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SANS 10400-XA Energy usage in buildings:

An architect's guide
to compliance in
home design



An architect's guide to compliance in home design

A Nedbank 'greener buildings' initiative

Nedbank is committed to doing its part to preserve and protect the environment. This also involves assisting and enabling other South Africans – be they individuals or organisations – to achieve and contribute to environmental sustainability in their home and work environments. Through this document, Nedbank hopes to support government's efforts to encourage energy efficiency in buildings by simplifying and explaining the new South African National Standard (SANS) 10400-XA Regulations for the benefit of homeowners, architects and property developers.

Introduction

South Africa's national electricity grid is under pressure, as the limited supply struggles to keep up with growing demand. The costs of generating electricity predominantly from coal and nuclear energy are rising, as the resource inputs they require become increasingly expensive. At the same time polluting mining processes, the impact of power plants on freshwater supplies and the production of greenhouse gases and harmful wastes pose significant challenges to the environmental sustainability of the country's base power supply.

Nearly 60% of the world's electricity is consumed by residential and commercial buildings, and the building sector is the single largest contributor to greenhouse gas emissions. Concerns about climate change and energy costs have resulted

in energy becoming an increasingly important consideration in the design of buildings, and energy-efficient buildings are now the norm in many parts of the developed world. The bulk of South Africa's buildings were designed and constructed when electricity was cheap, but rising costs are making them more and more expensive to run, and less affordable to their occupants.

The South African Constitution requires the protection of the environment for the benefit of all, and government is mandated to put rules and regulations in place to promote a more sustainable future. Following trends in other countries, our government is now focusing on improving the energy efficiency of existing buildings by retrofitting them for energy efficiency, and ensuring that new buildings are designed to be as energy efficient as possible. In 2011 the SANS 10400-XA 'Energy Usage

in Buildings' Regulations were added to the National Building Regulations for Energy Usage in Buildings to improve the energy efficiency of our country's buildings.

From the orientation of a building through to the specifications for insulation and water heating, architects play a key role in ensuring that buildings comply with SANS 10400-XA Regulations. Many of the principles contained in the regulations are not new, and should be familiar to those experienced in building design. Through their work, architects can help slow the growth in demand for grid electricity, with numerous benefits for their clients, the country and the planet. Incorporating energy efficiency principles into the design of homes not only helps reduce their operating costs; it also makes them more comfortable to live in, as they provide greater protection from extreme temperatures.

Buildings that consume energy as a result of human occupancy are the main target of the new regulations.



The SANS 10400-XA Regulations

The amended South African National Building Regulations require the following:

- **XA1** – buildings are to use energy efficiently and reduce greenhouse gas emissions in accordance with a set of requirements.
- **XA2** – not more than 50% of the annual volume of domestic hot water should be supplied by means of electrical resistance heating, ie 50% or more of the hot water used must be heated by energy sources other than electricity.
- **XA3** – compliance with the XA1 Regulations must be achieved by one of three methods. If practitioners build in accordance with SANS 10400-XA, the buildings will be 'deemed to comply' with National Building Regulation XA1.

The South African government is bound to promote and defend the implementation of these regulations through the mechanisms and procedures used to control new buildings. This responsibility lies with municipalities and, more specifically, with Building Control Officers.

Which buildings are affected?

Buildings that consume energy as a result of human occupancy are the main target of the new regulations. All new buildings must comply with the regulations, as must any additions and extensions to existing buildings. If the existing building is unaffected by an addition, only the addition will have to comply with the regulations. Renovations must comply with the regulations if they require planning approval from a local authority.

Garages and storage areas that are not within the building envelope and do not form part of the habitable area, do not have to comply with the SANS 10400-XA Regulations, and this also holds true for factories and the operational aspects of businesses.

How is compliance achieved?

According to the wording of Regulation XA3, SANS 10400-XA is 'deemed to satisfy' the regulations. Those who want to comply with the regulations should therefore start with this document, which can be purchased and downloaded from the 'Buy a Standard' section of the SABS website (www.sabs.co.za).

Compliance with the SANS 10400-XA Regulations requires that an architect satisfy certain conditions. There are three routes to compliance, namely:

- **The Prescriptive Route** as in paragraph 4.2.1 (b).
- **The Reference Building Route** as in paragraph 4.2.1 (c).
- **The Performance Route** as in paragraph 4.2.1 (a).

The **Prescriptive Route** is generally available to all persons, and will commonly be used for houses and smaller buildings. This route requires that a set of rules is adhered to for water heating, insulation and glazed areas, ie windows, glass doors and roof lights.

Compliance through the **Reference Building Route** or **Performance Route** can be achieved by means of a Rational Design by a **Competent Person – Energy**.

Hotels are, however, the only residential buildings to which the Performance Route is applicable; it cannot be used for residential homes.



By the time the plans are submitted to council, a decision must be made as to which of the three routes to compliance with the SANS 10400-XA Regulations will be followed.

What is a Rational Design?

A **Rational Design** is a document prepared by a Competent Person – Energy and submitted along with the plans for approval. This document typically contains –

- The credentials of the Competent Person – Energy.
- The methodology used to model energy usage.
- The choice of energy modelling software and its suitability – energy modelling software must be accredited by Agrément South Africa, for example Bsimac and Design Builder.
- The results of energy modelling.
- The opinion of the Competent Person – Energy on the building's compliance.

Who is responsible?

The owner of the building (the **Responsible Person**) is typically considered to be the person responsible for compliance with the SANS 10400-XA Regulations, unless he or she appoints a professional, eg an architect, draughtsperson or engineer, who is then deemed to be the **Appointed Person**.

By the time the plans are submitted to council, a decision must be made as to which route to compliance with the SANS 10400-XA Regulations will be followed. If the Performance Route or Reference Building Route is pursued, a **Competent Person – Energy** must be appointed.

What is a Competent Person – Energy?

A Competent Person is defined as 'a person who has the necessary education, training, experience and contextual knowledge to make a determination in terms of a functional regulation'. In this case a Competent Person – Energy will typically be a mechanical engineer or architect, who has been on appropriate courses pertaining to the SANS 10400-XA 'Energy Usage in Buildings' Regulations. Most multidisciplinary engineering consultancies should offer this service.

What documentation must be completed?

Once the plans are ready for submission, the Appointed Person (or Responsible Person, if a professional has not been appointed) must inform the local authority and Building Control Officer which compliance route has been chosen, by completing a set of four documents (Forms 1 to 4). These are standardised SABS forms that include a checklist indicating the client's choice of compliance route, and must be submitted to the local authority. The forms can be downloaded from the SABS website (www.sabs.co.za).

Form 1: 'Declaration by person responsible for preparing an application for approval of the erection of the building in terms of section 4 of the act'

The Appointed Person (or Responsible Person if a professional has not been appointed) is required to make a declaration as to the means by which the SANS 10400-XA Regulations will be satisfied under the 'XA: Energy Efficiency in Buildings' section of Schedule A. If the Performance Route or Reference Building Route is followed, he or she must provide the name of the Competent Person – Energy on Schedule B. The homeowner and Appointed Person must sign this form and it must be submitted to the Building Control Officer, along with the plans.

Form 2: 'Application for acceptance as an approved Competent Person in terms of Regulation A19'

If a Competent Person – Energy is required, he or she must indicate acceptance of responsibility for energy-related duties, by completing and signing Form 2. This includes a declaration that he or she has the qualifications, experience and contextual knowledge necessary to undertake such work. Based on this declaration, the local authority has to approve the Competent Person – Energy as fit to prepare the application. It is the local authority's prerogative to require that applicants undergo some form of training;

and some, eg the City of Cape Town, require that the professional be listed on the Building Control website (www.buildingcontrol.co.za) as having attended an appropriate training course. Please check with the local authority as to how it prefers the information to be supplied. The 'EE Supplemental Guide' can be downloaded from www.arcdirectory.co.za.

The owner and Competent Persons must sign this form and it must be submitted to the Building Control Officer, along with the plans. Please note that Form 2 is not required for the Prescriptive Route.

Form 3: 'Declaration by a Competent Person appointed to design a component or an element of a system'

If a Competent Person – Energy is required, Form 3 must be submitted to confirm that he or she is suited to the task. Section 2 of this form conveys critical design information relating to the building's energy performance, and Section 3 specifies the areas of responsibility to which the Competent Person – Energy's expertise is relevant.

Form 4: 'Certificate of Completion of the structural, fire-protection or fire-installation system in terms of section 14(2a) of the act'

If a Competent Person – Energy is required, he or she must complete and sign a Certification of Completion on a standard Form 4 on completion of the building to ensure that it is in accordance with the approved Rational Design. The Competent Person – Energy retains responsibility for seeing the energy aspects of a project through to completion. If the Prescriptive Route is followed, the 'energy efficiency in buildings' box does not have to be ticked.

Option 1: Compliance through the Prescriptive Route

As compliance through the Prescriptive Route does not require the appointment of a Competent Person – Energy, it is likely to be the route most widely used by architects who are new to energy modelling.

Who can use the Prescriptive Route?

The Prescriptive Route – otherwise known as the 'Building Envelope and Services Route' – is generally available to all persons. It requires that the design and materials follow all relevant provisions of SANS 10400-XA, and certain provisions of SANS 204. This is the simplest of the three compliance routes, as a Competent Person – Energy is not required.

What does the Prescriptive Route entail?

In following the Prescriptive Route, the building must be designed and built in accordance with paragraph 4.2.1 (b) of the SANS 10400-XA standard.

The requirements of paragraph 4.2.1 (b) have the following implications:

- At least 50% of hot-water demand must be met by means other than electric resistance heating.
- Roof or ceiling insulation is required, and must meet minimum requirements, depending on the climatic zone and roof material.
- Insulation is required for exposed hot-water pipes.
- Wall insulation is required for non-masonry external walls.

- Floor insulation is required if there is in-slab heating.
- Shading devices or performance glazing is required where glass areas are greater than 15% of net floor area.
- Other building services that use energy or control the use of energy must be provided in accordance with SANS 204.
- Orientation requirements in accordance with SANS 204 are non-mandatory, as the fenestration design can compensate for sub-optimal orientation.

This method of compliance must be chosen by the Appointed Person at the outset of the project.

What must be done to follow the Prescriptive Route?

To meet the minimum requirements of the Prescriptive Route, the architect must indicate on Schedule A of Form 1 that this route to compliance is being pursued, by ticking the first seven boxes under the 'XA: Energy Efficiency in Buildings' section. In addition, he or she must communicate the following to the local authority, either on the plans or on an attached schedule –

- 1 **Water heating:** Specify the location, capacity and type of hot-water installations, and indicate that at least 50% of the water will be heated by means other than electrical resistance heating.
- 2 **Insulation:**
 - **Roof and ceiling insulation:** Specify the insulation type and thickness required to achieve the minimum total R-value for insulation, depending on the climatic zone and roof material, using Table 7 of SANS 10400-XA.
 - **Hot-water pipes:** Specify the minimum R-value for insulation on all exposed hot-water pipes as determined by the pipe diameter. Pipes with an internal diameter of less than 80mm require insulation with a minimum R-value of 1,0, and all others must have a minimum R-value of 1,5.
 - **Non-masonry external walls:** If the building has non-masonry external walls, specify insulation to achieve the required total R-value as determined by the wall materials and climatic zone. Zones 1 and 6 require a total R-value of 2,2, while Zones 2 to 5 require a minimum of 1,9.
 - **Underfloor heating:** If the building has in-slab heating, specify under-slab insulation with a minimum R-value of 1,0.
- 3 **Glazed areas:** Indicate the **total glazed area** (including windows, glass doors and roof windows), the **net floor area**, and the total glazed area as a **percentage** of the net floor area (in accordance with SANS 204) –
 - If it is **more than 15%**, the fenestration must be designed to comply with SANS 204 using the calculations of paragraph 4.3.4 of SANS 204. This may require the additional specification of performance glazing or shading over glazed areas.
 - If it is **less than 15%**, no additional requirements have to be met.

What is an R-value?

The R-value of an element refers to its thermal resistance, or ability to prevent heat from passing through it. It is calculated by dividing the thickness of the element by its thermal conductivity. Constructing a building shell to achieve a certain prescribed R-value will make it easier to maintain comfortable indoor temperatures despite outside temperature changes, thus requiring less energy to heat or cool.

The wording of the SANS 10400-XA water-heating requirements is not prescriptive, and leaves the choice of technology open to innovation.

Which water-heating options should be used?

Conventional approaches to water heating use electricity to heat an element that heats water inside a geyser tank – this is known as ‘electrical resistance heating’. Approximately 50% of the average energy consumed by middle-to-upper-income households is used to heat water, so heating water using alternative sources is one of the most significant ways in which homeowners can save on electricity. Compliance with SANS 10400-XA requires consideration of the following options:

1 Solar water heaters

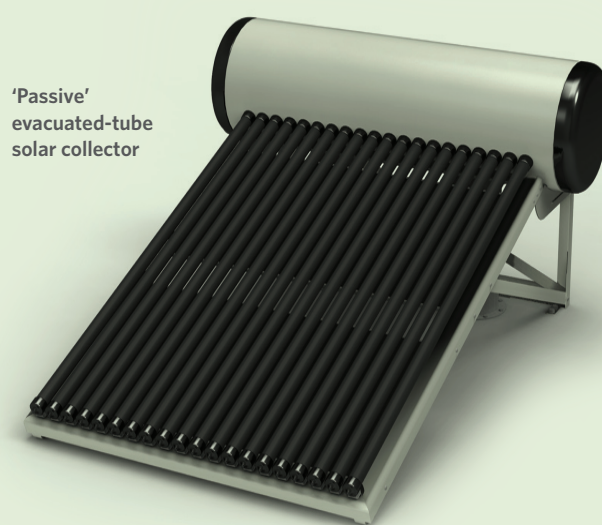
With South Africa’s abundant sunshine, using a device that harnesses the heat of the sun can save 25% to 40% on the electricity used by a conventional geyser. Solar water heaters (SWHs) are available in a variety of shapes and forms that impact on their cost, aesthetics and energy efficiency. The main options are –

- Passive or active? Passive systems take advantage of hot water’s tendency to rise above cold water, allowing natural circulation of water without an electric pump. These systems require that the tank be placed above the collector plate, typically on the roof. Active systems use a little more electricity to circulate the water, but allow for the tank to be concealed under the roof. Both systems can have an electrical element as a backup for times when the sun is not strong enough to reach the required water temperature.



Installed ‘active’ flat-plate solar collectors

- Flat plate or evacuated tube? A flat-plate system collects the sun’s heat through a weatherproof box with a glass cover, whereas an evacuated-tube system does so through a series of parallel glass tubes. Evacuated-tube systems are designed for colder climates and typically reach higher water temperatures than flat-plate systems.



‘Passive’ evacuated-tube solar collector

2 Heat pumps

Water can be heated by extracting heat from the air using a heat pump, which uses 50% to 70% less electricity than an electrical resistance water heater. A heat pump resembles a small air-conditioner unit attached to the exterior of the building, and is typically connected to a geyser inside. As heat pumps do not require roof space or direct sunlight, they are easier to incorporate into a home’s design than solar water heaters are.

3 Other options

The wording of the SANS 10400-XA water-heating requirements is not prescriptive, and leaves the choice of technology open to innovation. Other options that could be considered are those that recover heat from household systems, eg from fireplaces or stoves, or make use of combustible fuels such as gas, sawdust pellets or wood.

Option 2: Compliance through the Reference Building Route

If the Prescriptive Route requirements pose technical difficulties or are unaffordable, the project team may wish to pursue compliance through the Reference Building Route. This option permits a greater degree of flexibility and creativity, allowing the professional team to introduce innovative energy-efficient solutions to achieve an energy performance that is the same or better than that which would have been achieved by the strict application of the Prescriptive Route.

The factors influencing the choice of this compliance route are:

- The type of project (this route is better suited to multi-unit residential buildings or developments).
- The scale of the project.
- The skill set of the professional team.
- Client's preferences and willingness to pay for energy modelling.

If the Competent Person – Energy is working with a team with the requisite energy modelling expertise, or is skilled

in performing energy modelling, then design options can be checked for compliance at an early stage to ensure a cost-effective design.

Who may perform Rational Designs?

Pursuing the Reference Building Route requires the appointment of a Competent Person – Energy. If appropriately qualified, the architect may take on this role by undertaking the computer modelling or asking for assistance with this task.

What does the Reference Building Route entail?

A Reference Building is initially designed according to the client's vision and needs, with all the elements required to comply with the Prescriptive Route being included. The energy performance of this design is then calculated and used as a base case with which the energy performance of the improved design can be compared.

Thereafter, the design can be modified with recommendations from the professional team. The annual energy usage and demand is calculated and compared with the performance of the Reference Building (the base case). If the

modified design shows an equivalent or improved energy usage compared with the Reference Building, it complies with the regulations.

What must be done to follow the Reference Building Route?

To meet the requirements of the Reference Building Route, the architect must ensure that the following documents are submitted to the local authority, along with the plans:

- The completed Form 1, indicating that this route to compliance is being pursued, by ticking the last box in the 'XA: Energy Efficiency in Buildings' section of Schedule A. This document must be signed by the owner and Appointed Person.
- Form 2, completed and signed by the owner and Competent Persons.
- Form 3, completed and signed by the Competent Persons.
- A Rational Design document prepared by the Competent Person – Energy, appended to Form 3.
- A schedule of energy modelling calculations prepared by the Competent Person – Energy.

Nedbank: Leading by example

When Nedbank became the first African financial institution to achieve carbon neutrality in 2009, it committed itself to leveraging this achievement to promote, encourage and enable greater energy efficiency across all areas of South African industry and society. A significant component of this commitment is Nedbank's strong belief in leading by example, which is why, over the past three years, the group has made significant contributions to the country's energy efficiency and carbon-reduction efforts.

In 2012, Nedbank completed construction of its third 4-star Green Star SA-rated building. All of these Nedbank buildings are designed, constructed and operated in an environmentally sustainable and energy-efficient manner. In addition to recycled materials being used for their construction, the buildings use the latest in energy-efficient lighting and air-conditioning technology, various water-saving and storage systems, and effective waste limitation and management processes. Nedbank has also been actively

involved in the financing, planning and development of six of the seven Green Star SA-rated buildings we currently have in South Africa.

Nedbank was the first African signatory to the Equator Principles and is one of only 25 banks worldwide to be included in the Dow Jones Sustainability Index. In 2010, we were recognised at the *Financial Times* Sustainability Awards as the 'Emerging Markets Sustainable Bank of the Year for Middle East and Africa'.

This document was researched and compiled by the Sustainability Institute (SI) in collaboration with Structattherm Projects on behalf of Nedbank Limited.

The SI was established in 1999 to promote learning about sustainable living in South Africa. Located in the Lynedoch EcoVillage near Stellenbosch, the SI focuses on combining practice with theory in a way that integrates ecology and equity in support of a sustainable South Africa, with special reference to reducing and eradicating poverty. The SI has built a name for itself through its Masters Programme in Sustainable Development Planning and Management, which comprises a Postgraduate Diploma in Sustainable Development and a Master of Philosophy degree in Sustainable Development, in partnership with the School of Public Leadership at Stellenbosch University.

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