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Louisville District



# **Louisville District U.S. Army Corps of Engineers**

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# LEASONS LEARNED FOR AXIAL/MIXED FLOW PROPELLER PUMPS



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# Construction , Design Issues and Problems



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# *Design Criteria*



■ *Some lessons learned:*

*Get involved with construction  
activities*



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# *Design Criteria*



- ***Get involved with construction activity from shop drawing review to final field inspection***



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# *Design Criteria*



- ***Get involved with construction activity from shop drawing review to final field inspection***
- ***Develop good working relationship with Construction Office***



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# *Design Criteria*



- ***Get involved with construction activity from shop drawing review to final field inspection***
- ***Develop good working relationship with Construction Office***
- ***Demonstrate to them how important your input is***



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# *Design Criteria*



- ***Include your involvement in the Engineering Construction Instructions (ECIs)***



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# *Design Criteria*



- ***Include your involvement in the ECIs***
- ***Make your presence known in shop/field***



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# *Design Criteria*



- ***Include your involvement in the ECIs***
- ***Make your presence known in shop/field***
- ***Ask questions***



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# *Need Effective CQC Program*



- ***Enforce Contractor Quality Control program***



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# ***Need Effective CQC Program***



- ***Enforce Contractor Quality Control program***
- ***Get to know Quality Control person for pump manufacturer***



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# ***Need Effective CQC Program***



- ***Enforce Contractor Quality Control program***
- ***Get to know Quality Control person for pump manufacturer***
- ***Review Contractor Quality Control plan***



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# *Need Effective CQC Program*



- ***Enforce Contractor Quality Control program***
- ***Get to know Quality Control person for pump manufacturer***
- ***Review Contractor Quality Control plan***
- ***Ensure Contractor Quality Control plan includes pump manufacturer activities***



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# *Need Effective CQC Program*



- ***Require preparatory inspection for pump manufacture***



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# ***Need Effective CQC Program***



- ***Require preparatory inspection for pump manufacture***
- ***Attend Preparatory and Initial Inspections***



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# ***Need Effective CQC Program***



- ***Require preparatory inspection for pump manufacture***
- ***Attend Preparatory and Initial Inspection***
- ***Review Follow-up inspection reports***



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# *Contract Requirements*



- ***Read and understand contract specifications (technical and nontechnical).***



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# *Bottom of Impeller Hub Pump #2*

*(Note: Weights Welded in Hub)*





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# *Contract Requirements*



- ***Read and understand contract specifications (technical and nontechnical).***
- ***Read and understand referenced industry standards***



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# *Contract Requirements*



- ***Read and understand contract specifications (technical and nontechnical).***
- ***Read and understand referenced industry standards***
- ***Obtain copy of referenced industry standards***



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# **Contract Requirements**



- ***Read and understand contract specifications (technical and nontechnical).***
- ***Read and understand referenced industry standards***
- ***Obtain copy of referenced industry standards***
- ***Ask to see contractors copy of industry standards***



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# *Shop Drawings*



- ***Be familiar with the shop drawings.***



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# *Shop Drawings*



- ***Be familiar with the shop drawings.***
- ***Ensure contractor has approved shop drawings on-site***



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# *Shop Drawings*



- ***Be familiar with the shop drawings.***
- ***Ensure contractor has approved shop drawings on-site***
- ***Check that shop and manufacturing drawings agree***



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# *Shop Drawings*



- ***Be familiar with the shop drawings.***
- ***Ensure contractor has approved shop drawings on-site***
- ***Check that shop and manufacturing drawings agree***
- ***Check manufacture in accordance with shop/manufacturing drawings***



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# *Review/Witness* *Assembly Procedures*



## ■ *Witness Factory Assembly*



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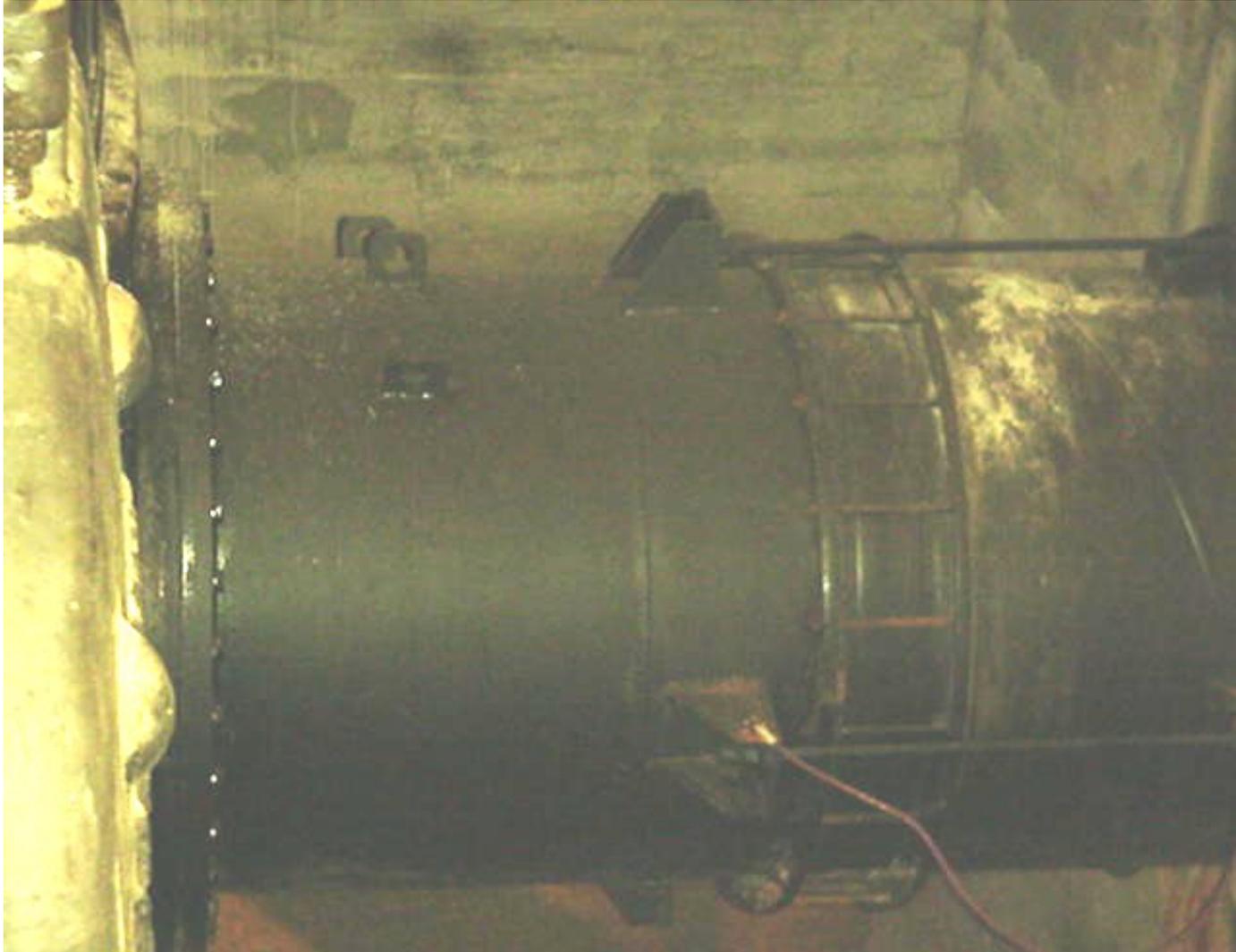
# *Review/Witness* *Assembly Procedures*



- ***Witness field assembly***



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# *Factory/Field Tests*

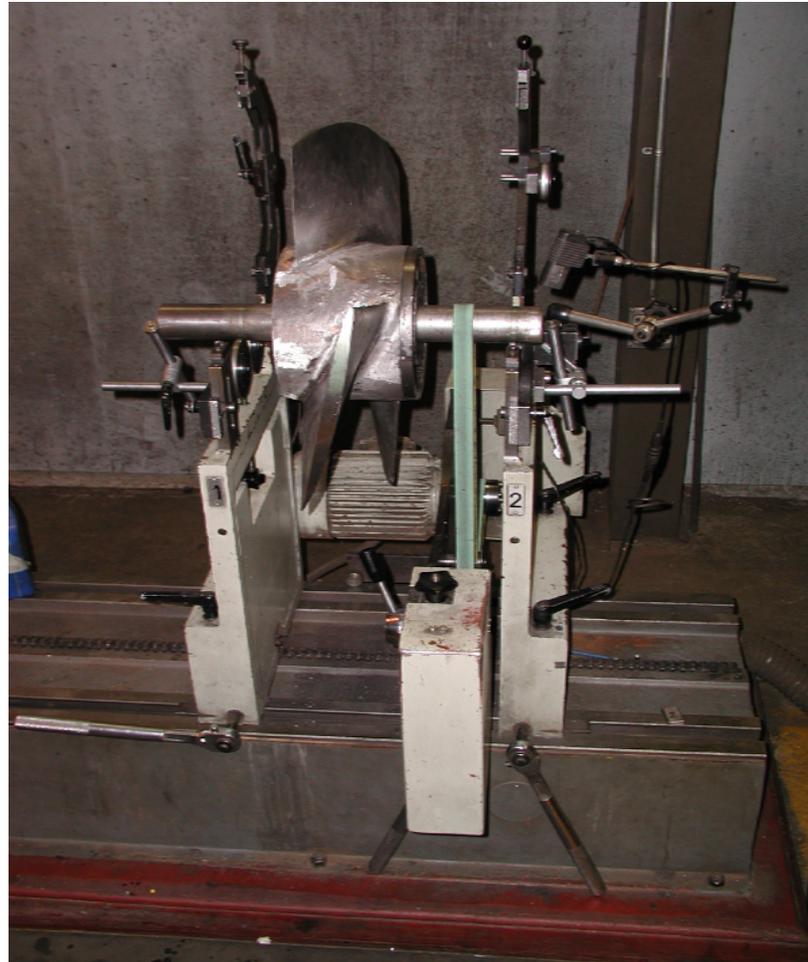


- ***Check calibration of testing equipment.***



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# *Impeller #2 on Balance Machine*





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# *Factory/Field Tests*



- ***Check calibration of testing equipment.***
- ***Review testing procedures***



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# *Factory/Field Tests*



- ***Check calibration of testing equipment.***
- ***Review testing procedures***
- ***Attend factory test***



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# *Factory/Field Tests*



- ***Check calibration of testing equipment.***
- ***Review testing procedures***
- ***Attend factory test***
- ***Attend field tests***



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**HELP!!!!**



- ***Ask for help from other Corps offices or Headquarters in Washington DC***



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**HELP!!!!**



- ***Ask for help from other Corps offices or Headquarters in Washington DC***
- ***Why is this important?***



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**HELP!!!!**



- ***Pumps are complex, built to close tolerances, requiring highly skilled craftsmen***



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# **HELP!!!!**



- ***Pumps are complex, built to close tolerances, requiring highly skilled craftsmen***
- ***Pumps are a combination of castings (impeller), forgings (shaft), and weldments (column)***



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**HELP!!!!**



- ***Each pump is built independently,  
specifically for your project***



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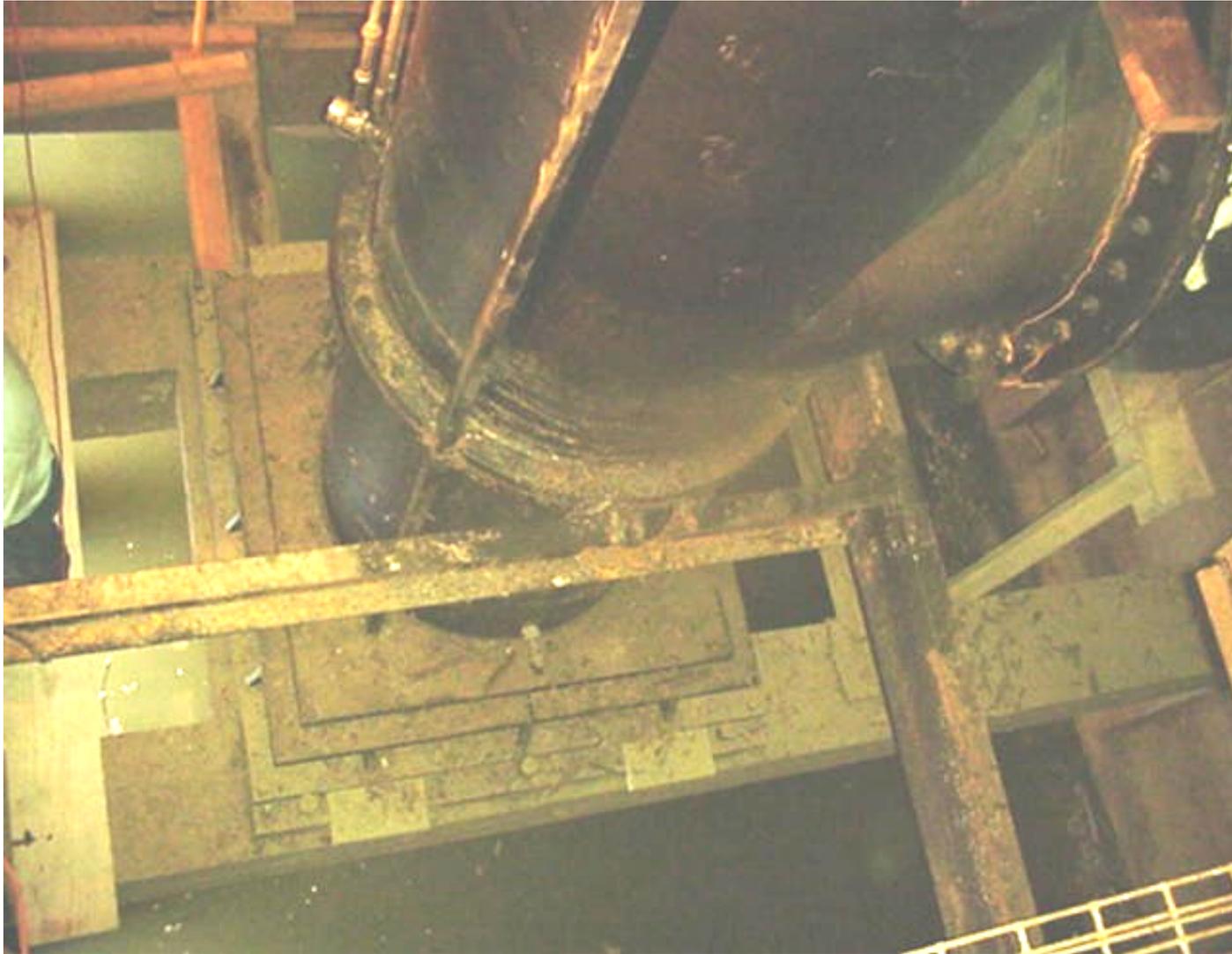


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**HELP!!!!**



- ***Each pump is built independently, specifically for your project***
- ***Quality of construction will determine success or failure of pump***



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# *Quality of Construction*



■ ***Quality of construction depends on:***



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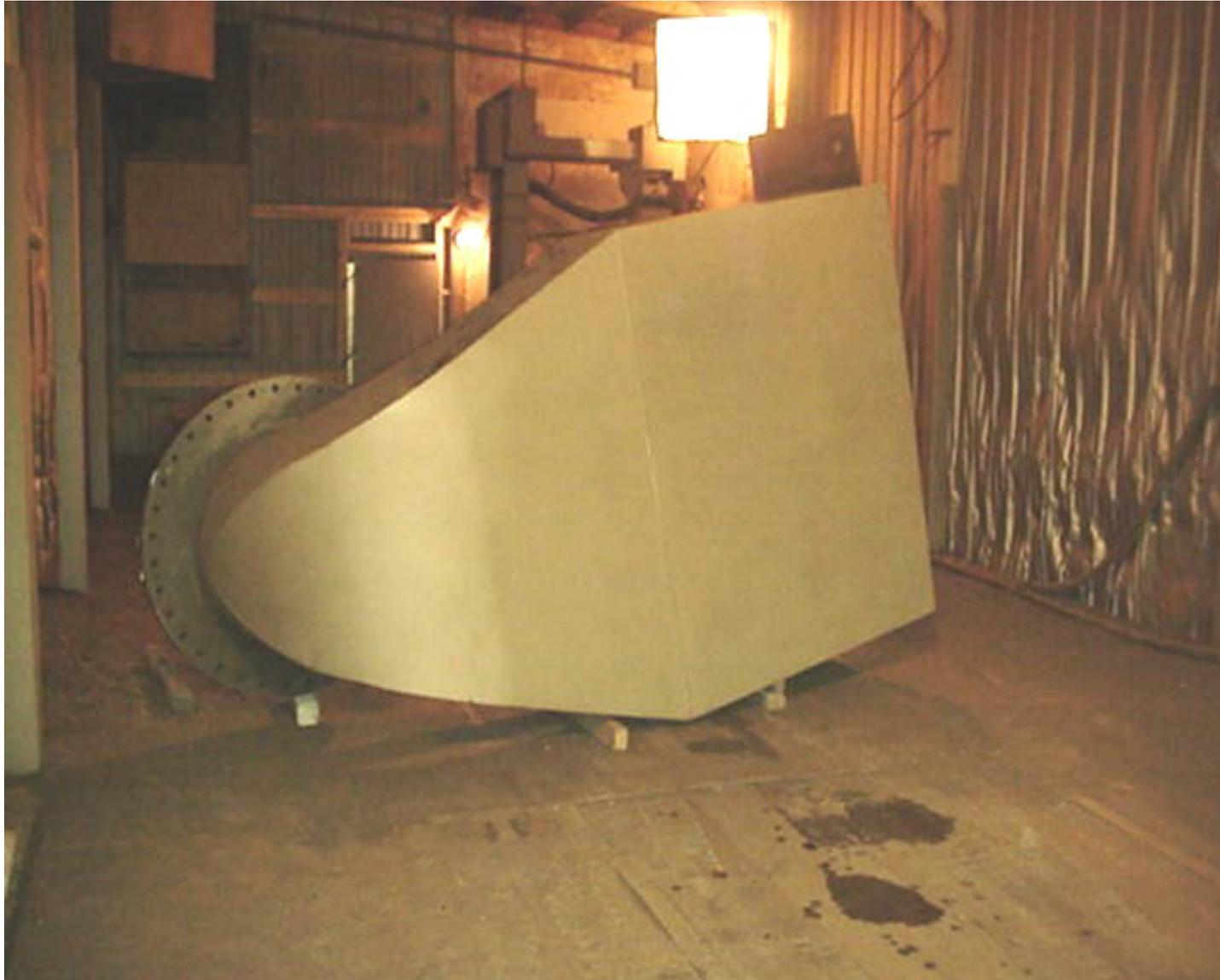
# *Quality of Construction*



- ***Skill level of workers, i.e., machinists, foundry workers, and welders.***



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# *Quality of Construction*



- ***Skill level of workers, i.e., machinists, foundry workers,***
- ***Built in accordance with shop drawings, manufacturing drawings***



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# *Quality of Construction*



- ***Skill level of workers, i.e., machinists, foundry workers,***
- ***Built in accordance with shop drawings, manufacturing drawings***
- ***Cleanliness of shop***



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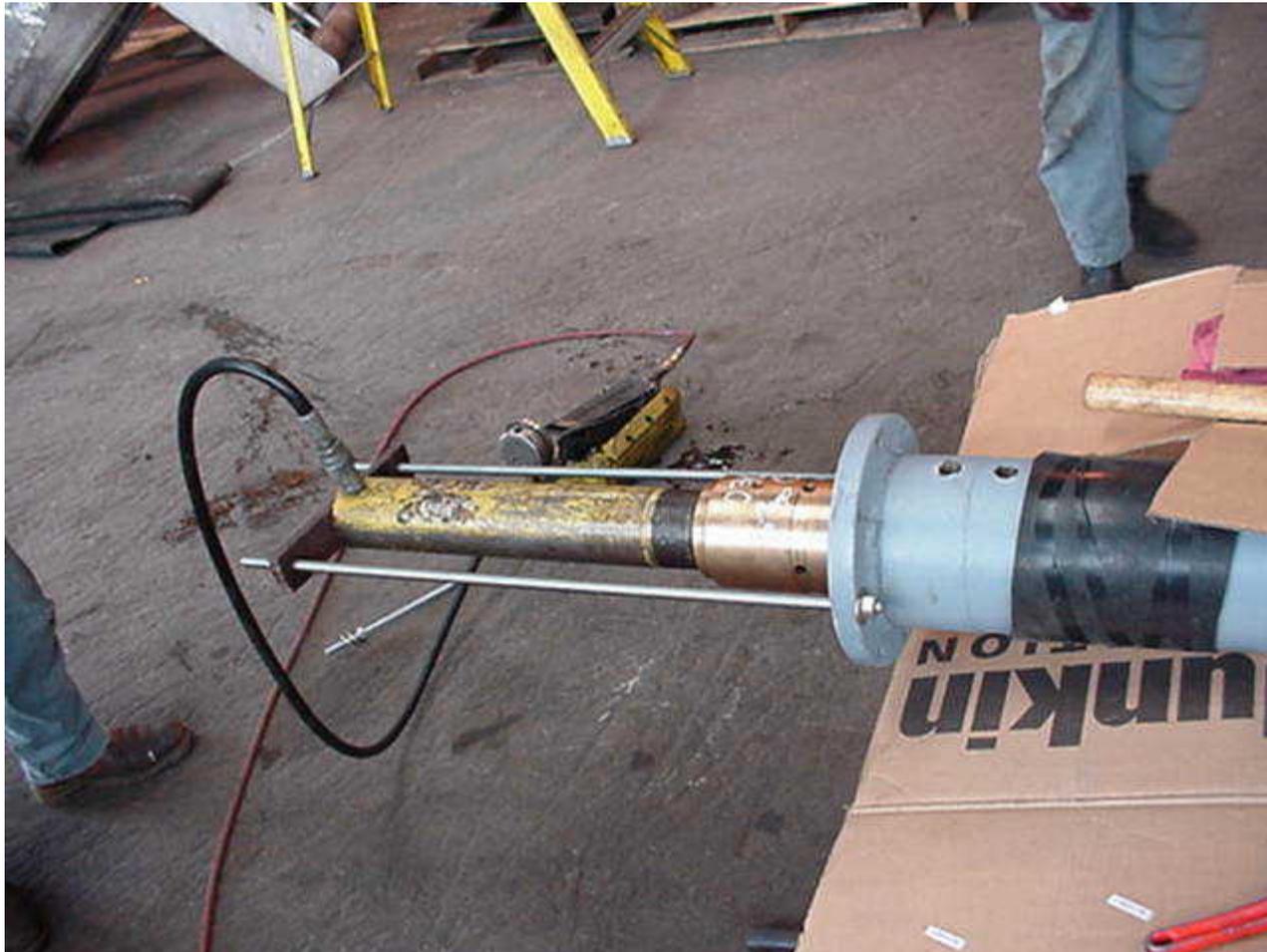
# *Quality of Construction*



- ***Skill level of workers, i.e., machinists, foundry workers,***
- ***Built in accordance with shop drawings, manufacturing drawings***
- ***Cleanliness of shop***
- ***Assembly/disassembly procedures***

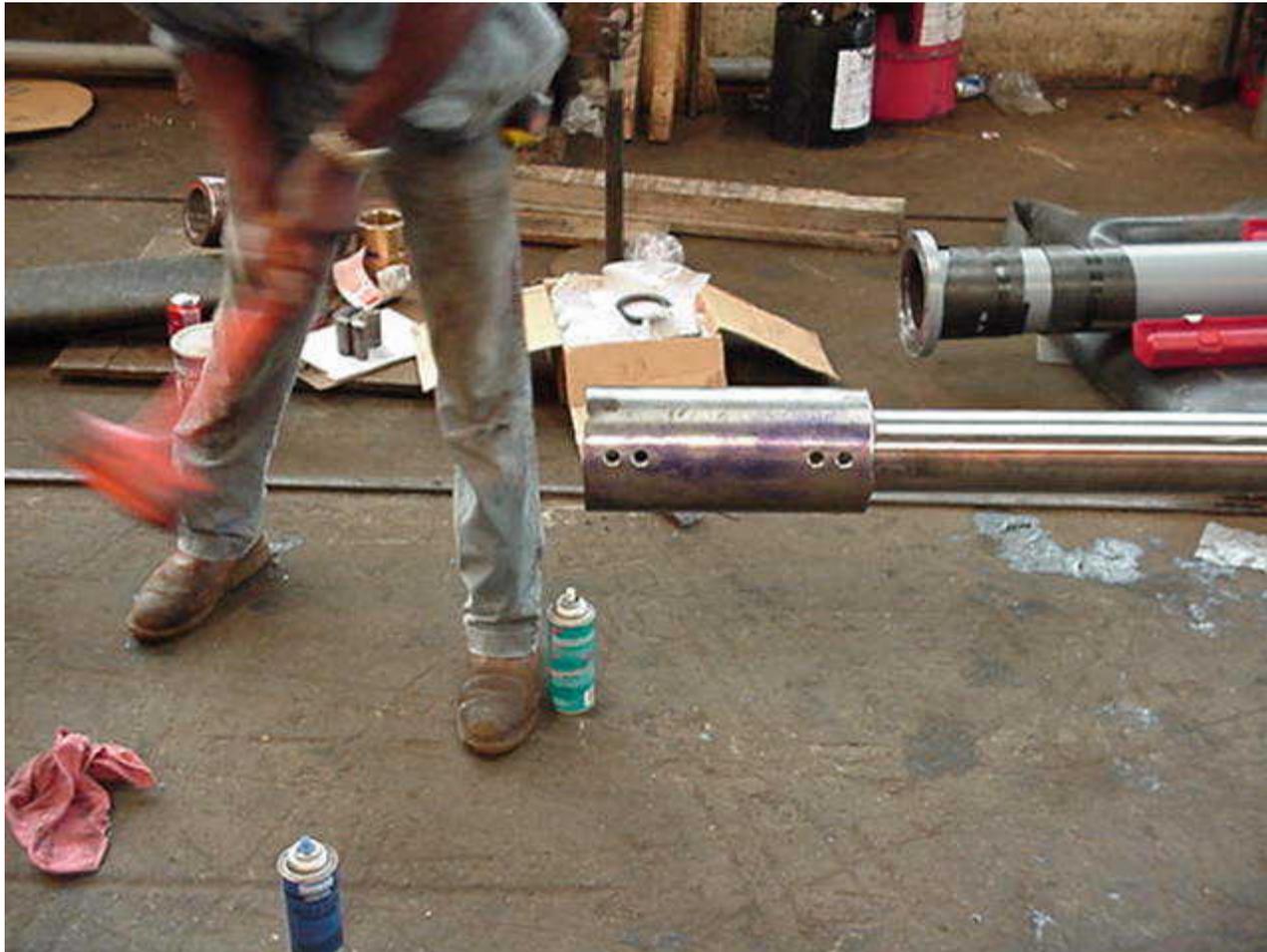


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# *Quality of Construction*



- ***Storage and Handling of equipment/components on-site (factory or field)***



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# Impeller #1 After Balancing (Note: Weights inside Hub)





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# *Quality of Construction*



- ***Storage of equipment/components on-site (factory or field)***
- ***Proper material selection, quality standards***



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# *What Can Go Wrong?*





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# *What Can Go Wrong?*



## *Seized or Damaged Bearings*



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# *What Can Go Wrong?*



***Seized or Damaged Bearings :***

- ***Improper clearance***



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# *What Can Go Wrong?*



## ***Seized or Damaged Bearings :***

- ***Improper clearance***
- ***Wrong surface finish***



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# *What Can Go Wrong?*



## ***Seized or Damaged Bearings :***

- ***Improper clearance***
- ***Wrong surface finish***
- ***Shaft misalignment***



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# *What Can Go Wrong?*



## ***Seized or Damaged Bearings :***

- ***Improper clearance***
- ***Wrong surface finish***
- ***Shaft misalignment***
- ***Bearing misalignment***



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# *What Can Go Wrong?*



## ***Seized or Damaged Bearings :***

- ***Improper clearance***
- ***Wrong surface finish***
- ***Shaft misalignment***
- ***Bearing misalignment***
- ***Incorrect or no lubricant***



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# *What Can Go Wrong?*



***Seized or Damaged Bearings cont:***

- ***Imbalance of Impeller or Propeller***



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# *What Can Go Wrong?*

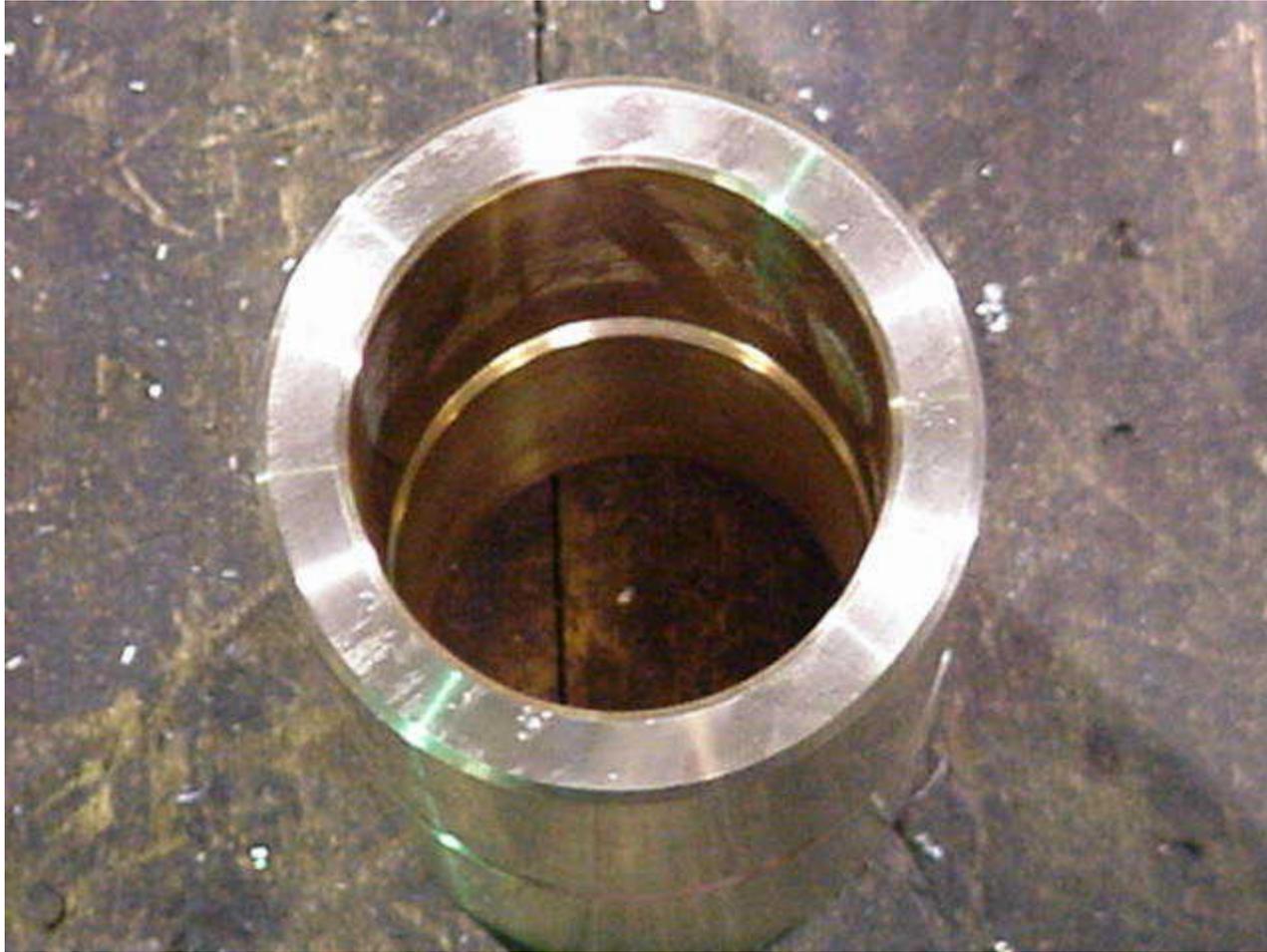


## ***Seized or Damaged Bearings cont:***

- ***Imbalance of Impeller or Propeller***
- ***Contamination by sand, silt or other foreign materials within the shaft or bearing housing***



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# *Pump Design*



- ***Operate at resonant frequency between the pump and motor can cause vibrations and damage the pump.***



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# *Pump Design*



- ***Operate at resonant frequency between the pump and motor can cause vibrations and damage the pump.***
- ***NPSHR > NPSHA***



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# *Pump Design*



- ***Operate at resonant frequency between the pump and motor can cause vibrations and damage the pump.***
- ***NPSHR > NPSHA***
- ***Fail performance and/or cavitation test***



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