# GUIDELINES FOR QUALITY CONTROL (QC) OF

# NASSCO's PACP™, LACP™ and MACP™ Surveys


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## Table of Contents

## Introduction

Pipeline condition assessment has become of paramount importance for the worldwide underground infrastructure rehabilitation industry to ascertain critical condition states of a utility's assets. NASSCO Pipeline Assessment Certification Program (PACP), Lateral Assessment Certification Program (LACP), and Manhole Assessment Certification Program (MACP) have enabled various industry groups and stakeholders to provide for standardization and consistency in the way we evaluate a pipeline or chamber's condition, and how we manage visual inspection data.

Renewal decisions made by qualified individuals, such as engineers, based on the data collected, are subject to the accuracy and quality of this data. Therefore, the need for Quality Control (QC) of PACP/LACP/MACP data is essential, and procedures for it should be easily applied and audited.

## Purpose

This document is meant to provide QC guidelines for two primary use-cases: evaluation of an individual PACP-certified individual, such as a camera operator; or the evaluation of a project submission, such as from a sewer services contractor to an asset owner (utility) or engineer.

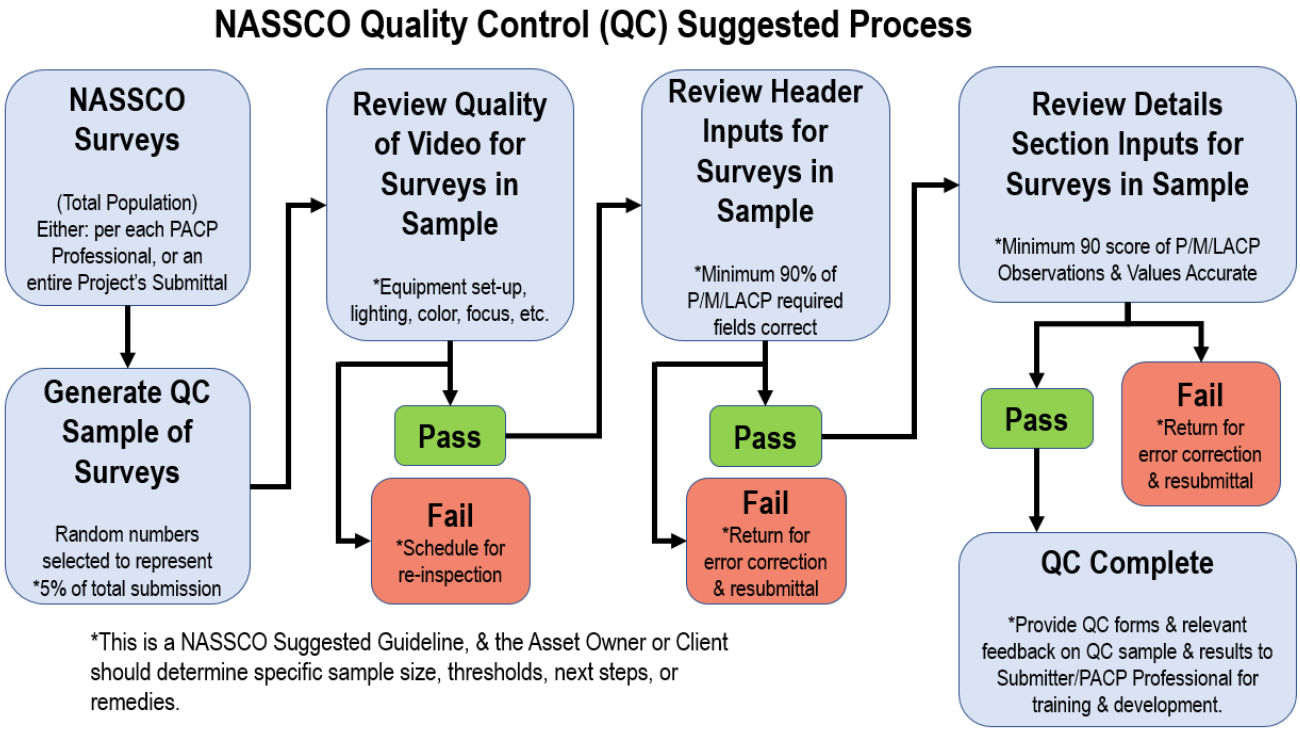
Thresholds for "Pass" and "Fail", or those for selecting the size of a QC sample population are NASSCO suggestions only, and the asset owner or client should determine, based on their unique project goals or circumstances, specific QC thresholds, or, in the event of QC Fail, next steps or remedies. The thresholds and resolutions should be included and outlined within contract specifications. Who is eligible to perform the QC should also be noted within the contract (i.e. a certified PACP/LACP/MACP user within the contractor's organization, within the client's organization, a third-party organization, etc.).

**General Method**

It is assumed that the PACP-certified individual(s) involved in creating the Surveys for QC possess current NASSCO certification, have provided a certified NASSCO PACP Interchange Database and have followed all relevant NASSCO guidelines for capturing data and creating Surveys, as per the most recent version of the PACP manual, specifically regarding:

- Visibility during inspection, such as providing an unobstructed (perspective) view of the entire pipe, including removal of obstructions, clean camera lens, minimal fogging, and sufficient lighting.
- Equipment set-up and appropriate cable calibration, such as beginning inspections at the interface of the pipe and access point wall (0.0 ft/m).
- NASSCO PACP camera speed limitation.

Inspection videos that do not meet the standards outlined above are to be rejected and the QC process need not continue. The QC processes described herein assume image and inspection quality meet these minimum requirements.



**Randomized Sample Population**

NASSCO pipeline condition assessment providers should have a Random Number QC procedure in place that can be used by clients to perform an audit. A Random Number is one of a series of numbers that have no detectable pattern, so that each inspection record in a total population has an equal chance of being selected. The client can carry out their own QC but it must be based upon the *Random Sampling* system, so that discrepancies regarding the method of choice of inspections to be reviewed are without bias. The intent is for the client to audit the CCTV contractor's QC procedure and not perform their own. If there is doubt regarding the results, the client may request a new set of Random Numbers to be created and be applied to the CCTV operator in question, thereby generating an additional set of inspections to be reviewed. A QC history may be created for each CCTV operator or PACP-certified individual, or created for each project or contractor.

Unbiased selection from a randomized sample population of PACP Surveys is fundamental to this QC procedure. In considering what portion of the total inspections that need to be checked (QC sample population), NASSCO suggests a minimum of 5% of Surveys be checked, and in cases where 5% of the total population yields a non-whole integer, then round up to the nearest whole number.

In the event a total sample population consists of fewer than 20 surveys, then one survey should be selected at random.

Example:

*If QC Sample is 5% of Total Sample of 25 Surveys, then:*
*25 * 0.05 = 1.25 then:*
*2 Surveys are selected for QC*

Generating random numbers can be performed by arbitrarily selecting surveys performed on different days at different times or by using an online resource for example, https://www.randomizer.org//.

## QC Procedures for Survey Headers

The Header of a PACP/LACP/MACP Survey is where general and descriptive information about the inspection and the pipe segment is found. This includes information, such as date of inspection and access point reference numbers. In order for datasets to be valid PACP/LACP/MACP deliverables for import and export, all mandatory fields must be populated with values as per the NASSCO Data Dictionary, plus optional fields that the client has stipulated to be populated. Prior to engaging in QC, PACP/LACP/MACP deliverables should first be validated using NASSCO Certified Software, to ensure databases are compliant, and do not contain missing or incorrectly input required fields.

Regarding the accuracy of completed fields in a validated database, it is NASSCO's suggestion that the accuracy of the Header records meet or exceed 90%, as most of the field contents are based upon quantitative observations, known asset identifiers, and other field-verified information.

The method for QC of the Header record is as follows:

Each of the required fields are counted, including both NASSCO standard mandatory fields and client-specified required optional fields; producing a "number of fields checked", for example 32.

Any fields with errors and/or nulls are counted, regardless of the level of severity of the error. In this example, an "error count" of 2 has been observed.

Therefore, the calculation is:

*(Error count / number of fields checked) * 100 = percentage error*
*100 - error percentage = accuracy percentage*
*(2/32) * 100 = 6.25%*
*100 - 6.25 = 93.75% accuracy level*

This accuracy level percentage (93.75%) is then logged within the QC Sample Population, which provides transparency in the calculated accuracy per the review. The table below provides an example of QC of mandatory PACP Header fields. Any discrepancies to the client's inventory data may be recorded and reported to the client.

## QC of PACP Survey Header Example

| Field | Description |
|---|---|
| Surveyed By | Ensure the PACP Certificate Number matches Surveyor's name, and that they are in good standing at the time of Survey |
| Certificate No. | Ensure the PACP Certificate Number matches Surveyor's name, and that they are in good standing at the time of Survey |
| Direction of Survey | Ensure accuracy and verify that it matches inventory data (GIS) |
| Street (Name & Number) | Ensure accuracy and verify that it matches inventory data (GIS) |
| Pipe Use | Ensure accuracy and verify that it matches inventory data (GIS) |
| Height (Diameter) | Measured accurately in the field and verify that it matches inventory data (GIS) |
| Shape | Ensure Shape is correct |
| Material | Ensure accuracy and verify that this matches inventory data (GIS) |
| Upstream MH No. | Verify that it matches inventory data (GIS) |
| Downstream MH No. | Verify that it matches inventory data (GIS) |

## QC Procedures for Survey Details

The Details Section of the PACP/LACP/MACP Survey is used to enter observations and defects observed in the interior of the pipe during the visual inspection. Each defect observation carries a numerical value used in the PACP Condition Grading System (see NASSCO's Pipeline Assessment and Certification Program Manual Appendix C), which is an essential tool in the process of asset management and planning. It is important to establish QC standards for the accuracy of condition assessment observations. The review structure provides a qualitative expression of accuracy based on Structural and O&M Grades (this includes some Construction and Miscellaneous family codes) for each PACP/LACP defect observation. The reviewer must be well versed in the PACP/LACP Condition Grading System in order to note the relative deduct scores based on the severity of the error of an observation or defect.

QC of the Details Form captures errors caused by missed observations, incorrectly coded observations that do not exist (false positives), incorrectly recorded codes (grease versus encrustation for example), incorrectly recorded clock positions and/or percentages. Each Details Form begins with an accuracy score of 100 points and points are deducted based on the following definitions:

| | |
|---|---|
| Large Error | -5 points |
| Medium Error | -3 points |
| Small Error | -1 points |

NASSCO suggests a minimum passing threshold of 90 points which would allow for 2 large errors.

**Large Errors (-5 points)** are defined as meeting any of the following:

- If the difference in condition grades between an observation made by the PACP-certified individual, and a correction noted during QC changes by 2 grades or more. Examples include:
    - Intruding lateral Tap connections which are not labeled as such.
    - Changing the Group code percentages for Deposits or Obstacles/Obstructions that result in a grade difference of 2 or more.
    - The use of the Miscellaneous General Observation (MGO) code to define a defect that otherwise has its own specific condition code, and results in a grade difference of 2 or more, depending on the defect being observed.
    - If a defect code that generates a Condition Grade of 2 or more that needs to be deleted (false positives for observations that do not exist).
- If a Structural family observation grade changes from Grade 3 to Grade 4.
- If a lateral Tap code was missed in a PACP inspection or a fitting code missed in an LACP inspection.
- If a continuous defect was started and/or closed down at an incorrect distance of 5 ft/1.5m or more in length of occurrence
- If distance value ("chainage") is incorrect for any observation by 5ft/1.5m or more.

**Medium Errors (-3 points)** are defined as follows:

- If the condition grade changes by 1 grade (with the exception of a Grade 3 to Grade 4 **structural** grades, which are defined as Large Errors). Examples include:
    - Changing the percentage of deposits or obstructions that would result in a grade difference of 1.
    - The use of the Miscellaneous General Observation (MGO) code to capture a defect that otherwise has its own specific condition code, and results in a grade difference of 1.
    - If a defect code that generates a Condition Grade of 1 needs to be deleted (false positives for observations that do not exist).
- If a mandatory ancillary field for any code has no (null) entry; e.g. Tap code with no size noted.
- If a Tap code is incorrect (i.e. diameter is off by more than 2in/50mm), or 2 clock positions or more in a PACP inspection.
- If a continuous defect should have been started.
- If a continuous defect was started and/or closed down at an incorrect distance of between 3ft/1m and 5ft/1.5m in length of occurrence.
- If chainage is incorrect for any observation by up to 5ft/1.5m.
- If Miscellaneous Water Level (MWL) was NOT coded for a 10% change or more.

**Small Errors (-1 points)** Small errors are defined as follows:

- If, due to a correction, the Condition Grade has not changed (e.g. TBA to TB, AMH to ATC, FBESL to FBEMR, FM to B, MGO to SZ, DSF 15% to DSGV 15%, etc.).
- If Miscellaneous Water Level (MWL) was coded but incorrectly by 10% or more.
- If an observation that has no score was missed, with the exception of Tap codes (e.g. Miscellaneous Material Change or Miscellaneous Size Change).
- If clock positions are incorrect by 2 clock positions or more (other than for tap codes) or if clock positions were recorded counterclockwise.
- If a defect code that does not generate a Condition Grade needs to be deleted.

If there is more than one error for a code, for example coding AMH at a distance never reached due to MSA and using the zoom function to the manhole; AMH instead of MSA = Small Error AND incorrect distance of between 3ft - 5ft = Medium Error - deductions are ONLY made for the worst/largest error. In this example, only 3 points would be deducted to reflect the Medium Error.

Another example of one line of code that may have two errors is coding Deposits Attached Encrustation (DAE) 10% from 2 o'clock to 10 o'clock, instead of the correct observation of 15% DAE from 10 o'clock to 2 o'clock. The two errors in this example are as follows: 10% to 15% DAE = Medium Error due to 1 grade change, and circumferential locations noted incorrectly counterclockwise = Small Error. In this example, only 3 points would be deducted to reflect the Medium Error.

Another example of a line of code containing two errors is Crack Multiple (CM) with one circumferential location recorded, instead of the correct observation of Fracture Multiple (FM) that requires two circumferential locations. CM to FM is a Structural Grade 3 to Structural Grade 4 defect change = Large Error and one mandatory ancillary field (circumferential location TO) was missed = Medium Error. In this example, 5 points would be deducted to reflect only the Large Error.

## QC Procedures for MACP

QC performed on MACP inspections are noted separately due to the complexity of MACP inspections. The data collected varies based on a Level 1 or Level 2 inspection, some codes are not applicable to MACP, and rules for recording continuous defects are different with respect to MACP. In general, MACP Level 1 and Level 2 inspections follow the same procedures as outlined for PACP and LACP. NASSCO recommends that QC be carried out by a minimum of 5% sample size; review of the quality of video/photos/model; and review of the quality of MACP inspection records.

### QC Procedures for MACP Survey Headers

The Header of a MACP Survey will follow the same QC process as outlined in the section "QC Procedures for Survey Headers." NASSCO continues to suggest a minimum 90% accuracy in the MACP Header mandatory fields and optional, client-required fields.

### QC Procedures for MACP Component Observation Form

Component Observation follow the same procedures as the Header section. It should be noted that a Level 2 inspection has many mandatory fields which may cause the QC process to become onerous within the Component Observation Form. Consider efficiencies in the QC process such a: removing the Component Observation Form from QC; QC of mandatory fields; QC of specific fields that may be particularly important to the customer; or reducing the minimum number of inspections to be checked. Please note that Version 7 has 1 to 5 condition grades for some observations. Previous versions do not have grades for components in this form.

### QC Procedures for MACP Details Section

The Details Section form is mandatory for a Level 2 inspection – optional for Level 1. The reviewer must be well versed in the MACP Condition Grading System in order to note the relative deduct scores based on the severity of the error of an observation or defect. It is important to note that MACP Condition Grading varies from PACP and LACP as outlined in Appendix C of the Version 7 manual (previous versions use the same grades). QC of the MACP Details Section continues to use the deduct scoring method; however, the definitions of the errors have changed with respect to MACP.

Each Details Form begins with an accuracy score of 100 points and points are deducted based on the following definitions: NASSCO suggests a minimum passing threshold of 90 points which would allow for 2 large errors.

| | |
|---|---|
| Large Error | -5 points |
| Medium Error | -3 points |
| Small Error | -1 points |

**Large Errors (-5 points)** are defined as meeting any of the following:

- If the difference in condition grades between an observation made by the PACP-certified individual, and a correction noted during QC changes by 2 grades or more. Examples include:
    - Changing the Group code percentages for Deposits or Obstacles/Obstructions that result in a grade difference of 2 or more.
    - The use of the Miscellaneous General Observation (MGO) code to capture a defect that otherwise has its own specific condition code, and results in a grade difference of 2 or more, depending on the defect being observed.
    - If a defect code that generates a Condition Grade of 2 or more needs to be deleted.
- If a Structural family observation grade changes from Grade 3 to Grade 4.
- If a continuous defect is recorded as starting and finishing in 2 different components.

**Medium Errors (-3 points)** are defined as follows:

- If the condition grade changes by 1 grade (with the exception of a Grade 3 to Grade 4 **structural** grades, which are defined as Large Errors). Examples include:
    - Changing the percentage of deposits or obstructions that would result in a grade difference of 1.
    - The use of Miscellaneous General Observation (MGO) code to capture a defect that otherwise has its own specific condition code, and results in a grade difference of 1.
    - If a defect code that generates a Condition Grade of 1 needs to be deleted.
- If a mandatory ancillary field for any code has no (null) entry – note 0% is an entry.
- If a continuous defect should have been started.
- If a continuous defect was started and/or closed down at an incorrect distance of 1ft/0.3m or more.
- If chainage is incorrect for any observation by 1ft/0.3m or more.

**Small Errors (-1 points)** Small errors are defined as follows:

- If, due to a correction, the Condition Grade has not changed e.g. FM to B, MGO to SZ, DSF 15% to DSGV 15%, IR in the Chimney to IG in the Chimney, etc.
- If an observation that has no score was missed e.g. Miscellaneous Water Mark or SZ.
- If clock positions are incorrect by 2 clock positions or more or if clock positions were recorded counterclockwise.
- If a defect code that does not generate a Condition Grade needs to be deleted.