

MAINTENANCE AND INSPECTION OF ROTARY EQUIPMENT

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CONTENTS

- Objective
- Types of Rotary Equipment
- Compressors
- Pumps
- Maintenance of rotary equipment
- Inspection of rotary equipment

OBJECTIVE

To understand

- Types of rotary equipment
- Working of Pumps and Compressors
- Components of equipment
- Inspection techniques
- Maintenance procedures

TYPES OF ROTATING EQUIPMENT

- Compressors
 - Rotating, screw and centrifugal types
- Turbines
 - Gas turbines
- Pumps
 - Basic types and Centrifugal

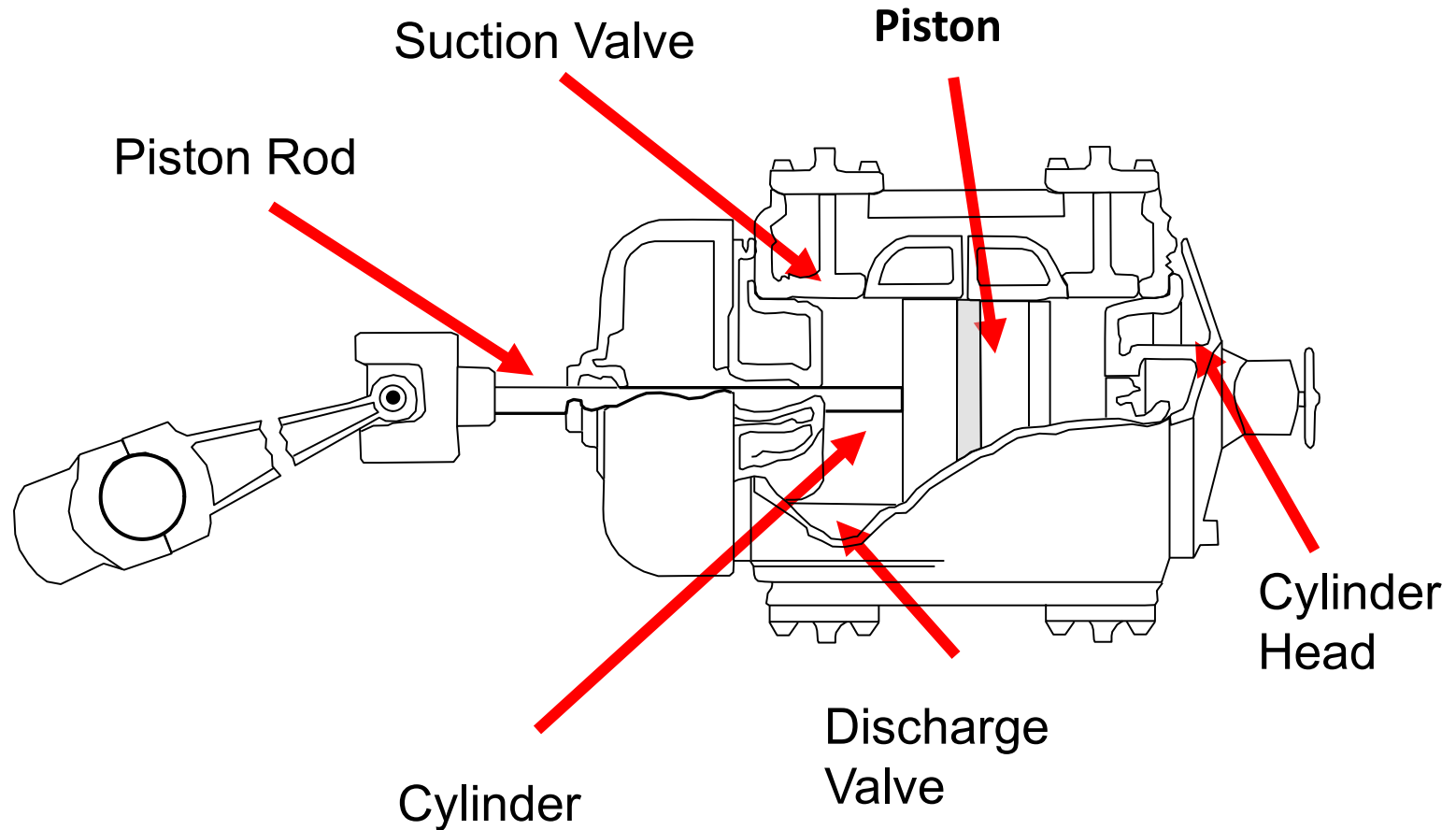
INTRODUCTION OF COMPRESSORS

- Compressors are used in all aspects of gas processing such as:
 - Gas Lift
 - Gas Gathering
 - Helium Recovery
 - Condensate Recovery
 - Transmission
 - Distribution

TYPES OF COMPRESSORS

- Reciprocating
- Centrifugal

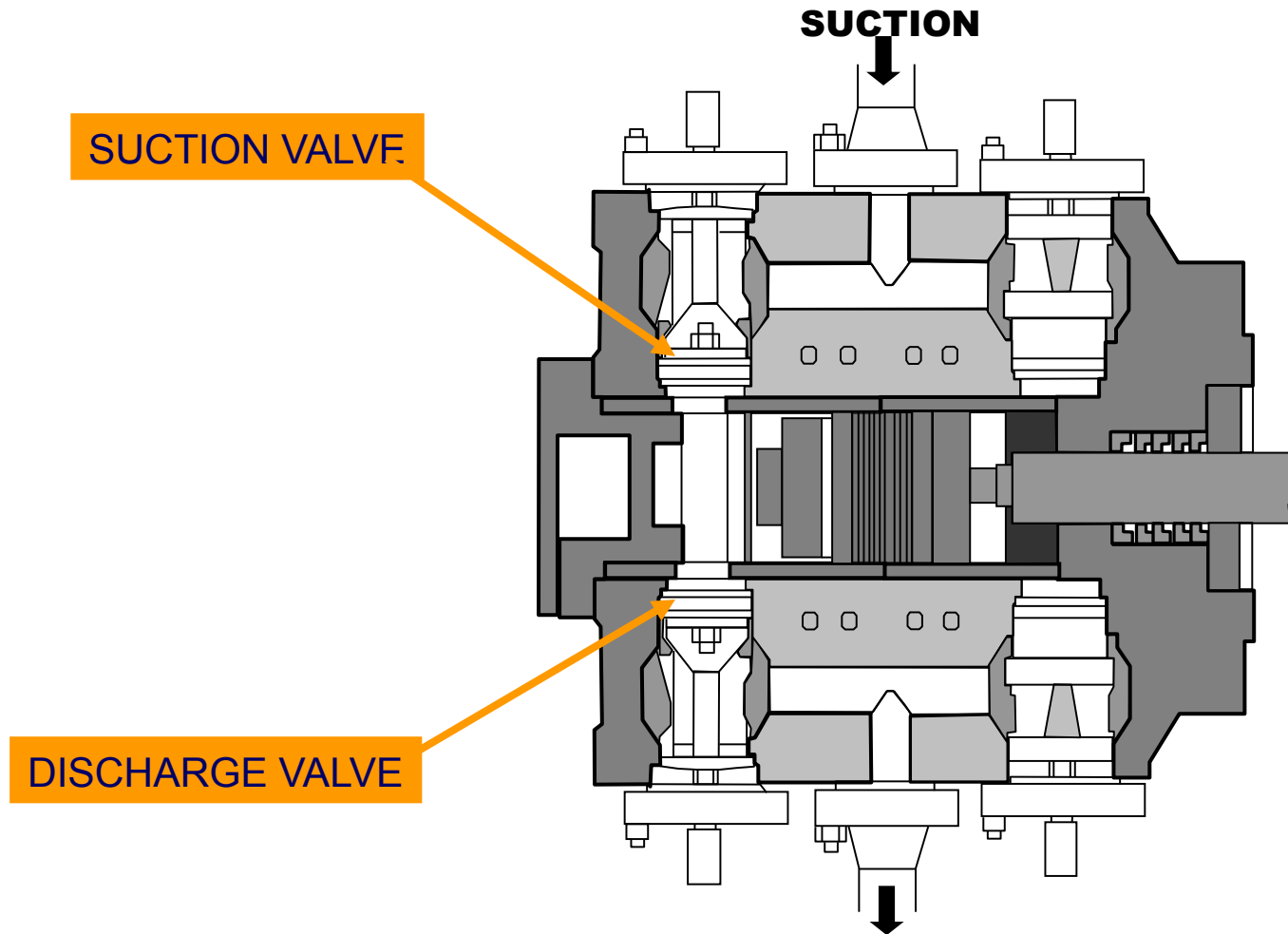
RECIPROCATING COMPRESSOR



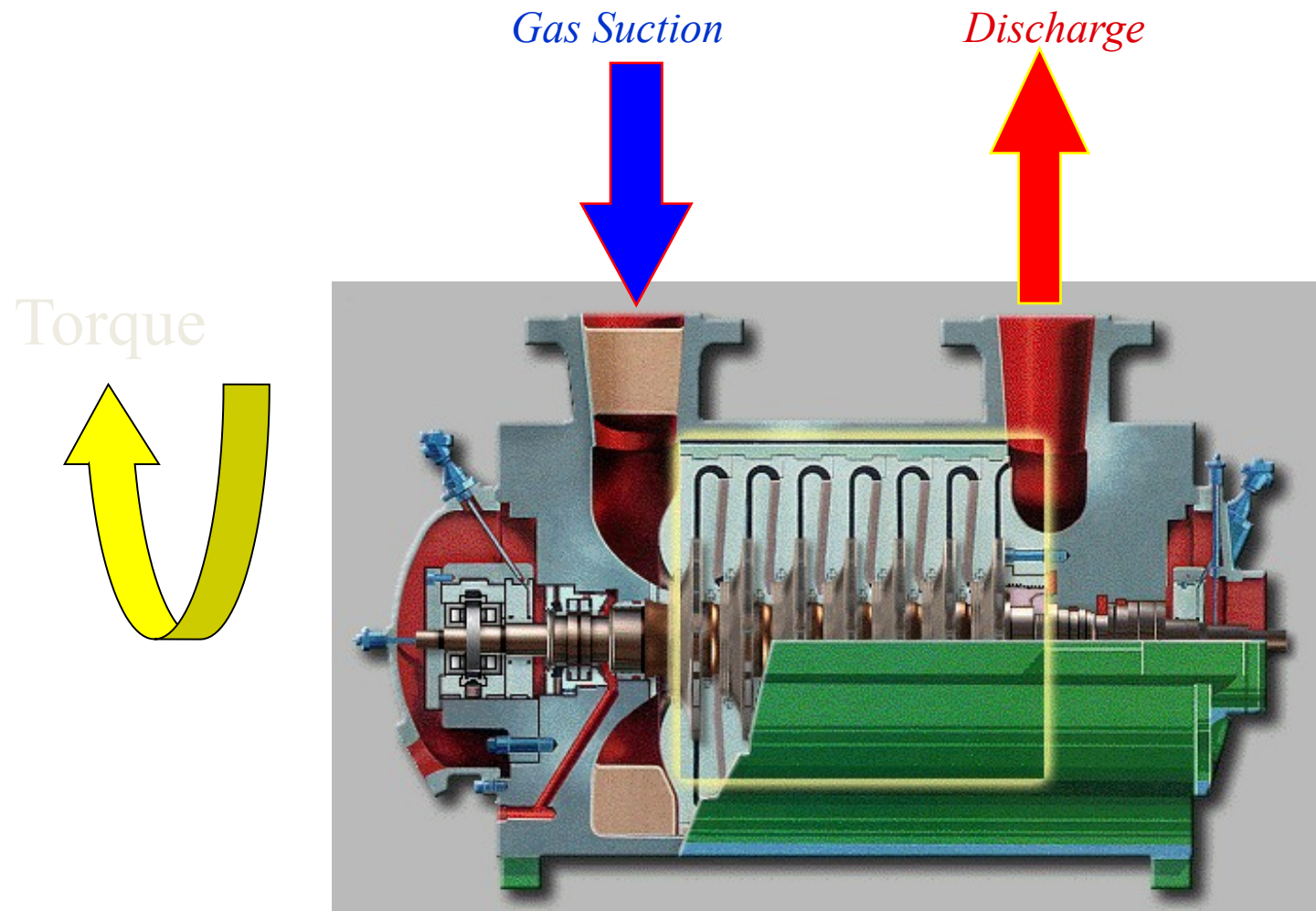
RECIPROCATING COMPRESSOR VIDEO

VIDEO

CYLINDER OPERATING VALVES

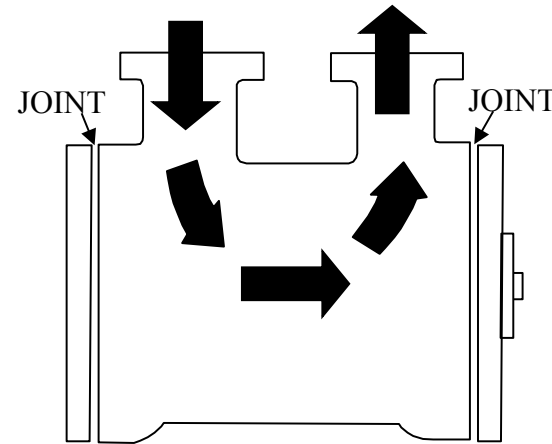
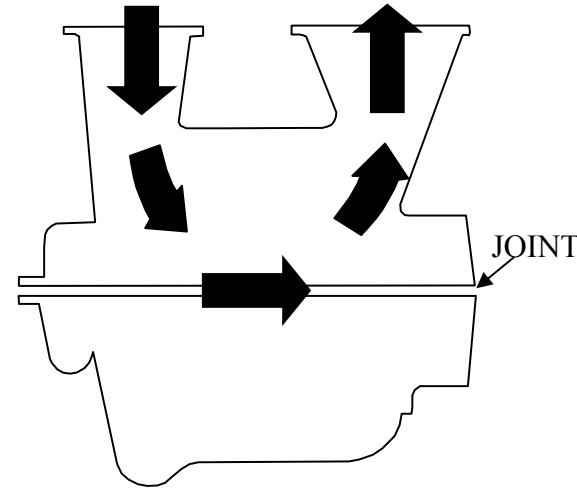


CENTRIFUGAL COMPRESSOR

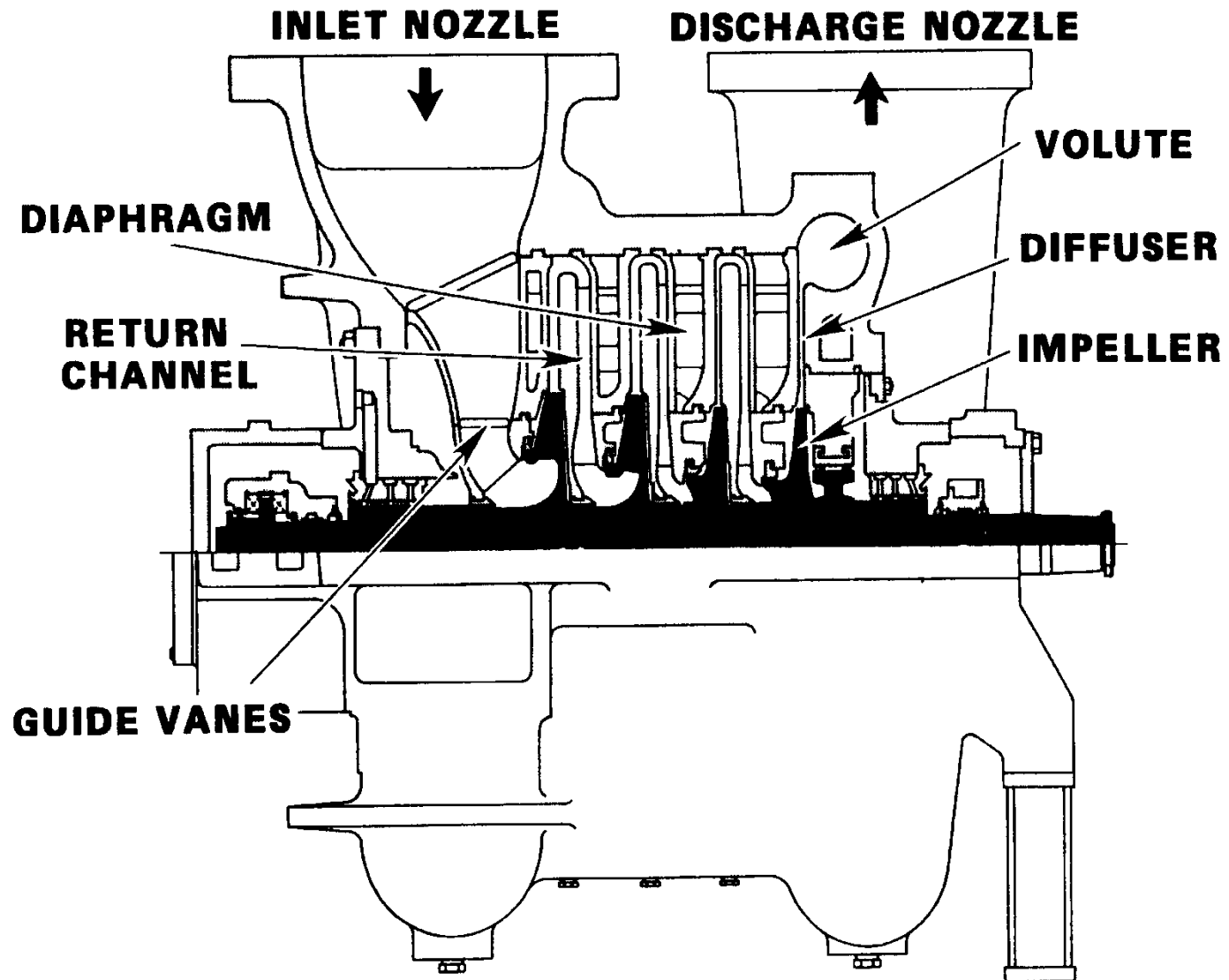


CENTRIFUGAL COMPRESSOR TYPES

- **Axial, or horizontally split**
- **Radial, or vertically split**



CENTRIFUGAL COMPRESSOR STAGE COMPONENTS



CENTRIFUGAL COMPRESSOR

VIDEO

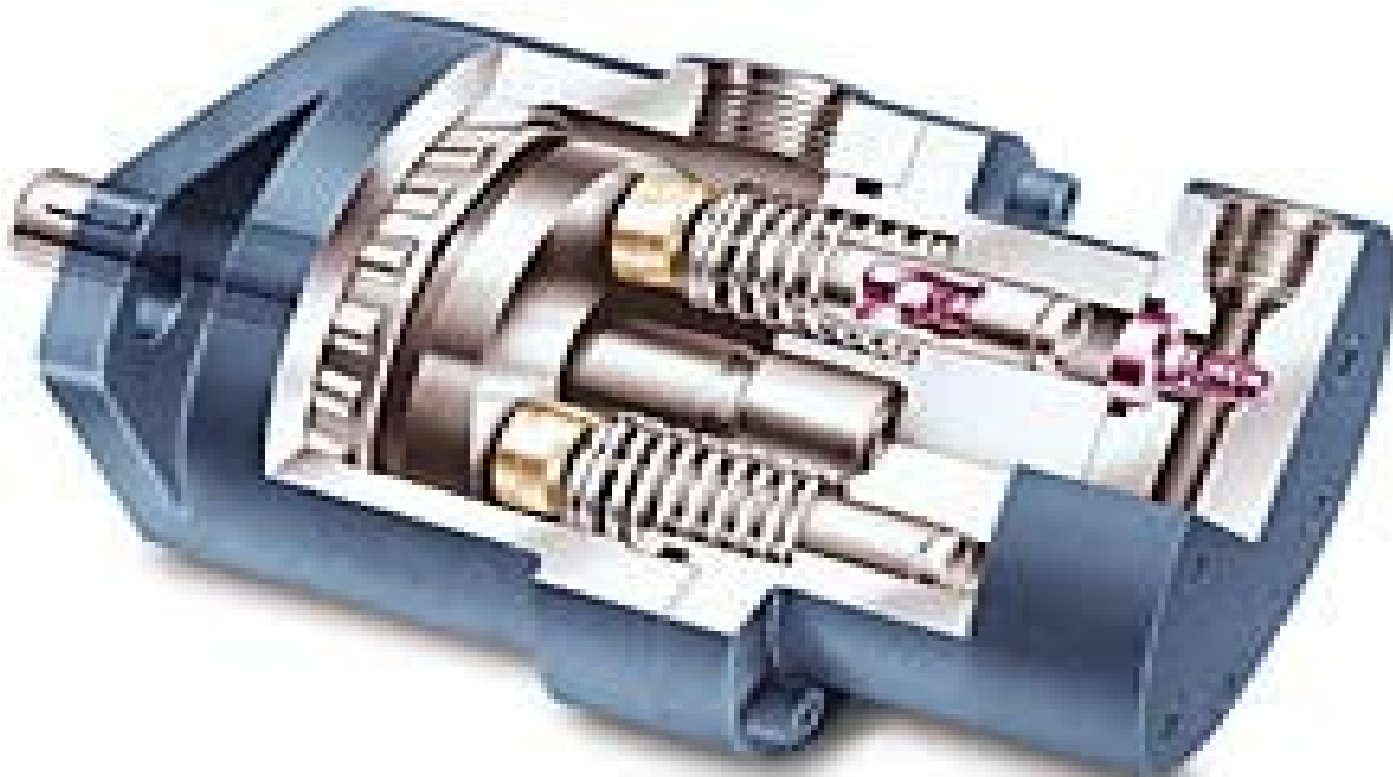
PUMPS

- Types
 - Positive Displacement - Overview
 - Screw Pumps
 - Gear Pumps
 - Piston Pumps
 - Plunger Pumps
 - Centrifugal - Overview

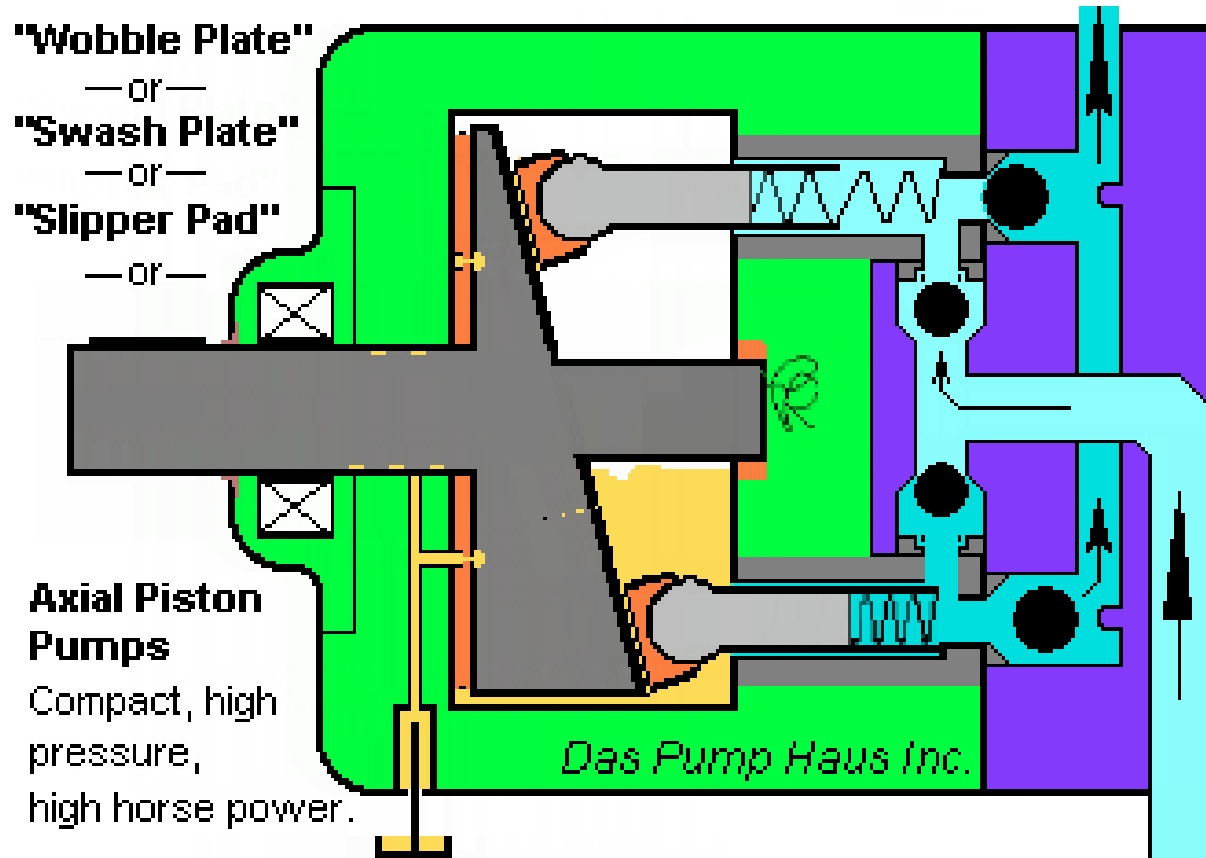
POSITIVE DISPLACEMENT PUMPS

- Screw Pumps
- Gear pumps
- Piston pumps

PISTON PUMPS



OPERATION AND APPLICATION



Piston Pump

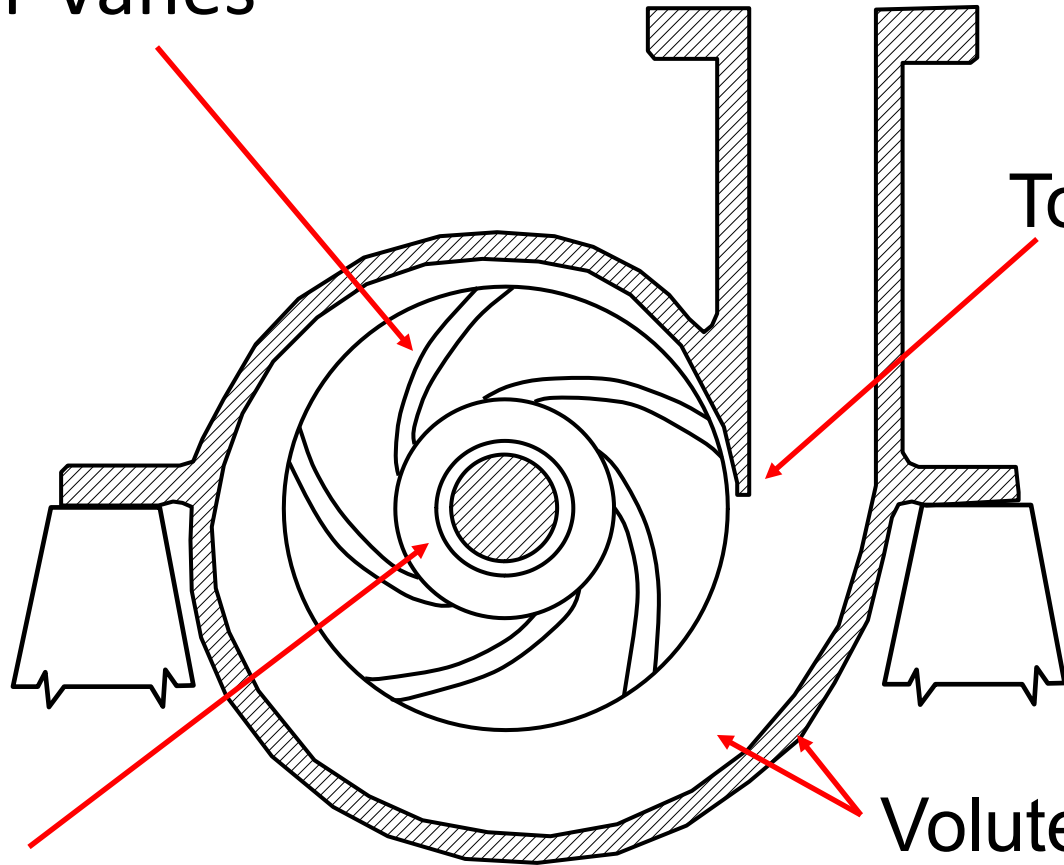
CENTRIFUGAL PUMPS

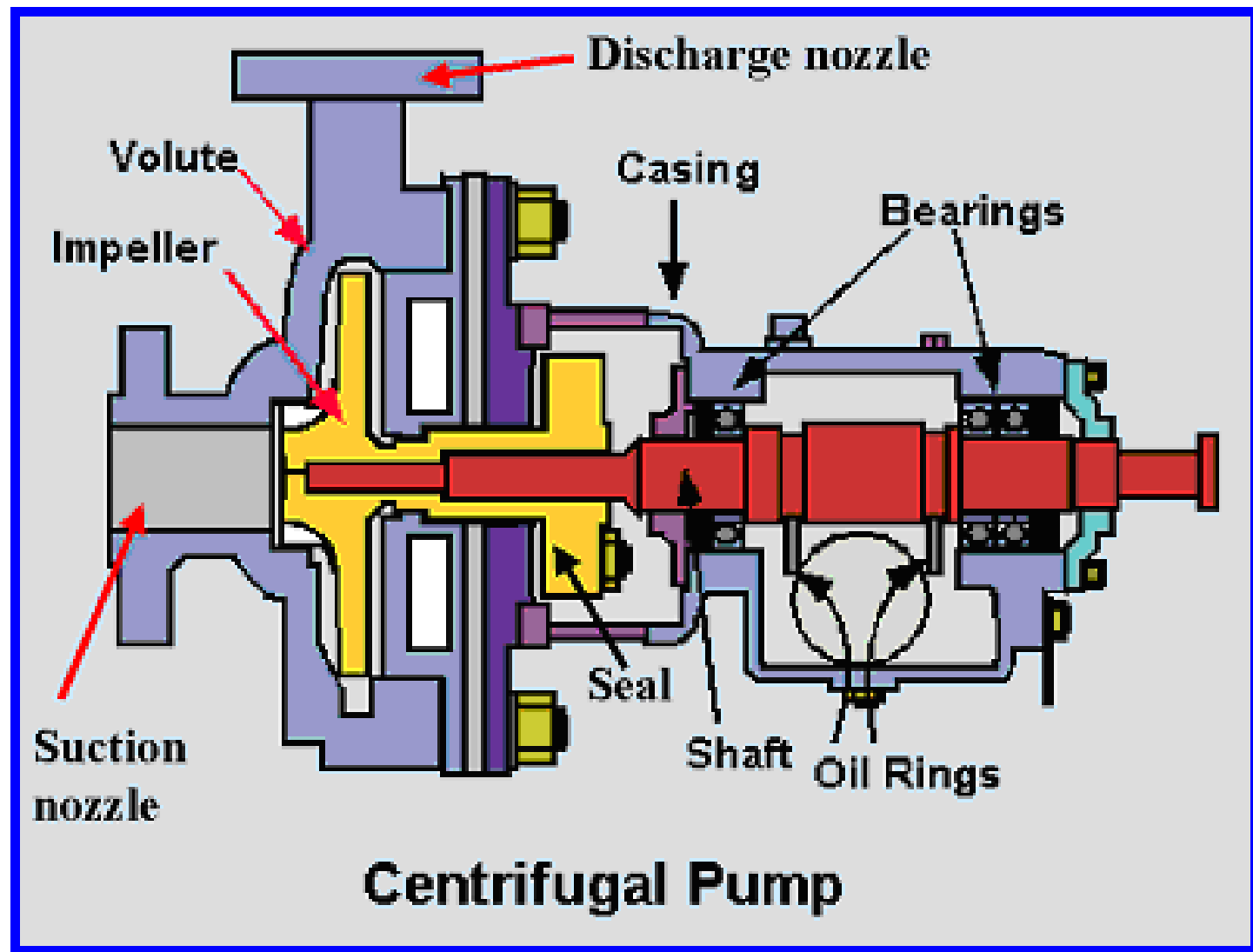
Impeller Vanes

Tongue

Eye

Volute





COMPONENTS

- Shaft Sleeve
- Coupling
 - Elastomeric couplings (having properties that resemble rubber)
 - Non-elastomeric
- Bearings

CENTRIFUGAL PUMP COMPONENTS

VIDEO

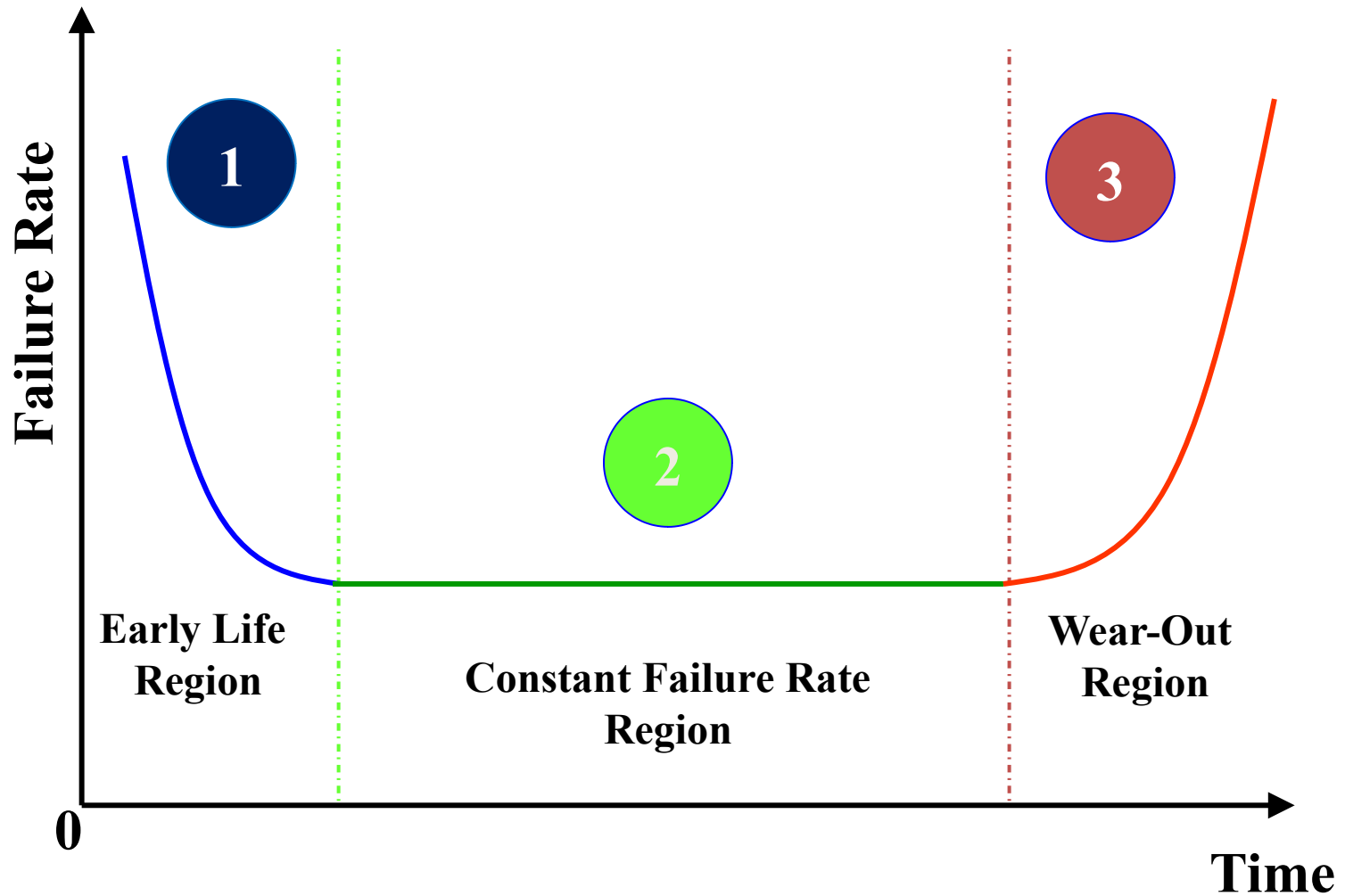
CENTRIFUGAL PUMP OPERATION

- Conversion of rotational driver energy into flow energy
- Work on the fluid is performed by impeller and Volute (higher flow, lower pressure) or Diffuser (lower flow, higher pressure)

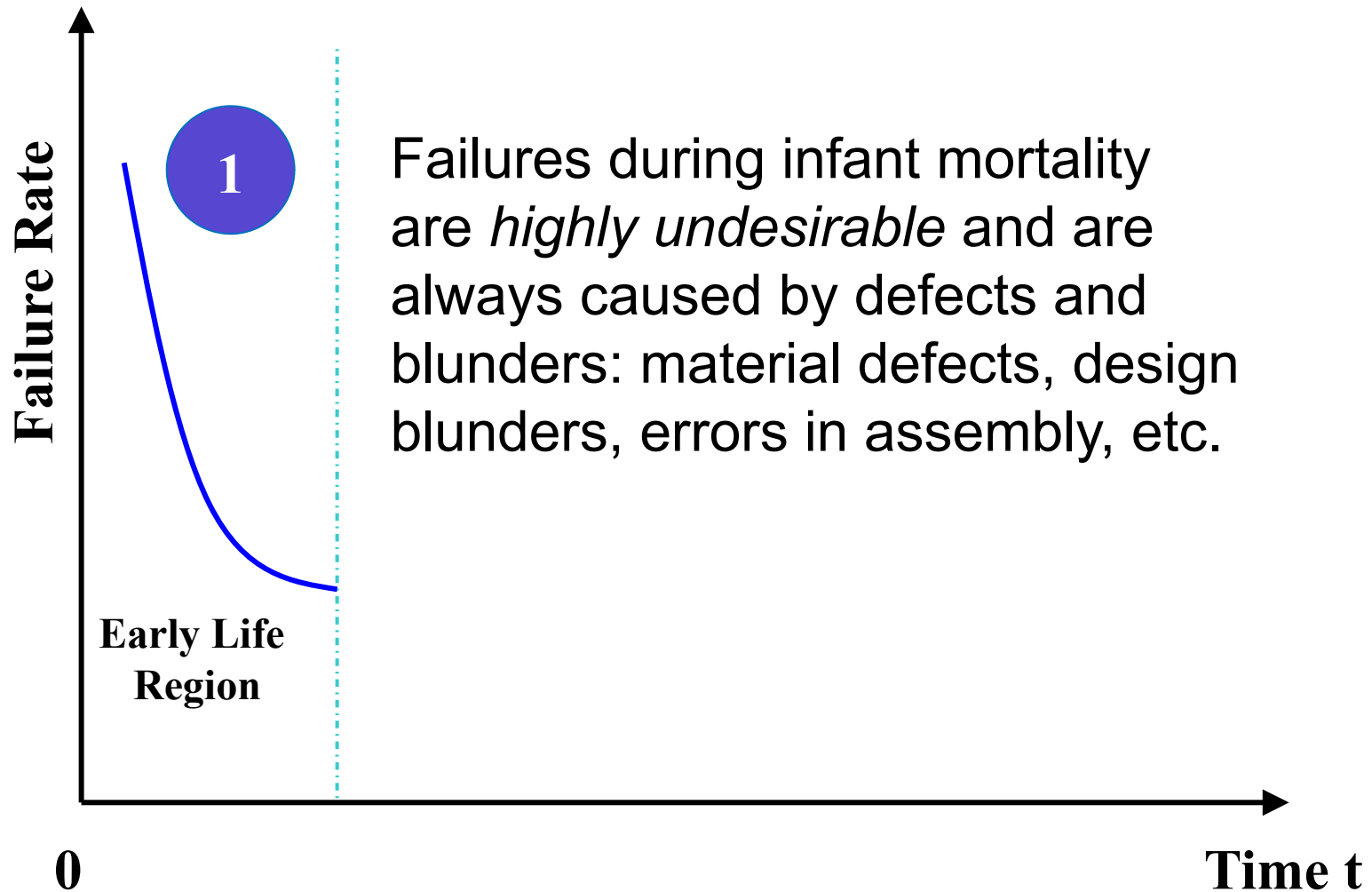
WHY MAINTENANCE

- To achieve product quality and customer satisfaction
- Maximize useful life / performance of equipment
- Keep equipment safe, avoid safety hazards and failures
- Minimize frequency and severity of interruptions / production loss
- Increase reliability of the operating systems

BATHTUB CURVE

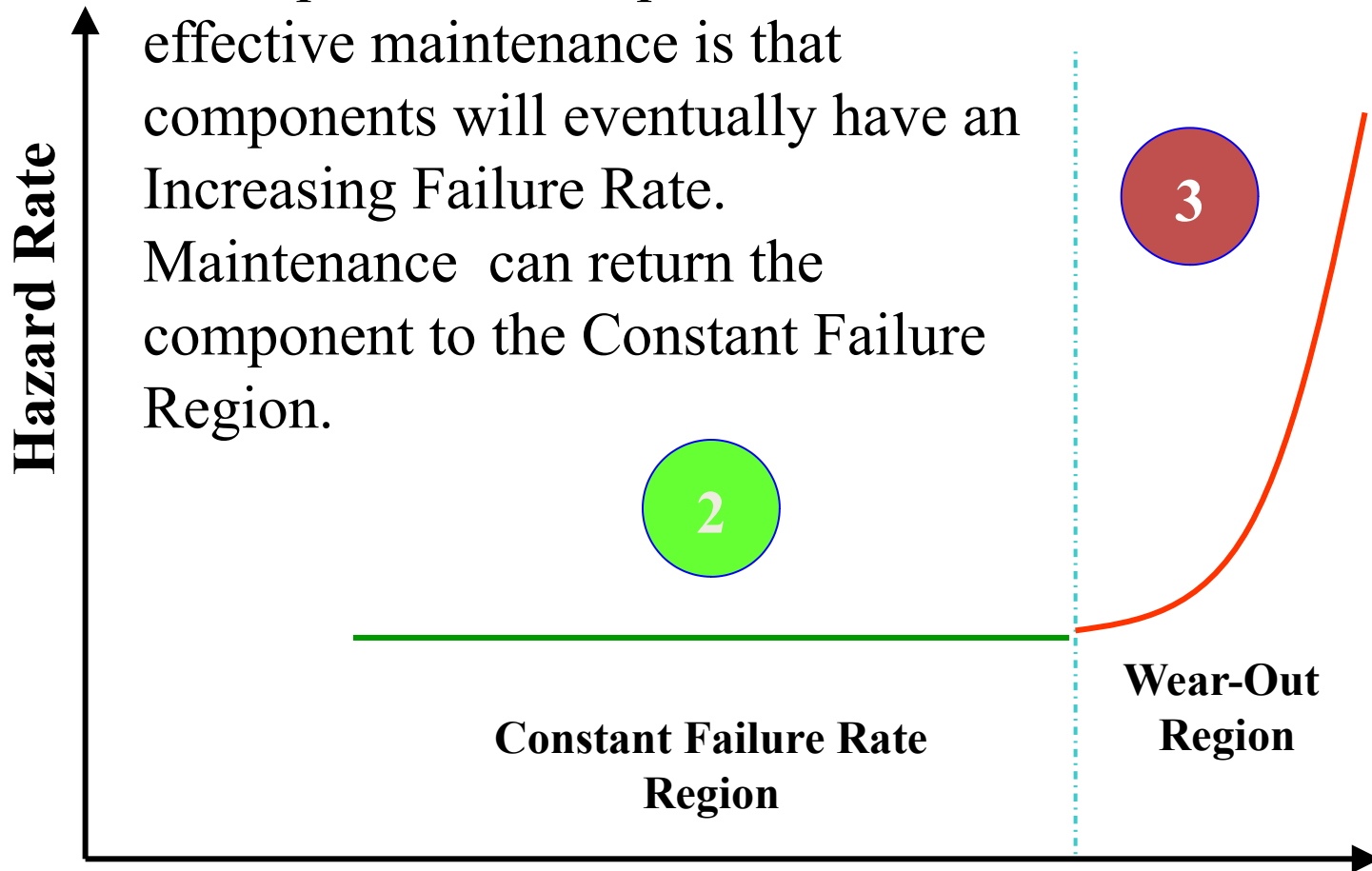


EARLY LIFE REGION

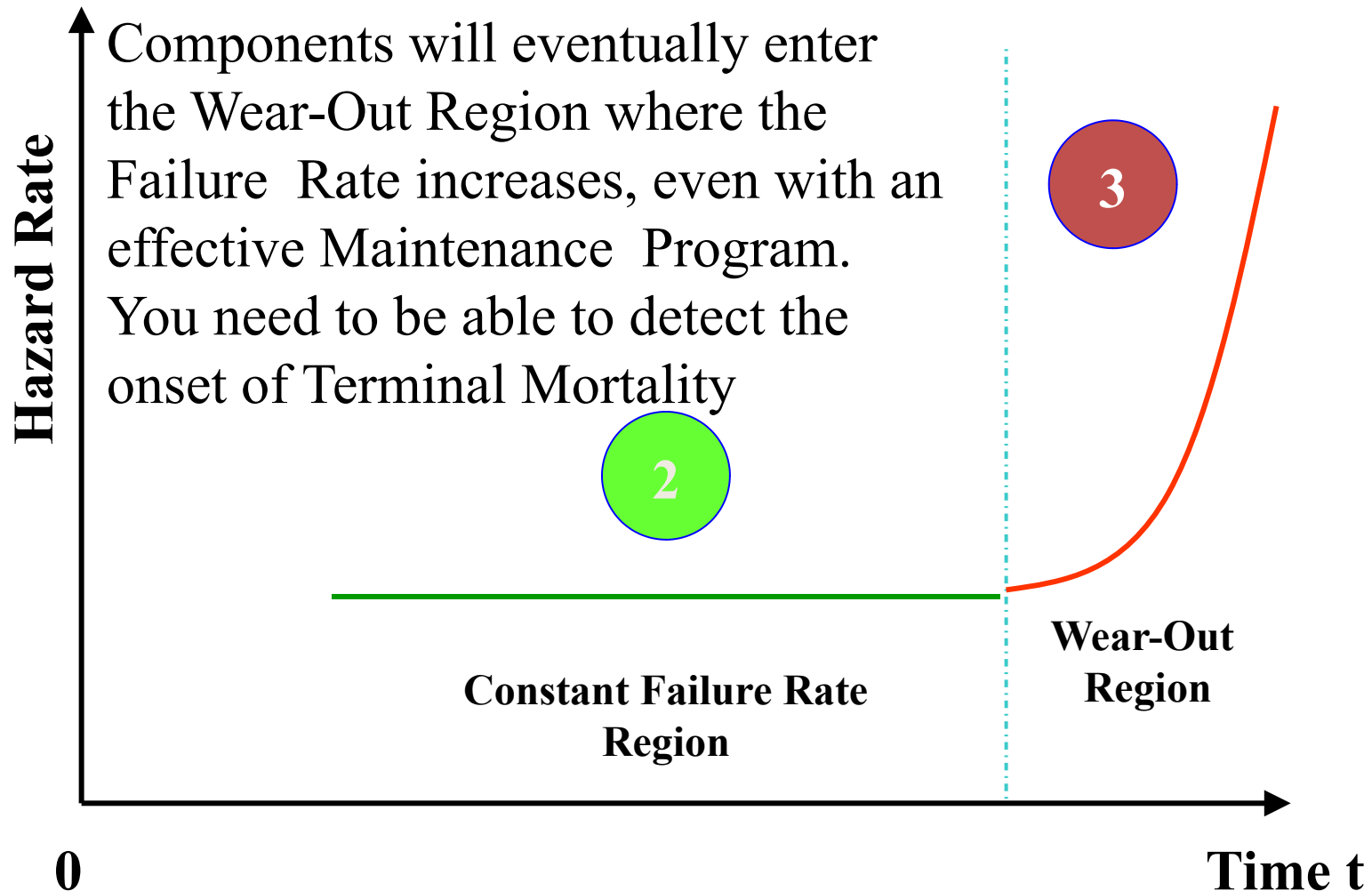


CONSTANT FAILURE REGION

An important assumption for effective maintenance is that components will eventually have an Increasing Failure Rate. Maintenance can return the component to the Constant Failure Region.



WEAR-OUT REGION



TYPES OF MAINTENANCE

Maintenance may be classified into three categories:

- Corrective or Breakdown Maintenance
- Preventive Maintenance
- Predictive (Condition-based) Maintenance

CORRECTIVE OR BREAKDOWN MAINTENANCE

- Corrective or Breakdown maintenance implies that repairs are made after the equipment is failed and can not perform its normal function anymore
- This maintenance is often most expensive because worn equipment can damage other parts and cause multiple damage.

DISADVANTAGES OF CORRECTIVE MAINTENANCE

- Breakdown generally occurs in inappropriate times leading to poor and hurried maintenance
- Excessive delay in production & reduces output
- Faster plant deterioration
- Increases chances of accidents and less safety for both workers and machines
- More spoilt materials
- Direct loss of profit

PREVENTIVE MAINTENANCE

- Principle – “Prevention is better than cure”
- Procedure - Stitch-in-time
- It locates weak spots of machinery and equipments
- It provides them periodic/scheduled inspections and minor repairs to reduce the danger of unanticipated breakdowns

ADVANTAGES OF PM

- Reduces break down and thereby down time
- Less odd-time repair and reduces over time of crews
- Greater safety of workers
- Lower maintenance and repair costs
- Less stand-by equipments and spare parts
- Better product quality and fewer reworks and scraps
- Increases plant life
- Increases chances to get

‘production incentive bonus’

PREDICTIVE (CONDITION-BASED) MAINTENANCE

- In predictive maintenance, machinery conditions are periodically monitored and this enables the maintenance crews to take timely actions, such as machine adjustment, repair or overhaul
- It makes use of human sense and other sensitive instruments, such as
 - vibration analyzer, pressure, temperature and resistance strain gauges etc.

PREDICTIVE MAINTENANCE (CONTD.)

- Unusual sounds coming out of a rotating equipment predicts a trouble
- An excessively hot electric cable predicts a trouble
- Simple hand touch can point out many unusual equipment conditions and thus predicts a trouble



MAINTENANCE OF CENTRIFUGAL PUMP

- Mechanical isolation
- Electrical Isolation
- Positive isolation
- Depressurize / drain
- Dismantle pump-motor coupling.
- Measure DBSE
- Remove pump bearings



MAINTENANCE OF CENTRIFUGAL PUMP *CONTD.*

- Leakage Check
- Repair or Replace
- Check and record



MAINTENANCE OF CENTRIFUGAL PUMP *CONTD.*

For bearing housing lubrication system. (Change oil after every six (6) month)

- Check constant level oiler for any leakage.
- Drain bearing housing oil and flush.
- Fill fresh oil in to the bearing housing.



MAINTENANCE OF CENTRIFUGAL PUMP *CONTD.*

- For Grease lubricated bearings: Replace bearing grease after every 6 month.
- Remove motor cover for inspection of motor thru Electrical Section (For M/L pump Motors).
- Clean / Change motor air filters (if any).
- Remove motor cooling fan inlet ducting and clean/service fan, duct& air tubes (For M/L pump Motors).



MAINTENANCE OF CENTRIFUGAL PUMP (BES) *CONTD.*

- Install the coupling hub & couple the pump
- Check / correct pump - motor alignment & record.
- Check pump casing stud bolts / foundation bolts.
- Carry out housekeeping /general cleaning.

For forced feed lubrication system:

- Remove lube oil tank cover & drain lube oil. After cleaning of tank, fill fresh oil. This activity will be carried out after every two (2) years.
- Clean / check / change lube oil filters.
- Clean / wash lube oil heat exchanger.
- Check / clean lube oil blower fan.
- Test run the forced feed lubrication system for any leakage.



INSPECTION OF CENTRIFUGAL PUMPS

After 1000 running hours or 3 months whichever earlier

- Bearing lubricant (for water contamination and sediments)
- Oil ring for performance
- Deflector for looseness
- Constant level oiler for leakage
- Mechanical seal for leakage
- Seal flushing/ quenching system (of mechanical seal) for clogging and chocking.



INSPECTION OF CENTRIFUGAL PUMPS

- Gland for leakage
- Cooling water flow in both the bearing housings
- Condition of bearing by sound and temperature (in running condition)
- Performance of all measuring instruments (pressure or temperature gauges and flow meters)



INSPECTION OF CENTRIFUGAL PUMPS

After 4000 running hours or 1 year whichever earlier

- Repeat all checks as per above slides.
- Flushing of bearing with lube oil and refilling of oil to required level,
- Flushing of cooling water lines and strainers(to ensure proper flow of cooling water).
- Foundation, foundation bolts and supports
- Replacement of old packing with new ones and condition of gland follower, lantern ring and sleeves (in case of gland packing)
- Condition of coupling, coupling bolts, nuts, spring washers and their conformity to uniform size.



INSPECTION OF CENTRIFUGAL PUMPS

After 8000 hours or 2 years whichever earlier

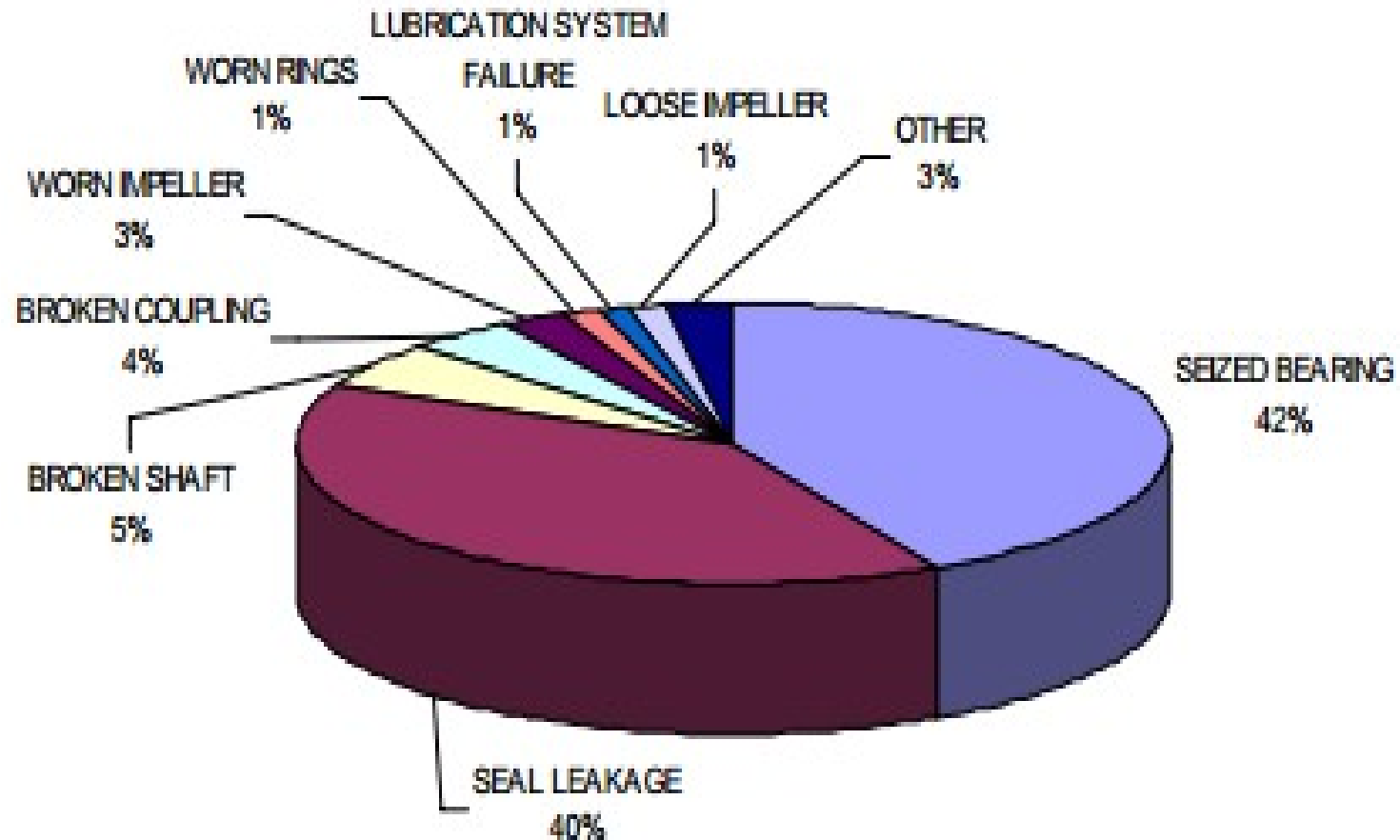
- Repeat all checks as per above slides.
- Condition of outboard bearing, lock nut and lock washer (in case lock washer found damaged and lock nut loose, shaft axial play shall be checked)
- Following items of Journal bearings :
 - a) High spot (High Spots shall be scrapped)
 - b) Condition of thrust bearing, lock nut and lock washer (in case lock washer found damaged and lock nut loose, shaft axial play shall be checked).
- Inspection of bearings (replace the bearings if necessary).
- Pump float (adjust if necessary)
- Oil filter for cleanliness if journal bearings are hydrodynamic



INSPECTION OF CENTRIFUGAL PUMPS

- Inspect condition of mechanical seals
- Alignment (Misalignment shall not be more than 0.05 mm)
- Painting of equipment

FAILURE MODES OF CENTRIFUGAL PUMP





MAINTENANCE OF MECHANICAL SEAL

- Ensure isolation
- Depressurize and drain.
- Decouple the pump
- Remove bearings
- Remove Mechanical Seal
- Dismantle and clean parts of Mechanical Seal.
- Replace all 'O' Rings



MAINTENANCE OF MECHANICAL SEAL

- Seal faces to be lapped or replaced
- Assemble the Mechanical seal
- Reinstall Mechanical seal
- Reinstall the bearings or replace if necessary.
- Pressurize the pump & check for any leakage.
- Check Alignment & record.
- Couple the pump
- Re-commission the Pump

Thank you