expected floor loading must be ascertained to ensure that the floor and supporting members are adequate
- The load is so arranged not to obstruct the drivers field of vision, including rearward vision through the driving mirrors
- A headboard should be used to protect the driver from shifting loads
- If practicable, the load should be placed in contact with the headboard

- To achieve maximum stability the load should be placed so that the centre of gravity is placed as low as possible, and near to the vehicle longitudinal centre line
- The weight of heavy goods of small dimension should be spread across the vehicle platform by use of load spreading devices
- The load should be checked frequently for security during the journey
- Equipment used for storing loads must be regularly inspected for wear and tear
- The machine should be securely lashed, the brakes engaged and any other necessary precautions must be taken to ensure that the machine cannot change position during transit

2.11 Loading and unloading a machine on a truck or trailer bed

Before driving the machine on or off a transporting vehicle, the machine operator should ensure that:

- The loading/unloading area is sufficiently large to accommodate the movement of the machine without striking obstructions or causing hazards to others
- The transporter is on firm and level ground and correctly positioned with its brakes on
- All ramps must be secure and long enough to keep the ramp angle low
- The machine transmission, clutches, brakes, etc are working correctly (An unserviceable machine will require the assistance of the transporter loading winch)
- The machine should be lined up with the ramps so no turning will be necessary
- Loading and Unloading should be carried out at the slowest possible speed, particularly at any point of balance
- Any necessary movement of the machine whilst on the transporter (i.e. to centralize it) must be carefully executed

2.12 Drivers and start-up inspection

The operator or driver should carry out a basic inspection at the start of every shift to identify any potential hazards and to ensure that the need for maintenance and servicing is identified as soon as possible. This inspection could be in form of a checklist which documents the process. Records of these inspections should be kept and signed by the site foreman or the site agent. The following is a non-exhaustive list of things which should be checked as part of a start-up inspection:

- Check the electrical system for frayed wires and loose connections
- Check the boom, bucket, sheet metal, tracks, etc. for any bent broken or missing parts
- Check all hardware for missing parts
- Drain water and deposits from fuel tank

- Check the hydraulic system for leaks, kinked hoses, and lines or hoses that rub against each other or other parts
- Check protective devices such as CCTV, guards, fenders, reversing alarms, flashing beacons to ensure they are functioning properly
- Carry out a basic brake test to ensure that brakes are working effectively. Thorough brake testing should be carried out at least every 6 months but basic tests may indicate a need for brake testing before the scheduled time
- The condition of steps, handrails, windows and mirrors etc should be checked to ensure that any maintenance required can be carried out immediately

2.13 Vehicle fire Prevention

To prevent fire during the operation and maintenance of machinery the following items need to be checked regularly:

2.14 Check for oil leaks

Check for oil leaks due to missing or loose clamps, kinked hoses, lines or hoses that rub against each other, damage to the oil-cooler, and loose oil-cooler flange bolts

Tighten, repair or replace any missing, loose or damaged clamps, lines, hoses, oil cooler and flange bolts

Do not bend or strike high pressure lines

Never install bent or damaged lines

2.15 Check for short circuits

- Clean and tighten all electrical connections
- Check before each shift or after 8-10 hours of operation for loose, kinked, hardened or frayed electrical cables or wires and for missing or damaged terminal caps
- Do not operate machine if cable or wires are loose, kinked, etc. Clean up flammables
- Spilled oil or fuel and rubbish, grease, debris, accumulated flammable materials cause fires. Inspect and clean the machine daily, remove all flammables

2.16 Clean up flammables

Spilled oil or fuel and rubbish, grease, debris, accumulated flammable materials cause fires. Inspect and clean the machine daily, remove all flammables

2.17 Check heat shields

Damaged or missing heat shields must be repaired or replaced before operating the machine

2.18 Fire Extinguishers

Extinguishers should be kept at hand in case of fire and all operators should be trained in their correct use. (Fire Extinguishing procedures are discussed in section 13.2 of this manual).

2.19 Precautions vehicle repairs

All vehicles and machinery need to be regularly serviced and appropriately maintained if they are to perform both safely and efficiently. A suitable maintenance programme needs to be developed which caters for basic daily inspections, regular servicing of vehicles, suitable reporting of defects procedures and maintenance and repair of vehicles and machinery.

- During vehicle repairs ensure:
- Brakes are applied and wheels chocked
- Raised bodies are always propped/supported
- Brakes are on and gears are in neutral when starting and running engines
- Axle stands are always used to support vehicles (Never rely on hydraulic jacks or blocks)
- Beware of explosive risk when draining and repairing fuel tanks, and from battery gases
- When inflating large tyres that are not fitted to the vehicle, and particularly with split rim wheels, tyre cages must be used
- Burns from battery short circuits are avoided

There is no exposure to asbestos dust from brake and clutch lining and pads

2.20 Precautions when changing vehicle tyres

Proper tyre changing procedures must be established for all different designs and sizes of tyres and wheels. Failure to observe safety procedures can lead to death or serious injury. Only those with suitable training, experience and equipment should attempt to carry out tyre work.

The following are general recommendations for safe tyre changing:

- Wheels and tyres must never be inflated, deflated, mounted or dismounted without the proper tools, equipment and expertise
- Manufacturers recommended procedures should always be adhered to.

- When jacking a machine to remove a wheel, a sound timber must always be used as a support for the jack; the jack itself should never be relied upon to support the machine. The machine must be supported on substantial timber packing
- Tyres should be deflated before removal by depressing the valve core stem to reduce the pressure, after which the valve core may be safely removed
- Before fitting a tyre, the tyre bead must be lubricated with a recommended lubricant to permit easy and proper seating. The maximum inflation pressures specified by the tyre manufacturer must never be exceeded in order to seat the bead
- A tyre cage must be used when inflating large tyres, e.g. tyres of tractors, trucks, buses, construction vehicles, which are not fitted to the vehicle. Where possible, only inflate tyres when they are fitted/bolted to the vehicle.
- If a tyre is wet or dry ballasted, the machine/manufacturers recommended inflating and deflating procedures must be closely followed.
- Tyre pressures should be marked on vehicles conveniently close to the wheels, so that the information is readily available.

3.0 Controlling Traffic On Working Sites

3.1 Authorization to control traffic

No person is permitted to control traffic unless they have completed training in traffic control by a competent traffic control training authority.

Traffic controllers **must** ensure their red coloured safety vest is fully fastened at the front.

Traffic controllers should be permitted to leave their safe work site for:

- emergency reasons
- as directed by the Supervisor
- as relieved by another person

3.2 Warning Signs

Traffic controllers and their Supervisor **must** ensure all warning signs are placed out in accordance to the Road safety requirements

3.3 Safety Vests

Traffic controllers **must** wear clean non-faded red coloured safety vests and on overcast days or at night must wear safety vests with reflective material to a recognized standard.

3.4 Controlling the Public

Traffic controllers must act in a sensible manner and control aggression by the General Public. Where the General Public fail to obey the traffic controllers instruction, the traffic controller should take notes as to the type of vehicle, colour, registration number and provide a written note as to the nature of the concern immediately to his Supervisor.

3.5 Relief for Traffic Controllers

It is recommended where possible, traffic controllers should be relieved to have rest breaks. On hot days traffic controllers must have access to:

- cool drinking water
- wear wide brim hats & 15+ sunscreen lotion
- abide by company policy in reference to acceptable types of clothing to ensure protection from UV rays.

3.6 Assistance for Traffic Controllers

“Whenever a traffic controller is working adjacent to the location of the work crews (to slow traffic where minimal clearance only is available) there must always be at least one additional traffic controller provided in advance of the works as per the relevant Standards for traffic control and/or as per the documented traffic control plan.”

3.7 Refresher Training Courses

Traffic controllers must be provided with communication devices where the traffic controllers are unable to have direct line of sight of each other or at a long distance apart.

Traffic controllers should attend refresher training courses every 2 years

3.8 Special Requirements for Signalers

The Signaler should be:

- Over 18 years of age
- For the purpose of training, be under the direct supervision of a competent person
- Fit, with particular regard to eyesight, hearing, reflexes and agility
- Physically able to handle lifting gear and equipment
- Training in the techniques of slinging
- Capable of selecting lifting gear and equipment in suitable condition for the load to be lifted
- Training in the techniques of signaling and understand the signal code
- Capable of giving precise and clear verbal instructions where audio equipment is used and be capable of operating the equipment
- Capable of operating and directing the safe movement of the crane and load
- Authorized to carry out the signaling and slinging duties
- Know the relevant statutory requirements e.g. those relating to lifting gear, etc.

NB: General safety guidelines for road construction activities are listed in annex 6 of this manual.

4.0 Bridges and Culverts

Falls and Trips

There is no distinction made between low and high falls so for all work at height, measures must be taken to prevent the risk of any fall that could cause injury. The following precautions:

4.1 Planning and selecting the right equipment for the job

- How long the job will take and how often it will be carried out are important selection issues.
- Whoever assembles and uses the equipment must be trained and competent to do so.
- Mobile elevating work platforms can provide excellent safe access to high-level work and can be easily moved from one location to another.
- Powered access equipment requires the operator to hold a certificate or licence to prove that they are trained and competent.
- Tower scaffolds are widely used and can provide an effective and safe means of access, however poorly erected and misused tower scaffolds are the cause of numerous accidents each year.
- Towers should only be erected by trained and competent people who are following a safe method of work.
- Ladders and stepladders are the most commonly used pieces of access equipment for a wide range of tasks and perhaps the most misused so it is essential that those who use ladders are trained and competent to do so.

Ladders should be your last option. They should only be considered for light work of short duration and where the use of other more suitable work equipment is not appropriate. If ladders are used, they should be:

- of the correct type
- in good condition
- placed on firm level ground
- properly secured; and,
- set at the correct length and angle for the job.

4.2 Roles of Site agent and foremen

- Identify jobs that involve work at height and plan the work to ensure that appropriate precautions are in place
- Have a risk assessment in place
- Have procedures for the selection of correct equipment and ensure that the selected equipment is actually used
- Communicate risk control measures to the workforce
- Ensure workers are competent to use the equipment that has been correctly installed/assembled

- Arrange inspection and maintenance of equipment as appropriate

4.3 Hierarchy of control measure when working at height:

- Avoid working at height if possible
- Use an existing safe place of work
- Provide work equipment to prevent falls
- Mitigate distance and consequences of a fall
- Instruction and training and/or other means.

For the above, collective protective measures (such as scaffolding) must be prioritized over personal protection (such as using a fall arrest harness).

Working at height does not have to involve unacceptably high risks. Proper management of the issues we have looked at will create a safer working environment for everyone and help you to comply with your legal duties. Take the time to plan the work, select the right equipment, and use it properly.

4.4 Good order

The site agent should consider how they will manage the site to ensure that it is kept in good order by:

- Segregating traffic routes from pedestrian routes.
- Managing the procurement of materials to ensure that only the minimum amount of materials is stored on site at any time.
- Ensuring that everyone working on the site is aware of the site policy for managing the movement and storage of materials around the site, and the removal of waste from work areas.

4.4.1 Role of site workers in ensuring health and safety

Everyone on site including workers needs to play their part by:

- Keeping walkways and stairs clear and free from obstructions
- Ensuring that footpaths are firm & level, stoned up if necessary, and gritted if icy
- Keeping work areas as clear as possible of unnecessary materials and waste
- Storing materials safely, whether in the site compound or around the site
- Complying with the site arrangements for the removal of waste
- Reporting good order problems to site management

5.0 Health and Safety at Quarry and Gravel sites

Activities at quarries and gravel pits involve extensive destruction and noise. There is also increased truck traffic, which usually impact the lifestyle and environmental quality of communities.

Environmental degradation includes threats to groundwater quality; impacts in and about fish bearing streams, such as channel widening or increased bank erosion; disruption of fish and wildlife habitat; increased noise and dust pollution; and disruption of environmentally sensitive areas. We need to find a way to balance the location and operations of pits and quarries with other community and environmental concerns.

The main causes of injury continue to be:

Manual handling / musculoskeletal injury
Falls from heights
Transport
Slips and trips

The main causes of occupational ill health continue to be:

musculoskeletal injuries
hand-arm vibration
asthma
noise
silica

5.1 Best Health and Safety Practices – Quarry and gravel Sites

There is need to put in place best practices at these sites to control and eliminate:

5.1.1 Respirable dust and silica exposures on site

The following points should be addressed:

- The dust masks being worn by workers needed to be replaced regularly
- Awareness training for operators of the risks associated with respiratory silica needed to be improved
- Management needed to be more robust to enforce the wearing of PPE at the sites
- A working procedure needed to be drafted
- Representation from the staff who work in the sites need to be heard.

5.1.2 Further improvements include:

- Operators should be issued and trained on air fed masks
- Silica awareness presentation should be given to all
- A new enforcement tool be developed to encourage managers to formally record both good and bad practice while talking to employees about their work activities

- Good practice guides should be put up in the working area

5.1.3 Dust removal system

The process of cutting and shaping stone at the sites creates a high level of airborne dust. The idea to counter this was based upon a wet suppression system found in asphalt plants.

A powerful fan should be located in a building where it is linked back to the masons' workstation. The fan will suck the dust through the ducting link which will pass through a series of water jets which send out a fine spray, turning the dust into slurry. This slurry will then fall to the bottom of the tank where it will be mixed with a flocculent and turned into a semi-solid, ready for disposal. This process will therefore remove the dust and release clean air into the atmosphere. As a consequence, the dust levels will have been cut by 50 per cent.

5.1.4 Musculoskeletal assessments for each employee

Back injury complaints at sites at these sites are common. Each employee should be given advice on how to prevent further damage and also how to strengthen weak areas. A major contributory factor to injury is dehydration as the muscles and joints become less flexible. To address this, more water dispensers have been installed across the site.

5.1.5 On-site health monitoring

Considerable thought has to go into a combination of engineering improvements; health surveillance; employee awareness, training and education; also first aid provision and an emergency rescue centre. Replacement of fixed plant has to be done to effect major reductions in dust, noise and the need for manual handling of heavy items. Comprehensive health surveillance is carried out by a health worker, who should attend the quarry workers for half an hour each day and advise workers on matters of diet, exercise, etc.

5.1.6 Personal protective equipment pouch

With the need to wear safety spectacles and carry extra personal protective equipment (PPE) at all times on site, the site safety team should issue operators with an easily-identifiable 'PPE Pouch' to provide a safe and convenient method of keeping the necessary equipment to hand at all times

5.1.7 Reducing hand arm vibration exposure

As the second most commonplace industrial disease within the industry, hand arm vibration exposure poses some serious challenges. There is need to control the risk of pneumatic powered breakers in particular.

Excavators/ tractors fitted with a hydraulic breaker on a remote arm can reduce exposure to hand arm vibration by 80 per cent for break-out work; manual handling will be eliminated entirely; noise levels are reduced dramatically; and there is no danger of whiplash injuries from pneumatic hoses parting.

5.1.8 Mechanized greasing system

Greasing the machinery and equipment at the sites constitutes a hefty manual task that requires the operators to continually climb up and down a ladder. Using the greasing gun also brought risks of repetitive strain injuries. The problem can be addressed by installing a small compressor onto the back of a wagon, along with pneumatic greasing equipment and an inertia hose reel. Once the lightweight reel has is pulled out and attached to the grease nipple, the compressor will do the rest.

5.1.9 Calculating daily hand-arm vibration exposure

Hand Arm Vibration Syndrome has become one of the most commonly reported diseases to Ministry of Labour and Vocational Training. Legislation should lay down action levels and control measures for differing amounts of vibration exposure. However, calculating daily exposure to employees who use different pieces of equipment can prove difficult and time-consuming.

To evaluate and measure actual vibration levels of hand tools used by stone masons and quarry men, a unique exposure points system should be introduced which will mark equipment with colour-coded plastic tags according to the vibration levels they emit i.e. green for low, amber for medium and red for high.

5.1.10 Air filtration system

All the mobile plant should be fitted with air filtration systems to protect drivers from respirable crystalline silica dust, which will offer adequate protection. There is need to design and install new High Efficiency Particulate Arrestor external air filtration systems to the cabs of two dump trucks and a loading shovel. Crucially, they incorporate a cab warning light which tells the operator when the filter will need constant replacement.

6.0 Quarry sites Surface drilling and blasting

The main disturbances created by blasting are:

- Vibrations which are seismic movements in the ground caused by rock blasting, piling, traffic, excavation, compaction etc. the size of the ground vibrations depends on : quantity of co-operating charge, construction, characteristics of the rock, distance from the blasting site and geology of covering earth deposits.
- Air blast/ Air shock waves breaking house windows
- Throw/ Fly rock mostly caused by improperly designed and charged blast; geology and drilling errors, influence of the explosives and the function of the blast hole diameter

6.1 Control of fly rock

To contain or control fly rocks, there is need to have:

- Adequate protection measures
- Good marking out of the drilling patterns
- Control of the deviations and depths of the blast holes
- Control the burden for blast holes of the first row
- Check for cavities, poor geology or weak zone in the rock masses, and the reduce the explosive in that area
- Control the charge and distribution of the explosive along the hole
- Control the height of stemming and the quality of the material used
- Select the initiation sequence that gives good break direction of the blast
- Utilize initiation in the bottom of the holes
- Use coverings if necessary which should have the following characteristics
 - Reduced weight
 - High resistance
 - Easy of union or overlapping of the elements
 - Permeability of gases
 - Economical and reusable

Always:

- Follow all laws and regulations applicable to explosive materials
- Keep the explosive under lock
- Keep explosive material away from food, eyes or skin
- Avoid exposure to excessive noise from the detonation of explosive materials
- Remain clear of detonation area until post blast fumes and dist
- Record the area handling explosive material. Use reasonable care to protect the explosive materials from heat, friction or shock.

Never:

- Abandon any explosive material
- Allow any source of fire or flame within 30 m of the blast area, magazine or vehicle carrying explosives
- Expose explosive materials to flame, excess heat, sparks, friction or impact
- Fight fires when explosive materials are involved. Remove all personnel to a safety position and guard the area against intruders
- Never shoot against explosive materials; explosive storage machines and vehicles carrying explosives
- Allow unauthorized persons near explosive materials
- Allow children near explosive materials
- Breathe dust or vapours of explosive materials

6.2 Transporting Explosive Materials

Always:

- Follow laws and regulations
- Keep matches, lights, flames and other ignition sources at least 15m away from parked vehicles loaded with explosive material
- Load and unload explosive materials carefully

Never:

- Transport explosive materials in any packaging except their original or alternate approved packaging
- Park vehicles containing explosives in congested areas and close to people
- Leave a vehicle carrying explosives unattended

6.3 Storing Explosive materials

Always:

- Separate magazines from other magazines, buildings, roads and railways
- Be sure that magazines are solidly built and securely locked and well protected from weather, fire and theft
- Keep insides of explosive magazines clean, dry, cool and well ventilated
- Clean up spills of explosive materials promptly following the manufacturers' instructions
- Use the oldest explosive materials first
- Locate perimeter warning signs
- Use safety lamps if artificial illumination is needed

Never:

- Allow combustible materials to accumulate within 10m
- Allow matches, lighters, flames and other ignition sources; at least 15m away from any magazine
- Attempt to make any repairs inside or outside of a magazine containing explosive materials
- Store a detonator with other explosive materials

- use explosive materials that show any sign of deterioration
- exceed the limit of storage capacity of the magazine
- open the boxes of explosives inside the magazine
- store detonating cord inside the magazine of explosives

6.4 Handling explosive materials

Always:

- ensure that the vehicle transporting the explosive materials complies with stipulated regulations
- Close partially used packages of explosive material
- Load and unload explosives, blasting caps, detonating cords etc. with care and without drops or blows
- Distribute the explosives to be used in the blast in order to avoid leaving large amounts piling up
- Place the blasting caps away from the charging zone
- Supervise unloading explosives until they are placed in blast holes and the round is connected
- Prevent access of anyone not directly involved with the handling of explosives to the marked zone and the periphery

Never:

- Use sparking metal tool to open cases of explosive materials
- Mix different explosives in the same case
- Use any explosive materials unless you are completely familiar with the safe and correct procedures for their use
- Put explosives in you pocket
- Handle explosives during an electric storm or its approach
- Smoke in or proximity of a vehicle transporting explosives
- Transport blasting accessories with explosives

6.5 Preparation of the Primer Charge

Always:

- Prepare the primers according to the methods recommended by the manufacturer
- Inset detonators in a hole made in the primer cartridges with a special tool made of wood , copper, bronze or plastic
- Check that the initiator is well placed inside the cartridge
- Prepare the primer only when it is going to be used

Never:

- Produce tension in the detonator cables or in the detonating cord and between the points of union
- Prepare the primer in the magazine or near it

6.6 Charging the Blast holes

Always:

- Examine the blast hole before charging to know its length and condition using a wooden or plastic rod
- Foresee the possibility of danger from static electricity when using a pneumatic auger
- Remember that relatively low humidity in the atmosphere increases the risk of static electricity
- The person charging the blast hole should not expose their body parts over the holes being charged
- Check the rising of the blast explosives and take necessary precautions in case of holes or cavities in the blast holes
- Confine the explosives in the holes with sand or any other appropriate incombustible material

Never:

- Leave any surplus explosives in the work area during and after charging the holes
- Charge the hole right after drilling without checking to see if they are clean and free of metal pieces or hot substances
- Deform, mistreat or let the primer drop into the blast holes
- Let any heavy weight fall on them
- Recharge holes that were already charged and fired before
- Use any kind of metal tamping tools
- Directly tamp the primer cartridges

6.7 Blasting with Electric Caps

Always:

- Keep the elastic blasting cap wires or conductors short circuited
- Check all blasting caps connected in series with the proper blasting ohmmeter
- Take away all surplus explosives from the shot area before placing or connecting the caps
- Push a copper rod into the ground close to the shot before any connection is done for the personnel handling the caps to discharge static electricity
- Stop heavy machinery from passing through the shot area
- Ensure that the ends of the leg wires are clean before making any connection
- Check the blasting machine and ohmmeter regularly

Never:

- Unroll the leg wires or use electric caps during a storm or near any source of static electricity
- Use caps or unroll their wire legs near radio transmitters or television stations, electricity lines etc. unless at the recommended distance and complying with regulations
- Place cables or electric lines near the blasting caps
- Place the fire line close to power lines or in contact with metal elements

- Connect one cap to another until firing time
- Check a caps without adequate safety ensured
- Use blasting caps of different sensitivities on the same circuit
- Connect the firing line to the blasting machine until ready to fire the blast and keep it short circuited
- Try to open or dismount a blasting cap

6.8 Blasting with safety fuse and fuse detonators

Always

- Blast as little as possible with fuses and reduce the number of blast holes in each round
- Handle the fuse with care to avoid damaging the cover
- Work with fuses at more than 1.5m interval
- Cut the fuse squarely across and insert it gently against the powder charge of the fuse detonator
- Clip the end of the fuse detonator with a cap clipper at the fuse entry point

Never:

- Have explosives in your hands when lighting the safety fuse
- Count the number of holes that have successfully blown and wait half an hour to determine misfires

6.9 Detonating Cord

Always

- Select detonating cords that has physical and performance characteristics consistent with correct blasting methods and type of explosive
- Handle detonating cords with care
- Avoid damaging, crimping or severing detonating cords
- Avoid loops or angles that direct detonating cords back toward the incoming line of detonation
- Connect detonators to cords following manufacturers recommendations
- Cut the detonating cord squarely across with a good knife without much friction

6.10 Destruction of explosives

Always

- Blast the explosives inside a hole
- Burn the detonating cord over a surface with combustible material
- Destroy the detonators inside a hole during the round
- Control pollution when destroying explosives by law favouring chemical destruction

Never

- Burn more than 5 kg of explosives in on place
- Burn the explosives in packing boxes
- Burn the detonating cord on the reel

7.0 ASPHALT PLANT SAFETY

Safety considerations cannot be overemphasized. Coal distillate, such as benzene or naphthalene in benzyl, is suspected carcinogens. Avoid all skin contact and do not inhale the vapors and gases from these distillates.

7.1 Cancer

Asphalt contains components suspected of causing cancer. Anyone handling asphalt must be trained on the health hazards. Dust is particularly hazardous because of its threat to your lungs and eyes. In addition, dust contributes greatly to poor visibility when trucks, front-end loaders, or other equipment are being used around the stockpiles or cold bins. Reduced visibility in work traffic is a prime cause of accidents.

7.2 Noise

Noise can be a double hazard. Noise is not only harmful to your hearing but also distracts your attention from moving equipment or other dangers.

7.3 Conveyors and belts

Moving belts transporting aggregates should be a constant concern, as should belts to motors and sprocket and chain drives. All pulleys and belts and drive mechanisms should be covered or otherwise protected.

7.4 Loose Clothing

Loose clothing that can get caught in machinery should never be worn at an asphalt plant. Good housekeeping is essential for plant safety.

7.5 Loose Wires

The plant and yard should be kept free of loose wire or lines, pipes, hoses, or other obstacles.

7.6 High Voltage Lines

High-voltage lines, field connections, and wet ground surfaces are other hazards. Any loose connections, grayed insulation, or improperly grounded equipment should be reported immediately.

7.7 Stockpiles

Plant workers should not work on stockpiles while the plant is in operation. Personnel should **NOT** walk or stand on the stockpiles or on the bunkers over the feeder gate openings. Many workers have been pulled down into the material and buried alive so quickly that nothing could have been done to save them.

7.8 Flames and High Temperatures

Burner flame and high temperatures around plant dryers are obvious hazards. Control valves that can be operated from a safe distance should be installed on all fuel lines. Flame safety devices also should be installed on all fuel lines.

7.9 Smoking

Smoking should not be permitted near asphalt or fuel storage tanks.

7.10 Oil Leaks

Check frequently for leaks in oil heating lines and steam lines or jacketing on the asphalt distribution lines.

7.11 Safety Valves

Be sure safety valves are installed in all steam lines, and they are in working order.

Make use of screens, barrier guards, and shields for protection from steam, hot asphalt, hot surfaces, and similar dangers.

7.12 “Chemical Goggles” and Face Shields

When handling heated asphalt, use chemical goggles and a face shield.

All shirt collars should be worn closed and cuffs buttoned at the wrist.

7.13 Gloves

Gloves with gauntlets that extend up the arm should be worn loosely so that they can be flipped off easily if they become covered with hot asphalt.

7.14 Screen Deck

Exercise extreme care when climbing and working around the screen deck.

All stairs and platforms should have secure handrails.

7.15 Hard Hat Areas

Hard hat areas should be labelled and demarcated. Hard hats should be worn by all personnel.

7.16 Traffic planning

Truck traffic patterns should be planned with both safety and convenience in mind.

Trucks entering the plant to pick up a load of hot mix should not have to cross the path of loaded trucks leaving the plant. If at all possible, trucks should not have to back up.

7.17 “Three Horn Sign”

All operators should know the three horn signals.

8.0 The Dangers of Handling Bitumen Products

The following hazards threaten safety of the tankage and overall safety:

- High temperatures
- Creation of flammable or explosive atmospheres
- Presence of toxic materials

To minimize hazards in tank farms, the tanks should be grouped with sufficient room for access. Bitumen tanks should not be less than 6m away from each other; they should be at least 15m from a boundary and 7.5m from any possible source of ignition.

8.1 High Temperatures

Bitumen is handled at high temperatures. This has a number of ramifications for storage and delivery to and from tankage.

Burns - Contact with bitumen or pipes carrying it at these temperatures can cause serious burns. All piping vessels and equipment should be suitably insulated or lagged to minimize this risk.

Contact With Water - Contact with water at high temperatures causes rapid expansion of the water and foaming of the bitumen. This leads to explosive boil over. Water is lighter than bitumen so water contamination in a tank will move to the top.

Measures that may be used to avoid water entrapment in tankage include the use of only hot oil or electrical heating, use of cone shaped roofs on tanks, and inspection to ensure that the tank roof is water tight.

Water finding gel should be used on cool tanks before they are heated to check for the presence of water. If water is present, the cooled bitumen should be heated through the range 92°C to 125°C at a rate of not more than 10°C to 15°C per hour. Addition of 0.1 percent silicone anti-foaming agent is helpful in preventing foaming and boil over.

Also:

- ensure that pipes are clear of water before using them to pump bitumen into the tank ensure that there is no water in any diluents or additives added to the bitumen

- proper personal protective equipment should be used when working in areas of pipes or vessels carrying high temperature bitumen material. Such equipment should be labelled appropriately

8.2 Creation of Flammable or Explosive Atmospheres

Bitumen normally has flash points greater than 250°C. This means that explosion potential is limited. However, flammable atmospheres may develop in confined storage if:

- contamination occurs due to: light ends, cutter, or fluxes. (This will be more likely in customers' tanks or in Mobile tankage)
- the temperature of the tank is allowed to rise above the flash point
- vapors become trapped in carbonaceous deposits or in insulation areas that are disturbed
- cracked bitumen vapors become trapped and build up over time

8.3 Sources of ignition

These include:

- sparks from electrical equipment
- auto-ignition

Auto-ignition can occur in bitumen fume/air mixtures at temperatures greater than 230°C.

8.4 Formation of Pyrophors

Pyrophor formation occurs when iron and hydrogen sulfide gases evolved from the bitumen at high temperature produce iron sulfide. This sulfide is reduced to sulphur or may react spontaneously with oxygen in the air auto-ignite.

8.5 Overheating due to Coking

The formation of coke insulates temperature sensors and may lead to overheating.

8.6 Static Electricity

Bitumen and products containing bitumen do not build a static charge. However, the bitumen will carry charges during handling from one piece of equipment to another. It is important that equipment such as pumps, tank walls, and pipes are grounded.

Measures that may be taken in tankage to avoid problems are:

- Construct tanks with weakened roof seams to relieve pressure upon explosion.
- Use non-absorbent insulation.
- Ensure accurate temperature measurement.
- Locate filling and load out nozzles near the bottom of the tank.
- Use high flash oil for heating.
- Maintain a nonflammable atmosphere in the vapor space.
- Use open vents.
- Use a tank level control system.

Control pyrophoric deposits and reactions by:
 Avoiding drafts of fresh air in the tank vapor space (this can create a sudden increase in oxidation rates.
 -Avoiding steep changes in temperature at surfaces; do not insulate the roof!
 -Cleaning the inside of the tank at regular intervals to prevent deposits from breaking off and exposing new surfaces; this may cause ignition.

- Clean coke out regularly and avoid buildup by ensuring that overheating does not occur.
 - Restrict access to the tank roof especially during product movements, heating up, periods of high wind, electrical storms, and blending operations, (especially of cutbacks).
 - Inspect all equipment regularly using a work permit system. Ensure that only trained personnel are used.
 - Ensure that insulation is sealed and is not impregnated with product.
 - Fire Prevention and extinguishing techniques are discussed in section 13.3 of this manual

8.7 Toxic Materials Associated with Bitumen Heating

Fumes can occur when bitumen is heated. These contain particulate bitumen, hydrocarbon vapour, and hydrogen sulphide. Of these, the only significant material for safety consideration inside the tanks is hydrogen sulfide (rotten egg gas). Vapour spaces in tanks can build up lethal levels (< 200 parts per million) of this highly toxic gas.

Safe practices and tank entry procedures, include

- use of correct breathing apparatus, always should be followed when entering bitumen tanks.
- good tank design can help minimize buildup of hydrogen sulfide by venting, avoiding dead space, and providing good temperature control.

9.0 Bitumen Plants Piping and Valving

The design, rating, and installation of pipes and valves for use with bitumen must meet the two main criteria of safety and maintenance of quality.

9.1 Safety

Safe operation requires control of temperature and pressure.

9.1.1 Pressure Control

Excess pressure in lines used to move bitumen may be controlled by relief valves set at 10 percent above the design working pressure. Pressure relief valves should also be used on pumps.

Relief valves are used to protect bitumen lines from excess pressure build up during warm up. These valves discharge out of the line. Pressure is relieved into the tank when all the bitumen valves in a circuit being heated are opened.

Incorporation of expansion bellows is desirable to keep the pipes within working limits because pipes expand when heated and contract when cooled.

9.1.2 Temperature Control

Valves and piping circuits should:

- be shielded and labelled appropriately to minimize risk of worker injury not be operated until the working temperature has been reached
- be left open except when closed to divert product

9.2 Quality

The transfer of hot bitumen through a pipeline is limited by the size of the line, the driving pressure, and the viscosity of the product.

Piping should be self draining; that is, it must not hold product. The pipe work should drain to low points where the product can be removed. An incline of not less than 8 percent is required for the lines to be self draining.

9.2.1 Pipe Connections

Piping should be lagged and heated to a temperature approximately that of the product temperature in the bulk storage tank. Heat loss calculations will be required to determine the thickness of insulation and the hot oil flow necessary to maintain the temperature. Lines should be allowed to warm to at least 150°C before use and should not be used for 10 to 20 minutes after this temperature is

achieved. Lines should never be heated with a blow torch to remove slugs of bitumen because this can destroy lagging and create hot spots.

Flanged pipe connections are preferred to screwed or welded types because they allow easier removal of a section of pipe to remove blockages.

9.2.2 Valves

Valves should be jacketed and traced. This will allow preheating before operation. Valves should be placed so that bitumen will drain from them. Gate or globe valves are preferred.

The aim of the above measures is to avoid localized overheating of the bitumen binder that will cause hardening and/or contamination from other parts of the plant. Valves should be 'one way' to avoid blow back of product. Such valves may allow switching, which enables product to be directed to different areas of the plant.

Valves made from cast steel are satisfactory; some remote control of valves by electric or air actuation is desirable. Local manufacturers should be contacted to determine the suitability of valves in their product line. The advice of VSS should be sought before any changes to pipe work.

9.2.3 Bitumen Pumps

Bitumen pumps are specially designed with the following general requirements:

- 9.3 jacketed
- 9.4 positive displacement
- 9.5 electrical motor of 25 to 50 hp, depending on flow rate and pressure
- 9.6 bypass valve for pressure relief

A typical positive displacement pump suitable for bitumen is shown in Figure 8.

Pumps that are to be used for bitumen must be sized for the flow rate requirement and the viscosity of the product to be pumped.

9.2.3.1 Pump Safety

Pumps should be preheated before use and lagged to prevent burns. Pressure relief valves need to be fitted and adjusted to 10 percent above design pressure.

Before being used, pumps should be run against closed circuits and the relief valves should be checked for operation. Do not pump on bypass for more than a few minutes because this places an unnecessary load on motors.

Motors should be sized above the load requirements by 10 percent to 15 percent.

10.0 Loading, Transportation and Discharge of Hot Form Bitumen

It is necessary that extreme caution and care are exercised when handling, transporting and using Bitumen and other petroleum product.

10.1 Vehicle Types

Bitumen is usually transported in bulk form in road tankers, rail tank cars, or ships. Insulated road tankers or trailers may be used. Length of the haul is an important consideration because some tankers are not heated.

Insulated tanks lose about 2°C per hour. Direct fired heating systems using gas or diesel fuels may be used to heat the bitumen and keep it hot in transit. The bitumen should be circulated during this process to avoid local overheating and potential cracking.

Rail tank cars may also be used. These should be equipped with a heating and circulation system.

Specially built ships are used for coastal transport and on inland waterways. These vary in size and configuration. They usually have double skin tankage. The tanks do not come into contact with the outer shell of the ship. Other designs use the bitumen itself at the surface (in a semi-solid state) as insulation. All have a heating system that allows the bitumen to be kept at 140°C to 180°C and to be pumped in circulation and onto and off the ship. Pump ratings are designed to accommodate cargo sizes of 5 tons to 40,000 tons and loading rates or off-loading rates of 175 to 500 tons per hour.

10.2 Loading

Different statutory requirements exist in each country for vehicles and their operation. These should always be checked with the relevant authorities. Load out into road or rail tanks is usually carried out by overhead load out arms or by direct pumping via the discharge valve. Direct pumping via valves is used for ships.

Hoses should be made of reinforced rubber or should be metallic. Gloves should always be worn by operators to prevent skin contact. All other safe loading practices should be followed during trans for operations. Couplings should be screw types or quick-acting types.

10.2.1 Preparation

Make sure that discharge and drain valves are closed and are not plugged with solidified bitumen. The tank must be completely emptied, if it was used for

storing water or water-based products. The tank should then be filled to 25 percent capacity and allowed to soak for an hour. If no frothing has occurred, loading can be completed. Silicone antifoaming agents may be used to contain any frothing problems that occur.

10.2.2 Froth-over during Loading

Operators should keep clear in case of a froth-over. Possible ignition sources should be removed from the loading point. Loading should not be carried out in a confined space. Five percent ullage should be allowed in the loaded vessel. A calibrated dip stick or meter is used to measure the volume of bitumen that has been delivered.

10.3 Discharges on Site Preparation

Bitumen may be discharged to the contractor's tankage by the "Preparation" procedures described above. All tankage has the same basic requirements, but configurations may differ between contractors' sites.

Instead of being delivered into a static storage tank, discharge may be carried out directly into a contractor's tanker or sprayer (distributor). In such cases, the bitumen may need to be reheated to ensure that it is sufficiently hot to achieve the desired application or transfer temperature from the any other vehicle. The appropriate course of action is:

- Locate the tanker in a level position with the emergency brake full on.
- Reheating may be carried out using the direct fired system on the tanker. Before heating, always check that there is sufficient ullage to allow the product to be contained after heating.
- Check the receiving tank for sufficient capacity. Check that there is no water or other contaminant present. Clean the receiving tank if necessary. Make sure that the receiving tank is vented.
- Make sure that the tanks are circulated and vented to air during heating. Do not heat unless the heating tubes are covered by at least 150mm of bitumen.
- Heating at a rate that does not exceed 25°C per hour.
- Make sure that there are no ignition sources nearby. Keep a fire extinguisher ready.
- After switching off the heat, allow 30 minutes for the tank to reach equilibrium.

Evacuate all personnel from the loading site immediately if a dull rumble is heard at any stage. This indicates water in the load and imminent froth over.

10.3.1 Discharging Procedures

Always use hoses of the correct size and with compatible couplings when is charging to a vehicle in the field.

Make sure that manhole covers are shut but unlatched (to allow venting) during discharging operations. Flexible hoses should be operated under suction. The bitumen should be drawn from the delivery vehicle using the pump on the receiving tank.

Ignition sources should be eliminated for safety reasons. Personnel should not be permitted to be on top of the discharge or receiving tanks during the discharge operation.

The bitumen should not be heated during discharge. Care should be taken at all times before discharging commences to ensure that there is sufficient ullage for the delivery. Quantities transferred can be monitored and measured by a meter or by a dip stick.

10.2.2 Cleaning after Bitumen Discharging

Cleaning the pumps and hoses is required after discharge. Kerosene, diesel, or similar cutter is all suitable for this purpose.

Solvents used for cleaning pumps and hoses should not be discharged into bitumen tankage. A separate circuit should be provided for this waste. Providing a waste or reclaim circuit avoids the need to disconnect lines during cleaning.

Turn off air pressure immediately after discharge is completed. Make sure that the pressurized vessel is safely vented down to atmospheric pressure.

Relatch the manholes on the delivery vehicle's tank if pumping has been used. Check that all manhole covers are secured before the vehicle is allowed to leave the site.

10.2.3 Clearance of Blockages

Blockages occur in bitumen distribution and delivery systems despite careful precautions to avoid them. They can be cleared by solvent soaking (filling the line or valve or pump with kerosene or diesel and allowing it to soak).

A direct flame from a butane torch or arc welding machine may be used to clear a blockage:

- where no solvent is present.
- when the system is not under pressure.
- when there is no lagging, and
- when the system is not blocked by solid bitumen.

This procedure should be applied by exception only and with extreme caution. This procedure should not be used on a routine basis. Make sure that there is a fire extinguisher nearby.

11.0 Loading, Transportation And Discharge Of Cold Form Bitumen

In some cases it may be convenient to package bitumen in a solid form. Industrial grades may be packaged in fiber cartons or steel drums; and paving grades may be packaged in steel drums, plastic bags, or bitutainers (small tanks in a standard shipping container frame) for remote areas.

11.1 Container Filling

Filling such containers may be achieved by conventional piping and tankage systems. Specialty filling heads are available for drums and fiber containers.

11.2 Reheating

Reheating at the contractor's site may be carried out in specially designed ovens that control temperature and heating rate to the above limits. This may be uncontrollable in remote areas and may lead to quality problems.

Bitutainers are integrally designed systems that carry their own heating equipment. Heating rates and handling are the same as for the bulk shipment of bitumen.

11.3 Taking Samples

Samples will need to be taken periodically for analysis to ensure that the bitumen meets specifications. Always use a standard method as per local standards. Sampling points on tank walls and in pipelines must be positioned with careful consideration for safety. They should be easily accessible and should not be in cramped areas. They should not be located where evacuation will be difficult in an emergency. All sampling points should be heated and lagged to prevent solidification of bitumen that will cause blockage.

11.3.1 Training and Safety for Hot Bitumen Drawers

Below are best practices to be used in drawing hot bitumen samples:

- All personnel required to draw hot bitumen samples should receive appropriate training before attempting this task.
- Suitable safety clothing and safety goggles should be worn at all times during the operation.
- Sleeves should be worn outside of gloves and trousers should be worn outside of boots to reduce the likelihood of spilled bitumen entering clothing.
- Samples should be drawn into metallic, insulated, sample containers.
- It is very important always to observe all safety practices when drawing, handling, or working with hot bitumen samples.

- In the event of an accident that results in skin contact, **NO ATTEMPT SHOULD BE MADE TO REMOVE THE BITUMEN**. Medical attention should be sought immediately (Refer to section).

11.4 Lighting Burners

When lighting burners, please follow the procedures below:

- Always dip the tank before lighting burners to ensure there is at least 150 mm of product above the tubes or coils.
- Position vehicle to avoid the flow of vapours from the tank vent to the burners. Ensure unit is well away from long grass and other fire risks.
- Remove fire extinguishers and place in a readily accessible position alongside. Ignite burners with proper Lighting.
- Have manhole cover loosened but closed.
- If there is need to add solvent to bitumen ensure that it through a connection in the fixed piping system, not through the manhole.
- After heating, turn off burners and continue circulating for 30 minutes.
- Never leave burner units unattended while heating or pumping.

11.5 Filling Storage tanks, Bulk Bitumen Tankers and Sprayers

It is recommended that:

- Wherever possible these operations should be performed with fixed piping and pump installations.
- Where a flexible hose has to be used to pump in “over the top” without the use of fixed tank fittings, the hose must be securely clamped in position prior to filling.
- Before filling make sure there is no foreign matter, solvent, water or emulsion in the tank which may cause boiling, frothing or overflow.
- All pumping equipment must be clean and clear before to the pump being started.
- Static leads must be attached between the source vessel and the delivery vessel whenever flammable liquids are being pumped.
- Only authorized trained personnel should be involved in loading an unloading storage tanks, bulk bitumen tankers and sprayers

NB: These guidelines should be complimented with Annex 6: General Safety Guidelines for Road construction activities.

12.0 The Safe Delivery of Bitumen Products

Bitumen is delivered hot (up to 230°C) and frequently under pressure. Therefore, exercising extreme caution and correct handling of bitumen to minimize risk of burns is essential.

Cutback bitumen, which contains Kerosene, is stored at a temperature above the flashpoint of Kerosene. It is recommended that:

- Additional care must therefore be taken when handling this product.
- Further advice should be obtained from your bitumen supplier when handling these products(Refer to Annex 2: PPE Guidelines for Drivers Delivering Bitumen).

12.1 Working Site

Proper site planning and layout is essential in ensuring the safety of the work place. There is need to have:

12.1.1 Designated Routes

It is recommended that:

- Clearly designated routes to and from the delivery points should be provided (via road markings, verbal instruction, or site plan) including access to and from Weighbridges for both vehicles and personnel.
- If drivers are required to weigh in and out, a walkway must be provided to enable safe access to and from the vehicle.
- All approach routes should be well lit, particularly during hours of darkness.

12.1.2 Delivery Points

A safe and readily accessible delivery point should be provided & the following areas should be considered:

- In selecting the delivery point, due regard should be paid to nearby haul roads and traffic routes
- The need for vehicle reversing must be kept to a minimum.
- A flat even surface for the vehicle, where the driver can discharge the load in safety and is protected from other traffic movements.
- Unrestricted movement around the vehicle for the driver (2 metres around the vehicle is required).
- No access within 6 metres of the delivery point to pedestrians not involved in delivery operation
- Lighting should be provided to adequately illuminate the entire discharge area.
- An area which is tidy and clear of obstruction.

- No surrounding or adjacent operations which could impair a safe delivery.
- A safe exit route for the driver in the event of an emergency

12.1.3 Emergency Shower and Washroom

An emergency shower must be provided within 20 meters of the discharge point, ensuring clear, safe emergency access, together with signs indicating its position. Advice on the treatment of bitumen burns should be displayed in the delivery area.

12.1.4 Safety Instruction

Instructions for the safe delivery operations should be posted in delivery area.

12.1.5 Receiving Facilities

All receiving facilities, including discharge points, tank gauges, vent pipes, and safety equipment should be regularly cleaned, checked for serviceability and any defects logged and rectified.

12.1.6 Disposal of Hose Drainings

A method should be provided for the collection and disposal of all hose drainings.

12.1.7 Dry Powder Fire Extinguishers Placement

A dry powder fire extinguisher should be provided in close proximity to the delivery flange.

13.0 Bitumen Storage and Associated Pipe work

Below are good practices for Bitumen Storage and pipe work safety:

- Sufficient tank ullage to take the load plus +10% safety margin should be provided.
- Each tank and its associated delivery pipe should be independently and uniquely identified with both the tank number and grade.
- Adequate and reliable means of gauging the tank contents and ullage should be available. Such gauges should clearly identify which tank they refer to, and be visible from the driver's position at the discharge point.
- Serviceability of content gauges should be regularly checked and maintained to the highest standard, and systems documented.
- Wherever possible a duplicate system should be provided in the plant control centre.
- A high level alarm system must be installed. The activation of the alarm system should be independent of the contents gauging system. To avoid product spillage whilst the delivery hose/line is being cleared, the alarms should be set to trigger at the maximum tank content less 10%.
- Alarms should clearly identify which tank they refer to, when activated.
- Contents gauges and high level alarms should be clearly visible and audible to all those responsible for the safe receipt of product. As with content gauges;
- High level alarms should be regularly tested and maintained.
- Vent pipes must be fitted and located where they do not pose a risk to personnel or delivery vehicles and must be kept clear at all times.
- Tank lids must be kept closed at all times during the delivery,. If in the event of a product overflow, there is a danger of bitumen spilling into the discharge area or any other populated areas, action must be taken to provide protection.
- delivery pipe work should be of adequate design, well supported and maintained and fitted with a delivery flange, 15 mm minimum thickness, located 0.5m-1m above ground level.
- Access to the customers delivery flange should be such as to allow for safe and easy connection of the delivery hose.
- Some customer tanks may have fill pipes that go to the bottom of the tank to minimize oxidation. Such fill pipes should be slotted, or fitted with an alternative device, to prevent siphoning.
- Distance between vehicle and the storage tank flanges should not be more than 2.5 meters.

- A flange security system, such as padlocks, should be fitted to maintain control & prevent cross contamination, and possible spillage.
- Each system should be robust, tank specific and fit for purpose.
- Tanks should be fitted with a correctly designed drain valve to enable the safe emptying of the tank for cleaning and maintenance.
- Should there be a requirement to take Product samples; a purpose designed valve should be permanently fitted to the tank or corresponding pipe work.
- Under no circumstances should samples be taken from the delivery vehicle or hoses at the delivery site.
- All access ladders and walkways on tank roofs should be fitted with suitable guards to prevent falls.
- Where bitumen EMULSION tanks are present, it is imperative that all supply, and return pipe work are segregated from the bitumen pipe work system.
- Fill point connections should be of the screw type, to prevent accidental connections.
- Where bitumen tanks are being returned to service, great care must be taken to ensure that the tank is free of water.

13.1 Procedures for Attended Bitumen Deliveries

It is incumbent on the customer to confirm that the grade and quantity being delivered are correct.

The customer's representative is responsible for signing the driver's documentation prior to each delivery to confirm:-

- Connection to the appropriate tank and receiving flange for the delivery
- That there is sufficient ullage to receive the full vehicle load
- Signing the driver's documentation prior to delivery
- That lines and valves are routed to correct tanks

The customer is responsible for the drivers well being whilst on their premises. Their representative must monitor the driver's safety during the discharge process by one of the following methods:

- Visually monitoring e.g. line of sight or CCTV
- Regular checks made during the delivery process as per site specific risk assessment for bitumen delivery.
- Attend the discharge process with the driver. (N.B. When the customer's representative is in the vicinity of the discharge point they must wear appropriate protective clothing.

All unauthorized personnel must be kept away from the area surrounding the delivery hose. Where tanks are situated inside buildings that are poorly ventilated, entry into that building must be restricted to authorized personnel only, and during discharge, activities inside the building must be kept to a minimum. At no time during the delivery should any personnel be on top of the

storage tanks.

Split loads are not recommended and should be avoided. However, if the load is to be delivered into more than one tank, each tank must be treated as a separate delivery point. If the vehicle needs to be moved, the delivery procedure must be repeated in full. This will require the removal of the delivery hose from both vehicle outlet and customer flange. Delivery documents shall be endorsed by the customer accordingly to identify the additional tank(s) and in particular, that ullage and grade checks have been completed prior to delivery.

On completion of delivery, the driver will clear all discharge pipework and disconnect the tanker hose. All hose drainings should be disposed of in the receptacle provided by the customer for this purpose.

On completion of the delivery, it is the customer's representative's responsibility to complete and sign the delivery documents to acknowledge receipt of load and also confirm that the flange security system is re-instated.

The driver is solely responsible for the operation of his vehicle and equipment throughout the discharge procedure and shall remain by the vehicle shut off valve whilst discharge is taking place. The driver shall wear full Personal Protective Equipment at all times during the discharge process as stated in appendix one.

Any deficiency in tanker driver's delivery procedures must be promptly reported to the bitumen supplier who will take corrective action be taken.

13.2 Bitumen Specific Training

All drivers employed in the transportation and delivery of bitumen products receive regular training under the following headings.

- ADR (International Agreement for Dangerous Goods by Road).
- Employer specific driver training programmes.

Customers representatives and delivery drivers should receive training, on the safe handling, storage and receipt of bitumen product. Training requirements should be reviewed regularly.

Training records of all individuals must be kept on file

Most bitumen suppliers will, upon request, offer assistance and advise on bitumen training.

13.3 Guidance for the Treatment of Bitumen Burns

Comprehensive advice, for the treatment of bitumen burns, has outlined in appendix 2

14.0 Bitumen Burns

All persons working with hot bitumen should be familiar with these recommendations in order to administer first aid to burns victims. This document should accompany the patient and be placed in a prominent position before transport to Doctor or Hospital.

No attempt should be made to remove the bitumen at the worksite.

When an accident has occurred the affected area should be cooled as quickly as possible to prevent further damage. The burn should be drenched in water for at least ten minutes for skin and at least 5 minutes for eyes. However, body hypothermia must be avoided.

No attempt should be made to remove the bitumen from the burned area.

14.1 Treatment, First Aid and Medical Care

The bitumen layer will be firmly attached to the skin and removal should not be attempted unless carried out at a medical facility under the supervision of a doctor. The cold bitumen will form a waterproof, sterile layer over the burn which will prevent the burn from drying out. If the bitumen is removed from the wound there is a possibility of complications. Furthermore, by exposing a second degree burn in order to treat it, there is a possibility that an infection or drying out will make the wound deeper.

14.1.1 Second Degree Burns

The bitumen should be left in place and covered with a Tulle dressing containing paraffin or a burn ointment containing paraffin, e.g. Flammazine (silver sulphadiazine). Such treatment will have the effect of softening the bitumen enabling it to be gently removed over a period of days. As a result of the natural re-epithelialisation of the wound any remaining bitumen will peel off in time.

14.1.2 Third Degree Burns

Active removal of the bitumen should be avoided unless primary surgical treatment is being considered due to the location and depth of the wound. In such cases removal of the bitumen is best carried out in the operating theatre between the second and fifth day after the burn occurred. By the second day the capillary circulation has usually recovered and the bed of the wound is such that a specialist can assess the depth to which the burn has penetrated. There are normally no secondary problems such as infections to contend with before the sixth day. However, it is essential to commence treatment using paraffin based substances from the day of the accident to facilitate removal during surgery.

14.1.3 Circumferential Burns

Where hot bitumen completely encircles a limb or other body parts the cooled and hardened bitumen may cause a tourniquet effect. In the event of this occurring the adhering bitumen must be softened and/or split to prevent restriction of blood flow.

14.1.4 Eye Burns

No attempt should be made to remove the bitumen by unqualified personnel. The patient should be referred urgently for specialist medical assessment and treatment.

Considerable effort has been made to ensure the accuracy and reliability of the information contained in this publication. However, Roads Authority can not accept liability for any loss, damage or injury whatsoever resulting from the use of this information.

14.2 Fire Extinguishing

It is important to prepare for fire extinguishing preparing for any unprecedented fire at the working sites. Some fire fighting tools and methods include:

- Make sure that the alarm raised
- Use the nearest dry chemical extinguisher
- Pull the safety pin
- Direct nozzle towards near edge of fire standing about 3 m away.
- Squeeze handle and move in slowly with a rapid sweeping motion of the nozzle, driving the fire towards the far edge until all flames are extinguished.
- If the fire appears to be out, shut off the extinguisher and wait until the powder clears and if any flame appears, use extinguisher again.
- Whenever possible, tackle fire from upwind direction.

15.0 Materials Laboratories

Types of hazards associated with Materials labs are mainly due to the nature of the chemicals involved and thus there is significant risk of explosion, fire and exposure due to poor handling, disposal, and mixing of incompatible chemicals leads to significant hazardous conditions. Once these chemicals are mixed and used in the making or “cooking” process, the production of other potentially harmful chemicals ensue.

15.1 Health effects related to exposure

Working in material testing laboratories poses significant dangers that one must be aware of or serious health effects could develop including the most extreme case of death. Knowledge of basic toxicology is crucial. The effect of a chemical can differ significantly depending on how it enters the body.

15.1.1 Body Entry Routes

Entry routes include inhalation, dermal absorption, and ingestion. Inhalation is the most common route of entry since we are continuously breathing. Noxious chemicals that are breathed in can rapidly enter the circulatory system (blood) and get transported throughout the body. Since we are performing manual labor during abatement of the lab our respiratory rate is higher leading to greater exposure.

Inhalation exposure also depends on the size of the inhaled particles and the properties of the exposed chemical. Chemicals with higher solubilities tend to get absorbed into the blood system faster. Toxins can also be absorbed through the skin. Although one may not feel pain or discomfort when the chemical contacts the skin, once it is absorbed it can travel throughout the body in the blood. Ingestion is the least likely exposure method but workers should be wary of eating and drinking within the confines of the lab.

15.1.2 Solvents

Solvents such as acetone, ether, Freon, hexane, methanol, and toluene target the eyes, skin, respiratory system, central nervous system, liver, and kidneys causing such symptoms as irritation to skin, eyes, nose and throat; headache; dizziness; central nervous system depressant/depression; nausea; vomiting; and visual disturbance.

15.1.3 Corrosive Substances

Corrosive chemicals such as anhydrous ammonia, hydrochloric acid, sodium hydroxide (lye), sodium thiosulfate, sulfuric acid (drain cleaner) target the eyes,

skin, and respiratory tract causing symptoms such as irritation to upper respiratory tract; cough; eye and skin irritation, inflammation and burns; gastrointestinal disturbances; thirst; chest tightness; dyspnea; muscle pain; syncope; and convulsions.

15.1.4 Hazardous Compounds

Metals such as iodine, lithium metal, red phosphorus, yellow phosphorus, sodium metal used in the process can target the eyes, skin, respiratory system, central nervous system, liver, kidneys, blood, cardiovascular system causing irritation to eyes, skin, nose and respiratory tract; lacrimation; headache; chest tightness; cutaneous hypersensitivity; abdominal pain; and jaundice.

15.2 Abatement & Hazardous Materials Handling Guidelines

Only trained personnel should be handling any chemicals. These individuals must be able to recognize chemical names and understand the effect of chemical combinations. Separating any incompatible chemicals can reduce the risk of explosion.

15.2.1 Ventilation

Ventilate all confined spaces thereby limiting the concentration of explosive fumes and turn off any heat sources. Make sure all the lab equipment is turned off and no longer heating the chemicals.

15.2.2 Cleaning

During cleanup and removal of contaminated materials, workers should have personal protection equipment. This includes eye, hand, and foot coverings. Disposable gloves and a jumpsuit are good precautions for direct contact exposure but if toxic fumes are suspected then a suitable breathing apparatus is needed.

There are no official regulations that dictate how lab needs to be cleaned up but the general steps involved are:

15.3 Airing out the Building

This will help dissipate any noxious fumes that have accumulated inside allowing safer conditions for removal crews. Depending on the particular situation this may include several days of airing out before, during, and after the remediation process. Using exhaust fans will help the process.

15.2.2 Removal and disposal of Hazardous Chemicals

Lab operators are not the cleanest or most meticulous people on the planet. Chemicals will be splashed, dripped, and spilled haphazardly around the lab. Any

items that are visibly contaminated should be double-bagged and removed. Many of the chemicals will be designated as hazardous materials and need to be disposed of properly.

15.2.3 Inspect surfaces

Walls, counters, floors and ceilings can retain some of the hazardous chemicals. Any surface that has visible contamination, stains, or gives off odors should be completely removed.

15.2.4 Inspect plumbing pipes

Most of the waste and chemicals are disposed of crudely down the household plumbing system (sinks, toilets, and drains) by the lab operators. The plumbing system may be collecting some of these chemicals and off gassing. A professional plumbing contractor should be contacted to properly address the problem.

15.2.5 Clean HVAC system.

Chemicals and residues can collect in the HVAC system so they should be properly cleaned. This would include cleaning the ductwork, vents and air returns, and changing air filters.

15.3 Procedural things to be avoided

Laboratory accidents can have serious results for both personnel and property. Do not let familiarity breed complacency when handling dangerous substances. By following these few rules, much of the danger will be taken from laboratory work.

- Experiments with chemicals should be forbidden unless specifically authorized.
- Never leave an operation unattended. If you must leave, see that someone is present to supervise the operation while you are away
- The person left in charge must be adequately instructed as to the potential dangers and corrective action to be taken.
- Whenever there is any possibility of an operation getting out of control, warn everybody in the vicinity.
- Keep all baffles and containers labeled with the correct contents.
- Watch the ventilation by keeping hazardous gases and vapours confined to the fume hoods.
- Before placing materials in waste containers or dumping their contents, check the container markings.
- Always protect the hands when inserting glass tubes into stoppers, etc. Never use force in this operation.
- Use appropriate protective clothing (e.g. tongs, gloves, goggles) when handling dangerous chemicals.

- Do not use laboratory containers for food storage.
- Do not eat food or smoke in close proximity to chemicals.
- Ensure flammable solvents are safely stored.

References

Code of Practice for Delivery of Bitumen Products May 2006
Environmental and Social Management Guidelines for the Malawi Road Sector
Vieria; A. 2007 Surface Drilling and Blasting Mota Engil Malawi.
OHS website

Annex 1: SAFETY EQUIPMENT AT ROAD CONSTRUCTION WORK AND BRIDGE SITES

Personnel Protective Equipment (P.P.E) must be worn where risks or hazards have been identified. Personal protective equipment should be provided to further protect workers from accidents with chemicals, hot bitumen and other harmful agents (e.g. noise, dust. etc.)

PROTECTIVE CLOTHING

Cotton drill overalls or long trousers and long sleeved shirts should be provided and must be worn for all activities involving the handling of hot bitumen products including asphalt.

FOOTWEAR

Protective safety footwear should be issued for use. Under no circumstances shall sandals, thongs or canvas shoes be permitted.

GLOVES

Thick soft leather or heavy duty P.V.C. gloves must be worn when handling hoses, valves, hatches, dips and the like.

EYE AND HEAD PROTECTION

When filling or discharging hot bitumen into sprayers, bulkers or tanks, full face eye shields and safety helmets must be worn. When working with grinders or drills, safety goggles or safety spectacles are required. When welding, use correct eye protection provided.

HOODS

Are to be worn when handling Hot Bitumen,

RESPIRATORY PROTECTION

Disposable or cartridge respirators should always be worn in dusty conditions. Where fumes are present ask your supervisor for the correct respiratory protection.

EAR PROTECTION

Ear protection will be provided and should be worn when using or working close to noisy equipment. Your supervisor will advise you when this is necessary.

CONTAMINATED CLOTHING

Don't wear clothing contaminated with chemicals, distillate, kerosene, petrol, etc.

NB. Refer to Annexes 1, & 2 for PPE guidelines for Drivers and Workers handling Bitumen and other petroleum products.

Annex 2: PPE Guidelines for Bitumen Delivery Drivers

The purpose of the PPE guideline is to establish the PPE minimum requirement:

Driver personal protective equipment (PPE):

• Working Boots

- a. All boots manufactured to BS EN345
 - b. 200 Joule toe cap protection
 - c. Antislip & antistatic soles
 - d. Heat resistant up to 250 degrees Celsius
 - e. Water, oils, chemical and solvent resistant
- * Rigger Boots with ankle support of the above standard are recommended for bitumen discharge operations

• Coveralls/Boiler suits

- a. Proban treated/flame retardant conforming to BS EN470-1 and EN531AB1C1
- b. Washable
- c. Hi-Vis or normal colour

• Gloves/Gauntlet

- a. Protection against Mechanical and Chemical hazard category II
- b. Approved to BS EN420 and EN388
- c. Forearm protection

• Head protection

- a. Hard hat approved to BS EN397.
- b. Full face visor with chin guard approved to BS EN166

c. Neck apron

- d. Ear defenders approved to BS EN352-2
- e. Eye protection approved to BS EN166-1F

• Hi-Vis

- a. Waistcoat – 2 Band and braces approved to BS EN471 Class 3
- b. Overcoat – 2 Band and braces approved to BS EN471 Class 3

• Driver Uniform

- a. Trousers
- b. Shirts
- c. Jacket

Annex 3: Vehicles fitting with CCTV Cameras and other reversing aids

| Machine Type | Reversing and visual aids required |
|--|---|
| Off-road Dump Trucks (Trailer to Rear of Driver) Payload greater than 7 Tonnes | Reversing Alarm and Flashing Beacon with CCTV or Convex Mirrors or a combination of both to allow vision from the driver's seat of all points more than 1 meter high and 1 meter from the machine at each side and at rear of driver. |
| Dumpers (front tip) No Cab | Reversing Alarm and Flashing Beacon |
| Dumpers (front tip) with Cab | Convex Mirrors; Reversing Alarm and Flashing Beacon |
| Wheel Loaders (Loading and shovels), including Skid Steer Loaders. | Reversing Alarm and Flashing Beacon with CCTV or Convex Mirrors or a combination of both to allow vision from the driver's seat of all points more than 1 meter high and 1 meter from the machine at each side and at rear of driver. |
| Backhoe Loaders All 360 ^o excavators | Convex Mirrors, Reversing Alarm and Flashing Beacon Movement Alarm and Flashing Beacon with CCTV or Convex Mirrors or a combination of both to allow vision from the driver's seat (without slewing) at all points more than 1 meter high and 1 meter from the machine. |
| Scrapers | Reversing Alarm, Flashing Beacon and CCTV or Convex Mirrors or a combination of both to allow vision from the driver's seat of all points more than 1 meter high and 1 meter from the machine at each side and at rear of driver. |
| All Tracked Type (Bulldozers) | Tractors Reversing Alarm and Flashing Beacon with CCTV or Convex Mirrors or a combination of both to allow vision at all points more than 1 meter high and 1 meter from the machine at each side and at rear of driver. |
| Graders | CCTV, Convex Mirrors, Reversing Alarm and Flashing Beacon |
| Telescopic handlers | Reversing Alarm and Flashing Beacon with CCTV or Convex Mirrors or a combination of both to allow vision from the driver's seat of all points more than 1 meter high and 1 meter from the machine at each side and at rear of driver. |
| Compactors/Rollers Cab and seat to rear | without Reversing Alarm and Flashing Beacon |

| | |
|--------------------------------------|--|
| Compactors/Rollers with seat to rear | Convex Mirrors, Reversing Alarm and Flashing Beacon |
| All Compactors/Rollers | Reversing Alarm and Flashing Beacon with CCTV or Convex Mirrors or a combination of both to allow vision at all points more than 1 meter high and 1 meter from the machine at each side and at rear of driver. |
| Road Planer | Convex Mirrors, Reversing Alarm and Flashing Beacon |
| Road Pavers | Convex Mirrors, Reversing Alarm and Flashing Beacon |

Annex 4: Minimum requirement during Bitumen loading and discharging operations:

- Uniform
- Boiler suit/coverall
- Safety Boots (boiler suit/coverall over top of boots)
- Hard hat, full face visor, chin - guard, Eye protection and Neck apron.
- Waistcoat or overcoat
- Gauntlets

As a standard the vehicle must also carry the following equipment:

- First aid kit
- Eyewash bottle
- Fire extinguishers

Annex 5: Bitumen Delivery Vehicle Equipment and Legal Requirements.

- Ground operation for all valve equipment.
- Handrails/brake interlocks.
- Emergency Secondary Safety Valve -with minimum 2- emergency shut down valves at different locations on tank trailer.
- Reverse Camera/Sensors
- Reverse Noise Warning bleeper
- Eye wash bottle

Legislative Requirements

- Fire Extinguishers
- Wheel Chocks/ Traffic cones or Warning Triangles.
- Brush/Shovel/ Spill kit
- Marking /Labelling

Annex 6: General Safety Guidelines

- Report all injuries and accidents to your Supervisor.
- Wear the correct clothing, footwear and protective equipment supplied for the job.
- Keep all work areas clean and tidy.
- Clean up spills immediately.
- Report the use of any fire extinguisher to your Supervisor.
- Make sure extinguishers are in place especially on sprayers or bulk tankers.
- Observe NO SMOKING rules.
- Report any unusual conditions or hazards immediately.
- Non Prescription drugs, or intoxicated persons, and personnel under the influence of drugs are not permitted on Company premises, in vehicles or on any job sites. The Company may request personnel to attend the Company Physician for treatment/testing.
- Don't jump from vehicles or equipment, always use ladders and steps provided.
- Don't attempt any heavy or awkward lifts before sizing up the load. Get help if necessary. Position feet, keep the load close to the body and let leg muscles do the lift.
- Catwalks, ladders and stairs must be clear of hoses, ropes, tools and other obstructions. When using ladders keep your hands free to grip the rungs. When using stairs keep one hand free for the handrail. Portable ladders should be secured at the top so they cannot slip.
- All machines must be stopped locked out and a "do not" operating tag placed on the machine before any work, repair or cleaning is done which involves access to moving parts. Power must be isolated before guards or panels are removed. Do not attempt any of this work on machinery or equipment unless first notifying your Supervisor.

- No-one shall attempt to correct electrical faults other than a qualified electrician.
- Personnel moving in and around the plant MUST NOT RUN.
- Riding or standing on vehicles where proper seating, platforms and handrails are not provided for that purpose is STRICTLY PROHIBITED.
- If a vehicle tyre has to be changed on the road, position the vehicle to avoid traffic dangers and never rely on the vehicle jack alone. Level and firm ground is essential.
- Employees will only be permitted to work alone in isolated environments when a properly constituted back-up and regular call-in check procedure is provided in the event of emergency.