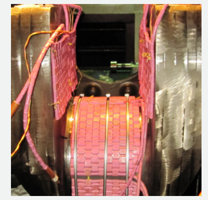
AN INDEPENDENT APPROACH MATTERS

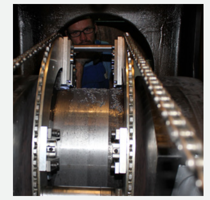
# REPLACE OR REPAIR?

## A COMPARISON OF ACTIVITIES, ROUGH COSTS AND DOWNTIME


Checking deflection at -3mm (high hardness areas visible on center and right side of crankpin journal)


Annealing equipment mounted on damaged crankpin


Installation of ceramic tile heating blankets for annealing


Post annealing machining of the crankpin journal

### INSPECTION AND SURVEY PHASE:

The inspection results are the same but the approach pursued dictates whether the owner/insurer are going to undertake a cost and time efficient repair or be subjected to a costly and time consuming crankshaft replacement

### REPAIR ACTIVITIES:

- Crankshaft machining and annealing equipment shipped to site
- In-situ machinist machines cracks from surface of crankpin
- Disassembly of adjacent main bearings and pistons
- Crankshaft is annealed to reduce hardness
- Crankshaft is finish machined and polished to final diameter
- Bearings reinstalled and affected cylinders reassembled
- Engine optested and restored to operation

CRANKSHAFT CAN BE
**REPAIRED**
Annealing and Straightening Approved by Class

Cost: <200K USD

Result for customer:
**CLASS-APPROVED REPAIR AND OPERATIONAL ENGINE**

DOWNTIME:
2-3 Weeks

**DECISION POINT:**
Pursue Annealing or Replace crankshaft?

CRANKSHAFT MUST BE
**REPLACED**
If annealing and straightening are not approved by Maker / Class

Crankshaft Purchase and Replacement Cost:
**1,500K USD**
approximately

Result for customer:
**CLASS-APPROVED REPAIR AND OPERATIONAL ENGINE**

DOWNTIME:
Multiple months

### INSPECTION RESULTS:

- Crankshaft has surface cracks that do not penetrate below max standard undersize (ex: -5mm).
- Crankshaft has hardness above maker limits and expected to penetrate below maximum journal undersize.
- Run-out checks show bend in crankshaft beyond maker limits.

### REPLACEMENT ACTIVITIES:

- Crankshaft purchase/delivery (delivery of new crankshaft often takes multiple months)
- Full disassembly of engine to remove condemned shaft (full diesel team of 5-7 men for around two weeks)
- Rigging of condemned shaft from engine room which often requires cutting holes in hull (welders and riggers)
- Transport of new crankshaft to engine location
- Rigging of replacement crankshaft into engine room (welders and riggers)
- Installation of crankshaft and rebuilding of engine (full diesel team of 5-7 men for about three weeks)
- Laser alignment and checking of engine (in most cases)
- Full range of operational testing and run-in procedures

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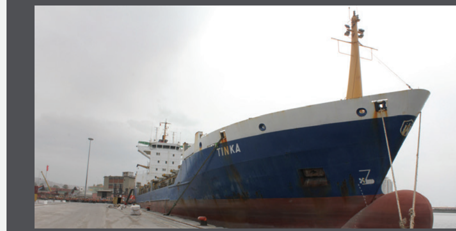
## ANNEALING SAVES CONDEMNED CRANKSHAFT



**Ship/Engine:** Containership with MAN 6L48/60
**Journal Diameter Pre-Machining:** 415mm
**Final Journal Diameter:** 410mm
**Max Hardness Pre-Annealing:** ~700 HB
**Max Hardness Post- Annealing:** <300HB

**THE REPAIR:** Goltens was called upon to inspect and perform magnaflux and hardness tests. The run out on the shaft was 0.11mm versus a maximum of 0.09mm as allowed by MAN. Hardness values were also well beyond the maker's limits. Cracks did not penetrate below the 5mm undersize – the smallest diameter for which standard undersized bearings were available. Goltens informed the owner that the crankshaft could be saved at -5mm – despite the surface cracking, slight bend and excessive hardness resulting from the casualty – via annealing and peening of the shaft. Subsequent inspection by the engine maker confirmed the previous findings. However, since MAN does not approve of annealing and peening to reduce hardness and straighten its crankshafts, the shaft was condemned by the maker.

**THE DECISION:** Goltens machined the crankshaft to -4mm to evaluate the condition of the shaft. It was determined that the hard spots did not lessen – in fact, they became worse. All of the surface cracks were removed, with the exception of a few that could be locally ground and not exceed the -5mm target. Goltens was now confident that they could salvage the crankshaft at -5mm. Due to the excessive hardness on the journal and the requirement to peen the shaft to straighten it, Goltens worked closely with Germanischer Lloyd (GL) to gain approval for a slight process modification to proceed with the annealing and peening of the shaft to restore it to the required tolerances.

**THE RESULT:**
Final inspections were verified by both owner and class and upon installation and additional work. The engine could be restored to operation. A costly crankshaft replacement had been avoided.

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