HOISTING ENGINEERING

COURSE STUDY GUIDE

2025

VIRGINIA Energy

VIRGINIA DEPARTMENT OF ENERGY

HOISTING ENGINEERING

CERTIFICATION STUDY GUIDE

2025

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Department of Energy
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VIRGINIA DEPARTMENT OF ENERGY

Disclaimer

Article 3 of the **Coal Mine Safety Laws of Virginia** establishes requirements for certification of coal mine workers. The certification requirements are included in §45.2-515 through §45.2-534 in which the Board of Coal Mining Examiners is established for the purpose of administering the certification program. The Board has promulgated certification regulations 4 VAC 25-20, which set the minimum standards and procedures required for Virginia coal miner examinations and certifications.

The Virginia Department of Energy developed this study guide to better train coal miners throughout the mining industry. The study guide material should be used to assist with the knowledge necessary for coal mining certifications. The material is not all-inclusive and should be used only as an aide in obtaining knowledge of the mining practices, conditions, laws, and regulations. This material is based upon the Coal Mining Safety Laws of Virginia, Safety and Health Regulations for Coal Mines in Virginia, Title 30 Code of Federal Regulations (30 CFR), State and Federal Program Policy Manuals and other available publications. Nothing herein should be construed as recommending any manufacturer's products.

The study guide and materials are available at the Virginia Department of Energy. Any questions concerning the study guide should be addressed to the Regulatory Boards Administrator at the Big Stone Gap Office.

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By: RDW

Hoisting Engineering Certification Study Guide

INTRODUCTION

The purpose of the Hoisting Engineering Certification Study Guide is to assist a qualified applicant in obtaining the Hoisting Engineering certification. The Board of Coal Mining Examiners (BCME) may require certification of persons who work in coal mines and persons whose duties and responsibilities in relation to coal mining require competency, skill, or knowledge in-order to perform consistently with the health and safety of persons and property.

The purpose of the hoisting engineering study guide is to assist an applicant who possesses **two-years** practical mining experience and one-year hoisting experience under the direction of a certified hoisting engineer or appropriately related work experience.

The hoisting engineering certification authorizes the holder to perform:

- Hoisting operations at shafts, slope, and surface inclines
- Pre-operations and other required safety checks of hoisting equipment
- Record results of hoisting equipment examinations
- Duties of an automatic elevator operator after completing the on-site demonstration required by Section 2.20 of the BCME regulations.

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Unit 1
Coal Mine Safety Laws of Virginia

§ 45.2-735. Hoisting equipment.

A. Every hoist used for handling miners shall be equipped with overspeed, overwind, and automatic stop controls.

B. Every suspended work deck or platform shall (i) operate automatically, (ii) be equipped with guardrails capable of protecting miners and materials from accidental overturning, and (iii) be equipped with safety belts and such other protective devices as the Chief shall require by regulation.

C. Every platform or work deck that is used for transporting miners or materials shall be equipped with leveling indicators, and such conveyance shall be maintained and operated in a reasonably level position at all times.

D. Every shaft, slope, or surface incline hoist shall be equipped with brakes capable of stopping and holding the fully loaded unbalanced cage or trip at any point in the shaft or slope or on the surface incline.

E. An accurate and reliable indicator showing the position of the cage or trip shall be placed so as to be in clear view of the hoisting engineer, unless the position of the cage or trip is clearly visible at all times to the hoisting engineer or other person operating the equipment.

F. Any conveyance that is used to haul miners or materials within a shaft or slope shall be (i) designed to prevent materials from falling back into the shaft or slope and (ii) equipped with a retaining edge of at least six inches to prevent objects from falling into the shaft or slope.

§ 45.2-736. Hoisting ropes.

A. The hoisting rope on any cage or trip shall be adequate in size to handle the load. A rope that is used to hoist or lower coal and other materials shall have a factor of safety of at least five to one. A rope that is used to hoist or lower miners shall have a factor of safety of at least 10 to one.

B. Each hoisting rope shall have at least three full turns remaining on the drum when extended to its maximum working length. The rope shall make at least one full turn on the drum shaft, or around the spoke of the drum in the case of a free drum and be fastened securely by means of clamps.

C. Each hoisting rope shall be fastened to its load by (i) a spelter-filled socket or (ii) a thimble and an adequate number of clamps that are properly spaced and installed.

D. Any cage, mancar, or trip used for hoisting or lowering miners with a single rope shall be provided with two bridle chains or wire ropes connected securely to the rope at least three feet above the socket or thimble and clamps and to the crosspiece of the cage or to the mancar or trip. Multiple hoisting ropes installed pursuant to subsection C may be used in lieu of two bridle chains.

E. If equipment or supplies are being hoisted or lowered in the slope, safety chains or wire ropes shall be provided and connected securely to the hoist rope. In addition, visible or audible warning devices shall be installed in the slope where they may be seen or heard by any miner approaching the slope track entry from any access.

§ 45.2-737. Hoisting cages.

A. Any cage used for hoisting miners shall be of substantial construction and have (i) adequate steel bonnets, with enclosed sides; (ii) gates, safety chains, or bars across the ends of the cage when miners are being hoisted or lowered; and (iii) sufficient handholds or chains for all miners on the cage to maintain their balance. A locking device to prevent tilting of the cage shall be used on all self-dumping cages when transporting miners.

B. The floor of each cage shall be constructed so that it is (i) adequate to carry the load and (ii) impossible for a miner's foot or body to enter any opening in the bottom of the cage.

C. Each cage used for hoisting miners shall be equipped with safety catches that act quickly and effectively in case of an emergency. The provisions of this subsection shall not apply to a capsule or bucket that is used for emergency escape or during shaft or slope sinking.

§ 45.2-738. Shaft and slope conditions.

A. Every shaft shall be equipped with safety gates at the top and at each landing. Safety gates shall be kept closed except when the cage is being loaded or unloaded.

B. At the bottom of each hoisting shaft and at each intermediate landing, a runaround shall be provided for safe passage from one side of the shaft to the other. This passageway shall be at least five feet in height and three feet in width.

C. Ice shall not be permitted to accumulate excessively in any shaft where miners are hoisted or lowered.

D. Positive-acting stopblocks or derails shall be installed near the top and at intermediate landings of slopes and surface inclines and at the approaches to all shaft landings.

E. Positive-acting stopblocks or derails shall be installed on the haulage track in the slope near the top of the slope. The stopblocks or derails shall be in a position to hold or stop any load to be lowered into the mine, including heavy mining equipment, until such time as the equipment is to be lowered into the mine by the hoist.

§ 45.2-739. Signaling; signal code.

A. Two independent means of signaling shall be provided between the top, bottom, and every intermediate landing of each shaft, slope, or surface incline and the hoisting station. At least one of these means of signaling shall be audible to the hoisting engineer or other person operating the equipment. Bell cords shall be installed in each shaft in such a manner as to prevent unnecessary movement of such cords within the shaft.

B. A uniform signal code approved by the Chief shall be in use at each mine and shall be kept at the cage station designated by the mine foreman.

§ 45.2-740. Inspections of hoisting equipment.

A. Before hoisting or lowering any miner in a shaft, the hoisting engineer shall operate an empty cage up and down each shaft for at least one round trip, both at the beginning of each shift and after the hoist has been idle for one hour or more.

B. Before hoisting or lowering any miner by slope or surface incline hoisting, the hoisting engineer shall operate an empty cage for at least one round trip, both at the beginning of each shift and after the hoist has been idle for one hour or more.
C. The hoisting engineer, at the time the inspections required by subsection A or B are performed, shall (i) inspect all cable or rope fastenings on every cage, bucket, or slope car; (ii) inspect hammer locks and pins, thimbles, and clamps; (iii) inspect safety chains on every cage, bucket, or slope car; (iv) inspect each braking system for malfunctions; (v) clean all excess oil and extraneous materials from the hoist housing construction; (vi) inspect the overwind, overtravel, and lilly switch or control from stopping at the collar and within 100 feet of the work deck; and (vii) check communications between the top house, work deck, and work deck tugger house.
D. The hoisting engineer shall inspect the hoisting rope on every cage or trip at the beginning of each shift.
E. A test of safety catches on every cage shall be made by an authorized person designated by the operator at least once each month. A written record shall be kept of such tests, and such record shall be available for inspection by interested persons.
F. An authorized person designated by the operator shall inspect daily the hoisting equipment, including the headgear, cages, ropes, connections, links and chains, shaft guides, shaft walls, and other facilities. Such person shall also inspect every bull wheel and lighting system on the head frame. Such person shall report immediately to the operator or his agent any defect found, and all such defects shall be corrected promptly. The person making such examination shall make a daily permanent record of such inspection, which shall be available for inspection by interested persons. If a hoist is used only during a weekly examination of an escapeway, then the inspection required by this subsection shall only be required to be completed weekly before the examination occurs.
G. Subsections A, B, C, and D shall not apply to automatically operated elevators.

§ 45.2-741. Hoisting engineers.

A. If miners are transported into or out of an underground area of a mine by a hoist or on a surface incline, a certified hoisting engineer shall be either on duty continuously or available within a reasonable time, as determined by the Chief, to provide immediate transportation while any person is underground.
B. When any miner is being hoisted or lowered in a shaft or on a slope or surface incline, the loading and unloading of any miner and the movement of the cage, car, or trip shall be under the direction of an authorized person.
C. Subsections A and B shall not apply to automatically operated elevators that can be safely operated by any miner; however, a person qualified as an automatic elevator operator shall be available at any such elevator within a reasonable time, as determined by the Chief.
D. An operator or agent of such operator of any mine worked by shaft, slope, or surface incline shall place a competent and sober hoisting engineer in charge of any engine or drum used for lowering or hoisting miners. No hoisting engineer in charge of such machinery shall allow any person, except a person who is designated for such purpose by the operator or his agent, to interfere

with any part of the machinery. No person shall interfere with or intimidate a hoisting engineer or automatic elevator operator who is engaged in the discharge of his duties.

§ 45.2-742. Operations of hoisting equipment.

A. The speed of the cage, car, or trip in a shaft or slope or on a surface incline shall not exceed 1,000 feet per minute when a miner is being hoisted or lowered.
B. When moving the platform or work deck, every miner traveling thereon shall have a safety belt secured.
C. No miner shall ride on a loaded cage.
D. The number of miners riding in any cage or car at one time shall not exceed the maximum prescribed by the manufacturer. The Chief may prescribe a lesser number when necessary to ensure the safety of miners being transported.
E. Any conveyance being lowered into a shaft in which a miner is working shall be stopped at least 20 feet above the area where such miner is working.
F. If any miner is working at the bottom of a shaft, there shall be an adjustable ladder or chain ladder attached to the work deck to provide an additional means of escape. Such ladder shall be at least 20 feet in length.
G. Every choker or sling used to transport materials within a shaft or slope shall meet specifications established by the American National Standards Institute.

§ 45.2-743. Maintenance of hoisting equipment.

Every hoist, rope, cage, and other component of any piece of hoisting equipment shall be maintained in a safe operating condition, as directed by the Chief. A hoisting rope shall be replaced as soon as there is evidence of possible failure.

Unit 2
Safety And Health Regulations for Coal Mines
4 VAC 25-20-140 Hoisting Engineer

A. Applicants shall possess two years of practical mining experience and one year of hoisting experience under the direction of a certified hoisting engineer or appropriately related work experience approved by the chief. A certified hoisting engineer will verify the hoisting experience.

B. The applicant shall pass the hoisting engineer and gas detection examination.

C. After the examination has been successfully completed, the applicant shall obtain permission from the mine official to have a representative from Virginia Energy to observe the applicant's operation of hoisting equipment at the mine. Permission shall be on company stationery, signed by the company official, and submitted to Virginia Energy.

D. A certified hoisting engineer may act as an automatic elevator operator after completing the on-site demonstration required by 4 VAC 25-20-240 C.

E. A hoisting engineer must be recertified every five years by:

1. Presenting written proof that he has performed hoisting engineer duties in his work during two of the last three years immediately preceding the expiration date: or
2. Retaking or passing the practical demonstration section of the hoisting engineer examination and meeting requirements of subsection C of this section.

F. Failure to maintain education or training requirements shall result in suspension of a person certification pending completion of continuing education or training. If the continuing education requirement is not met with in two years from the suspension date, the certification shall be revoked by the BCME.

G. The Coal Mine Safety department shall send notice of any suspension to the last address the certified person reported to the Coal Mine Safety department in accordance with 4 VAC 25-20-20 I. Upon request, Virginia Energy will provide the mine operator and other interested parties with a list of individuals whose certification is in suspension or has been revoked.

75.382 Mechanical escape facilities.

(a) Mechanical escape facilities shall be provided with overspeed, overwind, and automatic stop controls.
(b) Every mechanical escape facility with a platform, cage, or other device shall be equipped with brakes that can stop the fully loaded platform, cage, or other device.
(c) Mechanical escape facilities, including automatic elevators, shall be examined weekly. The weekly examination of this equipment may be conducted at the same time as a daily examination required by §75.1400-3.
(1) The weekly examination shall include an examination of the headgear, connections, links, and chains, overspeed and overwind controls, automatic stop controls, and other facilities.
(2) At least once each week, the hoist shall be run through one complete cycle of operation to determine that it is operating properly.
(d) A person trained to operate the mechanical escape facility always shall be available while anyone is underground to provide the mechanical escape facilities, if required, to the bottom of each shaft and slope opening that is part of an escapeway within 30 minutes after personnel on the surface have been notified of an emergency requiring evacuation. However, no operator is required for automatically operated cages, platforms, or elevators.
(e) Mechanical escape facilities shall have rated capacities consistent with the loads handled.
(f) Manually operated mechanical escape facilities shall be equipped with indicators that accurately and reliably show the position of the facility.
(g) Certification. The person making the examination as required by paragraph (c) of this section shall certify by initials, date, and the time that the examination was made. Certifications shall be made at or near the facility examined**.**

Subpart O--Hoisting and Mantrips

30 CFR § 75.1400 Hoisting equipment, general.

(a) Every hoist used to transport persons shall be equipped with overspeed, overwind, and automatic stop controls.
(b) Every hoist handling a platform, cage, or other device used to transport persons shall be equipped with brakes capable of stopping the fully loaded platform, cage, or other device.
(c) Cages, platforms, or other devices used to transport persons in shafts and slopes shall be equipped with safety catches or other no less effective devices approved by the Secretary that act quickly and effectively in an emergency. Such catches or devices shall be tested at least once every two months.
(d) Hoisting equipment, including automatic elevators, used to transport persons shall be examined daily.
(e) Where persons are transported into or out of a mine by a hoist, a qualified hoisting engineer shall be on duty while any person is underground. No such

engineer, however, shall be required for automatically operated cages, platforms, or elevators.

30 CFR § 75.1400-1 Hoists; brakes, capability.

Brakes on hoists used to transport persons shall be capable of stopping and holding the fully loaded platform, cage, or other device at any point in the shaft, slope, or incline.

30 CFR § 75.1400-2 Hoists; tests of safety catches; records.

A record shall be made in a book of the tests, required by §75.1400, of the safety catches or other devices approved by the Secretary. Each entry shall be signed by the person making the tests and countersigned by a responsible official.

30 CFR § 75.1400-3 Daily examination of hoisting equipment.

Hoists and elevators shall be examined daily, and such examinations shall include, but not be limited to, the following:
(a) *Elevators.* A visual examination of the rope for wear, broken wires, and corrosion, especially at excessive strain points such as near the attachments and where the rope rests on sheaves.
(b) *Hoists and elevators.* (1) An examination of the rope fastenings for defects.
(2) An examination of safety catches.
(3) An examination of the cages, platforms, elevators, or other devices for loose, missing, or defective parts.
(4) An examination of the head sheaves to check for broken flanges, defective bearings, rope alignment, and proper lubrication; and
(5) An observation of the lining and all other equipment and appurtenances installed in the shaft.

30 CFR § 75.1400-4 Certifications and records of daily examinations.

At the completion of each daily examination required by §75.1400, the person making the examination shall certify, by signature and date, that the examination has been made. If any unsafe condition is found during the examinations required by §75.1400-3, the person conducting the examination shall make a record of the condition and the date. Certifications and records shall be retained for one year.

30 CFR § 75.1401 Hoists; rated capacities; indicators.

Hoists shall have rated capacities consistent with the loads handled. An accurate and reliable indicator of the position of the cage, platform, skip, bucket, or cars shall be provided.

30 CFR § 75.1401-1 Hoists; indicators.

The indicator required by §75.1401 of this subpart shall be placed so that it is in clear view of the hoisting engineer and shall be checked daily to determine its accuracy.

30 CFR § 75.1402 Communication between shaft stations and hoist room.

There shall be at least two effective methods approved by the Secretary of signaling between each of the shaft stations and the hoist room, one of which shall be a telephone or speaking tube.

30 CFR § 75.1402-1 Communication between shaft stations and hoist room.

One of the methods used to communicate between shaft stations and the hoist room shall give signals which can be heard by the hoisting engineer at all times while men are underground.

30 CFR § 75.1402-2 Tests of signaling systems.

Signaling systems used for communication between shaft stations and the hoist room shall be tested daily.

30 CFR § 75.1403 Other safeguards.

Other safeguards adequate, in the judgment of an authorized representative of the Secretary, to minimize hazards with respect to transportation of men and materials shall be provided.

30 CFR § 75.1403-1 General criteria.

(a) Sections 75.1403-2 through 75.1403-11 set out the criteria by which an authorized representative of the Secretary will be guided in requiring other safeguards on a mine-by-mine basis under §75.1403. Other safeguards may be required.
(b) The authorized representative of the Secretary shall in writing advise the operator of a specific safeguard which is required pursuant to §75.1403 and shall fix a time in which the operator shall provide and thereafter maintain such safeguard. If the safeguard is not provided within the time fixed and if it is not maintained thereafter, a notice shall be issued to the operator pursuant to section 104 of the Act.
(c) Nothing in the sections in the §75.1403 series in this Subpart O precludes the issuance of a withdrawal order because of imminent danger

30 CFR § 75.1403-2 Criteria--Hoists transporting materials; brakes.

Hoists and elevators used to transport materials should be equipped with brakes capable of stopping and holding the fully loaded platform, cage, skip, car, or other device at any point in the shaft, slope, or incline.

30 CFR § 75.1403-3 Criteria--Drum clutch; cage construction.
(a) The clutch of a free drum on a personnel hoist should be provided with a locking mechanism or interlocked with the brake to prevent accidental withdrawal of the clutch.

(b) Cages used for hoisting persons should be constructed with the sides enclosed to a height of at least six feet and should have gates, safety chains, or bars across the ends of the cage when persons are being hoisted or lowered.
(c) Self-dumping cages, platforms, or other devices used for transportation of persons should have a locking device to prevent tilting when persons are transported.
(d) An attendant should be on duty at the surface when persons are being hoisted or lowered at the beginning and end of each shift.
(e) Precautions should be taken to protect persons working in shaft sumps.
(f) Workers should wear safety belts while doing work in or over shafts.

30 CFR § 75.1403-4 Criteria – Automatic elevators.

(a) The doors of automatic elevators should be equipped with interlocking switches so arranged that the elevator car will be immovable while any door is opened or unlocked, and arranged so that such door or doors cannot be inadvertently opened when the elevator car is not at a landing.
(b) A "Stop" switch should be provided in the automatic elevator compartment that will permit the elevator to be stopped at any location in the shaft.
(c) A slack cable device should be used where appropriate on automatic elevators which will automatically shut-off the power and apply the brakes in the event the elevator is obstructed while descending.
(d) Each automatic elevator should be provided with a telephone or other effective communication system by which aid, or assistance can be obtained promptly.

30 CFR § 75.1429 Guide and wire ropes

Source: Sections 75.1429 through 75.1438 appear at 48 FR 53239, Nov. 25, 1983, unless otherwise noted.
If guide ropes are used in shafts for personnel hoisting applications other than shaft development, the nominal strength (manufacturer's published catalog strength) of the guide rope at installation shall meet the minimum value calculated as follows: Minimum value = Static Load x 5.0.

30 CFR § 75.1430 Wire ropes; scope.

(a) Sections 75.1430 through 75.1438 apply to wire ropes in service used to hoist--(1) Persons
in shafts or slopes underground; or
(2) Loads in shaft or slope development when persons work below the suspended loads. (b) These standards do not apply to wire ropes used for elevators.

30 CFR § 75.1431 Minimum rope strength.
At installation, the nominal strength (manufacturer's published catalog strength) of wire ropes used for hoisting shall meet the minimum rope strength values obtained by the following formulas in which "L" equals the maximum suspended rope length in feet:

(a) *Winding drum ropes* (all constructions, including rotation resistant).
For rope lengths less than 3,000 feet:

Minimum Value = Static Load x (7.0--0.001L)
For rope lengths 3,000 feet or greater:

Minimum Value = Static Load x 4.0
(b) *Friction drum ropes.*
For rope lengths less than 4,000 feet:

Minimum Value = Static Load x (7.0--0.0005L)
For rope lengths 4,000 feet or greater:
Minimum Value = Static Load x 5.0
(c) *Tail ropes* (balance ropes).

Minimum Value = Weight of Rope x 7.0
[48 FR 53239, Nov. 25, 1983; 48 FR 54975, Dec. 8, 1983]

30 CFR § 75.1432 Initial measurement.

After initial rope stretch but before visible wear occurs, the rope diameter of newly installed wire ropes shall be measured at least once in every third interval of active length and the measurements averaged to establish a baseline for subsequent measurements. A record of the measurements and the date shall be made by the person taking the measurements. This record shall be retained until the rope is retired from service.

30 CFR § 75.1433 Examinations.

(a) At least once every fourteen calendar days, each wire rope in service shall be visually examined along its entire active length for visible structural damage, corrosion, and improper lubrication or dressing. In addition, visual examination for wear and broken wires shall be made at stress points, including the area near attachments, where the rope rests on sheaves, where the rope leaves the drum, at drum crossovers, and at change-of-layer regions. When any visible condition that results in a reduction of rope strength is present, the affected portion of the rope shall be examined on a daily basis.
(b) Before any person is hoisted with a newly installed wire rope or any wire rope that has not been examined in the previous fourteen calendar days, the wire rope shall be examined in accordance with paragraph (a) of this section.
(c) At least once every six months, nondestructive tests shall be conducted of the active length of the rope, or rope diameter measurements shall be made**--**
(1) Wherever wear is evident.
(2) Where the hoist rope rests on sheaves at regular stopping points.
(3) Where the hoist rope leaves the drum at regular stopping points; and
(4) At drum crossover and change-of-layer regions.
(d) At the completion of each examination required by paragraph (a) of this section, the person making the examination shall certify, by signature and date, that the examination has been made. If any condition listed in paragraph (a) of this standard

is present, the person conducting the examination shall make a record of the condition and the date. Certifications and records of examinations shall be retained for one year.
(e) The person making the measurements or nondestructive tests as required by paragraph (c) of this section shall record the measurements or test results and the date. This record shall be retained until the rope is retired from service**.**

30 CFR § 75.1434 Retirement criteria.

Unless damage or deterioration is removed by cutoff, wire ropes shall be removed from service when any of the following conditions occurs:
(a) The number of broken wires within a rope lay length, excluding filler wires, exceeds either--
(1) Five percent of the total number of wires; or
(2) Fifteen percent of the total number of wires within any strand.
(b) On a regular lay rope, more than one broken wire in the valley between strands in one rope lay length.
(c) A loss of more than one-third of the original diameter of the outer wires.
(d) Rope deterioration from corrosion.
(e) Distortion of the rope structure.
(f) Heat damage from any source.
(g) Diameter reduction due to wear that exceeds six percent of the baseline diameter measurement; or
(h) Loss of more than ten percent of rope strength as determined by nondestructive testing.

30 CFR § 75.1435 Load end attachments.

(a) Wire rope shall be attached to the load by a method that develops at least 80 percent of the nominal strength of the rope.
(b) Except for terminations where use of other materials is a design feature, zinc (spelter) shall be used for socketing wire ropes. Design feature means either the manufacturer's original design or a design approved by a registered professional engineer.
(c) Load end attachment methods using splices are prohibited.

30 CFR § 75.1436 Drum end attachment.

(a) For drum end attachment, wire rope shall be attached--
(1) Securely by clips after making one full turn around the drum spoke.
(2) Securely by clips after making one full turn around the shaft, if the drum is fixed to the shaft: or
(3) By properly assembled anchor bolts, clamps, or wedges, provided that the attachment is a design feature of the hoist drum. Design feature means either the manufacturer's original design or a design approved by a registered professional engineer.
(b) A minimum of three full turns of wire rope shall be on the drum when the rope is extended to its maximum working length

30 CFR § 75.1437 End attachment re-termination.

Damaged or deteriorated wire rope shall be removed by cutoff and the rope re-terminated where there is:
(a) More than one broken wire at an attachment.
(b) Improper installation of an attachment.
(c) Slippage at an attachment; or
(d) Evidence of deterioration from corrosion at an attachment.

30 CFR § 75.1438 End attachment replacement.
Wire rope attachments shall be replaced when cracked, deformed, or excessively worn.

Subpart O--Personnel Hoisting

Sec. 77.1400 Personnel hoists and elevators.

Except as provided in §77.1430, the sections in this Subpart O apply only to hoists and elevators, together with their appurtenances, that are used for hoisting persons.

Sec. 77.1401 Automatic controls and brakes.

Hoists and elevators shall be equipped with overspeed, overwind, and automatic stop controls and with brakes capable of stopping the elevator when fully loaded.

Sec. 77.1402 Rated capacity.

Hoists and elevators shall have rated capacities consistent with the loads handled.

Sec. 77.1402-1 Maximum load; posting.

The operator shall designate the maximum number of men permitted to ride on each hoist or elevator at one time; this limit shall be posted on each elevator and on each landing.

Sec. 77.1403 Daily examination of hoisting equipment.

Hoists and elevators shall be examined daily, and such examinations shall include, but not be limited to, the following:

(a) *Elevators.* (1) A visual examination of the ropes for, broken wires, and corrosion, especially at excessive strain points such as near the attachments and **where** the rope rests on the sheaves;(2) An examination of the elevator for loose, missing, or defective parts.
(b) *Hoists and elevators.* (1) An examination of the rope fastenings for defects;(2) An examination of sheaves for broken flanges, defective bearings, rope alignment, and

proper lubrication; and (3) An examination of the automatic controls and brakes required under §77.1401.

Sec. 77.1404 Certifications and records of daily examinations.

At the completion of each daily examination required by §77.1403, the person making the examination shall certify, by signature and date, that the examination has been made. If any unsafe condition is found during the examinations required by §77.1403, the person conducting the examination shall make a record of the condition and the date. Certifications and records shall be retained for one year.

Sec. 77.1405 Operation of hoisting equipment after repairs.

Empty conveyances shall be operated at least one round trip before hoisting persons after any repairs.

WIRE ROPES

Sec. 77.1430 Wire ropes; scope.

(a) Sections 77.1431 through 77.1438 apply to wire ropes in service used to hoist--
(1) Persons in shafts and slopes underground.
(2) Persons with an incline hoist on the surface; or
(3) Loads in shaft or slope development when persons work below suspended loads.
(b) These standards do not apply to wire ropes used for elevators.

Sec. 77.1431 Minimum rope strength.

At installation, the nominal strength (manufacturer's published catalog strength) of wire ropes used for hoisting shall meet the minimum rope strength values obtained by the following formulas in which "L" equals the maximum suspended rope length in feet:
(a) *Winding drum ropes* (all constructions, including rotation resistant).

For rope lengths less than 3,000 feet:
Minimum Value=Static Load x (7.0-0.001L)
For rope lengths 3,000 feet or greater:
Minimum Value=Static Load x 4.0

(b) *Friction drum ropes.*
For rope lengths less than 4,000 feet:
Minimum Value=Static Load x (7.0-0.0005L)
For rope lengths 4,000 feet or greater:
Minimum Value=Static Load x 5.0

(c) *Tail ropes* (balance ropes).

Minimum Value=Weight of Rope x 7.0

Sec. 77.1432 Initial measurement.

After initial rope stretch but before visible wear occurs, the rope diameter of newly installed wire ropes shall be measured at least once in every third interval of active length and the measurements averaged to establish a baseline for subsequent measurements. A record of the measurements and the date shall be made by the person taking the measurements. This record shall be retained until the rope is retired from service.

Sec. 77.1433 Examinations.

(a) At least once every fourteen calendar days, each wire rope in service shall be visually examined along its entire active length for visible structural damage, corrosion, and improper lubrication or dressing. In addition, visual examination for wear and broken wires shall be made at stress points, including the area near attachments, where the rope rests on sheaves, where the rope leaves the drum, at drum crossovers, and at change-of-layer regions. When any visible condition that results in a reduction of rope strength is present, the affected portion of the rope shall be examined on a daily basis.
(b) Before any person is hoisted with a newly installed wire rope or any wire rope that has not been examined in the previous fourteen calendar days, the wire rope shall be examined in accordance with paragraph (a) of this section.

(c) At least once every six months, nondestructive tests shall be conducted of the active length of the rope, or rope diameter measurements shall be made:
(1) Wherever wear is evident.
(2) Where the hoist rope rests on sheaves at regular stopping points.
(3) Where the hoist rope leaves the drum at regular stopping points; and
(4) At drum crossover and change-of-layer regions.

(d) At the completion of each examination required by paragraph (a) of this section, the person making the examination shall certify, by signature and date, that the examination has been made. If any condition listed in paragraph (a) of this standard is present, the person conducting the examination shall make a record of the condition and the date. Certifications and records of examinations shall be retained for one year.

(e) The person making the measurements or nondestructive tests as required by paragraph (c) of this section shall record the measurements or test results and the date. This record shall be retained until the rope is retired from service.

Sec. 77.1434 Retirement criteria.

Unless damage or deterioration is removed by cutoff, wire ropes shall be removed from service when any of the following conditions occurs:

(a) The number of broken wires within a rope lay length, excluding filler wires, exceeds either--

(1) Five percent of the total number of wires; or

(2) Fifteen percent of the total number of wires within any strand.

(b) On a regular lay rope, more than one broken wire in the valley between strands in one rope lay length.

(c) A loss of more than one-third of the original diameter of the outer wires.

(d) Rope deterioration from corrosion.

(e) Distortion of the rope structure.

(f) Heat damage from any source.

(a) Diameter reduction due to wear that exceeds six percent of the baseline diameter measurement; or

(b) Loss of more than ten percent of rope strength as determined by nondestructive testing.

Sec. 77.1435 Load end attachments.

(a) Wire rope shall be attached to the load by a method that develops at least 80 percent of the nominal strength of the rope.

(b) Except for terminations where use of other materials is a design feature, zinc (spelter) shall be used for socketing wire ropes. Design feature means either the manufacturer's original design or a design approved by a registered professional engineer.

(c) Load end attachment methods using splices are prohibited.

Sec. 77.1436 Drum end attachment.

(a) For drum end attachment, wire rope shall be attached--

(1) Securely by clips after making one full turn around the drum spoke.

(2) Securely by clips after making one full turn around the shaft, if the drum is fixed to the shaft: or

(3) By properly assembled anchor bolts, clamps, or wedges, provided that the attachment is a design feature of the hoist drum. Design feature means either the manufacturer's original design or a design approved by a registered professional engineer.

(b) A minimum of three full turns of wire rope shall be on the drum when the rope is extended to its maximum working length.

Sec. 77.1437 End attachment re-termination.

Damaged or deteriorated wire rope shall be removed by cutoff and the rope re-terminated where there is—

(a) More than one broken wire at an attachment.
(b) Improper installation of an attachment.
(c) Slippage at an attachment; or
(d) Evidence of deterioration from corrosion at an attachment.

Sec. 77.1438 End attachment replacement.

Wire rope attachments shall be replaced when cracked, deformed, or excessively worn.

Unit 4

EXAMPLE OF DAILY INSPECTIONS OF HOISTING EQUIPMENT

Date _____ **Time** _____

Note: Use check (√) mark after items listed if in safe operating condition. If defects or unsafe conditions are found, state action taken and promptly report to the operator or agent. (Defects shall be corrected promptly).

Items 1 through 17 shall be entered DAILY	**Check Mark (√)**	**Comments**
1. Visual examination of hoist ropes for wear, broken wires & corrosion, especially at excessive strain points near attachments and where ropes rests on sheaves.		
2. Examine rope fastenings for defects, connections, links and safety chains, alignment, and lubrication.		
3. Examine cages, platforms, elevators, or other devices for loose missing or defective parts.		
4. Examine head sheaves for broken flanges, defective bearings, rope alignment, & proper lubrication		
5. Examine head frame, headgear, bull wheels, lighting systems, & other facilities		
6. Examine shaft guides, shaft walls, lining &all other equipment & appurtenances installed in the shaft.		
7. Examine overspeed, overwind, over travel, Lilly switch, automatic stop controls & stop switch.		
8. Examine braking systems		
9. Examine slack cable device, which will automatically shut off power and apply brakes in the event the elevator is obstructed while descending.		
10. Anchorage of hoist; check for loose bolts, etc.		
11. Cages, platforms, elevators, or other devices such as skip, bucket, or cards position indicator.		
12. Test of signaling systems, used for communication between shaft stations and the hoist room. Telephone or other effective communication system by which aid can be obtained promptly.		
13. 3 wraps of rope around drum; fastening to spoke, etc.		
14. *Cage operated one round trip before men transported.		
15. Interlocking switches on doors or gates; landing gates or doors.		
16. Examine safety catches		
17. Examine hoist housing construction to ensure clean of excess oil & extraneous materials		
Test of safety catches (monthly) Date Tested: _____ _____ Countersigned: _____		

*Completed at the beginning of each shift when the hoist has been idle for one hour or more and when a fault occurs during normal operation.

Signature by examiner (Authorized Person) **Signed**

_____

AN EXAMPLE OF A WIRE ROPE EXAMINATION
At least every 14 Calendar Day

Date: _____ **Time**: _____

At least every 14 calendar days, each wire rope in service shall be visually examined along its entire active length for visible structural damage, corrosion and improper lubrication or dressing. In addition, visual examination for wear and broken wires shall be made at stress points, including the area near the attachments, where the rope rest on sheaves, where the rope leaves the drum, at drum crossovers, and at change-of-layer regions. Where any visible condition that results in a reduction of rope strength is present, the affected portion of rope shall be examined on a daily basis.

Note: Use check (√) mark after items listed if in safe operating condition. If defects or unsafe conditions are found, state action taken and promptly report to the operator or agent. Defects shall be corrected promptly.

Items shall be entered at least every 14 calendar days	**Check Mark (√)**					**Comments**
		#1	#2	#3	#4	
1. Visual examination of hoist ropes for wear, broken wires & corrosion, especially at excessive strain points near attachments and where ropes rests on sheaves.						
2. Examine rope fastenings for defects, connections, links and safety chains, alignment, and lubrication.						
3. Examine Hoist Ropes: • Rope at attachments on cage end • Rope at attachment on counterweight end • Ropes at head sheaves with cage up • Ropes at head sheaves with counterweight up • Rope between head sheave and cage with cage up • Rope between head sheave and counterweight with counterweight up • Rope at drum with cage up • Rope at drum with counterweight up • Remaining length of rope						
4. Examine Balance Ropes: • Rope at socket • Rope during slow speed • Rope at clamps • Ropes travel through guide timbers						

5. Examine Guide Ropes: • Rope at connection in headframe • Rope between connection(s) • Rope at connection(s) in sump						
6. Examine Hoist House • Hoist drum and threads • Housekeeping • Lights						
7. Examine Headframe • Cage wood retarder • Counterweight wood retarder • Structure • Lights						
8. Examine head sheaves for broken flanges, defective bearings, rope alignment, & proper lubrication						
9. Examine head frame, headgear, bull wheels, lighting systems, sheaves, flanges, bearings, lubrication & other facilities						
10. Examine (3) wraps of rope around drum; fastening to spoke, etc.						
11. Examine Shaft Bottom • Wood retarders • Sump • Balance rope guide timbers						

Signature by examiner **Signed**
(Authorized Person) _____

AN EXAMPLE OF A DAILEY INSPECTION OF HOISTING EQUIPMENT

DAILY INSPECTIONS OF HOISTING EQUIPMENT

Date _____ **Time** _____ **Shift** _____

Note: Use check (√) mark after items listed if in safe operating condition. If unsafe conditions are noted, state action taken:

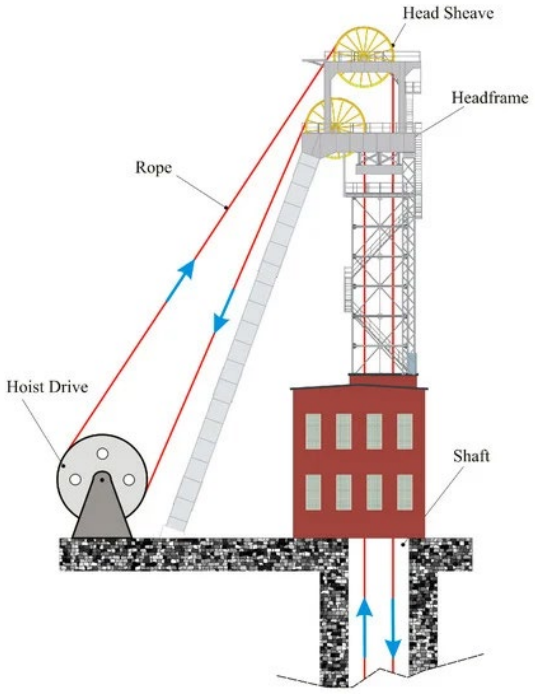
Items 1 through 13 shall be entered DAILY	**Check Mark (√)**	**Comments**
1. Visual examination of hoist ropes.		
2. Rope fastening, alignment, and lubrication.		
3. Safety catches. (Visual)		
4. Examination of cage, platform, elevators, etc.		
5. Head sheaves, flanges, bearings, lubrication.		
6. Ride top of cage or elevator to check guides buttons, power wires, etc.		
7. Overwind, overspeed, and automatic stop controls.		
8. Anchorage of hoist; check for loose bolts, etc.		
9. Cage, platform, skip, bucket, or position indicator.		
10. Signal systems.		
11. Three wraps of rope around drum. fastening to spoke, etc.		
12. Cage operated one round trip before men transported.		
13. Landing gates or doors locks.		
14. Test of safety catches (monthly) Date: _____		

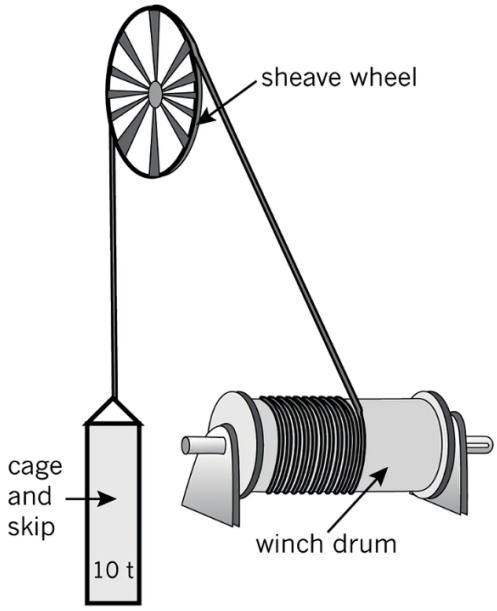
Signature by examiner **Signed** _____

Unit 5
MINE HOIST

Modern Hoisting Systems Updates:
Modern hoisting systems have significantly advanced due to the integration of Programmable Logic Controllers (PLCs) and Human-Machine Interfaces (HMIs). These technologies, combined with encoders, switches, and safety features, enable precise control, monitoring, and automation of hoist operations. PLCs optimize performance and enhance safety by incorporating features such as overspeed and overtravel prevention, as well as emergency braking. The HMI provides critical information to the operator, facilitating efficient monitoring and troubleshooting.

Rather than creating a separate section for PLC and HMI, their integration has been incorporated into relevant sections of the study guide. This approach offers a more comprehensive and thorough understanding of how these technologies contribute to the overall operation and safety of hoisting equipment.


Head Sheave
Headframe
Rope
Hoist Drive
Shaft


sheave wheel
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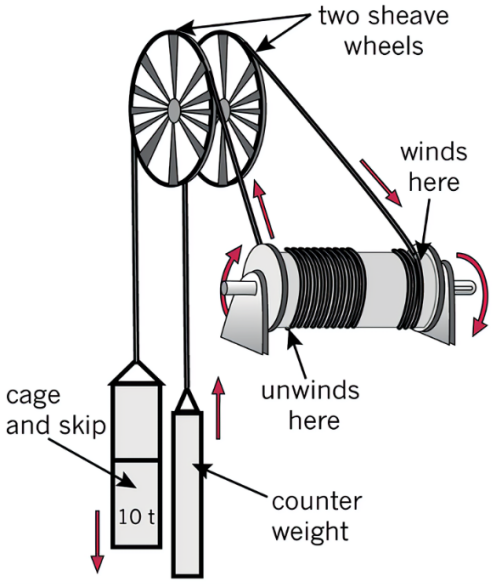
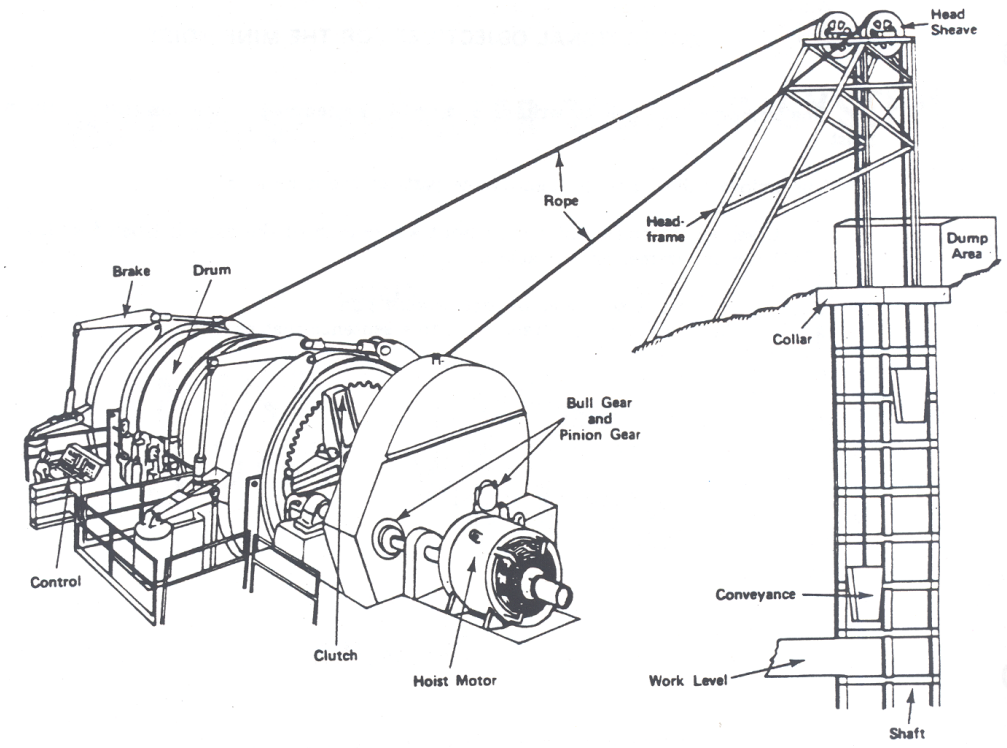

two sheave
wheels
winds
here
unwinds
here
cage
and skip
10 t
counter
weight

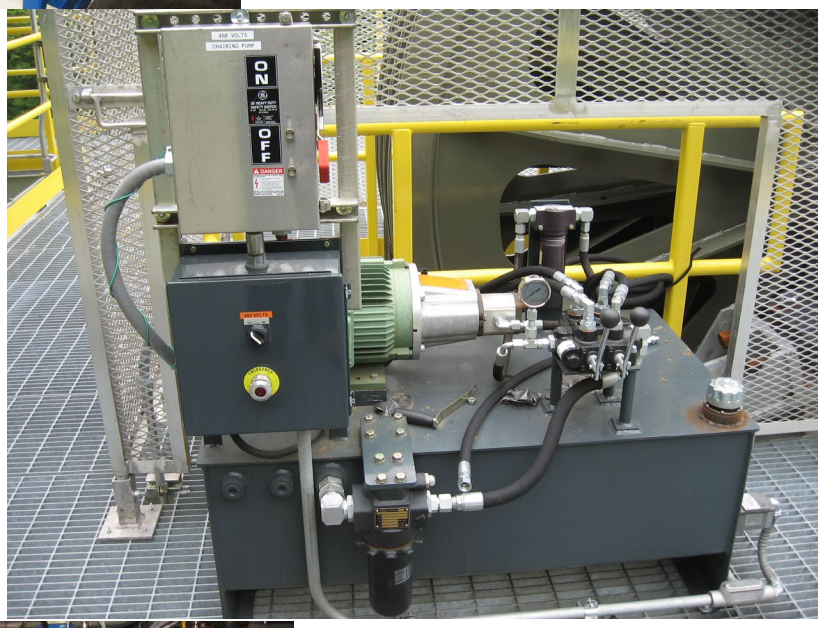


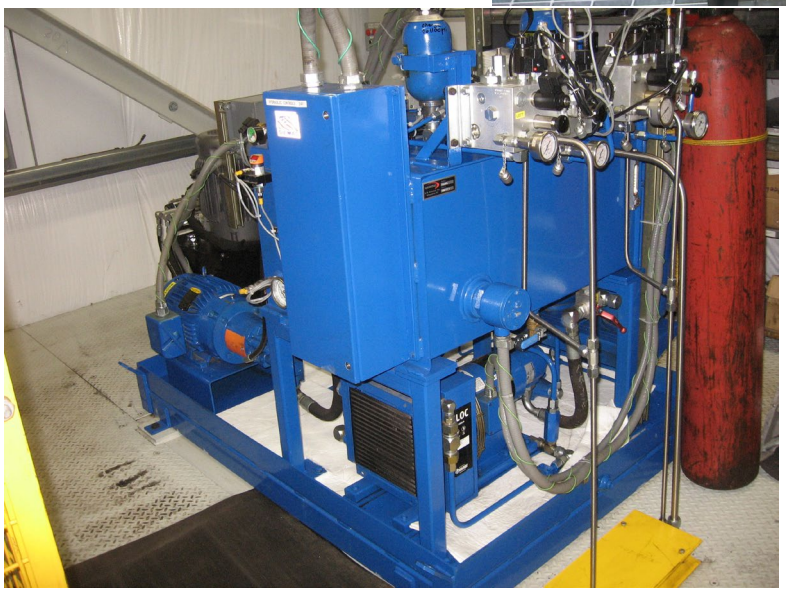
Purpose of mine Hoist:
The mine hoist lowers men and materials into the mine and raises men, materials, ore and waste out of the mine.

The principal parts of the hoist are:

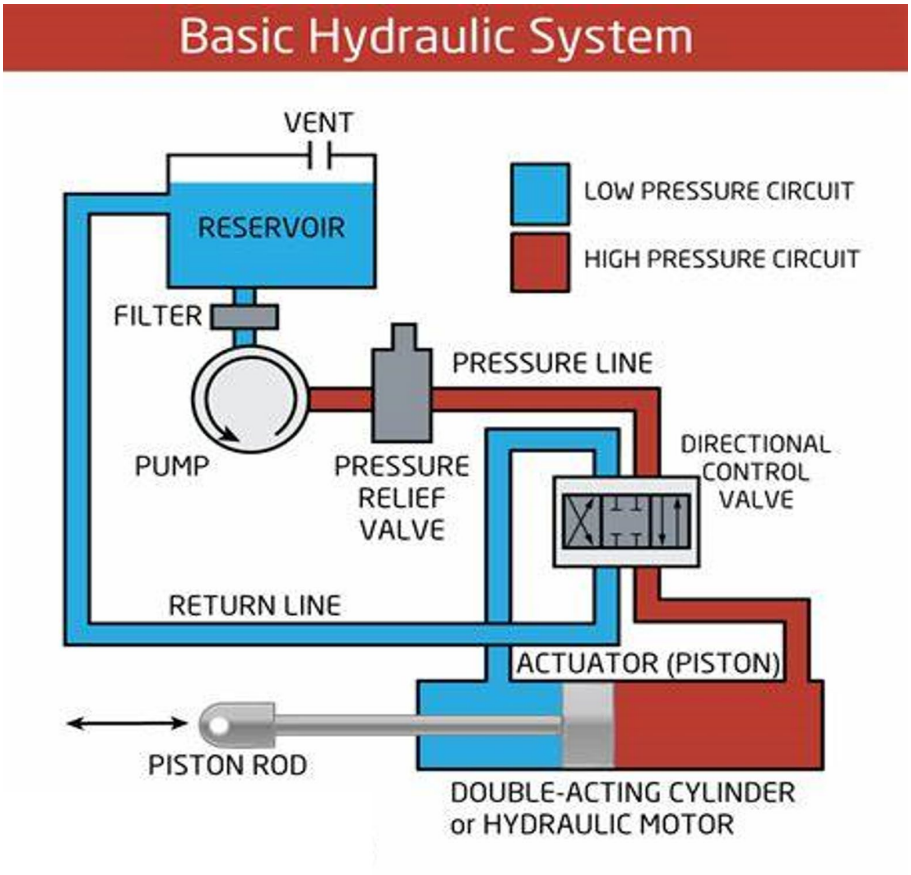
- **MINE SHAFT —** the path from the surface to the underground workings.
- **COLLAR** — the area surrounding the surface opening of the shaft.
- **DUMP AREA** — the area where ore and waste are deposited.
- **WORK LEVEL** — the mine level from which ore or waste is being hoisted.
- **CONVEYANCE —** the platform on which men, materials ore and waste are hoisted/lowered.
- **HEADFRAME** — the structure which holds the head sheave, rope(s), and conveyance.
- **HEADSHEAVE** — the grooved wheel which supports the rope.
- **HOIST ROPE** — the wire cable which raises and lowers the conveyance.
- **HOIST DRUM** or **WHEEL** — the drum or wheel which raises and lowers the hoist rope.
- **HOIST MOTOR** — the motor which turns the hoist drum or wheel.
- **SPEED REDUCER** – reduces the motor revolutions per minute (RPM) and it is connected to both the motor and hoist drum.
- **PINION** and **BULL GEARS** — gears which connect the hoist motor to the hoist drum or the hoist wheel.
- **CLUTCH** — the device which engages or disengages the drum from the hoist motor.
- **BRAKE** — the device which slows, stops, and holds the hoist rope.
- **CONTROL** — the station from which the hoist is operated.

Unit 6
HYDRAULIC SYSTEM





A **Hydraulic System** enables the hoisting engineer to apply or release the hoist brakes and to engage or disengage the clutch. These operations can be performed from a remote station with little effort from the operator. Controls cause oil under high pressure to force a piston or other mechanism to move and perform the desired work.



A basic hydraulic system consists of these parts:

- A Hydraulic Pump that will pressurize oil.
- An electric Drive Motor that operates the pump.
- A Drive Motor Control that will start and stop the drive motor.
- An Accumulator that will store oil at high pressure. The accumulator is usually a cylinder and piston. Oil at high pressure is stored beneath the piston. The space about the piston may be filled with pressurized air to force the piston downward against the oil. Sometimes coiled springs or weights instead of high-pressure air are used to force the piston against the oil.
- An Operating Control which the hoisting engineer uses to control the flow of oil in the system.
- A Sump that stores oil at low pressure.
- An Operating Mechanism, usually a cylinder and piston, that does the work. This mechanism may apply or release the brake or engage or disengage the clutch. If oil flows from the accumulator to the operating mechanism, the piston moves upward, lifts the weight, and moves levers in one direction. If the oil flows from the operating mechanism to the sum, the piston moves downward because of the weight, and the levers move in the opposite direction.

The system works as follows:

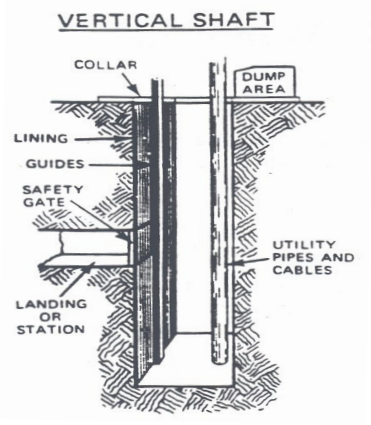
- Using operating control, the hoisting engineer allows oil to flow from the accumulator into the operating mechanism.
- The piston moves upward and may, for example, engage the clutch.
- When the hosting engineer wants to disengage the clutch, the hoisting engineer again uses the operating control. Oil is allowed to flow from the operating mechanism to the sump.
- The piston in the operating mechanism will move downward because of the weight.
- As oil flows out of the accumulator, the accumulator piston moves downward. This movement causes the drive motor control to start the drive motor.
- The drive motor operates the pump which pumps oil from the sump to the accumulator.
- This increase in oil raises the accumulator piston.
- When sufficient oil has been pumped, the upward movement of the accumulator piston shuts off the drive motor.

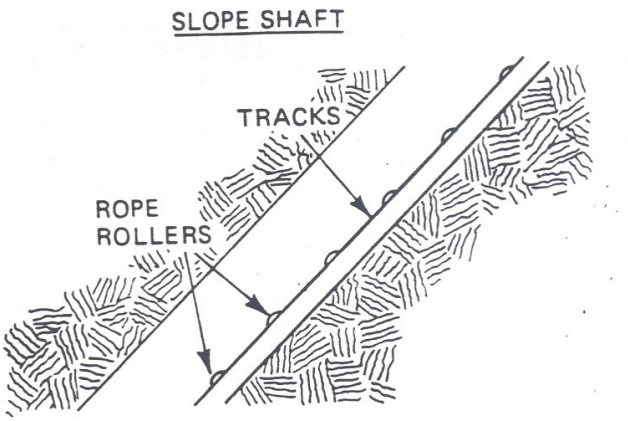
Unit 7
SHAFT

Shaft sinking is a complex engineering process involving the excavation of a vertical shaft from the surface to a desired depth. This technique is primarily used in mining and civil engineering projects to access underground resources or create underground structures.

A shaft serves as a vertical or inclined passageway for transporting materials, personnel, and utilities between the surface and underground workings. Shafts are typically classified into two main types: Vertical and Slope shafts.

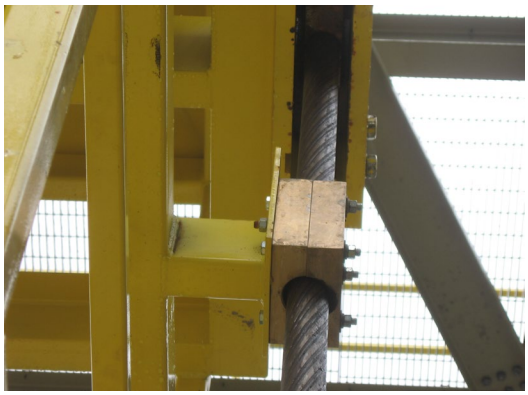
Both vertical and slope shafts are essential components of underground mining operations. The choice of shaft type depends on various factors, including the depth of the deposit, the geological conditions, and the specific mining method employed.





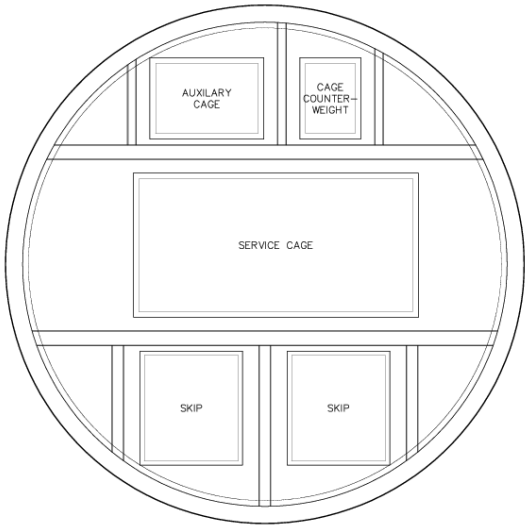
A shaft may be divided into Compartments. Each compartment provides a path for a conveyance, counterweight, cables, or other mining equipment.

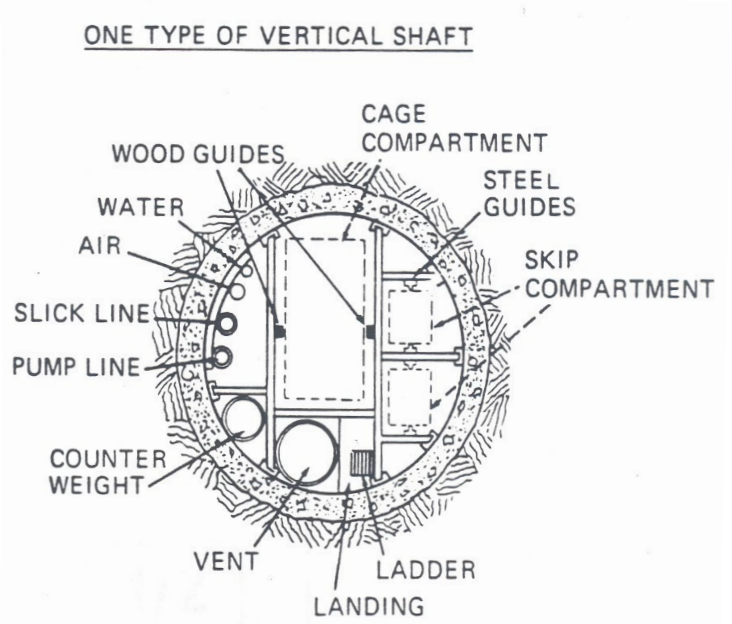
- Collar is the area surrounding the shaft opening at the face of the mine.
- Shaft Lining is the sides of the shaft. It is made of timber, steel, or cement.
- Shaft Guides keep the conveyance in proper position. Vertical shafts have fixed guides made of wood timbers or steel rails or rope guides of locked coil ropes. Slope shafts have tracks to guide the conveyance and rollers to guide the rope.
- Landing or Station is the opening of a level onto the shaft.
- Safety Gate is the guard across each opened landing of the shaft.
- Dump is the area where the conveyance empties its load of coal or ore.
- Utility Pipes and Cables are the paths for power, water, air, and communications. They enter the mine through the shaft.



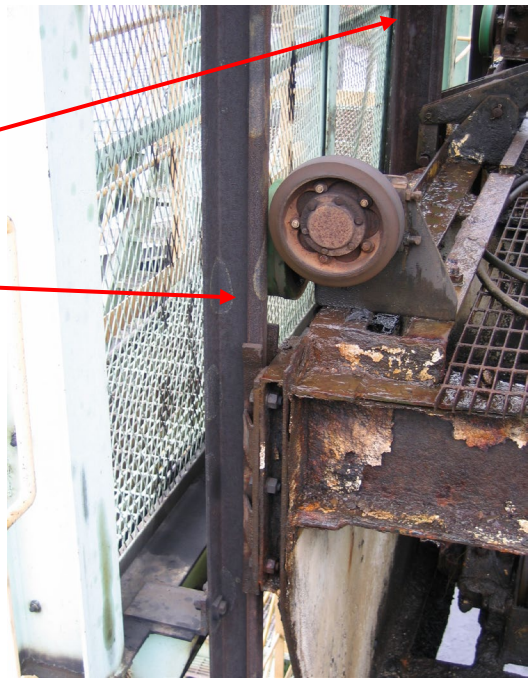
Guide Rope

Safety Gate

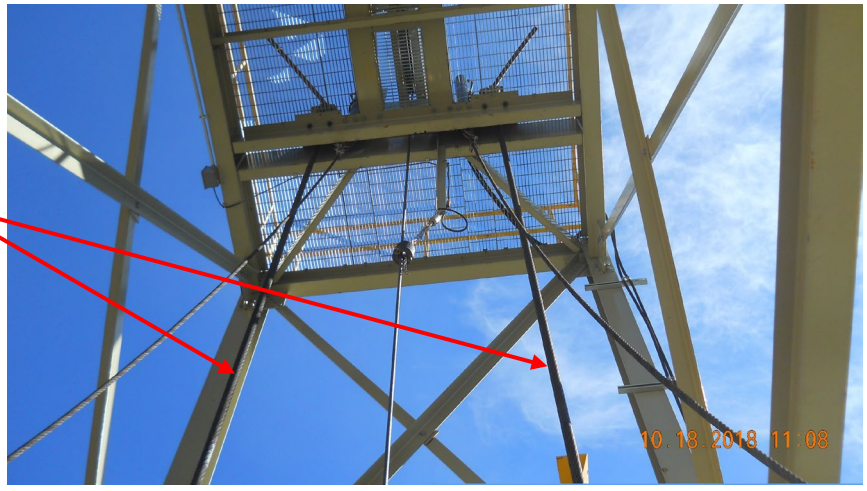

AUXILARY CAGE
CAGE COUNTER-WEIGHT
SERVICE CAGE
SKIP
SKIP


ONE TYPE OF VERTICAL SHAFT
CAGE COMPARTMENT
WOOD GUIDES
STEEL GUIDES
WATER
AIR
SKIP COMPARTMENT
SLICK LINE
PUMP LINE
COUNTER WEIGHT
VENT
LADDER
LANDING

Shaft Guide Rails



Ropes Used as Shaft Guide

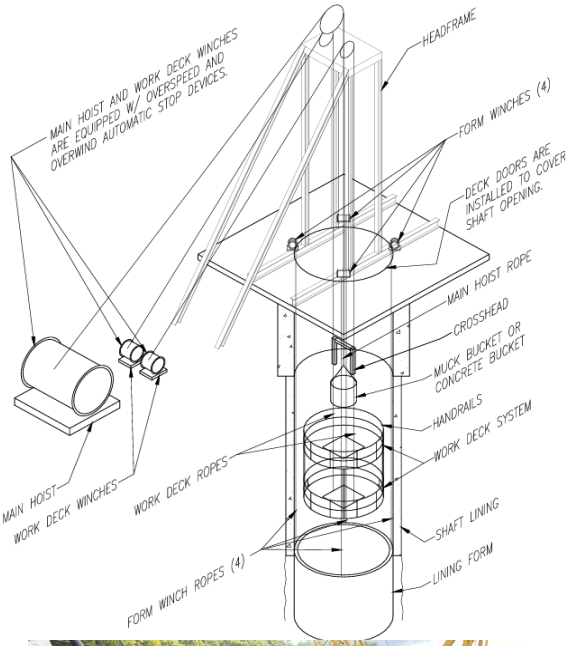


Shaft Sinking Work Deck Winches: A Critical Component

Shaft sinking work deck winches are essential pieces of equipment used in the construction of deep shafts for mining projects. These winches are responsible for the precise and controlled movement of personnel, equipment, and materials within the shaft.

They are designed to handle heavy loads under demanding conditions, ensuring the safety and efficiency of shaft sinking operations.

By carefully selecting and maintaining shaft sinking work deck winches, mining and construction companies can optimize their operations and ensure the safety of their workforce.



Unit 8

CONVEYANCES

A conveyance is a platform that carries men and equipment to the working levels of the mine, and carries men, equipment, ore, and muck to the surface.

In a shaft mine there are two basic kinds of conveyance:

- Cage—to carry men and equipment.
- Skip—to carry ore, waste, and some heavy equipment.

Skip

Muck Bucket

Muck Bucket

The parts of a cage are: (See Figure 1A and 1B)

- The man compartment is the protected enclosure that the men ride in.
- The bonnet protects the man compartment from falling objects.

Figure 1A

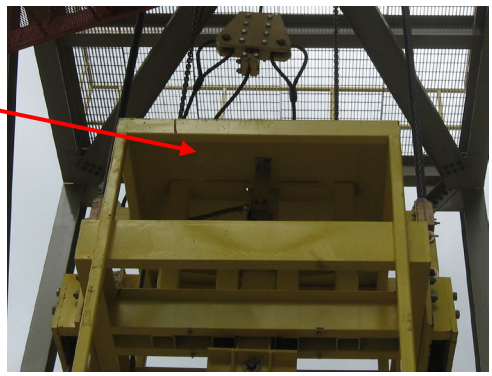


Figure 1B

A skip is designed to hold the materials being hoisted for the mine shaft. The skip is designed to dump its contents by:

- turning upside down, or
- opening its bottom or lower side.

The parts of an upside-down dumping skip are: (See Figure 3)

- The dump roller is a wheel or roller mounted on the side of the conveyance.
- The bail is the framework that supports the skip.
- The bucket is the container for the ore, waste, or heavy equipment.
- The latch holds the skip upright.
- The track or scroll engages the dump roller and dumps the skip.

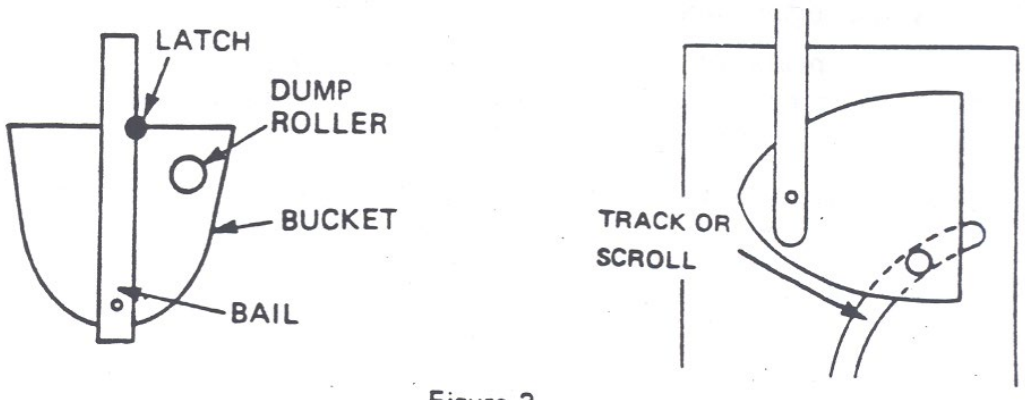


Figure 3

A skip that dumps its contents by opening its bottom or lower side is called a bottom-dump skip. The parts of a bottom-dump skip are: (See Figure 4)

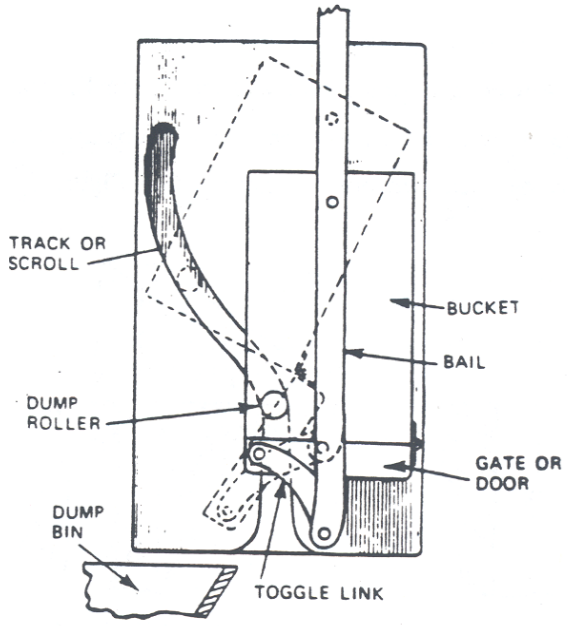


Figure 4

- The gate or door is the side or bottom that opens to let the materials out.
- The actuating mechanism is the linkage that causes the gate to open. It includes the dump roller, and the track or scroll.
- The bail is the framework that supports the skip.
- The bucket is the container for the ore, waste, and heavy equipment.
- The safety latch is the device which prevents the gate from opening accidentally. It is actuated by the toggle link as the dump roller enters the scroll.

As the skip nears the dump point, the dump roller follows along a track or scroll. The shape of the track or scroll causes the roller to move horizontally and turn the skip upside down or open the skip dump gates.

Some conveyances are combinations of a skip and a cage. These combinations may look like: (See

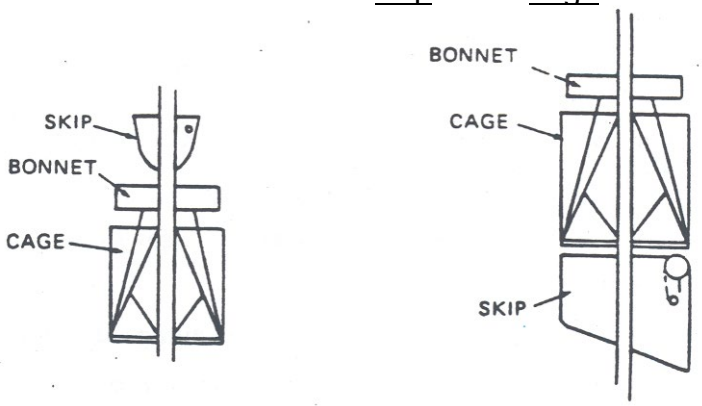


Figure 5

A vertical shaft hoist may have:

- A single rope and single conveyance. (See Figure 6)
- Two ropes with a conveyance and a counterweight. (See Figure 7)
- Two ropes with two conveyances. (See Figure 8)

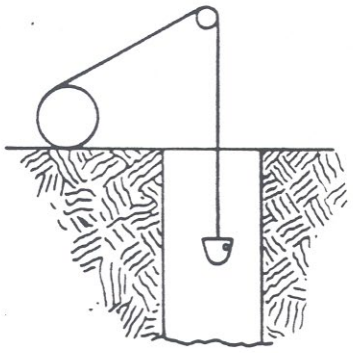


Figure 6

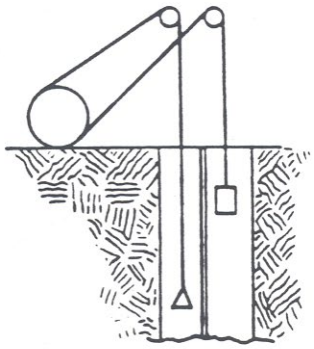


Figure 7

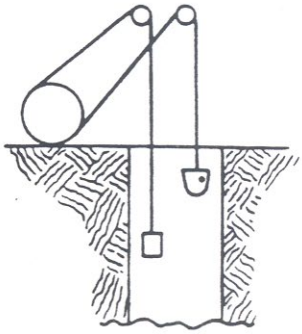


Figure 8

A tail rope may be connected to the bottom of the conveyances or conveyance and counterweight to balance the weight of the hoist rope. (See Figure 9)

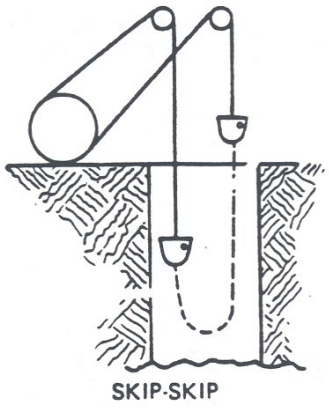


Figure 9

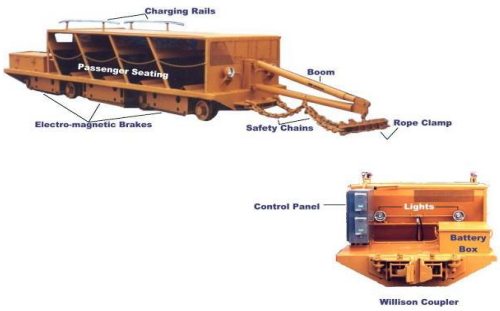
In a slope mine there are also two basic kinds of conveyance:

- Personnel cars—used to carry men and equipment up and down the slope. Personnel cars are fitted with seating facilities.
- Ore cars—used to carry ore, waste, and some heavy equipment up and down the slope. Ore cars can be dumped by turning them upside down or by opening the bottom. (See Figure 10)

Figure 10

Brakeman Car

The Brakeman Safety Car is an eight-wheeled unit equipped with six magnetic track brakes to prevent runaway trips in slope mines caused by rope breakage or hoist failure. It offers overspeed protection for descending personnel or materials and rollback protection for ascending loads. This safety car is recommended for use on slopes with gradients up to 18 degrees.

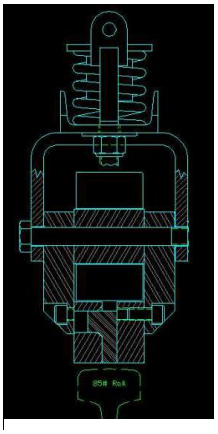


The Brakeman Safety Car employs six electro-magnetic brakes that are activated by four onboard batteries in response to an overspeed condition or emergency stop. When energized, these brakes exert approximately 15,000 pounds of clamping force against the rail, decelerating and stopping the car.

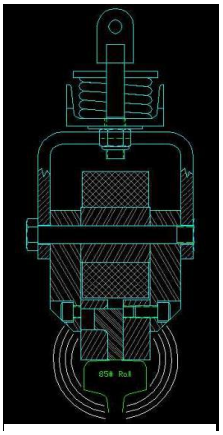
It's important to note that the Brakeman Safety Car does not have a failsafe braking system like those found on hoisting systems. Therefore, regular battery maintenance is crucial to ensure the car's ability to function correctly in an emergency.

The electro-magnetic brakes are designed to halt the Brakeman Car in the event of a rope failure or slackening.

Car Brakes and Brake Amp Indicator



De-energized



Energized

Emergency Braking Device

The safety catches (aka. safety dog) is an emergency braking device that is attached to the conveyance. A typical safety dog is shown in Figure 2.

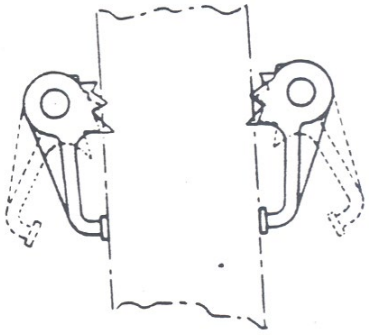
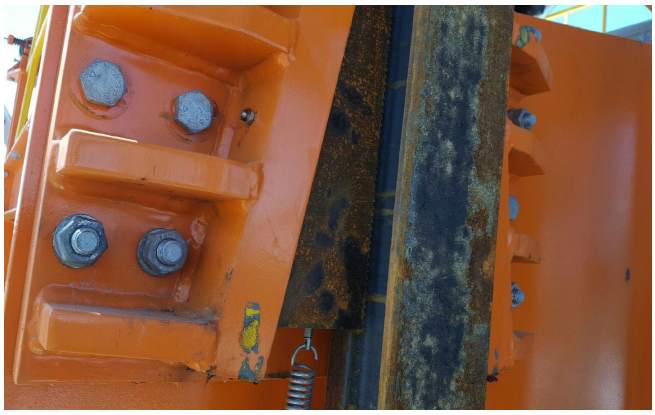


Figure 2



Fail Safe Braking System:
The safety catches (dog) is activated by a spring if slack appears in the hoist rope. When activated, the safety dog digs into the shaft guides or tighten on the guide ropes, bringing the conveyance to a stop.

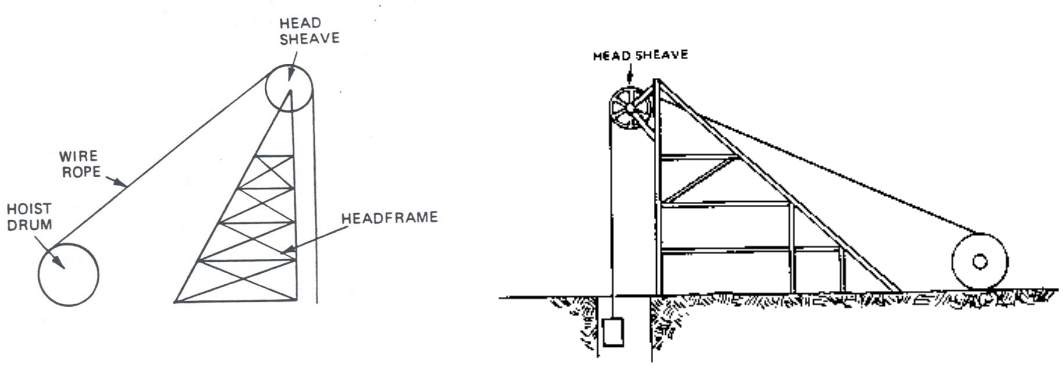
The guide shoe is the part of the conveyance that travels along the shaft guide. The guide shoe prevents the conveyance from moving horizontally in the shaft.

Guide roller are used on the man cage to keep the conveyance in the center of the shaft and from hitting the shaft structure.

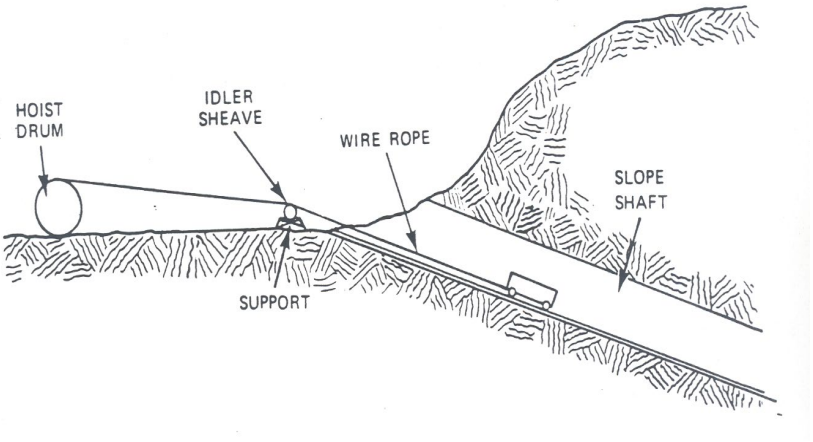
Unit 9
HEAD FRAME

The Headframe supports the head sheave or head (Koepe) wheel over a shaft. The headframe for a drum hoist holds a head sheave which supports the hoist rope.

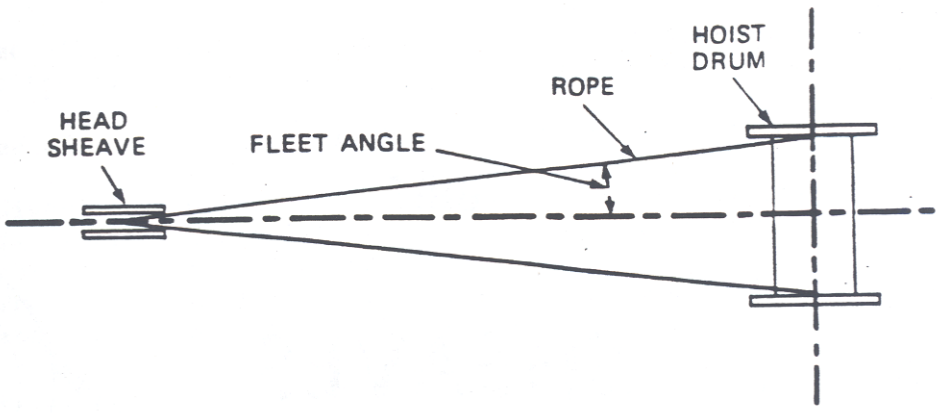
In a vertical shaft it looks like this



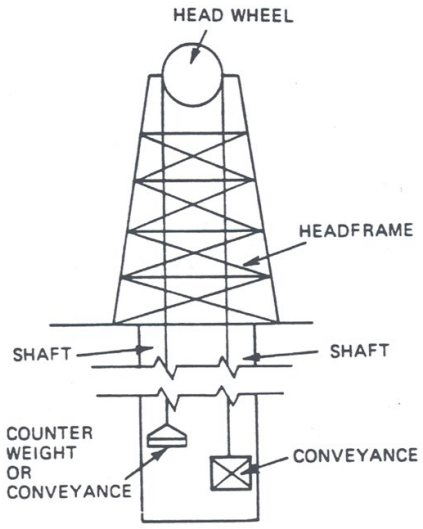
In a slope shaft an idle sheave and support replace the head sheave and headframe



The angle between the center line of the sheave and the hoist rope is called the fleet angle. The fleet angle must not be more than 1 1/2 degrees for smooth drums or 2 degrees for grooved drums or excessive wear on the rope will result.



The Headframe for Koepe or friction hoist may support the wheel and drive motor.



Unit 10
SHEAVES

A sheave is a grooved wheel which supports the hoist rope and changes the angle of repose.

There are three kinds of sheaves:

- An idler sheave which supports a long length of the rope. (See Figure 1 and 1A)
- A knuckle or curve sheave which supports the rope where it changes direction. (See Figure 2)
- A head sheave which supports the rope and the conveyance at the head of the shaft. (See Figure 3 and 3A)

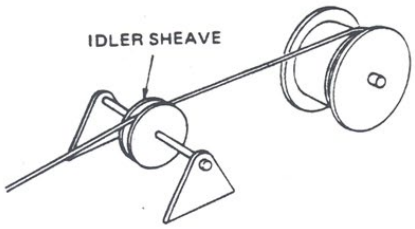


Figure 1

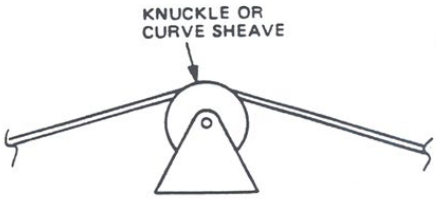


Figure 2

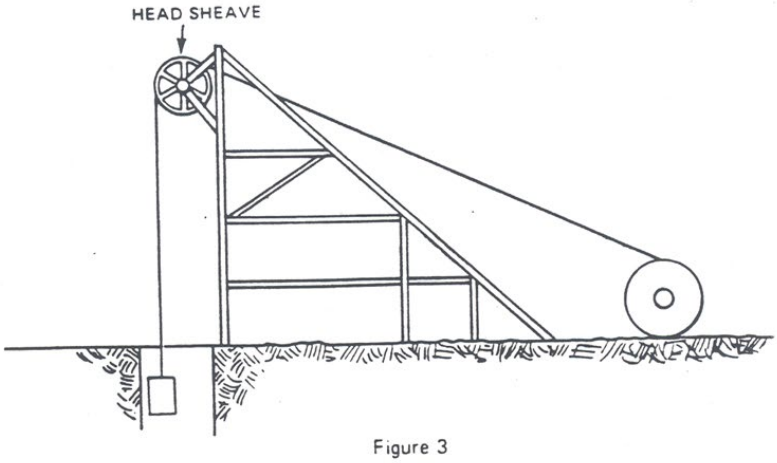


Figure 3

Figure 1A

Figure 3A

The critical features of a sheave are: (See Figure 4)

- Groove
- Diameter

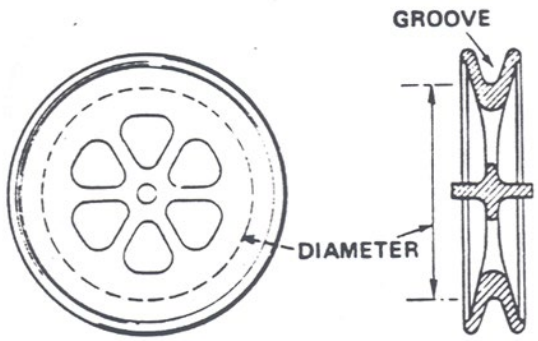


Figure 4

The groove is the part of the sheave that the hoist rope rest on. The size of the groove must be fitted to the size of the rope. (See Figure 5)

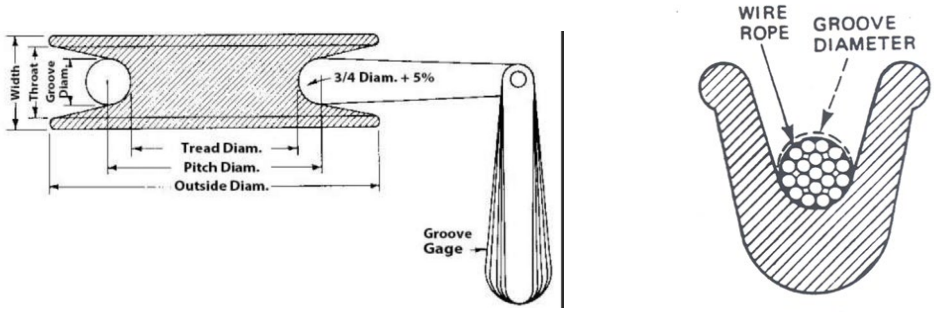


Figure 5

Too large a groove will tend to flatten the rope and cause the rope to weaken. (See Figure 6)

Too small a groove will squeeze, distort, and damage the rope as well as damage the groove. (See Figure 7)

To save the high replacement cost of a worn sheave, liners of wear-resistant materials are used. (See Figure 8)

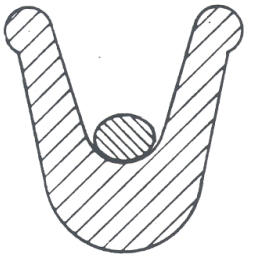


Figure 6

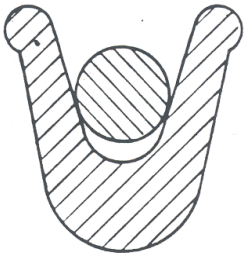


Figure 7

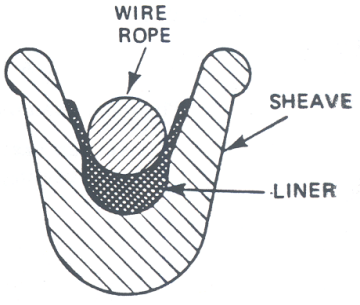


Figure 8

The size of a sheave is described by its diameter. (See Figure 4)

The diameter of the sheave must be suited to the diameter of the rope. Too small a sheave diameter will cause too sharp a bend in the rope and will damage the rope. (See Figure 9)

For the average mine hoist rope, the manufacturers recommend that the sheave diameter be 45 or more times the rope diameter. Little or no wear occurs if the sheave diameter is 90 times the rope diameter. (See Figure 10)

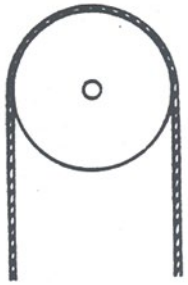


Figure 9

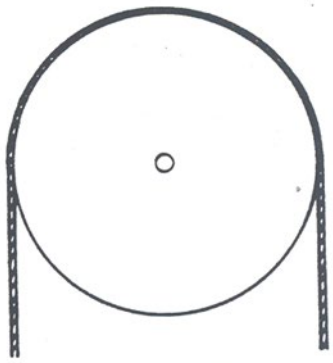


Figure 10

REGULATIONS

Metal and Nonmetallic Mines

- Head, idler, knuckle, and curve sheaves shall have grooves that support the ropes properly. Before installing new ropes, the groves should be inspected and where necessary machined to the proper contour and the proper groove diameter.
- Sheaves shall be inspected daily and kept properly lubricated.

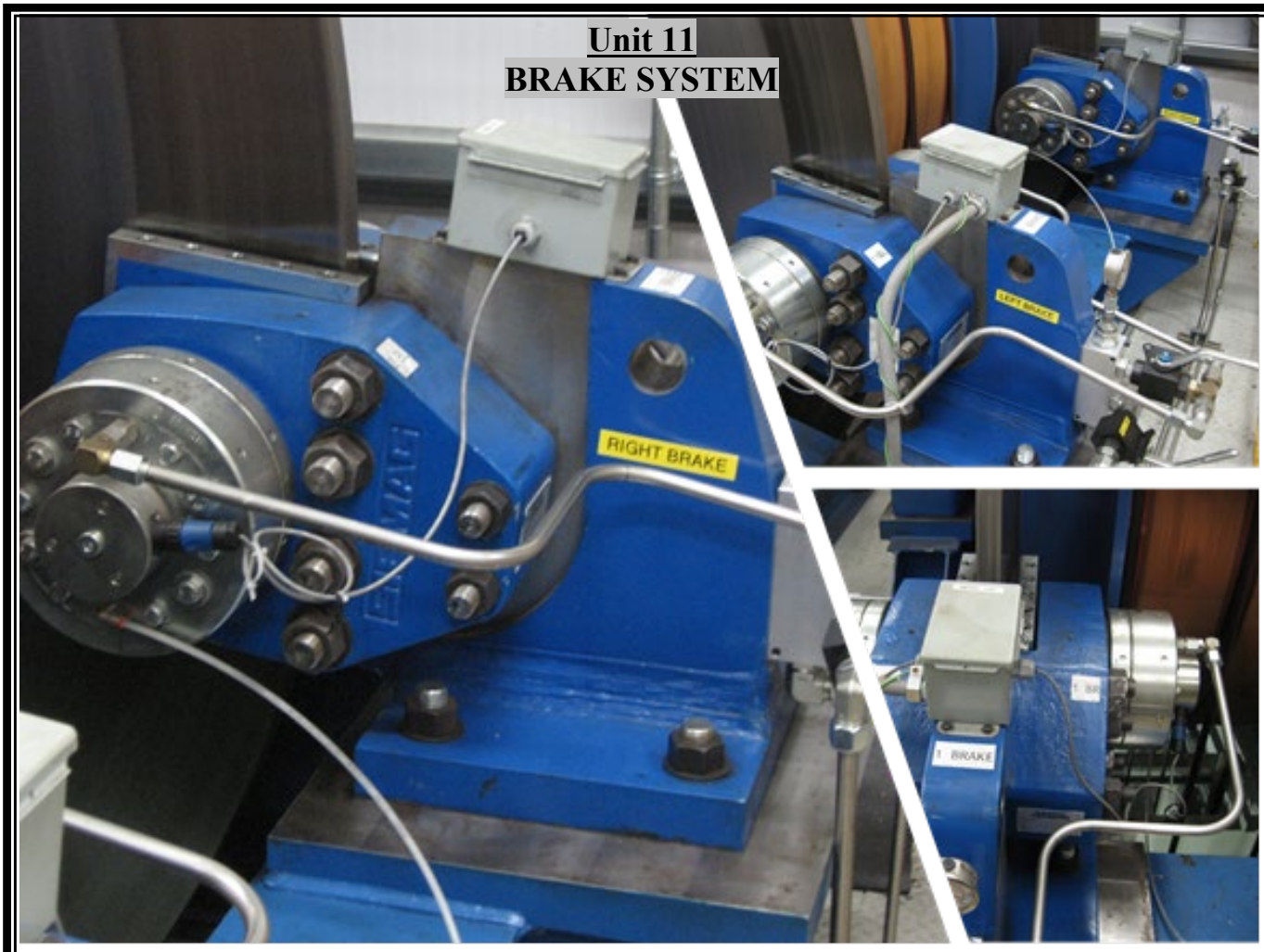
Coal Mines

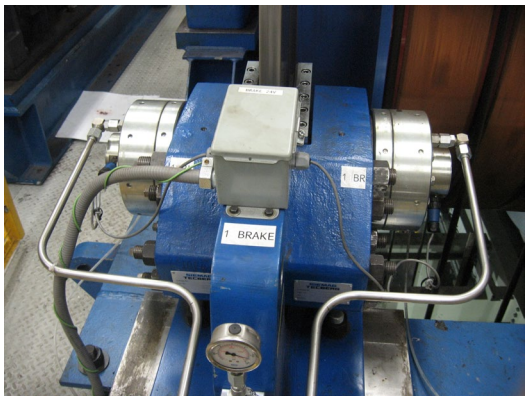
Daily Examination of Hoisting Equipment

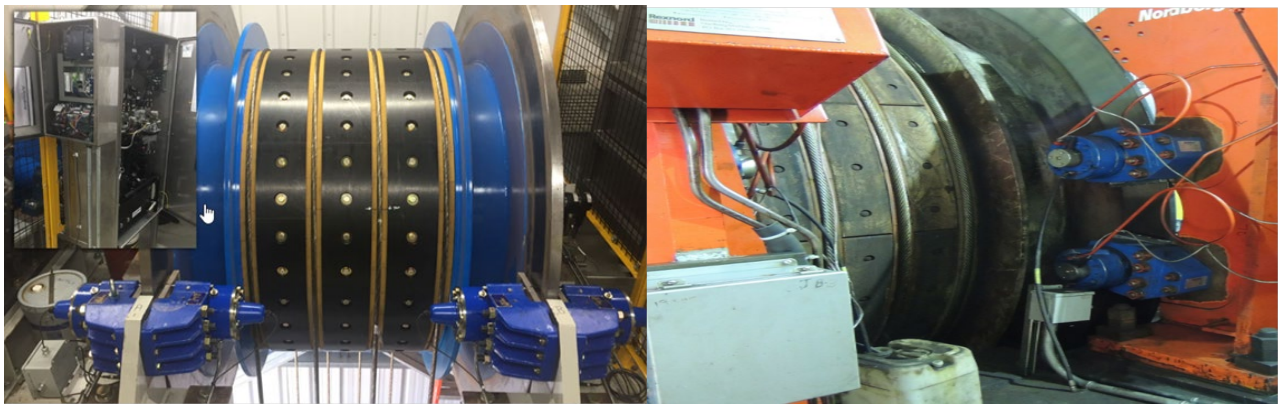
The daily examination of hoisting equipment shall include:

- An examination of the head sheaves to check for broken flanges, defective bearing, rope alignment, and proper lubrication.

Unit 11
BRAKE SYSTEM



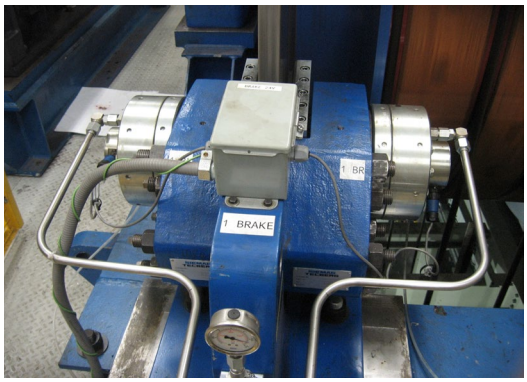


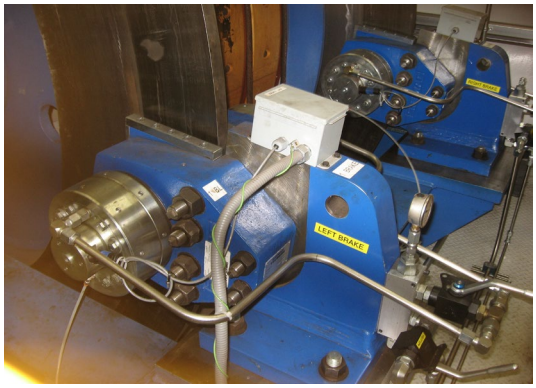


Brakes stop the hoist drum and holds it in position. There are two types of brakes:

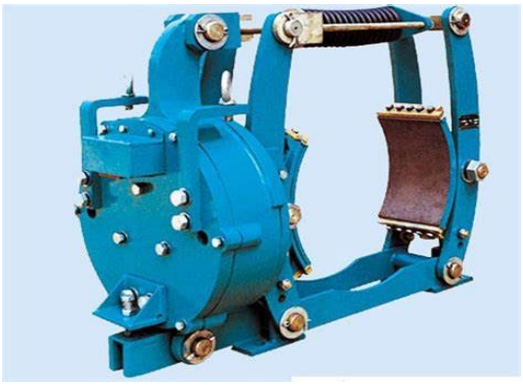
- Disc
- Ring or drum brakes.

Disc Brakes



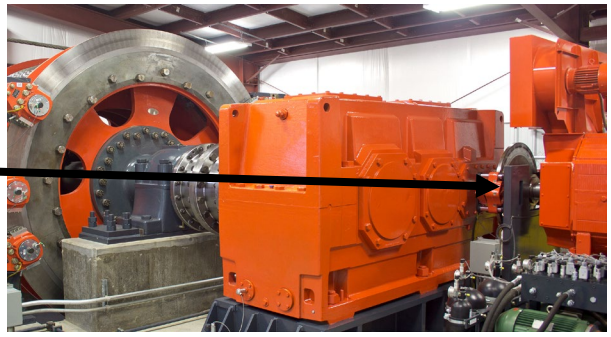


Drum Brakes



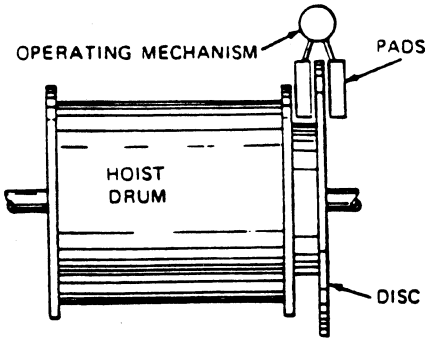
Some newer installed hoists are equipped with a motor brake. A disc brake is installed between the motor and speed reducer on the input pinon shaft. This motor brake works in conjunction with the flange disc brakes.

Disc brake mounted on input pinon between motor and speed reducer.

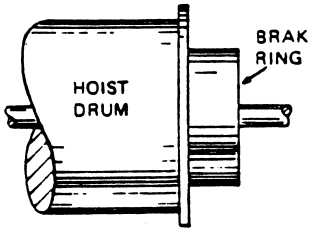


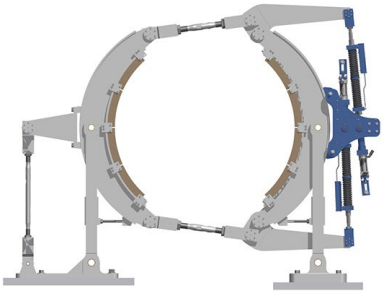
Modern Programmable Logic Controlled (PLC) hoists are equipped with disc brake pad wear indicators. A proximity sensor, installed in the disc brake, monitors the brake pad movement. The PLC tracks the brake pad's open (released) and closed (set) positions, as well as measuring the amount of pad wear. This system ensures optimal hoist performance and safety by providing real-time information about brake pad condition, enabling timely maintenance and replacement.

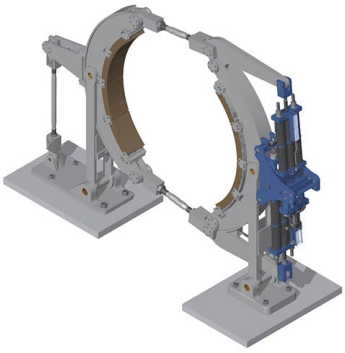
The Disc Brake is connected to the hoist drum like this:



The Ring Brake is connected to the hoist drum like this:



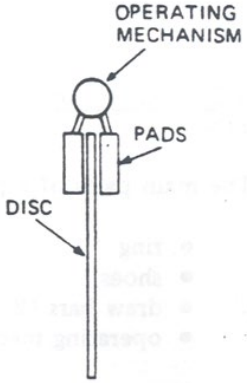


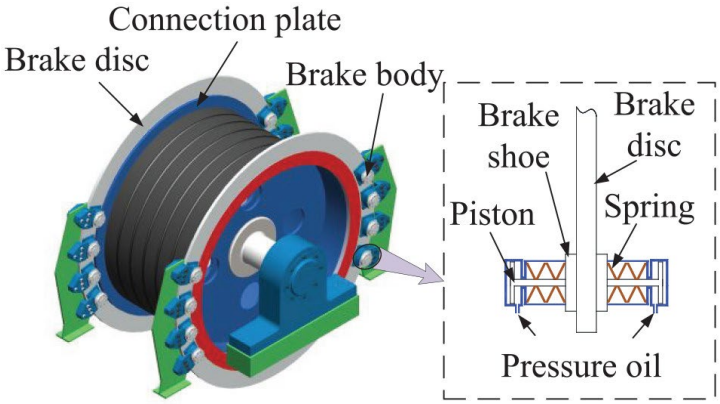


The main parts of a Disc Brake are:

- Disc
- Pads
- Operating mechanism

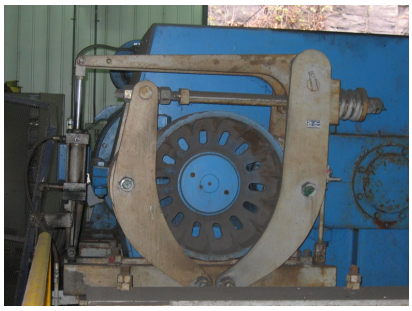
When the brake is applied the pads come together to press against the disc. This pressure prevents the disc from moving.





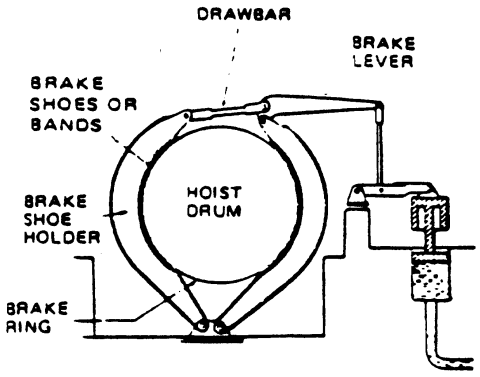
There are two types of Ring Brakes:

- Jaw and parallel motion.



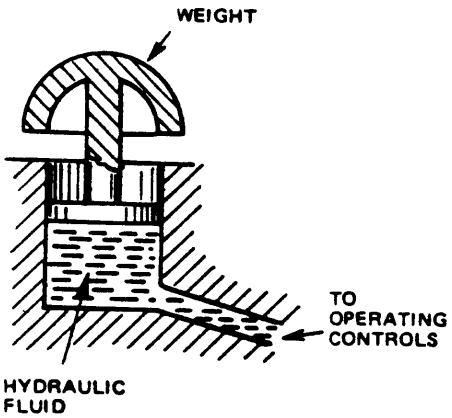
The main parts of a Jaw Brake are:

- Ring
- Shoes or bands
- Draw bar.
- Operating mechanism



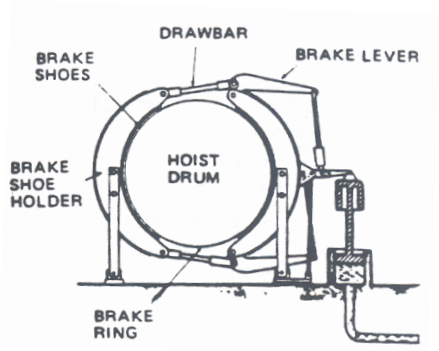
The brakes are operated by a combination of hydraulic and/or pneumatic pressure and gravity or by hand through a system of levers. To apply the brakes, the hydraulic pressure on the cylinder is released. The weight can then pull down on the brake lever which by pulling on the drew bar brings the brake shoe holders together. This action causes the brake shoes to press against the ring.

To release the brake, hydraulic pressure is restored to the cylinder. The weight is lifted and moves the brake lever upward. This action allows the brake shoe holders to separate and lift the brake shoes from the brake ring.



Hydraulic operated brake

A Parallel Motion Brake is similar to a jaw brake.



The main parts of a parallel motion brake are:

- Ring
- Shoes
- Draw bars (2)
- Operating mechanism

Theses brakes are also operated by gravity. The weight pulls on both brake levers and through the draw bars and the brake shoe holders press the shoes against the ring.

Any hoist used to hoist men shall be equipped with a brake or brakes which shall be capable of holding its fully loaded cage, skip or bucket at any point in the shaft.

The operating mechanism of the clutch of every man-hoist drum shall be provided with a locking mechanism or interlocked electrically or mechanically with the brake to prevent accidental withdrawal of the clutch.

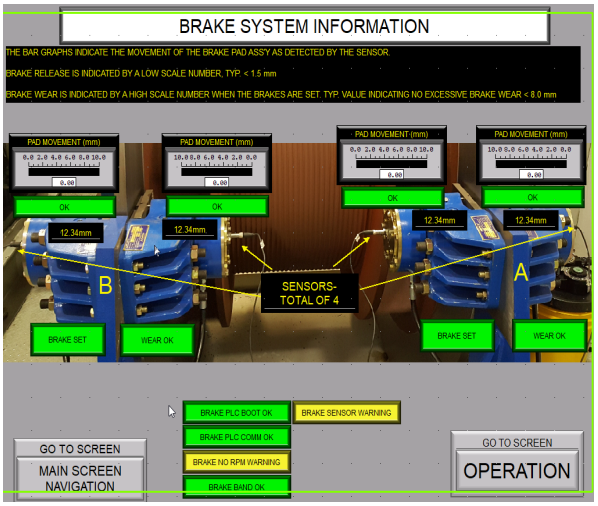
Automatic hoists shall be provided with devices that automatically apply the brakes in the event of power failure.

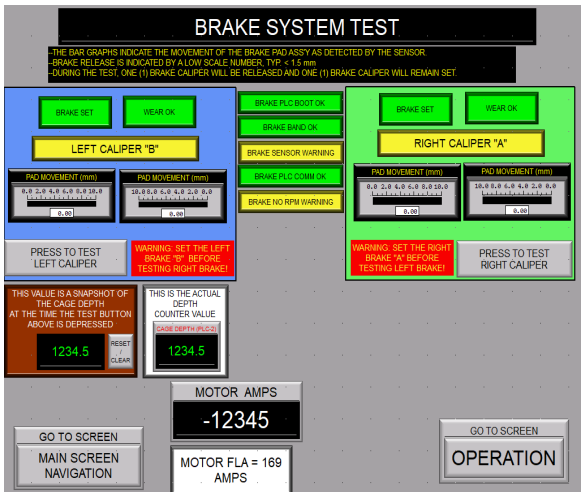
Hoist Brake Capability:

Brakes on hoists used to transport persons shall be capable of stopping and holding the fully loaded platform, cage, or other device at any point in the shaft, slope, or incline.

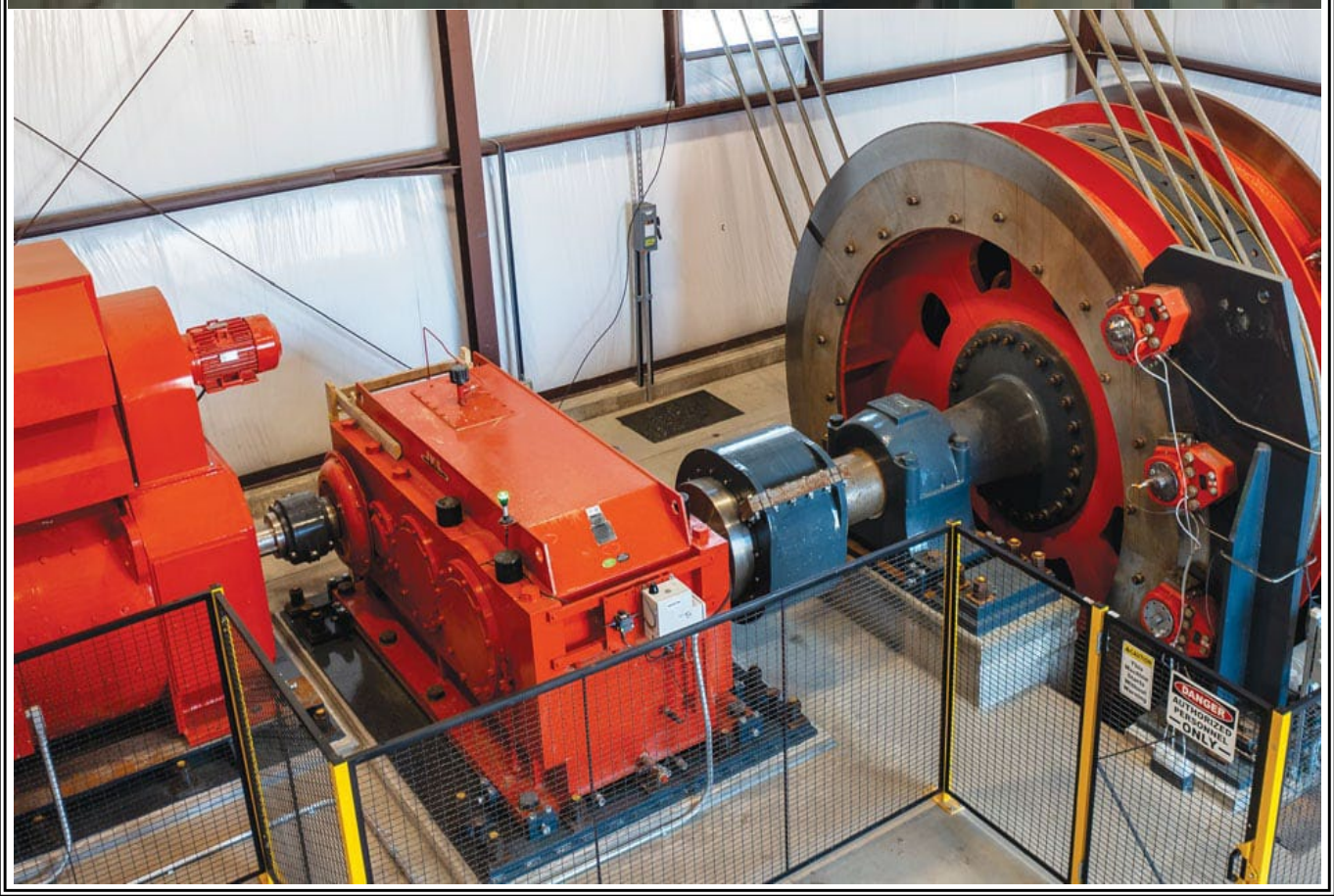
Brake Test:

Hoisting engineers conduct a brake test at the beginning of every shift. Modern Programmable Logic Controlled (PLC) hoists offer an automated brake test function. By selecting the brake test mode, the hoisting engineer initiates a PLC-controlled test of each brake individually. If any brake fails the test, the hoist must be immediately taken out of service for necessary repairs. This proactive approach ensures the safety and reliability of hoist operations.





Unit 12
CLUTCH



The clutch is the device which engages or disengages the drum from the hoist motor. There are two basic types of clutches: the tooth or positive engagement clutch and the friction clutch.

The parts of the tooth or positive engagement clutch are: (See Figure 1)

- clutch spider
- clutch ring
- operating mechanism

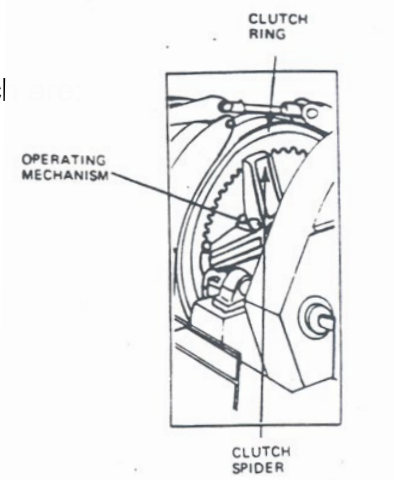


Figure 1

The clutch spider is keyed to the hoist drum shaft. The clutch ring is fastened to the hoist drum frame. The arms of the spider have grooves or teeth that match those on the clutch ring.

The operating mechanism moves the clutch spider away from or toward the clutch ring. This operating mechanism may be hydraulically or pneumatically powered.

When the clutch spider is against the clutch ring, the teeth on the spider engage with the teeth of the ring. If the drum shaft rotates, the clutch spider rotates and causes the drum to rotate.

When the clutch spider is moved away from the clutch ring, the teeth disengage, and the clutch is disengaged. The shaft can then turn independently of the drum. Some hoists have a friction or band clutch. (See Figure 2)

The parts of a friction clutch are:

- Clutch ring
- Clutch spider
- Bands
- Friction blocks
- Operating mechanism

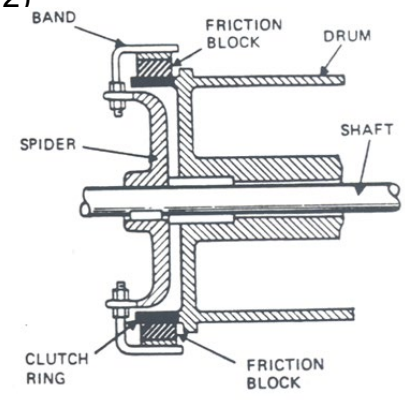


Figure 2

The clutch ring is fastened to the hoist drum frame. The clutch spider is keyed to the hoist drum shaft. The spider has a band on the end of each arm which supports a friction block.

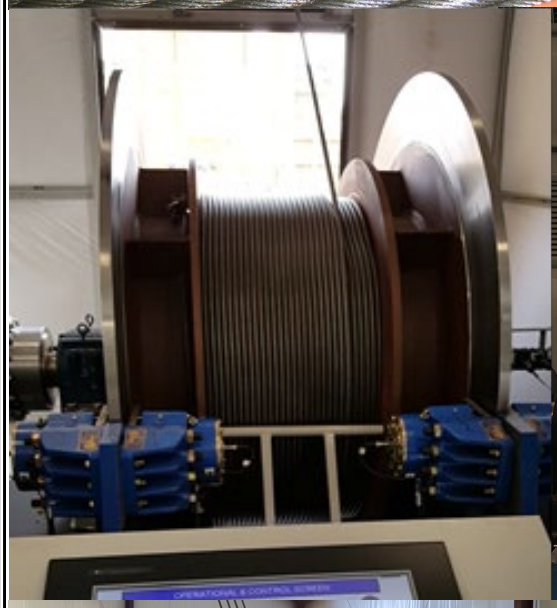
- To engage the clutch, the operating mechanism causes the friction blocks to press against the clutch ring.
- Friction between the friction blocks and the ring causes the ring and the attached drum to rotate with the shaft.
- To disengage the clutch, the friction blocks are pulled away from the clutch ring.

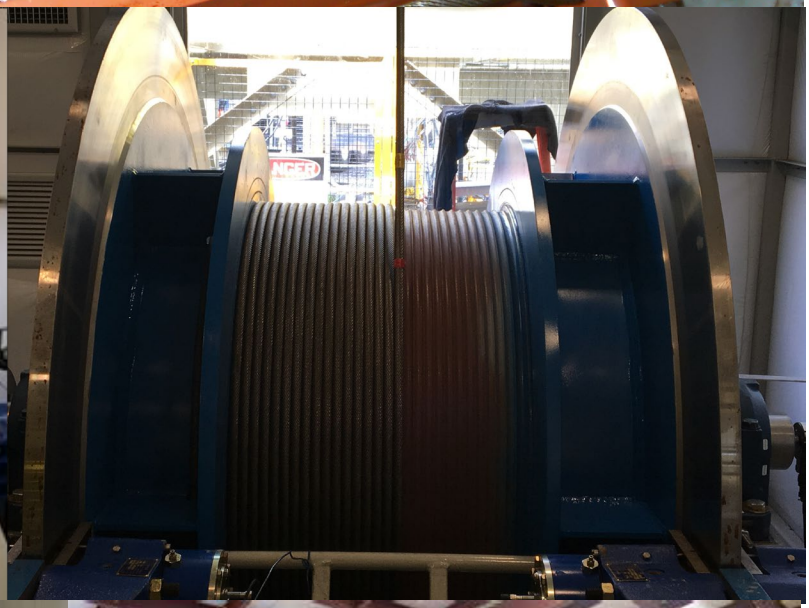
The hoist is equipped with a clutch brake interlock. This device requires that the brakes be applied to a drum before the clutch can be disengaged.

The operating mechanism of the clutch of every man hoist drum shall be provided with a locking mechanism or interlocked electrically or mechanically with the brake to prevent accidental withdrawal of the clutch.

COAL MINES
The clutch of free-drums on man-hoist shall be provided with a locking mechanism or interlocked with the brake to prevent the accidental withdrawal of the clutch.

Unit 13
DRUM/WHEEL





HOIST DRUM OR WHEEL ASSEMBLY

The hoist assembly lowers and raises the hoist rope into and out of the mine. There are two basic types of mine hoist assemblies:

- The Drum hoist in which the hoist rope is wound around a cylindrical drum and stored during the hoisting cycle.
- The Friction or Koepe wheel hoist in which the rope passes over the wheel during the hoisting process Friction between the rope and wheel moves the rope.

The drum and wheel are driven by a hoist motor through a gear train. Brakes are provided to slow, stop and hold the drum or wheel in a particular position.

The parts of a drum are: (See Figure 1)

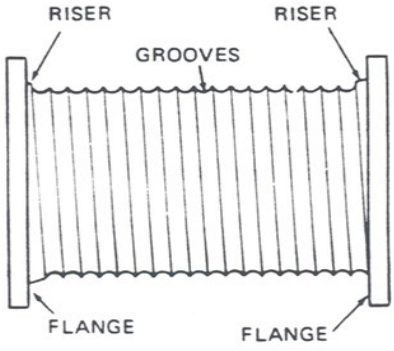


Figure 1

Flanges are the rims around the ends of the drum which present the rope from slipping off.
Flanges must extend at least three rope diameters (minimum 4”) beyond the last wrap. Risers are metal strips that raise each successive rope layer as it winds at the ends of the drum. A drum surface may be smooth, or it may be grooved. Grooves are channels in the surface of the drum in which the rope lies. Grooves reduce wear on the hoist rope.

There are three types of grooves: (See Figure 2)

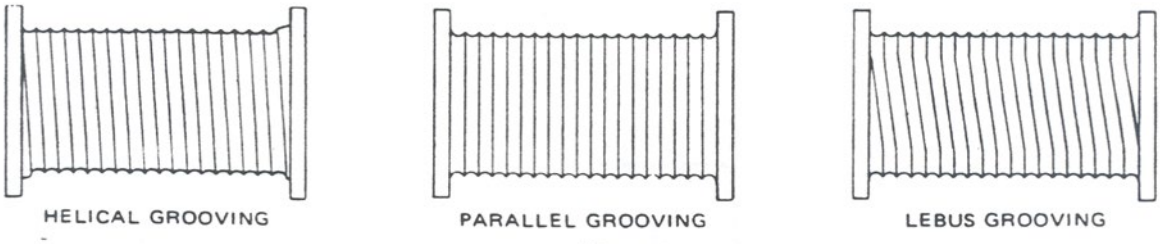


Figure 2

- Helical grooving is a continuous spiral usually used for single layers or rope.
- Parallel grooving is made up of evenly spaced grooves across the entire surface of the drum.
- LeBus grooving is a combination of helical and parallel. One half turn is parallel and then the grooves become helical. This used for high-speed multi-level winding.

In a Friction or Koepe wheel hoist, the drum is replaced by a wheel. The wheel may be mounted on the headframe, where the head sheave is mounted on a drum hoist. Other hoist may have the Koepe wheel located in the hoist house in place of the regular drum.

The parts of a Koepe wheel are: (See Figure 3)

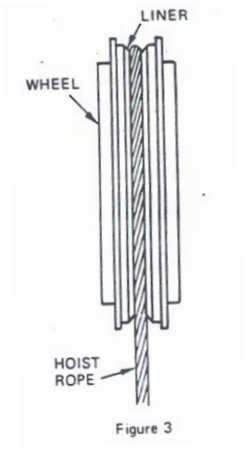
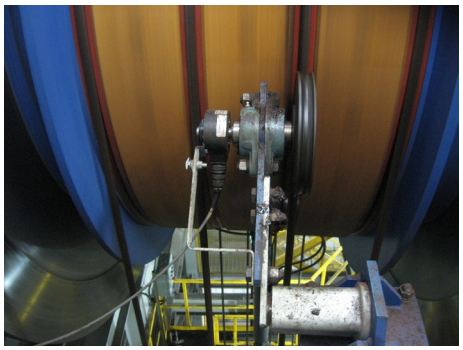


Figure 3

The liner provides a groove for the hoist rope to rest on. The hoist assembly may take one of several forms.



Drum Hoist: Some drum hoist may have only one conveyance and no counterweight. There will be one drum and one rope. One end of the rope is attached to the conveyance, the other is attached to the drum. (See Figure 4)

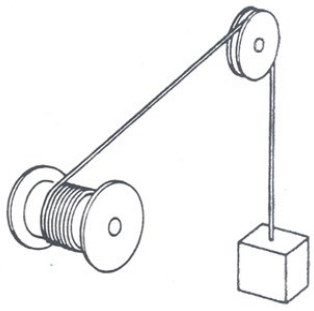


Figure 4

Other single drum hoists may have two conveyances or one conveyance and a counterweight. The ends of the rope are attached to the conveyances or to the conveyance and counterweight. The rope makes several turns around the drum. As one end of the rope is wound onto the drum, its conveyance is hoisted while the other end of the rope is unwound from the drum and its conveyance or counterweight is lowered. (See Figure 5)

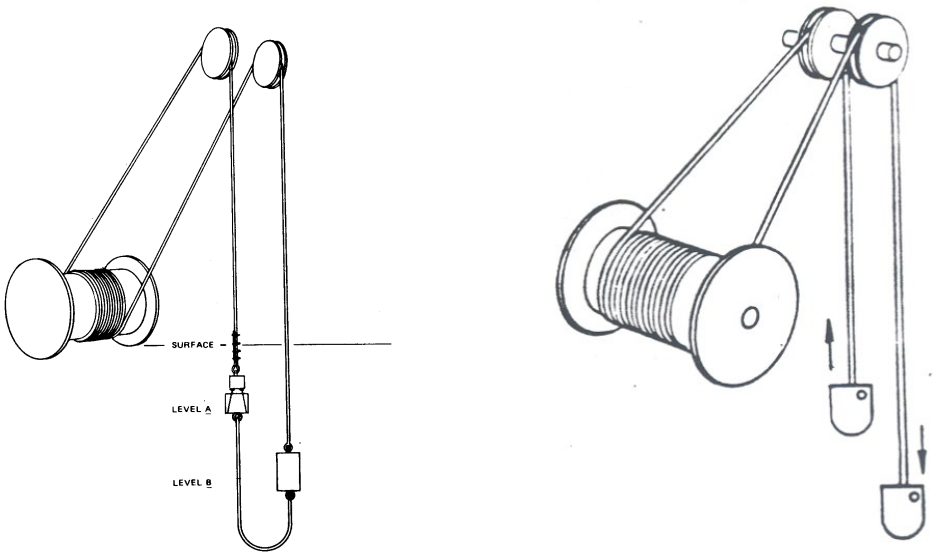


Figure 5

Some hoists have two drums on the same shaft; one rope is on each drum. One end of a rope is fastened to the drum and the other is fastened to the conveyance. The ropes are arranged so that when the rope on one drum is being wound, the rope on the other drum is being unwound.

On most two drum hoists, a clutch is provided so that the drums can be operated separately. This clutch is particularly advantageous in a production hoist in a multi-level mine.

For example, when hauling ore from one level, one skip is at the dump unloading while the other skip is at the loading level being loaded. When the dumping and loading are completed, the loaded skip is raised to the dump while the empty skip is lowered to the loading level, and the unloading and loading operation are repeated. If the loading level is changed, one skip must be moved on order for a skip to be at the dump while another is at the new loading level. (See Figure 6)

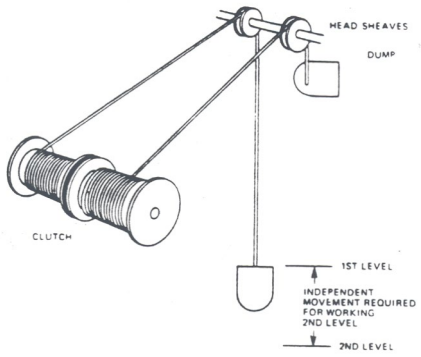


Figure 6

The Koepe Wheel or Friction hoist assembly is like the two conveyance and one drum hoist, except that there is only one-half turn of the hoist rope around the wheel. Several small ropes are normally used with the head (Koepe) wheel rather than on large rope. It is necessary that the length of each rope be equal so that the strain on each rope will be equal. (See Figure 7)
Tail ropes are provided on friction hoists to compensate for the weight of the hoist ropes.

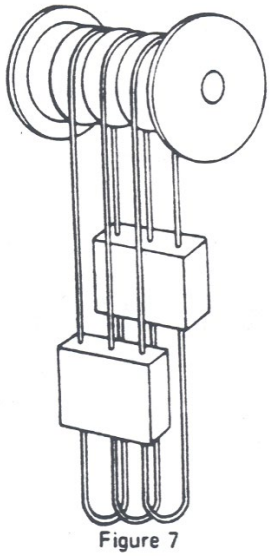
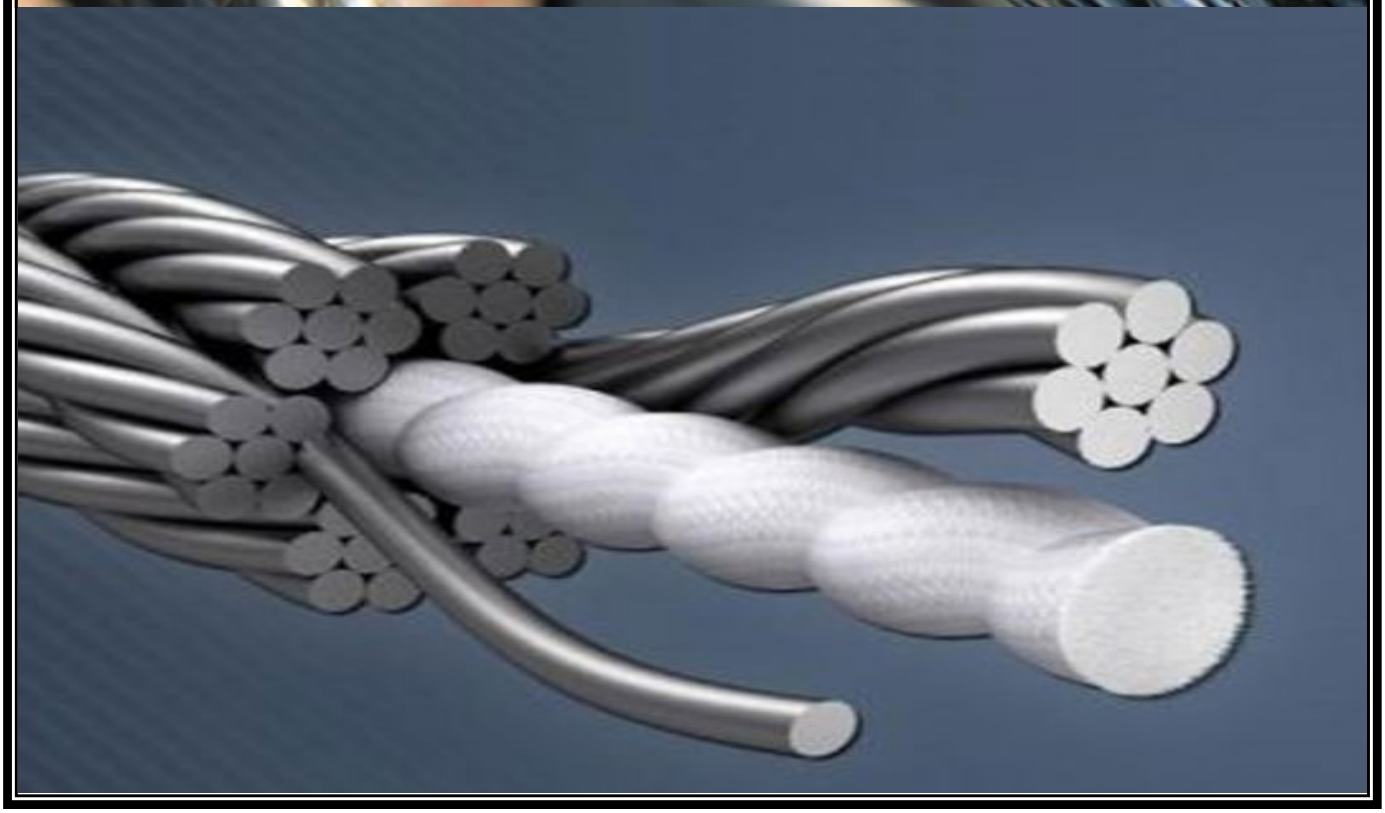


Figure 7

Flanges on drums shall extend radially a minimum of 3 rope diameters and not less than 4 inches beyond the last wrap.

Where grooved drums are used, the grooves shall be of suitable size and pitch for the rope used.

Unit 14
WIRE ROPE



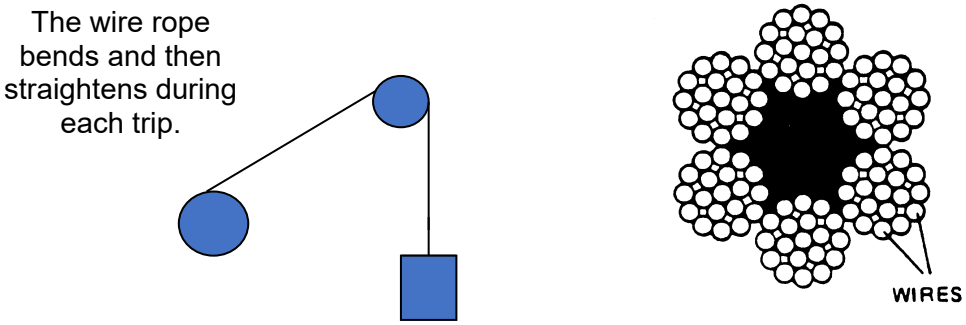
The care, installation, maintenance, and inspection of the hoist rope are engineering and/or maintenance functions. The hoisting engineer, however, is required to conduct or assist with wire rope inspections.

This unit will prepare the hoisting engineer to carry out their responsibilities. In mines where the hoisting engineer will be called upon to carry a heavier share of this load, they should receive further training. Many of the hoist rope manufacturers publish excellent materials which should be used for such training.

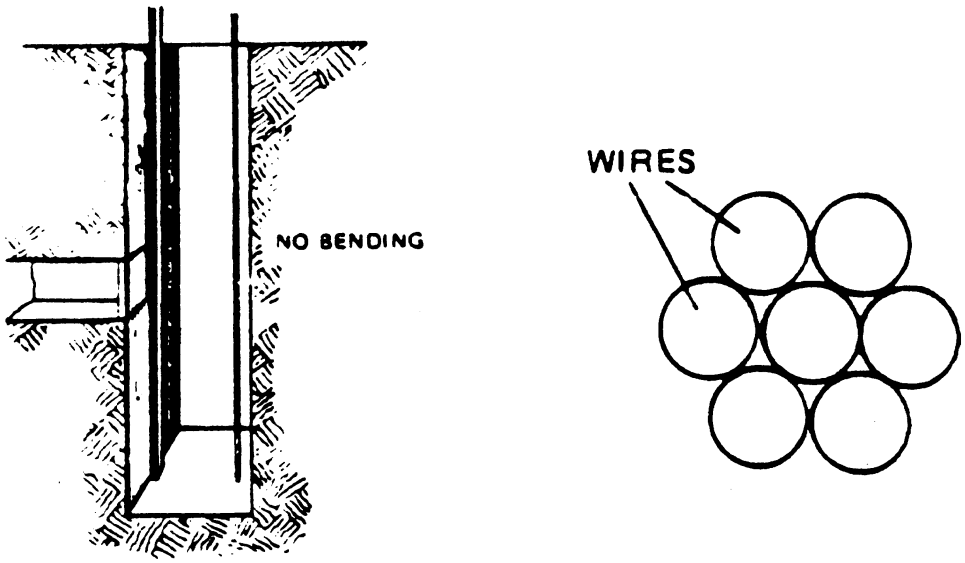
WIRE ROPE USE

Wire rope are used for the hoist rope, and in some mines, for shaft guides. It may also be used for guy wires for structures.

Wire rope bends frequently while in use, the hoist rope for example, must be flexible. It is made up of many wires of small diameter.



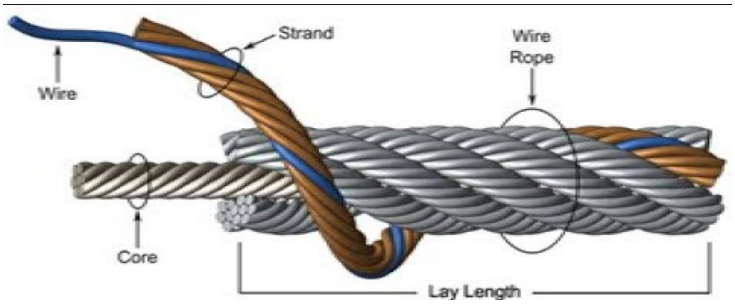
Wire rope that does not bend in use, shaft guides for example, need not be flexible. It is made up of few wires of large diameter.

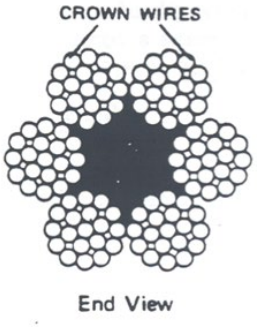


WIRE ROPE TERMS

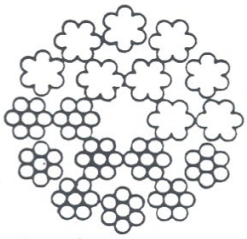
There are three parts to a wire rope:

- A core which forms the center of the rope.
- Wires which are twisted into strands. The wires which bear against a sheave or drum are called crown wires.
- Strands which are twisted around the core into rope.





Rope is designated by the **NUMBER OF STRANDS x THE NUMBER OF WIRES PER STRAND and ROPE DIAMETER**.

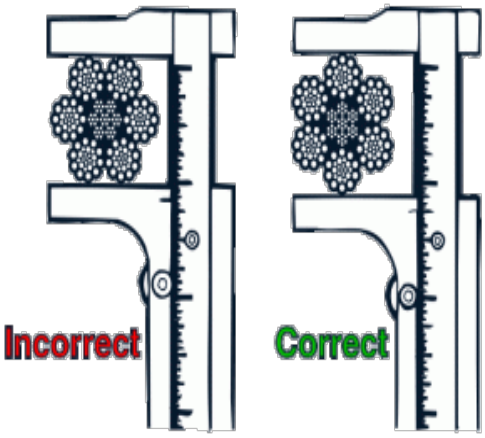


This rope has 18 strands of 7 wires each.
It is an 18 x 7.

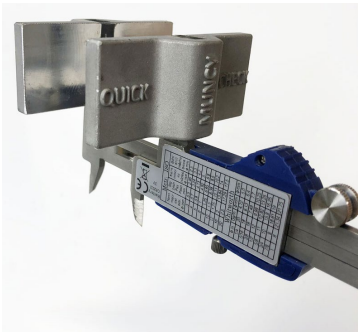
This rope has 6 strands of 19 wires each.
It is a 6 x 19.

A wire rope caliper with extended jaws or a go-no-go gauge should be used to measure rope crown wear or reduction of wire rope diameter.

Figure below shows the correct way to measure rope diameter for crown wear.

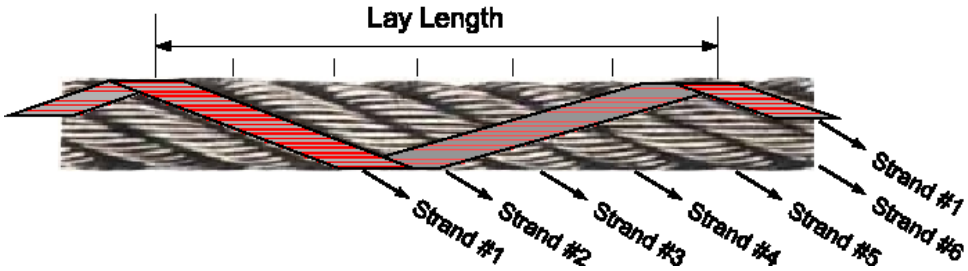


Photos below are of a wire rope caliper and a go-no-go gauge.

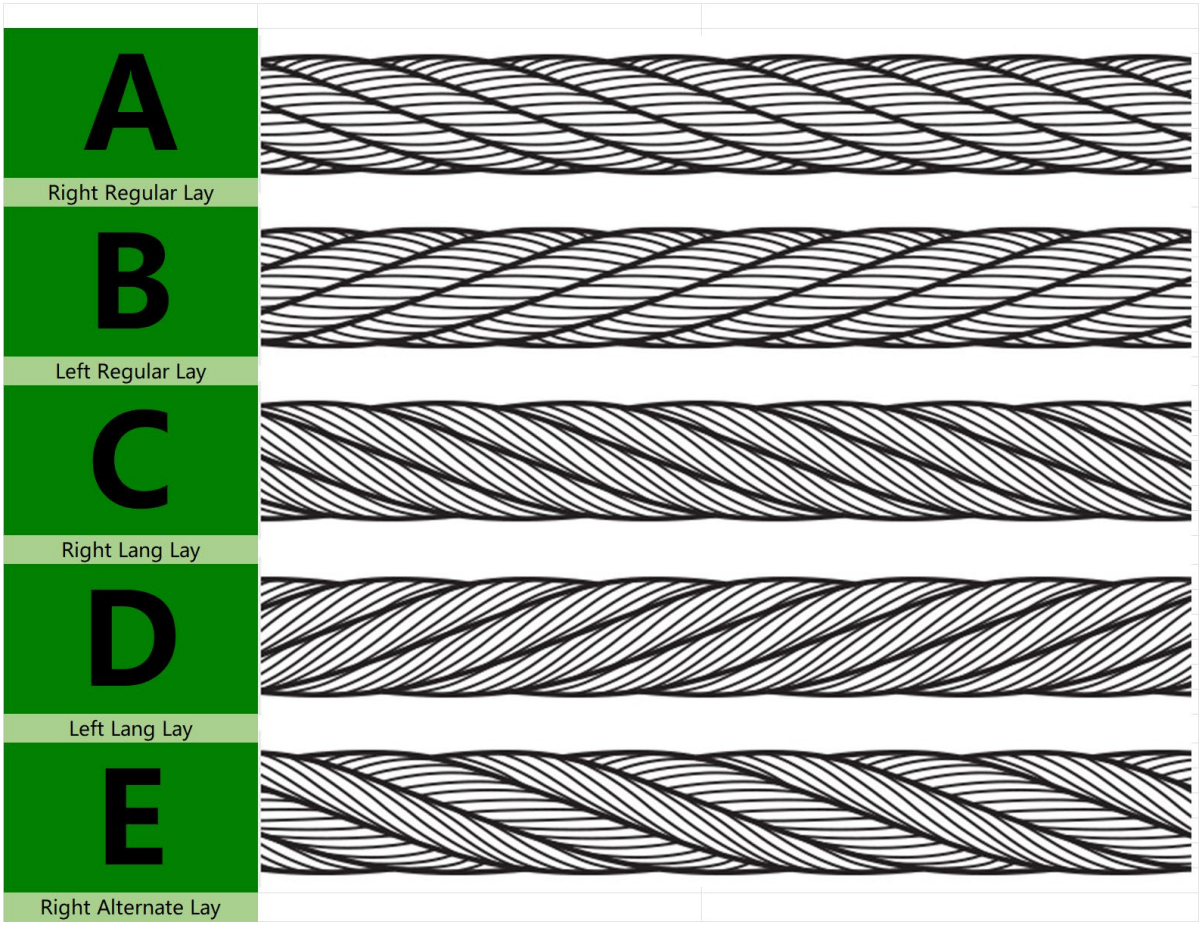


Lay:
The direction strands are wrapped or are layered around the core.

Lay of One Rope Length:
The length of rope that it takes for one strand to make a complete turn around the core is a Lay. In the photo below you there are six strands in one lay length.



The following photo show the different manufacturing type and direction of rope lays.



Safety Factor

The breaking strength of the rope divided by the load on the rope is the Safety Factor.

$$\text{Safety Factor} = \frac{\text{Breaking Strength}}{\text{Load}}$$

A rope with a 100,000-pound breaking strength carrying a normal load of 10,000 pounds has a Safety Factor of 10 to 1.

$$\textbf{Safety Factor} = \frac{\textbf{100,000 (Breaking Stren}}{\textbf{10,000 (Load)}} = \textbf{10}$$

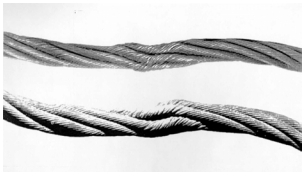
Wire Rope Care:

Wire rope is expensive. Handle it carefully to prolong its life.

Damaged Ropes

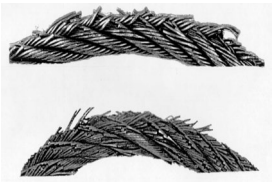
Corrosion

Kink

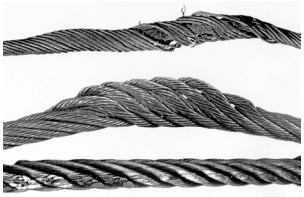


Popped Core

Bad Sheave

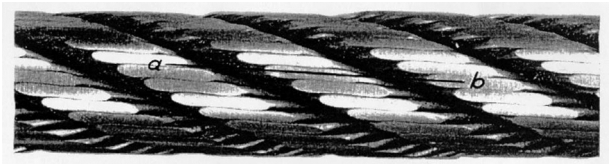


Drum Crushing

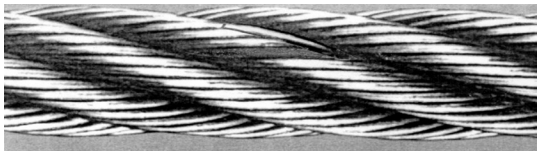


Bird Cage

Excessive Crown Wear



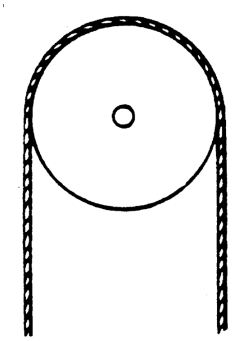
Broke Wire



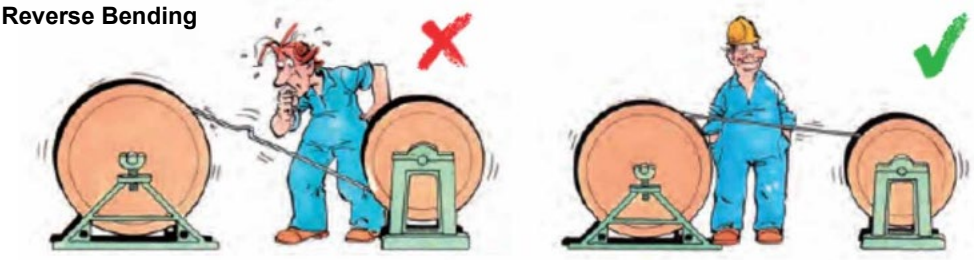
Avoid Sharp Bends

The use of too small a sheave or drum, or kinking will cause the wire rope to be weakened.

Too Small Sheave

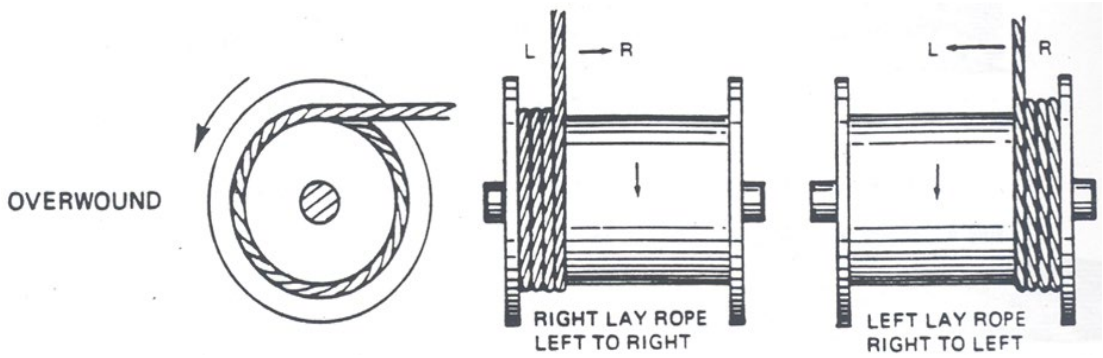


Avoid Reverse Bending

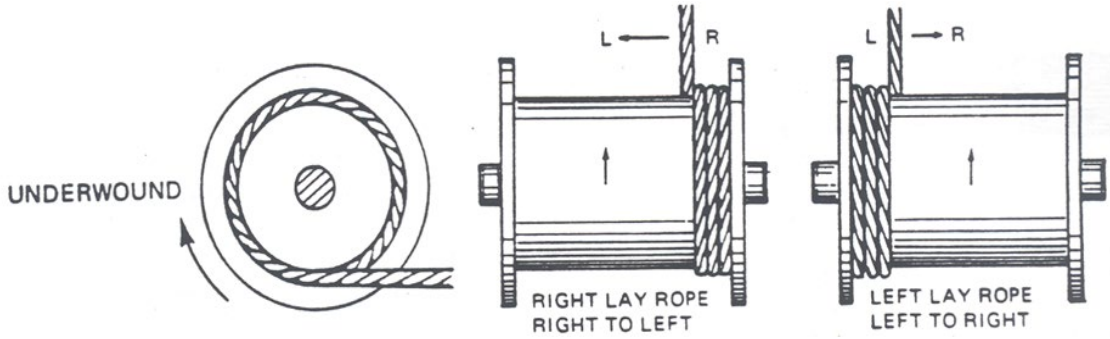


Use Proper Rope Lay

On Overwound drums start Right Lay from Left – Left Lay from Right.



On Underwound drums start Right Lay from Right – Left Lay from Left.



In all cases Use the Correct Rope for the Job.

Cutting and Attaching Wire Rope:

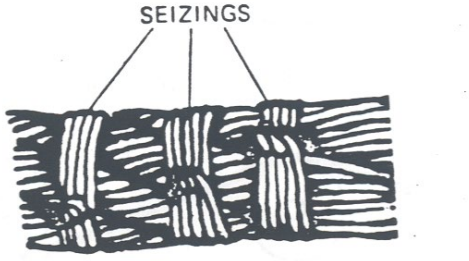
Wire rope is weakened if its shape or structure is changed. In cutting and attaching wire rope, the shape and structure is usually preserved by **"seizing"**.

Seizing:

Wire seizing is soft wire used to keep the individual wire rope component ends bound together while cutting, preparing, and handling a wire rope. It keeps them from opening, helps maintain lay lengths, and lowers the chances of distortion at the ends when cut that could lead to issues.

Cutting:

At least three seizing are made on each side of the planned cut.

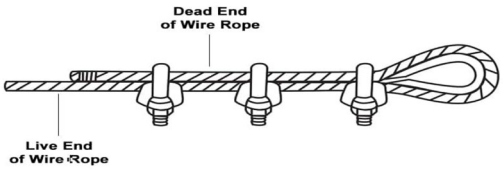


Attaching the Wire Rope

Normally an eye is put into the end of a wire rope to attach it to a drum, conveyance, counterweight, or other object.

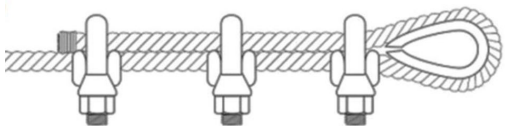
A thimble is usually placed in the eye for support.

The long end of the rope is the live or working end. The short end is the dead or bitter end.



The eye can be put into the end of the rope with:

- U-Clips



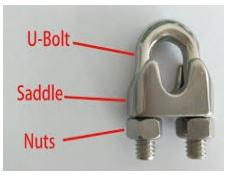
- Socket

- Eye Splice

- Wedge Socket

Application of Wire Rope Clips:

*(Note: always refer to the rope and U-Clip manufacturer for proper installation)



STEP 1:

Calculate the minimum number of u-clips, the required spacing between the clips and the minimum turnback length of the dead end of the wire rope.

Three simple formulas for figuring the number of wire rope clips needed are as follows:

- Number of clips – 3 x Wire Rope Diameter + 1
- Spacing between clips – 6 x Wire Rope Diameter
- Dead end turnback length – Number of Clips x Clip Spacing.

Example for a 1" rope:

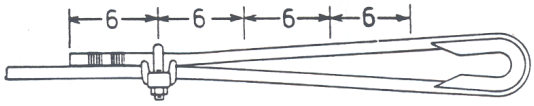
Number of clips:
3 x 1 (rope diameter) + 1 = 4 clips required

Clip spacing:
6 x 1 (rope diameter) = 6 x 1 = 6 inches.

Dead end turnback:
4 (number of clips) x 6 (clip spacing) = 4 x 6 = 24 inches

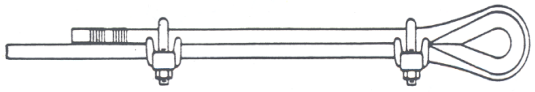
STEP 2:

Attach the U-Clip farthest from the eye. (Note that the U-Bolt touches the bitter end, NOT the working end).



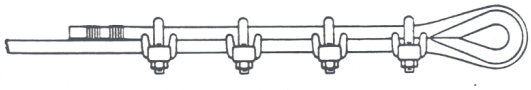
STEP 3:

Attach the U-clip nearest the eye.



STEP 4:

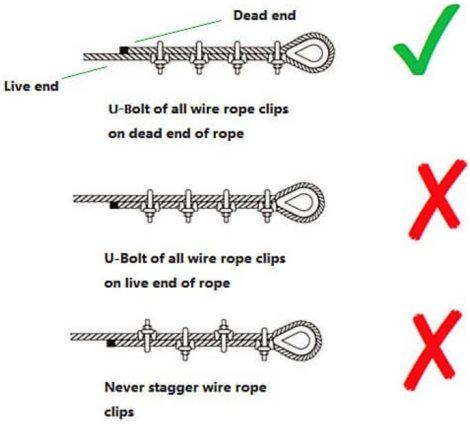
Attach and tighten the remaining clips to the manufacturer recommended torque. (*Over tightening clips can damage the wire rope).*

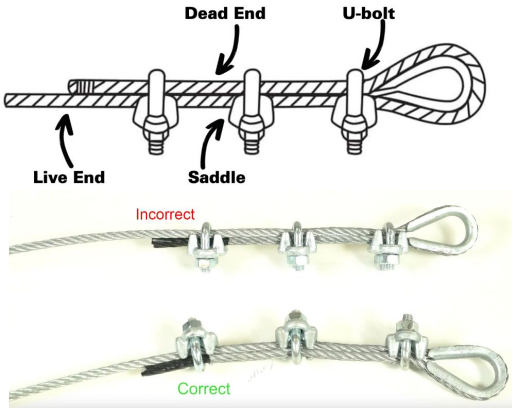


Installation of wire rope clips:

There's a well-known saying intended to aid in remembering which way to attach a wire rope clip that reads, **"never saddle a dead horse".**

The simple explanation is that by inverting the clip and fastening the saddle on the dead end, the U-bolt crushes down on the live load and drastically reduces the wire rope's capacity. It goes without saying that maintaining a predictable capacity is extremely important in ensuring the safety of your workers and load. Utilizing the correct wire rope clip technique is vital.





Manufacturer Recommended Chart

SIZE (IN.)	NUMBER OF CLIPS	TURNBACK LENGTH (IN.)	TORQUE FT-LBS.
1/8	2	3-1/4	4.5
3/16	2	3-3/4	7.5
1/4	2	4-3/4	15
5/16	2	5-1/4	30
3/8	2	6-1/2	45
7/16	2	7	65
1/2	3	11-1/2	65
9/16	3	12	95
5/8	3	12	95
3/4	4	18	130
1	5	26	225

Poured Socket Installation:

Poured sockets are used in many wire rope and structural strand termination applications where a high strength, permanent end attachment is required.

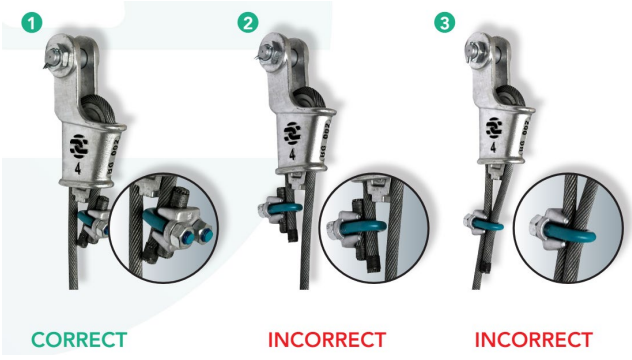
A socket is attached by means of zinc or resins.

The Spelter Process: A Step-by-Step Guide

1. **Socket Preparation:** The process begins by inserting the end of the wire rope into the narrow end of a cone-shaped socket or button.
2. **Wire Rope Preparation:** Before pouring the socket, the wire rope must be meticulously cleaned and "broomed." This involves creating a rough surface on the wire rope to ensure a strong bond with the molten metal or epoxy. Once prepared, the broomed wire rope is carefully pulled inside the socket cavity.
3. **Molten Metal or Epoxy Pouring:** The socket cavity is then filled with either molten zinc or epoxy resin. It's crucial to adhere strictly to the manufacturer's recommendations for both materials and procedures.
4. **Curing Process:** The final step involves allowing the socket to cure completely. The specific curing time will depend on the type of material used (zinc or epoxy) and the manufacturer's guidelines.

Wedge Socket Installation Instructions:

- **Centering:** Always mount the loaded wire rope in the center line of the pin.
- **Dead End Securing:** Secure the dead end with a wire rope clip.
- **Dead End Attachment:** Do not attach the dead end to the loaded wire rope.
- **Dead End Length:** The dead end should be at least 6 wire rope diameters long, but no less than approximately 6 inches.
- **Socket Fixation:** The socket must be fixed to prevent rotation.
- **Post-Load Inspection:** After the first load, inspect the wire rope and wedge to ensure they are fully seated in the socket. A poorly installed wedge can lead to slippage.

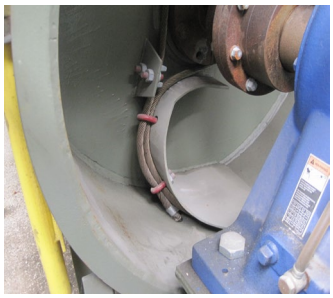


Wire Rope Inspection

State and Federal regulations requires that wire ropes used for hoisting shall be inspected regularly.

Location and parts of the rope that require close inspection: (See photos below)

- ✓ Points where the rope is connected to the conveyance and drum.
- ✓ Points where the rope leaves the sheaves or drums when the conveyance is at the loading levels or drum level.
- ✓ Every 100 feet.




Hoist rope "out-of-service" criteria:

- Corrosion or distortion, as from a kink.
- Reduced wire rope diameter.
- 65% crown wear.
- More than 6 broken wires in one lay of rope.
- 30% crown wear and 3 broken wires in one lay.
- Dead rope: rope will not stretch under load.

Manufacturer's information papers provide charts from which the ropes strength can be readily calculated if the number of broken wires in one LAY and "L", the length of wear on the crown wires, are known.

Inspection Process

The authorized person will:

- Clean off a full lay of rope surface with solvent.
- Measure and record the rope diameter.
- Measure and record the length of crown wear.
- Note and record the number of broken wires in that lay.
- Move the conveyance until the next inspection point on the rope is at the inspection station.

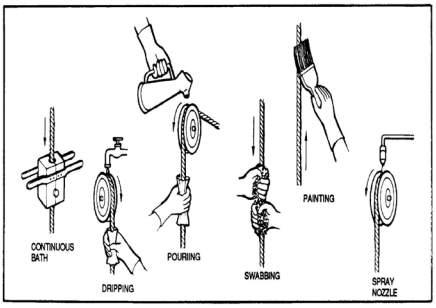
<u>Lubrication Systems</u>: A Crucial Component of Wire Rope Maintenance

Proper lubrication is essential for extending the operational life and enhancing the safety of wire ropes. When done correctly, lubrication penetrates both the exterior surfaces and the interior wires and core of the rope. This lubrication reduces friction between individual wires, minimizing wear and tear. Additionally, it provides essential corrosion protection, safeguarding the rope from environmental factors. However, effectively lubricating wire ropes can be challenging due to their complex structure and the need for precise application.

Several methods of lubricating the wire rope are:

Manual Lubrication: A Traditional Approach

Manual lubrication involves applying lubricant to wire ropes using methods such as dripping, brushing, spatula application, pouring, or using rubber gloves. While effective, these methods are often messy, time-consuming, and can pose environmental risks. The manual process requires significant labor and can be hazardous to workers, especially when dealing with moving equipment.



Automatic Lubrication: A Safer and More Efficient Solution

Automatic lubrication systems offer a safer, more efficient, and environmentally friendly approach to wire rope maintenance. By automating the lubrication process, these systems significantly reduce the risk of accidents and injuries associated with manual lubrication, which often involves exposure to dangerous moving components.

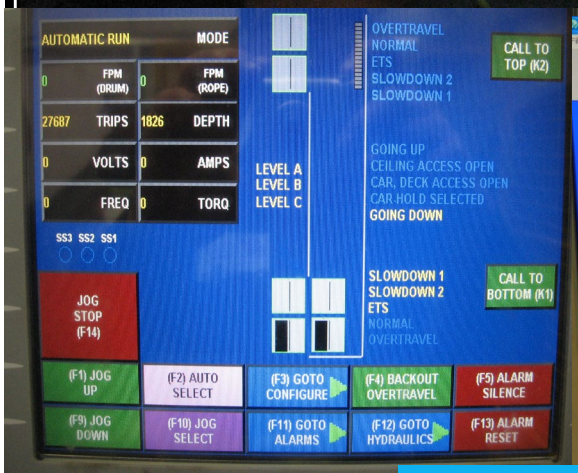
Additionally, automatic lubrication systems contribute to cost savings by minimizing lubricant usage and reducing leakage. By precisely controlling the application of lubricant, these systems ensure optimal performance and extend the lifespan of wire ropes. Furthermore, programmable features allow for tailored lubrication schedules, further enhancing efficiency and reducing maintenance downtime.

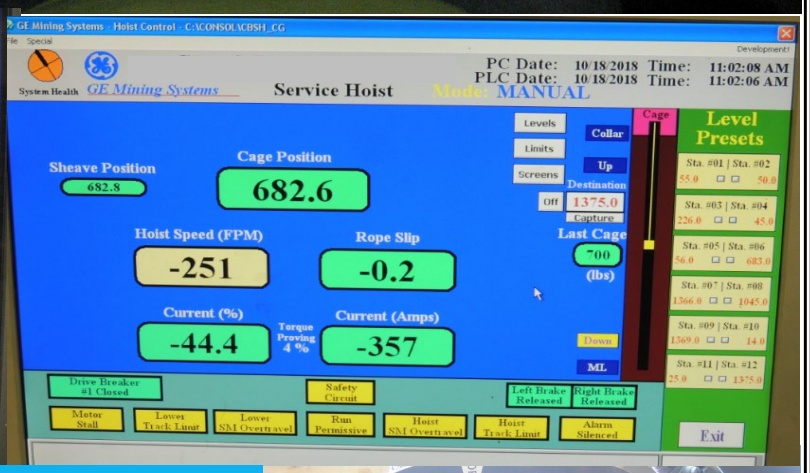
Note:

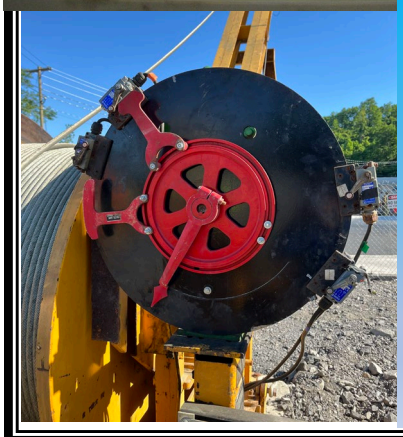
For static wire ropes, such as guide ropes, manual brushing or spraying is typically the most straightforward method of applying lubricant. This approach allows for precise application and ensures adequate coverage of the rope's surface.

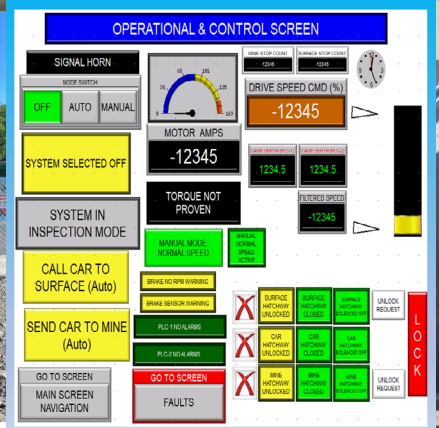
Unit 15

DEPTH INDICATOR









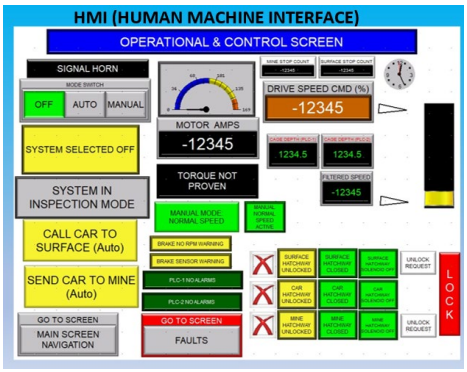
The depth indicator provides real-time information about the vertical position of the conveyance within the shaft. These indicators can be displayed digitally, on a dial, or as a cylindrical gauge.

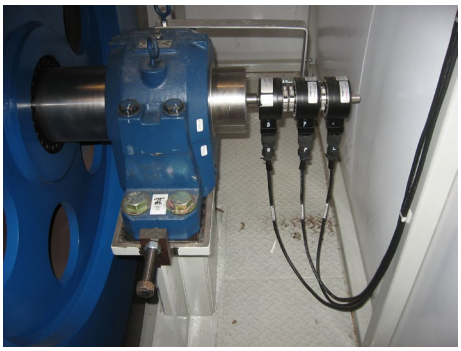
Digital Depth Indicator in Modern Mine Hoists
Modern mine hoists are controlled by Programmable Logic Controllers (PLCs), which enable the use of advanced Human-Machine Interface (HMI) systems for precise hoist operations. A key component of these HMIs is the digital depth indicator, which provides real-time information about the conveyance's vertical position within the shaft.

How it Works:

- **Encoder Installation:** Encoders are strategically mounted on both the hoist drum shaft and the motor shaft.
- **Signal Processing:** These encoders generate digital signals that are processed by the PLC.
- **Depth Calculation:** The PLC calculates the depth of the conveyance based on the rotational speed and direction of the drum and motor shafts.
- **Display on HMI:** The calculated depth is then displayed on the HMI screen, providing the operator with a clear and accurate visual representation.

By utilizing this technology, mine operators can maintain precise control over the hoisting process, ensuring safety and efficiency.





Dial Depth Indicator:
A dial depth indicator is a mechanical device that uses a rotating dial to display the vertical position of the conveyance within the shaft. A pointer, connected to the hoist drum via gears, moves around the dial. The dial is marked with specific points corresponding to the dump, collar, and various working levels in the mine. When the pointer aligns with a specific mark, it indicates the current position of the conveyance.

This traditional method, while reliable, has limitations compared to modern digital systems in terms of accuracy and ease of reading.

Figure 1 shows a dial indicator.

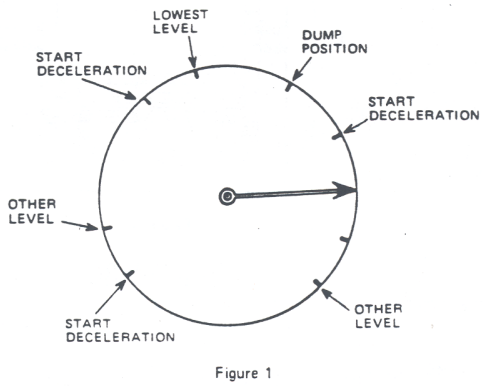
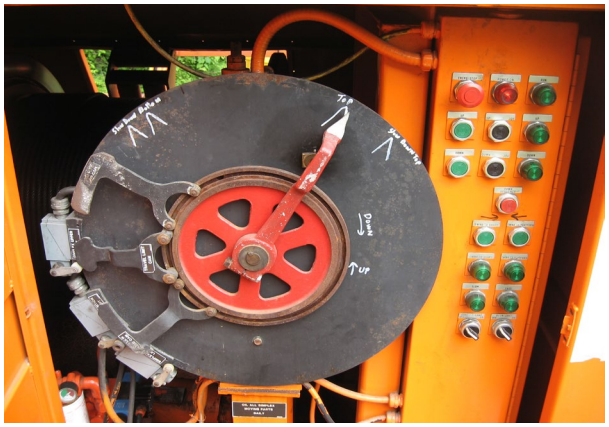
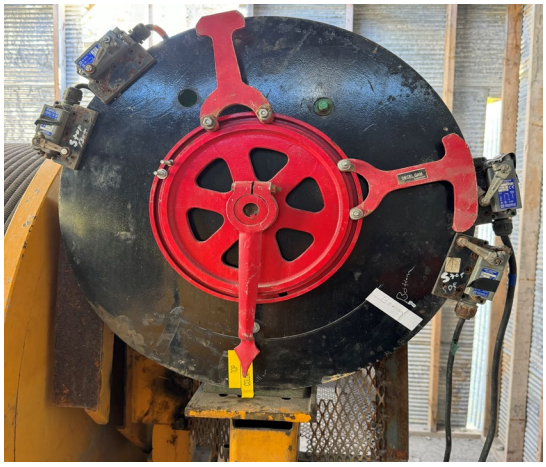


Figure 1





A depth indicator with overtravel switches.

Cylinder Depth Indicator:
The cylinder depth indicator is an older technology that has largely been replaced by more precise and reliable digital systems. It consisted of a threaded shaft and a cylinder that rotated in sync with the hoist drum. As the conveyance moved up and down the shaft, the indicator slid along the threaded shaft. A specific point on the cylinder's surface aligned with the end of the indicator when the conveyance reached a predetermined depth.
While this method was functional, it was prone to inaccuracies and required frequent calibration.

The cylindrical depth indicator is show in Figure 2.

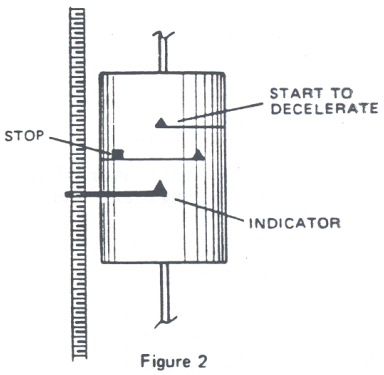
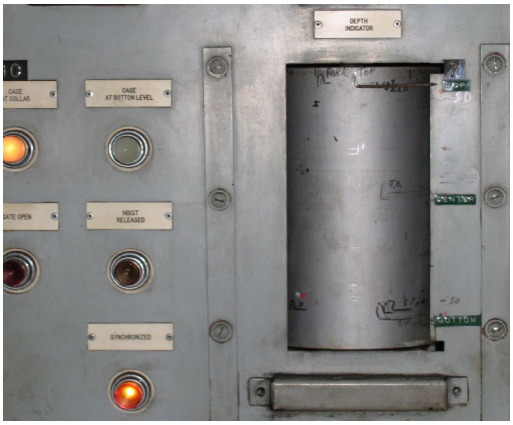


Figure 2



Experienced hoisting engineers mark points on the dial or cylinder depth indicator to signify critical locations within the mine shaft, including the dump level, working levels, collar, deceleration points, cruise speed points, and operator action points. They may also add additional marks at each stopping point to indicate where the conveyance should decelerate for a smooth stop, and they may adjust these markings to account for variations in load weight, shaft conditions, or other points where operator action is required.

Marks on Drum:
Experienced hoisting engineers may also mark the flange of the drum to provide a more accurate and easily read indication of the position of the conveyance.

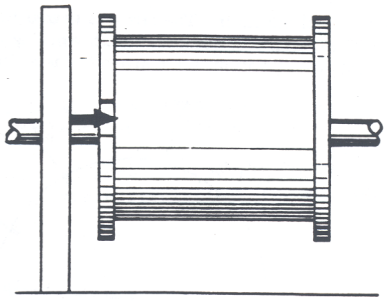
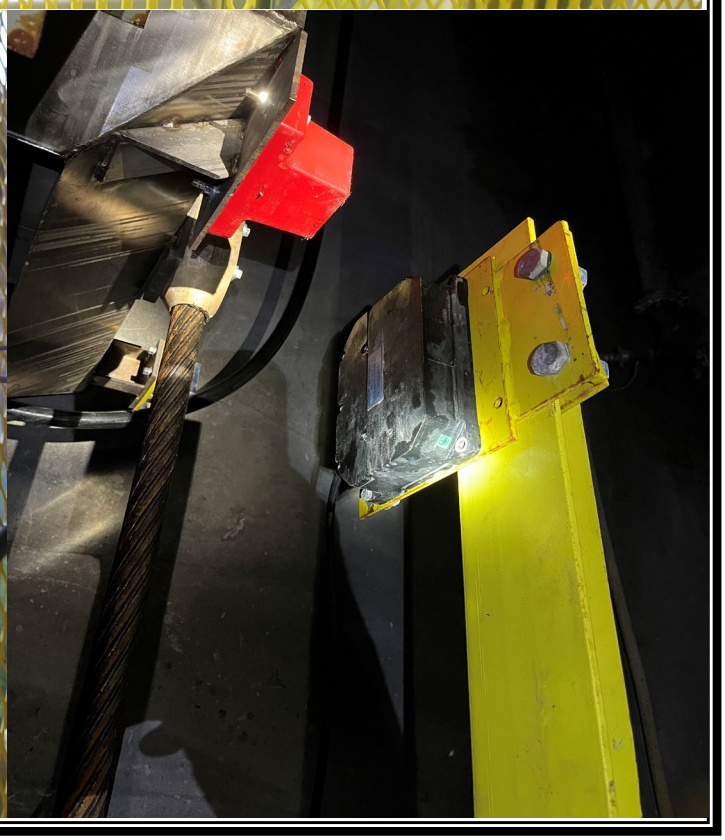


Figure 3

Hoist Indicators:
To ensure the safe and efficient operation of a hoist, a reliable and accurate indicator is essential for monitoring the position of the conveyance (cage, skip, bucket, or cars) within the shaft. This indicator must be clearly visible to the hoisting engineer and should be regularly checked to verify its accuracy.

Unit 16

SAFETY CONTROLLER



Safe operation of the hoist requires that the conveyance starts moving at slow speed, then accelerates to operating speed, then decelerates at the slow down location and then stop at the destinated location. This is accomplished by safety controls in the logic program and/or switches mounted at static location in the shaft or mounted to the depth indicator.

PLC Controller

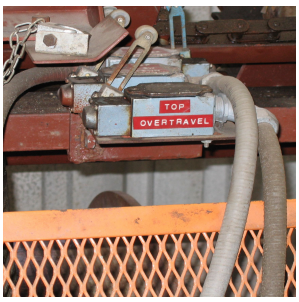
Programmable Logic Controllers (PLCs) have become indispensable in various industries, revolutionizing automation processes. Originally designed to simplify control system modifications, PLCs offer a significant advantage over traditional electromechanical relay systems. Instead of physically rewiring a complex network of relays, engineers can easily adjust control logic by simply downloading new software to the PLC.

PLCs are ruggedized computers built to withstand harsh industrial environments, including extreme temperatures and dusty conditions. They automate a wide range of processes in manufacturing, mining, and other industries, increasing efficiency, productivity, and safety.

A PLC is a robust computer designed to reliably operate in harsh industrial environments, such as those with extreme temperatures or excessive dust. It automates processes across various industries, including manufacturing and mining.

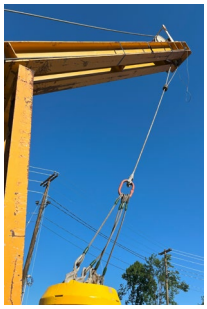
The controller is designed to permit slow conveyance speed prior to approaching a top, bottom, or other designated location. As the conveyance travels into the slow-down zone, it triggers a switch, informing the PLC controller that the conveyance is in the slow-down zone. The PLC controller reduces the speed in these zones. Slow-down zones are set according to the mine locations. Switches are mounted in the hoistway to trigger the slow-down zone.

Mechanical and Magnetic Switches:



Overtravel switches are safety devices that prevent the conveyance from moving beyond its designated operating limits. These switches are strategically positioned at the upper and lower extremes of the shaft. If the conveyance exceeds these limits, the overtravel switch triggers an alarm signal to the controller. The controller then immediately de-energizes the control circuit, halting the hoist's operation. Additionally, the controller sends a notification to the control station, alerting the operator to the overtravel event. (See photos on next page)

Most controllers are equipped with audible alarms, such as bells or buzzers, to alert the operator of specific events during hoist operations. These alarms may sound when the conveyance enters or exits the deceleration stage, during overtravel conditions, or in response to other automated control functions.

Human Machine Interface (HMI) Display:

An important part of a hoisting system is the need to provide accurate and helpful information to the hoisting engineer or technician. The PLC and Human-Machine Interface (HMI) provides information on:

Operating Conditions:

- Motor current
- Brake pressure
- Rope tension
- Hydraulic fluid pressure
- Temperature readings

Hoist Stats:

- Uptime
- Downtime
- Total cycles

Conveyance Location:

- Depth
- Speed
- Direction

Faults:

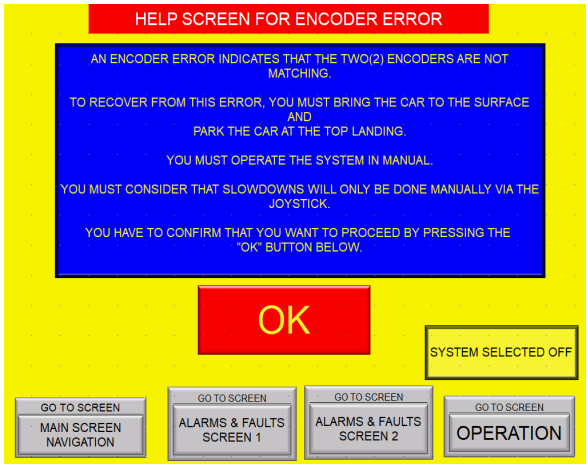
- Real-time fault codes
- Alarm notifications
- Historical fault logs

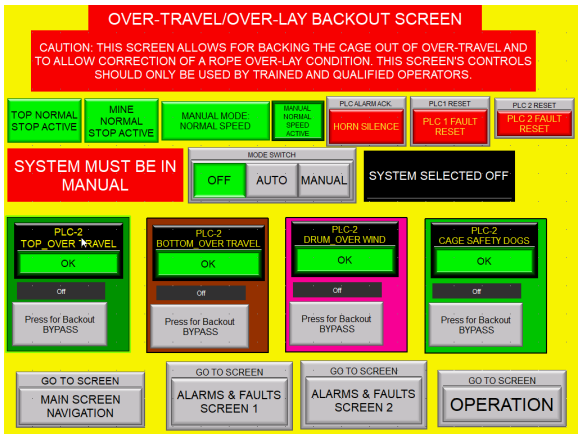
Troubleshooting Diagnosis:

- Diagnostic tools
- Step-by-step troubleshooting guides

Operation History:

- Event logs
- Performance metrics





By providing this comprehensive information, the HMI empowers hoist operators to make informed decisions, respond quickly to issues, and optimize the performance of the hoisting system. A well-designed HMI can significantly improve safety, efficiency, and overall system reliability.

Simplex/Lilly Controller:
A Simplex, Lilly, or similar automatic controller is a multi-purpose safety device that operates in conjunction with the hoist drum's rotation. This essential device safeguards the hoisting operation by preventing overspeed, overtravel, and automatically engaging the brakes in the event of a power failure.

The controller consists of:

- A governor which prevents overspeed. (See Figure 1)

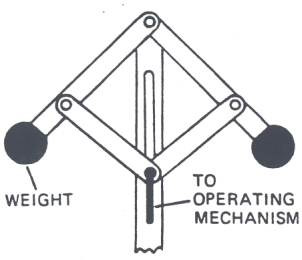


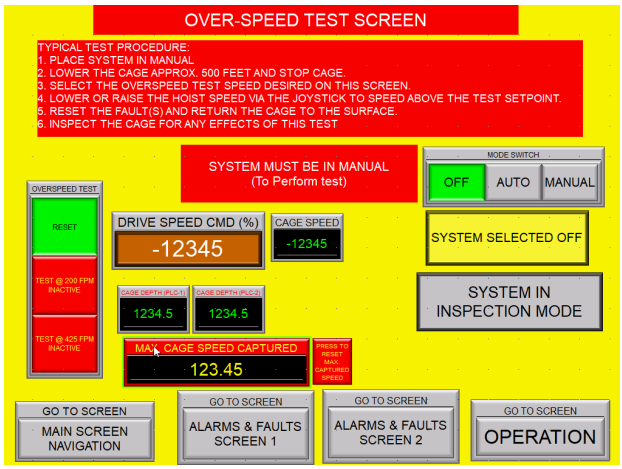
Figure 1

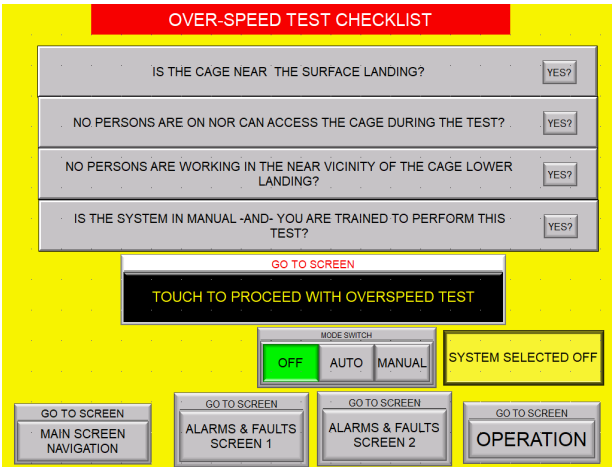
If the drum accelerates beyond a safe speed, the governor's weights are flung outward due to centrifugal force. This movement triggers a series of linkages that activate an electrical switch, which de-energizes the control power to the hoist motor and simultaneously engages the brakes, bringing the hoist to a halt.

Modern Programmable Logic Controller (PLC)-based hoist systems incorporate overspeed controls directly into their software. These controls allow for safe overspeed testing, where the hoisting engineer can initiate a controlled overspeed event. The PLC program is configured with a predetermined overspeed threshold. If the hoist exceeds this limit, the system triggers an overspeed fault, stopping the hoist and activating the brakes.

To perform a safe overspeed test, the PLC program temporarily adjusts the overspeed threshold to a lower value. This allows the hoist to reach a controlled, slower speed and simulate an overspeed condition without risking damage or injury. It's crucial to note that each hoist system has unique overspeed testing procedures, so operators must familiarize themselves with the specific guidelines for their equipment.

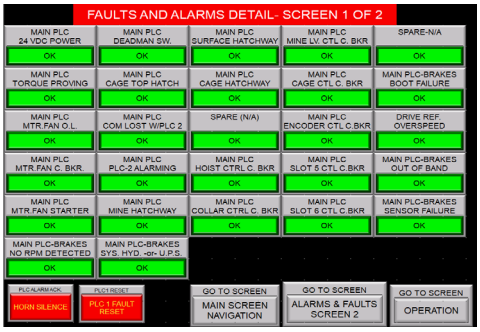
(Examples of an HMI over speed test screen)





Unit 17
CONTROL PANELS

Hoist Control Panels and Indicators



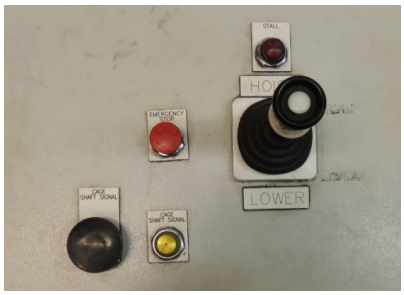
Hoist control panels are designed to provide the hoisting engineer with easy access and visibility to essential controls and indicators. Modern hoist systems often feature touch screen Human-Machine Interfaces (HMIs) that replace traditional switches and lights. These HMIs allow for intuitive control of various functions, including manual and automatic modes, fault diagnosis, conveyance positioning, depth monitoring, and speed control.

Traditional control panels may utilize levers, handles, or pushbuttons to operate the hoist. These controls are typically used to initiate hoisting operations, adjust speed, and engage or disengage brakes. Some control stations may be responsible for multiple operations, such as controlling the main hoist, derrick rotation, and auxiliary winches.

To enhance operator awareness, light indicators are used to visually signal the status of various hoist components and other equipment. These indicators may indicate the operating mode (manual or automatic), the state of bypass switches, clutch engagement, safety gate positions, and potential issues such as low oil pressure, low hydraulic or air pressure, or malfunctioning ventilation or flood control systems. Additionally, meters may display critical information like depth, speed, voltage, motor current, and hydraulic pressure.

Single Drum Hoist Operation:

The control panel in photos below are for a single drum hoist. The bakes are set when the control handle is pulled back and released when it is pushed forward. The rope on an overwound drum will be lowered when the motor control is pushed forward and raised when the motor control is pulled back. Electric braking can be done by reversing the motion of the control, that is, pulling the motor control lever back if lowering and pushing it forward if hoisting. If the hoist has an AC motor with dynamic braking, an additional switch and lever are provided to control the braking.



Double Drum, Single Clutch Hoist

The control panel in Figure 2 (next page) is for a double drum hoist with a clutch on the left drum only. The clutch and left drum brake is controlled by the same lever. The clutch is engaged when the lever is pulled to the right and disengaged when it its pulled to the left. The left drum brake must be applied in-order to get the clutch operating lever in the disengaged position. Some control stands have separate operating levers for the clutch and brake. The levers are interlocked, however, to

prevent disengaging the clutch when the drum brake is not applied. Some double drum hoists do not have a clutch and will have only one brake operating lever.

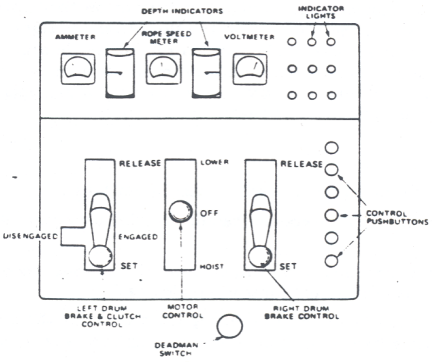


Figure 2

Double Drum, Double Clutch Hoist

The control panel in Figure 3 is for a double drum, double clutch hoist. The clutches are interlocked with the brakes just the same as in the double drum, single clutch hoist. Either drum can be operated as a single drum hoist.

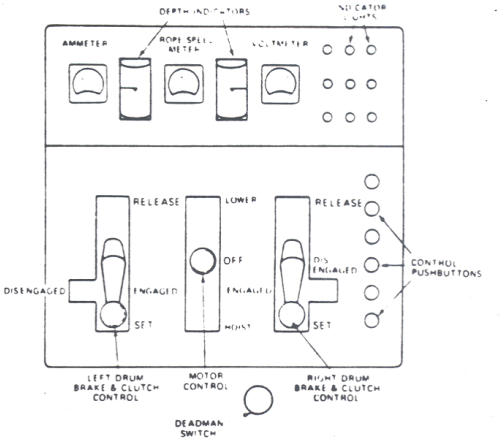


Figure 3

Control Panel for Automatic Operated Hoist

Unit 18
COMMUNICATION SYSYEMS

COMMUNICATION SYSTEMS

Communication systems provide the means of transferring information from one location to another. The hoisting engineer may receive information from the Foreman or Top Person (skip tender). The types of information to be transferred is depended on the operating needs of the hoist. Communication could be to raise or lower the conveyance to a working level, hoist or lower a muck bucket, a piece of equipment or other needed supplies. Other information may that indicate the condition of equipment or of the mine environment.

Types of communication systems:

- Hoist bell
- Telephone
- High frequency radio
- Public address system
- Indicator lights
- Meters and/or gauges
- Closed-circuit TV

Use of each communication system:

Hoist Bell: used to request or order the movement of the conveyance. For example, the skip tender, using a series of bells to signal a request for the conveyance to be hoisted or lowered.

Telephone or **Radio:** used for longer messages. For example, the hoisting engineer may inform the skip tender that the conveyance will not be available for a time. Therefore, the answer to the request will be delayed.

Public Address System: used to pass information to many people over a wide area. For example, it may be used to give a general announcement or to issue a warning in case of an emergency.

Indicator Lights: used to communicate that a malfunction has occurred, that power is on or off, or that a machine is operating. For example, in some mines an indicator light in the hoist room will show that the pumps are running.

Meters and Gauges: used to communicate conditions. For example, the ammeters indicate the load on the motor, the rope meter shows the speed of the rope, and the temperature gauges show temperatures in the mine.

Closed Circuit TV: provides a view of likely problem areas. The hoisting engineer can observe areas such as the shaft collar and the dumping area.

The specific use of a communication system varies from one mine to another. For example, in some mines the skip tender will telephone the hoisting engineer before giving a bell signal requesting the use of the hoist. It is a safe practice for the hoist engineer to acknowledge the bell signal prior to answering the request.

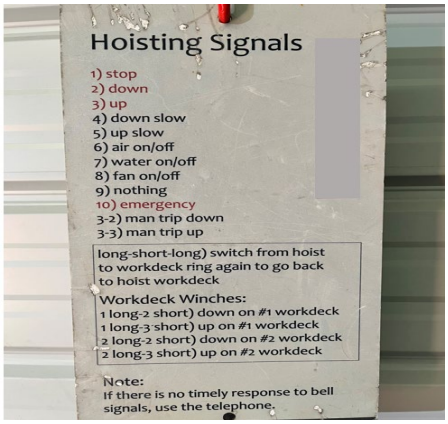
In general, basic bell codes are standard, but there are many variations among mines. The hoisting engineer must be thoroughly familiar with the operating procedures for communication systems of at the mine.

There shall be at least two effective approved methods of signaling between each of the shaft stations and the hoist room, one of which shall be a telephone or speaking tube.

Hoisting engineers shall accept hoisting instructions only by the regular signaling system unless it is out of order. During an emergency, the hoisting engineer shall accept instructions only from authorized persons to direct movement of the conveyances.

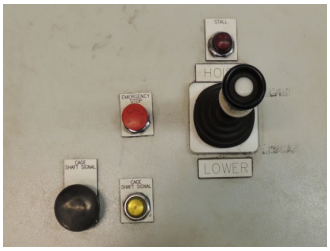
A method shall be provided to signal the hoisting engineer from cages or other conveyances at any point in the shaft. A standard code of hoisting signals shall be adopted and used at each mine. The movement of a shaft conveyance on a “one bell” signal shall be prohibited. A legible signal code shall be posted prominently in the hoist house within easy view of the hoistman, and at each place where signals are given or received.

Any person responsible for receiving or giving signals for cages, skips and/or mantrips when men or materials are being transported shall be familiar with the posted signaling code.



UNDERGROUND COAL MINES

There shall be at least two effective methods approved by Virginia Energy for signaling between each of the shaft stations and the hoist room, one of which shall be a telephone or radio. One of the methods used to communicate between shaft stations and the hoist room shall give signals which can be always heard by the hoisting engineer while men are underground. Signaling systems used for communication between shaft stations and the hoist room shall be tested each shift.



Unit 19
LUBRICATION

Lubrication prevents wear on surfaces that rub together and is a major part of machinery maintenance.

The typical parts of a mine hoist that require lubrication are:

- ✓ **Bearings of all rotating parts**
  - Hoist motor
  - Overspeed and overtravel control
  - Hoist drum
  - Air compressor
  - Head and other sheaves
  - Hydraulic pump

- ✓ **Joints of operating mechanisms**
  - Brake linkages or mechanism (do not apply lubricate to brake pads)
  - Clutch
  - **S**afety catch linkages
  - Limit switches
  - Hoist operating controls

- ✓ **Other surfaces that rub together**
  - Shaft guides and conveyance guide shoes
  - Hoist ropes

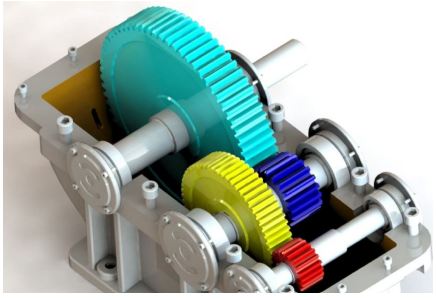
The types of lubricant are:

- Oil
- Grease

The methods of application are:

Oil

- Oil Reservoir — The bearing or part to be lubricated is submerged in oil. A dipstick or sight glass is provided to indicate if the oil is at the proper level. (See Figure 1)



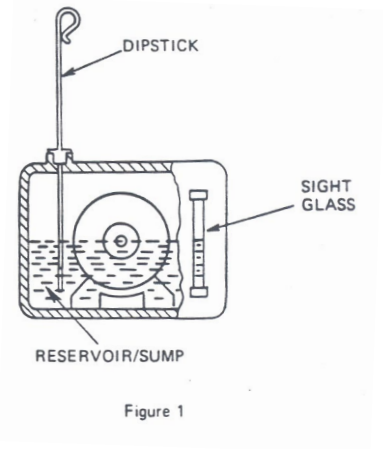


Figure 1

Oil Flow System

- Oil is fed to the bearing from an elevated tank by gravity or by a pump. After flowing through the bearing, the oil drains into a sump. A pump takes the oil out of the sump and pumps it to an elevated tank or directly to the bearing. A sight glass is usually provided to show whether or not oil is flowing in the required amount. A sight glass or dip stick can be

used to show if there is sufficient oil in the tank or sump. The gauge measures oil pressure. (See Figure 2)

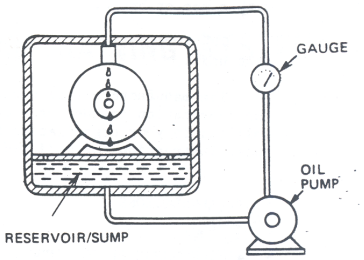


Figure 2

Grease

- Grease is forced between the parts to be lubricated (shaft and bearing, for example) by a grease gun. (See Figure 3)

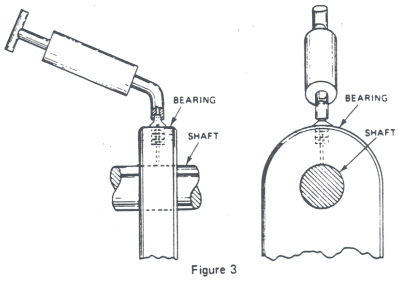


Figure 3

- The gun may be attached or portable. If it is attached, it may be operated automatically or manually.
- An adequate supply of grease should always be in the gun.

The person responsible for lubricating the hoist machinery must know:

- Parts to be lubricated.
- Method of lubricating each part
- Type of lubricant (grade and weight or oil-type of grease) used for each part.
- Location of the lubricant storage

Manufacturers of all hoist equipment include recommendations for lubrication and servicing in the instruction manual. These recommendations may be modified in your organization by the people responsible for maintenance. These instructions or modified instructions should be followed closely. Complete records must be kept of installation, lubrication, inspections, tests and maintenance of shafts and hoisting equipment.

The application of the lubricant to the shaft guides is usually done with a brush or spray. Ropes shall be kept well lubricated from end to end as recommended by the manufacturer. Sheaves shall be inspected daily and kept properly lubricated. Rollers used in inclined shafts shall be lubricated, properly aligned, and kept in good repair.

Unit 20

HOIST INSPECTION

HOIST INSPECTION

Periodic inspections of the hoist, shaft and related parts are made to assure that operations can be conducted safely. This unit outlines basic inspection requirements. You will learn detailed requirements from your mine's rules and regulations.

The hoisting engineer must know:

1. Hoist parts that require inspection.
2. How often these parts require inspection.
3. Conditions which indicate maintenance or attention is required.
4. Method of recording information in log.

At the beginning of each shift:

The hoisting engineer examines the hoist and tests overtravel, overspeed, deadman controls, position indicators, braking mechanisms, and other safety components.

This includes:

- **Visually checking:**
  - ✓ Wiring for loose connections, damaged insulation.
  - ✓ Hoist housing, structure and drum for loose bolts, cracks, and similar defects.
  - ✓ Brake mechanism for loose/worn shoes, mechanical defects, hydraulic pressure.
  - ✓ Safety cable for lubrication, broken wires, deformation.
  - ✓ Conveyance for loose, missing, or broken parts.
  - ✓ Safety dogs.

- **Operating hoist one complete round trip to ensure that:**
  - ✓ Shaft is clear and will accommodate skip/cage.
  - ✓ Appearance and sound of running hoist is normal.
  - ✓ Wire rope has no apparent defects.
  - ✓ Depth indicator, ammeter, rope speed meter, and other functioning properly
  - ✓ Brakes, clutches, and other components are normal.

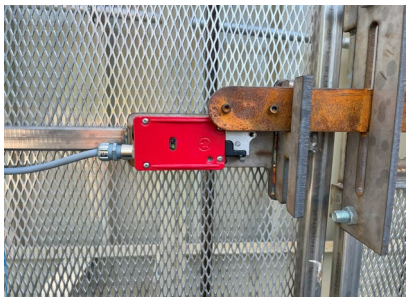
- **Test the following:**
  - ✓ Communication systems.
  - ✓ Overspeed controls.
  - ✓ Overwind controls.
  - ✓ Slack rope shut down.
  - ✓ Lapped rope shut down.

Daily – Visually Examine

- Rope and conveyance – connections to conveyances and drum should be checked.
- The hoisting engineer should look for abnormalities in the rope, including:
  - ✓ Reduction in rope diameter.
  - ✓ Stretching of the rope.
  - ✓ Worn, broken or corroded wires.
  - ✓ Indications of mechanical abuse.
  - ✓ Abrasions.
- Safety catches
- Sheaves
- Shaft (coal)

Some Inspection Key Points:

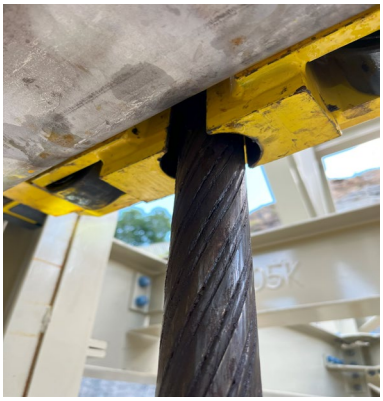
Safety gate, gate locking mechanizing, cage controls and communication

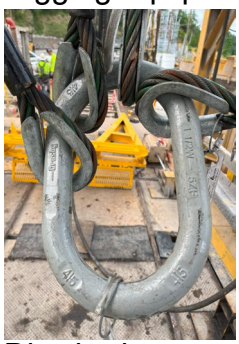

Safety bridle, master controls and gauges

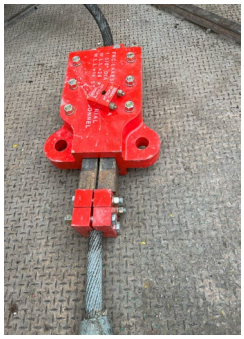

Automatic stops, rope termination anchor points, safety catches





Rigging equipment, rope termination, safety bridle,




Disc brake mounting pins not secured properly:



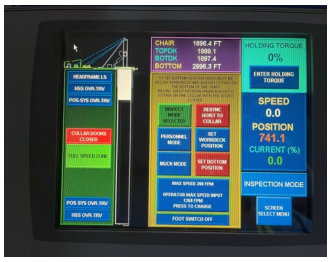
Man cage, guarding, depth indicator, over travel.



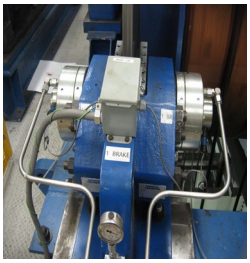

Lapped rope, sheeve wheels, rope wedge blocks and safety ropes, indicator lights and E-Stop




Depth indicator, speed, other safety, drum, and brakes





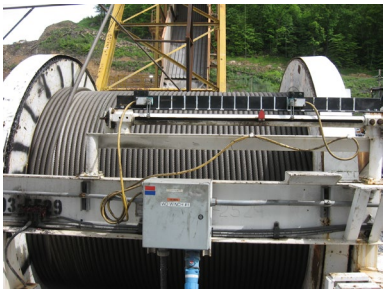


Safety catches, conveyance guides, load attachment equipment, guide rope tensioners




Shaft Sinking Work Deck Winch Inspection and Safety

Regular inspection and maintenance of shaft sinking work deck winches are crucial for ensuring their safe and reliable operation. A comprehensive inspection program should be implemented to identify and address potential issues before they escalate into major problems.



Key Inspection Points for Shaft Sinking Work Deck Winches:

1. **Mechanical Components:**
   - ✓ **Drum:** Inspect for wear, cracks, and corrosion.
   - ✓ **Brake System:** Check brake pads, linings, and linkages for wear and proper function.
   - ✓ **Gears and Gearboxes:** Inspect for tooth damage, excessive wear, and proper lubrication.
   - ✓ **Shafts and Bearings:** Check for alignment, wear, and proper lubrication.
   - ✓ **Drums and Ropes:** Inspect for wear, corrosion, and proper rope winding.
   - ✓ **Wire Ropes:** Check for wear, corrosion, and proper lubrication.
   - ✓ **Hooks and Attachments:** Inspect for damage, wear, and proper function.
2. **Electrical Components:**
   - ✓ **Motor:** Check for insulation damage, overheating, and proper operation.
   - ✓ **Control Panel:** Inspect for damage, corrosion, and proper function of switches, buttons, and displays.
   - ✓ **Wiring and Cabling:** Check for damage, insulation breakdown, and proper connections.
3. **Hydraulic System (if applicable):**
   - ✓ **Hydraulic Pump:** Check for leaks, noise, and proper operation.
   - ✓ **Hydraulic Hoses and Pipes:** Inspect for leaks, damage, and proper routing.
   - ✓ **Hydraulic Fluid:** Check for contamination, level, and proper viscosity.

Safety Considerations:

- ✓ **Operator Training:** Ensure that operators are properly trained and qualified to operate the winch safely.
- ✓ **Regular Maintenance:** Implement a regular maintenance schedule to address issues before they become critical.
- ✓ **Safety Devices:** Regularly inspect and test safety devices, such as emergency stop buttons, limit switches, and overload protection systems.

- ✓ **Workplace Safety:** Adhere to all safety regulations and guidelines, including the use of personal protective equipment (PPE).
- ✓ **Risk Assessments:** Conduct regular risk assessments to identify potential hazards and implement control measures.

By prioritizing regular inspections, maintenance, and safety practices, mining and construction companies can significantly reduce the risk of accidents and ensure the safe and efficient operation of shaft sinking work deck winches.

Unit 21

MAINTENANCE

Maintenance is the work that is done to keep the mine host and its parts repaired and in safe operating condition.

Maintenance includes:

- Housekeeping
- Inspection
- Lubrication
- Repairs
- Replacement of parts
- Adjustments

There are two kinds of maintenance:

- Corrective maintenance, which is repairing or replacing parts that have broken down.
- Preventive maintenance, which is repairing, adjusting, or replacing parts before they break down.

This work may be the responsibility of the hoisting engineer or the maintenance personnel. In either case, the hoisting engineer must have a systematic procedure and adequate records to assure that the required work is done according to regulations.

Maintenance instructions come from several sources:

- Federal, State, or local regulations
- Maintenance manuals provided by the manufacturers of the hoist, hydraulic systems, and other systems.
- Maintenance procedures implemented by the operator, mine foreman, maintenance foreman and other mine managers.

The hoisting engineer should know the maintenance procedures required to be performed:

- Pre-shift
- Post-shift
- Daily
- Weekly
- Monthly
- Annually
- And the person responsible for doing each.

The hoisting engineer should have a record of when each task was performed and who performed it. A check-off list with the above information is a must for a good maintenance.

Hoisting engineer shall be informed when men are working in a compartment affected by that hoisting operation. When men are working in a shaft “Men Working in Shaft” signs shall be posted at all devices controlling hoisting operations that may endanger such men.

Unit 22
BEGINNING OF SHIFT INSPECTION

Beginning of Shift

At the beginning of a shift, the hoisting engineer has five basic tasks to perform to assure that the hoist is ready to operate:

- Check the general condition of the hoist.
- Check the hoist parts for proper lubrication.
- Check the power supply to the hoist.
- Operate the hoist one complete cycle.
- Check the operation of the safety devices.

The ***first task*** the hosting engineer does is to find out the general condition of the hoist. To do this the hoisting engineer will:

Find out what happened to the previous shift:

- Read hoist log or other product records.
- Talk to previous hoisting engineers.

Visually inspect for defects:

- Hoist anchorage, structure, and drum for loose/broke bolts or missing bolts or fasteners and check the structure for cracks.
- Brakes for abnormal hydraulic or pneumatic pressure, missing or loose parts, loose shoes or worn bands.
- Check cable/wiring for damage, frayed wiring, missing insulation, loose connections.
- Inspect hoist rope for loose couplings or damaged rope on conveyance and safety cables, no slack in safety cable, and if lubrication is working.

The ***second task*** a hoisting engineer does when they come on shift is to assure that lubrication is provided to the points that require it.

In Unit 19 various lubrication systems were described. Here is how the hoisting engineer will use them to assure that the hoist is properly lubricated.

For installed grease systems:

- Inspect grease supply in reservoir.
- Test the system operation.
- Inspect for grease at the lubrication points.
- Request assistance if necessary.

With a portable grease gun:

- Inspect for grease at points to be lubricated.
- Lubricate where necessary.

For a hoist with an oil flow system:

- Inspect oil supply in reservoir.
- Inspect pump (look at pressure gauge).
- Inspect for leaks.
- Inspect sight glass for normal oil flow.
- Request assistance if necessary

Hoists with an oil reservoir system:

- Inspect oil supply in reservoir.
- Inspect bearings for leaks.
- Request assistance if necessary

The ***third task*** the hoisting engineer performs is to assure that power is available to all parts of the hoist. The power is controlled by switches. If the switch is CLOSED, power flows through the switch and is ON. If the switch is OPEN, power cannot flow through the switch and is OFF.

To assure that power is available to the switchboard the hoisting engineer will:

- Close the main power switch on the switchboard (turning power ON.)
- Note if the indicator light is ON.

To assure that power is available to the hoist control stand:

- Close the power switch on the control stand (turn power **ON**.)
- Move the motor control in one direction.
- Move the motor control in the other direction.
- Request assistance if test fails.

The ***fourth task*** the hoisting engineer does is to run an empty conveyance at slow speed the full length of the shaft. This is done to assure that the shaft is clear and that the controls operate properly. After a complete cycle into and out of the shaft, often a foreman rides in the cage to looks for abnormalities in the shaft. The specific procedure for operating the hoist is in the unit “Routine Shift Activities.”

The ***fifth task*** is to test the hoist safety devices. If a device fails its test, it must be repaired before starting operations. These tests may be performed by the hoisting engineer or by maintenance personnel trained to perform the test.

****All checks, test and exams are to be recorded in a book maintained at the mine site.**

Overspeed Protection and Testing

Overspeed protection is a critical safety feature in hoisting systems. It prevents the hoist from exceeding its designed operating speed, which could lead to catastrophic failure.

Mechanical Overspeed Controllers:

Older hoist systems often employ mechanical overspeed controllers, such as the Lilly or Simplex. These devices utilize centrifugal force to trigger a safety mechanism when the hoist reaches a predetermined speed. To test these mechanical controllers:

1. **Slow Down the Hoist:** Reduce the hoist's speed to a slow, controlled pace.
2. **Activate the Test Switch:** Carefully activate the test switch on the Lilly or Simplex controller.
3. **Monitor the Hoist:** Observe the hoist's response. The overspeed protection system should engage, causing the hoist to stop.

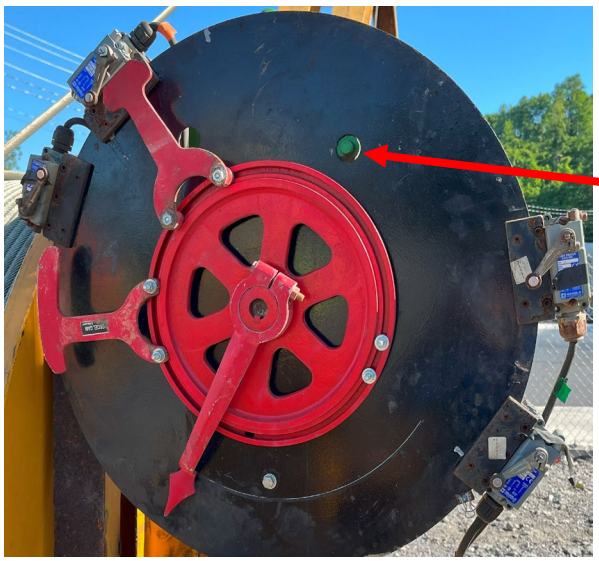
Modern Electronic Overspeed Control:
Modern hoist systems utilize programmable logic controllers (PLCs) to implement sophisticated overspeed protection systems. These systems monitor the hoist's speed using sensors, such as encoders, and compare it to predefined limits. If the speed exceeds the limit, the PLC triggers a safety response, such as braking or shutting down the motor.

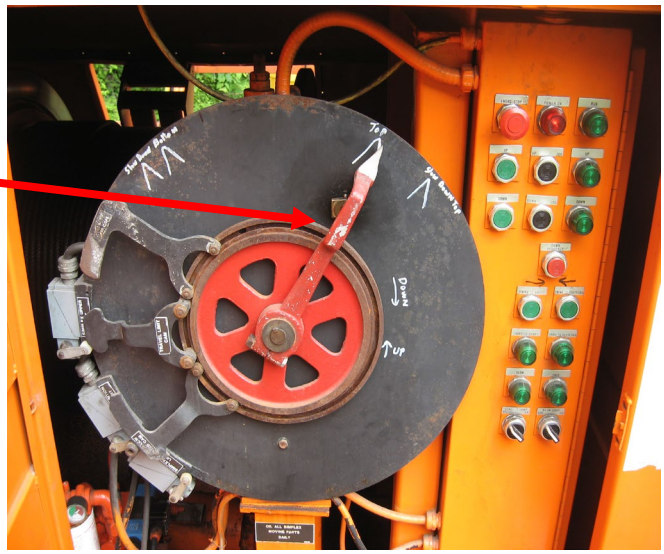
To test the overspeed protection system on a PLC-controlled hoist, the hoisting engineer typically uses the Human-Machine Interface (HMI) to enter a specific code or sequence of steps. This initiates a controlled overspeed test, where the PLC temporarily adjusts the overspeed limits to allow for a safe and controlled test.

Important Considerations:

- **Safety First:** Always follow the specific procedures and guidelines for your particular hoist system.
- **Qualified Personnel:** Only qualified personnel should perform overspeed tests.
- **Emergency Procedures:** Have emergency procedures in place in case of unexpected events.

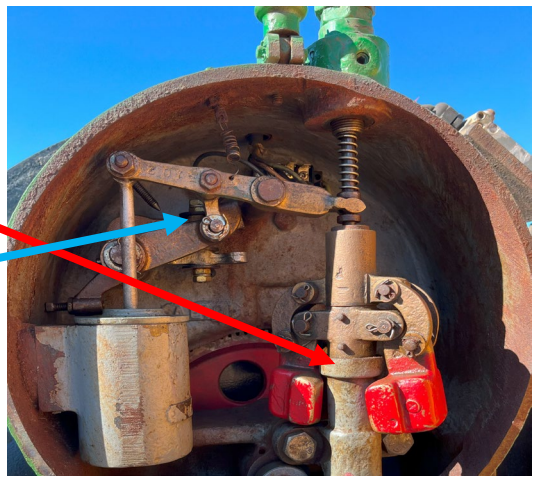
By regularly testing and maintaining overspeed protection systems, you can significantly reduce the risk of accidents and ensure the safe operation of your hoisting equipment.





If the cam is missing or inoperative, do the following:

- Set the brake and stop the hoist.
- Manually raise the weights on the governor.
- Check to see that the main power switch opens (power turns **OFF**)
- Close the cover if the circuit opens satisfactorily, otherwise have it repaired.



If any on the overspeed test fail, remove from service and make all necessary repairs. Once repairs are completed, start the checking, testing and exam procedure over again.

Overtravel Limit Switch Test

There are two limit switches to prevent overtravel, one at each end of the shaft. The switch near the top prevents the conveyance from traveling too far above the collar and into the headframe, the switch near the bottom prevents travel too far below the deepest landing.

To test the landing limit switches, the hoisting engineer will:

- Move the conveyance slowly above/below the collar/deepest landing.
- The hoist controls should stop the hoist and the brakes should set as the conveyance enters this limit switch.

To test the top overtravel, the hoisting engineer will:

- Move the conveyance slowly into the top landing switch, which should stop the hoist. (If this test fails, do not precede to next steps)
- Close the overtravel bypass switch and slow move conveyance into the top overtravel. The hoisting engineer should watch or have someone watch the conveyance as it moves near the top of the head frame into the overtravel (two-block) switch. If at any time the hoisting engineer or spotter feels that the conveyance has move to far, the test should be stopped.
- After moving into the top overtravel, the hoisting engineer will have to hold a bypass switch or activate a switch on the HMI to back the conveyance out of the top overtravel.
- Return the conveyance to the normal operating level.

If the main power switch does not open, the hoisting engineer will:

- Set the brake.
- Put the motor control on OFF.
- Request assistance.

On some hoists, the safety controller also has an overtravel limit switch. On such hoists the safety controller must be bypassed in-order to test the shaft overtravel switches.

Slack Rope Switch and Conveyance Safety Catches Test

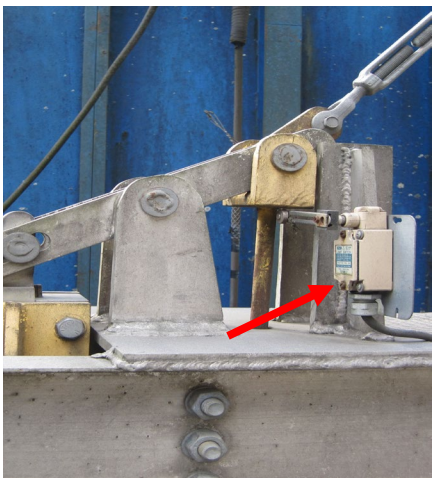
The slack rope switch will cut the control power to the hoist and apply the brakes if the rope goes slack.

- The hoisting engineer will extend the hydraulic cylinders out, allowing the conveyance to set on the safety catches.
- After the safety catches are set, the hoisting engineer lowers the main hoist rope allowing the conveyance to set on the safety catches and allowing the

slack rope switch to de-energize the controls. As the rope goes slack, the main power switch should open.

To test the safety catches and slack rope switch the hoisting engineer will:

- Support the conveyance, also known as chairing. The support may be wood/metal beams or chains.
- Some hoists use a hydraulic pumping unit and hydraulic cylinders to lift the conveyance to set the safety catches and slack rope switch. (See photo)
- The conveyance is lifted by the hydraulic cylinders, taking tension off the main hoist rope,
- As the tension on the main hoist rope decreases, the springs on the safety catches apply pressure to the safety catches, allowing the safety catches to clamp onto the shaft guide or guide rope.
- The hoisting engineer will extend the hydraulic cylinders out, allowing the conveyance to set on the safety catches.
- After the safety catches are set, the hoisting engineer lowers the main hoist rope allowing the conveyance to set on the safety catches and allowing the slack rope switch to de-energize the controls. As the rope goes slack, the main power switch should open.



If the test is successful:

- The hoisting engineer will raise the conveyance slowly until it is lifted off the supports if beams were used or ropes.
- If the hoisting engineer used the hydraulic cylinder to lift the conveyance, as the safety catches are released the conveyance move suddenly.
- Remove any supports.
- Operate the hoist one complete cycle to ensure proper operating.
- Record test.

If test fails, take the hoist out of service and request assistance.

Deadman Switch: A Critical Safety Feature

Most hoists are equipped with a crucial safety device known as a "deadman switch or man-in-position." This switch is typically a floor-mounted or hand-held control that requires constant pressure to maintain power to the hoist. If the operator releases the switch, either intentionally or unintentionally, the power is automatically cut off, and the brakes are engaged, bringing the hoist to a halt.

Testing the Deadman Switch
To ensure the proper functioning of a deadman switch, a regular testing procedure is essential:

1. **Disengage the Switch:** Ensure that the operator is not physically pressing or standing on the switch.
2. **Attempt to Activate the Hoist:** Try to activate the hoist using the control panel or other operating mechanisms.
3. **Verify Inactivity:** The hoist should remain inactive if the deadman switch is not engaged.

If the hoist starts operating without the switch being activated, it indicates a malfunction in the switch. In such a case, the hoist must be immediately taken out of service and repaired to prevent accidents.

By regularly testing deadman switches and ensuring their proper operation, you can significantly enhance the safety of hoisting operations.

This study guide is only a reference on how safety devices are tested and examined and is not an all-inclusive test/exam procedure.

State regulations require that complete records be kept of installation, lubrication, inspection, tests, and maintenance of shafts and hoisting equipment. Your mine will have specific rules for making log entries in agreement with these regulations.

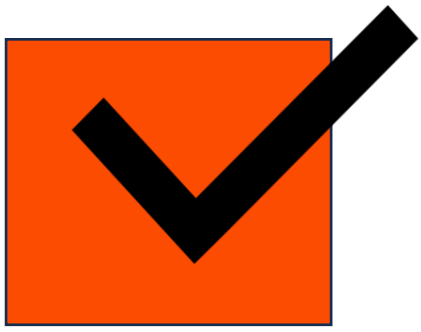
Key Points on Hoist Safety and Regulations

- **Unique Hoist Configurations:** Each hoist system has its specific safety features and testing procedures. It's crucial to familiarize yourself with the particular equipment you're operating.
- **Regulatory Compliance:** Adherence to local, state, and federal regulations is paramount. These regulations often mandate specific safety devices and testing protocols.
- **Record Keeping:** Detailed records of installation, maintenance, inspections, and tests are required by law. These records help ensure compliance and facilitate future troubleshooting.
- **Deadman Switch Importance:** The deadman switch is a critical safety device that automatically cuts power and engages brakes if the operator becomes incapacitated. Regular testing is essential to verify its functionality.

- **Overspeed Protection:** Overspeed protection devices, such as mechanical governors or electronic systems, prevent the hoist from exceeding safe operating speeds. Regular testing and calibration are necessary.
- **Additional Safety Features:** Hoist systems may incorporate additional safety features like overwind and overwind limit switches, emergency stop buttons, and automatic braking systems.

Remember, safety is paramount in hoisting operations. By understanding and adhering to safety protocols, operators can significantly reduce the risk of accidents and injuries.

REVIEW
QUESTIONS



Questions and answers for review:

1. Cages used for hoisting men shall have:
   Answer: Enclosed sides, adequate steel bonnets, and substantial construction.

2. The floor of cages shall be designed and constructed to:
   Answer: Be impossible for miner's feet or body to enter any opening in the bottom of the cage and carry the load.

3. A test of safety catches on cages shall be made:
   Answer: Monthly

4. The speed of cages when miners are being transported shall not exceed:
   Answer: 1000 feet per minute

5. Hoisting machinery shall be maintained in:
   Answer: Safe operating condition.

6. Platforms or work decks used for transporting miners or materials shall be equipped with:
   Answer: Leveling indicators

7. How many turns of rope must remain on the drum when extended to its maximum working length?
   Answer: Three turns.

8. Hoisting ropes shall be fastened to its load by:
   Answer: A spelter filled socket, or thimble and adequate number of clamps.

9. An indicator showing the position of the cage, shall be in clear view of the hoisting engineer unless:
   Answer: The position of the car or trip is clearly visible to the hoisting engineer or other person operating the equipment at all times.

10. Hoist “rope” on all cages except automatically operated elevators, shall be inspected:
    Answer: At the beginning of each shift by hoisting engineer.

11. Ropes used to hoist or lower men shall have a safety factor of:
    Answer: 10 to 1

12. Hoist shall be equipped with brakes capable of stopping and holding a:
    Answer: Fully loaded unbalanced cage at any point in the shaft.

13. The Lilly, simplex, or other safety controller is a multi-purpose safety device attached to the:
    Answer: Drum shaft

14. Safety factor of ropes used to hoist or lower coal:
    Answer: 5 to 1

15. Hoist used to transport persons at a coal mine shall be equipped with:
    Answer: Over speed, over wind and automatic stop controls.

16. What must be done before hoisting or lowering men when the cage has been idle for more than one hour?
    Answer: Empty cages must be operated up and down the shaft one complete trip.

17. Any rope attached to a cage or man car, or trip used for hoisting or lowering men or materials shall be provided with:
    Answer: Two bridle chains or cables.

18. Platforms or work decks shall be maintained in reasonably level position while:
    Answer: Transporting men and materials.

19. Defects found during daily hoist inspections shall be:

    Answer: Reported to operator or agent and corrected promptly.

20. The purpose of the safety dogs is to:

    Answer: Clamp down on the shaft guide if the rope slips or fails.

21. The two basic types of clutches used on hoist are:

    Answer: Centrifugal clutch & friction clutch

22. What device engages or dis-engages the drum from the hoist motor?

    Answer: Clutch

23. The main parts of a disc brake are:

    Answer: Disc, pads, and operating mechanism.

24. Brakes on hoist used to transport persons shall be capable:

    Answer: Of stopping and holding a fully loaded platform or cage.

25. How far should the drum flange extend above the spooled cable?

    Answer: 4 inches.

26. All self-dumping cages used to transport personnel shall be equipped with:

    Answer: Locking device to prevent tilting of the cage.

27. What is the purpose of the over-speed in the hoisting mechanism?

    Answer: Designed to de-energized the hoist in the event of excessive speed.

28. Signaling codes shall be in use at each shaft mine and approved by:

    Answer: The Chief, Virginia Department of Energy.

29. The two basic types of mine hoist are:

    Answer: Friction, and drum hoist

30. One of the methods of communication between shaft station and hoist room shall give a signal which can be heard at all times by:
    Answer: Hoisting Engineer

31. All suspended work decks and platforms shall be equipped with:
    Answer: Safety belts and guard rails.

32. Who can ride on a cage loaded with supplies?
    Answer: Not anyone.

33. Who shall inspect all bull wheels and lighting systems on the head frame?
    Answer: Authorized person designated by the operator.

34. How is the number of persons that can ride in any cage at one time determined?
    Answer: Number persons riding shall not exceed maximum prescribed by the manufacturer.

35. What shall be provided at the bottom of each hoisting shaft and t intermediate landings?
    Answer: A run around.

36. What is a sheave?
    Answer: A grooved wheel which supports the hoist rope.

37. The head frame for a drum hoist holds:
    Answer: Head sheave and wire rope

38. What is a “safety dog” on a cage used for?
    Answer: An emergency braking device.

39. The shaft lining is:
    Answer: The sides of the shaft

40. The safety gate is:

    Answer: A guard across a landing of the shaft.

41. The purpose of shaft guides are:

    Answer: Keep the conveyance or age in proper position.

42. The “skip” is used to transport:

    Answer: Ore, waste, coal, and equipment.

43. At a shaft mine the “collar” is referred to as:

    Answer: The area surrounding the shaft opening.

44. The hoist must be taken out of service:

    Answer: When there is evidence of damage or failure of hoist parts.

45. A daily visual examination of hoisting equipment should include the following:

    Answer: Headgear, cages, ropes, connections, links, chains, shaft guides, shaft walls, bull wheels, lighting systems and head frame.

46. The depth indicator for the shaft shows what?

    Answer: The position of cage or trip at any point in the shaft.

47. How does a hoist man check the over-wind to ascertain it is functioning properly?

    Answer: Manually operate the over-wind protection devices.

48. What are the requirements for certification for a hoisting engineer?

    Answer: Two years practical mining experience, pass hoist engineer and gas detection examination and one year hoisting experience.

49. When is a person that is certified to operate hoisting equipment required to be on duty?

    Answer: While any person is underground except where automatic elevators are used.

50. Who can certify personnel to operate a manually controlled hoist?

    Answer: Virginia Energy (CMS), Board of Examiners.

51. What is the minimum score an applicant must make to pass the hoist man examination?

    Answer: 80%

52. Who can operate automatic elevator?

    Answer: Any workman which can operate it safely.

53. Conveyances used to haul men and material shall have a six-inch retaining edge to prevent:

    Answer: Materials or objects from falling back into the shaft.

54. Where shall stop blocks and derails be located?

    Answer: Near the top of immediate landings of slopes, near the top of surface inclines, near the approaches to shaft landings.

55. Shafts shall be equipped with safety gates at:

    Answer: Each landing and the top of shafts.

56. What shall not be permitted to accumulate excessively on the walls of any shaft where men are hoisted or lowered?

    Answer: Ice

57. Whenever men are working at the bottom of the shaft there shall be an adjustable ladder or chain attached to the work deck to provide an additional means of escape. Such ladder shall be at least.
Answer: 20 feet in length.

58. Conveyances being lowered into a shaft in which miners are working shall be stopped how far above the miners?
Answer: Twenty feet.

59. What supplies or tool can be transported on the same cage with miners?
Answer: Only small hand tools that can be carried on the person.

60. What is the center of a wire hoisting rope called?
Answer: Core

61. The wires which bear against the sheave or drum are called?
Answer: Crown wires.

62. The breaking strength of the rope divided by the load on the rope is called:
Answer: Safety factor

63. A rope with 200,000-pound breaking strength carrying a normal load which includes a cage weighing 10,000 pounds and 5 ton of rock dust has a safety factor of:
Answer: 10 to 1

64. When shall wire ropes which are kinked or looped be taken out of service?
Answer: Immediately

65. What will cause a wire rope to be weakened?
Answer: Kinking, too small a sheave and too small a drum.

66. If a wire rope has six broken wires in one lay, should the rope be removed from service?
    Answer: Yes, it should be removed.

67. When there is evidence of corrosion in a wire rope, should it be removed from service?
    Answer: Yes.

68. If a rope has 65% crown wear, it would be required:
    Answer: To be removed from the hoist

69. If you 2-inch diameter wire rope and you are using clips and thimbles to connect the rope to the load, how many clips are required and what is the spacing of the clips?
    Answer: 7 clips and spaced 12 inches apart

70. When using thimble and clips to fasten a rope to its load, the distance between the clips should not be less than?
    Answer: Six times the diameter of rope.

71. When working on top of cages over open shafts and slopes personnel shall:
    Answer: Wear safety belts and have lines secured

72. What shall cages, platforms, or other devices used to transport persons in shafts and slopes be equipped with?
    Answer: Safety catches

73. What capacities shall Hoist be rated for?
    Answer: Capacities consistent with loads handled

74. How shall cages used for hoisting persons be constructed?
    Answer: Sides at least 6 feet high and should have gates, safety chains, or bars across the ends.

75. What shall self-dumping cages, platforms, or other devices used for the transportation of persons have?

Answer: A locking device to prevent tilting when persons are transported.

76. A hoist used to transport persons shall be equipped with:

Answer: Over speed, over wind, and automatic stop controls

77. Hoist handling a platform, cage, or other device used to transport persons shall be equipped with:

Answer: Brakes capable of stopping the fully loaded platform, cage, or other device

78. How often are safety catches on hoist required to be tested?

Answer: State regulations require to be tested monthly and Federal regulations require safety catches to be checked at least once every two months.

79. An accurate and reliable indicator for hoist shall be:

Answer: Placed so that it is in clear view of the hoisting Engineer and shall be checked daily to determine its accuracy.

80. Automatic elevators should be equipped with:

Answer: Interlocking switches which prevent movement of the elevator, while any door is open.

81. Automatic elevators shall be equipped with doors which:

Answer: Cannot be inadvertently opened when the elevator car is not at a landing.

82. Automatic elevator compartments should be provided with:

Answer: A stop switch that will permit the elevator to be stopped at any location in the shaft.

83. When shall hoist equipment, including automatic elevators, used to transport persons be examined?

Answer: Daily

84. Where persons are transported into or out of a mine by a hoist, except automatically operated cages, platforms, or elevators, who must be on duty?

Answer: A qualified hoisting engineer.

85. Records for safety catch testing shall be recorded and signed by:

Answer: The person making the tests and countersigned by a responsible official.

86. Hoist and elevators shall be examined daily, and the examination shall include:

Answer: Elevators, hoist, ropes, fastenings, safety catches, cages, platforms, and head sheaves.

87. At the completion of daily hoist examinations, a record must be:

Answer: Completed by the person making the examination and shall be retained for one year.

88. Signaling between each shaft station and the hoist room shall be accomplished by:

Answer: Two effective methods approved by Secretary, one of which shall be a telephone.

89. How often shall signaling systems between shaft stations and the hoist room be tested?

Answer: Daily

REFERENCE LISTING

- Coal Mine Safety Laws of Virginia
- Safety and Health Regulations for Coal Mining in Virginia
- Title 30 Code of Federal Regulations (30 CFR)
- Illinois Department of Natural Resources, Hoisting Manual
- Internet