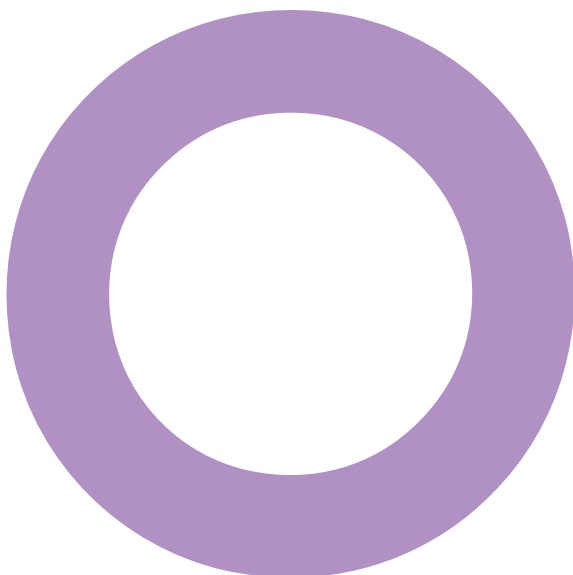


**Project RED Electrical
Infrastructure.
Manchester Royal Infirmary
Hospital.
Manchester University NHS
Foundation Trust.**

MEP ENGINEERING

ELECTRICAL INFRASTRUCTURE FEASIBILITY STUDY

REVISION 2 – 07 MAY 2021



Inside front cover

Audit sheet.

Rev.	Date	Description of change/purpose of issue	Prepared	Reviewed	Authorised
1	27/04/2021	First Issue	NV/SM	IH/PB	IH
2	07/05/2021	Updated Executive summary, sections 5.2, 5.3, 5.4 Tables 3 and 4 omitted, Drawings updated in Appendix 3 and 4	NV/SM	IH	IH

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Executive summary

In parallel with the Project RED scheme, a power study of the existing infrastructure has been undertaken by Sigma RJ. Further to the Sigma RJ study, it discounted the use of the existing roof mounted substation DSS170 for supplying Project RED. Hoare Lea have undertaken this electrical infrastructure feasibility study to review the options for providing new electrical distribution for the site.

The feasibility study considers various options with the selected option to be progressed as;

Option 2 is the provision of an electrical infrastructure scheme to serve Project RED New Build, ED Refurbishment, theatres 1 – 12, including RED/ED Refurb chillers and Phase 1 and 2 chillers, plus the addition of the Wellcome Centre building.

This option is to develop electrical distribution compound area adjacent to the Wellcome Building and with the aspiration of improving access to the ED refurbishment.

This allows the existing Wellcome building substation DSS110 and generator to be decommissioned. In additional adjacent DSS230 substation supplying the Phase 1 and 2 Chillers is to be decommissioned.

The electrical distribution compound area;

- Generator A
- Generator B
- Generator for Chillers
- central bulk fuel tank for the Generators
- Electrical distribution accommodation.

In addition, the compound also accommodates the new medical gas room for Project RED/ED Refurbishment and the relocated existing Wellcome Building Chiller.

The electrical distribution accommodation in the electrical distribution compound area, comprises a ground level with upper level.

The developed electrical infrastructure scheme for the main electrical distribution A and B supplies is in line with HTM06-01 to provide dual primary and secondary supplies with an N+1 arrangement.

The developed electrical infrastructure scheme for the chiller supplies is to provide single primary and secondary distribution.

The proposed HV Distribution for the electrical infrastructure associated with Project RED new build, ED refurbishment and theatres 1 – 12 will utilise both HV RING 1 and 4, in order to provide dual primary supplies as HTM06-01.

The proposed HV Distribution for the electrical infrastructure associated with RED/ED chillers and Phase 1 and 2 Chillers will utilise HV RING 2.

Options for the LV cable routes have been developed with Options C and D regarded as the preferred options.

- Option C - Cables run externally within ground and within the existing PFI hospital basement
- Option D - Cables run over the PFI hospital roof and within the existing PFI hospital basement

Option C and D doesn't involve re-planning of RED clinical spaces.

Option C uses North Road for the A distribution and RED/ED Chillers, and uses the existing PFI hospital basement for the B distribution cables.

Option D limits the LV cable distribution externally to the compound area and therefore does not involve routing cables along North Road.

1. Introduction

As part of the Project RED scheme, a power study of the existing infrastructure has been undertaken by Sigma RJ, see Appendix 6. Further to the Sigma RJ study, the study discounted the use of the existing roof mounted substation DSS170 for supplying Project RED, see Figure 1. Hoare Lea has undertaken this electrical infrastructure feasibility study to review the options for providing new electrical distribution for the site.



Figure 1 - Site Location Plan

The concept options within the initial project brief by Sigma RJ, see Appendix 7, have been reviewed and discussions have been held with the Trust to determine which option to progress, based upon an appraisal of sizing, location and future works.

The Trust confirmed during a workshop on the 18th March 2021, that Option 2 should be progressed with the inclusion of the Wellcome Centre building, allowing the supporting substation DSS110 and generator to be decommissioned. In addition, the adjacent DSS230 substation supplying the Phase 1 and 2 Chillers is to be decommissioned. The area of the decommissioned substations is intended to be used to improve access to the ED refurbishment.

Option 2 is the provision of an electrical infrastructure scheme to serve Project RED New Build, ED Refurbishment, theatres 1 – 12, including RED/ED Refurb chillers and Phase 1 and 2 chillers, plus the addition of the Wellcome Centre building.

The developed electrical infrastructure scheme for the main electrical distribution A and B supplies is in line with HTM06-01 to provide dual primary and secondary supplies with an N+1 arrangement. The baseline power resilience is in line with the HTM clinical risk grade C. Departments and services requiring an uninterrupted power supply are served via a UPS and Medical IT system, in line with the HTM clinical risk grade A and B.

The developed electrical infrastructure scheme for the chiller supplies is to provide single primary and secondary distribution.

2. Options appraisal

2.1 Initial options appraisal

The initial brief included the following options;

- Option 1 – Project RED/ED Refurb Only, including Project RED/ED Refurb Chillers
- Option 2 – Project RED/ED Refurb, including Project RED/ED Refurb Chillers + Theatres T1 to T12 + Phase 1 and 2 Chillers
- Option 2B – Project RED/ED Refurb, including Project RED/ED Refurb Chillers + Capacity for Phase 1 and 2 Ward and Phase 1 and 2 Chillers
- Option 3 – Project RED/ED Refurb, including Project RED/ED Refurb Chillers + Theatres T1 to T12 + Phase 1 and 2 Wards + Phase 1 and 2 Chillers

Refer to Appendix 7 for the initial project brief options.

For each of the options within the initial project brief, a distribution system and associated schematic has been developed including various options on the main electrical equipment layout / space provision and location.

Consideration has been given to;

- Blue light route of North Road
- Temporary Blue light route road amendment
- Temporary Ambulance parking area
- RED Site material drop off
- RED Site accommodation
- Future development opportunities on the site

The initial review includes layout options, see Appendix 1, for using the areas at the boundary of the site and options for using the roof level for the electrical distribution equipment (switchgear and transformers).

2.2 Selection of layout and option

With due consideration on the impact of the RED construction plan and site access, the focus was to develop a plan using the area adjacent to the Wellcome Building, with the aspiration of improving access to the ED Refurbishment, see Figure 2.



Figure 2 - Proposed Electrical Distribution Location

For the proposed electrical distribution area, shown in Figure 2, the following options have been further considered. Refer to Appendix 2 for the schematics associated with the selected option.

- Option 1 – Project RED/ED Refurb Only, including Project RED/ED Refurb Chillers
This option is ruled out on the basis there is a requirement to decommission the existing DSS 110 substation for the Wellcome Building and DSS 230 substation for the existing Phase 1 and 2 chillers.
- Option 1i – Project RED/ED Refurb Only, including Project RED/ED Refurb Chillers with Generator Plug in point provided for Chillers (e.g. no permanent Generator)
This option is ruled out on the basis there is a requirement to decommission the existing DSS 110 substation for the Wellcome Building and DSS 230 substation for the existing Phase 1 and 2 chillers.
- Option 2 – Project RED/ED Refurb, including Project RED/ED Refurb Chillers + Theatres T1 to T12 + Wellcome Building + Phase 1 and 2 Chillers
- Option 2i – Project RED/ED Refurb, including Project RED Chillers + Wellcome Building + Phase 1 and 2 Chillers

Note that by removing Theatres T1 to T12 in this option, it does change the size of the transformers and generators.

- Option 2ii – Project RED/ED Refurb, including Project RED/ED Refurb Chillers + Theatres T1 to T12 + Wellcome Building + Phase 1 and 2 Chillers with Generator Plug in point provided for Chillers (e.g. no permanent Generator)
- Option 2iii – Project RED/ED Refurb, including Project RED/ED Refurb Chillers + Wellcome Building Phase 1 and 2 Chillers with Generator Plug in point provided for Chillers (e.g. no permanent Generator)

Removing Theatres T1 to T12 from this option will impact on the size of the transformers and generators.

2.3 Development of electrical equipment layout and distribution

The feasibility study has been progressed on Option 2 as detailed above. A scheme for the Option 2 electrical distribution compound area, adjacent to the Wellcome Building has been developed with the design team.

The electrical distribution compound area;

- Generator A
- Generator B
- Generator for Chillers
- central bulk fuel tank for the Generators
- Electrical distribution accommodation.

The compound also accommodates the new medical gas manifold room for Project RED/ED Refurbishment and the relocated existing Wellcome Building Chiller.

The electrical distribution accommodation in the new compound area, comprises a ground level with upper level, refer to . Also refer to Appendix 2 schematic for Option 2.

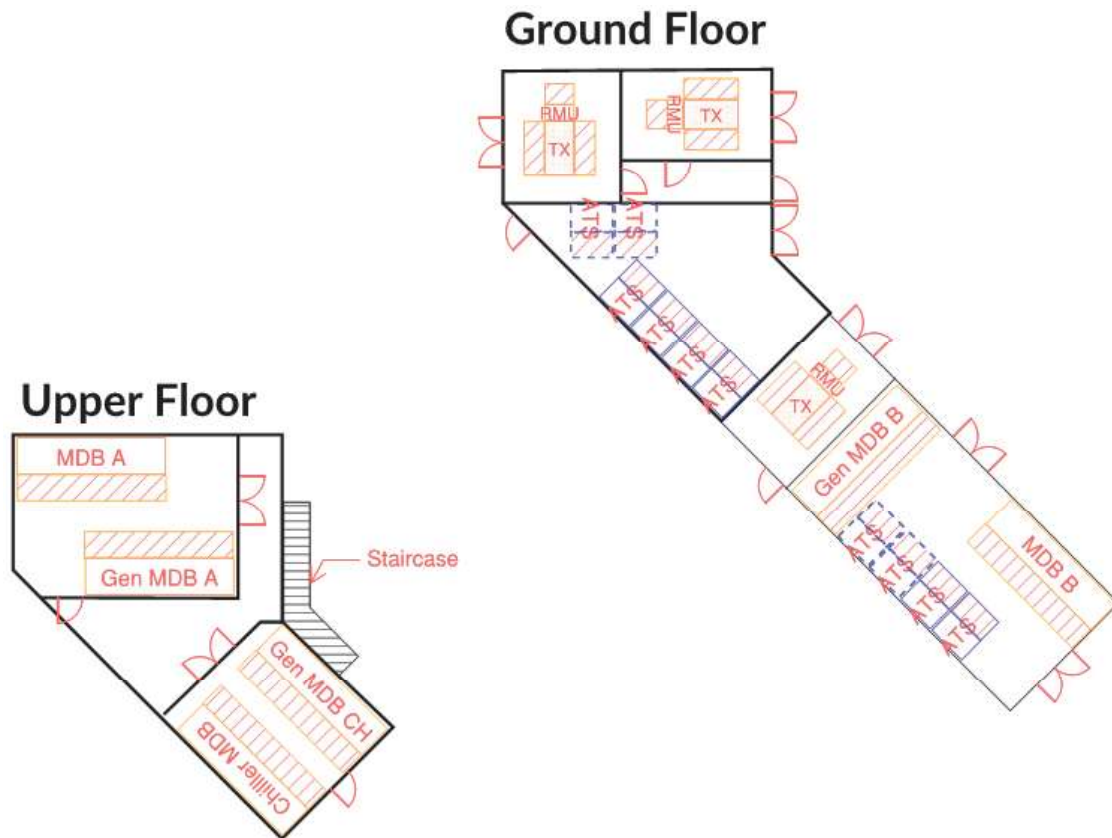


Figure 3 - Electrical distribution Accommodation in The Electrical Distribution Compound Area

The layouts have been developed to provide separation between the electrical distribution A equipment and electrical distribution B equipment, in line with HTM06-01.

The ground level accommodation is detailed showing;

- the ring main units (RMU) and associated transformers for each of electrical distribution A, electrical distribution B and chiller distribution.

- the main LV switchroom for LV distribution B, which contains Main distribution switchboard B (MDB B), generator main distribution switchboard B (Gen MDB B) and the associated automatic transfer switches (ATS) for electrical distribution B.
- switchroom for Automatic Transfer Switches (ATS) for electrical distribution A and chiller distribution

The upper level accommodation is detailed showing;

- the main LV switchroom for LV distribution A, which contains Main distribution switchboard A (MDB A) and generator main distribution switchboard A (Gen MDB A)
- the main LV switchroom for chiller distribution, which contains Main distribution switchboard for chiller supplies (MDB CH) and generator main distribution switchboard for chiller supplies (Gen MDB CH)

The feasibility study has been developed with the location of the Automatic transfer switches (ATS) within the electrical accommodation of the new compound area.

Separate A and B electrical supplies from ATS and N+1 configuration are to be routed separately from Electrical switchroom A and Electrical switchroom B within the RED/ED Refurb building at Level 3,

For Project RED/ED Refurb Chillers, a single supply will be routed, from an ATS, to a switchboard located adjacent to the Chillers on the RED roof. Coordination of the new switchroom location on the RED roof will be required as part of the redesign works associated with Project RED.

NEW SWITCHROOM FOR PROJECT RED/ED REFURB CHILLERS

For Phase 1 and 2 Chillers, a single supply will be routed from an ATS, to a new Phase 1 and 2 Chillers LV switchboard located in a new switchroom on the existing PFI roof adjacent to the existing Chiller LV distribution switchroom, refer to Appendix 4.

2.4 Generator Fuel Tank provision

Each of the generator containers will be provided with its own fuel tank with the addition to a centralised bulk fuel tank. The central bulk fuel tank is proposed to be located within the electrical distribution compound area.

HTM06-01 details that a 200-hour central bulk fuel tank be provided. It is usual to derogate from the 200-hour tank capacity due to the availability of fuel (by prior agreement with the Trust/Estates and based on site availability) and the potential need to replace the fuel. A fuel tank with 48-hour capacity, in the order of 40,000 litres, is proposed and this provision will need to be agreed with the Trust.

3. Electrical loads

3.1 Electrical Distribution A & B

The electrical distribution A & B will provide an N+1 arrangement for the supplies.

An assessment of the electrical loads was initially undertaken and detailed by Sigma RJ. These loads have been used and developed to assess the overall capacity requirements and size the required electrical infrastructure. The loads for the A & B supplies are detailed within Table 1. Table 1 - Electrical Distribution A & B Loads

Electrical Distribution A & B					
	kW	Spare %	kW		Notes
RED A	642	25%	802.50		
T1-T12 A	350	25%	437.50		
Wellcome A	175	25%	218.75		
RED B	-	-	-		Load as above
T1-T12 B	-	-	-		Load as above
Wellcome B	-	-	-		Load as above
Total requirement kW			1459	kW	
Total requirement kVA			1459	kVA	Assume power factor 1.00
					Required TX Size
Transformer Selection					1600kVA
		kW		Prime kVA	Required Set Size
Generator Selection		1459	0.8	1823	2000kVA

Table 1 - Electrical Distribution A & B Loads

Each area will be supplied via two separate substations, in line with HTM06-01, with each substation capable of taking on the full load in the event of supply failure. Each substation will also be backed up by a standby LV generator.

3.2 Chiller Distribution

The associated chillers are to be supplied via a dedicated substation with provision for a standby LV generator. The loads for the Chiller supplies are detailed within Table 2.

Chiller Distribution					
	kW	Spare %	kW		Notes
RED/ED Refurb Chillers - TX	714	25%	892.50		
Phase 1 and 2 Chillers - TX	700	0%	700.00		Assumed 25% spare included
RED/ED Refurb - G	714	25%	892.50		
Phase 1 and 2 Chillers - G	700	0%	700.00		Assumed 25% spare included
Total requirement kW			1593	kW	
Total requirement kVA			1593	kVA	Assume power factor 1.00
					Required TX Size
Transformer Selection					1600kVA
		kW		Prime kVA	Required Set Size
Generator Selection		1593	0.8	1991	2000kVA

Table 2 - Chiller Distribution Loads

4. HV Strategy

4.1 Existing HV Distribution

The existing HV RINGS 1, 2 and 4 are routed adjacent to the Wellcome Building and through the area of the site associated with Project RED and within the proposed Electrical infrastructure compound. The HV RINGS are supplied from the hospital site main HV intake switchgear located adjacent the Energy centre.

HV RING 1 and 4 supply various substations on the site which support clinical based loads.

HV RING 1 includes substations;

- DSS 110 Wellcome Building Sub-station.
- DSS 170 CCU Sub-station Roof mounted
- DSS 105 Upper Brook street substation.

DSS 105 and DSS170 substations provide the electrical supplies for the existing MRI building.

DSS 110 Wellcome Building Sub-station is located externally at ground level adjacent to the main building.

HV RING 2, in principal, supplies the Chillers associated with the site and includes substation;

- DSS 230 Phase 1 & 2 Chiller Sub-station

The Chillers associated with existing Phase 1 and 2 MRI main building are supplied from DSS 230. DSS 230 substation is located externally at ground level adjacent the main building.

4.2 Proposed HV Distribution

The proposed HV Distribution forming part of the electrical infrastructure associated with Project RED new build, ED refurbishment and theatres 1 – 12 will utilise both HV RING 1 and 4, in order to provide dual primary supplies as per HTM06-01.

The proposed HV Distribution forming part of the electrical infrastructure associated with RED/ED chillers and Phase 1 and 2 Chillers will utilise HV RING 2.

Refer to Appendix 3 for proposed HV cables routes and Appendix 5 for proposed amendments to the existing HV network.

Clarification of existing loads associated with the existing HV RINGS is required in order to develop the design into a technical design.

4.3 Decommissioning of existing HV Distribution

Through discussion with the Trust / Estates there is an opportunity to incorporate the loads associated with DSS 110 and DSS 230 within the infrastructure proposals and decommission them.

The existing DSS 230 substation does not have any standby generator provision.

The existing standby generator associated with the Wellcome Building is located within the same compound area as the DSS 110 Wellcome Building Sub-station.

4.3.1 Decommissioning of existing DSS 110 substation

In order to decommission the existing DSS 110 substation, part of the new distribution equipment will need to be provided, see section 4.3.3.

The Wellcome Building, at present is supplied by a single distribution supply from the DSS 110 Sub-station. As part of the decommissioning works it could initially be re-supplied by one of the new distribution supplies.

If required a temporary LV generator could be used to support the essential loads, supplied at a point in time where the existing generator needs to be removed. Alternatively, there may be an opportunity to temporarily relocated the existing generator.

4.3.2 Decommissioning of existing DSS 230 substation

In order to decommission the existing DSS 230 substation, part of the new distribution equipment will need to be provided to serve the existing phase 1 and 2 chiller supplies, see section 4.3.3.

4.3.3 Removal of existing supplies from existing DSS 110 and DSS 230 substation

A phasing strategy will need to be developed during the technical design stage to allow the new distribution to be provided and the existing DSS 110 and DSS 230 substations to be decommissioned.

Based on the proposed layout, the new distribution system would be able to be commissioned, with the exception of the standby generator associated with the A distribution, without the need to add any existing loads to the new distribution equipment.

Initially the new A distribution system will not be required as;

- the existing Wellcome Building supply would be transferred to the new B distribution
- the new chiller distribution system would be made available to allow the transfer of the existing phase 1 and 2 chiller supply.

Once the existing supplies have been removed from the existing DSS 110 and DSS 230 substations, the standby generator associated with the A distribution can be installed and commissioned.

5. Distribution Strategy

5.1 Electrical Distribution accommodation

The electrical distribution accommodation plan has been developed using typical equipment sizes with access to meet the requirements of HTM06-01.

5.2 HV cable routes

Refer to Appendix 3 for proposed HV cable routes.

With reference to Appendix 8, which details indicative existing cable routes, a below ground measured survey will be required in order to identify the existing cables and then allow the proposed new cable routes to be developed during the technical design stage.

In order to provide the proposed electrical distribution system diversions, temporary HV cable routes will be required for HV RING 1,2 and 4.

Where HV cabling is routed between the Wellcome Building and the existing MRI building, a ducting detail arrangement will need to be developed during the technical design stage to allow future access and maintenance. For example the replacement of the HV cabling, this is highlighted on the drawings in Appendix 3.

5.3 LV cable routes

Options for the LV cable routes as shown on the layouts provided in Appendix 4;

- Option A - Cables run externally within ground
- Option B - Cables run externally within ground
- Option C - Cables run externally within ground and within the existing PFI hospital basement
- Option D - Cables run across the existing PFI hospital roof and within the existing PFI hospital basement

Option A and B involve re-planning and will comprise the clinical spaces within the RED building. For these options all of the LV cabling will need to be routed along North Road and the installation will need to be coordinated with drainage installation.

Option C and D does not involve re-planning of RED clinical spaces

Option C whilst using North Road for the A distribution and RED/ED Chillers, uses the existing PFI hospital basement for the B distribution cables.

Option D limits the LV cable distribution externally to the compound area and therefore does not involve routing of cabling along North Road.

With all the options the Phase 1/2 Chillers rise externally to the Roof

We recommend that Option C and D are the preferred options.

Indicative cable sizes and types with installation methods have been detailed on a table on each of the layouts in Appendix 4, based on different installation methods and cable lengths derived from the cable routes shown on the layouts and electrical loads.

The installation method options are;

- Single core cables in a trench
- Multicore cables buried in the ground
- Multicore cables in a trench
- Multicore cable in ducting
- Single core cable on ladder
- Multicore cables on ladder

As noted on the table on the drawings, due to cable sizes, multicore buried cables and multicore ducted cables are deemed an inappropriate installation method due to the cabling requirements (size and quantity) for RED/ED Refurb A and B, Theatres 1 - 12 A and B and RED/ED Refurb Chillers.

5.4 LV cable routes riser requirements

There is a requirement for the LV cables to rise

- separately to the Electrical Switchroom A and B at level 3 for RED/ED Refurb and Theatres T1 to T12 distribution cables. Note the Theatre T1 to T12 distribution cables to be routed to existing area of the hospital, to be agreed.
- Project RED/ED Refurb Chillers
- Phase 1 and 2 Chillers

Based on LV cable routes Option C and D, refer to riser locations and requirements for cable routes shown on the layouts detailed in Appendix 4. Coordination will be required for the Electrical Infrastructure LV supplies will be required as part of the redesign works associated with Project RED.

As per section 2.3, coordination of the location of a new switchroom for the RED Chiller supplies on the Project RED roof will be required as part of the redesign works associated with Project RED.

In addition there is a requirement for a new switchroom on the existing PFI roof adjacent to the existing Chiller LV distribution switchroom.

The existing room to be surveyed to determine route of the LV containment for the chiller supplies, refer to drawing in Appendix 4.

Appendices

1. Options Appraisal Project - Updated 20210312
2. Selected Option schematics
3. HV cable routes
4. LV cable routes
5. HV schematics proposed amendments to existing HV network
6. MFT-PS02 DSS105-DSS170 Power Study
7. Brief Options and Electrical loads
8. Existing HV cable routes drawings

Appendix 1

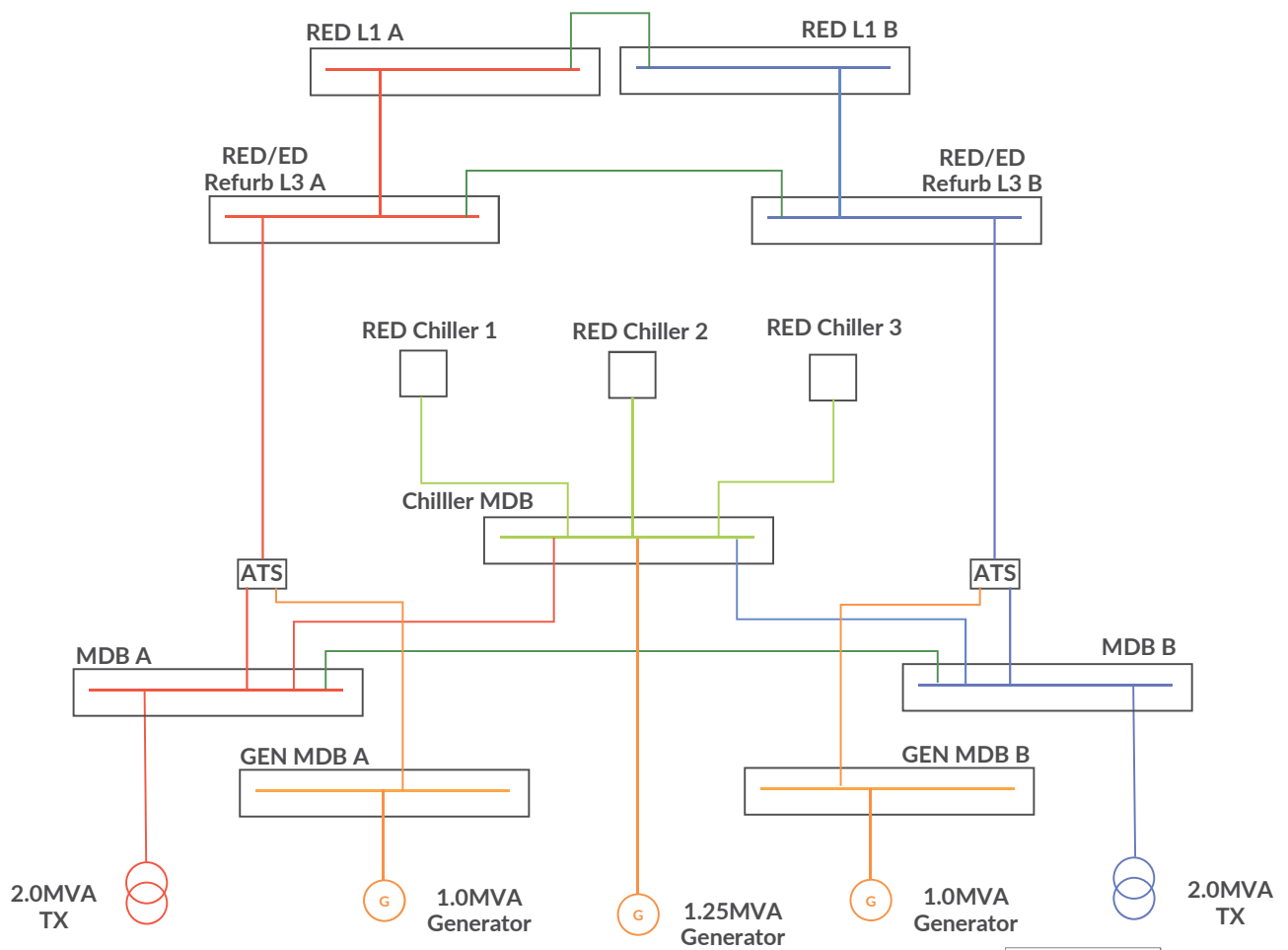
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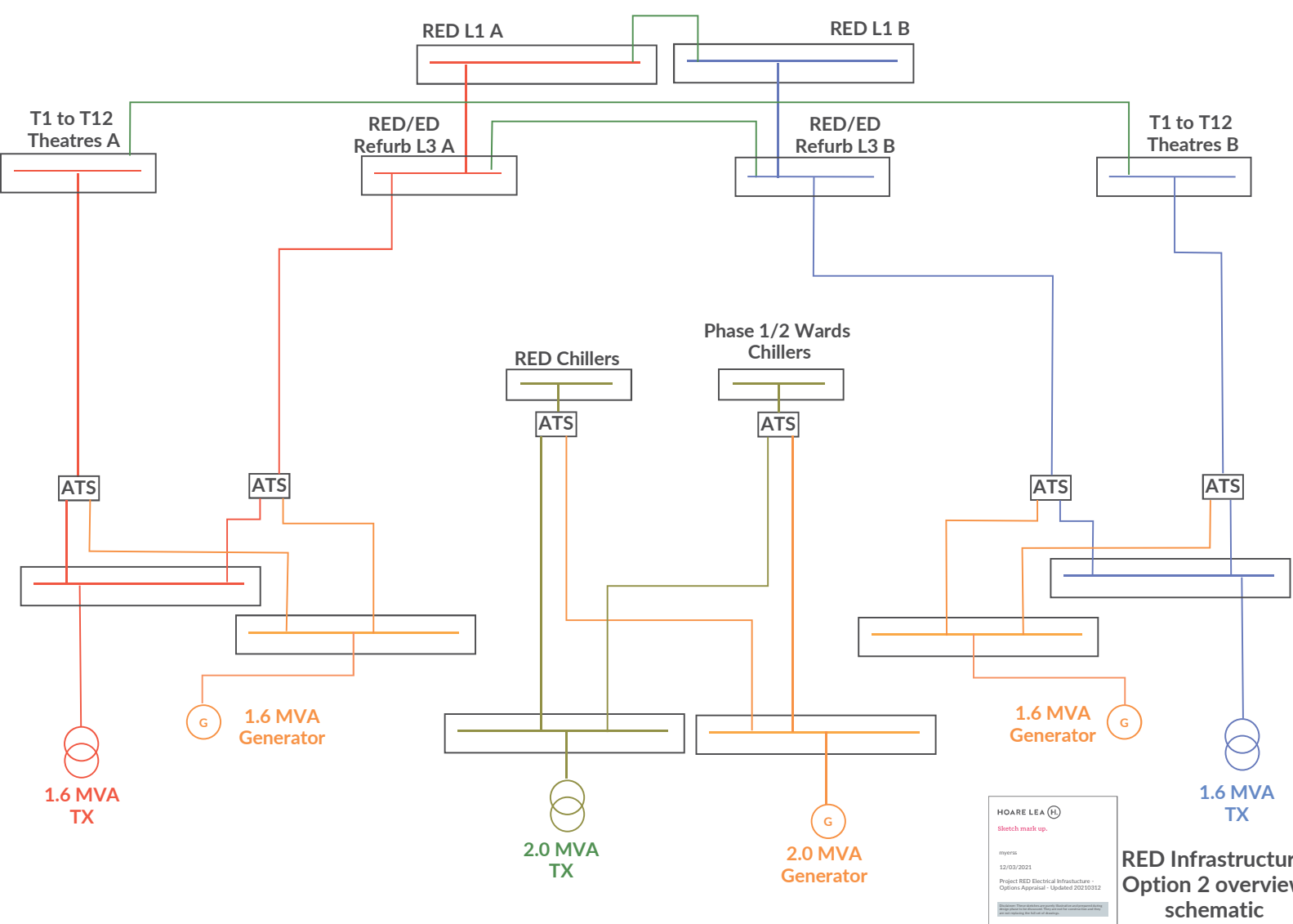
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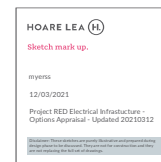
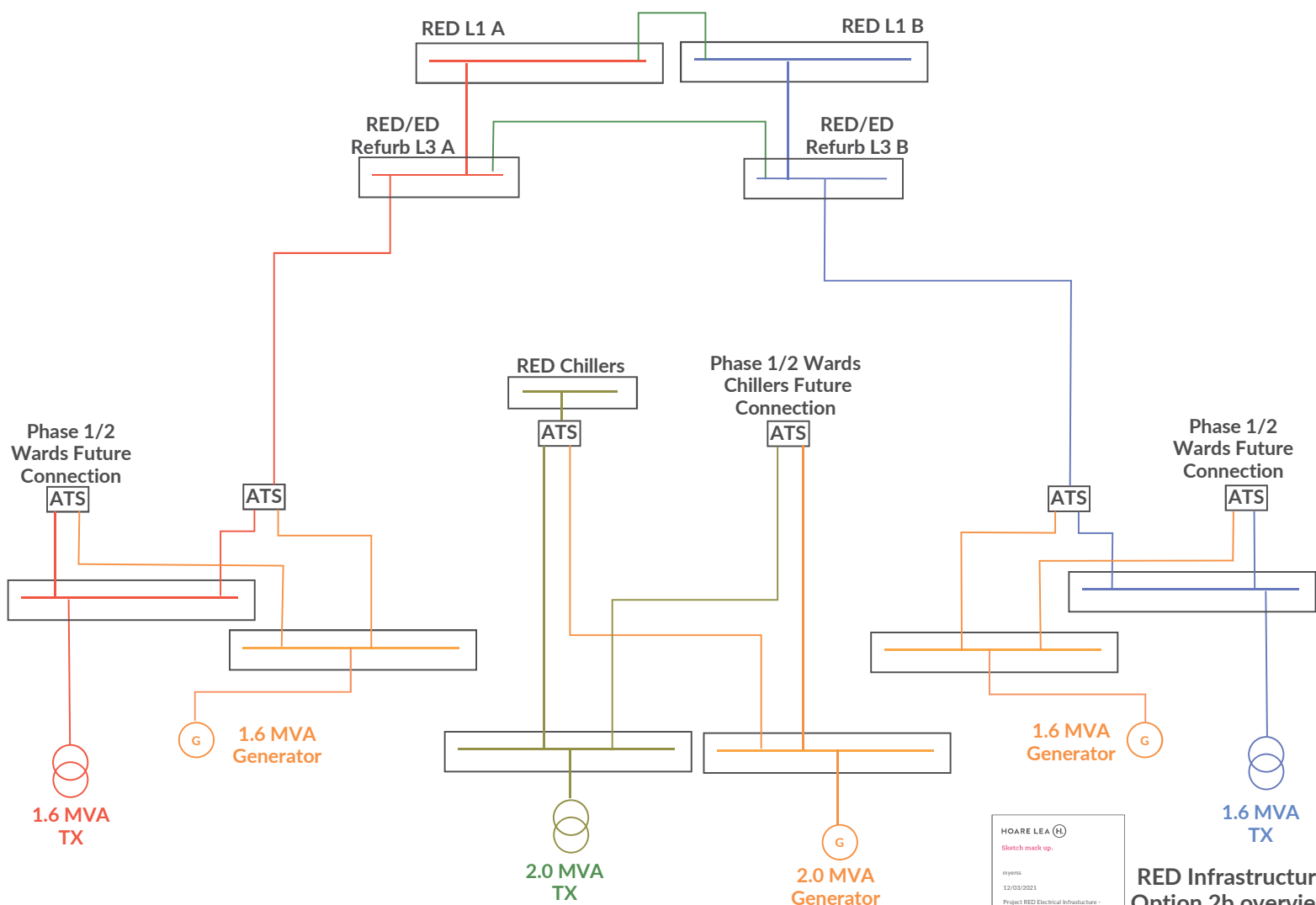
Options Appraisal

12 March 2021

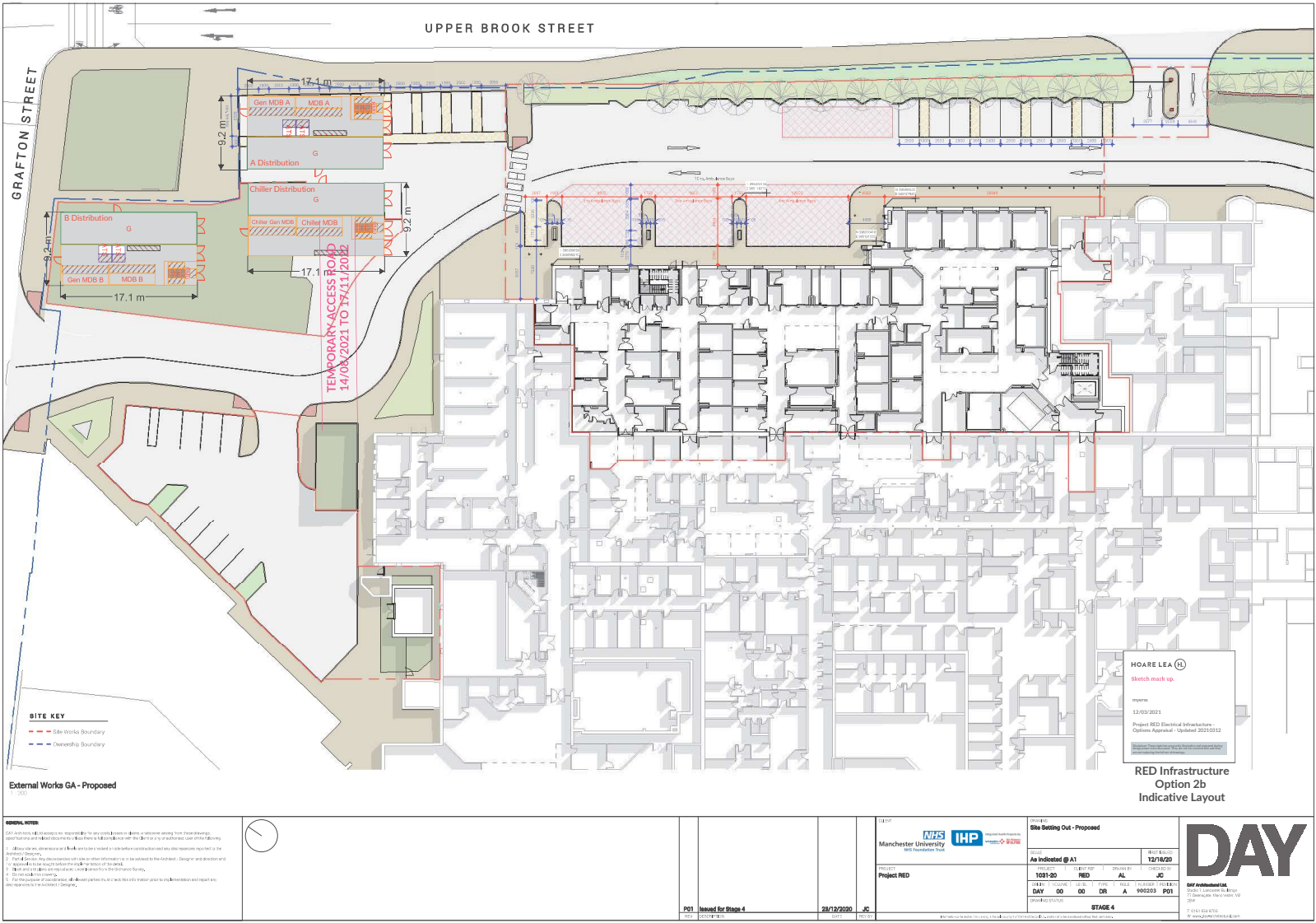


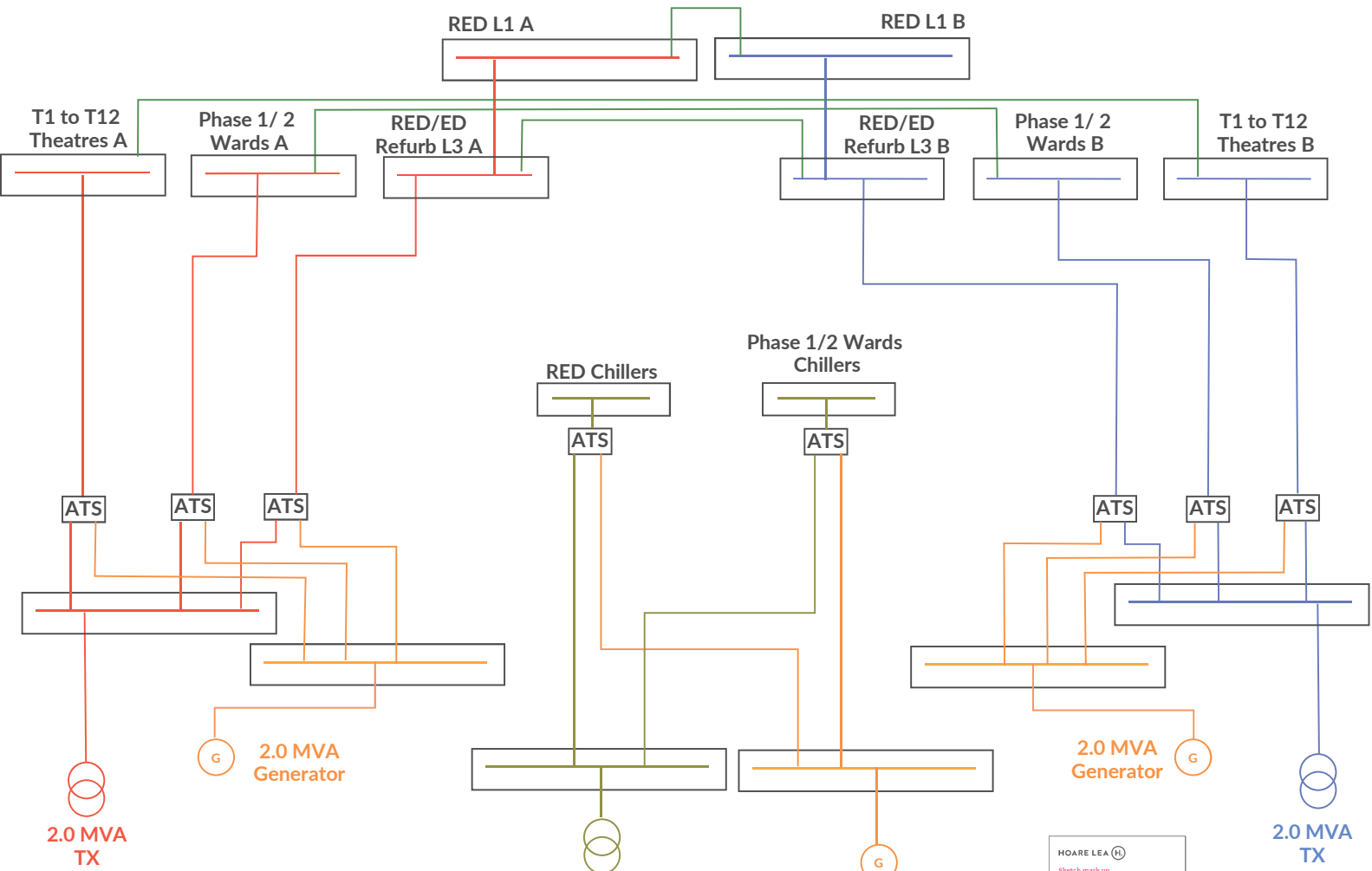






**RED Infrastructure
Option 2b overview
schematic**





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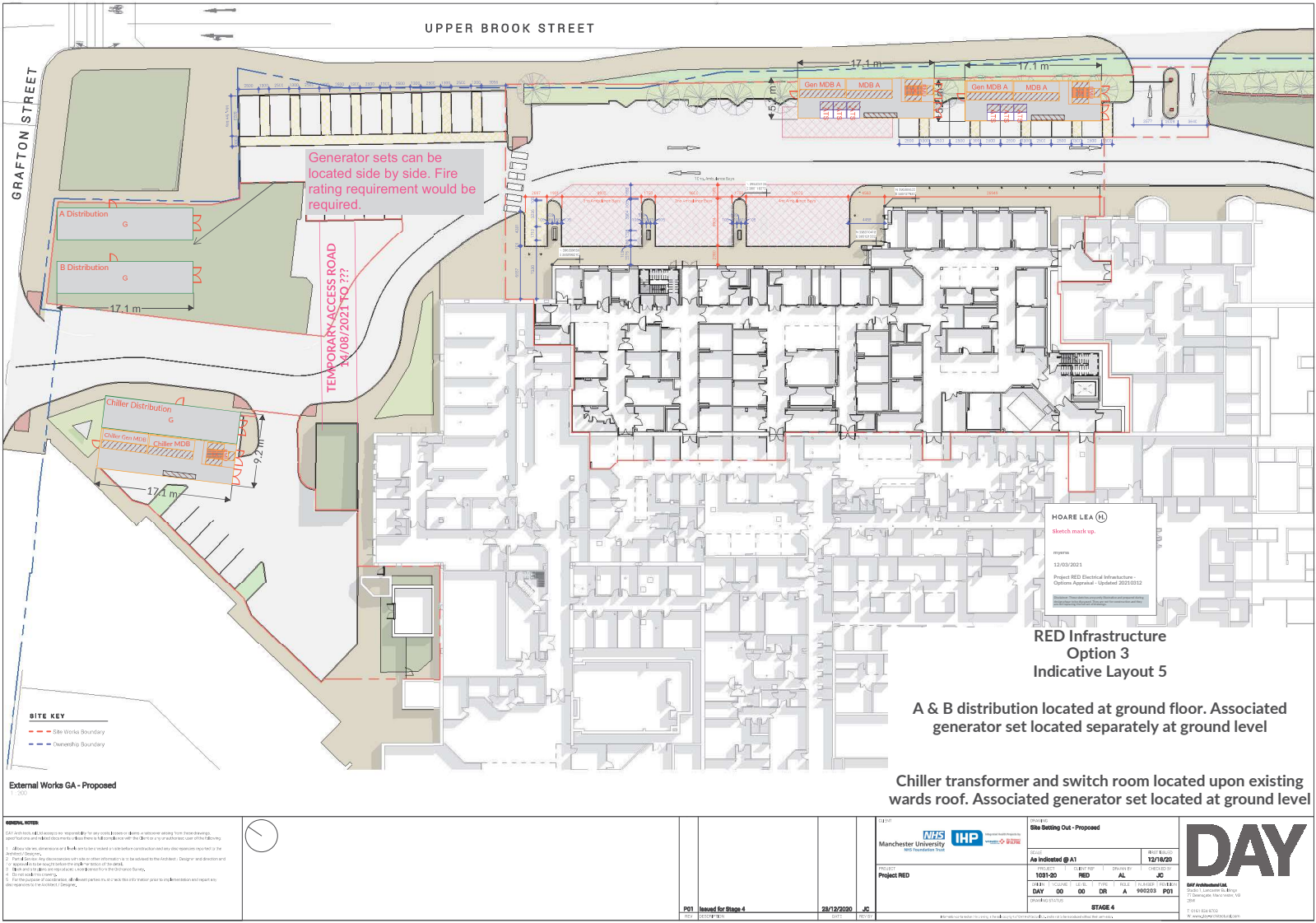
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Project RED Electrical Infrastructure - Options Appraisal - Updated 20210312

RED Infrastructure Option 3 overview schematic



External Works GA - Proposed

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REDACTED

1. All dimensions are approximate and should be used as a guide only. Final dimensions should be confirmed by the contractor.

2. All dimensions are approximate and should be used as a guide only. Final dimensions should be confirmed by the contractor.

3. All dimensions are approximate and should be used as a guide only. Final dimensions should be confirmed by the contractor.

4. All dimensions are approximate and should be used as a guide only. Final dimensions should be confirmed by the contractor.

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External Works GA - Proposed

200

REDACTED

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External Works GA - Proposed

200

REDACTED

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3. All dimensions are approximate and should be used as a guide only. Final dimensions should be confirmed by the contractor.

4. All dimensions are approximate and should be used as a guide only. Final dimensions should be confirmed by the contractor.

5. All dimensions are approximate and should be used as a guide only. Final dimensions should be confirmed by the contractor.

RED Infrastructure Option 3
Indicative Layout 5

A & B distribution located at ground floor. Associated generator set located separately at ground level

Chiller transformer and switch room located upon existing wards roof. Associated generator set located at ground level



