

NRS 048-9:2019

Edition 2

**ELECTRICITY SUPPLY —
QUALITY OF SUPPLY**

**PART 9: CODE OF PRACTICE –
LOAD REDUCTION PRACTICES,
SYSTEM RESTORATION PRACTICES
AND CRITICAL LOAD AND ESSENTIAL
LOAD REQUIREMENTS UNDER POWER
SYSTEM EMERGENCIES**

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Foreword

Emergency load reduction is a measure implemented by the System Operator and distribution control rooms in order to prevent a national, regional or local blackout when system conditions are such that demand cannot be met by the available power system capacity, or when adequate reserves required to manage the power system security cannot be maintained without a reduction in load. Emergency load reduction in this context refers to mandatory measures required over-and-above contracted load reduction (demand response), energy conservation schemes, and demand side management measures as may be in place at the time.

NOTE The *power system* includes generation, transmission and distribution infrastructure.

Emergency load reduction may take the form of *load shedding* (time-based interruption of supply to customers on a rotational basis), *mandatory load curtailment* (self-reduction by customers in response to an instruction given by the system operator), *load limiting* (a limit placed on the current or power consumed by a customer, typically enabled by smart meter technology), or customer *load switching* (remote switching of customer circuits to specific appliances, typically enabled by smart meter technology or ripple control technology).

Load shedding differs from a blackout in that load shedding is a controlled intervention affecting a limited number of customers at a time, whilst a blackout happens without warning in an uncontrolled manner and can affect many (if not all) customers simultaneously for an unpredictable period of time.

NOTE The media may at times refer to load shedding as “rolling blackouts”. The term load shedding is an internationally accepted engineering terminology for controlled load reduction by interrupting supply to customers on a rotational basis.

Restoration of supply to all customers after a significant system incident or blackout could take days to weeks. Whilst the order in which supply is restored to individual customers is often dictated by the nature of the incident, the ability to restore supply to essential loads as quickly as possible should form part of the restoration regime. This requires that essential load requirements are provided by customers to power system operators.

This part of NRS 048 was developed to address the need for a *national code of practice* for real-time emergency load reduction and restoration of supply after a major system incident. The code addresses not only the power system requirement (the load reduction required) but how this is done and communicated so as to have the least negative impact on critical infrastructure. This need for such a code arose subsequent to national load shedding undertaken in South Africa in 2008. Requirements for extreme power system constraints and blackout restoration have also been included in the form of essential load requirements.

This second edition of the code replaces the first edition published in 2010. Several changes and enhancements have been included in this edition, based on:

- a) experience in implementing the requirements of the first edition;
- b) execution of emergency load reduction since November 2013 (when it was required for the first time since 2008);
- c) feedback from licensees and customers;
- d) engagement with NERSA and the Grid Code Advisory Committee on various clarifications regarding the application of the code; and
- e) engagements with the Government War Room.

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The changes and enhancements included in this second edition are:

- a) revision of the forward and introduction to better address the *context* of load reduction and system restoration requirements;
- b) the inclusion of emergency load reduction scenarios in the introduction of this document to facilitate a better understanding of the context when available options for emergency load reduction are selected;
- c) clarification and expansion of the principles on which the code is based (in order to facilitate pragmatic decision-making by the System Operator to reduce the impact on customers and the economy). In particular, an increased pragmatism in application of the requirements of this document and a review of the concept of equitable participation;
- d) clarification of the definition of *a system emergency* given the requirement of the system operator to ensure adequate reserves during a system emergency, and to prudently manage reserves over various operating periods;
- e) clarification on the protocols for declaring a system emergency (inclusion of the definitions of a System Early Warning and System Alert condition);
- f) clarification of the application of the code in relation to other legal requirements that the electricity supply industry is subject to;
- g) clarification of the application of the code in managing a longer-term energy constraint through planned load reduction and rules of implementing this. This is in the absence of an approved energy conservation scheme (the first edition included an assumption that an energy conservation scheme would be in place to manage such constraints);
- h) removal of reference to an energy conservation scheme, noting that, should it be implemented, the rules of such a program will dictate how it relates to this code of practice;
- i) clarification on the pragmatic use of *load shedding* versus mandatory curtailment in the context of different system conditions;
- j) revision of the load shedding schedules to cater for all time periods under all stages of load reduction (24 hrs per day including weekends);
- k) greater standardisation of load shedding schedules for the electricity supply industry;
- l) introduction of an additional stage of scheduled load shedding, i.e. Stages 1 to 4. (This is to: address the large increment in load reduction required previously under Stage 3; manage deeper levels of reduction whilst limiting the impact on the country; and allow for greater levels of planned reduction whilst still allowing for an additional stage of scheduled load shedding should system conditions dictate this);
- m) differentiation of a 15 % notified curtailment requirement under Stage 3 vs. a 20 % notified curtailment requirement under Stage 4;
- n) inclusion of a new section related to a severe supply constraint and the implementation of *contingency schedules* for controlled load reduction requirements beyond Stage 4. This is in terms of the Disaster Management Act, which requires coordinated planning for electricity-related scenarios even where these may have a low likelihood of materializing;
- o) increased flexibility for curtailment customers through options that better match the economic impacts that these customers would be exposed to;
- p) removal of Stage 0 as a curtailment option given the low uptake of this option, the similar role that demand market participation plays, and in order to reduce the complexity of load shedding;

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- q) the specification of compliance and reporting requirements (general and real-time);
- r) guidance on the implementation of smart metering as a technology platform for reducing the impact of load shedding on customers; and
- s) extensive editorial changes to the document.

The second edition of this part of NRS 048 has been developed in the context of known system and technology limitations. These limitations include the embedded nature of some customers that may be severely impacted by load shedding in electricity networks as they are currently designed, as well as the limited penetration of smart metering technology in South Africa.

NOTE The implementation of smart metering offers the electricity supply industry with a significantly improved capability for emergency load reduction, both on an incentivized and mandatory basis. It also allows supply to be maintained to identified categories of customers during load shedding. This code supports the implementation of such technology.

Compliance with the requirements of this part of NRS 048 has been mandated by NERSA through inclusion of the first edition as a license condition to all licensees in the electricity supply industry. It is anticipated that NERSA will also mandate this edition, as modified during its consultation processes, as a license condition in terms of the Electricity Regulation Act. Alternatively, this code may be included as a requirement under the Grid Code. General compliance by licensees to the code will be overseen by NERSA in terms of its licensing processes.

It should be noted that NERSA may from time to time mandate alternative protocols or clarifications on the provisions related to the application of this code. Readers are advised to confirm any such changes with NERSA or their electricity supplier. It is anticipated that a formal structure will be identified or established by NERSA to review and make recommendations on clarifications and amendments required at short notice going forward, where implementation of this code such clarifications or amendments.

Whilst this code provides for an ordered and consistent approach to emergency load reduction, it does not subrogate any actions that the System Operator may deem necessary in real time to ensure the security of the national power system (in terms of its compliance to the Grid Code, amongst others to prevent a national blackout). This includes the requirement for the System Operator to prudently manage system operating reserves. In the context of an actual emergency, compliance with real-time load reduction requirements will be given effect to by the 'upstream' control centre (i.e. System Operator or control centre will instruct the level of load reduction required and take the necessary actions should this not be adequate).

Reference is made in this code to the Disaster Management Act, 2002 (Act No. 57 of 2002). In terms of the various requirements of the Act, this code supports disaster risk mitigation and response in relation to several identified electricity disaster risk scenarios, including: a national or regional blackout; a power system constraint at a national or regional level; and various scenarios that could give rise to a significant system constraint (including plant failure, natural phenomena, sabotage, and social and economic disruptions). In terms of the Disaster Management Act, the lead sector department responsible for national energy-related disasters is the Department of Energy. Each sector is responsible for the development of plans in the event of a significant supply constraint or blackout. The National Disaster Management Centre and the Provincial Disaster Management Centres are responsible for overseeing the coordination of these plans at a national and provincial level respectively.

Reference is made in the introduction to the potential legislation of essential load information to be provided by end-users of electricity. In South Africa this legislation might be the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), or the Mine Health and Safety Act, 1996 (Act No. 29 of 1996), or new legislation to cover energy and demand management.

The Board of Directors, Municipal Councils and management of electricity suppliers have fiduciary requirements in terms of the Public Finance Management Act, Municipal Finance Management Act

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and/or the Companies Act that may have bearing on the conditions under which this code is invoked.

Reference is made in annex B, forms B.1 and B2, to legislated limits. In South Africa such limits, where relevant, are those covered by the following Acts (as amended):

- a) The Constitution of the Republic of South Africa Act (Act No. 108 of 1996);
- b) The National Environmental Management Act (Act. No. 107 of 1998);
- c) The National Environmental Management: Air Quality Act (Act No. 39 of 2004);
- d) The National Environmental Management: Waste Act (Act No. 59 of 2008);
- e) The National Environmental Management: Biodiversity Act (Act No. 10 of 2004);
- f) The National Water Act (Act No. 36 of 1998);
- g) The Water Services Act (Act No. 108 of 1997); and
- h) The National Heritage Resources Act (No. 25 of 1999); and the said Occupational Health and Safety Act.

This part of NRS 048 was compiled by a working group appointed by the NRS Association. The working group membership included a wide range of stakeholders, including representatives of the South African Electricity Supply Industry, NERSA, Government, and customer groupings (including formal representation of the Energy Intensive User Group (EIUG) and Business Unity South Africa (BUSA)). The working group at the time of publication of the second edition comprised the following members:

Koch R G (Chairman)	Eskom
Batohi V	eThekweni Municipality
Bhana D K	Eskom (Top Customer Services)
Chatterton B	Eskom (Distribution)
Cole T	SAB Miller
Correia A J	Eskom (Risk & Resilience)
de Beer G	Sasol
Delport S	City of Ekurhuleni Metropolitan Municipality
Gonya B	Eskom (Distribution)
Greyling A J	Anglo Gold Ashanti
Hull M	Eskom (Distribution)
Jacobs S	National Energy Regulator of South Africa (NERSA)
Jaeger F P	City of Cape Town
Kekana I	City of Tshwane Metropolitan Municipality
Kgalema L	City Power Johannesburg
Kneen M	Marcus Kneen (Pty) Ltd
Krumm D	South 32
Langridge I	Anglo American
Malaza V	National Energy Regulator of South Africa (NERSA)
Marais D	Umhlathuze Electricity
Miller M	Mondi Group
Mncube M	Department of Energy (DoE)
Moloto M B	City Power Johannesburg
Moloto P	City of Ekurhuleni Metropolitan Municipality
Morison I	Energy Intensive User Group (EIUG)
Ngidi L N	SALGA
Nundlal V (Project Leader)	Eskom (Technical Governance)
Peterson B	Eskom (Transmission Division)
Pittorino L	Eskom (Transmission Division)
Ramagaga M	City Power Johannesburg
Ratema D	National Energy Regulator of South Africa (NERSA)
Shabalala N	City Power Johannesburg
Smit T	Eskom (System Operator)
Thenga T	City of Ekurhuleni Metropolitan Municipality

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NRS 048 consists of the following parts, under the general title *Electricity supply – Quality of supply*:

Part 2: Voltage characteristics, compatibility levels, limits and assessment methods.

Part 4: Application practices for licensees.

Part 6: Measurement and reporting of medium-voltage network interruption performance.

Part 7: Application practices for customers.

Part 8: Measurement and reporting of extra high voltage (EHV) and high voltage (HV) network interruption performance.

Part 9: National Code of Practice: Load reduction practices, system restoration practices, and critical load and essential load requirements under system emergencies.

Annexes B, C, and G form an integral part of this document. Annexes A, D, E, F and H are for information only.

Introduction

South Africa’s electricity infrastructure is exposed to a variety of potential threats and vulnerabilities including: generation, transmission and distribution plant and control systems failures; extreme weather incidents and the impacts of climate change; wilful damage (including vandalism and sabotage) to electricity infrastructure; the impact of a sequence of unforeseen events and potential failure of barriers and protection systems and electricity constraints due to infrastructure capacity shortages and disruptions to critical resources (such as coal, gas, and liquid fuel) that may arise from time to time. Should the associated risks materialise, the resulting impact on safety, society, the environment and the economy can be significant.

The risk of a national blackout, whilst inherent to the operation of a large power system, has a low likelihood of materializing given operating protocols and protection systems in place. However, should a national blackout materialize the impact on the country would be severe – impacting critical sectors of society and the economy including personal and occupational safety, water supply and sewage systems, telecommunications and transport infrastructure, and even national security.

NOTE A blackout differs from load shedding/curtailment in that the former is considered a sudden, unexpected interruption in supply to a significant area of supply, whilst the latter is a controlled (manual or automatic) intervention to protect the total system from collapse in the event of a system emergency. Load shedding and curtailment measures are one of the measures implemented to protect the system from a blackout.

The risk of a severe national or regional electricity constraint may arise where infrastructure is damaged or inadequate to provide the system demand. The impact of such a constraint is dependent on the season, as the country’s demand profile differs significantly in winter vs. summer. The winter demand profile is characterized by a high peak demand in the evening (3000 MW above the daily average) whilst the summer demand profile is more constant throughout the day. Typical winter and summer profiles are illustrated in Figure 1. With an increase in the penetration of grid-connected solar power in future, it can be anticipated that this profile may change.

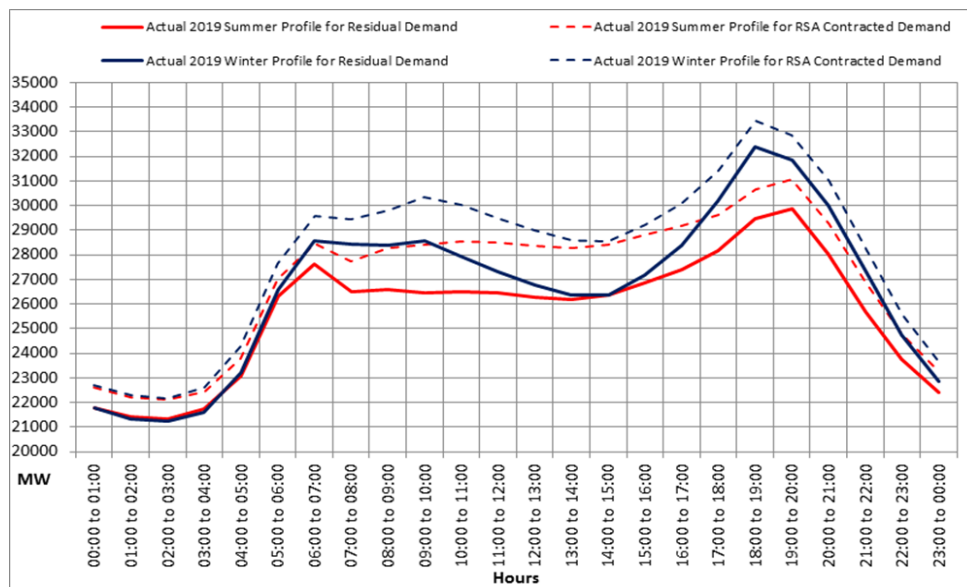


Figure 1 — Typical winter and summer demand profiles for the national power system (2019)

It is important to highlight that the need exists for a robust set of emergency load reduction protocols even under healthy system conditions, although the likelihood that emergency load reduction measures may be required when the power system is constrained for an extended period of time. A sequence of unexpected events or a large significant event in an otherwise healthy power system can give rise to the need for emergency load reduction. It should also be noted that emergency load

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reduction is not only required under generation capacity shortages, but could also arise due to regional or local transmission or distribution network constraints.

NOTE The 2003 blackout in Northeast USA and Ontario (Canada) that affected 50 million people was caused by transmission network constraints. The event could have been avoided by load shedding in the two hours of the emerging system emergency before the final cascading loss of multiple transmission lines and generators occurred (this last sequence of events took three minutes).

Whilst emergency load reduction is in principle implemented as a last resort (after contractual and voluntary arrangements for customer load reduction have been exhausted), it is important to note that prudent system operation requires adequate reserves to be maintained by the System Operator in order to ensure that anticipated contingencies can be catered for without the system being put at undue risk of a blackout (NOTE 1). The requirement to manage reserves applies also during a system emergency when load reduction is being implemented, as well as over extended operating periods where prudent operations requires that proactive measures to be deployed to manage available primary energy reserves (NOTE 2). In the absence of alternative load reduction protocols for managing longer-term energy constraints, load reduction may be necessary on a planned basis in order to provide greater predictability to customers under certain system constraints (NOTE 3). In this case, a given stage of load shedding or curtailment may be instructed for multiple days and available reserves would be used to manage variations in system supply and demand, rather than instructing different stages of load shedding on an ad-hoc basis.

NOTE 1 Such contingencies include a sudden loss of generation or transmission lines supplying electricity to South Africa from neighbouring countries.

NOTE 2 Under highly constrained system conditions that extend beyond a day or two, water reserves for the purpose of generating electricity may need to be managed pro-actively by implementing emergency load reduction.

NOTE 3 This application of emergency load reduction has been included in the second edition. The first edition was published under the assumption that an Energy Conservation Scheme would be approved.

Scenarios under which emergency load reduction may be required are identified in Figure 2. Indicative load reduction requirements are provided in Table 1 for winter and summer.

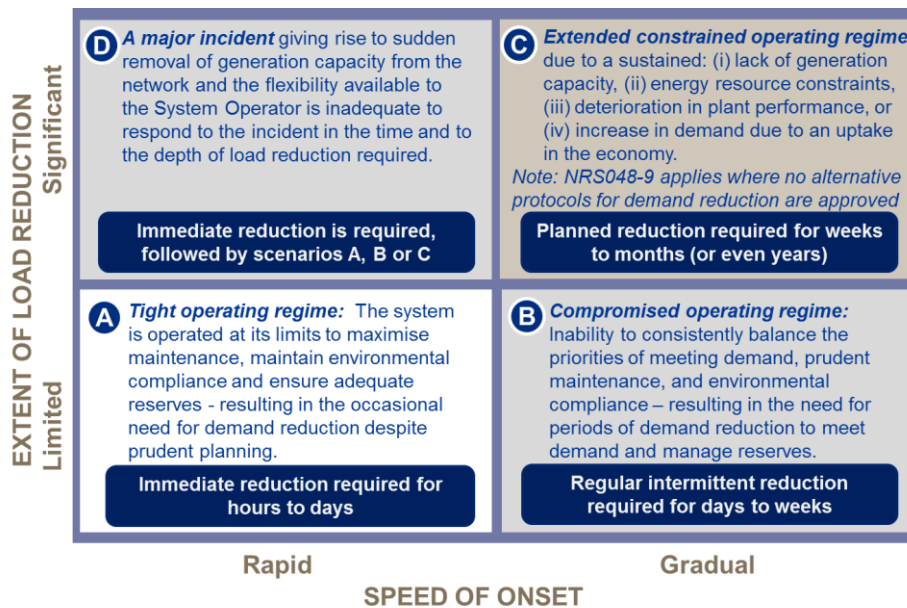


Figure 2 — Scenarios under which mandatory load reduction may be required showing the notice period and the depth/duration of load reduction

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Table 1 — Indicative mandatory load reduction magnitude and duration requirements and operating regimes for the identified scenarios in winter and summer

1	2	3	4
Scenario	Name	Winter reduction required (indicative only)	Summer reduction required (indicative only)
A	Tight operating regime	A few nights per week twice a month. Immediate reduction of 1000-2000 MW for 4 hrs.: 17h00-21h00 typically 15 min - 4hrs notice ^{a,f}	A few days per week twice a month. Immediate reduction of 1000-2000MW for 2-16hrs: 06h00-22h00 typically 15 min – 4 hrs. notice, generally towards the end of the week ^b
B	Compromised operating regime	A few nights a week every week. Regular intermittent reduction of 1000-3000 MW for 4 hrs.: 17h00-21h00 typically 15 min – 24 hrs notice ^{a,c,f}	A few days a week every week. Regular intermittent reduction of 1000-3000 MW for 16 hrs.: 06h00-22h00 typically 15min – 24 hrs. notice ^{b,c} . Possible weekend reduction to manage system reserves for the week ahead.
C	Extended constrained operating regime	Planned / anticipated reduction up to 7 days per week every week. Reduction of 2000-4000 MW for 4 hrs: 17h00-21h00, where possible notified 48 hrs to 2 weeks in advance ^d	Planned / anticipated reduction up to 7 days per week every week. Reduction of 2000-4000 MW for 16hrs: 06h00-22h00, where possible notified 48 hrs to 2 weeks in advance ^d
D	Major incident	Immediate reduction of 1000-3000 MW (Followed by scenarios A,B, or C ^e)	Immediate reduction of 1000-3000 MW (Followed by scenarios A,B, or C ^e)
<p>^a In order to only call on load reduction if it is necessary, the System Operator may call a System Alert to prepare all control rooms for load shedding but not implement this if the actual peak demand is lower than anticipated. In these cases, mandatory curtailment may not be called on given the 2hr notice required.</p> <p>^b Where the required reduction is anticipated to be more than 2-4 hrs, both load shedding and curtailment could be called on. Alternatively, a similar approach may be taken to (a).</p> <p>^c Day-ahead notice is likely to be given when the system is under severe pressure and/or reserves need to be built up (for example over the weekend when load reduction can be limited as much as possible).</p> <p>^d Whilst the stage of load shedding may be notified well in advance, it is possible that higher stages may be required at times to manage increased constraints due to incidents on the system.</p> <p>^e Depending on the nature of the incident, which could range from temporary loss of supply from neighbouring countries due to a line fault, to loss of multiple units at one power station for an extended period of time.</p> <p>^f The availability of contracted interruptible load will determine how many evening peaks of the week need to be managed by calling on load shedding.</p>			

In terms of international good practice and in compliance to the Disaster Management Act and the Electricity Regulation Act (and associated Grid Code), the System Operator is required to undertake adequate contingency planning for various system contingencies. This part of NRS 048 supports planning for a system constraint and a blackout related to a variety of contingencies (including plant failure, natural phenomena, sabotage, and social and economic disruptions).

The measures implemented under emergency load reduction have a potentially significant impact on the country. This part of NRS 048 therefore requires a system emergency to be formally declared at an operational level by the system operator to ensure that all parties are clear on when the protocols are activated and when they are terminated. Such a declaration may be made immediately when the system is entering a state of collapse, pre-emptively when the system is approaching a state of collapse (i.e. all resources available to the system operator have been exhausted and the need for mandatory load reduction is imminent in the next few hours), or in cases where measure need to be taken to prudently manage system reserves over a given period (e.g. the next week). The duration of the emergency may last from a few hours to multiple weeks or even months.

The application of this part of NRS 048 should be seen in the context of other long-, medium- and short-term measures required to manage a potential imbalance in supply and demand. Prior measures to prevent such an emergency condition could include voluntary load reduction by

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customers in response to a system constraint, pricing mechanisms that encourage load reduction on constrained days (critical peak day pricing), implementation of an energy conservation scheme, and shorter-term interventions such as the use of interruptible load that has been contracted for - either under a supply agreement or through market mechanisms (see Figure 3). Other longer-term measures include: adequate investment in generation and supply network capacity; interventions to maximize generation and supply network availability (NOTE); and energy efficiency programmes. This part of NRS 048 applies after measures such as these above have failed to prevent the integrated power system or a localized part of the system from approaching or entering a state of collapse.

NOTE Prudent power system operation requires adequate maintenance to be undertaken to manage long-term plant availability and ensure the safety of plant and personnel. In the short term however, such interventions generally increase the risk of an emergency, should the system already be constrained and unexpected conditions arise during this maintenance period.

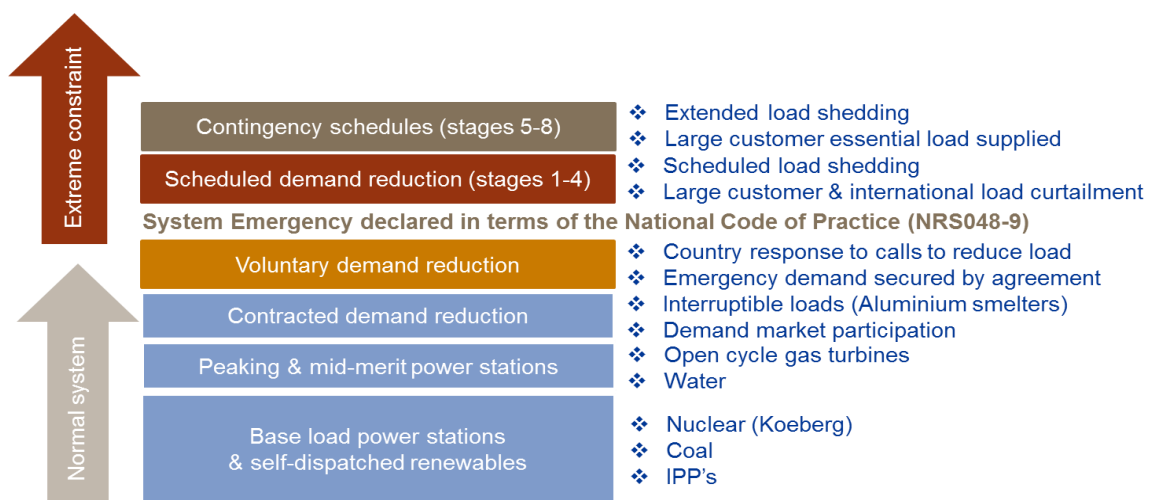


Figure 3 — Typical merit order showing the point at which this code is invoked. The implementation of scheduled demand reduction (Stages 1-4) and contingency demand reduction (stages 5-8) is shown

Manual, mandatory load reduction is an essential operating requirement under certain system conditions. Such reduction is a controlled intervention that takes into consideration issues such as equity, impact on customers, and information related to how and when customers are impacted. This needs to be proactively and prudently applied by the System Operator. Should this not be done timeously, or there is no time to implement load shedding and load curtailment, the System Operator will open breakers to interrupt supply to large supply areas (see Figure 4).

The final system defense against a national blackout is the under-frequency protection scheme which responds in under a second to a drop in frequency. Once this scheme is activated, supply and demand on the system needs to be brought back into balance by either bringing on line available reserves or by implementing emergency load reduction.

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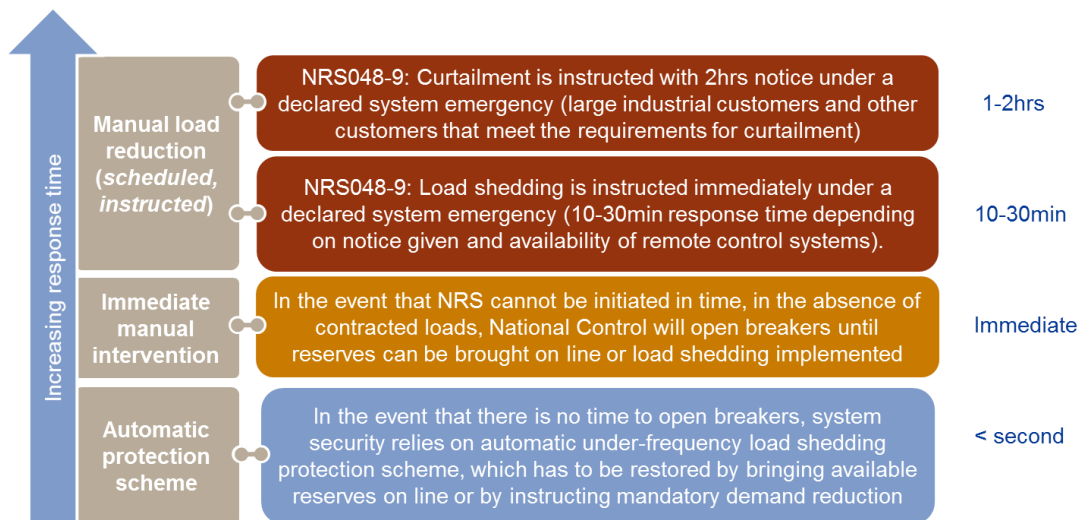


Figure 4 — Manual emergency load reduction (as applied in terms of this part of NRS 048-9) in relation to immediate manual interventions applied in the control room and automatic load reduction implemented through technology

Whilst laying down a national basis for the consistent application of load reduction and restoration practices by licensees (of NERSA), this part of NRS 048 also addresses:

- options available to customers to minimize the impact of load shedding (e.g. alternatives to load shedding such as load curtailment);
- the responsibilities of a variety of stakeholders (such as individual customers and local government) in relation to providing essential load information and protecting critical installations from the impact of load shedding; and
- measures that need to be taken within individual customer installations in the event of supply interruptions or load shedding and curtailment.

The development of mandatory load reduction requirements requires several factors to be taken into consideration. These factors sometimes present conflicting requirements, and need therefore to be balanced on a pragmatic basis. The factors considered in developing this part of NRS 048 are:

- the safety of people, the environment, and potential damage to plant associated with a critical national product;
- predictability of when and for how long a customer will be interrupted or required to reduce demand;
- equitable participation by customers, and how load reduction requirements are allocated between various regions across the country, metros, municipalities, large industrial customers, and international customers (see NOTES 1 and 2);
- the social impact of load shedding and curtailment;
- economic impact on the country;
- technical constraints on executing load shedding and curtailment or restoration; and
- the magnitude of the load reduction required and the speed at which this can be achieved.

NOTE 1 *Equitable participation* refers to a *striving for general fairness* in the manner in which customers are required to participate in load reduction schemes. It is recognized that *equal participation*, on the other hand,

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is not always possible given the nature of load shedding, system characteristics, and real-time-operational constraints.

NOTE 2 *Equitable participation* is a requirement that arises from the Electricity Regulation Act. This document therefore requires customers supplied by different licensees to be treated similarly.

This part of NRS 048 adopts a comprehensive approach to addressing various types of loads by specifying a range of interventions to make the country more resilient in the event of a system emergency. An approach that only considers supply network interventions to minimize the impact of mandatory load reduction (i.e. exclusion of such loads from load shedding schedules) is currently impractical, given the inflexible nature of existing network structures. This is largely because exclusion of some loads from load shedding schedules (and by implication other loads on the same electricity supply circuit) will increase the frequency at which other customers on the networks need to be shed. Similarly, a customer who would prefer to curtail load rather than be shed, cannot always be accommodated if other customers on the same circuit need to be shed.

Ideally the approach to addressing critical loads during emergency load reduction or restoration should be consistent from a national perspective (i.e. applied similarly by the various supply authorities). For this reason, this part of NRS 048 identifies a minimum set of critical load types that should be addressed by the various supply authorities. Given current system limitations, this part of NRS 048 considers various alternatives for treating critical loads, i.e.:

- a) the manner in which emergency load reduction is applied (i.e. time-based shedding versus a reduction of load for the duration of the emergency);
- b) the specific time of day that different types of load are shed;
- c) the exclusion of some specific loads from load shedding schedules;
- d) protocols for interaction between the customers' operating critical loads and the electricity supply utility;
- e) interventions in customer installations (e.g. the need for appropriate backup supplies); and
- f) load curtailment options available to customers who comply with specific criteria.

In the case where critical loads exist within a customer installation, this information should be provided to a supply authority (termed an "essential load requirement" in this part of NRS 048). This information is particularly vital for a supply authority to establish priorities for power system restoration after a blackout. However, provision of this information to the supply authority is not intended to relieve the responsibility of the customer to ensure that adequate back up supply is available. The format for submitting such information is also provided in Annex E of NRS 048.

NOTE It is anticipated that the provision of essential load information will at some stage be legislated (see foreword).

Several technology innovations that are currently under development have the potential to significantly enhance the manner in which emergency load reduction can be undertaken (i.e. smart metering and load limiting technologies). In particular, these technologies have the potential to significantly reduce present system limitations related to the protection from load shedding of specific loads (or embedded generators) on a given network. The aim of this part of NRS 048 is to provide a code of practice for load reduction under the current limitations, whilst preparing for the potential implementation of such technology solutions.

The introduction of embedded generation provides a challenge to the development of load shedding schedules, as demand reduction required from a specific feeder may be accompanied by disconnection of the embedded generator. Whilst feeders where such generation provides a net export to the grid may be removed from the schedules, feeders with a net demand are best managed through smart meter interventions rather than load shedding.

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NOTE It is estimated that the implementation of smart metering and load limiting relays on residential networks has the potential to achieve a load reduction of over 5 000 MW at system peak, when implemented by all distribution licensees in South Africa.

It is recognized that this part of NRS 048 is expected to evolve with time to take into account experience with the application of the requirements specified, as well as technology advances as discussed above.

Keywords

mandatory load reduction, load shedding, load curtailment, load limiting, load switching, critical loads, essential load requirements, load restoration, load shedding schedules, system emergency, smart metering.

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ELECTRICITY SUPPLY — QUALITY OF SUPPLY

Part 9: Code of Practice - Load reduction practices, system restoration practices and critical load and essential load requirements under power system emergencies

1. Scope

1.1 This part of NRS 048 is intended to provide for the implementation of a nationally consistent response to a variety of system emergencies. As such, this part of NRS 048:

- a) provides electricity suppliers (licensees) with a standard methodology for developing emergency load reduction (shedding, curtailment, load limiting, and load switching) practices,
- b) provides electricity suppliers (licensees) with best practice for prioritizing load restoration after a local, regional or national blackout,
- c) defines and categorizes critical loads and essential load requirements,
- d) provides electricity suppliers (licensees), customers, and national and local government with best practice on how to address critical and essential loads in the context of emergency load reduction or system restoration,
- e) identifies the responsibilities that all stakeholders have in relation to sharing information on critical and essential loads,
- f) identifies the responsibilities that the licensee utility has in terms of information sharing related to load shedding schedules and system status,
- g) provides standard definitions related to emergency load reduction principles in order to facilitate common understanding between stakeholders,
- h) defines the roles, responsibilities and limitations of licensees and customers in addressing various aspects of load shedding,
- i) provides reporting formats to facilitate the collection of essential load data, and
- j) specifies compliance and reporting requirements of licensees.

NOTE Examples are provided as annexes in order to facilitate understanding of the principles defined.

1.2 This part of NRS 048 is intended to be applied when all other measures (indicated in the introduction) are inadequate to prevent a demand-supply capacity constraint that could lead to risk of system collapse (at national or regional level).

NOTE It should be noted that NERSA may from time to time mandate alternative protocols or clarifications on the provisions related to the application of this code. Users of this code of practice are advised to confirm any such changes with NERSA or their electricity supplier.

1.3 This part of NRS 048 addresses manual load reduction. It is not intended to address the management of the automatic under-frequency load shedding scheme.

NOTE Annex A explains the relationship between manual load reduction as addressed by this part of NRS 048 and the automatic under-frequency load shedding scheme.

1.4 This part of NRS 048 applies to all licensees unless a deviation is approved by NERSA or an appropriately approved committee which can process exemption applications in a reasonable time, and where such deviations still provide the System Operator with the required load reduction for the relevant stage.

2. Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of this part of NRS 048. All documents are subject to revision and, since any reference to a document is deemed to be a reference to the latest edition of that document, parties to agreements based on this part of NRS 048 are encouraged to take steps to ensure the use of the most recent editions of the documents listed below.

NRS 048-2, *Electricity supply – Quality of supply – Part 2: Voltage characteristics, compatibility levels, limits and assessment methods.*

NRS 048-6, *Electricity supply – Quality of supply – Part 6: Measurement and reporting of medium-voltage (MV) network interruption performance.*

NRS 048-8, *Electricity supply – Quality of supply – Part 8: Measurement and reporting of extra high voltage (EHV) and high voltage (HV) network interruption performance.*

3. Terms, definitions and abbreviations

For the purposes of this specification, the following terms, definitions and abbreviations apply.

3.1 Terms and definitions

base load [of the licensee]: total load at system peak less excluded loads [annual maximum simultaneous demand of all the licensee's supply points that feed the licensee]

NOTE The effect of any licensee-embedded generation operating at system peak is inherently included in the total load.

excluded load: all load which the licensee may not shed or curtail according to the provisions set out in this part of NRS 048 (See 4.4.1, 4.4.4 and 4.4.6.)

control centre: Eskom distribution control centre or municipal control centre dedicated to operate a defined area network

critical load: load that is managed to minimise the impact of load shedding or loss of supply in order to either maintain the operational integrity of the power system, or to avoid a cascading impact on public infrastructure

NOTE 1 Examples include coal mines that supply power stations, refineries, and fuel pipelines (in the latter case the line may be severely impacted if load shedding were applied at several stages of the line throughout the day).

NOTE 2 Protection measures include the exclusion from load shedding schedules, installing back-up facilities, or implementing specific protocols for interaction between the customer and the licensee.

customer: person or legal entity that has entered into an electricity supply agreement with a licensee

demand response; DR customer: customer who has signed a contract with his supplier or Eskom to offer a portion of his load at a price, for the purpose of load reduction

NOTE Depending on his participation parameters, such a customer may be categorized as an Instantaneous DR (IDR), Emergency DR (EDR) or a Supplemental DR (SDR) customer.

essential load requirement: minimum customer load requirement (e.g. MW, notification time, and duration) to avoid a direct and significant impact on the safety of people, the environment, and physical plant or equipment (or both) for nationally critical products, and which has been (a) specifically notified as such by the customer to the licensee, and (b) agreed to in writing by the

licensee.

NOTE 1 The load required is generally part of the total load that a customer installation normally requires. A customer will be required to demonstrate the potential impact on safety, the environment, and physical equipment when notifying the licensee (see essential load requirements data format in annex B). The essential load requirement may be subject to verification by the licensee in terms of the requirements of this part of NRS 048.

NOTE 2 The load may be part of a larger installation that will still be required to participate in load shedding or curtailment schemes.

NOTE 3 This essential load requirement cannot be guaranteed to be served by a licensee.

NOTE 4 These loads should receive priority during restoration of the system (e.g. in the event of a major local interruption, or of a regional or national blackout).

NOTE 5 These loads were in the past categorized as SATEPSA loads under the (then) Republic of South Africa Telecommunications and Electrical Power Supply Authority (SATEPSA).

NOTE 6 Essential load requirements are typically less than 20 % of the customer installation's normal load.

feeder: point on the network where load is measured and interrupted for load shedding purposes

interruptible load: load where customers have signed long-term contracts with a licensee, whereby the licensee may interrupt a certain amount of load for a particular time period as a planned load intervention

NOTE These loads can specifically be used earlier in the merit order to reduce the possibility of a load reduction event.

interruption: phenomenon that occurs when one or more phases of a supply to a customer or group of customers are disconnected for a period exceeding 3 s
[NRS 047-1]

planned interruption: interruption that occurs when a component is deliberately taken out of service (by the licensee or its agent) at a selected time, usually for the purposes of construction, preventative maintenance or repair [NRS 047-1]

unplanned interruption: interruption that occurs when a component is taken out of service immediately, either automatically or as soon as switching operations can be performed, as a direct result of emergency conditions, or an interruption that is caused by improper operation of equipment or human error [NRS 047-1]

licensee: body, licensed by NERSA, that generates, transmits or distributes electricity

NOTE Such a body can be a direct licensee, or an agent (sub-distributor) of the licensee.

load curtailment: load reduction obtained from customers who are able to reduce demand on instruction

notified load curtailment: load that is curtailed within hours (typically with 2 h) of the instruction being issued

NOTE Instruction may be issued by the System Operator or its appointed agents.

load curtailment schedule: pre-defined load to be curtailed at pre-defined times during a load shedding event

load reduction: reduction in system load that can be achieved by load curtailment or load shedding (or both)

NOTE Load reduction might be required in order to

- a) balance system demand in relation to the available generation capacity at the time; or
- b) prevent overloading of transmission or distribution networks in the event of a network emergency (or both).

emergency load reduction: load reduction in response to an unplanned event or series of unplanned events on the system

NOTE Unplanned events could occur even when a healthy system reserve margin exists, and could be rotational should the event(s) last a few days

national load reduction: load reduction intervention required on a national level in response to national generation capacity shortages

planned load reduction: rotational load shedding or curtailment (or both) undertaken over an extended period of time to manage demand on the system

NOTE Planned load reduction might be the only option to secure the national system if power conservation measures are not effective. Whilst this part of NRS 048 could provide some guidance on elements of planned load shedding, it is intended to apply in the case of emergency load reduction only.

regional load reduction; local load reduction: load reduction intervention required to address regional or local power system capacity constraints

NOTE Although in some cases national schedules can be applied on a regional basis, the specific nature of the local event will determine what loads need to be reduced.

load switching: remote switching of appliances or circuits within a customer installation by a licensee

load limiting: reduction imposed by a licensee on the total load drawn by a customer at the supply point

load shedding: load reduction obtained by disconnecting load at selected points on the transmission or distribution system

automatic load shedding: load that is shed by automatic defence schemes in response to a sudden threat to the system **Example:** A sudden trip of several generation units that results in under frequency relays operating to reduce load.

manual load shedding: load that is removed by a human operator

NOTE Load shedding by its nature will affect all customers connected to the disconnected circuit.

rotational load reduction: regular shedding or curtailment (or both) required to manage demand over an extended period of time or for several load reduction events over a period of time, which spreads the requirement to reduce load over a wider customer base

load shedding schedule: schedule that pre-defines load to be shed at pre-defined times during a load shedding event

merit order: order in which generation or demand-side resources are applied by the System Operator as demand increases on the system

NOTE The merit order is determined largely by the relative cost of various reserves, as well as contractual provisions with participating customers.

normal load (in context of curtailment of customers' loads): average load measured reflective of typical demand

NOTE The purpose of calculating “a” value for normal demand is primarily for target setting and planning purposes for curtailment loads. Based on the length of the period chosen to calculate the average load, longer duration planned maintenance and plant breakdowns may be excluded. Some short term breakdowns may be considered as part of normal operations. Where customers reduce significant demand during night/early morning off peak periods, the average demand between 05h00 and 22h00 may be used to determine the normal load.

NOTE Defined for specific customers in determining the predetermined curtailment load. Annex H provides further clarity on how this is determined.

customer base load (CBL): is an average profile reflecting a typical normal daily operating demand profile

peak, off-peak (periods): periods at which system demand exceeds the normal demand throughout the day, periods at which system demand is significantly lower than the normal demand throughout the day

NOTE Peak periods vary and typically between 17h00 and 22h00 and match periods of higher demand and, off-peak periods between 22h00 and 06h00 the following day matching periods of lower demand.

point of supply: point at which the electrical installation of a **customer** (on any premises) is connected to the transmission or distribution system of the **licensee**

severe supply constraint: a system constraint that requires load reduction beyond that provided by the formal Stages 1-4 of load reduction as defined in this code of practice.

unavoidable loads: loads that would normally be sheddable, but that are excluded from the schedules because they are embedded in a network serving an excluded critical load

3.2 Abbreviations

BUSA: Business Unity South Africa

EIUG: Energy Intensive User Group

DR: Demand Response

KSACS: Eskom key customers

NERSA: National Energy Regulator of South Africa

SABS: South African Bureau of Standards

UFLS: Under-frequency load shedding

SO: System Operator

4. Application principles

4.1 Application by licensees

Licensees shall:

- a) develop and maintain plans for mandatory load reduction in accordance with the practices laid out in this part of NRS 048;
- b) execute these plans in accordance with the protocols laid out in this part of NRS 048; and
- c) report and communicate on mandatory load reduction in accordance with the requirements of this part of NRS 048.

Where alternative load reduction practices are deployed, these shall:

- a) achieve the equivalent load reduction requirements of the System Operator; and
- b) be approved in writing by NERSA after consultation with the System Operator.

NOTE Such alternative practices might relate, for example, to the manner in which smart metering and load limiting technologies are applied as these become available and are implemented, or in the manner in which equity between customers are managed.

Where licensees choose not to operationally implement load reduction themselves:

- a) such reduction shall be undertaken by the licensee supplying them; and
- b) they shall remain accountable for all the engagements with their affected customers as laid out in this part of NRS 048 – including the communication of load shedding schedules and addressing the requirements of critical and essential loads.

Where municipal licensees are unable to demonstrate the ability to reduce demand by at least 80 % of the required amount within 15 min on advance notification (provided at least 1 hour before possible load shedding), and the ability to restore 80 % of this load in under 30 min:

- a) Eskom shall shed the bulk supply points to these municipalities;
- b) Eskom shall include these municipalities on its schedules going forward; and
- c) the municipal licensees shall revise their schedules to reflect the relevant shedding times.

In all cases, the required amount of load to be shed shall comply with the requirements of the System Operator, whilst ensuring that the under-frequency system is not materially compromised.

4.2 Application by customers

Customers should take appropriate precautions or protective measures (or both) to prevent, or at least minimize, threat to life, or danger to the environment, or damage to equipment in the event of load shedding, an unplanned or planned interruption, or load restoration.

In particular, the requirements in this part of NRS 048 with regard to critical loads and essential requirements should be taken into consideration (NOTE 2).

NOTE 1 An unplanned interruption in supply could occur at any time due to local, regional or national network problems.

NOTE 2 Not all customers defined as critical loads are kept off the schedules.

4.3 Variations and exemptions

NERSA may from time to time issue variations or exemptions from this code of practice, where conditions require such variations or exemptions to be implemented outside of formal revisions of this code. Licensees may request such variations or exemptions from NERSA.

NOTE NERSA will consider such exemptions in light of the motivation provided, the requirements of the System Operator, and the principles outlined in section 4.4.

4.4 Principles

A co-ordinated approach to load reduction shall be developed by each licensee based on the principles articulated in 4.4.1 to 4.4.8.

4.4.1 Principle 1 – Protection of the automatic under-frequency scheme

The automatic under-frequency scheme is the last defense against a blackout of the national power system. For this reason:

- a) where time permits, manual load reduction shall be implemented in order to maintain the balance between demand and supply, ensure adequate system reserves, and thereby minimize the need for the automatic under-frequency system to operate;
- b) through appropriate design of the manual load reduction scheme, the integrity of the national automatic under-frequency load shedding system shall not be materially compromised when manual load reduction is undertaken;
- c) where system conditions dictate, proactive load reduction may be required to prevent deeper levels of load shedding that could place the system at greater risk later in the week;

NOTE Although both automatic under-frequency load shedding and manual load shedding respond to a supply/demand imbalance, the conditions that these respond to and the consequences of their failure to respond are very different. Manual load shedding is a controlled, ordered and pro-active measure to manage a short-term capacity constraint on the system. Automatic under-frequency load shedding is an immediate, reactive response to a sudden unplanned loss of generation that might otherwise compromise the system integrity. The consequences of an inadequate response by the automatic under-frequency scheme can be catastrophic and widespread, which includes a complete loss of supply to the entire national power system.

4.4.2 Principle 2 – Equitable participation by all customer installations

Customers supplied by different licensees should to be treated similarly in terms of the requirements of this code of practice. All customer installations should be considered for mandatory load reduction under a system emergency, based on broadly equitable participation by customers. To this effect, all customers should by default be shed, and such shedding shall be in terms pre-defined load shedding schedules, unless agreed otherwise in writing between the licensee and the customer in terms of the provisions provided in this document relating to demand response participation, critical loads, load curtailment, or independent power producers. Exclusion of customers for reasons not specified in this document shall be approved in writing by NERSA in terms of the provisions in 4.1.

NOTE 1 Manual load reduction in the event of a system emergency is required in order to prevent the power system from approaching or sliding into an unstable state. The financial implications associated with a national blackout far outweigh the economic cost of manual load curtailment or shedding. The financial impact to a specific customer alone is therefore not sufficient to justify exclusion of individual customer installations from the emergency load reduction. Other considerations related to possible exclusions from load shedding schedules (such as safety and impact on the environment) are addressed in this part of NRS 048 by the requirements related to critical and essential loads. Mechanisms are provided for under this part of NRS 048 in order to reduce the potential impact on customers. These include curtailment options (both voluntary and mandatory), options for customers to cooperate with each other to provide the required reduction, and technology options such as smart metering.

NOTE 2 The definition of mandatory load reduction in the event of a system emergency does not include contracted interruptible load and loads that participate in the demand market (demand response programme). Participation of customers providing such interruptible loads is addressed in this part of NRS 048 (for example, these may under certain conditions be excluded from Stages 1&2 of load shedding or curtailment).

NOTE 3 Broadly equitable participation by customers implies that factors such as practical network constraints, a customer's ability to curtail load, and essential loads requirements should be taken into account. For some customers, the scheduled outage time might have a consequent recovery time depending on their specific application of electrical energy, and so they might be more affected than other customers.

NOTE 4 Exclusions approved by NERSA might be in terms of critical impact at a specific period during the day (e.g. high crime areas), or in terms of related legislation (e.g. as a disaster risk reduction measure where an area is faced with a drought).

NOTE 5 Equitable participation is a requirement that arises from the Electricity Regulation Act.

4.4.3 Principle 3 – Protection of critical and essential loads

Critical loads and essential load requirements shall be taken into consideration in order to limit the potentially negative impacts of mandatory load reduction on safety, the environment, and infrastructure that is critical to communities and the economy.

NOTE It is not always possible for such loads to be excluded from load shedding schedules or mandatory load curtailment. Provisions for such loads are defined in this part of NRS 048.

4.4.4 Principle 4 – Availability of load shedding schedules

Load shedding schedules shall be proactively developed, maintained, and made available to customers.

4.4.5 Principle 5 – Nature of the load shedding schedules

Load shedding schedules should be developed in such a manner so as to ensure maximal standardization across all licensees, whilst still allowing for flexibility to address local conditions.

NOTE For this reason the minimum design requirements for the schedules do not strictly specific all parameters (e.g. some licensees may shed customers for 2 hrs, whilst other licensees may choose to shed customers for 4 hrs. but less frequently).

Load shedding schedules shall meet the following minimum requirements:

- a) coverage over 24 hours per day, all 7 days of the week;
- b) time-based, rotational slots of 2 to 4 hours (see NOTES 1, 2, 3);
- c) load reduction of 5 % to 6 % for each block (see NOTE 4);
- d) rotational timeslots that ensure that customers are not interrupted at the same time each day (see NOTES 5 and 6);
- e) all customers shall be on the schedules, with the exception of those provided for in this code of practice; and
- f) schedules should where possible be optimized for the seasonal demand profiles (NOTE 6).

Load shedding schedules and curtailment requirements are defined up to a predefined maximum load reduction (see NOTE 7). Where additional load shedding is required, this is regarded as an extreme system condition explicitly excluded from the principles in this section, and which will be handled in accordance with the situation prevalent at the time (see NOTE 8).

NOTE 1 Time-based manual load shedding is chosen for the following reasons:

- a) customers generally prefer to know when their supply will be interrupted so that they can better plan their operations and arrangements;
- b) the communication of load shedding schedules is less onerous;
- c) licensees are able to some extent to pro-actively identify and implement suitable time slots that will lessen the impact on society.

NOTE 2 In the interest of standardization and of limiting the impact of load shedding on the distribution network (due to cold-load pickup), a 2 hr time-slot is recommended for utilities operating networks using remote control systems. Analysis has shown complete loss of diversity of geyser load is less than a 2 hour period. The cold load pick up on urban networks after 2 hour load shedding can be as high as 180% of the normal value. Where switching is done manually, or where engagements with customers suggest otherwise, longer less-frequent periods of load shedding may be considered (e.g. 3 or 4 hrs).

NOTE 3 In the communication of the schedules, common practice is that an additional 30 min is included in the time-slot to allow for rotation (interruption and restoration).

NOTE 4 Schedules are built up using blocks of load. The first stage of shedding uses only one block and subsequent stages use two or more blocks to achieve the load reduction in a given time slot. The requirement for a minimum of 5 % is based on the minimum requirement of the first stage of load shedding, which is 5 %.

NOTE 5 Since there is a difference in the risk of load shedding between peak and non-peak times during winter and summer, equity across peak and non-peak periods is not possible without some sort of rotation or additional scheduling. Licensees are advised to use the suggested block-time rotation described in annexes F, G and H. If the licensee prefers to use other schedule types, then that is allowable as long as the block size remains in accordance with this specification. The licensee must then be able to explain how equity is achieved in their schedule.

NOTE 6 Certain customers may prefer to be in a consistent time slot rather than a rotating time slot. If this can be accommodated without impacting other customers, the licensee may pursue this. The licensee must be able to demonstrate equity across weekdays vs. weekends, peak vs. non-peak periods, customer categories.

NOTE 7 The winter peak is typically between 17h00 and 21h00. This would suggest two 2hr slots or one 4hr slot to be most appropriate in winter with rotation at odd hours in order to avoid unnecessary rotation on half-slots. The summer profile lends itself to a timeslots that rotate at even time slots.

NOTE 8 Load reduction in this document is scheduled and published for the first four stages, Subsequent stages (five to eight) are also scheduled, but these are not published.

NOTE 9 For this level of emergency load reduction to be required, the implementation of all other mitigation actions and initiatives would have been exhausted. This means that the supply constraint is extremely serious and bordering on a total collapse of the entire network load. Under these conditions, the focus is entirely on managing the network from a technical point of view - i.e. to avoid a total loss of load on the entire network. The consequence of a total loss of the system is that cold start sequences will have to be initiated which could take many hours (even days) before load is restored. Therefore technical considerations should take preference over the principles designed to lessen the consequential impact on customers.

4.4.6 Principle 6 – Declaration of a system emergency

Mandatory load reduction in accordance with this part of NRS 048 shall only be instructed under a declared system emergency.

NOTE 1 The declaration of a system emergency is initiated by the System Operator in the case of a national emergency and by the regional or local control room in the event of a regional or local emergency.

NOTE 2 The declaration of a system emergency is an operational requirement instituted to ensure that all parties executing load reduction are clear on the regime under which load reduction is executed. This includes communication of such a declaration to control rooms who execute load shedding and customers who undertake mandatory curtailment.

NOTE 3 A system emergency is a formally declared operating condition under which mandatory load reduction (shedding and/or curtailment) is instructed by the System Operator. The System Operator will under such conditions instruct when load shedding, mandatory load curtailment or both are executed. This means that there may be periods during a system emergency under which the System Operator might find it prudent to lift mandatory load reduction whilst the emergency condition remains in place (e.g. in the early hours of the morning when demand is low).

NOTE 4 Should the System Operator have insufficient time to instruct load shedding or curtailment, the System Operator will take any measures it deems necessary to ensure the security of the power system in terms of its mandate under the the Grid Gide. This may include manually interrupting customers to manage demand until an emergency can be declared and the provisions of this part of NRS 048-9 can be invoked.

4.4.7 Principle 7 – Minimized impact on customers

The execution of mandatory load reduction should be undertaken in a pragmatic manner in order to minimize the expected impact on customers, subject to the necessary system load reduction requirements being met. This includes:

- a) the consideration of the expected load reduction requirements related to the winter and summer load profiles (see NOTE 1); and
- b) pragmatic decision making when calling on load shedding and or mandatory load curtailment (see NOTE 2).

NOTE 1 The System Operator should, where possible, instruct load shedding to be initiated at times at which schedules are rotated (on the hour). In cases where an immediate response is required, this may not possible.

NOTE 2 Under some system conditions:

- a) Load shedding may not be required if load curtailment has already been instructed and the load reduction is adequate to meet the system requirements. Under such conditions, load shedding might not be called on;
- b) Mandatory load curtailment may not be appropriate if the load reduction requirement is for a limited period of time (given the 2hr notice period required to implement curtailment). Under such conditions, load shedding might only be called on (given the 10-30min implementation time);
- c) A full stage of load reduction may not be required, in this case the System Operator may not call on all control rooms to shed load. The rotation of control rooms would in this case be necessary to ensure that the principle of equitable participation is met. For this to be effective the System Operator must have insight into the likely shedding volume of each control room for each load shedding period; and
- d) Under some system conditions, mandatory load reduction may be called on proactively to manage reserves and thereby limit the depth of expected load shedding later in the week.

4.4.8 Principle 8 – Predictability and advance warning of load reduction

The execution of mandatory load reduction should be undertaken in a manner that maximizes the predictability for customers and for those executing the load reduction, subject to the necessary system load reduction requirements being met. Predictability and advance warning should be addressed by:

- a) the provision of warnings and alerts to control rooms and customers of periods of heightened probability of mandatory load reduction; and
- b) the pragmatic implementation of planned load shedding in the case of extended periods under which the system is expected to be constrained (see scenario C in Figure 2).

NOTE 1 Planned load shedding refers to the advance announcement of load reduction stages to be implemented for specific days over an extended period of time (weeks to months). Under such conditions, calling on ad hoc load reduction would be significantly more disruptive and frustrating to customers.

NOTE 2 Application of planned load reduction is most appropriate under scenario C in Figure 2. NRS048-7 addresses the requirements for planned load reductions (a minimum of 48 hrs. notice is required). Application of load reduction to manage real-time reserves under scenario B in Figure 2 requires real-time decision-making, under which advance warning of 8-12hrs is more appropriate when implementing weekend load reduction.

NOTE 3 Given the unpredictable nature of real-time variations in system conditions, a focus on predictability may mean that load shedding is implemented at times and at levels that this reduction is not absolutely necessary for the system. On the other hand, it is possible that deeper levels of load reduction may be required, should system conditions deteriorate beyond that expected. A decision to implement planned load

shedding needs to be taken prudently, considering both the system risks and need to limit the impact on customers.

4.4.9 Principle 9 – Customers participating in load reduction

Customers who participate voluntarily in formal, real-time load reduction products designed to avoid declaration of a system emergency shall be excluded from early stages of load shedding in accordance with the provisions of this part of NRS 048.

NOTE Should the power system be constrained, voluntary participation in load reduction may be called on to avert a system emergency. Examples of such products include the supplemental demand response (SDR) and instantaneous demand response programme based on the SO requirements.

NOTE Load reduction achieved under a scheme designed to manage a longer term energy constraint is not considered as emergency load reduction, as this is unable to respond to real-time system requirements. Unless otherwise determined in the rules of such a scheme, a customer will still be required to reduce load under a system emergency, in accordance with the requirements of this part of NRS 048.

4.5 Load reduction in the event of a national supply constraint

4.5.1 Requirements and stages of load reduction

The specific reduction in load required to stabilize the system under a national supply constraint will be dictated by the power system conditions that prevail at the time. However, in order to facilitate the development of load shedding and curtailment schedules that can be made available to the public, pre-determined stages of load reduction are specified in this part of NRS 048 (see table 2). These stages range from stages 1 to 4 (scheduled load shedding and notified mandatory curtailment).

Emergency load reduction under an extreme supply constraint (i.e. beyond Stage 4) should be executed through implementing the extended schedules and curtailment requirements detailed in section 5. Whilst these contingency schedules shall be available to the control room staff, communication of these to the public is not required unless otherwise instructed by NERSA in terms of section 4.3.

The level of reduction required under stages 1 to 4 is defined at each stage as a percentage of national load (see Table 1). This reduction is achieved by both load shedding (according to pre-defined schedules) and by reduction required from customers eligible for notified curtailment (see NOTE). Under a system emergency, the System Operator shall declare the applicable stage of load shedding.

NOTE Customers may offer load curtailment instead of being shed, subject to:

- a) the specific conditions listed in 4.5.3.2; and
- b) an agreement between the customer and the licensee.

Where a customer has responded to a request for voluntary load reduction shortly before declaration of an emergency, the licensee should endeavour to deduct from the customer's contribution during stages 1 and 2 the prior contribution to load reduction.

Table 2 — National load reduction requirements (load shedding and curtailment) under a system emergency declared by the System Operator in the event of a national generation capacity constraint .

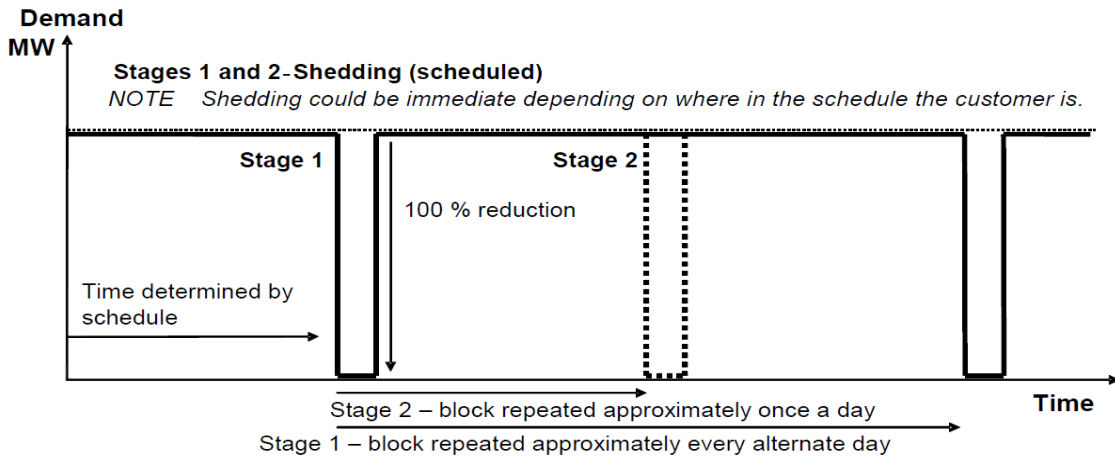
1	2	3	4
Stage	Type	Reduction required from end-use customers by <i>load shedding</i> (see footnotes ^{a b c})	Reduction required from end-use customers eligible for <i>curtailment</i> (see footnote ^d)
Stage 1	Scheduled (notified)	All Stage 1 load scheduled by utilities, approximately 5 % reduction in load profile of the national non-curtailment load (e.g. ±1 000 MW at system peak)	10 % reduction in normal demand profile within the agreed notification period and for the duration instructed
Stage 2	Scheduled (notified)	All Stage 2 load scheduled by utilities, approximately 10 % reduction in load profile of the national non-curtailment load (e.g. ±2 000 MW at system peak)	
Stage 3	Scheduled (notified)	All Stage 3 load scheduled by utilities, approximately 15 % reduction in load profile of the national non-curtailment load (e.g. ±3 000 MW at system peak)	15 % reduction in normal demand profile within the agreed notification period and for the duration instructed
Stage 4	Scheduled (notified)	All Stage 4 load scheduled by utilities, approximately 20 % reduction in load profile of the national non-curtailment load (e.g. ±4 000 MW at system peak)>	20 % reduction in normal demand profile within the agreed notification period and for the duration instructed
<p>^a The national load reduction (shedding and curtailment) requirements in this table are allocated to each distribution licensee in accordance with the procedure specified in 4.5.2.</p> <p>^b Licensees are required to develop load shedding schedules that follow the natural load profile of their system, providing the full allocation at peak,</p> <p>^c The required reduction may be rounded to a specific number of megawatts (e.g. 1 000 MW rather than 980 MW).</p> <p>^d Customers who comply with the requirements in 4.5.3.2 may elect to curtail load as specified rather than be shed.</p> <p>^e The curtailment indicated here is mainly from systems such as geyser control, voltage reduction schemes, use of municipal generation offered by licensees and applies to customers who would otherwise be shed under subsequent stages (i.e. the load reduction provided is likely to already be included under subsequent stages, should these be required).</p> <p>^f Load reduction under a severe supply constraint is addressed in accordance with section 5.</p>			

Figure 5 illustrates the options available to eligible customers, based on the general requirements in Table 2. These options are detailed in 4.5.2 to 4.5.4.

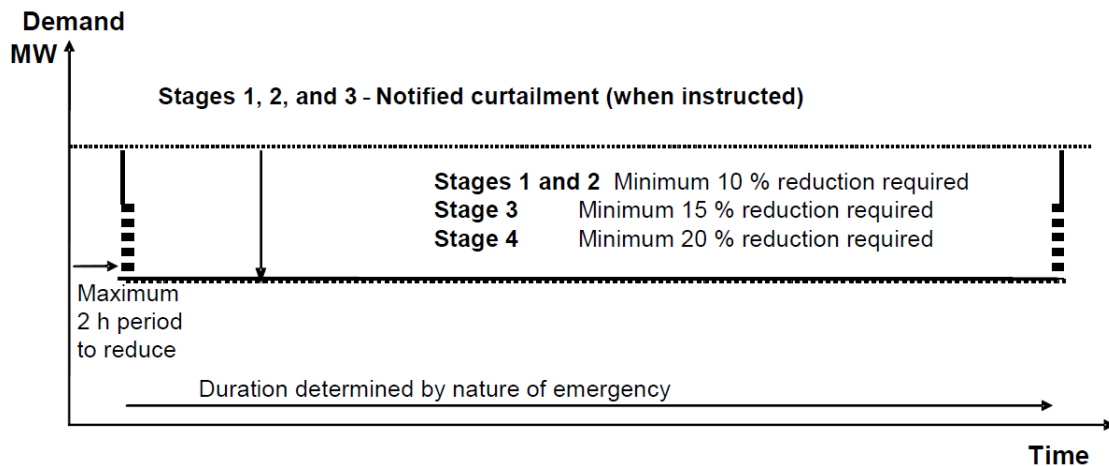
Customers who are eligible for curtailment shall be required to select an option up-front. This decision should be informed by the scenarios illustrated in Figure 2 and detailed in Table 1.

NOTE 1 The need to have stable schedules does not allow customers to select a curtailment option at the time of any emergency.

NOTE 2 Annex C provides practical approaches to addressing the needs of individual customers who are not eligible for curtailment. These may involve up-front costs that should be paid by the customer(s) concerned.



(a) Stages 1 and 2 rotational load shedding (stages 3 and 4 are similar, but at more regular intervals).



(b) Stages 1, 2, 3 and 4 notified curtailment for eligible customers

Figure 5 — Summary of load reduction options – a) Shedding or b) notified curtailment

4.5.2 Load shedding (Stages 1 to 4)

4.5.2.1 All customers shall be on the load shedding schedules, with the exception of

- a) critical loads and loads with essential load requirements, where such exceptions are provided for under conditions set out in this part of NRS 048 (see clauses 6 and 7);
- b) loads that comply with the requirements for notified curtailment (see 4.4.2 and 4.4.4);
- c) some loads that participate in the merit order (see 4.4.6);
- d) where alternative reduction options have been agreed with the licensee and approved by NERSA (see 4.1); and
- e) loads where exemptions have been pre-approved by NERSA.

Load shedding shall be executed in accordance with published schedules. Schedules shall be prepared for stages 1, 2, 3 and 4 in accordance with the requirements in 4.6.

4.5.2.2 Although utilities would establish time-based schedules using specific time slots (as specified in Annexure H), customers may engage with utilities to consider alternatives such as doubling the duration of being shed, whilst reducing the frequency of such shedding. Such discussions need to be finalized well before an emergency to ensure that the schedules are adapted for this request. Such requirements may not in all cases be possible for the licensee to meet.

Typical cases in which these may be accommodated are:

- a) where all the customers on a feeder agree on a similar requirement;
- b) where the customer can be isolated; and
- c) where a large customer is able to absorb the total load reduction requirement of a licensee. there would an agreement between the large customer and the other customers within the area of supply

Where a customer indicates as such, supplies that rely on each other should be considered in developing schedules.

4.5.3 Notified mandatory load curtailment (Stages 1 to 4)

4.5.3.1 A licensee may identify specific customers who, instead of being shed, can provide a pre-defined amount of load to be curtailed within a maximum of 2 h on instruction from the licensee.

NOTE 1 Given the requirements below, these will typically be larger customers.

NOTE 2 Such curtailment is not subject to payment, as might be the case in demand market participation schemes. The latter involves use of demand curtailment options much earlier in the merit order, where use of such options is determined at the time in the context of other demand and supply options (generally on a least-cost basis).

4.5.3.2 Customers who comply with the following requirements are eligible and should be accommodated for notified load curtailment under stages 1, 2, 3 and 4:

- a) the customer shall be able to offer at least 10 % of normal load for curtailment under stages 1 and 2, 15 % of normal load under stage 3 and 20 % of normal load under stage 4;
- b) this curtailment shall be maintained for the duration of the emergency, or as otherwise instructed by the System Operator during the system emergency (see NOTE 1);
- c) the curtailment shall be effected within an agreed time frame (notification time) based on the nature of the customer installation. The time-frame shall be 15 min to a maximum of 2 hrs (NOTE 2);
- d) the curtailment shall not affect the integrity of the national under-frequency load shedding scheme. For customers with under frequency loads on their premises the customer shall indicate which load is curtailed to obtain the required load reduction to confirm that the under-frequency scheme is not compromised. If it is the same load the customer shall supply an alternative load to be allowed to curtail;
- e) the required load curtailment can be measured and verified;
- f) the customer's essential load requirement is met through this curtailment (Note 3);
- g) protection of this customer from load shedding shall not result in the need to exclude significant other load from load shedding due to network limitations (i.e. recognizing this customer might not be on the same circuit as other customers that are on the load shedding scheme). Where this customer represents over 80% of the load supplied by a specific feeder, curtailment provided by this customer may be considered adequate. Where this criterion is not met, and where the customer can offer the equivalent load for curtailment, curtailment may be considered; and

- h) actual load curtailment instructed during an event complies with the requirements agreed upon with the licensee.

NOTE 1 Where an emergency is declared for several days, the System Operator may allow curtailment loads to return during periods of low demand, where the requirements to replenish reserves have been met (typically between 10 pm and 6 am the next morning).

NOTE 2 For example, where a residential estate participates in load curtailment, this should be in the same time-frame as load shedding – i.e. within 15 min of the instruction being given. On the other hand, a deep level mine may require 2hrs notification before the reduction is provided.

NOTE 3 Where it can be demonstrated that the essential load requirement can at times during the operating cycle not be met given the reduction required in each of the stages, the customer may engage the licensee on alternative options to provide demand reduction in a manner that ensures equity.

Where such conditions are not met, a customer shall not be eligible to be removed from the load shedding schedules (and may be placed back on the schedule if the actual load curtailment is not achieved during an event).

4.5.3.3 The base line for determining the percentage reduction shall be in accordance with Annex I, or as otherwise agreed between the customer, the licensee, and the System Operator.

4.5.3.4 Customers who participate under the notified load curtailment scheme

- a) shall be excluded from load shedding schedules (Stages 1 to 4); and
- b) shall not exceed normal demand profile for 12 h after the emergency with the exception of the periods between 23h00 and 04h00 the next morning.

4.5.3.5 Customers who can demonstrate the ability to manage the required percentage reduction across several independent installations in a given supply area may be accommodated (e.g. a customer or group of customers may agree to completely close down one plant while other plants remain in operation). This arrangement applies to a national emergency (load reduction requirement), and should not compromise the specific requirements for regional load shedding in the event of a regional load shedding requirement (i.e. local supply constraints).

4.5.3.6 A licensee may use preferred load curtailment information provided by several independent customers to develop a co-ordinated load curtailment plan. This plan shall demonstrate the ability to manage the required percentage reduction across several customers within a single licensee's area of control (i.e. a customer may choose to completely close down one plant while other customers remain in operation). A licensee cannot guarantee that the notified requirements for load curtailment can be accommodated in such a plan. In cases where combined offerings are required over multiple licensee areas, then this should be handled through the exemption process (refer 1.4).

NOTE A survey of large customer curtailment preferences has indicated that even within the same sector, customers sometimes have different preferences – i.e. some customers may prefer to curtail by 80 % for a day and then resume normal operations, rather than reducing by 10 % or 20 % for several days should the emergency last this long.

4.5.3.7 In the event that a customer does not achieve the load curtailment requirements during an emergency, the licensee shall have the right to shed the customer after reasonable notice has been given, and to place the customer on the load shedding schedule going forward.

4.5.4 International customers

4.5.4.1 Cross-border load to other utilities supplied by South African generators shall be treated equitably with South African customers in the event of national or regional load reduction. Cross-border load reduction requirements should be (at least) the same percentage as the load reduction required in South Africa – i.e. the sales from South Africa to these countries shall be reduced by the same amount under the reduction instructed.

NOTE This requirement implies that during a national emergency, energy sales from South Africa will be reduced.

4.5.4.2 In the event that power is wheeled through the South African network from one country to another, the reduction requirement would not apply. In the case of an emergency in the Southern African region, a reduction might, however, also be required in power wheeled through South Africa.

4.5.5 Exclusions based on participation in the merit order

4.5.5.1 Where interruptible load has been contracted on a commercial basis as part of the merit order (i.e. in terms of a special pricing agreement or in terms of demand market participation), these loads may be excluded from the first two stages of manual load reduction schedules in accordance with the requirements in section 4.5.5.3. Under emergency conditions, specific agreement may be reached with these customers on further load curtailment.

NOTE Interruptible load is required by the System Operator also during emergencies to manage short-term variations on the system.

4.5.5.2 The System Operator (or its agent) shall advise each licensee of all contracted Demand Response Participants embedded within that licensee's networks.

4.5.5.3 Where it is technically feasible to isolate such customers, customers on supplemental demand response may be excluded from Stage 1 and 2 load reduction under the following conditions:

- a) the customer shall participate with a minimum of 25 % of their average MW load (Annexure I). The customer's average MW load is based on the consumption between 05h00 and 22h00, weekdays only;
- b) the customer shall be available and assist when called at least 150 times per annum/contract period;
- c) the minimum load reduction event period shall be 2 hours;
- d) the load reduction performance when called upon shall be at least 90 % of the reduction required under normal plant conditions;
- e) where the customer's processes and/or technologies do not allow them to reduce 25 %, the customer shall participate with the same volume energy not consumed. This might mean that the customer is required to participate more than 150 times per annum or reduce for longer event hours. Under these conditions, the minimum requirement is for the customer is to provide at least 20 % of their average MW load;
- f) where customers are able to provide SDR above 25 % at a particular plant, they may carry over the additional reduction beyond 25 % to other plants within their group; and
- g) these customers shall participate in Stage 3 and 4 load curtailment.

4.5.5.4 Where it is technically feasible to isolate such customers, customers on Instantaneous demand response may be excluded from Stage 1 and 2 load reduction under the following conditions:

- a) the customer shall participate with a minimum of 25 % of their average MW load (Annex I). The customer's average MW load is based on the consumption between 05h00 and 22h00, weekdays only;
- b) the customer shall be available and assist when called at least 200 days per annum/contract period;
- c) the available amount of times a day shall be at least 2 events;
- d) the maximum load reduction event period shall be 10 min;

- e) the load reduction performance when called upon shall be at least 90 % of the reduction required under normal plant conditions;
- f) IDR provides protection from stage 1 and 2 curtailment only at plant level. Customers may not carry over additional reduction to other plants within the same group; and
- g) these customers shall participate in Stage 3 and 4 load curtailment.

Table 3 — Exemption rules for customers participating in a contracted demand response programme.
 (NOTE This excludes participation in the automatic under-frequency protection scheme and residential demand response)

1	2	
Type	Exemption rules	
	Requirement	Exemption
Supplementary demand response (SDR)	25 % of average demand, at least 150 times per annum, for at least 2hrs (or equivalent volume of energy as in 4.4.6.3)	Stage 1 and 2
Instantaneous demand response (IDR)	25 % of average demand, at least 200 days per annum, at least twice a day for up to 10 min	Stages 1 and 2
NOTE 1 The SDR exemption may be applied at plant or group level, whilst the IDR exemption shall only be applied at plant level.		
NOTE 2 Both the SDR and IDR contracts will limit the maximum usage. The requirement indicated is the threshold for exemption.		

4.5.5.5 The System Operator shall determine how much supplemental or instantaneous demand can be contracted for a given period.

4.5.6 Interruptible load as a term of contract

Where interruptible load is a general requirement under the contract, and not applied commercially as part of the merit order, this shall be considered as load curtailment – however, the customer shall comply with all the requirements under load curtailment to be kept off the load shedding schedules.

4.6 Load reduction requirements in the event of a regional emergency

Given the difficulty in determining the specific areas affected in the event of a regional or local network capacity constraint, specific load reduction requirements are not pre-determined.

However, where possible in the event of a regional supply constraint, load reduction should be undertaken using the schedules developed for national load shedding.

If not possible, then emergency plans pertinent to particular areas should include locally relevant load shedding schedules.

NOTE The nature of a regional or localized event might require higher stages of load shedding at peak periods.

4.7 Execution of emergency load reduction

4.7.1 Conditions for the declaration and lifting of a system emergency

4.7.1.1 The declaration of a system emergency is a requirement for implementing manual mandatory load reduction (load shedding and/or load curtailment) as defined in this part of NRS 048.

4.7.1.2 The declaration of a system emergency shall be made by the System Operator in the event of a national power system constraint.

4.7.1.3 Once a system emergency has been declared, the initiation and termination of load shedding and/or curtailment shall be executed under the instruction of the System Operator.

NOTE 1 The declaration of a system emergency does not automatically mean that the initiation of load shedding or curtailment has been instructed by the System Operator. The initiation, termination, or change of stage of load reduction is specifically instructed under a system emergency.

NOTE 2 The declaration of a system emergency is an operational protocol. The manner in which this is communicated externally is addressed in section 4.7.3.

4.7.1.4 Conditions under which the System Operator might declare a system emergency include, but are not limited to, the following:

- a) should the power system immediately enter a state of collapse;
- b) should the system begin to proactively approach a state of collapse (i.e. where reserves need to be prudently managed in terms of the System Operator's mandate to ensure the security of the national power system); or
- c) on a planned basis to address a medium to long-term system constraint, where no alternative load reduction protocols have been approved by NERSA, and where at least 48 hrs. notice has been provided to NERSA, customers, and stakeholders (see 4.6.5).

4.7.1.5 The System Operator shall lift the declared system emergency once the constraint is lifted.

4.7.2 Power system alert protocol and early warning

4.7.2.1 In the event of a high risk of national load shedding, the System Operator shall issue a "Power System Alert" instruction to Eskom Distribution control centres, who in turn should issue this instruction to all municipal control centres that undertake their own load reduction.

NOTE 1 Such an instruction is generally given telephonically and recorded digitally.

NOTE 2 The System Operator may also at times choose to issue a "Power System Early Warning" communication when system conditions can be expected to deteriorate to the point where a formal Alert instruction might be issued. Such a communication does not require a formal action by downstream control rooms.

4.7.2.2 In the event that a "Power System Alert" instruction has been issued by the System Operator, all control rooms shall prepare for the execution of load shedding at short notice.

4.7.3 Power System Emergency protocol and implementation of load reduction

4.7.3.1 In the event that national load reduction will be initiated, the System Operator shall issue a "Power System Emergency" instruction to Eskom Distribution control centres, who in turn should issue this instruction to all municipal control centres that undertake their own load reduction.

NOTE Such an instruction is generally given telephonically and recorded digitally.

4.7.3.2 When instructing the initiation of emergency load reduction, the System Operator shall specify:

- a) the applicable stage of load reduction;
- b) whether load curtailment, load shedding or both are being implemented;
- c) the time at which load shedding shall commence, and, if applicable; and
- d) the time by when load curtailment shall commence and by when the required reduction should be in place, bearing in mind the minimum notice period required.

When instructing the termination of emergency load reduction, the System Operator shall specify:

- a) the time at which load shedding should be terminated; and
- b) the time, from which curtailment customers may begin to pick up load again.

4.7.3.3 An instruction to terminate load reduction shall be accompanied by the time at which the control center may begin restoring load that has been shed.

4.7.3.4 All control centres shall report to their upstream control rooms:

- a) when the load under the instructed Stage has been shed and approximately how much has been shed (MW); and
- b) when all the load has been restored after the instruction to restore.

NOTE In order to manage the system frequency during the restoration of load, not all control rooms might be instructed to return load at the same time by the System Operator.

4.7.4 Use of load curtailment vs. load shedding, load limiting and load switching

The System Operator shall determine if load shedding (as well as load limiting and load switching), notified load curtailment, or both methods of load reduction will be instructed, based on the following guidelines:

- a) In the event of the need for an immediate load reduction, load shedding (as well as load limiting and switching) will most likely be required, given the response time (15 min -30 min);

NOTE Should load shedding be called over an evening peak, it is possible that load curtailment may not be required, as the longer time required for load curtailment will be unable to meet the load reduction requirement.

- b) In the event of a pro-active declaration of an emergency, the applicable notice should be given to affected customers at what time load curtailment is instructed. The instruction to prepare for load shedding should be issued to all control centres, however the instruction to proceed with load shedding might be instructed only should system conditions require this;

NOTE Should load curtailment be called before evening peak, it is possible that load shedding may not be required if the load reduction obtained from curtailment and public announcement of the system emergency is adequate.

- c) That for the purpose of meeting the winter peak, load shedding (as well as load limiting and switching) may be implemented, without curtailment, provided that the expected load reduction is either Stage 1 or Stage 2. Where a load reduction of greater than Stage 2 is anticipated at least 2 hrs. before the constraint, the System Operator should call on the appropriate level demand curtailment 2 hrs. before the expected constraint;
- d) Stage 3 or 4 load curtailment should not be instructed without at least load shedding (as well as load limiting and switching) (Stages 1 and 2) having also been implemented or anticipated; and
- e) Load curtailment should not be implemented for a period of more than 24 hrs. without load shedding (as well as load limiting and switching) also having been implemented.

4.7.5 Managing medium/long-term system constraint

4.7.5.1 Noting the potentially negative impact of regular but unpredictable load reduction on customers, in the absence of an alternative load reduction protocol approved by NERSA, the following approach should be adopted in managing medium- to long-term system constraints:

- a) planned load reduction (shedding and/or curtailment) may be implemented by the System Operator to improve predictability for customers where load shedding is required for extended periods of time (weeks to months);

- b) where possible, customers shall be informed day(s)/week(s) ahead in advance of the expected load reduction regime (i.e. the expected load reduction Stage and applicable schedules to be implemented). This notwithstanding that system conditions and operational requirements on the day may at times result in variance from the communicated reduction regime; and
- c) planned load reduction may be deployed by the System Operator before use of some peaking plant and reserves in order to: (i) limit the variance from the communicated load reduction regime and (ii) ensure adequate operating and emergency reserves in managing the security of the national power system.

4.7.5.2 Noting the requirements of the related regulatory standard NRS 047, the following approach should be adopted when pro-actively implementing planned load reduction in the event of a medium- to long-term system constraint:

- a) Eskom shall inform NERSA in writing of the reasons for such actions within at least 48 hours before the planned implementation;
- b) Where time permits and the security of the power system is not at immediate risk, Eskom shall provide its customers with advance notification of the intent to implement planned load reduction, with a minimum notice period of at least 48 hours in advance; and
- c) This notification shall include the expected start time and period(s) of load reduction.

4.8 Load shedding schedules

4.8.1 General requirements

4.8.1.1 Licensees shall be responsible for the development and maintenance of their load shedding schedules, and for communicating these to their customers.

4.8.1.2 Maintenance of the schedules should include ad hoc revisions in response to changes in the operating environment, as well as a formal review every year.

4.8.1.3 Where the supply areas of one or more licensees adjoin one another, the licensees should take account of the need for co-ordination when load shedding is being scheduled - particularly in respect of factors such as traffic flows, and fuel and sewage pumping.

4.8.1.4 An individual licensee may choose to be completely shed instead of implementing its own rotational shedding. This shall be undertaken in consultation with the upstream licensee supplying this licensee. The final arrangement shall not negatively impact on the integrity of the load shedding regime. The licensee shall remain responsible for communicating schedules to its customers, and for managing the critical and essential load requirements of its customers.

4.8.1.5 The national load shedding allocations shall be agreed between the upstream and downstream utilities at least annually.

4.8.1.6 Audits may be undertaken by the System Operator from time to time to provide assurance that the self-rotating utilities can demonstrate the ability to load shed as described in this code of practice. Licensees must be able, on request, to demonstrate to the System Operator and NERSA that the schedules meet the requirements of this code of practice.

4.8.1.7 The latest schedules shall at all times be immediately available to operational staff.

4.8.2 Design of load shedding schedules

4.8.2.1 The load base to be shed (shedtable load) shall be determined for each stage as follows:

- a) each control centre shall determine the load (in MW) under its control based on the previous year's peak demand;
- b) from this load, critical loads, international loads, and any loads that form part of the merit order that are explicitly excluded from shedding served under the stage of shedding by the control centres shall be subtracted to obtain the base load on which the required reduction for that control centre is determined;
- c) the load to be shed by each control centre shall be determined by subtracting the load under curtailment from the control centre's base load. This is the non-curtailment load; and
- d) each control centre shall follow the schedule requirements and submit the resulting load block size for each of the four scheduled stages to the upstream control centre.

4.8.2.2 Licensees shall build load shedding blocks based on the normal feeder annual peak demand associated with a particular feeder breaker (see NOTE 2). Licensees should take into consideration potential diversity between feeder demands so as to ensure that the overall reduction complies with the requirement in each time slot.

NOTE 1 This pragmatic approach is taken for the reasons summarized in annex D. Where the actual load reduction might not be sufficient at certain times of the day, the System Operator (or regional control centre in the case of regional events) will compensate by making adjustments to the stage of shedding instructed.

NOTE 2 Normal annual peak demand excludes operating conditions where a feeder is used to supply (back feed) loads that are not normally associated with that feeder.

4.8.2.3 Annexures F, G and H provide guidelines for the development of schedules.

4.8.2.4 Where a customer prefers to be shed repeatedly at the same time of the day for successive manual load shedding events, as opposed to the rotation of time slots, where possible this may be provided for. This subject to the licensee ensuring that the impact on affected parties is not significant, and that schedules can be adapted to accommodate this.

NOTE For example: (i) in respect of traffic signals, to mitigate interruptions to city centres during peak traffic times, (ii) in respect of interdependent companies that work in the same sector such as manufacturing processes dependent on air products.

4.8.2.5 If practical, schedules may be adjusted to accommodate customers who prefer to be shed for a longer period of time, but less frequently.

NOTE For example, where several of such customers can be coordinated to provide the necessary load reduction over the various days.

4.8.3 Technology solutions as an alternative to load shedding

4.8.3.1 Where technology options such as curtailment using load limiting relays become available, the schedules shall be revised accordingly.

NOTE For example, larger residential areas may rather be subject to curtailment than shedding for the same load requirement to be achieved.

4.8.3.2 A licensee may choose whether to use load limiting on a rotational basis using schedules or to apply load limiting to all customers at the same time.

4.8.4 Addressing under-frequency protection requirements in schedules

4.8.4.1 The integrity of automatic under-frequency protection schemes shall be maintained during load shedding and curtailment. The approach taken by various licensees may differ as long as the integrity of the national automatic under-frequency load shedding scheme is maintained. (see Annex A).

4.8.4.2 In the absence of a specifically designed method, the following procedure shall be applied to address the implications of load being shed or curtailed also being required for under-frequency load shedding during a particular stage:

- a) each control centre should determine the load under its control;
- b) for the first 10 % of system load required for automatic under-frequency load shedding, a percentage of this total requirement shall be allocated to various time slots on the load shedding schedule; and
- c) a proportionate increase in the available load for the under-frequency load shedding scheme shall then be implemented to address the load that may not be available in any given time slot.

The System Operator shall specify the maximum and minimum deviations from the planned automatic reduction as part of the under-frequency scheme specifications.

An example of coordinating under-frequency load shedding scheme requirements with load shedding schedules is provided in Annex A.

4.8.5 Changes to load shedding or curtailment schedules

The ability to adjust schedules is important to limit the societal impact of load shedding. Such adjustments may be

- a) planned – in accordance with 8.6.6, certain sites may be removed from the schedules, or
- b) unplanned – for example in response to a concern raised during load shedding with respect to a critical load.

4.8.6 Catering for special events

4.8.6.1 In the case of special events (such as national and international events that involve large numbers of people), certain loads may be temporarily protected from load shedding.

NOTE The implication is that more load shedding will be required in other parts of the network for the duration of the special event.

4.8.6.2 It is the responsibility of the licensee to revise its schedules to ensure that the required load to be shed is available.

4.8.6.3 In exceptional cases of national or regional interest, an agreement may be reached with the System Operator for selected sites may be removed temporarily for the duration of the event without implementing 4.8.6.5.

4.8.7 Catering for non-electricity related emergencies

4.8.7.1 In the case of emergencies that require electricity to be maintained to a given supply area, certain loads may be temporarily protected from load shedding.

NOTE Examples include where this is a disaster risk mitigation or, where significant security incidents are being managed.

4.8.7.2 Such temporary protection and the impact on the reduced load expected to be shed shall be agreed with the System Operator.

4.8.7.3 Where the incident is of a duration of more than 21 days, the System Operator may require the schedules to be revised to provide the require load reduction.

4.9 Operational information exchange

4.9.1 Information related to the implementation of load shedding schedules

4.9.1.1 Eskom Distribution control centres shall provide the System Operator with information on the manner in which load reduction requirements have been implemented for the various stages as and when required by the System Operator.

4.9.1.2 Municipal and metropolitan control centres shall provide the Eskom Distribution control centres with information on the manner in which load reduction requirements have been implemented for the various stages as and when required by the Eskom Distribution control centre.

4.9.2 Real-time information on the system status

4.9.2.1 The System Operator shall make daily system status information available to regional, municipal and metropolitan control centres.

NOTE This information might also be made available to curtailment customers.

4.9.2.2 This information shall provide an indication of the expected need for emergency load reduction for the day.

NOTE At the time of publication of this part of NRS 048, technical information on the weekly system status can be found at www.eskom.co.za (i.e. the system adequacy report).

4.10 Communication with customers and stakeholders

4.10.1 Information related to load shedding schedules

4.10.1.1 All licensees shall make load shedding schedules available to their direct customers. An appropriate mechanism for communicating changes to schedules should be implemented.

4.10.1.2 Licensees who do not shed their own customers (i.e. shedding is executed by the licensee supplying them), shall remain accountable for the communication of load shedding schedules to their direct customer.

NOTE Such schedules may be published in print media, made available on a website, or attached to electricity bills.

4.10.2 Prior notice of mandatory load reduction under a system alert

4.10.2.1 Licensees should, where practicable, notify their direct customers when the System Operator has issued notice that load shedding or curtailment has been or is expected to be implemented.

4.10.2.2 In the case of critical loads, specific communication requirements related to impending load shedding are prescribed in clause 7.

4.10.2.3 Where practicable, licensees should inform curtailment customers by direct communication (e.g. SMS, telephone, email) when there is a high probability that load shedding or curtailment may implemented.

4.10.2.4 Licensees are encouraged to identify other customers who will be notified by direct communication (e.g. SMS, telephone, email), whilst the bulk of customers may receive such communication through media primarily such as radio and television.

NOTE If, for example, a national generation capacity shortage is expected at evening peak, such notification may be issued during the day. However, if such a shortage was unexpected, the notification period may be short.

4.10.3 Notice of mandatory load reduction implemented under a system emergency

4.10.3.1 The media shall be informed when mandatory load reduction or curtailment is being implemented. This information shall include the stage of load reduction implemented, the start time, and the expected duration (or end time).

NOTE In the case of national load shedding, such media communications is the responsibility of Eskom. In the case of mandatory load reduction due to a constraint within municipal boundaries, it is the responsibility of the municipal authority to communicate this to the media.

4.10.3.2 Notified curtailment customers that have signed agreements in this regard shall be instructed to implement mandatory load curtailment via the agreed protocol (typically verbal instruction). These customers shall also be provided notification in writing retrospectively that a System Emergency was declared, based on communications to this effect provided by Eskom in the event of a national or provincial constraint, and the licensee in the case of a local constraint.

NOTE Whilst declaration of a System Emergency is primarily an operational requirement, curtailment customers require notification in writing that a System Emergency was declared in the event that insurance claims arise from the execution of (self) curtailment.

4.10.4 Information related to the system status

Information on the general status of the system shall be made available by the System Operator to customers. Such information should include:

- a) anticipated system constraints for the next 3 months;
- b) week-a-head system status; and
- c) system status on the day.

NOTE 1 This information may assist customers in making decisions regarding the operation of their plant. However, by the nature of certain types of system events, a healthy system status report is no guarantee that an emergency cannot occur at any time after the report has been issued.

NOTE 2 At the time of publication of this part of NRS 048, technical information on the weekly system status can be found at www.eskom.co.za (i.e. the system adequacy report).

4.10.5 Information related to unplanned interruptions to customers

4.10.5.1 Licensees should make information available to customers about networks that are affected by unplanned interruptions during load shedding. This information should include the affected areas and expected time of restoration of supply.

4.10.5.2 Licensees should make information available to the media on request about networks that are affected by unplanned interruptions during load shedding.

NOTE Unplanned interruptions may occur from time to time during periods of load shedding that impact the perceived time and duration of load shedding negatively.

4.11 Reporting

4.11.1 Real-time operational reporting

The following reporting shall be implemented on a daily basis during load shedding:

- a) the municipal control room shall for each time period report to the Eskom control room the estimated amount of load shed, the expected load curtailed and, where relevant, the additional generation used in lieu of load reduction; and

NOTE The actual curtailed load may not be available, hence the expected load curtailed is based on the curtailment agreement in place.

- b) the Eskom control centre will summate the estimated total load shed and curtailed for the supply area as well as the additional generation provided and report a single load reduction number to System Operator.

4.11.2 Annual licensee performance reporting to NERSA

Licensees shall retain records of load shedding undertaken (estimated load shed at each time slot) for the purpose of reporting that may be required by NERSA. This information shall be retained for at least 5 years. This information is also required as a basis for exclusions in interruption performance reporting specified in NRS 048-6 and NRS 048-8.

NOTE NRS 048-6 and NRS 048-8 require that load shedding events be removed from interruption performance statistics when reporting.

4.11.3 General

The use of contracted demand response resources used as part of the merit order to manage load, shall not be reported as part of load shedding or curtailment.

NOTE For example, contracted interruptible loads and demand response participation (DR) customers.

4.12 Technology applications to reduce impact on customers

4.12.1 General

Several existing and emerging technologies have the potential to reduce the impact of load shedding on customers.

4.12.2 Metropolitan and municipal generation

4.12.2.1 Where a municipality or metropolitan municipality has embedded generation, and such generation is not already included in the normal load profile of the municipality, such generation may be used to reduce the load reduction required under emergencies.

4.12.2.2 Such generation may be offered as unscheduled reduction under a system constraint, particularly where the possibility of further stages of load reduction can be avoided. Where this generation has been considered as part of the load reduction required during subsequent stages, offering such generation voluntarily when called on under a system constraint should not increase the required reduction from individual municipalities or metropolitan municipalities during subsequent stages of load reduction.

NOTE Cost and resource limitations (e.g. pumped hydro schemes) might impact on the decision by a municipality or metropolitan municipality to offer this. However, this increases the likelihood that the System Operator needs to declare a Stage 1 emergency – at which stage such generation is likely to be applied in any case.

Customers with internal generation capability, but who are still taking some supply from a licensee, should be required to reduce load according to this part of NRS 048, if their generation follows a regular usage pattern.

Customers who have generation that is not normally scheduled should be allowed to generate to reduce their off take by the same amount required for load curtailment in lieu of load shedding load. If they have an agreement with the single buyer office to generate (e.g. gas turbine peaking plant) this plant cannot be used to off-set load reduction requirements.

4.12.3 Geysers control

4.12.3.1 Geysers control, where not part of the normal load profile, can be used to offset load shedding.

NOTE Where geysers control is used as a normal part of managing peak demand by a licensee, the requirement for additional load reduction during a system emergency may not be available from these systems. These may, however, be useful for emergency applications during off-peak periods.

4.12.3.2 Where geysers control is used for extended periods that overlap with periods when geysers control would normally have operated, additional load reduction is required.

4.12.3.3 Where used, geysers control should ensure that cold load pick-up does not negate the load reduction required.

4.12.3.4 The public should be informed that this is being implemented, and the regime being deployed.

4.12.3.5 Licensees should assess the scheme to assess the load reduction achieved in lieu of load shedding and report on this in accordance with the reporting requirements outlined in section 4.11.

4.12.4 Voltage reduction schemes

4.12.4.1 Voltage reduction schemes may be applied on carefully selected feeders to reduce demand during an emergency, where this is not likely to result in contraventions of the requirements of NRS 048-2.

NOTE 1 It is important to take into consideration that in residential networks, emergency load reduction is most likely to coincide with peak loading on the feeder – i.e. when the lower voltage limit specified in NRS 048-2 is at the greatest risk of being transgressed.

NOTE 2 Voltage reduction on urban networks is generally more feasible than on rural networks, which are by their nature more likely to be voltage constrained.

4.12.4.2 Where such schemes are implemented by a licensee, the licensee should provide appropriate evidence that the required load reduction is achieved.

4.12.4.3 Licensees should assess the scheme to assess the load reduction achieved in lieu of load shedding and report on this in accordance with the reporting requirements outlined in section 4.11.

4.12.5 Smart metering and load limiting schemes

4.12.5.1 Smart meters and intelligent load limiting schemes may be deployed as a technology solution to limit the impact on customers, whilst still providing a load reduction under a system emergency.

NOTE 1 The implementation of smart metering and load limiting schemes allows greater flexibility in protecting critical loads from load shedding on a given circuit (i.e. allowing these to remain connected, whilst other customer loads on the same circuit are interrupted or curtailed).

NOTE 2 The implementation of smart metering and load limiting schemes allows individual customers to maintain supply to limited appliances (e.g. lighting, computers, televisions, wifi routers etc.)

NOTE 3 Emergency load reduction may be achieved through facilities such as load limiting (setting a dynamic current threshold) and appliance control (direct switching of appliances such as pool pumps).

4.12.5.2 Where the equivalent reduction can be demonstrated, smart metering and load limiting schemes may be used by licensees to off-set their load shedding requirements under Stages 1 to 4, as well as under extreme system constraints (Stages 5 to 8).

4.12.5.3 Load limiting or load switching may be implemented to achieve curtailment in accordance with the required stages (percentages) of load curtailment in Table 1.

4.12.5.4 Load limiting or load switching may be implemented to achieve the equivalent of rotational load shedding on a rotational basis in accordance with the required stages of load shedding (Table 1).

4.12.5.5 In both 4.12.5.3 and 4.12.5.4 the following shall apply

- a) the notification period should be restricted to a maximum of 15 minutes;
- b) the licensee should adjust the current limit threshold or have the loads switched to achieve the required load reduction; and
- c) customers shall be treated equitably.

NOTE The current limit is likely to be much smaller where smart meters are used to provide the equivalent of rotational load shedding.

4.12.6 Feeders with embedded generation

Feeders with embedded generation should be addressed on a case-by case basis, whilst ensuring that the required demand reduction is met. Where there is uncertainty, the System Operator should be consulted to determine the adequacy of the reduction regime.

NOTE Examples include Cooperation between customers and generators on the feeder to ensure that the feeder demand requirement meets the equivalent load shedding requirement (e.g. customers reduce demand over the two hour period), and/or the implementation of smart meters.

5. Extreme supply constraint (Contingency planning)

5.1 General

5.1.1 The System Operator is responsible for developing, maintaining, and testing plans for an extreme power system constraint. Such a constraint may require load reduction beyond that provided by Stage 4 schedules and curtailment.

5.1.2 Licensees shall develop emergency load reduction protocols and schedules that support the plans for an extreme supply constraint, as indicated in this section.

NOTE The Disaster Management Act No.57 of 2002 requires plans to be in place to manage all identified electricity related disasters, including those with a low likelihood of occurrence. An extreme supply constraint is one such disaster scenario. In order to ensure adequate preparedness for such a scenario, licensees are required to prepare contingency schedules in accordance with this section of the code of practice.

5.1.3 Where practicable, an extreme supply constraint shall be managed in terms of the measures and associated priorities indicated in. The System Operator may however at any time at its discretion implement alternative interventions, should these become necessary.

Table 4 — Mechanisms and associated priorities for responding to an extreme supply constraint (beyond Stages 1 to 4).

1	2	3
National power system load reduction required	Mechanisms	Priorities
Approximately 1000MW to 4000MW	(a) Load shedding in terms of published schedules Stages 1-4 (b) Load curtailment (Stages 1&2 10%, Stage 3 15%, Stage 4 20%) (c) Load reduction via limiting and load switching (Smart Meters) (NOTE See Table 1)	(a) Controlled, manual, mandatory load reduction implemented by control rooms and customers under instruction by the System Operator. (b) Minimised impact on customers through limiting the load curtailment requirement and the duration of load shedding time slots. (c) Pre-published schedules in place to provide predictability. (d) Critical loads managed through schedules and associated protocols.
Approximately 4000MW to 8000MW	(a) Contingency schedules Stages 5-8 (b) Load curtailment down to essential load requirements as instructed by the System Operator (either all customers or on a rotational basis) (c) Load reduction via limiting and load switching (Smart Meters) (NOTE See Section 5)	(a) Controlled, manual, mandatory load reduction implemented by control rooms and customers under instruction by the System Operator. (b) Limiting potentially large system frequency variations. (c) Limiting the extended operational impact of load reduction on distribution licensees. (d) Supply to essential loads (as far as is practicable) (e) Critical loads managed where possible through schedules and associated protocols. Customer contingency planning essential. (f) Contingency schedules in place and made available should these be required.
Beyond 8000MW	As instructed by the System Operator	(a) Managing system frequency. (b) As far as possible, maintaining an integrated power system, but pre-emptive islanding if necessary. (c) Open transmission lines to control voltages. (b) Maintaining generation to initiate system restoration after the constraint.
NOTE The System Operator will generally instruct licensees and curtailment customers to implement load reduction as required. In exceptional cases and/or when a rapid response is required, the System Operator will intervene directly by interrupting bulk supply to specific areas.		

5.2 Contingency schedules for extended load shedding

5.2.1 Minimum requirements for contingency schedules

Contingency load shedding schedules shall comply with the following minimum requirements.

- a) **transition from Stage 4:** Schedules beyond Stage 4 shall be implemented so as to facilitate a smooth transition from Stage 4; and
- b) **magnitude of the load switched:** The load switched out at any transition from one time slot to another shall not be larger than the blocks of load being shed under Stage 4.

NOTE The approach adopted in responding to an extreme supply constraint is to limit the complexity and magnitude of load reduction beyond Stage 4, manage critical and essential load requirements, as well as to ensure a smooth transition from Stage 4 shedding to subsequent extreme stages. This is necessary given control system limitations, operational limitations, and the impact on system frequency variations of increased load switching.

5.2.2 Design of contingency load shedding schedules

In the absence of any other approach approved in writing by the System Operator, contingency schedules for extended load shedding shall be based on the Stage 1 to 4 schedules in accordance with the minimum requirements in 5.2.1 and the design parameters defined Annex J.

5.2.3 Execution of contingency load shedding schedules

Licensees shall execute the schedules as instructed by the System Operator.

The System Operator may instruct staggered implementation of the schedules as these are initiated and in the transition to the following block of load during load rotation (see NOTE 1 and 2). Licensees shall ensure that control and field staff is adequately trained to implement such staggered schedules.

NOTE 1 The System Operator may instruct some areas of the country to execute these earlier than others in order to manage the impact on system frequency – typically over a period of 30 min.

NOTE 2 The System Operator's priority of managing system frequency under a severe system constraint exceeds the priority for schedules to be accurately adhered to. Under a severe system constraint system frequency may be impacted more than under normal conditions due to (i) the larger load returned to the system when a block of load is restored and (ii) the smaller frequency bias of the system when it is serving less demand (i.e. a smaller change in load or generation gives rise to bigger variation in frequency).

5.2.4 Extended load curtailment

An instruction may be issued by the System Operator for curtailment customers to reduce their load to the pre-determined essential load requirement. This instruction may be issued to all customers simultaneously or may be instructed on a rotational basis. The notification period shall, where practicable, take into consideration the safety and environmental implications on the customer installation.

NOTE Example: A 6 hour period may be required to evacuate some deep level mines.

The instruction for curtailment customers to curtail beyond Stage 4 should, where practicable, not be implemented for more than 24 hrs without extended load shedding schedules being invoked.

5.2.5 Extended load limiting and appliance switching

Load limiting may be instructed through instructing a deeper limit or increasing the duration of the reduction.

5.3 Load reduction beyond the contingency schedules

The system operator will instruct load reduction or undertake switching to reduce demand as required, should this be required. Licensees shall respond as instructed.

6. Blackout restoration

6.1 General

6.1.1 The System Operator is responsible for developing, maintaining, and testing plans for restoring supply after a national or regional blackout.

6.1.2 Licensees shall support the System Operator in developing restoration plans that support the national and regional restoration plans.

6.1.3 Restoration plans should as far as possible take essential load requirements into consideration, once the system is adequately stable.

NOTE 1 It should be noted that stabilization of the power system will generally take precedence over restoring supply to specific customers (including essential loads).

NOTE 2 The National Disaster Management Centre and the Provincial Disaster Management Centres are responsible for overseeing the development of multi-sectoral plans for a country response to a national or

regional blackout. Licensees are required in terms of the Act to engage with the disaster management structures to develop coordinated plans.

6.2 Licensee responsibilities

6.2.1 Licensees are responsible for developing, maintaining and testing plans for restoring supply after a regional or local blackout. These plans should be reviewed annually. The plans should take the essential load requirements of clause 6 into consideration.

6.2.2 Licensees are responsible for ensuring that their management plans for restoring supply after a blackout are incorporated in the national and provincial multi-sectoral plans to respond to a blackout.

6.2.3 A customer's supply may be cut off if that customer exceeds the notified essential load data during the restoration process.

6.3 Customer responsibilities

6.3.1 Customers should provide their suppliers (licensees) with information on essential load requirements in terms of the requirements in clause 6.

6.3.2 Customers may also be required to cooperate in the case of exercises related to blackout preparedness.

7. Essential load requirements

7.1 General

7.1.1 A register of essential loads is required by a licensee for the prioritization of restoration of supply in the case of a major system incident or blackout. Customers are required to provide the necessary information to ensure that they are prioritized for restoration after a major system incident or blackout.

7.1.2 The essential load requirement agreed in writing with the licensee is also the maximum customer load that will be supplied should load reduction be implemented under an extreme supply constraint (see section 5), and where this is practicable.

7.1.3 An essential load requirement agreed with the licensee can generally be met during load reduction emergency (Stages 1 – 4 as well as under extreme conditions up to Stage 8) by a licensee where customers meet the requirements of a curtailment customer. Where this is not the case, such essential load requirements may not be possible to be supplied unless interventions are agreed with the licensee.

7.2 Application by licensees

7.2.1 Licensees are required to collect essential load data and to appropriately address customer essential load requirements. Licensees should notify customers at least every two years that such information is required.

7.2.2 A licensee should provide its upstream licensee with the power supply requirements to comply with its essential load requirements (i.e. its own essential loads and that of its customers). Annex E provides the format for such submissions.

7.2.3 In the absence of a submission from a licensee, the maximum power requirement associated with essential load allocated to a licensee should be 20 % of the notified maximum demand. A licensee should evaluate its essential power requirements, and where these are greater than this amount, this will need to be justified based on

- a) individual essential load requirements from its customers; and
- b) essential load requirements in its area of supply (see Annex E for municipal and metropolitan municipality submissions).

7.2.4 Clarification of the requirements should be undertaken, where required. The upstream licensee should notify the licensee of the agreed essential load requirement.

7.2.5 A licensee cannot guarantee that essential load requirements can be met under supply emergencies.

7.3 Application by customers

7.3.1 Customers should notify their licensee of their essential load requirements. Such requirements should be regularly updated (at least every two years) by the customer to reflect any changes to processes or requirements (or both) with regard to safety or the environment.

7.3.2 Where a customer does not provide an essential load requirement, the licensee should be entitled to assume that no such requirement exists.

7.3.3 It is incumbent on a customer to ensure that appropriate measures are taken in the case of an interruption of the supply of electricity to an essential load.

7.4 Identification of essential load requirements

7.4.1 Essential loads are identified by customers within their own business environment. Customers should inform their supply authority of their essential load requirements by completing and submitting standard forms designed for this purpose (see Annex B). The relevant supply authority should collate such information and compile a registry of essential load requirements within his area of supply.

7.4.2 The essential load requirements may be subject to verification by the licensee in terms of the following criteria:

- a) critical safety;
- b) critical environment impact; and
- c) critical national product.

7.4.3 Where the submission does not comply with these verification requirements, the licensee should inform the customer.

7.4.4 Customers with essential load requirements should ensure that appropriate backup systems are in place, as restoration times cannot be guaranteed for the various possible system emergencies that could occur.

7.4.5 Where customers meet the requirement for curtailment, essential loads may be catered for under the load not curtailed. Where essential loads are embedded in networks that are shed, protection against load shedding may not be possible.

7.5 Identification of loads with essential load requirements

All customers in the following categories should be required to provide essential load details:

- a) deep level mines;
- b) hospitals and medical centres with life-support requirements;
- c) sewerage systems;
- d) prisons;
- e) refineries;
- f) national key points reliant on electricity for their core operations; and

g) potable water systems.

NOTE In the case of some customers' processes, the essential load requirement might belong to another customer who is providing an essential service or product.

8. Critical loads

8.1 General

Critical loads are loads that are critical for maintaining the operational integrity of the power system, or for avoiding a cascading impact on public infrastructure in the event of a system emergency. Critical loads should as far as possible be protected from the impact of load shedding or loss of supply. Protection measures could include the exclusion from load shedding schedules, installing of backup facilities, or implementing of specific protocols for interaction between the customer and the licensee. This section addresses the specific interventions associated with identified critical loads.

8.2 Application by licensees

8.2.1 Licensees are required to appropriately interact with customers in addressing critical loads as defined in 8.4 to 8.6.

8.2.2 Licensees should identify the feeders to which these critical loads are connected.

8.2.3 Licensees who choose to be shed completely by an upstream licensee should ensure that the critical load requirements are addressed or that alternative arrangements have been agreed with customers operating affected critical loads. Information related to such arrangements should be made available to the upstream licensee should this be requested. Provision of such information should not constitute a change in responsibility of the licensee to address the requirements of the critical load, or that alternative arrangements have been agreed.

8.3 Application by customers

8.3.1 Customers who operate critical loads should evaluate their level of preparedness and protection of their facilities in terms of the practices in this part of NRS 048.

NOTE A licensee cannot guarantee that the requirements can be met under all supply emergencies and it is incumbent on the customer to take appropriate measures to protect their installations in such cases.

8.3.2 All customers are entitled to apply to a licensee for critical load status. Such status should be determined by the licensee in accordance with the requirements set out in this section.

8.4 Treatment of critical loads

8.4.1 Specific critical loads are identified in clause 8.6, together with the required treatment of these

8.4.2 In the case of critical loads not identified in this part of NRS 048, licensees and customers should cooperate in addressing the requirements of these loads by considering at least the following alternatives:

a) exclusion from load shedding schedules and curtailment requirements. This should, in principle, be limited to cases where the load can be isolated so that other loads that should be shed are not also protected from the load shedding schedules. Critical loads that must be excluded but cause unavoidable loads to be likewise excluded should be accommodated through design of the schedules (through shedding other load to accommodate this).

NOTE Exclusion from load shedding is possible where the customer load is supplied direct (not one of several loads on a given feeder), or where smart metering or load limiting technologies have been installed on all loads on the feeder.

- b) whether the installation complies with the conditions for load curtailment as described in clause 4, and is not severely impacted by such curtailment;
- c) if shedding is required, the specific time of day that these loads are shed (i.e. times when the impact of shedding these loads might not be so severe);
- d) interventions within the installation (e.g. appropriate backup supplies); and

NOTE In the case of many critical loads, such intervention might be necessary in any case to protect the installation in the event of a supply interruption due to a local network outage.

- e) protocols for interaction between the customers who operate critical loads and the electricity supply utility

NOTE 1 For example, provision of a direct line of communication to a regional or municipal/metropolitan department designated to assist such cases in the event that the on-site backup supply fails.

NOTE 2 Care needs to be taken to limit pre-calling and emergency switch-back to “critically important” critical loads under extreme conditions.

8.4.3 Where a customer considers an installation that is not listed in this section to be a critical load, the supplier may be engaged to consider the implementation of specific interventions. Where these include exclusion from the load shedding schedules, a customer should seek approval from NERSA to be listed as a critical load. In determining the critical load status, NERSA should consider representation of the licensee in this regard.

8.5 National key points

National key points other than those identified as critical loads and that are reliant on electricity for their core operations should be included in load shedding schedules, with the exception of the Union Buildings and the National Parliament. National key points need to provide essential load requirements in terms of the provisions of 7.3.

8.6 Requirements for specific types of critical loads

8.6.1 General

The requirements for specific types of critical loads are summarized in Table 5 and addressed in detail in 8.6.2 to 8.6.18.

Table 5 — Summary of how critical loads are required to be addressed

1	2	4	5
Load	Scheduled for load shedding	Protocols before / during shedding	Comment
Airports	Yes	Yes / Yes	Airports require on-site backup supplies as a legal requirement
Rail (Commuter)	No	None	Where the power supply system allows for this
Rail (Long distance)	Yes	None	May be treated as curtailment loads where practicable
Traffic lights	Yes	None	The treatment of high, medium, and low impact traffic lights is addressed
Water (Power stations)	No	None	
Water (Industrial)	Yes	None	
Water (Agricultural)	Yes	None	May be temporarily removed if a state of disaster is declared.
Water (Potable)	No*	None	* Bulk supply systems
Stadiums	Yes	No	May be temporarily removed in the event of a major event
Sewage	Yes*	None	* Unless the impact cannot be addressed
Refineries	No	None	May be treated as curtailment loads
Fuel pipe lines	No	None	
Coal mines	No*	None	* Only those mines that supply power stations
Education	Yes*	None	* Special arrangements may be made for temporary removal at critical times
Police	Yes	None	Adequate backup systems must be in place
Telecom's	Yes*	None	* See requirements related to data centres
Hospitals	Yes	Yes/Yes	
Clinics	Yes	None	
Data centers (National footprint)	Yes	Yes*	* Hotline for customers should backup systems fail
Ports authorities	Yes	None	
Government Buildings	Yes*	None	* With the exception of the Union Buildings and National Parliament
Electricity Control Centres	No	N/A*	* Control centres are notified by default of load shedding as part of the load shedding process
NOTE National key points in general are not by default considered critical loads. Application for temporary or permanent exemption needs to be made in terms of the criteria for critical loads.			

Where these installations are not excluded from load shedding, functional requirements are specified for protecting these installations. Technology choices, however, are not specified and the most appropriate option is to be determined by the relevant stakeholder.

8.6.2 Airports

8.6.2.1 Airports should be required to participate in emergency load shedding or curtailment.

8.6.2.2 The licensee control centre that manages the emergency load reduction of the airport should provide the airport with direct communication and cooperation to the control room in the case of an emergency (e.g. the failure of backup generators).

8.6.2.3 Protocols should be in place for notifying these customers that load shedding has commenced, so as to allow them to start up the backup generators, if required.

8.6.2.4 Airports should ensure that on-site backup supplies should be available for critical processes.

NOTE Secondary power supplies, independent of the public power supply should be provided in accordance with the standards and recommendations of the Convention on International Civil Aviation, as adopted or adapted by the Civil Aviation Authority of South Africa.

8.6.3 Rail

8.6.3.1 Category 1 – Commuter rail systems

Commuter rail systems should be excluded from schedules and load curtailment requirements, where the network configuration allows.

NOTE Long distance passenger rail systems are not considered.

8.6.3.2 Category 2 – Long distance rail systems

Long distance rail systems are not excluded from load shedding unless the operators of such systems can engage with the relevant licensee(s) to be treated as curtailment customers

8.6.4 Traffic lights

8.6.4.1 General

The electricity supply infrastructure to traffic lights might not allow for isolation from other loads in the event of load shedding.

NOTE All traffic light installations should be fitted with reflective indicators in the event of an interruption in supply during the night.

8.6.4.2 Category 1 – High impact intersections

High impact intersections are defined as those that would lead to significant congestion on major highways, in central business districts, or important access points (e.g. roads to airports).

One of the following treatment methods is recommended:

- a) backup systems able to support the supply for at least 4 h; or alternatively; and
- b) effective deployment of points men should be planned.

NOTE Theft of components of the backup systems is a concern.

8.6.4.3 Category 2 – Medium impact intersections

Contingency plans should be implemented at medium impact intersections to ensure that traffic flow is maintained. Plans could include the co-ordinated deployment of point men or traffic officials, based on the schedules.

8.6.4.4 Category 3 – Low impact intersections

No specific interventions are required at low impact intersections.

8.6.5 Water

8.6.5.1 Supply to power stations

Water supply systems to power stations (including co-generators) should be excluded from load reduction requirements.

8.6.5.2 Industrial water

Water supply systems to industrial plants should be addressed under essential load requirements.

Users should have adequate contingency plans in place to allow for a disruption of water supply.

8.6.5.3. Agricultural water schemes

Water supply systems to agricultural areas shall in principle be included in load shedding.

In periods of drought, declaration of a disaster in terms of the Disaster Management Act may allow exclusion from the schedules for the duration of the declared disaster, subject to the need for this being clearly identified.

8.6.5.4 Reticulated potable water supply

8.6.5.4.1 Potable water is a national critical product and the power supplies required to supply potable water should be treated in terms of the requirements in this clause.

8.6.5.4.2 Operators of potable water systems should assist with load curtailment when they can.

NOTE 1 Under extreme heat conditions when the demand for potable water is high, load curtailment might not be possible.

Load curtailment under emergencies should be undertaken by considering the specific impact and technology being used by the public water system (for example, pumping versus gravity fed systems).

NOTE 2 Restoration of water supply can take several hours after an interruption in electricity supply due to factors such as

- a) the time taken to fill reservoirs; and
- b) the treatment process utilized (load needs to be increased slowly to ensure good quality of the water).

8.6.5.4.3 Licensees that supply public water systems should take adequate measures to ensure that these systems are addressed in terms of the provisions set out in 8.6.5.2.4 to 8.6.5.2.6.

8.6.5.4.4 Should a licensee choose not to curtail but to refer this curtailment to a higher voltage level (i.e. the upstream supplier), the former licensee should still be responsible for ensuring that the critical load requirement is considered.

8.6.5.4.5 Typically the provisions set out in Table 6 could apply for major public potable water distribution systems, where such major systems meet curtailment requirements.

Table 6 — Typical provisions for major potable water distribution systems

1	2	3
Provision	Stages 1 and 2	Stages 3 and 4
Notice period	4 h to 5 h	4 h to 5 h
Curtailment	10 % to 15 %	15 % to 20 %
Duration	3 h to 4 h	3 h to 4 h

NOTE 1 Such systems will not save energy, in that the energy used is proportional to the quantity of water pumped. Shedding these systems will therefore only result in a load reduction at the time. Significant energy will be used to make up the water demand and therefore consideration of the specific type of emergency might be required (i.e. if the expected duration of the emergency is more than 2 h in 72 h, load curtailment from these systems will in general not be appropriate).

NOTE 2 Public potable water systems have extensive hydraulic networks. Interrupting the electrical supply to these systems will result in pressure surges which can endanger the health and safety of the public.

NOTE 3 Public potable water systems consist of hydraulic networks and gravity distribution networks. Interrupting the electrical supply to these systems for an extensive period will result in the ingress of air into the hydraulic system. The removal of air from these systems can take days during which the operators of potable water systems will not be able to supply potable water to the public.

8.6.5.4.6 Licensees should engage with water suppliers and other licensees where water systems cross supply boundaries to minimize the impact of shedding on these systems.

8.6.6 Sports stadiums

8.6.6.1 Sports stadiums should be required to participate in emergency load shedding or curtailment.

8.6.6.2 Stadiums should ensure that on-site backup supplies should be available for critical processes.

8.6.6.3 The licensee control centre that manages the emergency load reduction of the stadium should provide the stadium with direct access to the control room in the case of an emergency (e.g. the failure of backup generators). Where the licensee is notified of a major sporting event, protocols should be agreed upon for notifying these customers that load shedding has commenced – so as to allow them to start up the backup generators.

8.6.6.4 In the case of major sports events, the requirements in section 4.8.6 may be applied.

8.6.7 Sewerage

Generally sewerage systems should be included in load shedding schedules. Special attention should be given to identify linked pump stations and to co-ordinate load shedding to ensure that shedding will not result in adverse environmental consequences. Where this is not possible, these systems may be removed from load shedding schedules.

8.6.8 Refineries and fuel pipe lines

Refineries, fuel pipe lines, and associated loading and off-loading depots should be excluded from emergency load reduction requirements.

NOTE Current refinery and pumping capacity is limited in the country.

8.6.9 Mines that supply power stations

Coal mines that supply power stations (including co-generation plant) should be excluded from load shedding schedules.

8.6.10 Educational facilities

Educational facilities should be included in load shedding schedules.

NOTE 1 These facilities are generally within communities and would result in significant sections of load not being shed to maintain supply to these installations.

NOTE 2 It is possible that arrangements may be made to limit the impact of load shedding on educational facilities at critical times of the academic year through consultation between government and NERSA. This

may entail pre-planning on the system and the use of only curtailment loads whether the system constraint can still be managed.

8.6.11 Electricity control centres

Electricity control centres may be excluded from load shedding schedules.

NOTE These will by default be informed of load shedding as part of the load shedding process.

8.6.12. Ports authorities

Ports authorities should be included in load shedding schedules.

8.6.13 Essential services

Police, fire fighting, and other essential services should be included in load shedding schedules. These customers should provide their own backup facilities.

Processes should be in place to provide fire fighting services with information when load shedding has commenced. In the event of a fire, these services should liaise directly with the control centre or appropriate liaison mechanism provided for in advance by the licensee.

NOTE These facilities are generally within communities and would result in significant sections of load not being shed to maintain supply to these installations.

8.6.14 Telecommunications infrastructure

The facilities of telecommunication service providers should be included in load shedding schedules. These customers should provide their own backup facilities and contingency plans.

NOTE 1 These facilities are generally within communities and would result in significant sections of load not being shed to maintain supply to these installations.

NOTE 2 The need for contingency plans and backup applies in particular to electricity control room to control room communication.

8.6.15 Hospitals and medical centres

8.6.15.1 General

8.6.15.1.1 Hospitals and medical centres should be included in load shedding schedules.

8.6.15.1.2 State and private hospitals should be treated equally.

8.6.15.2 Category 1 – Hospitals with life-support systems

8.6.15.2.1 These hospitals should provide their own backup facilities.

8.6.15.2.2 Protocols should be in place for hospitals to contact the local operations centre directly in the event of an emergency, for example, if the backup facility is out of service at the time of load shedding.

8.6.15.2.3 Protocols should be in place for notifying these customers that load shedding has commenced – so as to allow them to start up the backup generators.

8.6.15.3 Category 2 – Hospitals without life-support systems

8.6.15.3.1 Hospitals should, if practicable, provide their own backup facilities.

8.6.15.3.2 Protocols should be in place for hospitals to contact the local operations centre directly in the event of an emergency.

8.6.15.3.3 Protocols should be in place for notifying these customers that load shedding has commenced – so as to allow them to start up the backup generators.

8.6.15.4 Category 3 – Clinics and medical centres

Clinics and medical centres are not classified as critical loads.

8.6.16 Public health and safety

8.6.16.1 Category 1 – Danger to life and safety

8.6.16.1.1 All officers in charge of public buildings and facilities should be required to assess the risks to the public associated with power interruptions, implement appropriate back-up supplies and declare their essential load requirements.

NOTE Declaration of essential load requirements is for the purpose of restoration after a blackout / interruption.

8.6.16.1.2 By exception such buildings or facilities may be considered as critical loads.

8.6.16.2 Category 2 – Environmental or health hazard

8.6.16.2.1 All officers in charge of public buildings and facilities should be required to assess the risks to the public associated with power interruptions and declare their essential load requirements.

8.6.16.2.2 By exception such buildings or facilities may be considered as critical loads.

8.6.17 Data centres

8.6.17.1 General

8.6.17.1.1 Data centres should be included in load shedding schedules.

8.6.17.2 Data centres supplying critical national infrastructure

8.6.17.2.1 Data centres supplying critical national infrastructure should provide their own backup facilities.

8.6.17.2.2 Protocols should be in place for these customers to contact the local control centre directly in the event of an emergency, for example, if the backup facility is out of service at the time of load shedding.

NOTE 1 In this context, critical national infrastructure includes the supply of water, electricity, telecommunications, and financial services.

NOTE 2 Implementation of these protocols should be limited to exceptional circumstances beyond the ability of the customer to have reasonably foreseen or to have provided for.

8.6.18 National critical product

Where the destruction or damage to plant, equipment, or facilities would disrupt production of a nationally critical product, the minimum power required to prevent such damage may be considered as an essential load requirement.

NERSA shall in any dispute rule on the nature of a product being considered a national critical product.

NOTE Examples include water, petroleum.

9. Technical considerations when developing schedules

9.1 General

Practical systems limitations and the impact of load shedding on plant operated by both licensees and customers need to be considered when load reduction protocols are being developed.

9.2 Supervisory versus manual control

Many municipalities and some metropolitan municipalities require the manual switching of circuits. This may impact on the ability to switch at feeder level. In such cases it might be prudent or necessary to switch at a point further back in the network.

9.3 Cold restoration considerations

Care needs to be taken when returning load after it has been shed. The cold load pick up may be significantly higher than normal full load, placing the system under renewed stress. This is really a problem in municipalities, because they often do not have the means to limit the load after power restoration.

NOTE One of the motivations for continuing to operate and extend "ripple control" systems is their ability to limit and control the pick-up load.

10. Roles and responsibilities

10.1 NERSA

NERSA will ensure the implementation of this code of practice by licensees through:

- a) instructing licensees on what elements of this code are to be implemented;
- b) implement audits as and when necessary to ensure that the relevant requirements of this code are implemented; and
- c) an appropriate reporting system to ensure that licensees have implemented the requirements.

NERSA will, with regard to variations or exemptions from this code:

- a) consider and approve (or otherwise) any application by a licensee or customer for a variation or exemption from the requirements of this document.
- b) when considering such applications, consult the affected licensees and the System Operator on the impact of such variations or exemption on the power system
- c) publish a list of sites approved for exclusion from the schedules, including those that are approved for exclusion on application from a licensee or customer

10.2 System operator

The System Operator is empowered in terms of the Grid Code to implement any intervention it deems necessary to ensure the stability of the power system. Where conditions at the time allow, the System Operator shall instruct distribution licensees (or their agents) to implement load reduction in terms of this part of NRS 048.

10.3 Distribution licensees

Distribution licensees shall implement load reduction as instructed by the System Operator. This implementation shall be in terms of the requirements of this part of NRS 048.

Annex A – Ensuring the integrity of the under-frequency load shedding scheme when developing manual load shedding schedules (informative)

A.1 Under-frequency load shedding

The national under-frequency load shedding (UFLS) scheme is designed to ensure that the system responds immediately to a frequency drop caused by a sudden and significant imbalance between available generation capacity and demand. The response required is for load to be shed immediately to prevent a cascading loss of generation units due to low frequency. This is done by the automatic removal of pre-defined loads from the system by means of under-frequency protection relays. This type of under-frequency protection is typically required when a single system event results in multiple generation units being removed from the system (e.g. a fault in the transmission yard of a large power station).

The UFLS scheme is addressed by the Grid Code – and as such is not specified in this part of NRS 048.

A.2 Emergency load reduction (shedding and curtailment)

Emergency load shedding and curtailment as specified in this part of NRS 048 relates to the proactive, manual reduction in demand by the System Operator where it becomes clear that insufficient generation resources are available to serve the prevailing or expected load.

A.3 Stages of emergency load reduction (shedding and curtailment)

The UFLS scheme makes use of several stages of automatic load shedding. These stages are not related to the stages of mandatory load shedding specified in this part of NRS 048.

A key requirement of this part of NRS 048 however, is that where emergency load reduction schedules are built, these are built in such a manner that the under-frequency load shedding (UFLS) scheme is not materially compromised (i.e. that loads shed or curtailed under emergency load reduction are not those also required for the automatic protection system to respond to a significant incident involving loss of generation on the system).

A.4 Development of load shedding schedules considering UFLS

The development of load shedding schedules needs to address integrity of the under-frequency load shedding scheme. Schedules that address this requirement will provide the system operator with significantly enhanced capability to manage system constraints – i.e. controlled, manual load reduction can be safely implemented without placing the system at increased risk should an incident occur that requires load to be automatically shed.

NOTE In January 2008 a general system emergency was declared due to concerns about the security of the power system being compromised. This code, through addressing the integrity of the under-frequency protection system, ensures a much more robust regime for managing a system constraint.

A.5 Example of the calculation of schedules taking automatic under-frequency load shedding (UFLS) into consideration

Table E.1 is an example of how the integrity of the under-frequency scheme is maintained through careful allocation of loads to the scheduled time slots. In theory, if the UFLS loads are perfectly spread among the load shedding blocks then load shedding, if perfect, will reduce the instantaneous demand by the exact amount that the loss of the UFLS load would have required for compliance. Since a perfect spread is not possible, the utility will have to evaluate the gap from the analysis as per table E.1, provide the additional UFLS load and inform the System Operator of the extra amount now likely to be shed in the case of a UFLS event taking place outside of load shedding.

Annex A
(concluded)

The example in table A.1 assumes the following:

- a) A schedule of eight 3 h time slots, with a 200 MW reduction required per time slot; and
- b) UFLS stage 3 loads totalling 160 MW(10% of the peak demand) (see total in column 3)

Because of the percentage gap seen in column 6, additional UFLS is added in column 7 to achieve 100 % of the UFLS requirement under the load shedding condition. The increased amount is what is required to fill the largest gap in the UFLS coverage (5 MWs), which must be scheduled at other times, with no other time being having more UFLS scheduled than the previous largest amount (25 MWs).

Table A.1 — Example of the calculation of schedules taking UFLS into consideration

	1	2	3	4	5	6	7	8
3 h time slot	Load base	Manual load shedding (MW)	UFLS CVA required before LS	UFLS CVA required after LS	UFLS lost in LS stage	UFLS % available	UFLS lost in LS stage	UFLS % available
00:00-03:00	1600	200	160	140	17	102%	17	102%
03:00-06:00	1600	200	160	140	15	104%	15	104%
06:00-09:00	1600	200	160	140	25	96%	25	100%
09:00-12:00	1600	200	160	140	15	104%	15	107%
12:00-15:00	1600	200	160	140	25	96%	25	100%
15:00-18:00	1600	200	160	140	18	101%	18	105%
18:00-21:00	1600	200	160	140	22	99%	25	102%
21:00-24:00	1600	200	160	140	23	98%	25	101%
Total	NA	1600	NA	NA	160	NA	165	NA

Annex B – Essential load data for system restoration planning and load shedding – Model forms for information required from customers (end users)

(normative)

B.1 Model form for information on essential loads in the case of a network collapse and restoration

Form B.1

ESSENTIAL LOADS IN THE CASE OF NETWORK COLLAPSE AND RESTORATION			
<ul style="list-style-type: none"> ▪ Details regarding requirements for the return of electrical power supply and the priority of restoration after a national or regional large-scale network collapse are to be recorded in this form. ▪ Typically, there would be a total loss of power and the details submitted are required to determine the duration before power is returned to the customer's site and the extent of power that should be returned. ▪ All production would be shut down, and minimal power will be made available for the purposes of <ul style="list-style-type: none"> a) avoiding danger to the lives and safety of persons, b) avoiding a potential hazardous condition from developing, c) shutting plant down safely. ▪ No provision should be made to continue with normal or reduced production until after the emergency has been concluded. 			
CATEGORY A1: THE RETURN OF POWER TO PREVENT DANGER TO LIVES AND FOR SAFETY			
Maximum permissible duration of power interruption before dangerous conditions develop <i>(Explanation: the amount of time before conditions become life threatening)</i>	Survival load required once power has been returned after the above interruption <i>(Explanation: the amount of load required to effectively remove personnel or prevent a dangerous condition from developing.)</i> <i>(Not intended for continuous use, but for the purposes of a controlled and safe shutdown, evacuation, etc.)</i>	Details of plant, equipment, facilities which will be operated by the power detailed herein. <i>(For example, winders, vent fans, dewatering pumps.)</i>	
HOURS	MVA	Please describe plant in the space below	General comments

Annex B
(continued)

CATEGORY A2: THE RETURN OF POWER TO PREVENT A POTENTIAL ENVIRONMENTAL OR HEALTH HAZARD			
<p>Maximum permissible duration of power interruption before a potential hazard develops <i>(Explanation: length of time before an outage (complete interruption) causes damage to a resource or results in legislated limits e. g. environmental or occupational hygiene limits) (see foreword) to be exceeded.</i></p>	<p>Survival load required once power has been returned after the above interruption <i>(Explanation: the amount of load needed to bring the limits back to acceptable levels. If the load needs to be continuous, please indicate this) (Not intended for continuous use, but for purposes of a controlled and safe shutdown, if possible.)</i></p>	<p>Details of plant, equipment, facilities which will be operated by the power detailed herein. <i>(For example, dust control plants, oil water separation units, sewer pumps.)</i></p>	
HOURS	MVA	Please describe in the space below	General comments How is it required?

CATEGORY A3: THE RETURN OF POWER TO PREVENT THE DESTRUCTION OF OR DAMAGE TO PLANT, EQUIPMENT OR FACILITIES WHICH WOULD DISRUPT PRODUCTION OF A NATIONALLY CRITICAL PRODUCT			
<p>Maximum permissible duration of power interruption before damage or destruction occurs <i>(Explanation: the amount of time before plant, equipment, facilities will incur damage. This applies only to plant, equipment or facilities and not to the product itself. If the plant, equipment, facility, will be instantly damaged or incur irreversible damage, please describe in field provided.)</i></p>	<p>Survival load required <i>(Explanation: the amount of power, following an interruption which will be needed to prevent damage to the plant, equipment, facility. This may imply the need for continuous load but ideally should be the amount of load needed to ramp down the plant, facility, in a non-damaging way. Please describe the load (continuous or ramp-down) in the field provided.)</i></p>	<p>Details of plant, equipment, facilities, which will be operated by the power detailed herein. <i>(For example smelters, silting of pipelines, freezing of charge or chutes.)</i></p>	
HOURS	MVA	Please describe in the space below	<i>If the plant, equipment, facility will be instantly damaged or incur irreversible damage, please describe in field below</i> General comments

SUMMARY FOR ALL THREE " A " CATEGORIES		
Category	Time (hours)	Survival load (MVA)
A1		
A2		
A3		
TOTAL		
NOTE Categories A1, A2, and A3 should be mutually exclusive of one another.		

Annex B
(continued)

B.2 Model form for information required in the case of continuous load reduction (load shedding or curtailment)

Form B.2

<p>ESSENTIAL LOADS IN THE CASE OF CONTINUOUS LOAD REDUCTION (LOAD SHEDDING OR CURTAILMENT)</p> <ul style="list-style-type: none"> ▪ Details regarding application for the electrical power requirements during an emergency situation where load is curtailed to customers without an interruption are to be recorded in this appendix. ▪ This is the power required to sustain life, prevent violation of legislated limits (see foreword) and prevent damage to equipment, plant, facilities, for a limited period during a limited emergency. ▪ Typically, the outage reduction would last a few hours, generally according to a schedule. Customers should also supply details where extended duration could cause further damage, which may not be realized if the duration were confined to a few hours. ▪ The numbers here refer to load needed to maintain the plant in stasis without a complete shutdown. • No power will be available for production requirements, except for temporarily sustaining life, until the load shedding has been switched to another location. 				
<p>CATEGORY B3: REDUCE POWER TO A LEVEL THAT PREVENTS DESTRUCTION OF OR DAMAGE TO PLANT, EQUIPMENT, OR FACILITIES WHICH WOULD DISRUPT PRODUCTION OF A NATIONALLY CRITICAL PRODUCT</p>				
<p>Minimum notification period required before a reduction of power supply. <i>(Explanation: the amount of time required to ensure that plant, equipment or facilities can be shut down or ramped down so that no destruction or damage occurs.)</i></p>	<p>Minimum load required <i>(Explanation: the amount of power required to continuously operate plant, equipment, or facilities such that damage or destruction does not occur; i.e. after ramp-down period, the amount of power required to maintain the status of the plant, equipment or facility.)</i></p>	<p>Details of plant, equipment or facilities which will be operated by the power detailed herein. <i>(Please describe what plant will be run by the power required.)</i></p>	<p>In the event of being shed without being reduced, is the amount of load needed different? <i>(Explanation: Sometimes the amount of load needed to restart critical equipment or processes is greater than the running load. Please supply details.)</i></p>	
HOURS	MVA	Description of minimum load	MVA	Please give details.

Annex B
(continued)

CATEGORY B2: REDUCE POWER TO A LEVEL TO PREVENT A POTENTIAL ENVIRONMENTAL OR HEALTH HAZARD				
Minimum notification period required before a reduction of power supply. <i>(Explanation: the amount of time required to ensure that all activities are completed to avoid damage to a resource or to avoid exceeding a legislated environmental or health limit (or both).)</i> (see foreword)	Minimum load required <i>(Explanation – the amount of power required to continuously keep the system from exceeding legislated contamination limits (see foreword) for the period of the scheduled load shedding.)</i>	Details of plant, equipment or facilities which will be operated by the power detailed herein. <i>(Please describe what plant will be run by the power required.)</i>	In the event of being shed without being reduced, is the amount of load needed different? If so, how much is it? <i>(Explanation: Sometimes the amount of load needed to restart critical equipment processes is greater than the running load.)</i>	
HOURS	MVA	Description of minimum load	MVA	Please supply details.

CATEGORY B1: REDUCE POWER TO A LEVEL THAT DOES NOT ENDANGER LIVES AND THE SAFETY OF PERSONS				
Minimum notification period required before a reduction of power supply. <i>(Explanation: the amount of time required to ensure that all activities can be performed to ensure that no dangerous condition can develop.)</i>	Minimum survival load required. <i>(Explanation: the amount of load needed to keep the conditions in the plant, facility habitable without performing any actual work or production. People should be able to stay safely where they are for the duration of the load reduction (load shedding) and will not have to be moved. Therefore, power required for evacuating personnel should not be included. Please include power required to restart critical equipment.)</i>	Details of plant, equipment or facilities which will be operated by the power detailed herein. <i>(Please describe what plant will be run by the power required.)</i>	In the event of being reduced without being shed, is the amount of load needed different? If so, how much is it? <i>(Explanation: often the amount of load needed to restart critical equipment is greater than the running load. If load critical to sustaining life needs a high start-up power, please put into the field below, while continuous running values can be placed here.)</i>	
HOURS	MVA	Description of minimum survival demand	MVA	Please give details.

SUMMARY FOR ALL THREE CATEGORIES			
Category	Time (hours)	Minimum survival load (MVA)	Reduced load (MVA) Demand (MVA)
B1			
B2			
B3			
TOTAL			

Annex B
(concluded)

B.3 Model form for details of officials to be contacted during emergencies related to power supplies

Form B.3

OFFICIALS TO BE CONTACTED DURING EMERGENCIES RELATED TO POWER SUPPLIES

Official 1: (Primary contact)

Name	
Designation	
E-mail	
Telephone	
Fax	
Cellphone	

Official 2: (Secondary contact)

Name	
Designation	
E-mail	
Telephone	
Fax	
Cellphone	

Official 3: (Alternative 1)

Name	
Designation	
E-mail	
Telephone	
Fax	
Cellphone	

Official 4: (Senior Manager in charge – Last resort contact)

Name	
Designation	
E-mail	
Telephone	
Fax	
Cellphone	

Details of generally manned station such as the Mine Rescue Team (proto team) or main security offices:

Name	
Designation	
E-mail	
Telephone	
Fax	
Cellphone	

Do you have any other means by which the above persons may be contacted, for example, radio, satellite? Give details:

.....

Can you offer any further information or motivation not captured elsewhere in this form that will be useful in identifying and evaluating your requirements related to power supplies during emergencies? (Attach separate pages, if required.)

.....

Annex C – Practical considerations and alternatives

(informative)

C.1 Overview

This annex provides options on how customers can reduce the impact of emergency load reduction.

C.1 Types of emergency load reduction

The types of emergency reduction defined in this part of NRS 048 are:

- a) **load shedding** utilising time-based rotational schedules for stages 1 to 4 and contingency schedules for stages 5 to 8 – this is the default method of load reduction;
- b) **load curtailment** – where customers comply with specified curtailment requirement; and
- c) **load limiting/switching** – where customers are supplied with smart meters.

C.2 Collaboration between customers or groups of customers

Groups of customers may collaborate and agree with a licensee on how the above options can be accommodated through mutual cooperation. This type of collaboration could be provided by third-parties who establish the necessary protocols, metering and control technologies, and agreements with the licensee.

Examples include:

- a) **targeted curtailment:** A mining house with several different facilities may choose to undertake load reduction by significantly curtailing load at one installation, whilst others remain in full production for the full duration of the emergency. This is typically enabled by a central control room at which the total load reduction for all facilities can be monitored and confirmed to be meeting the Stage 1 and 2 requirement of 10 %, the Stage 3 requirement of 15 %, and the Stage 4 requirement of 20 %.
- b) **time-aggregated curtailment:** Several customers on a given circuit may agree amongst each other on how load is curtailed to prevent the need for shedding the full circuit that they are being supplied from. This could take the form of customers taking turns to switch off for the duration of the incident. For example, if seven similar-sized customers are supplied by the same feeder, they may each make themselves available on a different day to take up the full load reduction requirement.
- c) **demand-aggregated curtailment:** Several customers on a given circuit (for example a large residential estate) may agree to install demand response technologies (such as smart meters) to provide the required load reduction through load limiting or load switching.

Figure D.1 sets out an example of the options for customers and a critical load served by a feeder that serves several customers or groups of customers.

C.3 Considerations

The extent to which a licensee can accommodate specific customers' requests for mitigation of the effects of load shedding will vary on a case by case basis. Licensees cannot commit to accede to all such requests because of network constraints and resource limitations.

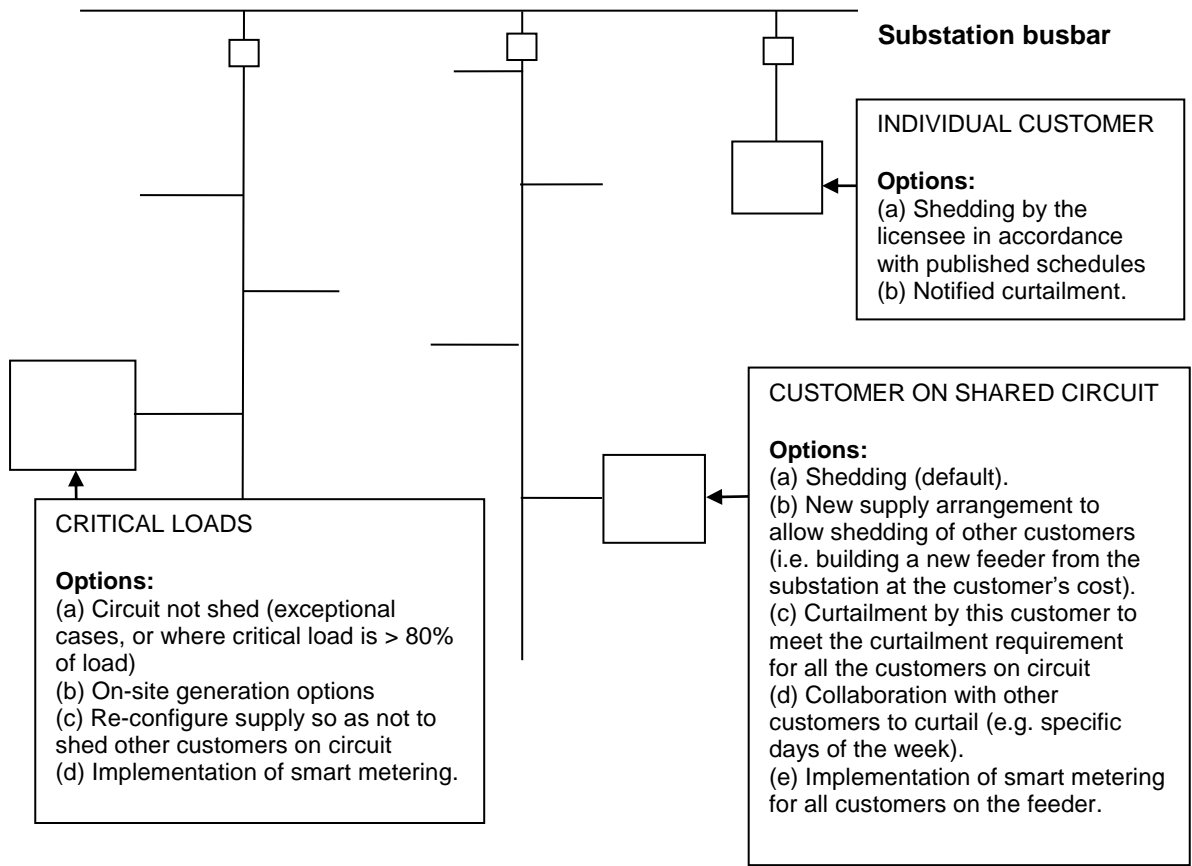


Figure C.1 — Illustration of the options for loads served by a feeder that serves other loads.

Annex D – Background to the approach adopted for setting up load shedding schedules based on fixed stages

(informative)

D.1 Balancing load shedding objectives and practical considerations

D.1.1 From a System Operator's point of view, load shedding would ideally be seen as a resource of a given size (MW) that can be dispatched at any point in the day (i.e. if 1 000 MW is required by the system, the sum of all the load shed by the various licensee control centres will provide this – regardless if this is in winter or summer, at peak or off peak).

D.1.2 Complying with this requirement is, however, complicated by the factors given in (a) to (c).

- a) The key objective of ensuring predictability of load shedding for customers requires that specific feeders be pre-selected for each time slot in the load shedding schedule of a given licensee. These feeders will have a varying load profile for different days of the year.
- b) Many licensees do not have feeder-level load profile data available in order to build schedules that will provide a specified, equal load reduction at each time slot in a given day. What licensees have available is peak feeder loading.
- c) Diversity between licensee load profiles changes throughout the year, making it difficult to provide a given load reduction against a pre-defined schedule.

D.2 Approach adopted

D.2.1 For the above reasons, the approach adopted in this part of NRS 048 is that load shedding will provide the System Operator with a percentage reduction in demand at any point in the daily system profile (i.e. at system peak a stage 1 emergency may provide 1 000 MW at peak and 800 MW at another point during the day – in each case achieving approximately a 5 % reduction in system demand associated with non-curtailment customers).

D.2.2 Should an incident on the system result in an unplanned loss of generation capacity, the System Operator will make a call on the stage of load shedding required to match the evening peak, and to declare this for the period required.

D.2.3 The requirement in this part of NRS 048 is therefore for licensees to build load shedding schedules based on the normal feeder annual peak demand (i.e. excluding abnormal operating conditions). Licensees are further required to take into consideration the diversity between feeders so as to ensure that the overall reduction complies with the requirement in each time slot (and particularly at peak) not to shed feeders at peak that do not contribute to peak demand.

Annex E – Model for essential load data for system restoration planning and load shedding – information required from municipalities and metropolitan municipalities

(normative)

E.1 Form E.1 – Essential loads register questionnaire

General information (information per bill)

NOTE A QUESTIONNAIRE MUST BE COMPLETED FOR EACH SUPPLY POINT REQUIRED

1 Details of customer

1.1	Customer's name:	
1.2	Account number:	
1.3	Physical address:	
1.4	Postal address:	
1.5	Postal code:	

2 Details of point of supply

Normal power provision

2.1	Power supplied from (substation name)	
2.2	Supply voltage	
2.3	Notified and highest maximum demand recorded in the last season	
2.4	Notified maximum demand	
2.5	Highest demand during low season demand (September to May) summer months	
2.6	Highest demand during high season demand (June to August) winter months	

3 Emergency power supply plant facility

3.1 Does your organization have an emergency power procedure and plan to deal with the loss of power supply or other power supply interruptions? (Tick correct option.)

Yes	
No	

If the answer is "NO", when will you have a procedure/plan?

.....

3.2 Can you supply your emergency power requirements by means of a standby generator?
Tick correct option.

Yes	
No	

Annex E
(continued)

If the answer is “**YES**”, to what category level can you provide own generation according to the attached appendices? (Tick applicable box.):

APPENDIX A (NETWORK COLLAPSE and RESTORE CONDITION)	CAT 1 – PREVENT DANGER TO LIFE and SAFETY	CAT 2 – PREVENT POTENTIAL ENVIRONMENTAL HAZARD	CAT 3 – PREVENT DAMAGE TO EQUIPMENT
APPENDIX B (LOAD SHEDDING OR LOAD REDUCTION CONDITION)	CAT 1 – PREVENT DANGER TO LIFE and SAFETY	CAT 2 – PREVENT POTENTIAL ENVIRONMENTAL HAZARD	CAT 3 – PREVENT DAMAGE TO EQUIPMENT

If the answer is “**NO**”, are the hazards and risks which may be present during loss of power supply or other power supply interruptions adequately addressed in your emergency power procedure/plan?

.....

3.3 Standby generator capacity MVA

3.4 Maximum duration that the standby generator can be utilized?

Duration without refuelling (hours)	
Duration with refuelling (hours)	

4 Load reduction (load shedding) notification period

What notification period do you require before load reduction commences to ensure that all personnel are removed from high risk areas?

Annex E
(continued)

5 Aggregate of essential load requirements

The following spread sheet should be used to capture all the aggregated information from the municipal customers. Add all the loads required per hour from the time of notification for a national blackout in terms of the categories in the end-use customer essential load forms that you have received from your customers. This will be put into a graphical form for the control centre supplying you. See example in figure F.1.

Time from notification	Category 1 – Safety (MVA)	Category 2 – Environment (MVA)	Category 3 - Nationally critical product plant (MVA)
00:00	0	0	0
01:00	0	0	0
02:00	0	0	0
03:00	0	0	0
04:00	0	0	0
05:00	0	0	0
06:00	0	0	0
07:00	0	0	0
08:00	0	0	0
09:00	0	0	0
10:00	0	0	0
11:00	0	0	0
12:00	0	0	0
13:00	0	0	0
14:00	0	0	0
15:00	0	0	0
16:00	0	0	0
17:00	0	0	0
18:00	0	0	0
19:00	0	0	0
20:00	0	0	0
21:00	0	0	0
22:00	0	0	0
23:00	0	0	0
00:00	0	0	0

Annex E
(continued)

6 Official(s) to be contacted during emergencies related to power supplies:

Official 1: (Primary contact)

Name	
Designation	
E-mail	
Telephone	
Fax	
Cellphone	

Official 2: (Secondary contact)

Name	
Designation	
E-mail	
Telephone	
Fax	
Cellphone	

Official 3: (Alternate 1)

Name	
Designation	
E-mail	
Telephone	
Fax	
Cellphone	

Official 4: (Senior manager in charge – Last resort contact)

Name	
Designation	
E-mail	
Telephone	
Fax	
Cellphone	

Details of generally manned station such as the control centre

Name	
Designation	
E-mail	
Telephone	
Fax	
Cellphone	

Do you have any other means by which the above persons may be contacted, for example, radio, satellite? Give details:

.....

Annex E
(continued)

Can you offer any further information or motivation that is not captured elsewhere in this questionnaire which will be useful in identifying and evaluating your requirements during emergencies related to power supplies?

.....
.....

7 General

7.1 Submit this form via e-mail or fax or arrange to have it delivered by hand to your relevant Customer Executive. Please confirm via email that your Customer Executive has received the form, and keep a record of the confirmation.

Customer Executive's name:

Telephone number:

Fax number:

Cellphone number:

E-mail address:

Date submitted:

7.2 If you do not receive an acknowledgement of receipt within 21 days, please contact your relevant Customer Executive.

7.3 Information in this questionnaire will be treated as confidential and should be certified as correct by a person from top management such as a director or general manager.

INFORMATION CERTIFIED AS CORRECT:

NAME AND SURNAME:

DESIGNATION:

SIGNATURE:

DATE:

Annex E

(continued)

E.2 Example of graphical form of aggregated end-use customers' essential loads

Time from notification	Category 1 Safety	Category 2 Environment	Category 3 Nationally critical product/plant
00:00	2	1	0
01:00	1	1	0
02:00	0	2	2
03:00	0	1	3
04:00	0	3	2
05:00	0	4	1
06:00	1	3	0
07:00	2	3	0
08:00	3	1	1
09:00	3	1	1,5
10:00	3	1	2
11:00	5	1	2
12:00	3	1	1,5
13:00	2	1	1
14:00	1	1	0
15:00	0	1	0
16:00	1	1	0
17:00	1	1	0
18:00	1	1	0
19:00	0	1	0
20:00	0	1	0
21:00	0	1	0
22:00	0	1	0
23:00	0	1	0
00:00	0	1	0

Annex E
(concluded)

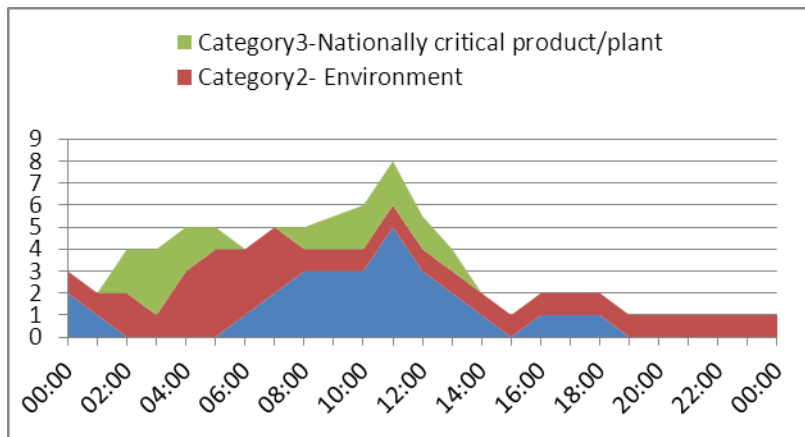
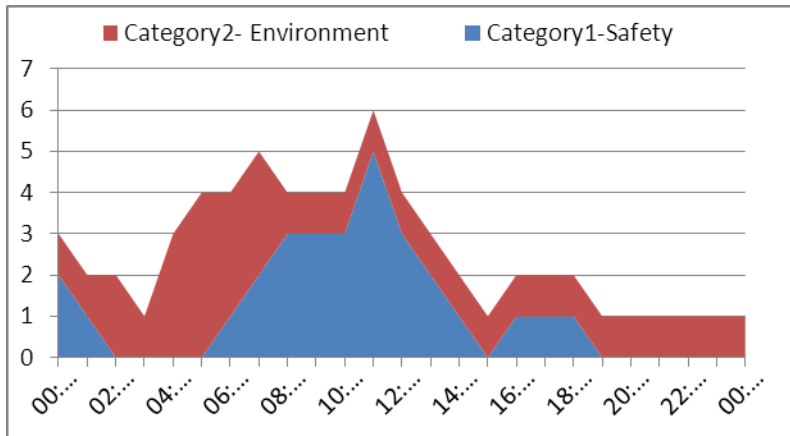
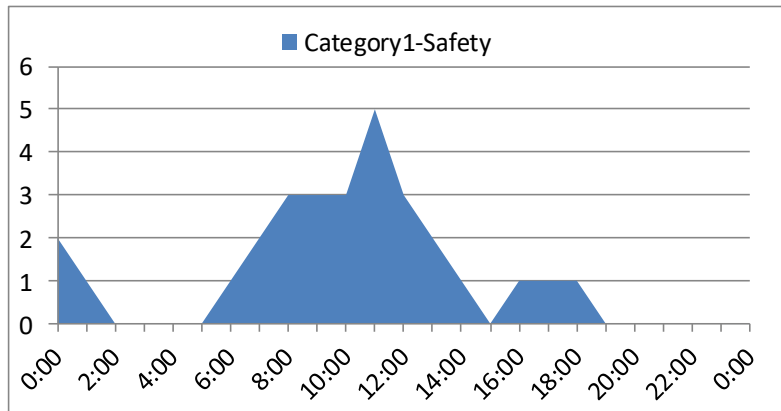


Figure E.1 — Example of graphical form of aggregated end-use customers' essential loads

Annex F – Development of load shedding schedules (informative)

F.1 Option 1: 16/19 block expansion (see example schedules in annex G)

F.1.1 Stage 1 (scheduled)

The non-curtailed load (sheddable load), as determined in 4.8.2, should be divided into 19 blocks of load, as close to the same size as possible, based on the peak load values at the identified points of shedding. These blocks will then be arranged to follow each other on a 24 hour rotation, in accordance with the 2, 3 or 4 hour based schedules described in annex G. Each load block size will be at least 5 % of sheddable load.

NOTE 1 Each block must be at least 5% of the load. This leaves 5% available to manage the potential unequal block sizes, and a modest amount of critical load.

NOTE 2 Published schedules will indicate that customers are impacted for 2, 3 or 4 hours at a time. In practice, each time slot may overlap its adjacent time slot by an additional 0,5 h to facilitate smooth change over. The potential 0,5 h overlap should be noted in the communication of the schedules

F.1.2 Stage 2 (scheduled)

Using the 19 blocks described in stage 1, the licensee will schedule two such blocks in each of the time periods described in stage 1. The licensee will ensure that the same load block is not repeated in consecutive time periods. An example is illustrated in Annex G. Each load block size will be at least 10 % of sheddable load.

F.1.3 Stage 3 (scheduled)

Using the load blocks resulting from stage 2 and stage 1, the licensee will schedule two such blocks from each stage in each of the time periods described in stage 1. The licensee will ensure that the same load block is not repeated in consecutive time periods. An example is illustrated in annex G. Each load block size will be at least 15 % of sheddable load.

F.1.4 Stage 4 (scheduled)

Using the load blocks resulting from stage 2, the licensee will schedule two such blocks in each of the time periods described in stage 1. The licensee will ensure that the same load block is not repeated in consecutive time periods. An example is illustrated in annex G. Each load block size will be at least 20 % of sheddable load.

F.2 Option 2: 24 block expansion (see example schedules in annex H)

F.2.1 Stage 1 (scheduled)

5 % of the non-curtailed load, as determined in 4.8.5 shall be determined. The load allocated to the 24 blocks shall be based on the peak load values at the identified points of shedding. These blocks will then be arranged to follow each other on a 24 hour rotation, in accordance with the 2 hour schedule. Each load block size will be at least 5% of the sheddable load.

NOTE 1 Each block must be at least 5 % of the load. This leaves 5 % available to manage the potential unequal block sizes, and a modest amount of critical load.

NOTE 2 Published schedules will indicate that customers are impacted for 2 hours at a time. In practice, each time slot may overlap its adjacent time slot by an additional 0,5 h to facilitate smooth change over. The potential 0,5 h overlap should be noted in the communication of the schedules.

Annex F
(concluded)

F.2.2 Stage 2 (scheduled)

Using the 24 blocks described in stage 1, the licensee will schedule two such blocks in each of the time periods described in stage 1. The licensee will ensure that the same load block is not repeated in consecutive time periods. An example is illustrated in annex H. Each load block size will be at least 10 % of sheddable load.

F.2.3 Stage 3 (scheduled)

Using the load block from Stage 2 and adding another block the licensee will ensure that the same load block is not repeated in consecutive time periods. Each total load block size will be at least 15 % of sheddable load.

F.2.4 Stage 4 (scheduled)

Using the load blocks resulting from stage 3, the licensee will schedule another block. Each total load block size will be at least 20 % of sheddable load.

Annex G – Examples of 24/7 rotational load shedding schedules based on 19 blocks (informative)

G.1 Overview

Typical model load shedding schedules are shown in this annex, based on the 19 blocks identified for the load shedding schedules, as described in annex F. The model schedules provided address load shedding periods of 2hrs (figure G.1), 3hrs (figure G.2), and 4hrs (figure G.3).

Licensees may use these model schedules to generate their own schedules based on the normative requirements in sections 1 to 10 of this Code.

G.2 Methodology

The assumption made in the examples provided is that the base load has been divided into 19 equal blocks, of between 5 and 6% of the base load each. These are then rotated across the day, over all 24 hours, and all 7 days of the week. In this case the pattern is expected to repeat every 19 days.

Figure G.1 — Model load shedding schedule for a 2 hour shedding period (each number in the table designates the number of the block shed of the 19 blocks)

Day	Stage	00:00 - 02:00	02:00 - 04:00	04:00 - 06:00	06:00 - 08:00	08:00 - 10:00	10:00 - 12:00	12:00 - 14:00	14:00 - 16:00	16:00 - 18:00	18:00- 20:00	20:00 - 22:00	22:00 - 00:00
1	Stage 1	1	2	3	4	5	6	7	8	9	10	11	12
	Stage 2	1,6	2,7	3,8	4,9	5,10	6,11	7,12	8,13	9,14	10,15	11,16	12,17
	Stage 3	1,6,11	2,7,12	3,8,13	4,9,14	5,10,15	6,11,16	7,12,17	8,13,18	9,14,19	10,15,1	11,16,2	12,17,3
	Stage 4	1,6,11,16	2,7,12,17	3,8,13,18	4,9,14,19	5,10,15,1	6,11,16,2	7,12,17,3	8,13,18,4	9,14,19,5	10,15,1,6	11,16,2,7	12,17,3,8
2	Stage 1	13	14	15	16	17	18	19	1	2	3	4	5
	Stage 2	13,18	14,19	15,1	16,2	17,3	18,4	19,5	1,6	2,7	3,8	4,9	5,10
	Stage 3	13,18,4	14,19,5	15,1,6	16,2,7	17,3,8	18,4,9	19,5,10	1,6,11	2,7,12	3,8,13	4,9,14	5,10,15
	Stage 4	13,18,4,9	14,19,5,10	15,1,6,11	16,2,7,12	17,3,8,13	18,4,9,14	19,5,10,15	1,6,11,16	2,7,12,17	3,8,13,18	4,9,14,19	5,10,15,1

Annex G
(continued)

3	Stage 1	6	7	8	9	10	11	12	13	14	15	16	17
	Stage 2	6,11	7,12	8,13	9,14	10,15	11,16	12,17	13,18	14,19	15,1	16,2	17,3
	Stage 3	6,11,16	7,12,17	8,13,18	9,14,19	10,15,1	11,16,2	12,17,3	13,18,4	14,19,5	15,1,6	16,2,7	17,3,8
	Stage 4	6,11,16,2	7,12,17,3	8,13,18,4	9,14,19,5	10,15,1,6	11,16,2,7	12,17,3,8	13,18,4,9	14,19,5,10	15,1,6,11	16,2,7,12	17,3,8,13
4	Stage 1	18	19	1	2	3	4	5	6	7	8	9	10
	Stage 2	18,4	19,5	1,6	2,7	3,8	4,9	5,10	6,11	7,12	8,13	9,14	10,15
	Stage 3	18,4,9	19,5,10	1,6,11	2,7,12	3,8,13	4,9,14	5,10,15	6,11,16	7,12,17	8,13,18	9,14,19	10,15,1
	Stage 4	18,4,9,14	19,5,10,15	1,6,11,16	2,7,12,17	3,8,13,18	4,9,14,19	5,10,15,1	6,11,16,2	7,12,17,3	8,13,18,4	9,14,19,5	10,15,1,6
5	Stage 1	11	12	13	14	15	16	17	18	19	1	2	3
	Stage 2	11,16	12,17	13,18	14,19	15,1	16,2	17,3	18,4	19,5	1,6	2,7	3,8
	Stage 3	11,16,2	12,17,3	13,18,4	14,19,5	15,1,6	16,2,7	17,3,8	18,4,9	19,5,10	1,6,11	2,7,12	3,8,13
	Stage 4	11,16,2,7	12,17,3,8	13,18,4,9	14,19,5,10	15,1,6,11	16,2,7,12	17,3,8,13	18,4,9,14	19,5,10,15	1,6,11,16	2,7,12,17	3,8,13,18
6	Stage 1	4	5	6	7	8	9	10	11	12	13	14	15
	Stage 2	4,9	5,10	6,11	7,12	8,13	9,14	10,15	11,16	12,17	13,18	14,19	15,1
	Stage 3	4,9,14	5,10,15	6,11,16	7,12,17	8,13,18	9,14,19	10,15,1	11,16,2	12,17,3	13,18,4	14,19,5	15,1,6
	Stage 4	4,9,14,19	5,10,15,1	6,11,16,2	7,12,17,3	8,13,18,4	9,14,19,5	10,15,1,6	11,16,2,7	12,17,3,8	13,18,4,9	14,19,5,10	15,1,6,11
7	Stage 1	16	17	18	19	1	2	3	4	5	6	7	8
	Stage 2	16,2	17,3	18,4	19,5	1,6	2,7	3,8	4,9	5,10	6,11	7,12	8,13
	Stage 3	16,2,7	17,3,8	18,4,9	19,5,10	1,6,11	2,7,12	3,8,13	4,9,14	5,10,15	6,11,16	7,12,17	8,13,18
	Stage 4	16,2,7,12	17,3,8,13	18,4,9,14	19,5,10,15	1,6,11,16	2,7,12,17	3,8,13,18	4,9,14,19	5,10,15,1	6,11,16,2	7,12,17,3	8,13,18,4

Annex G
(continued)

8	Stage 1	9	10	11	12	13	14	15	16	17	18	19	1
	Stage 2	9,14	10,15	11,16	12,17	13,18	14,19	15,1	16,2	17,3	18,4	19,5	1,6
	Stage 3	9,14,19	10,15,1	11,16,2	12,17,3	13,18,4	14,19,5	15,1,6	16,2,7	17,3,8	18,4,9	19,5,10	1,6,11
	Stage 4	9,14,19,5	10,15,1,6	11,16,2,7	12,17,3,8	13,18,4,9	14,19,5,10	15,1,6,11	16,2,7,12	17,3,8,13	18,4,9,14	19,5,10,15	1,6,11,16
9	Stage 1	2	3	4	5	6	7	8	9	10	11	12	13
	Stage 2	2,7	3,8	4,9	5,10	6,11	7,12	8,13	9,14	10,15	11,16	12,17	13,18
	Stage 3	2,7,12	3,8,13	4,9,14	5,10,15	6,11,16	7,12,17	8,13,18	9,14,19	10,15,1	11,16,2	12,17,3	13,18,4
	Stage 4	2,7,12,17	3,8,13,18	4,9,14,19	5,10,15,1	6,11,16,2	7,12,17,3	8,13,18,4	9,14,19,5	10,15,1,6	11,16,2,7	12,17,3,8	13,18,4,9
10	Stage 1	14	15	16	17	18	19	1	2	3	4	5	6
	Stage 2	14,19	15,1	16,2	17,3	18,4	19,5	1,6	2,7	3,8	4,9	5,10	6,11
	Stage 3	14,19,5	15,1,6	16,2,7	17,3,8	18,4,9	19,5,10	1,6,11	2,7,12	3,8,13	4,9,14	5,10,15	6,11,16
	Stage 4	14,19,5,10	15,1,6,11	16,2,7,12	17,3,8,13	18,4,9,14	19,5,10,15	1,6,11,16	2,7,12,17	3,8,13,18	4,9,14,19	5,10,15,1	6,11,16,2
11	Stage 1	7	8	9	10	11	12	13	14	15	16	17	18
	Stage 2	7,12	8,13	9,14	10,15	11,16	12,17	13,18	14,19	15,1	16,2	17,3	18,4
	Stage 3	7,12,17	8,13,18	9,14,19	10,15,1	11,16,2	12,17,3	13,18,4	14,19,5	15,1,6	16,2,7	17,3,8	18,4,9
	Stage 4	7,12,17,3	8,13,18,4	9,14,19,5	10,15,1,6	11,16,2,7	12,17,3,8	13,18,4,9	14,19,5,10	15,1,6,11	16,2,7,12	17,3,8,13	18,4,9,14
12	Stage 1	19	1	2	3	4	5	6	7	8	9	10	11
	Stage 2	19,5	1,6	2,7	3,8	4,9	5,10	6,11	7,12	8,13	9,14	10,15	11,16
	Stage 3	19,5,10	1,6,11	2,7,12	3,8,13	4,9,14	5,10,15	6,11,16	7,12,17	8,13,18	9,14,19	10,15,1	11,16,2
	Stage 4	19,5,10,15	1,6,11,16	2,7,12,17	3,8,13,18	4,9,14,19	5,10,15,1	6,11,16,2	7,12,17,3	8,13,18,4	9,14,19,5	10,15,1,6	11,16,2,7

Annex G
(continued)

13	Stage 1	12	13	14	15	16	17	18	19	1	2	3	4
	Stage 2	12,17	13,18	14,19	15,1	16,2	17,3	18,4	19,5	1,6	2,7	3,8	4,9
	Stage 3	12,17,3	13,18,4	14,19,5	15,1,6	16,2,7	17,3,8	18,4,9	19,5,10	1,6,11	2,7,12	3,8,13	4,9,14
	Stage 4	12,17,3,8	13,18,4,9	14,19,5,10	15,1,6,11	16,2,7,12	17,3,8,13	18,4,9,14	19,5,10,15	1,6,11,16	2,7,12,17	3,8,13,18	4,9,14,19
14	Stage 1	5	6	7	8	9	10	11	12	13	14	15	16
	Stage 2	5,10	6,11	7,12	8,13	9,14	10,15	11,16	12,17	13,18	14,19	15,1	16,2
	Stage 3	5,10,15	6,11,16	7,12,17	8,13,18	9,14,19	10,15,1	11,16,2	12,17,3	13,18,4	14,19,5	15,1,6	16,2,7
	Stage 4	5,10,15,1	6,11,16,2	7,12,17,3	8,13,18,4	9,14,19,5	10,15,1,6	11,16,2,7	12,17,3,8	13,18,4,9	14,19,5,10	15,1,6,11	16,2,7,12
15	Stage 1	17	18	19	1	2	3	4	5	6	7	8	9
	Stage 2	17,3	18,4	19,5	1,6	2,7	3,8	4,9	5,10	6,11	7,12	8,13	9,14
	Stage 3	17,3,8	18,4,9	19,5,10	1,6,11	2,7,12	3,8,13	4,9,14	5,10,15	6,11,16	7,12,17	8,13,18	9,14,19
	Stage 4	17,3,8,13	18,4,9,14	19,5,10,15	1,6,11,16	2,7,12,17	3,8,13,18	4,9,14,19	5,10,15,1	6,11,16,2	7,12,17,3	8,13,18,4	9,14,19,5
16	Stage 1	10	11	12	13	14	15	16	17	18	19	1	2
	Stage 2	10,15	11,16	12,17	13,18	14,19	15,1	16,2	17,3	18,4	19,5	1,6	2,7
	Stage 3	10,15,1	11,16,2	12,17,3	13,18,4	14,19,5	15,1,6	16,2,7	17,3,8	18,4,9	19,5,10	1,6,11	2,7,12
	Stage 4	10,15,1,6	11,16,2,7	12,17,3,8	13,18,4,9	14,19,5,10	15,1,6,11	16,2,7,12	17,3,8,13	18,4,9,14	19,5,10,15	1,6,11,16	2,7,12,17
17	Stage 1	3	4	5	6	7	8	9	10	11	12	13	14
	Stage 2	3,8	4,9	5,10	6,11	7,12	8,13	9,14	10,15	11,16	12,17	13,18	14,19
	Stage 3	3,8,13	4,9,14	5,10,15	6,11,16	7,12,17	8,13,18	9,14,19	10,15,1	11,16,2	12,17,3	13,18,4	14,19,5
	Stage 4	3,8,13,18	4,9,14,19	5,10,15,1	6,11,16,2	7,12,17,3	8,13,18,4	9,14,19,5	10,15,1,6	11,16,2,7	12,17,3,8	13,18,4,9	14,19,5,10

Annex G
(continued)

18	Stage 1	15	16	17	18	19	1	2	3	4	5	6	7
	Stage 2	15,1	16,2	17,3	18,4	19,5	1,6	2,7	3,8	4,9	5,10	6,11	7,12
	Stage 3	15,1,6	16,2,7	17,3,8	18,4,9	19,5,10	1,6,11	2,7,12	3,8,13	4,9,14	5,10,15	6,11,16	7,12,17
	Stage 4	15,1,6,11	16,2,7,12	17,3,8,13	18,4,9,14	19,5,10,15	1,6,11,16	2,7,12,17	3,8,13,18	4,9,14,19	5,10,15,1	6,11,16,2	7,12,17,3
19	Stage 1	8	9	10	11	12	13	14	15	16	17	18	19
	Stage 2	8,13	9,14	10,15	11,16	12,17	13,18	14,19	15,1	16,2	17,3	18,4	19,5
	Stage 3	8,13,18	9,14,19	10,15,1	11,16,2	12,17,3	13,18,4	14,19,5	15,1,6	16,2,7	17,3,8	18,4,9	19,5,10
	Stage 4	8,13,18,4	9,14,19,5	10,15,1,6	11,16,2,7	12,17,3,8	13,18,4,9	14,19,5,10	15,1,6,11	16,2,7,12	17,3,8,13	18,4,9,14	19,5,10,15

Annex G
(continued)

Figure G.2 — Model load shedding schedule for a 3 hour shedding period (each number in the table designates the number of the block shed of the 19 blocks)

Day	Stage	00:00 - 03:00	03:00 - 06:00	06:00 - 09:00	09:00 - 12:00	12:00 - 15:00	15:00 - 18:00	18:00 - 21:00	21:00 - 00:00
1	Stage 1	1	2	3	4	5	6	7	8
	Stage 2	1,17	2,18	3,19	4,1	5,2	6,3	7,4	8,5
	Stage 3	1,17,14	2,18,15	3,19,16	4,1,17	5,2,18	6,3,19	7,4,1	8,5,2
	Stage 4	1,17,14,11	2,18,15,12	3,19,16,13	4,1,17,14	5,2,18,15	6,3,19,16	7,4,1,17	8,5,2,18
2	Stage 1	9	10	11	12	13	14	15	16
	Stage 2	9,6	10,7	11,8	12,9	13,10	14,11	15,12	16,13
	Stage 3	9,6,3	10,7,4	11,8,5	12,9,6	13,10,7	14,11,8	15,12,9	16,13,10
	Stage 4	9,6,3,19	10,7,4,1	11,8,5,2	12,9,6,3	13,10,7,4	14,11,8,5	15,12,9,6	16,13,10,7
3	Stage 1	17	18	19	1	2	3	4	5
	Stage 2	17,14	18,15	19,16	1,17	2,18	3,19	4,1	5,2
	Stage 3	17,14,11	18,15,12	19,16,13	1,17,14	2,18,15	3,19,16	4,1,17	5,2,18
	Stage 4	17,14,11,8	18,15,12,9	19,16,13,10	1,17,14,11	2,18,15,12	3,19,16,13	4,1,17,14	5,2,18,15
4	Stage 1	6	7	8	9	10	11	12	13
	Stage 2	6,3	7,4	8,5	9,6	10,7	11,8	12,9	13,10
	Stage 3	6,3,19	7,4,1	8,5,2	9,6,3	10,7,4	11,8,5	12,9,6	13,10,7
	Stage 4	6,3,19,16	7,4,1,17	8,5,2,18	9,6,3,19	10,7,4,1	11,8,5,2	12,9,6,3	13,10,7,4
5	Stage 1	14	15	16	17	18	19	1	2
	Stage 2	14,11	15,12	16,13	17,14	18,15	19,16	1,17	2,18
	Stage 3	14,11,8	15,12,9	16,13,10	17,14,11	18,15,12	19,16,13	1,17,14	2,18,15
	Stage 4	14,11,8,5	15,12,9,6	16,13,10,7	17,14,11,8	18,15,12,9	19,16,13,10	1,17,14,11	2,18,15,12

Annex G
(continued)

6	Stage 1	3	4	5	6	7	8	9	10
	Stage 2	3,19	4,1	5,2	6,3	7,4	8,5	9,6	10,7
	Stage 3	3,19,16	4,1,17	5,2,18	6,3,19	7,4,1	8,5,2	9,6,3	10,7,4
	Stage 4	3,19,16,13	4,1,17,14	5,2,18,15	6,3,19,16	7,4,1,17	8,5,2,18	9,6,3,19	10,7,4,1
7	Stage 1	11	12	13	14	15	16	17	18
	Stage 2	11,8	12,9	13,10	14,11	15,12	16,13	17,14	18,15
	Stage 3	11,8,5	12,9,6	13,10,7	14,11,8	15,12,9	16,13,10	17,14,11	18,15,12
	Stage 4	11,8,5,2	12,9,6,3	13,10,7,4	14,11,8,5	15,12,9,6	16,13,10,7	17,14,11,8	18,15,12,9
8	Stage 1	19	1	2	3	4	5	6	7
	Stage 2	19,16	1,17	2,18	3,19	4,1	5,2	6,3	7,4
	Stage 3	19,16,13	1,17,14	2,18,15	3,19,16	4,1,17	5,2,18	6,3,19	7,4,1
	Stage 4	19,16,13,10	1,17,14,11	2,18,15,12	3,19,16,13	4,1,17,14	5,2,18,15	6,3,19,16	7,4,1,17
9	Stage 1	8	9	10	11	12	13	14	15
	Stage 2	8,5	9,6	10,7	11,8	12,9	13,10	14,11	15,12
	Stage 3	8,5,2	9,6,3	10,7,4	11,8,5	12,9,6	13,10,7	14,11,8	15,12,9
	Stage 4	8,5,2,18	9,6,3,19	10,7,4,1	11,8,5,2	12,9,6,3	13,10,7,4	14,11,8,5	15,12,9,6
10	Stage 1	16	17	18	19	1	2	3	4
	Stage 2	16,13	17,14	18,15	19,16	1,17	2,18	3,19	4,1
	Stage 3	16,13,10	17,14,11	18,15,12	19,16,13	1,17,14	2,18,15	3,19,16	4,1,17
	Stage 4	16,13,10,7	17,14,11,8	18,15,12,9	19,16,13,10	1,17,14,11	2,18,15,12	3,19,16,13	4,1,17,14

Annex G
(continued)

11	Stage 1	5	6	7	8	9	10	11	12
	Stage 2	5,2	6,3	7,4	8,5	9,6	10,7	11,8	12,9
	Stage 3	5,2,18	6,3,19	7,4,1	8,5,2	9,6,3	10,7,4	11,8,5	12,9,6
	Stage 4	5,2,18,15	6,3,19,16	7,4,1,17	8,5,2,18	9,6,3,19	10,7,4,1	11,8,5,2	12,9,6,3
12	Stage 1	13	14	15	16	17	18	19	1
	Stage 2	13,10	14,11	15,12	16,13	17,14	18,15	19,16	1,17
	Stage 3	13,10,7	14,11,8	15,12,9	16,13,10	17,14,11	18,15,12	19,16,13	1,17,14
	Stage 4	13,10,7,4	14,11,8,5	15,12,9,6	16,13,10,7	17,14,11,8	18,15,12,9	19,16,13,10	1,17,14,11
13	Stage 1	2	3	4	5	6	7	8	9
	Stage 2	2,18	3,19	4,1	5,2	6,3	7,4	8,5	9,6
	Stage 3	2,18,15	3,19,16	4,1,17	5,2,18	6,3,19	7,4,1	8,5,2	9,6,3
	Stage 4	2,18,15,12	3,19,16,13	4,1,17,14	5,2,18,15	6,3,19,16	7,4,1,17	8,5,2,18	9,6,3,19
14	Stage 1	10	11	12	13	14	15	16	17
	Stage 2	10,7	11,8	12,9	13,10	14,11	15,12	16,13	17,14
	Stage 3	10,7,4	11,8,5	12,9,6	13,10,7	14,11,8	15,12,9	16,13,10	17,14,11
	Stage 4	10,7,4,1	11,8,5,2	12,9,6,3	13,10,7,4	14,11,8,5	15,12,9,6	16,13,10,7	17,14,11,8
15	Stage 1	18	19	1	2	3	4	5	6
	Stage 2	18,15	19,16	1,17	2,18	3,19	4,1	5,2	6,3
	Stage 3	18,15,12	19,16,13	1,17,14	2,18,15	3,19,16	4,1,17	5,2,18	6,3,19
	Stage 4	18,15,12,9	19,16,13,10	1,17,14,11	2,18,15,12	3,19,16,13	4,1,17,14	5,2,18,15	6,3,19,16
16	Stage 1	7	8	9	10	11	12	13	14
	Stage 2	7,4	8,5	9,6	10,7	11,8	12,9	13,10	14,11
	Stage 3	7,4,1	8,5,2	9,6,3	10,7,4	11,8,5	12,9,6	13,10,7	14,11,8
	Stage 4	7,4,1,17	8,5,2,18	9,6,3,19	10,7,4,1	11,8,5,2	12,9,6,3	13,10,7,4	14,11,8,5

Annex G
(continued)

17	Stage 1	15	16	17	18	19	1	2	3
	Stage 2	15,12	16,13	17,14	18,15	19,16	1,17	2,18	3,19
	Stage 3	15,12,9	16,13,10	17,14,11	18,15,12	19,16,13	1,17,14	2,18,15	3,19,16
	Stage 4	15,12,9,6	16,13,10,7	17,14,11,8	18,15,12,9	19,16,13,10	1,17,14,11	2,18,15,12	3,19,16,13
18	Stage 1	4	5	6	7	8	9	10	11
	Stage 2	4,1	5,2	6,3	7,4	8,5	9,6	10,7	11,8
	Stage 3	4,1,17	5,2,18	6,3,19	7,4,1	8,5,2	9,6,3	10,7,4	11,8,5
	Stage 4	4,1,17,14	5,2,18,15	6,3,19,16	7,4,1,17	8,5,2,18	9,6,3,19	10,7,4,1	11,8,5,2
19	Stage 1	12	13	14	15	16	17	18	19
	Stage 2	12,9	13,10	14,11	15,12	16,13	17,14	18,15	19,16
	Stage 3	12,9,6	13,10,7	14,11,8	15,12,9	16,13,10	17,14,11	18,15,12	19,16,13
	Stage 4	12,9,6,3	13,10,7,4	14,11,8,5	15,12,9,6	16,13,10,7	17,14,11,8	18,15,12,9	19,16,13,10

Annex G
(continued)

Figure G.3 — Model load shedding schedule for a 4 hour shedding period (each number in the table designates the number of the block shed of the 19 blocks)

Day	Stage	00:00 - 04:00	04:00 - 08:00	08:00 - 12:00	12:00 - 16:00	16:00 - 20:00	20:00 - 00:00
1	Stage 1	1	2	3	4	5	6
	Stage 2	1,13	2,14	3,15	4,16	5,17	6,18
	Stage 3	1,13,6	2,14,7	3,15,8	4,16,9	5,17,10	6,18,11
	Stage 4	1,13,6,18	2,14,7,19	3,15,8,1	4,16,9,2	5,17,10,3	6,18,11,4
2	Stage 1	7	8	9	10	11	12
	Stage 2	7,19	8,1	9,2	10,3	11,4	12,5
	Stage 3	7,19,12	8,1,13	9,2,14	10,3,15	11,4,16	12,5,17
	Stage 4	7,19,12,5	8,1,13,6	9,2,14,7	10,3,15,8	11,4,16,9	12,5,17,10
3	Stage 1	13	14	15	16	17	18
	Stage 2	13,6	14,7	15,8	16,9	17,10	18,11
	Stage 3	13,6,18	14,7,19	15,8,1	16,9,2	17,10,3	18,11,4
	Stage 4	13,6,18,11	14,7,19,12	15,8,1,13	16,9,2,14	17,10,3,15	18,11,4,16
4	Stage 1	19	1	2	3	4	5
	Stage 2	19,12	1,13	2,14	3,15	4,16	5,17
	Stage 3	19,12,5	1,13,6	2,14,7	3,15,8	4,16,9	5,17,10
	Stage 4	19,12,5,17	1,13,6,18	2,14,7,19	3,15,8,1	4,16,9,2	5,17,10,3
5	Stage 1	6	7	8	9	10	11
	Stage 2	6,18	7,19	8,1	9,2	10,3	11,4
	Stage 3	6,18,11	7,19,12	8,1,13	9,2,14	10,3,15	11,4,16
	Stage 4	6,18,11,4	7,19,12,5	8,1,13,6	9,2,14,7	10,3,15,8	11,4,16,9

Annex G

(continued)

6	Stage 1	12	13	14	15	16	17
	Stage 2	12,5	13,6	14,7	15,8	16,9	17,10
	Stage 3	12,5,17	13,6,18	14,7,19	15,8,1	16,9,2	17,10,3
	Stage 4	12,5,17,10	13,6,18,11	14,7,19,12	15,8,1,13	16,9,2,14	17,10,3,15
7	Stage 1	18	19	1	2	3	4
	Stage 2	18,11	19,12	1,13	2,14	3,15	4,16
	Stage 3	18,11,4	19,12,5	1,13,6	2,14,7	3,15,8	4,16,9
	Stage 4	18,11,4,16	19,12,5,17	1,13,6,18	2,14,7,19	3,15,8,1	4,16,9,2
8	Stage 1	5	6	7	8	9	10
	Stage 2	5,17	6,18	7,19	8,1	9,2	10,3
	Stage 3	5,17,10	6,18,11	7,19,12	8,1,13	9,2,14	10,3,15
	Stage 4	5,17,10,3	6,18,11,4	7,19,12,5	8,1,13,6	9,2,14,7	10,3,15,8
9	Stage 1	11	12	13	14	15	16
	Stage 2	11,4	12,5	13,6	14,7	15,8	16,9
	Stage 3	11,4,16	12,5,17	13,6,18	14,7,19	15,8,1	16,9,2
	Stage 4	11,4,16,9	12,5,17,10	13,6,18,11	14,7,19,12	15,8,1,13	16,9,2,14
10	Stage 1	17	18	19	1	2	3
	Stage 2	17,10	18,11	19,12	1,13	2,14	3,15
	Stage 3	17,10,3	18,11,4	19,12,5	1,13,6	2,14,7	3,15,8
	Stage 4	17,10,3,15	18,11,4,16	19,12,5,17	1,13,6,18	2,14,7,19	3,15,8,1

Annex G
(continued)

11	Stage 1	4	5	6	7	8	9
	Stage 2	4,16	5,17	6,18	7,19	8,1	9,2
	Stage 3	4,16,9	5,17,10	6,18,11	7,19,12	8,1,13	9,2,14
	Stage 4	4,16,9,2	5,17,10,3	6,18,11,4	7,19,12,5	8,1,13,6	9,2,14,7
12	Stage 1	10	11	12	13	14	15
	Stage 2	10,3	11,4	12,5	13,6	14,7	15,8
	Stage 3	10,3,15	11,4,16	12,5,17	13,6,18	14,7,19	15,8,1
	Stage 4	10,3,15,8	11,4,16,9	12,5,17,10	13,6,18,11	14,7,19,12	15,8,1,13
13	Stage 1	16	17	18	19	1	2
	Stage 2	16,9	17,10	18,11	19,12	1,13	2,14
	Stage 3	16,9,2	17,10,3	18,11,4	19,12,5	1,13,6	2,14,7
	Stage 4	16,9,2,14	17,10,3,15	18,11,4,16	19,12,5,17	1,13,6,18	2,14,7,19
14	Stage 1	3	4	5	6	7	8
	Stage 2	3,15	4,16	5,17	6,18	7,19	8,1
	Stage 3	3,15,8	4,16,9	5,17,10	6,18,11	7,19,12	8,1,13
	Stage 4	3,15,8,1	4,16,9,2	5,17,10,3	6,18,11,4	7,19,12,5	8,1,13,6
15	Stage 1	9	10	11	12	13	14
	Stage 2	9,2	10,3	11,4	12,5	13,6	14,7
	Stage 3	9,2,14	10,3,15	11,4,16	12,5,17	13,6,18	14,7,19
	Stage 4	9,2,14,7	10,3,15,8	11,4,16,9	12,5,17,10	13,6,18,11	14,7,19,12
16	Stage 1	15	16	17	18	19	1
	Stage 2	15,8	16,9	17,10	18,11	19,12	1,13
	Stage 3	15,8,1	16,9,2	17,10,3	18,11,4	19,12,5	1,13,6
	Stage 4	15,8,1,13	16,9,2,14	17,10,3,15	18,11,4,16	19,12,5,17	1,13,6,18

Annex G
(continued)

17	Stage 1	2	3	4	5	6	7
	Stage 2	2,14	3,15	4,16	5,17	6,18	7,19
	Stage 3	2,14,7	3,15,8	4,16,9	5,17,10	6,18,11	7,19,12
	Stage 4	2,14,7,19	3,15,8,1	4,16,9,2	5,17,10,3	6,18,11,4	7,19,12,5
18	Stage 1	8	9	10	11	12	13
	Stage 2	8,1	9,2	10,3	11,4	12,5	13,6
	Stage 3	8,1,13	9,2,14	10,3,15	11,4,16	12,5,17	13,6,18
	Stage 4	8,1,13,6	9,2,14,7	10,3,15,8	11,4,16,9	12,5,17,10	13,6,18,11
19	Stage 1	14	15	16	17	18	19
	Stage 2	14,7	15,8	16,9	17,10	18,11	19,12
	Stage 3	14,7,19	15,8,1	16,9,2	17,10,3	18,11,4	19,12,5
	Stage 4	14,7,19,12	15,8,1,13	16,9,2,14	17,10,3,15	18,11,4,16	19,12,5,17

Annex H – Examples of 24/7 rotational load shedding schedules based on 24 blocks

(informative)

H.1 Overview

Typical model load shedding schedules are shown in this annex, based on the 24 blocks identified for the load shedding schedules, as described in Annex F (section F.2). The model schedules provided address load shedding periods of 2hrs (figure H.1).

Licensees may use these model schedules to generate their own schedules based on the normative requirements in sections 1 to 10 of this code.

H.2 Methodology

The assumption made in the examples provided is that the base load has been divided into 24 equal blocks, of between 5 % and 6 % of the base load each. These are then rotated across the day, over all 24 hours, and all 7 days of the week.

The schedule is designed from Monday to Sunday, 24/7 for Stages 1 to 4, from 06h00 to 22h00 (the likely period of load shedding) and from 22h00 to 06h00 (the unlikely period of load shedding). The following is applied:

- a) the schedule is made up of blocks and each block is scheduled for 2 hours with a 30 minute overlap to allow for switching. Two (2) hour blocks are designed to prevent numerous waiting load trip outs when restoring supply and to prevent a customer from experiencing a prolonged outage. However, it was noted that certain industrial customers preferred a longer time period for their block under Stage 3 and 4 due to the start-up time requirements which was not accommodated;
- b) the blocks are labeled from 1-24. Blocks 1-16 are largely residential and commercial type customers and blocks 17-24 are largely industrial customers;
- c) from Monday to Sunday, blocks 1-16 are included from Stage 1 and blocks 17-24 are included from Stage 3;
- d) the minimum duration before a block is shed again under the relevant stages for the likely period (06h00 to 22h00) of load shedding from Monday to Sunday are:
 - i) Stage 1, a block (hence customer) will be affected every second day (48 hours);
 - ii) Stage 2 and 3, a block will be affected once a day (24 hours); and
 - iii) Stage 4, a block will be affected once a day and twice a day for every second day with a 6 hour break.
- e) blocks 1-16 are only scheduled under the relevant stages for the unlikely period (22h00 to 06h00) of load shedding from Monday to Sunday;
- f) the block allocation to the time periods during the likely period of load shedding from Monday to Sunday adheres to the following:
 - i) Blocks 1-16 are rotated in the morning, day and evening periods,
 - ii) 06h00 to 08h00 is considered the morning period, 08h00 to 16h00 is considered the day period and 16h00 to 22h00 is considered the evening period, and
 - iii) A block under Stage 1 has no more than 2 evening time periods and under Stage 2 and 3 has no more than 3 evening time periods.

Annex H
(continued)

- g) a block has no more than one consecutive evening time period;
- h) blocks remained grouped throughout the week for Stages 1, 2 and 3;
- i) the time periods allocated to the different blocks ensure that there is full rotation from Monday to Sunday for the likely period of load shedding considering a Stage 2 emergency. (i.e. no block has a repeat time slot); and
- j) blocks 12, 13 and 15 are used to accommodate traffic congestion in the City Centre and adheres to the following:
 - i) These blocks are not allocated from 06h00 to 08h00 from Wednesday to Friday; and
 - ii) These blocks are not allocated from 16h00 to 18h00 from Monday to Friday.

Annex H
(continued)

Monday					Tuesday			
Time	Stage 1	Stage 2	Stage 3	Stage 4	Stage 1	Stage 2	Stage 3	Stage 4
00:00-02:00	6	6,11	6,11,13	6,11,13,4	3	3,16	3,16,2	3,16,2,7
02:00-04:00	16	16,3	16,3,7	16,3,7,2	12	12,8	12,8,4	12,8,4,13
04:00-06:00	15	15,4	15,4,8	15,4,8,9	10	10,7	10,7,11	10,7,11,5
06:00-08:00	2	2,13	2,13,23	2,13,23,11	8	8,12	8,12,24	8,12,24,14
08:00-10:00	9	9,5	9,5,19	9,5,19,1	13	13,2	13,2,23	13,2,23,5
10:00-12:00	3	3,16	3,16,17	3,16,17,10	6	6,11	6,11,18	6,11,18,15
12:00-14:00	4	4,15	4,15,21	4,15,21,12	16	16,3	16,3,17	16,3,17,7
14:00-16:00	11	11,6	11,6,18	11,6,18,2	14	14,1	14,1,20	14,1,20,8
16:00-18:00	1	1,14	1,14,20	1,14,20,9	5	5,9	5,9,19	5,9,19,13
18:00-20:00	10	10,7	10,7,22	10,7,22,3	15	15,4	15,4,21	15,4,21,6
20:00-22:00	12	12,8	12,8,24	12,8,24,4	7	7,10	7,10,22	7,10,22,16
22:00-00:00	14	14,1	14,1,5	14,1,5,10	1	1,14	1,14,9	1,14,9,8
Wednesday					Thursday			
Time	Stage 1	Stage 2	Stage 3	Stage 4	Stage 1	Stage 2	Stage 3	Stage 4
00:00-02:00	13	13,2	13,2,6	13,2,6,3	4	4,15	4,15,12	4,15,12,14
02:00-04:00	5	5,9	5,9,8	5,9,8,11	2	2,13	2,13,3	2,13,3,16
04:00-06:00	15	15,4	15,4,14	15,4,14,12	10	10,7	10,7,11	10,7,11,6
06:00-08:00	11	11,6	11,6,18	11,6,18,2	5	5,9	5,9,19	5,9,19,8
08:00-10:00	4	4,15	4,15,21	4,15,21,3	16	16,3	16,3,17	16,3,17,7
10:00-12:00	10	10,7	10,7,22	10,7,22,9	15	15,4	15,4,21	15,4,21,14
12:00-14:00	12	12,8	12,8,24	12,8,24,1	13	13,2	13,2,23	13,2,23,6
14:00-16:00	2	2,13	2,13,23	2,13,23,11	8	8,12	8,12,24	8,12,24,5
16:00-18:00	3	3,16	3,16,17	3,16,17,4	7	7,10	7,10,22	7,10,22,16
18:00-20:00	9	9,5	9,5,19	9,5,19,10	14	14,1	14,1,20	14,1,20,15
20:00-22:00	1	1,14	1,14,20	1,14,20,12	6	6,11	6,11,18	6,11,18,13
22:00-00:00	7	7,10	7,10,16	7,10,16,2	9	9,5	9,5,1	9,5,1,15
Friday					Saturday			
Time	Stage 1	Stage 2	Stage 3	Stage 4	Stage 1	Stage 2	Stage 3	Stage 4
00:00-02:00	6	6,11	6,11,13	6,11,13,2	3	3,16	3,16,4	3,16,4,15
02:00-04:00	16	16,3	16,3,7	16,3,7,4	12	12,8	12,8,2	12,8,2,14
04:00-06:00	14	14,1	14,1,15	14,1,15,9	11	11,6	11,6,10	11,6,10,13
06:00-08:00	3	3,16	3,16,17	3,16,17,10	15	15,4	15,4,21	15,4,21,5
08:00-10:00	1	1,14	1,14,20	1,14,20,11	7	7,10	7,10,22	7,10,22,13
10:00-12:00	12	12,8	12,8,24	12,8,24,2	14	14,1	14,1,20	14,1,20,8
12:00-14:00	9	9,5	9,5,19	9,5,19,4	6	6,11	6,11,18	6,11,18,16
14:00-16:00	10	10,7	10,7,22	10,7,22,3	5	5,9	5,9,19	5,9,19,15
16:00-18:00	11	11,6	11,6,18	11,6,18,1	13	13,2	13,2,23	13,2,23,7
18:00-20:00	2	2,13	2,13,23	2,13,23,12	8	8,12	8,12,24	8,12,24,14
20:00-22:00	4	4,15	4,15,21	4,15,21,9	16	16,3	16,3,17	16,3,17,6
22:00-00:00	8	8,12	8,12,5	8,12,5,10	1	1,14	1,14,9	1,14,9,16
Sunday								
Time	Stage 1	Stage 2	Stage 3	Stage 4				
00:00-02:00	10	10,13	10,13,5	10,13,5,4				
02:00-04:00	9	9,14	9,14,7	9,14,7,2				
04:00-06:00	11	11,16	11,16,8	11,16,8,6				
06:00-08:00	1	1,14	1,14,20	1,14,20,3				
08:00-10:00	8	8,12	8,12,24	8,12,24,4				
10:00-12:00	2	2,13	2,13,23	2,13,23,6				
12:00-14:00	7	7,10	7,10,22	7,10,22,5				
14:00-16:00	3	3,16	3,16,17	3,16,17,1				
16:00-18:00	4	4,15	4,15,21	4,15,21,8				
18:00-20:00	6	6,11	6,11,18	6,11,18,2				
20:00-22:00	5	5,9	5,9,19	5,9,19,7				
22:00-00:00	12	12,15	12,15,1	12,15,1,3				

Annex I – Calculation of a Curtailment Base Load Profile (CBL) (informative)

I.1 Determining curtailment base load

A Curtailment Base Load profile (CBL) is created for every day of the week based on historic demand consumption. An average daily demand profile is created based on a half-hourly average of previous similar demand profile days.

The following options may be used to select historical demand data to determine CBL:

- a) where a customers' operations are routine and the daily profiles are fairly repetitive, 3 previous "like" days may be used to determine a CBL. 3 week days may be used to determine a week day profile and 3 weekend days to determine a weekend profile;
- b) a longer duration may also be utilised to determine the CBL. For example, 1, 2 or 3 month historical demand data;
- c) where the customers' daily operations are similar, a single CBL day may be determined. Other options include a daily CBL for each of the 7 days of the week; a weekday and weekend CBL, etc.;
- d) the CBL shall consist of average half-hourly profiles. These profiles shall exclude other curtailment days and Demand Response days for those participating in Demand response programs. A planned and unplanned maintenance day may be excluded for the purpose of CBL calculations; and
- e) public holidays may be treated as a Saturday or Sunday.

The CBL should be updated at a frequency that takes into consideration the type of operation and the seasonal changes.

I.2 Performance Monitoring and Assessment Method

The relevant CBL is compared with the profile of the customer during the emergency declaration period. The difference in the profiles is used to calculate an average percentage reduction which is compared with the targets for the relevant load curtailment stages.

Load curtailment (LC) shall be calculated per the Integration Period, subtracting the Actual Load from the CBL and summated for the duration of the load curtailment request. The calculation is as follows:

$$LC = \text{sum} [(CBL (n) - \text{Actual Load} (n)) \dots (CBL (m) - \text{Actual Load} (m))]$$

where

n = first Integration Period of the Load Curtailment request

m = last Integration Period of the Load Curtailment request

If the Actual Load exceeds the CBL, the said difference shall be a negative variance and if the Actual Load is less than the CBL, the said difference shall be a positive variance. For each load curtailment event, the positive variances and the negative variances shall be summated.

For each Load curtailment event, the CBL shall be scaled up or down to match the Actual Load in proportion to the difference between the average of the CBL and the average Actual Load during the first 2 Integration Periods X(z) of a moving 3 completed Integration Periods immediately prior to the Load Reduction event.

Annex I
(concluded)

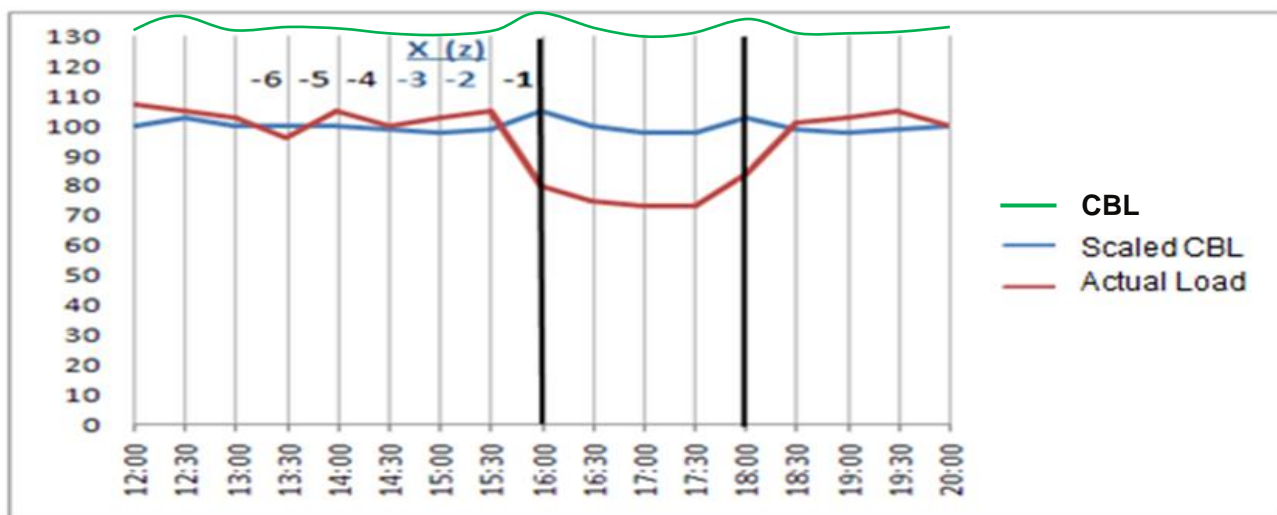


Figure H.1 — Curtailment base line measurement

The reference point $X(z)$ may be moved to a mutually agreed period of normal consumption up to point -6, as indicated in the illustration. The allowed options for such a movement shall be limited to points (-1 and -2), (-3 and 4), (-4 and 5) or (-5 and 6).

Annex J – Design of contingency schedules (normative)

J.1 Overview

Contingency schedules are a requirement of this part of NRS048 in order to provide the System Operator with a controlled load reduction in the event of an extreme constraint (beyond Stages 1 to 4). The requirements below are normative, unless agreement has been reached with the System Operator for alternative approaches.

NOTE The implications of controlled switching at this level may significantly affect system frequency, and therefore the System Operator is required to approve and coordinate reduction regimes adopted by licensees.

J.2 Contingency schedule design

Licensees shall prepare extended load shedding schedules (Stages 5 to 8) based on a doubling of the time-slots for each block related to the respective load shedding stages (illustrated in figure J.1)

NOTE Whilst Stage 4 shedding provides up to approximately 4000 MW of load reduction, the reduction provided by contingency schedules is doubled to 8000 MW in 1000 MW increments from Stages 5 to 8.

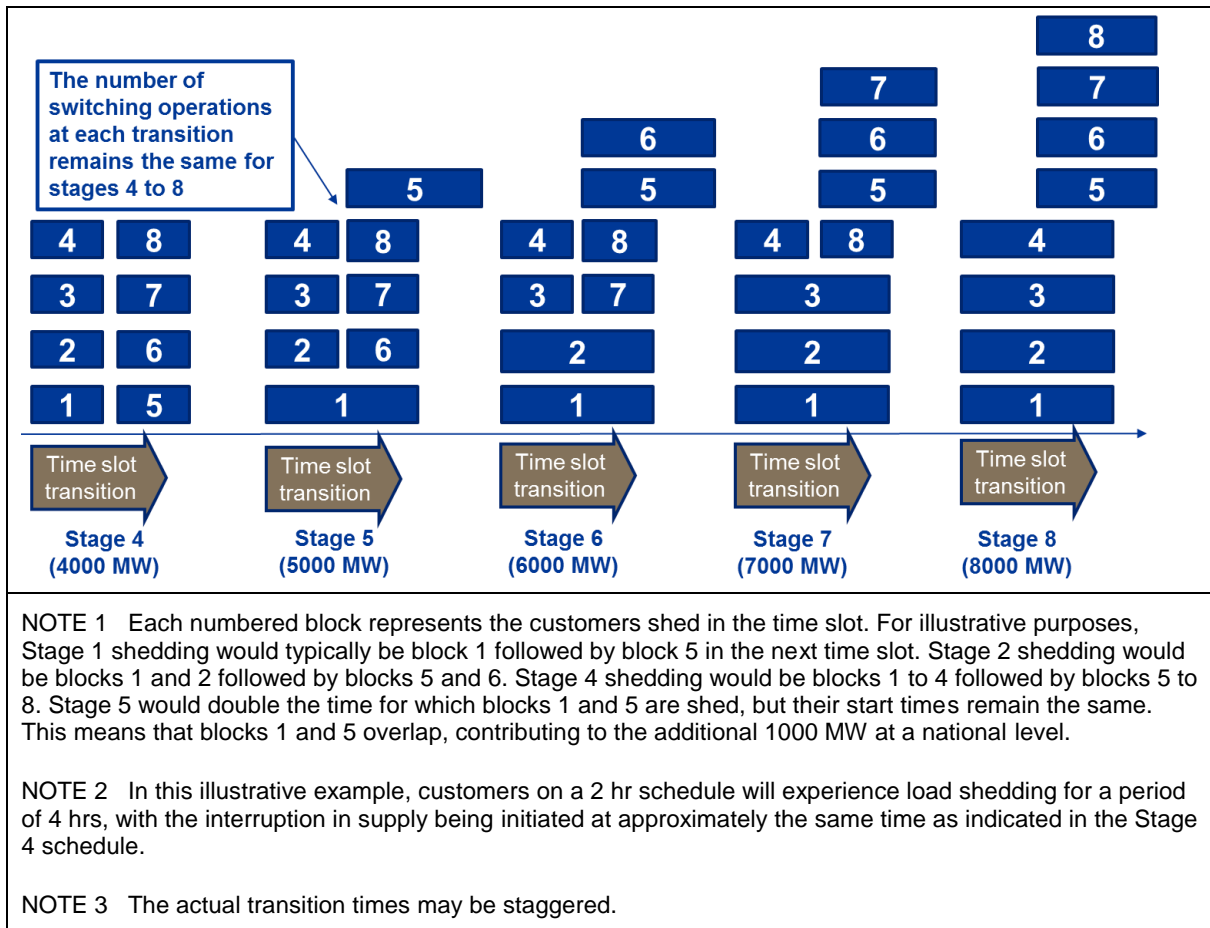


Figure J.1 — Illustration of contingency schedules based on progressively extended switching durations from Stage 5 (one block interrupted for double the time) to Stage 8 (all blocks interrupted for double the time)

Annex J
(concluded)

The design shall be implemented as follows:

- a) **stage 5 schedules** shall be the same as Stage 4 schedules with the exception that blocks shed under Stage 1 are doubled in time (e.g. 2 hr time slots become 4 hr slots).
- b) **stage 6 schedules** shall be the same as Stage 4 schedules with the exception that blocks shed under Stage 1 and 2 are doubled in time (e.g. 2 hr time slots become 4 hr slots).
- c) **stage 7 schedules** shall be the same as Stage 4 schedules with the exception that blocks shed under Stage 1, 2, and 3 are doubled in time (e.g. 2 hr time slots become 4 hrs slots).
- d) **stage 8 schedules** shall be the same as Stage 4 schedules with the exception that all blocks shed are doubled in time (e.g. 2 hr time slots become 4 hrs slots).

Annex K – 16 Block rotating schedule for a standard month (informative)

K.1 Overview

Typical model load shedding schedules are shown in this annex, based on the 16 blocks identified for the load shedding schedules. The model schedules provided address load shedding periods of 2hrs (figure K.1), 3hrs (figure K.2), and 4hrs (figure K.3).

Licenseses may use these model schedules to generate their own schedules based on the normative requirements in sections 1 to 10 of this Code.

K.2 Methodology

The assumption made in the examples provided is that the base load has been divided into 16 equal blocks, of just more than 6% of the base load each. These are then rotated across the day, over all 24 hours, and all 7 days of the week. The pattern is repeated until the 31st day, to establish a standard pattern for each month. The pattern begins again on day 1 of each month and runs until the end of the month, be it a 28 day, 30 day or 31 day month.

Table K.1- pattern of 16 2hour block schedule rotated through 31 days
The blocks are listed per stage per day, and accumulate as the stages increase. In other words:

- Stage 1 consists of the Stage 1 listed block
- Stage 2 consists of the Stage 2 and 1 listed block,
- Stage 3 consists of the Stage 3, 2 and 1 listed blocks and
- Stage 4 consists of the Stage 4, 3, 2 and 1 listed blocks.

Time	Stage	Day of the month, repeating at the end of the month, not rolling over																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
00:00-02:30	1	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16
	2	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4
	3	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8
	4	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12
02:00-04:30	1	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1
	2	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5
	3	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9
	4	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13

Annex K
(continued)

04:00-06:30	1	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2
	2	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6
	3	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10
	4	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14
06:00-08:30	1	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3
	2	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7
	3	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11
	4	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15
08:00-10:30	1	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4
	2	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8
	3	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12
	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16
10:00-12:30	1	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5
	2	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9
	3	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13
	4	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1
12:00-14:30	1	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6
	2	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10
	3	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14
	4	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2
14:00-16:30	1	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7
	2	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11
	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15
	4	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3

Annex K
(continued)

16:00-18:30	1		9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8
	2		13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12
	3		1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16
	4		5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4
18:00-20:30	1		10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9
	2		14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13
	3		2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1
	4		6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5
20:00-22:30	1		11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10
	2		15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14
	3		3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2
	4		7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6
22:00-00:30	1		12	8	4	16	13	9	5	1	14	10	6	2	15	11	7	3	16	12	8	4	1	13	9	5	2	14	10	6	3	15	11
	2		16	12	8	4	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	6	2	14	10	7	3	15
	3		4	16	12	8	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3
	4		8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	13	9	5	1	14	10	6	2	15	11	7

Annex K
(continued)

Table K.2 — Pattern of 16 4hour block schedule rotated through 31 days. The blocks are listed per stage per day, and accumulate as the stages increase as per table K.1

Time	Stage	Day of the month, repeating at the end of the month, not rolling over																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
00:00:00	1	1	7	13	3	9	15	5	11	2	8	14	4	10	16	6	12	3	9	15	5	11	1	7	13	4	10	16	6	12	2	8
	2	5	11	1	7	13	3	9	15	6	12	2	8	14	4	10	16	7	13	3	9	15	5	11	1	8	14	4	10	16	6	12
	3	9	15	5	11	1	7	13	3	10	16	6	12	2	8	14	4	11	1	7	13	3	9	15	5	12	2	8	14	4	10	16
	4	13	3	9	15	5	11	1	7	14	4	10	16	6	12	2	8	15	5	11	1	7	13	3	9	16	6	12	2	8	14	4
04:00:00	1	2	8	14	4	10	16	6	12	3	9	15	5	11	1	7	13	4	10	16	6	12	2	8	14	5	11	1	7	13	3	9
	2	6	12	2	8	14	4	10	16	7	13	3	9	15	5	11	1	8	14	4	10	16	6	12	2	9	15	5	11	1	7	13
	3	10	16	6	12	2	8	14	4	11	1	7	13	3	9	15	5	12	2	8	14	4	10	16	6	13	3	9	15	5	11	1
	4	14	4	10	16	6	12	2	8	15	5	11	1	7	13	3	9	16	6	12	2	8	14	4	10	1	7	13	3	9	15	5
08:00:00	1	3	9	15	5	11	1	7	13	4	10	16	6	12	2	8	14	5	11	1	7	13	3	9	15	6	12	2	8	14	4	10
	2	7	13	3	9	15	5	11	1	8	14	4	10	16	6	12	2	9	15	5	11	1	7	13	3	10	16	6	12	2	8	14
	3	11	1	7	13	3	9	15	5	12	2	8	14	4	10	16	6	13	3	9	15	5	11	1	7	14	4	10	16	6	12	2
	4	15	5	11	1	7	13	3	9	16	6	12	2	8	14	4	10	1	7	13	3	9	15	5	11	2	8	14	4	10	16	6
12:00:00	1	4	10	16	6	12	2	8	14	5	11	1	7	13	3	9	15	6	12	2	8	14	4	10	16	7	13	3	9	15	5	11
	2	8	14	4	10	16	6	12	2	9	15	5	11	1	7	13	3	10	16	6	12	2	8	14	4	11	1	7	13	3	9	15
	3	12	2	8	14	4	10	16	6	13	3	9	15	5	11	1	7	14	4	10	16	6	12	2	8	15	5	11	1	7	13	3
	4	16	6	12	2	8	14	4	10	1	7	13	3	9	15	5	11	2	8	14	4	10	16	6	12	3	9	15	5	11	1	7
16:00:00	1	5	11	1	7	13	3	9	15	6	12	2	8	14	4	10	16	7	13	3	9	15	5	11	1	8	14	4	10	16	6	12
	2	9	15	5	11	1	7	13	3	10	16	6	12	2	8	14	4	11	1	7	13	3	9	15	5	12	2	8	14	4	10	16
	3	13	3	9	15	5	11	1	7	14	4	10	16	6	12	2	8	15	5	11	1	7	13	3	9	16	6	12	2	8	14	4
	4	1	7	13	3	9	15	5	11	2	8	14	4	10	16	6	12	3	9	15	5	11	1	7	13	4	10	16	6	12	2	8

Annex K
(concluded)

20:00:00	1	6	12	2	8	14	4	10	16	7	13	3	9	15	5	11	1	8	14	4	10	16	6	12	2	9	15	5	11	1	7	13
	2	10	16	6	12	2	8	14	4	11	1	7	13	3	9	15	5	12	2	8	14	4	10	16	6	13	3	9	15	5	11	1
	3	14	4	10	16	6	12	2	8	15	5	11	1	7	13	3	9	16	6	12	2	8	14	4	10	1	7	13	3	9	15	5
	4	2	8	14	4	10	16	6	12	3	9	15	5	11	1	7	13	4	10	16	6	12	2	8	14	5	11	1	7	13	3	9

Bibliography

NRS 086, *Centralized load control systems.*