Vacuum Excavation Best Practice & Guideline – Suggested Updates

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March 2019
Best Practices for Vacuum Excavations around Live Gas Lines

- Guideline written by Keyhole Group, published by GTI, based on findings by an Enbridge sponsored research project by Waterloo University (Jan 2012)
  - #3: “Below a depth of 18” the water pressure to be used with a straight tipped nozzle during excavation shall be reduced to a maximum of 1,500 psi”
  - #4: “The maximum water pressure to be used at any time with a spinning nozzle during excavation shall be 3,000 psi”
  - #5: “The pressurized air or water wands shall never remain motionless during excavation”
  - #6: “A distance of 8” shall be maintained between the end of the pressure wand nozzle and the underground facility and/or subsoil”
Best Practices for Vacuum Excavations around Live Gas Lines

• Guideline written by GTI based on findings by an Enbridge sponsored research project by Waterloo University (Jan 2012)
  – Based on:
    • Ontario CGA Best Practices (June 2014)
    • IHSA Safe Practice Guide for Excavating with Hydrovacs in the Vicinity of Underground Electrical Plant (Sept 2013)
    • TSSA Guidelines for Excavations in the Vicinity of Gas Lines (Nov 2017)
Best Practices for Vacuum Excavations around Live Gas Lines

• Guideline written by GTI based on findings by an Enbridge sponsored research project by Waterloo University (Jan 2012)
  – Based on:
    • Ontario CGA Best Practices (June 2014)
      – 4-28: Defines Vacuum Excavation as using water or air jet devices
      – 4-30: Vacuum Excavation operators should follow the next two guidelines
    • IHSA Safe Practice Guide for Excavating with Hydrovacs in the Vicinity of Underground Electrical Plant (Sept 2013)
    • TSSA Guidelines for Excavations in the Vicinity of Gas Lines (Nov 2017)
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- Guideline written by GTI based on findings by an Enbridge sponsored research project by Waterloo University (Jan 2012)
  - Based on:
    - Ontario CGA Best Practices (June 2014)
    - IHSA Safe Practice Guide for Excavating with Hydrovacs in the Vicinity of Underground Electrical Plant (Sept 2013)
      - 100: “Hydrovac can be used as an alternate method to hand digging…”
    - TSSA Guidelines for Excavations in the Vicinity of Gas Lines (Nov 2017)
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• Guideline written by GTI based on findings by an Enbridge sponsored research project by Waterloo University (Jan 2012)
  – Based on:
    • Ontario CGA Best Practices (June 2014)
    • IHSA Safe Practice Guide for Excavating with Hydrovacs in the Vicinity of Underground Electrical Plant (Sept 2013)
    • TSSA Guidelines for Excavations in the Vicinity of Gas Lines (Nov 2017)
      – 8.1: “Hydrovac may be used as an alternative to hand digging”
      – Appendix 5: Procedures for using hydro-excavation machines to locate and expose pipelines as an alternative to hand digging
  • Where almost all of the numbers for the best practices came from
Best Practices for Vacuum Excavations around Live Gas Lines

• Guideline written by GTI based on findings by an Enbridge sponsored research project by Waterloo University (Jan 2012)
  – Biggest Questions:
    • Are straight jet water nozzles safe to operate within the guidelines?
    • Why is the safer spinning water nozzle not allowed to operate closer than a more dangerous straight jet water nozzle?
    • Why are there no specific guidelines for air lances?
Straight Jet Water Nozzle Testing Parameters

• Question 1: Are straight jet water nozzles safe to operate within the guidelines?

• Adhere to:
  – Best Practice #3 – Reduce the water pressure of a straight tipped water nozzle to a maximum of 1,500psi
  – Best Practice #6 – Maintain a distance of 8in between the end of the nozzle and the underground facility

• Background Information:
  – Waterloo tested straight jet water nozzles at pressures greater than 3,000psi
## Straight Water Nozzle

<table>
<thead>
<tr>
<th>Nozzle Name</th>
<th>Water Pressure</th>
<th>Pipe</th>
<th>Height Above Surface</th>
<th>Time to Puncture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vactor Reveal Nozzle (Single Straight Jet, 6 GPM)</td>
<td>1500psi</td>
<td>MDPE</td>
<td>8in</td>
<td>3 sec</td>
</tr>
<tr>
<td>Vactor Reveal Nozzle (Single Straight Jet, 6 GPM)</td>
<td>1500psi</td>
<td>MDPE</td>
<td>9in</td>
<td>4 sec</td>
</tr>
<tr>
<td>Vactor Reveal Nozzle (Single Straight Jet, 6 GPM)</td>
<td>1500psi</td>
<td>MDPE</td>
<td>10in</td>
<td>8 sec</td>
</tr>
<tr>
<td>Vactor Reveal Nozzle (Single Straight Jet, 6 GPM)</td>
<td>1500psi</td>
<td>MDPE</td>
<td>11in</td>
<td>12 sec</td>
</tr>
</tbody>
</table>
Video of Straight Water Jet at 8in

- Vactor Reveal Nozzle
  - Single Jet at 6 GPM – 1500 PSI
- Height Above Pipe = 8in
- Pipe = MDPE
# Triple Straight Jet Water Nozzle

<table>
<thead>
<tr>
<th>Nozzle Name</th>
<th>Pipe</th>
<th>Height Above Surface</th>
<th>Time to Puncture</th>
<th>Time to Pierce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vactor Reveal Nozzle (Triple Straight Jet, 8 GPM)</td>
<td>MDPE</td>
<td>8in</td>
<td>5 sec (Center and Right Jet)</td>
<td>None (After 3 min) (All Nozzles Punctured)</td>
</tr>
<tr>
<td>Vactor Reveal Nozzle (Triple Straight Jet, 8 GPM)</td>
<td>MDPE</td>
<td>10in</td>
<td>5 sec (Only Center Jet)</td>
<td>Not Tested</td>
</tr>
</tbody>
</table>

All Testing Performed at 1500psi
Straight Water Nozzle Testing Results

• Punctured at 8” height after 3 seconds
  – Is remaining in place for 3 seconds “motionless” (Best Practice #5)
• Punctured at heights greater than 8”
  – Longer time required spent motionless to achieve puncture

• Does this still satisfy the Best Practices for Straight Water Nozzles due to the motionless claim, or should they be updated?
Spinning Water Nozzle Testing Parameters

• Question #2: Why is the safer spinning water nozzle not allowed to operate closer than a more dangerous straight jet water nozzle?

• Adhere to:
  – Best Practice #4 – Maximum water pressure of a spinning water nozzle is 3,000psi
  – Best Practice #6 – Maintain a distance of 8in between the end of the nozzle and the underground facility

• Background Information:
  – Enbridge/Waterloo Testing found no damage to Aldyl-A and MDPE pipe with a spinning water when under 3,000psi at a height of 1in above the pipe
### Spinning Water Nozzle

<table>
<thead>
<tr>
<th>Nozzle Name</th>
<th>Pipe</th>
<th>Height Above Surface</th>
<th>Time to Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vactor HXXpose Nozzle #4 (Spinning, 3.2 GPM @ 2500 psi)</td>
<td>MDPE</td>
<td>5in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Vactor HXXpose Nozzle #4 (Spinning, 3.2 GPM @ 2500 psi)</td>
<td>MDPE</td>
<td>1in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Vactor HXXpose Nozzle #8 (Spinning, 6.3 GPM @ 2500 psi)</td>
<td>MDPE</td>
<td>1in</td>
<td>None (After 5 min)</td>
</tr>
</tbody>
</table>

**#4 Spinning Nozzle @ 1730psi**  
**#8 Spinning Nozzle @ 1600psi**
Video of Straight Water Jet at 8in

- Vactor Reveal Nozzle
  - Single Jet at 6 GPM – 1500 PSI
- Height Above Pipe = 8in
- Pipe = MDPE
Spinning Water Nozzle Testing Results

• No damage to MDPE pipe at 1 in above the pipe while staying motionless for 5 minutes
  – Validates results from testing done by Waterloo

• Why aren’t there less stringent standards for Spinning Water Nozzles?
  – Would encourage the use of safer nozzles if operators are allowed to use them at distances closer to the live gas line
Air Lance Testing Parameters

• Question 3: Why are there no specific guidelines for air lances?
  • Adhere to:
    – No Standards set for Maximum Air Pressure or Air Flow
    – Best Practice #6 – Maintain a distance of 8in between the end of the nozzle and the underground facility
  • Background Information:
    – Waterloo only tested water nozzles
    – TSSA Standards & IHSA Guidelines only account for “Hydrovac”
  • Goal
    – How safe are air lances while operating around MDPE & Aldyl-A Pipe?
# Air Lances – Standard Compressor

<table>
<thead>
<tr>
<th>Nozzle Name</th>
<th>Pipe</th>
<th>Height Above Surface</th>
<th>Time to Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Spade 2000 90 PSI/150 CFM</td>
<td>MDPE</td>
<td>5in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 2000 90 PSI/150 CFM</td>
<td>MDPE</td>
<td>3in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 2000 90 PSI/150 CFM</td>
<td>MDPE</td>
<td>1in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 2000 90 PSI/150 CFM</td>
<td>Pressurized MDPE</td>
<td>1in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 2000 90 PSI/150 CFM</td>
<td>Aldyl-A</td>
<td>1in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 2000 135 PSI/170 CFM</td>
<td>MDPE</td>
<td>5in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 2000 135 PSI/170 CFM</td>
<td>MDPE</td>
<td>3in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 2000 135 PSI/170 CFM</td>
<td>MDPE</td>
<td>1in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 2000 135 PSI/170 CFM</td>
<td>Pressurized MDPE</td>
<td>1in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 2000 135 PSI/170 CFM</td>
<td>Aldyl-A</td>
<td>1in</td>
<td>None (After 5 min)</td>
</tr>
</tbody>
</table>

Top = MDPE  
Middle = Aldyl-A  
Bottom = Pressurized MDPE
## Air Lances – Large Compressor

<table>
<thead>
<tr>
<th>Nozzle Name</th>
<th>Pipe</th>
<th>Height Above Surface</th>
<th>Time to Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Spade 4000 250 PSI/290 CFM</td>
<td>MDPE</td>
<td>8in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 4000 250 PSI/290 CFM</td>
<td>MDPE</td>
<td>5in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 4000 250 PSI/290 CFM</td>
<td>MDPE</td>
<td>3in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 4000 250 PSI/290 CFM</td>
<td>MDPE</td>
<td>1in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 4000 250 PSI/290 CFM</td>
<td>Aldyl-A</td>
<td>3in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 4000 250 PSI/290 CFM</td>
<td>Aldyl-A</td>
<td>1in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 4000 250 PSI/290 CFM</td>
<td>Pressurized MDPE</td>
<td>3in</td>
<td>None (After 5 min)</td>
</tr>
<tr>
<td>Air Spade 4000 250 PSI/290 CFM</td>
<td>Pressurized MDPE</td>
<td>1in</td>
<td>None (After 5 min)</td>
</tr>
</tbody>
</table>

Top = MDPE  
Middle = Aldyl-A  
Bottom = Pressurized MDPE
Video of Air Lance – Large Compressor at 1in

- Air Spade 4000 250 PSI – 290 CFM
- Height Above Pipe = 1in
- Pipe = Pressurized MDPE @ 60psi
Air Lance Testing Results

• No damage to MDPE, Aldyl-A, nor Pressurized MDPE pipe at 1in above the pipe while staying motionless for 5 minutes, even with a large compressor
  – Seems to be as safe as Spinning Water Nozzles

• Why aren’t there any different standards for Air Lances?
  – No requirements listed for allowable pressures and flows
  – Would encourage the use of safer tools
    • Large Compressor Air Lances break up the soil as fast as Straight Jet Water Nozzles (OTD Project 5.16.f) and are much safer
Recommendations of Changes to Best Practices

• Establish Separate Standards for Each of the 3 Nozzle Types
  – Straight Water Jet Nozzles
    • Define motionless as staying in place for more than 3 seconds
  – Spinning Water Jet Nozzles
    • Change the distance to be maintained to 1” for just these nozzles
  – Air Lances
    • Establish a separate standards for Air Lances
      – Set maximum air pressure and flow
      – Change the distance to be maintained to 1” for air lances
Next Steps

- Validation of this testing with further testing of air lances
  - Conduct tracer wire testing with air lances
  - Test air lances on steel and cast iron pipe
- Contact TSSA
  - Why did they set an 8-inch minimum distance?
  - Can we establish these 3 separate standards?
    - Especially for air lances since there currently are none
- Establish new Keyhole Working Group to update our document
Questions?