M. Tech. Dissertation Report

on

Design Of Safe Operating Procédure and Maintenance Requirements For Lifting Equipment used at India Glycols Ltd

Submitted by

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In partial fulfilment for the award of the degree of
Master of Technology
in
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Under the guidance of

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BONAFIDE CERTIFICATE

Certified this titled "**Design of Safe Operating Procedures and maintenance requirements for Lifting Equipment used at India Glycols Ltd**is the bonafide work of **Vinod Kumar Chowdary. Gunnam (R080213015)** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree was conferred on an earlier occasion on this or any other candidate.

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Declaration

I hereby declare that the work entitled "**Design Of Safe Operating Procédures and Maintenance Requirements For Lifting Equipment used at India Glycols Ltd**" is submitted in partial fulfilment of the requirement for the award of the degree in **M. Tech – Health, Safety and Environment** at **University of Petroleum and Energy Studies**, is a record of the my own work carried out by me during the academic year 2014 - 2015 under the supervision and guidance of, Mr. Venkata Khrishnakanth.Valluri Assistant Professor, Department of Health, Safety and Environment, University of Petroleum and Energy Studies. The extent and source of information are derived from the existing literature and have been indicated through the dissertation. The matter embodied in this work is original and has not been submitted for the award of any other degree, either in this or any other University.

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Any piece of work that has proved its way remains incomplete if the sense of gratitude and respect is not being deemed to those who have proved to be supportive during its development period. Though these words are not enough, they can at least pave way to help understand the feeling of respect and admirance I have for those who have helped the way through.

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Vinod Kumar Chowdary. Gunnam

Date

Abstract

Lifting equipment/machinery became the commonest entities in almost all industrial sectors, due to which the material handling become easier rather depending upon manual material handling. if being used/ handled properly these will help in improving the efficiency and effectiveness of production. In spite of technical design changes of these equipment, the hazards associated with lifting machinery are still prevailing. According to the study of past accidents associated with lifting equipment, happened due to various factors in which improper planning of lift, dynamic conditions of work site, improper maintenance which could lead to structural failure of equipment and the inherent nature of material being handled were some of the main factors to be considered. Hence ,by considering afore said factors an attempt was made to develop safe operating procedures for the usage of lifting equipments and accessories along with proper pre lift plan, selection and rejection criteria and maintenance requirements as per statutory rules and regulations, particularly for chemical process industrial facility.

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Chapter -1

Introduction

1.1 Overview of Introduction of India Glycols Limited:

India Glycols Limited is a leading company that manufactures green technology based bulk, specialty and performance chemicals and natural gums, spirits, industrial gases, sugar and nutraceuticals. The company was established as a single mono-ethylene glycol plant in 1983. Since then, IGL has brought together cutting-edge technology, innovation and an unflagging commitment to quality, to manufacture a wide range of products that have found global demand.

IGL‟s state-of-the-art, integrated facilities manufacture chemicals. These products are manufactured in compliance with stringent global standards of plant operations, quality and safety. The company's facilities have been approved and certified by international agencies including Det Norske Veritas (DNV). The operations at all plants are closely monitored through Distributed Control Systems (DCS), which facilitate a high degree of control over the quality of products.

IGL businesses: IGL‟s flagship chemicals division started out with a path-breaking green approach to manufacturing ethylene oxide and derivatives. Using the molasses-ethyl alcohol-ethylene 'green route', the company is the only one of its kind in the world. With the emphasis now increasingly shifting to green manufacturing, the chemical division is well poised to meet the industry's need for environmentally responsible products and production techniques.

Keeping in mind the critical dependence on agricultural feedstock, the company has taken up several initiatives including backward integration into sugar manufacturing to ensure seamless raw material availability. Other complementary initiatives include co-opting the cane growing community to ensure cane availability while providing adequate returns to the farmer.

Apart from chemicals, India Glycols has a significant presence in the natural active pharmaceuticals and nutraceuticals space with Ennature Biopharma; a well-established natural gum division manufacturing guar gum and a variety of derivatives; a spirits division that manufactures country and Indian-made foreign liquor adhering to the highest quality standards; and Shakumbari Sugar – a well-established player in the Indian sugar industry.

Exports: IGL has traditionally looked to leverage the export potential of its products. The company has therefore initiated the process of aligning to emerging global trends and has

established facilities and operations that are in compliance with global good manufacturing practices.

Kashipur Plant:-

Kashipur Division is located near Bazpur Road, Uttam Singh Nagar, Kashipur, and Uttarakhand. ssIt comprises of a petrochemical plants. The plant is equipped to produce various types of Chemical.

Products:-

1. Performance Chemicals: IGL's range of performance chemicals caters to a wide range of industries. Each product meets strict quality and purity norms. Technical knowhow from Sanyo Chemical Industries, Japan, has been integrated with the manufacturing experience and R&D expertise of India Glycols to create products that consistently meet performance standards.

2. Polyethylene Glycols: India Glycols employs internationally proven technology to produce polyethylene glycols (PEG) that meet Indian and International Pharmacopoeia, such as IP / USP / NF specifications. These are essentially non-toxic, stable and versatile solvents that find application in the pharmaceutical, cosmetic, oral care, automotive, textile, paint, resin and plastic and ceramic industries. The company's range of products is sold under the POLYMEG series with different grades having molecular weight from 200 to 10,000. It is Highly Flammable, Explosive & Toxic.

3. Glycol Ethers and Acetates: IGL is India's largest glycol ether producer and the only plant in India to use a continuous process with world-renowned Sulzer Chemtech technology. IGL's focus is on manufacturing ethyl / butyl glycol ethers and its acetates, which find application in the paint and coating, automotive brake fluid and electronic chemical industries. The company also has the capability to produce methyl glycol ethers, phenoxy ethanol, etc. IGL's products meet stringent international specifications and are marketed under the IGSOL, IGTOL and IGACE series of products. The company has established markets in Europe, South East Asia and the Middle East.

4. Fatty Acid Ethoxylates: India Glycols manufactures fatty acid ethoxylates such as stearic acid ethoxylates, lauric acid ethoxylates and coco fatty acid ethoxylates. Marketed under the STEXEL series, these products find application in textile formulation and the manufacture of spin finishes. The company also offers customers the benefit of tailor- made moles and products that meet specific requirements. Bulk orders are also undertaken.

5. EO / PO Co-polymers: India Glycols manufactures ethoxylated and propoxylated (EO / PO) co-polymers that meet stringent Indian and international standards. Marketed under the EPOXEL series, the company‟s products find application mainly in anti-foam formulations, as emulsifiers in water treatment, paint and oil field chemicals. IGL is well equipped to meet bulk requirements and also offers customers specific moles and products that meet their individual requirements. It is Highly Flammable, Explosive & Toxic.

6. Brake fluids: IGL's brake fluids are manufactured with know-how from M/s Sulzer Chemtech, Switzerland. IGL‟s facility is the largest and the only continuous process glycol ether plant in India ensuring consistent quality. The company manufactures DOT-3 and DOT-4 grades of brake fluid as per international specifications and is approved by ARAI, Pune, a leading automobile research institute in India. The company's product range includes DOT-3 and DOT-4 brake fluids under the IGDOT brand. Components for brake fluids such as PEG, DEG and higher glycol ethers are also available.

7. Brake Fluids And Anti-freeze Coolant: IGL's products for the automotive sector include brake fluid and anti-freeze coolant. The company has ensured that both products adhere to the strict quality norms required by Indian and international companies.

8. Natural Gums: Guar gum, a natural, high molecular weight polysaccharide due to its high water-binding ability, finds use in a number of applications. IGL‟s state-of-the-art facility manufactures a wide range of guar products such as treated and pulverized guar gum, de polymerized guar gum and derivatives guar gum, etc.

9. Fatty Alcohol Ethoxylates: IGL manufactures a number of high-purity fatty alcohol ethoxylates, which find application as cleaning and scouring agents, shampoos and detergents, and as emulsifiers in the textile and personal care industries. The products in this segment are: Tridecyl alcohol ethoxylates: Marketed under the IGSURF series, the product is available in variants from 3 to 20 moles. Lauryl alcohol ethoxylates: This is used as a raw material for the manufacture of Sodium Lauryl Ether Sulphate (SLES) for shampoos and detergents. Variants from 1 to 20 moles are available and marketed under the brand LARYDET. Ceto stearyl alcohol ethoxylates: Variants of 10 to 20 moles are marketed under the CETODET series. These find use as emulsifiers in pharmaceutical and cosmetic applications such as ointments and creams. The company also offers customers specially customised products.

10. MEG / DEG / TEG: India Glycols has set up its ethylene glycol plant in technical collaboration with Scientific Design Inc, USA. The plant produces three derivatives of ethylene

glycols = monoethylene glycol (MEG), Diethylene glycol (DEG) and triethylene glycol (TEG). IGL has been manufacturing bio-MEG derived from bio-ethanol since 1989, and meeting stringent international specifications as required by the polyester fibre, yarn, film and PET resin industries. MEG is a colorless, odorless, non-volatile liquid. It is completely miscible in water and many organic solvents. The MEG manufactured is of minimum 99.5 per cent purity and meets the required UV transmittance values specified by polyester manufacturers. DEG is a stable, high-boiling, odorless and hygroscopic liquid, which is completely miscible in water. TEG is a colorless, odorless and stable liquid with low viscosity and a high boiling point. It is miscible in water and hygroscopic in nature.

11. Extra Neutral Alcohol / Rectified Spirit: India Glycols' Uttarakhand unit is considered one sof the most efficient distilleries in India, producing the finest quality extra neutral alcohol (ENA), with a capacity of 20 million litres per annum. IGL's ENA conforms to international standards and is exported in food grade HDPE drums and ISO tanks to Middle East, Africa and Sri Lanka, apart from being supplied to many of India's premium liquor brands. The ENA plant is based on the principles of multi pressure-cascading techniques and the process control is done by Digital Distributed Control System. In addition to its use in the production of potable alcohol, ENA is used as a reaction aid in the pharmaceutical industry and as a volatile carrier of flavour and fragrances.

12. Alkyl Phenol Ethoxylates: India Glycols manufactures a variety of alkyl phenol ethoxylates of consistently high quality, and low color and odour. The company's product range includes:

- Nonyl phenol ethoxylates (4 to 50 moles)
- Octyl phenol ethoxylates (10 to 20 moles)
- Styrenated phenol ethoxylates (20 moles)
- Card phenol ethoxylates (5 to 30 moles)

These chemicals are excellent oil / water soluble detergents, emulsifiers / co-emulsifiers, wetting / cleaning and dispersing agents and intermediates for sulphation. As such, they find application in the textile, detergent, agrochemical, emulsion polymerisation and paint industries.The products are marketed under the ALPHOX brand. The company also offers customers the option of requirement-specific moles and products.

13. Polysorbates: IGL uses internationally proven technology to manufacture ethoxylates with high purity, low colour and odour. The company's product range includes sorbitan ester

ethoxylates under the SORBOX brand. The company can develop specific moles of products as per customer requirements.

Awards and Achievements:

- 2013:- Award of Business Leader of the Year - Innovation for year 2013 conferred to our CMD, Mr. U.S. Bhartia Organisations Chemtech CEW Leadership & Excellence Awards
- 2008:- Award Best Quality ENA Award in recognition of quality ENA production. Best Enhanced Performance for enhanced performance in exports, northern region Organisations Ciab Concor
- 2005:- Award International Safety Award in recognition and commendation of services rendered to the cause of safety. Organisation British Safety Council, UK
- 2004:- Award Best Performing Power Plant International Safety Award in recognition of proven track record of maintaining excellent safety standards. Organisations Wartsila British Safety Council, UK.

(This information is taken from the IGL home site).

1.2. Background

Lifting equipment and associated accessories are really most helpful in industrial work environments, provided if being handled in safe manner. However, due to human errors at various operational / maintenance stages lead to fatalities. The below table 1 represents the crane accident statics according to detailed analysis of accidents involved crane operations from 2004 to 2010 done by King & Ray Addison

ITEM	ALL JOBS	COMMERICAL	INDUSTRIAL	HIGHWAY	RESIDENTIAL
Tower	27	24	2		1
Mob-Lat	115	55	46	14	
Bridge	14		14		
Mob-Hy	130	42	53	16	18
Cable way	1			1	
Derrick	3		3		
Pedestal	5		5		

Gantry	2		2		
MEGA	3	1	2		
Launching	2			2	
Others	15	2	12		1

Table No.1: Statistical data showing % of accidents due to lifting equipments

This shows the importance of proper and safe handling of lifting equipments and thus makes it necessary for a safety professional, design engineer, operator and supervising staff to ensure " Safe Lift ".

More over during the External compliance audit by factories inspectorate /Third party requires such a kind of appropriate document regarding all lifting equipment and accessories.

In view of this,

1.3. Objectives:

Following are the objectives of this project:

- To study and understand various materials handling equipment's being used at Indian Glycols Limited.
- To understand various hazardous activities in which this Lifting equipment's are involved.
- To develop safety manual for lifting equipments and accessories according to the IS, BS and ISO standards.

1.4. Scope:

The scope of this product is restricted to the following aspects

- Development of SOPs (Standard Operating Procedures) for the usage of all the lifting equipments and associated accessories used in IGL –Kashipur.
- To define various pre lifting as well Post lifting hazard identification /safety inspectional procedures.
- Test requirements for both lifting equipment and test loads.

CHAPTER- 2

Literature Survey

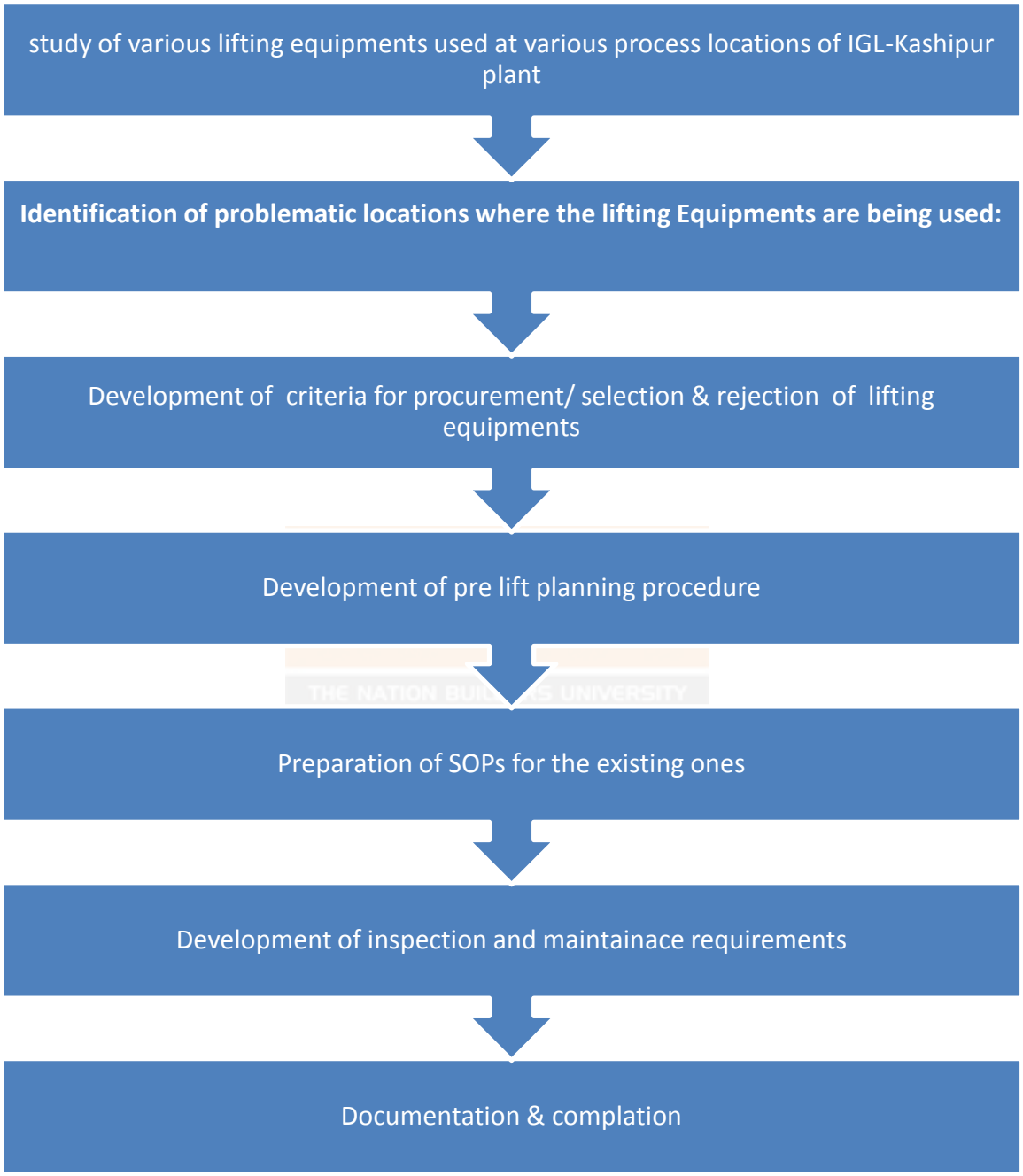
1. **Crane accidents and their prevention revisited- Karl Häkkinen, 2002**

    - This paper summarized accidents preventive measures in case of crane usage by identifying the risk or valuable factors of crane's structural failure.
    - Also, an overview of technical changes in the design of cranes was described and with the help of two accidents cases, the importance of procedure, good pre planning of lifting operation and safety management was also provided.

2. **Improving lifting motion planning and re-planning of cranes with consideration for safety and efficiency**
    - Safe and efficient operation of cranes requires not only good planning, but also sufficient and appropriate support in real time.
    - Due to dynamic nature of construction sites unexpected changes in site layout may create new obstacles for the crane that can result in collisions and accidents.
    - Hence, an algorithm based software tool introduced in this paper to eradicate the above said problem, by its ability to predict the safe operational zone of a crane with given site conditions.

Chapter: 3

Methodology



3.1 Study of various lifting equipments used at various process locations of IGL-Kashipur plant:

1) As per the provision of details of equipments by mechanical & maintenance department of IGL- Kashipur plant, a summarized collective list of lifting equipments and accessories was prepared.
2) The prepared list was reviewed by conduction of site visit
3) Operational manuals available with maintenance staff were being collected and studied

3.2 Identification of problematic locations where the lifting Equipments are being used:

Based on past accidents (details are provided) as records maintained by HSE department, working conditions such as arrangement and management lifting machine traffic, frequency of the lift as required by plant's production process and based on type of material being handled/lifted, problematic areas in IGL-Kashipur was identified.

3.3 Development of criteria for procurement/ selection & rejection of lifting equipments:

By the information obtained from above two steps the selection and rejection criteria of a particular lifting equipment to be used at a specific location to handle a particular kind of material was developed by taking reference from various national (IS standards) as well international standards (BS/ISO standards).

3.4 Development of pre lifts planning procedure:

The pre lifting procedures are developed according to the working conditions and site conditions in to consideration. The hazard indentation is made by the safe lift management and proper planning is with reference to hazardous work environment.

3.5 Preparation of SOPs for the existing ones:

In compliance With Indian Factories Act 1948 and reference of above said standards as well OHSA regulations 29 CFR 1926 1413, 1414, 1438,602 ,various IS, BS codes sops are were developed

The developed SOPs were reviewed and modified according to the suggestions, directions and requirements communicated by maintenance staff of the plant.

3.6 Development of inspection and maintenance requirements:

Once again with reference to the frequency of operation of these Equipments and as per the inspection requirements mentioned by Sec-29 of Indian Factories Act-1948, the inspection and maintenance criteria were developed by referring to BS, IS codes.

3.7 Documentation & compilation

By compiling above all collected details, a draft report prepared and submitted to both HSE department and Head of maintenance department.

Based on their directions or suggestions the necessary modifications were made and final reports were submitted to HSE department for final approval.

Chapte-4

Study of Various Lifting Equipments

4.1 List of equipment used

The various lifting equipments used in the Indian Glycol Limited are as follows

Lifting equipments	Lifting Accessories
• Cranes 1. Mobile cranes 2. Overhead/gantry cranes 3. mobile aerial platforms 4. Fixed lifting beams & monorails	• Wire rope slings • Chains and chain slings • Fiber slings • Beam and Plate clamps • Eye bolts & swivel rings • Hoist rings • Spreader beams • Hooks • D- shackles
• Hoists 1. Manual lever 2. Manual overhead 3. Chain block	
Forklifts	
Sheave Blocks	

Table No: 2 Lifting Equipments used in IGL-Kashipur

4.2 List of lifting equipments used vs locations

The different equipments are used in different locations of the plant for the regular process and maintenance related works as shown in the below table

Lifting Equipment	Location	Lifting Accessories required
Mobile Crane-Hydra	All most all plant location based on the requirement	• Wire rope slings • Chains and chain slings • Fiber slings • Beam and Plate clamps • Eye bolts & swivel rings • D- shackles
Overhead/gantey crane	1. MEG plant 2. Guar gum plant	• Wire rope slings • Chains and chain slings

	3. Power House 1,2,3	• Fiber slings • Beam and Plate clamps • Eye bolts & swivel ring • D- shackles
Mobile Arial platform- Webbing crane	Almost all plant location for personal lift normally used by regular maintenance activities	
Fixed lifting Beams / Monorails	1. Mechanical work shop 2. Chlorine storage 3. Meg plant , 4. Distillery 5. Bio Gas plant	• Wire rope slings • Chains and chain slings • Fiber slings • Beam and Plate clamps • Eye bolts & swivel rings • D- shackles
Manual Chain block	All most all plant location based on the requirement	• Wire rope slings • Chains and chain slings • Fiber slings • Beam and Plate clamps • Eye bolts & swivel rings • D- shackles
Fork lift	All most all plant location based on the requirement	• Wire rope slings • Chains and chain slings • Fiber slings

Table No: 3 various lifting equipments used at different locations in IGL- Kashipur

4.3 Identification of Problematic Locations

As mentioned in the previous chapter (methodology) by analyzing the details of site layout based on past accidents (details are provided) as records maintained by HSE department, working conditions such as arrangement and management of lifting machine traffic, frequency of the lift as required by plant's production process and based on type of material being handled/lifted, problematic areas in IGL-Kashipur were identified. The below table no: 4 shows the details of the problematic locations as follows

Location	Frequency A	Working conditions B	Material being handled C
Distillery	1	I & III	I
Meg location	1	I & III	i & ii
Power house	3	I & IV	-
Industrial Gases Division	3	II & III	i & ii
Liquor Bottling plant	2	I & III	i & iii
GUARGUM Powder Plant	4	II	I

Table No: 4 Identification of problematic location in IGL- Kashipur where lifting equipments are being used

A. Frequency

Based on the recurrence of lifting operations ranging from daily operations to monthly operations

1. Very frequently - More than 4 times in a day
2. Frequently - 1 or 2 times per a day
3. Moderately frequent - 2 or 3 times in a week.
4. Less frequent - 2 or 3 times in a month
5. Rare - 1 or 2 times in 3months.

B. Working conditions

Based on the site survey and by the interaction with the employees working conditions were categorized as follows

I. Congested space

II. More than one lifting equipment simultaneously in the same area

III. Toxicity/ flammability

IV. Dusty Atmosphere

C. Material/Equipment being handled

Based on the chemical properties /hazards of equipment being handled or the material, the following categorization was considered

i. Toxic

ii. Flammable

iii. Reactive chemicals

Chapter: 5

Development of Criteria for Procurement/ Selection & Rejection of Lifting Equipments

5.1 Design

The technical (engineering) department ensures that lifting equipment is fit for purpose and designed or modified in accordance with international/national recognised standards and/or manufacturer's recommendations.

The following internationally-recognized authorities and/or national standards and/or documents are applicable for lifting and hoisting operations.

The following is to be noted:

- All engineered lifting points shall be certified bysss authorized manufacturer or an external inspection/certification company.
- Any Lifted Equipment units not certified to an accepted code shall be structurally verified by a qualified engineer (chemical industries or external engineering company) and load tested.

The technical department should liaise with the lifting engineer for possible input.

5.2 Procurement

It is the procurement department's responsibility to ensure that selected companies provide lifting equipment with appropriate certification and provide services with properly certified equipment and qualified personnel.

All lifting equipment shall be ordered / provided, taking into account the requirements as mentioned hereafter and in consultation with the technical department and/or chemical industries lifting engineers as shown in the table below

All lifting equipment shall be supplied with a certificate issued by the manufacturer, min. as per ISO 10474 3.1B or ISI Mark or an approved certification body

An overview of design and procurement requirements of lifting equipments as provided in table below:

Category	**Applies to**	**International Standard**
Design and Procurement Maintenance Operation	Swing Jib Cranes	BS 7333 BS EN 14985 IS 807 IS 13367
Design and Procurement Maintenance Operation	Overhead Traveling Cranes	ASME B30.11 & B30.16 & B30.17 & B30.2 BS 466-1984 BS EN 14492 IS 3177
Design and Procurement Maintenance Operation	Mobile Cranes	BS EN 13000 BS EN 13586 Access BS 7121 Pt 1,2 & 3 BS 5744 –1979 IS 14470 part 2
Design and Procurement Maintenance Operation	Chain Blocks	ASME B30.16 JIS B 8802 BS EN 13157 BS EN 14492 IS 3832
Maintenance Operation	Rope Blocks	BS EN 13157 IS 2762
Design and Procurement Maintenance Operation	Winches	ASME B30.7 BS EN 14492-1
Maintenance Operation	Fork Lift Trucks	BS 5639 Pt 1 BS ISO 2330 BS ISO 5057 IS 14770

		IS 7617
Design and Procurement Maintenance Operation	Pallet Trucks	BS EN ISO 3691 – 5
Design and Procurement Maintenance Operation	Mobile Elevated Work Platforms	BS ISO 16368 BS ISO 16653 BS EN 280 BS ISO 18893 IEC 61057 IEC-TS 61813
Design and Procurement	Textile Slings - Flat	BS EN 1492-1
Design and Procurement	Textile Slings - Round (see note above)	BS EN 1492-2
Design and Procurement	Wire Rope Slings	ISO 8792, ISO 8793, ISO 8794 BS EN 13414-1 ISO 7531 ASME B30.9 IS 2762
Design and Procurement	Steel Wire Ropes	BS EN 12385 API Spec 9A ISO 10425
Design and Procurement	Lifting Components for Steel wire Rope Slings	BS EN 1677 BS EN 13411-2
Design and Procurement	Short Link Chain for Lifting Purposes (Non Calibrated)	BS EN 818
Design and Procurement	Chain Slings - Grade T (Metric)	BS EN 818
Design and Procurement	Chain Slings - Grade T (Imperial)	ASTM A 391
Design and Procurement	Lifting Components for	BS EN 1677

	Grade T Chain Slings	
Design and Procurement	Shackles (Metric) Shackles (Imperial)	BS EN 13889 BS 3551
Design and Procurement	Collared Eyebolts (Metric) Collared Eyebolts (Imperial)	EN ISO 3266 ASTM A489 ASTM A 153 (zinc coating) IS 4190
Design and Procurement	Thimbles for Wire Rope	BS EN 13411-1
Design and Procurement	Rigging Screws and Turnbuckles	BS 4429
Design and Procurement	Hoist or Sling Hooks	BS EN 1677 IS 3822 IS 3938
Design and Procurement	Wire Rope Grips	BS EN 13411-5
Design and Procurement	Wedge Sockets	BS EN 13411-6
Design and Procurement	Monorails	BS 2853 BS EN 1993-6

Table: 5 Standards for the design and procurement of Lifting Equipments

CHAPTER: 6

Development of pre-lift planning procedures

6.1 Steps required for pre lift planning procedures

Lifting operations are potentially dangerous and therefore have to be controlled. Prior to execution the activity has to be carefully planned.

Following steps are taken:

1) Planning
2) Risk Assessment
3) The Hazards and Effects Management Process (HEMP), for which the risk matrix and a Job Hazard Analysis is the basis, is applied to all lifting operations, which may be a Routine Lift, or a Non-Routine Lift, and shall address:
    - Planning the lift
    - Identifying the hazards and restricted areas
    - Selecting competent personnel
    - Specifying the minimum number of people to conduct the lifting operation
    - Selecting Lifting Equipment
    - Communicating lift requirements and hazards
    - Procedures for changing the Lift Plan
    - Emergency, recovery and contingency plans

6.2 Work Environment Conditions

Environment conditions specific to the work location are identified and accounted for in the planning and execution of all lifting operations. Whenever there is a reasonable chance of changes in environmental conditions, then contingency plans and procedures will be developed as part of the work planning.

Parameters addressed may include weather, visibility, noise, communications, terrain stability or slope, surrounding operations and installations, and site access and egress.

Simultaneous nearby operations and their work environment conditions that could impact or be impacted by the lift are identified and addressed in the risk assessment. Controls are established, including criteria for suspending operations, and communicated to all relevant personnel.

6.3 Categorization of Lifting Operations

Lifts are categorized and controlled according to complexity and risk. Details on categorization and associated controls are provided in Procedure Lift planning/-Execution.

6.3.1 Lift Plan:

- For all lifts a Job Hazard Analysis (JHA) and a Lift Plan shall be prepared and documented. Details on preparation of a Lift Plan are provided in Lift Planning / -Execution.
- Lift Plans specify conditions under which work shall not be continued, including unplanned loss of communications, and the associated contingency plans for ensuring a safe situation is created if the lift is stopped.
- For Routine Lifts, the JHA and Lift Plan may be generic. Generic JHA's and Lift Plans specify each type and location(s) of lift they cover.

For Non-Routine Lifts, specific Lift Plans and JHA's are required. They must be reviewed and approved by chemical industries lifting engineer before they are implemented.

6.3.2 Execution:

A Toolbox Talk shall be held to ensure that all personnel involved in the lift fully understand the JHA and Lift Plan. Prior to all lifts (Routine Lifts and Non-Routine Lifts) the person in charge of the lift (PIC) ensures that the following '10 questions for a safe lift' have all been addressed.

10 Questions for a Safe Lift

1. **is everyone aware of and do they fully understand the lifting and hoisting**
2. **Procedures applicable to the lift?**
3. **Has everyone attended the toolbox talk?**
4. **Has a pre-use inspection of the Lifting Equipment been carried out and are the Lifting Accessories tagged or marked with:**

- **Safe Working Load**
- **A unique identification number**

- **A valid certification date**

5. **Are all safety devices working?**
6. **Does everyone know the Person-in-Charge of the lift?**
7. **Is everyone competent and aware of his or her tasks?**
8. **Is there a current Lift Plan and JHA and does everybody understand the job and precautions?**
9. **Does everyone know the environmental limits (e.g. maximum permissible windspeed) for the lift?**
10. **Is the lift area controlled and is everyone clear if the load falls or swings?**
11. **Are signaling methods and communication agreed and clear to you?**

6.3.3 Controlling Access to the Lift Area

- Access to the work area(s) and to the lifting equipment shall be appropriately controlled, which includes the use of security measures and barriers.
- No personnel are allowed under a load.
- Each asset team is responsible for the operation of lifting equipment under their control. The Competent Authorized Person at each location is responsible for ensuring lifting activities do not take place unless the equipment and procedures meet chemical industries' requirements.

6.3.4 Personnel Lifting

- Personnel lifting operations should not be allowed, unless specifically designed and certified equipment is used (aerial platforms, stabbing board).
- And it should be necessary to deviate from this, then personnel lifting operations shall only be performed when the risks are ALARP (As Low As Reasonably Practible).

  These personnel lifting operations shall be:

  - Categorized as Non-Routine Critical Lifts
  - Authorized in writing by the Site Manager

6.3.5 Maintenance and Repairs

To ensure equipment reliability, a maintenance management system (chemical industries and contractors) shall be established for all lifting appliances. The system is to be based on manufacturer's recommendations, operating experience and integration of preventative and

predictive maintenance techniques. Chemical industries has to be implemented SAP. The system ensures the provision of adequate spare parts, qualified maintenance technicians, maintenance procedures and manufacturer manuals

A maintenance plan shall be available for every lifting appliance. The maintenance quality with the contractors is verified by chemical industries by monitoring equipment performance, as well as through audits. The maintenance database system of chemical industries (SAP) contains information on all lifting appliances owned by chemical industries. The system produces work orders for the equipment according to defined schedules. The contractor shall operate a similar system. Proposals to change maintenance schedules should be reviewed and approved by the lifting engineer before they are implemented.

Repairs are permitted, but no welding repairs shall be made to critical components, such as booms and swing assemblies, without specific repair procedures and recommendations from the original Crane Manufacturer. All major replacement parts have to be equal or exceed the original equipment manufacturer's recommendations. Written reports have to be maintained by the Crane Owner, confirming the adequacy of major repairs or alterations as implemented.

6.3.6 Inspection, Testing and Certification

All cranes and other lifting equipment, new and existing, used within chemical industries shall undergo testing, inspection, and certification. It helps ensure its integrity and hence continued safe operation of the equipment. Inspection, testing and certification shall be carried out by qualified personnel and shall comply with the requirements of Inspection, Testing and Certification regarding frequency and acceptance/rejection criteria. Chemical industries lifting engineer verifies that the inspection and certification requirements are met for all lifting equipment operated within chemical industries by means of auditing.

All new lifting equipment shall be proof load tested/inspected prior to its first use, and provided with correct certification. Proof load testing shall comply with the requirements as mentioned in App.5 and shall be witnessed either by chemical industries and/or an approved Inspection Company. Prior to testing/inspection the risks are assessed and controlled. Where existing lifting equipment is significantly altered or a major repair to components in the load path is carried out, a proof load test shall be conducted and witnessed by chemical industries and/or an approved Inspection Company. Deviation from this requirement must

be approved by chemical industries lifting engineer and documented in the equipment records. A proper test must be used for proof testing of lifting accessories.

All existing lifting equipment shall be subjected to periodic inspection / function testing (if applicable) to verify operability and includes safety systems and equipment (e.g. alarms and cut-outs).Intervals shall not exceed. Lifting accessories/-appliances, having passed the 12 monthly inspections, shall be coded with the applicable color.

Inspections shall also be conducted if the integrity of the equipment may have been affected due to:

- Involvement in an incident
- Exposure to overloads
- Modification or repair
- Change in condition of use e.g. environment

Prior to each use all lifting equipment shall also be visually inspected / function tested by / under the supervision of the person in charge (PIC) to ensure, so far as is practicable, it is in a good state of repair and safe to be used.

Certification services shall be provided by an independent authority. They shall record the results of their activities and the certificate shall clearly state safe or not safe for use.

The details of all existing and new lifting equipment shall be recorded in a lifting equipment register established for each location. The Competent Authorized Person (CAP) is responsible for maintaining the register at each location. All chemical industries lifting appliances are also included in a master asset register in SAP and controlled by CAP. The contractors shall maintain a similar system.

The following information shall be recorded in the registers:

- Manufacturer and description
- Identification number
- SWL
- Date when the equipment was first taken in use
- Particulars of defects and steps taken to remedy them

- Dates and numbers of certificates of tests, inspections, and examinations, and name of the person who performed these
- Due dates for previous and next periodic inspection or periodicity of inspections
- Maintenance particulars

All lifting equipment owned or contracted by chemical industries has a unique identification number (ETN: Equipment Tag Number) to allow it to be identified throughout its life cycle**.** This shall be clearly and permanently marked on the equipment, along with the Safe Working Load and the next certification date**.** The issue of the unique number is controlled by the Competent Authorized Person. Contracted equipment is identified by the unique number assigned to it by its manufacturer or owner. These identification numbers are used on all documents and records related to the specific equipment.

Notes:

1. Special attention shall be given to second hand cranes. Prior to use on chemical industries premises, the cranes and its full documentation, including certificates of load- and function tests, must be checked and approved by the lifting engineer. Experience has learned that certificates provided with second hand cranes are not always reliable. Therefore load- and function tests have to be (re)performed locally and witnessed/certified by an independent Certification Authority.
2. Over the years several mobile cranes were involved in (sometimes fatal) accident.

   Whereby the cranes failed whilst operating within their safe working load limit. Subsequent investigations revealed that they failed due to fatigue stresses as a result of prolonged years of service. Therefore mobile cranes shall not be used after exceeding their life time limit.

6.3.7 Competence, Training, Qualifications and Certification

To ensure that tasks are performed adequately, personnel (chemical industries and contractors) involved in lifting operations / lifting equipment shall be qualified.

The Qualification process shall comprise requirements on:

- the physical condition of the person (Yearly medical check)
- the level of competency
- Specific chemical industries approved training courses and assessments. (trainer and assessor shall be different persons)

This process shall be documented and the records be available for review.Upon satisfactory completion of the qualification process the personnel will be provided with a certificate/permit. The duration of the certification shall not exceed 1year, and has to be followed by a refresher course / re-assessment.

6.3.8 Storage

It is the responsibility of the asset custodian or the contractor to store loose lifting equipment in such a manner as to avoid mechanical damage, corrosion, chemical exposure, etc.

It shall be a dedicated permanent store or a transportable container with racks and bins. It shall contain a secure quarantine area to prevent use of rejected items.

The issue and return of the loose lifting equipment shall be controlled. A register shall be kept to ensure traceability.

6.3.9 Document Retention

All new lifting equipment or equipment having undergone major repairs have to be accompanied by manufacturing records, certificate of conformity, 3rd party certificate etc. depending on the type of equipment. All these records have to be retained during the life span of the equipment. Records of periodic inspection have to be retained for a minimum of 1 year

6.3.10 Auditing and Review

- Auditing is an important activity to verify implementation of chemical industries requirements and to be able to identify areas for improvement.
- Audits shall be carried out at random on lifting activities within chemical industries's operations during the year. The activities of contracting companies shall be audited as well (It does not discharge the contractors of their task to carry out their own internal audits).
- An annual audit plan for lifting equipment is prepared for the start of each year by chemical industries's lifting engineer. The plan takes into account the status and importance of the activities to be audited. The results of previous audits are taken into account during the planning.

- Remedial actions identified during the audit are recorded in the audit report. The report is sent to the person responsible for the activity. All remedial action items arising from the report are also recorded on a non-conformance report (NCR) or opportunity for improvement (OFI) report form and will be stored in a tracking system.

- It records the details of the remedial action, along with the person responsible for completing the action and a target completion date.

- The information obtained from the audits serves as input for the annual review of the lifting management documents.

6.3.11 Annual Lifting Management Review

An annual review shall be carried out to assess the effectiveness of the management of lifting equipment/-operations within chemical industries. The review can also be called in response to a major non-conformity, an unsatisfactory audit result or a major incident involving lifting equipment. The review will include the following:

The results of internal quality audits and asset integrity reviews

- Outstanding issues from the previous management review
- Implemented corrective actions
- Requests for improvements
- Overall HSE performance related to lifting equipment

6.4 Factors to be considered for pre-lift planning

It is important that workers involved with hoisting and lifting activities are trained in both safety and operating procedures. Hoisting equipment should be operated only by trained personnel.

The cause of lifting accidents can often be traced due to a lack of knowledge on the part of lifting equipments. Training programs provide workers with a basic knowledge of principles relating to safe hoisting and lifting practices in the industry. In spite of all this they should also requires the detailed knowledge of the Inspection and Rejection criteria of the Lifting equipment.

A safe lifting operation requires knowing

• The weight of the load and lifting hardware

• The capacity of the hoisting device

• The working load limit of the hoisting rope, slings, and hardware.

When the weights and capacities are known, the rigger must then determine how to lift the load so that it is stable.

Training and experience enable riggers to recognize hazards that can have an impact on a hoisting operation. Riggers must be aware of elements that can affect hoisting safety, factors that reduce capacity, and safe practices in rigging, lifting, and landing loads. Riggers must also be familiar with the proper inspection and use of slings and other rigging hardware.

Most crane and rigging accidents can be prevented by field personnel following basic safe hoisting and rigging practices along with the appropriate lifting equipment for the suitable working condition.

6.5 Elements that can Affect Hoisting Safety:

Working Load Limit (WLL): not known. Don't assume. Know the working load limits of the equipment being used. Never exceed these limits.

Defective components: Examine all hardware, tackle, and slings before use. Destroy defective components. Defective equipment that is merely discarded may be picked up and used by someone unaware of its defects

Questionable equipment: Do not use equipment that is suspected to be unsafe or unsuitable, until its suitability has been verified by a competent person.

Hazardous wind conditions: Never carry out a hoisting or rigging operation when winds create hazards for workers, the general public, or property. Assess load size and shape to determine whether wind conditions may cause problems. For example, even though the weight of the load may be within the capacity of the equipment, loads with large wind- catching surfaces may swing or rotate out of control during the lift in high or gusting winds. Swinging and rotating loads not only present a danger to riggers-there is the potential for the forces to overload the hoisting equipment.

Weather conditions: When the visibility of riggers or hoist crew is impaired by snow, fog, rain, darkness, or dust, extra caution must be exercised. For example, operate in "all slow", and if necessary, the lift should be postponed. At sub-freezing temperatures, be aware that loads are likely to be frozen to the ground or structure they are resting on. In extreme cold conditions

avoid shock-loading or impacting the hoist equipment and hardware, which may have become brittle.

Electrical contact: One of the most frequent killers of riggers is electrocution. An electrical path can be created when a part of the hoist, load line, or load comes into close proximity to an energized overhead power line. When a crane is operating near a live power line and the load, hoist lines, or any other part of the hoisting operation could encroach on the minimum permitted distance (see table on the next page), specific measures described in the Construction Regulation must be taken. For example, constructors must have written procedures to prevent contact whenever equipment operates within the minimum permitted distance from a live overhead power line. The constructor must have copies of the procedure available for every employer on the project.

Hoist line not plumb: The working load limits of hoisting equipment apply only to freely suspended loads on plumb hoist lines. If the hoist line is not plumb during load handling, side loads are created which can destabilize the equipment and cause structural failure or tip-over, with little warning.

6.2 Factors that Reduce Capacity

The working load limits of hoisting and rigging equipment are based on ideal conditions. Such ideal circumstances are seldom achieved in the field. Riggers must therefore recognize the factors that can reduce the capacity of the hoist.

Swing: The swinging of suspended loads creates additional dynamic forces on the hoist in addition to the weight of the load. The additional dynamic forces (see point below) are difficult to quantify and account for, and could cause tip-over of the crane or failure of hoisting hardware. The force of the swinging action makes the load drift away from the machine, increasing the radius and side-loading on the equipment. The load should be kept directly below the boom point or upper load block. This is best accomplished by controlling the load's movement with slow motions.

Condition of equipment: The rated working load limits apply only to equipment and hardware in good condition. Any equipment damaged in service should be taken out of service and repaired or destroyed.

Dynamic forces: The working load limits of rigging and hoisting equipment are determined for static loads. The design safety factor is applied to account, in part, for the dynamic motions of the load and equipment. To ensure that the working load limit is not exceeded during

operation, allow for wind loading and other dynamic forces created by the movements of the machine and its load. Avoid sudden snatching, swinging, and stopping of suspended loads. Rapid acceleration and deceleration also increases these dynamic forces.

Weight of tackle: The rated load of hoisting equipment does not account for the weight of hook blocks, hooks, slings, equalizer beams, and other parts of the lifting tackle. The combined weight of these items must be added to the total weight of the load, and the capacity of the hoisting equipment, including design safety factors, must be large enough to account for the extra load to be lifted.

Chapter-7

Development of Safety Inspection, Rejection Criteria for the Lifting Equipments

Any item what so ever which is used or designed to be used directly or indirectly to connect a load to a lifting appliance or lifted equipment (e.g. a cranes, chain block, monorails) and which does not form part of the load, but which is not itself able to lift, or lower a load is said to be as Lifting accessories. The Equipments which are used to lift the load are designated as the lifting Equipments.

e.g.

Lifting Accessories	
SLINGS	LIFTING COMPONENTS
Wire rope slings Chains slings Flat synthetic slings Webbing slings Polyester round slings Fibre rope slings	Eyebolts Hooks Lifting Caps and Stubs Shackles Swivels

Table: 6 List of lifting accessories used in IGL- Kashipur

Exclusions

The following items are specifically excluded from the definition of this procedure:

- Guying and stay wires and other items subject to static loading conditions only.
- Wire ropes and wire rope arrangements used for pulling.

7.1 Slings

The slings which are used for lifting purpose is categorized as below

- Chain Slings
- Wire Rope Slings
- Natural and Synthetic Fibre Slings
- Lifting Beams/Frames and Spreader Bars

7.1.1 Chain Slings:

- Chain slings are suited to applications requiring flexibility and resistance to abrasion, cutting and high temperatures.
- Alloy steel chain grade is marked with an T8, S (6), or M(4) is marked on the chain sling..
- Alloy steel chain od grade of M(4) is the only type which can be used for acidic conditions..
- As with all slings and associated hardware, chain slings must have a design factor of 5.
- Always check with manufacturers to determine the design factor on which their working load limits are based.
- If the design factor is less than 5, calculate the working load limit of the chain by multiplying the catalogue working load limit by the manufacturer's design factor and dividing by 5.

  $\frac{\text{CATALOGUE WLL x MANUFACTURER'S D.F}}{5}$ =WLL (based on design factor of 5)

  Example – 1/2" Alloy Steel Chain
  - Catalogue WLL = 13,000 Ibs.
  - Design Factor = 3.5
  - $\frac{\text{13,000 Ibs x 3.5}}{5}$ = 9,100 Ibs.
- Wherever they bear on sharp edges, chain slings should be padded to prevent links from being bent and to protect the load. Never tie a knot in a chain sling to shorten the reach. Slings can be supplied with grab hooks or shortening clutches for such applications.
- Inspect chain slings for inner link wear and wear on the outside of the link barrels as shown in the figure1 below.
- Manufacturers publish tables (figure: 3) of allowable wear for various link sizes. Many companies will also supply wear gauges to pindicate when a sling must be retired or links replaced. Gauges or tables from a particular manufacturer should only be used on that brand of chain since exact dimensions of a given nominal size can vary from one manufacturer to another.

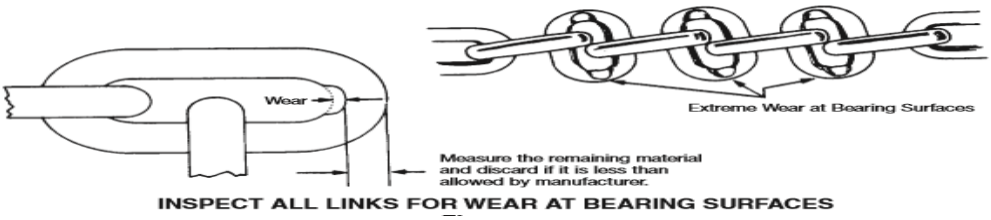


Figure: 1

A competent worker should check chain slings for nicks and gouges that may cause stress concentrations and weaken links (Figure 2). If nicks or gouges are deep or large in area, or reduce link size below allowable wear, remove the chain from service. Any repairs must be done according to manufacturers' specifications.

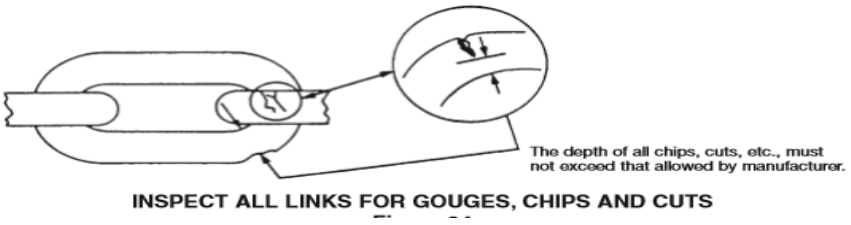
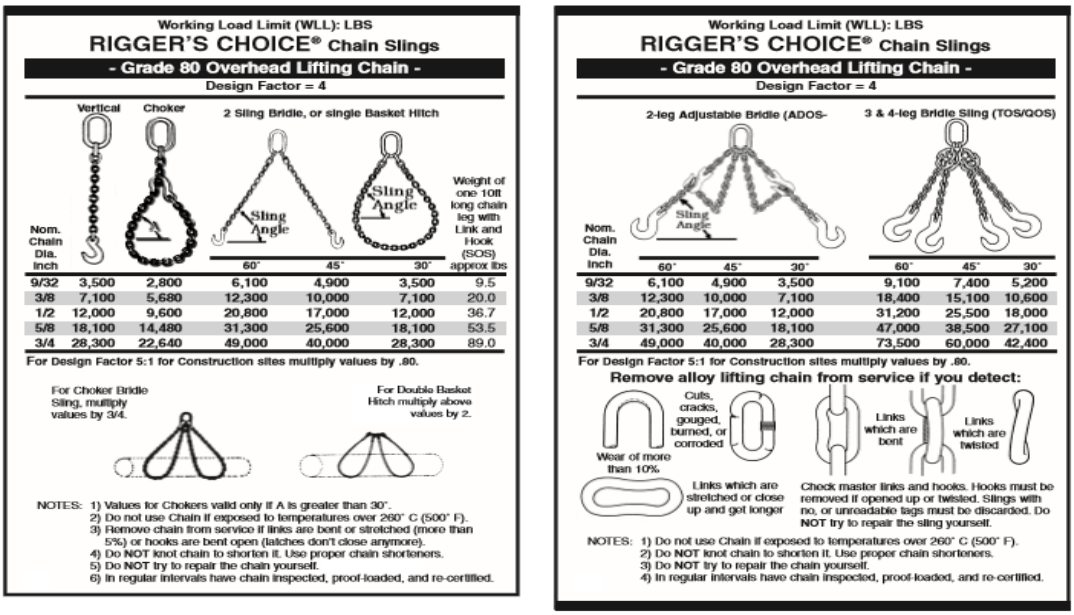


Figure: 2

Never use repair links or mechanical coupling links to splice brokeif slings n lengths of alloy steel chain. They are much weaker than the chain links. Never use a chain if the links are stretched or do not move freely.



Working Load Limit (WLL): LBS

RIGGER'S CHOICE® Chain Slings

- Grade 80 Overhead Lifting Chain -

Design Factor = 4

Nom. Chain Dia. Inch	Vertical	Choker	2 Sling Bridle, or single Basket Hitch 60°	45°	30°	Weight of one 10ft long chain leg with Link and Hook (SOS) approx lbs
9/32	3,500	2,800	6,100	4,900	3,500	9.5
3/8	7,100	5,680	12,300	10,000	7,100	20.0
1/2	12,000	9,600	20,800	17,000	12,000	36.7
5/8	18,100	14,480	31,300	25,600	18,100	53.5
3/4	28,300	22,640	49,000	40,000	28,300	89.0

For Design Factor 5:1 for Construction sites multiply values by .80.

For Choker Bridle Sling, multiply values by 3/4.

For Double Basket Hitch multiply above values by 2.

NOTES: 1) Values for Chokers valid only if A is greater than 30°.
2) Do not use Chain if exposed to temperatures over 260° C (500° F).
3) Remove chain from service if links are bent or stretched (more than 5%) or hooks are bent open (latches don't close anymore).
4) Do NOT knot chain to shorten it. Use proper chain shorteners.
5) Do NOT try to repair the chain yourself.
6) In regular intervals have chain inspected, proof-loaded, and re-certified.

Working Load Limit (WLL): LBS

RIGGER'S CHOICE® Chain Slings

- Grade 80 Overhead Lifting Chain -

Design Factor = 4

Nom. Chain Dia. Inch	2-leg Adjustable Bridle (ADOS- 60°	45°	30°	3 & 4-leg Bridle Sling (TOS/QOS) 60°	45°	30°
9/32	6,100	4,900	3,500	9,100	7,400	5,200
3/8	12,300	10,000	7,100	18,400	15,100	10,600
1/2	20,800	17,000	12,000	31,200	25,500	18,000
5/8	31,300	25,600	18,100	47,000	38,500	27,100
3/4	49,000	40,000	28,300	73,500	60,000	42,400

For Design Factor 5:1 for Construction sites multiply values by .80.

Remove alloy lifting chain from service if you detect:

Cuts, cracks, gouged, burned, or corroded

Wear of more than 10%

Links which are bent

Links which are twisted

Links which are stretched or close up and get longer

Check master links and hooks. Hooks must be removed if opened up or twisted. Slings with no, or unreadable tags must be discarded. Do NOT try to repair the sling yourself.

NOTES: 1) Do not use Chain if exposed to temperatures over 260° C (500° F).
2) Do NOT knot chain to shorten it. Use proper chain shorteners.
3) Do NOT try to repair the chain yourself.
4) In regular intervals have chain inspected, proof-loaded, and re-certified.

Figure : 3 table showing the angle of slings for lifting

7.1.1.1 Inspection and rejection Criteria for Chain Slings

a) Ensure the Sling has the Identification Number and Safe Working Load clearly and legibly marked, and corresponds with the manufacturer's certificate.

b) Match up the legs and check for stretch in the individual legs.

c) Inspect each individual leg along its entire length for distortion of links e.g. bends, twists, corrosion, elongation and nicks.

d) Check for wear between chain links and load pins.

e) Check for heat or chemical attack.

f) Inspect end terminations fitted e.g. hooks, connectors etc in accordance with the appropriate procedure. With reference to its standard

g) Ensure all coupling components are free from distortion, cracking and the securing/ load pins are secure.

REJECTION CRITERIA	
i.	Missing or illegible Identification Number or Safe Working Load
ii.	Any mechanical damage i.e. nicks, cuts, gouges etc.
iii.	Wear on the link diameter in excess of 5%
iv.	Stretch of more than 3% measured over 10-20 links.
v.	Any severe pitting corrosion or general corrosion in excess of 5%.
vi.	Twist in excess of half a turn in 4 metres (or equivalent).
vii.	Any chain or fitting made of Wrought iron
viii.	"T" grade slings used in an Hydrogen enriched atmosphere
ix.	Hard stamping with low stress stamps

Table: 7 Rejection criteria for chain slings

Note: As per the standards

IS: 8324: Code of practice for safe use and maintenance on non-calibrated round steel link lifting chains and chain slings

7.1.2 Synthetic Web Slings

Web slings are available in two materials –

1. Nylon
2. Polyester (Dacron).

Nylon is resistant to many alkalis whereas polyester is resistant to many acids. Consult the manufacturer before using web slings in a chemical environment. Nylon slings are more common but polyester slings are often recommended where headroom is limited since they stretch only half as much as nylon slings.

Synthetic web slings offer a number of advantages for rigging purposes.

- Their relative softness and width create much less tendency to mar or scratch finely machined, highly polished or painted surfaces and fewer tendencies to crush fragile objects than fibre rope, wire rope or chain slings as shown in figure 4 below.

Figure: 4

- Because of their flexibility, they tend to mold themselves to the shape of the load as shown in the figure: 5 below

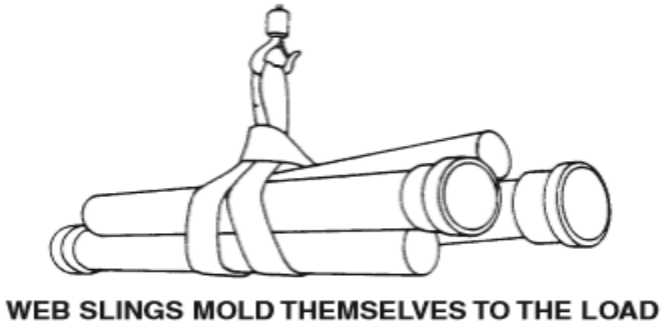


Figure: 5

Synthetic web slings are available in a number of configurations useful in construction.

Endless or Grommet Slings – both ends of one piece of webbing lapped and sewn to form a continuous piece. They can be used as vertical hitches, bridle hitches, in choker arrangements or as basket hitches. Because load contact points can be shifted with every lift, wear is evenly distributed and sling life extended Figure 6 below.

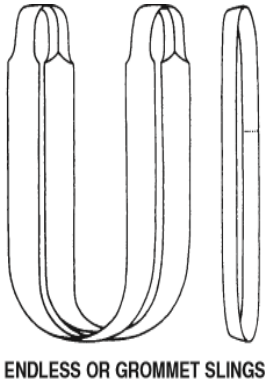


Figure: 6

Standard Eye-and-Eye – webbing assembled and sewn to form a flat body sling with an eye at each end and eye openings in the same plane as the sling body. The eyes may be either full web width or tapered by being folded and sewn narrower than the webbing width as shown in the below figure 7.

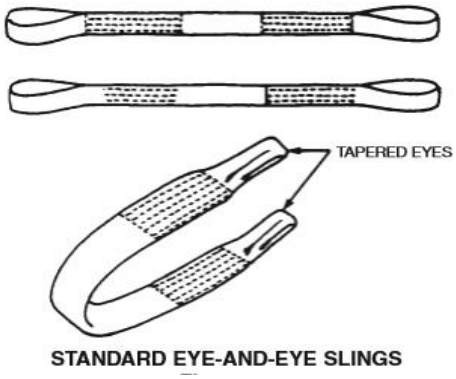


Figure: 7

Twisted Eye – an eye-and-eye with twisted terminations at both ends. The eye openings are at 90° to the plane of the sling body. This configuration is available with either full-width or tapered eyes as shown in Figure: 8

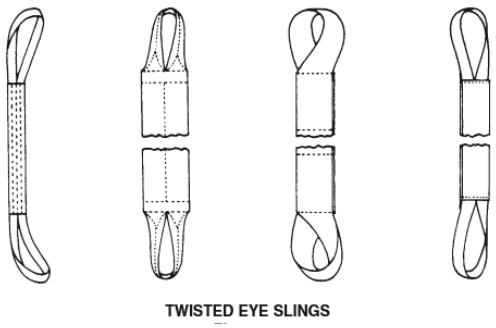


Figure: 8

In place of sewn eyes, web slings are available with metal end fittings. The most common are triangle and choker hardware. Combination hardware consists of a triangle for one end of the sling and triangle/rectangles (choker attachment) for the other end. With this arrangement, choker and basket as well as straight hitches may be rigged. Such attachments help reduce wear in the sling eyes and thus lengthen sling life

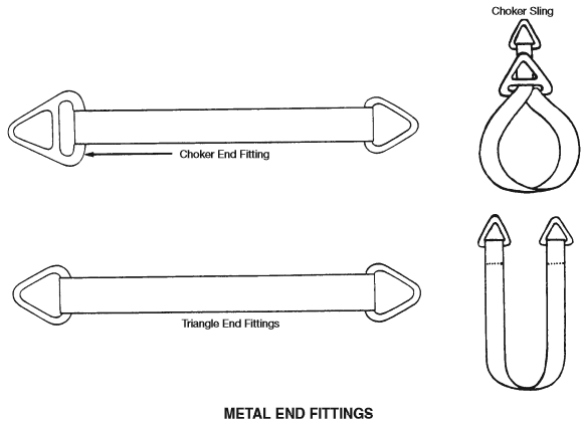


Figure: 9

- They do not rust and thus will not stain ornamental precast concrete or stone.
- They are non-sparking and can be used safely in explosive atmospheres.
- They minimize twisting and spinning during lifting.
- Their light weight permits ease of rigging, their softness precludes hand cuts, and the danger of harm from a free-swinging sling is minimal.
- They are elastic and stretch under load more than either wire rope or chain and can thus absorb heavy shocks and cushion loads. In cases where sling stretching must be minimized, a sling of larger load capacity or a polyester sling should be used.
- Despite their inherent toughness, synthetic web slings can be cut by repeated use around sharp- cornered objects and abraded by continually hoisting rough-surfaced loads.
- The rated capacity of synthetic web slings is based on the tensile strength of the webbing, a design factor of 5 and the fabrication efficiency. Fabrication efficiency accounts for loss of strength in the webbing after it is stitched and otherwise modified during manufacture. Fabrication efficiency is typically 80 to 85% for single-ply slings but will be lower for multi-ply slings and very wide slings.
- Slings with aluminum fittings should never be used in acid or alkali environments.
- Nylon and polyester slings must not be used at temperatures above 194°F (90°C).
- Inspect synthetic web slings regularly.

- Damage is usually easy to detect. Cuts, holes, tears, frays, broken stitching, worn eyes and worn or distorted fittings, and burns from acid, caustics or heat are immediately evident and signal the need for replacement as shown in the **figure :10** below**.**
- Do not attempt repairs yourself.

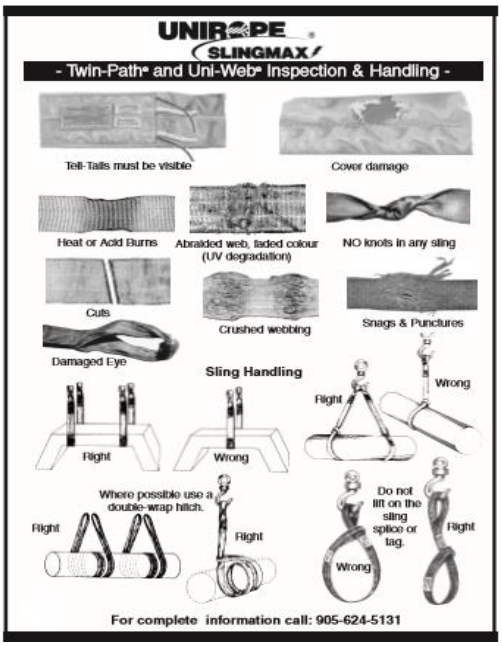


Figure: 10 wears and correct method of using web slings

7.1.2.1 Inspection and rejection Criteria for Flat Synthetic Web Sling

a) Ensure the Sling has the Equipment Tag Number and Safe Working Load clearly and legibly marked, and corresponds with the manufacturer's certificate.

b) Inspect along its entire length for cuts, tears, chafing, chemical damage or heat damage and long term U.V. exposure.

c) Inspect the fibres for the ingress of foreign bodies.

d) Inspect for any paint on the sling.

e) Inspect the point of change in section, from 1 to 2, 2 to 3 layers, as these are high stress areas.

f) Inspect metal eyes fitted for wear, stretch and distortion, corrosion and cracking.

g) Inspect end terminations e.g. hooks, connectors etc in accordance with the appropriate paragraph of this procedure.

REJECTION CRITERIA	
i.	Missing or illegible Identification Number or Safe Working Load
ii.	Any mechanical damage i.e. nicks, cuts, gouges, etc.
iii.	Any breakage of the stitches on the body or the eye
iv.	Any worn stitching in load bearing areas
v.	Any burn marks i.e. melting, charring etc
vi.	Any sign of chemical damage
vii.	Any friction damage or badly abraded spots
viii.	Knotted slings
ix.	Any fibre brittleness or extruding fine dust due to extended UV exposure
x.	Any paint or felt tip pen markings on the sling

Table: 8 Rejection criteria for flat synthetic web slings

Note: As per the standards

ISO 4878: 1981 -Flat woven webbing slings

BS: 1492- Code of practice for safe handling of flat synthetic web sling.

IS 15041:2001-Textiles flat woven webbing slings made of man-made fibers for general services.

7.1.3 Metal Mesh Slings

- Metal mesh slings, also known as wire or chain mesh slings, are well adapted for use where loads are abrasive, hot or tend to cut fabric slings and wire ropes.
- They resist abrasion and cutting, grip the load firmly without stretching and can withstand temperatures up to 550° (288°C). They have smooth, flat bearing surfaces, conform to irregular shapes, do not kink or tangle and resist corrosion

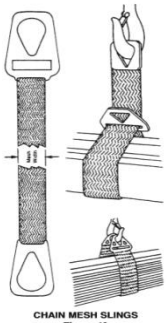


Figure: 11 Chain Metal Slings

- For handling loads that would damage the mesh, or for handling loads that the mesh would damage, the slings can be coated with rubber or plastic.
- Note that there is no reduction in working load limit for the choker hitch. This is because the hinge action of the mesh prevents any bending of individual wire spirals.
- Check the manufacturer's rating for the WLL of the specific sling you are using.

7.1.4Fibre Rope Slings

- Fibre rope slings are preferred for some applications because they are pliant, grip the load well and do not mar its surface. They should be used only on light loads, however, and must never be used on objects that have sharp edges capable of cutting the rope or in applications where the sling will be exposed to high temperatures, severe abrasion or acids.
- The choice of rope type and size will depend on the application, the weight to be lifted and the sling angle. Before lifting any load with a fibre rope sling, be sure to inspect the sling carefully. Fibre slings, especially manila, deteriorate far more rapidly than wire rope slings and their actual strength is very difficult to estimate.
- Like other slings, fibre rope slings should be inspected regularly. Look for external wear and cutting, internal wear between strands, and deterioration of fibres.
- Open up the rope by untwisting the strands but take care not to kink them. The inside of the rope should be as bright and clean as when it was new. Check for broken or loose yarns and strands. An accumulation of powder-like dust indicates excessive internal wear between strands as the rope is flexed back and forth during use

7.1.4.1 Inspection and rejection Criteria for Round fibre Sling

a) Ensure the Sling has the Equipment Tag Number and Safe Working Load clearly and legibly marked, and corresponds with the manufacturer's certificate.

b) Inspect along its entire length for cuts, tears, chafing, chemical damage, heat damage and damage due to UV exposure.

c) Inspect the fibres for the ingress of foreign bodies.

d) Inspect for any paint on the sling.

e) Inspect end terminations e.g. hooks, connectors etc in accordance with the appropriate paragraph of this procedure.

	REJECTION CRITERIA
i.	Missing or illegible Identification Number or Safe Working Load
ii.	Any mechanical damage i.e. nicks, cuts, gouges etc.
iii.	Any breakage of the stitching
iv.	Any worn stitching in load bearing areas
v.	Any burn marks i.e. melting, charring etc
vi.	Any sign of chemical damage
vii.	Any friction damage or badly abraded spots
viii.	Cuts in the outer protective cover, exposing the inner fibres.
ix.	The core of round sling is displaced or exposed.
x.	Knotted slings
xi.	Any paint or felt tip pen markings on the sling

Table: 9 Rejection criteria for the Round fibre ropes

Note: As per the standards

IS 2762 – wire rope slings

BS 1492-2: 2000- slings made of natural and mane made fibre ropes

7.1.5 Wire Rope Slings

The use of wire rope slings for lifting materials provides several advantages over other types of sling. While not as strong as chain, it has good flexibility with minimum weight. Breaking outer wires warn of failure and allow time to react. Properly fabricated wire rope slings are very safe for general construction use.

On smooth surfaces, the basket hitch should be snubbed against a step or change of contour to prevent the rope from slipping as load is applied. The angle between the load and the sling should be approximately 60 degrees or greater to avoid slippage as shown in the figure 12 below.

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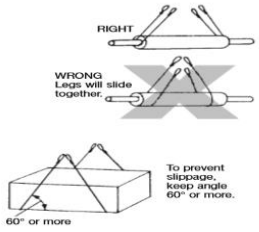

Figure: 12 Correct Angle of Loading the Object of wire ropes

7.1.5.1 Inspection and rejection Criteria for Wire Ropes and Wire Rope Slings

a) Ensure the Sling has the Equipment Tag Number and Safe Working Load clearly and legibly marked, and corresponds with the manufacturer's certificate.

b) Inspect each individual leg along its entire length for wear, corrosion, abrasion, mechanical damage, and discolouration due to heat or chemical damage, evidence of shock loading and broken wires.

c) Inspect each ferrule and ensure the correct size of ferrule has been fitted.

d) Check that the end of the loop does not terminate inside the ferrule unless the ferrule is of the long tapered design, which has an internal step. I.e. Flemish eye.

e) Ensure the ferrule is free from cracks and other deformities.

f) Inspect each thimble, if fitted, for correct fitting, snagging damage and elongation. (Stretched thimbles/eyes could indicate possible overload).

g) Inspect wire rope around thimbles as it is often to be found abraded due to the sling being dragged over rough surfaces.

h) Inspect end terminations e.g. hooks, connectors etc in accordance with the appropriate paragraph of this procedure.

REJECTION CRITERIA	
Condition	**Discard Criteria**
Information	Missing or illegible Identification Number or Safe Working Load
Mechanical Damage	Nicks, cuts, gouges etc.
Wire Breaks	If the number of wires in the sling are known: a) 5% of the wires in 10 diameters b) 3 or more closely grouped wires
Wire Breaks	If the number of wires in the sling is not known: a) 5 wires in any 6 diameters b) 3 or more closely grouped wires
Wear	Any wear resulting in a flat on the outer wires of more than 3/4 of the original wire diameter
Loss of Diameter	When the diameter of the rope has decreased by a value of 7% or more, compared to the original rope diameter.
Distortion	Due to a) kinking b) crushing c) core collapse d) knotting
Heat Damage	Discolouration of the wires, weld spatter etc
Damaged Ferrules and eyes	a) Cracks in the ferrule

	b) Severe crushing or abrasion c) Pulling out of the ferrule d) Concentration of broken wires near to the ferrule e) Fractured wires on the outside surface of the eye f) Closing of the thimble
Wire Rope Core	Fibre cored wire rope
Number Stamps	Hard stamping with low stress stamps

Table: 10 Rejection criteria for the Round wire ropes

Note: As per the standards

IS: 12735 - Wire rope slings - safety criteria and inspection procedures for use

BS: 13414 –Wire rope slings safety

7.2 Eye Bolts

- For hoisting, use eye or ring bolts of forged alloy steel.
- Use bolts with shoulders or collars. Shoulder less bolts are fine for vertical loading but can bend and lose considerable capacity under angle loading (Figure 13). Even with shoulders, eye and ring bolts lose some capacity when loaded on an angle.

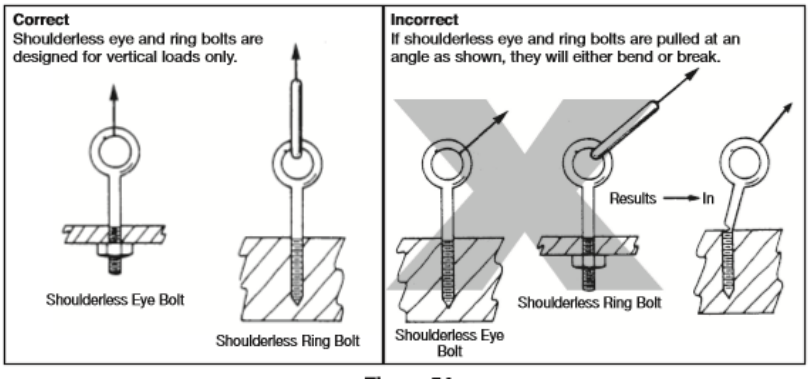

Figure 13 Correct and Method of Using Eye Bolts

- Make sure that bolts are at right angles to hole, make contact with working surface, and have nuts property torqued (Figure 14).

- Pack bolts with washers when necessary to ensure firm, uniform contact with working surface (Figure 14).
- Make sure that tapped holes for screw bolts are deep enough for uniform grip (Figure 14).
- Apply loads to the plane of the eye, never in the other direction (Figure 14). This is particularly important with bridle slings, which always develop an angular pull in eye bolts unless a spreader bar is used.
- Never insert the point of a hook in an eye bolt. Use a shackle instead (Figure 14).
- Do not reeve a sling through a pair of bolts. Attach a separate sling to each bolt

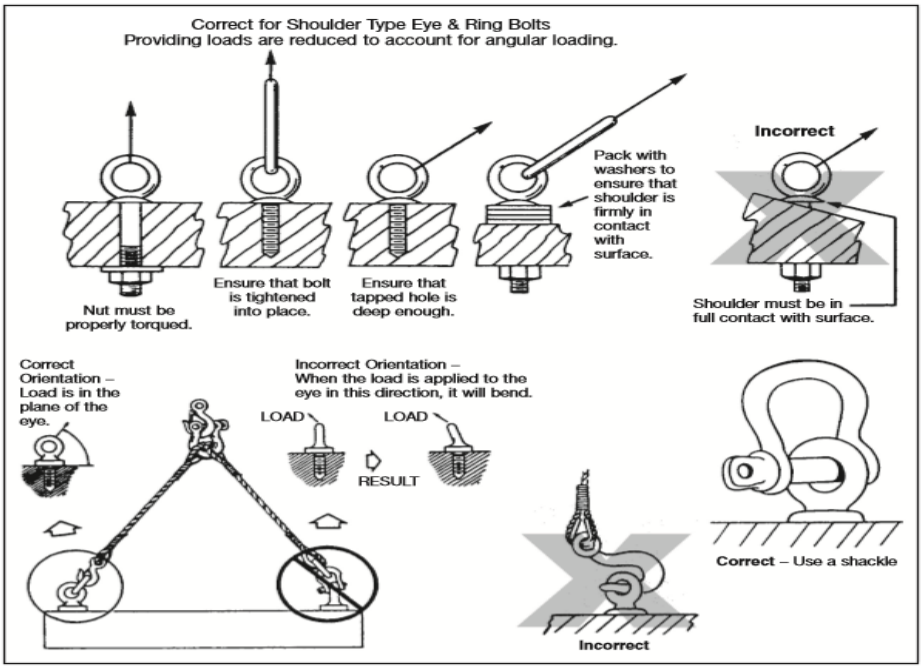

Figure: 14 Correct Methods of Loading Load to the Eye Bolt

7.2.1 Inspection Criteria for Eyebolts

a) Ensure the Eyebolt has the Equipment Tag Number and Safe Working Load clearly and legibly marked, and corresponds with the manufacturer's certificate.

b) Inspect threads for wear, stretch or impact damage. The threads must be complete (no broken threads) and full (i.e. no flats on top).

c) The threads should be concentric and fit neatly in a standard nut.

d) Inspect the eye of the bolt for wear, stretch and distortion.

e) Inspect the eye of the bolt for cracking at the crown of the ring (This also applies to any link if fitted) and cracking.

f) Check squareness of shank against shoulder.

g) The complete Eyebolt shall be subjected to non-destructive testing at a period not exceeding 1 year.

	REJECTION CRITERIA
i.	Missing or illegible Identification Number or Safe Working Load
ii.	Any mechanical damage i.e. nicks, cuts, gouges etc.
iii.	Any wear or corrosion in excess of 5% of the original dimension
iv.	Any distortion or stretch
v.	Cracking
vi.	No hard stamping/cast markings of thread type
vii.	Any thermal damage or evidence of welding on the eyebolt i.e. nuts welded on
viii.	All "Dynamo" type eye bolts (parallel shank no collar)
ix.	Any modification to the eye bolt i.e. thread shortening, lengthening etc.
x.	Hard stamping with low stress stamps

Table: 11 Rejection criteria for rejection of Eye bolts

Note: As per the standards

IS 4190: 1984- Specifications for the eye bolt general requirement.

IS0 3266-Forged steel eyebolts grade 4 for general lifting

7.3 D-Shackles

Available in various types as shown in below fig 15

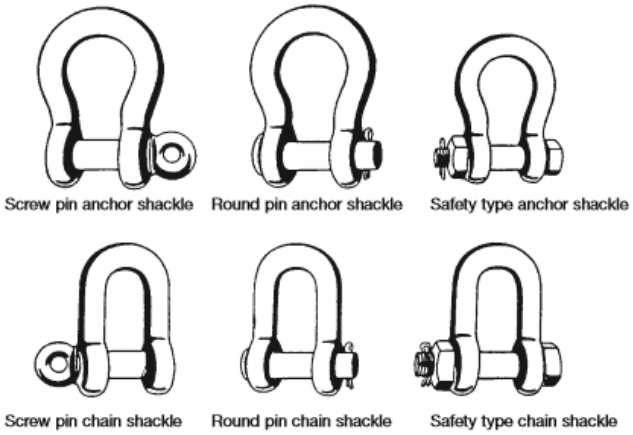

Figure: 15 Type of D- Shackles

- For hoisting, should be manufactured of forged alloy steel.
- Do not replace shackle pins with bolts Pins are designed and manufactured to match shackle capacity as shown in the figure 16.
- Check for wear, distortion, and opening up. Check crown regularly for wear. Discard shackles noticeably worn at the crown. As shown in the figure 17
- Do not use a shackle where it will be pulled or loaded at an angle. This severely reduces its capacity and opens up the legs as shown in the figure 18
- Do not use screw pin shackles if the pin can roll under load and unscrew as shown in the figure 18

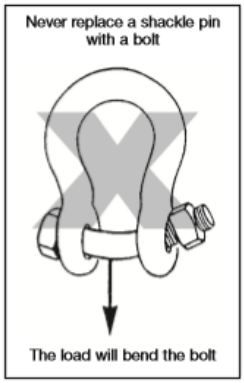

Figure : 16 Never replace a shackle pin with a bolt

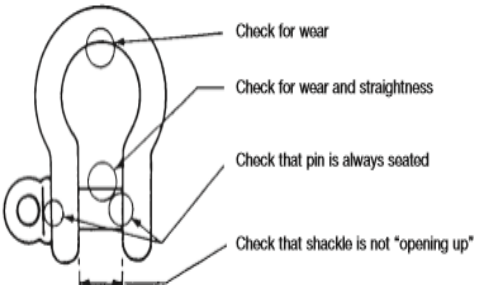

Figure: 17 cheks to be made for shackles

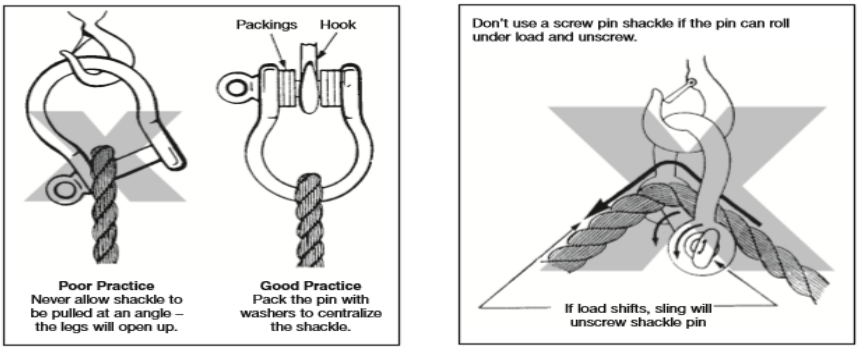

Figure: 18 Poor and Good Practice Of Loading Shackles & Don't Use Screw Pins

7.3.1 Inspection and rejection Criteria for Shackles

a) Ensure the Shackle has the Equipment Tag Number and Safe Working Load clearly and legibly marked, and corresponds with the manufacturer's certificate.

b) Ensure that all stamping is done using low stress stamps in the position recommended in BS 3551.

c) Remove the shackle pin and inspect for wear deformation and cracking.

d) Ensure it is the correct pin for the shackle.

e) Inspect pin threads for wear/deformation.

f) Inspect shackle body for deformation and cracking and check for wear in the crown and pin hole.

g) Check alignment of pinhole and ensure the pin fits correctly.

h) In case of safety pin shackles, ensure split pins are fitted.

i) The complete shackle shall be subjected to non-destructive testing at a period not exceeding 1 year.

REJECTION CRITERIA	
i.	Missing or illegible Identification Number or Safe Working Load
ii.	Any mechanical damage i.e. nicks, cuts, gouges etc.
iii.	Excessive movement between the shackle pin and the shackle threaded hole
iv.	Any wear or corrosion in excess of 5% of the original dimension
v.	Any thermal damage or evidence of welding on the shackle
vi.	Any cracks
vii.	Stamping out with the recommended positions shown in BS 3551
viii.	No split pin fitted in safety or bolt type shackles
ix.	Hard stamping with low stress stamps

Table: 12 Rejection criteria for the D- Shackles

Note: As per the standards

IS: 2415- FORGED SHACKLES FOR GENERAL LIFTING PURPOSES - DEE SHACKLES AND BOW SHACKLES

7.4 Hoisting Hooks

- Should be equipped with safety catches (except for sorting or grab hooks) as shown in the below figure 19
- Should be forged alloy steel with WLL stamped or marked on the saddle as shown in the below figure 19
- Should be loaded at the middle of the hook. Applying the load to the tip will load the hook eccentrically and reduce the safe working load considerably.
- Should be inspected regularly and often. Look for wear, cracks, corrosion, and twisting – especially at the tip – and check throat for signs of opening up as shown in the below figure 19

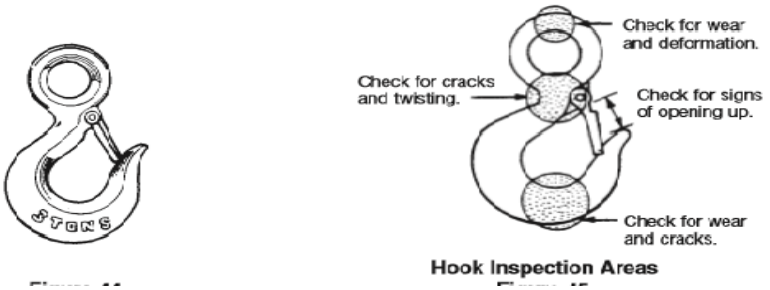

Figure: 19 Hook With Safety Latch & Checks to Be Made On the Hook

7.4.1 Inspection Criteria for Hooks

a) Ensure the Hook has the Equipment Tag Number and Safe Working Load clearly and legibly marked, and corresponds with the manufacturer's certificate.

b) Inspect the hook body for wear, distortion and corrosion.

c) Inspect the hook body for cracking at the crown of the hook.

d) Ensure safety catch is fitted and operational.

e) Any stamping is done only in zone "A"

f) There are three main types of hooks

g) Eye Hooks

   1) Inspect the eye of the bolt for wear, stretch and distortion.

   2) Inspect the eye of the bolt for cracking at the crown of the ring (This also applies to any link if fitted).

h) Shank Hook

   1) Inspect threads for wear, stretch or impact damage. The threads must be complete (no broken threads) and full (i.e. no flats on top).

   2) The threads should be concentric and fit neatly in a standard nut, zone D

   3) Wear on the shank more than 8% of original diameter.

   4) Check squareness of shank against shoulder.

   5) Additional holes drilled in the shank

i) Swivel Hook

   1) Inspect swivel part of the hook in accordance with 7.5

2) The complete hook shall be dismantled for inspection and NDT survey at a period not exceeding 4 years. At the discretion of the Lifting engineer, the dismantling and NDT survey frequency may be changed.

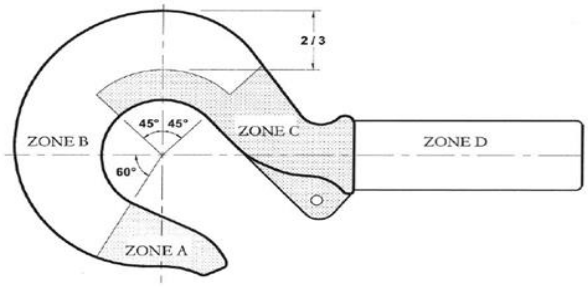

Figure : 20 Zones of the hook

	REJECTION CRITERIA
i.	Missing or illegible Identification Number or Safe Working Load
ii.	Any mechanical damage i.e. nicks, cuts, gouges etc.
iii.	For zone A (see sketch, appendix 1) worn more than 15% of original thickness.
iv.	For zone B (see sketch, appendix 1) wore more than 10% of original thickness.
v.	For zone C (see sketch, appendix 1) worn more than 5% loss of original thickness.
vi.	For zone D (see sketch, appendix 1) minimum thread size and/or 8% loss of original diameter
vii.	Increase in throat opening distance in excess of 15%
viii.	Threads that are corroded more than 20% of the nut engaged length.
ix.	Any thermal damage or evidence of welding on the hook i.e. nuts welded to hook shanks
x.	Any cracking or stretch
xi.	Hard stamping with low stress stamps or hard stamping in Zones “B”, “C” or “D”

Table: 13 Rejection Criteria For The Hook

Note: As per the standards

IS: 14470, 3822, 2758

BS: 7121 part-2 & 3

7.5 Inspection and rejection Criteria for Swivels

a) Ensure the Swivel has the Equipment Tag Number and Safe Working Load clearly and legibly marked, and corresponds with the Manufacturer's Certificate.

b) Inspect the swivel body for wear, distortion and corrosion.

c) Inspect the eyes of the swivel for wear, stretch and distortion.

d) Inspect the eye of the swivel for cracking at the crown of the ring.

e) Remove the jaw pin and inspect for wear deformation and cracking.

f) Ensure it is the correct pin for the swivel.

g) All dimensions must be within 5% of original dimensions

h) Ensure the swivel rotates freely.

i) The component parts of the swivel assembly shall be subjected to non-destructive testing at a period not exceeding 2 years.

REJECTION CRITERIA	
i.	Missing or illegible Identification Number or Safe Working Load
ii.	Any mechanical damage i.e. nicks, cuts, gouges etc.
iii.	Any wear resulting in a loss of more than 5% of the original dimension
iv.	Any wear or corrosion in excess of 5% of the original dimension
v.	Any stretch, distortion or cracking
vi.	Hard stamping with low stress stamps

Table: 14 rejection criteria for the Swivels

Note: As per the standards

IS: 4531(Part 1) – 1988

BS 6166 (part 3)

7.6. Inspection and Rejection Criteria for Cantilever, Fixed Gantry Cranes and Portal Crane.

Hydraulics

- Ensure all fluid levels are correct.
- Inspect the hydraulic system pipes, rotary coupling, rubber hoses for leaks, corrosion, wall section loss and mechanical damage
- Ensure that only crimped end connections have been used.
- Inspect all hydraulic cylinders for leakage, corrosion on the rods and alignment. Visually check end fixings for wear, security and lubrication.
- Ensure that the reinforcing steel braiding of the rubber hoses is not exposed.
- Ensure that no part of the hydraulic hoses has been painted.
- Inspect all check/holding valves for leaks, corrosion and mechanical damage.
- Ensure that the stroke lengths of hydraulic cylinders working in tandem are equal.

Structure Including the Crane Pedestal

- Inspect the crane structure for corrosion, mechanical damage, fatigue stress etc.
- Inspect all accessible load-bearing welds to ensure freedom from defects.
- Ensure all bolts, and fastenings are checked for tightness and condition. At the discretion of the lifting engineer, sample bolts may be removed to enable a thorough inspection and/or NDT.
- Check all anchorage and pivot pins/bushes for security.
- The thickness of any part of the structure may be checked using an appropriate NDT method; this will be at the discretion of the lifting engineer. The permissible levels of wear, erosion and/or corrosion are given in Table :15
- At intervals at the discretion of the Lifting Engineer, if applicable, the critical load bearing parts such as the boom section and areas that are not accessible during the routine inspections shall be dismantled to facilitate inspection. Critical load bearing parts shall be visually inspected and NDT using an appropriate testing method to ascertain their integrity. Load bearing parts to be considered:

- Main Jib/Boom
- Fly Jib and / or attachments
- Slew rings
- Hook blocks etc.

The Lifting Engineer may specify other parts of the crane to be tested if he has reason to believe that there are possible defects, which can only be detected by NDT.

Telescopic and Lattice Booms

- Check the operation of the telescopic boom; ensure the boom length markings are clearly legible. During operation, checks if the telescopic motion is through direct or indirect ram operation.
- In the case of indirect ram operation inspect the extending/retracting chains/ropes for corrosion, mechanical damage etc, refer to table 15 for limits.
- Any telescopic boom's extending/retracting chains/ropes and any internal hydraulic cylinders may, at the discretion of the Lifting Engineer, be required to be removed to facilitate a thorough inspection. During the chains/ropes removal, the boom shall be given a thorough internal inspection.
- Inspect the telescopic boom end stops, and the guides for security and wear.
- Inspect the entire length of the boom, including manual extension and fly jib, if fitted, or mechanical damage, loss of section and corrosion, fatigue stress, pay particular attention to the boom section end connections.
- Inspect the boom heel pins and luffing cylinder, top and bottom anchorages for excessive wear.
- For lattice jibs, inspect each section of the jib for mechanical damage and/or corrosion, loss of section to the cords and bracings ensure no bracings are missing.
- Inspect the lattice jib section joint pins and bushes for wear.
- Ensure that a boom angle indicator is fitted and operational (electronically or mechanical).

- The thickness of any part of the boom/jib may be checked using an appropriate NDT method; this will be at the discretion of the Lifting Engineer. The permissible levels of wear, shall be as advised by the crane manufacturer.

ITEM	LIMIT
MATERIAL LOSS on BOOM, JIB and STRUCTURAL MEMBERS	As defined by the crane manufacturer. Where no maximum material loss limit has been defined a maximum of 10% at any point, shall be the used.
LOOSE GEAR	5% on any diameter 3% on any pin/shaft or hole
WIRE ROPE	5 wires in any 6 diameters, 3 or more closely grouped wires. When the diameter of the rope has decreased by a value of more than 7% compared to the original rope diameter. Mechanical damage etc, full rejection criteria is contained within ISO 4309. Discolouration of the wires indicating internal corrosion.
CHAINS	Cracked or missing link plates Loose, worn pins with damaged heads, pins rotating in the outer plate. Loss of free movement (Seized chain). Wear, damage and corrosion of chain, anchor pin and anchor (including integral anchors). Wear between the pin and the plate (elongation) The load chains shall be of equal tension. Measurement of elongation must be made over a minimum of ten pitches, the rejection criteria based on elongation alone is: Leaf Chains 3% Roller Chains 3%

Table 15 -Gives the maximum thickness reduction permissible due to wear, corrosion etc for cranes

Ropes, Hook Block Assemblies and Sheaves

- Thoroughly inspect the entire length of all wire ropes fitted, including rope anchorage for wear, splintering, corrosion and mechanical damage etc. Special attention should be given to the section of rope on standing or equalizing pulleys. Wire rope rejection limits are given in Table: 15.
- Inspect all rope end terminations, splices etc for damage and wear with particular attention being paid to broken wires at ferrule connections.
- Inspect the wedge and socket, ensure the correct size of wedge and socket is fitted, and there is no miss-match between the wedge and socket.
- Ensure the rope fitted is of the correct size and construction for the crane.
- Inspect all sheaves for wear, cracking and rope path alignment and bearing condition.
- Ensure that at least five (5) full turns of wire rope remain on the drum at any time.
- Inspect crane hook in accordance inspection and rejection criteria for hook.
- Irrespective of the results of the inspections, all ropes shall be replaced after a period not exceeding 6 years.
- At intervals not exceeding four (4) years, all crane hook assemblies shall be dismantled for visual inspection and NDT survey of all load-bearing components. At the Lifting Engineer's discretion, this routine may be requested during the time of annual inspection.
-

Rope Drums

- Inspect all rope drums for cracks and for defects liable to damage the rope.
- Inspect all rope drums for security.
- Inspect rope anchorage for security and efficiency.
- Any fleeting device fitted to the drum requires to be checked for effective operation.

- At the Lifting Engineer's discretion, all the hoist units (main, auxiliary) may be removed to allow a thorough inspection of all enclosed parts i.e. gearbox shafts, bearings etc.

Slew Ring

- Slew ring rocking clearances shall be taken and recorded annually by the Owner. The clearances shall be compared against the maximum allowable, specified by the crane manufacturer. A log shall be kept showing the rocking clearances trend against the allowable rocking clearance limit, the log shall be kept for a minimum of 6 years.
- The backlash of the slew ring shall be taken and recorded annually. The backlash clearance shall be compared against the maximum allowable, specified by the crane manufacturer. A log shall be kept showing the back lash clearance trend against the allowable back lash clearance limit, the log shall be kept for a minimum of 6 years.
- Inspect the slew ring gearing and the slew drive motor gear for wear and damage.
- Check the slew ring and slew motor holding down bolts for tightness.
- Ensure that on multi drive units they are synchronized.

Brakes and Clutches

- Inspect the condition of all drive belts, gearing, shafts etc.
- Inspect the condition of the clutch and brake drum condition and lining for wear.
- Check the linings are properly secured.
- Ensure that all brakes and clutches function correctly.
- Check the operating linkage for excessive wear and maladjustment, which may interfere with proper operation
- Ensure that any pawls fitted to hoist units are functioning correctly.

Power Source

- Check the power source for proper performance and compliance with regard to safety requirements.

- If applicable, inspect the engine fuel lines and fuel tanks for leaks. Similarly, the exhaust system requires to be checked for security and leaks. The power source holding down bolts must be in place and secure.
- If applicable, check the engine oil, hydraulic fluid and water are at the correct level.
- Check for leakage of engine oil, hydraulic fluid and water.
- Ensure if fitted, the hydraulic start system is operational.

Control Station, Cab and Controls

- Inspect the cab/control structure for security and mechanical damage.
- Inspect all means of access (i.e. steps, ladders) for damage and security. Ensure adequate means of escape is provided. For mobile cranes it has to comply with IS standard.
- Ensure all controls are legibly marked with their mode of operation in bilingual notation. Where bilingual notation marking is not practical then a suitable control diagram shall be provided
- Inspect all control levers for excessive wear and maladjustment, which may interfere with proper operation
- Ensure the warning horn and engine stop control operates correctly.
- Ensure that all lighting fitted is functioning.
- If fitted with a free fall function, ensure that it has been disabled. (Piling rig excluded)

Safety Systems and Function Test

- Carry out a full function test (without load attached). I.e. telescoping, luffing, slewing and hoisting ensuring that the upper hoist/over lower, slewing, maximum and minimum radius limits etc. fitted are functioning correctly.
- Check the condition of hoses, piping and or electric cables.
- Ensure that the emergency load lowering is system is operational and clearly marked.
- Ensure the crane's audible and visual warning devices for damage, security and integrity, and functionally test the warning devices for correct operation.
- Ensure that a fire extinguisher is fitted and has a current inspection tag attached.

- Ensure that the crane is fitted with an overload protection device, inspect and functionally check the unit to ensure its correct operation. The accuracy of the device requires to be verified at the time of load testing. The accuracy of the device fitted shall be ± 5%. The overload protection device shall be calibrated when it exceeds the accuracy of ± 5% or every 6 years, whichever is sooner. The calibration certificate shall be made available to the Lifting Engineer.

Note:

1. Care should be exercised to prevent damage to the crane when function testing the safety limits.

2. A manual powered crane shall not be fitted with an overload protection device.

Electrical

- Copies of the crane electrical maintenance schedules and maintenance records shall be made available for scrutiny.
- Ensure that the isolating and emergency stops are clearly marked and are operational.
- Ensure that the isolating switch operating handle is in sound condition and can be locked off.

Check that all lights fitted are fully working.

7.7 Inspection and rejection criteria of Powered overhead Travelling, Manual overhead travelling Cranes:

Safe Working Load and Identification Number

Ensure the SWL and Identification number are legibly marked in characters of a contrasting colour not less than 75mm high on the bridge of the crane.

Structure

- Inspect the crane structure for corrosion and mechanical damage etc.
- Inspect all load-bearing welds to ensure freedom from defects.
- Ensure all bolts, and fastenings are checked for tightness and condition. At the discretion of the lifting engineer, sample bolts may be removed to enable a thorough inspection and/or NDT.

- Inspect all long and cross travel rail wheels for wear and security, ensure the wheel flange to rail clearance is not excessive.
- If fitted, inspect the anti-derailment brackets for corrosion and mechanical damage.
- Inspect the entire length of the long travel beam, rails and support structure as well as the cross travel beams and crab unit for cracks, weld deformation and corrosion. The levels for rejection due to wear and corrosion are given in Table: 15.
- Check the beams to ensure that they are level and parallel. At the Lifting Engineer discretion additional checks may be carried out in accordance with BS 466.
- At the discretion of the Lifting Engineer, the thickness of any part of the structure may be checked using an appropriate NDT method. The permissible levels of wear, erosion and/or corrosion are given in Table: 15.

Ropes and Hook Block Assemblies

- Thoroughly inspect the entire length of all wire ropes fitted, including rope anchorage for wear, splintering, corrosion and mechanical damage etc. Special attention should be given to the section of rope on standing or equalising pulleys. Wire rope rejection limits are given in Table: 15.
- Ensure the rope fitted is of the correct size and construction for the crane.
- All rope end terminations, splices etc shall be inspected with particular attention being paid to rope anchorage.
- Ensure that at least five full turns of wire rope remain on the drum when the bottom limit is activated.
- All sheaves shall be inspected for wear, cracks and rope path alignment and bearing condition.
- Inspect crane hook in accordance with inspection and rejection criteria of hook as said before in chapter 7.4
- At intervals not exceeding four (4) years, the crane hook assemblies shall be dismantled for visual inspection and NDT survey of all load-bearing components. At the Lifting Engineer s discretion, this routine may be requested during the time of annual inspection.

Rope Drums

- Inspect all rope drums for cracks and for defects liable to damage the rope.
- Inspect all rope drums for security.
- Inspect rope anchorage for security and efficiency.
- Check the rope guide for wear, cracking and damage.

Pendant Control

- Ensure the pendant control buttons are legibly marked with their mode of operation in bilingual notation. Where bilingual notation marking is not practical then the control buttons require to be clearly marked using arrows.
- Check the emergency stop switch for correct operation.

Electrical

- Copies of the crane electrical maintenance schedules and maintenance records shall be made available for scrutiny.
- Ensure that all isolating and emergency stops are clearly marked, visible and operational.
- If fitted with two long travel drive motors ensure they are synchronised for start, drive and stop functions.

9. Chain Block and Ratchet Lever Block

Inspection

The Lifting Engineer shall conduct a thorough inspection of the block in its assembled condition. Any of the following defects found during inspection shall be cause for rejection as shown in the table 14 and load test and light load test and endurance test can be performed with reference to **IS 3832 Hand operated chain pulley block**

COMPONENT	DEFECT TYPE	REJECTION CRITERIA
Load Chain (Round Link)	a) Wear b) Damage c) Corrosion	a) Wear in excess of 5% of original link dimensions. b) Cracks, heat damage, severe nicks, gouges or distortion of links

	d) Reeving e) Gauge length	c) Excessive corrosion, pitting or any chemical attack. d) Load chain reeving incorrect. e) Load chain gauge length increase greater than 3%.
Load Chain (Plate Link)	a) Wear b) Damage c) Corrosion d).Gauge Length	a) Wear in excess of 5% of original link or pin dimensions. b) Cracks, heat damage, severe nicks, gouges or distortion of links c) Excessive corrosion, pitting or any chemical attack. d) Load chain gauge length increase greater than 3%.
Chain Anchorage	a) Wear b) Damage c) Corrosion	a) Wear in excess of 5% of original diameter. b) Any cracks or distortion. c) Excessive corrosion, pitting or any chemical attack.
Hooks	As per Chapter 7	As per Ch 7 Paragraph 7.4
Block Body	a) Damage	a) Any mechanical damage or loose covers.
Powered Drive (where fitted)	a) Wear b) Operation	a) Excessive wear on drive mechanism. b) Incorrect or labored drive operation.
Manual Drive (where fitted)	a) Chain b) Drive sprocket	a) Broken or distorted links. b) Any cracks, excessive wear or distortion.
Ratchet Lever	a) Damage b) Operation	a) Cracked or broken operating lever b) Incorrect or laboured drive operation.

Table: 16 Inspection and rejection criteria of chain block

7.8. Inspection and rejection criteria for Trolley type crane

The Lifting Engineer shall conduct a thorough inspection of the trolley in its assembled condition. Any of the following defects found during inspection shall be cause for rejection:

COMPONENT	DEFECT TYPE	REJECTION CRITERIA
Wheels and Gears	a) Wear b) Damage c) Corrosion	a) Excessive wear on wheels, gears and bearings. b) Gear teeth broken or sheared, bearing collapse. c) Excessive corrosion, pitting or chemical attack.
Pins	a) Wear	a) Any wear in excess of 10% of original diameter.
Cheek Plates	a) Damage b) Corrosion	a) Cracks, severe cuts, gouges or distortion. b) Excessive corrosion, pitting or any chemical attack.
Load Attachment Point	a) Wear b) Damage c) Corrosion	a) Any wear in excess of 5% of original dimensions. b) Any cracks, cuts or distortion. c) Excessive corrosion, pitting or chemical attack
Powered Drive (where fitted)	a) Wear b) Operation	a) Excessive wear on drive mechanism. b) Incorrect or laboured drive operation.
Manual Drive (where fitted)	a) Chain b) Drive sprocket	a) Broken or distorted links. b) Any cracks, excessive wear or distortion.

Table 17: inspection and Rejection criteria for the Trolley mounted crane

Note:

Any block and /or trolley forming part of a crane configuration shall be subject to inspection intervals as detailed in Chapter 6 (Inspection and Load Testing of Cranes).

7.9 Inspection and rejection criteria of Mechanical Handling Equipment:

The list of the mechanical handling equipments used in IGL- Kashipur is shown in the below table-18 below.

MECHANICAL HANDLING MACHINE
• Excavator, Crawler, Powered
• Excavator, Wheeled, Powered
• Excavator/Loading Shovel, Combined, Powered
• Loading Shovel, Powered

Table 18: list of the mechanical handling Equipments used in IGL- Kashipur

Safe Working Load

- Ensure durable legible manufactures rating chart(s), with text in English and Hindi are provided in the operators cab. The charts shall be applicable to the mechanical handling machine model under inspection.
- On mechanical handling machines with a single load rating, ensure the SWL is legibly marked in characters of a contrasting colour not less than 75mm high.
- Ensure the unique identification number is legibly marked.
- Any hook fitted to the bucket shall have the SWL legibly marked in characters of a contrasting colour not less than 75mm high.

Hydraulics

- Ensure all fluid levels are correct.
- Inspect the hydraulic system pipes, rotary coupling, and rubber hoses for leaks, corrosion, wall section loss and mechanical damage. Ensure that only crimped end connections have been used.
- Ensure that the reinforcing steel braiding of the rubber hoses is not exposed.
- Ensure that no part of the hydraulic hoses have been painted.
- Inspect all check/holding valves for leaks, corrosion and mechanical damage.
- Ensure that the stroke length of hydraulic cylinders working in tandem are equal.

- Ensure all hydraulic lifting cylinders are fitted with check/holding valves.

Structure

- Inspect the chassis of the unit for corrosion, cracks and mechanical damage.
- Inspect load-bearing welds to ensure freedom from defect.
- Inspect for loose, missing and corroded fixings. Sample bolts may be removed to
- enable a thorough inspection and/or NDT at the discretion of the Lifting Engineer.
- Inspect all anchorages and pivot pins/bushes for wear and security.
- At the discretion of the Lifting Engineer, the thickness of any part of the structure may be checked using an appropriate NDT method. The permissible levels of wear, erosion and/or corrosion are given in Table :14
- Inspect the mechanical handling machine load arms for cracks, weld deformation and corrosion.
- If fitted with a sliding boom, inspect the end stops and the guides for security and wear.

Slew Ring

Slew ring rocking clearances shall be taken and recorded annually by the Owner. The clearances shall be compared against the maximum allowable, specified by the manufacturer. A log shall be kept showing the rocking clearances trend against the allowable rocking clearance limit, the log shall be kept for a minimum of 6 years.

The back lash of the slew ring shall be taken and recorded annually. The back lash clearance shall be compared against the maximum allowable, specified by the equipment manufacturer. A log shall be kept showing the back lash clearance trend against the allowable back lash clearance limit, the log shall be kept for a minimum of 6 years

- Inspect the slew ring gearing and the slew drive motor gear for wear and damage.
- Check the slew ring and slew motor holding down bolts for tightness.
- Ensure that on multi drive units they are synchronised.

Brakes and Clutches

- Inspect the condition of all drive belts, gearing, shafts etc.

- Inspect the condition of the clutch and brake drum condition and lining for wear.
- Ensure that all brakes and clutches function correctly.
- Ensure that any pawls fitted to hoist units are functioning correctly.

Power Source

- Check the power source for proper performance and compliance with regard to safety requirements.
- Inspect the engine fuel lines and fuel tanks for leaks. The power source holding down bolts must be in place and secure.
- Check battery electrolyte level

Cab and Controls

- Inspect the cab for security and mechanical damage.
- Inspect all means of access (i.e. steps, ladders) for damage and security. Ensure adequate means of escape is provided.
- Ensure all controls are legibly marked with their mode of operation in bilingual notation. Where bilingual notation marking is not practical then a suitable control diagram shall be provided
- Inspect all control levers for excessive wear and maladjustment, which may interfere with proper operation
- Ensure the warning horn and engine stop operate correctly.
- Ensure that all lighting fitted is functioning.

Safety Systems and Function Test

- Carry out a full function test (without load attached). I.e. telescoping, luffing and slewing ensuring that any limit switches fitted are functioning correctly.
- If fitted, ensure the equipment "movement warning" alarm/horn/light is functioning.
- Ensure that a fire extinguisher is fitted and has a current inspection tag attached.
- If fitted, the Load Indicator shall be visually inspected and functionally checked to ensure correct operation. Verification of the LI must be carried out annually. The

accuracy of Load Indicator shall be ± 5%. Load Indicator shall be calibrated every 6 years. The calibration certificate shall be made available to the Lifting Engineer.

Crawler Tracks etc

- Inspect the crawler plates, attachment links; drive sprockets and chains for cracking, wear and mechanical damage.
- Inspect the top and bottom guide rollers for cracking and lubrication failure.

Car Body, Chassis and Outriggers and Steering

- Inspect the car body and chassis of the crane for corrosion, cracks and mechanical damage.
- Check the condition and operation of any travel axle blocking devices.
- Inspect the outriggers and outrigger pads for damage to structure and pipe work, and leaking oil seals.
- Ensure that the slew locks and tail weights, if fitted, are fully functioning.
- Ensure the outrigger indication lights and interlocks, if fitted, are functioning.
- Ensure that levelling indicator is fitted and functioning.
- Inspect the steering assembly for excessive play.

Tyres and Brakes

- Inspect the pneumatic tyres for deterioration through wear or damage. All tyres including any spare must comply with the Road Transportaion of India. Any cuts in the walls of tyres shall be a cause for rejection.
- The correct tyre inflation pressure for each tyre shall be clearly marked adjacent to it.
- Check the operation of both the travel and park brakes.

Documentation

- Copies of the maintenance schedules and maintenance records, NDT reports and previous certificates of inspections shall be provided to the third party Certifying Lifting Engineer by the owner, for inspection.

- Copies of the manufacturer's certificate of tests stating specified and actual breaking load and the rope construction shall be provided to the third party Certifying Lifting Engineer following any rope renewal, for inspection.
- Details of the certificate/s for the wire rope/s and/or chains to be checked, and entered on the Certificate/Report.
- The log of daily, weekly and monthly inspections shall be provided to the third party certifying Lifting Engineer by the equipment owner, for inspection.

7.10 Inspection and rejection criteria for the Forklift and stacker

Mechanical Handling Equipment
1. Fork Lift Truck, Reach, Powered
2. Fork Lift Truck, Rough Terrain, Powered
3. Fork Lift Truck, Side loading, Powered
4. Telescopic Handler, Powered
5. Fork Lift Truck, Attachment
6. Pallet Truck, Manual
7. Stacking Truck, Manual

Table: 19 List of Mechanical Handling Equipments used in IGL- Kashipur

Safe Working Load

- Ensure durable legible manufactures rating chart(s), with text in English and Hindi are provided in the operator's cab. The charts shall be applicable to mechanical handling machine model under inspection.
- On mechanical handling machines with a single load rating, ensure the SWL is legibly marked in characters of a contrasting colour not less than 75mm high.
- Ensure the unique identification number is legibly marked.

Hydraulics

- Ensure all fluid levels are correct.

- Inspect the hydraulic system pipes, rotary coupling, and rubber hoses for leaks, corrosion, wall section loss and mechanical damage. Ensure that only crimped end connections have been used.
- Ensure that the reinforcing steel braiding of the rubber hoses is not exposed.
- Ensure that no part of the hydraulic hoses has been painted.
- Inspect all check/holding valves for leaks, corrosion and mechanical damage.
- Ensure that the stroke lengths of hydraulic cylinders working in tandem are equal.
- Ensure all hydraulic lifting cylinders are fitted with check/holding valves.

Structure

- Inspect the chassis of the unit for corrosion, cracks and mechanical damage.
- Inspect all load-bearing welds to ensure freedom from defect.
- Inspect for loose, missing and corroded fixings. At the discretion of the lifting engineer sample bolts may be removed to enable a thorough inspection and/or NDT.
- Inspect all anchorages and pivot pins/bushes for wear and security.
- At the discretion of the Lifting Engineer, the thickness of any part of the structure and the integrity of welds may be checked using an appropriate NDT method. The permissible levels of wear, erosion and/or corrosion are given in Table :19
- Inspect the mechanical handling machine load arms for cracks, welds deformation and corrosion. At the discretion of the Lifting Engineer, the integrity of welds may be checked using an appropriate NDT method.
- If fitted with a sliding boom, inspect the end stops and the guides for security and wear.

Mast and Fork Carriage Assembly

- Inspect the mechanical handling machine mast assembly for wear, cracks, welds deformation and corrosion
- Check the mast pivots for excessive wear.
- Check the hydraulic tilt cylinders anchorage's for excessive wear.
- At a period not exceeding 48 months, the mast assembly shall be dismantled to allow for a thorough inspection of the guide rollers and internal chains and inaccessible welds.

- At the discretion of the Lifting Engineer, the mast may be subjected to non-destructive testing.

Load Chains

- Inspect the entire length of all chains fitted, the rejection criteria is listed in Table :19
- Irrespective of the results of the inspection, chains, removable anchors and anchor pins shall be replaced after a period not exceeding 6000 operating hours or 3 years, which ever is the shorter.

Load Forks

- Inspect the load forks for cracking; particular attention should be given to the heel and top and bottom hooks including their attachment to the shank.
- Heel, top ansd bottom hooks to be subjected to NDT annually.
- Check for straightness between the upper face of the blade and the front of the shank.
- Check the fork angle between the upper face of the blade and front face of the shank.
- Check the fork tip height differences when mounted on the carriage.
- Check for blade for wear; pay particular attention to the heel.
- Check the fork position lock is in good condition and is working correctly.

Note:

Under no circumstances must load forks be repaired.

REJECTION CRITERIA	
Straightness	Deviation not to exceed 0.5% of the length of the blade
Fork Angle	Not to exceed 93 degrees
Fork Tip Height Differences	Not to exceed 3% of the length of the blade
Blade wear	Heel shall not be less than 90% of original thickness i.e. 10% wear
Welding	Any welding or flame cutting carried out on any part of the fork

Table: 20 Rejection criteria for the Forklift and Stackers

Brakes and Clutches

- Inspect the condition of gearing, shafts etc.
- Inspect the condition of the clutch and brake drum condition and lining for wear.
- Ensure that all brakes and clutches function correctly.

Engine

- Check the engine for proper performance and compliance with regard to safety requirements.
- Inspect the engine fuel lines and fuel tanks for leaks. The engine holding down bolts must be in place and secure.
- Check battery electrolyte level

Cab and Controls

- Inspect the cab for security and mechanical damage.
- Inspect all means of access (i.e. steps, ladders) for damage and security.
- Ensure all controls are legibly marked with their mode of operation in bilingual notation. Where bilingual notation marking is not practical then a suitable control diagram shall be provided
- Inspect all control levers for excessive wear and maladjustment, which may interfere with proper operation
- Ensure the warning horn and engine stop operate correctly.
- Ensure that all lighting fitted is functioning.

Safety Systems and Function Test

- Carry out a full function test (without load attached). I.e. telescoping, hoisting and lowering ensuring that any limit switches fitted are functioning correctly.
- If fitted, ensure the equipment "movement warning" alarm/horn is functioning.
- Ensure that a fire extinguisher is fitted and has a current inspection tag attached.
- Ensure that an amber warning light is fitted and functioning.

- If fitted, the Load Indicator shall be visually inspected and functionally checked to ensure correct operation. Verification of the LI must be carried out annually. The accuracy of Load Indicator shall be ± 5%. Load Indicator shall be calibrated every 6 years. The calibration certificate shall be made available to the Lifting Engineer.

Car Body, Chassis and Outriggers and Steering

- Inspect the car body and chassis for corrosion, cracks and mechanical damage.
- Inspect the outriggers and outrigger pads for damage to structure and pipe work, and leaking oil seals.
- Ensure the outrigger indication lights and interlocks, if fitted, are functioning.
- Inspect the steering assembly for excessive play.

Tyres and Brakes

- Inspect the pneumatic tyres for deterioration through wear or damage. All tyres including any spare must comply with the Indian Road Transport Regulations.
- Any cuts in the walls of tyres shall be a cause for rejection.
- The correct tyre inflation pressure for each tyre shall be clearly marked adjacent to it.
- Check the operation of both the travel and park brakes.

7.10. Inspection and rejection criteria for Goods Lifts

Goods Lifts are defined as lifting machines or appliances, which have a travelling platform or cage. The directional movement of which is restricted by guides, which are used for transporting materials from one level to another.

Motor Room

- Ensure that no unauthorised access can be made into the motor room.
- Check all machinery holding down arrangements to ensure they are secure and that any supporting structures are satisfactory.
- Inspect the lift motor, gearbox, sheaves, shafts, clutches and brakes ensuring they are in a satisfactory condition and in good working order.

- At the time of load testing the emergency brake release and hand winding device shall be demonstrated. It must be ensured that the brake fully engages immediately the emergency brake is released.

Gearbox

- At intervals not exceeding 10 years and most conveniently when re-roping is being carried out, the top cover of the gear case shall be removed to allow a thorough inspection of all enclosed parts i.e. gearbox shafts, bearings etc.
- Particular attention should be given to shafts having changes in diameter, which are likely to result in points of high stress concentration.

Car Top

- Ensure the lift car top is fitted with a car top control and an emergency stop switch (stop switch to be of mushroom head type).
- Ensure the stop switch and inspection change over switch are functioning correctly prior to riding on top of the lift.
- Ensure the inspection change over switch is shrouded to prevent accidental change over.

Lift Shaft

- Check the lift shaft to ensure that it is clear of any obstruction that could affect the safe operation of the lift.
- Inspect the guide rails, support brackets and fixings for tightness and condition.
- Check the operation of all upper and lower limit switches plus all floor level switches.
- In the event that the lift safety gear has been operated, due to the high forces generated by the actuation of the safety gear, a detailed inspection of the guide rails, guide rail supports and fixings shall be made to check their condition.
-

Landing Gates or Doors

- Check the electro mechanical interlocks of all the landing doors for correct operation and function.
- Check the engagement of the mechanical interlock is adequate.

- A thorough internal inspection of the interlocks, including enclosed parts, shall be made to confirm the condition of the mechanical locking mechanism and electrical contacts at periods not exceeding 1 year.
- Ensure that it is not possible to open a landing door unless the lift is at the landing.

Suspension Ropes and Safety Gear Rope

- Thoroughly inspect the entire length of the suspension and safety gear ropes, including rope anchorage for wear, splintering, corrosion and mechanical damage etc. The ropes shall be replaced if the number of broken or corroded wires exceeds 5% in any 10 rope diameters or mechanical damage, which approaches or exceeds the discard criteria set out in ISO 4344.
- Inspect all rope end terminations, splices etc for damage and wear with particular attention being paid to broken wires at ferrule connections.
- Inspect the wedge and socket, if fitted, to ensure the correct size of wedge and socket is fitted, and there is no miss-match between the wedge and socket.
- Ensure the rope fitted is of the correct size and construction for the lift.
- Inspect all sheaves for wear, cracking and rope path alignment and bearing condition.
- Irrespective of the results of the inspections, all ropes shall be replaced after a period not exceeding 10 years.
- If a slack rope trigger switch is fitted to the suspension rope, its operation shall be verified

Lift Pit

- Check the lift pit to ensure that it is clear of any obstruction that could affect the safe operation of the lift.
- Ensure there is adequate clearance between the bottom of the counterweight and the top the buffer when the lift car is at the top floor.
- Ensure that the counterweight guards are fitted and check for correct positioning.
- Check the lift car and counterweight buffer’s electrical cut out switches to ensure correct operation.

- Checks shall be made to ensure that the buffers are in place and are correctly positioned to engage the car and counterweight striking plates.
- Ensure the lift pit is free from debris and water.

Lift Car

- Ensure the lift serial/capacity plate is in position and showing the correct capacity for the lift.
- Check the operation of the lift floor selector panel for correct operation over the full travel of the lift.
- Check the alignment of the lift car floor and the landing floor level and smoothness of travel.
- Passenger carrying lifts shall be inspected as detailed above in addition the following car emergency devices shall also be tested.

Emergency and Safety Equipment

- Audible alarm (to be audible outside the lift).
- Emergency Telephone (if fitted).
- Emergency Stop Button.
- Emergency roof escape with electric switch fitted to the escape panel.
- Emergency Lighting.

Over Speed Governor and Safety Gear

- Inspect the over speed governor frame holding down arrangements for security.
- Check the over speed governor operating mechanism tripping action is free.
- Check the safety gear to ensure that the jaw or wedge running clearances are as recommended by the manufacturer.
- Operate the safety gear by hand while at rest to check freedom of movement and engagement of jaws or wedges with the guide rails.
- The over speed governor shall be tested every 5 years and on every occasion when the over speed governor has been subject to any repairs which may affect its operation, or

the governor rope has been renewed. The test shall ensure correct tripping operation and tripping speed,

- The safety gear shall be tested every 5 years and on every occasion when the safety gear has been subject to any repairs, which may affect its operation, or the safety gear, rope has been renewed to ensure correct operation.
- Where an overload detection device is fitted, a full load calibration test shall be carried out at time of load test.

Documentation

- Copies of the lift maintenance schedules and maintenance records, NDT reports and previous certificates of inspections shall be provided to the third party Certifying Lifting Engineer by the owner, for inspection.
- Copies of the crane electrical maintenance schedules and maintenance records shall be made available, for inspection.
- Copies of the rope manufacturer's certificate of tests stating specified and actual breaking load and the rope construction shall be provided to the third party Certifying Lifting Engineer following any rope renewal, for inspection.
- Details of the certificate for the wire ropes to be checked, and entered on the Certificate/Report.
- If the condition of the lift gives rise to doubt, the Lifting Engineer at his discretion, may request additional inspection/testing or request additional information he considers pertinent to verify the safe condition of the lift for further use.

Chapter-8

Standard Operating Procedure

8.1 Standard operating procedure for the Overhead crane

Statistics say that accidents, incidents are very common on cranes. It may be during shifting of material or during maintenance work. Considering the hazards and associated risks involved

A. Scope

This operating procedure will be applicable to all EOT cranes in operation or during maintenance. The subject has been addressed from the following three different aspects and adherence to the requirements evolving thereof shall ensure better control of and protection from foreseeable hazards: · Relevant Statutory Provisions · Engineering Controls to Ensure Safety · Standard Work Practices

B. Relevant Statutory Provisions

Fencing of Machinery (Sec 21) - Unless they are in such position or of such construction as to be safe to every person employed in the factory as they would be if they have securely fenced the following namely

a) Every part of an electric generator or rotary convertor

b) Every part of a transmission machinery and

c) Every dangerous part of any other machinery shall be securely fenced by safe guards of substantial construction which shall be constantly maintained and kept in position while the parts of machinery they are fencing are in motion or in use.

Work on or near machinery in motion (Sec 22) – Where in any factory, it becomes necessary to examine any part of machinery referred to in Sec (21) while the machinery is in motion, such examination or operation shall be made or carried out only by a specially trained adult male worker wearing tight fitting clothing whose name has been recorded in the register prescribed in this behalf. No woman or young person shall be allowed to clear, lubricate or adjust any part of any machine if the cleaning, lubrication or adjustment thereof would expose the woman or young person to risk of injury from any moving part either of that machine or any other adjacent machinery.

Self-acting machines (Sec 25) – No traversing part of a self-acting machine in any factory and no material carried there on, shall, if the space over which it runs is a space over which any

person is liable to pass whether in the course of employment or otherwise be allowed to run on its outward or inward traverse within a distance of 50 cm from any fixed structure which is not part of the machine.

Lifting machines, chains, ropes and lifting tackles (Sec 29) – In any factory, the following provisions shall be complied with in respect of every lifting machine (other than a hoist and lift) and every chain rope and lifting tackle for the purpose of hoisting or lowering persons, goods or materials.

1. All parts including the working gear, whether fixed or moveable of every lifting machine and every chain rope or lifting tackle shall be

2. of good construction, sound material and adequate strength and free from defects.
3. Properly maintained and

4. Thoroughly examined by a competent person at least once in every period of 12 months or at such interval as the Chief Inspector may specify in writing and a register shall be kept containing the prescribed particulars of every such examination.

5. No lifting machine and no chain rope or lifting tackle shall, except for the purpose of test, be loaded beyond the safe working load (SWL) which shall be plainly marked thereon together with an identification mark and duly entered in the prescribed register and where this is not practicable, a table showing the safe working loads of every kind and size of lifting machine or chain rope or lifting tackle shall be displayed in prominent positions in the premises

6. While any person is employed or working on or near the wheel track of a travelling crane in any place, where he would be liable to be struck by the crane, effective measures shall be taken to ensure that the crane does not approach within six meters of that place.

Floors, stairs and means of access (Sec 32) – In every factory, all floors, steps, stairs, passages and gang-ways shall be of sound construction and properly maintained and shall be kept free from obstructions and substances likely to cause persons to slip and where it is necessary to ensure safety, steps, stairs, passages and gangways shall be provided with substantial handrails. There shall, so far reasonably practicable, be provided and maintained safe means of access to every place at which any person is at any time required to work. When any person has to work at a height from where he is likely to fall, provision shall be made, so far as reasonably practicable, by fencing or otherwise to ensure the safety of the person so working.

C. Engineering Control

1. Identification number and SWL to be painted in bold letters on the crane itself in such size and clarity that it is easily visible, readable from Floor Level.
2. One portable CO2 fire extinguisher of suitable capacity is to be kept in the crane operator's cabin.
3. Safety switches, preferably of lockable push button type shall be provided on four corners of the crane near the ladder so that it can be operated either from Gantry or from the bridge platform. In addition, one such switch shall be provided in the operator's cabin also
4. An audible warning device shall be provided in the operator's cabin to warn people working below, while operating the crane.
5. Sufficient light shall be hung from the girder of the crane so that the working area under the crane is properly illuminated drive couplings and protruded extended shafts etc are to be securely guarded as referred above
6. There shall be at least two plug points of voltage 220 AC and 24 volts ac respectively fitted in the crane girder to facilitate during maintenance work.
7. Panel nomenclature to be painted on the outer side of individual panel doors and all circuit components to be adequately labeled and all control cables properly ferruled to facilitate correct identification.

D. Standard Work Practices

1. Only the designated crane operator or a specially trained and authorized person having sufficient knowledge and skill regarding safe operation of various mechanisms of the crane shall be allowed to operate a crane
2. The crane which is to be shut down for maintenance and repair, shall be brought to the repair bay or to the repair platform or to any other suitable place where the crane may be shut down for maintenance with least interference to other cranes
3. Before the maintenance work on a crane is taken up, the group incharge shall inform the operation shift incharge regarding the nature and duration of work
4. When the crane is brought to the required place, the group incharge of maintenance shall arrange for necessary power shut down in relation to the nature of repair work and place of repair work on the crane.

5. When power has been shut down as required, the isolation switch/switches shall be locked and tagged and the keys are to be kept with the group incharge for maintenance. The power rails in the repair bay shall be adequately earthed.
6. In case of end crane rail, stops (scotch blocks) shall be placed on the runway rails on the required side at a distance of 6 meters from the crane. In case of a middle crane, rail stops shall be fixed on both sides 6 meter away from the crane
7. Crane operators on the adjacent cranes shall be notified by the group incharge about the work to be done on the crane under shutdown and about the places of the rail stops.
8. A red flag during day time and a red lamp during night shall be hung from the center of the crane on the required side (both sides if it is a middle crane) to draw attention of the adjacent crane operator. The ground area below the crane shall be cordoned off and red flags during the day and red lamps during nights shall be exhibited to warn men on the floor.
9. Use of scaffolding on the crane for repair maintenance work shall be prohibited except for location not otherwise possible.
10. Persons deployed on the crane during maintenance or supervision should have secured foothold while at work and must guard themselves against tripping, slipping or getting unbalanced. They must make use of full body harness with double lanyard wherever necessary. The group incharge shall brief this to all persons before start of work
11. Before any work is commenced and men are sent over the crane the group incharge shall make sure that all necessary safety precautions have been taken
12. If the crane under repair is to be shunted then the supervisor wanting such an operation must inform the group incharge of the maintenance so that he can arrange to remove the rail stocks and his men from dangerous positions and move to a safe and secure place before the shunting is done.
13. Care shall be taken to ensure that no tools or loose parts fall down. The material from above shall not be thrown down or it shall be lowered down to selected place
14. On completion of the maintenance of an EOT crane, all loose items, tools and equipment shall be removed from the crane or securely fixed or stored in a secured container.
15. The work shall not be considered complete unless all the safety guards and other safety devices are back in position and spillage of oil or grease, oily rags and other refuge removed from the crane.

16. Before the job is declared complete, the incharge of the repairmen must inspect the crane thoroughly and satisfy himself that everything is all right
17. When the work is completed, the red flags and the lamps on the crane and on the ground and the rail stops shall be removed and all men must leave the crane. Then the group incharge of maintenance shall remove the danger boards from the isolating switches, unlock them and ask the operator to take over the crane. The crane operators of the adjacent cranes and shop foremen shall also be informed of the completion of the work.
18. When taking over the crane, the crane operator shall ensure that all local safety rules relating to the use of cranes are being observed. The following inspection / operational checks shall be carried out by the crane operator to ensure that the crane is in safe working condition

8.2 Standard Operating Procedure (SOP) For Manual Operated Chain Block:

1. Safety principles:

Never : Use the chain block for lifting and transporting people.

Never : Lift or transport loads over or near people.

Never : load the chain block more than the lifting capacity shown on the chain block nameplate.

Always : ensure safe holding the load in a stable position after termination of the manipulation.

Always : make sure the load carrying structure will provide adequate support to handle fully loaded chain block and all the lifting operations.

Always : let people around to know when a lift is about to begin.

Always : read operation manual and safety instructions. ensure physically fit, qualified and instructed persons over 18 years of age familiarized with this manual and trained in safety conditions and way of work operate the chain block.

Always : check the chain blocks daily before use according Daily inspection".

Always : make sure the length of the rope is long enough for the intended work.

Always : ensure the carrying rope is clean and undamaged.

Always : make sure the carrying rope is firmly fastened to the shackle of the upper pulley block.

Always : make sure the rope is properly drawn on the grooves in the pulleys.

Always : make sure the pulleys in the upper and lower pulley blocks are free to rotate.

Never : pull loads firmly imbedded or of unknown weight.

Never : pull without knowledge of necessary tensioning forces.

Never : use damaged or worn out chain block.

Never : use chain block with jumped out, damaged or missing hook safety latch.

Never : use chain block without visible marking of the lifting capacity.

Never : use modified or deformed hooks.

Never : use chain block marked by the label „ OUT OF OPERATION ".

Never: perform modifications of the chain block (e.g. welding) without consulting the manufacturer.

Always : consult the manufacturer or his authorized representative, if you plan to use a chain block in non-standard or extreme environments.

When in use:

Always : make sure the load is properly seated in the hook.

Always : make sure the safety latches of hooks work in the correct way.

Always : pay attention to the limit positions.

Always : when manually lifting loads approaching the nominal lifting capacity of the chain block, we recommend, regarding the operating forces, the operation was ensured by two persons.

Always : mark the defective or repaired chain block by the suitable label (for example „OUT OF OPERATION").

Never : use fouled or damaged rope.

Never : use chain block for anchoring loads.

Never : allow swinging the load, causing impacts or vibrations.

Never : hitch load on the hook tip.

Never : pull the rope over any edge.

Never : weld, cut or make other operations on suspended load.

Never : connect other parts for rope lengthening (textile one).

Never : lengthen steel wire ropes by attachment of other part by means of clamps.

Never : do maintenance when a load is suspended on the chain block.

Never : use a chain block, which is under repair!

2. Safety working environment:

1. The operating staff of the chain block shall be demonstrably familiarized with this manual, shall follow safety and hygienic regulations and shall be qualified to the operation of this equipment.
2. The operating staff must be equipped with helmet, gloves and suitable footwear when operating the chain block.
3. Only verified binding means of appropriate lifting capacity are to be used for binding loads.
4. When more persons take part in the operation, only one of them must be determined, that is trained in safety work instructions and responsible for manipulation with the chain block.
5. The person shall have a clear and unobstructed view of the whole working area still before starting the work. When it is not possible, one or more persons must help to supervise in the nearby area of the chain block.
6. The operating staff must check whether the entire work place is safe and whether there is a possibility of escaping from this area in case of endanger before starting to operate the chain block.
7. During the work with the chain block the suitable distance of the operating staff from the load must be kept. It is prohibited to lift or lower bulky loads preventing to keep sufficient distance.
8. When operating the chain blocks in limited area, you must prevent the hook or load do not hit into obstacles or to the chain block body.

3. Positioning of the chain block:

The erection procedure will vary with the application and should be carried out in accordance with the supplier's instructions paying attention to the following matters:

- Prior to installation inspect the equipment to ensure no damage has occurred in store or transit.
- Ensure the support structure is adequate for the full loads that will impose, is tested and marked with the SWL.
- When erecting trolleys ensure they are correctly set for the beam width and that the track is fitted with end stops and remains level at all loads up to the maximum.

- When suspending appliances by a top hook ensure the support fits freely into the seat of the hook. After erection ensure that the chain/wire rope hangs freely and is not twisted or knotted.
- Use safety equipment when suspending the chain block in heights to avoid falls from heights.
- Always the user is responsible for the load carrying structure.

4. Operation of the chain block:

A. Use of the chain block

The chain block is the multipurpose device, determined for lifting, lowering and pulling of loads under normal atmospheric conditions in the workplace. It is designed for universal usage as portable equipment during assembling, repairing and other works. Since work with heavy loads may present an unexpected danger, it is necessary to follow all the "Safety Principles"

B. Instructions for operating staff

1. Putting on the rope:

We put on the carrying rope to the chain block so that we will start at the upper pulley block, and then alternately put on the rope to both pulley blocks until all pulleys are roped. We will fasten the end of the rope to the shackle of the upper pulley block so that sufficient safety of the connection is ensured. At chain blocks of small lifting capacities the pull on the rope can be induced manually, for higher lifting capacities by help of winch, rope-drum or other adequate equipment. Perform fastening of the rope to the lifting eye by means of three at minimum rope clamps.

2. The chain block position when pulling:

The chain block shall be installed so that the axis of the hook of the upper pulley block and axis of the hook of the lower pulley block were in one straight line. Before setting (anchoring) of the chain block to the working position we make sure, whether the suspension element is firm enough to support the supposed loading for all the time of the manipulation.

3. **Lifting (pulling) or lowering:**

We perform lifting by means of pulling the free end of the rope. As the chain block has no brake that could hold the load in any position after the interruption of the pulling, the winch or rope-drum shall be equipped with a brake. The lifting force and lifting speed as well are inversely proportional to a number of carrying cross sections of the rope.

WARNING:

Do not continue to operate if the lower pulley block reaches the maximum or minimum lift. Such cases can cause fall of the load.

When pulling or tensioning load an unexpected move of the load can take place and release and fall of unsecured chain block as well. Therefore be careful.

5. Inspection and Maintenance:

1. Inspection classification:

1. **Initial inspection:** it precedes prior to initial use. All new or repaired chain blocks shall be inspected by a responsible, qualified person to ensure qualified fulfillment of requirements of this manual
2. .Inspections of chain blocks in regular operation are generally divided into two classifications according to intervals at which should be performed. The intervals depend upon the nature of the critical components of the chain block and the degree of their wear and tear, damage or malfunction. The two general classifications are herein designated as daily and regular ones. The respective intervals are defined as follows

(a) Daily inspection: visual inspection provided by the operating staff designated by the user at the beginning of each usage.

Daily inspection checks whether chain blocks are not damaged or are without any defect. Perform this inspection also during the operation in the interval between regular inspections. Qualified employees shall determine whether any defect or damage can constitute a hazard or more detailed inspection is required.

Part	INSPECTION METHOD	LIMIT/CRITERIA FOR DISCARDING	REMEDY
1. Function of pulleys	By rotating of the pulley.	Pulleys seizes, go stiff, make an excessive noise, etc	Clean pulleys and lubricate pivots.
2. Rope fastening on the shackle of the upper pulley block	Visual check.	End of rope is not sufficiently fastened to the shackle	Repair of the rope fastening.
3. Hooks (1) Appearance	Visually.	Safety latch jumped out from the hook top. Bent shank of the hook, other visible hook deformations	Professional inspection of lifting device – putting out of the operation
(2) Hook rotation	Turn the hook around its axis.	Hook does not rotate fluently or scrub.	Clean and lubricate.
(3) Safety latch of hook	Manual springing of safety latch.	Safety latch does not return after compression.	Clean, lubricate, repair or replacement

Table: 21 Daily inspection checks for the Chain Block

(b) Regular inspection: visual inspection provided by the qualified person designated by user.

1) Normal operation – annually,

2) Heavy operation – twice per year

3) Special or infrequent operation – as recommended by a qualified person at first usage and according to the directions of the qualified employees (maintenance workers)**.**

Regular inspection complete inspections of the chain block perform as recommended regular inspections. These inspections may be performed with the chain block in its normal location and do not require dismantling the chain block. The recommended regular inspection defined shall be performed under the supervision of competent persons who determine whether the

complete disassembly of the chain block is necessary. These inspections shall include the requirements of the daily inspection as well.

PART	INSPECTION METHOD	LIMIT/CRITERIA FOR DISCARDING	REMEDY
1. All parts	Visual check.	Worn out or damaged parts. Fouled and non-lubricated parts.	Putting out of the operation. Dismount, clean, lubricate and assemble again
2. Name plate	Visual check.	Lifting capacity is illegible.	Repair or replace by the new one
3. Hooks (1) Deformation of hook (opening)	Measure dimension „C“ by slide caliper. Visual check.	Measured value is higher than set by the table. Deformation is visible during visual check	Qualified check of lifting device – putting out of the operation. Putting out of the operation.
(2) Wear and tear of hook	Measure dimensions „A“ and „B“ by slide caliper.	Do not use hook, if the dimensions “A”/ “B“ get smaller by more than 10%.	

Table: 22 Regular inspection of the chain block

2. The chain block occasionally used:

1. The chain block that has been idle for a period of one month or more but less than one year shall be put through a detailed inspection conforming to the requirements of the daily inspection before it is placed again in operation.
2. The chain block that has been idle for a period of one year shall be put through a detailed inspection conforming to the requirements of the regular inspections before it is placed again in operation

8.3 Standard operating procedure for the mobile hydraulic crane

1. The crane should centered over the load before starting the hoist to avoid swinging of the load as lifting starts .load should not be swung by cranes to reach areas not under or with reach of crane
2. Crane should be operated smoothly to avoid jerk and about movements of the load slack must be taken from the sling & hoisting ropes before the load is lifted
3. The crane hoisting ropes should be kept vertical. crane must not be used for side pulls
4. The area should be clean and all persons in the area aware when the load is lifted. This is to be ensured by a warning signals while lifting, lowering & while moving .Additional warning signals to be used in the high traffic density area
5. The load should be checked to be certain that it is lifted high enough to clear all obstructions and personal when moving
6. Load must not be carried over people, especially load carried to clear magnets. Load or parts of loads held magnetically may drop. Failure in power to magnet will result in dropping of the load unless back up power supply is furnished
7. Lifts should not be attempted beyond the rated capacity of the crane, slings ropes chains etc.
8. On all capacity or near capacity load, the hoist brakes should brakes be tested by returning the motor switch or push button to the OFF position after raising the load a few inches off the floor. If the hoist brakes do not hold the load should be set on the floor and the crane not further operated. The defects should be reported immediately to the supervisor
9. Before moving a load, load slings, load chains or other lifting devices must be fully seated on the saddle of the hook
10. The block should never be lowered below the point where less than two fill wraps of the ropes remain on the drum. Should all the ropes get unwrapped from the drum, it should be rewound in the drum groove in the correct direction and seated properly in the groove otherwise the rope may get damaged and thee hoist limit switch will not operate to stop the hoist in the high position
11. At no time load should be held suspended from the crane with the power ON unless the operator is at the operator switch. Under this condition the load should be kept as close as possible to the floor to minimize the possibility of an injury if the load should drop.

12. When a hitcher is used, it is joint responsibility of the crane operator and the hitcher to see that hitches are secure and that all loose materials has been removed from the load before starting a lift.
13. Slings hooks hanging loose should not be used to lift load (if slings hooks are needed they should be properly stores
14. All slings or ropes should remove from the crane hook when not in use (dangling slings or hooks hung in slings rings can inadvertently snag other objects when moving the crane)
15. The crane should not be operated if limit switches are out of order or if ropes show defects or wear
16. Crane operator should not use limit switches to stop the hoist under normal operating conditions
17. (these are emergency devices and should not be used as operating control)
18. Limit switch should not be blocked adjusted or disconnected in order to go higher than what switch will allow
19. Electrical limit switches or warning devices should never be by passed
20. Upper limit switch and lower limit switch should be tested in stopping the hoist at the beginning of each shift or as frequently as may be directed
21. Load limit switch or load devices must not be used to measure loads being lifted. This is an emergency switching device and is not to be used as production operating control
22. A crane should never move or bump another crane that has a warning signal displayed
23. Contact with runaway stop or other cranes shall be made with extreme caution. The operator must take particular care for the safety of person on or below the crane and only after making certain that person on the other cranes are aware of what is being done
24. If pligging protector is not provided the controller must always be stopped momentarily in OO position before reversing(a slight pause is necessary to give the braking mechanism time to operate)
25. In case of an emergency or swing inspection, repairing cleaning or lubricating a warning sign or signal should be displayed and the main switch should be locked in OFF position
26. An attempt should never be made to close a switch that has an OUT OF ORDER or DO NOT Operate card on it. It is necessary to make a careful check to determine that no one else is working on crane, before removing the card

27. If the electrical power is disrupted the controllers must be placed in OFF position and kept there until power is again to operate
    a. Before leaving the crane the operator should perform the following
    b. rise all hook to an intermediate position
    c. Spot the crane at an approved designed location
    d. Place all controls in OFF position
    e. Open the main switch to the OFF position
    f. Make visual check before leaving the crane

8.4 Standard operating procedure for the Forklift Trucks

Anyone using the forklift trucks must be certified in their operation and licensed according to the standard IS 6305.Non certified personals are not to operate this equipment under any circumstances

Suitable training should be offered to the person by safety training department

These procedures have been prepared to provide a basic source of reference and a means of uniformity for use of forklift trucks. When a question arises that cannot be suitably answered by reference to these operating procedures, it is suggested the Operator's manual be consulted or the matter be discussed with the supervisor

A. Physical Qualifications for Operators

1. No physical or mental condition that would jeopardize the safe operation of the truck (dizzy spells, medication, bad back, etc.)
2. Good vision, of at least 20/40, corrected if necessary; depth perception of at least 90 percent of normal. Wearing vision protection is recommended at all times.
3. Normal hearing, preferably without need of a hearing aid.
4. Normal reflexes and reaction time.
5. No use of illegal substances; no excessive use of alcohol.
6. Ability to understand and read instructions, signs, etc.

B. Pre-Shift Inspection

A pre-shift inspection of the forklift truck is required before the equipment is used. The following items must be checked before operating the equipment:

1. Fuel level and gauge.
2. Oil level.

3. Hydraulic oil level.
4. Power shift oil level.
5. Battery water level.
6. Visual inspection of battery for corrosion and loose terminals.
7. Coolant water level.
8. Visual inspection of the fan belt.
9. Brakes for proper operation – both service and parking.
10. Lights – head, tail, turn, and warning.
11. Horn.
12. Hoist mechanism: chain bearings, nuts, and cotters. Lube as required. Also check the forks for
13. cracks, heel wear, tip wear, and alignment.
14. Steering.
15. Hydraulic controls.
16. Tires: remove foreign material and check inflation.
17. Visual inspection for oil, fuel, and exhaust leaks.

At the end of the usage, all the above items must be checked again. In addition, the operator must

place all controls in neutral and set the parking brake. During the winter, the engine heater must

be plugged in if the unit is so equipped.

C. Lift Truck Operation

Leaving the truck: Whenever the operator leaves the truck, the forks or attachment must be fully lowered, the controls set in neutral, and the parking brake set. If the operator goes 25 feet or more away from the truck, or is out of sight of the truck, the engine must be shut off, and the operator must have the key in his or her possession.

Visibility: The operator must always have a clear view of the path in the direction of travel. If the load being carried blocks forward view, the driver must travel with the load trailing.

Load handling: Only stable and safely arranged loads within the rated capacity of the truck should be handled. Operators are not to pick up and move loads that are too heavy. If, upon attempting to lift the load, the rear wheels of the truck begin to rise, set the load down immediately and obtain proper equipment to lift a load of that size.

When picking up a load, center the load evenly on the forks, and engage loads squarely until the load rests against the vertical portion of the forks or load backrest. Check the fork length. Forks must be at least 2/3 the length of the load. Carefully tilt the mast backward just enough to stabilize the load. Forks on a lift truck are adjustable; spread them to fit the load. Normally, the wider the better.

Loads can be of many sizes and descriptions. Many lift truck applications handle loads on pallets. Pallets are loaded with boxes, bags, packages, or other small objects. All loads should be made stable by either interlocking the objects, or strapping or shrink-wrapping the load, to prevent individual objects from falling off the pallet.

Long loads, such as carpet rolls, reduce the stability of a lift truck. Long, wide, or high loads require more room, so watch the clearance. The load may be very secure until something is run into that shifts the truck's center of gravity. This creates the potential for a lateral overturn. Lifting long loads that extend directly in front changes the weight center of the truck and reduces the lifting capacity of the truck. When right angle stacking or moving with a raised load to clear low objects, move very slowly and avoid sharp turns.

When raising a load, use extra caution. An elevated load must not be tilted forward except when the load is in the correct position to be deposited. When stacking, use only enough backward tilt to stabilize the load

Operating surfaces: Operate the forklift trucks only on improved surfaces if possible. If operating off of improved surfaces, make sure the surface will support the weight of the vehicle and not create unstable conditions before entering the area.

On grades, ramps, slopes, and inclines, travel straight up and down. Never turn on ramps, slopes, inclines, or severe grades; wait until you are back on a level surface. Never try to cross a ramp, slope, incline, or severe grade perpendicular to the fall line. This creates the potential for a lateral overturn. Without a load, travel up or down with the forks pointing downgrade.

Pedestrians: The operator of the forklift truck is responsible for operating in a safe manner; this includes avoiding all pedestrians in the work area. Always face the direction of travel. Pedestrians use the same roadway, so sound the horn at intersections and blind spots.

Watch for people in the work area because they may not watch for the forklift, even if there are warning lights and/or alarms. If it is determined that they may not see the lift truck, do not move until eye contact is made. Make people stand back, even if the lift truck is stopped. Pedestrians may not understand that the lift truck has rear steering and there are visibility

restrictions. If the view is blocked because of the load, travel backwards. If the lift truck must move forward, make sure that people are out of the way and move the lift truck slowly. Use a spotter to help you. If the spotter or a clear path of travel is not visible, don't move the lift truck.

Watch for employees working in the same area. Don't let anyone walk under raised forks or load. If given a load to handle and someone is required to hold or position the load while the lift truck is moving – STOP. There is something wrong. If unable to handle the load alone, change the load or the equipment. Otherwise, someone will eventually be hurt badly. Don't take this risk. Find a better way to move the load

Personnel and moving platforms: The lift truck is never to be moved or repositioned with a platform elevated or with personnel on the platform. Always lower the platform and have all personnel dismount before moving or repositioning the truck. The only way to raise personnel to a work site is with the appropriate platform. Never allow anyone to use the upright or mast of the truck as a ladder.

Before using a platform, always ensure that it is securely stacked to the fork/backrest mechanism and secured with a safety chain before the truck is moved. Make sure that no part of the platform interferes with the operation of the carriage or upright assembly. Also, be certain that there are no mechanical problems which might cause the upright to bind. Raise and lower the platform alone, to test its operation, before allowing any person on it.

When a work platform is raised and lowered, watch for slack chains, or any stationary object, which could cause the forks, rails, or platform to hang up or drop. Keep the upright in a vertical, untilted position while the platform is raised. Stay with the truck during the entire time the platform is raised. Do not allow anyone to climb on the upright or walk under the raised platform. Never allow anyone to ride on the platform while the lift truck is being moved.

D. Lift Truck Tip over

Lift trucks can be tipped over if not operated properly. Observe the following procedures to lessen the possibility of a tip over:

1. Slow down before turning. Go into and out of turns slowly, using a slow rotation of the steering wheel.
2. Drive with the forks or attachments lowered and tilted back only enough to stabilize the load. Raising a load high moves the center of gravity and lowers the capacity. Keep

your loads down, with the masts vertical or tilted back only enough to stabilize the load. If a heavy load is tilted too far forward or back while it is raised, the truck can tip over

3. Check capacities – don’t overload the truck

Chapter: 9

Frequency of Maintenance of the Lifting Equipments

9.1 Maintenance frequency of lifting accessories

All lifting accessories shall be thoroughly inspected in accordance with this procedure at time intervals not exceeding 12 months with reference to Indian standards..

At time of initial inspection, the Manufacturer's Test Certificate shall be produced by the asset custodian / owner for review by the Lifting Inspector to verify equipment details. Failure to provide the original Manufacturer's Test Certificates will result in the equipment being rejected.

9.1.1 Thorough Inspection at 12 Monthly Intervals of lifting accessories

All items of lifting accessories shall be subject to a thorough inspection giving critical appraisal of the item in question, in accordance with this procedure. All inspections of lifting accessories shall be undertaken by a Lifting Inspector, who shall assess the fitness for its intended use in accordance with the relevant item, as per**(a) (iii) of sub section (1) of the section 29 of Factories Act-1948.** This is the minimum level of inspection required.

Any defects found that result in the item being unserviceable and not repairable, shall be painted red, placed in a segregated area, and disposed of immediately after the inspection has been completed. If to be repaired it shall be painted black.

9.1.2 Repairs

All items that are found unserviceable, but considered repairable shall be placed in a quarantine area designated by the technician and a tag tied to the item giving details of the repairs required. All proposed repairs to damaged items of lifting accessories must have the approval of the Lifting Engineer.

Items of lifting tackle that have been repaired shall be proof load tested before being taken back into service.

Note:

No repairs shall be carried out on any sling, shackle, ring or eyebolt. These types of defective lifting items must be destroyed**.**

9.1.3 Service Life of Lifting Accessories

No maximum service life is specified for any item of lifting tackle, serviceability is determined by the findings of the twelve monthly inspections.

9.1.4 Marking and Colour Coding of Lifting Accessories

Ensure that all hard stamping of lifting items is carried out using low stress stamps. Ensure that no damage to the item has occurred due to the hard stamping. All lifting accessories, which have been inspected and found fit for purpose for a maximum twelve months, shall be colour coded and they of chemical industries colour coding. All items shall have as a minimum the unique number and the safe working load (SWL).

9.2 Maintenance Frequencies for the Cranes:

CRANE TYPES	12 MONTHLY INSPECTION	48MONTHLY INSPECTION AND LOAD TEST
Crane, Wall Mounted Swing Jib	YES	YES
Crane, Cantilever	YES	YES
Crane, Fixed Gantry	YES	YES
Crane, Portable Gantry	YES	YES

Table: 23 Maintenance Frequencies for The mobile crantry Cranes

Frequency of Inspection

All cranes listed in Table 23 shall be thoroughly inspected and load tested in accordance with this procedure at time intervals detailed in table 23.

At time of initial inspection, the Manufacturer's Test Certificate shall be produced by the asset custodian / owner for review by the Lifting Engineer to verify appliance details.

Thorough Inspection

The Lifting Engineer shall carry out a thorough inspection of the crane in accordance with **IS 13367 part1**This is the minimum level of inspection required.

Due to the many varying designs of cranes, not all aspects of the inspection will apply to every crane.

Pre-Inspection Function Test

During any thorough examination, it is necessary to carry out an operational function test without load to prove the operation of the crane and the function of its safety devices. The crane must be operated by a fully qualified crane operator under the control of the Lifting Engineer. Prior to the test, the Lifting Engineer shall establish, with reference **to IS 13367 part1**

- That all controls operate correctly and smoothly, and are free from wear and other damage.
- That the crane driver is certified, and has adequate experience.
- That any limitation of crane operations in accordance with operating site safety requirements, i.e. weather conditions, etc. are observed.
- The crane is provided with a valid RAS (Roadworthiness Assurance Standards) sticker.
- The crane is fit to perform the required movements.
- Equipped with sufficient falls of wire rope for the test load.
- The operational function test shall cover the items listed below. If any defects are found which adversely affect the safe operation of the crane during the thorough inspection, then they shall be corrected before proceeding further:
- Main and auxiliary load hoisting and lowering mechanism.
- Boom hoisting and lowering mechanism.
- Slewing mechanism.
- Boom hoist and load limits.
- All brakes and clutches.
- Boom angle (mechanical or electronically) and safe load indicators.

Safe Working Load and Identification Number

- Ensure durable legible manufacturer’s rating chart(s), with text in English and/or Hindi are provided in the operators cab or primary control station. The charts shall be for the

crane model under inspection and cover all possible configurations of the crane including manual extensions and fly jibs, if applicable.

- Ensure the correct load-rating charts for the crane configuration in use, is accessible to the operator.
- On cranes with a single load rating, ensure that the SWL is legibly marked in characters of a contrasting colour not less than 75mm high, on the boom or structure of the crane.
- Ensure the unique identification number is legibly marked in characters of a contrasting colour not less than 75mm high, on the boom or structure of the crane.

9.3 Maintenance frequencies of Overhead cranes.

All the cranes in Table: 24 shall be thoroughly inspected and load tested in accordance with this procedure at time intervals detailed in Table: 24

At time of initial inspection, the Manufacturer's Test Certificate shall be produced by the asset custodian / owner for review by the Lifting Engineer to verify appliance details.

CRANE TYPES	12 MONTHLY INSPECTION	48 MONTHLY INSPECTION AND LOAD TEST
Crane, Powered Overhead Travelling	Yes	Yes
Crane, Manual Overhead Travelling	Yes	Yes
Crane, Manual Overhead Travelling Structure	Yes	Yes

Table: 24 Maintenance frequencies of load test for overhead cranes

Thorough Inspection

The Lifting Engineer shall carry out a thorough inspection of the crane in accordance with this above table. This is the minimum level of inspection required. Due to the many varying designs of cranes, not all aspects of the inspection will apply to every crane.

Pre-Inspection Function Test

During any thorough examination, it is necessary to carry out an operational function test without load to prove the operation of the crane and the function of its safety devices. The crane

must be operated by a fully qualified crane operator under the control of the Lifting Engineer. Prior to the test, the Lifting Engineer will establish.

- That the crane operator is certified, and has adequate experience.
- That any limitation of crane operations are observed.
- The crane is fit to perform the required movements.

The operational function test shall cover the items listed below. If any defects are found which adversely affect the safe operation of the crane during the thorough inspection, then they shall be corrected before proceeding further:

- Main and auxiliary load hoisting and lowering mechanism.
- Hoist upper and lower limits.
- All brakes and clutches.
- Safe load indicators.

Inspection, Load Test and Overhaul Frequency

Inspection

- The frequency of inspection of (loose) appliances shall be at intervals not exceeding 12months, following initial registration. All inspections shall be carried out by a Lifting Engineer.
- Where required, accurate dimensional checks of components shall be conducted for verification to appropriate design standards and as datum's for future comparison purposes i.e. hook throat.
- At time of initial inspection, the Manufacturer's Test Certificate shall be produced by the asset custodian / owner for review by the Lifting Engineer to verify appliance details. Failure to provide the original Manufacturer's Test Certificates will result in the equipment being rejected.

Note: The inspection frequency of complete systems, eg monorails, trolley and chain block, shall be subjected to annual thorough examination and 4 yearly load tests.

Identification / Marking

- All appliances shall be clearly marked with the following information:
- a) Equipment Tag Number (ETN)

- b) Safe Working Load (S.W.L.)
- c) Date of Inspection
- d) Next Due Date (of Inspection)

Overhaul Frequency

- At intervals not exceeding **four (4)** years, all appliances require to be dismantled for inspection and NDT survey of all load-bearing components i.e. hooks, ratchet and pawls, baseplate etc, prior to being presented for a thorough inspection and load test. The Lifting Engineer shall inspect all load-bearing parts after NDT has been carried out and before reassembly.
- At the Lifting Engineer's discretion, the load testing and overhaul frequency may be Changed.
- All lifting appliances, which have been inspected and certified as being fit for purpose for a maximum 12 months,

9.4 Maintenance frequencies of Mechanical Handling Equipment

All items of mechanical handling equipment listed in table 25 shall be thoroughly inspected in accordance with this procedure at time intervals detailed in table 25

At time of initial inspection, the Manufacturer's Certificate of Test shall be produced by the asset custodian / owner for review by the Lifting Engineer to verify appliance details.

MECHANICAL HANDLING MACHINE	6MONTHLY INSPECTION	LOAD TEST
Excavator, Crawler, Powered	YES	NO
Excavator, Wheeled, Powered	YES	NO
Excavator/Loading Shovel, Combined, Powered	YES	NO
Loading Shovel, Powered	YES	NO
Piling Rig, Excavator Mounted, Powered	YES	NO

Table No: 25 Maintenance frequencies of the Mechanical Handling Machines

Thorough Inspection

The Lifting Engineer shall carry out a thorough inspection of the mechanical handling equipment in accordance with this section. This is the minimum level of inspection required.

Due to the many varying designs of mechanical handling equipment, not all aspects of the inspection will apply to each unit.

Pre-Inspection Function Test

During any thorough examination, it is necessary to carry out an operational function test without load to prove the operation of the mechanical handling equipment and the function of its safety devices. The mechanical handling equipment must be operated by a fully qualified operator under the control of the lifting engineer. Prior to the test, the Lifting Engineer will establish:

- That the operator is certified, and has adequate experience.
- That any limitation of the mechanical handling equipment operations are observed.
- The equipment is provided with a valid RAS (Roadworthiness Assurance Standards) sticker.

Operational functional Test

The operational function test shall cover the items listed below. If any defects are found which adversely affect the safe operation of the mechanical handling equipment during the thorough inspection, then they shall be corrected before proceeding further:

- Load hoisting and lowering mechanism.
- All brakes.
- Safe load indicators.

9.5 Maintenance frequencies of the Fork lift

All mechanical handling machines listed in Table: 26 shall be thoroughly inspected and load tested in accordance with this procedure at time intervals detailed in Table: 26.

At time of initial inspection, the Manufacturer's Certificate of Test shall be produced by the asset custodian / owner for review by the Lifting Engineer to verify appliance details.

MECHANICAL HANDLING EQUIPMENT	6 MONTHLY INSPECTION	48 MONTHLY INSPECTION & LOAD TEST
Fork Lift Truck, Counterbalanced	YES	YES
Balanced, Powered	YES	YES
Fork Lift Truck, Manual	YES	YES
Fork Lift Truck, Reach, Powered	YES	YES
Fork Lift Truck, Rough Terrain, Powered	YES	YES
Fork Lift Truck, Side loading, Powered	YES	YES
Telescopic Handler, Powered	YES	YES
Fork Lift Truck, Attachment	YES	YES
Pallet Truck, Manual	YES	YES
Stacking Truck, Manual	YES	YES

TABLE: 26 Maintenance frequencies for load test of Fork lift

Thorough Inspection

The Lifting Engineer shall carry out a thorough inspection of the mechanical handling equipment in accordance with this section. This is the minimum level of inspection required.

Due to the many varying designs of mechanical handling equipment, not all aspects of the inspection will apply to each unit.

Pre-Inspection Function Test

During any thorough examination, it is necessary to carry out an operational function test without load to prove the operation of the mechanical handling equipment and the function of its safety devices. The mechanical handling equipment must be operated by a fully qualified operator under the control of the Lifting Engineer. Prior to the test, the Lifting Engineer will establish:

- That the operator is certified, and has adequate experience.

- That any limitation of the mechanical handling equipment operations is observed.
- The mechanical handling equipment is fit to perform the required movements.

The operational function test shall cover the items listed below. If any defects are found which adversely affect the safe operation of the mechanical handling equipment during the thorough inspection, then they shall be corrected before proceeding further:

- Load hoisting and lowering mechanism.
- All brakes.
- Safe load indicators.

9.6 Maintenance frequencies of the goods lift

Goods Lifts are defined as lifting machines or appliances, which have a travelling platform or cage. The directional movement of which is restricted by guides, which are used for transporting materials from one level to another.

Inspection Frequency

- Each passenger or goods lift shall be inspected at period's not exceeding 12months and load tested at periods not exceeding 60 months (5 years).
    - At time of initial inspection, the Manufacturer's Certificate of Test and commissioning tests shall be produced by asset custodian / owner for review by the Lifting Engineer to verify appliance details.

Chapter -10

Conclusion

Proper planning, implementation of best work practices and proper maintenance are the basic requirements for the effective usage of material handling equipment particularly in chemical process industry that deal with variety of chemical hazards, is necessary.

In this project all of the above conditions were addressed in terms of pre lift planning, , selection and rejection criteria, designing SOPs and maintenance criteria, by studying and understanding various activities carried out by lifting equipment at IGL-Kashipur along with working conditions and kind of material being handled.

Thus this document provides all kinds of necessary details /requirements of effective mechanical material handling for chemical process industry where the production and process safety is of main focus.

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