Air Pollution Control Division

Technical Services Program

APPENDIX QA4

Standard Operating Procedure for the Zero Air Generator Verification

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Standard Operating Procedure for Zero Air Generator Certification

1 SCOPE AND APPLICABILITY

1.1 Introduction

This standard operating procedure (SOP) document describes the procedures used by members of the Air Pollution Control Division (APCD) to certify a Zero Air Generator (ZAG) at the State of Colorado, Department of Public Health and Environment's (CDPHE) lab and air quality monitoring sites. This includes ZAGs at State and Local Air Monitoring Stations (SLAMS), Special Purpose Monitoring (SPM), Photochemical Assessment Monitoring Stations (PAMS), and NCore monitoring stations. The CDPHE uses the Teledyne Advanced Pollution Instrumentation (TAPI) zero air generators in its air monitoring network and this SOP covers the 701 and 701H models. The procedures given in this SOP are a supplement to APCD's Quality Assurance Project Plan (QAPP), the latest information published in the Code of Federal Regulations, and the Operator's manual for TAPI zero air generators.

1.2 Method Overview

ZAGs are required by the EPA to be certified on a yearly basis. This is accomplished by certifying Level II (QA/CAL) ZAGs to a lab Reference ZAG (Level I). These Level II standards then will be used in the field to certify the station ZAGs (Level III). Table 1 shows the terminology and relationships between the Levels and where the certification is performed. Thus for a lab ZAG certification, the Reference ZAG is a Level I and the Candidate ZAG is a Level II. The Level II ZAGs are then used in the field at the stations as the Reference ZAG and the station ZAG is the candidate as a Level III. This procedure was developed to meet the EPA's annual requirement of ZAG certification.

Table 1 Certification Terminology

Level	Lab Certification	Field/Station Certification
I	Reference	
II	Candidate	Reference
III		Candidate

This method was developed in response to the inability to obtain a zero air gas cylinder standard with trace constituents lower than the various analyzers stated lower detectable limits.

1.3 Format and Purpose

The sequence of topics covered in this verification method follows 2007 EPA guidance on preparing standard operating procedures (SOPs) (US EPA, 2007). This method was also written to help personnel understand how and why key procedures are performed. The purpose of the SOP is to describe the certification process of a ZAG within the CDPHE air quality monitoring network.

2 SUMMARY OF METHOD

Once a year the lab Reference ZAG output concentration is measured by the lab instruments and is compared with and without additional scrubbers to determine whether the Reference ZAG scrubbers are operating at optimal efficiency. The additional scrubbers will have been replaced with new scrubber material at the time of the lab certification. A comparison of the Level II, QA and Calibration, ZAGs is performed against the Level I Reference

ZAG. This comparison will be done with and without additional scrubbers on the Level II ZAGs to determine the effectiveness of the current scrubbers in the level II ZAGs. Once the Level II ZAGs are certified, they will be introduced into the field during Calibrations and/ or QA audits to certify the Level III station ZAGs.

3 DEFINITIONS

The CDPHE/APCD/TSP QAPP contains an appendix P2 of acronyms and definitions. Any commonly used shorthand designations for items such as the sponsoring organization, monitoring site, and the geographical area will be defined and included in this SOP or in the QAPP.

4 HEALTH AND SAFETY WARNINGS

Electrical Hazards

1. Always use a ground wire on all instruments.

2. If it is necessary to work inside an instrument while it is in operation, use extreme caution to avoid contact with high voltage contacts inside the calibrator. There are high voltages in certain parts of the circuitry, including a 110 volt AC power supply. Refer to the manufacturer's instruction manual and know the precise locations of these components before working on the instrument

3. Avoid electrical contact with jewelry. Remove rings, watches, bracelets, and necklaces to prevent electrical burns.

4. Always unplug the calibrator whenever possible when servicing or replacing parts.

5 CAUTIONS

To prevent damage to the equipment, the following precautions should be taken:

1. Keep the interior of the instrument clean.

2. Inspect the system regularly for structural integrity.

3. To prevent major problems with leaks, make sure that all sample and calibration lines are reconnected after required checks and before leaving the site.

4. Inspect tubing for cracks and leaks.

5. It is recommended that the ZAG be leak checked after replacement of any pneumatic parts.

6 INTERFERENCES

Interferences are physical or chemical entities that cause measurements to be higher (positive) or lower (negative) than they would be without the entity. The ZAG scrubbers can become depleted or contaminated to create a less than optimal zero air output, requiring the replacement of the scrubbers. It is the intent of this SOP to identify and remove any interference in all reference and candidate ZAGs.

7 PERSONNEL QUALIFICATIONS

General Personnel Qualifications are discussed in the CDPHE/APCD/TSP QAPP main body.

8 APPARATUS AND MATERIALS

8.1 Equipment

8.1.1 Zero Air Generator

8.1.1.1 TAPI Model 701(H)

The regenerative, heatless dryer removes water and produces gas with a dew point of less than -20°C (up to 15 SLPM flow rate), independent of the inlet dew point, and assists in the removal of other gases, greatly increasing the life of the chemical scrubbers for the 701. The specifications for the 701 and the 701h are given in Table 2 and a typical 701 layout is given in Figure 1 (Teledyne-API, 2014).

The basic Model 701 includes an oil and diaphragm free pump plus scrubbers to remove SO_2, NO, NO_2, O_3 and H_2S. Optional high performance scrubbers are available to remove CO and Hydrocarbons.

Inlet air is pulled into the pump and routed through a pre-cooler and water trap to remove moisture. The air then passes through the regenerative scrubber for final drying and then to the storage tank.

Tank pressure is monitored and maintained at a preset level by cycling the pump automatically as needed, thereby extending both the pump and scrubber life. Outlet air then passes through a filter to assure a clean, dry, analytical zero air supply. A microcontroller cycles the regenerative dryer and water trap valves to prevent the pump from starting against full head pressure.

Table 2. TAPI 701 and 701H Specifications

Parameter	Specification		
	T701, 701	**T701H, 701H**	
Output	20 SLPM at 30 psig	30 SLPM at 35 psig	
Max delivery pressure	35 psig (50 psig for calibrators with special features that include restricted output).	35 psig	
Dewpoint	-20°C up to 15 SLPM -10°C above 15 SLPM	-40°C	
Dryer	Regenerative heatless dryer with lifetime of greater than 5 years		
Output Concentration	SO_2 and H_2S < 0.1 ppb	SO_2 and H_2S < 0.025 ppb	
	NO < 0.1 ppb	NO < 0.025 ppb	
	NO_2 < 0.1 ppb	NO_2 < 0.025 ppb	
	O_3 < 0.4 ppb	O_3 < 0.3 ppb	
	CO < 20 ppb[1]	CO < 10 ppb	
	HC < 5 ppb[1]	HC < 0.25 ppb	
Compressor	Internal long-life, oil-less piston pump		
Power[2]		**T701, 701** Typical Power Consumption [2]	**T701H, 701H** Typical Power Consumption [2]
	115 V~ 60 Hz, 7.0 A	230W (309 W)[1]	427 W
	220 – 240 V~ 50 Hz, 5.0 A	324W (357 W)[1]	402 W
Weight	56 lbs. (25.4kg) (64 lbs. (29kg))[1]	69 lbs. (31.3kg)	
Mounting	Bench type (standard), Rack mount (optional)		
Dimensions	8.75" H x 17"W x 28"D (22.2 cm x 43.2 cm x 71.12 cm)		
Operating Temp	5-40°C		
Environmental Conditions	Installation Category (Over Voltage Category) II Pollution Degree 2 Intended for Indoor Use Only at Altitudes ≤ 2000m Maximum Relative Humidity: 95%		

[1] with HC Scrubber or HC/CO option
[2] Power Consumption measured at 10LPM for T701 and 20LPM for T701H. Individual results may differ due to flow demand, altitude and temperature.

8.1.2 Wiring, Tubing and Fittings

Teflon™, stainless steel are inert materials that should be used exclusively throughout the zero air generations system. It is recommended that Polytetrafluoroethylene (PTFE) or Fluoroethylpropylene (FEP) Teflon™ tubing be used. PTFE or FEP Teflon is the best choice for the connection between an intake manifold and the bulkhead fitting. Examine the tubing and discard if particulate matter has collected on the tube's interior. All fittings and ferrules should be made of Teflon™ or stainless steel.

8.1.3 Spare Parts and Incidental Supplies

TAPI 701(H): See Chapter 6(Maintenance), Chapter 7 (Troubleshooting) in the TAPI "**Operation Manual Models T701, T701H, 701, and 701H Zero Air Generators**" for specific maintenance and replacement requirements.

8.2 Certification Equipment

The certification of the level II ZAGs are done in the lab with the lab standard suite of instruments. Analyzers for NOx, SO_2, and CO as well as a calibration system are utilized during the ZAG certification. An additional scrubber setup is required to test the candidate ZAG scrubber condition and function. The additional scrubber consists of a regulator to restrict output flow, canisters with activated charcoal, Purafil, and TAPI's CO catalyst. Level III ZAG certification will be done on site with site analyzers, a certified level II ZAG, as the Reference, for comparison.

9 CERTIFICATION PROCEDURE

9.1 Level II ZAG Certification

9.2 Introduction and Description of Procedure

The certification procedure consists of comparing the output of a Reference (Level I, Lab Standard) ZAG for all gaseous parameters to a Candidate (Level II) ZAG output.

9.2.1 Procedure

1. Turn on all the lab analyzers and dilution system
2. Connect all the analyzers and dilution system to a common manifold
3. Connect the Reference ZAG (Level I) to the dilution system and start a ZERO on the calibrator. See Figure 2 for the setup configuration.
4. Verify excess flow at the manifold with a minimum of 200 ccm of flow. And keep manifold pressure less than 10 psi.
5. Fill out the site name (use Lab), operator, and date and time sections in the ZAG Certification Form (Figure 3).
6. Fill out the Candidate section in the ZAG Certification Form.
    a. Record the make, model, and serial number of the Candidate ZAG.
    b. Record the date for when each scrubber was replaced for the Candidate.
7. Fill out the Reference section in the ZAG Certification Form.
    a. Record the make, model, and serial number of the Reference ZAG.
    b. Record the date for when each scrubber was replaced for the Reference ZAG.
8. Fill out the Reference External Scrubber section by entering the make and model of the scrubber unit and the most recent date that each scrubber media was replaced.
9. Fill out the Analyzer section on the ZAG Certification Form.
    a. Record make, model, and serial number
    b. Ensure that the As-is Zero Cal limit and the RMS Noise for each is up to date in the form (see Table 4).

10. Let the instruments stabilize for at least 30 minutes, while running a Zero on the calibrator.

11. Record a 10 minute average (based on 1 minute data logger averages) for the gaseous analyzers responses on the ZAG Certification Report.

12. Ensure that the Reference ZAG analyzer response is within the As-is zero calibration limit, if not perform a zero calibration on the analyzers and restart the ZAG Certification Procedure (Step 1).

13. Place the calibrator in STANDBY and disconnect the Reference ZAG from the dilution system.

14. Connect the Candidate ZAG (Level II) to the dilution system and start a ZERO on the calibrator (Figure 2)

15. Verify excess flow at the manifold with a minimum of 200 ccm of flow. And keep manifold pressure less than 10 psi.

16. Allow the instruments to stabilize for at least 30 minutes.

17. Record a 10 minute average (based on 1 minute data logger averages) for the gaseous analyzers responses on the ZAG Certification Report.

18. Place the calibrator in STANDBY and disconnect the Candidate ZAG.

19. Connect the external scrubber system after the Candidate ZAG and connect the output of the eternal scrubber to the calibrator's diluent in port. Reference Figure 2 for setup configuration.

20. Verify excess flow at the manifold with a minimum of 200 ccm of flow. And keep manifold pressure less than 10 psi.

21. Allow the instruments to stabilize for at least 30 minutes.

22. Record a 10 minute average (based on 1 minute data logger averages) for the gaseous analyzers responses on the ZAG Certification Report.

23. Compute the difference between the 10 minute averaged concentration measured when sampling from the Candidate ZAG and the 10 minute averaged concentration measured when sampling from the Reference ZAG for each of the gaseous analyzers. Use the equation,

    Equation 1. Difference Candidate from Reference

    $$Difference = Candidate\ Conc_i - Reference\ Conc_i$$

    where Candidate $Conc_i$ is the measured concentration of pollutant *i* when sampling the Candidate ZAG output and Reference $Conc_i$ is the measured concentration of pollutant *i* when sampling the Reference ZAG output.

24. Compute the difference between the 10 minute averaged concentration measured when sampling from the Candidate ZAG plus the external scubber system and the 10 minute averaged concentration measured when sampling from the Candidate ZAG without the external scrubber system for each of the gaseous analyzers. Use the equation,

    Equation 2. Difference Candidate from Candidate with External Scrubber

    $$Difference = CandidateExt\ Conc_i - Candidate\ Conc_i$$

where CandidateExt Conc$_i$ is the measured concentration of pollutant *i* when sampling the Candidate ZAG with the external scrubber system output and Candidate Conc$_i$ is the measured concentration of pollutant *i* when sampling the Candidate ZAG output.

25. Determine if the Candidate ZAG passes the certification

    a. The Candidate ZAG passes Certification if:

        i. Reference ZAG is within the As-is zero calibration criteria

        ii. $Candidate\ Conc_i - Reference\ Conc_i$ is within ± 5 X RMS Noise

        iii. $CandidateExt\ Conc_i - Candidate\ Conc_i$ is within ± 5 X RMS Noise

    b. If $Candidate\ Conc_i - Reference\ Conc_i$ is < -5 X RMS Noise, then there is an issue with the Reference ZAG scrubbers not operating at optimal efficiency and must be investigated. Once the issue is resolved (possibly by replacing the scrubbers) the zero certification must be repeated.

    c. If $Candidate\ Conc_i - Reference\ Conc_i$ is > +5 X RMS Noise, then there is an issue with the Candidate ZAG scrubbers not operating at optimal efficiency and must be investigated. Once the issue is resolved (possibly by replacing the scrubbers) the zero certification must be repeated.

    d. If $CandidateExt\ Conc_i - Candidate\ Conc_i$ is < -5 X RMS Noise, then there is an issue with the Candidate ZAG scrubbers not operating at optimal efficiency and must be investigated. Once the issue is resolved (possibly by replacing the scrubbers) the zero certification must be repeated.

    e. If $CandidateExt\ Conc_i - Candidate\ Conc_i$ is > +5 X RMS Noise, then there is an issue with the external scrubber system not operating at optimal efficiency and must be investigated. Once the issue is resolved (possibly by replacing the scrubbers) the zero certification must be repeated.

9.3 Level III ZAG Certification

9.4 Introduction and Description of Procedure

The certification procedure consists of comparing the output of a Reference (Level II) ZAG for all gaseous parameters to a Candidate (Level III) ZAG output. The Level III ZAG passes certification if the difference in analyzer response between the two is within specified criteria.

9.4.1 Procedure

The in situ field certification of station ZAGs (Level III, Candidate; see Table 1) uses the lab certified transfer standard Level II Reference ZAG, plus dedicated field external scrubber, just as the Lab Level I ZAG certifies the Level II ZAG in section **9.2.1 Procedure** above, but with one modification.

Because station calibrators, from their regular daily use, can accumulate small amounts of test gasses, such as SO2, that coat the calibrator's relatively large internal pneumatic surfaces, it can take variable, impractical lengths of time to flush the station calibrator fully for a proper ZAG III certification.

One station ZAG Level III test is done with the complete station system, including station calibrator (fig. 2), with no additions, as it would normally be operated, but this result is not used under the limiting criteria in Tables 3, 4, 5 and 6, <u>at least directly</u> (see below). This is recorded in the **Station ZAG + Station 700** row on the ZAG Certification Form (fig. 3).

Since the direct object of this procedure is to test and certify the station Level III ZAG with as few outside variables as possible, all other ZAG Level III tests are used with a familiar, clean and trusted audit or calibrations 700 calibrator, in place of the station 700. Alternatively, a dedicated audit or calibrations nonreactive stainless steel valve or regulator can be used. In any case the reference calibrator, valve or regulator is only used as a flow control device. As in section 9.2.1.4, make sure that there is a minimum manifold excess flow of 200 cc/m, and a manifold pressure less than 10 psi so that there is minimal back pressure on the station analyzers.

Thus the airflow train is different from that done in the lab:

On the ZAG Certification Form (fig. 3), for a Level III certification in the field, these terms represent these air flow configurations (differences from lab certification in **bold**):

Table A

Reference ZAG	Reference ZAG → **Audit/Calibrations Calibrator** → Manifold → Analyzer(s)
Candidate ZAG	Candidate ZAG → **Audit/Calibrations Calibrator** → Manifold → Analyzer(s)
Candidate ZAG + Scrubber	Candidate ZAG → External Scrubber System → **Audit/Calibrations Calibrator** → Manifold → Analyzer(s)
Station ZAG + Station 700	Candidate ZAG → Station 700 → Analyzer(s) (regular station set up)

On one row of the ZAG Certification Form, **(Stat 701/700) – Ref ZAG** is the difference between the full native station system and the Level II Reference ZAG, automatically calculated. Even though officially this value isn't used in the Level III certification under the limit criteria, it can be useful in defining what proportion of the non-zero difference seen is caused by the station calibrator alone when compared to the Candidate ZAG result.

In cases where the Level III ZAG passes all criteria, but the **Station ZAG + Station 700** does not, the accepted certification of the Level III ZAG stands, and judgement must be made about the station 700's effect on the supplied zero. Maintenance or cleaning may be needed for the station 700.

In situations where the Level III ZAG fails one or more criteria for tables 3, 4, 5 or 6, actions in table 3 are taken during that cert session, if possible, by the calibrations personnel (e.g. depending on availability of ZAG scrubber replacement material on hand, etc.). QA personnel will usually not perform any calibration or maintenance actions but report the out-of-spec situation.

All other procedures, schedules and reporting are the same as in the rest of this Zero Air Generator Certification document.

9.5 Reporting and Filing of Certification Results

All data is entered on the ZAG Certification Form which is built into the Calibration Database. This report is also a database which will store all the certification results and computes all the metrics to determine if the ZAG is within the specified criterion for passing certification. The master database is available on the J drive at J:\\ZSFILES\Calibrations\Master Calibrations DB. A copy of this database can exist on the operator's laptop and configured to upload data to the J:Drive master database. Once the report is complete a paper copy will be retained in the Zero Air Generator Certification Binder.

9.6 Zero Air Generator Scrubber Maintenance

9.6.1 Charcoal or Purafil© Change Procedure

To change either charcoal or Purafil:

1. Turn the Zero Air Generator off and unplug from wall socket.
2. Open the front of the zero air pack. There are two matt-silver cylinders. Take note of their order and orientation.
3. Disconnect the input line normally on the top of the right-hand cylinder. This will release pressure build up within the zero air pack which can be loud or startling.
4. Disconnect the output line normally on the bottom of the left-hand cylinder. Remove both cylinders which may be held in place with a strap.
5. Remove one end of the hose connecting the two cylinders.
6. Check the tubing for abrasions or rubbing that could lead to holes forming in the lines.
7. Remove the cap and the pad just inside the cap, and empty the contents into the trash.
8. Using a lint-free wipe, clean the inside of the cylinder and the pad.
9. If contamination is particularly high the pad on the other end of the cylinder may also be removed and cleaned.
10. Reassemble including refilling with fresh charcoal or Purafil by following the above steps in reverse order.
11. Ensure that the tubing is free and clear of objects and other tubing to minimize rubbing.

9.6.2 CO Scrubber Change Procedure

To change the CO Scrubber media:

1. Turn the Zero Air Generator off and unplug from wall socket.
2. Remove the lid of the ZAG.
3. Locate the CO scrubber housing, on the hydrocarbon scrubber heater, and remove the inlet and outlet tubing from the top of the scrubber cartridge.
4. Remove the unions.

5. Remove the four screws to remove the cartridge.

6. Remove the retaining screens.

7. Dump the catalyst media in the trash.

8. Reassemble including refilling with new CO catalyst media by following the above steps in reverse order.

9.6.3 Molecular Sieve change Procedure

To change the molecular sieve media:

1. Turn the Zero Air Generator off and unplug from wall socket.

2. Remove the lid of the ZAG.

3. Allow the pressure to bleed to zero (must be restricted)

4. Remove the two pneumatic connections and the electrical connection from the 4-way manifold.

5. Remove the dryer from the chassis by unscrewing the 4 captive screws in the dryer base.

6. Remove the 4-way valve bracket from the upper manifold and let the valve hang loose attached to the lower manifold.

7. Remove the upper manifold

8. Remove the two columns.

9. Remove the retainer pads from the two columns and dump the molecular sieve into the trash.

10. Wipe out the inside of the columns with a clean lint free cloth.

11. Examine the surface and ports in the upper and lower manifolds. If dirty or corroded, disassemble and clean.

12. Place two new clean retainer pads in each end of each column. Push pads 1/8 inch in to the column

13. Pour new clean molecular sieve into each column, up to ¼ inch from the top. Rap the side gently to settle the molecular sieve, and top up to the ¼ inch mark again.

14. Place two new clean retainer pads on top of the molecular sieve. Push the pad 1/8 inch into the column.

15. Change the four o-rings in the circular grooves in the upper and lower manifolds.

16. Place the bottom of the two columns with two pads in the circular groves in the lower column.

17. Wipe the ends of the columns, as they are the surfaces that seal the o-rings.

18. Place the upper manifold on top of the two columns. Ensure that the columns are in the grooves.

19. Replace the nuts and lock-washers on the three tie rods, but do not tighten them.

20. Push down hard on the center of the upper manifold with one hand and finger-tighten the nut to soft resistance.

21. With a wrench tighten each nut in turn, ½ turn at a time for an even seal.

22. Examine the fit of the columns in the manifold groove one more time.

23. Attach the 4-way valve bracket.

24. Replace the dryer in the chassis and tighten the 4 captive screws.

25. Reconnect the two pneumatic fittings and the valve power cord.

26. Plug in and turn on the 701.

27. Check for leaks, if none then 701 is ready for use.

10 TROUBLESHOOTING

10.1 Environmental Factors

Environmental conditions can play a role in the operational characteristics of calibrators. Some external factors may be constant while others are sporadic in nature. External factors to check include:

1. Is the shelter temperature stable throughout the certification sequence?

2. Is vibration from other equipment causing an effect?

3. Is the air conditioner or heater blowing directly on the instrument?

4. Is the ZAG pulling shelter air or ambient air into the inlet?

10.2 Zero Air Generator Troubleshooting

Troubleshooting of problems with ZAGs is specific to each ZAG and its design. Common problems with ZAGs include:

1. Flow problems (high or low)

2. Continuously running pump

3. Leaks

4. Poor scrubbing

5. No output

6. ZAG completely inoperative

Troubleshooting sections in specific ZAG operation and service manuals, located at each site or in the APCD office, should be consulted to assist in resolving instrument problems. Equipment used in troubleshooting includes digital voltmeters, pressure gauges, and caps.

Chapter 7 outlines the troubleshooting techniques for the ZAG in the 701, 701H, and T701 manuals, respectively. Troubleshooting techniques for the data logger and remaining sample system, including any external solenoid manifolds and calibration systems, are the purview of their respective SOPs, manuals, and the experience of qualified operators.

11 DATA MANAGEMENT AND RECORDS MANAGEMENT

11.1 Data Management

Data are generated from the analyzer(s) at intervals internally set, ranging from an averaging time of 20 seconds to 5 minutes. The data is collected by the on-site data logger as near-real-time data (often every 3 to 10 seconds) and is aggregated into 1 and 5 -minute averages.

11.2 Records Management

Records of laboratory ZAG Certification data are kept in both electronic and hard-copy formats. These records are kept in the relevant databases and filing locations. A hardcopy of the ZAG Certification Form is kept in the ZAG Certification notebook.

12 QUALITY CONTROL AND QUALITY ASSURANCE

The performance criteria for a ZAG to pass certification (outlined in Figure 4) are listed in Table 3. This criterion was developed by APCD. Since the ZAG certification procedure determines if the ZAG is producing clean zero air by comparing differences between a reference and candidate values, it is important to include the uncertainty in each measurement. APCD chose to use the manufacturer stated root mean square of the zero noise as the criteria to see if the difference is statistically different. Due to the long certification procedure the analyzers could drift during the certification, it was determined through testing that a typical certification could drift as much as one sixth of the EPA 24 hour drift requirement. Thus the 5 times the RMS zero noise would account for the drift and be the criteria of whether the difference is statistically different form zero.

Table 3. ZAG Certification passing criteria

Parameter	Passing Criteria	Action if Failure	Comments
Output Concentration: Reference ZAG	Less than or equal to As-is Zero Cal limit for each pollutant	Re-calibration of analyzer	Zero exceeds QC tolerance
Output Concentration: Candidate ZAG minus Reference ZAG	Greater than or equal to negative five times the RMS noise for each pollutant	Investigate Reference ZAG scrubbers	RMS noise is from each instrument manufacturer's manual
Output Concentration: Candidate ZAG minus Reference ZAG	Less than or equal to negative five times the RMS noise for each pollutant	Investigate Candidate ZAG scrubbers	RMS noise is from each instrument manufacturer's manual
Candidate ZAG with External Scrubbers minus Candidate ZAG	Greater than or equal to negative five times the RMS noise for each pollutant	Investigate Candidate ZAG scrubbers	RMS noise is from each instrument manufacturer's manual
Candidate ZAG with External Scrubbers minus Candidate ZAG	Less than or equal to negative five times the RMS noise for each pollutant	Investigate External Scrubber system' s scrubbers	RMS noise is from each instrument manufacturer's manual

The As-is zero cal limits are specified for each analyzer are listed in Table 4.

Table 4. As-is zero calibration limits and instrument zero noise RMS.

Analyzers	As-is zero cal limit	Zero Noise RMS	5x Zero Noise RMS
CO ambient	0.1 ppm	0.05 ppm	0.25 ppm
NOx Ambient	2 ppb	0.2 ppb	1.0 ppb
SO_2 ambient	2 ppb	0.2 ppb	1.0 ppb
Ozone	2 ppb	0.25 ppb	1.25 ppb

The As-is zero calibration criteria is based on the APCD's MQO. The APCD's final calibration criteria is the acceptable range during the adjustments of the instrument's background coefficients.

A scrubber replacement schedule has been created to ensure that the ZAGs are producing optimal zero air and is based on manufacturer recommendations. Table 4 lists the replacement schedule for each scrubber at each ZAG location, including the external scrubber system. Figure 5, is the form for each ZAG to record the replacement of any scrubbers in the ZAG. This information is also recorded in the ZAG Certification Form during the certification process.

Table 4. ZAG scrubber replacement schedule

Scrubber	Ambient Station (Candidate)	External Scrubber System	Lab Certification Rack (Reference)
Molecular Sieve	Every 3 years	Not Applicable	Every 2 years
Purafil	Yearly	Yearly	Yearly
Activated Charcoal	Yearly/ As needed	Yearly	Yearly
CO Catalyst	as needed	Every 2 Years or as needed?	Every 2 Years
Comments	ZAG in use Continuously	Used only for ZAG Certification	ZAG in use regularly

13 REFERENCES

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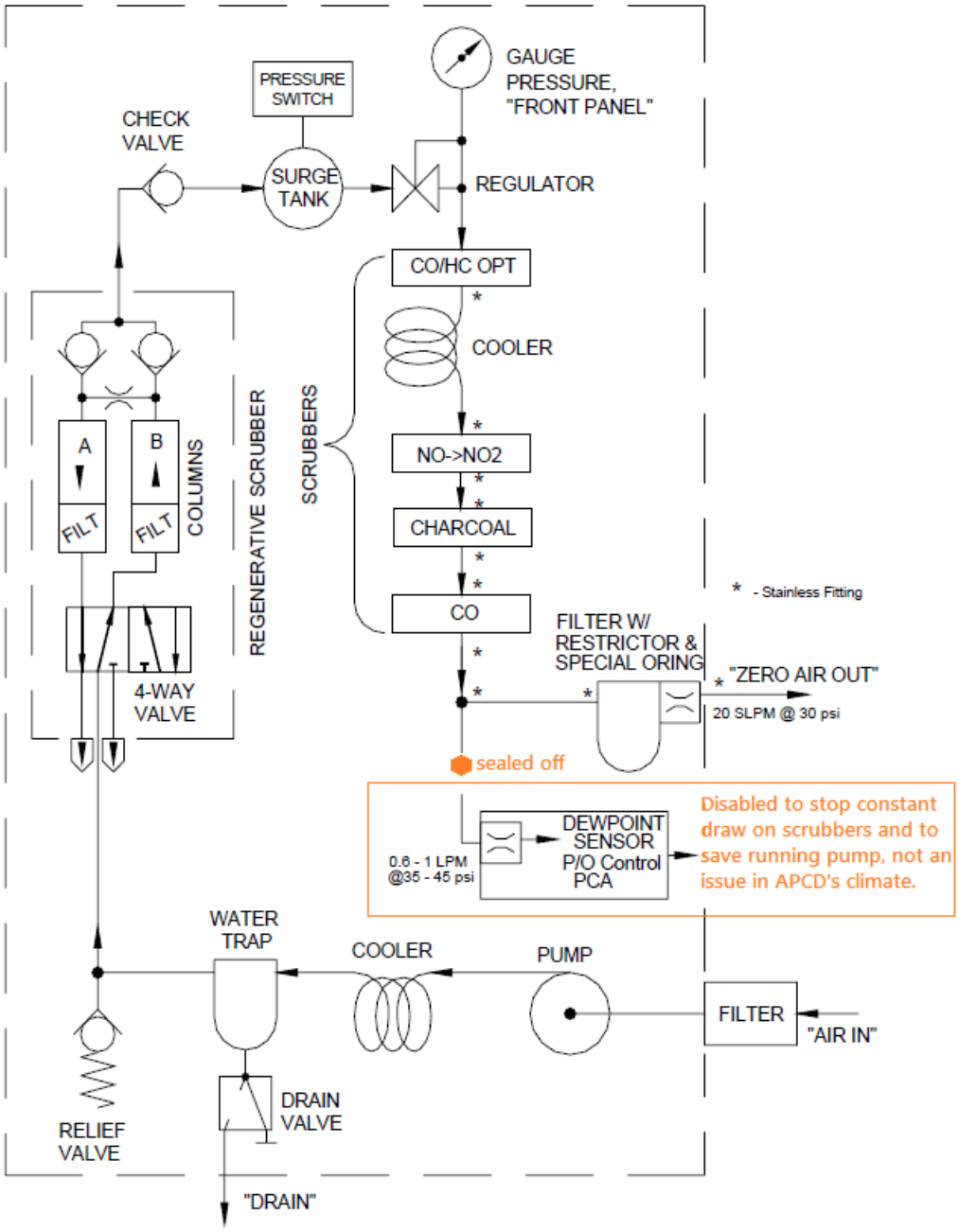

Figure 1 Typical zero-air supply system - TAPI 701H

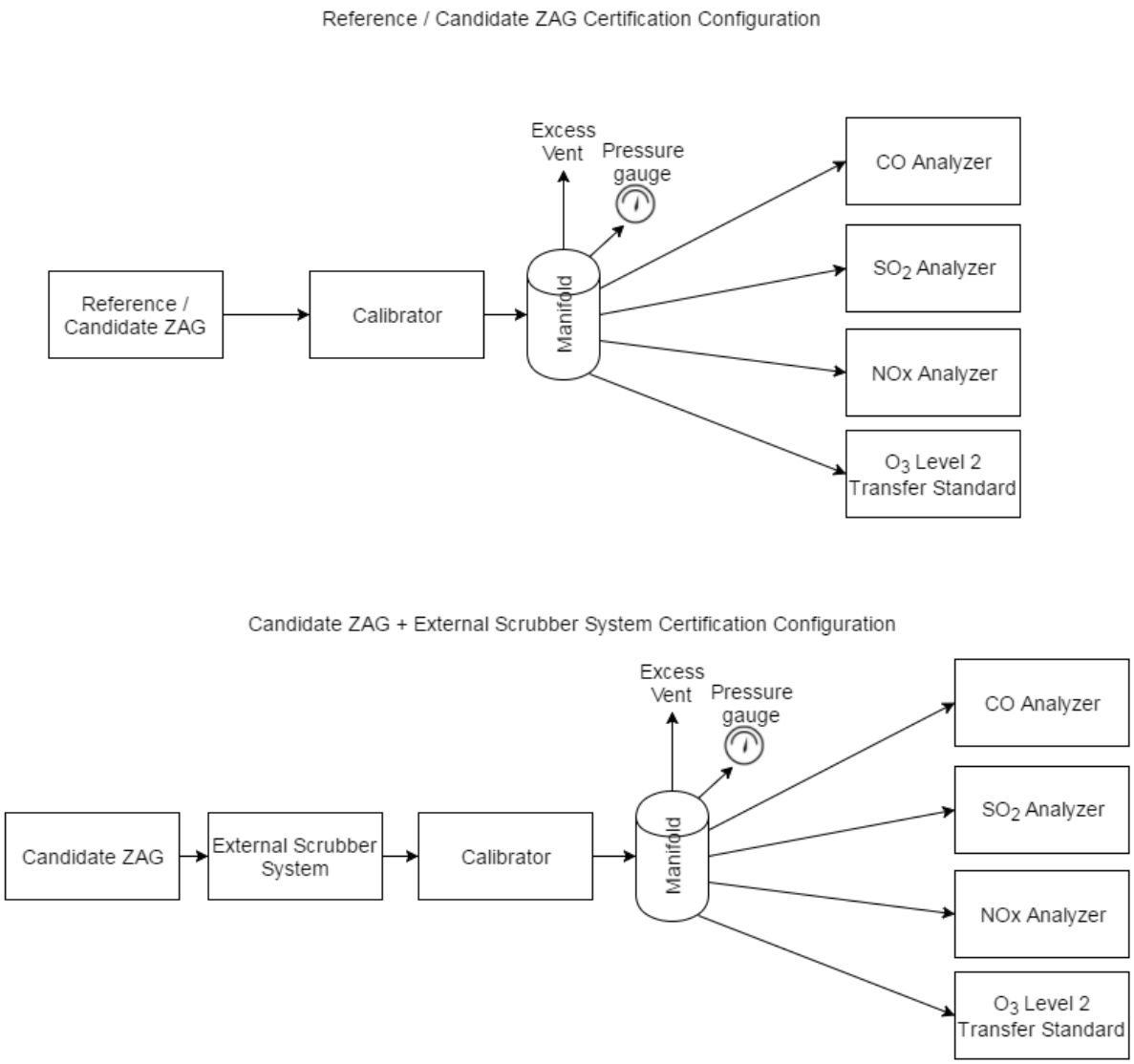

Figure 2 Zero Air Generator Certification Setup Configurations

Zero Air Certification Form

Calibrator's Initials
Date (mm/dd/yy)
Time (hh:mm)

Canidate ZAG (Level III) Make Model: SN: Owner:

Scrubber Install and Expiration Dates

Purafil: exp: CO catalyst: exp:
Charcoal: exp: Mol. Sieve: exp:

Reference ZAG (Level II) Make Model: SN:

Scrubber Install and Expiration Dates

Purafil: exp: CO catalyst: exp:
Charcoal: exp: Mol. Sieve: exp:

Reference External Scrubber Make Model: SN:

Scrubber Install and Expiration Dates

Purafil: exp: CO catalyst: exp:
Charcoal: exp: Mol. Sieve: exp:

Station/Lab Analyzers

CO Ambient
Make Model: SN: As is Zero Cal Limit: +/- 0.4 ppm RMS Noise: +/- 0.05 ppm

CO Trace
Make Model: SN: As is Zero Cal Limit: +/-40 ppb RMS Noise: +/- 20 ppb

NOx Ambient
Make Model: SN: As is Zero Cal Limit: +/-5 ppb RMS Noise: +/- 0.2 ppb

NOx Trace (NOy)
Make Model: SN: As is Zero Cal Limit: +/-0.25 ppb RMS Noise: +/- 0.025 ppb

SO2 Ambient
Make Model: SN: As is Zero Cal Limit: +/0.5 ppb RMS Noise: +/-0.2 ppb

SO2 Trace
Make Model: SN: As is Zero Cal Limit: +/-0.25 ppb RMS Noise: +/- 0.025 ppb

Ozone (laboratory evaluation only)
Make Model: SN: As is Zero Cal Limit: +/-n/a ppb RMS Noise: +/- 0.25 ppb

Response: 10 min Average

	CO Amb (ppm)	CO Trace (ppb)	NOx Amb (ppb)	NOx/NOy Trace (ppb)	SO2 Amb (ppb)	SO2 Trace (ppb)	Ozone (ppb)
Reference ZAG:							
Candidate ZAG:							
Candidate ZAG + Scruber:							
Station ZAG +Station 700:							

ZAG Cert Criteria

	CO Amb (ppm)	CO Trace (ppb)	NOx Amb (ppb)	NOx/NOy Trace (ppb)	SO2 Amb (ppb)	SO2 Trace (ppb)	Ozone (ppb)
Ref ZAG < Zero Limit:							
Cand. ZAG - Ref ZAG:							
Cand. + Ext - Cand. ZAG:							
(Stat 701/700) - Ref ZAG:							
5 x RMS Noise:							
PASS/FAIL:							

Comments:

Figure 3 ZAG Certification Form

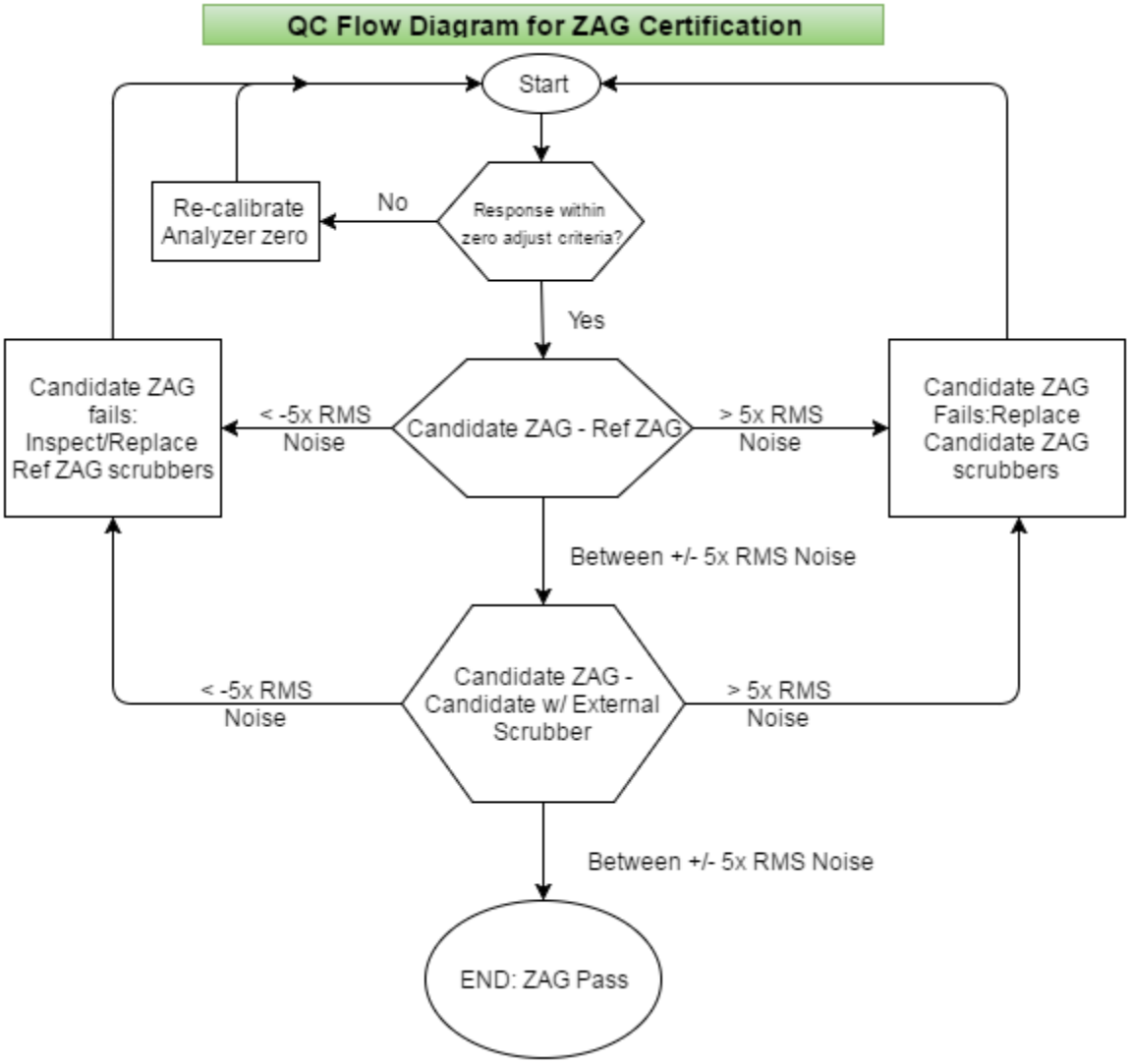

Figure 4 QC Flow Diagram for Certification of ZAG

Site: _____ 701 model: _____ SN: _____

	Scurbber Name	Date of Replacement	Operator
1			
2			
3			
4			
5			
6			
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Figure 5 ZAG Scrubber Replacement Schedule Form