



# **Induction Brazing for Shipboard Pipe Applications**

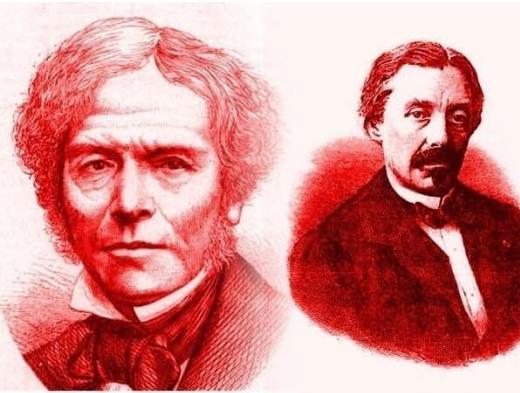
Spring 09 SP-7 Meeting  
Hanover, PA

Patrick M Hoyt  
Chief Welding Engineer  
Northrop Grumman Shipbuilding  
New Orleans

# Why Bother? What's wrong with my torch?

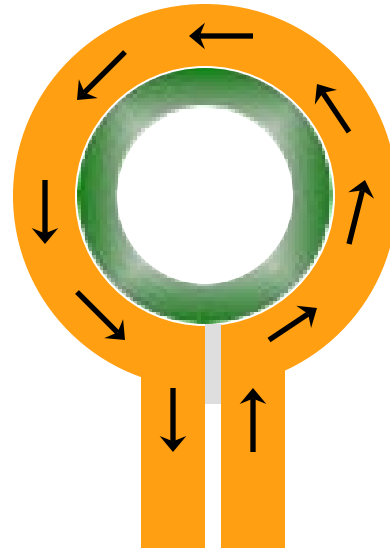
- Induction Brazing allows us to reduce the hazards of hot work, no open flame, no shipboard fires
- Reduced cycle time. 2 minutes for induction brazing vs. 6 minutes for torch brazing
- Operator skill level less critical. Will allow the use of less experienced brazers on shipboard joints with difficult access
- The heating cycle is consistent and repeatable, no variation between brazers. Consistent braze joint quality

# What is Induction Heating?



When an alternating current flows through an induction coil a magnetic field is generated

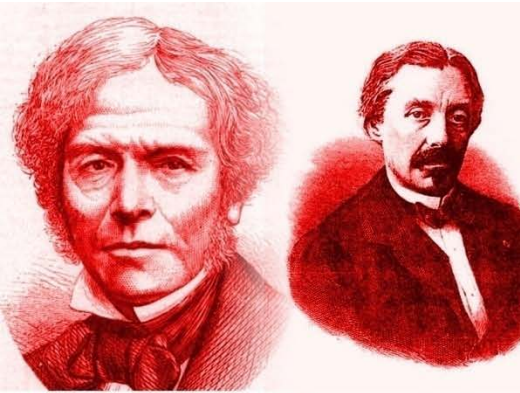
$$\varphi = \iint_S \vec{B} \cdot d\vec{S}$$



Induction Heating Coil

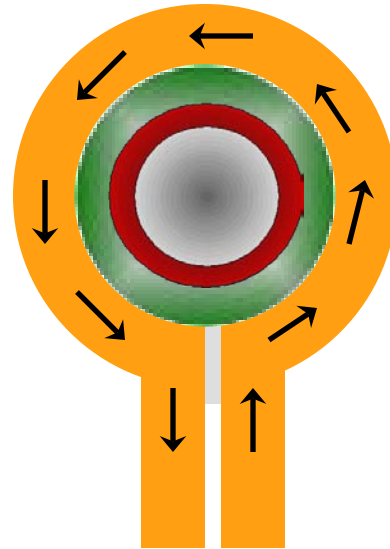
This field is concentrated on the inside of the coil and its magnitude depends on the strength of the current and the number of turns in the coil

# Theory of Induction Heating



If a metal object is placed in the coil, eddy currents will be induced in the object

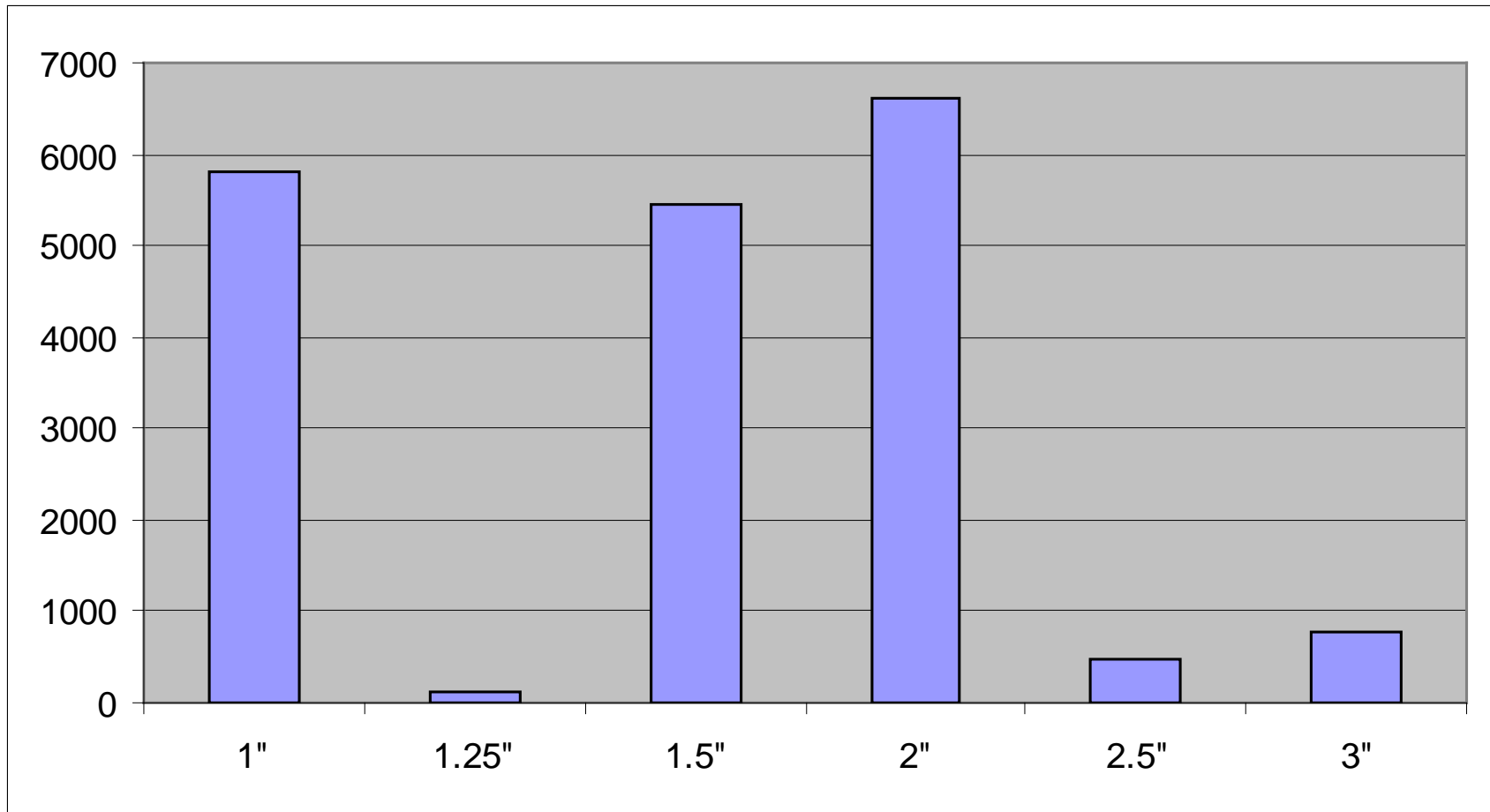
$$\varphi = \iint_S \vec{B} \cdot d\vec{S}$$



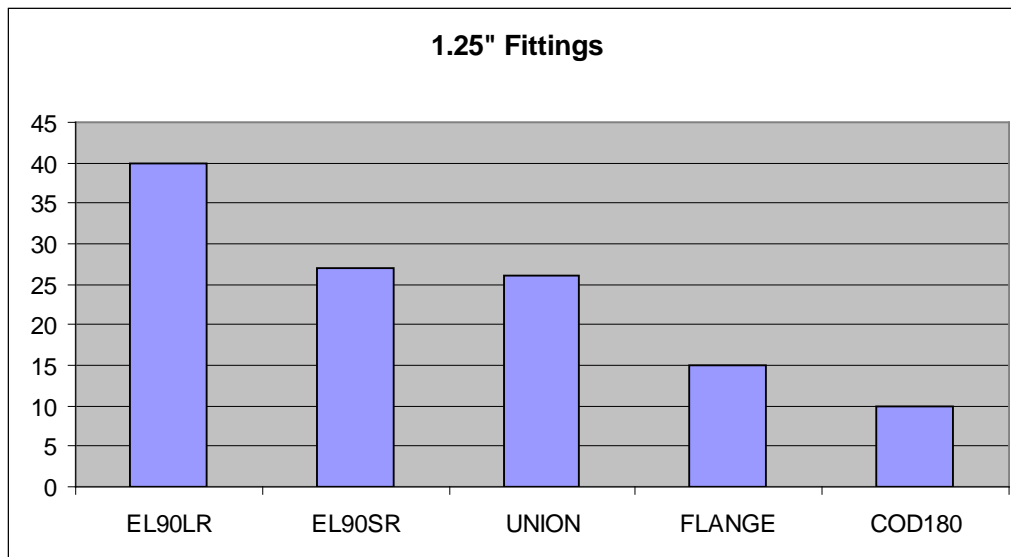
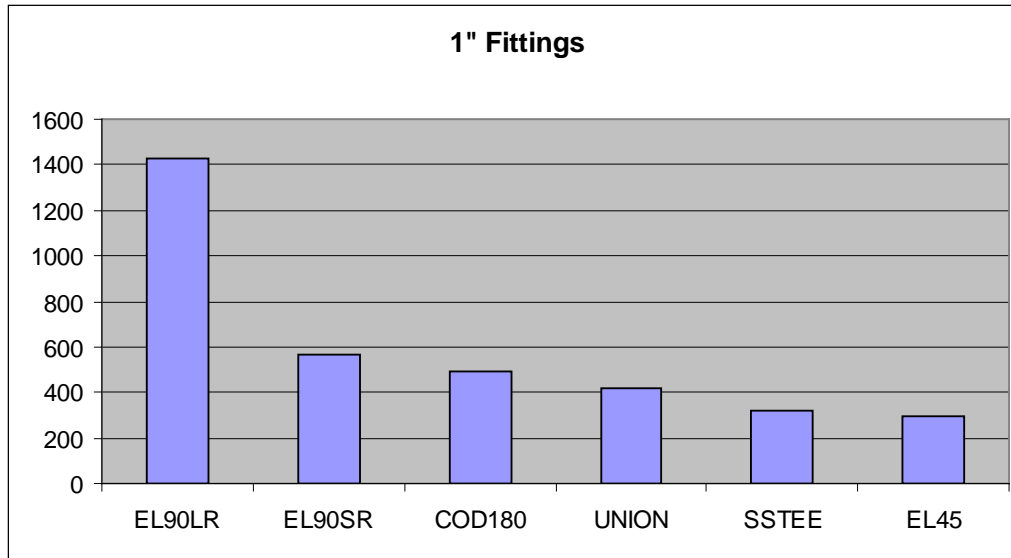
Induction Heating Coil

Due to the resistance of the material, heat is developed in the region through which the eddy currents flow

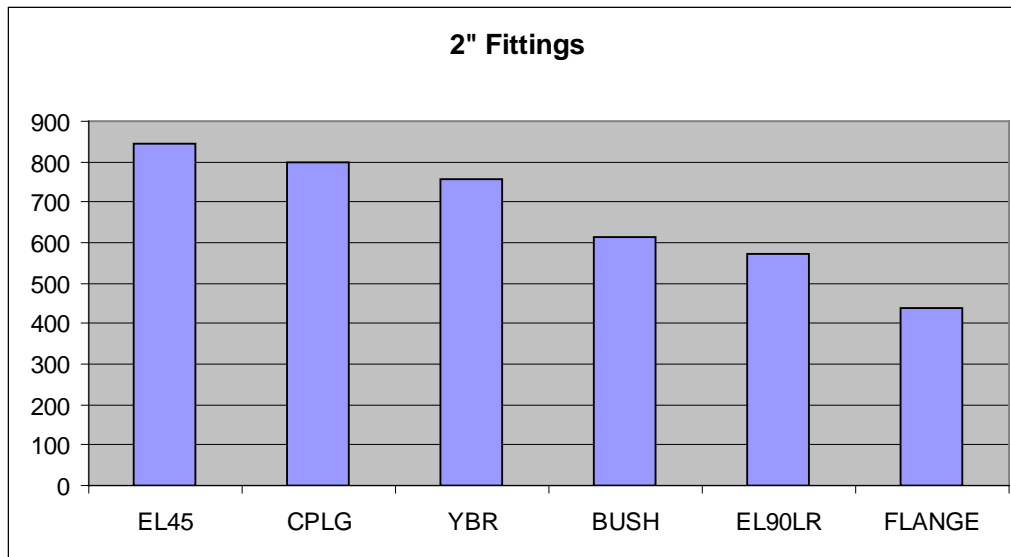
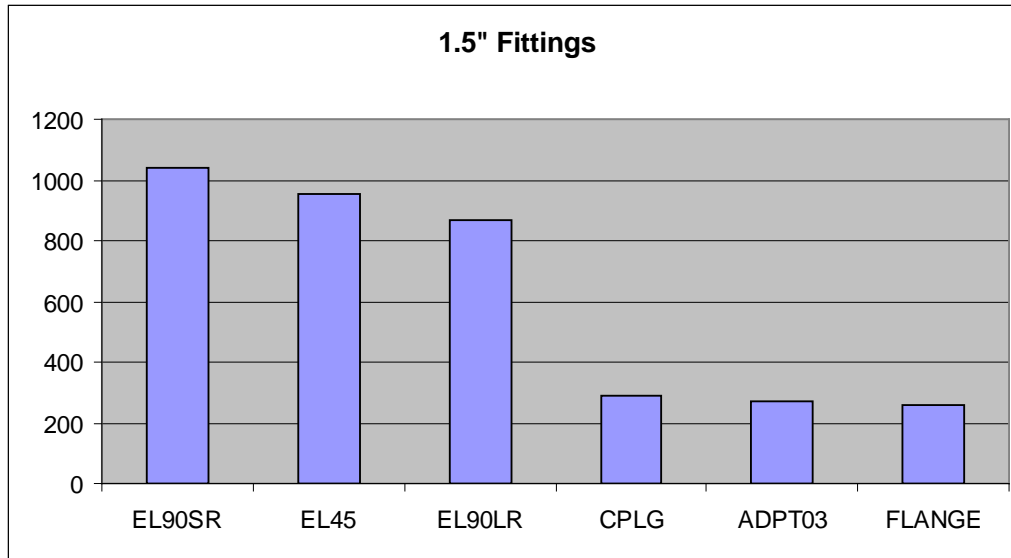
# Fitting Quantity by Pipe Size for LPD Class Ship



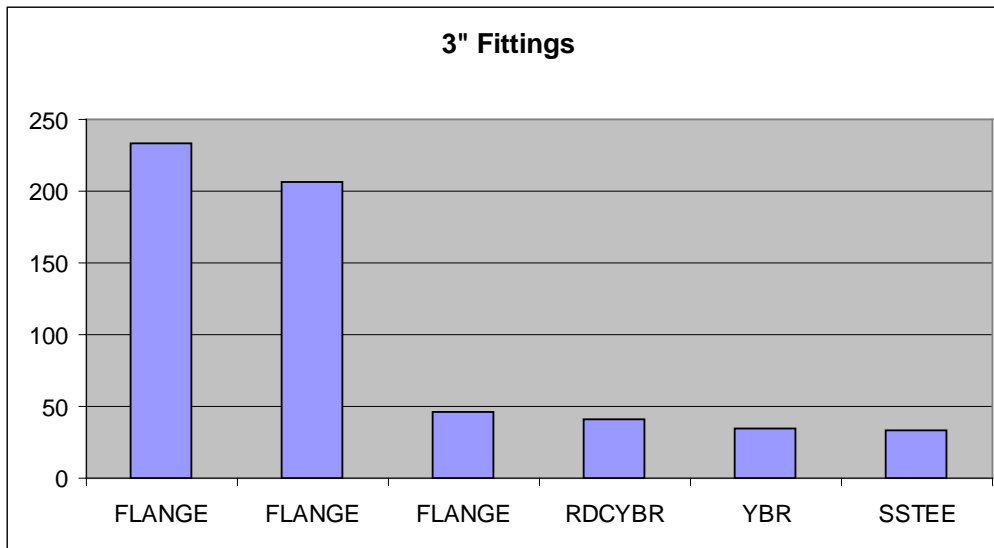
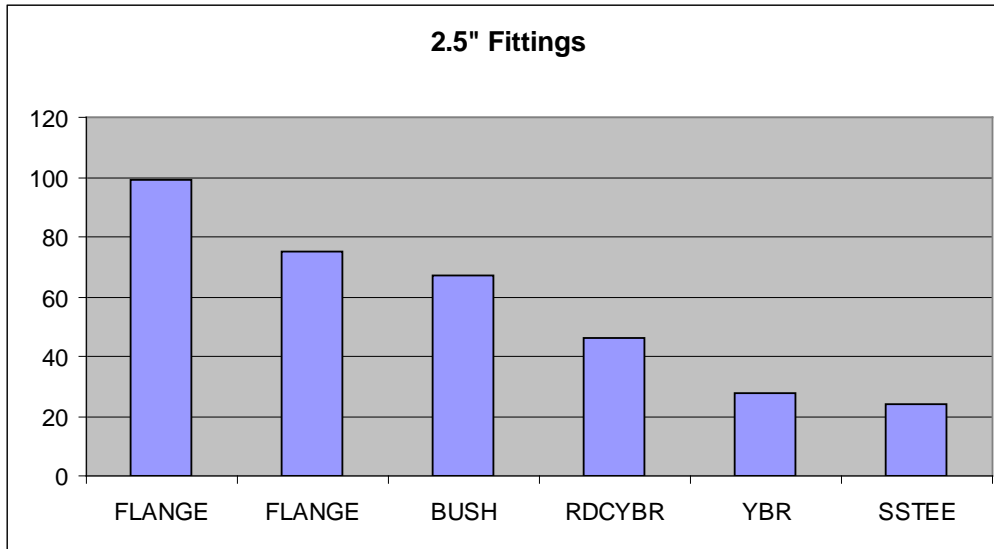
# Fitting Types by Pipe Size



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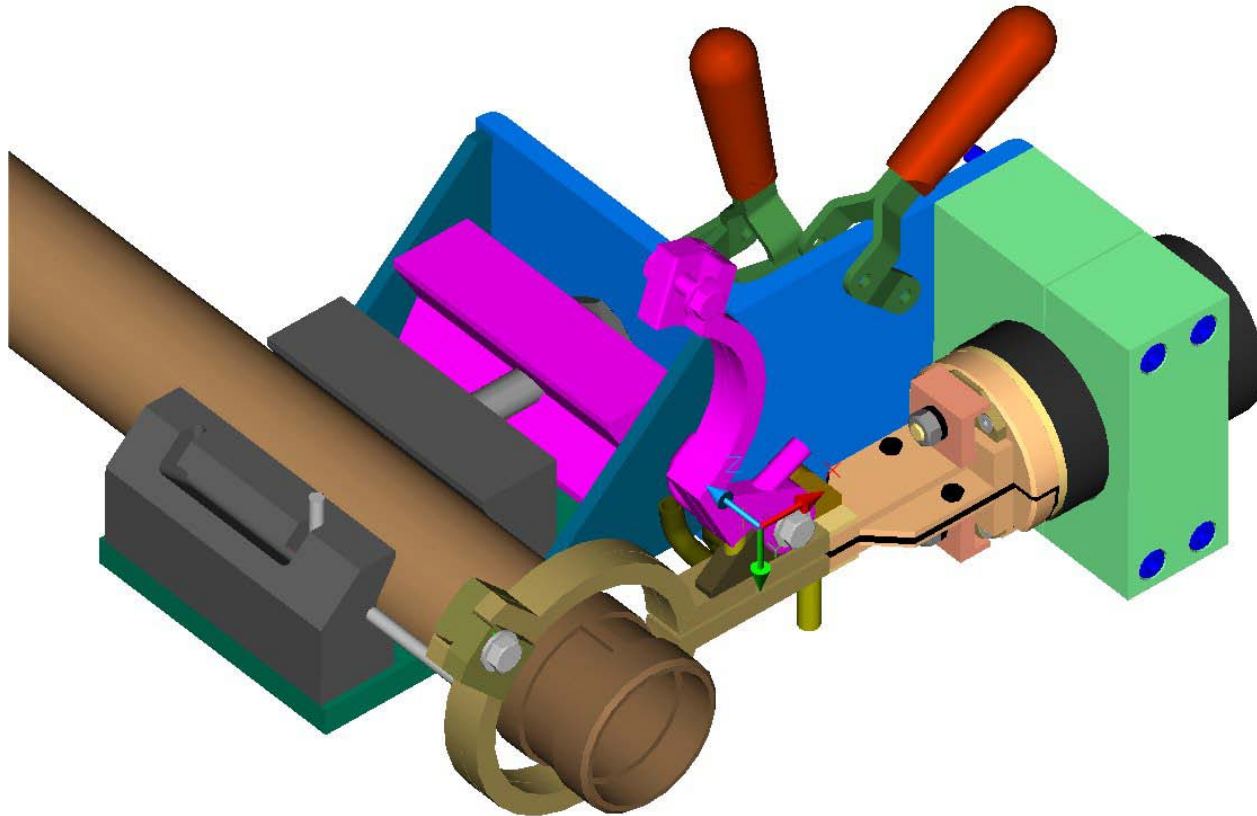


# Fitting Types by Pipe Size



- EFD has developed a prototype induction coil.
- It is reusable, not a consumable.
- It is a “clamshell” style coil.
- It clamps to the pipe to be brazed. The brazer does not have to support the induction coil.
- It will accommodate different sizes. For example the 2” pipe coil can be use to braze 1.5” pipe also.

# Induction Coil Design



# Coil in Operation



- **Visual Inspection** – Joints shall show a complete ring of brazing alloy between the outer surface of the pipe and the face of the fitting.
- **Peel Test** – The total unbrazed area shall not exceed 30% of the total land area nor exceed 45% of the area of the inner or outer land.
- **Tensile Test** - For base material failure, the failure strength shall not be less than 90% of the minimum base material tensile strength.

# Visual Inspection



# Peel Test



# Tensile Test

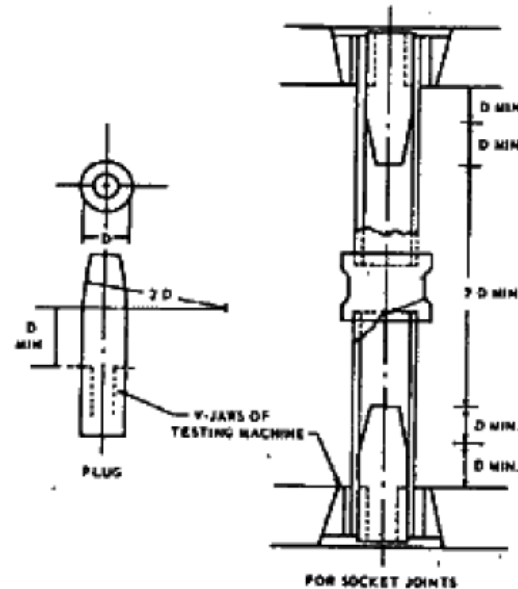


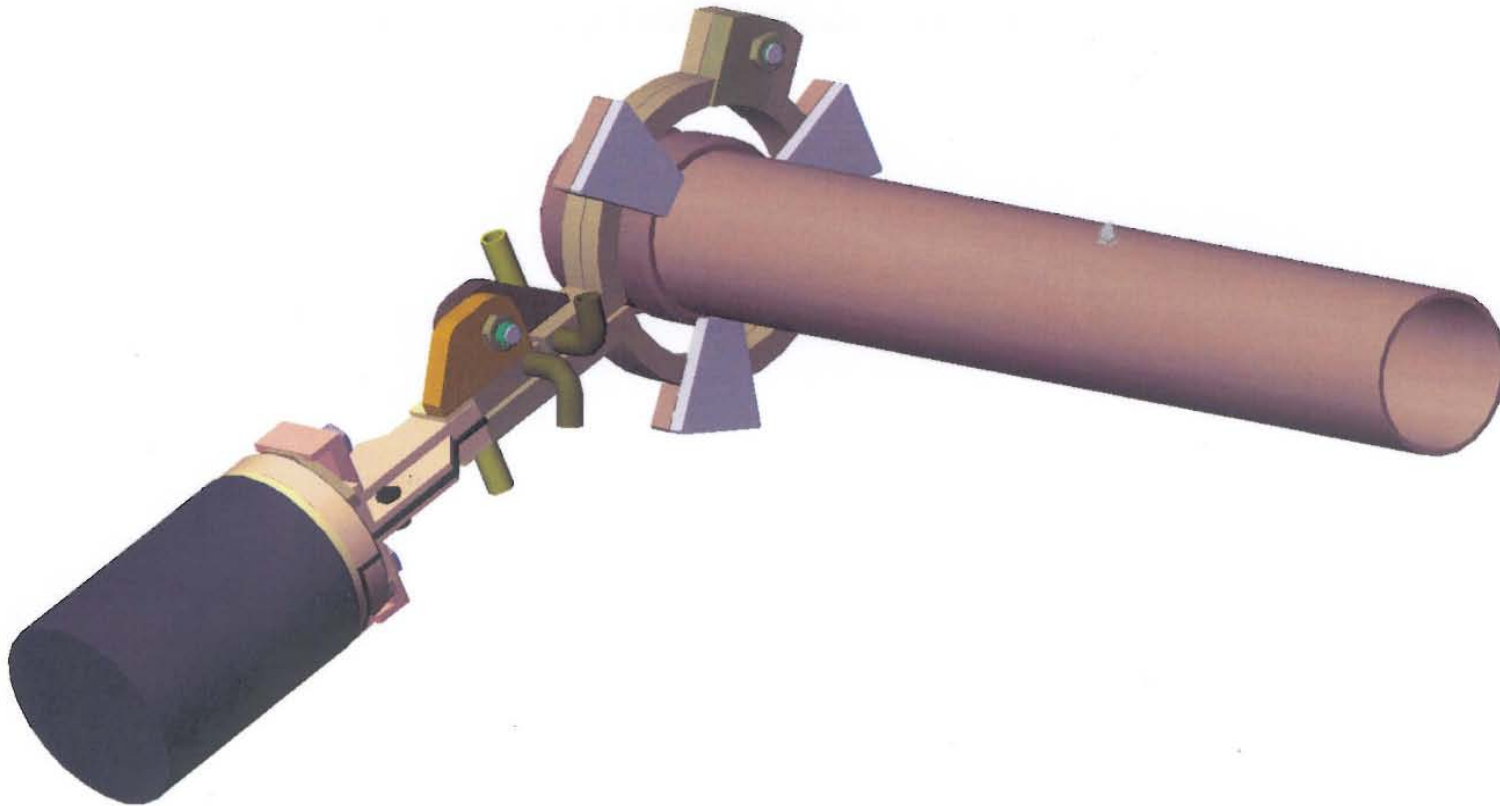
FIGURE 4-2

PROCEDURE QUALIFICATION TENSION  
TEST SPECIMEN FOR SMALL DIAMETER  
PIPE (3-INCHES OR LESS)

Specimen	Acceptance Standard	Tensile Strength (ksi)	Failure Location	Test Result
330A/330B	4.2.7.3.1(2) of 0900-LP-001-7000	29.8	pipe	Acceptable
330CC/330DD	4.2.7.3.1(2) of 0900-LP-001-7000	29.5	pipe	Acceptable
330E/330F	4.2.7.3.1(2) of 0900-LP-001-7000	28.3	pipe	Acceptable
330G/330H	4.2.7.3.1(2) of 0900-LP-001-7000	29.2	pipe	Acceptable

The minimum tensile strength for copper pipe in accordance with Mil-T-24107 is 30 ksi. When failure occurs in the base material, 4.2.7.3.1(2) of 0900-LP-001-7000 specifies that the strength at failure shall not be less than 90% of the specified base material tensile strength,  $30 \text{ ksi} * 0.9 = 27 \text{ ksi}$

# Final Coil Design



# Revised Schedule

Quarter	Task	Description	Performed By	Due Date	Revised Due Date
1	1	Determine fitting types and pipe sizes most prevalent among the shipyard team members.	NGS, NGNN, BIW	1/17/2008	
1	2	Quarterly Status Report	EFD, NGS	3/31/2008	
4	3	Develop reusable induction brazing coils based on shipyard requirements	EFD	5/19/2008	11/19/2008
4	4	NGSS utilizes reusable coils with brazing unit to determine conformance to Navy brazing requirements	NGS	6/19/2008	12/19/2008
2	5	Quarterly Status Report	EFD, NGS	6/30/2008	
1	6	EFD develops shipboard pipe brazing unit	EFD	9/19/2008	2/19/2009
3	7	Quarterly Status Report	EFD, NGS	9/30/2008	
1	8	NGS demonstrates shipboard pipe brazing system	NGS	12/4/2008	4/15/2009
1	9	Final Report	EFD, NGS	12/19/2008	4/30/2009

***NORTHROP GRUMMAN***

