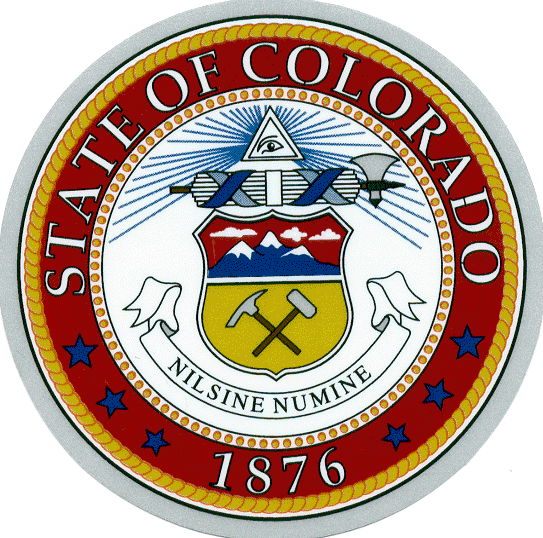
|  |
| --- |
| **ATTACHMENT C** |
| **GENERATION 2 COLORADO ON-ROAD VEHICLE EMISSIONS REMOTE SENSING (GEN2COVERS)**  **SPECIFICATIONS** |
|  |
|  |
| **April 2013** |



# Colorado Department of Public Health & Environment

# Air Pollution Control Division

# Mobile Sources Section

4300 Cherry Creek Drive South, Denver, CO 80246

PHONE:(303)692-3120**TABLE OF CONTENTS**

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**Department Mission**

The mission of the Colorado Department of Public Health and Environment is to protect and improve the health of Colorado’s people and the quality of its environment.

**Department Vision**

Colorado will be the healthiest state with the highest quality environment. The department will continue to work closely with our local public health and environmental health partners to make Colorado the healthiest place to live, and a place that offers its residents and visitors the highest quality environment. The department will serve as the recognized leader that sets the agenda for public health and environmental quality in the state. The Colorado Department of Public Health and Environment will be a model of efficiency in governmental processes by using creative and innovative means to achieve desired health and environmental improvements. The department is the place to work to make a difference in public health and environmental quality.[[1]](#footnote-1)

TITLE 42. VEHICLES AND TRAFFIC   
REGULATION OF VEHICLES AND TRAFFIC   
ARTICLE 4.REGULATION OF VEHICLES AND TRAFFIC   
PART 3. EMISSIONS INSPECTION

C.R.S. 42-4-301 (2012)

(1) The general assembly hereby finds and declares that [sections 42-4-301](http://web.lexisnexis.com/research/buttonTFLink?_m=cb48d704fe0c636a1083fb0c3c3531e5&_xfercite=%3ccite%20cc%3d%22USA%22%3e%3c%21%5bCDATA%5bC.R.S.%2042-4-301%5d%5d%3e%3c%2fcite%3e&_butType=4&_butStat=0&_butNum=2&_butInline=1&_butinfo=COCODE%2042-4-301&_fmtstr=FULL&docnum=1&_startdoc=1&wchp=dGLbVzt-zSkAz&_md5=4f063c42c3d6365239a2a8cf206f3705) to [42-4-316](http://web.lexisnexis.com/research/buttonTFLink?_m=cb48d704fe0c636a1083fb0c3c3531e5&_xfercite=%3ccite%20cc%3d%22USA%22%3e%3c%21%5bCDATA%5bC.R.S.%2042-4-301%5d%5d%3e%3c%2fcite%3e&_butType=4&_butStat=0&_butNum=3&_butInline=1&_butinfo=COCODE%2042-4-316&_fmtstr=FULL&docnum=1&_startdoc=1&wchp=dGLbVzt-zSkAz&_md5=ce0fd45b3e9280f652ff9d03d5a4f936) are enacted pursuant to, and that the program created by said sections is designed to meet, the requirements of the federal "Clean Air Act", as amended by the federal "Clean Air Act Amendments of 1990", 42 U.S.C. sec. 7401 et seq., as the same is in effect on November 15, 1990.

**42 U.S.C. section 7401 (Clean air Act Amendments of 1990)**

**(b) Declaration**

The purposes of this subchapter are—

(1) to protect and enhance the quality of the Nation’s air resources so as to promote the public health and welfare and the productive capacity of its population;

(2) to initiate and accelerate a national research and development program to achieve the prevention and control of air pollution;

(3) to provide technical and financial assistance to State and local governments in connection with the development and execution of their air pollution prevention and control programs; and

(4) to encourage and assist the development and operation of regional air pollution prevention and control programs.

**(c) Pollution prevention**

A primary goal of this chapter is to encourage or otherwise promote reasonable Federal, State, and local governmental actions, consistent with the provisions of this chapter, for pollution prevention.**I SCOPE**

This specification addresses roadside remote sensing equipment, performance requirements, acceptance testing, data format, audits, and quality assurance. In this specification, the words “shall” and “required” denote that the associated requirement is essential. The words “may” and “should” denote that the associated requirement is an objective. Failure to meet an objective must be fully substantiated. CDPHE reserves the right to revise or amend this specification as technology changes.

1. **REQUIREMENTS**

## General Requirements

Performance specifications and general technical requirements for GEN2COVERS are as follows:

* + 1. The GEN2COVERS shall measure and record tailpipe concentrations of Carbon Monoxide (CO %), total hydrocarbons in hexane (HC ppm), Carbon Dioxide (CO2%), and Nitric Oxide (NO ppm). [CO/CO2], [HC/CO2], and [NO/CO2] ratios shall also be recorded.
    2. The GEN2COVERS should be capable of sampling most vehicles during heavy traffic flow, at the rate of about one vehicle per 0.7 second with the best attainable accuracy.
    3. The GEN2COVERS shall sample vehicle exhaust at a rate of no less than 100 samples per second.
    4. The GEN2COVERS shall be stand alone.
    5. GEN2COVERS shall be battery operated and capable of sixteen hours of continuous operation per charge.
    6. GEN2COVERS ancillary equipment, including but not limited to the license plate capture, speed / acceleration, and computer systems shall be battery operated.
    7. GEN2COVERS shall record a video image of each vehicle where an emissions reading is collected including its license plate; rear pictures are required for each plate capture. Automatic license plate readers (ALPRs) are preferred. ALPRs if used shall have a capture rate of at least 97%. Video images shall be linked to vehicle records by: Site Code, Test Date, Detector Unit Number, Record Number, and shall have at a minimum the GEN2COVERS Detector Unit Number, Site Code, Record Number, and Test Date, superimposed on every image. Emission readings shall also be on the images as well as Bookend Status, Speed, Acceleration, Samples, and Max CO2.
    8. GEN2COVERS shall record the vehicle’s speed and acceleration at which the emission reading is taken. Data host processing shall calculate and record Vehicle Specific Power[[2]](#footnote-2) (VSP) based on the latest CDPHE approved VSP equation for each record.
    9. GEN2COVERS should be capable of measuring emissions of vehicles with ground to body panel clearances of 5 to 14 inches (road surface at lane center to bottom of body panel) with original equipment tailpipe heights on both passenger cars and light trucks including but not limited to pickups, vans, and SUVs.

1. The GEN2COVERS shall automatically and continuously compensate for background emissions for each interest gas.
2. The GEN2COVERS shall automatically and continuously compensate for the effects of temperature and pressure. Ambient temperature and pressure shall be part of each record.
3. The GEN2COVERS shall undergo a calibration upon start-up, or upon failing any individual calibration verification audit (CVA), or for other errors including but not limited to alignment alarms. Parameters shall not be set and equipment shall be maintained to promote alarms that may force unnecessary calibrations. The GEN2COVERS shall prompt for a calibration and/or CVA when required. Calibration procedures must be automated to the point that authorized personnel can accomplish this via wireless or cellular communication if needed. The GEN2COVERS shall record background emission readings before, and after calibration. The calibration information shall be recorded in a calibration file with the correct format as detailed in GEN2COVERS Specifications section IV.
4. Calibration Verification Audit (CVA)
   1. CVA is a mandatory, periodic audit procedure that verifies the most recent calibration is within a predetermined acceptable range. It must occur at a minimum within fifteen minutes after every calibration. It may occur at any time after that and shall be performed via internal gas cell containing gases approved by CDPHE.
   2. Based on CVA cell gas values, the GEN2COVERS shall automatically compute the expected gas readings (the gas readings that the GEN2COVERS should report if there are no measurement errors). Pass-Fail limits and tolerances are then automatically based on the expected values.
   3. The maximum pass-fail tolerances shall be no greater than + 12% of the expected bottle values or no greater than an absolute value of ± 0.20 for CO, ±200ppm for HC, or ±200ppm NO whichever is greater, and shall consist of no more than three (3) consecutive passing CVA cell cycles for a pass or two (2) consecutive failing CVA cell cycles for a failing CVA. Cell cycles shall be controlled by software. A cell cycle is one round trip of the cell into and out of the IR/UV beam.
   4. If the overall pass/fail status is pass, the CVA is automatically completed.
   5. If CVA status does not reach a pass condition, the GEN2COVERS automatically enters into a data collection lockout status. A successful calibration and CVA is then required to change the status from “Lockout” to a “Go” status.
   6. Each of the CVA cell cycles shall be marked pass or fail according to the pass-fail limits. The overall CVA session result (pass or fail) is recorded in a CVA Session Status field written to every GEN2COVERS record.
5. Successful completion of the initial calibration and subsequent CVA shall constitute an opening “Bookend.”
6. For data to be considered usable it must be collected between two “bookends.” A closing bookend shall be the result of a Contractor’s Quality Assurance Check (QAC) or DOR Audit per Audit Procedures, section VII.
   1. **Detector and Source Requirements**
      1. All components shall be height adjustable for varying road conditions and stable enough to withstand normal roadside vibrations and environmental conditions with minimal disruption to operation or accuracy. Automatic or remote controlled alignment correction is preferred.
      2. GEN2COVERS wiring harnesses should be integrated to the greatest extent possible and should withstand repeated set-up and tear down.
      3. All GEN2COVERS components not climate-controlled (heated / cooled) must be capable of continuous operation with no appreciable degradation in performance at ambient temperatures ranging from 20oF to 120°F.
      4. A spinning band-pass filter / single stationary detector arrangement shall be used for infrared-based channels and a spectrometer shall be used for ultraviolet channels.
   2. **Software Requirements**
7. The operating system for the GEN2COVERS shall be Microsoft Windows 7 or newer.
8. A firewall shall be present and shall be Norton, MacAfee or AVG. The firewall shall be kept up to date.
9. Antivirus software shall be present and shall be Norton, MacAfee or AVG. Antivirus software shall be kept up to date.
10. Wi-Fi access shall meet the 802.11g standard at a minimum and be secured according to the WPA2 standard.
11. GEN2COVERS software shall be secured from unauthorized personnel. Privileges shall be assigned for State-authorized personnel to access GEN2COVERS parameter, configuration, and communication files, flash memory, and the registry. No field or in-use access shall be permitted to the OEM calibration curves. Access to calibration curves is only for OEM engineers and scientists when the unit is not within the boundaries of the State of Colorado. Any time a unit leaves the State it shall be acceptance tested by CDPHE before it returns to State service. All units submitted to CDPHE for acceptance testing shall be accompanied by a Contractor’s Certification report verifying the instrument meets the accuracy requirements set forth in this document. CDPHE staff shall have access to necessary levels of operational software security, for acceptance testing purposes.
12. The CDPHE and the DOR shall have access to all fields necessary for program analysis and quality control. The Contractor may establish (but must identify and document) any information or tables considered proprietary.
13. In the event of a failed calibration, the software shall flag data as invalid until the GEN2COVERS passes subsequent calibration and CVA.
14. Prior to submitting any software revision for authorization and introduction into State service, the Contractor shall provide CDPHE with written documentation to include:
    1. Engineering Modification Request (emr)
       1. Written description of proposed changes and affected functions.
15. Approved data will be identified as such once the GEN2COVERS passes its Quality Assurance Check (QAC) or DOR Audit closing bookend.
16. A separate identifier is required for CVAs, DOR Audits and QACs.
17. Stand-alone software will be provided in each GEN2COVERS unit for managing DOR Audit data and printing of those results. In the case of stand alone units, DOR audit results may be collected on a flash drive or similar device and printed at a later time if necessary.
    1. **COMMUNICATION REQUIREMENTS**
       1. Wi-Fi hardware shall be compatible with the 802.11g standard at a minimum.
       2. Cellular modem shall be equivalent to, at a minimum, as of October 2012, the AirLink Raven XE Intelligent 3G Gateway.
    2. WIRELESS / WI-FI CELLULAR COMMUNICATION / ACCESS
       1. GEN2COVERS may be wireless / Wi-Fi / cellular communication capable.
          1. If wireless capable the system shall be DOR and CDPHE accessible via smart phone (iPhone and android platforms), iPad, and /or laptop.
          2. Contractor shall supply each GEN2COVERS DOR auditor with a laptop.
          3. Contractor shall supply CDPHE with one laptop.
          4. Contractor shall supply CDPHE and DOR with a GEN2COVERS app that is iPhone and/or Android compatible.
       2. If GEN2COVERS not intended for wireless / Wi-Fi / cellular use, then all wireless / Wi-Fi / cellular hardware must be removed, and not simply deactivated.
       3. No more than three remote users may be connected to the unit by Wi-Fi and/or cellular at any one time. A message box shall notify user #4 that they are not currently allowed access to the system.
       4. Any emails originating from the unit shall be copied to a designated State CDPHE and DOR recipient.
       5. DOR auditors shall have the ability to disconnect cellular communications during audits and prohibit other Wi-Fi connected users from accessing the unit during audits.
       6. Wireless / Wi-Fi / cellular access shall be password protected.
          1. Password levels:
             1. **Level 1:** used to access GEN2COVERS operational status including but not limited to battery status, hit rate, record count, temperature, pressure, speed acceleration and camera status.
             2. **Level 2:** used to access / change GEN2COVERS Parameter fields CO2 and NOx only. Level 2 includes Level 1.
             3. **Level 3:** used by OEM engineers only to assess / change / update GEN2COVERS software and/or parameters.
       7. CDPHE shall have Level 2 passwords and may request temporary Level 3 passwords.
       8. CDPHE shall have at all times up-to-date lists of all individuals that have passwords, and their password levels.
       9. Wireless / Wi-Fi / cellular access may include but not be limited to:
          1. Calibration, CVA, QAC, GEN2COVERS Parameters, software updates, GEN2COVERS monitoring, and data transfer.
          2. DOR audits by DOR personnel only.
       10. DOR and CDPHE Wireless / Wi-Fi / cellular Access Notification
           1. The GEN2COVERS if wireless / Wi-Fi / cellular capable shall generate an email to DOR and CDPHE **any time** the GEN2COVERS is accessed in addition to emails specified in II.E.2.2 above.
           2. Emails shall include but not be limited to the following information:
              1. Date and time of log on, unit number, site code, and employee number (Contractor/DOR/CDPHE), date and time of log off, and record range between log on and log off.
              2. Reason for access and any changes to the GEN2COVERS. Reasons shall include but not be limited to GEN2COVERS access to assess battery charge, record count, hit rate, speed / acceleration, camera status, GPS location, and alarms. Changes shall include but not be limited to recalibration due to an alarm, routine CVA, QAC or DOR audit performed, camera re-alignment, GEN2COVERS parameter change, etc. Any email resulting from a change shall include the pertinent before and after change values.
    3. **BATTERY POWER**
       1. The battery / batteries shall supply adequate power for sixteen continuous hours of use at ambient conditions of 20 – 120oF and 0 – 95% humidity (non-condensing).
18. **PERFORMANCE SPECIFICATIONS**
    1. **Detector Accuracy**
19. The CO2% reading shall be within an absolute ± 0.25 value or ±10% of the Certified Gas Sample whichever is less restrictive. Negative values shall be included and shall not be rounded to zero.
20. The CO% reading shall be within ± 0.20 or ±12% of the Certified Gas Sample whichever is greater Negative values shall be included and shall not be rounded to zero.
21. The HC reading (ppm propane) shall be within ± 200ppm or ±12% of the Certified Gas Sample whichever is less restrictive. Negative values shall be included and shall not be rounded to zero.
22. The NOx reading (ppm) shall be within ± 200ppm or ±12% of the Certified Gas Sample whichever is less restrictive. Negative values shall be included and shall not be rounded to zero.
23. Other channels such as NO2, SO2, and NH4 are desired but not required but shall meet accuracy standards equivalent to those in III.A.2 – 4 above.
24. GEN2COVERS shall submit readings within the following limits:

CO + CO2 ≤ 21.0 %, HC ≤35,000 ppm hexane, CO2 ≤ 16.0 %, and NO ≤ 7000 ppm.

1. The GEN2COVERS shall record at least three and display at least two measures of plume characteristics, for example the maximum number of CO2 molecules seen, the average number of CO2 molecules seen, and the number of valid samples (measurements) made.
2. Each unit shall demonstrate during controlled acceptance testing the above criteria 98% of the time. Ninety-eight percent (98%) shall mean that one hundred percent (100%) of the valid records shall have the following fields filled correctly with accurate data, ninety-eight percent (98%) of the time:

CO2%

CO %

HC ppm hexane

NO ppm

* 1. **Speed and Acceleration Accuracy**

1. The vehicle speed measurement should be accurately recorded within ± 1.0 mile per hour.

1. The vehicle acceleration measurement should be accurately recorded within ± 0.5 mile per hour / second.
2. The speed and acceleration GEN2COVERS shall demonstrate during controlled acceptance testing the above criteria ninety-five percent 95% of the time. Ninety-five percent (95%) shall mean that one hundred percent (100%) of the valid records shall have the speed and acceleration fields filled correctly with accurate data, ninety-five percent (95%) of the time.
3. VSP shall be calculated during host processing using the most recent CDPHE approved equation.
   1. **Ambient Weather Data** 
      1. The GEN2COVERS shall record the following meteorological data into the test record Ambient temperature

Ambient barometric pressure

1. The GEN2COVERS shall record within the following accuracy tolerances:

Barometer: + 0.05" Hg

Ambient temperature: + 2°F

* 1. **Time Accuracy**
     1. All time keeping devices shall be synchronized within five (5) minutes of GMT and adjusted to local time. The date shall be correct.
  2. **Gas Accuracy**
     1. All gases, including certification, audit, and calibration, shall be blended to at least ± 1% of the specified concentration with the contents tested to ± 1% of the actual labeled contents. Propane shall be used as the hydrocarbon. All gases and gas blends shall be obtained from a gas blender who has been certified by CDPHE to meet the requirements of AQCC Regulation #11, Appendix A, and the *Colorado AIR Program Gas Naming/Verification Lab Procedures, August, 2004.* Gases shall be traceable to NIST, SRM, CRM, or NTRM and have a stated uncertainty to within 1% of the standard by Gas Comparison Methods. Audit gases shall meet the same analytical tolerances. Approval of calibration and audit gases in high-pressure cylinders will be done on an individual basis. Each cylinder must be submitted to the Broomfield Emissions Technical Center (BETC) for verification. A certificate of analysis shall accompany each cylinder. Upon approval, the Contractor shall be notified that the cylinder is ready for pick-up. Approved cylinder(s) with a Colorado Approved label attached, may be picked up during business hours (8:00am – 4:30pm) Monday – Friday. Labels will be provided by the State of Colorado’s BETC, and will contain appropriate information to include; Cylinder Number, Gas concentrations, Blender, Certification date, and Blend description.
  3. **Data Processing**

1. A valid record shall be defined as those records:
2. Collected between the opening daily calibration/CVA (opening bookend) and either a passing DOR Audit or passing QAC (closing bookend).
3. With valid plume characteristics.
4. With valid gas readings.
5. Between 20o and 120oF.
6. With a valid speed and acceleration measurement.
7. Where the ambient temperature does not exceed GEN2COVERS specifications.
8. Where all fields in all tables are accurately populated to specification and with the appropriate license plate picture.
9. With vehicle specific power (VSP) between 3 and 22kW/t [[3]](#footnote-3)
10. Invalid gas readings are not considered grounds for a DOR Audit failure, and non-triggers (no record created) shall not be considered grounds for a DOR Audit failure.
11. Invalid or suspect data, due to inadequate plume size and/or abnormal plume decay rate shall be marked as invalid and easily identified.
12. A copy of all valid, tag edited, registration matched data shall be delivered uploaded to the CDPHE FTP site no later than thirty (30) days after the end of the previous month, for example, the data for June would be due July 31. Data shall also be made available to CDPHE and DOR via host access through a broadband Internet connection.
13. Ninety-seven percent (97%) of all readable Colorado license plates shall be accurate. If an optical character recognition GEN2COVERS is employed with a performance level below the 97% efficiency level, manual post processing supplementation shall be used to meet the 97% requirement.
14. Data shall be withheld from the host until the GEN2COVERS passes its final Contractor-performed QAC or DOR Audit closing bookend. CDPHE may perform the DOR Audit if necessary.
    1. **Gas Puff Dispensing GEN2COVERS for DOR Audit and cdphe Acceptance testing**
       1. The gas puff dispensing GEN2COVERS shall be capable of automatic control.
       2. Automatic control shall be via software.
15. **GEN2COVERS DATABASE and TABLES**

Each GEN2COVERS unit shall create one vehicle database in Microsoft Access (.mdb / .accdb) format per remote sensing GEN2COVERS per operational shift using as many tables as necessary. All tables shall be available to CDPHE and DOR via Intellitrak or similar rapid access data retrieval system.

The database filename shall include at a minimum the detector unit number, date, and time the database was created (hours and minutes in 24 hour notation), and site code separated by underscores followed by the .mdb or .accdb file extension.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Detector Number | Date | 24-hour time | Site Code | Raw records in the DB | File Extension |
| xxxx | 09172013 | 1330 | 8068 | 5062 | .mdb |

**Example: xxxx\_09172013\_1330\_5062\_8068.mdb**

GEN2COVERS shall compile remote sensing records into the following tables: (1) Raw data (.csv table), (2) a.mdb database, (3) b.mdb database

* + - * 1. Raw Records – CSV File

|  |  |
| --- | --- |
| Mnemonics | Description |
| RecordNumber | Sequential record index |
| Unit | GEN2COVERS serial number |
| Date | Date of data collection |
| Time | Time of data collection |
| RecordStatus | Type of gas record. ‘A’ = audit; ‘N’ = normal |
| Valid | Gas record validity identifier |
| cva SessionStatus | CVA status for each record. G, S, X, L |
| AuditType | A |
| AuditMode | CVA, QAC, DOR identifiers. 1P, 2P, 3P |
| AuditResult | F: fail; P: pass; X: purge puff |
| BookendStatus | F: fail; I: incomplete; P: pass; X: no bookend |
| samSpeed | Vehicle speed measurement |
| samAccel | Vehicle acceleration |
| samFlag | Speed/acceleration data validity flag |
| perCO | CO concentration from combustion equation |
| perCO2 | CO2 concentration from combustion equation |
| ppmHChex | HC(hexane) concentration from combustion equation |
| ppmNO | NO concentration from combustion equation |
| uvSmoke | UV Smoke Factor |
| COCO2 | Ratio of measured amount of CO to CO2 |
| HCCO2 | Ratio of measured amount of HC to CO2 |
| NOCO2 | Ratio of measured amount of NO to CO2 |
| maxCO2 | Peak amount of CO2 in the measured plume. |
| avgCO2 | Average amount of plume CO2 used in gas calculations. |
| samples | Number of samples used in gas calculations |
| TempAlarms | reserved |
| AmbientAlarms | Bit encoded ambient alarm status |
| MiscAlarms | reserved |
| pcVersion | PC console software version |
| GEN2COVERSVersion | GEN2COVERS flash-code software version |
| calfactorCO | CO calibration factor |
| calfactorCO2 | CO2 calibration factor |
| calfactorHC | HC calibration factor |
| calfactorNO | NO calibration factor |
| calDate | Date corresponding to cal factors |
| calTime | Time corresponding to cal factors |
| PLATE | Vehicle plate tag |
| temp | temperature ambient |
| baro | pressure ambient |
| GEN2COVERS\_temp | GEN2COVERS internal temperature |
| GEN2COVERS\_baro | GEN2COVERS barometric pressure |
| ambCO | Ambient amount of CO (slow filtered) |
| ambCO2 | Ambient amount of CO2 (slow filtered) |
| ambHC | Ambient amount of HC (slow filtered) |
| ambCOfast | Ambient amount of CO (fast filtered) |
| ambCO2fast | Ambient amount of CO (fast filtered) |
| ambHCfast | Ambient amount of CO (fast filtered) |
| AMB\_CORR\_CO2 | CO2 correction factor |
| AMB\_CORR\_CO | CO correction factor |
| AMB\_CORR\_HC | HC correction factor |
| ambRef | Reserved |

* + - * 1. **a.mdb database / Records, Mnemonics and Description:**

**LOG Table**

|  |  |
| --- | --- |
| Mnemonics | **Description** |
| Time | The actual time a logged engineering event occurred |
| Message | Description of the recorded engineering event |
| Source / Targer | The component(s) or system(s) the engineering event accessed / modified, i.e., GEN2COVERS, Speed Accel, etc. |
| Reason | Why accessed; what was changed / modified; pre and post values. |
| Accessed by whom | User ID# |

**VALID RECORDS Table**

|  |  |
| --- | --- |
| Mnemonics | **Description** |
| SITE\_CODE | Site code entered from console |
| UNIT\_NUM | GEN2COVERS serial number |
| SEQ\_NUM | Vehicle Sequence Number |
| DATE\_TIME | Date and time of reading |
| CO | CO reading |
| CO\_FLAG | Gas flag |
| COCO2 | COCO2 reading |
| CO2 | CO2 reading |
| CO2\_FLAG | CO2 flag |
| MAX\_CO2 | Maximum CO2 reading |
| CO2\_VOLUME | CO2 volume for plume criteria |
| SAMPLES | Samples |
| AMB\_CO | Ambient CO |
| AMB\_CO2 | Ambient CO2 |
| AMB\_HC | Ambient HC |
| AMB\_CO\_FAST | Ambient fast CO |
| AMB\_CO2\_FAST | Ambient fast CO2 |
| AMB\_HC\_FAST | Ambient fast HC |
| AMB\_REF | Ambient ref |
| HC | HC reading (PPM) |
| HC\_FLAG | HC Flag |
| HCCO2 | HCCO2 reading |
| NOX | NOX reading |
| NOX\_FLAG | NOX Flag |
| NOCO2 | NOCO2 reading |
| OPAC | IR smoke reading |
| OPAC\_UV | UV smoke reading |
| OPAC\_FLAG | IR smoke flag |
| SPEED | Vehicle speed reading |
| SPD\_FLAG | SA flag |
| ACCEL | Vehicle Acceleration reading |
| ACC\_FLAG | SA flag |
| SA\_UNITS | Speed/Acceleration (S/A) units |
| UV\_SMK\_FLG | UV smoke flag |
| SLPERR\_CO | Slope error CO |
| SLPERR\_HC | Slope error HC |
| SLPERR\_NO | Slope error NO |
| RECORD\_STATUS | VDF record status |
| SESSION\_STATUS | CVA record status |
| LOCK\_RESULT | Lock results |
| VALID | VDF valid |
| AMBIENT\_ALARMS | Ambient alarm |
| TEMP\_ALARMS | Temperature Alarms |
| MISC\_ALARMS | Misc alarms |
| TEMP\_UNITS | Temperature unit |
| HUMIDITY | Humidity reading |
| BAROMETER | Barometer reading |
| BAROMETER\_UNITS | Barometer units |
| PLATE | Vehicle license plate data |
| PLATE\_INFO |  |
| PLATE\_STATE | Plate state |
| PLATE\_CONFIDENCE | Plate confidence |
| PROGRAM\_CODE | Program Identifier |
| TEST\_COUNTY | County code |
| JPG\_IMAGE | Image |

**CVA Table**

|  |  |
| --- | --- |
| **Mnemonic** | **Description** |
| CVA\_KEY | CVA key |
| CO\_BOTTLE\_VAL | CO bottle value / cell value |
| CO2\_BOTTLE\_VAL | CO2 bottle value / cell value |
| HC\_BOTTLE\_VAL | HC bottle value / cell value |
| NOX\_BOTTLE\_VAL | NOX bottle value / cell value |
| CO\_PRED\_PCNT | CO predicted percent |
| HC\_PRED\_PCNT | HC predicted percent |
| NOX\_PRED\_PCNT | NOX predicted percent |
| CO\_LOCKOUT\_PCNT | CO lockout percent |
| HC\_LOCKOUT\_PCNT | HC lockout percent |
| NOX\_LOCKOUT\_PCNT | NOX lockout percent |
| CO\_AUD\_PCNT | CO audit percent |
| HC\_AUD\_PCNT | HC audit percent |
| NOX\_AUD\_PCNT | NOX audit percent |
| CO\_PRED\_MIN | CO predicted min |
| HC\_PRED\_MIN | HC predicted min |
| NOX\_PRED\_MIN | NOX predicted min |
| CO\_LOCKOUT\_MIN | CO lockout min |
| HC\_LOCKOUT\_MIN | HC lockout min |
| NOX\_LOCKOUT\_MIN | NOX lockout min |
| CO\_AUD\_MIN | CO audit min |
| HC\_AUD\_MIN | HC audit min |
| NOX\_AUD\_MIN | NOX audit min |
| CO\_IDEAL\_VAL | CO ideal value |
| HC\_IDEAL\_VAL | HC ideal value |
| NOX\_IDEAL\_VAL | NOX ideal value |
| CO\_HI\_PRED | CO high predetermined value |
| HC\_HI\_PRED | HC high predetermined value |
| NOX\_HI\_PRED | NOX high predetermined value |
| CO\_LO\_PRED | CO low predetermined value |
| HC\_LO\_PRED | HC low predetermined value |
| NOX\_LO\_PRED | NOX low predetermined value |
| CO\_HI\_LOCKOUT | CO high lockout |
| HC\_HI\_LOCKOUT | HC high lockout |
| NOX\_HI\_LOCKOUT | NOX high lockout |
| CO\_LO\_LOCKOUT | CO low lockout |
| HC\_LO\_LOCKOUT | HC low lockout |
| NOX\_LO\_LOCKOUT | NOX low lockout |
| CO\_HI\_AUD | CO high audit |
| HC\_HI\_AUD | HC high audit |
| NOX\_HI\_AUD | NOX high audit |
| CO\_LO\_AUD | CO low audit |
| HC\_LO\_AUD | HC low audit |
| NOX\_LO\_AUD | NOX low audit |

**AUDIT Table**

|  |  |
| --- | --- |
| **Mnemonic** | **Description** |
| UNIT\_NUM | GEN2COVERS serial number |
| SITE\_CODE | Site code entered from console |
| DATE\_TIME | Date and time of audit |
| SEQ\_NUM | Sequence number |
| CVA\_KEY | CVA key |
| AUDIT\_TYPE | Audit type. ‘A’ |
| AUDIT\_RESULT | Audit result. X, P, F |
| DISPENSE\_SECS | Dispense seconds 0000 for CVA and QAC |
| PURGE\_SECS | Purge seconds 0000 for CVA and QAC |
| PREDICTIVE\_RES | Predictive result |
| LOCKOUT\_RES | Lockout result |
| CYL\_INSTALL\_DATE | Install date DOR cylinders |
| CYL\_POSITION | Cylinders Identifier, 1, 2, 3, external for DOR audit only; otherwise is QAC gas cell identifier |
| CYL\_SERIAL | Cylinder serial for DOR audit only; otherwise is QAC gas cell identifier |
| CYL\_EXPIRE | Cylinders expiration date for DOR audit only; otherwise is QAC gas cell identifier |
| CYL\_BLENDER | Cylinders blender for DOR audit only; otherwise is QAC gas cell identifier |
| CYL\_CO | Cylinders CO |
| CO | Percent CO |
| CYL\_CO2 | cylinder CO2 |
| CO2 | Percent CO2 |
| CYL\_HC | Cylinder HC |
| HC | Ppm HC |
| CYL\_NOX | Cylinder NO |
| NOX | Ppm NO |
| AUDIT\_MODE | 1P = CVA, 2P=QAC, 3P=DOR |
| AUDIT\_DATE |  |
| AUDIT\_PUFF | Puff # for DOR audit or cell cycle # for QAC / CVA |

Notes: A “0” fill (e.g., 0000) shall be used for all known invalid numeric readings without an assigned validity flag.  This does not apply to unused data fields.

* + - * 1. **b.mdb database / Records, Mnemonics and Description :**

**REGISTRATION MATCHED Table**

|  |  |  |
| --- | --- | --- |
| **Mnemonic** | | **Description** |
| DATA\_VER | | Data version |
| DATE\_TIME | | The date and time the emissions test was conducted |
| UNIT\_NUM | | Identifies the GEN2COVERS unit that conducted the emissions test |
| SEQ\_NUM | | Test number for the GEN2COVERS unit for the given date |
| SITE\_CODE | | Site designation code |
| PROGRAM\_CODE | | Program identifier |
| CO | | CO reading (%) |
| CO2 | | CO2 reading (%) |
| MAX\_CO2 | | Maximum CO2 reading (%) |
| CO2\_VOLUME | | CO2 volume for plume criteria |
| HC | | HC reading (ppm) |
| NOX | | NO reading (ppm) |
| NOX\_FLAG | | NO reading flag |
| OPAC | | Opacity reading (percentage) |
| SPEED | | Speed of passing vehicle |
| ACCEL | | Acceleration of passing vehicle |
| SA\_UNITS | | Speed/Acceleration (s/a) units |
| TEMPERATURE | | Temperature |
| HUMIDITY | | Humidity |
| PLATE\_CONFIDENCE | | Plate confidence |
| ALPR\_VENDOR | | ALPR (automatic license plate reader)vendor |
| TEST\_COUNTY | | The county where tested |
| CRC | | Cyclic redundancy check |
| PLATE | | Final plate number |
| PLATE\_STATE | | Final state which issued this plate |
| PLATE\_TYPE | | License plate type |
| VIN | | Vehicle identification number |
| LZIP | | Owner legal ZIP code |
| STATE\_MAKE | | State vehicle make |
| STATE\_MODEL | | State vehicle model |
| COUNTY | | Owner county of residence |
| VEH\_YEAR | | Vehicle model year |
| EM\_FLAG | | Emissions flag |
| POLK\_VEH\_YEAR | | Polk vehicle year |
| POLK\_MAKE | | Polk vehicle make |
| POLK\_VEH\_TYPE | | Polk vehicle type |
| POLK\_MODEL | | \*Polk model code (Model and Series) |
| POLK\_DISP | | \*Polk engine displacement (liters) |
| POLK\_GVW | | \*Polk manufacture’s GVW rating |
| TEMP\_UNITS | | Temperature units. Number stands for ASCII code for flag letter |
| BAROMETER | | Barometer |
| BAROMETER\_UNITS | | Barometer units. Number stands for ASCII code for flag letter |
| SAMPLES | | Ambient |
| AMB\_CO | | Ambient CO |
| AMB\_CO2 | | Ambient CO2 |
| AMB\_HC | | Ambient HC |
| AMB\_CO\_FAST | | Ambient CO fast |
| AMB\_HC\_FAST | | Ambient CO2 fast |
| AMB\_REF | | Ambient reference |
| COCO2 | | Gas ratio CO\_CO2 |
| HCCO2 | | Gas ratio HC\_CO2 |
| NOCO2 | | Gas ratio NOX\_CO2 |
| OPAC\_UV | | UV smoke reading |
| VEH\_COLOR | |  |
| cva SessionStatus | | CVA status for each record |
| AuditType | | A |
| AuditMode | | CVA, QAC, DOR identifiers  1P, 2P, 3P |
| AUDIT\_PUFF | |  |
| AuditResult | | F: fail; P: pass; X: purge puff |
| BookendStatus | | F: fail; I: incomplete; P: pass; X: no bookend |
| vdf RecordStatus | | Type of gas record  A, N |
| SLPERR\_CO | | Slope error CO | |
| SLPERR\_HC | | Slope error HC | |
| SLPERR\_NO | | Slope error NO | |
| LOCK\_RESULT | | Lock results | |
| CVA\_KEY | | CVA key | |
| LOCKOUT\_RES | | Lockout result |
| TEMP\_ALARMS | | Temp alarms flag |
| MISC\_ALARMS | |  |
| AMBIENT\_ALARMS | | Ambient alarms flag |

**(2) SITE Table**

|  |  |
| --- | --- |
| **Mnemonic** | **Description** |
| DATA\_VER | Data version |
| DATE\_TIME | the date and time the data was collected |
| UNIT\_NUM | Identifies the GEN2COVERS unit that collected the data |
| SITE\_CODE | Site designation code |
| PROGRAM\_CODE | Program identifier |
| SITE\_DESCRIPTION | Site description |
| CRC | csr-16 computed on all fields in the record up to this point, in the order listed. |
| ROAD\_SLOPE | Site road slope |

Notes: A "0" fill (e.g., 0000) shall be used for all known invalid numeric readings without an assigned validity flag.  This does not apply to unused data fields.

1. **ACCEPTANCE TESTING PROCEDURES (ATP) AND EQUIPMENT**

##### Introduction

* + 1. Manufacturers seeking CDPHE authorization must provide data from in-house testing demonstrating the ability to meet GEN2COVERS specifications requirements. The CDPHE intends to test accuracy using dry gas, blended at various concentrations. Equipment setup may either duplicate typical on road configuration or be conducted in a controlled off-road configuration, with each setup including similar source to detector path length and height.
    2. CDPHE shall acceptance test each GEN2COVERS and its ancillary equipment including but not limited to speed & acceleration equipment, data processing hardware & software, and license plate capture system, prior to disbursement for data collection. After initial acceptance, individual GEN2COVERSs shall be acceptance tested prior to being reintroduced into the field for testing after any of the following has occurred or biennially whichever occurs first:

1. Returning from manufacturer service, manufacturer maintenance, or manufacturer repairs.
2. New software revision.
3. New hardware revision.
4. Any component level change that deviates from Original Equipment (OE) design or function.
5. At the CDPHE’s discretion.
   1. **Test Equipment**

CDPHE shall quantify GEN2COVERS capabilities by delivering dry audit gas in a controlled environment utilizing a software controlled puff audit. Dry gas concentrations are listed below in F.1.

* 1. **Test Preparation (GEN2COVERS Devices)**
     1. **GEN2COVERS Equipment**

Every GEN2COVERS unit used in the Colorado Clean Screen Program shall have the same quality and capability as subsequent devices. Each unit will be individually acceptance tested.

A passing CDPHE ATP is not considered a data opening bookend. Nor is a passing CDPHE ATP considered a data closing bookend. ATP results are not stored on the host and hence are not part of the normal bookend process.

* + 1. **Location**

All CDPHE controlled acceptance testing will be performed in a CDPHE approved on-road site or an approved indoor environment.

* + 1. **Set Clock Time**

All time keeping devices shall be synchronized within five (5) minutes of GMT and adjusted to local time. The date shall be correct.

1. **Data format and Submission**

Upon testing conclusion, all records will be downloaded and analyzed. Downloaded data must be in section IV formats.

**Software Controlled Puff Audit ATP**

CDPHE shall dispense the test gas via software controlled puff audit in a controlled environment. Gas shall be dispensed at no more than 30psig static. Puff audits shall be performed using only gases approved and labeled by CDPHE. The delivery of audit gas shall be controlled by software. Once testing is completed, data is copied to disk then used to verify adequate flow rate, compare reported gas values to allowable tolerances, and verify date, and time.

Once the GEN2COVERS unit has received internal certification from the Contractor, the unit will be allowed two (2) attempts at successfully passing an ATP in three months. The three-month clock begins at the start date of the first ATP attempt and is counted in calendar days not business days and holidays are not exempt. If the unit fails to meet this criterion, the unit must receive a new internal certification from Contractor before any further ATP’s are attempted.

* + - 1. **Acceptance Testing Gases**

**1. Gas Concentrations**

CDPHE selected these dry gas blends to simulate a wide range of automobile gasoline engine emissions. The audit gases include carbon monoxide (CO), hydrocarbon (HC), carbon dioxide (CO2), and nitric oxide (NO) blends and shall reflect in-use vehicle exhaust gas concentrations. The dry gas blends shall contain propane for the hydrocarbon. Nitrogen (N2) shall be used as the balance gas. Gases used will be blended to ± 1% of the specified concentration and tested for accuracy to at least ± 1% of the actual contents. Bottled dry gases shall be analyzed, named, and labeled by CDPHE at the BETC Gas Naming / Verification Lab to confirm actual blend concentrations. CDPHE reserves the right to amend this list as necessary.

### 

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Gas Blend | CO% | CO2% | HC ppm (propane) | NO ppm |
| A | 0.00 | 15.05 | 0 | 0 |
| B | 0.50 | 14.70 | 500 | 3000 |
| C | 1.00 | 14.38 | 3000 | 2000 |
| D | 2.00 | 13.63 | 1000 | 1000 |
| E | 2.75 | 13.11 | 2000 | 500 |
| F | 5.00 | 11.50 | 6000 | 250 |
| G | 0.20 | 14.91 | 100 | 1500 |
| H | 0.30 | 14.84 | 200 | 1000 |
| J | 0.50 | 14.70 | 400 | 1000 |
| K | 1.00 | 14.34 | 500 | 300 |
| L | 1.50 | 13.99 | 750 | 750 |
| M | 0.20 | 14.91 | 100 | 2000 |
| N | 0.50 | 14.70 | 400 | 1500 |
| O | 0.80 | 14.49 | 700 | 1000 |
| P | 2.70 | 13.13 | 1050 | 600 |
| Q | 3.00 | 12.92 | 1100 | 500 |
| R | 3.30 | 12.70 | 1150 | 200 |
| S (Cal gas) | 3.00 | 12.92 | 1500 | 1500 |

### GEN2COVERS ATP TEST PROCEDURES

* 1. **On-Road Tests:**

**Test 1 - Speed Determination Accuracy**

Purpose: To determine the accuracy of the GEN2COVERS speed acceleration system.

Test vehicles: Vehicle with known accurate speedometer or GPS.

Vehicle speeds: Various speeds to be determined by CDPHE

Drive mode: Steady state

Test iterations: At least 10 passes for each speed

**Test 2: Camera Alignment**

Purpose: To verify camera functions and license plate video capture.

Test vehicles: Various, depends on the site.

Vehicle speeds: Various, depends on the site.

Drive mode: Various, depends on the site.

Test duration: Minimum of 10 minutes.

CDPHE staff shall perform several iterations of camera focus, zoom, f-stop, pan left, right, up, down, and shutter speed. CDPHE staff shall ensure license plate captures are written to database in a separate picture file with the required watermarks and that pictures are readable.

An ALPR ATP will be similar.

* 1. **tests that may be performed Off-ROAD:**

**Test 3 - Calibration/CVA**

Purpose: Verify proper GEN2COVERS calibration/CVA frequency

Test times: Perform this test for one continuous period for up to eight-hours on each GEN2COVERS unit.

Procedure: Confirm operation of the following:

Calibration is required upon start-up, followed by a mandatory, passing CVA. The unit shall prompt for CVA after every calibration. The CVA cannot be cancelled or disallowed. Data is marked “GO” upon passing CVA or “LOCKOUT” upon failing CVA.

**Test 4 –Emissions Determination Accuracy and Repeatability**

Purpose: Verify emission reading accuracy and consistency for dry gases.

Test gases: At least four different blends.

Test iterations: At least 10 puffs for each gas blend.

**Test 5 - Verify Clock**

Purpose: Verify GEN2COVERS clock reading is within + 5 minutes of accepted "actual" time.” Verify that the actual time is recorded in the GEN2COVERS test record. CDPHE staff will verify GEN2COVERS time set correctly, and record appropriate time and record sequence numbers accordingly.

Test Times: Random during on-road testing.

Procedure: Verify all GEN2COVERS test record times match manually recorded times. Recheck time on both GEN2COVERSs upon test completion for time variations.

Test 6 – QAC

Perform at least one failing and one passing QAC.

Failing QAC must trigger a lockout and require re-calibration and CVA to achieve GO status. Four QAC restarts must trigger a lockout and flag all data as invalid back to the most recent bookend. CDPHE staff will check to see QAC is properly identified in the database.

Test 7 – DOR audit

Perform at least one passing and one failing DOR audit. Failing audit must trigger automatic shutdown and generate the necessary email notifications. All data back to most recent bookend must be flagged as invalid. CDPHE staff will check to see the DOR audit is properly identified in the database.

Test 8 Wi-Fi / Cellular communications and Email Generation

Check for Wi-Fi network with a WIFI compatible device (cell phone, iPad).

Check for network name, that network is WPA2 secure, and is password protected.

Log in using level 1 password, check system status, make sure parameters cannot be changed at this password level then log out.

Log in again using level 2 password, check system status and change one or more parameters. Log out.

Log in as DOR auditor. Check to make sure cellular communication is disabled. Check to make sure other users logged in via WiFi are disconnected and that no one can log in via Wi-Fi once audit has begun.

Verify proper emails are generated with required information and sent to required recipients. Check log file(s) to make sure these events are recorded.

1. **Documentation**

Acceptance Test documentation is recorded and maintained by CDPHE staff.

1. **AUDIT PROCEDURES**
2. Audit and Quality Assurance Procedures

Each GEN2COVERS shall be subjected to Q/A and audit procedures using approved equipment and procedures and performed by:

* The Contractor on a daily basis.
* DOR on a schedule determined by DOR staff pursuant to 42-4-305(12) C.R.S and adopted by DOR Rules and Regulations 1 CCR 204-11.

1. Requirements

The Contractor will conduct at a minimum a QAC at the end of the operating shift for each GEN2COVERS. The Department of Revenue shall randomly conduct controlled Puff Audits within a maximum of five (5) business days. Uncontrollable and unforeseeable events may cause a variance including but not limited to, inclement weather, unfavorable road conditions, etc. Each completed audit or QAC shall constitute a closing “bookend” (either passing or failing). In addition, all passing bookends serve as an opening bookend. Failing bookends shall flag all records subsequent to the relative opening bookend in that data set as ineligible for use in the clean screen program

Audits may be conducted any time a unit is set up and operational at an approved site. Once an audit or QAC is initiated, it shall be completed with subsequent notice and determination of either:

* Pass
* Failure
* Cancel
  + - * 1. DOR Audit may cancel any time
        2. QAC may cancel twice and restart a maximum of three times. A third cancel and fourth restart shall trigger a lockout.
    1. The Contractor shall provide the CDPHE and the DOR with a notification of each GEN2COVERS unit's daily status and location.
    2. All GEN2COVERS sites shall have current permit, licensing, and approval documentation. Documentation packets shall be available for onsite inspection any time a detection unit is operating on-road collecting data.
    3. QACs shall include:
       1. Analytical GEN2COVERS accuracy based upon multiple gas cell blend measurements which shall include at a minimum blend A and S.
  1. **DOR AUDITS**

1. DOR audits shall include, but may not be limited to:
   1. Site evaluation/verification.
   2. GEN2COVERS equipment proper set-up and verification. To include:
      1. Measurement of GEN2COVERS alignment laser height at lane center (8-14 inches), traffic permitting.
      2. GEN2COVERS side-to-side level (level ± ½ bubble measured with bubble level).
      3. If an external speed bar is used, then the GEN2COVERS to speed bar distance shall be no more than 6 ½ feet ± 6 inches measured from the GEN2COVERS alignment laser to the nearest edge of the speed bar.
   3. Automated “Puff Audit”
   4. Verification of correct GEN2COVERS date and time stamps, as well as site and unit numbers for data records.
   5. Analytical GEN2COVERS accuracy based upon multiple gas blends.
   6. Verification of correct console software version numbers.
2. DOR AUTOMATED PUFF AUDITS
   1. 1. Puff audits may be performed by DOR anytime a detection unit is operating with the intent to collect vehicle data that shall be utilized to demonstrate vehicle emissions compliance for registration purposes. Before initiating the audit the auditor shall verify that the audit cylinder’s regulated output gauge will read zero psi. If the audit cylinder’s regulated output gauge will not read zero psi then the audit shall not be initiated. It the audit cylinder’s regulated output gauge will read zero then the auditor shall set the regulated output pressure to a static value of 30 psig and may begin the audit.
3. The DOR audit shall be performed via its own software.
   1. 2. The delivery of audit gas shall be controlled in software, and initiated wirelessly.
   2. Only the DOR auditor shall have access to the GEN2COVERS during the audit. Upon initiation of the audit a message box shall ask the auditor if he/she wishes to end all other wireless / cellular access to the GEN2COVERS. An affirmative response shall terminate any and all other wireless users for the duration of the audit.
   3. 3. Puff audits shall be performed using only gases approved and labeled by CDPHE. The Contractor shall provide each DOR auditor a spare gas bottle regulator that can be put into service when needed.
   4. 4. The gases used shall be blends A, L, and S. DOR may choose the order.

5. A successful on-road puff audit test shall include compliance with items C.1. (a-g) and C.2. (1-4) above and:

* 2. 1. Three puff readings per each of the three required gas blends, within these tolerances:
  3. 2. CO: + 12 % of gas blend or + 0.20 whichever is less restrictive.
  4. 3. HC: + 12 % of gas blend or + 200 ppm propane, whichever is less restrictive.
  5. 4. NO: + 12 % of gas blend or ± 200 ppm, whichever is less restrictive.
     1. The roadside remote sensing equipment must read and record the audit gas within the above limits on all puffs to pass the audit. If the unit passes, the audit is completed as passing and the closing bookend is established. Upon completion of passing audit an email shall be generated by the audit software and sent to DOR, CDPHE, and the Contractor that includes but is not limited to the date time the audit was initiated and completed or canceled; the site code, the unit number, the record number range between the beginning and ending time stamps; the auditor ID, audit cylinder numbers, cylinder expiration dates, cylinder content concentrations, and each cylinder’s nominal pressure and regulated pressure. Regulated pressure shall not exceed 30 psig static.
     2. The auditor shall have the option of cancelling the audit at any time for any reason. If the audit is cancelled the auditor shall be required by the software to enter via text box and/or drop down list a reason or reasons for the audit cancel. The audit shall not officially cancel until this requirement is met, nor shall another, immediate, subsequent audit be allowed until this requirement is met, nor shall the GEN2COVERS stop collecting data.
     3. Relative to DOR audits, data collection only stops upon audit fail.
     4. If any one of the “Puff” gas readings per gas blend is outside of the tolerance limits, the roadside remote sensing equipment fails the audit and the closing bookend is not established. All data affected by the failed audit shall be marked invalid by the GEN2COVERS. Upon completion of failing audit an email shall be generated by the audit software and sent to DOR, CDPHE, and the Contractor that includes but is not limited to the date time the audit was initiated and completed or canceled; the site code, the unit number, the record number range between the beginning and ending time stamps; the auditor ID, audit cylinder numbers, cylinder expiration dates, cylinder content concentrations, each cylinder’s nominal pressure and regulated pressure (regulated pressure shall not exceed 30 psig static) the audit gas blend(s) that failed and which puff(s) failed. An information box shall inform the auditor that this email has been generated and sent. This information box shall then be followed by a second information box that the GEN2COVERS is automatically shutting down. The auditor will verify shut down before leaving the site.

In the event an audit cannot be completed for some reason other than Audit Cancel, all associated data for the immediate bookend time period shall be identified and suspended from clean screen processing until such time as CDPHE can determine the appropriate action necessary for the unit in question.

A GEN2COVERS returning to service after failing a DOR audit must pass a subsequent calibration, CVA, and DOR audit before any new data collected will be allowed on the host.

* 1. The State reserves the right to revoke a GEN2COVERS’ license when a pattern of audit fails is present. A system whose license has been revoked may be required to undergo manufacturer diagnosis, maintenance, and repair. Any time a system’s license is revoked the system must undergo ATP.
  2. **Quality Assurance Checks**

1. The QAC will be performed by contractor personnel during normal roadside remote sensing operating conditions at least at the close of each operational period at the licensed site at which the data collection occurred.
2. The delivery mechanism of QAC gas shall be internal gas cell controlled by software.
3. Each QAC shall be performed using gas cells containing gases approved by CDPHE.
4. The gases used shall be blends A and S (cal gas).

**NOTE:** QACs shall use two-point curve verification.

1. A successful QAC shall include compliance with:
2. Three puff readings per each of the two required gas blends, within these tolerances:
   * + 1. CO: + 12 % of gas blend or + 0.20 whichever is less restrictive.
       2. HC: + 12 % of gas blend or + 200 ppm propane, whichever is less restrictive.
       3. NO: + 12 % of gas blend or ± 200 ppm, whichever is less restrictive.
3. The GEN2COVERS unit must read and record the audit gas within the above QAC limits on all cell cycles to pass the QAC. If the unit passes the QAC, the QAC is completed as passing and the closing booking is established.
4. If any one of the cell cycle readings per gas blend is outside of the tolerance limits, the GEN2COVERS unit fails the QAC and a closing bookend is not established.
5. In the event a QAC cannot be completed for any reason, all associated data for the immediate bookend time period shall be identified and suspended from clean screen processing until such time as CDPHE can determine the appropriate action necessary for the unit in question. In addition CDPHE and DOR shall receive written notification to include, but not limited to, the date and time the QAC could not successfully be completed, the record number range between the beginning and ending time stamps, the employee ID and an explanation regarding the situation surrounding the incomplete or failed QAC.

## Incomplete Quality Control Check

1. An incomplete QAC results from contractor personnel not being able to complete the QAC check within two hours. Reasons for incompletion include but are not limited to: inclement weather, equipment problems, etc.
2. Data that is not bookended by a subsequent QAC by the end of the shift shall be flagged as not bookended.
3. Audit Document Distribution

The DOR Audit software referenced in Section II.C.7 shall print out the DOR Audit Summary report that will include, but may not be limited to the following:

* Date and Time
* GEN2COVERS number
* Site number
* State Auditor
* Audit cylinder information:
  + - * Blend Identification
      * Cylinder number
      * Gas concentrations
    - Overall results:
      * Audit results
        + Failed blend(s)

Results of all completed state audits shall be filed by GEN2COVERS unit number and retained in the DOR's main office, with a copy distributed to the contractor and CDPHE within two business days.

1. **Glossary**

|  |  |
| --- | --- |
| **Terms:** | **Definitions:** |
| a.mdb tables | Raw records generated by GEN2COVERS units are maintained in these tables. |
|  |  |
| Audit | A sequence of specific quality assurance tests used by DOR or CDPHE to determine if the Contractor and equipment used in the Colorado AIR Program are meeting Colorado program requirements |
|  |  |
| ATP | Acceptance Testing Procedure. A series of comprehensive testing criteria used by CDPHE to evaluate equipment and software used in the Colorado AIR Program |
| b.mdb tables | Registration matched records used for clean screen eligibility. |
|  |  |
| Band pass filter | A **band-pass filter** is a device that passes frequencies within a certain range and rejects (attenuates) frequencies outside that range.[[4]](#footnote-4) |
|  |  |
| Bookend | A reference point marking a group of data. A successful initial calibration and subsequent CVA shall be considered the opening bookend for the beginning of a set of collected data; a state audit or Quality Assurance Check shall be considered a closing bookend, marking an ending point of that data set. |
|  |  |
| CDPHE | Colorado Department of Public Health and Environment |
|  |  |
| CO | Carbon monoxide |
|  |  |
| CO2 | Carbon dioxide |
|  |  |
| CO2 MAX | The maximum amount of CO2 seen per record |
|  |  |
| CSV | Comma Separated Variable file |
|  |  |
| CVA | Calibration Verification Audit - A sequence of specific quality assurance tests controlled in software and performed by the Contractor to verify calibration. |
|  |  |
| DOR | Department of Revenue |
|  |  |
| Dry Gas | Gases blended to specification by an approved blender and contained in cylinders for use in audit and acceptance testing |
|  |  |
| Gas cell(s) | A small volume of approved gas blend(s) capable of automatic rotation into and out of an infrared and/or ultraviolet beam to accomplish CVA or QAC. |
| GEN2COVERS | Source/Detection Module part of the roadside remote sensing equipment. This module emits UV and IR energy and senses the transmittance of that energy through an exhaust plume. The operating principle is the Beer-Lambert Law. The GEN2COVERS measures that transmittance and generates an electrical signal. |
|  |  |
| HC | Hydrocarbon |
|  |  |
| NH4 | Ammonia |
|  |  |
| NO | Nitric oxide |
|  |  |
| NO2 | Nitrogen dioxide |
|  |  |
| Non-Trigger Event | Phenomenon occurring when one or more vehicles pass by the equipment and no record is created. This may occur as a result of an internal calibration function or as a result of a design feature that prevents records being created unless specific plume characteristics are met. |
|  |  |
| Operational Period | A specific period of time when the equipment is operating at a licensed site. This could be a whole day or one part of a day or shift. |
|  |  |
| POLK | R.L. Polk & Company. Providers of automotive information. |
|  |  |
| QAC | Quality Assurance Check - A sequence of specific quality assurance tests controlled in software and performed by the Contractor. |
|  |  |
| Roadside remote sensing equipment | A complete, functional, and operating collection of equipment designed for the remote sensing of motor vehicle emissions. |
| SAMPLES | The number of valid samples per record |
|  |  |
| SO2 | Sulfur dioxide |
|  |  |
| Stop Work Order | Order issued by DOR including but not limited to audit failure. |

1. http://www.colorado.gov/cs/Satellite/CDPHE-Main/CBON/1251588829190 [↑](#footnote-ref-1)
2. EPA420-B-04-010, July 2004; "Guidance on Use of Remote Sensing for Evaluation of I/M Program Performance", p.18 [↑](#footnote-ref-2)
3. McClintock, Peter; The Denver Remote Sensing Clean Screening Pilot, CDPHE, December 1999. USEPA, EPA420-B-02-001 Guidance on Use of Remote Sensing for Evaluation of I/M Program Performance, July 2002. Pokharel, Sajal; Contributions to Motor Vehicle Emissions Analysis, U. of Denver PhD Dissertation, 2002. [↑](#footnote-ref-3)
4. http://en.wikipedia.org/wiki/Band-pass\_filter [↑](#footnote-ref-4)