

# ***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 objects**
  - 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

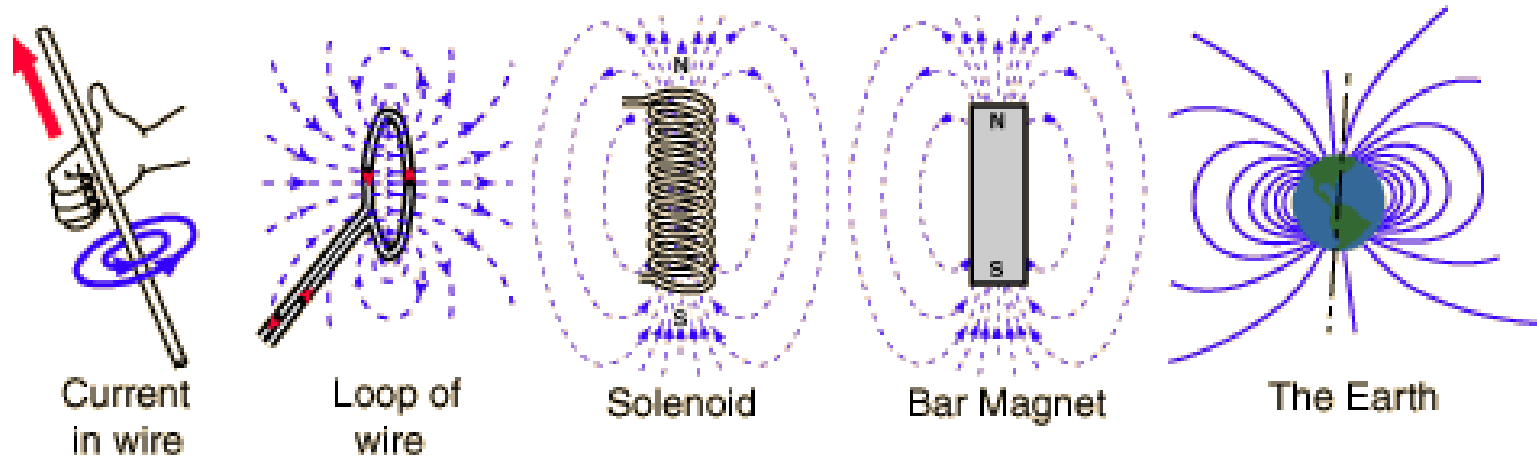
**Power  
Source**

**Induction  
Coil**

**Target Work Piece  
(12" Pipe)**

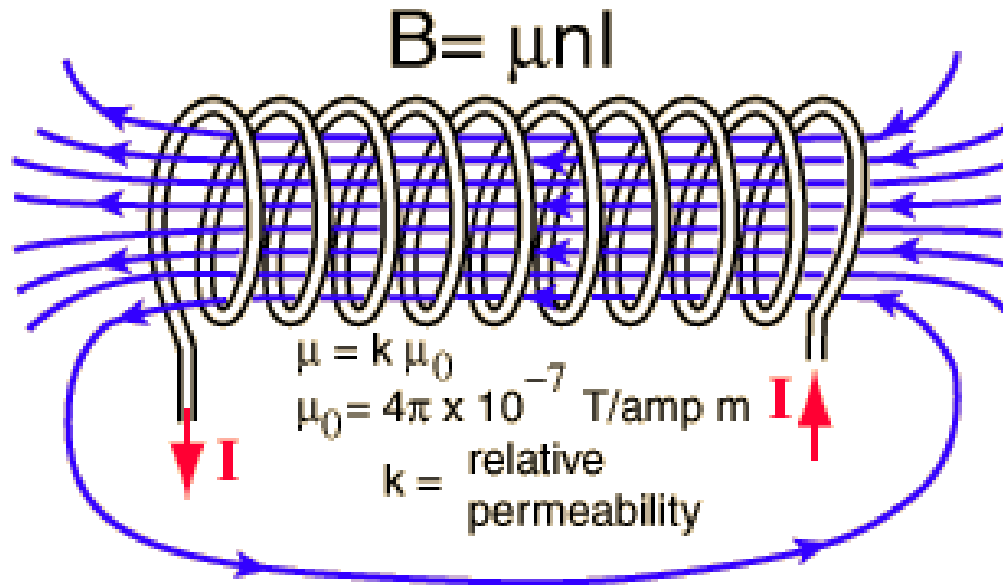


# Sources of Magnetic Fields



Magnetic Field Sources

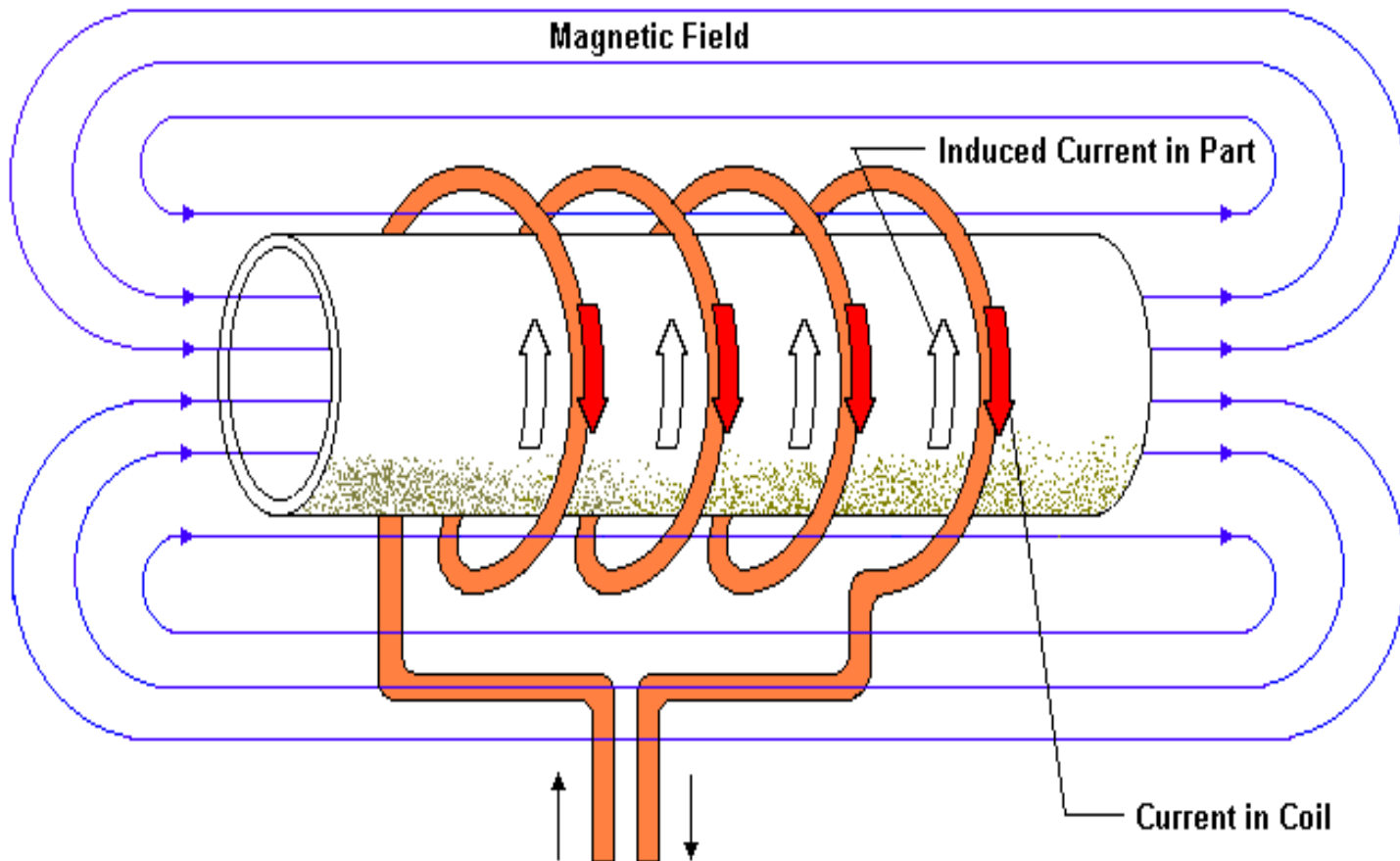
# Magnetic Field Created by a solenoid coil



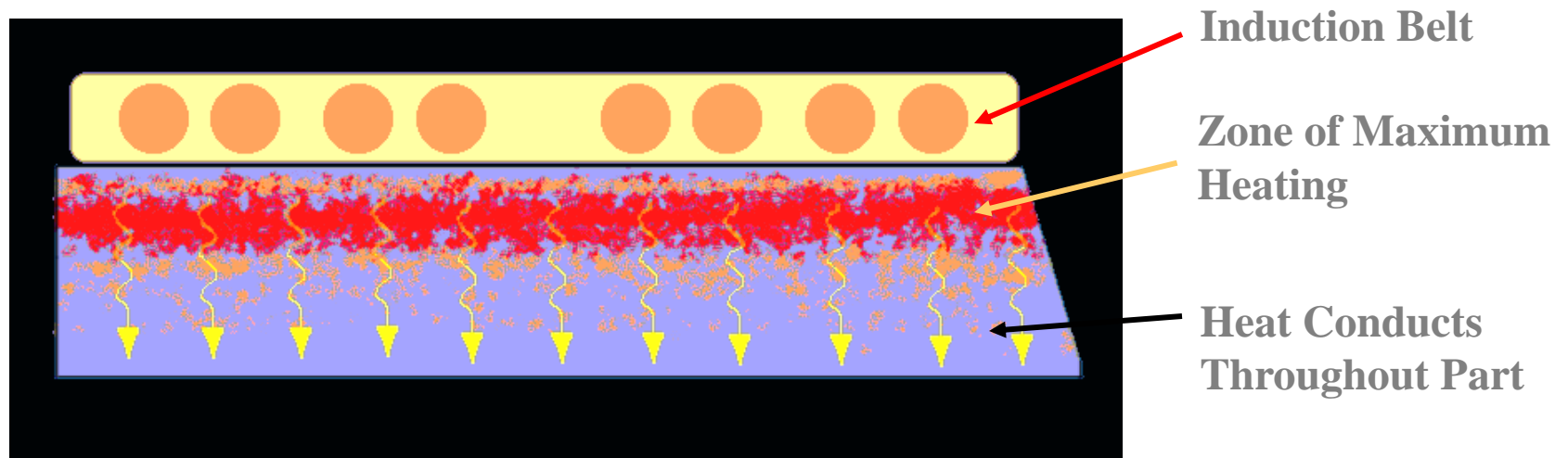
Magnetic field =  
permeability x turn density x current



# 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)***







# ***Induction Heating***

## **Repairs – Fossil Plant Feedwater Heater**



# ***Induction Heating***

## **Heating on the Fly**

### **Stationary coil, Rotating Part**



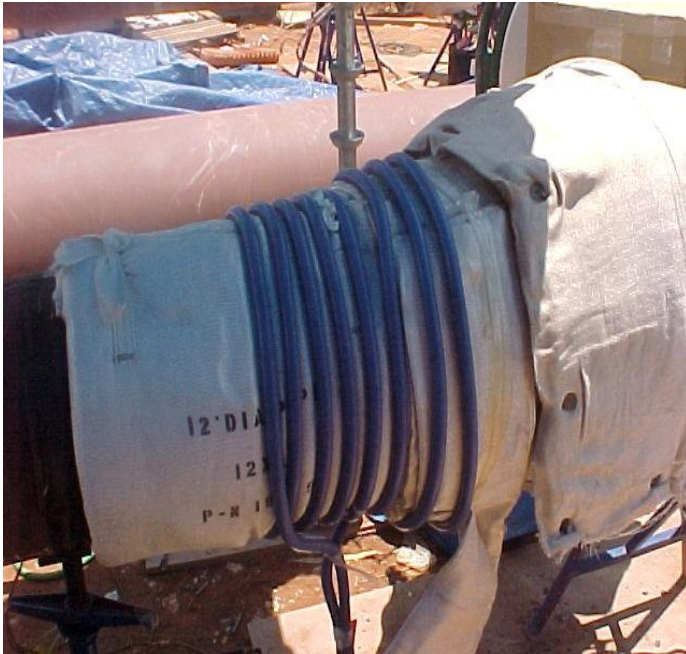


# ***Induction Heating***

## **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***

- 20" diameter – 90mm wall – P92
- Soak Temperature 1400° F (760° C)



# ***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***

- Uniform Heating
- Quick Time-To-Temperature
- Maintain Interpass





# ***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...***



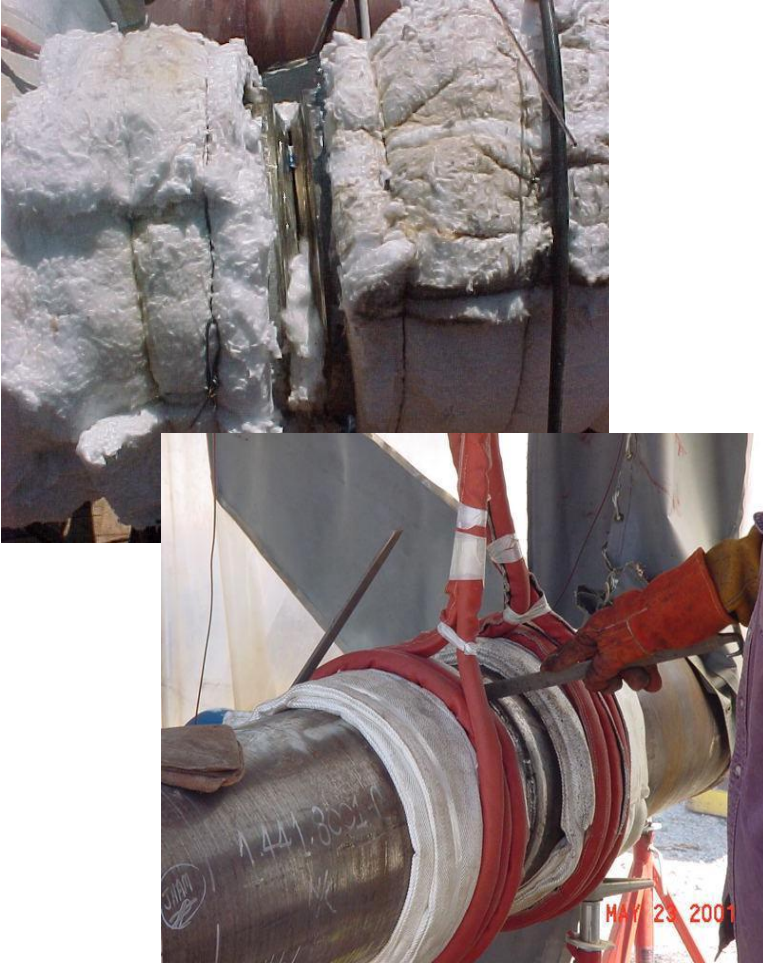
- Uniform Heating
- Inter-pass Control
- Proven Reliability
- Simple to Operate
- Welder Friendly Environment
- Portable
- Fast
- Safe

# ***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



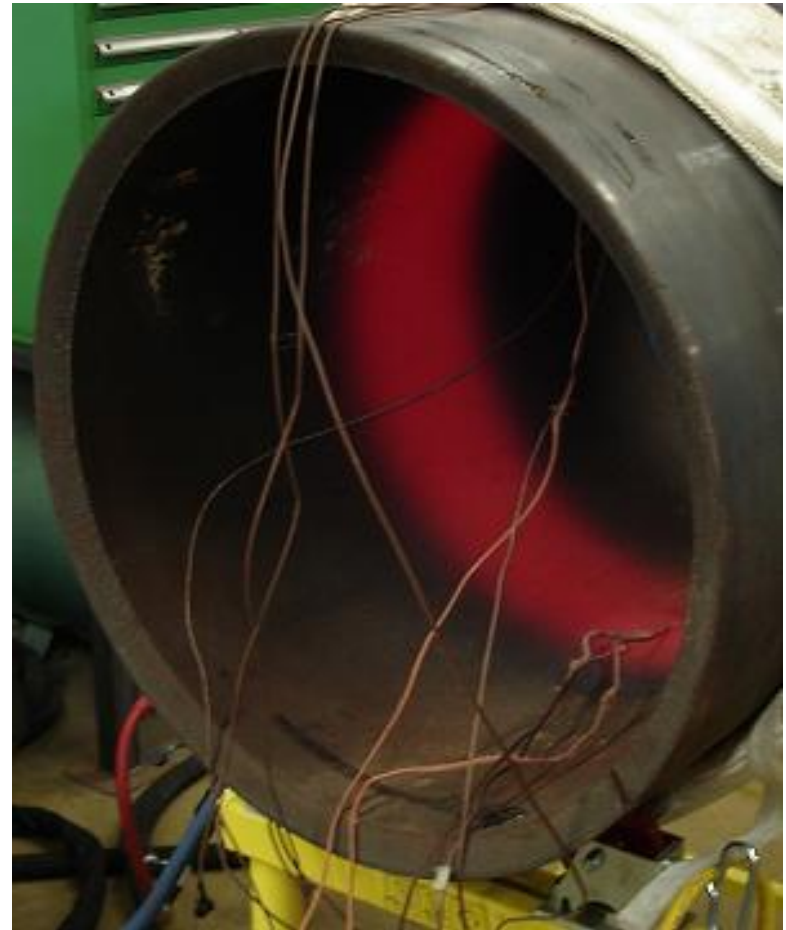
# ***Ease of Use***



- 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

The screenshot displays the Miller website's product page for the ProHeat 35 induction heating system. The top navigation bar includes links for 'Order Literature', 'Contact Us', 'Ready to Buy', and a search bar. The main header features the Miller logo and the tagline 'The Power of Blue'. Below this, a navigation menu lists 'PRODUCTS', 'WHERE TO BUY', 'SERVICE', 'RESOURCES', 'INDUSTRIES & INTERESTS', and 'ABOUT US'. The main content area is titled 'PROHEAT™ 35' and features a large image of the induction heating unit. To the right of the image, a 'New!' badge is followed by the text 'Hot Cost Savings'. Below this, a paragraph explains that Miller's unique induction heating technology can save hundreds of thousands of dollars per week by bringing a part to temperature in a fraction of the time and holding it at the specified temperature. A 'Share This' button is also present. Below the main image, there are links to 'ProHeat 35 Spec Sheet [PDF]' and 'ProHeat Induction Blankets [PDF]'. To the right of the main image, there is a section titled 'Order your FREE Understanding Induction Heating CD' with an 'Order Now' button. Below the main content area, there is a section titled 'Powering a Heating Revolution' with a subheading 'Induction Heat Systems Solve Ongoing Preheating & Stress Relieving Problems'. This section includes a paragraph about the ProHeat 35 system and a list of applications: 'Welding fabrication and construction', 'Preheating of welds', 'Post-weld heat treatment', 'Coating removal, and', and 'Shrink Fit'. A small image shows a pipe being heated. Below this, a paragraph states that applications that would typically require hours to heat can be done in minutes utilizing induction heating. At the bottom of the page, there is a section for 'eNewsletters' with a 'Subscribe Today' button and a 'Follow Us' section with social media icons for Facebook, Twitter, YouTube, and RSS. The footer contains links for 'Home', 'Products', 'Where to Buy', 'Service', 'Resources', 'Industry & Interests', 'About Us', 'Partner Login', 'International', 'Site Help', 'Privacy Policy', and 'Terms of Use'.

Miller

The Power of Blue

PRODUCTS WHERE TO BUY SERVICE RESOURCES INDUSTRIES & INTERESTS ABOUT US

PROHEAT™ 35

**New!** Hot Cost Savings

Compared to flame or resistance heating, Miller's unique Induction Heating technology can save hundreds of thousands of dollars per week. Induction heating brings a part to temperature in a fraction of the time and holds the part at specified temperature.

ProHeat 35 Spec Sheet [PDF]  
ProHeat Induction Blankets [PDF]

Order your FREE Understanding Induction Heating CD

Order Now

Summary How it Works Applications Calculators Resources Where to Buy/Rent

**Powering a Heating Revolution**  
Induction Heat Systems Solve Ongoing Preheating & Stress Relieving Problems

With the introduction of the Pro-Heat 35 Induction Heat System, this simple and cost-effective heating process can be applied in the following applications to deliver fast and consistent heat:

- Welding fabrication and construction;
- Preheating of welds;
- Post-weld heat treatment;
- Coating removal; and
- Shrink Fit.

Applications that would typically require hours to heat can be done in minutes utilizing induction heating. Discover the dramatic benefits of using induction compared to current processes by using the calculators for time-to-temperature for typical heating applications of pipe and plate.

In addition to the simplicity and efficiency of ProHeat, this heating system solves many key issues in today's environment:

- Induction heating does not require the significant expense of fuel gases;
- Induction heating produces fewer fumes than flame heating.

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- [http://www.millerwelds.com/products/induction\\_heating/](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