There are many other considerations to be made when selecting a circuit breaker for the installation but most of those consider the circuit breaker independently of the manufacturer. Sometimes the features and circuit protection capability and a high degree of adjustability. Sometimes the features and current limiting circuit breakers (Short circuit protection) are not tolerated due to the high costs involved. The challenge for the designer is to ensure the SCPDs of a system work together to ensure system safety and minimize the occurrence of fault conditions as well as integrating with existing devices.

Selection study example

Current selectivity makes use of the let through peak current graphs. This method is still in use and is only applicable when the fault levels are low and the devices are not too close together. It utilizes the let through energy curves. This method makes use of the let through peak current graphs. This method can be helpful when selectivity data of circuit breakers in series is not available from the manufacturer. Energy selectivity is achieved when the total clearing energy of the circuit breaker and how it is selected. The fundamental purpose of the Short Circuit Protection Device (SCPDS) is to protect the cables and its operators and users from damage. It also has

When designing the electrical system a consideration is that the designer needs to take into consideration commercial and aesthetic issues. The focus of this Technical Newsletter is to provide practical information related to overload and short circuit protection. In the early days, fuses and electromagnetic induction relays provided some protection. Advancements in technology have produced circuit breakers today with precise circuit protection capability and a high degree of adjustability. Sometimes the features and current limiting circuit breakers (Short circuit protection) are not tolerated due to the high costs involved. The challenge for the designer is to ensure the SCPDs of a system work together to ensure system safety and minimize the occurrence of fault conditions as well as integrating with existing devices.

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The other methodology is **selectivity** which was previously called discrimination. Selectivity is in which the device closest to the fault and only that device trips to safely clear the fault. There are different types of selectivity as follows (refer to fig 2).

**Full or Total Selectivity**: Downstream device only trips up to its short circuit rating. Therefore, the downstream device so its fault rating is equal to or larger than the prospective fault current at that point in the installation.

**Example 1**: Upstream circuit breaker: 630 A, 50 kA (p/n: S630CE) Prospective fault current at downstream circuit breaker: 36 kA

If a fault of 36 kA occurs downstream of the S630CE it only will trip and the upstream device will stay closed. For a fault between 10 kA and the maximum prospective fault current at the switchboard, in which case, tripping the incomer will possibly limit damage to another device or the downstream device.

**Partial Selectivity**: Downstream device only trips down to its short circuit rating or less than its short circuit rating. This occurs when similar surge arresters are used in series because the upstream device will operate in a similar amount of time as the downstream device.

**Example 2**: Upstream circuit breaker: 630 A, 50 kA (p/n: S630CE) Prospective fault current at downstream circuit breaker: 400 A, 36 kA (p/n: S400CJ)

If a fault of 10 kA occurs in the S400CJ it only will trip and the upstream device will stay closed. For a fault between 10 kA and the maximum prospective fault current it will trip. As the breaker's characteristic curves overlap it can trip should the prospective fault current be 10 kA. If a fault of 36 kA occurs downstream of the S400CJ it only will trip and the upstream device will stay closed.

**Enhanced Selectivity**: Downstream device only trips at a short circuit rating in case of its short circuit rating is the difference in the assistance of the upstream MCCB. This is often the case in MCCB/MCB combinations.

**Example 3**: Upstream circuit breaker: 160 A, 36 A (p/n: S160NJ) Prospective fault current at downstream circuit breaker: 36 kA

If a fault of 36 kA occurs downstream of the DTB20C90 only it will trip and the upstream device will stay closed.

**Zone Selectivity**: Downstream device only trips based on communication signals between the circuit breakers.

Most manufacturers produce selectivity tables based on tested selectivity combinations. NHP's selectivity data (refer extract image, below) is available in the NHP Part C catalogue and for more information via NHP's Analysis Software. To assist in a selectivity analysis, manufacturers provide customers with software. NHP’s TemCurve 6 is arguably the most user friendly package available. The user needs only to follow three steps to conduct the study. This software is available as add-on to TemCurve 6 or is available upon request. TemCurve 6 enables you to select the devices and select breakers accordingly. No time selectivity current is easily conducted with setting changes made on the device. The device data settings in the TemCurve 6 are also available in tested combinations. TemCurve 6 provides sign-off sheets for this purpose.

There are several parts to the time current curve. For a thermal magnetic circuit breaker there are two parts, viz:- thermal and magnetic. Electronic circuit breakers there are three parts, viz:- long time delay (LTD), short time delay (STD) and instantaneous (Inst). Refer to the time current curves overleaf. The thermal, magnetic, long time delay, short time delay and instantaneous are the areas under consideration for time current selectivity. This is sometimes referred to as a grading study and the aim is to ensure that the curves do not overlap.

For the ≤ 30 ms magnetic/instantaneous parts of the curve, it is necessary to refer to the manufacturer's selectivity curves to determine the selectivity status under large fault conditions. If a circuit breaker's time current curve is shown in radially it is not uncommon to see series breakers overlap in the long time delay (LTD) area. This is not a true reflection of the circuit breaker's performance in the end only disregards the user. One-hopping time current curves that is ≤ 30 ms does not mean that there is no selectivity. For the example overleaf, between the upstream device 630 A breaker and downstream 36 kA breaker test results confirm that there is selectivity to 36 kA up to 50 kA.

For the combination of all three circuit breakers in this example, time current selectivity is confirmed because the current curves do not overlap in the region t > 30 ms. For the region t ≤ 30 ms, the selectivity table data is presented and confirms that selectivity is achieved in the circuit breaker by the inclusion of these characteristic curves, right. These add a degree of subjectivity as a breaker's performance is in external conditions. For future fault conditions (refer characteristic curves, right).
One of the first SCPD selection considerations is the device's fault rating (see left). With the increased electrical demand, supply transformer/generator sizes and circuitry have been incrementally increased to meet the demand. Consequently, the nominated fault level of a switchboard is often larger than the nominal fault current of the equipment. For future supply increases, the fault levels often result in significantly oversized protection devices (Technical Weekly 7 discusses fault level calculations). Therefore, the various types of selectivity as follows (by 25 kA):

- Full or Total Selectivity: Downstream devices only trips up to its short circuit rating. Therefore, the downstream device so that its fault rating is equal to or larger than the prospective fault current at that point in the installation.
  
  Example 1:
  - Upstream circuit breaker: 630 A, 50 kA (p/n: 5636CE)
  - Prospective fault current at downstream circuit breaker: 36 kA
  - If a fault of 36 kA occurs downstream of the 5636CE only, it will trip and the upstream device will stay closed.

- Partial Selectivity: Downstream device only trips, at a short circuit rating less than its full rating. This occurs when several similar circuit breakers are used in series because the upstream device will operate in a similar amount of time as the downstream device.
  
  Example 2:
  - Upstream circuit breaker: 630 A, 50 kA (p/n: 5636CE)
  - Prospective fault current at downstream circuit breaker: 400 A, 3 A (p/n: 6400CE)
  - If a fault of 10 kA occurs downstream of the 5636CE only it will trip and the upstream device will stay closed.

- Enhanced Selectivity: Downstream device only trips, at a short circuit rating in excess of its short circuit rating. The device is chosen so that its fault rating is equal to or larger than the prospective fault current at that point in the installation.
  
  Example 3:
  - Upstream circuit breaker: 160 A, 6 kA (p/n: 5616UJ)
  - Prospective fault current at downstream circuit breaker: 36 kA
  - If a fault of 36 kA occurs downstream of the 5616UJ only, it will trip and the upstream device will stay closed.

- Zone Selectivity: Downstream device only trips based on communication signals between the circuit breakers.

The other methodology is SELECTIVITY which was previously called discrimination. Selectivity is where the breaker is closed to the fault and only that device trips to safely clear the fault. There are three types of selectivity as follows (by 25 kA):

- Cascading today makes use of a development that is applicable to most moulded case circuit breakers. Historically, a device in series will stay closed if the upstream device at which the fault has occurred trips while it assists the downstream device only trips, at a short circuit rating in excess of its short circuit rating. The device is chosen so that its fault rating is equal to or larger than the prospective fault current at that point in the installation.

- Illustrating ‘old style’ back-up protection is where the protective device immediately upstream of the device at which the fault has occurred trips while it assists the downstream device to safely clear the fault. The result is that both devices trip. The downstream device has a lower fault rating than the prospective fault current. The disadvantage with this method is that power to all other feeds from the upstream circuit breaker to the switchboard.

- There are several parts to the time current curve. For a thermal magnetic circuit breaker there are two parts, viz. thermal and magnetic. For electronic circuit breakers there are three parts, viz. long time delay (LT), short time delay (STD) and instantaneous (I). Refer to the time current curve overview.

- The standard gives information on the device's performance and in the end only enables the user to make the best choice. One key factor in current curve tests is that the time current curve is a graphical representation of how quickly the breaker will trip under fault conditions. For the region t > 30 ms, the selectivity table data is presented and results confirm that there is selectivity to 36 kA and cascading to 50 kA.
One of the first SCPD selection considerations is the device’s fault rating (see left).

With the increased electrical demand, supply transformer/generator sizes and circuits have increased in capacity, which means higher instantaneous fault current. Interestingly, the nominated fault level of a switchboard is often lower than the system’s available fault current. The various types of selectivity as follows (see Fig. 2).

Full or Total Selectivity: Downstream device only trips up to its short circuit rating. Therefore, the downstream device is interrogated so its fault rating is equal to or larger than the prospective fault current at that point in the installation.

Example 1:

Upstream circuit breaker: 630 A, 50 kA (p/n: 5636CE)
Prospective fault current at downstream circuit breaker: 36 kA

If a fault of 36 kA occurs downstream of the 5636CE only it will trip and the upstream device will stay closed. For a fault between 10 kA and the maximum prospective fault current at that point in the installation.

Example 2:

Upstream circuit breaker: 630 A, 50 kA (p/n: 5636CE)
Prospective fault current at downstream circuit breaker: 400 A, 5 kA (p/n: 540DO)

If a fault of 5 kA occurs downstream of the 540DO only it will trip and the upstream device will stay closed. For a fault between 10 kA and the maximum prospective fault current at that point in the installation.

Enhanced Selectivity: Downstream device only trips up to a short circuit rating in series of its immediate upstream device. This is the case in MCCB/NCB combinations.

Example 3:

Upstream circuit breaker: 160 A, 6 kA (p/n: 516UJ)
Prospective fault current at downstream circuit breaker: 35 kA

If a fault of 35 kA occurs downstream of the DT5820JD only it will trip and the upstream device will stay closed.

Zone Selectivity: Downstream device only trips based on communication signals across the circuit.
Selectivity study example

Current selectivity makes use of the let through peak current graphs. This method is distinctly used and is only applicable when the fault levels are low and the able current of the circuit breaker is high. The let through current of the circuit breaker is compared to the let through current of the preceding device. The horizontal axis is RMS current. It should also be noted that large short circuits are generally not practical because they have a large DC component due to the resistance of the cable. Hence, the normal peak to RMS conversion does not apply. Accordingly, AS3439 introduces the notion of maximum fault current to avoid this. In this, current selectivity is achieved when the let through peak current of the downstream device is less than 2 times the instantaneous setting of the upstream device.

Energy selectivity compares the let through energy curves. This method of selectivity applies primarily to fuses as they have clearly defined pre-arcing and total clearing characteristics. Energy selectivity is achieved when the total clearing energy of the circuit breaker and how the circuit protection capability and a high degree of adjustability. Sometimes the features and functionality of today’s devices such as communication and power monitoring overshadow the basic fundamental which needs to be considered. This article concentrates on the core function of the circuit breaker and how it is selected.

When designing the electrical network system for a commercial building the designer needs to take into consideration recent electrical trends. The focus of this Technical Newsletter is to introduce the selection of circuit breakers for overload and short circuit protection. In the early days, fuses and electromechanical induction relays provided such protection. Advancements in technology have produced current circuit breakers today with precise circuit protection capability and a high degree of adjustability.
Selectivity study example

Current selectivity makes use of the let through peak current graphs. This method is seldom used and is only applicable when the fault levels are low and the cable runs long. It is important to highlight that the vertical scale is PEAK current and the horizontal scale is RMS current. It should also be noted that large short circuits are generally more critical than they have a large DC component due to the resistance of the cable. Hence, the normal peak to RMS conversion does not apply.

Selectivity applies primarily to fuses as they have clearly defined pre-arcing and total clearing characteristics. Energy selectivity is achieved when the total clearing energy of the downstream device is less than the upstream device. Accordingly, AS3439 introduces the n factor to make allowance for this. In short, selectivity data of circuit breakers in series is not available from SCPDs. Selectivity and cascading however deals with the normal occurrence of circuit breakers in series and their corresponding performance. Software tools such as TemCurve 6 make the designer's job much easier and NHP is here to assist.

When designing the electrical network system for a commercial building, the designer needs to take into consideration many different aspects. The focus of this Technical Newsletter is the selection of circuit breakers for overload and short circuit protection. In the early days, fuses and electromechanical induction relays provided such protection. Advancements in technology have produced circuit breakers today with precise circuit protection capability and a high degree of adjustability. Sometimes the features and functionality of today’s devices such as communication and power monitoring overshadow the basic fundamental aspects which need to be considered. This article concentrates on the core function of the circuit breaker and how it is selected.

The fundamental purpose of the Short Circuit Protective Device (SCPĐ) is to protect the cables (and consequently, the entire installation, its operation and users) from damage. We also live in an era where reliance on technology is not tolerated due to the high cost of downtime. The challenge for the designer is to ensure the SCPĐs of a system work together to ensure system safety and minimise unexpected interruptions under fault conditions as well as integrating with existing devices.