Vacuum Excavation Best Practice & Guideline – Suggested Updates

Travis Cottle
Engineer – GTI
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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)

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  - 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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  - Based on:
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    - 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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  - Based on:
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    - 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

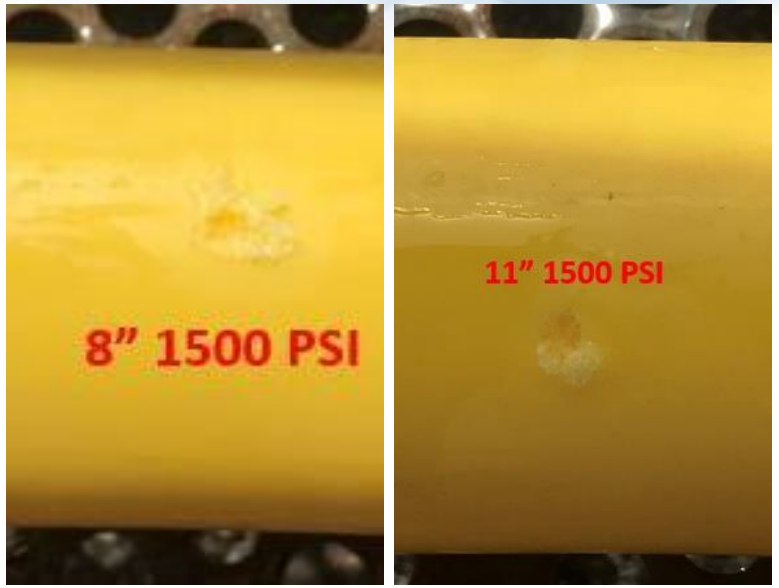
- Guideline written by GTI based on findings by an Enbridge sponsored research project by Waterloo University (Jan 2012)
  - Biggest Questions:
    - Are straight jet water nozzles safe to operate within the guidelines?
    - Why is the safer spinning water nozzle not allowed to operate closer than a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

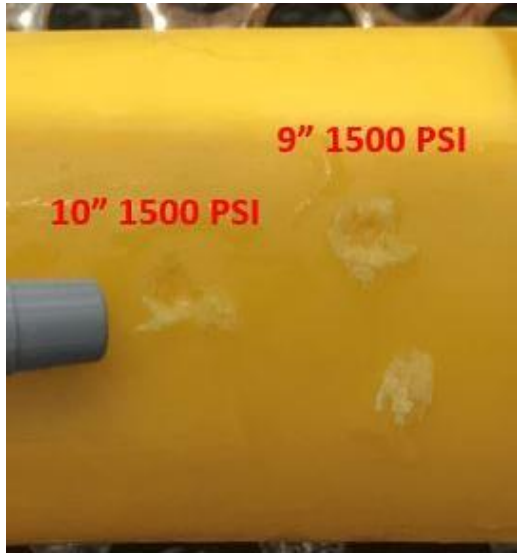
Straight Jet Water Nozzle Testing Parameters

- 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

Nozzle Name	Water Pressure	Pipe	Height Above Surface	Time to Puncture
Vactor Reveal Nozzle (Single Straight Jet, 6 GPM)	1500psi	MDPE	8in	3 sec
Vactor Reveal Nozzle (Single Straight Jet, 6 GPM)	1500psi	MDPE	9in	4 sec
Vactor Reveal Nozzle (Single Straight Jet, 6 GPM)	1500psi	MDPE	10in	8 sec
Vactor Reveal Nozzle (Single Straight Jet, 6 GPM)	1500psi	MDPE	11in	12 sec





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

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

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?

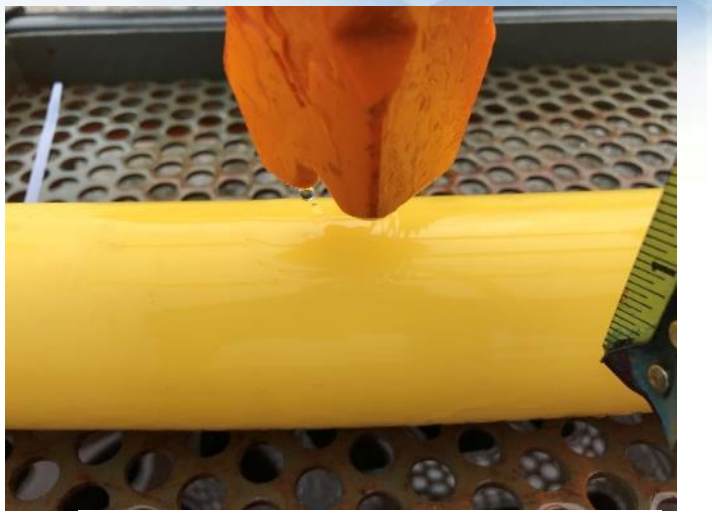
Spinning Water Nozzle Testing Parameters

- 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

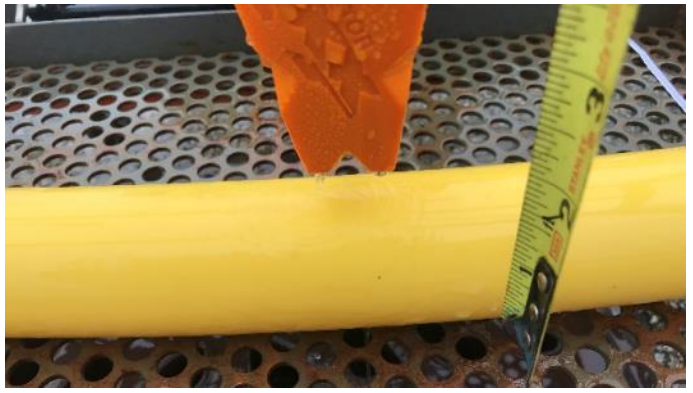
Spinning Water Nozzle

Nozzle Name	Pipe	Height Above Surface	Time to Failure
Vactor HXXpose Nozzle #4 (Spinning, 3.2 GPM @ 2500 psi)	MDPE	5in	None (After 5 min)
Vactor HXXpose Nozzle #4 (Spinning, 3.2 GPM @ 2500 psi)	MDPE	1in	None (After 5 min)
Vactor HXXpose Nozzle #8 (Spinning, 6.3 GPM @ 2500 psi)	MDPE	1in	None (After 5 min)

#4 Spinning Nozzle @ 1730psi
#8 Spinning Nozzle @ 1600psi



#4 Spinning Nozzle on MDPE @ 1” Height



#8 Spinning Nozzle on MDPE @ 1” Height

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 1in 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?

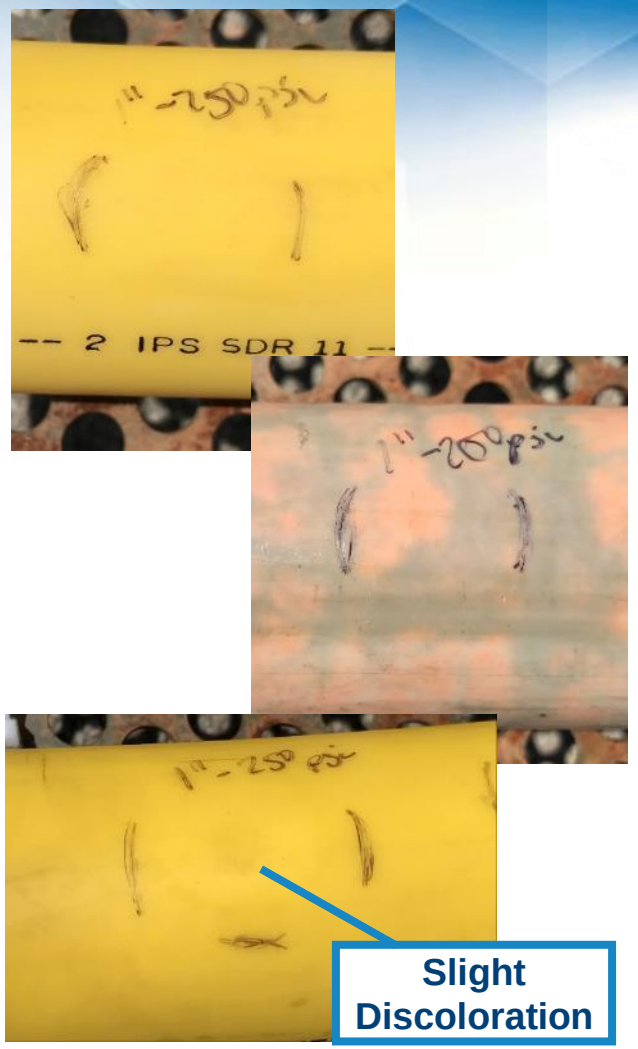
Air Lances – Standard Compressor

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

Top = MDPE
Middle = Aldyl-A
Bottom = Pressurized MDPE

Air Lances – Large Compressor

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



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?