Braking Systems

Introduction

The primary function of braking systems is to stop the lift under all anticipated design load conditions. The brakes must hold the maximum design loads and stop or prevent reverse rotation. Brakes and brake systems must also not simultaneously apply in a manner that causes excessively rapid deceleration.

Workplace Safety Considerations

Safety considerations for brake systems include: the awareness that when open and not applied, brake systems may contain an immense amount of stored energy in the form of weights, springs, and hydraulic pressure. The mechanism for opening the brake may also contain significant stored energy in the hydraulic or pneumatic systems along with the associated plumbing. All maintenance personnel must be aware of these hazards. The brake system is normally a closed circuit and as such, removing control power should result in a closed brake. It should be noted, the complete release of stored energy is not guaranteed in all systems and therefore proper safety precautions as outlined in the manufacturer’s guidelines or the ski area’s procedures should be applied. While working on braking systems, various hazards may be encountered. Throughout all 3 levels of training, the following list of safety considerations should be considered:

- **PPE** – harnesses, gloves, proper footwear, eye protection, hard hat, etc., when applicable.
- **Proper Lifting and Back Safety** – working with heavy equipment, tools and materials.
- **Tool Use** – hand and power tool use (including guarding).
- **Pinch Points** – working around lifts and rigging equipment.
- **Slips, Trips and Falls** – while performing work on ground and elevated surfaces.
- **Working at Heights** – Appropriate and compliant Fall protection/Qualified Climber procedures/training, PPE/equipment, climber rescue plan.
- **Powered Platforms and Man Lifts** – qualifications and training in the use of.
- **Lockout/Tagout** – proper and compliant procedures developed, implemented and employed.
- **Rigging** – proper training and use of hoists, straps, chains, scaffolding, and other equipment.
- **Occupational Noise Exposure** – proper hearing protection as required.

LEVEL ONE

A Level One LMT should be able to understand and apply the following terms and concepts and be able to perform the following functions and procedures under the supervision of a more experienced LMT.

1. **Types and Functions of Brakes**
   
i. **Service Brake** – Braking that occurs on the high-speed side of the gearbox and drive train. It is normally associated with a “Normal Stop” or “Service Stop”.
   
   ii. **Bullwheel Brake** – Braking that occurs on a bullwheel, typically on the drive bullwheel. It is normally associated with an “Emergency Stop” or “Emergency Shutdown”.
   
   iii. **Drive Train Backstop** – A brake that stops or prevents reverse rotation and is typically located on the high-speed side of the gear box and drive train.
iv. **Rollback Device** – A brake that stops or prevents reverse rotation and is located on the low-speed side of the gearbox, typically on a bullwheel.

v. **Regenerative Braking** – Braking that involves the electric motor and electrical energy (negative horsepower) to provide deceleration to a set speed (near zero-speed) when the Service Brake is applied. Some installations may have several “deceleration ramps” which are used under different fault conditions.

2. **Brake application and Release** – Brake application may be automatic or manually activated. One example of automatic application would be if the lift detects an over-speed fault. An example of manual application would be a Normal Stop button activated by the operator. There are several methods of brake application and release including:
   I. Spring applied and hydraulically released.
   II. Weight applied and hydraulically released.
   III. Weight induced hydraulic pressure applied, hydraulic release.
   IV. Spring applied and electrically released.
   V. Spring applied and pneumatically released.

3. **Types of Brakes and Braking Mechanisms** – The LMT may be working with a number of different types of brakes and braking mechanisms including:
   I. **Service Brake** – Caliper, Drum, Shoe/Double Shoe, Thruster, Motor-Brake (Internal).
   II. **Emergency brake** – Caliper, Flange, Drum on Planetary, Bullwheel Band, Shoe/Double Shoe, Track Rope Brake.
   III. **Drive Train Backstop** – Cam Clutch, Zurn, Formsprag, Ringspann, Link Belt, External Ratchet.
   IV. **Rollback Device** – Drop Dog, Pawl on Spoke, Caliper, Traction Rope Brake, Band Brake.

4. **Brake Application Rate and Force** – Timing of brake actuation from application to fully closed, measuring stopping distances and keeping proper documentation.

5. **Proof of Torque** – The LMIT should understand the concept.

6. **Daily and Regular Maintenance of Braking Systems** – Perform simple lubrication, checking fluid levels, cleaning of hydraulic leaks, spills, brake dust, etc. Inspections as described by the manufacturer, AHJ, or ANSI B77.1. Clearing of snow and ice from bullwheels, brakes and other system components. Assisting in torque testing.

7. **Dynamic and Static Brake Torque Testing** – Understands the concepts of dynamic and static brake torque testing.

**LEVEL TWO**

In addition to the Level One terms, concepts, and functions previously listed, a Level Two LMT should be able to understand, analyze and apply the following terms and concepts, and be able to perform the following functions and procedures. The Level Two LMT should also be able to direct and train others in the job activities and procedures that they are proficient in.

1. **Brake Application Rate and Force** – Proper adjustments to the braking systems are critical. Level Two LMTs must fully understand the system before adjusting. LMTs should understand and be able to properly adjust the force applied by the brake which includes the analysis of braking curves and the adjustment and timing of the brake to be fully closed.

2. **Daily and Regular Maintenance of Braking Systems** – Perform regular brake system inspections, verification of proper brake operation, including: proof of torque and brake open requirements, alignment, adjustments and testing, changing of fluids and filters, full disassembly, reassembly, setup, testing, and
documentation of these tasks. These procedures should be completed in accordance with the lift manufacturer’s and the brake unit manufacturer’s specified procedures.

3. **Brake Application in a Control Power Loss Situation** - Understand that a control power loss situation may involve a total failure or shutdown of the low voltage system or the control system, resulting in the simultaneous application of all or multiple brakes creating an over-braking condition (over-deceleration).

4. **Brake Application Logic** - Understanding of the sequence when each brake applies for the different stopping situations. Brakes and combinations of brakes may apply at different times depending on the load, drive method (electric or diesel) or type of stop circuit tripped.

5. **Dynamic and Static Brake Torque Testing** – Understands the concepts of and performs static and/or dynamic testing on brakes and/or brake systems. Testing includes isolation of various brakes and performing the tests in accordance with the lift manufacturer’s and the brake unit manufacturer’s specified procedures. Able to analyze results and retest as necessary.

**LEVEL THREE**

In addition to the Level One and Two terms, concepts, and functions previously listed, a Level Three LMT should be able to analyze, evaluate and apply the following terms and concepts and be capable of developing updated and/or improved procedures or processes to resolve complex issues, as identified, based upon their knowledge and experience. The Level Three LMT should also be able to oversee, direct and train others.

Level Three LMTs should have the ability to troubleshoot, repair, and oversee the replacement of all brake systems and their components.

1. **Brake Force Adjustment Calculations**
   i. Detailed brake curve analysis.
      a. Understanding the meaning of the slope on speed/time graph and how to calculate deceleration rates.
      b. Understanding possible fluctuations and possible causes related to braking, timing and brake force.
      c. Relating stop graphs to ANSI B77.1 and other applicable requirements.
   ii. Tracking brake performance over time to monitor changes in overall friction within the lift and possible changing braking requirements. Changes in torque values and testing procedures may require review by a qualified engineer.
   iii. Ability to perform a Load Test or Dynamic Test ensuring that all brakes are adjusted properly and are performing as required.
   iv. Responsible for reviewing the documentation of all tests and results.

2. **Brake Application** – Able to recognize brake application, over and under deceleration issues and develop and implement processes and procedures to identify issues and solutions.

3. **Brake System Problems** – Able to identify and analyze brake system problems and perform repairs and when to seek additional expertise, if needed.

4. **Quality Assurance Measures and Processes** – Ability to develop suitable tests, inspections and verifications when necessary, other than, or in addition to those already mandated by ANSI B77.1, the manufacturer or the AHJ.

5. **Technical Classes** – Ability to develop and present training classes/sessions on sheave assemblies and towers, including adjustment, repair and rebuilding.

6. **Documentation and Record Keeping** – Responsible for developing, implementing, reviewing, and management of all technical, work, inspection, maintenance and other documents, logs, records and work procedures.
7. **Notification** – Knowledgeable of when and how to notify the AHJ and/or the lift manufacturer when appropriate and necessary.