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March 1984
Issue 1

METROHM

MODEL 9A INSULATION & CONTINUITY TESTERS

INSTRUCTION MANUAL

Edgcumbe Instruments

WARNING

When using this Tester to monitor high voltages, turn off the power before connecting the Tester.

Where possible, do not touch the Tester or its leads when the power is on.

Turn off the power, before dis-connecting the Tester.

SAFETY RULES

WARNING

This tester has been designed with your safety in mind. However, no design can completely protect against incorrect use. Electrical circuits can be dangerous and/or lethal when lack of caution or poor safety practices are used.

READ THE MANUAL

Read this Instruction Manual carefully and completely.

Voltages within the capability of this test equipment can be hazardous. Follow the instructions in this manual for every measurement. Read and understand the general instructions before attempting to use this tester. Do not exceed the limits of the tester.

SAFETY CHECK

Double check the switch setting, and lead connections before making measurements. Are you following all of the instructions?

Dis-connect the tester or turn off the power before changing switch positions.

When replacing fuses use only specified type fuses and insert in correct fuse holder.

DON'T TOUCH

Don't touch exposed wiring, connections or other 'live' parts of an electrical circuit. If in doubt, check the circuit first for voltage before touching it.

Turn off the power to a circuit before connecting

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SAFETY WARNING cont'd.

test probes to it. Be sure there is no voltage present before you touch the circuit.

Do not use cracked or broken test leads.

HIGH VOLTAGE IS DANGEROUS

Always start with the power off. Be sure there is no voltage present before making connections to the circuit.

Before disconnecting the tester, turn the circuit off and wait for the meter to return to 'zero'.

SAFETY IS NO ACCIDENT

DESCRIPTION OF METROHM

The Model 9A Metrohm has been designed with the 15th Edition of the IEE Wiring Regulations specifically in mind. The scale on the continuity range provides good sensitivity and accuracy from 0-1Ω, and the insulation scale is semi-logarithmic over 4 decades range.

The instrument incorporates HP7 pen cell dry batteries, which provide power for the test voltage generator and the electronic scale shaping circuit. The movement has an integral housing so that sticking problems caused by dust, etc, are eliminated.

The instrument is supplied in a standard, heavy duty or royalite type carrying case which contains the instruction manual, test leads and test clips. The standard instrument has 4 mm terminals. For additional protection, leads with 4 mm safety plugs and/or fuse leads can be provided.

There are 4 models of Model 9A Metrohm available with the following test voltages, 100V, 250V, 500V or 1000V.

MEASURING INSTRUCTIONS

Before using the Model 9A METROHM make sure that the instrument is functioning correctly by checking the following procedure.

ZERO ADJUST:— If the pointer does not coincide with the zero on the left hand side of scale then insert "trim tool" (or a fine screwdriver) in the hole through the latch button as shown in Figure1 Adjust as required.

BATTERY HOLDER:— The 6-HP7 (or equivalent) pen cell 1.5V batteries are located in the rear of the instrument. Slacken the captive screw on the cover by using the trim tool supplied (or a screwdriver) and when free, slide the cover towards the base of the instrument (approx. 4 mm) and

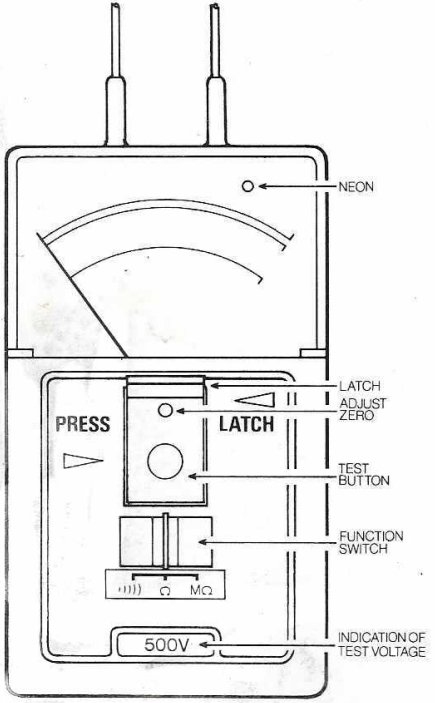


Fig.1

remove cover. Insert batteries and reassemble.

BATTERY CHECK:— With the leads shorted and the Range switch in the MΩ position, press the test button and the pointer should read within the mark "□BAT" on the scale. If not then replace batteries. If the pointer moves to the right of the "□BAT" sign, the batteries should be replaced.

TEST:— The test button is shown in Figure 1 and is pressed to operate.

LATCH:— If the latch toggle is lifted it will latch in the open position retaining the TEST button in the operative position.

FUSE:— If no indication is given when checking the battery then check the fuse which is housed in the rear of the instrument in the battery compartment.
The fuse is rated 1 amp. (See specification.)

WARNING:— A live circuit is indicated by the neon and also by deflection of the pointer. DO NOT press the switch if the pointer deflects immediately on connection to a circuit. This shows that the circuit is live.
Note: If the test button is pressed or latched then NO indication of live circuit will be given.

MEASURE AC VOLTS 0-500 VOLTS AC:— With the range switch in any of the 3 positions, the voltage is measured on the black scale when the Metrohm 9A is connected to a live circuit.

CONTINUITY 0-100Ω:— With the Range Switch in the Ω position, the continuity is measured on the green scale, by pressing the TEST button. If required the button can be maintained in this position by lifting the LATCH (see Fig.1)

BUZZER:— With the Range Switch in the •))))) position the buzzer is sounded on any measurements below 10Ω. The continuity resistance is still measureable as above. If required, the button can be maintained in this position by lifting the latch (see Fig.1)

INSULATION 0-100MΩ:— With the Range Switch in the MΩ position, the Insulation Resistance is measured on the RED scale, by pressing the TEST button. The latch facility described above is also available if required.

CAPACITANCE DISCHARGE:— When testing insulation, the equipment under test should remain connected after releasing the TEST button. This discharges the line capacitance via the tester and the neon indicates the period of discharge.

ELECTRICAL SPECIFICATION

Insulation Test

Range:— 0-100 MΩ-∞ .

Test Voltage:— 100V, 250V, or 500V D.C. ± 10% above 1MΩ load. 1000V D.C. ± 10% above 2 MΩ load.

Short Circuit Current:— 2 mA nominal.
Accuracy:— ±1.6 mm of scale arc length.
Battery Consumption:— 70 mA nominal.

Continuity Test

Range:— 0-100Ω-∞ .
Test Voltage:— 200 mV approx.
Short Circuit Current:— 20 mA nominal.
Accuracy:— ±1.6 mm of scale arc length.
Battery Consumption:— 20 mA nominal.

Buzzer

Range:— operates below 10Ω.
Battery Consumption:— 30 mA nominal.

Voltage

Range:— 0-500 Volts A.C.
Accuracy:— ±3% full scale deflection.
Input Impedance:— approx. 160K Ω at 250V.

General

Battery:— 6 off HP7 pen cell or equivalent.
Fuse:— 1 amp Fast Blow 5 × 20 mA DIN.
Battery Range:— 7-9.5V.

Battery Life

On Insulation: 15 hours continuous or 10,000 operations with 5 sec. test.
On Continuity; 30 hours continuous or 20,000 operations with 5 sec. test.

MECHANICAL SPECIFICATION

Instrument Size:— 142 × 82 × 50 mm
Material:— Polycarbonate/A.B.S.
Weight w/o Carry Case:— 460 gms
Movement:— 1 mA sensitivity, taut band suspension
Scale Length:— 70 mm approx.
Sockets:— 4 mm
Test Leads:— 1m long with shrouded crocodile clips.
Carrying case:— 145 × 92 × 90 mm approx.

NOTE:—Care should be taken when removing instrument from carrying case to ensure that the latch button does not foul the strap on the carrying case.

ENVIRONMENTAL SPECIFICATION

Operating Temperature:— 0-35°C
Storage Temperature:— — 10°C — 50°C
Vibration Test:— BS2011 Part 2 Fc
Bump Test:— BS2011 Part 2 Eb
Cold
Temperature:— BS2011 Part 2 Ab.
Dry Heat:— BS2011 Part 2Bd
Humidity:— 90% at 20°C

SPARES

Leads, Standard Set	DFK 0010
Leads, De Luxe Set	DFK 0011
Fused Probe Acc. Kit	DFK 0013
Leads, Fused Set	DFK 0012
Fused 1 amp 5 × 20 mm Fast Blow	CEF 0038
Carrying Case Standard	DFK 0009
Carrying Case Heavy Duty	DFK 0016
Carrying Case Royalite	DFK 0015
Movement Housing Assembly	DDC 0043/-V
P.C.B. Assembly	DFB 0049/-V
Battery HP7 or equivalent	CEJ 0003

RING CIRCUIT CONTINUITY

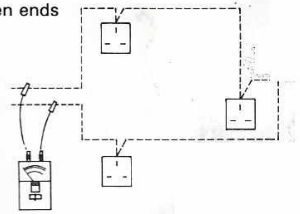
REGULATION 613-2

This Regulation states "A test shall be made to verify the continuity of all conductors (including the protective conductor) of every ring final circuit". However, Item 2 of Appendix 15 requires *measurement* and two methods of measurement are suggested.

METHOD 1
The continuity of each conductor of the ring circuit (phase, neutral and earth) is measured between the two ends of the conductor before completion of the ring and the resistance values are noted.
The two ends of each conductor are then connected to complete the ring. The continuity is measured between each of the three connections and the appropriate terminal at the outlet nearest to the midpoint of the ring, using a test lead and the resistance values are noted. The resistance of the test lead is measured and subtracted from previous readings. The resulting values obtained should be approximately one quarter of the corresponding value obtained before completion of the ring.

The test sequence is illustrated below.

1. Measure between ends of earth ring, A.



2. Measure from closed ends to midpoint, B.

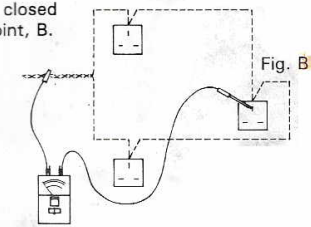
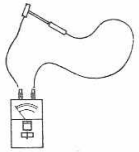


Fig. B



3. Measure test lead, C.
4. Check that $A/4 = B - C$
5. Repeat for two other rings (phase and neutral).

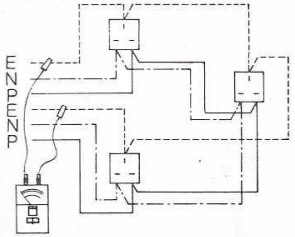
For example, assume that the results of a series of tests on the phase conductor were:

(i) test between ends of phase ring $= 0.48\Omega$
(ii) test from closed ends to midpoint of phase ring $= 0.31\Omega$
(iii) test between ends of test lead $= 0.18\Omega$
(iv) continuity of closed phase ring, ends to midpoint $= 0.31 - 0.18\Omega = 0.13\Omega$

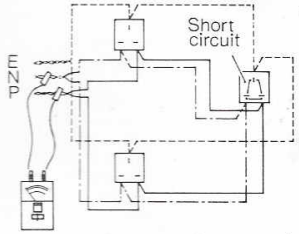
The final calculation (0.13Ω) should be approximately one quarter of the first test reading (0.48Ω).
Check: $\frac{0.48}{4} = 0.12\Omega = 0.13\Omega$

METHOD 2
The continuity of each conductor of the ring circuit (phase, neutral and earth) is measured between the two ends of the conductor before completion of the ring and the resistance values are noted.
The two ends of each conductor are then connected to complete the ring and the three conductors of the ring circuit are short-circuited at a point near the centre of the ring. The continuity is then measured between the phase and neutral conductors at the connected ends and the resulting resistance value should be approximately half the value obtained for either the phase or neutral conductor before completion of the ring. A further measurement of the continuity should be made between the phase and earth conductors at the connected ends and the resulting resistance value should be approximately quarter the value obtained

for the phase conductor plus quarter the value obtained for the earth conductor before completion of the ring. This test is only required when the protective conductor is in the form of a ring. The test sequence is illustrated below



1. Measure between ends of earth ring, A, neutral ring, B, and phase ring, C.



2. Measure between phase and neutral with midpoint short-circuited, D.
3. Check that $D = B/2 = C/2$
4. Measure between phase and earth with mid-point short-circuited, E.
5. Check that $E = A/4 + C/4$

For example, assume the results of a series of tests to be as follows:

(i) test between open ends of phase and neutral rings, $= 0.32\Omega$

(ii) test between open ends of earth ring $= 0.24\Omega$

(iii) test between closed ends of phase and neutral rings short-circuited at mid-point $= 0.15\Omega$
This value, 0.15Ω, is approximately one half of the value obtained for the opened phase (or neutral) ring, i.e.
$\frac{0.32}{2} = 0.16 = 0.15\Omega$

(iv) test between closed ends of phase and earth rings short-circuited at mid point $= 0.13\Omega$
This value, 0.13Ω, is approximately one quarter of the value obtained for the opened phase plus earth rings,
i.e. $\frac{0.32}{4} + \frac{0.24}{4} = 0.14 = 0.13\Omega$

differences between calculated and measured values are due to point of the ring to which connection is made (Method 1) or which is short-circuited (Method 2), not being exactly at its centre.

PROTECTIVE CONDUCTOR CONTINUITY

Regulation 613-3
This Regulation states "Every protective conductor shall be separately tested to verify that it is electrically sound and correctly connected. This test shall include all conductors and any extraneous conductive parts used for equipotential bonding (see item 3 of Appendix 15)".
Where earth fault loop tests are carried out (Regulation 613-15), there is no need for protective conductor measurement because its value will be included in that of the measured loop. However, continuity checking will still be necessary because the circuit must be energised to carry out an earth fault loop test, and may be dangerous when energised if the protective conductor has a high impedance or is wrongly connected.
Measurement of the resistance of the protective

conductor is required to comply with Regulation 413-3 and Appendix 7.

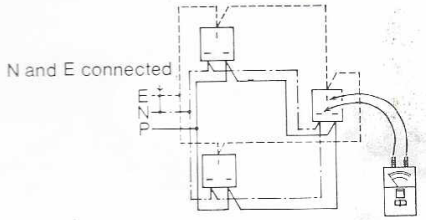
The Model 9A Metrohm can be used to check or measure the continuity of protective conductors only, provided no part of the protective conductor consists of steel conduit or other steel enclosure.

TEST

The continuity of the protective conductor may be checked or measured before connection of the supply by connecting together the neutral and protective conductors at the mains inlet and checking between earth and neutral at every outlet. When a measurement is required, this can be calculated from the reading obtained by the formula shown below:

$$\text{Protective Conductor Resistance} = \text{continuity reading} \times \frac{\text{neutral c.s.a.}}{\text{protective c.s.a.} + \text{neutral c.s.a.}}$$

where c.s.a. is cross-sectional area of conductor. The test is illustrated below.



Continuity test of the protective conductor.

For example, assume the results of a test to be as follows:

(i) Test between neutral and earth at socket $= 0.64\Omega$

(ii) Cross-sectional area of neutral conductor $= 2\ mm^2$

(iii) Cross-sectional area of earth conductor $= 3\ mm^2$

Therefore, the protective conductor resistance

$$= 0.64 \times \frac{2}{2+3}$$

$$= 0.64 \times 2/5$$

$$0.256\Omega$$

INSULATION RESISTANCE

GENERAL

The regulations specify four types of insulation tests; and the relevant regulation along with the recommended method of testing will be described in the following sections. However, Regulation 613-5 provides some guidelines, described below, which relate to the first two types of insulation tests.

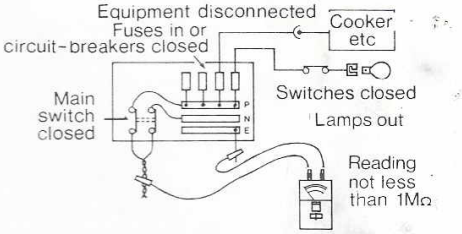
These tests should be made before the installation is permanently connected to the supply.

A large installation with many circuits effectively has the insulation resistance of each circuit in parallel with all the others. So, 50 circuits, each with an insulation resistance of 10MΩ, would give a result of 10/50 or 0.2MΩ where connected and tested as one large installation. Where such a problem exists, the regulation states that large installations can be divided into groups of not less than 50 outlets, an outlet being defined as a point or switch, except that a socket outlet, appliance or light incorporating a switch is regarded as one outlet.

The tests should be conducted with a D.C. test voltage not less than twice the nominal voltage of the circuit concerned (r.m.s. value for an A.C. supply), provided that the test voltage need not exceed 500 volts D.C. for installations rated up to 500 volts, or 1000 volts D.C. for installations rated above 500 volts up to 1000 volts.

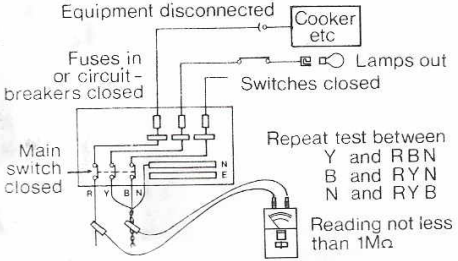
÷ The test voltage applied by the Metrohm is shown on the label on the front of the instrument.

Insulation Test to Earth
Regulation 613-6 states "Where measured with all fuse links in place, all switches (including, if practical, the main switch) closed and, except for TN-C systems, all poles or phases of the wiring electrically connected together, the insulation resistance to Earth shall not be less than 1 megohm".
As TN-C systems have the neutral and protective functions combined in a single conductor, this test is clearly impossible with such systems. The test to earth should be carried out with all phases connected together, fuses in, switches and breakers closed, lamps removed and other equipment disconnected. The figure below illustrates this test.



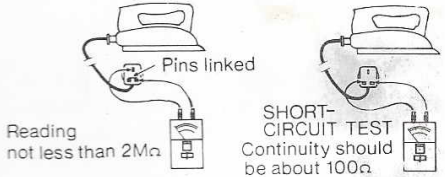
Insulation Test Between Phases
Regulation 613-7 states "When measured between all conductors connected to any one phase or pole of the supply and, in turn, all conductors connected to each other phase or pole, the insulation resistance shall not be less than 1 megohm. Wherever practicable, so that all parts of the wiring may be tested, all lamps shall be removed and all current using equipment shall be disconnected and local switches controlling lamps or other equipment shall be closed. Where the removal of lamps and/or the disconnection of current using equipment is impracticable, the local switches controlling such

lamps and/or equipment shall be open. Particular attention shall be given to the presence of electronic devices connected in the installation and such devices shall be isolated so that they are not damaged by the test voltage";
For a single phase system the test is between the phase and neutral conductors.
For a three-phase and neutral system, four tests are necessary:—
a) Red phase to yellow, blue and neutral, all connected together
b) Yellow phase to red, blue and neutral, all connected together
c) Blue phase to red, yellow and neutral, all connected together
d) Neutral to red, yellow and blue, all connected together
The figure below illustrates these tests



Insulation Test On Disconnected Equipment
Regulation 613-8 states "Where equipment is disconnected for the tests prescribed in Regulations 613-6 and 613-7, and the equipment has exposed conductive parts required by these Regulations to be connected to protective conductors, the insulation resistance between the exposed conductive parts and all live parts of the equipment

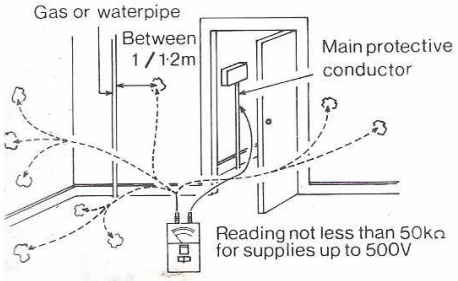
shall be measured separately and shall comply with the requirements of the appropriate British Standard for the equipment. If there is no appropriate British Standard the insulation resistance shall be not less than 0.5 megohm''. The relevant British Standard for household and similar electrical appliances is BS3456 and states that with a D.C. voltage of approximately 500V applied, the insulation resistance measured between live parts and metal parts of appliances should be not less than 2 megohms, the measurement being made one minute after application of the voltage. In industrial installations, the relevant British Standard for equipment disconnected should be consulted. The figure below illustrates this test and a test to check for short-circuits.



Insulation Test on Non-Conducting Walls and Floors

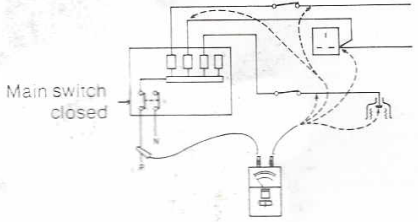
Regulation 613-13 states ''Where protection against indirect contact is to be provided by a non-conducting location intended to comply with Regulations 413-27 to 413-31 and 471-19, the resistance of the floors and walls of the location to the mains protective conductor of the installation shall be measured at not less than three points on each relevant surface, one of which shall be not less than 1 m and not more than 1.2 m from any extraneous conductive part in the location''.
The test result must be not less than 50kΩ (50000Ω) for normal supply voltages but will need to be 100kΩ where the supply voltage is between 500 and 1000 volts. Steps may need to be taken

so that humidity will not affect the resistance of floors and walls to such an extent that they do not comply with this regulation.
This test is illustrated below.



Polarity
Regulations

Regulation 613-14 states ''A test of polarity shall be made and it shall be verified that all fuses and single-pole control devices are connected in the phase conductor only, that centre-contact bayonet and Edison-type screw lampholders in circuits having an earthed neutral conductor have their outer or screwed contacts connected to that conductor, and that wiring has been correctly connected to socket outlets.
This check is important from safety considerations



as a circuit could appear safe when it is live if the control switch is in the neutral conductor. If appliances are to be safe, their polarity must be correct and this means that the polarity of all socket outlets must be correct. The polarity test can be carried out by a continuity check between the phase conductor at the mains inlet (before connection of the supply) and all the phase conductors throughout the installation as illustrated

Records of Tests

It is essential that the condition of an installation should not only be first class initially, but that it should be maintained in that condition. This can be achieved by regular testing and so that any deterioration may be detected it is recommended that a log book be kept in which dates and results may be recorded and from which comparisons may be made. This record should include notes on any unusual atmospheric conditions which may exist, and if possible, details of any alterations to the installation or remedial work done.

LIMITED WARRANTY

Edgcumbe Instruments warrant instruments and test equipment manufactured by them to be free from defective material or factory workmanship and agree to repair or replace such products which, under normal use and service, disclose the defect to be the fault of our manufacturing, with no charge for parts and service. If we are unable to repair or replace the product, we will make a refund

of the purchase price. Consult the Instruction Manual for instructions regarding the proper use and servicing of instruments and test equipment. Our obligation under this warranty is limited to repairing, replacing or making refund of any instrument or test equipment which proves to be defective within one year from the date of original purchase.

This warranty does not apply to any of our products which have been repaired or altered by unauthorised persons in any way so as, in our sole judgement, to injure their stability or reliability, or which have been subject to misuse, abuse, misapplication, negligence or accident or which have had the serial numbers altered, defaced or removed. Accessories, not of our manufacture used with this product, are not covered by this warranty.

To register a claim under the provisions of this warranty, return the instrument or test equipment to Edgcumbe Instruments, Main Street, Bothwell, Glasgow. Upon our inspection of the product we will advise you as to the disposition of your claim. ALL WARRANTIES IMPLIED BY LAW ARE HEREBY LIMITED TO A PERIOD OF ONE YEAR, AND THEPROVISIONS OF THE WARRANTY ARE EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES EXPRESSED OR IMPLIED.

The purchaser agrees to assume all liability for any damages and bodily injury which may result from the use or misuse of the product by the purchaser, his employees, or others, and the remedies provided for in this warranty are expressly in lieu of any other liability Edgcumbe Instruments may have, including incidental or consequential damages.

Edgcumbe Instruments reserve the right to discontinue models at any time, or change specifications, price or design, without notice and without incurring any obligation.

REPAIRS

Please complete the tear-off card and return with the Tester to:—

Edgcumbe Instruments, NEI Electronics Ltd.,
Main Street, Bothwell.
Telephone: (0698) 852574
Telex: 778873

REPAIR CARD (Standard Metrohm Series)

1. Date of purchase (approx.).....
2. Type of instrument.....
3. Name and address of Vendor.....
   .....
4. Nature of fault.....
   .....
   .....
5. Are case and leads returned with Tester?* YES/NO
6. Is this the first time the instrument has been returned for repair?* YES/NO
7. If no, please state reasons for previous return/repair.....
   .....
   .....
8. Name and address.....
   .....
   .....
9. Do you own any other 'Metrohm' test equipment?* YES/NO
10. If yes, please state which items and where purchased .....
    .....
    .....

Thank you for your assistance.
*Please delete as appropriate.