NRS 048-9:2023 EDITION 3

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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

Foreword

Emergency load reduction is a measure implemented by the System Operator and electricity utility distribution control rooms in order to prevent a national, regional, or local blackout when the power 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) or load curtailment. Load curtailment can be implemented with the following options: self-managed curtailment (self-reduction by customers in response to an instruction given by the system operator or upstream control centre), load limiting (a limit remotely imposed on the total load drawn 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 term 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 to have the least negative impact on critical infrastructure. The need for such a code arose after national load shedding was 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 third edition of the code replaces the second edition published in 2017. Several changes and enhancements have been included in this edition, based on:

a) experience in implementing the requirements of the previous editions;

b) extensive use of higher stages of loadshedding, Stage 5 and Stage 6;

c) feedback from licensees and customers;

d) engagement with NERSA and the Grid Code Advisory Committee (“GCAC”) on various clarifications regarding the application of the code;

e) engagements with the many sectors represented in the NRS048-9 working group; and

f) Over 100 comments sent in by the members of the working group, which were managed by 8 subject specific task teams.

The changes and enhancements included in this third edition are:

a) consolidation of the loadshedding stages into a single system from stage 1 to 16, restricting all licensees to using this system as specified in this code of practice, or being able to explain to NERSA why they do not and how their specific system still adheres to the principles herein.

b) clarification on methods for setting baselines for curtailment customers.

c) Increased control of how load shedding and load curtailment are determined and carried out, providing more stability to the network and more certainty to curtailment customers.

d) Inclusion of the right for curtailment customers to reduce by 10 % per stage (2 stages of loadshedding), up to stage 10, 50 % of their load, or to go to essential loads, depending on their own capacity, rather than being forced to essential loads after Stage 4.

e) the specification of compliance and reporting requirements (general and real-time);

f) guidance on the implementation of smart metering as a technology platform for reducing the impact of load shedding on customers; and

g) extensive editorial changes to this specification.

The third 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.

This edition was written with input from 8 subject specific Task teams, but many of the suggestions could not be accommodated because of the ongoing:

a) lack of technological investment in the reticulation industry (e.g., smart meter technology, remote fast switching systems);
b) practical limitations of predicting generator plant failure;
c) lack of legal changes allowing any specific sectors or products to achieve special status;

For this reason, the possibility of using economic considerations, which rely on advanced metering, legal agreements, and more research into the impact of load reduction on specific parts of the economy, especially at higher stages, has been excluded from this edition. It is anticipated that future editions will continue to examine this possibility until it can be included.

NOTE The implementation of smart metering offers the electricity supply industry 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 previous editions as a license condition to all licensees in the electricity supply industry. 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. 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 requires 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 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 of practice 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 Mineral Resources and 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 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 third edition comprised the following members:

Correia A J (Chairman)	Eskom **(voting member)**
Bhana D K	Eskom (Top Customer Services) **(voting member)**
Chatterton B	Eskom (Distribution)
de Beer G	Sasol
Devnarain N	eThekwini Metropolitan Municipality Electricity **(voting member)**
Jaeger F P	City of Cape Town Metropolitan Municipality **(voting member)**
Jooste F	Eskom (Research, Testing and Development) **(voting member)**

Modiselle L	City of Tshwane Metropolitan Municipality **(voting member)**
Kgalema L	City Power Johannesburg **(voting member)**
Kgopa M	National Energy Regulator of South Africa (NERSA)
Kgomo J	City of Ekurhuleni Metropolitan Municipality **(voting member)**
Mwanza C	National Energy Regulator of South Africa (NERSA)
Marais D	Umhlathuze Municipality Electricity **(voting member)**
Minnaar U J Dr	Eskom (Research, Testing and Development) **(voting member)**
Mlangeni G	Eskom
Morison I	Energy Intensive User Group (EIUG)
Ngidi L N	SALGA
Nundlal V (Project Leader)	Eskom (Technical Governance)
Peterson B Dr	Eskom (Transmission Division)
Pittorino L	Eskom (Transmission Division)
Shabalala N	City Power Johannesburg
Tomlinson D M Dr	Eskom (Research, Testing and Development) **(voting member)**

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 specification. Annexes A, D, E, F and H are for information only.

This specification was approved by the Management Committee of The NRS Association of SA, which at the time of publication, comprised the following members:

Padayachee VP (Chairman)	The Association of Municipal Electricity Utilities of Southern Africa (AMEU)
Dlamini J	South African Bureau of Standards (SABS)
Ferrier R	Buffalo City Metropolitan Municipality (“BCMM”) & CENTLEC
Kgopa M	National Energy Regulator of South Africa (NERSA)
Lamour B	Nelson Mandela Bay Metropolitan Municipality (“NMBM”)
Mostert H	City of Cape Town
Naicker J	NRS Project Management Agency (NRS PMA)
Naidoo L	Eskom Transmission
Nkambule T (Ms)	Eskom Distribution
Ramnarain V	eThekwini Metropolitan Municipality
Raseboka S	City Power Johannesburg (SOC) Ltd
Rasetlola M	City of Tshwane
Rikhotso C	City of Ekurhuleni

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 are measures implemented to protect the system from a blackout.

There exists a need 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 is much higher when the power system is constrained for an extended period of time, such as when infrastructure is damaged or inadequate to provide the system demand. 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 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).

Emergencies are inherently unpredictable. This has been highlighted in the last few years by the use of loadshedding across every time of day, day of the week and period of the year.
This section of NRS 048 is intended to provide the System operator with a structured and reliable way to restrict electricity demand for every contingency, at any time, up to any amount of load reduction.
This edition provides the System Operator with the following tools to protect system stability:

a) Loadshedding stages from just one block shed at a time to all load off simultaneously;
b) A new definition of certain curtailment customers known as strategic curtailment customers;
c) The freedom to use loadshedding/curtailment and strategic load curtailment separately;
d) The freedom to instruct deviations from the schedule and declaration to specific control centres;
e) Best practice instructions for control centres on loadshedding methods to limit system stability impacts from switching loads.

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 (see 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 be deployed to manage available primary energy reserves (see 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. In this case, a given stage of load shedding/curtailment or strategic 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 and diesel reserves for the purpose of generating electricity may need to be pro-actively managed by implementing emergency load reduction.

Scenarios under which emergency load reduction may be required are identified in Figure 1.

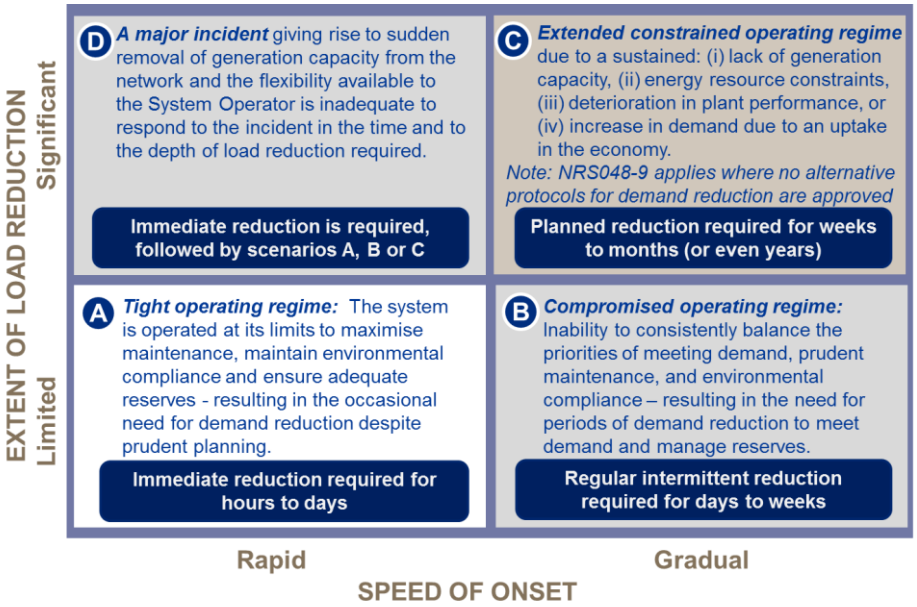


Figure 1 — Scenarios under which mandatory load reduction may be required showing the notice period and the depth/duration of load reduction

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 code of practice 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 could have a significant impact on the country. This code of practice 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 measures 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 code of practice should be seen in the context of other long-, medium- and short-term measures required to manage a potential imbalance in supply and demand. Measures to prevent such an emergency condition could include:

- voluntary load reduction by customers in response to a system constraint,
- pricing mechanisms that encourage load reduction on constrained days,
- 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 2).

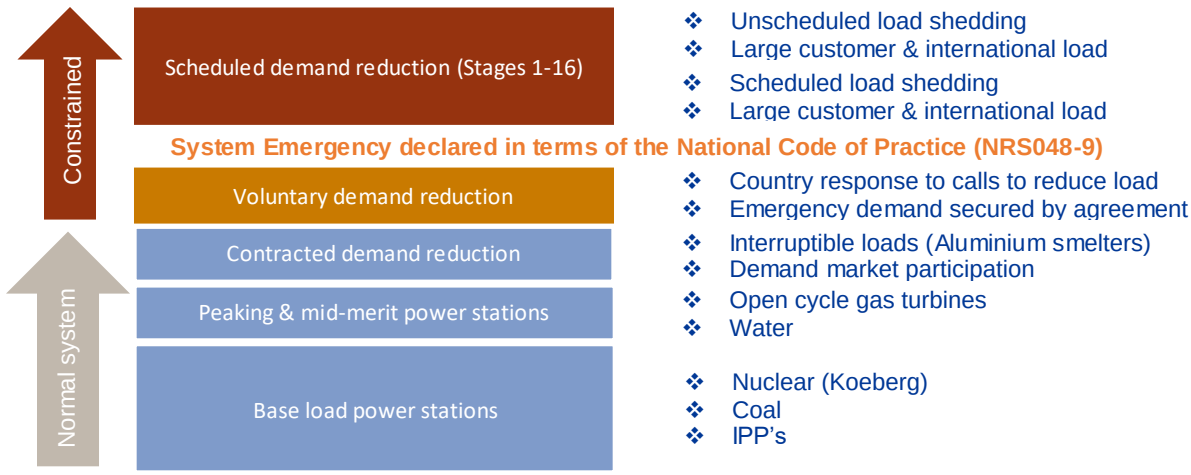


Figure 2 — Typical merit order showing the point at which this code is invoked. The implementation of scheduled demand reduction- Stages 1-16 are a last resort.

Other longer-term measures include:

- adequate investment in generation and supply network capacity;
- interventions to maximize generation and supply network availability; and
- energy efficiency programmes.

This code of practice applies after measures such as those 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.

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 if there is no time to implement load reduction, the System Operator will intervene directly in the grid, possibly by disconnecting large areas at high voltage levels.

The final system defence 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 using available reserves or by implementing emergency load reduction (see Figure 3).

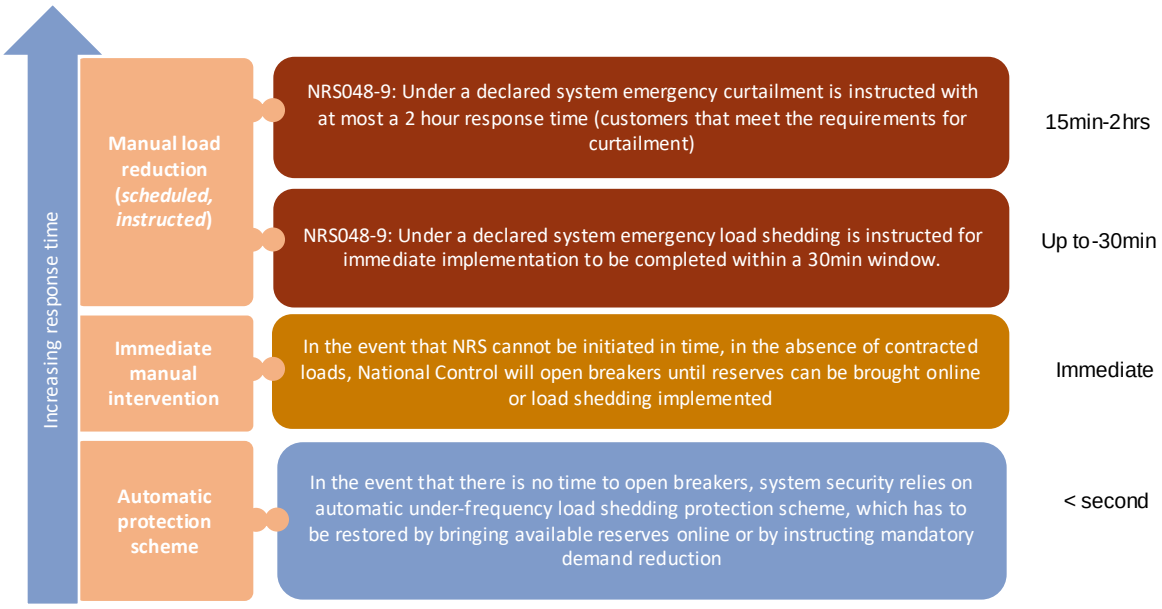


Figure 3 — Emergency load reduction methods

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

a) options available to customers to minimize the impact of load shedding (e.g., alternatives to load shedding such as load curtailment);

b) 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

c) measures that need to be taken within individual customer installations in the event of supply interruptions or load reduction.

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

a) the safety of people, the environment, and potential damage to plant associated with a critical national product;

b) the magnitude of the load reduction required and the speed at which this can be achieved.

c) equitable participation by customers in respect of the common power supply (Eskom and Grid level IPPs) a requirement of the Electricity Regulation Act, and how load reduction requirements are allocated between various regions across the country, metros, municipalities, large industrial customers, and international customers;

d) predictability of when and for how long a customer will be interrupted or required to reduce demand;

e) technical constraints on executing load shedding and curtailment or restoration;

f) the social impact of load shedding and curtailment; and
g) economic impact on the country.

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

This code of practice 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 code of practice identifies a minimum set of critical load types that should be addressed by the various supply authorities. Given current system limitations, this code of practice considers various alternatives for treating critical loads, shown here in order of preference:

h) load curtailment options available to customers who comply with specific criteria.

i) protocols for interaction between the customers' operating critical loads and the electricity supply licensee;

j) the specific time of day that different types of loads are shed;

k) interventions in customer installations (e.g., the need for appropriate backup supplies); and

l) the exclusion of some specific loads from load shedding schedules;

In cases where critical loads exist within a customer installation, this information should be provided to a supply authority (termed an "essential load requirement" in this code of practice). 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 D of NRS 048.

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

Several technological 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 reduce present system limitations related to the protection of specific loads (or embedded generators) on a given network from load shedding. 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.

It is recognized that this code of practice 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.

Contents

Page

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 code of practice 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 code of practice for developing emergency load reduction practices, as defined in 3.1.,

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 loads and essential load requirements 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 loads and essential load requirements,

f) identifies the responsibilities that the licensee 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 code of practice is intended to be applied when all other measures (indicated in the introduction) are inadequate to prevent a demand-supply constraint that could lead to risk of system collapse (at national or regional level).

NOTE It should be noted that NERSA may 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.

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

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

1.4 This code of practice applies to all licensees unless a deviation is approved by NERSA or a body with the legal authority to set license conditions aside, 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 code of practice. 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 code of practice are encouraged to take steps to ensure the use of the most recent editions of the documents listed below.

Electricity Regulation Act 4 of 2006 (as amended)

South African Grid Codes

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

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 code of practice (see principles listed in 4.4).

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

upstream control centre
control centre immediately upstream from a supply point

downstream control centre
control centre immediately downstream from a supply point

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

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

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

demand response; DR customer
customer who has signed a contract with their supplier or Eskom to offer a portion of their load at a price, for the purpose of load reduction. This could be as an Instantaneous DR (IDR), Emergency DR (EDR) or a Supplemental DR (SDR) customer

equity
defined by both the amount of reduction imposed on a customer and the time over which it takes place. The Electricity Regulation Act (ERA) requires that the application of this specification may not discriminate between customers or customer classes, except for objective reasons agreed to by NERSA. This specification applies the concept of non-discriminatory treatment through this definition of equity. More or less loadshedding than other customers or being reduced at times that are more convenient or onerous than other customers is not equitable. For this reason, the default schedule rotates all load throughout all time periods equally for a given stage. Alternative schedules must demonstrate equity, unless dictated by regulations or a disaster declaration

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 code of practice.

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 3s [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 or through the application of load switching or load limiting:

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

strategic load curtailment: load that meets the load curtailment requirements but has also been assigned a role in system stability since it meets criteria specified in 4.5.4. Unless otherwise specified strategic curtailment loads will be considered identical to normal curtailment loads.

NOTE Instruction for strategic curtailment may be issued by the System Operator or its appointed agents. The instruction may take the form of a verbal, written or electronic communication. Non-strategic (normal) curtailment load must adhere to the stages instructed under loadshedding.

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. While this code of practice provides 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
limit remotely 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 e.g. a sudden trip of several generation units that results in under frequency relays operating to reduce load.

manual load shedding: load removal that is initiated 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 load curtailment. 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 F provides further clarity on how this is determined.

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, periods of higher demand, typically take place between 17:00 and 22:00 and off-peak periods, periods of lower demand, typically take place between 22h00 and 06h00 the following day.

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**

System Operator ("SO")
The Eskom System Operator (SO) is responsible for the reliability and security of the South African national electricity grid by monitoring, controlling, and operating it in a safe, economical, and reliable manner

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

AMEU: The Association of Municipal Electricity Utilities of Southern Africa
BUSA: Business Unity South Africa
EIUG: Energy Intensive User Group
DR: Demand Response
KIC: Key Industrial Customers (consuming >100GWH per annum)
NCC: National Control Centre
NERSA: National Energy Regulator of South Africa
SABS: South African Bureau of Standards
UFLS: Under-frequency load shedding
SO: System Operator

4. Application and Principles

4.1 Application by licensees

Licensees shall:

a) develop and maintain plans for mandatory load reduction in accordance with the practices in this code of practice;

b) execute these plans in accordance with the protocols in this code of practice; and

c) report and communicate on mandatory load reduction in accordance with the requirements of this code of practice.

Where alternative load reduction practices are deployed, these shall:

a) achieve the equivalent load reduction requirements of the System Operator; and

b) be agreed with the upstream licensee to ensure no risk to system stability; and

c) defendable to any NERSA audit as still complying with the principles in this code of practice.

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 is managed.

Where licensees choose not to implement load reduction themselves:

a) such reduction shall be undertaken by the licensee supplying them; and

b) they shall remain accountable for all engagements with their affected customers as stated in this code of practice – 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), switch between load blocks as per the schedule described in 4.5 in under 30 minutes 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 code of practice 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

4.3.1 This part of NRS 048 becomes a license condition when approved by NERSA. It will never override a law or a legal judgement that seems to contradict it. Decisions which change the context in which this specification must be used can lead to a change in this specification, but until this specification has been updated, the licensees must apply the law as they best understand it in all aspects of their operations.

4.3.2 Additionally, 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.

4.3.3 NERSA is still accountable for considering applications for such exemptions, as described in section 9.1. However, for practical reasons this function is delegated to the various electricity utilities to consider whether such applications for exemption are allowed by NRS 048-9. If the applicant is unhappy with the decision from the said utility, then such applications can be escalated to NERSA whose decision will then be final.

4.3.4 Alternatively an application can be referred by the utility itself to NERSA for consideration if the utility is unable to consider the said application for various reasons.

4.3.5 A proper register shall be maintained by all utilities of such applications.

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 4.4.9.

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

Although both automatic under-frequency load shedding and manual load reduction 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 reduction 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 automatic under-frequency scheme is the last defence against a blackout of the national power system. The consequences of an inadequate response by the automatic under-frequency scheme could be catastrophic and widespread, including a complete loss of supply to the entire 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.

4.4.2 Principle 2 – Equitable participation by all customer installations

4.4.2.1 Customers supplied by different licensees should 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 of pre-defined load shedding schedules unless agreed otherwise in writing between the licensee and the customer in terms of the provisions provided in this code of practice relating to demand response participation, critical loads, load curtailment, or independent power producers.

4.4.2.2 Utilities will provide a process whereby customers may submit applications for exclusion, curtailment or other non-loadshedding options as provided for in this code of practice.

4.4.2.3 The licensee's process will determine the validity of exclusion submissions by assessing if the exclusion is allowed by the principles and guidance provided by this section of NRS 048-9.

4.4.2.4 Any exclusions allowed by the licensee may be examined by NERSA, the SO or the upstream licensee for validity.

4.4.2.5 If SO or the upstream licensee do not agree with the validity of the exclusion, then the disagreement may be submitted to NERSA for a final determination.

4.4.2.6 The exclusion will remain in place until NERSA's decision. NERSA's decision on any exclusion is final and must be adhered to.

4.4.2.7 Exclusion of customers for reasons not specified in this code of practice are likewise subject to NERSA approval if questioned or audited.

4.4.2.8 Since excluding customers is beneficial to the licensee and must be balanced by increased shedding of the rest of the Electricity Supply Industry customer base, the licensee will keep a register of all exclusions, including temporary exclusions.

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 shedding or curtailment. 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 code of practice by the requirements related to critical and essential loads. Mechanisms are provided for in this code of practice 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 code of practice (for example, these may under certain conditions be excluded from Stages 1 and 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 code of practice.

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 standardization across all licensees, whilst still allowing for flexibility to address local conditions.
Load shedding schedules shall meet the following minimum requirements:

a) coverage over 24 hours per day, all 7 days of the week, throughout the year. There can be no gaps in the schedule.

b) time-based, rotational slots of loadshedding, preferably no longer than 2 hours long each (see Note 2), incrementing stages by increasing frequency of shedding up to at least Stage 4. This will result in time slots beginning on even hours or odd hours (i.e., at 02h00, 04h00 etc., or 01h00,03h00 etc.) The licensee may decide which option they prefer assuming the System Operator does not dictate otherwise (see 4.5.2).

c) From stage 5 onwards the licensee may continue to increase the frequency of the block rotation, or it may use a system such as that described in Annex E, which uses increasing time periods to limit the switching to Stage 4 levels. In every system, the licensee must have as many blocks out simultaneously as the declared stage.

d) load reduction of 5 % to 6,25 % for each block, based on a load base split into no more than 16 blocks (see NOTE 4). Utilities using more than 16 blocks will be shedding a smaller portion on a pro-rata basis. This can only be considered equitable if the licensee can prove, using historical performance data, that the 5 % per stage requirement over the whole profile has been continuously met. By definition no more than 20 blocks, 5 % each as per the minimum requirement, can be allowed, assuming perfectly equally sized blocks.

e) rotational schedules, moving time slots for customers in a predictable way, ensuring that customers are equally exposed to all the time periods in a day and week, to provide equity in when customers are loadshed as well as for how long (see NOTE 5);

f) all customers shall be on the schedules, with the exception of those provided for in this code of practice (see NOTE 10); and

g) schedules should where possible be optimized for the seasonal demand profiles (NOTE 6).

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;

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-hour timeslot is recommended for utilities operating networks using remote control systems. Analysis has shown that loss of diversity of geyser load affects network restoration if the outage lasts more than 2 hours. The cold load pick up on urban networks after 2 hours of load shedding can be as high as 180 % of the normal value.
Once the load reduction requirement has reached higher stages this concern can no longer be accommodated. Rotation will continue to take place at 2-hour intervals, with overlapping time periods used for increased stages (see NOTE 9).

NOTE 3 In the communication of the schedules, common practice is that an additional 30 min is included in the timeslot 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.
Utilities must split their base load into 16 blocks. This makes blocks of 6,25 % of the base. Since Stage 1 and each incremental stage requires 5 % of the base load to be shed, this difference is intended to provide surety under changing demand conditions. It may also be used, if the licensee can guarantee 5 % reduction of the base load under changing conditions, to exclude loads which benefit the whole customer base. Utilities using more than 16 blocks would have less access to this difference for internal exclusion and would have to guarantee the 5 % per stage minimum reduction.

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, and customer categories.

NOTE 7 Load reduction in this code of practice is scheduled and published for all scheduled stages.

NOTE 8 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.

NOTE 9 Experience with loadshedding has shown that most control centres can only be expected to manage switching 4 blocks in and 4 blocks out at most, which limits this to Stage 4. To get to higher stages individual blocks can be shed for longer time periods. This allows an additional block to be off for each stage up to 16, without requiring more switching than is done at Stage 4.

NOTE 10 All customers shall be on the schedule, even if switching them is inconvenient or entirely manual. If necessary, the licensee may switch at a higher voltage level, where the last automatic relay can be controlled.

4.4.6 Principle 6 – Declaration of a system emergency

Mandatory load reduction in accordance with this code of practice shall only be instructed under a system emergency declared 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 1 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 2 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.

NOTE 3 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 Grid Code. This may include manually interrupting customers to manage demand until an emergency can be declared and the provisions of this code of practice 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. The System Operator is not forced to use loadshedding/normal curtailment and strategic load curtailment at the same time and same stage but is empowered by this section of NRS 048 to call stages for each separately from each other to ensure greater system stability. This means that:

a) Load shedding and normal curtailment may not be required if strategic load curtailment has already been instructed and the load reduction is adequate to meet the system requirements. Under such conditions, load shedding and normal curtailment might not be called upon.
b) Load curtailment may not be appropriate if the load reduction requirement is for a limited period of time (given the maximum 2 h period to implement curtailment). Under such conditions, load shedding might only be called on (given the shorter 30 min implementation time-window).
c) For system stability considerations, the System Operator may limit the use of strategic load curtailment whilst load shedding is active; and
d) Under some system conditions, strategic load reduction may be called on proactively to manage reserves and thereby limit the depth of expected load reduction 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 reduction is implemented at times and at levels 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 reduction 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 code of practice.

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 does not provide the ability 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 code of practice.

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 code of practice (see table 2).

The level of reduction required under each stage is defined in detail in Annex E. This reduction is achieved by both load shedding (according to pre-defined schedules) and by reduction required from customers eligible for load curtailment. Under a system emergency, the System Operator shall declare the applicable stage of load shedding and strategic load curtailment, respectively.

NOTE When emergency load reduction is declared by the System Operator, the stage of reduction declared for strategic load curtailment may differ from the stage declared for load shedding.

Where a customer has responded to a request for voluntary load reduction shortly before declaration of an emergency, the licensee should endeavour to deduct this from the customer's contribution to load reduction, taking the reduction and the time over which, it was reduced into account.

4.5.1.1 Requirements of instructed loadshedding beyond rotational loadshedding:

NCC instructions to reduce load must be complied with by all utilities. Table 2 provides the requirements for each instruction for further load shedding. The requirement to sustain rotational loadshedding as described in Annex E, is the most convenient, equitable and predictable option for customers, but will become untenable at very high stages of loadshedding. This is because when the system is very lightly loaded, such as during high stages of loadshedding, the impact of deleterious electromagnetic effects will require a different mode of operating. Under these conditions the requirement for another 5%-6,25% of load reduction from NCC stands, but the network switching might have to change to avoid the negative impact to equipment.

For this reason, utilities are required to determine, by studying their own networks, at what stage of loadshedding they would have to switch from the rotational style of loadshedding to an alternative plan that manages the voltage rise and other effects on the network.
Once that stage has been determined, the licensee will be required to discuss the implementation of the alternative plan with the upstream licensee that supplies them.

Possible alternative plans include:

a) In consultation with the upstream licensee, allowing all or part of their network to be shed; bearing in mind that the main impact would be a much larger amount of reduction than the minimum prescribed in Table 2.
c) Redesign the switching regime to take out larger parts of the network as well as the end loads to reduce the equipment in service that would cause voltage rise at low loading levels.
d) Change to a completely new schedule that comes into effect once rotational schedules are exceeded.

The responsibility for keeping the national electricity grid stable lies with the NCC. Therefore, if the NCC requires additional load reduction utilities may assume this is in the best interest of the grid. The System Operator will undertake to understand, via network studies, the impact and management of the grid under lightly loaded conditions caused by high (above stage 8) stages of load shedding.

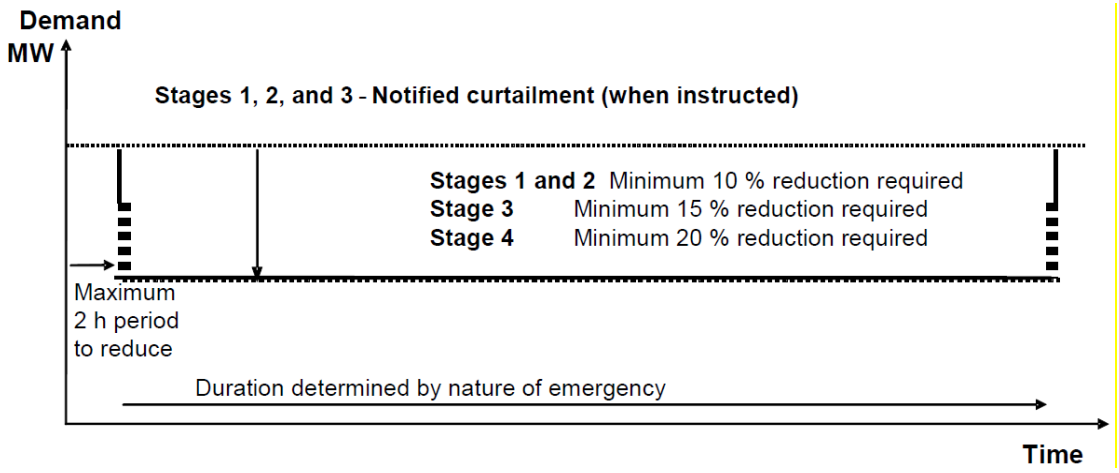
Table 1 — National load reduction requirements (load shedding and curtailment) under a system emergency declared by the System Operator in the event of a national generation capacity constraint.

1	2	3	4
Stage	**Type**	**Reduction required from end-use by *load shedding.* Demand excluding curtailment load.**	**Reduction required from curtailment customers (strategic and normal), continuously for the duration of the declared emergency.**
Stage 1	Scheduled (notified)	All Stage 1 load scheduled by utilities. The System operator will assume this is about 5% of the demand at the time.	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. The System operator will assume this is about 10% of the demand at the time.	
Stage 3	Scheduled (notified)	All Stage 3 load scheduled by utilities. The System operator will assume this is about 15% of the demand at the time.	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. The System operator will assume this is about 20% of the demand at the time.	20 % reduction in normal demand profile within the agreed notification period or reduce to essential loads.

Stage 5	Scheduled (notified)	All Stage 5 load scheduled by utilities. The System operator will assume this is about 25% of the demand at the time.	30 % reduction in normal demand profile within the agreed notification period or reduce to essential loads.
Stage 6	Scheduled (notified)	All Stage 6 load scheduled by utilities. The System operator will assume this is about 30% of the demand at the time.	
Stage 7	Scheduled (notified)	All Stage 7 load scheduled by utilities. The System operator will assume this is about 35% of the demand at the time.	40 % reduction in normal demand profile within the agreed notification period or reduce to essential loads.
Stage 8	Scheduled (notified)	All Stage 8 load scheduled by utilities. The System operator will assume this is about 40% of the demand at the time.	
Stage 9	Scheduled (notified)	All Stage 9 load scheduled by utilities. The System operator will assume this is about 45% of the demand at the time.	50 % reduction in normal demand profile within the agreed notification period or reduce to essential loads.
Stage 10	Scheduled (notified)	All Stage 10 load scheduled by utilities. The System operator will assume this is about 50% of the demand at the time.	
Stage 11	Scheduled (notified)	All Stage 11 load scheduled by utilities. The System operator will assume this is about 55% of the demand at the time.	Reduction to essential loads, or as instructed by the System Operator.
Stage 12	Scheduled (notified)	All Stage 12 load scheduled by utilities. The System operator will assume this is about 60% of the demand at the time.	
Stage 13	Scheduled (notified)	All Stage 13 load scheduled by utilities. The System operator will assume this is about 65% of the demand at the time.	
Stage 14	Scheduled (notified)	All Stage 14 load scheduled by utilities. The System operator will assume this is about 70% of the demand at the time.	
Stage 15	Scheduled (notified)	All Stage 15 load scheduled by utilities. The System operator will assume this is about 75% of the demand at the time.	
Stage 16	Scheduled (notified)	All Stage 16 load scheduled by utilities. The System operator will assume this, 80% of the demand at the time, is all the load available for shedding.	

Figure 3 illustrates the options available to eligible customers, based on the general requirements in Table 1. These options are detailed in 4.5.2 to 4.5.4.

Customers who are eligible for curtailment shall be required to declare and arrange this with their licensee. The need to have stable schedules does not allow customers to select a curtailment option at the time of any emergency. Only once it has been agreed and the load shedding schedules have been adjusted to accommodate this reduction in load, will they be curtailed instead of being loadshed. This decision should be informed by the scenarios illustrated in Figure 1 and as detailed



Stages 1, 2, 3 and 4 notified curtailments for eligible customers, demonstrating the continual nature of the demand reduction used in load curtailment.

Figure 3 — Summary of notified load curtailment

4.5.2 Management of frequency during loadshedding

The National Control Centre (NCC) will manage the frequency of the system during loadshedding. 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. In order to limit the volatility of the system frequency during loadshedding utilities will implement and execute loadshedding in the following way:

Implementation of a new stage of loadshedding will see the necessary blocks shed or restored to comply with the declaration of the new stage inside of the 30 minutes after the time communicated as the beginning of the new stage.

From Stage 2 onwards the licensee must not shed all the load and then restore it all, since this causes the largest frequency swings. When rotating the stage from one time period to another the licensee must shed and then restore one block at a time.

At any time, the System Operator may instruct any of the following changes as to how utilities implement shedding at any time:

To delay a particular licensee's implementation of loadshedding;
Extend the period over which a stage rotates through a time period to 1 hour;
Or any other instruction which the System Operator decides is necessary for system stability.

The System Operator may also instruct changes to the load shedding schedules of individual utilities if it can be shown that this will improve system stability. In particular, the System Operator may instruct utilities to change their schedules from having time slot rotation from odd hours to even or even hours to odd, to split the load more evenly being shed and returned at each hour.

4.5.2 Load shedding

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

a) loads that comply with the requirements for load curtailment (see 4.4.2 and 4.4.4);

b) certain critical loads (see Table 5 for a complete view on how these loads should be managed) and certain loads with essential load requirements, and only where such exceptions are provided for under conditions set out in this code of practice (see sections 6 and 7).

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.

Where a large customer is able to absorb the total load reduction requirement of a licensee this may only be pursued if the licensee's other customers and upstream supplier agree to the arrangement

4.5.4 Load curtailment

4.5.4.1 A licensee may identify specific customers who, instead of being shed, can provide a pre-defined amount of load to be curtailed within an agreed time period, to be no less than 15 minutes and no more than 2 hours, on instruction from the licensee.

NOTE 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).

4.5.4.2 Customers who comply with the following requirements are eligible and should be accommodated for notified load curtailment:

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(Note 5), at least 30 % of their load in stages 5 and 6, at least 40 % of their load in stages 7 and 8 and at least 50 % of their load in stages 9 and 10 or reduce to pre-notified essential loads;

b) If the customer cannot reduce its load in line with the stage declaration, then it must reduce to essential loads, if these have been declared and accepted;

c) this curtailment shall be maintained for the duration of the emergency, or as otherwise instructed by the System Operator through the licensee, as per instructed loadshedding stages, during the system emergency (see NOTE 1);

d) the curtailment shall be effected within an agreed timeframe (notification time) based on the nature of the customer installation, but as short as is feasible. The agreed timeframe shall be at least 15 min and at most 2 hrs (see NOTE 2);

e) 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;

f) the required load curtailment can be measured and verified;

g) the customer will sustain their essential load requirement while curtailing, ensuring that the essential loads are powered by the remaining supply;

h) 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 (NOTE 4); and

i) 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, either or both strategic and normal, 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 the agreed time frame should be 15 min from 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.

NOTE 4 Whilst it may be possible for a customer to meet the requirements of load curtailment, the licensee may find it technically and operationally impractical to implement as protection of this customer from load shedding may then require the licensee to switch multiple breakers at much lower voltages/levels in the network. Aside from complexity of such switching, the switching may result in additional switching times and may create difficulty for the licensee to achieve the desired switching timelines on load shedding schedules. Where a licensee deems a special customer measure to be impractical when still trying to meet the requirements of this specification, the special measure may be refused as the system stability depends on adherence to this specification.

NOTE 5 The customer might not be operating at their normal load when a request is made for load curtailment. This may be due to a plant trip, load ramp up after a plant trip or maintenance outage. In such instances, the customer should be allowed to recover their load to their normal operating level less the load curtailment requirement. This should not be used as a means to increase demand beyond their most recent normal operating level. A guideline of 24hrs to 48hrs may be used. Post event analysis by licensee must substantiate this allowance.

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).

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

4.5.4.4 Customers who participate under the notified load curtailment scheme

a) shall be excluded from load shedding schedules; and

b) shall not exceed normal demand profile for 12 h after the emergency.

4.5.4.5 Customers who can demonstrate the ability to manage the required percentage reduction across several independent installations for a given licensee 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). Licensees may agree to manage group curtailment across licensees where technically and operationally possible.

4.5.4.6 A licensee may use 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.

4.5.4.7 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. A customer on self-managed load curtailment must meet the requirements of load curtailment for at least eight out of the ten most recent load curtailment days/events. Should the customer fail to meet these requirements, the customer shall be placed back onto load shedding schedules. Customers with essential loads would be instructed to reduce to essential loads for their loadshedding period, remaining at that level for at least the loadshedding period, with reduction and ramping up not being part of the load reduction period. If this is not complied with, load disconnection is necessary. Customers would need to make a new application to the licensee to be considered for load curtailment and indicate the measures taken to prevent future non-compliance.

NOTE Where a licensee has implemented load curtailment as part of its load shedding response, the licensee will assess performance based on daily assessments. In general, most curtailment performance will be assessed based on curtailment events as notified by the System Operator.

4.5.5 Strategic Load Curtailment

4.5.5.1 Requirements

The System Operator may identify certain loads as strategic for system stability. These loads will have at least two of the following three characteristics:

a) The load must be at least 20 MW at peak consumption.
b) The load must be at least 80 % rotating machinery.
c) The load must run at a load factor of 0,7 or higher.

Loads with at least two of these characteristics can be used to sustain system stability in periods of high loadshedding or can be used in place of loadshedding.

4.5.5.2 Notification

Strategic curtailment loads will be called separately from other curtailment loads, which will be called by their utilities in line with loadshedding stages.
The System Operator will indicate a stage for the strategic curtailment loads and this will be communicated to them directly by their utilities, to avoid public confusion of this with loadshedding stages.

4.5.5.3 Equity

Strategic load curtailment loads, and loads reduced under loadshedding stage instructions will be shed equitably. These loads might not be shed at the same time since the System operator has the discretion to use either reduction system as it sees fit to stabilise the system. In order to ensure equity over the long term, the System Operator must:

a) Track the use of loadshedding/curtailment loads on the basis of stages called and hours used.
b) Track the use of strategic curtailment loads on the basis of stages called and hours used.
c) Compare the two values and aim to equalise them over the long term.
d) Be able to provide this comparison on request by an authorised body.

4.5.6 International customers

4.5.6.1 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.

4.5.6.2 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.

4.5.7 Exclusions based on participation in the merit order

4.5.7.1 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 this section. 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.

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

4.5.7.3 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 load curtailment in stages above Stage 2.

4.5.7.4 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 (see table 3):

a) the customer shall participate with a minimum of 25 % of their average MW load (see annex F). 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 stages 1 and 2 curtailments 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 load curtailment in stages above Stage 2.

Table 2 — 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.		

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

4.5.8 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 strategic/normal load curtailment) as defined in this code of practice.

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;

NOTE Should the system collapse, this would certainly trigger a disaster declaration by the NDMC. This section of NRS 048 supports that decision without in any way stipulating it.

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.

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 reduction, 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 strategic load curtailment, load shedding/load curtailment 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/load curtailment should be terminated; and
b) the time, from which strategic load 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 centre 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/curtailed 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 strategic load curtailment versus load shedding

The System Operator shall determine if load shedding, strategic 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 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 given to affected customers will include the 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 will 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 strategic 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 of strategic load curtailment 2 hrs. before the expected constraint;

d) In general, strategic curtailment and shedding should be within 2 stages of each other for equity. For example, Stage 4 load shedding should be accompanied by at least Stage 2 strategic load curtailment, and visa-versa. Should this not be possible for reasons of stability, rather that convenience, the System Operator retains the authority to manage the load reduction system in any way it sees fit.

e) Strategic load curtailment should not be implemented for a period of more than 24 hrs. without load shedding 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 reduction 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 the 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 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 Utilities will design the loadshedding schedules according to this specification, using their pre-determined load base. The load base, which will determine the amount of load to be shed per stage in a 16-block schedule, shall be agreed between the upstream and downstream utilities at least annually.

4.8.1.6 Audits may be undertaken by the System Operator, or its delegate, 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 base load to be shed (sheddable 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, excluded loads as defined in 4.5.3 will be deducted. The result is the licensee's base load.

c) schedules shall be prepared for all the stages in this code of practice, in accordance with the requirements in 4.

d) each control centre shall follow the schedule requirements and submit the resulting load block size for each of the scheduled stages to the upstream control centre.

e) Load shedding shall be executed in accordance with published schedules.

Detailed description of schedule design is explained in Annex E. The main principles used in schedule design are:

a) Base load, as determined in 4.8.2.1 is divided into, at most, 16 blocks. The number of blocks must be 16 or fewer to ensure the licensee complies with cross-licensee equity- See 4.4.5 Principle 5 and Note 4 on implications of non-adherence.

b) Each stage is executed by shedding an additional block. This means that there are 16 possible stages of loadshedding before the whole base has been shed and stays without power (Stage 16).

c) The blocks for each stage are rotated in time. The licensee must ensure, as a default position for their customers, that all blocks are equally exposed to all the times of the day and week in each of the stages. This can be achieved by following Annex G.

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 C. 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 Annex E provides guidelines for the development of schedules.

4.8.2.4 Where a customer prefers a different scheme to the one described here, such as being shed repeatedly at the same time of the day for successive manual load shedding events, as opposed to the rotation of time slots, this may be provided for if the customer meets the curtailment load requirements. This is 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.

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 to use any technology available to them but must ensure that the 9 principles stated in 4.4 are adhered to, the default scheme, in the absence of special arrangements will be loadshedding as described herein.

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 to achieve this 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

c) 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. 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 to be removed temporarily for the duration of the event without implementing 4.8.6.2.

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.

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

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 be implemented, to allow readiness for reduction. Strategic curtailment load customers must be informed by direct communication of the strategic curtail stage, since this is different to the loadshedding stage.

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 is being implemented. This information shall include the stage of load reduction implemented, the start time, and the expected duration (or end time). In the case of national load shedding, such media communication 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. While every effort must be made to provide notice of impending loadshedding or changing stages of loadshedding, it must be noted that sudden increases in stages may be called on for emergency purposes. The media notice might be delayed but must take place, explaining the need for the sudden change in stage of load reduction.

4.10.3.2 Where possible the System Operator will initiate load reduction on the hour, aligning with existing loadshedding schedules. If a sudden reduction is required, this may not be possible.

4.10.3.3 Notified curtailment customers that have signed agreements in this regard shall be instructed to implement load curtailment via the agreed protocol (typically verbal instruction). On request, 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 may 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

Under conditions of high of supply side unpredictability, with the impact exacerbated by the absence (or minimal level) of any reserve margin in generation with rapid cascading of circumstances can result in a very fast and unpredictable movement from lower to higher stages of shedding. For this reason, long term warning of load reduction is not feasible.

On the other hand, adequate warning (day(s)/week(s) in advance) and predictability through a consolidated communication channel are considered vital to a durable system of dynamic supply and demand response.

Therefore, this section of NRS048 mandates the System Operator to provide the information it has on the general status of the system to public and private stakeholders, with the clear understanding that it cannot be used for load reduction prediction, system. Such information should include:

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

NOTE 1 Public and industry could benefit from long-term and accurate shorter term system outlook dashboard for information purposes that could potentially improve their decision-making ability 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 system status can be found at www.eskom.co.za.

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 negatively impact the perceived time and duration of load shedding.

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 Licensee or private generation

4.12.2.1 Where a licensee or end-use customer has embedded generation, and such generation is not already included in the normal load profile of the licensee or customer, 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.

Customers with internal generation capability, but who are still taking some supply from a licensee, shall be required to reduce load according to this part of NRS 048, if their generation follows a regular usage pattern. The required reduction will depend on the amount of power taken from the licensee.

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 per stage, in lieu of load shedding load. If that power is already running when load reduction is called for it cannot be used to offset load reduction directly. 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.

Wheeling of energy must be taken into consideration when determining the target for customers. If the energy generated remotely is used during normal production, then it is part of the customer's profile and can be used to reduce the customers load base used to set targets. It cannot be used to directly offset load reduction. If the remote energy is only generated during load reduction periods, then this may be used to offset loadshedding since it would not have been part of the customers normal baseload.

4.12.3 Load switching

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

NOTE Where load switching, such as geyser 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 load switching is used for extended periods that overlap with periods when load switching would normally have operated, additional load reduction is required.

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

4.12.3.4 The customer should be informed about the regime being implemented.

4.12.3.5 Licensees should assess the scheme to determine 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 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, Wi-Fi 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 geysers and 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

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 In both 4.12.5.2 and 4.12.5.3 the following shall apply

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

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.

4.13 Extended load curtailment

An instruction may be issued by the System Operator for strategic or normal 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 strategic 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. Blackout restoration

5.1 General

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

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

5.1.3 Restoration plans should as far as possibly 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.

5.2 Licensee responsibilities

5.2.1 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.

5.2.2 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.

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

5.3 Customer responsibilities

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

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

6. Essential load requirements

6.1 General

6.1.1 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.

6.1.2 The essential load requirement agreed in writing with the licensee is also the maximum customer load that will be supplied should load reduction be at a level that the customer can no longer incrementally reduce demand, as well as the maximum load once the System Operator has instructed a reduction to essential loads.

6.1.3 An essential load requirement agreed with the licensee can generally be met during load reduction emergency 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.

6.2 Application by licensees

6.2.1 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.

6.2.2 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 D provides the format for such submissions.

6.2.3 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 D for municipal and metropolitan municipality submissions).

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

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

6.3 Application by customers

6.3.1 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.

6.3.2 Where a customer does not provide an essential load requirement, the licensee will assume that no such requirement exists.

6.3.3 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.

6.4 Identification of essential load requirements

6.4.1 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 their area of supply.

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

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

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

6.4.4 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.

6.4.5 Where customers meet the requirement for curtailment, essential loads must 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.

6.5 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.

7. Critical loads

7.1 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 implementing specific protocols for interaction between the customer and the licensee, installing of backup facilities, or even, in case of extreme impact to the public, the exclusion from load shedding schedules. This section addresses the specific interventions associated with identified critical loads.

7.2 Application by licensees

7.2.1 Licensees are required to appropriately interact with customers in addressing critical loads as defined in 7.4 to 7.6.

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

7.2.3 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.

7.3 Application by customers

7.3.1 Customers who operate critical loads should evaluate their level of preparedness and protection of their facilities in terms of the practices in this code of practice.

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.

7.3.2 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.

7.4 Treatment of critical loads

7.4.1 Specific critical loads are identified in clause 7.6, together with the required treatment of these.

7.4.2 In the case of critical loads not identified in this code of practice, licensees and customers should cooperate in addressing the requirements of these loads by considering at least the following alternatives:

a) whether the installation complies with the conditions for load curtailment as described in clause 4, and is not severely impacted by such curtailment;

b) protocols for interaction between the customers which operate critical loads and the electricity supply licensee;

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.

c) 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 3 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) 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, as listed in table 5, 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.

7.4.3 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 and the licensee's upstream licensee.

7.5 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.

7.6 Requirements for specific types of critical loads

7.6.1 General

The requirements for specific types of critical loads are summarized in Table 5 and addressed in detail in 7.6.2 to 7.6.18.

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

1	2	3	4
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	Only 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 pipelines	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 centres (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.

7.6.2 Airports

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

7.6.2.2 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).

7.6.2.3 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.
7.6.2.4 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.

7.6.3 Rail

7.6.3.1 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.

7.6.3.2 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

7.6.4 Traffic lights

7.6.4.1 General

The electricity supply infrastructure to traffic lights might not allow for isolation from other loads in the event of load shedding.
Municipalities concerned that this could have safety implications must take measures to protect the public, such as the installation of reflective indicators.

7.6.4.2 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).

The following treatment methods are recommended:

a) backup systems able to support the supply for at least 4 h;
b) planned deployment of points men.

7.6.4.3 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.

7.6.4.4 Category 3 – Low impact intersections

No specific interventions are required at low impact intersections.

7.6.5 Water

7.6.5.1 Supply to power stations

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

7.6.5.2 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.

7.6.5.3. 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.

7.6.5.4 Reticulated potable water supply

7.6.5.4.1 Potable water is vital for life and the power supplies required to supply potable water should be treated in terms of the requirements in this clause.

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

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

7.6.5.4.3 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 7.6.5.2.4 to 7.6.5.2.6.

7.6.5.4.4 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.

7.6.5.4.5 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.

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

7.6.6 Sports stadiums

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

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

7.6.6.3 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.

7.6.6.4 In the case of major sports events, the requirements in section 4.7.6 may be applied.

7.6.7 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, where the network allows.

7.6.8 Refineries and fuel pipelines

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

7.6.9 Mines that supply power stations

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

7.6.10 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 strategic curtailment loads, assuming system stability is not affected.

7.6.11 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.

7.6.12 Ports authorities

Ports authorities should be included in load shedding schedules.

7.6.13 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.

7.6.14 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 must be coordinated and assured with telecommunication service providers.

7.6.15 Hospitals and medical centres

7.6.15.1 General

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

7.6.15.1.2 State and private hospitals should be treated equally.

7.6.15.2 Category 1 – Hospitals with life-support systems

7.6.15.2.1 These hospitals should provide their own backup facilities.

7.6.15.2.2 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.

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

7.6.15.3 Category 2 – Hospitals without life-support systems

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

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

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

7.6.15.4 Category 3 – Clinics and medical centres

Clinics and medical centres are not classified as critical loads.

7.6.16 Public health and safety

7.6.16.1 Category 1 – Danger to life and safety

7.6.16.1.1 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 also required for the purpose of restoration after a blackout / interruption.

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

7.6.16.2 Category 2 – Environmental or health hazard

7.6.16.2.1 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.

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

7.6.17 Data centres

7.6.17.1 General

7.6.17.1.1 Data centres shall be included in load shedding schedules.

7.6.17.2 Data centres supplying critical national infrastructure

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

7.6.17.2.2 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.

7.6.18 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 determine the proper process, including the appropriate government departments and legal changes needed, to rule on the nature of a product being considered a national critical product.

8. Technical considerations when developing schedules

8.1 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.

8.2 The technical/operational capability to reduce load

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.

Even for utilities with widespread SCADA resources, higher stages of loadshedding could impact the networks being used to shed load. The system for executing loadshedding to stage 16 described in annex E only required the ability to shed at Stage 4, after which the increased time periods mean that stages higher than 4 do not require any more switching. However, the increased time period may impact the systems being used to shed remotely. While this is understood to be a technical limitation, the inability to meet the time-based requirements specified in this code of practice, does not constitute a reason to ignore these specifications. If the licensee cannot reduce load as described herein, then they can request to be shed by the upstream licensee. An arrangement in which the downstream and upstream licensee agree on a stage at which control will pass from downstream to upstream, should be made in advance.

If a licensee can meet the requirements but its upstream licensee cannot, the licensee will not be able to execute their own load reduction.

8.3 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 likely to be more severe under higher stages of loadshedding which use longer time periods for loadshedding. The extensive use of inverter and battery backup as a response to loadshedding has exacerbated this problem. Utilities are advised to consider this when designing load blocks in order to actively manage the impact to the local network being restored. If utilities have ripple control systems, these can be used to manage the load return in particular areas.

Large deviations from normal load because of battery charging, while understandable in the loadshedding context, will mean that the System Operator may need to use higher stages of load reduction than would have been necessary.

9. Roles and responsibilities

9.1 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) periodically audit exemptions utilities have granted directly to customers to ensure these align with the requirements of this specification.

b) consider and approve or reject any application by a licensee or customer for a variation or exemption from the requirements of this specification.

c) when considering such applications, consult the affected licensees and the System Operator on the impact of such variations or exemption on the power system.

d) 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.

9.2 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.

9.3 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.

10. Disaster Declarations

The Electricity Regulation Act makes allowances, as it must in law, for the change in operation under emergency and disaster conditions. Under a declared disaster the ministers in charge of the disasters can issue instructions that may contradict the measures provided in this code of practice. While utilities must comply with these regulations, the electrical system shall never be put at risk. To balance what could be competing aims, the licensee should:

a) Confirm with the System Operator whether the measures being put in place can be accommodated within the current system condition;
b) Ensure the measures do not jeopardise the safety of the network or personnel;
c) Ensure that such measures, if they conflict with NRS048-9, are temporary and will be reversed after the disaster declaration- if not a NERSA exemption will be needed;
d) When applying measures that conflict with NRS048-9, apply these measures as narrowly as possible, with technical limitations of the network being a main consideration;
e) Ensure its comfort with applied regulations or escalate concerns to the SO or NERSA.

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 pro-active, 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 used, these are designed in such a manner that the under-frequency load shedding (UFLS) scheme is not materially compromised.

A.4 Development of load shedding schedules considering UFLS

The development of load shedding schedules needs to address the 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 that can be safely implemented without materially compromising the load to be automatically shed.

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 licensee 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 2 h time slots, with a 200 MW reduction required per time slot; and
b) UFLS stage 4 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 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 load that needs to be added	UFLS % available
00:00-02:00	1600	200	160	140	**17**	102%	**0**	102%
02:00-04:00	1600	200	160	140	**15**	104%	**0**	104%
04:00-06:00	1600	200	160	140	**25**	96%	**5**	100%
08:00-10:00	1600	200	160	140	**15**	104%	**0**	107%
10:00-12:00	1600	200	160	140	**25**	96%	**5**	100%
12:00-14:00	1600	200	160	140	**18**	101%	**0**	105%
14:00-16:00	1600	200	160	140	**22**	99%	**2**	100%
16:00-18:00	1600	200	160	140	**23**	98%	**3**	100%
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 ▪ 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 a) avoiding danger to the lives and safety of persons, b) avoiding a potentially 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 *(Explanation: the amount of time before conditions become life threatening)*	**Survival load required once power has been returned after the above interruption** *(Explanation: the amount of load required to effectively remove personnel or prevent a dangerous condition from developing.)* *(Not intended for continuous use, but for the purposes of a controlled and safe shutdown, evacuation, etc.*)	**Details of plant, equipment, facilities which will be operated by the power detailed herein**. *(For example, winders, vent fans, dewatering pumps.)*	
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			
Maximum permissible duration of power interruption before a potential hazard develops *(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.***	**Survival load required once power has been returned after the above interruption** *(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.)*	**Details of plant, equipment, facilities which will be operated by the power detailed herein**. *(For example, dust control plants, oil water separation units, sewer pumps.)*	
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			
Maximum permissible duration of power interruption before damage or destruction occurs *(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.)*	**Survival load required** *(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.)*	**Details of plant, equipment, facilities, which will be operated by the power detailed herein.** *(For example, smelters, silting of pipelines, freezing of charge or chutes.)*	
HOURS	**MVA**	**Please describe in the space below**	*If the plant, equipment, facility will be instantly damaged or incur irreversible damage, please describe in field below* **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

ESSENTIAL LOADS IN THE CASE OF CONTINUOUS LOAD REDUCTION (LOAD SHEDDING OR CURTAILMENT)

- 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 form.
- 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.

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

Minimum notification period required before a reduction of power supply. *(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.)*	**Minimum load required** *(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.*)	**Details of plant, equipment or facilities which will be operated by the power detailed herein.** *(Please describe what plant will be run by the power required.)*	**In the event of being shed without being reduced, is the amount of load needed different?** *(Explanation: Sometimes the amount of load needed to restart critical equipment or processes is greater than the running load. Please supply details.)*	
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. *(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).)* (See foreword)	**Minimum load required** *(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.)*	**Details of plant, equipment or facilities which will be operated by the power detailed herein.** *(Please describe what plant will be run by the power required.)*	**In the event of being shed without being reduced, is the amount of load needed different? If so, how much is it?** *(Explanation: Sometimes the amount of load needed to restart critical equipment processes is greater than the running load.)*	
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. *(Explanation: the amount of time required to ensure that all activities can be performed to ensure that no dangerous condition can develop.)*	**Minimum survival load required.** *(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.)*	**Details of plant, equipment or facilities which will be operated by the power detailed herein.** *(Please describe what plant will be run by the power required.)*	**In the event of being reduced without being shed, is the amount of load needed different? If so, how much is it?** *(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.)*	
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.2 Types of emergency load reduction

The types of emergency reduction defined in this code of practice are:

a) **load shedding** utilising time-based rotational schedules for stages 1 to 16, increasing the number of blocks out simultaneously for each stage, from 1 block of 16 shed in Stage1 to all blocks shed in Stage 16.

b) **load curtailment** – where customers comply with specified curtailment requirement; and

C.3 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 requirements of 10 %, incrementing until the load has dropped to essential load requirements.

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.

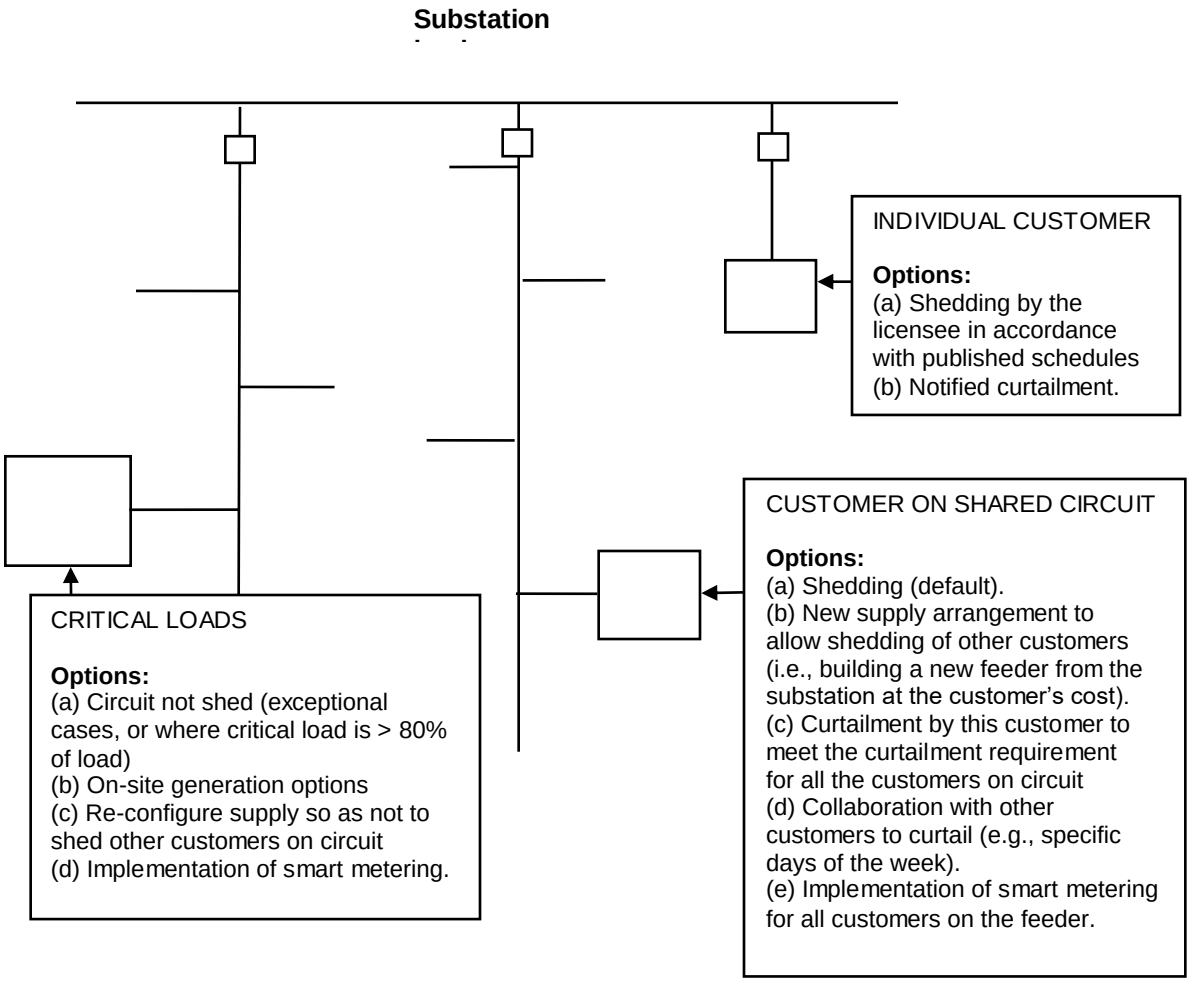
c) **demand-aggregated curtailment**: Several customers on a given circuit (for example a large residential estate) may agree to install demand response technologies (such as smart meters) to provide the required load reduction through load limiting or load switching.

Figure C.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.4 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 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 – Model for essential load data for system restoration planning and load shedding – information required from municipalities and metropolitan municipalities

(normative)

D.1 Form D.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 D
(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 D
(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 D.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 D
(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 D
(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: .....

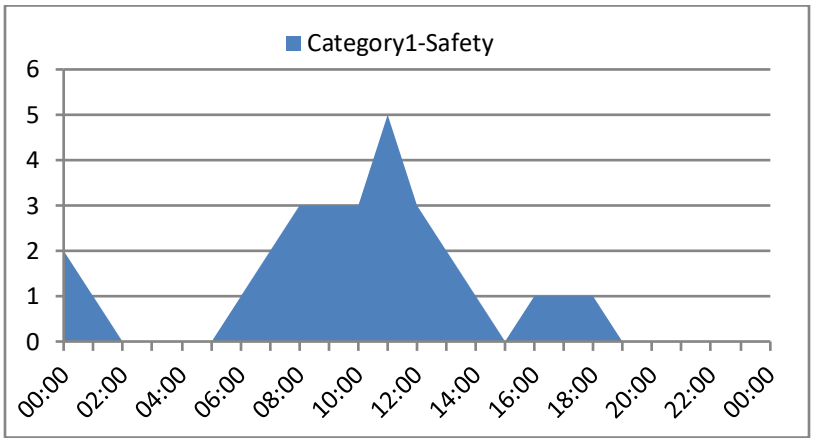
DATE: .....

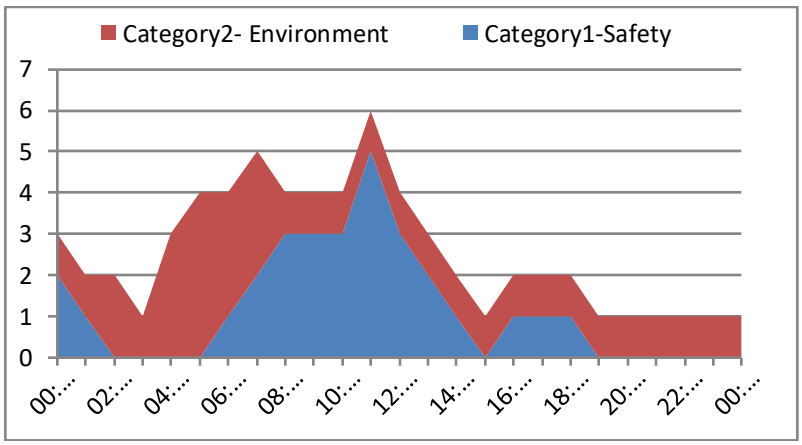
Annex D
(continued)

D.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 D
(concluded)





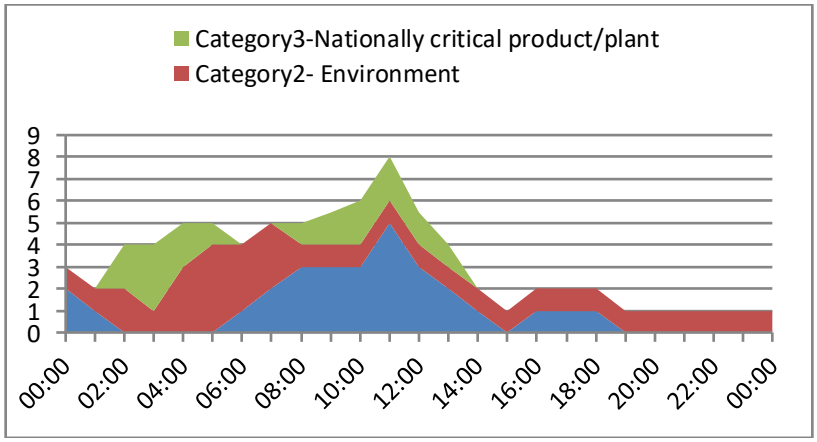


Figure D.1 — Example of graphical form of aggregated end-use customers' essential loads

Annex E – Development of load shedding schedules

(informative)

E.1 Balancing load shedding objectives and practical considerations

E.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).

E.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 times of the day and 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.

E.2 Approach adopted

E.2.1 For the above reasons, the approach adopted in this code of practice 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).

E.2.2 Should an incident on the system result in an unplanned loss of generation capacity, the System Operator will decide on the stage of load shedding required and to declare this for the period required.

E.2.3 The requirement in this code of practice 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).

E.3 Loadshedding block sizes

The non-curtailment load (sheddable load), as determined in 4.8.2, should be divided into 16 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. Each load block size will be at least 5 % of sheddable load. If the licensee has more data than just the peak feeder value then this must be used to further assure the 5 % value at any time of day; if not, the licensee must aim to make the block equal to 6,25 % of the base load.
Published schedules will indicate how long customers will be impacted for at each stage, including an additional 0,5 h to facilitate smooth change over.
If the licensee cannot accommodate 16 blocks, then fewer blocks are acceptable as long as the whole of the base as determined in 4.8.2 is used the development of the blocks. More than 16 blocks mean less frequent shedding than the standard, which would violate principle 2, equitable participation by all customers. A licensee using more than 16 blocks must be able to prove compliance with the 5 % per stage reduction at all times during loadshedding. Systems using more than 20 blocks are

impossible to accept since that would make them smaller than 5 % of the licensee's sheddable load base.

NOTE 1 Each block must be at least 5 % of the load. This leaves 1,25 % per block available to manage the potential unequal block sizes, and a modest amount of critical load. The licensee may use some of this for the common good of their customers, such as the exemption of critical traffic areas or potable water supplies. These exemptions can be examined and reversed by NERSA should they be considered inequitable.

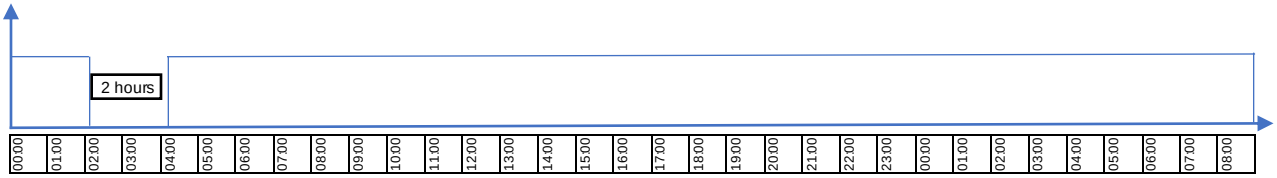
E.4 Schedule design

The licensee must design schedules which rotate blocks throughout 24 hours, continuously, with no gaps, even during traditionally low load periods such as weekends. This schedule must be communicated to the licensee's customer base. For each increment in stage another block is shed simultaneously.

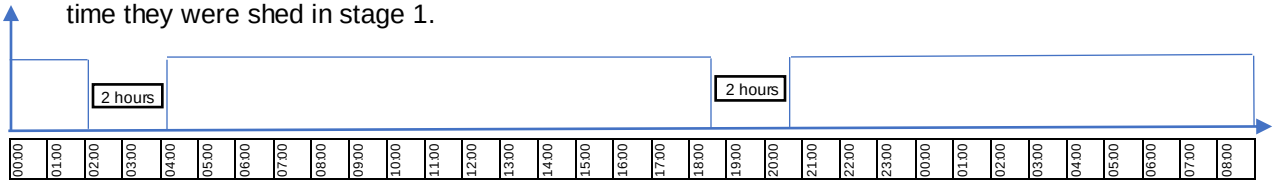
Most utilities have historically struggled to rotate more than 4 blocks within the 30 minutes allowed for rotation. For this reason, the system below has been developed with incrementally increased time periods from stage 5, maintaining the same amount of switching as at stage 4 for every stage onwards. This is a suggested system that balances customer convenience and network capability, but any system that can be proven to meet the principles of this specification is acceptable.

The graphs below each stage description show the customer's experience of the loadshedding stage. The design can be seen as a 32-hour period broken into 4*8 hour slots. An additional slot is used for each stage up to stage 4; after that the loadshedding period is extended to increase the load shed. The design shall be implemented as follows:

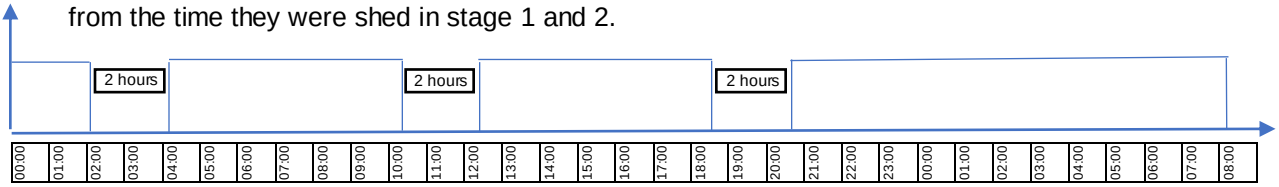
a) **In stage 1** each block shall be shed for 2 hours at a time**,** rotating through all 16 blocks.



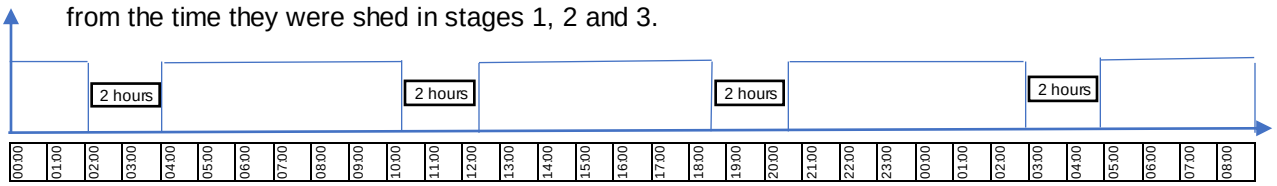
b) **In Stage 2** each block is shed again within the 32 hour period, reasonably separated from the time they were shed in stage 1.



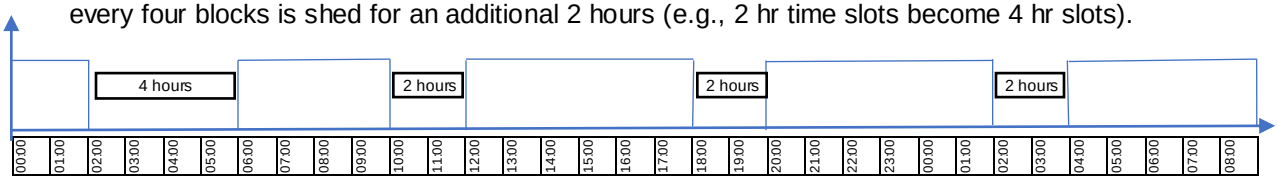
c) **In Stage 3** each block is shed for a third time within the 32 hour period, reasonably separated from the time they were shed in stage 1 and 2.



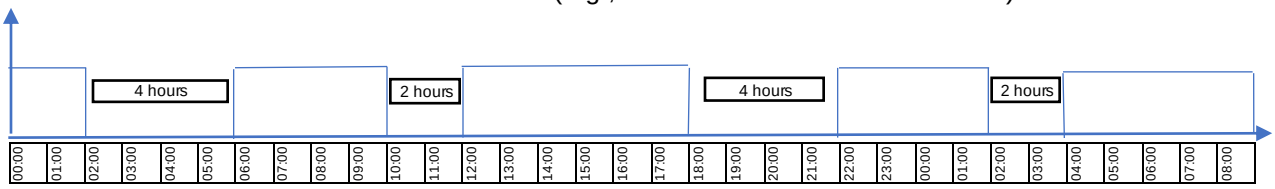
d) **In Stage 4** each block is shed for a fourth time within the 32 hour period, reasonably separated from the time they were shed in stages 1, 2 and 3.



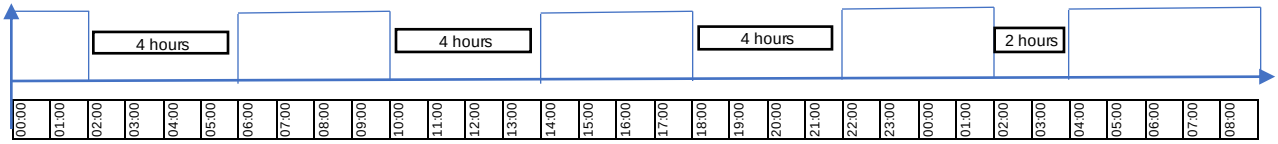
e) **Stage 5 schedules** shall be the same as Stage 4 schedules with the exception that one of every four blocks is shed for an additional 2 hours (e.g., 2 hr time slots become 4 hr slots).



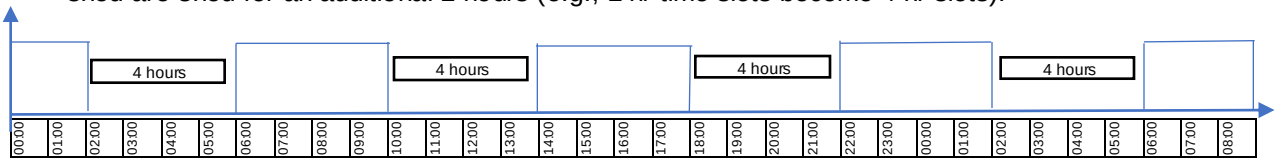
f) **Stage 6 schedules** shall be the same as Stage 4 schedules with the exception that 2 of four blocks are shed for an additional 2 hours (e.g., 2 hr time slots become 4 hr slots).



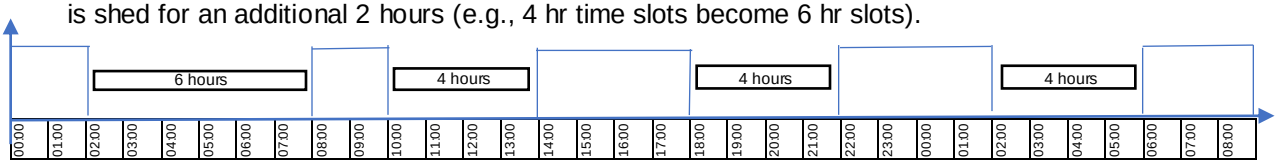
g) **Stage 7 schedules** shall be the same as Stage 4 schedules with the exception that 3 of four blocks are shed for an additional 2 hours (e.g., 2 hr time slots become 4 hr slots).



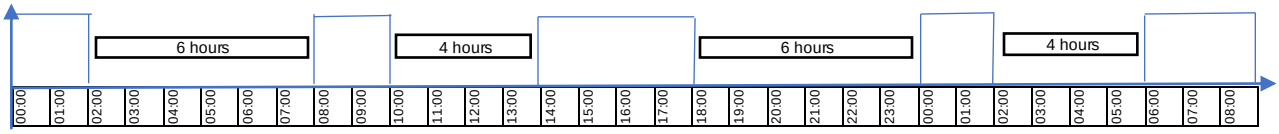
h) **Stage 8 schedules** shall be the same as Stage 4 schedules with the exception that all blocks shed are shed for an additional 2 hours (e.g., 2 hr time slots become 4 hr slots).



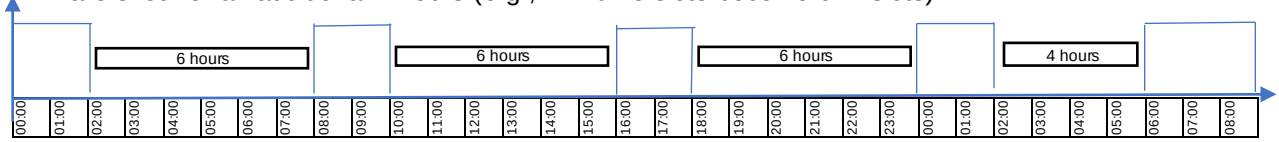
i) **Stage 9 schedules** shall be the same as Stage 8 schedules with the exception that one block is shed for an additional 2 hours (e.g., 4 hr time slots become 6 hr slots).



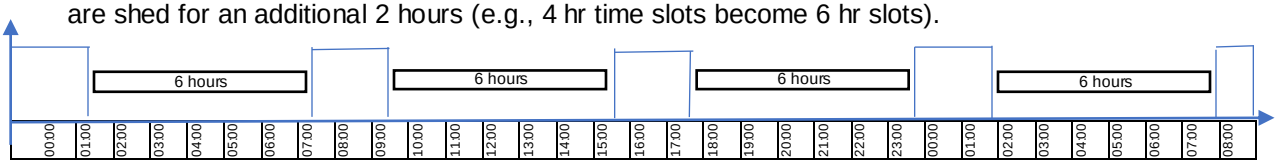
j) **stage 10 schedules** shall be the same as Stage 8 schedules with the exception that 2 blocks are shed for an additional 2 hours (e.g., 4 hr time slots become 6 hr slots).



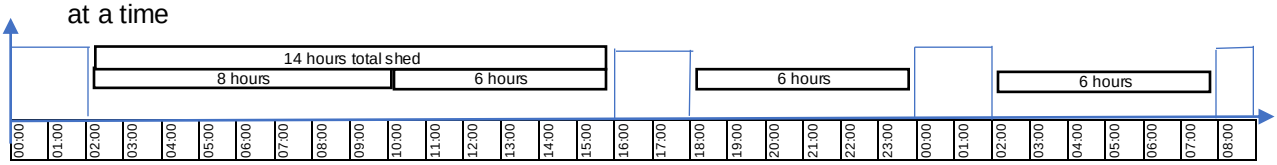
k) **stage 11 schedules** shall be the same as Stage 8 schedules with the exception that 3 blocks are shed for an additional 2 hours (e.g., 4 hr time slots become 6 hr slots).



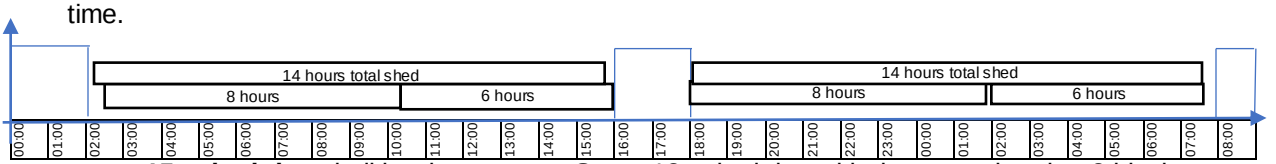
l) **stage 12 schedules** shall be the same as Stage 8 schedules with the exception that all blocks are shed for an additional 2 hours (e.g., 4 hr time slots become 6 hr slots).



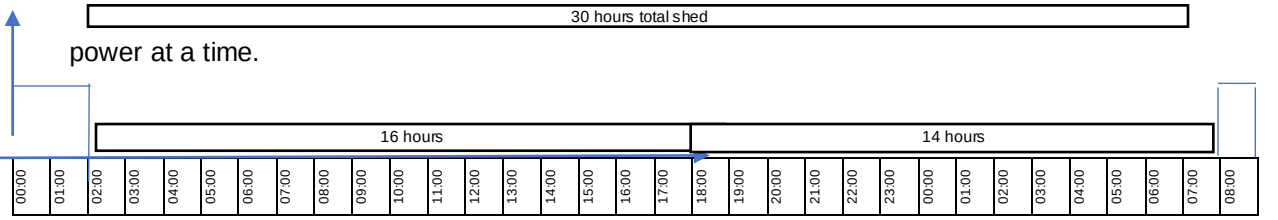
m) **stage 13 schedules** shall be the same as Stage 12 schedules with the exception that one of the blocks shed under Stage 13 is shed for an additional 2 hours (e.g., 6 hr time slots become 8 hr slots), with no power provided before the next loadshedding period. Only 3 blocks will have power at a time



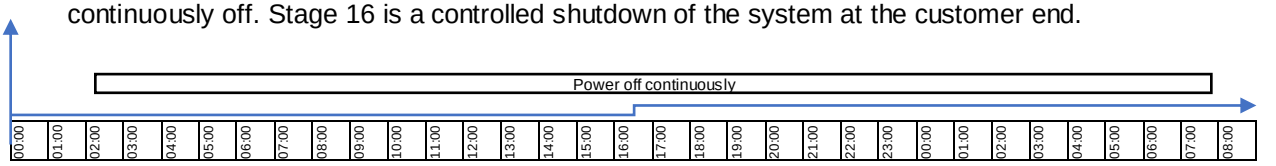
n) **stage 14 schedules** shall be the same as Stage 12 schedules with the exception that 2 blocks shed under Stage 14 are shed for an additional 2 hours (e.g., 6 hr time slots become 8 hr slots), with no power provided before the next loadshedding period. Only 2 blocks will have power at a time.



o) **stage 15 schedules** shall be the same as Stage 12 schedules with the exception that 3 blocks shed under Stage 13, 14 and 15 are shed for an additional 2 hours (e.g., 6 hr time slots become 8 hr slots), with no power provided before the next loadshedding period. Only 1 block will have power at a time.



p) **stage 16 schedules** shall consist of all 16 blocks off simultaneously. All the load will be continuously off. Stage 16 is a controlled shutdown of the system at the customer end.



Annex F – Performance Assessment of Curtailment Customers
(informative)

The following methods are proposed for the assessment of load reduction of customers participating in load curtailment.

F.1 Method A: Suitable for large base load customers

This method is mostly suitable for larger base load customers (typically >10MW) who operate 24 hours a day, 7 days a week.

F.1.1 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 weekdays may be used to determine a weekday 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, however the history must be representative of the customer's current operating level;

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.

F.1.2 Performance Assessment

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:

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

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 continuous load

curtailment declarations longer than 24 hours, the assessment may be conducted on a daily basis and the performance averaged over this period.

Annex F
(concluded)

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. See Figure F.1.

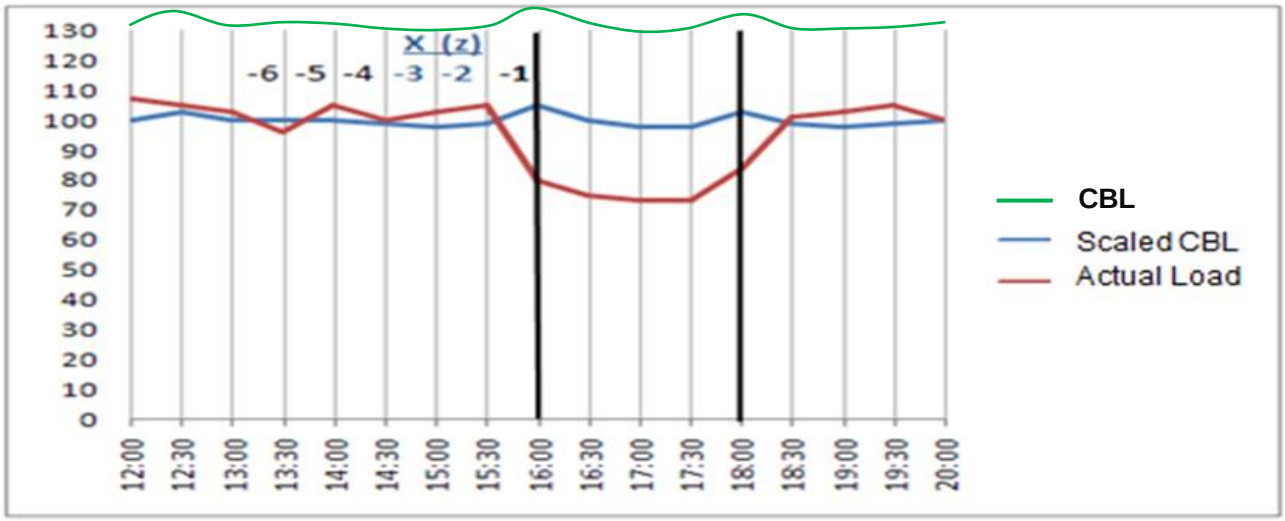


Figure F.1 — Curtailment base line measurement

The reference point X(z) may be moved to a mutually agreed period of normal consumption. In some instances, the above scaling of the CBL may not be appropriate as the customer may have experienced a plant trip, in the process of ramping up to normal load prior to the load curtailment request or a customer may artificially increase demand above normal operating levels. In such instances either a static CBL (average) may be used to determine the customers load reduction or the integration period over which the scaling is assessed may be increased over multiple integration periods.

The minimum curtailment requirement is 80 % of the target reduction. This is to allow for inaccuracies of the assessments, e.g., the weather, choice of sample days and metering

F.2 Method B: Suitable for smaller load customers

This method is proposed for smaller load customers (typically <10MW).

F.2.1 Determining curtailment base load

The curtailment base load day is determined from 6 selected sample days. The 6 sample days are selected as described below. Previous Load-shedding/curtailment days and public holidays are excluded from the selection.

- 1st sample day: One week back from assessment day
- 2nd sample day: One week back from 1st sample day

- 3rd sample day: One week back from 2nd sample day
- 4th sample day: One week back from 3rd sample day
- 5th sample day: One week back from 4th sample day
- 6th sample day: One week back from 5th sample day

If the sample day is a previous load-shedding/curtailment day or public holiday, the sample day is moved by 1 week until a non-load-shedding day is found.

Where a customer's demand varies based on seasonality, the licensee may consider changing the 4th sample day to one year (364 days) back from assessment the day. Should this day result in a previous load curtailment day or public holiday, then the sample day may be selected by adding or subtracting a week until an appropriate day is found.

After the 6 sample days have been selected the customer base load profile is calculated by taking the 3rd highest value for each half-hour as shown in the example below.

Time	1st sample	2nd sample	3rd sample	4th sample	5th sample	6th sample	CBL
	kW, kWh or A values	kW, kWh or A values	kW, kWh or A values	kW, kWh or A values	kW, kWh or A values	kW, kWh or A values	3rd highest value of the 6 samples
00:30	10.0	11.0	10.5	10.7	10.2	10.9	10.7
01:00	10.5	11.2	10.8	10.9	10.4	11.3	10.9
01:30	11.0	11.7	11.0	11.5	10.9	11.0	11.0
02:00	12.5	12.0	11.8	11.9	11.4	12.3	12.0

F.2.2 Performance Assessment

The performance assessment is similar to the method A described above. However, no further scaling of the CBL is required.

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 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. For continuous load curtailment declarations longer than 24 hours, the assessment shall be conducted on a daily basis.

The minimum curtailment requirement is 80 % of the target reduction. This is to allow for inaccuracies of the assessments, e.g., the weather, choice of sample days and metering.

F.3 Suitability of Customer Base Load Profile

Utilities may adopt other methodologies in establishing a customer base load profile. This should however be reflective of the customers most recent operating profile and the assessment method must demonstrate that the customer has met the requirements of curtailment.

Where curtailment has been called for extended periods of time (weeks or months) without any stoppage, the licensee may find it difficult to obtain base load reference profiles to assess compliance.

In such instances, the licensee may suspend curtailment for short durations to establish such a base load reference profile. The suspension of curtailment for customers should not occur all at once, but rather rotated to minimise the impact on the power system. The licensee should further ensure that customers do not artificially raise their reference profile during these periods.

Annex G – 16 Suggested block rotating schedules for a standard month

(informative)

G.1 Overview

Typical model load shedding schedules are shown in this annex, based on the 16 blocks identified for the load shedding schedules.
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 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.
For each stage of loadshedding another block is added, accumulating blocks.
From stage 5 onwards the blocks accumulate in a way that results in increased duration, rather than increased switching.
By stage 16 all the blocks are all scheduled for every time period, resulting in a schedule for a controlled full shutdown.

Time		STAGE	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	02:00:00	1	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12	8	1	13	9	5	2	14	10	6	3	15	11	7	4	16	12
		2	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16	12	5	1	13	9	6	2	14	10	7	3	15	11	8	4	16
		3	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4	16	9	5	1	13	10	6	2	14	11	7	3	15	12	8	4
		4	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
		5	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13	9	2	14	10	6	3	15	11	7	4	16	12	8	5	1	13
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Time		STAGE	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
		14	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3	15	8	4	16	12	9	5	1	13	10	6	2	14	11	7	3
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Bibliography

NRS 086, *Centralized load control systems.*