VT33

SERIES

Safety, Operation, and Procedure Instructions for the VT33 VLF Hipot/Capacitor Discharge Cable Fault Locator

Please Refer to Documentation Before Operation

Danger- Lethal Voltages:

Equipment to be used by trained personnel only

This Operator Manual contains instructions for the operation of a High Voltage power source. The operator of this equipment must use good judgement and follow all safety precautions noted in this guide to ensure the protection of himself and others in close proximity to the test area. Failure to follow the instructions could result in injury or death. Proper grounding of the test set must be done prior to connecting this unit to a power source.

Operator Manual

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About the Operator Manual

Important

This Operator Manual describes the features and safe operation of a High Voltage Test Set. The instructions are intended to be clear and simple, but the operator must be trained and qualified according to established procedures for the use of this type of equipment.

This Operator Manual is organized to provide information on the VT33 in steps that familiarize the new operator with the entire scope of operation of this test set.

Section 1: Specifications and Controls.

Section 2: Setup and Operation.

Section 3: Performing Special Operations.

The Functions, Features, and Specifications of the VT33 VLF Hipot/Capacitor Discharge Cable Fault Locator are also discussed in the VT33 Brochure available from High Voltage, Inc.

SECTION

1

General Information

This section familiarizes the operator with the features and specifications of the

VT33 VLF Hipot/Capacitor Discharge Cable Fault Locator manufactured by HIGH VOLTAGE, INC.

Operation of this unit with standard TDR fault locating devices is possible using the internal Arc Reflection Filter.

Theory of Operation

With the use of buried underground cables in primary feed electrical installations, it is necessary to locate faults and repair the cable as quickly as possible to restore power to affected areas. The VT33 Cable Fault Locator utilizes a Very Low Frequency voltage source to HIPOT and/or BURN a fault, and an energy storage capacitor to provide a pulse of energy to create an audible sound at the fault location for tracing. Arc reflection devices can also be used with the internal Arc Reflection Filter (TDR coupler) in this unit.

WARNING

DO NOT OPERATE THE VT33 HIPOT SET IF THE HIGH VOLTAGE TANK IS 5° OR MORE FROM LEVEL.

IF THE UNIT IS OPERATED OUT OF LEVEL, OVERHEATING AND INTERNAL ARCING MAY OCCUR.

DO NOT STORE OR TRANSPORT VT33 ON IT'S SIDE

Features and Specifications

The VT33 cable fault locating test set provides continuously adjustable output voltage for the VLF hipot testing and location of faults in primary cables. The 13 kV Capacitor Discharge Section provides adequate energy at a relatively low voltage to quicken fault location while not overstressing the cables and terminations.

Standard features of the VT33 VLF/Capacitor Discharge Fault Locator

- Emergency STOP Pushbutton
- "Zero Start" Interlock provision
- Continuously adjustable output voltage, VLF Hipot or Capacitor Discharge Function
- Three separate Operating Mode pushbuttons- VLF Hipot/VLF Burn/Cap Discharge
- Single range bipolar (+/- ,center null) volt meter
- Single range current meter
- Single-Pulse or Continuous Capacitor Discharge Mode operations
- Fixed continuous discharge timing of 8 seconds
- Manually operated Coupler Mode pushbutton with ON-Radar and OFF-Direct positions
- Two internal discharge solenoids, one for the output cable, one for the internal capacitor bank
- External Interlock plug to "Lock-out" High Voltage during set up
- One piece portable design
- Transit protected meters prevent meter damage between test sites
- Shielded high voltage output cable
- 4 AWG Braided ground cable for secure ground connection

Operating Environment

Indoor/Outdoor-fair weather

Altitude: 100% of rating; Sea-level, up to 5000ft.(approx.1500M). The output power is de-rated 10% above 5000 ft. altitude, 20% above 12,000 ft.(approx. 3600M), and 30% above 15,000 ft.(approx. 4500M)

Storage Temperature: -20°C to 70°C(-4°F to 158°F)

Operating Temperature: -5°C to 45°C(22°F to 113°F) Output power is de-rated linearly by 15% from 30 to 45°C ambient.

Maximum Relative Humidity: 80% up to 31°C(88°F), decreasing linearly to 50% at 40°C(104°F)

Mains supply fluctuation: +/-10% of rated voltage

Installation: Category II

Pollution: Degree 2

WARNING

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DO NOT STORE OR TRANSPORT VT33 ON IT'S SIDE

Safety Symbol Identification

Warning! Please refer to documentation before operation

Protective Earth Terminal

Warning: Hazardous Voltage

VT33 MODEL SPECIFICATIONS

	VT33 Part No. CDS-0185S
Input	120 V, 50/60 Hz, 8 amps 230 V, 50/60 Hz, 5 amps
Output	VLF- 0-33 kV PEAK, 0.1Hz, 1.0 uF CAP DISCHARGE- 0-13kV PEAK, 760 Joules (at 13 kV), Negative Polarity
Duty	Continuous
Kilovoltmeter	-40/0/40 PEAK KILOVOLTS, +/-2% F.S.
Current Meter	0-50 PEAK MILLIAMPERES, +/-2% Full Scale
Terminations	Input line: 10 Ft. Return/High Voltage Cable: 50 ft or 15 ft. with MC connector for use with cable reel. 4 AWG Braided Ground Lead: 50 ft.
Size	29.5"w x 26"d x 44" high With Wheels 23"w x 17.5"d x 44" high Without Wheels
Weight	245 lbs. (111kg)

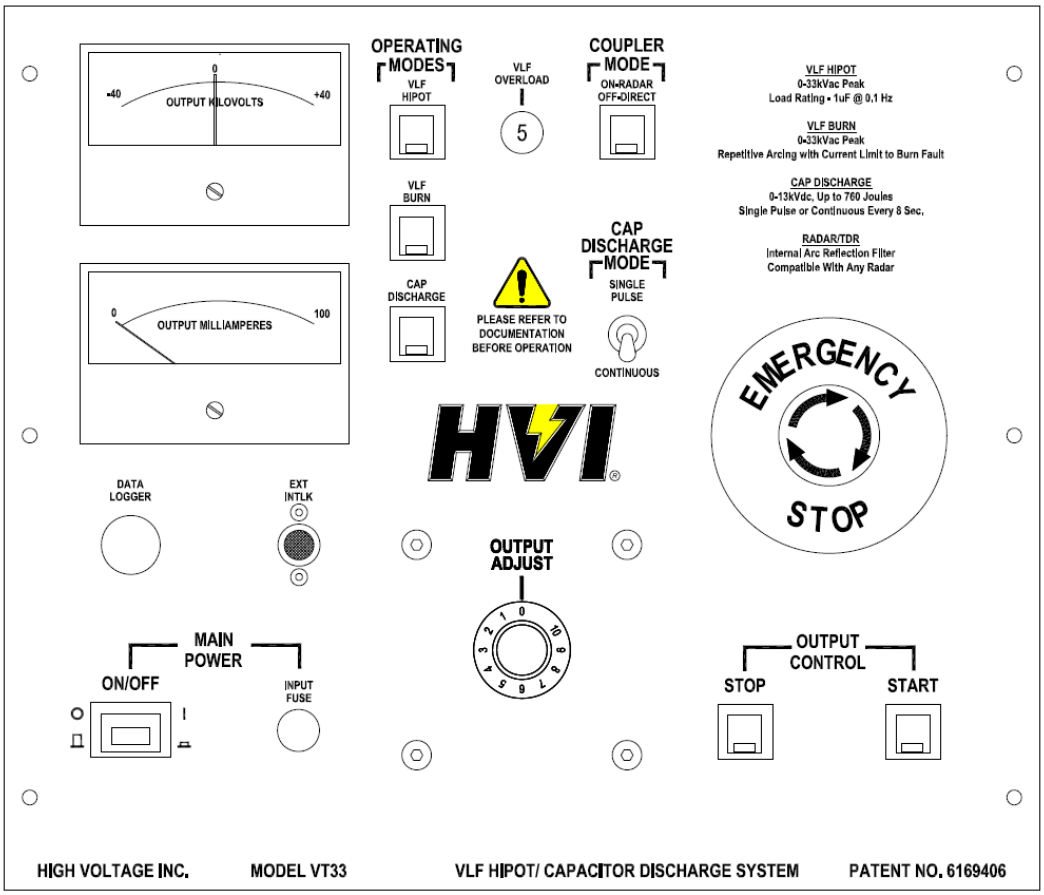

Figure 1 *VT33 front panel controls.*

MAIN POWER

The MAIN POWER pushbutton switch provides the power to the control and power circuits. The neon lamp in the switch will light when the power is on and voltage is available through the input line cord. The INPUT FUSE located electrically before the MAIN POWER switch provides line fault protection for the unit.

START/STOP

The START/STOP pushbuttons activate (de-activate) the high voltage power circuits. The LED indicators provide long life positive indication of the circuit status. The RED (START) LED lights when high voltage is energized, the GREEN (STOP) LED lights when the high voltage is de-energized.

EMERGENCY STOP

The EMERGENCY STOP pushbutton de-activates the high voltage power circuits and drops all solenoids to discharge internal voltages. The EMERGENCY STOP pushbutton must be rotated to release the switch and re-energize the high voltage.

OUTPUT ADJUST

The OUTPUT ADJUST control variable transformer sets the output voltage. The 0-100% markings on the knob indicate the low to high setting. The control must be at ZERO (0) to energize the high voltage circuits. The output control must always be returned to zero at the completion of testing, prior to de-energizing the output.

VOLTMETER

The KILOVOLT METER indicates the output voltage. 1% precision measurement resistors minimize the need for re-calibration due to aging shift.

CURRENT METER

The CURRENT METER provides output current readings for the HIPOT/BURN function.

OPERATING MODES

The VLF HIPOT switch presets the control circuits for VLF HIPOT operation. When using the VLF HIPOT mode, a failure of the cable will shut off the high voltage control circuits.

The VLF BURN switch presets the control circuits for VLF BURN operation. When using the VLF BURN mode, a failure of the cable will not shut off the high voltage control circuits. Instead, a current limiting reactor is inserted in the high voltage primary to burn the fault for locating in the CAP DISCHARGE mode.

A Note on VLF Cable Burning

A thumper burner is used to reduce the impedance of a fault, or make it a worse fault. Many conventional thumpers offer 20 – 50 mA of DC current from their DC hipot outputs for this purpose. (High Voltage, Inc. thumpers offer up to 400 mA on some models). To burn down a cable fault with only 25 or 30 mA can take many hours. The fastest method of burning down cable faults is with a VLF burner. The VLF hipot automatically raises its output voltage until the cable arcs. This repeated arcing of alternating positive and negative polarities (the VLF has a sinusoidal AC output), combined with the cable's stored energy discharged into the fault every half cycle, rapidly reduces the fault arc-over voltage to a very low level, permitting the use of a lower voltage and joule rated thumper. The 760 joule output from the VT33 is more than ample energy to locate low impedance faults.

The CAP DISCHARGE switch presets the control circuits for a single pulse (for use with TDR) or allows the circuit to run continuously.

COUPLER MODE

The COUPLER MODE switch controls the connection of the TDR (RADAR) coupler circuit and insertion of a high voltage isolating inductor for fault tracing in the CAP DISCHARGE mode. This control is only active in CAP DISCHARGE mode.

CAP DISCHARGE MODE

The CAP DISCHARGE toggle switch is used to select between a timed (CONTINUOUS) discharge, or a SINGLE PULSE discharge.

EXT INTLK

The EXT INTLK external interlock socket provides a safety interlock to disable the high voltage control circuits. A normally closed switch from a test cage or foot switch can be wired to this connector to provide access control or electrical lockout ability. The circuit is within the 120Vac control circuit.

VLF OVERLOAD

The VLF OVERLOAD thermal circuit breaker protects the unit from primary overload conditions. It is active in the VLF HIPOT and CAP DISCHARGE modes and bypassed in the VLF BURN mode. The circuit breaker button will pop up and expose a red band when it has overloaded.

SECTION

2

SETTING UP THE EQUIPMENT

The setup of this equipment has been minimized by careful consideration for the operator during design. The VT33 one-piece field portable construction makes this the preferred unit for fault locating.

1. Select a location for the unit that will allow easy viewing of the meters at a safe distance from the test cable.

> *Caution!!*
>
> *Before making any cable connections, ensure that the cable being tested has been properly identified, de-energized, and grounded!*

2. Be sure that all the controls are off, in their de-energized or fully counterclockwise position.

3. Unspool the cables onto the ground. Separate the input line cord, ground lead and output cables from each other.

4. Secure the ground test lead to the cabinet. The Ground stud on the rear panel of the unit must be used for that purpose. A 4 AWG braided copper lead has been provided for the ground connection. Proper grounds are essential when operating high voltage test equipment and especially when fault locating with a capacitor discharge device. Connect the ground lead cable clamp to the station ground of the cable being tested.

WARNING

DO NOT OPERATE THE VT33 HIPOT SET IF THE HIGH VOLTAGE TANK IS 5° OR MORE FROM LEVEL.

IF THE UNIT IS OPERATED OUT OF LEVEL, OVERHEATING AND INTERNAL ARCING MAY OCCUR.

DO NOT STORE OR TRANSPORT VT33 ON IT'S SIDE

Operating the Equipment

This section provides step-by-step instruction on various test methods. Many facilities have their own in-house test procedures, and this manual is not to supercede these. The purpose of this section is to explain the capabilities of this test set in real world applications.

Note on VLF Cable Burning

A thumper burner is used to reduce the impedance of a fault, or make it a worse fault. Many conventional thumpers offer 20 – 50 mA of DC current from their DC hipot outputs for this purpose. (High Voltage, Inc. thumpers offer up to 400 mA on some models). To burn down a cable fault with only 25 or 30 mA can take many hours. The fastest method of burning down cable faults is with a VLF burner. The VLF hipot automatically raises its output voltage until the cable arcs. This repeated arcing of alternating positive and negative polarities (the VLF has a sinusoidal AC output), combined with the cable's stored energy discharged into the fault every half cycle, rapidly reduces the fault arc-over voltage to a very low level, permitting the use of a lower voltage and joule rated thumper. The 760 joule output from the VT33 is more than ample energy to locate low impedance faults.

VLF Insulation Testing of Cables in the VLF Hipot or VLF Burn Mode

When testing cables, either single or three phase, there are certain steps that must be observed to ensure safe operation.

1. Ensure that all the steps listed in Setting up the Equipment have been accomplished. Take special note to ground the unit to a solid earth ground using the supplied 4 AWG braided copper lead. Connect the ground lead cable clamp to station ground.

> *Caution!!!*
>
> *Before making any cable connections, ensure that the cable being tested has been properly identified, de-energized, and grounded!*

2. To preclude flashover, make sure that all insulators, stress cones, and pot heads are clean and free of moisture. Be particularly diligent to remove any lightning arresters connected to the test cables if going above 8kV, or false failures will occur.

The shields of all cables must be securely tied to ground at the nearest end of the cable.

3. Isolate the far end of the conductors under test for the test voltage; that may mean separating some of the conductors in a multi-conductor cable from each other and their shields.

4. Any conductors or wires in the cable or the vicinity not being tested must be grounded to avoid a buildup of charge and possible shock hazard.

5. Prior to connecting anything to the test sample, be sure the test sample is identified, de-energized and grounded until ready to test.

6. Connect the RETURN clamp to the GROUNDED neutral or shield of the cable being tested.

7. Connect the HV lead clamp to the center conductor of the cable being tested.

Note: If an output cable reel is being used, connect the high voltage MC connector to the center plug on the reel, connect the return ring terminal to the brass return stud on the reel. Make all load test connections to the cable from the reel leads as noted in steps 6 and 7.

8. Connect the input power cord to a grounded power source (see specifications for input voltage and frequency). If the distance to a power source is greater than the cord provided, a grounded extension cord of sufficient ampacity will work.

9. Operate the MAIN POWER ON to energize the control circuits.

10. Select the OPERATING MODE by depressing the VLF HIPOT or VLF BURN pushbutton depending on the desired result of test.

11. Voltage must be applied according to specifications from the cable manufacturer or any other applicable test standards. (Refer to IEEE 400.2)

CAUTION

POTENTIALLY LETHAL VOLTAGES MAY BE PRESENT

12. With the OUTPUT ADJUST at zero (zero start interlock engaged), depress the START pushbutton. The START light will glow.

13. Increase the output by rotating the OUTPUT control slowly clockwise until the desired output voltage is reached.

NOTE: At 0.1Hz, it will take 2.5 seconds to reach the peak output during the cycle. Be cautious not to overshoot your desired test voltage.

14. Maintain the output voltage for the test time specified in your standard procedures. Charging current may be read on the current meter at this time. Should the test cable arc or fail; in VLF BURN mode the output will collapse to a lower value and the current meter reading will increase, in VLF HIPOT mode the VLF OVERLOAD will trip and shut down the high voltage. In some cases, it may take several cycles of arcing before the output overload will shut down the unit.

The thermal overload may not trip below 20% of full output. Due to thermal characteristics and high voltage circuit impedance, the current peaks are not enough to trip the overload. Above 20%, the overload reliably trips at the peak of the output wave.

15. Burning of the cable for CAP DISCHARGE can be accomplished at this time by allowing the fault to VLF BURN until the peak output voltage is below 13 kV, permitting the use of the CAP DISCHARGE section of the VT33.

16. At completion of test or operation, rotate the OUTPUT ADJUST to zero, then the depress the STOP pushbutton. The output cable load will be discharged through an internal discharge resistor. Turn off the MAIN POWER switch.

17. Always use a GROUND HOOK to ground the cable(s) prior to disconnecting the output cable.

It should be noted that the VT33 test set IS NOT intended to be used on vacuum bottles or switchgear without cables connected. The VT33 requires a minimum of .005uF load capacitance to achieve full output. If the capacitance of the load is too low, the kilovolt meter will not read the actual peak output and damage to the unit (and/or load) may result.

Note: Cables exhibiting high failure rates (greater than 4 times in 18 months) should be investigated further to determine the age and likelihood of continuing problems. Replacement may be indicated.

Cap Discharge Fault Locating (thumping)

Without radar

High Voltage Cables

When testing cables, either single or three phase, there are certain steps that must be observed to ensure safe operation. The CAP DISCHARGE Mode of the VT33 requires that the fault be conditioned to arc below 13 kV or the energy discharge will not occur. Use the VLF BURN mode of the VT33 to condition the fault for CAP DISCHARGE.

1. Ensure that all the steps listed in Setting up the Equipment have been accomplished. Take special note to ground the unit to a solid earth ground using the supplied 4 AWG braided copper lead. Connect the ground lead cable clamp to the station ground of the cable being tested.

> *Caution!!!*
>
> *Before making any cable connections, ensure that the cable being tested has been properly identified, de-energized, and grounded*

2. Make sure that all insulators, stress cones, and pot heads are clean and free of moisture. This will prevent flashover in areas other than the fault site.

The shields of all cables must be securely tied to ground at the nearest end of the cable.

3. Isolate the far end of the conductors under test for the test voltage; that may mean separating some of the conductors in a multi-conductor cable from each other and their shields.

4. Any conductors or wires in the cable or the vicinity not being tested must be grounded to avoid a buildup of charge and possible shock hazard.

5. Connect the RETURN clamp to the GROUNDED neutral or shield of the cable being tested.

6. Connect the HV lead clamp to the center conductor of the cable being tested.

Note: If an output cable reel is being used, connect the high voltage MC connector to the center plug on the reel, connect the return ring terminal to the brass return stud on the reel. Make all load test connections to the cable from the reel leads as noted in steps 5 and 6.

7. Connect the input power cord to a grounded power source (see specifications for input voltage and frequency). If the distance to a power source is greater than the cord provided, a grounded extension cord of sufficient ampacity will work.

8. Operate the MAIN POWER switch to energize the control circuits.
9. Select the OPERATING MODE by depressing the CAP DISCHARGE pushbutton.
10. Voltage must be applied according to specifications from the cable manufacturer or any other applicable test standards.
11. Assure that the COUPLER MODE switch is in the OFF-DIRECT position (NO LED).
12. Place the CAP DISCHARGE MODE switch in the center position.

CAUTION

POTENTIALLY LETHAL VOLTAGES MAY BE PRESENT

STORED ENERGY LEVELS IN THE CABLE GREATLY INCREASE THE RISK OF FATAL INJURY IF CONTACT IS MADE WITH THE LOAD WHILE AT ANY VOLTAGE.

13. With the OUTPUT ADJUST at zero (zero start interlock engaged), depress the START pushbutton. The START light will glow.
14. Increase the output by rotating the OUTPUT ADJUST slowly clockwise until the desired CAP DISCHARGE (Thumping) voltage is reached. The OUTPUT ADJUST percentage markings will provide a good guide to the level the output will reach. The cable fault will break over ('Thump') at the fault location and acoustical devices can be used to pinpoint the resulting sound.
15. Place the CAPACITOR DISCHARGE MODE in CONTINUOUS position. The VT33 will discharge it's stored energy into the cable, causing an arc at the fault every 8 seconds.
16. Upon locating the failure point, depress the STOP pushbutton to interrupt the test cycling.
17. At completion of test or operation, depress the STOP pushbutton. The internal capacitor and output cable load will be discharged through two internal discharge resistors. Turn off the MAIN POWER switch.
18. Always use a GROUND HOOK to ground the cable(s) prior to disconnecting the output cable.

Cap Discharge Fault Locating

High Voltage Cables Using a TDR Device

When testing cables, either single or three phase, there are certain steps that must be observed to ensure safe operation. The CAP DISCHARGE Mode of the VT33 requires that the fault be conditioned to arc below 13 kV or the energy discharge will not occur. Use the VLF BURN mode of the VT33 to condition the fault for CAP DISCHARGE.

Please Note: *The TDR Coupler is always active. When in the DIRECT MODE, the TDR can operate as a TDR-RADAR, but the Arc-Reflection Mode of the TDR will not work in DIRECT.*

1. Ensure that all the steps listed in Setting up the Equipment have been accomplished. Take special note to ground the unit to a solid earth ground using the supplied 4 AWG braided copper lead. Connect the ground lead cable clamp to the station ground of the cable being tested.

2. The TDR or Radar device should be plugged directly into the AC receptacle on the side panel of the VT33 cabinet. The TDR signal input is connected to the BNC connector (on the side panel) marked TDR SIGNAL. The TDR trigger input (if on TDR) connects to the BNC marked TDR TRIGGER.

Caution!!!

Before making any cable connections, ensure that the cable being tested has been properly identified, de-energized, and grounded!

3. Make sure that all insulators, stress cones, and pot heads are clean and free of moisture. This will prevent flashover in areas other than the fault site.

The shields of all cables must be securely tied to ground at the nearest end of the cable.

4. Isolate the far end of the conductors under test for the test voltage; that may mean separating some of the conductors in a multi-conductor cable from each other and their shields.

5. Any conductors or wires in the cable or the vicinity not being tested must be grounded to avoid a buildup of charge and possible shock hazard.

6. Connect the RETURN clamp to the GROUNDED neutral or shield of the cable being tested.

7. Connect the HV lead clamp to the center conductor of the cable being tested.

Note: If an output cable reel is being used, connect the high voltage MC connector to the center plug on the reel, connect the return ring terminal to the brass return stud on the reel. Make all load test connections to the cable from the reel leads as noted in steps 6 and 7.

8. Connect the input power cord to a grounded power source (see specifications for input voltage and frequency). If the distance to a power source is greater than the cord provided, a grounded extension cord of sufficient ampacity will work.

9. Operate the MAIN POWER switch to energize the control circuits.

10. Voltage must be applied according to specifications from the cable manufacturer or any other applicable test standards.

11. Select the OPERATING MODE by depressing the CAP DISCHARGE pushbutton.

12. Operate the COUPLER MODE switch to the ON-RADAR position(RED LED).

13. Make sure the CAP DISCHARGE MODE switch is in the center position.

14. Set up the TDR in accordance with manufacturer's instructions. At this time you should see a low voltage trace on the screen and the TDR should be "armed" or "awaiting thump".

15. With the OUTPUT ADJUST at zero (zero start interlock engaged), depress the START pushbutton. The START light will glow.

16. Increase the output by rotating the OUTPUT ADJUST slowly clockwise until the desired Cap Discharge (Thumping) voltage is reached. The OUTPUT ADJUST percentage markings will provide a good guide to the level the output will reach.

17. Push the CAP DISCHARGE MODE switch upward to the SINGLE PULSE position. The VT33 will discharge one pulse. If the cable fault arcs over, you should see a deflection on the TDR screen. If not, you may need to repeat this step several times at a higher voltage.

18. Once you have pre-located the fault with the TDR, you can change over to the CONTINUOUS CAP DISCHARGE MODE. The cable fault will break over ('Thump') at the fault location every ten seconds and acoustical devices can be used to pinpoint the resulting sound.

19. Upon locating the failure point, depress the STOP pushbutton to interrupt the test cycling.

20. Always use a GROUND HOOK to ground the cable(s) prior to disconnecting the output cable.

Cap Discharge Fault Locating

High Voltage Cables CIM

When testing cables, either single or three phase, there are certain steps that must be observed to ensure safe operation. The CAP DISCHARGE Mode of the VT33 requires that the fault be conditioned to arc below 13 kV or the energy discharge will not occur. Use the VLF BURN mode of the VT33 to condition the fault for CAP DISCHARGE.

Please Note: *When in the DIRECT MODE, the TDR can only be used for the Current Impulse Method of fault locating, the Arc-Reflection Mode of the TDR will not work in DIRECT.*

21. Ensure that all the steps listed in Setting up the Equipment have been accomplished. Take special note to ground the unit to a solid earth ground using the supplied 4 AWG braided copper lead. Connect the ground lead cable clamp to the station ground of the cable being tested.

22. The TDR or Radar device should be plugged directly into the AC receptacle on the side panel of the VT33 cabinet. The TDR signal input is connected to the BNC connector (on the side panel) marked TDR SIGNAL. The TDR trigger input (if on TDR) connects to the BNC marked TDR TRIGGER.

Caution!!!

Before making any cable connections, ensure that the cable being tested has been properly identified, de-energized, and grounded!

23. Make sure that all insulators, stress cones, and pot heads are clean and free of moisture. This will prevent flashover in areas other than the fault site.

The shields of all cables must be securely tied to ground at the nearest end of the cable.

24. Isolate the far end of the conductors under test for the test voltage; that may mean separating some of the conductors in a multi-conductor cable from each other and their shields.

25. Any conductors or wires in the cable or the vicinity not being tested must be grounded to avoid a buildup of charge and possible shock hazard.

26. Connect the RETURN clamp to the GROUNDED neutral or shield of the cable being tested.

27. Connect the HV lead clamp to the center conductor of the cable being tested.

Note: If an output cable reel is being used, connect the high voltage MC connector to the center plug on the reel, connect the return ring terminal to the brass return stud on the reel. Make all load test connections to the cable from the reel leads as noted in steps 6 and 7.

28. Connect the input power cord to a grounded power source (see specifications for input voltage and frequency). If the distance to a power source is greater than the cord provided, a grounded extension cord of sufficient ampacity will work.

29. Operate the MAIN POWER switch to energize the control circuits.

30. Voltage must be applied according to specifications from the cable manufacturer or any other applicable test standards.

31. Select the OPERATING MODE by depressing the CAP DISCHARGE pushbutton.

32. Leave the COUPLER MODE switch to the OFF-DIRECT position.

33. Make sure the CAP DISCHARGE MODE switch is in the center position.

34. Set up the TDR in accordance with manufacturer's instructions.

35. With the OUTPUT ADJUST at zero (zero start interlock engaged), depress the START pushbutton. The START light will glow.

36. Increase the output by rotating the OUTPUT ADJUST slowly clockwise until the desired Cap Discharge (Thumping) voltage is reached. The OUTPUT ADJUST percentage markings will provide a good guide to the level the output will reach.

37. Push the CAP DISCHARGE MODE switch upward to the SINGLE PULSE position. The VT33 will discharge one pulse. If the cable fault arcs over, you should see a deflection on the TDR screen. If not, you may need to repeat this step several times at a higher voltage.

38. Once you have pre-located the fault with the TDR, you can change over to the CONTINUOUS CAP DISCHARGE MODE. The cable fault will break over ('Thump') at the fault location every ten seconds and acoustical devices can be used to pinpoint the resulting sound.

39. Upon locating the failure point, depress the STOP pushbutton to interrupt the test cycling.

40. Always use a GROUND HOOK to ground the cable(s) prior to disconnecting the output cable.

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SECTION 3

PERFORMING SPECIAL OPERATIONS

The following section contains information on the care and upkeep of your new VT33 VLF HIPOT/Capacitor Discharge Cable Fault Locator. There are some notes on troubleshooting and service, which will save much time and money over the life of the unit.

Meter Re-calibration

The VT33 fault locator uses precision metal film resistors for measurement and calibration of the voltmeter and the current meter. The use of these resistors in both the high voltage tank and the metering circuits has minimized circuit drift due to aging and temperature.

If the current meter will not calibrate, the meter should be replaced once it has been determined the current sense resistor is not the cause.

The certification of meters on a yearly basis by a qualified calibration service is recommended to ensure accurate test results.

Maintenance

The VT33 fault locator should be opened and visually inspected for accumulation of dirt on internal components. Once a year, the front panel should be removed and the interior should be vacuumed or blown out with a low pressure hose. Looking for frayed or damaged connections can be accomplished at the same time. If problems are seen, contact the factory for instruction.

NEVER WORK ON ENERGIZED EQUIPMENT. ALWAYS GROUND THE OUTPUT CABLE AND INTERNAL CAPACITOR BEFORE ATTEMPTING TO DO WORK ON THE VT33 WITH THE FRONT COVER REMOVED.

Oil Insulated High Voltage Tanks

Although not suggested for units in Warranty, the oil-filled tanks in all VLF HIPOT/Capacitor Discharge Cable Fault Locators are field serviceable. The only requirement is that the tank must be oil filled under vacuum at re-assembly if left out of the oil for longer than 2 hours. The parts to service the tank are available from HIGH VOLTAGE, INC. at the address noted on the inside front cover of this manual.

The oil level in the tank should be .5 inches from the lid when the oil temperature is 20°C.

RETURNED MATERIAL

If for any reason it becomes necessary to return any equipment or materials to High Voltage, Inc., the Service Department of High Voltage, Inc. must be notified, and authorization received, prior to the shipment of the equipment. When notified, the following information must be provided:

MODEL:
SERIAL NO:
PART NO:
REASON FOR RETURN:
SUSPECTED DEFECT:
CAUSE OF DEFECT:

With the above information provided, High Voltage, Inc. will determine if the return of the equipment is appropriate. If deemed appropriate, a Return Authorization Number will be issued. At that time, the Purchaser will be instructed how to mark and return the equipment.

The above procedure must be adhered to in order to ensure prompt service. No equipment should be returned without the prior knowledge and authorization of High Voltage, Inc.

REPLACEMENT PARTS ORDERING

To order replacement parts, first refer to the Parts List for the product in question. Every part is issued a part number. It will be necessary for this part number and the product model and serial number to be provided. When calling High Voltage, Inc. request the Service Department.

Appendix A:

Very Low Frequency (VLF) AC Cable Testing

Recommended Test Voltage Levels And Durations

With much of the world abandoning DC testing of solid dielectric cable, VLF AC hipots are becoming widely used. Since an AC test is a proof (or withstand) test on a go/no-go (pass/fail) basis, the test voltage is applied for a set duration. The cable being tested either holds the test voltage or fails. The question arises, and there is and has been much debate, as to the proper test voltage and the time length of the test. There are differing recommendations and standards in existence that define voltage level and duration. Here we will attempt to summarize what exists and offer recommendations.
Most standards call for a Maintenance test voltage of 3 times the normal line-to-ground operating voltage, or 3Vo (higher for 5 kV cable). However, the voltage applied, per IEEE400.2, is 3Vo rms of the operating voltage but used as the peak of the sine wave output from a sine wave producing VLF unit. For example, a 13.2 kV operating system has a line to ground voltage of 7,621 volts. Three times 7,621 equals 22,864 volts. The IEEE standard calls for a VLF Maintenance test on 15 kV cable to be 22 kV peak, which would be equivalent to an rms voltage from the VLF of 16kV. Test voltages may vary depending on the operating voltage. For instance, a 15 kV cable may have a phase-to-phase operating voltage of 11 kV, 12.5 kV, 13.2 kV, 13.8kV, etc. The chart on the next page shows the various voltage levels for different voltage class cable.

European Standard – VDE DIN 0276-620

The oldest standard for VLF cable testing mandates a test voltage of 3Vo (three times line-to-ground voltage) for 60 minutes. The 60-minute duration was/is believed to be necessary to grow any significant defects through to failure during the test.

IEEE 400.2 Draft Standard Recommendation.

Following are excerpts from the latest draft (D3 published in 11/03) of the new IEEE VLF standard.

6.1 General VLF Testing

6.1.1 VLF Test Parameters. During a VLF test an electrical tree at the site of an insulation defect is forced to penetrate the insulation. Inception of an electrical tree and channel growth time are functions of test signal frequency and amplitude. For an electrical tree to completely penetrate the insulation during the test duration, VLF test voltage levels and testing time durations have been established for the two most

commonly used test signals, the cosine-rectangular and the sinusoidal wave shapes. [The High Voltage, Inc. VLF units produce a sine wave output.]
The voltage levels (Installation and Acceptance) are based on most used practices worldwide of between 2 and 3Uo for cables rated between 5 and 35 kV. The Maintenance test level is about 80% of the Acceptance test level. One can reduce another 20 % if more test cycles are applied [14,15,16].
Tables 3 and 4 list voltage levels for VLF withstand testing of shielded power cable systems using cosine-rectangular and sinusoidal waveforms [7, 14, 15, 19]. [Only table 4 is shown below as that applies to the sine wave VLF.] For a sinusoidal waveform the rms is 0.707 of the peak value if the distortion is less than 5%.

Table 4: VLF Hz Test Voltage for Sinusoidal Waveform1

Cable Rating phase to phase	Installation2 phase to ground	Acceptance2 phase to ground	Maintenance3 phase to ground
kVrms	kVrms or (kVpk)	kVrms or (kVpk)	kVrms or (kVpk)
5	9 (12)	10 (14)	7 (10)
8	11 (16)	13 (18)	10 (14)
15	18 (25)	20 (28)	16 (22)
25	27 (38)	31 (44)	23 (33)
35	39 (55)	44 (62)	33 (47)

[VLF is also suitable for higher voltage cable. HVI offers VLF up to 200 kV.]
1 For sinusoidal VLF the voltages are given in both rms and peak values.

2 The results of field tests on over 15000 XLPE cable circuits tested** showed that ~68% of the recorded failures occurred within 12 minutes, ~89% within 30 minutes, ~95% after 45 minutes 100% after 60 minutes [19]. The recommended testing time varies between 15 to 60 minutes although the data in [19] suggest a testing time of 30 minutes. The actual testing time and voltage may be defined by the supplier and user and depend on the testing philosophy, cable system, insulation condition, how frequently the test is conducted and the selected test method. Testing databases or [7] may be consulted when choosing a preferred testing time. When a VLF test is interrupted, it is recommended that the testing timer be reset to the original time when the VLF test is restarted.

3 For a 0.1 Hz VLF test voltage, the suggested maintenance voltage duration is 15 minutes [7].

** Data taken from VLF testing performed in Malaysia using High Voltage, Inc. VLF products.

[It comes down to engineering compromises. One can test for an hour and expose nearly 100% of defects, or test for 30 minutes and be satisfied that the great majority of defects were grown to failure and be willing to live with a 2 – 3% in-service failure rate over the next few years on cables that passed the VLF test. Even at 3%, the in-service failure rate would be less by multiples than if the cable was never tested or tested with DC voltage.
In addition to the years of European and North American research, an extensive review of VLF testing performed in Japan by Furukawa Electric indicated that if a cable passes a VLF test at 3Vo for 15 minutes, there is a 97% chance that the cable will not fail in service for at least three years. This data is consistent with other users experiences.]

Typical Recommendations

The goal is to test for a long enough time and at the proper voltage to grow significant defects thru to failure without triggering partial discharge in minor defects that would not have caused cable failure for many years. The typical test duration is for at least 30 minutes at a voltage of 3Vo at 0.1 Hz. This voltage level and time duration allows adequate stress to grow major defects to failure without aggravating minor defects. Very important in VLF testing is that should a failure occur, the cable must be retested following the repair. Once the cable holds 3Vo voltage for the 30 minute duration, one can be satisfied that 95+% of the cables tested will not contain any further defects that will result in in-service failures in the next few years. A 60 minute test will reveal closer to 99% of defects.

Other data and knowledge of the cables tested is helpful. For instance, if a cable fails twice during a VLF test, both times the insulation and not accessories, then you may want to consider not continuing the test if it is known that the cable is very old and it or like cables have a history of high failure rate. Maybe stop testing, rather than cause multiple failures, and mark that cable for replacement soon. If the failures are to the accessories, then keep testing, as the VLF is a great splice checker for material problems and/or workmanship.

All of the above numbers apply to VLF testing at 0.1Hz. If lower frequencies are used, the test duration should be longer. At 0.1Hz, the period of the sine wave is 10 seconds with a peak voltage applied every 5 seconds. At 0.05 Hz, a peak voltage is applied every 10 seconds. We suggest that if using 0.05 Hz the test time be doubled and perhaps tripled if using lower frequencies. Lower test frequencies are sometimes necessary for testing highly capacitive loads; very long cables. (Most HVI models are powerful enough to allow testing all three phases at once.)

TERMS AND CONDITIONS AND LIMITED WARRANTY Rev. 102113

High Voltage, Inc., 31 County Route 7A, Copake, NY USA 12516
Phone: (518) 329-3275 Fax (518) 329-3271 E-mail: factory@hvinc.com

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a. High Voltage warrants to the original Purchaser of any new goods that the goods are free from defects in material and workmanship under normal use and service for a period of one (1) year from the date of shipment by High Voltage. The obligation of High Voltage under this Limited Warranty is limited, in High Voltage's exclusive option, to repair, replace with new or reconditioned parts or issue credit for goods, parts or materials which prove to be defective. Costs incurred by Purchaser for labor or other expenses to repair or replace such goods, parts and/or materials shall be the sole responsibility of Purchaser. High Voltage shall not be responsible for any damage or lack of performance resulting from: (i) defects due to accident, negligence, alteration, modification, faulty installation, abuse or misuse, whether by Purchaser, Purchaser's agents or employees, or by others than High Voltage (ii) attempted or actual dismantling, disassembly, service or repair by any person, firm or corporation not specifically authorized in writing by High Voltage, or (iii) defects caused by or due to handling by carrier, or incurred during shipment, transshipment or other move.

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i. Purchaser must notify High Voltage in writing as soon as is reasonably possible, but within the applicable warranty period, of any alleged defect in material, workmanship, or operation of any goods covered under this Limited Warranty. Such notice must describe in detail the defect, any and all defective parts, and the alleged cause of the defect. No goods may be returned to High Voltage without High Voltage's prior written permission, which permission may be withheld by High Voltage in its sole discretion.

ii. At the exclusive option of High Voltage, Purchaser may be directed in writing to dismantle the goods at the Purchaser's cost and expense and ship the goods prepaid to High Voltage (refer to "Returns" Section 10 for provisions regarding the return of any goods to High Voltage). If High Voltage elects to inspect the goods at Purchaser's site, and to repair, replace,

[Section 9.c.ii. continued on page 2]

or ship the defective goods to High Voltage's factory, Purchaser, at its own cost and expense, shall provide the facilities for such work as needed to inspect and evaluate and possibly repair/replace the goods. If inspection discloses that the defect is not one for which High Voltage is liable, then Purchaser shall promptly reimburse High Voltage for all expenses incurred.

iii. Upon receipt of the defective goods, or following access to the same, High Voltage shall inspect and evaluate the goods and determine the validity of Purchaser's claim.

iv. The validity of any warranty claim, Purchaser's compliance with the Limited Warranty and Limited Warranty Claim Procedure, and the obligation to replace, repair, or issue credit for any goods are solely and exclusively to be determined by High Voltage and any determination shall be final and binding.

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11. **SECURITY INTEREST.** In order to induce High Voltage to ship goods without full payment, Purchaser grants a security interest to High Voltage in any and all of Purchaser's right, title and interest in the goods, and Purchaser agrees to comply with any reasonable request of High Voltage to perfect such security interest. Purchaser hereby further authorizes High Voltage to perfect High Voltage's security interest in said goods and consents to filing one or more financing statements without the signature of Purchaser.

12. **ARBITRATION.** Any controversy arising out of or relating to this document, or any breach thereof, including, without limitation, any claim that this document is voidable or void, shall be submitted to final and binding arbitration before, and in accordance with, the Commercial Rules of the American Arbitration Association then in effect, and judgment upon the award may be entered in any court have jurisdiction thereof; provided, however, that this clause shall not be construed to limit any rights which High Voltage may have to apply to any court of competent jurisdiction for equitable, injunctive or provisional relief. This arbitration provision shall be deemed self-executing, and in the event that either party fails to appear at any properly noticed arbitration proceeding, an award may be entered against such party notwithstanding said failure to appear. Such arbitration shall be conducted before a single arbitrator under the aegis of the American Arbitration Association in Columbia County, State of New York. The arbitrator shall have the authority to award expenses to the successful party.

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[End]

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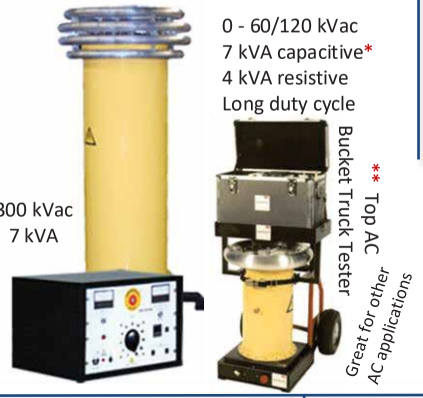

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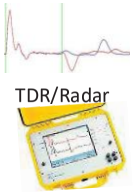

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