Mundesley - Isles of Scilly

Heating Systems – Condition and Options Report

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For Council of the Isles of Scilly
Report by Jeff Hocking - Director

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Heating System – Condition and options report

1. Reason for the report

A site visit was carried out on 17th December 2015 to review the condition of the presently installed heating system at the above site with a view to upgrading or replacing it to current standards. The inspection is visual only and comments based on these observations and experience.

Discussions were also held with the end users and comments made by the current system maintainer in respect of defects noted and faults logged.

No intrusive tests were carried out at the time of inspection but it is suggested that for any new system, the locations and types of emitters and zoning be checked and reviewed as part of the design.

Due to the lack of gas on the islands unless provided by LPG, the report will consider only the available fuels including oil as currently installed.

Where feasible and practical, the report will also consider the renewable technologies available or those offering opportunity for grants.

2. The Existing System

The existing system comprises two oil fired boilers serving a radiator type heating system installed throughout the building. The system suffers from poor zoning resulting in more areas being heated than are actually in use at certain times. This controllability is discussed further later in the report.

The boilers serve a mixed flow Variable Temperature heating circuit equipped with a twin head pump and a Constant Temperature HWS primary circuit with a twin head pump.

Both of the above circuits are fed from two oil fired Ideal Buccaneer boilers fitted with NuWay burners and serving a low loss header via a twin head boiler circulation pump. The boilers are piped as reverse return and are therefore self balancing when sharing the heating and hot water duty.

The boilers serve a domestic hot water calorifier which is very elderly, in poor condition and should be replaced as part of the works. The calorifier serves a pumped secondary circulated HW service which may be retained as the pipework appears in reasonable condition and no faults or issues have been reported.

The existing pipework should be adapted to connect to a new calorifier as set out later in this report.

Secondary Circulation shall be retained.

New temperature monitoring is recommended to comply with prevention of Legionella guidance and recommendations. This may be achieved by sensors linked to the proposed BMS and automatic logging set up within the software.

The single pipe loop heating exits the boiler house in a number of places to rise through the building. It serves not only the dormitory areas, but also the House Parents flat and two additional flats that are rented to private occupants.

When any space needs heat, the whole building must be heated and this results in very poor efficiency as unused spaces are heated as well as occupied spaces.

It will not be possible to re-zone using the existing plant and pipework as the single pipe loop does not lend itself to this nor should re-use of pipework of this age be considered.

The condition of the plant is as follows:-

Boilers

The Boilers are approximately 1989 vintage as the building was re-boilered at this time. The boilers are obsolete and parts availability is limited. Some parts are not available at all. Boilers are size 5 and rated at 38kW heat output per unit. New boilers would be checked for size against building heat losses taking account of any changes made to the building fabric since installation.

The burners serving them are however much more recent and are in good order. It may be possible to consider re-use of the burners alone or setting them aside for use in other places.

Pumps

Pumps are in varying conditions with some new heads fitted and some appearing original to the 1989 re-boilering.

Control valves

Control Valves and associated actuators appear to have been replaced recently or at least the control actuator has been as this appears to be relatively new.

Pipework and valves

Pipework and valves including commissioning sets and isolation valves are in varying conditions with some in good order and others in poor condition.

Feed and Expansion Tanks

Feed and expansion tanks for the heating were not examined as it is not proposed to re-use them in any new scheme.

Feed tanks to the hot water service were also not checked as this system will be re-used in its entirety and it is assumed that the Maintainers have carried out all relevant checks and chlorination procedures as part of ongoing maintenance.

Oil Fuel Storage

The Fuel Storage tank is a buried unit which feeds oil to the boilers via a dead weight fire valve and a pair of Tiger Loops. These all appear in good order. The tank condition cannot be assessed without intrusive investigation as it is buried in the ground and hence not available for visual inspection.

Controls

The Control Panel is life expired as is the Climatronic Optimiser compensator. Any new system should incorporate a BMS with ability to control zones as required and to optimise the system based on internal and external temperatures.

The amount of defects and regularly occurring faults as noted later in this document would indicate that the system is becoming unreliable and as residential premises, the consequences of failure could result in the building being taken out of use with the subsequent disruption for the users or the need to find and install temporary heating to maintain operations.

3. Observations

The system is single pipe loop and has been extended and adapted over a significant number of years.

Much of the original system is elderly with old style emitters that are poorly zoned but replacement central plant has been fitted. This however is also now life expired in accordance with BSRIA and CIBSE guidance and therefore due for replacement.

The single pipe loop system is likely to be original and therefore well past life expiry.

There is no zoning of areas to permit economical running of the plant.

There are no Thermostatic Valves on the system emitters and this will result in significant overheating of spaces with consequential energy wastage.

Call outs to the maintenance company are a regular occurrence which will all be related to the age of the system and its extended/expanded nature.

Devices are failing and require replacement on a regular basis.

4. Departures from Standards/Regulations

The following is a summary of the noted departures from recognised standards and good practice:-

- Life expired pipework and emitters
- Zoning inadequate and not easily identifiable
- Zoning does not take account of building use and orientation/heat losses
- Poor or no local control resulting in overheating of spaces
- Facility for temperature monitoring of Hot Water flow and return was not obvious

It was advised during the visit that there is known asbestos within the plant room and access is very restricted to Authorised persons only. This must be addressed as part of any new scheme and a Demolition type Survey and report will be required to ensure that all areas of asbestos or potential asbestos are identified.

As the works within the building are to be significant, it will also be necessary to carry out a survey and report to identify any issues that may be encountered during installation of a new heating system.

If the Council already hold a report and asbestos register for the building and there are no known hazards, this may be sufficient for the purposes of the reheating works.

5. Scope for Renewables Integration

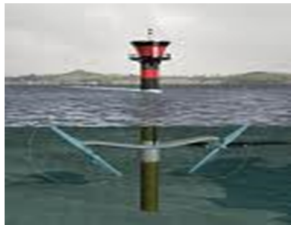
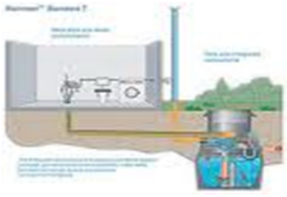
The following renewable technologies were considered for use within this scheme and the relative benefits and disadvantages of each noted.

Some items are deemed impractical due to space, cost or location.

Technology	Image	Comments
Solar Thermal		Available in two main forms as flat plate and evacuated tube collectors. In general, the evacuated tube system is more efficient however it is less robust and more prone to breakage of the tubes. Flat Plate is favoured in areas where it is accessible and therefore is a more robust solution. Either system is in common usage mainly for hot water generation. Due to location, Flat plate would appear most appropriate for Mundesley and with the high sunlight levels generally found on Scilly, may allow a significant amount of the Building hot water needs to be generated from this renewable source. There is a suitable area on the flat roof above the dormitory building where panels could be fitted in the correct orientation to maximise solar collection. There is also a simple route down to the plant room in the corner of the building for flow and return pipework to the collectors.
Solar Photo Voltaic		There are a number of distinct types of solar Photo voltaic Cell. These are usually made from silicon, The silicon is treated or "doped" so that when light strikes it, electrons are released, so generating an electric current. There are three basic types of solar cell. **Monocrystalline** cells are cut from a silicon ingot grown from a single large crystal of silicon whilst **polycrystalline** cells are cut from an ingot made up of many smaller crystals. The third type is the **amorphous** or **thin-film** solar cell. As the Scilly Islands suffer less pollution than other areas of the British Isles, the quality and quantity of sunlight is improved. It is therefore reasonable to expect a higher level of output from the cells. Solar panels are expensive and payback in this particular installation may not be economic unless used specifically for export generation. If these are to be considered further, a much more detailed appraisal will be required.
Wind Generation		Small scale wind turbines as may be suitable and could be roof or mast mounted. The wind turbine is available in a number of types with both horizontal axis and vertical axis blades. Horizontal axis is generally more efficient but all wind turbines require a clear air path and minimal turbulence to achieve best results. The proximity to the sea may offer this opportunity but noise and strobing within a residential area could be an issue and would also be visually intrusive. Planners may well have comment to make on any proposed installation. For this reason, it is likely that wind turbines are unlikely to be practical and should be ruled out for this project.

Biomass		Biomass boilers can produce heat from a variety of fuels including wood pellet, wood chip, waste to energy (eg refuse incineration) sewerage off-gassing. The boilers can also take many forms from small single room space heaters to very large scale systems suitable for district heating schemes. Each will have a fuel source appropriate to the size of plant. For the Mundesley project, Biomass is possible but the existing boiler room would not be suitable as fuel transfer and storage is required in close proximity to the boiler itself. There is no space to build a fuel store adjacent to the boiler room without significant internal alterations. One alternative would be to provide a fully packaged Biomass boiler with fuel store housed in a container which could be located in the garden and screened to reduce visual intrusion. This would involve the construction of a concrete base plinth and installation of heating mains run to the existing boiler room which would then become a pump and valve chamber serving the proposed new zones (see later) A suitable packaged plant room including boiler space, fuel store and buffer vessel would be in the order of 8.5m x 3.5m x 3.2m high and as such falls outside of the permitted development rules and would therefore require a planning application. Fuel delivery is a further concern as for woodchip, it is necessary to have vehicle access so it can be tipped into the storage hopper. Pellet fuels are more flexible in that they can be blown via a hose to a store without the lorry being parked alongside. Pellet however has a greater embodied energy due to the production method and therefore is not as environmentally friendly as chip fuels. In addition, there is no supplier of pellet or chip on the island and as such it will have to be shipped from the mainland thus incurring transport costs and the CO2 impact of sea and road transport from the supplier to the islands.
Combined Heat and Power (Micro-Generation)		Combined heat and power uses a fossil fuel such as diesel or gas to run an engine to drive a generator which in turn produces electricity. The unit then recovers and uses the heat normally wasted by the internal combustion engine, gas turbine sterling engine or other motive power to produce hot water, space or process heating. These systems require a reasonably stable base heat load and long run times to be at their most efficient. For Mundesley there is no reliable base heat load and therefore the system would not run efficiently. These systems are therefore ruled out for this project.

District Heating		These systems use a single point of heat generation or a number of heat generators serving a district heating ring to heat a number of buildings on a site without the need for dedicated plant in each building. There are economies of scale in such systems but there are also heat losses from the distribution pipework to consider. Systems such as these are often favoured on sites such as military bases where multiple plant rooms feeding the circulation mains also offer a high degree of resilience to the heating within the buildings served. If the building was located closer to other Council owned properties such as the Town Hall and Park House, district heating using a central plant room may be an option but in this case, the distance and potential benefit from centralised plant would be far outweighed by the costs and heat losses of installing heating mains from the Town Hall to Mundesley. On that basis, District Heating should be ruled out for this project.
Heat Pumps (Air, Water or Ground Sourced)		Among the most efficient energy sources currently available in the market and more affordable than many others. Heat pumps use electrical energy to “extract” heat energy from the air, water or ground. A Coefficient Of Performance of up to 4 means that for every one unit of electrical energy used, there is a potential output of 4 units worth of heat energy. These systems require careful design and integration with the heating systems and are better linked to heating systems that require a low grade heat such as underfloor heating. It should be noted that the lower the output flow temperature from the heat pump can kept, the higher the COP is likely to be. For Mundesley, these systems are impractical as there is insufficient space on site to provide ground coupling for Ground Sourced Heat Pump. Air Sourced Heat Pumps could be located in the garden and suitably screened for visual intrusion and noise. The site however has a limited electrical supply and the demand of the heat pump would likely take a significant proportion of the available capacity. In addition as heat pumps need to deliver lower flow temperatures than traditional boilers in order to remain efficient, larger emitters are required to deliver the heat inputs to the spaces. This will increase the space required for radiators in every room and they will never feel “hot” as they would from a traditional boiler. Retrofitting of underfloor heating which is much more suitable for use with Heat Pumps, although possible would be exceptionally disruptive and very costly. The final consideration would be noise from the external heat pump unit in a residential area. Heat pumps are not recommended for this project.

Wave and Tidal Power		Although a renewable and therefore mentioned for completeness, wave and tidal power is generally large scale and feeding into the national grid rather than for more local use. The only exception to this may be where a premises is located close to a river or mill stream where a water wheel or small scale hydro plant could be considered for connection to an onsite generator. This would however be an exceptional installation and rare for developments of the type under consideration.
The Fuel Cell		An electrochemical cell that converts a source fuel into an electrical current. It generates electricity inside a cell through reactions between a fuel and an oxidant, triggered in the presence of an electrolyte. The reactants flow into the cell, and the reaction products flow out of it, while the electrolyte remains within it. Fuel cells can operate continuously as long as the necessary reactant and oxidant flows are maintained. These have been historically used in spacecraft but are gaining ground in more terrestrial applications such as cars and Off- Grid Power supplies. It is not believed that they could be used here and are ruled out.
Rain Water Recovery		Recovery and storage or rain water run-off from south facing roofs which is stored in underground tanks and then pumped to end user points using a small pressurisation set or submersible pump located in or adjacent to the tank. Common uses include toilet flushing or wash down facilities as may be applicable on this development. Whilst not strictly a renewable energy technology in itself, recycling rainwater decreases demand for water to the site which in turn reduces the energy required at source to produce and deliver potable water. The benefit is therefore one step removed, but still beneficial to the environment when considered holistically. Other than toilets, Mundesley has a water demand for showering and cooking, neither of which could be supplied from stored rain water unless filtered and suitably purified. An underground tank could be located in the garden with a pressure pump in the tank delivering water on demand via the treatment system, or a header tank fitted in the loft with water pumped up from the underground tank and then systems gravity fed from this point. Any implications on water system head and delivery pressure for showers etc could be met by fitting a pressure pump on the tank system downfeed. There would be significant management implications for rainwater use other than for WC flushing and would also require substantial alterations to internal pipework within the building to accommodate the purified rain water main. It is not believed that the cost of

		installation, maintenance and running can be justified by the saving made in mains water and for this reason it is suggested that it be ruled out.

6. Proposed Works

The entire heating system and central hot water generation should be replaced.

Based on the site inspection and consideration of the various options as noted above, it is believed that the existing arrangement of direct oil fired heating is likely to provide the most economical solution in terms of installation and ongoing use.

Other technologies whilst they have their advantages also provide significant installation issues in terms of space or practicality.

The caveat to this would be the use of Solar Thermal to generate hot water. There is benefit to this and it should be considered as part of the design and tender even if budgets later dictate that it be removed as a value Engineering saving.

Biomass may be possible only if the planning concerns of a packaged plant located to the front of the building can be addressed and there is potential for providing cost reduction by obtaining the Renewable Heat Incentive. However, previous experience on Porthmellon showed a reluctance by the Grant Funders to issue such tariffs to the Local Authorities with preference being given to companies and private individuals.

A detailed performance specification or fully detailed design for the system as yet to be agreed with the Council shall be prepared which shall be developed into an installation design taking account of all risk areas and the relevant Educational Building Bulletins for residential accommodation and Building Regulations.

In general the system shall comprise the following main elements:-

- Boilers (or renewable technology)
- Pumps
- Pressure Set
- Pipework
- Emitters
- Hot Water Generation by new calorifier fed from the Boiler.
- New Building management system

The system shall be zoned by the use of control valves and simple Building Management to serve the following areas independently:-

- Zone 1 Dormitory Block Ground floor
- Zone 2 Dormitory Block First floor
- Zone 3 Communal Area
- Zone 4 House Parents flat
- Zone 5 Rental Flat Ground Floor*
- Zone 6 Rental Flat First Floor*

It may be beneficial to remove the link to the two rental flats from the Mundesley boiler plant and serve them independently with their own heating if they are to remain as independent units.

Currently there appears to be no method of re-charging the occupants for the heat used or to allow them any degree of control other than switching it off in their areas. There is still however heat being emitted in their areas from the single pipe loop.

Any newly designed system would be able to offer a greater degree of control than that presently available, however any heating derived from the central boiler will still be dependent upon the main plant being in operation.

Should the areas revert to use by Mundesley as has been suggested, retaining them on the central plant but providing zone control would be the better option.

If the areas are to be permanently let to private tenants, a simple electric heating system in each space using panel heaters or storage in the main living rooms and panels in the bedrooms should be considered. Boiler plant is not practical as it will involve locating additional dedicated oil or LPG tanks/cylinders on what is an already constricted site.

An alternative will be to fit heat meters to each flat such that the actual heat energy used can be monitored and a charge per kWh of heat agreed. This does however require management either by Mundesley or by the Council and an appropriate billing and charging mechanism established.

7. Electric Heating Alternative to Oil

It would be possible to consider an alternative heating method to oil. This would involve the use of on peak electrically operated convector heaters/panel radiators.

From an installation and ongoing maintenance perspective, this is potentially a cheaper solution than oil but will also require electric heating of the water currently heated from the main boilers.

The building has a three phase electricity supply entering via the hallway. This is rated at 100A/phase but WPD generally rate this size of supply at approximately 60kW. Checks will be required with WPD not only to assess what they have allowed on the incoming cable but also what capacity is available in the local network to add a significant heating load.

It is possible that when considering that the boilers are delivering nearly 80Kw of heat load into the building space heating and hot water, that this will immediately use all of the presently available supply capacity and will require an upgrade to the incoming cable and metering to serve electric heating. This element alone could be a significant cost especially if any external network reinforcement is required.

Running costs of electrical systems are also significant especially with the present trend of lower oil prices. That is not however to say that this trend will be maintained and as is often the case, all fuels will fluctuate.

To install an electrically operated system, works will include a new mains intake with the supply upgraded to suit, new distribution to serve both existing circuits and the new heating.

Wiring run to each heater position with controls installed and linked to provide zone control of each area.

BMS control will still be possible and some degree of optimisation.

Local control in each space will also be possible by the use of room thermostats which should be tamperproof in dormitory type rooms and communal areas and set at commissioning.

Flats and House Parent areas can be more user friendly and available for adjustment by the occupants.

8. Installation Costs - Oil Fired System

The costs noted below are a budget estimate only, based on industry standards including SPONS Price guidance. They will fluctuate with the Contractors tenders and any specific requirements.

Note that costs for works on the islands will be higher than those on the mainland due to increased transport and labour costs. These have been factored in within the costs given but until a tender exercise is carried out, the costs cannot be confirmed in detail.

To replace the existing system with a new oil fired wet system throughout the building including all zoning and sub-zoning of new emitters, new BMS and controls, new Hot Water Generator and commissioning:-

£65,000.00

This cost does not include builders work or making good to the building fabric for which a further sum of **£7500.00** should be allowed.

Note that existing hot water service pipework through the building is retained and re-used. If any defects are found during the works, there may be additional cost to rectify these defects.

Solar water heating if added to the scheme as part of the overall package would cost in the region of:-

£4500.00

If Biomass is still to be considered this may add a further **£200-250 per kW** to the above prices based on a standard installation. Normally for this project the extra over cost would be in the region of **£22500.00.**

As packaged plant is likely to be the only option due to space constraints in and around the existing plant room, the costs will be significantly higher and may well add closer to **£50,000.00** by the time builders work, planning fees and associated costs are added.

9. Installation Costs – All Electric System

As previously suggested this system will be significantly cheaper due to the lack of central plant.

It is estimated that a basic electrically operated system with point of use heaters and no zoning will cost in the region of:-

£20,000.00

With BMS and zoning Control this will rise to approximately

£28,000,00

An allowance for WPD supply upgrading and network reinforcement cannot be ruled out and a further sum of **£5000.00** should be allowed for this.

The builders work sum above should still be included as there will be making good to carry out and there will still be a requirement to lift floors and chase out for wiring as would have been the case for a wet system.

It can therefore be seen that the electrically operated system will represent a lower capital cost and may be easier to maintain using island based resources, but in terms of ongoing running cost it is likely to be more expensive than the equivalent oil fired system.

Note that the heating units used cannot be the most basic and cheap as found in many electrical wholesalers. The surface temperature of these panels is such that scald risk is high.

It will be necessary to select a low surface temperature unit particularly for the spaces occupied by the children.

Electrical heaters used in bathroom and WC spaces will be IP rated and suitable for use in wet environments. These will again be protected or of a type where scald risk is minimised.

10. Potential Running Costs

The running costs for the revised system are likely to be similar to that presently installed, but more likely to be lower due to better control and zoning.

It would not be unreasonable to expect savings of 10-15% on the present bills due to not heating areas when not required and optimising control both overall and at room level by the inclusion of room Thermostats and Thermostatic Radiator Valves.

More efficient modern boiler plant and effective weather compensation will further increase the savings.

Further savings and a reduction in plant capacity could be effected if the rented flats were provided with their own systems thereby reducing the energy used by Mundesley.

Until the actual heating profile is established and the scope of the scheme agreed as to what parts of the building will remain on the central plant and whether solar heating is to be included, it is not possible to place actual figures on the running costs, as all of the above will have an impact.

The costs can only be assumed at this stage and may vary significantly when in use if the profile is different to the assumptions made.

11. Conclusions

The system as it stands is in poor condition, unreliable, inefficient and elements are beyond life expiry.

The report concludes that a complete replacement is the only way forward and that this replacement will address all the issues noted with the present scheme.

Any new project must seek to provide proper zoning and control such that the use of the building is flexible and areas only heated when required.

Renewables may be included but the scope for these is limited. It is likely that only solar thermal hot water generation will be practical. The information tabulated above explains in detail why technologies may or may not be suitable.

The most suitable and economical heating method will be to remain with the oil fired system as presently fitted.

This however has a higher capital cost than an electric based system.

Electric heating has not been recommended as there is the ongoing running cost to consider.

That is not to say that the system cannot be made economic by proper zoning and control and this will be essential if the electric option is to be considered further.

Maintenance and breakdowns must also be considered and it is likely that there will be persons on the islands with experience of electric and oil fired systems who will be able to maintain them easily. Other technologies such as the Biomass and heat Pumps etc may require expertise to be sought from the mainland with the associated delays and increased costs.

All departures from good practice and current standards shall be addressed as part of the new scheme and it shall be certified on completion as compliant with all relevant standards and the specification.

End of Report
IQ Engineering Consultants Ltd
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