Asian Development Bank

Electricity and Water Safety Standards for the Nauru Utilities Corporation

March 2011

IT Power (Australia) Pty Ltd
ABN 42 107 351 673

PO Box 6127
O'Connor ACT 2602

ph: +61 (0)2 6257 3511

fax: +61 (0)2 6257 3611

email: itpau@itpau.com.au

Report for: **Asian Development Bank**

For: **Nauru Utilities Corporation**

March 2011

IT Power Ref: A0055

Submitted by:

IT Power (Australia) Pty Ltd

PO Box 6127

O'Connor ACT 2602

ph: +61 (0)2 6257 3511

fax: +61 (0)2 6257 3611

email: itpau@itpau.com.au

web: www.itpau.com.au

Document control	
File path & name	2010/A0055 ADB NUA Bill/1Deliverables/NUC Water and Electricity Standards
Authors	Philippe McCracken
Reviewed	Julia McDonald
Approved	Simon Franklin
Date	8th March 2011
Distribution level	Commercial in Confidence

Template: ITP Form 009a Proposal Issue: 01; Date: 10/12/03

TABLE OF CONTENTS

1. Executive Summary

As part of its corporatization strategy, the Nauru Utilities Authority (NUA) is undergoing structural changes to the way it is managed, governed and operated. As part of the corporatization process, the NUA will be legislated to abide by a set code of safety standards for water distribution and electricity transmission. From December 2010 to February 2011, the Asian Development Bank provided the NUA with technical assistance for the establishment of safety standards; this technical assistance was provided by IT Power (Australia), and the findings of the consultancy are provided in this report.

The NUA currently uses *AS/NZS 3000:2007 – The Wiring Rules*, as its standard for electricity transmission and distribution. This standard is used throughout utilities in the South Pacific and as such its use by the NUA is in line with Nauru's neighbours. However, despite the NUA nominally following AS/NZS 3000, the low level of training of many of its staff and the lack of regulatory oversight mean that installations and working methods may not be compliant with the standard. Furthermore, the adoption of AS/NZS 3000 is not universal across the private sector, leading to varying quality of installations. A simplified version of AS/NZS 3000:2007 has been attached to this report, to act as a quick reference guide for untrained utilities personnel.

Water is produced by reverse-osmosis machines at the NUA, stored in concrete tanks, and trucked to customers' water tanks by the NUA or by a private company. The NUA nominally abides by the *Australian Drinking Water Guidelines 6 (2004)* with the Ministry of Health conducting testing of the drinking water. The staff at the NUA have limited safety equipment (chlorine dispensing equipment for the tanker), but they lack the training to use it. Sample Standard Operating Procedures for water quality monitoring have been attached to this report.

As a next step to this consultancy, training for the electricity staff (specifically the Line Gang, the unit at the NUA responsible for the high-voltage transmission network) and water storage team at the utility is recommended. Standards alone will not improve the safety of the electricity and water sectors in Nauru; the staff who are to implement the standards must be adequately trained. Furthermore, regulation to ensure nationwide compliance with the standards is also required, as private electrical installations and water tanks are currently beyond the purview of the NUA but still have consequences for safety and health of the public.

2. Introduction and scope of works

The Nauru Utilities Authority (NUA) is the sole provider of grid electricity and treated drinking water in Nauru, with over 2,000 electricity and water customers. It generates its electricity using refurbished diesel generator sets, and treats seawater using three reverse-osmosis machines. The NUA was formed from the water, electricity and fuel distribution branches of the now-defunct Nauru Phosphate Corporation, and has been running as a State-Owned Enterprise since 2007.

The Government of Nauru is currently investigating options for the corporatization of the NUA, into the Nauru Utilities Corporation (NUC). As part of this process, legislation is being drafted to set up the framework for the management and operation of the NUC. In addition, safety standards are being developed with which the NUC must comply. This reform of the NUA and its transition into the NUC is being undertaken with assistance from the Asian Development Bank (ADB)

In December 2010, the ADB contracted IT Power (Australia) to:

- review the existing technical standards applied to the supply of water and/or electricity in Nauru
- consult with all relevant stakeholders
- recommend appropriate technical standards to be applied to the supply of water and/or electricity in Nauru in the future

IT Power visited Nauru from January 26th to February 2nd 2011, and met the following stakeholders:

- 'Apisake Soakai, CEO, Nauru Utilities Authority
- Wintam XXX, Head of the high voltage Line Gang, NUA
- Mark XXX, Head of water production, NUA
- Jeremy XXX, Head of water distribution, NUA
- Samuel Grundler, Director, Department of Planning and Policy Division
- Tai'atu Ata'ata, XXX
- Catriona XXX, Legal counsel, XXX
- Denzel Hankinson, ADB consultant for utilities policy

IT Power was also briefed on the water sector in Nauru by SOPAC's Pacific Hydrological Cycle Observing System (HYCOS) team, who provided valuable input into the water situation in Nauru and what the needs and constraints of the sector are.

3. Electricity

Electricity is transmitted at 11 kV via a ring main around the island, and the network currently operates under a load-shedding regime as there is insufficient capacity at the powerhouse to meet electricity demand. Some critical buildings, such as the hospital, the airport, and the government offices are fed by a spur line from the power station. This spur line provides power 24 hours a day to these essential services. All work on the 11 kV lines is undertaken by the NUA's Line Gang.

Load-shedding is currently done on a 3 hours on, 6 hours off basis. This load shedding regime came into effect in January 2011, following a year and a half period of 24-hour power availability. Load shedding is undertaken manually, by switching various sections of the 11 kV grid on or off at preset times. As reported by the head of the Line Gang, some of the high-voltage switches, such as the one in front of the civic centre or the one in front of the airport, are damaged beyond repair, and have been bypassed to continue to provide electricity to the sections of the grid to which they are connected. The bypassing has been done in an unsafe manner, due to the lack of proper equipment and training. The cables have been stripped bare and are spliced together in PVC conduit. The correct procedure would be to have the cables stripped bare, spliced, and re-insulated with heat shrink, however the NUA does not have heat shrink in its inventory.

Four new high-voltage switches have been purchased and are available at the power station, however the head of the Line Gang reports that neither he nor his staff have any training in the installation of these switches. He has also indicated that because nobody on the island has the training to properly install the switches, they will not be installed until the Line Gang receives adequate training in installation procedures. Only two members of the Line Gang have any form of training in AS/NZS 3000 procedures; the rest have learned on the job from their more experienced counterparts. A linesman died of electrocution in 2003 as a result of an accident while maintaining the high-voltage lines; although it was not apparent what the immediate cause was, lack of training and safety equipment were likely contributing factors. The head of the Line Gang will generally undertake the more complicated procedures himself, such as termination of high-voltage equipment, despite not having any formal training in high-voltage electrical work.

The transformers used on the transmission lines are nearing or past the end of their useful life, as many of them still date from the days of the British Phosphate Company, i.e. pre-1967. They will have to be replaced in the near future. The NUA already has two new transformers, however the Line Gang does not have sufficient training to install, operate or maintain them. Consequently, these transformers have not and will not be installed until the Line Gang staff are properly trained.

Many of the power poles on the island are made of steel and are corroding due to the tropical marine environment in Nauru. The NUA has purchased treated timber poles and a vehicle-mounted auger to install them. However, there are approximately 300 steel poles that need to be replaced and the utility has a fewer than 10 timber poles (the head of the Line Gang keeps some in reserve in case some steel poles suddenly collapse). The quality of the installation of the power lines is variable, as the spacing between the cables and their sag are not kept consistent throughout the network. Furthermore, high-voltage electrical contractors who visited the island in 2009 under the European Union's programme to install prepayment meters noted that the size of the transmission lines appears to be insufficient for the loads that they carry. This results in large voltage drops and significant energy losses. However, this observation is merely anecdotal, and is to be confirmed by the Pacific Power Association's (PPA) upcoming supply-side management study (to be undertaken in March-April 2011).

The quality of wiring in domestic installations is variable, but in general the average home has marginal quality wiring. Bypassed circuit breakers, undersized wires, compromised wiring

insulation and a lack of earthing are common occurrences. The head of the Line Gang reports that one of the most common problems he sees in residential switchboards is the lack of a proper earthing system, and anecdotal evidence suggests that poor earthing is a prevalent problem in Nauru. Although the NUA's responsibility stops at a customer's electricity meter, problems that occur in a customer's installation can manifest themselves on the grid. For instance, some homes have backup diesel or petrol generators that are used when the grid is not available. Some of these generators are connected to the building's internal circuitry without an automatic transfer switch, meaning that it is possible to energize the main grid using the backup generators. This is a dangerous situation for the Line Gang operating on what it thinks is a safely de-energized grid.

The private sector does not universally adopt electricity standards. Interviews with private contractors have revealed that some companies nominally abide by AS/NZS 3000:2007 (due to the lack of regulators on the island, the level to which this standard is complied with is unknown), while other companies have never heard of AS/NZS 3000:2007 and wire buildings without adherence to any formal standards. While the NUA theoretically abides by AS/NZS 3000:2007, inspections of homes under EDF-9's prepayment meter programme suggests a low level of compliance with the standard. This is likely due to a lack of funds for proper equipment and poor training of NUA electricians.

The PPA visited Nauru in late 2010 to undertake a training needs assessment of utility staff. The findings of the training needs assessment were not made available to the consulting team.

4. Water

Fresh water is available from wells that tap into the freshwater lens that sits above sea level in Nauru's porous limestone rock. However, in some wells the water can be contaminated with oil or bacterial activity, and its salinity is variable. The salinity of the freshwater lens under the island is inversely correlated to the amount of rain incident on the island (i.e. the more it rains, the less saline the freshwater lens becomes). However, in times of drought, when rainwater tanks are empty and people are more reliant on groundwater, the freshwater lens becomes brackish, and may become non-potable in some areas.

SOPAC's HYCOS is assisting the Government of Nauru and the NUA in monitoring Nauru's water resources, the quality of Nauru's water and the forecasting of future droughts and periods of heavy rainfall. SOPAC's studies suggest that there may be over extraction of Nauru's groundwater in some areas, leading to increasing salinity of well water.

The only source of fresh drinking water during droughts in Nauru is the reverse-osmosis (RO) units at the power station. The reverse-osmosis units are run by the NUA, with delivery to customers by the NUA and by a private contractor. Nauru has no piped reticulation system to homes and businesses around the island and as such water delivery is undertaken by tanker trucks into customers' or communities' water tanks. Some homes have rainwater catchment systems, although it is estimated that these account for only half of homes. There are three RO units, each capable of providing 120,000L/day, for a total plant production of 36L/person/day. However, breakdowns are common, posing a water security risk in times of drought. In times of heavy rainfall, the RO units are still used, as some homes and businesses do not have rainwater catchment systems.

Water that is desalinated in the RO machines is stored in open air belowground concrete tanks before being piped to the tanker trucks. These concrete tanks are leaking, to the point where they never reach their full capacity, even during periods of heavy rainfall. Four of the six tanks are not used because of excessive leaking. There is an older tank near the phosphate loading cranes that is used occasionally when there is surplus water capacity.

HYCOS's March 2010 mission report states that water that is treated by the RO machines is free of any microbiological contamination (with an *E. coli* count of 0 per 100 mL) as it leaves the RO machines, but contamination occurs in the concrete storage tanks. The report recommends that the concrete storage tanks be improved in order to reduce contamination.

The utility is the only entity in Nauru that deals with public production of treated water (the Menen Hotel also has a desalination machine, but it is mainly for the benefit of its guests). The NUA also distributes water, but when its tanker truck breaks down a private company, Capelle's, handles distribution.

At the time of IT Power's visit to Nauru, the temporary shelter that was erected over the concrete freshwater tanks at the NUA had recently collapsed, necessitating a cleanup of the water tanks. A permanent structure is expected to be completed in the coming months.

According to the head of the water production department of the NUA, once a permanent shed is erected to cover the concrete tanks, a UV disinfection system will be installed to treat water leaving the concrete tanks. The water distribution team recently acquired chlorination equipment for the tanker trucks, but lacks the training to effectively use the equipment. The head of the water distribution team has stated that he does not want his team to start chlorinating water until staff have received proper training.

Bacteriological testing of water is being conducted by the Ministry of Health (MoH). In late 2009, SOPAC's HYCOS team provided MoH with equipment and training for regular testing of bacteriological contamination of water. Sampling procedures and schedules were also provided to MoH and NUA staff.

The NUA nominally abides by the *Australian Drinking Water Guidelines 6 (2004)*, although in practice the NUA lacks the funds to comply with all the clauses and testing procedures laid out in the requirements (e.g. cadmium contamination from phosphate dust that is caused as a result of the phosphate mining and drying). Discussions with SOPAC's HYCOS team have revealed that the most practical, cost-effective method of ensuring a minimum level of drinking water safety would be the implementation of Standard Operating Procedures for preventing contamination. Sample SOPs are provided in Appendix 2, although these are mostly focused on water sampling rather than procedures for minimizing contamination at the different stages of distribution.

5. Recommendations

Electricity

As the NUA has already adopted AS/NZS 3000:2007 as its standard for electricity distribution, no further standards are required (AS/NZS 3000 calls on other standards for high-voltage switchgear, renewable energy power systems, cable sizing, etc. so the adoption of AS/NZS 3000 automatically includes the adoption of these other standards). A summarized version of AS/NZS 3000 is provided in Appendix 1, and is intended only as a quick reference guide for electricians unfamiliar with AS/NZS 3000.

The next step for increasing the NUA's safety of electricity transmission and distribution would to be establish a training programme for the Line Gang, in conjunction with purchasing safety equipment (e.g. high-voltage gloves, steel-toed insulating boots). PPA's training needs assessment will provide the utility with guidance on which subjects its Line Gang staff needs to focus, and may provide a preferred method of instruction. The NUA should consider the following options when deciding how to train its staff:

a. Off-island training

Training an electrician in Australia and New Zealand takes several years, much of which is spent as an apprentice. Sending people off-island for training may be the fastest way to get them fully trained, but there may be some shortcomings with this method for training, such as:

- Sending someone for overseas training is expensive, especially if the training is to be for several years to become a fully-licensed electrician. Shortening the training period may be a cost-savings measure, but would not achieve the objective of having properly-trained electricians.
- Given the expense incurred in sending someone for overseas training, the utility may be more inclined to send over the people it thinks will benefit the most from the training, i.e. its brightest/hardest-working staff. This would result in a concentration of knowledge within the utility, instead of a broadening of knowledge across all staff.
- If the best staff are sent overseas, there would be a lack of good electricians at the utility for a significant period of time.
- The electricians would not be trained to operate in Nauru, but rather operate overseas. This may not be very practical, as electricians overseas may have access to tools and components that are difficult to come by in Nauru, so the electricians may come back after their training and not have access to the tools that they had become accustomed to using.
- A careful drafting of the conditions under which staff are sent over for training would be necessary, so that they come back to Nauru once trained. Working conditions at the utility would need to be good for trained staff, in order to provide an incentive for furthering their education.

This method of training may work best for recent high school graduates who show initiative and a determination for hard work. Using existing staff may be impractical as they may have had many years of bad work habits, or their temporary absence from the utility would adversely impact its operations. The Government of Australia has scholarship programmes for young recruits at the Government of Nauru's Ministry of Finance; perhaps this model of training could be replicated for electricians at the utility.

b. Secondment at the utility

Another method of training would be to bring in an electrician from overseas to work at the utility, either full-time or part-time. The electrician would then train the NUA electricians on-the-job, and would be able to adapt a teaching curriculum to the local situation. There are several aspects to consider with such a methodology:

- One trainer could train several people at differing levels of training (e.g. inexperienced staff with the basics, more experienced staff with more advanced techniques).
- The trainer could be heavily involved in doing the work at first, and then could slowly be less involved as the staff get more experienced.
- The trainer could adapt the training to the Nauruan context (e.g. what to do in case certain tools or equipment are unavailable).
- The trainer would actively participate in the day-to-day operations at the utility (e.g. installing new switches, installing new power poles, etc.), thus increasing the standard of safety of the work done.
- The trainer may end up doing most of the work in order to get the work done well, rather than accept a lower standard of work but have it done by the local staff. The local staff may end up deferring to the expatriate staff, thus defeating the purpose of the training. Procedures would need to be adopted to prevent this from happening.
- There may be some resentment at having an expatriate in a position of authority. Ideally the expatriate staff would be put in as an advisory role, within the NUA hierarchy.
- Working arrangements could be full time for a given number of years, or part-time (e.g. 3 weeks on-island, 2 weeks off-island)

c. Training at vocational school

Another possible solution would be to bring in a trainer to work at the vocational school at the newly-built Nauru High School (NHS). This method would present several advantages over the previous two methods:

- A trainer at the vocational school is able to train electricians for both the utility and for the private sector. As many wiring problems in private electrical installations can manifest themselves on the transmission grid, training the private sector is also beneficial to the utility.
- The trainer could work part-time at the utility and part-time as a trainer, thus benefiting the utility by training its staff and by doing some of the utility's work
- Trainees can attend classes part-time, so that any NUA staff being trained can also work when not in class, thus reducing the lost capacity that off-island training would involve.
- With a trainer at the vocational school, recent high-school graduates would have the opportunity for electricians' training without having to work for the NUA or move overseas.

This method of training would require capital funds to set up a training centre at the vocational school, as well as an annual budget for consumables. The Ministry of Education should be consulted regarding training for electricians.

Water

The NUA nominally adheres to the *Australian Drinking Water Guidelines 6 (2004)*, so there is no need for additional standards for water quality. The MoH has received training for water quality testing and monitoring, so there are already procedures in place for indentifying water contamination. However, standard operating procedures for handling water storage and distribution need to be developed, and NUA staff trained in these procedures, which should be as simple and cost-effective as possible. Some sample SOPs are given in Appendix 2, although these relate mainly to water sampling.

As with the electricity sector, the water teams at the NUA would benefit greatly from training. This training could take two forms: training at the utility, and training at the vocational school. The water handling and treatment SOPs would be developed during the training, to tailor the SOPs to the equipment available at the NUA.

a. Training at the utility

In this scenario, an expatriate staff could be placed at the NUA, and act as a trainer for the water department staff. The training would be focused on prevention of contamination, as the MoH is already trained for monitoring. Under this form of training:

- The trainer could conduct one-off training sessions on specific standard operating procedures, depending on the equipment available (e.g. provide training now on chlorination of water, and provide training on UV treatment later once the UV filter is installed).
- Like the secondment option for training of electricians, this option could be done on a part-time basis.
- Training could also be provided to the private sector delivery staff, as water delivery to customers is not solely the purview of the NUA
- The benefits of the training would be lost as staff leave, as there would be no permanent locally-based training mechanism

b. Training at vocational school

As with the training for electricians, a trainer could be based at the vocational school. This would have all the advantages of the training for electricians (i.e. the ability to work part-time at the utility, the ability to train recent high school graduates, NUA staff and the private sector, and the low level of disruption to utility operations by having only part of its staff in class at any given time). However, as the amount of course material may not be significant, having a standalone course may not be cost-effective. Therefore, training in water treatment/delivery standard operating procedures could be made part of a general plumbing or water technology course. The Ministry of Education should be approached regarding this point.

Overall, the training of staff at the utility would likely be the most cost-effective and quick short-term solution. Setup time is shorter than training at the vocational school, as no curriculum needs to be developed, and training can be more focused and hands-on.

Summary

The table below provides an overview of the consultancy's recommendations. The recommended method of training is underlined.

	Electricity	**Water**
Recommended standards	Business as usual: use AS/NZS 3000:2007	Business as usual: use *Australian Drinking Water Guidelines 6 (2004)*
Training	Option a: Overseas training	Option a: Training of staff at the utility
	Option b: Secondment of expatriate staff at utility	Option b: Training at vocational school
	Option c: Training at vocational school	