GUJARAT NRE MINERALS LIMITED
A.B.N. 28 111 244 896
NRE No 1 Colliery

FLUID POWER SYSTEMS SAFETY MANAGEMENT PLAN MSMP 033

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CONTENTS

1 INTRODUCTION

There has been a general increase in fluid injection injuries from the use of pressurised fluid power systems used as an energy source on equipment operating in mines. The effect on personnel can range from minor injuries such as lacerations through to more serious injuries requiring amputations or even in some cases death. Pressurised fluid power systems can become a major hazard if not effectively managed and controlled to maintain a safe operating system. This Gujarat NRE Minerals Ltd (NRE) standard aligns with the *Department of Primary Industries (NSW),* recognised MDG41 - A Guideline for Fluid Power System Safety at Mines.

Pressurised fluid power systems present a range of unique safety hazards, including the potential for:

- An uncontrolled release of high pressure fluid escaping to atmosphere at a high velocity causing a fluid injection, or
- Uncontrolled hose whipping causing physical injuries.

This Standard (MSMP) describes the process to be employed, the standards to be referenced and the issues to be addressed for the management of fluid power systems at NRE operations. It is also a component of the Mine Safety Management System, and in particular Mechanical Engineering Management Plan (MSMP 013) and should be read in association with other applicable mine safety system components.

The effective implementation of this NRE standard requires designers, manufacturers, suppliers of plant, NRE and Contractor personnel to be aware of these requirements and Sites need to have systems and procedures in place to apply them.

2 PURPOSE

The purpose of this Standard is to promote a consistent and structured approach to the management of Fluid Power Systems across NRE and to set the framework for formulating a management system approach that mitigates the risks associated with fluid power systems. NRE recognises that it is essential to effectively manage and control fluid power energy, particularly when the various fluid power energy sources require effective isolation and pressure dissipation to enable them to be worked on safely.

The aim of this Standard is to promote:

- protection for all personnel on NRE sites from uncontrolled releases of high pressure fluid and therefore mitigate the potential for injury and illness.
- a hazard awareness including the dangers of high-pressure hydraulics and fluid injection.
- a comprehensive Hydraulic Management Plan to manage the risks associated with high-pressure fluids.
- making all plant and equipment safe to work on by using an effective policy detailing a process to positively isolate the fluid power system and or parts of a system by lockable means and the ability to decay residual pressure safely.
- an effective hydraulic hose and adaptor management system by implementing a predictive maintenance strategy for determining hose replacements, including monitoring of failures and damage. This includes clear identification (e.g. colours, labels and signs) of hydraulic fluid lines from high-pressure through to low-pressure including valving.

- the use of hydraulic hoses and adaptors with an appropriate factor of safety, fatigue life, resistance to damage and corrosion and to understand the level of risk of proximity to persons relevant to their installation location.
- the use of anti-whip constraining devices and guarding for those hoses and adaptors most vulnerable to becoming disconnected or damaged. This will ensure all personnel working around high-risk hydraulic systems are effectively protected by guards or other such devices that will diffuse the release of hydraulic energy and provide equivalent levels of safety.
- compliance with relevant legislative requirements and in accordance with relevant Australian or International Standards, or in their absence recognised engineering principles.
- prescribe effective lifecycle management of fluid power systems including design, installation, commissioning, operation, maintenance, repair and decommissioning.

3 SCOPE

This Standard applies to surface and underground mining equipment such as mobile plant, roadway development equipment, Longwalls, fixed plant installations and compressed air systems, where there is a risk of a high pressure injection injury from sources such as the following:

- hydraulic fluids including mineral oil or soluble oil from hydraulic circuits or components
- compressed air from pneumatic circuits or components and mine reticulation systems
- grease from pressurised greasing circuits
- water from mine reticulation systems

This Standard is applicable to NRE employees and all persons, such as contractors and visitors, who are present on NRE sites, including all NRE subsidiary companies and all NRE managed sites ï hereafter referred to simply as NRE.

4 REFERENCES AND ASSOCIATED DOCUMENTS

This plan has been developed with a view to reduce the likelihood of incident and injury through reference to the following documentation;

- NSW OHS Act 2000
- NSW OHS Regulations 2001
- NSW Coal Mine Health and Safety Act 2002
- NSW Coal Mine Health and Safety Regulation 2006

Australian Standards

- AS1318 - Industrial Safety Colour Code
- AS1319 - Safety Signs for the Occupational Environment
- AS1345 - Identifications of the contents of Pipes, Conduit and Ducts
- AS2660 - Hose and Hose Assemblies ï Air / Water ï For an Underground Coal Mine
- AS2671 - Hydraulic Fluid Power - General Requirements for Systems
- AS2788 - Pneumatic Fluid Power - General Requirements for Systems
- AS3791 - Hydraulic Hose

- AS3947 - Control circuit devices and switching elementsï Electrical emergency stop device with mechanical latching function
- AS4041 ï Pressure Piping
- AS4801 - Occupational Health and Safety Management Systems
- AS3788 ï Pressure Equipment ï In Service Inspection

DIN Standards:

- DIN EN 20043 - Staple-lock couplings for hydraulic power transmission circuits

SAE Standards:

- SAE J1467 ï Clip (Staple Lock) Fastener Fitting

ISO Standards:

- ISO 1000 - SI units and recommendations for the use of their multiples and of certain other units.
- ISO 1219-1 - Fluid power systems and components ï Graphic symbols and circuit diagrams ï Part 1: Graphic symbols
- ISO 5598 - Fluid power systems and components ï Vocabulary.
- ISO 6805 - Rubber hoses and hose assemblies for underground mining - Wire-reinforced hydraulic types for coal mining
- ISO 6605 - Hydraulic fluid power - Hoses and hose assemblies - Test methods
- ISO 8778 - Pneumatic fluid power

5 DEFINITIONS AND ABBREVIATIONS

For the purpose of this Standard, the following abbreviations and definitions apply.

AS: Australian Standards
AS/NZS: Australian / New Zealand Standard
DIN: German Standard
FRAS: Fire Resistant and Antistatic
ISO: International Organisation for Standardisation
JSEA: Job Safety Environmental Analysis
MPa: Mega-Pascal (SI unit of pressure measurement)
MSDS: Material Safety Data Sheet
SHRECQ: Non Conformance Report
PPE: Personal Protection Equipment
SAE: USA based Society of Automotive Engineers
SI: System International
SWP: Safe Working Procedure
MDR: Mines Design Registration
MIR: Mines Item Registration

High Risk Area

Any area where fluid power pressure exceeds 5MPa (50 bar) or the temperature of the pressurised fluid exceeds 60°C and where a hose, fitting, adaptor or connection could break, burst or fail and expose people in the vicinity of the area to the pressurised and/or hot fluid creating a risk to health and safety (as per MDG41)

Hose Assembly

A hose with its hose ends securely attached ready for use.

Hose End

The hose coupling or hose fitting that is securely attached to each end of a single piece of hose.

Hose Service Life

Is the effective lifespan of the hose meeting system requirements without requiring replacement.

Factor of Safety (FOS)

The Factor of Safety (FOS) is used to provide a design margin over the theoretical design capacity to allow for any uncertainty in the design and/or in the manufacturing process and/or that provides an appropriate engineering margin of safety based on historical experience and usually codified in Standards. The simplest interpretation of the Factor of Safety is FOS = Strength of Component / Design Load on component.

Fit for Purpose

An item is Fit for Purpose if it meets adequate engineering standards for the intended outcome over the equipmentôs lifecycle.

Fluid Injection

Fine streams of escaping pressurised fluid, which penetrate the skin and enter the human body. Despite their often benign initial appearance, high-pressure injection injuries can be associated with severe necrosis (i.e. severe tissue damage), that may result in limb amputation and can even cause death.

Fluid Power Systems

Includes pressurised hydraulic and pneumatic compressed air systems for the transmission and control of energy. These include, but are not limited to; fluid power mineral and emulsion oil based hydraulic systems, oil and grease lubrication systems; compressed air, diesel fuel and water systems.

Minimum Bend Radius

The minimum bend radius of a hose as defined by the hose manufacturerôs specifications.

Pressure Intensification

The usually unintended amplification of fluid pressure within a system or component in excess of its designed working pressure rating creating potentially hazardous consequences for persons and plant. That is, since pressure equals force divided by area, then when the rod side (annulus) of a cylinder has its port blocked and a force is developed by pressurised fluid on the piston side, then the pressure will intensify on the rod annulus side due to the difference in and proportional to the cross-sectional surface area that often leads to catastrophic failure.

Safe Work Procedure

A safe work procedure provides the information necessary to assist all personnel to perform tasks safely. These procedures assist in identifying the hazards associated with the tasks to be performed, as they provide the rules and steps necessary to ensure that personnel can perform their work in a safe manner.

Whipping Hose

A whipping hose is caused when a pressurised hose assembly blows apart and at high speed the loose hose flails or whips with great force.

Pressure Vessels

All vessels that are used with NRE Mines will be supplied with MDR documentation. All vessels that fall within hazard level ñAò ñBòor ñCòshall be MIR.

6 ACCOUNTABILITY AND RESPONSIBILITY

All persons at the Mine have a responsibility to comply with the requirements of this plan and identify and communicate to the Manager of Mining Engineering or senior mining staff any identified deficiencies as they arise. Specific individual responsibilities identified per staff or employee level have been identified, although these are not intended to be exhaustive.

All personnel, including management, staff, employees, contractors and visitors have a responsibility to report any occurrence, issue and/or event that may threaten the health and safety of any person under the NSW Occupational Health and Safety Act 2000 and the associated regulations.

Manager of Mining Engineering

- Ensuring that the Plan is developed, implemented, maintained and effective in ensuring the safety of personnel.
- Assist in establishing standards relating to Fluid Power Systems, and ensuring training is undertaken as well as assigning responsibility for maintaining resources
- Responsible statutorily for Fluid Power Systems on site and their operation, communicating responsibilities under this plan as well as ensuring the administrative responsibilities are undertaken under for this Plan
- Initiating triennial internal reviews, audits related to this MSMP and any SWPôs related to this management Plan
- Ensuring operational risk assessments are undertaken to determine hazards and apply effective controls to provide safe operation of the proposed machinery.
- Appoint Fluid Power Systems operators as required.

Undermanagers

- Provide support in daily administration of this Plan and associated Safe Work Procedures and gather Plan performance data
- Aid in conducting triennial internal Plan reviews and recommend changes to the Plan
- Participate in review of machine specification with respect to operational considerations
- Review/identify any safe modifications necessary for Fluid Power Systems to meet operational expectations

- Facilitate release of personnel to undertake training in operation of Fluid Power Systems and assist in the development of revised SWPôs relating to use of Fluid Power Systems where required.
- Confirm proposed operational procedures are appropriate and isolation procedures are understood by personnel in a working environment required to work around Fluid Power Systems
- Ensure Fluid Power Systems are only operated by trained, accredited and appointed RC machine operators
- Undertake spot audits to confirm level of compliance with approved Fluid Power Systems operating procedures
- Review operational and maintenance procedures to confirm operators are not exposed to hazards of Fluid Power Systems, and where exposures are confirmed, cause the machine to be isolated and reported.
- Ensure approved Fluid Power Systems SWPôs are implemented and complied with.

Manager of Mechanical Engineering

- The Manager of Mechanical Engineering must ensure that the equipment with a Fluid Power System within can be operated safely (mechanically at the mine, this may include an assessment at the pre purchase or design stage as well as commissioning, operation and maintenance).
- Review use of ñPower Fillò and ñPower Greaseò facilities so that personnel operating these facilities are not required to be in a ñNo Goò zone established under this or any other associated procedures.
- Maintain high standards on Fluid Power System as per OEM specifications.
- Check proposed machine design and fluid power control configurations for potential hazards to maintenance personnel required to service the machine.
- Check that safety systems prevent unintended movement of multiple functions from single function.
- Schedule training program for personnel for servicing of Fluid Power System components
- Assist in the development of a pre-start checklist and its use during commissioning and after each modification, repair or maintenance procedure.
- Develop SWPôs for mechanical maintenance activities and review of isolation procedures
- Assist in the auditing of personnel in compliance with Fluid Power System procedures

OHS Advisor

- Assist in documenting, numbering and filing risk assessment findings.
- Assist in determining safe working practices by risk assessment.
- Establish reporting procedure for abnormal operation or movement of machine.
- Assist in the establishment, review, auditing and feedback procedures for Fluid Power Systems.
- Assist in the development of operational procedures based on risk assessment, to address normal operation and recovery of machine under abnormal or breakdown conditions.

- Review operational and maintenance procedures to confirm employees will not be exposed to hazards and inadvertent movement of machine.

Responsible Engineering Manager

- Ensure that the Purchase Contract addresses, full mine site specifications and the delivery of full approval documentation to NRE.
- Ensure all machine training aids are presented with the machine including operator instruction, manuals, pre operational checks and adjustments are received and passed to the Training Officer so as the appropriate training packages(s) can be developed.
- Information is available regarding unloading requirements and arrangements, Surface commissioning, Installation and fit-up underground and initial production commissioning. In the commissioning phase of introducing Fluid Power Systems into operation at the mine.
- The responsible purchasing manager must ensure that the equipment meets the original specification and co-ordinate the mine induction of equipment supplier representatives that may be required to work at the mine during surface unloading and commissioning.
- In the procurement stage of sourcing Fluid Power System into the mine and/or operations at the mine, all endeavours must be made to ensure that the equipment and the controls comply with the requirements of any Australian or applicable standard.

Training Officer

- Determining availability of accredited trainers, assessors and suitable training programs for the particular Fluid Power System proposed
- Develop training modules for operation of and around machinery that utilise any Fluid Power System.
- Liaising with Responsible Purchasing Manager and equipment Supplier to specify training modules, training material and equipment manuals to be supplied as part of the purchase contract
- Schedule trainers to conduct training sessions where required and Co-ordinate practical training and refreshers of trained and trainee operators and recommend trained operators to Manager of Mining Engineering for appointment as competent operators, Issue and file appointments granted
- Develop and implement maintenance procedures in consultation with the appropriate engineering departments for each item of remote controlled equipment.

Tradesmen

- Maintain equipment to the standards set out in this document.
- Ensure they only interact with Fluid Power Systems for which they have received appropriate training.
- Ensure correct isolation and dissipation procedures are observed when working on Fluid Power Systems.

7 RISK MANAGEMENT

Risk management relates to the effective control of workplace hazards, This section identifies hazards associated with the operation, maintenance and repair of a Fluid Power System and the process to follow to eliminate or establish controls to minimise the risk.

7.1 Identification of Hazards

Specific hazards associated with a fluid power system that may lead to personal injury and or property damage may include but not be limited to:

1. Uncontrolled release of pressurised fluid resulting in:
    - Fluid injection
    - Burns from conveyed fluid
    - Fires being fuelled
    - Ignition or explosion
2. Harmful exposure to hazardous fluids resulting in:
    - Exposure to toxic vapours
    - Exposure to hazardous substances
    - Chemical burns
    - Disease e.g. skin irritation/contact dermatitis (refer to fluid MSDS)
3. Catastrophic failure of a pressurised system resulting in:
    - Persons being struck by projectiles (flying material)
    - Fluid injection
    - Whipping hoses
    - Unexpected mechanical movement (e.g. actuator, motor, pump, steering, and brakes)
4. Pressure intensification resulting in:
    - Fluid injection
    - Catastrophic failure
5. Excessive noise exposure resulting in Hearing loss
6. Excessive temperature exposure, either by direct exposure to operating oil temperature or excessive surface temperatures
7. Electrical conductivity resulting in:
    - Static electric discharge initiating a fire or explosion of the environment
    - Electric shock
8. Uncontrolled mechanical movement from:
    - Fluid power control system failure
    - Catastrophic failure

This is not an exhaustive list and there may be other hazards present in a Fluid Power System.

7.2 Risk Assessment

It shall be listed in the Technical Specification for the scope of supply for any Fluid Power System that the manufacturer must complete a design risk assessment to identify all risks associated with the operation, maintenance and repairs of their supplied system. The manufacturer will then implement the appropriate risk controls into the Fluid Power System and provide a copy to the nominated NRE Contract representative prior to the equipment being brought onto the site.

This design risk assessment shall be kept on file and reassessed at the site by completing a ógap analysisô risk assessment for any future variations in design, use, conditions or environment that may change the risk profile.

This design risk assessment shall be used to form the basis of an operational risk assessment. An operational risk assessment shall be carried out on the use of all medium to large fluid power systems (e.g. Longwall).

This operational risk assessment should include:

1. Identifying the risks to health and safety of people in the vicinity of fluid power systems
2. Identifying the risks to health and safety of people operating, maintaining and repairing the fluid power systems
3. Identifying all high risk areas
4. Controlling the identified risks to an acceptable level
5. Determining additional safeguards that may be required for specific circumstances
6. Determining the maintenance inspection frequency and requirements to ensure the fluid power system is always safe to use
7. Developing Safe Work Procedures based on the outcomes of the Risk Assessment

7.3 Safe Work Procedures

Safe work procedures (SWP) should be available for routine maintenance activities such as isolation, commissioning, component testing and change-out, inspections. A SWP should also be available for all non routine maintenance activities and the replacement of any item that may cause a significant risk if removed or installed incorrectly.

A SWP should be developed and implemented in accordance with:

1. The manufacturerôs recommendations
2. Consultation with relevant site personnel

These SWPôs should include and identify such hazards as:

1. Never feeling for leaks
2. Never venting hydraulic fluid to atmosphere unless the release is controlled
3. Never disconnecting any fluid line where it has not been confirmed that all residual pressure has been fully decayed (including due care with load-locked cylinders)
4. Never working on a Fluid Power System without positive Locking and Tagging of every energy source
5. Using only plastic caps on cylinder ports to mitigate the potential for intensification
6. Never disconnecting a cylinder before supporting the load.

7.4 Fluid Injection Emergency Preparedness (High Pressure Injection)

Emergency preparedness is an essential part of working with fluid power systems and requires the development of an action plan for managing every suspected Fluid Injection injury including specific First Aid requirements. Refer to MSMP 029 High Pressure Injection Management Plan for detail on response.

NOTE: *Do not delay or treat a potential Fluid Injection as a simple laceration, specialist treatment is urgently required. Immediate recognition of the injury is crucial to successful management. The seemingly and deceptively innocuous presentation of this type of injury has often led to a lack of appreciation of its grave significance.*

7.5 Energy Isolation and Dissipation

Procedures shall be supplied by the Fluid Power System manufacturer and maintained by the relevant NRE site for the safe energy isolation and dissipation of all fluid power systems. A person shall not carry out repairs to a Fluid Power System unless the energy source is isolated and residual pressure has been dissipated to ensure the system cannot be reenergised inadvertently.

The fluid power system must be able to be positively isolated and locked from the energy source and enable the safe dissipation of the pressurised fluid to prevent unexpected movement or an uncontrolled release of fluid when maintenance activities are being carried out.

The system of energy isolation and pressure dissipation adopted shall incorporate:

1. All Isolation points shall be capable of being locked in the isolated position
2. All Isolation points shall be clearly visible and their status should be apparent(i.e. open or closed)
3. There must be a method available to confirm the pressurised energy has been dissipated
4. Lockout, Isolation and dissipation shall be undertaken as per MSMP 011 Isolation of Energy Management Plan.

8 DESIGN AND OPERATING REQUIREMENTS

8.1 Factor of Safety (FOS)

- All hose assemblies shall have a ***minimum*** factor of safety of 4:1, based on rated working pressure to burst pressure.
- All adaptor fittings shall also have a ***minimum*** factor of safety of 4:1, based on rated working pressure to failure of the component to perform its function.
- All other components shall have a ***minimum*** factor of safety of at least 2.5:1 based on rated working pressure to bursting pressure, unless otherwise stated within this document.

8.2 Excessive System Pressures

A means or device must be provided to protect the circuit against excessive system pressures (e.g. relief valve). This relief valve needs to limit the pressure in the system to a maximum prescribed rate and must prevent excessive system pressures developing.

The device should be:

1. Adequately supported and mechanically protected from damage in high wear or impact areas

2. Positioned for easy access for maintenance purposes
3. Labelled with such description and pressure setting
4. Positioned or guarded in such a way as to reduce the ingress of dirt, coal dust and vermin from the working environment
5. If pressurised fluid has to vent to atmosphere, the pressurised fluid being released from such a device must be diffused, or the vent port positioned or protected by guarding so as to prevent injury to people in the vicinity of the fluid being released.
6. Tamper Resistant Protection. Where a hazard or damage may result from operating pressures being exceeded then where possible a tamper-resistant (e.g. internal positive stop, non-adjustable, wire lock etc.) overpressure protection shall be provided.

8.3 Machine Stops

All Machine stops shall be provided at a suitably located workstation for each Fluid Power System. In addition, at least one button should be remotely located to stop the system in the event of an emergency. All Machine Stops shall be:

1. Clearly identified
2. Readily accessible for the operatorôs
3. Of the latched type, where the latching function ensures the button stays in the actuated position until reset by a separate manual action in accordance with AS3947.
4. Coloured ñREDò in accordance with AS3947

8.4 Emergency Stops

An emergency stop shall be provided at a suitably located workstation for each Fluid Power System. All Emergency Stops shall be:

1. Clearly identified
2. Readily accessible for the operatorôs
3. Of the latched type, where the latching function ensures the button stays in the actuated position until reset by a separate manual action in accordance with AS3947.
4. Coloured ñREDò in accordance with AS3947

8.5 Fluid Power Components

Pumps

When Pumps are connected in parallel they should have appropriate valving that isolates each individual pump assembly while the other pump(s) is (are) still in operation and allow the safe dissipation of any pressure. (Double Block and Bleed)

Fluid Reservoir

1. The reservoir capacity should be at least 5 to 6 times the rated litres per minute of the pump assembly/assemblies.
2. The reservoir should include approved high and low-level switches or transducers interlocked into the electrical control circuit.
3. Reservoirs should include a through the top mounted, approved type, magnet assembly.
4. The reservoir drain port should be fitted with a ball valve with a plug and be clearly labelled.
5. A desiccant type breather should be mounted on top of the reservoir.

Valves

1. All valves should be labelled consistent with the circuit diagram (i.e. Part Number)
2. All manual valves should be labelled with the valves function of operation.
3. All valves should be securely mounted.
4. All valves used for isolation must be lockable.

Cylinders

General:

1. A device or means shall be provided to prevent pressure intensification on all hydraulic cylinders (i.e. Relief Valve), any device used for this purpose shall have a means on controlling the discharge flow.

Circuits incorporating load bearing cylinders must include the following safety features:

1. A device to prevent over pressurisation of the Cylinder (i.e. Relief valve).
2. A device, such as a load lock, that will stop the movement of the load in the event of a hose rupture or pipe fracture. This load lock valve must be either an integral part of the cylinder or hard piped if mounted remotely.

Hydraulic Accumulators

Circuits incorporating accumulators must include the following features:

1. Accumulators shall be designed for a rated working pressure not less than the maximum system pressure and shall have a safety factor of not less than 4:1.
2. Hydraulic accumulators and associated fittings should be securely installed and protected from operational damage (e.g. damage from falling rock or by stepping onto the components during maintenance).
3. A manual bleed valve should be fitted to allow pressure decay for maintenance purposes. This bleed valve must be labelled with operation and fluid returned to tank.
4. Gas charged accumulators should be labelled stating the type and pre-charge pressure. If the gas pressure is to be maintained in situ during its service life, a procedure on a suitable label shall be affixed at the installed location.
5. Gas charging valves shall be guarded to protect it from accidental damage.
6. Spring type accumulators should be labelled with a warning informing personnel that the contents are under óspring pressureô
7. Accumulators should be fitted with a pressure gauge and labelled with a warning sign regarding depressurisation before the commencement of any maintenance work.

Filtration

Particle contamination accelerates wear of hydraulic components. The rate at which damage occurs is dependent on the size and quantity of particles present in the fluid and the system pressure. Adequate fluid filtration should be provided to protect all fluid circuits from such contamination.

1. All Return Line Filters shall be positioned in the circuit just before the reservoir. The Return Filter/s shall include a built in bypass and be adequately sized to allow a clean flow pressure drop of approximately1/3 of the bypass setting.
2. All Pressure Filter housings including fittings shall have a minimum factor of safety of at least 2.5:1 based on rated working pressure to bursting pressure.

3. All filters should be equipped with a device to indicate when the filter needs servicing. Where appropriate differential pressure gauges or transducers should be fitted to enable continuous condition monitoring of the filter element.
4. Return Filters can be typically 10 micron or less.
5. Pressure Filters can be typically smaller than Return Filtration filters due to the positive pressure available to force fluid through the media.
6. All pressure filters shall be labelled with a warning regarding depressurisation before the commencement of any maintenance work.
7. Fluid cleanliness shall be maintained in accordance with Appendix 1

Pressure Indicators

Permanent pressure indicators should be installed into all circuits at relevant locations.

1. Indicators should be clearly labelled showing the working pressure range.
2. The scale range of the gauge should exceed the maximum working pressure by 25%.
3. A Green zone should mark the correct operating pressure range on all pressure gauges.
4. Where possible, a dial type pressure gauge should have the indicating needle operating between the range of 9 o'clock and 2 o'clock on the dial under normal system pressure.
5. All pressure gauges should be in standard SI units in accordance with AS/ISO1000.
6. Pressure gauges should be adequately supported and mechanically protected from damage in high wear or impact areas.
7. Pressure gauges should be located where the operators can clearly read the gauge.

Pressure Gauges

Permanent pressure gauges should be installed into all circuits at relevant locations. All pressure gauges shall be clearly labelled with the calibration date and calibrating company and the signature of the calibrating officer.

1. Gauges should be clearly labelled showing the working pressure range.
2. The scale range of the gauge should exceed the maximum working pressure by 25%.
3. A Green zone should mark the correct operating pressure range on all pressure gauges.
4. Where possible, a dial type pressure gauge should have the indicating needle operating between the range of 9 o'clock and 2 o'clock on the dial under normal system pressure.
5. All pressure gauges should be in standard SI units in accordance with AS/ISO1000.
6. Pressure Gauges shall be logged, recorded and maintained to ensure compliance with the appropriate Australian Standard (AS 1271, AS1349, AS4706)
7. Pressure gauges should be adequately supported and mechanically protected from damage in high wear or impact areas.
8. Pressure gauges should be located where the operators can clearly read the gauge.

Pressure Switches and Transducers

1. Pressure Switches and Transducers shall have the operating pressure settings, ranges and maximum allowable differentials clearly indicated.
2. Pressure Switches and Transducers shall have a rated proof or shall withstand pressure of not less than 250 percent of the maximum possible pressures for the systems in which they are installed.

3. All pressure switches and Transducers shall be clearly labelled with the calibration date and calibrating company and the signature of the calibrating officer
4. Pressure gauges should be adequately supported and mechanically protected from damage in high wear or impact areas.

Hose Fittings & Staples

The reduction of the effective service life of a hose assembly is predominately contributable to poor installation, system design and or environmental conditions. The following should be considered in the selection of hose assemblies in order to maximise the effective service life:

Detailed information on the specific requirements for hose assemblies can be gained from the NRE hose supply contract.

General requirements for hose assemblies:

1. Hose assemblies must be compatible for the fluid type being used.
2. All supplied hose assemblies must have a minimum factor of safety of 4:1 based on burst pressure to maximum working pressure for the maximum operating temperature.
3. All hoses should be adequately sized to minimise pressure loss and avoid damage from heat generation due to excessive fluid velocity.
4. All hoses should be FRAS rated and be abrasion resistant where applicable for their intended application.
5. Suction hoses should be selected to withstand both the negative and positive pressures imposed by the fluid system.
6. A hose energy diffusion type sleeve shall be fitted to all hydraulic hoses located in a ôHigh Risk Areaô or where there is high potential of harm to people due to an uncontrolled release of fluid in the event of a hose failure. This is the minimum requirement for all areas where hydraulic hoses are outside of guards that are designed to prevent fluid coming into contact with personnel in the event of a hose assembly failure. This diffusion type sleeve must be FRAS rated and should be securely attached at each hose end.
7. Each supplied hose assembly must have plastic caps securely fastened to each end to ensure no possible ingress of contamination prior to installation.
8. Each hose assembly should be proof tested to two times the rated working pressure by the manufacturer.
9. The Supplier cannot alter the supply of product without the approval of the NRE Managers of Mechanical Engineering.

Gujarat NRE Minerals Ltd reserves the right to conduct an audit of any aspect of the quality control procedures relating to the design, manufacture, and assembly and testing of the hose assemblies and fittings.

Hose Identification

Each supplied hose assembly must have a label attached showing:

a. Supplierôs company name (or Logo)
b. Hose assembly part number
c. Hose assembly description ie DN10 x 3.2m
d. Date of assembly

e. Working pressure
f. NRE stores Stock code number
g. For new or overhauled equipment, all hose labels should include the circuit piping diagram number where possible.

Note: All hose labels should be robust enough to last the life of the hose and shall be placed on both ends of the hose assembly. A third label shall be secured direct to the hydraulic hose under the diffusion sleeve.

When a Colouring system is required to be used the following colours shall be the standard used:

a. Pressure: Red
b. Hi Set: Red with a Yellow Strip through centre
c. Return fluid: Orange
d. General Purpose Water: Green
e. Compressed Air: Blue
f. Shearer Water: Yellow
g. Stonedust: White

Hose Assemblies Installation (also see Section on Training)

The hose assembly should:

1. Be mechanically protected from damage in high wear or impact areas
2. Be of sufficient length required for the intended movements
3. Be routed to prevent coming into contact with sharp edges or other surfaces that may wear the hose cover causing premature failure
4. Be securely restrained in high risk areas to eliminate the potential of a whipping hose due to failure
5. Be sufficient in length necessary to avoid sharp flexing and straining of the hose during operation
6. Not be bent at a radius smaller than those recommended by the manufacturer
7. Be clean prior to and during installation
8. Any staple type hose fitting shall be installed with new staples.

Adaptors

General requirements for the supply of Adaptors shall:

1. Include the Manufacturerõs name or logo
2. Show maximum working pressure
3. If the adaptor is threaded, then the pressure rating shall be limited to the thread rating
4. Be individually plastic heat shrink wrapped to stop the ingress of contamination during storage

In house made or fabricated adaptors can not be used unless they have been designed by a qualified engineer, tested and certified. Where a special adaptor is required it must be provided with a complete certification stating the working pressure, test pressure and safety factor.

Where welding is unavoidable then it shall be supervised and carried out strictly in accordance with AS 4041 - ***Soldering, brazing, copper loading or other similar processes*** shall not be used in pressured circuits. Galvanised water type fittings shall not be used in pressurised hydraulic circuits.

Non Standard Type Adaptors (including Manifolds)

Non standard type Adaptors, manifolds, including manifolds or any other proprietary type fitting, must comply with the following recognised standard:

a. Be certified by the manufacturer as designed and assessed to SAE J1065 and be certified and proof tested to ISO 6605 or SAE L343 or AS 1180.5 with a minimum FOS of 4:1. Testing to ISO 6802 or ISO 8032 is preferred.
b. Be designed such that the use of other manufacturerôs proprietary fittings / components cannot easily be mistaken and used in the wrong system creating a hazard to the end user.
c. Be fit for purpose for the intended application over the fittingôs lifecycle such that the fitting does not fail due to fatigue, cyclic loading, and contamination during the intended operating environment or removal and assemble for maintenance.

8.6 Documentation

When alterations are required to be made to the fluid power system, a Change Management form must be completed to ensure all interface hazards have been recognised and that the respective documents and procedures are to be updated as soon as practicable. This will minimise the likelihood of additional hazards being created by the use of incorrect information. Where a hazard could exist from the misinterpretation of a symbol, the meaning of the symbol should be clarified in writing.

All documentation should identify all system parameters with the International (SI) units to be used in accordance with AS/ISO1000.

Documentation should include:

Circuit diagram – Schematic

The following information should be clearly identified on the schematic circuit:

1. All system components, including electro-hydraulic
2. All pressures settings
3. All flow rates
4. Any other devices

Circuit diagram – Piping

The following information should be clearly identified on the piping diagram:

1. Hose type and pressure rating
2. Hose size and length and individual circuit hose position number.
3. Colour coding (where applicable)
4. Adaptors size and type
5. Valves with porting shall have the ports clearly labelled

Operation and maintenance manuals – *OEM to supply*

All Operation and Maintenance manuals are to be supplied in both soft and hard copies. All hard copies are to be either laminated or printed on plastic paper.

1. Recommended preventative maintenance requirements to maintain the fluid system in a safe operating condition
2. Recommended inspection frequency and any tests required to check if the equipment is safe to operate
3. A detailed parts list of all system components consistent with the circuit diagram
4. Operating system fluid type
5. Identification of any known hazards involved in maintaining and operating the equipment
6. Energy isolation, dissipation and control procedures
7. Safe work guidelines to carry out routine maintenance on the system, including setting of controls and component replacement.
8. Protective equipment requirements
9. A Trouble shooting guide

Records

Records must be kept in a central database of the results of all inspections, maintenance and repair activities to a Fluid Power System with the exception of hydraulic hoses. Hydraulic hose records will be kept in a stand alone database that interfaces between the hose supplier and NRE. These records should be periodically reviewed to determine if any modification and improvements could be made to improve safety and the reliability of the equipment. Fluid Power circuit diagrams and maintenance documents must be kept up to date and be readily available for use on the equipment at all times. The information contained within these databases is considered to be a part or the machine safety file.

9 INSPECTION MAINTENANCE AND REPAIR

This section details the process to follow for commissioning, inspecting and maintaining the Fluid Power System.

9.1 Commissioning

A commissioning procedure shall be developed for each Fluid Power System. This commissioning procedure should include any potential hazards and risks associated with commissioning the Fluid Power System. The procedure should include a commissioning sheet developed in accordance with the manufacturerÕs requirements and include:

1. A visual inspection prior to pressurising circuit to confirm:
    a) Hose security (i.e. Staples and any restraining devices are fitted correctly)
    b) Location of all personnel in the vicinity
2. An inspection and test to prove the correct operation and installation of all safety devices, including:
    a) Emergency stop functions
    b) Isolation points with pressure dissipation points available
    c) Warning and identification labels are in place
    d) Protection devices settings and alarms as applicable

3. Function and pressure test each component of the system at the designed working pressure
4. Hose layout and routing checking for wear points, allowable hose bend radius and movement range.
5. To identify and confirm that the system is complete and is ready for normal operation, by checking:
    a) Circuit pressure and flow rates
    b) Completeness of circuits to drawings, identification and labelling of components
    c) Software functionality
    d) Sample taken to confirm cleanliness of the hydraulic fluid

Consultation should be carried out between all relevant stakeholders such as mechanical, electrical and operational groups to determine the commissioning sequence. All commissioning results should be recorded and signed by the respective person completing the checks and stored for future reference as stated in the section related to records.

9.2 Inspections

Each Fluid Power System shall have a regular frequency of inspections and the results documented to ensure it is maintained in a safe operating condition over its intended lifecycle.

These Inspections, maintenance and repairs should be documented and include:

1. Verifying the functionality of the circuit
2. Verification that the information held in the databases matches the installed components.
3. Systematically inspecting and maintaining all components of the system in accordance with the manufacturer recommendations (i.e. pressures and the like)
4. Periodically checking safety critical functions and warning devices / labels
5. Only using competent persons familiar with the particular fluid power system
6. Periodic inspections and maintenance schedules that are to be complied with (e.g. daily, weekly, monthly, six monthly, annual and overhaul).

9.3 Hose Management

General

An effective hose management program is a part of each site's overall maintenance strategy. The intent of this hose management program is to reduce equipment downtime, maintain peak operating performance and reduce the potential risk for personal injury and/or property damage.

The hose management program includes:

1. A database of the range of hose assemblies on each NRE mine site, including the hose type, size, length and working pressure
2. An inspection schedule included as apart of each particular piece of Plant's maintenance plan, such that all hose assemblies is inspected at a frequency required to assess the potential risk for personal injury and/or property damage.
3. Previously used (old) hose assemblies removed from service are not to be reinstalled unless tested and certified in accordance with this management plan. These hoses must be then be cleaned and labelled in readiness for reuse.

4. Keep a database of hose and fitting failures including where possible a mode of failure analysis. This database should be periodically reviewed and analysed for future equipment improvements or overhauls.
5. Periodic removal of a sample hose and adaptor for testing to determine the status of service life. In the case of the Longwall, this means testing samples from a range of inner-shield hoses and staples every 12 months.

The hose management plan aims for the ñin service inspection and assessmentò to determine when to discard a hose, prior to a ócatastrophic in service failureôoccurring. This will also allow an analysis to determine when to re-hose the Fluid Power System due to escalating in-service failures potentially affecting the safety of people and property damage.

Hose and Adaptor Inspections

All hose assemblies and adaptors should be rigorously inspected periodically by a competent person, who is capable of making a valid assessment of the condition, to ensure the system remains in a safe operating condition. Where hose assemblies show damage steps should be taken to determine the suitability for continued use. This should be based on the consequences of failure with respect to the safety of people and damage to property should the failure occur.

This inspection should provide recommendations as to whether the hose assembly:

1. Is fit for continued service, or
2. Is fit for limited service (replace at the next available window), or
3. Should be replaced immediately.

Hose Discard Criteria

Hose assemblies should be replaced when the hose assembly shows signs of damage and there is a belief that it is no longer fit for purpose or does not offer the desired level of safety.

Hoses should be discarded if the inspection finds:

1. Visual evidence of leaks along the hose or around the hose ends of the assembly
2. Damaged, broken or corroded braid wires
3. Cracked, damaged, or badly corroded hose ends
4. Significant outer sheath damage or end not being secure on the hose
5. Incorrect length of hose (i.e. hose appears to be tight)
6. Kinked crushed or flattened hose
7. Hard, stiff, blistered, soft, degraded hose.

If there is any doubt the hose must be replaced.

Other Maintenance Inspections (All Other Components)

When visually inspecting hoses and fittings you should also inspect the Fluid Power System components for these related items:

a. Leaking ports.
b. Damaged or missing guards or shields.
c. Excessive dirt and debris around hoses and valves.
d. System fluid, specifically level, type, contamination, condition and air entrapment.

Hose storage

Hose assemblies should be stored in a cool, dark, dry area with plastic end caps securely fitted. These plastic caps must be secured using heat shrink to ensure they can not be easily removed.

Hose Service Life

Hydraulic hoses and components have a limited life and at some stage the hose assembly should be replaced irrespective of the visual condition. This period may vary depending upon the risk exposure to people upon failure of the hose. The hose replacement criteria shall be:

1. Where hoses in high risk areas have been in service for a period of greater than five years then they should be replaced unless:
   a) A sample of hoses have been removed and tested in accordance with section on hoses, and
   b) An assessment based on service history and condition is made to justify an extended period that is approved in writing by the site Maintenance and Engineering Manager.
2. All other hoses in hydraulic systems shall have a maximum service life of eight years.

10 TRAINING

All people associated with the maintenance of any Fluid Power System (including contractors) should be trained to ensure they are competent to safely carry out maintenance and repairs on the respective Fluid Power System. Specific training and assessment on energy isolation should also be carried out on large and complex Fluid Power Systems such as Longwall Roof Supports.

The training records of the maintenance personnel should include an understanding of:

1. System functional requirements and operating parameters
2. Troubleshooting and individual component testing
3. Safe energy isolation and dissipation in accordance with the NRE Control of Energy (ñIsolationò) procedure
4. Electrical / fluid power interfaces and control circuitry
5. Hose management
6. Importance of cleanliness

11 AUDITING

The NRE Wongawilli Fluid Power Safety Management System will undergo a formal internal audit as per the NRE SHECQ Internal Audit mechanism, the audit shall be undertaken after initial implementation then after 6 months with an triennial review undertaken thereafter. The purpose of an audit will be to establish site compliance as written, and to examine the technical adequacy of the plan to manage the Fluid Power Systems in the underground environment based on existing operational experience.

The audit team may comprise both internal and external members who will document their investigation and make recommendations regarding non compliances and improvement ideas.

An audit of the Fluid Power Safety Management System (MSMP 033) would also be undertaken in the event of any significant incident that, in the opinion of the Manager of Mining Engineering or District Inspector of Mines, warrants such an audit.

The internal audit and review of this MSMP 033 shall have a Pronto PM Work Order raised to ensure completion.

12 PLAN MONITORING AND CORRECTIVE ACTION

It is vital to the ongoing effectiveness of any Management Plan for all employees to have access to a system that allows them to highlight, at any time, non conformances with Plan provisions and recommendations that may improve the Plan.

Should any employee discover a non conformance with the provisions of the NRE Wongawilli Fluid Power Safety Management System or wish to submit a suggestion aimed at improving the effectiveness of the Plan in managing any aspect of Fluid Power Systems, he shall complete a written report of his observation or suggestion. Fill out the SHRECQ Corrective Action Request.

It is the responsibility of the Manager of Mining Engineering to ensure that the person responsible for any corrective action is informed and that an agreed scheme of work is carried out to resolve the situation.

The person responsible shall assess the validity of the report and:

- Taking immediate action to correct a non conformance with the Plan provisions or
- Assessing (or arranging for a suitably qualified person to assess) the merit of the improvement idea and arranging for its implementation if appropriate or documenting the reasons why it will not be implemented

and, in each case,

- Advising the Manager of Mining Engineering of actions taken in response to the report received.
- Provide feedback to the report initiator regarding the outcome of his report,
- Document any modifications to the Plan content resulting from the reported observation or recommendation and re-issue the relevant pages according to the Document Control procedures and
- Communicate any amendments to the Plan content to personnel affected who do not receive controlled copies of the Management Plan.

GUJARAT NRE MINERALS LIMITED
A.B.N. 28 111 244 896
NRE No 1 Colliery

Appendix 1 - Filtration Standards

Information provided by Pall Filter Corporation

Recommended Fluid Cleanliness Level Worksheet*

1. Operating Pressure & Duty Cycle

Duty	Examples	Operating Pressure, bar (psi)					Actual
		(-70 (0-1000)	>70-170 (>1000-2500)	>130-275 >2500-4000)	>275-410 (>4000-6000)	>410 (>6000)	
Light	Steady duty	1	1	2	3	4	
Medium	Moderate pressure variations	2	3	4	5	6	
Heavy	Zero to full pressure	3	4	5	6	7	
Severe	Zero to full pressure with high frequency transients	4	5	6	7	8	

2. Component Sensitivity

Sensitivity	Examples	Weighting	Actual
Minimal	Ram pumps	1	
Below Average	Low performance gear pumps, manual valves, poppet valves	2	
Average	Vane pumps, spool valves, high performance gear pumps	3	
Above Average	Piston pumps, proportional valves	4	
High	Servo valves, high pressure proportional valves	6	
Very High	High performance servo valves	8	

3. Equipment Life Expectancy

Life Expectancy (hours)	Weighting	Actual
0 – 1,000	0	
1,000 – 5,000	1	
5,000 – 10,000	2	
10,000 – 20,000	3	
20,000 – 40,000	4	
>40,000	5	

4. Component Replacement Cost

Replacement Cost	Examples	Weighting	Actual
Low	Manifold mounted valves, inexpensive pumps	1	
Average	Line mounted valves and modular valves	2	
High	Cylinders, proportional valves	3	
Very High	Large piston pumps, hydrostatic transmission motors, high performance servo components	4	

5. Equipment Downtime Cost

Downtime Cost	Examples	Weighting	Actual
Low	Equipment not critical to production or operation	1	
Average	Small to medium production plant	2	
High	High volume production plant	4	
Very High	Very expensive downtime cost	6	

6. Safety Liability

Safety Liability	Examples	Weighting	Actual
Low	No liability	1	
Average	Failure may cause hazard	3	
High	Failure may cause injury	6	