

# Failure Analysis

## Methodology

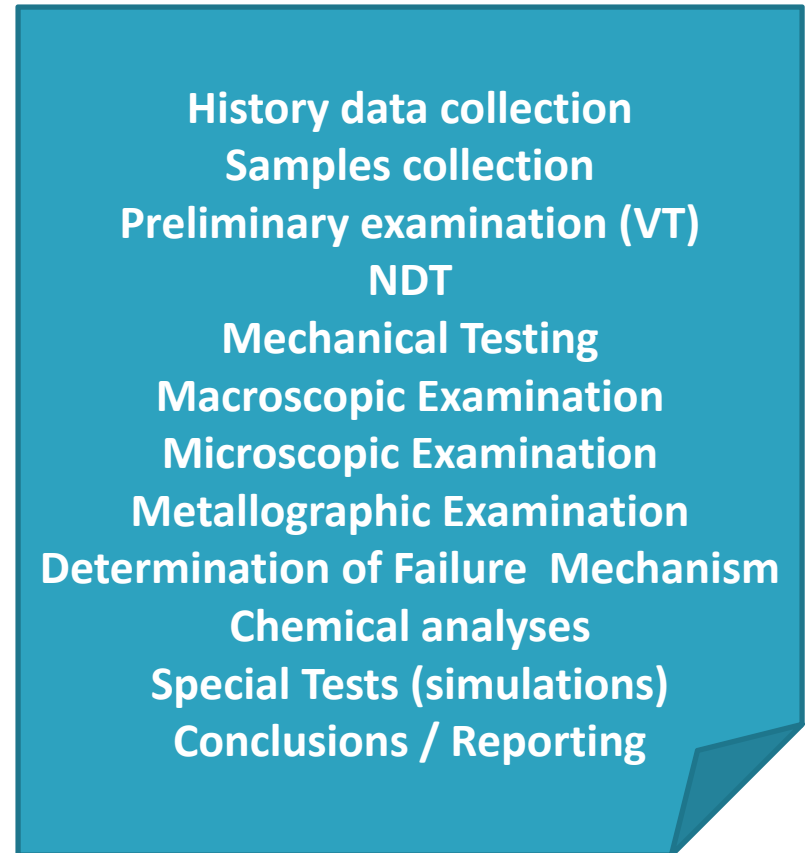
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# Objective

“The basic objective is to find out the preliminary cause of failure and after taking a corrective action, suitable measures are to be taken in order to avoid recurrence in future”

# Stages



# Historic Data Collection

## To Do Items:

All the files and records related to the failed part be made available on your working table

Soft copies of scanned reports, email notifications, correspondence with vendors / manufacturer

Photographs of all the previous inspections shall be looked into

## Goals:

Collection of all of the following:

Specification sheet of the component  
Manufacturing design data

In-service inspection records

Failures occur in the past

Latest modification made, if any

Last failure mode, if available

Reports of past failure analysis, if any

Photographic records

# Sample Collection

## To Do Items:

Reach the site at your earliest  
Look for the failed parts and pieces  
Survey of the whole area along with other skilled inspectors  
Discussions with the operating staff  
Listen carefully to the eye-witnesses, if any

## Goals:

Failed part and pieces to be collected  
Photographs shall be taken immediately  
Look for other evidences  
Operating conditions at that specific time  
Interview the eye-witnesses  
Listen to everybody present at the site  
Take notes

# Preliminary Examination

## To Do Items:

Thorough visual examination without any cleaning  
Photography of the fractured part and surfaces  
Group discussions with inspectors

## Goals:

General assessment of basic design and workmanship be made  
Apparent surface defects which can be seen with naked eye must be logged  
The original shape just after fracture be saved for reference  
Save the photographs of the fractured parts and surfaces  
Make a report of preliminary examination

# Non-destructive Testing

## To Do Items:

Applicable NDT to be made:

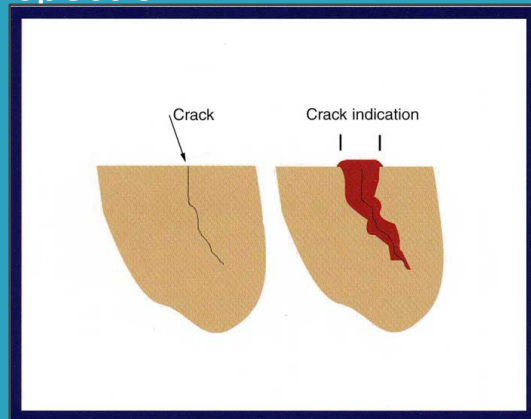
Dye Penetrant Testing

Magnetic Particle Testing

Ultrasonic Testing

Radiography

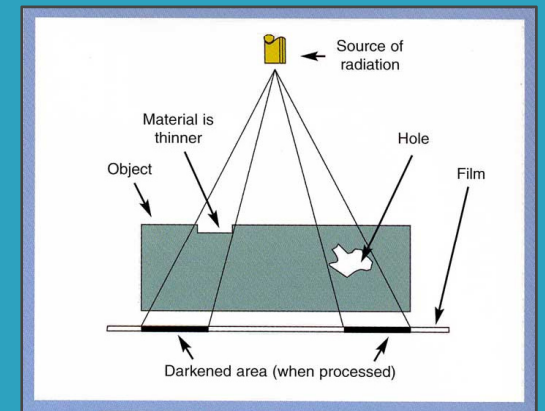
Eddy-Current Inspection



## Goals:

Cracks, flaws, discontinuities, metal thickness loss and other surface or below surface defects must be picked up using applicable NDT techniques

Formation of all applied NDT reports including all the observations / abnormalities



# Mechanical Testing

## To Do Items:

Mechanical attributes of the failed part to be considered

Why that material was selected?

Principal mechanical properties of the failed part

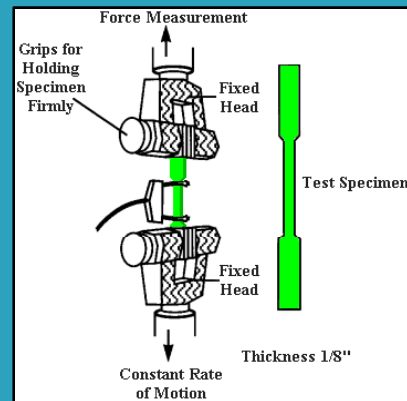
Selection of Mechanical Testing to be made:

Hardness

Tensile

Impact

Fatigue



## Goals:

Evaluate if desired mechanical attributes present in the failed part

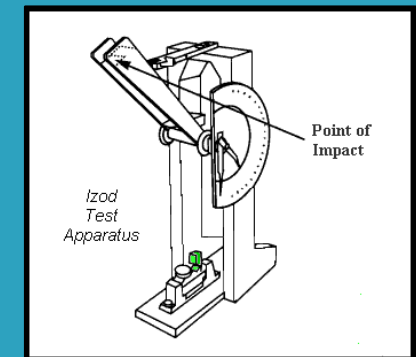
If not then evaluate what was wrong

among the following?

Material selection

Process conditions

Operating practices etc.



# Macroscopic Examination

## To Do Items:

Surface examinations at magnifications ranges 1 to 100x  
Examination with unaided eye or hard lens  
Low-power optical microscope may be used

## Goals:

Determine the direction of crack growth  
Presence of Chevron marks  
Determine the origin of fracture

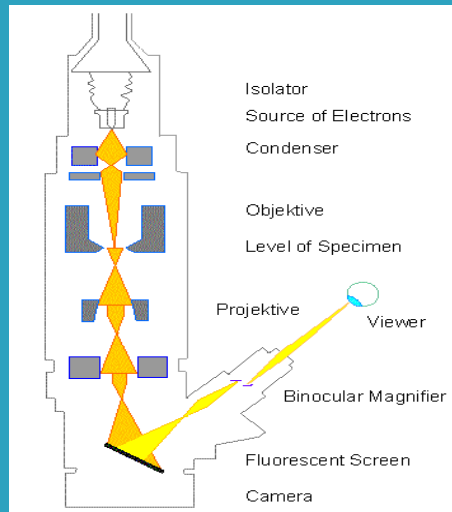


Origin of the fracture on the left

# Microscopic Examination

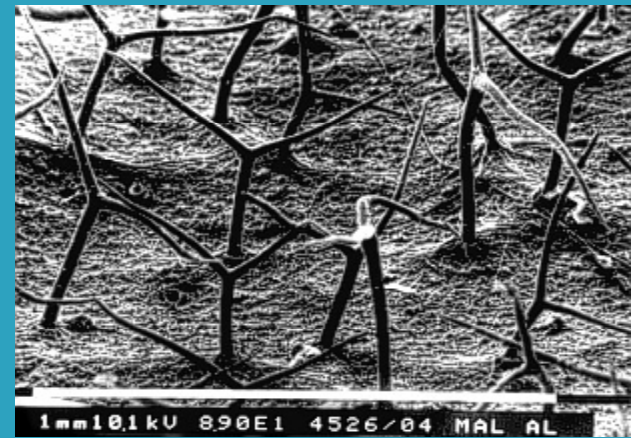
## To Do Items:

Transmission electron microscopes to be used for magnification up to 1500x  
Scanning electron microscope for magnification in the range of 10 000x to 60 000x



## Goals:

Determination of dimpled fracture, cleavage facets, brittle intergranular fracture, hydrogen embrittlement, fatigue failure etc.



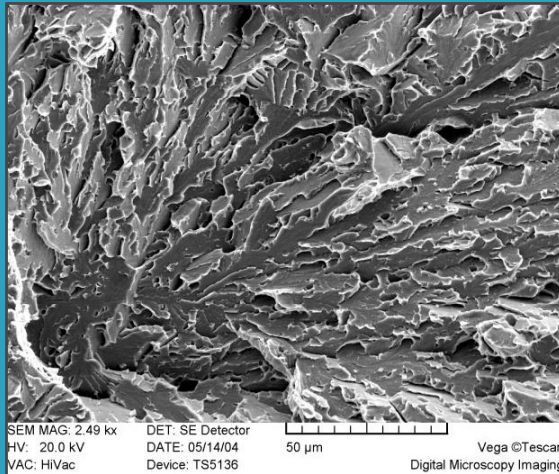
Result of Scanning electron  
Microscope (SEM)

# Metallographic Examination

## To Do Items:

Selection of the metallographic sections  
Preparation of the metallographic sections

Polishing and etching



## Goals:

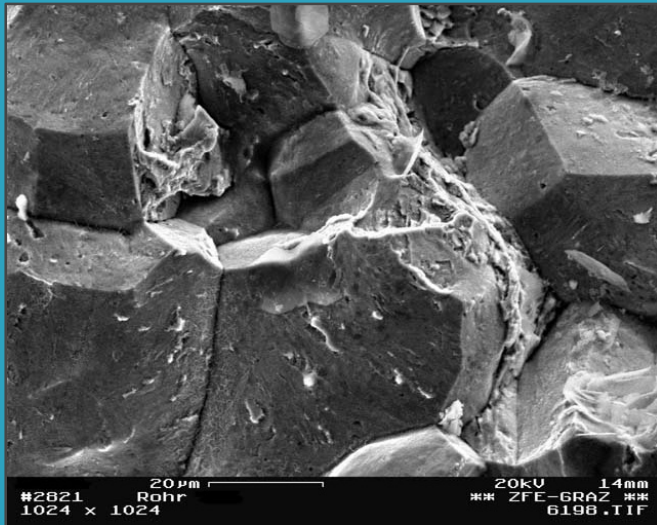
Determine whether the material has the required structure  
Look for the following:

Inclusions  
Microstructural segregation  
Decarburization  
Carbon pick up  
Improper heat treatment  
Intergranular corrosion

# Determination of Fracture Type

## To Do Items:

Collection of all previous information  
Translating all the information to detect fracture type



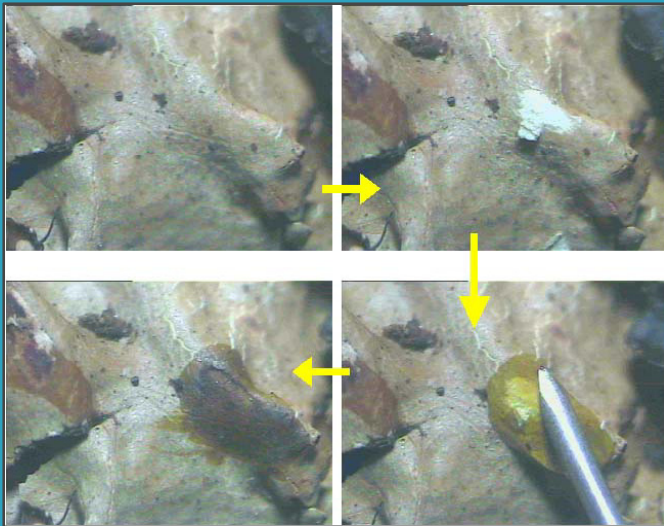
## Goals:

Determine among the following:  
Ductile Fracture  
Transgranular Brittle Fracture  
Intergranular Brittle Fracture  
Fatigue Fracture  
Stress Corrosion Cracking  
Liquid Metal Embrittlement  
Hydrogen Embrittlement  
Creep & Stress Rupture failure

# Chemical Analysis

## To Do Items:

Analysis of bulk surface  
Analysis of deposits  
Spot tests



## Goals:

Determine:  
Presence of required alloying  
Exact match with required material  
Extent of any deviation



# Simulated Service Testing

## To Do Items:

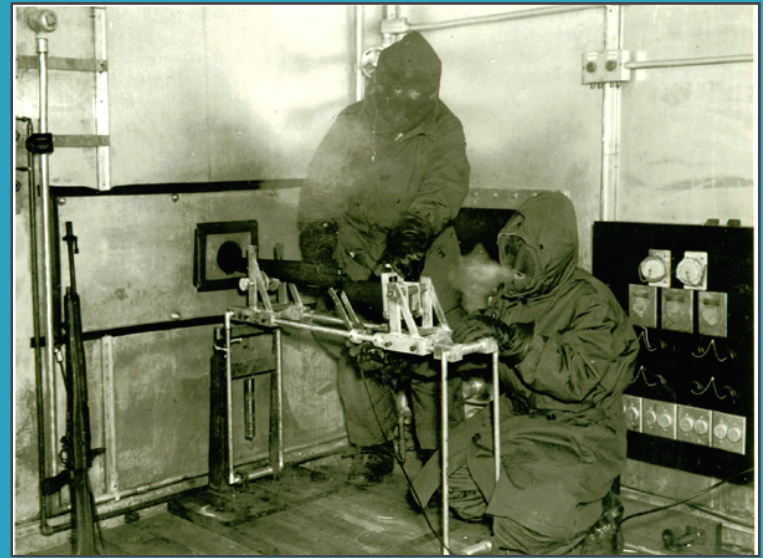
Simulation may be made if possible  
Conditions at the time of failure to be replicated

Seek laboratory assistance  
Make a video, if possible



## Goals:

Recurrence of failure to be seen  
Conclude your investigation with the aid of simulation



# Conclusions / Reporting

## To Do Items:

- Write down the methodology adopted
- Work performed and results found
- Assemble all the pictures and videos
- Make a complete presentation involving laboratory reports

## Goals:

- State reasons of failure
- Provide recommendations to avoid recurrence





For more details & information, please contact us.



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