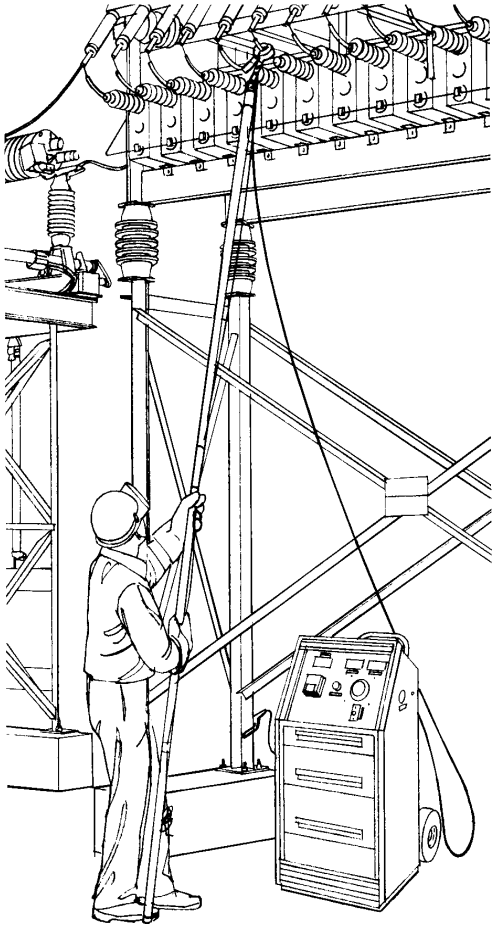
INSTRUCTION
AND
OPERATING MANUAL



CAP CHECK II

Substation Type
Model CC-II/102

HD ELECTRIC COMPANY
1475 LAKESIDE DRIVE • WAUKEGAN, ILLINOIS 60085 U.S.A.
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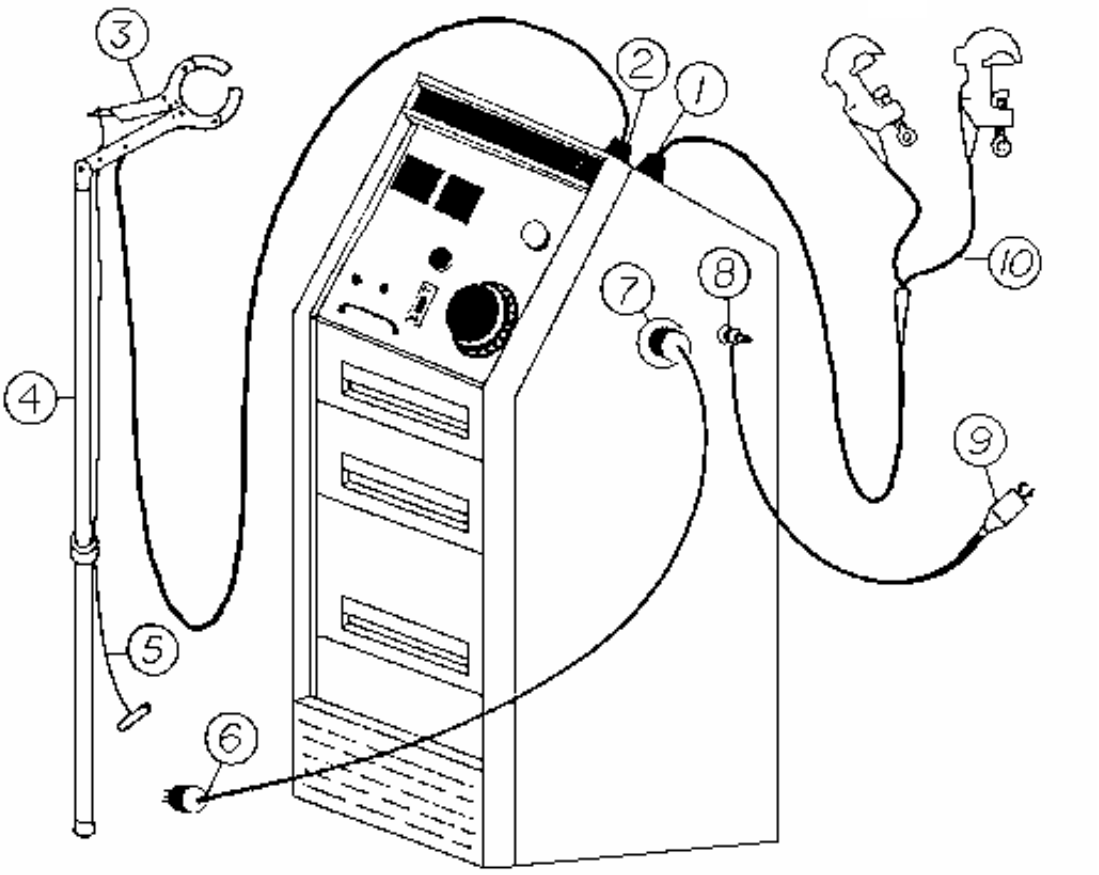
COMPONENT IDENTIFICATION
CAP CHECK II – Substation Type
MODEL CC-II/102

OPERATING COMPONENTS LAYOUT



1. Plug for the Current Transformer
2. Polarized plug for the energizing leads
3. Current Transformer (insulated for 600V) senses individual capacitor current
4. Hotstick provided for measuring capacitors while standing on the ground, 4 sections provided
5. Actuating rope for the Current Transformer when transformer is attached to the hotstick
6. Polarized 3/C 120 volt source cable – 20 amp source required
7. AC power inlet
8. Cabinet ground stud
9. Cabinet ground clamp
10. Live line clamps for attachment of energizing leads to capacitor bank

COMPONENT IDENTIFICATION
CAP CHECK II – Substation Type
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PANEL

11. Test Voltage Selection Switch
12. AC Milliamps Digital Meter
13. Panel Meter Fuse
14. Variable Transformer Fuse
15. Test Loop
16. ON/OFF Switch
17. Momentary Test Loop Pushbutton Switch
18. Variable Transformer (Variac)
19. AC Volts Digital Meter

CAUTION

CAUTION Make certain capacitors are shorted and de-energized COMPLETELY prior to testing. ALWAYS be certain capacitor bank to be tested is out of service. Allow at least 5 minutes for capacitors to fully discharge.

CAUTION Make certain leads NEVER cross phases or drape across bushings, live transformers, etc. Cordage must remain free and clear of all objects, including the human body, AT ALL TIMES.

CAUTION Make certain maximum capacitor KVAR and voltage do not exceed the Cap Check II testing limits. Maximum KVAR for the Cap Check II can be noted on the Pass/Fail Limit Rating Chart located at the end of the manual.

CAUTION Make certain the Cap Check II voltage (Variac) is set to zero (0) prior to turning the instrument on and energizing capacitors.

CAUTION Always turn the Variac to zero after testing capacitors and before turning the Cap Check II off. This action will discharge the capacitor.

NOTE: Familiarize yourself with the Cap Check II instrument panel layout as diagrammed on the previous pages, prior to conducting your first test.

ADDITIONAL SAFETY NOTES

Please note that your Company may have additional safety rules and procedures, which should be employed while using this equipment. You must check to make certain that all safety considerations are properly addressed when using this equipment. These are recommended safety rules and are to be used as guidelines in establishing and integrating your own safe procedures.

OPERATING PRINCIPLE

The Cap Check operates by measuring the current flowing through the capacitor under test. The operating convenience of this tester comes from the fact that a bank of paralleled capacitors is energized but currents are measured individually without opening any connections. Of course, the current drawn by the paralleled group must not exceed the capacity of the power supply.

SET UP PROCEDURE

IMPORTANT: THE PROCEDURES DESCRIBED ARE GENERAL AND MUST BE REVIEWED AND MODIFIED AS NECESSARY TO CONFORM TO THE USER'S SAFETY RULES, STANDARDS AND REGULATIONS.

ALWAYS REMEMBER THAT THE DISTRIBUTION EQUIPMENT UNDER TEST OPERATES AT HIGH VOLTAGE. THE CAPACITOR BANKS MUST BE DE-ENERGIZED AND COMPLETELY DISCHARGED BEFORE THE TESTING AT THE RELATIVELY LOW VOLTAGE IS PERFORMED.

Every group of paralleled capacitors must be discharged. If these parallel groups are not equipped with shorting switches this must be accomplished in accordance with the user's standard safe operating procedures.

SET UP AND TESTING

To obtain correct results it is necessary that the Cap Check energizing leads be connected across the single parallel group of capacitors being tested. If shorting switches are installed, these can limit the energized capacitors to those under test. If switches are not available it will be necessary to use jumpers. The energizing leads may then be attached to the phase lead and the neutral. It is also possible to attach the energizing leads to each of the paralleled sections, but this defeats the timesaving feature of the Cap Check.

Other arrangements of jumpers or switching can be devised to suit the network under test.

When the system consists of paralleled series-parallel groups it probably will not be necessary to switch or jumper the parallel leg—as a matter of fact, that leg must not be shorted or too much of it jumped to avoid drawing excessive power from the tester.

After the test of all parallel groups is completed the tester voltage should be turned down to minimum and the supply should be de-energized. This action will discharge the capacitors which were last tested.

DESIGN OF THE PROCEDURE

The objectives to be considered when establishing a test procedure must put safety first and then consider the convenience and efficiency of the work crew. The basic consideration will be to minimize the number of jumper shifts during the course of testing.

PROCEDURE REVIEW

HD Electric Company will be happy to discuss special problem networks or to review proposed test sequences, but the responsibility for the safe design of these procedures and the safe operation of the test set lies with the using authority.

INTRODUCTION

This Substation Capacitor Checker applies a low AC, 60 Hz voltage to a group of parallel-connected capacitor units. Capacitors are measured individually with a clamp-type ammeter probe to determine if the capacitor units have a defect. The defect may be either a partial or complete short or an open pack. To test the entire capacitor bank, the test voltage energizing leads must be moved around the capacitor bank and connected to each group of parallel capacitors. The capacitors being tested remain connected to the bus through their individual fuses.

Exception: A capacitor which has its individual fuse blown will not be energized when voltage is applied to the main bus.

Step 1. Verify that the capacitor bank is out of service and isolated from its source. If the capacitor bank is in service, open the source device and wait a full five (5) minutes for the capacitors to discharge. Then temporarily short circuit the capacitors with the bank shorting switch. Ground the bank according to the approved methods.
Note: Capacitor structures and associated shorting and grounding devices vary between locations.

FOR TESTING CAPACITORS WITH BLOWN FUSES

Capacitor units which have had their protective fuses blown must be temporarily shorted and grounded on an individual basis and test leads subsequently connected to each capacitor. To obtain the individual capacitor reading, clamp the Current Transformer around the ground lead from the capacitor under test. See the following instructions.

Step 2. Disconnect and remove the following type capacitors from the bank:

1. Any visually bulged units.
2. Any unit which shows an insulating liquid leak. These leaks may occur at the phase bushings, the neutral attachment, the fill hole or a seam. Any loss in insulating liquid may result in an internal flashover to the case and possible case rupture. The packs and leads are very confined and a void in the insulating liquid can precipitate a failure.

   A leaking capacitor may test OK because a pack hasn't completely shorted or open. However, the gas generated from a pack in the process of failing can cause tank swelling or force liquid out a weakened seal or seam.

SAFETY PLEASE NOTE

A CAPACITOR MUST BE SHORT CIRCUITED AT THE TERMINALS BEFORE IT CAN BE CONSIDERED DE-ENERGIZED.

Step 3. **Suggested Cap Check Hookup Procedure**

A. Connect the Cap Check cabinet ground to the station ground.

B. Plug the polarized plug of the Energizing Leads into the Cap Check. Connect the energizing leads via live line clamp to the section of bank to be checked (red clamp to phase bus, black to neutral bus). Use rigorous and approved hotstick work precautions.

C. Verify that the Cap Check On/Off switch is in the **OFF** position and that the Variable Transformer is at **zero** (0).

D. Connect the Cap Check power supply cord to a 120-volt outlet (120 volt, 20-amp circuit required). Adapter pigtails are provided for twist-lock and non-twist-lock connectors.

Step 4. A. **Outdoor Substation Racks**

Attach the Current Transformer to the hotstick to permit measuring individual capacitors while the operator stands at ground level. The hotstick consists of four eight-foot sections. Also assemble the Actuating Rope.

B. **Pad Mounted Enclosure Capacitor Rack**

The Current Transformer may be operated without the hotstick, but rubber gloves are required because bare connections are energized at 120 volts. Hotsticks are still advised under **all** conditions.

Step 5. Determine the rating of the capacitors under test and determine the test voltage to be applied by referencing the Pass/Fail Limit Rating Chart located at the end of the manual. Set the Test Voltage Selection Switch to the correct position for that voltage. **Note:** It is possible to attain the 50 and 120 Volt setting in the 240 Plus position. This action can yield incorrect readings and can cause serious damage to the internal components of this tester.

Step 6. With the Variable Transformer at zero turn the Cap Check on. The digital meters will light and may flash at random for a few seconds. Slowly advance the Variable Transformer and observe the rate of voltage and current increase. If this rate appears slower than when the Test Loop is used or the input circuit breaker trips, an overload is indicated. This condition will rarely be found in banks with individually fused capacitors. It is a likely occurrence when testing isolated capacitors. A completely shorted capacitor is the extreme case of this type.

If this condition is found, try searching with a lower than listed voltage using the Current Transformer. The bad capacitor will have a very high current when compared to good capacitors. The digital meter has a maximum reading of 2000 milliamperes and flashes zero above that value. Do not attempt a long search unless some other clamp-on current meter is used to limit the search current to 8 amperes at 50 volts and even then, do not exceed 30 minutes.

When measuring suspected individual capacitors that are disconnected from the bank, place the Current Transformer on the bushing prior to applying the test voltage. Shorted capacitors will provide high current readings even with less than normal testing voltage.

Step 7. Verify with the Current Transformer that each capacitor is within the range specified on the Pass/Fail Limit Rating Chart.

NOTE: Capacitors which have **low** readings may have open packs or corroded terminals, either on the capacitor or at the fuse connection to the bus. Corrosion results in an excessive voltage drop and an incorrect reading. Wire brush the connections and reconduct the test if this is observed. Values **above** the accepted range indicate one or more groups of packs are shorted. Replace the units not in the acceptable range indicated on the Pass/Fail Limit Rating Chart.

Step 8. When the group check is complete, return the Variable Transformer to zero to short out the capacitors. Turn the Cap Check off.

Step 9. Repeat Steps 1 – 8 for the remaining groups to be tested.

Step 10. Upon completion of the test, store the leads in the appropriate drawers in the Cap Check.

NOTE: The unit is **not** weatherproof. Exercise care to prevent moisture damage.

USE OF THE PANEL MOUNTED TEST LOOP

The Test Loop is furnished to permit verification that the Cap Check is operating properly. It consists of capacitors which have been checked for various readings when 120 volts is applied. Each Cap Check has been individually calibrated for its Test Loop and the proper test values are located on the front panel.

Procedures (refer to diagrams on pages 1 and 2)

1. Make certain the Cap Check is **OFF**.
2. Disconnect the Cap Check Energizing Leads (#10) from the Energizing Cord Plug (#1) located on the upper rear section of the cabinet. If left plugged in, it will distort the reading from the Test Loop.
3. Place the Current Transformer (#3) around the Test Loop (#15).
4. Select “50-120 VOLTS” on the Test Voltage Selection Switch (#11).
5. Turn the unit **ON** with the Variable Transformer (#18) set at zero.
6. Press and hold the Momentary Test Loop Pushbutton Switch (#17) and turn the Variable Transformer until the AC Volts Digital Meter (#19) displays 120 volts. Do not release the Momentary Pushbutton Switch as this disconnects the Test Loop.
7. Note the Current Reading on the AC Milliamps Digital Meter (#12).
8. Compare this reading to the proper values located on the front panel. Please note that you should allow for approximately ± 7% variation due to ambient temperature.
9. After noting the results, turn the Variable Transformer back to zero and release the Momentary Pushbutton Switch.
10. Turn the unit **OFF**.

PLEASE NOTE: This test does not determine the accuracy of the Cap Check. It is designed to be used as an in-field check system, which will allow the operator to determine if all systems are working correctly. It should not be used to determine the accuracy of the instrument. If your test results yield greater than 7% variation, factory calibration may be required. Please contact the factory for details.

SERIES-PARALLEL GROUP TESTS

General

The use of series-parallel capacitor groups is common to obtain the necessary voltage and capacity ratings for substation banks.

The Cap Check has been designed to test these capacitor groups without the need for disconnecting any leads. The series connection of parallel groups may require the use of some shorting jumpers or movement of the energizing lead connection points.

It is necessary that the energizing voltage appear directly across the capacitors under test. It is necessary to locate the leads or jumpers to accomplish this.

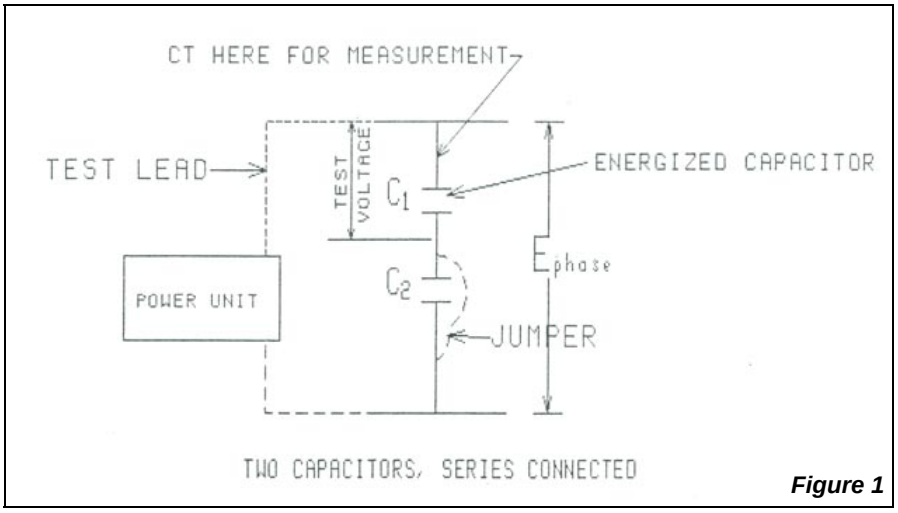


Figure 1

Figure 1 shows a pair of series connected capacitors.

By definition, C = 1/(1/C1 + 1/C2) and KVAR = 2 πfC $(kV)^2$ x 10^{-3}; C in µFd.

We may calculate the following for a selected case:

Voltage	KVAR	CµFd	
7960	100	4.19;	two such units in series give:
15920	200*	2.10;	* the 200 KVAR has been calculated for the 2.1 µFd

Therefore, when two identical capacitors are connected in series to permit operation at a doubled voltage, the KVAR value will be the sum of the total KVAR rating of the two units.

The energizing leads may be placed across the group of capacitors under test as shown in **Figure 2** below. This will place the balance of the groups in series and reduce the current load presented by them. The loading effect of these capacitors strung in series will be equal to 1/n x group KVAR; where n is the number of groups in series loading the power unit. In the case shown in Figure 2, the loading effect would be ¼ x group KVAR.

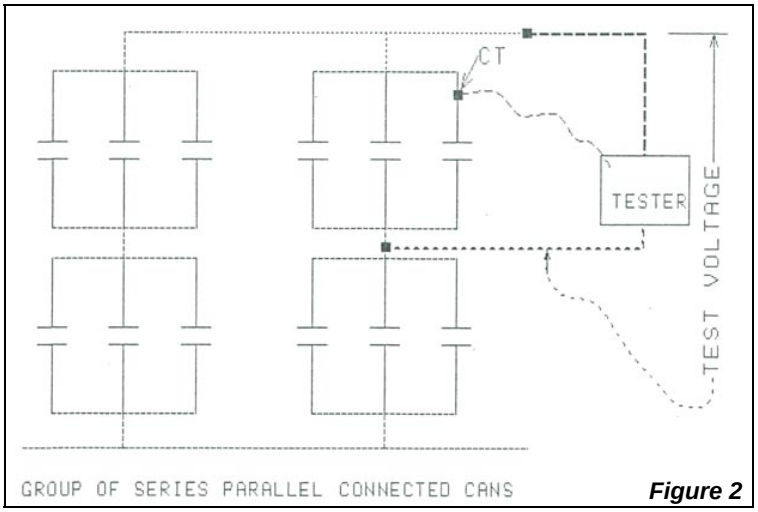


Figure 2

Figure 3 below shows the same group of capacitors with a different energizing lead connection, which would require the use of a jumper. This would increase the effective load on the power unit. If the bank load does not exceed the capacity of the unit, any connection arrangement may be used.

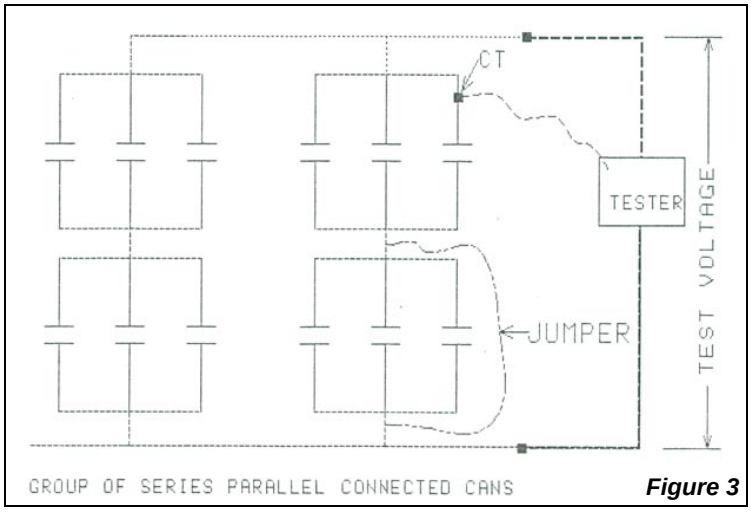
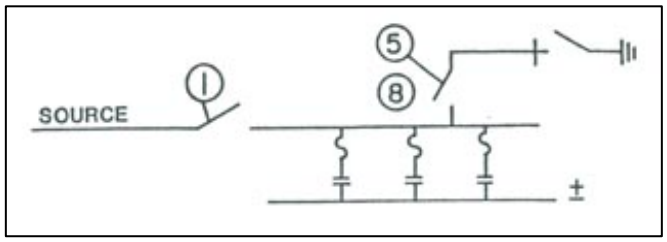


Figure 3

The Pass/Fail Limit Rating Chart at the end of the manual provides a maximum load per phase for the Cap Check. These values are for continuous duty and some overload capacity is available.

TYPICAL SUBSTATION CAPACITOR – ONE LINE

Suggested Substation Cap Check Hookup Procedure



1. De-energize the substation capacitor bank per approved work practices. Capacitor rack designs vary throughout systems.

2. Install the Cap Check cabinet ground lead to the station ground.

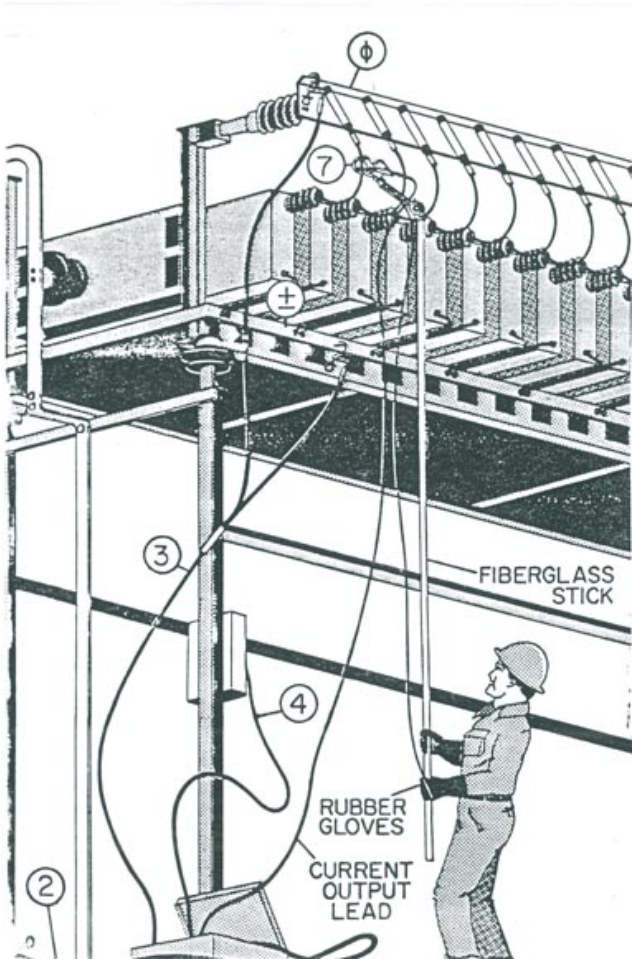
3. Attach the energizing leads to the Ø and ± bus of capacitors to be tested.

4. Check to make sure the Cap Check is **off** and the Variac is set to **zero**. Connect the AC source to the Cap Check.

5. Open the bank shorting switch.

6. Set the Test Voltage Selection Switch to the proper setting. Turn the Cap Check **on**. Set the voltage with the Variable Transformer per the Pass/Fail Limit Rating Chart.

7. Connect the live line clamp to the Cap Check and take measurements on each energized capacitor and compare with the range limits on the Pass/Fail Limit Rating Chart.



8. Repeat steps 3 – 7 for each set of group connected capacitors.

HD Electric Company will be happy to review questions presented regarding jumper arrangements and the load capacity of the Cap Check, but cannot assume responsibility for safe operation and the design of operating procedures.

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Cap Check II

PASS / FAIL LIMIT RATING

Nameplate Data			Test Current		Maximum Energized
V	KVAR	V Test	Min	Max	Bank Load, KVAR
2200	15	50	138	186	1050
2200	25	50	232	313	
2200	50	50	467	628	
2200	100	50	937	1260	
2200	150	50	1407	1891	
2200	300	50	2817	3785	
2200	600	50	5637	7572	
2400	15	50	115	157	1300
2400	25	50	194	263	
2400	50	50	392	528	
2400	100	50	787	1058	
2400	150	50	1182	1588	
2400	200	50	1577	2118	
2400	400	50	3157	4238	
2400	800	50	6316	8477	
2400	15	120	284	375	500
2400	25	120	475	625	
2400	50	120	953	1250	
2400	100	120	1909	2500	
2400	200	120	3820	5000	
4000	50	50	139	188	3600
4000	100	50	281	375	
4000	150	50	424	563	
4000	200	50	566	750	
4000	400	50	1135	1500	
4000	800	50	2272	3000	
4000	15	120	99	135	1500
4000	25	120	168	225	
4000	50	120	338	450	
4000	100	120	680	900	

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Nameplate Data			Test Current		Maximum Energized
V	KVAR	V Test	Min	Max	Bank Load, KVAR
4160	15	120	94	125	1600
4160	25	120	156	208	
4160	50	120	315	416	
4160	100	120	632	832	
4160	200	120	1267	1664	
4160	400	120	2538	3328	
4800	50	50	96	130	5200
4800	100	50	196	260	
4800	150	50	295	391	
4800	200	50	395	521	
4800	400	50	792	1042	
4800	800	50	1587	2083	
4800	15	120	69	94	2150
4800	25	120	116	156	
4800	50	120	236	313	
4800	100	120	474	625	
4800	200	120	951	1250	
4800	400	120	1905	2500	
6640	15	300	92	122	1650
6640	15	120	37	49	4150
6640	25	120	61	82	
6640	50	120	122	163	
6640	100	120	245	327	
6640	150	120	367	490	
6640	200	120	490	653	
6640	400	120	980	1306	
6640	800	120	1960	2613	
7200	15	300	76	104	1950
7200	25	120	52	69	4900
7200	50	120	104	139	
7200	100	120	208	278	
7200	150	120	313	417	
7200	200	120	417	556	
7200	300	120	625	833	
7200	600	120	1250	1667	
7200	1200	120	2500	3333	

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Nameplate Data			Test Current		Maximum Energized
V	KVAR	V Test	Min	Max	Bank Load, KVAR
7300	100	120	203	270	5050
7300	150	120	304	405	
7300	200	120	405	540	
7300	300	120	608	811	
7300	600	120	1216	1621	
7300	1200	120	2432	3243	
7620	15	300	70	93	2200
7620	25	300	116	155	
7620	50	120	93	124	5500
7620	100	120	186	248	
7620	150	120	279	372	
7620	200	120	372	496	
7620	300	120	558	744	
7620	600	120	1116	1488	
7620	1200	120	2232	2976	
7960	15	300	64	85	2400
7960	25	300	107	142	
7960	50	120	85	114	6000
7960	100	120	170	227	
7960	150	120	256	341	
7960	200	120	341	455	
7960	400	120	682	909	
7960	800	120	1364	1818	
8320	15	300	59	78	2600
8320	25	300	98	130	
8320	50	120	78	104	6550
8320	100	120	156	208	
8320	150	120	234	312	
8320	200	120	312	416	
8320	400	120	624	832	
8320	800	120	1248	1664	
9960	200	50	91	121	22550
9960	300	50	136	181	
9960	100	120	109	145	9400
9960	150	120	163	218	
9960	200	120	218	290	
9960	300	120	327	435	
9960	600	120	653	871	
9960	1200	120	1306	1742	

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Nameplate Data			Test Current		Maximum Energized
V	KVAR	V Test	Min	Max	Bank Load, KVAR
10300	100	120	102	136	10050
10300	150	120	153	204	
10300	200	120	204	271	
10300	400	120	407	543	
10300	800	120	814	1086	
10800	200	120	185	247	11050
13200	25	480	62	83	4100
13200	50	480	124	165	
13200	100	480	248	331	
13200	50	300	77	103	6600
13200	100	300	155	207	
13200	150	120	93	124	16500
13200	200	120	124	165	
13200	400	120	248	331	
13200	800	120	496	661	
13280	50	300	77	102	6650
13280	100	300	153	204	
13280	150	300	230	306	
13280	100	120	61	82	16700
13280	150	120	92	122	
13280	200	120	122	163	
13280	300	120	184	245	
13280	600	120	367	490	
13280	1200	120	735	980	
13800	25	480	57	76	4500
13800	50	480	113	151	
13800	50	300	71	95	7200
13800	100	300	142	189	
13800	100	120	57	76	18050
13800	150	120	85	113	
13800	200	120	113	151	
13800	400	120	227	302	
13800	800	120	454	605	
14400	25	480	52	69	4900
14400	50	480	104	139	
14400	100	480	208	278	
14400	50	300	65	87	7850
14400	100	300	130	174	
14400	100	120	52	69	19650

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Nameplate Data			Test Current		Maximum Energized
V	KVAR	V Test	Min	Max	Bank Load, KVAR
14400	150	120	78	104	
14400	200	120	104	139	
14400	300	120	156	208	
14400	600	120	313	417	
14400	1200	120	625	833	
15200	150	120	70	93	21900
16000	200	120	84	113	24250
17000	300	300	280	374	10950
19920	200	120	54	73	37600
19920	300	120	82	109	
19920	50	480	54	73	9400
19920	100	480	109	145	
19920	150	300	102	136	15000
19920	200	300	136	181	
19920	300	300	204	272	
21600	150	300	87	116	17650
21600	200	300	116	154	
21600	50	480	46	62	11050
21600	100	480	93	123	
21600	150	480	139	185	
21600	200	480	185	247	
22130	100	480	88	118	11600
22130	150	480	132	176	
22130	200	480	176	235	
22500	50	480	43	57	11950
22500	100	480	85	114	
22500	150	480	128	171	
22500	200	480	171	228	
25000	100	480	69	92	14800
25000	150	480	104	138	
25000	200	480	138	184	

Note: Maximum Energized Bank Load, KVAR refers to the capacitors which the Cap Check II can energize as a group. The operating manual includes information on load calculations for series-parallel connected banks.

When more than one test voltage is listed for a capacitor nameplate rating, select the highest value while considering the Cap Check bank capacity rating.

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LIMITATION OF WARRANTY AND LIABILITY

NOTICE: READ THIS LIMITATION OF WARRANTY AND LIABILITY BEFORE BUYING OR USING THIS PRODUCT. IF THE TERMS ARE NOT ACCEPTABLE, RETURN THE PRODUCT AT ONCE, AND THE PURCHASE PRICE WILL BE REFUNDED.

It is impossible to eliminate all risks associated with the use of this product. Risks of serious injury or death, including risks associated with electrocution, arcing and thermal burns, are inherent in work in and around energized electrical systems. Such risks arise from the wide variety of electrical systems and equipment to which this product may be applied, the manner of use or application, weather and environmental conditions or other unknown factors, all of which are beyond the control of HD Electric Company.

HD Electric Company does not agree to be an insurer of these risks. WHEN YOU BUY OR USE THIS PRODUCT, YOU AGREE TO ACCEPT THESE RISKS.

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