CHAPTER 8

EQUIPMENT MAINTENANCE AND CALIBRATION

1. **GENERAL**.

a. The maintenance and calibration of industrial hygiene equipment is critical to ensure that precise and accurate measurements of the workplace are made. Many far-reaching decisions are based on the results of workplace evaluations of toxic chemicals or harmful physical agents. An underestimation of an employee’s or group of employees’ exposure may result in medical as well as legal complications. Overestimation may result in costly and unnecessary control measures, reduced production, and employee relations problems.

b. Determination of any given employee’s "actual" exposure is a difficult task. To minimize errors and most closely approximate employees’ exposure, it is necessary to have a comprehensive calibration program in addition to professional experience, sound sampling strategies, and established analytical procedures.

2. **SCOPE**. This chapter provides the requirements for calibration and maintenance of all Navy industrial hygiene equipment. Although the calibration of most Navy technical equipment is covered by the Metrology Requirements List (METRL), NAVSEA Publication OD 45845 (Reference 8-1) under the Metrology Engineering Center, Pomona, California, medical and industrial hygiene equipment has generally not been included in this calibration program. One notable exception is the calibration of heat stress meters by METCAL facilities. Although use of METCAL facilities is an option, use of this calibration source is not required since many items of industrial hygiene equipment are neither handled by nor familiar to METCAL facilities. This chapter does not apply to RADIAC equipment.

3. **RESPONSIBILITIES**. Each command owning industrial hygiene equipment must be responsible for the correct operation, maintenance and calibration of that equipment.

4. **CALIBRATION, CHECKS, AND MAINTENANCE**.

a. General. Most types of industrial hygiene equipment require periodic laboratory calibration. Many must also be field calibrated or field checked by the user. Examples of field calibrated items are personal sampling pumps, sound level meters, rotameters, toxic gas monitors, combustible gas monitors, and oxygen meters. An example of an item that must be field checked but cannot be calibrated is a hand-held sampling pump for detector tubes.

b. Laboratory Calibration. Certain equipment must be calibrated periodically by a calibration laboratory, recommended calibration laboratories are those operated by the equipment manufacturer (who is the most familiar with the equipment), the Navy Environmental Health Center Calibration Laboratory, or other accepted calibration laboratory. Examples of other accepted laboratories would be those recommended by the manufacturer or those with a demonstrated ability to calibrate a specific piece of equipment and a quality control program which provides traceability to National Institute of Standards and Technology (NIST) standards. BUMED activities which obtain laboratory calibration from sources other than the manufacturer or Navy Environmental Health Center (NAVENVIRHLTHCEN) are requested to provide a list of those laboratories to the Industrial Hygiene Directorate, Navy Environmental Health Center for publication on the NEHC web site to assist other activities seeking such services.

(1) The NAVENVIRHLTHCEN will calibrate the following equipment:

(a) Type 1 sound level meters: Bruel & Kjaer models 2230, 2232, 2235 and 2236; CEL models 266/3, 275/3, 414/3, 493/3, 553, 573 and 593; General Radio models 1982 and 1988; Quest models 155, 1700, 1800 and 1900; and Sper Scientific model 840029.

(b) Type 2 sound level meters: CEL models 231, 254, 275, 328/3 and 383/3; General Radio model 1565B; MSA model 695090; Quest models 211, 211F/S, 214, 215, 228, 2200, 2400, 2500, 2700, 2800 and 2900; and Simpson models 884 and 886.

(c) Filters: Quest Filters models OB50, OB100, OB145 and OB300.

(d) Noise dosimeters: Ametek/Dupont models MK1, MK2 and MK3; CEL models 281, 328 and 420/460; General Radio model 1954 (See Note 1), Larson Davis model 705; Metrosonics models db307, db308, db3070, db3080, db3088 and db3100.

(e) Calibrators: Bruel & Kjaer model 4230; CEL models 282 and 284; Dupont models AC1 and AC94; General Radio models 1562A, 1986 and 1987; Larson Davis model 250; Metrosonics models CL302 and CL304; MSA model 695094; Quest models CA12,

CA12A, CA12B, CA12M, CA15B, CA22, CA32, QC10 and QC20; Simpson model 890.

NOTE 1: NAVENVIRHLTHCEN is phasing the GENRAD model 1954 out of the calibration program because these dosimeters are outdated. NAVENVIRHLTHCEN needs indicator to calibrate and recommends surveying unit due to age.

NOTE 2: Due to the volume of equipment received, repairs are not being done at NAVENVIRHLTHCEN at this time. If equipment needs repairs, it will be returned to you with a recommendation that you send it to the manufacturer.

NOTE 3: If you have noise measurement equipment not listed above, calibration may be available from NAVENVIRHLTHCEN. To find out, please send a copy of the instrument's instruction manual, with the instrument, along with a request on command letterhead stating what is required to Commanding Officer, Navy Environmental Health Center, Attention: Administrative & Support Directorate-Calibration Laboratory.

(2) This service is provided only for Bureau of Medicine and Surgery activity owned equipment. If you have other questions about the capabilities of the calibration laboratory, please call NAVENVIRHLTHCEN.

(3) When sending equipment for calibration, furnish a complete return address with the point of contact, department or division, building number, street address, city, state, nine digit zip code and a commercial telephone number. To protect the equipment against damage during shipping, it should be shipped in the equipment case if possible, with the case(s) packed in a shipping carton. If this is not possible, each piece of equipment should be well protected in bubblewrap, packed in at least a double wall carton, and shipped by a traceable source to:

Commanding Officer
Navy Environmental Health Center
Attn: Calibration Laboratory
620 John Paul Jones Circle
Suite 1100
Portsmouth, VA 23708-2103

Limit your shipment to a maximum of 10 instruments per order.

c. Calibration Schedule. Table 8-1 lists general equipment laboratory and field calibration intervals. If conflicts exist with individual manufacturer's requirements, the manufacturer's requirements take precedence.

d. Shipboard Industrial Hygiene Equipment Calibration. Equipment aboard ships is entered in the ship's calibration program for periodic recall. The tender or Shore Intermediate Maintenance Activity will send the equipment to the appropriate calibrating authority.

e. Equipment Maintenance and Repair. Maintenance shall be conducted in accordance with the manufacturer's recommendations and, for shipboard equipment, per the Planned Maintenace System (PMS) requirements.

(1) Routine field maintenance, such as replacing batteries, changing filters, and replacing minor components (i.e., normal end-user maintenance described in the manufacturer's operators manual) may be accomplished by the user, provided the user has the necessary expertise.

(2) Medical repair facilities may be capable of performing certain repairs but in many cases are not sufficiently familiar with industrial hygiene equipment that they rarely repair. More complex maintenance or repairs should be accomplished by the manufacturer or similar specialized repair facility.

(3) Great care should be taken to ensure that the calibration or operation of the equipment is not adversely affected by the maintenance or repairs. Whenever any repair is accomplished which has a significant probability of affecting the instrument's calibration (e.g., work on internal electronic circuits, replacement of circuit boards, repair after being dropped or hit), the instrument should be recalibrated at a calibration laboratory. Minor repair actions such as reconnecting a broken battery lead do not require a laboratory recalibration.

(4) An adequate supply of spare replacement parts should be maintained by the user to allow timely repair of equipment when such repair is within the user's capabilities.

5. **BATTERIES**. Always check the instrument manufacturer's instruction manual for the proper batteries to use. If a piece of equipment is designed to work with alkaline batteries, for example, it may not function properly with carbon zinc cells. The most commonly used types of batteries are listed below.

a. Carbon zinc batteries. These cells are the least costly, but, in general, have a short life under continuous use and are not rechargeable. The most commonly used cell sizes are AA, C, D, and the rectangular shaped 9 volt. To prevent equipment damage due to leakage, always remove carbon zinc batteries from the instrument when not in use. Do NOT attempt to recharge carbon-zinc batteries.

b. Alkaline batteries. Alkaline cells are more expensive than carbon zinc, but have a more stable voltage output and longer service life. Certain instruments require that only alkaline batteries be used. They come in the same cell sizes as carbon zinc batteries. Alkaline batteries are less prone to leakage, but should also be removed from instruments when not in use. Rechargeable alkaline batteries are now available but before recharging an alkaline battery verify that the battery is rechargable and that the charger is intended for use with alkaline batteries (i.e., a Ni-Cad battery charger canNOT be used to recharge alkaline batteries).

c. Nickel-cadmium (Ni-Cad) batteries.

(1) Rechargeable Ni-Cad batteries should be charged only in accordance with manufacturer's instructions. Chargers are generally designed to charge batteries quickly (approximately 8 to 16 hours) at a high charge rate or slowly (trickle charge). A battery can be overcharged and ruined when a high charge rate is applied for too long a time; however, some Ni-Cad batteries may be left on trickle charge indefinitely to maintain them at peak capacity. Refer to the manufacturer's instructions for charging guidance for a specific instrument.

(2) It is undesirable to discharge a multi-celled Ni-Cad battery pack to voltage levels which are 70 percent or less of its rated voltage - doing so can drive a reverse current through some of the cells which can permanently damage them. When the voltage of the battery pack drops to 70 percent of its rated value, it is considered depleted and should be recharged. Modern instruments contain circuits that turn the instrument off before this point is reached.

d. Nine-volt batteries. The negative (-) clip on a new nine volt battery can be so tight that it breaks off the negative battery connector on the instrument. Breakage can be prevented by slightly expanding the clip prior to insertion in the instrument.

e. Rechargeable battery packs. Battery condition circuits are built into many modern instruments and give a good indication of remaining battery life. Older instruments may require the use of a voltmeter to measure battery charge. Always check battery voltage under load and after 5 minutes of operation to allow the voltage to stabilize. If using a voltmeter, take extreme caution not to short circuit the battery terminals. Some battery packs contain a current limiting resistor, which a short circuit will cause to burn out, necessitating a costly battery pack replacement.

f. Lithium batteries. These batteries offer longer life, but the higher current may affect the operation of the equipment. If the manufacturer does not specify lithium battery use, consult the manufacturer before using.

6. **EXPLOSIVE ATMOSPHERES**. No instrument shall be used in flammable or explosive atmospheres unless the instrument is certified intrinsically safe by the Mine Safety and Health Administration (MSHA), Underwriter's Laboratory (UL), Factory Mutual (FM), or another testing laboratory recognized by the Occupational Safety and Health Administration for the type of atmosphere present (ANSI/UL/NFPA 913 - 1988). When batteries are being replaced, use only the type of battery specified by the manufacturer.

CAUTION: The intrinsic safety seal applies to the pump, but not usually to the charger. Do NOT charge battery packs in an explosive atmosphere.

7. **FIELD CALIBRATION OF PERSONAL SAMPLING PUMPS**. The same type of media/devices (e.g., glass fiber filter preceding impinger) used to collect the sample must be in line during calibration. Calibrate personal sampling pumps before and after use, on the day of sampling, using one of the calibration methods listed below. Record calibration data on NEHC Form 5100/13 or NEHC Form 5100/14, as appropriate.

a. Bubble meter method. This is a primary calibration standard.

(1) Allow the pump to run 5 minutes prior to voltage check and calibration. Refer to the manufacturer for fully charged voltages.

(2) Wet the inside of the burette with soap solution.

(3) Connect the collection device, tubing and pump to the bubble meter as appropriate.

(4) Visually inspect all tygon tubing connections.

(5) Momentarily submerge the opening of the burette in order to capture a film of soap.

(6) Draw two or three bubbles up the burette in order to ensure that the bubbles will complete their run.

(7) Visually observe a single bubble and time the bubble for a known volume (usually 100 ml, 500 ml, or 1,000 ml). Read the bubble at the edge where it touches the glass.

(8) Repeat the procedures described above three times for all pumps to be used for sampling and use the average for the flow rate. All readings should be within 5 percent of the mean. The same cassette and filter may be used for all calibrations involving the same sampling method.

(9) If the pump is equipped with a rotameter, while the pump is still running, mark the pump or record the position of the center of the float in the pump rotameter as a reference.

> NOTE: The ball-type flow meters and rotameters built into most air samplers are primarily intended to serve as flow indicators and are therefore of low accuracy. Also there is a different pressure drop across each type of sampling media. Built-in flow meters must be calibrated against an absolute flow standard such as a bubble meter. To attempt to set the flow using only the built-in rotameter, if the sampling media has been changed, will result in sampling rates outside the levels permitted by NIOSH recommendations and/or OSHA regulations.

b. Precision rotameter method. The precision rotameter is a secondary calibration device. It may be used in place of a bubble meter if the following procedures are observed:

(1) Calibrate the rotameter with a bubble meter at least quarterly as follows:

(a) Without the precision rotameter in line, connect the pump to the bubble meter and adjust the pump flow control to obtain the maximum flow rate (it is not necessary to have sampling media in line);

(b) Determine the exact flow rate by timing 3 repetitions of a bubble traveling a known volume and calculating the average. Record the flow;

(c) Disconnect the bubble meter connection and attach the precision rotameter. Record the precision rotameter reading;

(d) Repeat steps (a) through (c) for at least 5 different flow rates (maximum, minimum, and 3 intermediate);

(e) Plot a curve of actual flow rate versus precision rotameter readings;

(f) Recalibrate the precision rotameter according to steps (a) through (e) after cleaning, at least quarterly, or more frequently if a change in flow characteristics of the rotameter is suspected;

(g) After the precision rotameter has been calibrated, the pump may be set to the desired flow rate by simply connecting it in line with the precision rotameter. The pump flow rate may then be adjusted until the desired precision rotameter reading, corresponding to the desired flow rate determined during calibration, is obtained.

(2) Disassemble and clean as necessary. Always recalibrate after cleaning. Use with care to avoid dirt and dust contamination which may affect the flow.

(3) Use the rotameter such that the pressure drop across it is minimal. The precision rotameter should not be used with a ball adjustment valve accessory, nor with any other restriction that would cause substantial pressure drop.

(4) In order to determine if the desired flow rate is being maintained during sampling, one of the following two methods may be used.

(a) After the flow rate is initially set using the precision rotameter, observe and note the pump rotameter reading. A piece of tape may be placed on the pump housing with a pen mark showing the location of the center of the rotameter ball.

(b) The precision rotameter can be plugged into the cassette, and knowing the desired precision rotameter setting, the pump flow rate can be adjusted. RECORD ANY ADJUSTMENTS ON THE SAMPLING FORM.

(5) If the pump cannot be readjusted to the initial flow rate, replace the pump.

(6) If barometric or temperature conditions at the sampling site are substantially different than at the calibration site (i.e., approximately ± 40 mm Hg (1,500 feet elevation) or ± 20° F change), it is necessary to calibrate the precision rotameter at the sampling site where the same conditions are

present. Alternatively, a correction factor can be calculated for temperature and/or pressure, if the conditions at both use and calibration locations are known, and then be applied to the flowrate or volume.

c. Electronic soap bubble flow calibrator method. This is a primary calibration standard. These units are high accuracy electronic flow meters that provide instantaneous air flow readings and a cumulative averaging of multiple samples. These calibrators measure the flow rate of gases using an "electric eye" to time the travel of a soap bubble and report volume per unit of time. The result is in actual flowrate at the temperature and pressure conditions at the calibration location. The range with different cells is from 1 cubic centimeter per minute to 30 liters per minute.

(1) All calibrations using this method are performed in accordance with the manufacturers' instructions. The calibrator is factory calibrated using a NIST traceable standard.

(2) Maintenance of calibrator

(a) Clean before use. Remove the flow cell and gently flush with water. Wipe with cloth only. Do not allow center tube, where sensors detect soap film, to be scratched or get dirty. NEVER clean with acetone. Use only soap and warm water. When cleaning prior to storage, allow flow cell to air dry. If a residue exists, it is possible to remove the bottom plate. Squirt a few drops of soap into the slot between base and flow cell to ease removal.

(b) The system shall be leak checked at 6" H_2O by connecting a manometer to the outlet hose and evacuate the inlet to 6" H_2O. No leakage should be observed if the instrument is functioning properly.

(c) Performance shall be field verified annually against another primary standard (e.g., a one liter glass burette at 1,000 cc/min for maximum accuracy). The calibrator performance shall be verified to be linear throughout its range.

(b) The instrument shall be returned to the manufacturer for recertification to NIST tracebility whenever a field comparison to another primary standard indicates that it may not be functioning correctly.

d. Electronic dry flow calibrator method. This is a primary standard. These instruments use an electronic timer to measure the time to move a known volume of air which is measured by the travel of a teflon®-coated piston. Results are reported in volume per unit time. The result is in actual flowrate at the temperature and pressure conditions at the calibration location. However, a version which automatically corrects for temperature and pressure is available. Typical features include averaging of consecutive trials and a continual test mode where a new test is started as soon as a test is completed. The main advantage is that no soap solution is needed eliminating problems with spilled soap solution and buildup of soap film residue. The range with different cells is from 1 cubic centimeter per minute to 50 liters per minute. Each flowcell has a linear performance throughout its range.

(1) All calibrations using this method are performed in accordance with the manufacturers' instructions. The calibrator is factory certified to a NIST traceable standard.

(2) Maintenance of calibrator

(a) The manufacturer's internal leak test shall be performed quarterly or whenever damage is suspected.

(b) Calibration shall be field verified annually against another primary standard (e.g., a one liter glass burette at 1,000 cc/min for maximum accuracy). The calibrator performance shall be verified to be linear throughout its range.

(c) The instrument shall be returned to the manufacturer for recertification to NIST tracebility whenever a field comparison to another primary standard indicates that it may not be functioning correctly.

(d) Models of this device which have integral temperature and pressure sensors to allow automatic correction for the effects of those variables, require annual calibration to ensure this feature provides accurate results.

e. Mass flow meter method. The mass flow meter is a secondary standard device which directly measures the quantity of air flowing through a sensor. The output of the sensor is amplified and fed to a meter that is calibrated directly in liters or cubic centimeters per minute. These devices measure flowrate at standard conditions and do not require corrections for temperature and pressure since they are location independent.

(1) A mass flow meter must be field calibrated quarterly in much the same manner as a precision rotameter, using a pump and bubble meter to determine the flow rate. Disconnect the bubble meter, connect the mass flow meter, and record the results. As in the procedure for a precision rotameter, take readings at 5 different flow rates. If the flow rates do not

agree within 5 percent of those obtained from the bubble meter, refer to the manufacturer's instructions and adjust the calibration.

(2) The previous statements about precision rotameter cleanliness and care apply equally to the mass flow meter. In this case, there may be the addition of a battery power supply (although many of these instruments operate off a dc power supply from an ac adapter) and electronic circuitry. Ensure that the instrument has a fresh battery and that it seems to be in proper working order. If the instrument does not function properly or if the calibration cannot be adjusted into range, return it to the manufacturer for repair and calibration.

(3) Personal sampling pumps with built-in mass flow meters are now available. The manufacturer advertises a flow rate accuracy of 2.5 percent and claims that once calibrated, the pump calibration will hold for 200 hours of running time. The flow meter in this pump must be calibrated in the same manner as the stand alone version. Air sampling pumps with an integral mass flowrate controller must still be pre- and post-calibrated by the user.

8. **FIELD CALIBRATION OF NOISE MEASURING INSTRUMENTS**.

a. Sound level meters (SLM). Calibrate SLMs using the appropriate acoustical calibrator before and after each use. Calibrate in accordance with the manufacturer's instructions. Record all the required calibration data on NEHC Form 5100/17. The SLM should be calibrated in the same temperature, pressure, and relative humidity environment as that in which it is to be used. Certain SLMs may incorporate a "Cal" button. When activated, this button checks the internal circuitry of the meter for proper operation, but may not include the proper functioning of the microphone. The use of the "Cal" button does not eliminate the need for acoustical calibration.

(1) Calibrate the SLM on the "A" and "C" networks before and after each use with the companion calibrator at 1,000 Hertz. Quarterly, check the "A" and "C" networks at all frequencies provided on the calibrator for reading within the proper tolerance as found in the charts contained in ANSI S1.4-1983 (R1994) - Table IV. Follow the manufacturer's instructions, especially in relation to altitude/atmospheric pressure correction. Use only the acoustical calibrator designed to be used with your meter. The use of brand X calibrator and brand Y meter, even if the microphones are physically the same size, should be avoided unless specifically recommended by the manufacturer. Variations in calibrator chamber volume can cause errors in calibration, unless correction factors are applied.

(2) If the meter has a mechanical movement as opposed to a digital display, the meter should be calibrated at the same angle of tilt as it is to be used. If this is not possible, check to make sure that the meter readings at the vertical and horizontal angles are within 0.5 dB of each other.

b. Noise dosimeters. Noise dosimeters must be calibrated using an acoustical calibrator before and after each use with the results being recorded. Calibration will be performed in accordance with the manufacturer's instructions. Readouts of the dosimetry results should be done before post-calibration of the dosimeter is performed. Record required calibration data on NEHC Form 5100/18.

c. Acoustical calibrators. Acoustical calibrators used to calibrate sound level meters or noise dosimeters shall be electroacoustically calibrated and certified annually.

9. **FIELD CALIBRATION CHECKS OF DETECTOR TUBE PUMPS**.

a. Leakage test.

(l) Each day prior to use, perform a leakage test on the pump in accordance with the manufacturer's instructions, to minimize erroneous readings due to air leaks around the seals, or pinholes in bellows type pumps. This is usually done by inserting an unopened detector tube into the pump tube holder and withdrawing locking the piston in the outer position, or fully squeezing the bellows. The vacuum generated should hold for the minimum time specified by the manufacturer.

(2) If leakage cannot be repaired in the field, do not use the pump. Repair or replace the pump as necessary.

(3) Record that the leakage test was made on NEHC 5100/15, "Industrial Hygiene Direct Reading Sample Survey Form."

b. Calibration check. Check the flowrate of the detector tube pump for proper volume measurement at least quarterly. For multiple orifice pumps check the flow for all orifices.

(l) Connect the detector tube pump directly to the bubble meter with suitable adapters and a detector tube.

(2) Wet the inside of the 100 ml bubble meter with a soap solution. Dip the end of the bubble meter into the soap solution to imitate the bubble and pull the piston or squeeze the bellows several times to ensure the bubble will travel at least 100 ml before bursting. Initiate a new bubble and gently pull the

piston or release the bellows until the bubble reaches the zero graduation. At this point, for a piston pump, push the piston in all the way while watching the bubble. If the bubble remains stationary, pull the piston handle all the way out and lock into position. If the bubble in the tube goes down when the piston is pushed in, the check valve is leaking and the pump needs to be repaired. When using a bellows pump, when the bubble reaches the zero graduation, squeeze the bellows as much as possible and release. As above, if the bubble goes down when squeezing the bellows, repair the pump.

(3) Allow 4 minutes for the pump to draw the full amount of air and note where the bubble stops. The volume must be within 5 percent of the manufacturer’s specified volume for a full stroke (usually 100 ml).

(4) Also check the volume for 50 cc (1/2 pump stroke) and 25 cc (1/4 pump stroke), if applicable. Plus or minus 5 percent error is permissible. If error is greater than 5 percent, repair and recalibrate the pump before using.

(5) Record the calibration information required in the calibration log.

10. **FIELD CALIBRATION OF COMBUSTIBLE GAS METERS**.

a. Combustible gas meters are calibrated before and calibration is checked after use.

b. When measuring explosive levels in atmospheres where the identity of the explosive contaminant is known, calibrate the combustible gas meter using the manufacturer’s recommended calibration gas and use the manufacturer's response curves/conversion charts for that explosive contaminant.

c. When measuring explosive levels in atmospheres where the identity of the explosive contaminant is not known or no manufacturer’s response curve is available for the explosive contaminant, many manufacturers consider it best to calibrate the combustible gas meter with either propane or pentane (consult the manufacture of the particular meter), since they fall in the middle of the relative sensitivity/response chart, and most gases and vapors will respond within a reasonable safety margin. (Due to the affect of some substances (e.g., silicones, halogenated hydrocarbons) to reduce the sensitivity or poison the combustible sensors or filaments of the meter, it is recommended that methane also be used to check the meter for loss of sensitivity to methane. This check is not a recalibration but is to be done in addition to the propane or pentane calibration.)

11. **FIELD CALIBRATION OF OXYGEN METERS**.

a. Following manufacturer's guidelines, calibrate the oxygen meter in air known to contain 20.9% oxygen and outside of the space to be tested.

b. Changes of altitude or atmospheric pressure can affect the performance of some oxygen meters, requiring that the oxygen meter be calibrated for existing conditions.

12. **FIELD CALIBRATION OF TOXIC GAS METERS**. Following manufacturer's guidelines, calibrate the toxic gas meter before use and check calibration after use.

13. **FIELD CALIBRATION OF DIRECT READING DUST MONITORS**. Calibrate the dust monitor following manufacturer's guidelines.

14. **FIELD CALIBRATION OF AIR VELOCITY METERS.**

a. Rotating vane anemometer. No field calibration is necessary. However, the anemometer should be qualitatively checked to ensure that it is in good working condition.

b. Heated wire anemometer. No field calibration is necessary. However, the anemometer should be qualitatively checked to ensure that it is in good working condition.

c. Swinging vane anemometers-velometer.

(1) Alnor Jr. No field calibration is performed, however, the following checks should be made prior to use:

(a) Cover the inlet and outlet ports with masking tape. Lay the velometer down so that the meter is in a horizontal plane. Turn the zero adjust so that the meter reads slightly upscale from zero. Raise the velometer so that the meter is vertical and observe any change in the reading. If the needle moves over 1/4 of an inch, the unit needs recalibration.

(b) Blow gently into the larger air intake orifice, moving the pointer to full scale. Watch for any sticking of the pointer as it returns down-scale to zero.

(2) Alnor 6000AP. No field calibration is necessary, however, the zero adjustment should be checked periodically. Close both ports, if the pointer does not indicate zero, the zero adjustment screw on the front of the case should be turned slowly until the pointer indicates zero.

15. **OUT OF TOLERANCE EQUIPMENT**.

a. Equipment that fails to field calibrate within the manufacturer's specifications, fails to hold calibration, or is damaged in such a way as to render the results unreliable will be clearly identified and removed from service. Do not return the equipment to service until it has been repaired and recalibrated.

b. Equipment that has not been maintained/calibrated within the interval specified in this document will be identified and removed from service. This equipment can only be used in extraordinary situations and then only with great caution and only if the meter responds properly to field calibration.

16. **EQUIPMENT LIFECYCLES**. Table 8-2 shows the expected service life for typical industrial hygiene equipment. Information in this table was derived from field input and experience. Where applicable, the service life values were matched to the United States Navy Bureau of Medicine and Surgery Equipment Management Manual (NAVMED P-5132), Annex 25 (Reference 8-2). The service life values listed in this table are for normal replacement and do not account for damage.

17. **RECORDKEEPING**.

a. Comprehensive and accurate records are necessary to document the calibration of industrial hygiene sampling equipment.

b. Calibration of air sampling pumps, sound level meters and noise dosimeters must be recorded on the sampling forms as appropriate.

c. Calibration records shall contain, as a minimum:

(1) Item description, including manufacturer and model number;

(2) Item serial number;

(3) Dates of calibration;

(4) Who performed the calibration; and

(5) In the case of scheduled periodic calibration, when the next calibration is due.

d. Additional calibration records may be in the form of a log, card file, or other appropriate method which provides the necessary documentation.

18. **REFERENCES**.

8-1 Metrology Requirements List (METRL), NAVSEA Publication OD 45845/NAVAIR 17-35MTL-1

8-2 United States Navy Bureau of Medicine and Surgery Equipment Management Manual (NAVMED P-5132), Annex 25

Table 8-1. Laboratory and Field Calibration Intervals and Actions.

Instrument Type	Laboratory Calibration Interval (Years)	Field Check or Calibration
Battery Chargers		
Single or multiunit chargers	*	None
Bioaerosol Samplers	*	Before and after use
Combustible Gas Indicators	1	Before and after use
with oxygen indicator	1	Before and after use
with oxygen and toxic gas indicators	1	Before and after use
Dust/Aerosol Monitors	1	Before and after use
Flow meters		
Precision Rotameters	*	Quarterly
Electronic Bubble Meters	*	Annual
Electronic Dry Flow Meters	*	Annual Quarterly leak check
Kurz Mass Flow Meter	*	Quarterly
Heat Stress Monitors	3	Operational check before and after use
Indoor Air Monitors		
Temperature and Humidity	1	Semi-annual humidity check if saturated salt bottles provided
...with CO2 and/or toxic gas sensor(s)	1	Zero and span cal before and after use
Light Meters	1	Zero check
Non-Ionizing Radiation Meters	1	None

NOTE: * = Inspect/repair as necessary

Table 8-1 (Continued). Laboratory and Field Calibration Intervals and Actions

Instrument Type	Laboratory Calibration Interval (Years)	Field Check or Calibration
Pump, Detector Tube	*****	Leak check prior to use
Pumps, High Volume	*	Before and after use
Pumps, Personal	*	Before and after use
Sound Measuring Instruments (e.g., sound level meters, microphones, 1/3, 1/2, and 1/1 octave filters, personal noise dosimeters)	1	Before and after use
Sound Level Calibrators	1	None
Toxic Gas/Vapor Monitors, in General	1	Zero and span cal before and after use
Bacharach MV-2 Mercury Vapor Meter	0.5	Zero check before use
Air Velocity Meters and Flow Hoods	1	Zero check before use
Miscellaneous		
Portacount Respirator Fit Tester	1	None

NOTE: * = Inspect/repair as necessary

Table 8-2. IH Equipment Lifecycle List.

Equipment Description	Comments	Lifecycle Service Life (Years)
Air Sampler, High Flow	High flow pump >4 L/min	10
Air Sampler, Low Flow	Low flow pump <4 L/min	7*
Air Sampler, Multi Flow	Multi flow pump	10
Balance, Microbalance		7
Borescope		7**
Calibrator, Air Sampler	Pump calibrator such as Gilibrator® or Drycal®	10
Calibrator, Noise Dosimeter		10**
Calibrator, Permeation		7**
Calibrator, Sound Level Meter		10
Charger, Battery, 10 Unit		10
Charger, Battery, 5 Unit		10
Detector Tube Kit	Such as Draeger® or Bendix®	10**
Dosimeter, Noise		10
Dosimeter, Toxic Gas	Such as for CO, H_2S, NO or NO_2	7**
Dosimeter, Toxic Gas, Sensors	Such as for CO, H_2S, NO or NO_2	Service life varies for electrochemical sensors depending on use.
Flame Ionization Detector (FID), Portable	Portable unit	7**
Gas Chromatograph (GC), Portable	Portable unit	7*
Infra-Red (IR) Spectrophotometer, Portable	Portable unit Such as MIRAN® or Sapphire®	7**
Machine, Fog		10**
Meter, Air Velocity, Heated Element		10
Meter, Air Velocity, Hot Wire		7*

Equipment Description	Comments	Lifecycle Service Life (Years)
Meter, Air Velocity, Room Diffuser	Balometer	7
Meter, Air Velocity, Rotating Vane		10
Meter, Air Velocity, Swinging Vane		10
Meter, Heat Stress		10**
Meter, Indoor Air Quality (IAQ)		7**
Meter, IAQ, Sensors	Such as for CO and other chemicals	Service life varies for electrochemical sensors depending on use.
Meter, Light		10
Meter, Mercury Vapor		10
Meter, Moisture		7**
Meter, Radio Frequency (RF)		10
Meter, RF, Check Source		10**
Meter, RF, Contact Current		10
Meter, RF, Extremely Low Frequency (ELF)		10
Meter, RF, Induced Current		10
Meter, RF, Magnetic Field		10
Meter, RF, Probe		7**
Meter, RF, Very Low Frequency (VLF)		10
Meter, Sound Level, Type I		10
Meter, Sound Level, Type II		10
Meter, Toxic Gas	Such as for CO and other chemicals	7**
Micromanometer		10**
Microscope		10
Monitor, Aerosol		5**
Photo Ionization Detector (PID), Portable	Portable unit	7**
Printer, Calibrator, Air Sampler		5

Equipment Description	Comments	Lifecycle Service Life (Years)
Psychrometer, Motorized		5
Recorders, Strip Chart		8
Thermohygrometer		5**
Vacuum Cleaner, Special	Such as HEPA or Mercury	7**
Vaporizer, Acetone	For fiber counting	10**

NOTE:
Unless otherwise annotated by * or **, lifecycle service life listed in Table 8-2 is the same as it is listed in United States Navy Bureau of Medicine and Surgery Equipment Management Manual (NAVMED P-5132), Annex 25.

* Lifecycle service life differs from that listed in United States Navy Bureau of Medicine and Surgery Equipment Management Manual (NAVMED P-5132), Annex 25, due to the specific equipment being different from the general equipment listed or due to field input and experience.

** Lifecycle service life based on field input and experience and is not listed in United States Navy Bureau of Medicine and Surgery Equipment Management Manual (NAVMED P-5132), Annex 25.