EPA-AA-IMS/80-5-C

TECHNICAL REPORT

MARCH 1981

RECOMMENDED SPECIFICATIONS FOR EMISSION INSPECTION ANALYZERS: CHANGE NOTICE NUMBER 1

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By

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Notice

This Report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of the issue using data which are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments which may form the basis for a final EPA decision, position or regulatory action.

NOTE: This report is the third in a series of reports. Report EPA-AA-IMS/80-5-A contains background, technical discussions, and policy information on Inspection Analyzers. Report EPA-AA-IMS/80-5-B provides the Recommended Technical Specifications for inspection analyzers. This report (EPA-AA-IMS/80-5-C) provides modifications to those specifications. The reports are available separately.

Inspection and Maintenance Staff
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Office of Air, Noise, and Radiation
U.S. Environmental Protection Agency

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I. FORWARD

In September of 1980, EPA published two technical reports dealing with I/M inspection analyzers. The first report, "Analysis of the Inspection Analyzer" (EPA-AA-IMS/80-5-A), discussed background information on the analyzers themselves, provided a brief comparison of analyzers specifications, listed some sample cost calculations, and indicated a few policy implications. The second report, "Recommended Specifications for Emission Inspection Analyzers" (EPA-AA-IMS/80-5-B) detailed the I/M Staff's findings on analyzer specifications for both a manually operated inspection analyzer and a computer operated inspection analyzer.

Once EPA's analyzer recommendations were formalized, analyzer manufacturers could then justify the time and expense of initiating engineering design studies targeted towards building an EPA analyzer. From these studies came several requests for better interpretation or clarification of certain portions of the EPA specifications. In other cases, the specifications stimulated the manufacturers to come up with "better mouse trap" approaches that met the intent of the specifications, but might not have passed a bureaucratic interpretation of the specifications. In still other areas, the manufacturers offered new evidence or more convincing arguments that a relaxation of the specifications in a few specific instances was necessary from a technical perspective in relation to the targeted market and cost.

As discussed in the "Recommended Specifications ..." (80-5-B), the technical report format used by the Office of Mobile Source Air Pollution Control (OMSAPC) has no formal mechanism for instituting a change to previous reports other than publishing a new report. This report (80-5-C) constitutes such a change-notice to EPA-AA-IMS/80-5-B, and when published, officially superceeds those portions of 80-5-B.

This report does not recompile the original specification report (80-5-B). With only a few exceptions, the format of this report (80-5-C) is laid out in two sequences which are used interchangeably. In all cases, the chapter and section of 80-5-B are identified. As appropriate, the subsection and item are identified followed by a descriptive sequence of either:

a) Previous Concept:
b) New Concept:
c) Reason for Change:
d) New Wording:

or

a) Previous Wording:
b) New Wording:
c) Reason for Change:

In most cases, the format keys around the word "item", and the new wording is a direct replacement for the previous wording under that "item" (e.g. Section D, Subsection 3.d), Item i)2); or Section I, Item, Subsection 2.). Following the "item" heading is the page number location (in parenthesis) of that heading in report 80-5-B. The few cases that are not in this specific format are reasonably self-evident.

The changes discussed in this report will not adversely affect analyzer lead-time, the number of manufacturers interested in developing an EPA analyzer, or state implementation schedules. In fact if anything, these changes (relative to 80-5-B report) should decrease the lead-time and increase the number of manufacturers interested in producing an EPA inspection analyzer. Therefore, the publication of these changes should not cause any disruption in current state implementation schedules or plans.

EPA wishes to acknowledge the valuable comments and considerable efforts put forth by the Equipment and Tool Institute in supporting the development of this report.

As always, the I/M staff at EPA's Ann Arbor Facility is available to provide additional assistance and information as necessary. You may contact Tom Cackette, Donald White, or Bill Clemmens at (313) 668-4367.

II. Modified Sections in Chapter VI

A. Section D. Defintions and Abbreviations (p. 13)

1. New Definitions

a) Indicator Lights: Indicator lights as used in his document mean any means used to effectively communicate with the operator (e.g., lights, computer prompts, etc.).

b) Output Device: For the purpose of this document, output device means any device that displays or prints emission values. If an output device displays information other than the emission values (e.g., CRT diagnostic display), only the emission value portion of the multiple display is considered the output device.

c) Switches: Switches as used in this document are a generic term meaning any process used to control analyzer functions (e.g., switches, buttons, alpha-numeric keyboard, etc.).

III. Modified Section in Chapter VII

A. Recommended Qualification Program (p. 17)

1. Item III. Subsequent Production QA/QC (p. 17)

a) Previous Concept: Required full accredidation testing on all aspects every three years after initial certification.

b) New Concept: Requires re-certification testing only on specified key parameters every three years after initial certification.

c) Reason for Change: The change to recertifying key parameters is implemented to reduce the re-certification testing costs.

d) New Wording: The accreditation may be re-certified for a three year period at any time by passing selected evaluation tests on two of three units selected randomly from a production run of 20. The selected tests will include the following:

1. Testing of all specifications in Section E of Chapter VII (Analyzer Performance Specifications).

2. Testing of all specifications in Section F of Chapter VII (Sample Systems Performance Specifications).

3. Testing the following at the high temperature specifications of test procedure G.1. in Chapter VI (Operating Environmental Test Procedures).

a. Analyzer Calibration Curve
b. Pressure and Temperature Compensation (if used)
c. Analyzer zero and span drift
d. Analyzer Response Time

4. Testing the following at the low temperature specification of test procedure G.1. in Chapter XI (Operating Environment Test Procedures)

d. System Warm-up

2. Item IV. QA/QC Testing Criteria (p. 18)

a) Previous Concept: Repairs due to random failures during evaluation testing were allowed on pre-production units only. Justification required.

b) New Concept: Allow repair of random failure during accredidation and re-certification testing as long as justified by engineering report.

c) Reason for Change: To reduce the cost of accredidation and re-certification testing.

d) New Wording: Random failures must have sufficient documentation (i.e., published report available to regulatory bodies) to justify why the failure can be attributed as a random failure and not minor design failure. Random failures may be repaired on all units. A condition to allow the repair of production analyzers is the development of a plan (where necessary) to prevent the specific type of failure in future production units. After repairs, those tests that might be affected by the repairs should be rerun.

B. Section A. Gases (p. 19)

1. Subsection 2. Item d) zero gas

a) Previous Wording: Zero gas may be

i) bottled air,

ii) chemically purified room air such as with an activated charcoal trap on the anlysis system, or

iii) catalytically purified room air.

b) New Wording: Zero gas may be air or N_2. The impurities in bottled zero gas must be analyzed at less than the maximum allowable level. Ambient room air may be used for routine spanning of inspection equipment.

c) Reason for Change: To clarify original intent between in-use zero gas and audit gases (see sub-section 3).

2. Subsection 3. Recommended number of gases: b) for in-use systems. Item ii) (p. 20).

a) Previous Wording: purified room air zero gas

b) New Wording: zero gas may be drawn from the ambient air (room-air). It is preferred that the pick-up of ambient zero air is as high off the floor as practical. Suggested accessory items (not required) are chemical or catalytic devices to purify the ambient air, or a zero-air port that would allow use of ambient zero air drawn from outside the test cell or building.

c) Reason for Change: To clarify original intent to not require bottled zero gas on in-use analyzers.

3. Subsection 3. Recommended number of gases c) for periodic check ... Item iii) (p. 20).

a) Previous Wording: bottled zero gas

b) New Wording: bottled zero gas (because the audit check will use bottle zero gas and the in-use system will use ambient room air, a background emission calculation must be used during the audit check.)

c) Reason for Change: In allowing ambient room air to be used as zero gas for in-use systems, there can be an offset in the gain setting of the span control if there is a significant level of background emissions. Background emission levels can vary substantially from location to location. In order to evaluate the operation of the machine, background levels should be measured during the audit check.

Spec: B.1.

C. Section B. Gas Cylinders (p. 21)

1. Subsection 1. Item d)

a) Previous Wording: Disposable cylinders may not be used

b) New Wording: Disposable cylinders are generally not desireable in the context of gas blending, gas stability, and gas traceability. Also, the quantity of gas in the disposables is generally quite small (approximately 7-8 cubic feet) compared to the refillable bottles (160 cubic feet). The small size of the disposable bottles requires more frequent replacement in the field. The disposables are, however, convenient to handle and ship. Therefore, disposable cylinders may be used for in-use systems (not audit) provided that the suppliers of the disposable bottles include the following quality control measures.

i) The inside surfaces of the cylinder conform with the NBS CRM or SRM procedures for preparation, cleanliness, trace materials, composition, coatings, etc. for the gas composition and concentrations used.

ii) The cylinder valve shall conform with NBS CRM or SRM procedures for preparation, packing materials, cleanliness, composition, etc. for the gas composition and concentrations used.

iii) The stability over the normal usage time of the gas concentraton shall be periodically checked from random production lots by the NBS CRM procedure.

c) Reason for Change: To allow the use of disposable cylinders.

Spec: D.3.d) & e)
and
D.7.b)

D. Section D. Design Requirements

1. Subsection 3. Sample System d) Water Trap, Item i) 2) (p. 24)

a) Previous Concept: Electronic compensation (based on pressure and temperature) of the water in the sample was allowed.

b) New Concept: The previous concept assumed that the sample leaving the water trap was saturated. This may not be the case for all systems under all conditions. Therefore, the wording for Item 2. is deleted, and new wording is substituted.

c) New Wording:

Option 2: Other techniques to either remove the water from the sample (e.g. permapure ®, etc.) or correct for the water content (electronic dew point, pressure, etc.) may be used if they can be demonstrated to be equivalent to Option 1.

2. Subsection 3. Sample System e) Particulate Filter, Item vi) (p. 24)

a) Previous Concept: The particulate filter before the optical bench was required to be 5 micron or less.

b) New Concept: The particulate filter before the optical bench is preferred to be 5 micron or less.

c) Reason for Change: To allow more flexibility in system design.

d) New Wording: It is preferred that the filter element and filter system shall be designed to prevent particulates larger in size than 5 microns from entering the sample cell of the analyzer. The location of this suggested optical bench filter (5 micron) is up to the manufacturer and may be on the pressure or vacuum side of the system. If this filter only filters sample gases passing through the analyzer, the manufacturer may elect to have an additional filter prior to the system pump(s). The particulate size of this optional filter is at the discretion of the manufacturer. Verification of filter particulate size removal may be determined by the filter manufacturer using standardized ASTM or Filter Industry procedures.

3. Subsection 7. Analyzer Spanning System, Item b) (p. 26)

a) Previous Wording:

Recommended Gas Spanning Frequency: It is recommended that the analyzer be gas spanned after:

i) every "power on" and warm-up sequence, and

ii) every 4 hours of "power-on" condition when testing.

b) New Wording:

Recommended Gas Spanning Frequency: It is recommended that the analyzer be gas spanned after:

i) every "power on" and warm-up sequence, and

ii) every 4 hours of "power-on" condition when testing.

iii) If this gas spanning frequency is used, the analyzer is not required to have any temperature or barometric correction.

c) Reason for Change: To clarify original intent.

4. Subsection 7. Analyzer Spanning System, Item e) (p. 26)

a) Previous Wording: Last sentence in subparagraph e) ... The audit port should interconnect the span system downstream of the span/zero switching valve.

b) New Wording: Delete the last sentence in subparagraph e).

c) Reason for Change: The sentence was included to allow for leak checking the span/zero switching valve during the audit. There are other ways to check this valve more cost effectively.

5. Subsection 7. Analyzer Spanning System, Item h) (p. 26)

a) Previous Concept: Subparagraph h) required operator tracking of the gain setting to identify analyzer problems or dirty sample cells.

b) New Concept: Replaces operator tracking by requiring the analyzer manufacturers to limit the overall gain adjustment such that gain cannot be turned up to the point where the signal-to-noise ratio prevents the analyzer from meeting the calibration curve and drift requirements.

c) Reason for Change: To allow the manufacturers more flexibility in the analyzer design.

d) New Wording: (Delete the previous wording for subparagraph h) and substitute the following). The overall analyzer span gain-control shall be limited such that when compensating for analyzer degradation the operator runs out of gain adjustment before the signal-to-noise ratio of the analyzer prevents the analyzer from complying with the calibration curve and drift requirements in Section E.

Spec: D.7.1)

6. Subsection 7. Analyzer Spanning System, 1) Span Cylinders, Item i) (p. 27).

a) Previous Concept: Requires the use of and supporting equipment for 200 cubic foot gas cylinders.

b) New Concept: Make specifications consistent with changes in Section B. (Gas Cylinders) that allow the possible use of disposable cylinders.

c) Reason for Change: Consistency with other changes.

d) New Wording: For stand alone centralized inspection analyzers (a condition determined by the State or Contractor) and all decentralized analyzers, the analysis system shall include a structure for safely securing two refillable span cylinders, or shall include an easily utilized source for procurement of such a structure by the owner as well as safety and operating instructions for use of the structure. Appropriate regulator(s) and lines shall be provided for the type of cylinder(s) used. All analyzers not utilizing a refillable bottle shall prominently display a label or a sticker which indicates that "AN OPTIONAL KIT INCLUDING A GAS REGULATOR AND HOSE IS AVAILABLE THAT ALLOWS THE USE OF LARGER MORE ECONOMICAL GAS CYLINDERS". The analyzer manufacturer must provide such a kit. The manufacturer's kit shall be evaluated during the accreditation tests. The kit shall be included in all areas where disposable bottles of traceable span gas are not available from an accredited source. In areas where disposable bottles are available, the manufacturer's sales literature and presentations should at least give equal treatment to the kit and larger bottles (compared to the disposable bottle system). A fair comparison of captial costs, operating costs, bottle change-out frequency, payback time, etc. is suggested. If the system includes a CO_2 analyzer, regulator(s) and lines shall be provided for one cylinder of CO_2 span gas.

E. Section E. Analyzer Performance Specifications (p. 31)

1. Subsection 1. Calibration curve uncertainty, Item a) (p. 31).

a) Previous Wording: 5% of point (i.e. true value of reading).

b) New Working: 5% of point (i.e. true value of reading) at and above 1.2% CO and 220 ppm HC. Below 1.2% CO and 220 ppm, the uncertainty limits are 0.06% CO and 11 ppm HC.

c) Reason for Change: The previous calibration curve uncertainty specification (5% of point) at low CO values was necessary due to the possibility of newly promulgated Federal LDT and HD idle standards of 0.47% CO becoming performance warranty standards. It is now reasonably clear that 5% of point uncertainty at 0.5% CO is beyond the capability of optical benches that are available or will be available in the near future without major redesign or modifications. Although selected units of the current designs can meet the previous specifications, the production lot of the equipment is not expected to have the consistency to meet the previous specifications. The new specifications are a compromise among accuracy, cost, and availability.

2. Subsection 3. Compensation, Item b)i) (p. 31)

a) Previous Wording: The temperature compensation network shall provide accurate results over the ambient temperature range specified in Section G of this chapter as well as exhaust gas temperatures up to 49°C (120.2°F). (Units with heated sample cells are excluded from this requirement).

b) New Wording: The analyzer shall provide accurate results over the ambient temperature range specified in Section G of this chapter as well as exhaust gas temperatures (at the sample cell) up to 49°C (120.2°F). (Units with heated sample cells are excluded from this requirement). If the automatic temperature compensation network does not compensate for the full range of the required temperatures, the analyzer should revert to a 4 hour gas span check at temperatures outside of the compensated range. If the evaluation temperatures for Section G are outside the compensated range, the standard uncertainty procedures (which include prior gas span at the prevailing ambient temperatures) should be used at these temperatures. Also, if the evaluation temperatures are outside the compensated range, additional tests should be performed to evaluate the compensation network. The tests should include checking the actual activation and deactivation temperatures as well as checking the analyzer uncertainty with the compensation network active at a temperature 2°C above the actual activation temperature, and at a temperature 2°C below the actual deactivation temperature (e.g. 12.8°C to 35°C (55-95°F) compensation range, test temperatures should be 14.8°C and 33°C). The actual activation and deactivation temperatures should be $\pm$3°C of the manufacturer's stated temperatures.

c) Reason for Change: The use of a temperature compensation network is optional at the analyzer manufacturer's discretion. Current compensation networks are somewhat limited in the ability to maintain (through electronic compensation) an accurate calibration curve over the full temperature range required in Section G. However, over their limited operating range (usually 55-95°F), they are reported to perform adequately. The advantage of the compensation network is the ability to shift from the recommended 4 hour span check to a weekly span check. The change in the compensation specification was made in order to utilize the benefits of lower span gas consumption exhibited by the compensated analyzers while maintaining the required accuracy.

3. Subsection 7. Sample Cell Temperature, Item b) (p. 32).

a) Previous Concept: If the sample cell is not heated, the system must provide temperature compensation.

b) New Concept: If the sample cell is not heated, it is preferred that the system provide temperature compensation.

c) Reason for Change: The original concern was about changes in the sample gas temperatures entering the optical bench. Current systems tend to reduce the sample gas temperature to near ambient temperatures at (or near) the water trap/filter assembly(s). Fundamentally, this practice should reduce variability of the sample gas entering the optical bench. Another concern was the potential for the sample gas temperature to be different from the span gas temperature. Any difference in temperature would cause an error in the span setting that could only be detected when sampling a vehicle. Large span errors due to temperature differences should be able to be identified by the correlation test (to laboratory analyzers) on vehicle exhaust (Section I). Theoretically, then, the requirement for temperature compensation can be eliminated, but to be on the safe side, we would prefer (but not require) temperature compensation if the sample cell is not heated.

d) New Wording: If the sample cell is not heated, it is preferred that the analysis system compensates for temperature effects on the gas (sample or span) measurement process as in Section 3.

4. Subsection 8. Interferences b) Electronic, Item v) (p. 33).

a) Previous Wording:

Line voltage and : Frequency Variation (90-130 vA.C.) (59-61 hz)	1.0% fs L.S.

Spec: E.8.

b) New Wording:

Line voltage and : 1.0% fs L.S.
Frequency Variation

1) Normal system operation at 115 vA.C. ±10%

2) Electronics to be tested between 100-130 vA.C.

3) Normal system operation at 59-61 hz

c) Reason for Change: Most manufacturers use the same source for the sample pump. The particular sample pump used has difficulty operating at low voltages, and won't start at extremely low voltages. The reason for the wide voltage specifications in the previous wording was that line voltage fluctuation and location in the power grid as well as "brown-outs" in urban areas can easily cause the true line voltage to exceed tradition voltage specifications (115 vA.C. ±10%). The concern was about the accuracy of the analyzer when the voltage available for the analyzer was outside of the traditional values. Therefore, to prevent pump damage, the evaluation test will not attempt to start the sample pump below 106 vA.C, but will test the electronics down to 100 vA.C.

Spec: F.1.3. & 5.

F. Section F. Sample System Performance Specifications (p. 34)

1. Item, Subsection 1. (p. 34)

a) Previous Wording: Maximum sample cell mean pressure differences between gas spanning and sampling: 4" H_2O

b) New Wording: Maximum sample cell mean pressure differences between gas spanning and sampling: 4" H_2O or exhibit less than a 1% difference in the mean low-range calibration curve (see E.1.) measured through the span port compared to the mean low-range calibration curve measured through the probe.

c) Reason for Change: Allow the manufacturers more flexibility.

2. Item, Subsection 3. (p. 34)

a) Previous Wording: Maximum sample cell mean pressure difference between normal flow and low flow indication : 4" H_2O

b) New Wording: Maximum sample cell mean pressure difference between normal flow and low flow indication: 4" H_2O or exhibit less than a 1% difference in the mean response on the low range to a span gas measured through the probe at normal flows compared with the mean response on the low range to a span gas measured through the probe at a flow rate corresponding to the flow rate that activates the low flow indication.

c) Reason for Change: Allow the manufacturers more flexibility.

3. Subsection 5. System Leakage, Item b) (p. 34).

a) Previous Wording: The pressure side of the sample system shall be leak free as determined by a "bubble" leak-check method (not to be used in the field).

b) New Wording: The pressure side of the sample system shall be leak free as determined by a "bubble" leak-check method (not to be used in the field). The sample cell pressure shall not exceed the maximum normal operating pressure for this check.

c) Reason for Change: To protect the analyzer from possible damage due to overpressure.

4. Subsection 5. System Leakage, Item c) (p. 34).

a) Previous Wording: The vacuum side leak-check method shall consist of a comparison of the span gas response introduced through the span network to the response of the same span gas introduced through the probe and sample line. In the future with demonstrated and historical data, other leak-check techniques may be accepted or equivalent to the gas comparison leak-check.

b) New Wording: The vacuum side leak-check method shall consist of a comparison of the span gas response introduced through the span network to the response of the same span gas introduced through the probe and sample line. Other leak-check techniques may be accepted as equivalent to the gas comparison leak-check with appropriate comparative evaluation of the fundamental mechanisms involved, and a demonstration of the technique. These other techniques (such as vacuum level/time decay) shall use a 1.5% measurement error trigger instead of the 3% measurement error trigger specified for the gas comparison leak check.

c) Reason for Change: Provide the manufacturers more flexibility.

5. Subsection 6. HC Hang-up, Item a) (p. 35).

a) Previous Wording: The HC analyzer response to room air sampled through the probe and sample line shall be less than 20 ppm C6 prior to testing a vehicle or the test is void.

b) New Wording: The HC analyzer response to room air sampled through the probe and sample line shall be less than 20 ppm C6 (as measured by the analyzer zeroed on room air) prior to testing a vehicle or the test is void.

c) Reason for Change: Most analyzers will set zero with room air. The difference between room air measured from the zero port and room air measured from the sample line will usually be adequate to indicate the amount of hang-up for this type of testing.

Spec: G.1.

G. Section G. Operating Environment (p. 36).

1. Subsection 1.b) Ambient Relative Humidity, Item i) (p. 36).

a) Previous Wording: Range of field operation: 0% to 100% condensing (i.e. raining or dense fog).

b) New Wording:

Range of field operation: The analyzer shall be designed for use inside a building or semi-protective shelter that is vented or open to outside ambient humidity. The analyzer shall be designed for use in such locations when the outside relative humidity ranges between 0% to 100% condensing (i.e. raining or dense fog).

c) Reason for Change: To clarify intended instrument use, and to indicate that instrument need not be designed for submersible operation.

H. Section H. Fail-Safe Features

1. Subsection 1. Warm-up c) lock-out, Item i) (p. 37).

a) Previous Wording: When system power is turned on. The lock-out shall stay on until the zero drift is stabilized. The manufacturer must condition the lock-out on analyzer parameters, and may not use clock time as a sole criteria to determine warm-up condition. Verification of proper zero stabilization is determined by observing the zero drift over a 5 minute period after the lock-out feature deactivates. The zero drift during this 5 minute period may not exceed one-half of the zero drift specifications in Section E. If digital sampling of the zero level is used, the sample rate shall be at least 10 hertz. Analog observation of zero drift is permissible.

b) New Wording: When system power is turned on. The lock-out shall stay on until the zero drift is stabilized. The manufacturer must condition the lock-out on analyzer parameters, and may not use clock time as a sole criteria to determine warm-up condition. Verification of proper zero stabilization during the evaluation test is determined by observing the zero drift over a 5 minute period after the lock-out feature deactivates. The zero drift during this 5 minute period may not exceed one-half of the zero drift specifications in Section E.

c) Reason for Change: To clarify intent and to remove test procedure specifications to the test procedure section.

IV. Modified Sections in Chapter VIII

A. Introduction to Chapter VIII (p. 41).

1. Add Sentence: "... the word "void" prominently and/or superimposed over the data." Alternatively, a different format for inspection form versus repair form may be used in place of the printer interlock and void stamp, provided that there is an easily discernable difference between the formats and that the repair form can not be used for inspection results. "All valid test results ..."

2. Reason for Change: Provide more flexibility for the designer.

B. Section A. Automatic Zero/Span Check (p. 41).

1. Item, Subsection 6. (p.41, 42).

a) Previous Wording: The concentrations of span gas shall be entered via switches or other convenient means to the following resolution:

HC = XXXX ppm propane
CO = X.XX% CO

The switches or interlock that allows the entering of the span gas values shall be in an anti-tamper box as described in this chapter.

b) New Wording: The concentrations of span gas shall be entered via switches or other convenient means to the following resolution:

HC = XXXX ppm propane
CO = X.XX% CO

The switches or interlock that allows the entering of the span gas values shall be in an anti-tamper box as described in this chapter. In place of locating the span gas concentration switches in the anti-tamper box, the analyzer manufacturer may allow user access to those switches if the system prints the gas concentrations, as determined by those switches, on each consumer inspection ticket. The printed value of the span gas concentration need not be identified as long as the format allows the auditor to check the values. To use this alternative (printing concentration values) with the optional automatic data collection (ADC) system, the microprocessor shall automatically enter the span gas values determined by the position of those switches into the ADC storage medium for each test.

c) Reason for Change: To allow the manufacturers the flexibility to allow user access to the span gas concentration switches while maintaining audit capability on the use of those switches.

C. <u>Section B. Automatic Leak Check (p. 43).</u>

1. <u>Item, Subsection 3. (p. 43).</u>

a) <u>Previous Wording:</u> Activation of the automatic leak-check system shall cause the analyzer to automatically perform (or check) a span sequence, automatically introduce span gas to the probe, compare the difference between the span and probe readings, and make a pass or fail determination.

b) <u>New Wording:</u> Activation of the automatic leak-check system shall cause the analyzer to automatically perform (or check) a gas span sequence, introduce span gas to the probe, compare the difference between the gas span and the probe readings, and make a pass or fail determination. Minimal activity by the operator (such as setting the probe in a holder, adjusting probe flow to limits preset and checked by the computer, capping the probe, etc. is permitted provided errors resulting from improper operator action would be identified by the computer and would require corrective action, or improper operator action would tend to cause the system to fail a leak check.

c) <u>Reason for Change:</u> To clarify original intent.

D. Section E. Dual Tailpipes (p. 45)

1. Item, Subsection 1.-4. (p. 45)

a) Previous Concept: The dual tailpipe option provided for automatic averaging of the results from each tailpipe.

b) New Concept: Delete requirement from Chapter VIII.

c) Reason for Change: The number of vehicles in affected non-attainment areas with true dual exhaust systems is expected to be very small.

d) New Wording: E. [Deleted].

E. Section H. Vehicle Diagnosis (p. 48)

1. Item, Subsection 2. (p. 48)

a) Previous Wording: Activation of the "Vehicle Diagnosis" switch shall allow the analyzer to continuously monitor the vehicle exhaust.

b) New Wording: Activation of the "Vehicle Diagnosis" switch shall allow the analyzer to continuously monitor the vehicle exhaust regardless of inspection status (e.g. system needs weekly span check, leak check, warm-up condition, etc.).

c) Reason for Change: Allows more flexible (but possibly less accurate) use of the equipment for vehicle repair.

2. Item, Subsection 3. (p. 48)

a) Previous Wording: The printer, or any automatic data collection system, shall be prevented from operating anytime the analysis system is in a "Vehicle Diagnosis" status.

b) New Wording: The printer, or any automatic data collection system, shall be prevented from operating anytime the analysis system is in a "Vehicle Diagnosis" status unless one of the options described in the introduction to Chapter VIII is used.

c) Reason for Change: Allow printer to be used in vehicle diagnosis.

F. Section I. Anti-Tampering (p. 48)

1. Item, Subsection 2. (p. 48)

a) Previous Wording: All switches or entry access for automotive zero/span check adjustments, anti-dilution limits, span gas concentration values, diagnostic switches, etc. shall be contained in a box or other tamper-proof mechanism with provisions for an inspector's seal. A gummed label with the inspectors initials and date which must be torn to gain access, or a braided wire and crimped lead seal (or similar device) would be sufficient for sealing.

b) New Wording: All switches or entry access for automotive zero/span check adjustments, anti-dilution limits, span gas concentration values, diagnostic switches, etc. shall be contained in a box or other tamper-proof mechanism with provisions for an inspector's seal. Span gas concentration switches may be accessible to the user if the switch values are printed for each test (see option in Section A, subsection 6.). A gummed label with the inspectors initials (or authorized stamp) and date which must be torn to gain access, or a braided wire and crimped lead seal (or similar device) would be sufficient for sealing.

c) Reason for Change: To make subsection 2. consistent with changes in Subsections A.6. and I.3.

2. Item, Subsection 3. (p. 48)

a) Previous Wording: The tamper-proof system must allow convenient access by an inspector.

b) New Wording: The tamper-proof system must allow convenient access by an inspector or authorized service personnel.

c) Reason for Change: Allow service personnel to repair or adjust analyzers.

V. Modified Sections in Chapter IX

A. Section B.

1. Item, Subsection (all) (p. 52)

a) Previous Wording: B. [Deleted]

b) New Wording:

Dual Exhaust Systems

1. The system shall have the capability to automatically calculate the average reading for dual tailpipes.

2. The dual tailpipe system shall use integrated test values from the automatic read system for averaging.

3. Activation of dual tailpipe system shall allow two activations of the automatic read system without activating the hang-up check interlock.

4. The dual tailpipe system shall display the average value on operator command, and hold the value until reset. The average value is the value that would be forwarded to an automatic data collection system.

c) Reason for Addition: To provide guidance for those programs that choose the option to have the capability of testing dual exhaust system vehicles and conveniently enter that data into an automatic data collection system.

B. Section C. Anti-Dilution (p. 53)

1. Item, Subsection 6. (p. 53)

a) Previous Wording: The CO_2 analyzer shall meet all of the analyzer specifications in Chapter VII between CO_2 values of 6% and 14%. (CO_2 interference specification does not apply). Specifications in Chapter VIII apply to computer analyzers.

b) New Wording: The CO_2 analyzer shall meet all of the analyzer specifications in Chapter VII between CO_2 values of 5% and 14%. Exceptions are: 1) the CO_2 interference specification does not apply, and 2) the uncertainty of the calibration curve shall be $\pm 0.9\%$ CO_2 in the range of 5-10% CO_2, and $\pm 0.5\%$ CO_2 in the range of 10-14% CO_2. Specifications in Chapter VIII apply to computer analyzers.

c) Reason for Change: The common method of adding a CO_2 analysis capability to an HC/CO measurement system is to add a detector chip to an existing sample cell. The length of the sample cell is very critical in determining the accuracy and discrimination of an NDIR analyzer. Fortunately, little compromise is necessary in selecting the optimum sample cell length for HC and CO. Thus, the same sample tube (cell) can be satisfactorily used for both HC and CO measurement. Unfortunately, the optimum length for CO_2 measurement is quite different than that for HC and CO measurement. Therefore, if we want the economy of adding just a CO_2 detector chip to the HC/CO sample tube, we must accept the type of accuracy that the non-optimum CO_2 path length gives us. The alternative, if more accuracy is required, would be to use an additional sample cell complete with IR source, optics, detector, and electronics; in short another complete optical bench, just for CO_2 measurement. The alternative approach while being more accurate, in our judgment is not worth the cost.

C. Section D. Loaded Mode Kit (p. 54)

1. Item, Subsection 4. (p. 54)

a) Previous Wording: None - new subsection.

b) New Wording: Alternatives to the 7°C maximum water trap temperature moisture-removal system are:

i) A 13°C maximum water trap temperature with corrections for water content (electronic dew point, pressure, etc.) if the system can be demonstrated to provide equivalent emission results to the base water removal system.

ii) A partial pressure type watertrap (permature @ etc.) may be substituted for the base water removal system provided it can be demonstrated to be as efficient in water removal.

iii) Any water removal system in conjunction with a heated sample cell (with heated internal plumbing) and an electronic water correction system (electronic dew point, pressure, etc.) may be used provided that the water removal system: 1) lowers the sample gas temperature at least 8°C (14.4°F) below the sample cell temperature; 2) the internal plumbing between the water removal system and the sample cell does not allow the wall temperature of the components to drop below the water removal gas temperature; and 3) the overall system provides equivalent emission results to the base water removal system.

c) Reason for Change: To allow the analyzer manufacturers more flexibility in designing a loaded mode system.

VI . Modified Sections in Chapter XI

Note: Throughout the test procedures, various test-point values are required based on the analyzer specification values. Revisions to some of these specifications (found in report 80-5-C) may affect test-point or reference values. Therefore, the reader is cautioned to carefully check the test procedures to assure that values from 80-5-C are used for evaluation testing.

A. Item, Introduction to Chapter XI (p. 59)

1. Previous Wording (Last Paragraph): The procedures as written are generally independent of tolerance specification values. Following each test procedure, a reference value corresponding to the values given in Chapter VII through X will be given in parenthesis.

2. New Wording: The procedures as written are generally independent of tolerance specification values. Following each test procedure, a reference value corresponding to the values given in Chapter VII through X will be given in parenthesis.

It is important to reemphasize that analyzer manufacturers may instrument candidate analyzers to decrease set-up time during evaluation (see Chapter VII introduction). An example of such pre-instrumentation is demonstrated by the problem of obtaining an analog chart paper trace from a digital readout or CRT display. Clarification of the type of pre-instrumentation allowed was requested by several manufacturers. Most digital displays are driven by BCD code. Many CRT final stage screen-writing electronics are also driven by BCD. Chart recorders are now available that will accept a BCD signal and print a stepped analog trace. Providing suitable add-on signal conditioning equipment in order to buffer or parallel (with parallel driver if necessary) the BCD signal output to the user readout device or CRT screen-writer for the purpose of using a BCD chart recorder would be an example of acceptable pre-instrumentation.

In addition to the general instructions given above, results from previous testing performed for BAR 80 accreditation can be used in lieu of performing the tests listed in Table XI-1. Results can only be used from valid tests performed as part of the accreditation procedure leading to full accreditation. The data from the BAR 80 results is, however, subject to the 3 year accreditation period (e.g. 1979 BAR 80 data could be used until 1982).

Table XI-1

EPA Test Procedures For Which BAR 80 Results May Be Substituted

EPA Test Procedure No.	Description of Procedure
C.2.	Sample Line Crush
C.3.	Sample Handling Temperature Effect
C.4.	Filter Check and Hang-up
D.6.a.	Sample Line Flexibility
E.3.a.	Altitude Compensation
E.9.	Analyzer Electrical Inference - all except low line-voltage testing
E.10.	Propane to Hexane Conversion Factor
G.1.ii)	Low Temperature Environment - all tests except warm-up and response time

c) Reason for Change: To add flexibility and to reduce evaluation testing costs.

B. Specific Test Procedure Changes

1. Section E. Subsection 1., Item b) i) (p. 72)

a) Previous Wording: If necessary, follow the manufacturer's instructions for initial start-up and basic operating adjustments.

b) New Wording: If necessary, follow the manufacturer's instructions for initial start-up and basic operating adjustments. If the analyzer is equipped with an automatic read system, the auto-read system may be used for this test.

c) Reason for Change: To add flexibility.

2. Section E. Subsection 3. Item a) v) (p. 77)

a) Previous Wording: None - adding a new subparagraph.

b) New Wording: An alternative test procedure may be used to evaluate the analyzer's ability to be properly spanned at different altitudes. The procedure consists of arbitrarily renaming the span bottle used based on the expected density changes at the various test altitudes. The new values are:

V_H = (BARO/24) (span gas concentration)
V_L = (BARO/31) (span gas concentration)

Where: BARO is in (in.HgA)

Use the standard gas span procedure to span to the V_H and to the V_L values. See iv) for acceptance criteria.

c) Reason for Change: To add flexibility and reduce testing costs.

3. <u>Section E. Subsection 3, Item b) i) (p. 78)</u>

a) Previous Wording: Testing concepts: This test procedure is to be performed in order to identify the performance of any pressure or temperature compensation systems under the various environmental conditions that may be encountered during vehicle inspection testing. In general, temperature compensation will be evaluated during the more hostile environmental temperature tests specified in Section G. No other special testing would normally be necessary.

In order to evaluate pressure compensation systems, additional testing is necessary. If the analyzer manufacturer can make a case that testing the pressure compensation system in a manner similar to the procedure specified in Chapter V Section E.3.a) (altitude compensation) will represent actual analysis system operating conditions in the field, then that procedure (E.3.a) may be used for check-out. If a sufficient case cannot be made, and a suitable alternative test procedure cannot be determined, then performance evaluations of the pressure compensation system must be carried out in an altitude chamber. The pressure compenstion test shall be conducted at each environmental temperature condition specified in Chapter V. The tests shall be performed on each range of each analyzer.

b) New Wording: Testing concepts: This test procedure is to be performed in order to identify the performance of any pressure or temperature compensation systems under the vairous environmental conditions that may be encountered during vehicle inspection testing. In general, temperature compensation will be evaluated during the more hostile environmental temperature tests specified in Section G. No other special testing would normally be necessary. However, if the temperature compensation network does not compensate for the full range of temperature specified in Section G, the activation and deactivation temperatures of the system shall be checked as well as the calibration curve uncertainty at a temperature 2°C above the actual activation temperature, and at a temperature 2°C below the actual deactivation temperature. Checking of the activation temperature etc. may be performed during the Section G. check-out.

In order to evaluate pressure compensation systems, additional testing is necessary. If the analyzer manufacturer can make a case that testing the pressure compensation system in a manner similar to the procedure specified in Chapter V Section E.3.a) (altitude compensation) or in any other manner (such as component testing) will represent actual analysis system operating conditions in the field, then that procedure (E.3.a. or other procedure justified by the manufacturer) may be used for check-out. If a sufficient case cannot be made, and a suitable alternative test procedure cannot be determined, then performance evaluations of the pressure compensation system must be carried out in an altitude chamber. The pressure compenstion test shall be conducted at each environmental temperature condition specified in Chapter V. The tests shall be performed on each range of each analyzer.

c. Reason for Change: To be consistent with previous temperature compensation changes and to allow more flexibility in the testing of pressure compensation networks.

4. Section F. Subsection 5., Item b) xiv) (p. 104)

a) Previous Wording: None - adding a new subparagraph.

b) New Wording: Repeat steps i) through xiii) with the tee fitting between the filter assembly and the leak check sensor.

c) Reason for Change: To compensate for and to test adequately alternative leak-check systems that are allowed due to changes in Chapter VII.F.5.

5. Section G. Subsection 1., Item b) (p. 105)

a) Previous Wording:

Test Conditions

i) 105°F (±5%°F) with a relative humidity between 80 and 85 percent (non-condensing).

ii) 40°F (±5%°F) with a relative humidity between 75 and 80 percent with a 10 mph wind.

iii) 35°F (±5%°F) with a relative humidity between 10 and 20 percent.

b) New Wording:

i) 105°F (±5%°F) with a relative humidity between 80 and 85 percent (non-condensing).

ii) 40°F (±5%°F) with a relative humidity between 75 and 80 percent with a 10 mph wind.

c) Reason for Change: Test conditions ii) and iii) were somewhat similar, therefore to reduce evaluation testing time and cost, test condition iii) was dropped.