Miller ProHeat 35

Induction Heating Theory and Applications

Agenda for Today

- Induction Theory – How it works
  - Al Sherrill,
    Miller Pipe Welding Products
- Applications Pictures / Summaries
- ProHeat 35 Advantages

How many ways can something be heated?

- FLAME - chemical
- RESISTANCE - electrical
- RADIATION – solar
- FRICTION – mechanical
- INDUCTION – electro-magnetic

Induction heating

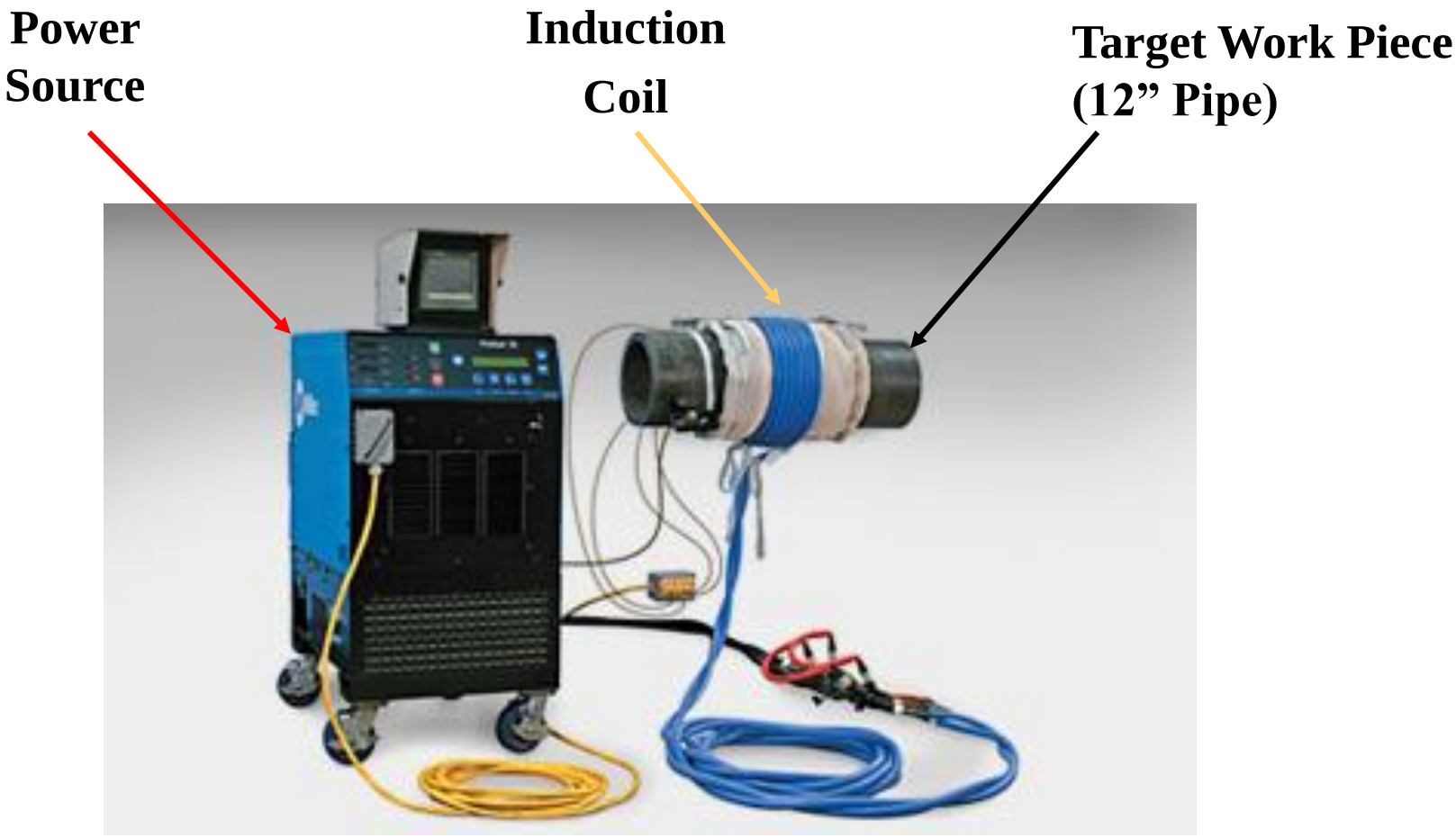
- is the process of heating an electrically conducting object (usually a metal) by electromagnetic induction, where eddy currents are generated within the metal and resistance leads to Joule heating of the metal. An induction heater (for any process) consists of an electromagnet, through which a high-frequency alternating current (AC) is passed. Heat may also be generated by magnetic hysteresis losses in materials that have significant relative permeability. The frequency of AC used depends on the object size, material type, coupling (between the work coil and the object to be heated) and the penetration depth.

- Wikipedia, 2008

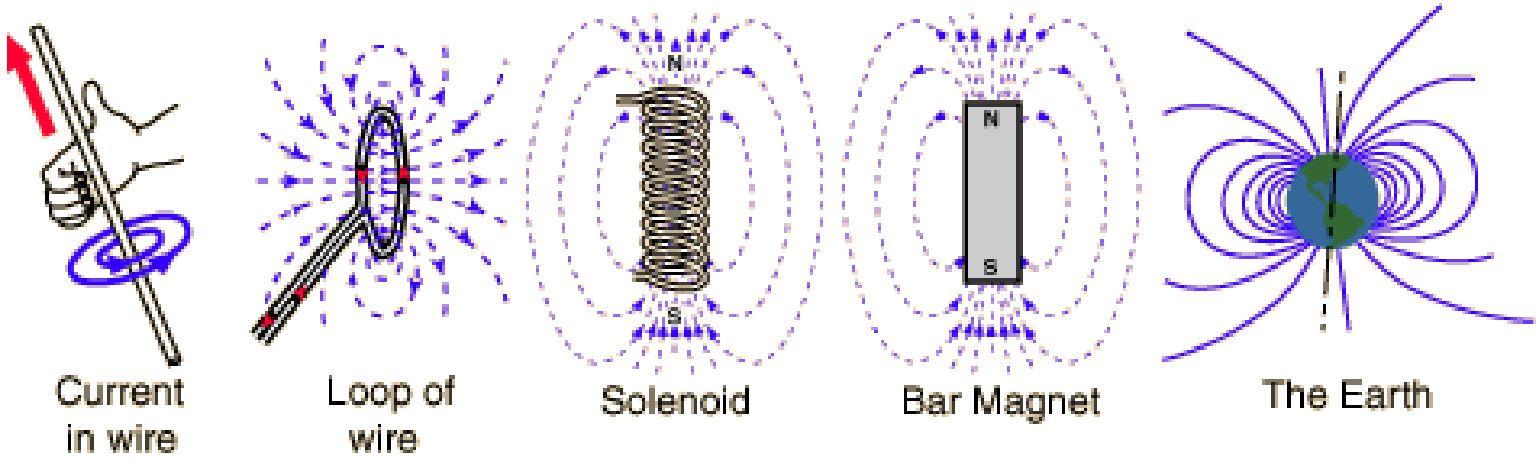
Induction heating

- Only heats electrically conducting object s
  - Does not heat wood, plastic, other non-conducting materials. We can use these to fabricate fixtures.
- An induction heater consists of an electromagnet, through which a high-frequency alternating current (AC) is passed. The frequency of AC used effects the penetration depth of the heat.
- Eddy currents are generated within the metal and resistance leads to Joule heating of the metal.
- Heat may also be generated by magnetic hysteresis losses in materials that have significant relative permeability.

Induction Heating – System

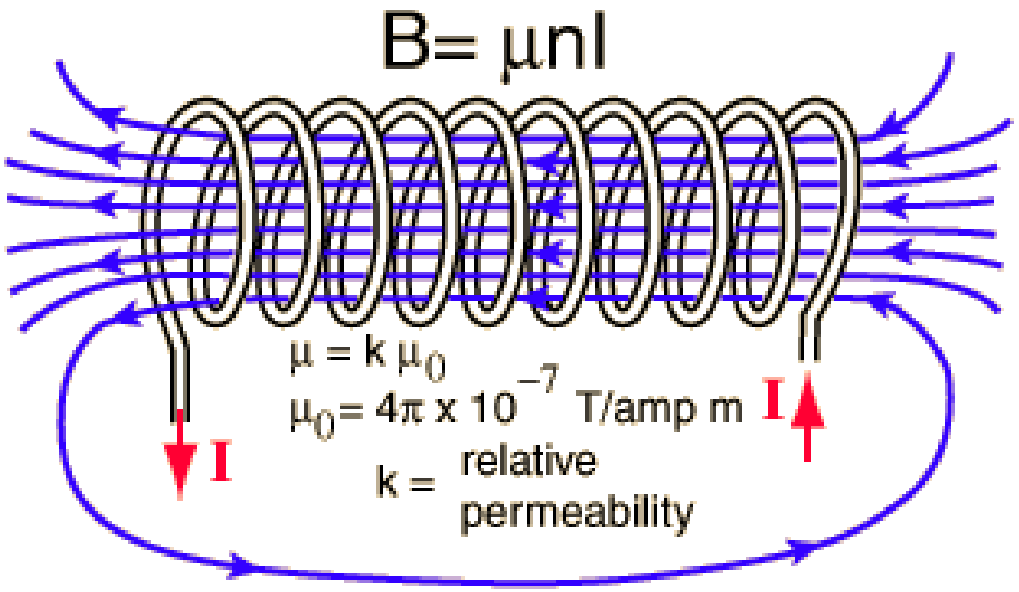


Sources of Magnetic Fields



Magnetic Field Sources

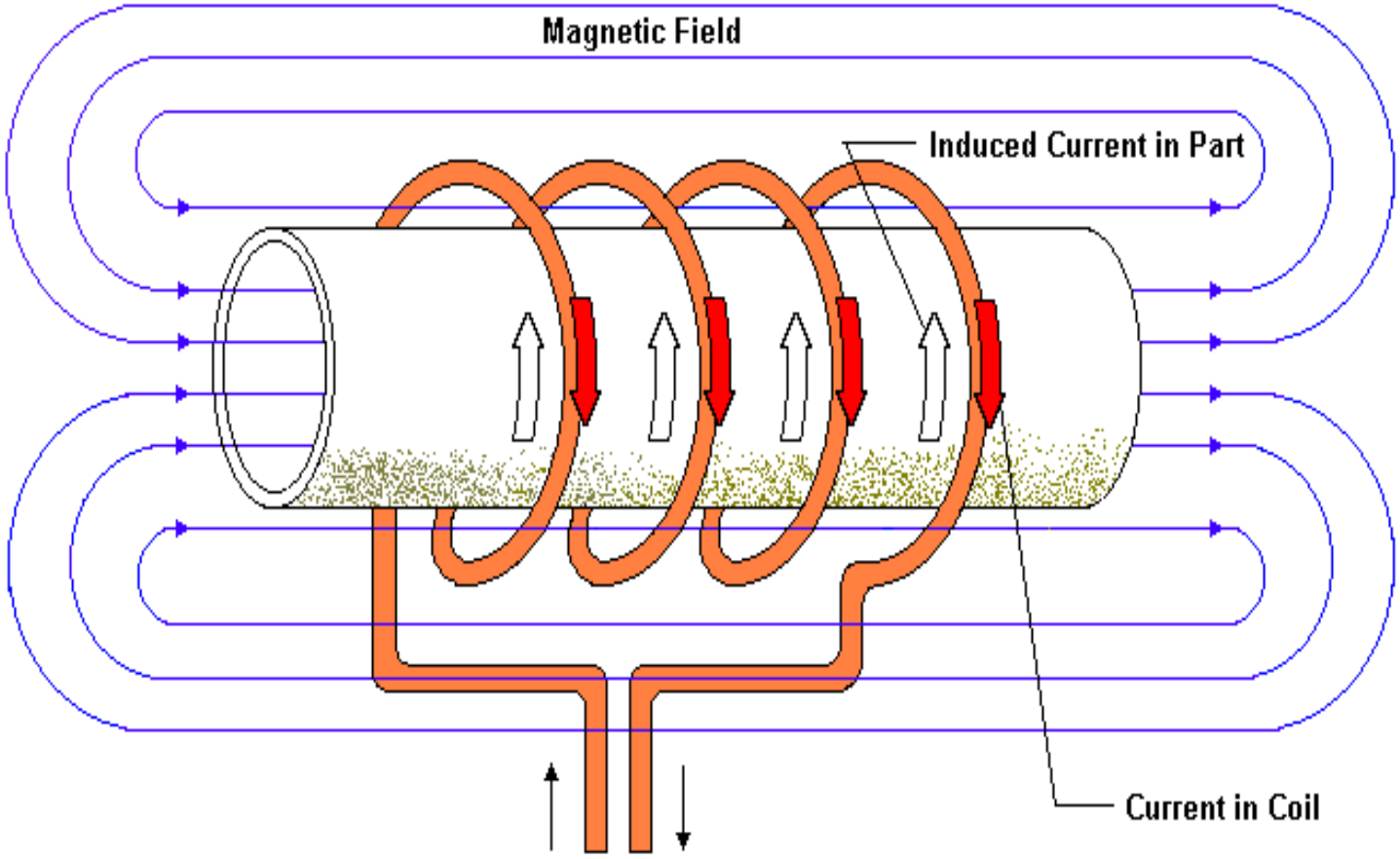
Magnetic Field Created by a solenoid coil



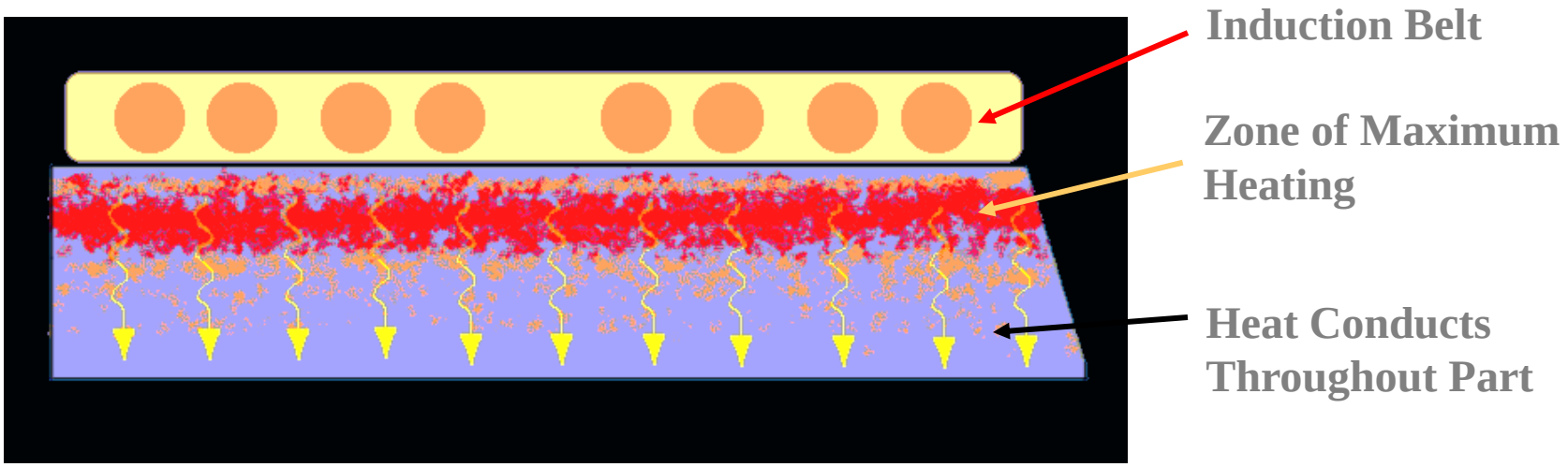
Magnetic field =

permeability x turn density x current

Induction Heating



Induction Heating - "How It Works"



For thick sections, heat needs time to conduct throughout the part to reach interpass temperature specifications.

Induction Systems in Heavy Construction

Applications

- Water Cooled
  - Up to 1450 ° F (780° C)
  - Pre-Heat and PWHT
- Air Cooled
  - Limit to 400° F (204° C)
  - Fast Changeover

Applications
Water Cooled Systems

- Transmission Pipeline Repair
- Power Plant Construction
- Fabrication Shops
- Heavy Equipment Fabrication and Repair
- Shrink Fit Castings/Bearings on Shafts

Induction Preheats

Flexible Induction Coil and Insulation for Preheating

- Reusable Insulation 1/2” Thick
- Water Cooled Cable wrapped both sides of joint.
- Protective Hose Cover
- Access loop five feet.

Induction vs. Resistance

- Typical 15 minute set-up
- Reusable insulation
- Coil is not hot
- One cable to coil / simple
- More comfortable work environment (no hot air in your face, no insulation particulate)

- Typical 2-4 hr set-up
- Insulation falls apart after use
- Pad is hot like a toaster element
- Several wires go to pads
- Common for pads to fail
- Much slower time to temperature

Process Piping Systems

Steam Drain Valve Multiple Joints

- P22 Material
- (2) 8” Nozzles
- 2 and 2 ¾ Wall
- 400F Preheat
- Single Coil
- Self Perform….

Pipe O-let

- Carbon Steel
- 8” O-let
- 20” Main Pipe
- 400F Preheat
- Single Coil
  - 4 turn pancake
  - 4 turn solinoid

Hot Tap (in Service Repair)


T3402

Induction Heating

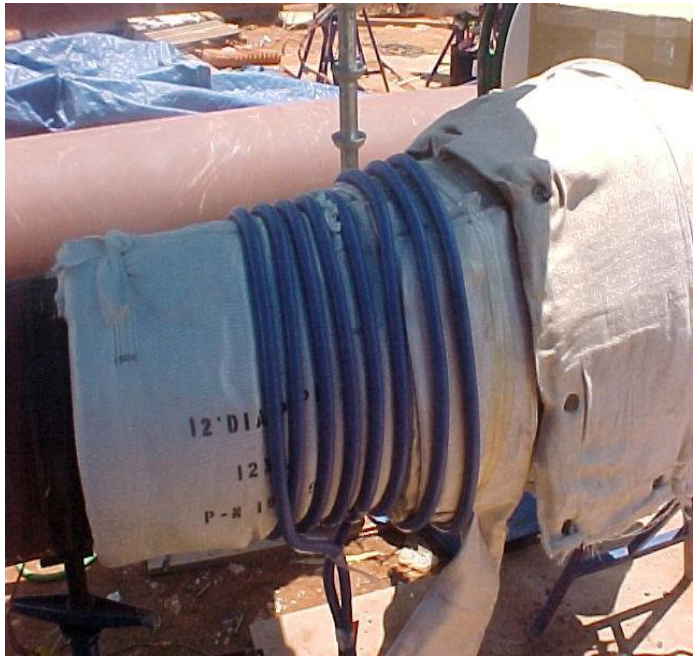
Repairs – Fossil Plant Feedwater Heater

Induction Heating

Heating on the Fly
Stationary coil, Rotating Part

Induction Heating
Heating from the I.D.

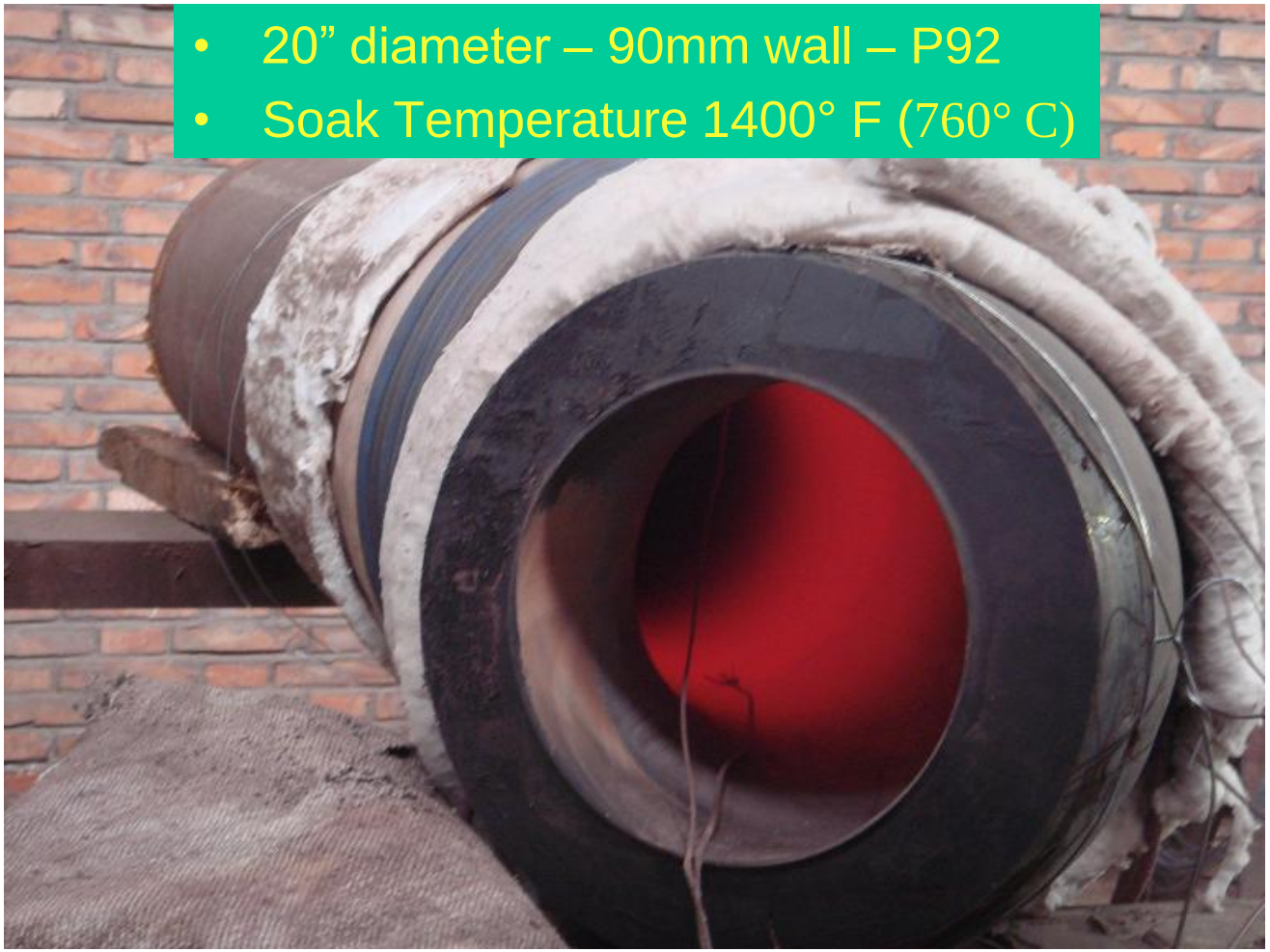
Induction Heating
Stress Relief



Flexible Induction Coil and Insulation For Stress Relieving

- Reusable Insulation Blanket 1” Thick
- Water Cooled Heating Cable Centered on Joint
- No Protective Cover

Horizontal Pipe Application



Vertical Pipe Application

- Weldolet - 16” Diameter - 2”Wall
- Stress Relieving Cycle Time - 5 1/2 Hours.
- Soak Temperature 1350° F.

Drill Pipe Applications

- The new Proheat 35 can heat multiple joints
- This application is on two joints post weld heat treatment at 1350 degrees F

Drill Pipe Applications

- The new Proheat 35 can heat multiple joints
- This application is on four joints post weld heat treatment at 1350 degrees F
- The applications are identical.

Applications
Air Cooled Systems

- Transmission Pipeline – Onshore
- Transmission Pipeline – Offshore
- Shipbuilding
- Structural Steel
- Mining Equipment Repair

Transmission Pipelines

Pipeline Application

Bechtel – NGC Trinidad

LNG Transmission Pipe

- Main Line
- Tie-Ins
- Hot Tapping
- Repair

Offshore Transmission Pipeline (Lay-Barge)

- Less Time
- Safety
- Propane Costs

Ship Hull Application

- Blankets can be mounted on inside of product.
- This allows the item to be heated while welding.
- Item is heated thoroughly
- Work Environment

Ship Hull Application

- Reduced Preheat time from 1 week to 1 day
- Safety
- Work Environment

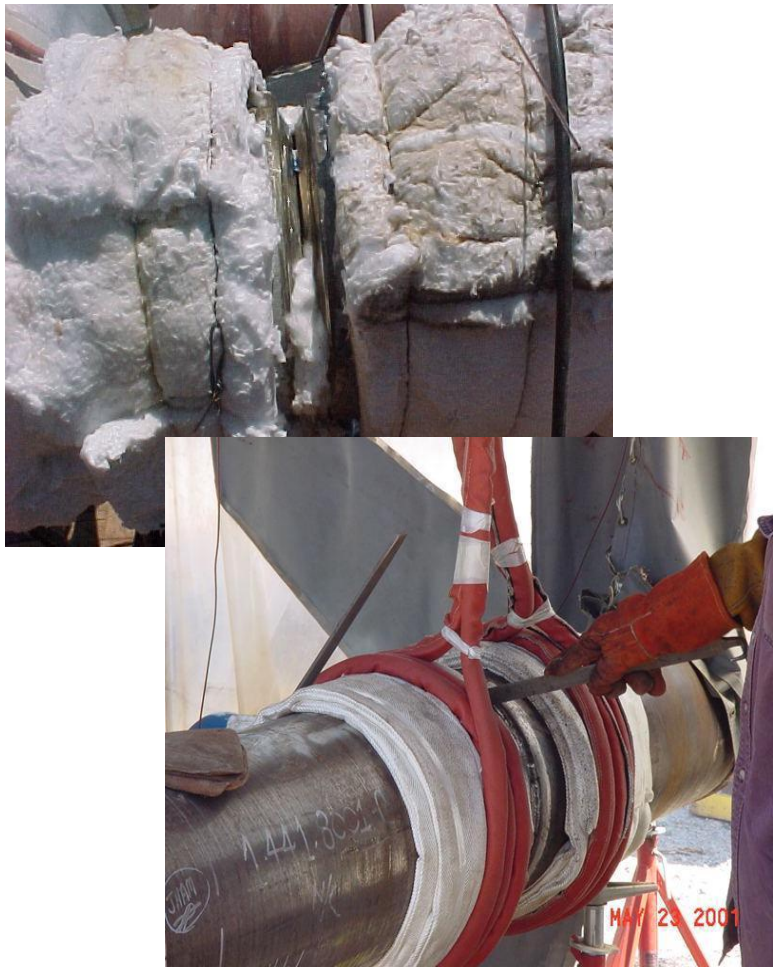
ProHeat 35 Advantages...

- Uniform Heating
- Inter-pass Control
- Proven Reliability
- Simple to Operate
- Welder Friendly Environment
- Portable
- Fast
- Safe

Simple and Easy-To-Use
Just another "Tool in the box…."

- Simple to wrap insulation and install cable
- Usually 15 minute set-up operation versus up to 4 man hours w/ resistance
- Work performed by welders and fitters - Maintain schedule and control
- Cabling consists of one cable to power source, one cable to work and TC's
- Equipment is portable

Ease of Use



- Reusable Insulation
- Reduction in disposal cost of potentially hazardous insulation
- Durable Hose - no fragile wires or ceramic pads to repair or purchase.
- Fewer T/C Failures
- Induction system does not melt connectors and wires.

Quality

- **Improved heat uniformity.**
- **Ability to automatically maintain a desired temperature during the heating process.**
- **Adjust heat during the process.**
- **Cable removal after product is up to temperature.**

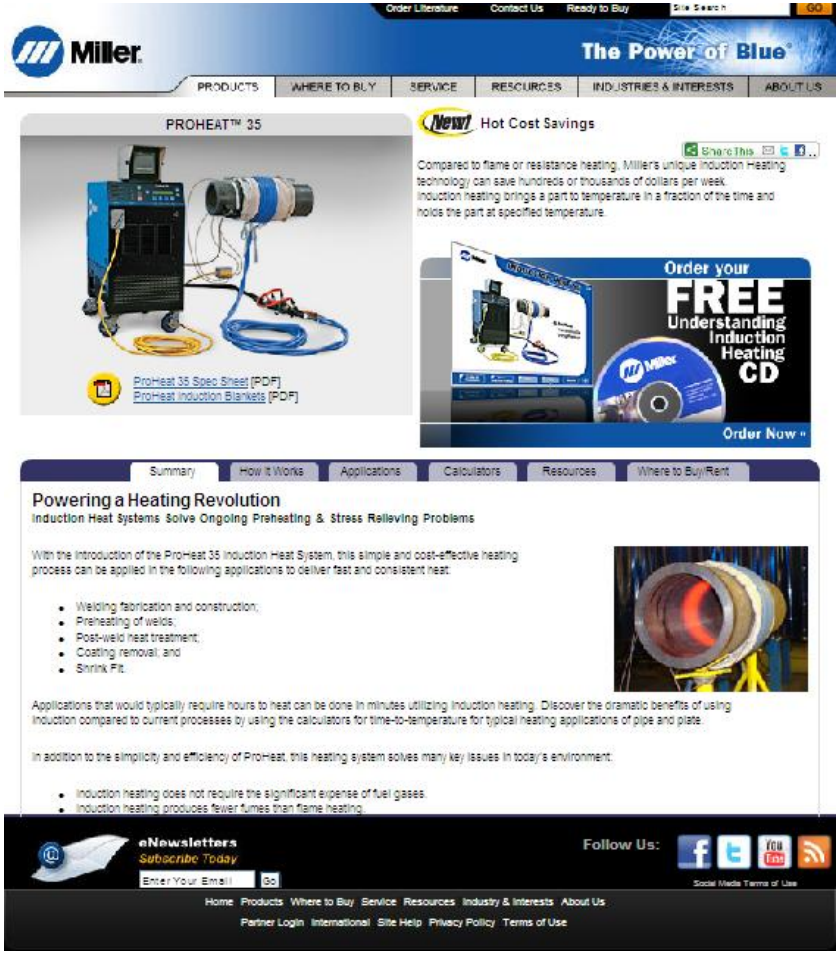
SAFETY!!!

- Reduces burns to welders
- Cooler welding environment helping welders to work more efficiently and safely
- Less airborne insulation fiber to inhale or get on skin
- Insulation Breakdown Detection.

Cost Savings

- **From Labor Savings**
  - Faster Set-up time
  - Faster Time to Temperature
  - Can tear down while part is still hot
- **From Better Quality**
  - No re-work due to cracks from non-uniform heat
  - No re-running PWHT cycles due to failed pads or broken contactors
- **From Utility Savings**
  - More efficient process
  - Many installations qualify for REBATES from the local power co.
  - No waste heating the air!

Online Resources
www.MillerWelds.com



- **http://www.millerwelds.com/products/induction_heating/**
  - Apply for free CD “Understanding Induction”
  - How it Works Video
  - Application Cases
  - Time to Temperature Calculators
  - MSDS Sheets
  - Calibration Verification Procedures
  - Contacts to Buy/Rent

Testimonials & Endorsements

"…both indicate a high level of success during the preheat and post weld bake phase of the trial. Equipment set-up is substantially faster than with the traditional resistance heaters currently being used. Jesse reported that "welder down-time" is reduced by approx. 75% using the new equipment. The reduction is related to faster set-up and the elimination of lost time due to "losing a heating pad", which causes the resistance heaters to be shutdown while the problem is fixed. Additionally, welding is easier due to better access to the joint (more compact heating design) and cooler welding conditions. (The induction equipment senses heat as welding begins, and as the heat input from the welding arc increases, the amount of heat supplied from the induction heating equipment is reduced, maintaining a constant preheat temperature). Not only does this provide the welders with a more comfortable welding environment, but also welders are able to weld continually, eliminating the need to wait for the pipe to cool below the maximum interpass temperature between subsequent welding passes. This all sums to a 50% reduction in the time required to completed a welded joint vs. resistance heating…."

- Nooter Construction
- Fluor
- Bechtel / Pipeline
- KB&R
- Duke / TVA / So. Co. / Progress / Dominion / LG&E
- Exxon / Mobile
- BP (APLOCA Award)
- Shipyards/Portsmouth /Norfolk/Puget/Pearl
- EPRI / EWI / ETD