

CHAPTER : 4

TITLE : EMERGENCY SUPPLIES AND THE DC SYSTEM

LESSON : 1

TITLE : PURPOSE OF THE DC AND EMERGENCY AC SUPPLIES

OBJECTIVE : On successful completion of this lesson you will be able to:

(a) give a brief description of the design basis of the Duvha DC and emergency AC system

(b) explain briefly the purpose of each board mentioned in this lesson

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1. PURPOSE OF THE DC AND EMERGENCY AC SUPPLIES

1.1 Introduction

In the older stations, essential equipment was duplicated with a DC backup or DC only was used. With this system, diesel-driven DC generators were often provided. If all supply to a unit was lost, they would start up and maintain the DC load.

The Duvha system uses diesel-driven three-phase AC generators for the above purpose, and all essential auxiliaries are AC-driven from a special board which is known as the 380 V diesel generator board. The battery chargers are then fed from this board to maintain the DC supply, (which is essential for certain jobs).

1.2 Design basis

The DC and emergency AC power supplies at Duvha are designed to:

- (a) allow safe shut down of the plant if normal power supplies are lost
- (b) maintain communication, instrumentation and protection facilities for certain periods after loss of normal power supplies
- (c) provide emergency lighting where needed
- (d) keep plant in suitable states of readiness, where practicable, for rapid restart when normal power supplies are restored
- (e) prevent critical instrumentation from tripping plant for short breaks in normal power supplies

The attached sketches Fig. 59 and 60 show the various systems in single line form.

380 and 220 V AC emergency power is provided for general station loads and boiler/turbogenerator loads by diesel generators. This emergency power should become available 15 seconds after normal power supplies and standby supplies are lost. It is used for emergency lights and auxiliary plant which is essential for safe shut down of main plant units. Equipment powered from this source should be suitable for voltage deviation of + 10% - 15% and frequency limits of 47 to 53 Hz.

220 V single-phase AC power is supplied by static no-break systems for the unit computers, which cannot tolerate breaks or excessive dips or frequency fluctuations in the normal power supplies. This source has voltage limits of +2 per cent and frequency limits of 49,5 to 50,5 Hz under steady state conditions.

DC power is supplied for general station loads, boiler/turbogenerator loads, high-voltage yard loads, and outside plant loads at 220 V, 50 V and 24/48 V, by means of batteries with battery chargers powered from normal AC power supplies from the diesel generator board with the diesel generators as backup.

220 V DC power is used for protective relays, circuit breaker tripping, closing and spring rewinding devices, a limited amount of emergency lighting and valve actuators, trip coils, and oil pumps essential for safe shut down of main plant. Equipment powered from this source should be suitable for voltages from 187 V to 242 V.

50 V DC power is used for telephones, mimic and supervisory control, the station alarm system and equipment associated with the system control and load despatch installation.

32 V DC power is used for protective relays and circuit breaker tripping for 11 kV and 3,3 kV outside plant switchgear. The batteries and chargers for this duty are powered via a voltage selector relay from one of the two cable-connected voltage transformers on the incoming circuits.

24/48 V DC power (i.e. + 24 V with centre point earthed) is used for control and instrumentation equipment and alarm systems for the boiler/turbogenerator units and auxiliary plant. Equipment powered from these sources should accept voltages from 20,4 V to 26,5 V/40,8 V to 53 V. Ripple voltages on these supplies are limited to 4 per cent.

A separate self-contained 24 V battery with charger is provided for the NAMRAN communication installation.

In accordance with Operations Standard BS 3012, the batteries for power line carrier, teleme-try, telecontrol and telephone equipment are rated for a minimum of 8 hours, and the batteries for radio voice channel and supervisory equipment are rated for 24 hours. The batteries for protection, tripping and closing are rated for 4 hours, at the end of which an open-close-open sequence for half the solenoid valves and circuit breakers is possible.

1.3 Consolidation

Answer the following questions.

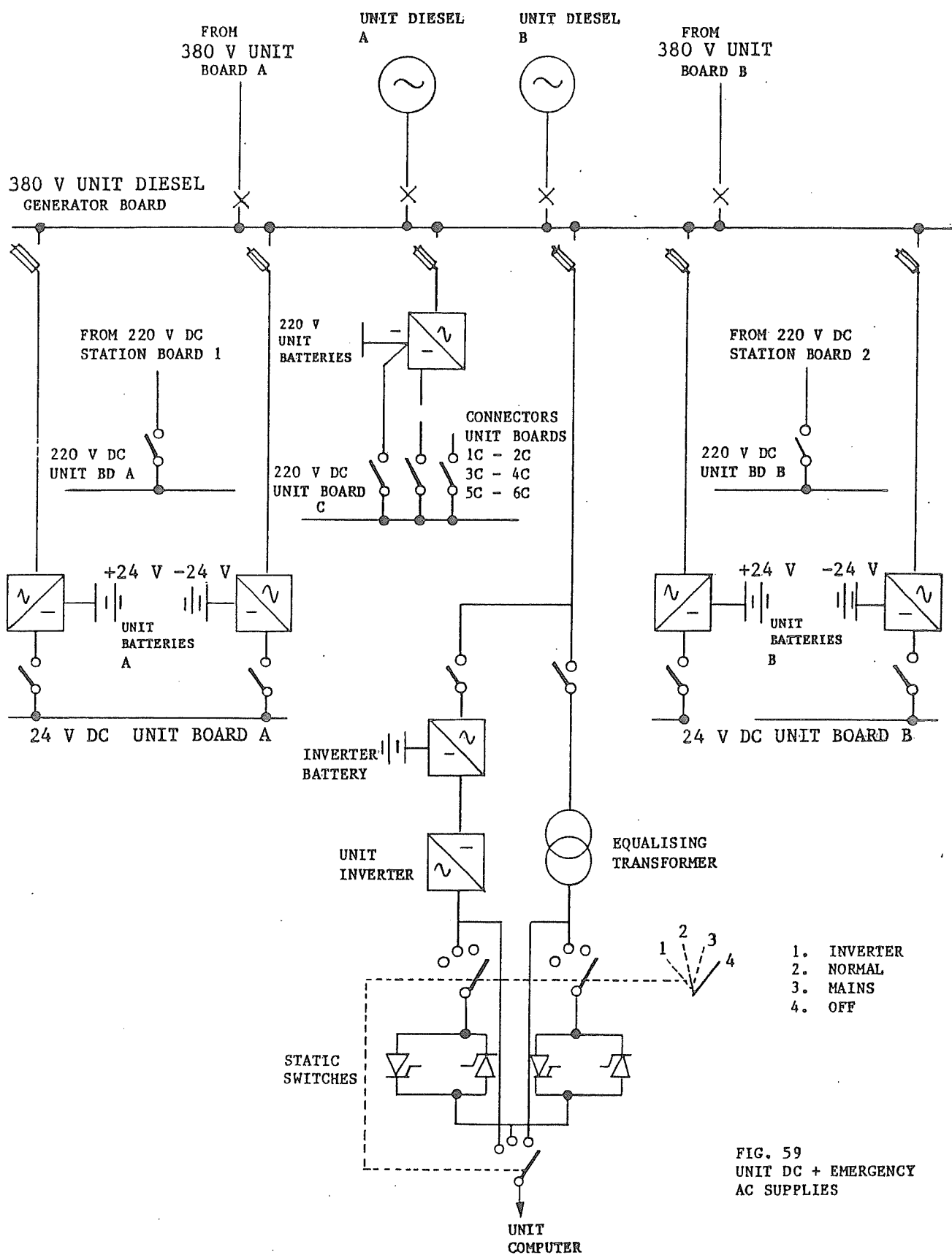


FIG. 59
UNIT DC + EMERGENCY
AC SUPPLIES

Fig. 59: Unit DC and emergency AC supplies

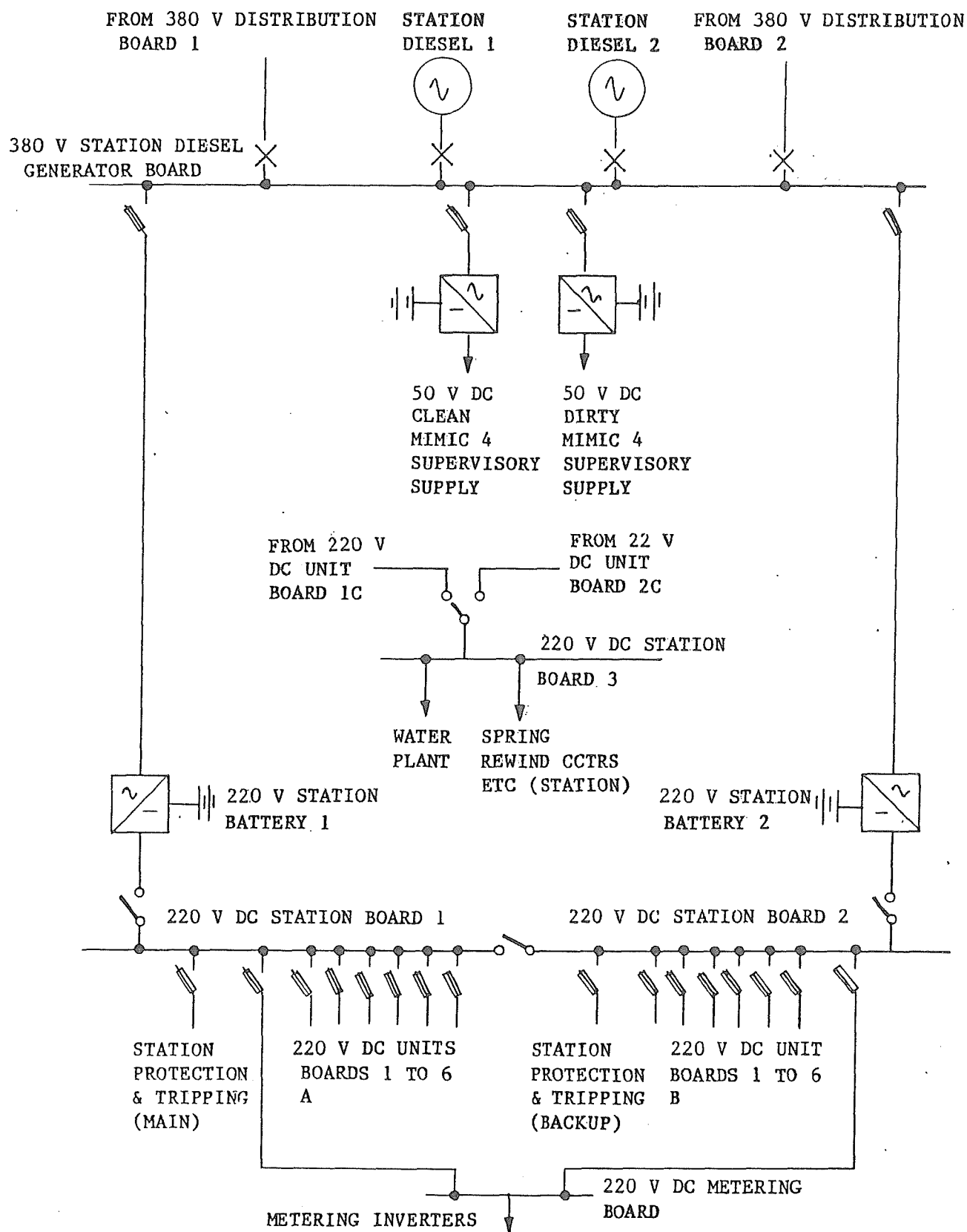


Fig. 60: Station DC and emergency AC supplies

CHAPTER : 4

TITLE : EMERGENCY SUPPLIES AND THE DC SYSTEM

LESSON : 2

TITLE : 380 V UNIT BOARD EMERGENCY AC POWER SUPPLY

OBJECTIVE : On successful completion of this lesson you will be able to:

(a) explain with the aid of a sketch the layout of the 380 V unit board system showing where the normal and standby supplies come from

(b) explain with the aid of a sketch which breakers are open, and which are closed for normal operating conditions

(c) explain how the chop-over supplies operate for all the conditions described in the lesson

(d) explain how the diesel generators are synchronised, and how they are shut down

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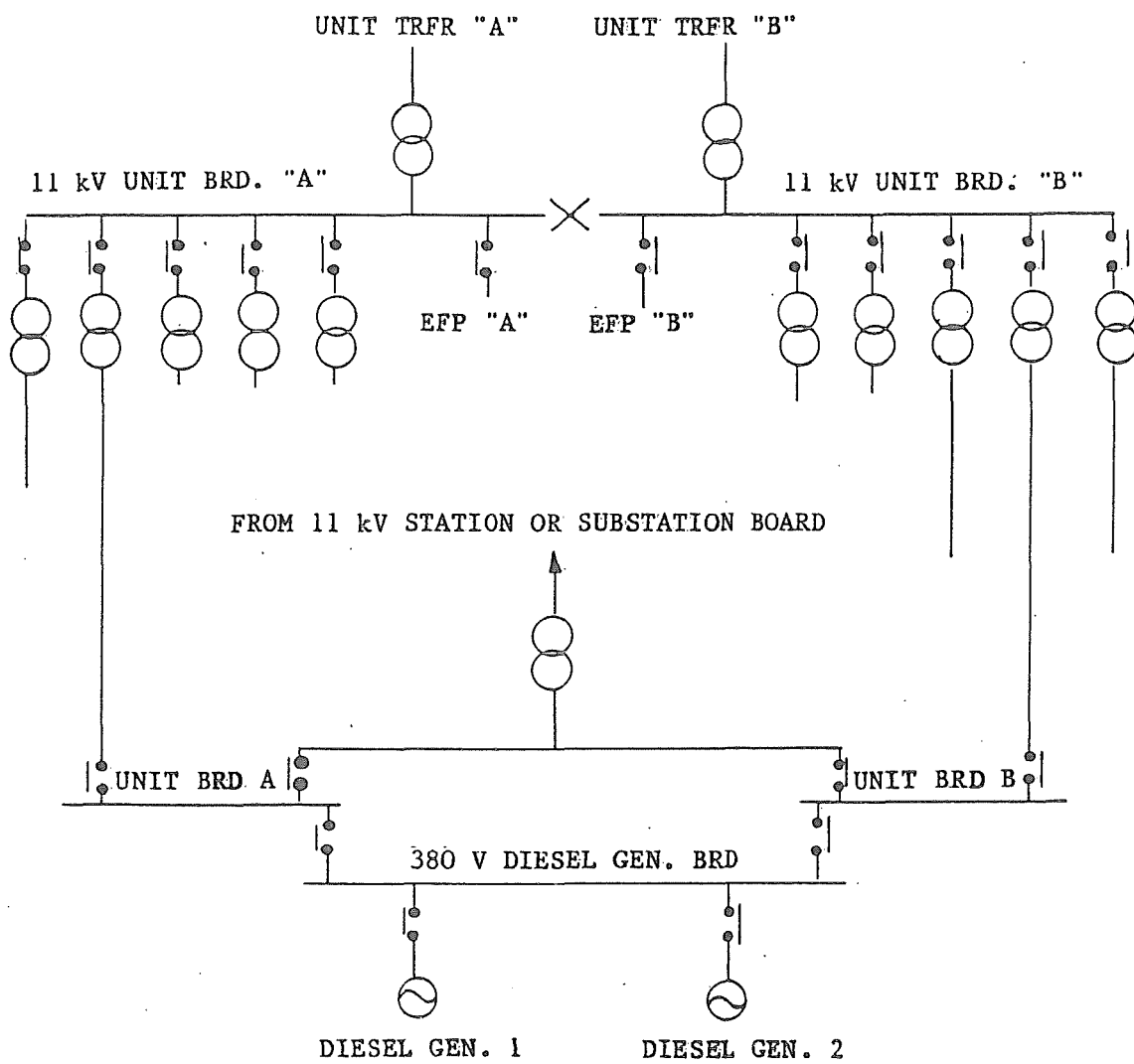


Fig. 61: Layout of 780 V unit boards

2. 380 V UNIT BOARD EMERGENCY AC POWER SUPPLY

2.1 Introduction

As mentioned in an earlier chapter, the system is designed such that in the event of a loss of normal electrical supplies to a unit, alternative supplies to essential equipment will be available to enable the unit to be shut down in a safe and orderly manner. This lesson will explain how this takes place.

2.2 System layout

The system consists of the following boards, each unit being similar (Fig. 61).

2.2.1 380 V unit board A

Normal supply to this board is taken from 11 kV unit board A. A standby supply is provided as follows:

(a) For units 1 - 3 the standby supply is taken from 11 kV station board 1.

(b) For units 4 - 6 the standby supply is taken from 11 kV substation west board.

2.2.2 380 V unit board B

Normal supply to this board is from 11 kV unit board B. The standby supply for this board comes from the same places as that of 380 V unit board A (Fig. 61).

NOTE: 380 V board A must be given preference to supply the 380 V unit diesel generator board. The system is designed such that 380 V unit board A automatically has preference to the standby supply.

2.2.3 380 V unit diesel generator board

Normal supply to this board is from 380 V unit board A. An alternative supply is from 380 V unit board B, which will automatically close if supply to 380 V unit board A is lost.

NOTE: When supply to 380 V unit board A is restored, no auto chop-over to this supply will occur. (Supplies must be normalised manually.)

Emergency supplies for the 380 V diesel generator board come from two diesel generators. Each diesel generator has an output of one megawatt.

2.3 Normal operating conditions (Fig. 62)

Under normal circumstances the following breakers are closed:

On 11 kV unit board A: breaker A

On 11 kV unit board B: breaker B

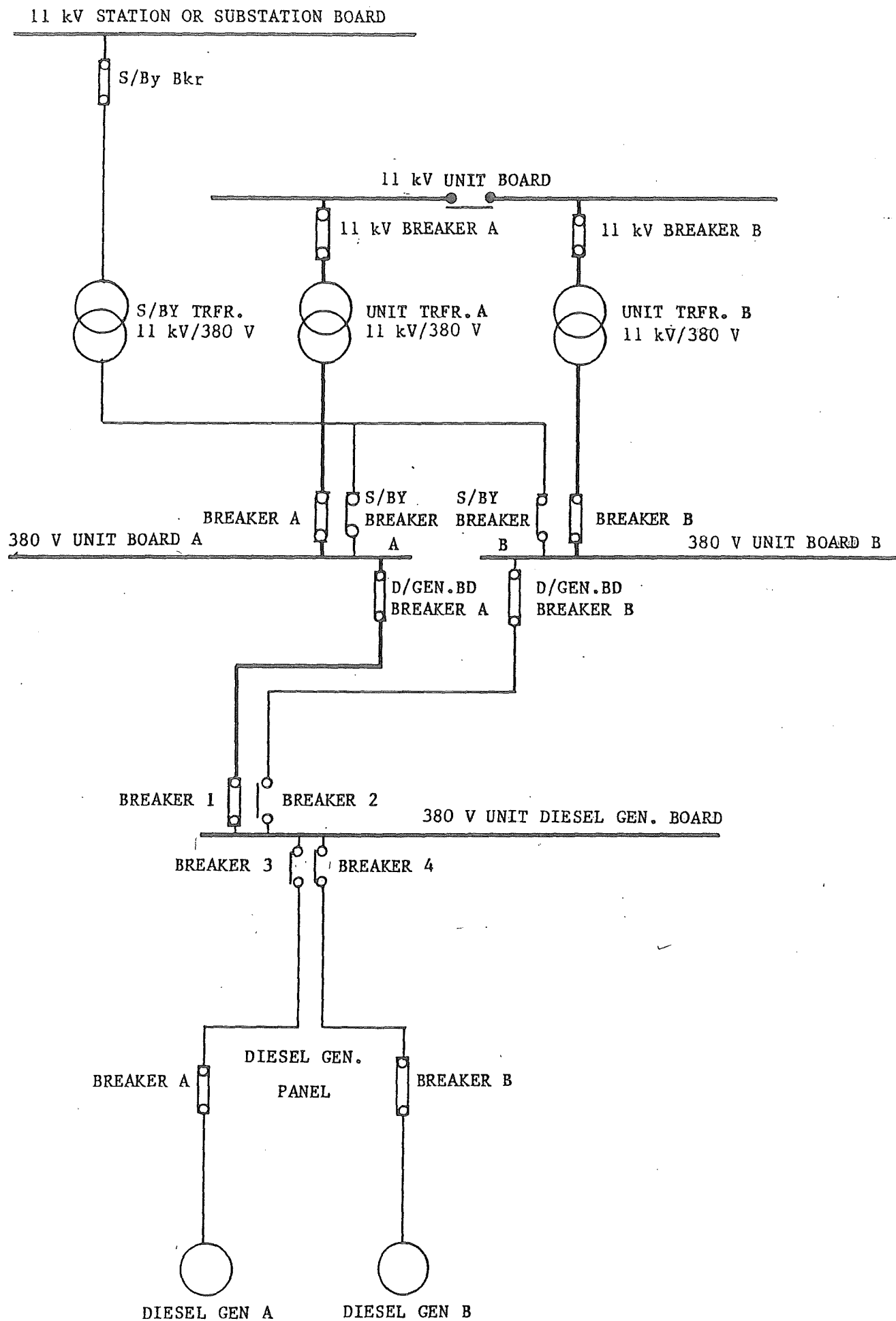


Fig. 62: Normal supplies

On 11 kV station substation west board: standby supply breaker

On 380 V unit board A: breaker A and diesel generator board breaker A

On 380 V unit board B: breaker B and diesel generator board breaker B

On 380 V diesel generator board: breaker 1

On 380 V diesel generator panel: breaker A and B

When diesel generator board breaker A on 380 V unit board A is closed first, breaker 1 on the 380 V diesel generator board will close automatically and lock out breakers 2, 3 and 4.

Similarly, if diesel generator board breaker B on 380 V unit board B is closed first, breaker 2 on the 380 V diesel generator board will close automatically and lock out breakers 1, 3 and 4.

Breakers 1, 2, 3 and 4 have a plus minus 5 second delay on tripping, except under fault conditions when tripping is instantaneous.

NOTE: 380 V unit board A must be given preference to supply the 380 V unit diesel generator board. The system is designed such that 380 V unit board A automatically has preference to the standby supply.

2.4 Operation of the unit 380 V chop-over system

NOTE: (a) For this system to function, all breakers as described under 'Normal operating conditions' must be racked in or in the test position.

(b) When any breaker needs racking in, it is advisable to pull the breaker test block out before racking the breaker in. The breakers obtain their operating voltage via auxiliary contacts on the breaker and it may be possible that a condition exists that will cause the breaker to close when the auxiliary contacts 'make' without the power contacts being fully 'home'.

2.4.1 Loss of supply to 380 V unit board A

When the supply to 380 V unit board A fails, breaker A trips automatically. The supply voltage is measured on the supply cable VTs. Standby breaker A closes automatically without any time delay (Fig. 63).

When normal supply to breaker A is restored, standby breaker A trips and the normal supply breaker A closes automatically without any time delay.

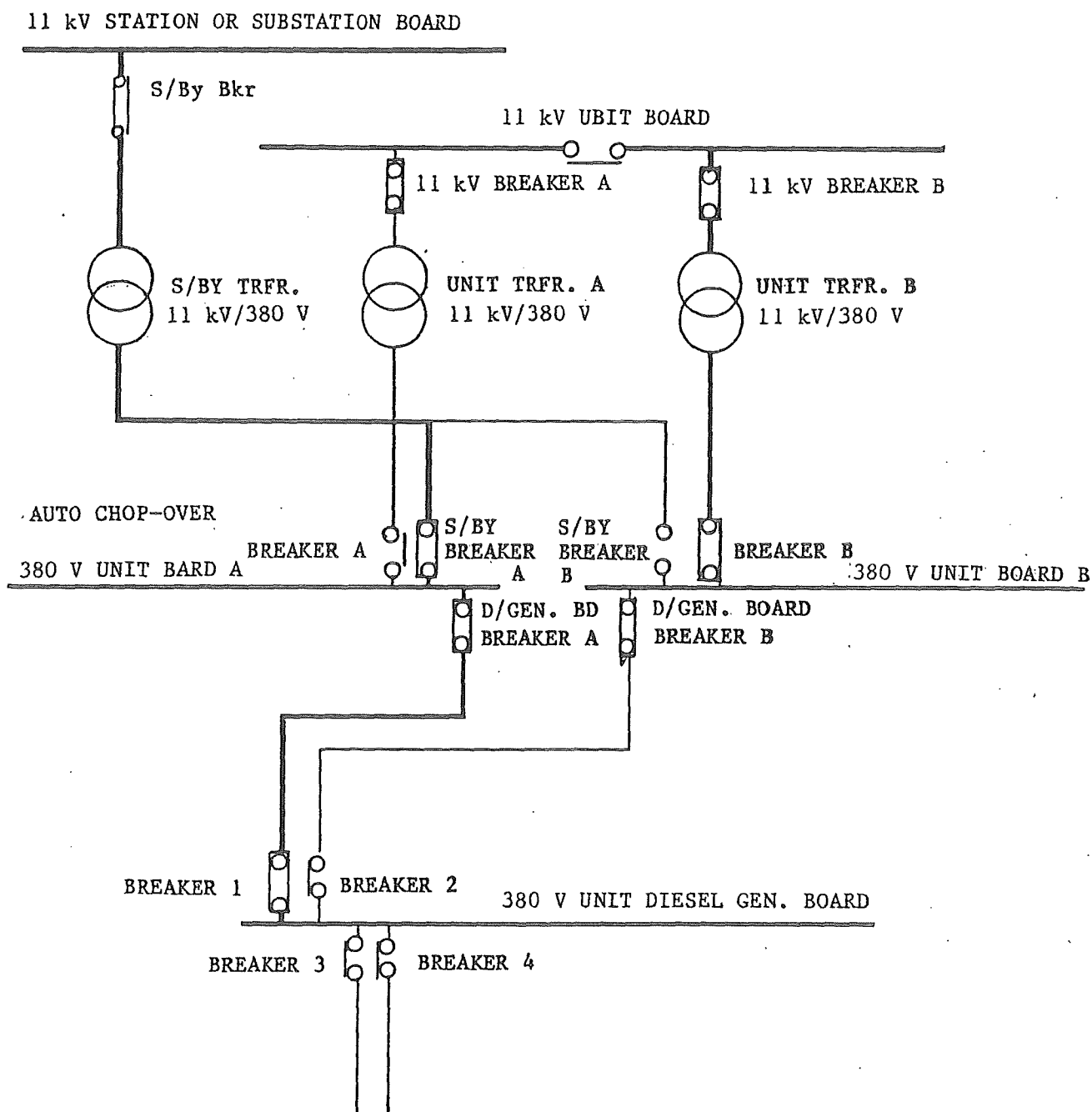


Fig. 63: Normal supplies to 380 V unit board A failed

2.4.2 Loss of supply to 380 V unit board B (Fig. 64)

When the supply to 380 V unit board B fails, breaker B trips automatically. The standby supply breaker B will automatically close after a time delay of 2 - 4 seconds. This is to ensure that standby breaker A has preference, should the supply to 380 V unit board A fail as well (refer to 2.4.3).

When normal supply to breaker B is restored, the standby breaker B will trip automatically and the normal supply breaker B will close without a time delay.

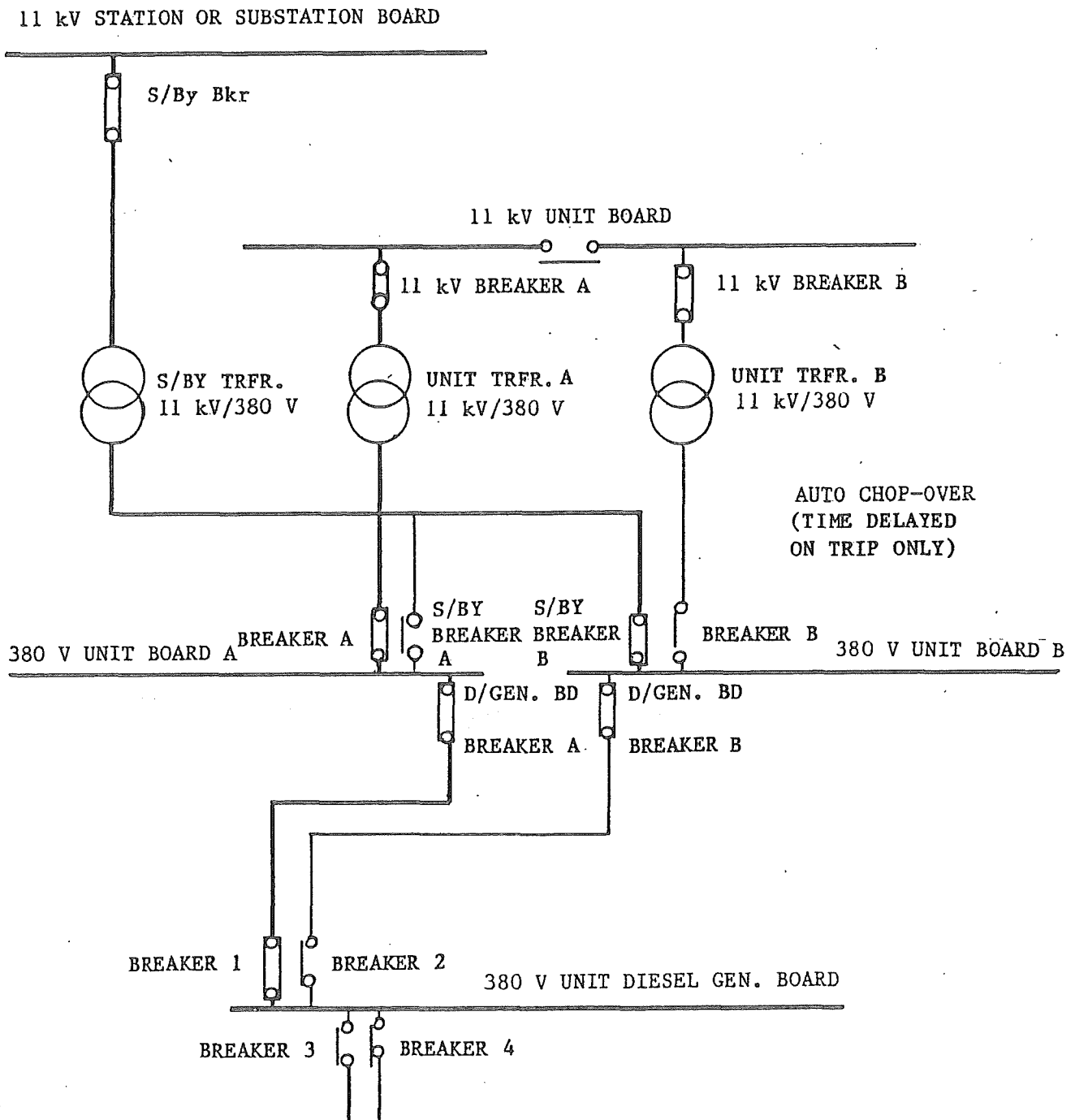


Fig. 64: Normal supplies to 380 V unit board B failed

2.4.3 Loss of supply to 380 V unit boards A and B

When supply to both 380 V unit boards A and B is lost, only the standby supply breaker on 380 V unit board A will close, the standby supply breaker on 380 V unit board B will not close (Fig. 65).

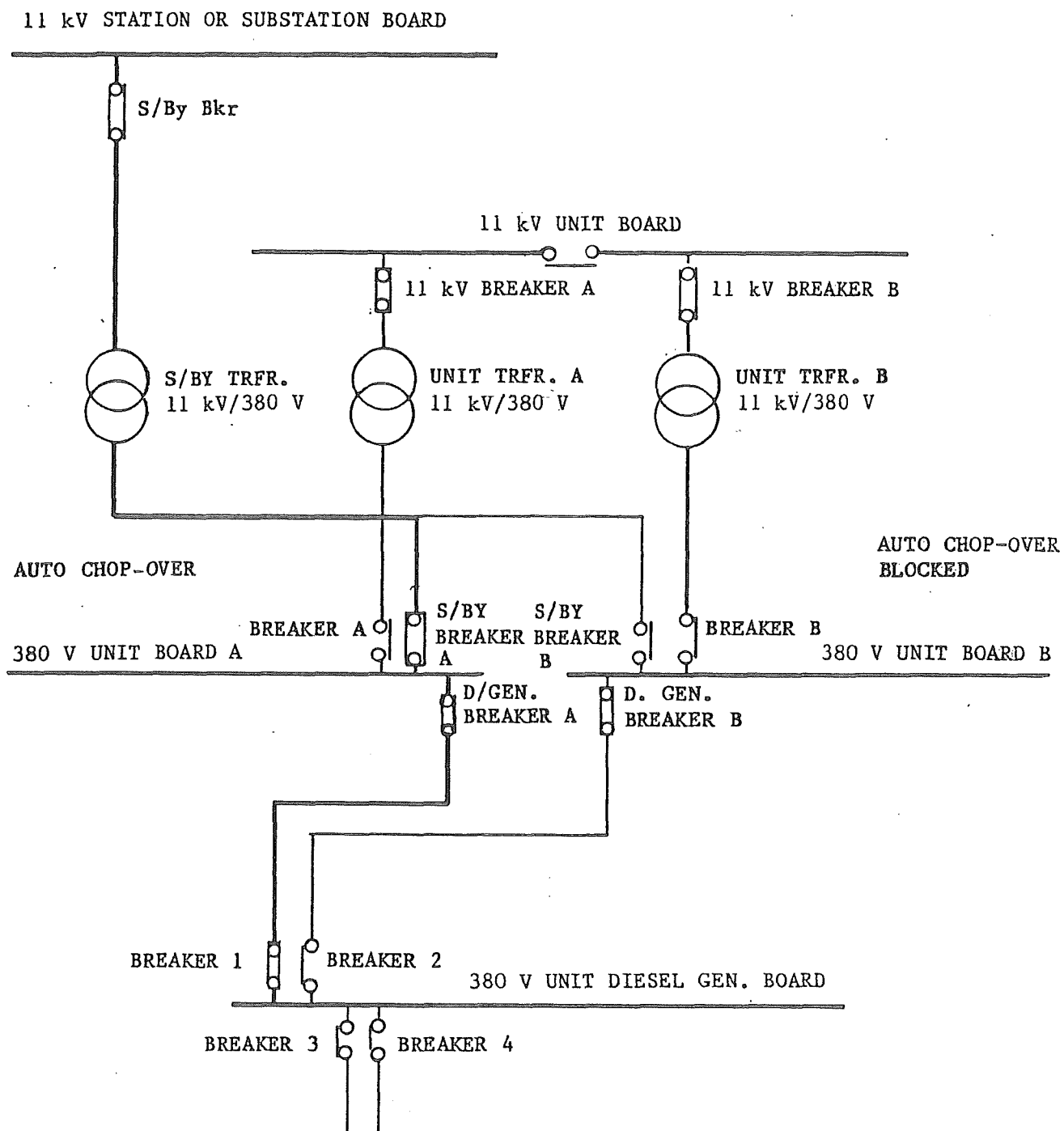


Fig. 65: Normal supplies to 380 V unit board A failed

2.4.4 Total loss of supply to 380 V unit board A

In the event of total loss of supply to 380 V unit board A (i.e. normal and standby supply), breaker 1 on the 380 V diesel generator board trips and breaker 2 on the 380 V diesel generator board will close without a time delay (Fig. 66).

When supply to 380 V unit board A is restored no 'auto chop-over' from breaker 2 to breaker 1 on the 380 V diesel generator board will occur. This may be done manually, but will result in temporary loss of supply to the unit auxiliaries. Preferably the supplies must be changed over as described under 'No-break chop-over'.

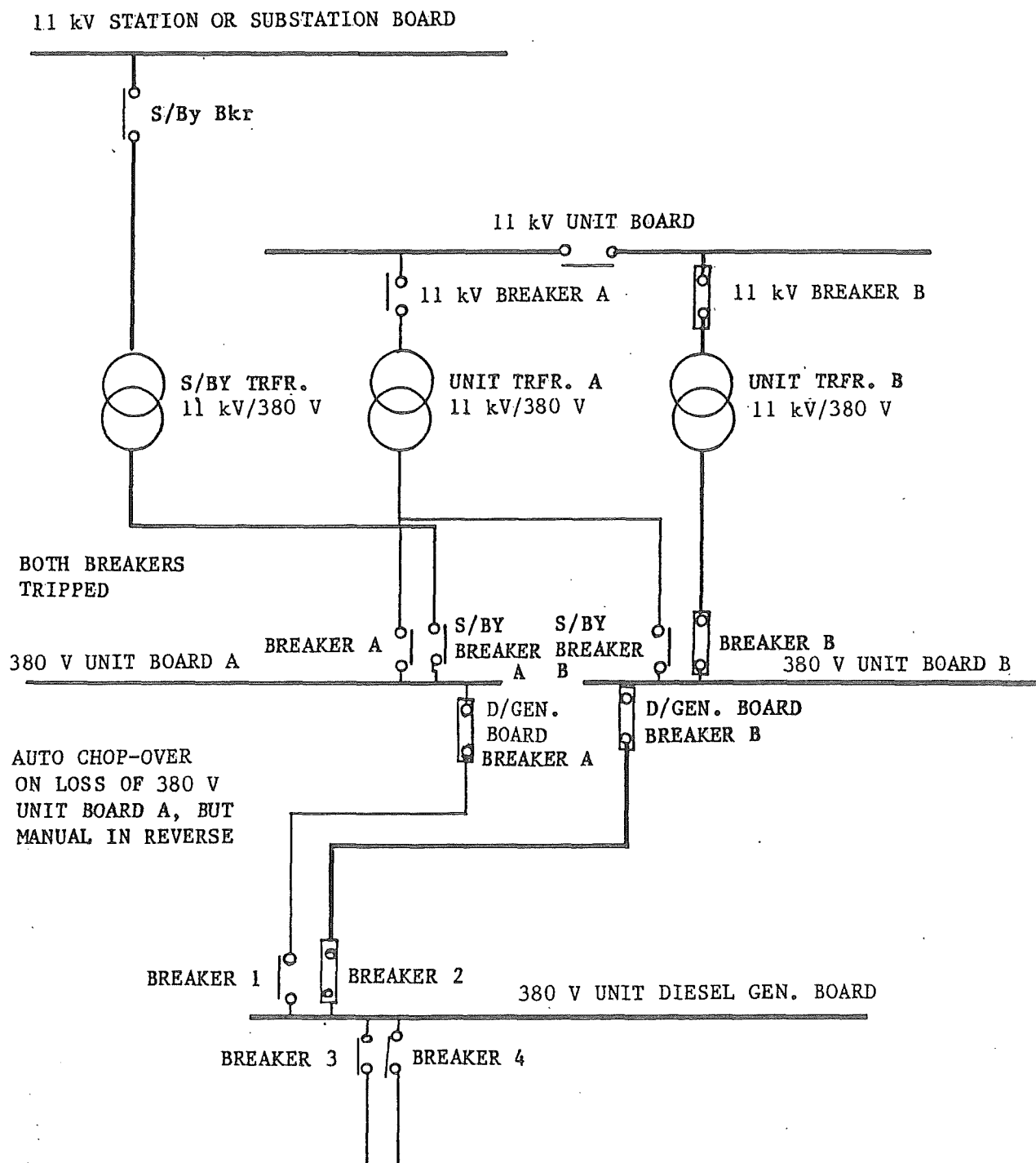


Fig. 66: Total loss of supply to 380 V unit board A

11 kV STATION OR SUBSTATION BOARD

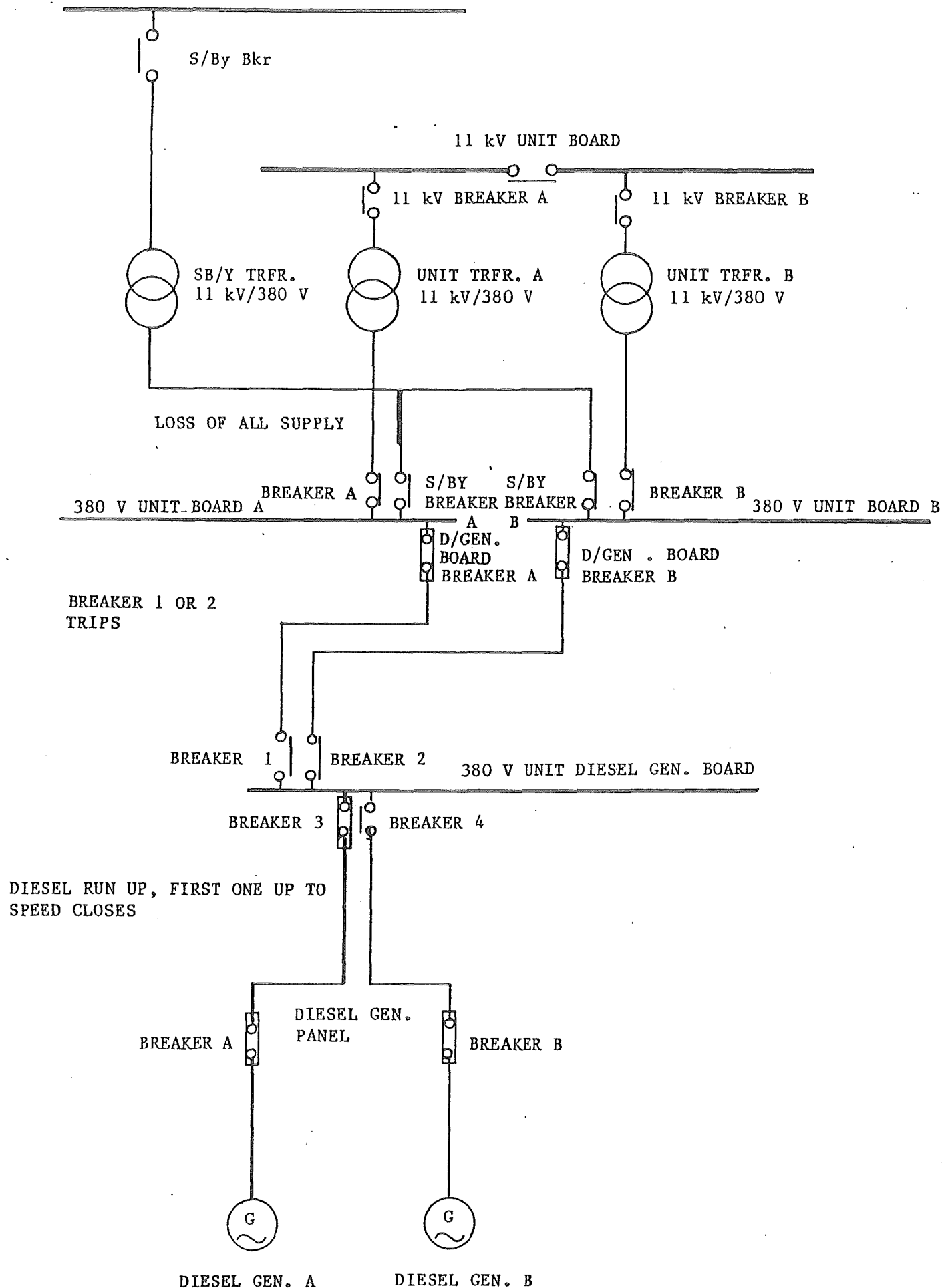


Fig. 67: Total loss of supply to 380 V unit boards A and B

2.4.5 Total loss of supply to 380 V unit boards A and B

When all supplies to 380 V unit boards A and B fail (i.e. standby and normal supply), breaker 1 or 2, whichever one happens to be closed at the time on 380 V diesel generator board will trip after plus minus 5 seconds. Both diesel generators (if standby) will start up. The first diesel generator that is up to speed will take the load. The other diesel generator will run for a preset time of plus minus 5 minutes and then shut down. The diesel generator board is now fed from the diesel generators (Fig. 67).

When normal supplies are reinstated, no auto chop-over will occur, and so to normalise supplies, you must synchronise the diesel generator with the supply from 380 V unit board A and then the diesel generator may be shut down.

Automatic starting of the diesels is initiated after a short time delay by undervoltage contacts which close for diesel generator board busbar voltage less than 80%. A contact in the local panel for each diesel closes when the associated generator is ready. The contact is wired to close the circuit breaker energising the board. The second diesel runs on for a time after the undervoltage contacts are reset, then shut down automatically remaining on standby.

The diesel start cycle consists of two continuous cranking attempts of 15 seconds each, with a 10 second break between attempts. The starter is locked out and an alarm raised if the second attempt is unsuccessful.

2.5 Semi-automatic synchronising of a diesel generator

When the 380 V diesel generator board is on normal supply and say diesel generator A has to be put on load (Fig. 68). (This may be required for test purpose.)

- (a) Start the diesel generator manually.
- (b) On the diesel generator synchronising panel, select the CB (circuit breaker) control to auto.
- (c) Select the synchro select switch to CB3.
- (d) Equalise the system and diesel generator voltages.
- (e) Adjust the engine speed so that the synchro disc rotates very slowly in a clockwise direction.
- (f) When the mark on the synchro disc is almost at the 12 o'clock position, press the synchronising switch and keep it depressed until CV closes. (An auto synchro mechanism is initiated which will close CB 3 when both supplies are in synchronism.)
- (g) By increasing on the engine speed switch, the generator will take all the load.
- (h) If required CB 1 on the diesel generator board can now be tripped and the diesel generator will continue to supply the load.

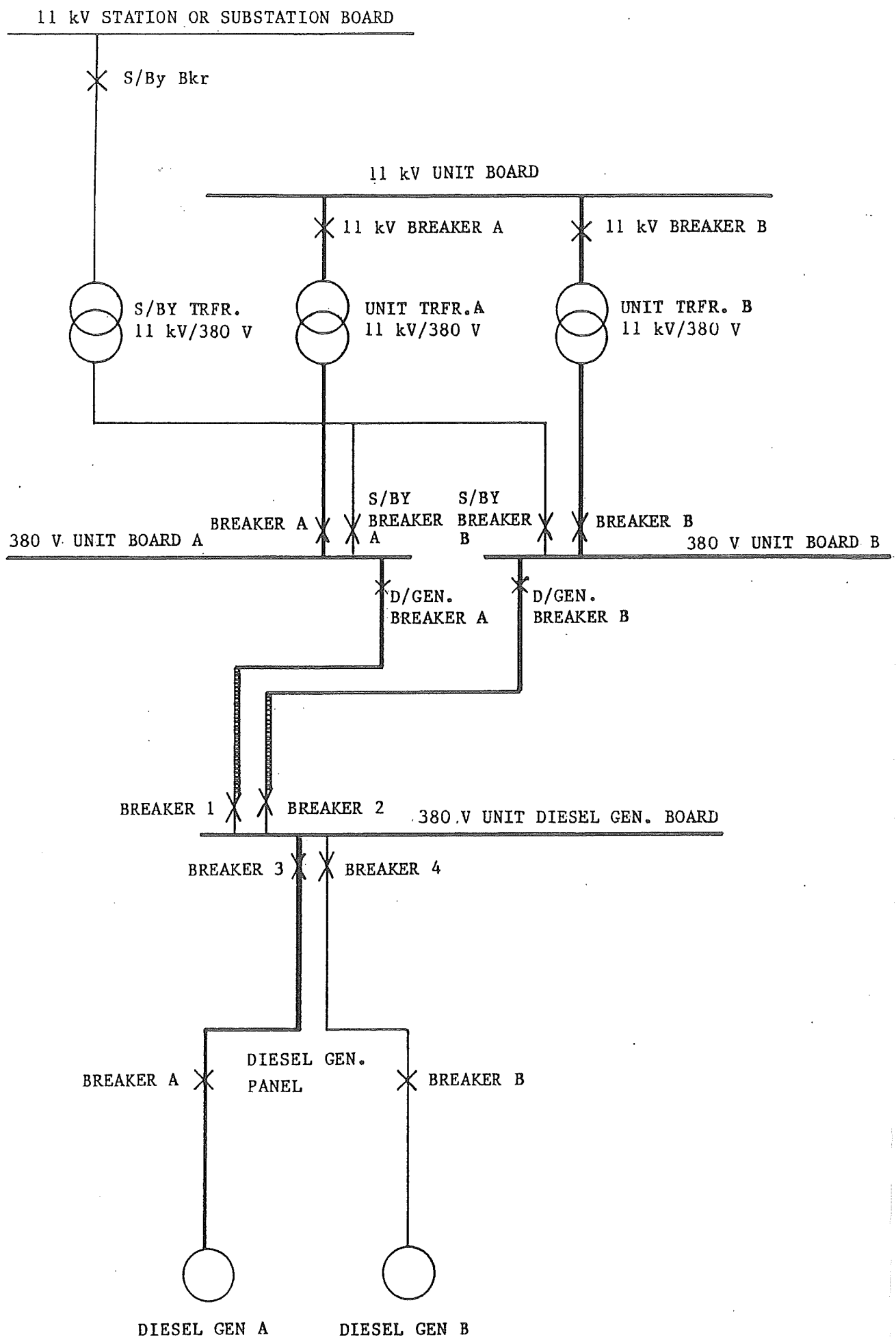


Fig. 68: Normal supplies on, but diesel generator supplying 380 V diesel board

2.6 Manual synchronising of a diesel generator

Synchronising a diesel generator onto the diesel generator board:

- (a) Any diesel generator can be started by selecting its selector switch to manual and pressing the start button.
- (b) Adjust the generator frequency to plus minus 50 cycles by altering the engine speed switch.
- (c) Equalise the system and generator voltages by adjusting the generator voltage switch.
- (d) Adjust the engine speed so that the synchro disc rotates very slowly in a clockwise direction.
- (e) When the mark on the disc is almost in the 12 o'clock position, close the appropriate breaker on the diesel generator board (i.e. breaker 3 or 4).

NOTE: This method should only be used under abnormal circumstances as it is possible to close the breaker out of synchronism due to the synchronising check relay being inoperative.

2.7 Shutting down a diesel generator

In all cases remove the load from the diesel generator by adjusting the engine speed selector switch.

2.7.1 Automatic shutdown

- (a) Put the running generator panel selector switch on auto.
- (b) Open CB3 or 4 by pushing its trip button.
- (c) This brings in a timer set at plus minus 5 minutes which will keep the diesel generator running for no-load cooling purpose.
- (d) The diesel generator will shut down automatically when the timer runs out.

2.7.2 Manual shutdown

The diesel generator can be stopped by pressing the 'stop' push-button.

An emergency 'stop' push-button is also fixed. This should, however, only be used when a real emergency exists as frequent use could damage the engine due to the rapid stopping.

2.8 No-break chop-over

- (a) Start up a standby diesel generator
- (b) Synchronise the diesel generator with the supply from 380 V unit board B.

This is done on the diesel generator panel by closing breaker 3 or 4 depending on which diesel generator is running (see 'synchronising a diesel generator').

(c) Trip breaker 2 on the diesel generator board.

(d) Synchronise the diesel generator with the supply from 380 V unit board A (i.e. close breaker 1 on the 380 V unit diesel generator board).

(e) Shut down the diesel generator.

NOTE: (i) Breakers A and B on the diesel generator panel are only used for isolating the diesel generators from the 380 V diesel generator board and for protection purpose.

(ii) Both diesel generators can be synchronised to the 380 V diesel generator board and run in parallel.

(iii) All circuit breakers on the 380 V diesel generator board must either be in the 'racked in' or 'test' position for the chop-over system to function.

(iv) When racking in a breaker, the danger exists that it can close automatically before it is fully racked in. A safety measure is to pull the test block out and only replace it when the breaker is fully racked in.

(v) If for any reason the supplies to the diesel generator panel are switched off, the chopover on the 380 V diesel generator board will not function.

2.9 Consolidation

- Answer the following questions.
- Ask your trainer to show you the boards mentioned as well as the diesels.
- As soon as the opportunity arises you should witness the synchronising and shut down of a diesel generator.