



# LHM Marthinusen

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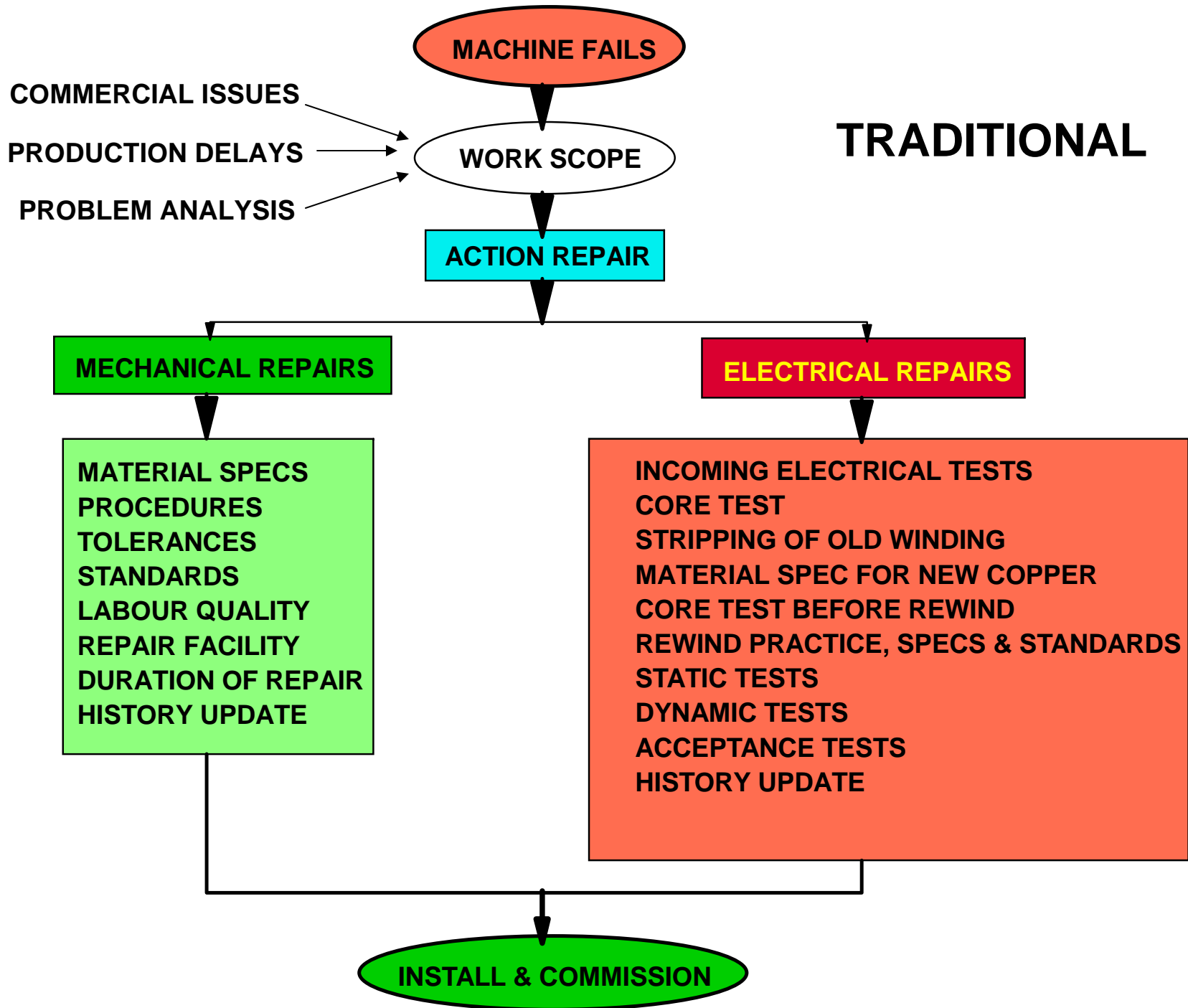


**One Vision**

**CUSTOMER SERVICE**

**LHM ROTATING MACHINES  
CONFERENCE 2004**

# **MACHINE REPAIRS**



## **NEW ISSUES**

**REPAIR OR REPLACE – WHEN, HOW?**

**WHAT STANDARDS SHALL APPLY?**

**WHAT EFFICIENCY IS ACCEPTABLE?**

**AT WHAT COST?**

**POWERFACTOR?**

**HARMONICS? (CONTAMINATION OF WEAK GRID)**

## **MAIN CAUSES OF FAILURE**

1. **MECHANICAL – MISALIGNMENT, ETC**
2. **ELECTRICAL – INSULATION FAILURE**

**PROBLEM – TOO MUCH HEAT IS GENERATED,**

**LEADING TO BEARING FAILURES, JOURNAL FAILURES,  
CORE FAILURES, CONDUCTOR FAILURES,  
INSULATION FAILURES.**

## **MECHANICAL FAILURE**

**100% OF THE TIME CAUSED BY EXCESSIVE HEAT**

**AS A RESULT OF FRICTION BETWEEN PARTS.**

## **ELECTRICAL FAILURE**

**100% OF THE TIME CAUSED BY EXCESSIVE HEAT**

**AS A RESULT OF OVERLOADING, PARASITIC CURRENT,**

**HARMONICS, EDDY CURRENT, INSUFFICIENT**

**DIELECTRIC STRENGTH OF INSULATION, SATURATION**

**OF MAGNETIC PATHS, HYSTERESIS LOSS,**

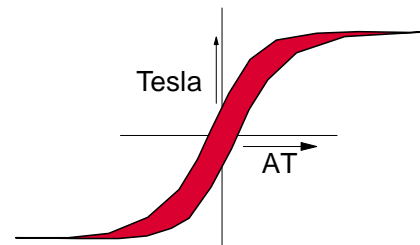
**EXCESSIVE CURRENT DENSITY IN CONDUCTORS.**

# LOSSES

## 1. CORE LOSS (15 – 25% of Total Losses)

a. Hysteresis – The energy necessary to change the direction of the magnetic field.

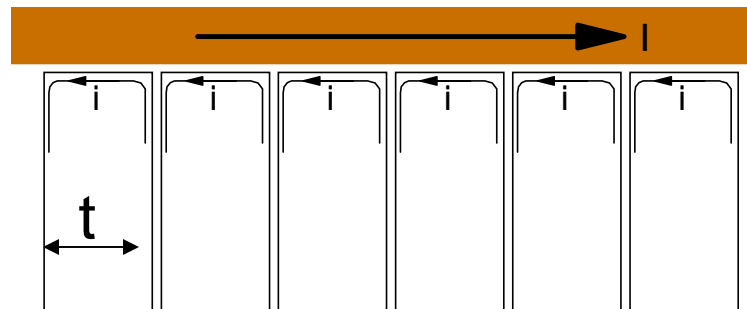
Cure – Use low carbon steel or silicon steel.



$$P_h \propto \eta \cdot \text{Vol.} \cdot F \cdot B^2 \text{max}$$

b. Eddy Currents – Stray currents found in ferromagnetic materials as magnetic fields are induced into them.

Cure – Use thin insulated laminations.



$$P_e \propto F^2 \times t^2 \times \text{Vol} \times B^2 / \rho$$

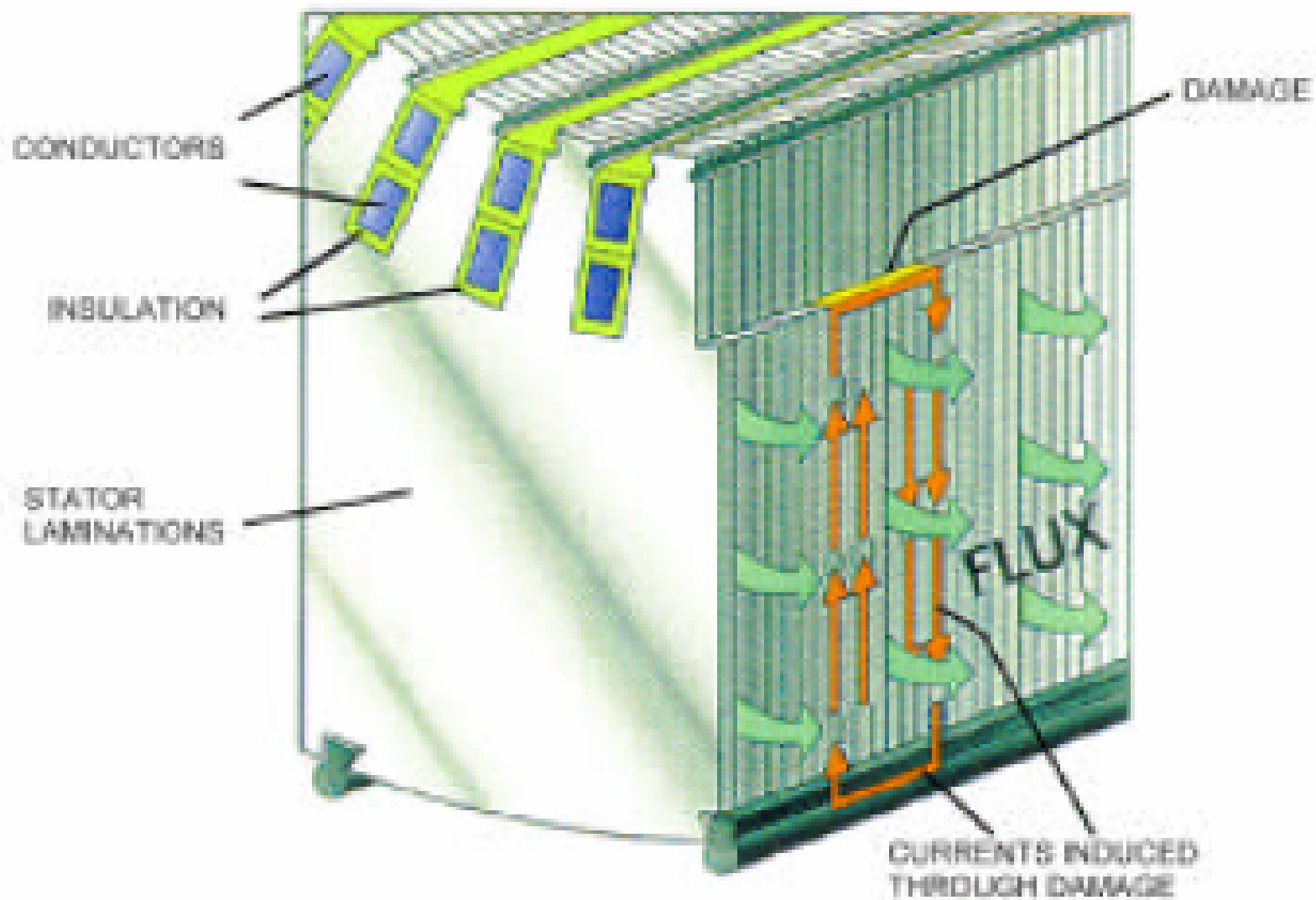


Fig 1 Eddy currents induced in a laminated core due to inter-lamination damage at the base of a slot

## **LOSSES (cont.)**

- 2. Windage & Friction (5 – 15% of Total Losses)**  
Due to air density, turbulence within the stator, bearings, fans and anything causing a friction force on the shaft like mis-alignment, seals etc.
- 3. Stator Losses (25 – 40% of Total Losses) –  $I^2R$**   
Due to current flow through the stator winding.  
**Reduce by increasing conductor size.**
- 4. Rotor Losses (15 – 25 % of Total Losses) –  $I^2R$**   
Due to current flow in the rotor conductors and end rings / - windings.
- 5. Stray Losses on No-Load and on Load (10 – 20%)**  
Due to leakage, harmonics, & other unaccountables.

## **EFFICIENT REPAIR PHILOSOPHIES.**

### **MECHANICAL REPAIRS.**

**USE BETTER MATERIALS WITH LOWER  
COEFFICIENT OF FRICTION AND THAT  
CAN WITHSTAND HIGHER OPERATING  
TEMPERATURE AT ELEVATED SPECIFIC LOADING.**

**NEW LUBRICANTS  
CERAMICS  
MAGNETIC BEARINGS  
IMPROVED ALIGNMENT METHODS  
ETC.**

## **EFFICIENT REPAIR PHILOSOPHIES.**

### **ELECTRICAL**

**IMPROVED METHODS OF STRIPPING WINDINGS,  
MECHANICAL STRIPPING OR HEAT CLEANING?**

**IMPROVE CORE MATERIAL BY USING MODERN  
SILICON STEEL AND THIN LAMINATIONS.**

**IMPROVE DESIGN BY UTILISING MODERN DESIGN  
PHILOSOPHIES AND NEW MATERIALS FOR INSULATION.**

**ENSURE THAT CONDUCTOR SHAPE AND CROS-SECTION  
WILL NOT MODIFY MACHINE CHARACTERISTICS  
ADVERSELY.**

**DO NOT INCREASE AIR GAP BY SKIMMING ROTOR OR  
LINE BORING STATOR UNNECESSARILY.**

**MODERN PROCESSES LIKE VPI CAN IMPROVE EFFICIENCY.**

# **HIGH EFFICIENCY ?**

- 1. DO YOU RUN AT OPTIMUM LOAD FOR THE MACHINE?  
IF NOT – USE A STANDARD MACHINE**
- 2. IS THE MACHINE SUPPLY VOLTAGE AT ITS DESIGN VALUE?  
IF NOT – YOU LOOSE OUT**
- 3. DO YOU HAVE A CLEAN SUPPLY ON THE MOTOR TERMINALS?  
IF THE HARMONIC CONTENT IS HIGH – YOU LOOSE.**
- 4. DID YOU CHECK IF THE MACHINE STILL COMPLIES AFTER  
IT WAS REPAIRED.**