

Construction Quality Assurance, Quality Control For Trenchless Technologies

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Editor's Note: This is the first in a series of articles aimed at exploring not only the overall concept, but also methods of implementing quality assurance, quality control procedures for the trenchless market.

According to the Environmental Protection Agency (EPA), \$11.6 billion in funding is required annually to sustain required sewer renovation in the United States. *Underground Construction* magazine estimates that actual spending will be closer to \$3.5 billion. This represents a significant shortfall of current spending that will need to be made up in the future. The "pay me now or pay me later" scenario becomes obvious.

Half of the over 20 million existing manholes and 72 million sewer laterals also need some rehabilitation which will add another one billion dollars annually to potential expenditures. The EPA now estimates that the nation must spend \$390 billion over the next 20 years to replace existing, deteriorating wastewater systems and to meet increasing demands.

The demand for trenchless technologies has therefore increased significantly. The reasons for this accelerated demand can be summarized by an increased awareness of our aging piping infrastructure, requirements by federal and state agencies to eliminate CSO's and SSO's, more frequent occurrence of premature or unexpected pipe failure under emergency conditions, and the many requirements placed on municipalities by NPDS permits and EPA consent decrees.

Traditional excavation techniques and the associated disruption of other utilities have made trenchless technology rehabilitation techniques increasingly desirable.

The technology choices to meet these demands are many as illustrated in Figure 1.



Raising the quality bar for the future will require significantly greater attention to quality assurances written into specifications, quality controls enforced in the field during construction and the enforcement of testing and inspection requirements.

Background

Trenchless technologies have evolved and improved significantly over the last 30 years. This evolution has resulted in improved and more efficiently installed products. Through this evolution, industry standards have been developed through trial and error and the efforts of organizations such as ASTM, ASCE, NASSCO and other standards associations. But even with this long evolution, technologies in some instances do not perform as expected. In many cases, the wrong products are specified or the incorrect tool is approved. Specifications are relaxed to accommodate multiple technologies, even though they may not be applicable or appropriate, for the sake of obtaining the lowest bid possible. The bottom line will always be, "You Get What You Pay For."

As a result, customers sometimes suffer the inconvenience of accepting inferior products or have the expense of subsequent replacement earlier than originally anticipated. The customer is unhappy and disillusioned about trenchless technology and may wait some time before attempting its use again.

So why are some technologies performing better than others?

In many cases, insufficient independent evaluation was performed on available technologies and the wrong technologies were specified for the project. Communication with reputable manufacturers and contractors and good research, by the engineer, can solve problems up-front in lieu of an evaluation after project start or completion. The detailed project specifications must then be specific and complete in all aspects.

After the best applicable products and technologies are selected, the contractor or applicator qualifications must be defined in the specifications so that installation is completed by knowledgeable and experienced personnel. It is important to independently verify the qualifications.

Weak specifications can be a major factor in poor technology performance. Quality assurance requirements in the specifications combined with well-conceived, written quality control verification requirements plus appropriate testing during installation will ensure quality technology performance.

Well-written and inspector enforced specifications, requiring qualified installers to perform in accordance with the QA/QC requirements and appropriate testing, will result in superior performance when using trenchless technologies for infrastructure rehabilitation.

Remember, the 80/20 rule simply states that 80 percent of all technology non-performance or failures result from inadequate specifications and unqualified contractors performing poorly – "human error."

Asking questions

If we are to be serious about achieving successful projects where, at the end of the job, the finished product meets and possibly exceeds expectations, the following questions need to be answered and further defined: *(continued on pg. 52)*

QA/QC For Trenchless Technologies

(continued from pg. 49)

- When is the finished product acceptable? (Properly installed, repaired or replaced);
- If it isn't acceptable, how is that determined? (Quality and acceptance criteria specified); and
- What can the industry do to achieve acceptable results more frequently? (QA/QC, testing and inspection).

Some prerequisites that can therefore be examined include correct product selection and qualifications. In order for trenchless technologies to perform on a consistent basis, the product selected must meet the specific requirements for the project and must have a performance history in the same or similar environments. Some key factors to consider include:

- Minimum product qualification (i.e., lineal feet in the ground, square feet applied, quantity and size install, etc.);
- Verifiable manufacturer quality control program for the product selected;
- Longevity and history of the selected material for similar applications;
- Verified third party testing of the material in a similar environment.

Once the product or products have been selected a detailed specification is prepared that will ensure performance by the contractor and deliver a final product that meets the customers expectations. Some typical specifications would include:

- Prescriptive (design) specifications;
- Applicable to custom projects. Detailed installation procedures and requirements are typically defined;
- Performance specifications – Typically, applicable to commodity products and systems. Leaves the means and methods of construction up to the contractor with defined QA/QC and testing procedures in the specifications;
- Combination of prescriptive and performance – Used for custom designs but with commodity product installation.

Prescriptive (design) type specifications are currently the most commonly type used in the trenchless technology industry. Some aspects would include:

- They can be open or closed;
- Open is most common, allowing for all identified competitive products;
- Modified open is limited to a specific family of products or specifically identified products;
- Closed might be specific to one individual product with unknown equals;
- The contract work items are usually specifically defined;
- Project constructed based on engineer's design and approval;
- Designer must be completely knowledgeable of the specified technology – and its practical application limits – in order to prepare specifications that enable the proper installation of the technology; and
- Construction difficulties or disagreements typically end up as change orders to the contract.

Performance specs

Performance specifications are becoming more popular in the trenchless industry. Some key aspects might include:

- Performance specifications strive to provide for the best commercial practices for the identified technology;

- They will typically define the QA/QC requirements and attract the most qualified contractors;
- Include a statement of the project requirements in terms of anticipated results typically termed a Performance Work Statement (PWS);
- Define the functional requirements of the product after installation;
- Include specific QA/QC, testing and inspection criteria for verifying compliance by the engineer;
- Specify construction or application by contractor means and methods and owner inspection for compliance; and
- Construction difficulties are typically the responsibility of the contractor.

Some key elements of performance specifications would include:

- Performance work statement (PWS);
- Detailed installer performance requirements;
- Measurable performance standards;
- Remedies for non-performance;
- Incentives for performance;
- Penalties for non-performance; and
- Quality Assurance Plan (QAP) including quality controls and testing requirements.

A performance work statement would contain such data as:

- Measurable rather than prescriptive performance requirements;
- Materials as specified and verified;
- Technology specific equipment requirements for efficient installation of the technology;
- Advertised or anticipated product performance;
- Verified contractor experience and training;
- Proposed inspection and testing to be performed during construction; and
- A detailed safety and hazard assessment plan.

Some performance specifications questions to ask:

- Can the contractor submit a competitive bid?
- Are performance requirements clearly defined?
- Are the required tasks realistic and achievable?
- Is there sufficient detail for submittals?
- Are all QA requirements clearly defined and measurable?
- Are all QC controls clearly outlined including documentation formats and requirements?
- Are delivery and completion dates clearly stated?

Figure 2

SAMPLE FORM Quality Assurance/Quality Control						
Contract Name: CIPP Lining		Contract No.:				
Contract Installer: _____		Construction Inspector: _____				
Report No. _____		Structure Temp: Ambient _____ Surface _____				
Other Work in Progress: By Pass Pumping, Clearing, Borehole Repairs, Traffic Control, CCTV						
No.	Quality Assurance	Performance Standard	Acceptable Quality	Quality Control	Inspection Results	Comments
1	Tube meet type, size, length thickness and quality as specified. Submit for third party testing as required.	ASTM F1248, F1943	100%	Measure the length, weight and thickness of material submitted for the project. Document all data for the daily logs.		Review testing lab report.
2	Resin meet type and quality as specified and approved. Submit materials for testing as specified.	ASTM D690 B, F1248, F1943	100%	Document resin and catalyst amounts and adhere to the formulas.		Review testing lab report.
3	Method - Quantity of resin used to impregnate tube. Wet-out procedure to ensure quality spots.	Industry Standard	90-100%	Follow mix instructions and use instructions.		
4	Curing and cool down of installed unit's resin-meet rate. Release pressure only after recommended temperature have been achieved.	ASTM F1248, F1943	90-100%	Verify cure times of cure temperature (per note) exceed 10 hrs.		
5	Final test pipeline shall be continuous defect free and 100% light within the host pipe.	ASTM F1248, F1943	95-100%	Final inspection and test. Pass/Fail note and record sheet. Check and B at joint connections and accessories.		
Contract Representative Name: _____		Signature: _____		Date: _____		
Contract Installer Representative Name: _____		Signature: _____		Date: _____		

- Are all testing requirements and time for performance defined and included in the specifications?

Contractor qualifications

Contractor qualifications are a major component for achieving a successful trenchless technology installation or application and must be clearly defined in the specifications. Some key aspects to evaluate would include:

- The contractor or applicator should be licensed, certified, trained, etc. by the manufacturer;
- An installation history of technology, by the installer for similar project size and applications, must be verifiable;
- Field supervision must be experienced and have a background on similar projects; and
- The personnel performing the work in the field also need to have a minimum experience requirement.

Equipment requirements

Equipment requirements as defined in the specification should be submitted by the contractor as part of the PWS and should reflect equipment as recommended by the product manufacturer having the correct size and capacity for the project. The plan should outline, proposed calibration requirements, inspection for operational ability and a back-up plan in the event of equipment failure.

Quality Assurance/Quality Control

Specifications Quality Assurance and Quality Control requirements contribute significantly to the success or failure of a project. They are the means for defining what is expected of the contractor and what will be done to verify that the work is being installed to the customer's requirements and satisfaction.

Quality Assurance requirements must be clearly defined in the specifications and must be technology specific. A QAP should be prepared and submitted by the contractor, conforming to the contract specifications, and outlining proposed points in the technology installation where quality control inspections will be performed. It must include a schedule for manufacturer's certifications submittals and raw material and finished product sampling and testing to be performed by the owner.

Clearly defined repair/replacement criteria for the technology in the event of defects or failure should be included in the QAP based on manufacturer's recommendations and owners expectations.

The QAP will define such aspects as the

purpose of the QAP, assignment of project responsibilities including communication between all parties and approval of all services to be provided, specific procedures to be followed, measures for performance assessment, performance controls and remedies defined.

Contract quality control requirements are an implementation of QAP and provide for the written documentation of quality control inspections. They are a guide for the inspector to determine the type and level of information to be documented during the installation of the technology. Figure 2 (pg. 52) is an example of a quality control form that would be used by an inspector to evaluate project performance during installation.

Inspector qualifications

Inspectors assigned to a trenchless technology project must have a minimum knowledge of the key aspects and components of the product or system being installed.

Inspector technology training should include knowledge of quality control documentation of the product being installed, and instrumentation to be used to verify compliance to the contract documents. They need to be able to recognize key elements of the products success or failure and must have defined responsibilities for quality control reporting during the project execution.

In some cases, training of the owners inspectors can be included as a bid item in the contract proposal. The contract specifications would require either independent trainers or manufacturers representatives to provide inspector training prior to the start-up of the project.

The impact of trained inspectors for reducing failures is significant. Trained and qualified inspectors improve quality and the level of quality control on the project, through increased and improved inspection techniques that contribute to project success.

Testing

Product testing must be performed by owner-paid and selected, qualified independent inspectors and/or testing laboratories. The laboratories must follow accepted industry specifications and testing protocol and must have a track record for the performance of the required testing.

Testing of the technology components can be performed through destructive or non-destructive methods.

- Non-Destructive – Visual or CCTV, sonar, spark testing, ultra sound, mandrel sizing and sample coupons; and
- Destructive – Core samples, pull tests and excavation.

Safety plan

A detailed safety plan including emergency procedures should be submitted and a Daily Job Hazard Identification & Communications plan should be defined and implemented prior to beginning the project.

Safety training may include: OSHA compliance, confined space entry, first aid/CPR, personal protection equipment certification, fall protection, trench safety, traffic control, by-pass pumping and others as applicable

Warrantees & warranty inspections

Warrantees are required by the owner more frequently and for extended time periods. In some cases, warrantees can be as long as 20 years. Warrantees without good periodic inspections are not nearly as effective as when inspections are performed. Warranty inspections are the key to the long term performance of trenchless technologies. Technologies may require different time intervals for inspection but all warrantees will be more effective if inspections are required.

Information which should be required in conjunction with the warranty inspection would include:

- Detailed time schedule for warranty inspections;
- Specific inspection type work to be accomplished;
- Parties who will be participating in the warranty inspection;
- Written documentation of inspection results based on specified requirements; and
- Acceptable remedies clearly defined in the specifications for repair and/or replacement of the product if defects are found.

Project results

Project results should meet or exceed the manufacturer's claims, meet the intent of the specifications and fulfill customer expectations.

About the author: Gerry Muenchmeyer, marketing director for Raven Lining Systems, has over 40 years of practical, hands-on industry experience, working for municipalities, contractors, manufacturers and as a civil engineer, and has been an active participant within the trenchless industry for decades. Muenchmeyer currently serves as president of NASSCO.