

HEATING REPORT

at

**ST. PAUL'S CE CHURCH,
EDENFIELD ROAD,
NORDEN,
ROCHDALE.
OL12 7SL.**

Prepared by;

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SECTION 1

PURPOSE OF REPORT

The purpose of this report is to act on the instruction given by the The PCC of St. Paul's CE Church, Norden as per the e-mail confirmation from the Church Warden – Andrew Mawson, dated 31st January 2024 for this report to provide the following Consultancy advice in relation to the Heating Services serving & within that Church.

Services to be provided:-

Mechanical Services;

- (i) Assess the heating & energy characteristics of the building
- (ii) Examine the condition, performance & capability of the present heating system in relation to the heating requirements of the building.
- (iii) Make appropriate recommendations in relation to the proposed replacement heating scheme

SECTION 2

BASIS OF REPORT

The basis of this report is as follows:-

- (i) Survey of the building and heating services by John Book on 11/01/2024
- (ii) Issue of drawings from the Parish's Architect – Richard Storah.

SECTION 3

HEATING SERVICES

The Church is currently heated by a low pressure hot water heating system from a gas fired heating plant located within the existing basement boiler room, located below the Vicar's Vestry at the South East corner of the Church. It should be noted that the pipework from the boilers leaves the boiler-room into the floor voids within the Church itself.

The boiler plant contains 1No. boiler to serve the Church space, and that this is an Ideal Concord C330 having a rated output of 96.7kW. The boiler-plant is served from an internal gas supply pipe and internal gas meter located within the boiler-room.

Heat is distributed from the boiler via a circulation pump system. The pipework distribution system has been installed on the design basis of what is known as a two-pipe flow & return system.

There exists a set of flow & return pipework systems which runs from the boiler location into the floor void below the Church floor itself from where circuits rise to above ground floor level on the North & South walls of the Nave to serve exposed 3" cast-iron pipe coils, whilst on the front and rear pews there are a number of steel panel radiators and 3" cast-iron pipe banks. In addition to the foregoing there has been a number of steel panel radiators around the perimeter walls.

The boiler plant appears to have been installed at least some 38 years ago and is certainly well beyond the normal 20/25 year life expectancy for this type of boiler. The existing heating circulating pump appears to be operating satisfactorily along with the existing feed and expansion tank system which is located at high-level in the Vicar's Vestry.

The boiler plant is flued conventionally through via an asbestos cement flue & flue liner into an existing chimney stack arrangement which terminates above the Vestry roof level.

It is worth noting that, other than the boiler, this is the original heating system and which would have initially been served with a coke fired boiler which would have been allowed to run for 24 hours per day, 7 days per week all though the heating system with a view to providing a constant temperature of 12degC.

Control of the heating system is made by a Randall 851 time programmer, located within the Vicar's Vestry, with a Satchwell room thermostat within the Chancel area.

Energy characteristics of the existing system;

The heat loss from the Church building is currently assessed as being 75kW.

The heat emission surface from the cast-iron pipe loops and pipe bank radiators within the Church is calculated as being able to produce 47kW.

It can therefore be seen that the existing boiler which has a total rated output of 96.7kW is over-sized for maintaining the full heat output required from the installed heat emitters within the Church, and indeed the actual required heat loss of the Church, which leads to large standing losses and poor operating efficiency. Furthermore the use of large bore cast-iron pipework systems within a Church like St. Paul's also requires a large amount of energy to heat the water content within the system, even before any heat is given out from the pipe emitters, which again gives poor operating efficiency. I think it can be seen from the above figures that whilst the original cast-iron pipework system would have been designed only to provide for 12degC, that the addition of the latter steel panel radiators would only appear to be capable of providing 14degC at 0degC external ambient.

Whilst it can be seen that the output from the existing heating system serving the Church itself is only 63% of the calculated heat loss it should be pointed out that the calculated heat loss is based on a room temperature of 18°C (65°F) at an external ambient of 0°C (32°F). It should therefore be appreciated that the output from the system would have only been designed based on what the original heating system consisted of, which was only to be capable of providing an internal temperature of 12°C (54°F) at an external ambient of 0°C (32°).

A further consideration of the above outputs is that these are based on the normal operating temperature from a low pressure hot water heating system, ie. 82°C (180°F) flow and 71°C (160°F) return, and hence it is more likely that the temperature within the Church from the current installed system would not exceed 14°C (57°F) at an external ambient of 0°C (32°).

Condition of the existing system;

The condition of the existing heating system is considered to be quite reasonable for the age of the system, and whilst no leakage appears to be evident, there is evidence that various pipework leaks have previously occurred to some of the existing cast-iron pipe changes to steel within the boiler-room connections.

It should be pointed out that no inspection of the pipework below floor level was possible.

The life expectancy for the boiler plant is likely to be in the order of 20/25 years from the date of installation, and hence it is clear that as the existing boiler-plant will be due for replacement almost immediately, however before that can happen the removal of the asbestos based material within the boiler-room must be dealt with.

Requirements for a Church heating system;

A Church heating system must be capable of not only providing 'warmth' to the congregation but must also be able to be used to assist in the condition maintenance of the Church fabric & fitments. The assistance towards condition maintenance of the Church fabric & fitments is made by trying to ensure that the internal surface temperature of the structure is slightly higher than the external surface temperature. This helps to prevent interstitial condensation within the fabric construction and hence damp and stale/moisture laden air within the space. It is thought that the use of the existing controller will adequately provide for good control of the heating system by ensuring that the Church is currently not allowed to become too cold by maintaining the internal space at a temperature not less than 12degC.

Existing System Considerations;

From the survey & report perspective the following points should be worth noting:-

- (i) It should be recognised that the heating system is only capable of providing 'warmth' conditions rather than true comfort levels, however it is felt that due to the age and construction of the building it is felt that these lower temperatures do provide some benefit to the maintenance of the Church both in terms of fabric condition and in making the space reasonably comfortable to worship in, although with only one boiler running it is likely that the system may have to run for longer periods of time.
- (ii) System operating efficiency & conditions provided within the Church are paramount for consideration and perhaps it would be worthwhile to again point out that in addition to the current boiler being over-rated for the installed heating system, plus the fact that the existing system is not capable of providing recognised comfort temperatures within the Church, then the overall efficiency of the existing heating system is very low.
- (iii) It should be noted that the existing incoming electrical supply is a 3-phase supply with this being fused at 100amps per phase at the point of entry, however currently there is only a single phase being utilised.
- (iv) For reference purposes, please see the apportionment of the heat loss from the various elements of the building as follows;

Air heat loss	-	19%
Heat loss through windows	-	12%
Heat loss through walls	-	27%
Heat loss through roof	-	31%
Heat loss through floor	-	11%

Heat Source options available to consider;

The following 2-stage considerations are being proposed but the recommendations are being made on an eventual complete replacement heating system basis due to the current inefficient boiler system and the existing large-bore one-pipe heating system. Clearly for the consideration for replacing the existing heating boiler we need to consider what options are available to us, as follows;

- a) Direct gas fired boiler replacement – normal life expectancy 20/25 yrs
- b) Electric boiler replacement – normal life expectancy 15/20 yrs
- c) Biomass boiler – normal life expectancy 20/25 yrs
- d) Air source heat pump – normal life expectancy 15/20 yrs
- e) Ground source heat pump – normal life expectancy 15/20 yrs
- f) Hybrid System combining Boiler & direct electric radiant system 20/25 yrs
- g) Hybrid System combining both ASHP & Boiler System 20/25 yrs

Direct Gas Fired Boiler Replacement:-

This option would certainly be the most economical one of the options for a conventional boiler replacement to be carried out by utilising a modulating form of ‘Hydrogen Ready’ gas boilers, which would modulate to meet the actual heat output temperatures at varying times and at varying outside ambient temperatures. The use of these types of gas boiler system is likely to show a small improvement in running costs to that what is currently being experienced, in the order of 10%, even though the new boiler plant operation is likely to show a 50% increase in efficiency from the existing boilers. Clearly these savings on running costs would only be further improved if a new low water content system was to be provided. For the avoidance of doubt the existing gas boilers are only likely to be 45% efficient, whereas a new boilers would have an efficiency of 90%, therefore would reduce the current carbon generation by one half. A further point to consider is that as we are currently being advised that a 20% hydrogen gas mix should be available within the next 5 / 6 years, then this will further reduce the carbon being generated, when this may be introduced into the National Grid system

A budget cost indication for this work would be in the order of £24,500.

Electric Boiler Replacement:-

Whilst this option currently exists to replace the gas boilers with electric boilers which would reduce the carbon footprint slightly, the fact that these currently only operate at 100% efficiency, ie. meaning that for every kW of heat produced you would use 1kW of electricity, this therefore means that as electricity is currently more expensive than gas, then this would be an expensive option to run.

A budget cost indication for this work is not being considered as a boiler plant of this nature would be unaffordable to run, plus the existing incoming electrical supply which is 100amp 3-phase, and which would have a capacity of approx., 60kW, then this does not have the capacity to run this type of electric boiler system.

Biomass Boiler System:-

A biomass boiler installation to replace the existing boiler system would be a possibility to consider but would entail high initial capital costs, and whilst the Government's Renewable Heat Incentive (RHI) Scheme closed in March 2021, then there is no incentive other than carbon reductions to consider looking at this option. However there are a couple of issues with considering biomass for you (i) it is unlikely that you would be able to provide the space for fuel storage, and (ii) fuel delivery would be a problem

A budget cost indication for this work is not being considered as a boiler plant of this nature would not be possible to be provided for.

Air Source Heat Pump System (ASHP):-

An air source heat pump (ASHP) system utilises some externally located 'condensers' which you are likely to have seen previously serving an air-conditioning system. These units simply utilise an electrical supply and the type of ASHP we would be looking at using is known as a Air to Water heat pump, which extracts heat from the air and injects this into the water based heating system. The difference between an air to water heat pump and a boiler is that an air source unit will not get the heating water at as high a temperature as a boiler, which would mean that ASHP's are more suited to underfloor heating or a type of heat emitter which can operate with lower water temperatures. However a range of higher temperature heat pumps is now being made available, although the existing electrical supply would still not be adequate enough to support a total ASHP system delivering some 75kW of heat

A budget cost indication for this work would be in the order of £70,000 (includes external condenser units and internal heat packs, but excludes a possible electrical supply upgrade required to source a full ASHP system)

Ground Source Heat Pump system (GSHP):-

This type of system (GSHP) is almost identical to what has been described above for an ASHP, the only difference being that ground loops or boreholes would have to be installed in the adjacent land and the performance from a GSHP is more reliable than an ASHP as ground temperatures do not vary as much as air temperatures do, although we would share the concerns of this type of plant on the existing system, as indicated for the ASHP, along with the existing running periods required.

A budget cost indication for this work is not being considered as the costs required for either boreholes or an extensive amount of land would not be affordable.

Hybrid System combining both ASHP & Boiler System:-

This type of system as an option is currently being utilised in some Churches whereby a ASHP system would only be used for supplying heating to achieve the background temperature level of 10/12degC within the Church, but has the capacity from gas supplies to support a boiler source which can be used to top-up the heating temperatures required upto say 16 / 18degC.

With regards to St. Paul's Church, it is clear that the existing electrical supply would only be capable of supplying a partial ASHP heat output system and therefore the top-up boiler would be a hydrogen ready one.

A budget cost indication for this work would be in the order of £49,000.

Hybrid System combining direct electric heating & Boiler System:-

This type of system as an option is currently being utilised in some Churches whereby a boiler system would only be used for supplying heating to achieve the background temperature level of 10/12degC within the Church, but then a system of electric direct radiant form of heating could be used to provide direct warmth to the congregation when required for the Worship Service times in different areas at any time.

With regards to St. Paul's Church, it is clear that the existing electrical supply would only be capable of supplying a limited form of direct electric heating, possibly within the side aisles and Chapel areas, with the remaining wet system being served by a hydrogen ready gas boiler.

A budget cost indication for this work would be in the order of £63,000.

HEAT EMITTER OPTIONS AVAILABLE TO CONSIDER;

There is no doubt that the best method of heating a Church is by the use of a radiant form of heating, and again whilst the best form of radiant heating is the use of an underfloor heating system, these are only affordable if works are already being contemplated to the floor itself, such as the removal of pews, plinths, etc., and the lifting of the whole floor for replacement with some new level deck floor construction which can incorporate the underfloor heating pipework and insulation required. Whilst the cost of the underfloor heating installation would be no different to that indicated below for the radiator installation, if no works were being considered to the floor then you would need to at least double, if not treble the radiator cost to be able to considered providing an underfloor heating system. Incidentally underfloor heating systems are ideally suited to the use of heat pump systems, both ASHP & GSHP types.

Hence the only other real recommendation which I would make, which is common to all of the foregoing heat source options would be to try and reduce the water content of the heating system by replacing the existing large bore pipework system.

As can be seen from the predicted heat output from the existing heating system with the poor operating efficiencies being identified it would be necessary to install a new smaller bore steel pipework system with new high-efficiency heat emitters to be able to achieve full efficiency in operation and more acceptable comfort conditions. It is likely that the new system would comprise of new high efficiency radiators and steel finned element pipework to be provided in identical locations to what currently exist, ie. with radiators on the North wall of the Nave, on the front & rear pews, in the Vestries, in the Chancel, and at the West end of the Church, with steel finned element pipework being currently proposed on the South wall of the Nave. The budget figure indication for a replacement heating system on this nature, in addition to the heat source costs would be in the order of £42,000.

If the option was to have a gas boiler providing the background heat via a new system of radiators, but with the use of electric direct radiant heaters within the Side Aisles & Chapels, then the budget estimate for the radiator installations would be £38,500 and the cost of the electric heaters would be in the order of £24,500, thereby giving a similar overall cost consideration of £63,000.

Running costs are likely to be reduced by some 10% with a new heating system but at least the temperatures being provided would be more comfortable than those at present, whilst the reduction in carbon being generated from the use of these systems would be a valuable step to be taken in assisting carbon reduction in line with the Church of England's aspirations in becoming carbon neutral by 2030.

Note !

The figures make no allowance for dealing with any asbestos material related matters and it has been assumed that the Church has already been provided with an asbestos certificate showing that it would be safe to work in all areas of the Church particularly the floor voids and boiler-room. Professional Fees and VAT need to be added to all costs indicated, and therefore for assessment purposes 15% & 20% respectively will need to be added to the above figures, although the 20% VAT will be able to be reclaimed through the Listed Places of Worship scheme.

Considerations for the provision of Solar PV panels;

Clearly one of the common points for Church buildings is that generally one aspect of the roof is usually South facing, and hence ideal for locating Solar PV panels on, providing that the roof structure is suitable for such an installation to take place. Solar PV panels generate electricity and can assist in reducing electricity taken from the grid supply. However as this electricity will be generated at times when the Church is not in use, then the benefit in use of these systems would have been taken from the export of electricity with the Feed-in-Tariff, but unfortunately that scheme is no longer in place and monies paid for such export by electrical suppliers is minimal and does not really contribute towards the installation costs. Furthermore the actual suitability of the mains electrical supply into the building is crucial to be able to connect such PV systems into, and whilst fortunately the electrical supply into St. Paul's Church is of a reasonable quality, a budget cost consideration of £31,500 can be indicated for the provision of a 36No. roof PV panel system that would have the facility to generate 13.86kW, which would of course be very useful if an ASHP 'hybrid' system option was to be used as this would require an electrical supply of 18kW.

It should however be pointed out that full Planning and Building considerations would need to be carried out regarding the suitability of the roof construction prior to trying to gain Approval for the installation of such panels on the roof of this Church, and this would have to be undertaken by the Church Architect / Building Surveyors.

Status of St. Paul's and space usage;

It is important to recognise that the Church of St. Paul is a Grade II Listed building, and has occasional daily uses and therefore the heating is 'on', only on the days required. **The purpose of the heating is therefore both for conservation reasons as well as comfort reasons.**

SECTION 4

RECOMMENDATIONS;

The first stage in the decision making process would be to decide whether the Parish are satisfied with the level of temperatures being provided by the existing heating system itself, or whether they may require slightly higher temperatures provided, ie. from say 14degC to 18degC.

If the answer was to be that the temperatures provided by the existing system was satisfactory then I think my advice would be to simply replace the existing gas boiler with a new hydrogen ready one, and leave the existing heating system in place until such time as it starts to fail and needs replacement. The budget cost for this work would be in the order of £24,500 +fees, +VAT. It should be pointed out that whilst new replacement boilers are likely to reduce the carbon generated by approx., 50%, that if a new system was to be eventually provided then these boilers could remain as part of a new 'hybrid' system with ASHP's, which would then further reduce the carbon generated.

If the answer is that there is a requirement to provide enhanced space temperatures then clearly there would be 2 options to consider, ie. (i) a hydrogen ready gas boiler and new radiator system at a budget cost in the order of £24,500 + £42,000, plus fees & VAT, or (ii) an ASHP / Hybrid system with appropriately selected types of heat emitters, at a budget cost in the order of £49,000 + £42,000, plus fees & VAT.

The above costs make no allowance for carrying out an asbestos R & D survey, if one isn't already in place, or any possible remedial works that may be found to be necessary.

The heat source to serve the new Church heating system needs some careful consideration, with a view to possibly looking at installing one of the 'hybrid' systems with a ASHP & hydrogen ready gas boiler, interconnected to serve the heating circuits, with the overall total budget cost assessment of £91,000 for the ASHP & Boiler system. It is clear that whilst this would provide a reduction in carbon generation, it is unlikely to reduce the running costs, from that which would be provided from the use of the existing gas boiler system, and could possibly increase to achieve more comfortable conditions, along with fabric protection. The reason for this being is that the current gas rate is at only 5.03p/kW, whilst the electricity cost is 25.37p/kW (average).

As an indication in the likely annual running costs for the hybrid systems, it is estimated that these could be as follows;

- | | |
|--|----------|
| 1. ASHP & gas boiler with new heating system | = £4,566 |
| 2. Estimated existing gas heating costs | = £2,834 |
| 3. Estimated existing electrical costs | = £ 714 |

As an indication in the likely annual carbon generation for the hybrid systems, it is estimated that these could be as follows;

- | | |
|--|------------------------------|
| 4. ASHP & gas boiler system
(this is for full system usage) | = 11.7tonnes CO ₂ |
| 5. The existing heating system
(this is for the only partial usage) | = 19.6tonnes CO ₂ |

It would therefore be my recommendation to consider running with the ASHP & gas boiler system option as this would appear to have the lowest of the two hybrid system running costs and carbon generation emissions.

Hence it can be seen that the overall likely expenditure to provide the new Church heating system with the ASHP & gas boiler system with new heat emitters would be £91,000 plus fees and plus VAT. Depending on what grant funding schemes that you may be looking at applying into, you may also wish to add the solar PV panels to this sum at £31,500, which whilst giving you a new overall total of £122,500, would actually be greatly reducing your running costs and carbon generation further significantly.

Clarification note regarding fees;

As an indication for fees based on the initial likely option to be taken, ie. the replacement of the existing gas boiler with a hydrogen ready gas boiler system, it can be seen that as the indicated budget costs for this would be £24,500, then based on the 15% fee requirement then this would indicate a fee of £3,675.00p +vat.

The fees required for the heating system replacement based on the £42,000 value would be £6,300.00p +vat.

If a whole 'hybrid' ASHP / boiler system was to be progressed alongside a completely new heating system then the fees for this based on £91,000 value would be £13,650 +vat.

I can confirm that I have already indicated that the fees being paid for this report at £700 would be considered for being offset against any further fees incurred, and also no 20% vat needs adding to my fees as my Private Practice through which I do all my Church works through. Hence whilst I would be prepared to offset the total £700 off a complete hybrid & new system scheme, which would reduce that fee down to £12,950, I would also offer a further reduction on that fee down to a fixed sum of £10,500, which would be split at £7,350 upto the design & tender stage and £3,150 on completion of the works.

If just the boiler replacement works were to be carried out I would omit part of the £700 fee which would indicate a net lump sum fee of £3,500. This fee would be applied for at £2,450 on completion of tender stage, and £1,050 on completion of the works.

I have not indicated any further fee considerations for the heating system alone or the possible solar PV scheme, as that would not seem to be appropriate at this time.

I would clarify the purpose of paying a fee is to not only prepare a specification and any drawings required for DAC / Faculty considerations, but also to obtain competitive tenders from 3 or 4 recognised Church Heating Contractors, and hence the costs of the fees is normally recovered against savings made from this competitive tendering.

Furthermore if you are looking at approaching any grant funding bodies to assist in the financing of these works, then it would be a requirement that they would also require sight of at least 3 tenders plus the specification and design drawings prior to considering such funding, hence it should be pointed out that your initial fee expenditure commitments for a total heating plant & system replacement would be the £7,350 fee upto tender stage for this, plus of course the current £700 fee payable for this report.

I am able to advise you that in terms of possible grant funding, that after carrying out a postcode check for St. Paul's, that you do fall within the boundary for consideration by both Valencia & Suez Community Waste Management funds, that I have successfully applied to for heating replacement heating systems, where we have obtained what equates to 80% of the overall costs, whilst VAT can of course be reclaimed under the Listed Places of Worship Scheme. In terms of applications for these funding streams, they normally meet every 3 months and that you then normally get a decision within 3 months of those closing date submissions

In addition to this of course there are other bodies such as the Benefact Trust who support heating replacement with new technology systems, but you may also obtain further advice on this from the Manchester Diocese.

I think it is again important to recognise and point out that the heating system required for this Church does need to satisfy both the Conservation requirements and Comfort level requirements, which in my opinion can only reasonable be provided by a wet system of heating previously detailed, and supplied via a 'hybrid' ASHP / boiler plant.

CHURCH of ENGLAND'S GUIDANCE NOTES

Hydrogen (extract from - ChurchCare Advice and guidance for church buildings)

The Faculty Jurisdiction (Amendment) Rules 2022 require churches to obtain permission for any gas-for-gas or oil-for-oil boiler replacement; hydrogen and Hydrotreated Vegetable Oils (HVO) have been cited as an alternative to gas and oil for like boiler replacement.

The obvious appeal of hydrogen is that it does not release CO₂ when burnt and that it can be made from water, an almost limitless resource.

Hydrogen is produced commercially by separating the hydrogen from water in a process called electrolysis. For hydrogen to be considered "green", electricity from renewable sources has to be used to electrolyse the water. There are three forms of hydrogen commercially available; only **one** is green, and most of the world's hydrogen is currently manufactured using fossil fuels.

Generating electricity from wind or solar, converting it into hydrogen and then burning the hydrogen at home uses more energy than just using the electricity to directly heat a home, with a heat pump.

“Heating homes in the UK with green hydrogen would use approximately six times more renewable electricity than heat pumps. We do not have the time or resources to waste further investigating hydrogen's role in home heating, especially when the well-known laws of thermodynamics determine the answer.” Second National Infrastructure Assessment

It seems likely that any future use of hydrogen will be limited rather than universal. It is likely best suited to applications or places that are hard to electrify – in the main, transport-related. This limited—rather than universal—use of hydrogen should inform our decisions.

The Church Buildings Council concludes that hydrogen **is not** likely to be practically and economically viable for use in the short and medium term for heating churches.

Hydrogen as a potential future fuel has **limited rather than universal uses**. It is highly unlikely that hydrogen will play a role in achieving the Church's Net Zero Carbon goal by 2030. Distribution and storing hydrogen presents significant safety challenges making it more suitable for use in regulated commercial settings.

The limited, rather than universal, use of hydrogen should inform design choices for heating systems. A new replacement boiler being hydrogen-ready will not make a meaningful contribution towards a shift to net zero.

Hybrid boiler systems (advice from the Environmental & Sustainability Office – Cathedral and Church Buildings Department).

The main message is, **consider hybrid or bivalent solutions where there is no one technology suitable.** Sample of one passages below.

Hybrid boilers are now marketed by heat pump manufacturers, they combine an air source heat pump with a conventional gas boiler. This approach can be achieved without the need for a manufacturers solution if designed and installed correctly. Here the heat pump is designed to operate efficiently and is adequately sized to meet the energy demands for most days of the year, with the “top up boiler” typically a gas boiler providing top up energy (heat) on days when there is a high demand for heat, i.e. very cold winter days. **Hybrid solutions are not a zero-carbon solution because they still use some natural gas or oil so they should be considered as a *transitional* approach.**