

CONSTRUCTION CONSTRAINTS FOR BRILL TOWER DEVELOPMENT ADJACENT TO THE FRANCIS CRICK INSTITUTE

Background

The Francis Crick Institute is a direct response to the independent 'Review of UK health research funding' (HM Treasury, HMSO 2006) undertaken by Sir David Cooksey on behalf of the HM Treasury against a brief set by the Chancellor of the Exchequer. The recommendations of the 'Cooksey Report' sought to be a coherent attempt to make the very best of the UK's resources that are devoted to health research.

Formerly known as the UK Centre for Medical Research and Innovation (UKCMRI), the project brought together the Medical Research Council, the Wellcome Trust, Cancer Research UK, University College London, King's College London and Imperial College London who set out to identify a site that would fully meet the Cooksey Report's vision for the future.

The Brill Place site was identified in 2007 and procured by UKCMRI in July 2008. Following appointment of a consultant team and a series of engagements with key stakeholders including LB Camden, a planning application was submitted in September 2010 and granted in March 2011.

Throughout this period, and despite austerity measures, the Government ring fenced investment in science and research which included, specifically, the Francis Crick Institute. Indeed, the Crick was identified as a crucial part of the UK's investment in science and research infrastructure in the first edition of the National Infrastructure Plan (HM Treasury & Infrastructure UK, HMSO 2011), which was published in 2011.

Work on the building started in July 2011 and in 2016 the Crick moved into its brand-new state-of-the-art building.

The Francis Crick Institute brings together 1500 scientists and support staff working collaboratively across disciplines, making it the biggest biomedical research facility under a single roof in Europe. It is dedicated to understanding the fundamental biology underlying health and disease and the work seeks to help understand why disease develops and to translate discoveries into new ways to prevent, diagnose and treat illnesses such as cancer, heart disease, stroke, infections and neurodegenerative diseases.

Under the 2018 Industrial Strategy the importance of the Francis Crick Institute is specifically recognised in terms of the economic case that the sector contributes to the UK economy and the benefits of investment into cutting-edge facilities which included the Crick. Indeed, the Crick is identified as one of the world's largest research institutes and an important part of the life sciences sector which itself is identified as a UK-wide endeavour.

At a local strategic level, the Crick is identified in the London Plan as a specialist cluster within the Central Activities Zone. Forming part of the MedCity network of medical and life sciences research districts, the plan seeks to support and protect these innovation nodes and networks.

Overall, the Francis Crick Institute is a recognised national asset that sits centrally within the UK's life science strategy; part of the national Industrial Strategy. It is a building at the heart of UK Government interests, which makes a wide-ranging contribution to the UK economy and helps elevate the UK's global position in medical science and research.

This paper therefore seeks to set the criteria, standards and/or specifications that development within the vicinity of the Crick will need to achieve to ensure that the operations and future of the Crick is not prejudiced. These may have some impact on the construction work proposed, but, if considered by the designer, and built into the methods to be employed by the Contractor should have little time or cost impact on the project overall.

The most sensitive façade of the FCI is the Southern, but the basement is sensitive all round. Whilst a number of imaging and other highly delicate measuring instruments are located in the basement mostly towards the southern façade, the BRF area is situated to the Northern side. Whilst the diaphragm wall forming the basement along this façade provides an amount of cut-off from outside activities, it also allows transmission of external impacts over a wide area of the building. The instrumentation and science within the basement can be disturbed by noise, vibration and electromagnetic influences emanating from surprisingly long distances.

As noted above, and in more detail later, areas of the basement are subject to legally defined regulations, in particular the Code of Practice for the Housing and Care of Animals Bred, Supplied or Used for Scientific Purposes – Animals (Scientific Procedures) Act 1986. The FCI takes its duties under legislation very seriously and is regularly inspected and monitored by Government Inspectors to confirm compliance. Work on site must not cause conditions in these areas to be put at risk and on occasions when work on site is being carried out in relatively close proximity to these facilities, it will be necessary to have live monitoring in place inside the FCI.

Operational Hours

The normal working hours within the Brill Tower Development site shall be Mondays to Fridays between 0800 and 1800 hours and Saturdays between 0800 and 1300 hours, with no working on Sundays or Public Holidays. Exceptionally, consent for work outside these hours may be given after consultation with LBC Environmental Health Officer (EHO). The Francis Crick Institute (FCI) should be consulted with regard to any proposed extended hours which would result in noise or vibration beyond the site boundary, since this might impact on-going experimental work in the Institute. A minimum of fourteen days' notice will be required from the Contractor when seeking such consent due to the long-term nature of the work being undertaken by the FCI.

Monitoring of Noise and Vibration (N&V) and Electro Magnetic Interference (EMI)

The Noise and Vibration Criteria discussed in the following Sections A & B and possibly the EMI Criteria discussed in Section C will require the Contractor to install active monitoring systems to show the actual levels of construction noise and vibration at the FCI and that the Contractor is complying with the required criteria. These systems will require monitoring on a 24hr basis using a web portal accessible to both the Brill Tower Development and the FCI.

As noted below, measurements of particularly heavy plant or construction activities which are deemed likely to generate noise and vibration levels above agreed criteria will be required in advance to demonstrate that the methods proposed will not exceed the agreed criteria.

Sensors shall be installed within the FCI to monitor Peak Particle Velocity (ppv) and Total Noise Levels $L_{Aeq,T}$.

Should, after discussion, an EMI risk to areas of the FCI be anticipated, EMI performance will also require the flux density be monitored in real time. The FCI will provide controlled access for the Contractor to install and maintain these instruments and for them to be removed on completion of the Development works.

All monitoring works will be the responsibility of the Contractor and will be at no cost to the FCI.

A) NOISE CRITERIA

Ambient Noise Levels

The level of construction noise, $L_{Aeq,T}$ from all sources when measured 1.5m above the ground at 1m from any part of the FCI building northern façade where there are normally occupied spaces (i.e. not facades to unoccupied spaces such as stairwells and plantrooms) shall either not exceed the agreed criteria or not exceed by more than 3dB(A) the existing ambient noise level, $L_{Aeq,T}$, at the receiver location measured over the same period, whichever is the greater.

If pre-construction ambient noise levels are likely to be above or close to the agreed criteria set out in the schedule, it may be appropriate to carry out noise monitoring at or near the FCI building prior to commencement of the works. The results from this monitoring should act as the baseline pre-construction ambient noise level data with which compliance with the requirements set out is to be tested. The data will either be measured at or be corrected to be representative of the pre-existing noise levels at the northern façade of the FCI and provided in terms of hourly L_{A90} , L_{Aeq} and $L_{Amax,S}$ noise indices.

PROPOSED CONSTRUCTION		NOISE CRITERIA	
		Total Noise Levels at North Facing Basement Level 2 Lightwell	
Period	Hours	Construction Noise Level $L_{Aeq,T}$ dB(A)	Period T over which $L_{Aeq,T}$ is applicable, hours
Mondays to Fridays	0800-1800	78	any 4 hours
Saturdays	0800-1800	78	any 4 hours
Sundays and any other days or time periods outside of the normal (if permitted)		Construction Noise Levels subject to negotiation with EHO and FCI representative	

T1 Construction Noise limits

(i) Construction noise levels in the schedule relate to levels as measured at 1m from the FCI building façade.

Exceptionally, the Contractor carrying out works may be given permission to carry out works which exceed the noise levels in the Schedule, provided that 28 days' notice of the date and timing of the work is given, and the Contractor demonstrates that he has taken all reasonable measures to mitigate any noise nuisance. After consultation with the FCI representative and the Local Authority and, in accordance with Section 72 (Best Practicable Means) of the Control of Pollution Act 1974 and the recommendations in BS 5228-1:2009+A1:2014: Code of practice for noise and vibration control on construction and open sites, a decision would normally be given within 7 days of receipt of the notice. In some locations, it may cause significant issues within the FCI if the Schedule levels are exceeded. The FCI will advise the Contractor of these particularly sensitive areas. It will be necessary to trial the works which might impact these areas on distant areas of the site and measure the actual on-site noise and vibration levels before agreeing additional mitigation measures or allowing the works to commence closer to the FCI.

If the need arises to measure noise levels at locations other than one of the designated noise sensitive locations (e.g. upper floor facade on the Francis Crick Institute building), the permitted noise level shall be related to the nearest designated noise sensitive part of the building facade.

The Contractor shall employ the best practical means to minimise the noise and vibration produced by his operations and shall have regard to Section 72 of the Control of Pollution Act 1974 and the recommendations in BS 5228-1:2009+A1:2014: Code of practice for noise and vibration control on construction and open sites.

Without prejudice to the generality of the Contractor's obligations set out above, the Contractor shall comply in particular with the following requirements: -

- All vehicles and mechanical plant used for the purpose of carrying out the works shall be fitted with effective exhaust silencers and shall be maintained in good and efficient working order so that extraneous noises shall be reduced to a minimum.
- All compressors and generators shall be "sound reduced" models fitted with properly lined and sealed acoustic covers which shall be kept closed whenever the machines are in use. All ancillary pneumatic percussion tools shall be fitted with mufflers or silencers of the type recommended by the manufacturers. Generators shall be positioned and enclosed so as to minimise noise transmission to the inhabitants in the neighbourhood and the FCI.
- All pumps shall be positioned and enclosed so as to minimise noise transmission to inhabitants in the neighbourhood and the FCI.
- All machines in intermittent use shall be shut down in the intervening periods between work or, where this is impracticable, throttled down to a minimum.
- No machine shall be permitted which uses a system of dropping a heavy weight, power assisted or by gravity, for the purpose of breaking up hard material, paving or foundations. The use of percussive plant for breaking up obstructions shall be limited to the minimum practicable amount but will still be required to be fully compliant with vibration levels below.
- Access to the Site shall be such as to ensure a minimum of disturbance to persons in the FCI by vehicles or plant entering or leaving the Site. No deliveries to Site shall take place outside the agreed working hours except by written prior agreement with the FCI.
- Any work agreed to be carried out between 1800 and 0800 hours will be subject to agreement to noise levels with the Environmental Health Officer and consultation with the FCI representative. The Contractor shall provide details on work involved, machinery or plant used, exact location, and calculated noise levels at monitoring points.

Any fixed or static plant operating outside normally permitted working hours shall not operate at more than 3dBA in excess of the prevailing background noise level.

Without prejudice to the foregoing, the Contractor shall not be permitted to carry out percussive piling including driven piles or sheet piling works, except where such work is absolutely necessary for the saving of life or property and the safety of the Works and with prior agreement with the FCI.

- Piling shall utilise Continuous Flight Auger (CFA) or other minimum noise and vibration methods to the maximum extent possible. Bored piles shall not use percussive methods to advance casings at any time except by prior written consultation with the FCI. Vibration resulting from the use of casing vibrators to advance or withdraw casings is discussed in Section B.

The maintenance of mechanical or other constructional plant in the proximity of the FCI building shall not take place outside the hours of 0800 to 1800 on Mondays to Saturdays or at any time on Sundays and public holidays, except with prior consultation with the FCI.

B) VIBRATION CRITERIA

With regard to standards for vibration during construction, these have been developed with reference to the documents and recommended values set out below. Again, it is noted that operations and activities being carried out in the FCI basements are particularly sensitive to disturbance by vibration. A number of the scientific experiments taking place in the FCI may be in progress for some weeks and any disturbance would disrupt readings, requiring abandonment and re-starting with the consequent time and cost effects.

Document	Onset of Effect of Vibration on People	Onset of Potential Cosmetic Damage to Buildings
BS 5228:1992:Part 4 ¹	0.14 – 0.30 mms ⁻¹ PPV	10.00 mms ⁻¹ PPV
DIN 4150:1986:Part 3 ²	0.20 mms ⁻¹ PPV	5.00 – 20.00 mms ⁻¹ PPV
BS 6472:2008 ³ criteria relative to residential accommodation	0.20 ms ^{-1.75} VDV _{day}	N/A

T2 Vibration standards summary

It is worth noting that the 0.2 mms⁻¹ PPV (Peak Particle Velocity) referred to in DIN 4150 and BS 6472 is around the human threshold of perception of vibration, although there is some variation between individuals.

Taking all these factors together and given the vibration sensitive nature of much of the laboratory work undertaken in the building, all construction processes that are likely to generate a vibration level in excess of 0.3mms⁻¹ PPV in the north facing basement level 2 lightwell of the FCI, are subject to a more detailed assessment and on-site testing to determine whether mitigation measures are appropriate.

That assessment should be undertaken with a view to establishing not only the levels of vibration likely to be generated but also the duration and frequency of their occurrence so that Vibration Dose Values (VDVs) can be calculated and compared to the relevant standard in BS6472 highlighted in the table. If this criterion is exceeded, then mitigation measures or alternative means of carrying out particular activities will need to be investigated.

As noted in A) above, no percussive piling work will be allowed, and the use of casing vibrators should be minimised, preferably by the use of CFA techniques. The use of vibrators to insert cages into CFA piles will be considered acceptable subject to a prior demonstration on site that these will not cause vibration in excess of 0.3mms⁻¹ PPV in the north facing basement level 2 lightwell. Should vibrators be employed to advance or withdraw casings for bored piles, then trials should be undertaken at distant areas of the site to demonstrate that measured vibration levels do not exceed 0.3mms⁻¹ PPV in the north facing basement level 2 lightwell.

¹ British Standard 5228: 1992: Noise control on construction and open sites: Part 4.

² Deutsche Norm 4150: 1992: Erschütterungen im Bauwesen – Einwirkungen auf Menschen in Gebäuden.

³ British Standard 6472-1: 2008: Guide to evaluation of human exposure to vibration in buildings

Also, as noted above, breaking out of obstructions in the ground will need to be carried out using minimum vibration techniques. The use of hydraulic crushing and bursting techniques or saw cutting and removal of the cut sections to another distant part of the site for breaking up shall be the preferred method employed.

C) ELECTRO MAGNETIC INTERFERENCE (EMI)

The comments made under section B) with regard to vibration sensitivity also apply to sensitivity to EMI interference. In addition, there is a potential for permanent electrical equipment installed close to the FCI to cause interference. When the initial design of the FCI was undertaken, the EMI emissions profiles both above and below ground were measured to assess the potential impacts on EMI imaging and research tools to be located in the new FCI building.

Impacts noted included electric and diesel trains above and below ground at St Pancras station, the local LUL and Thameslink trains, moving vehicles on local streets, the 50Hz power Utility Services, RF broadcast communication / Wi-Fi systems etc. The DC EMI flux density above ground shows a very complex emission profile from moving vehicles, trains, underground trains and the DC traction power systems. These were noted particularly close to Midland Road (Road traffic, St Pancras Station and Thameslink), but decayed very rapidly with distance into the FCI site.

Each of these impacts was considered and the design was advanced on the basis of putting the most sensitive equipment at the greatest distance from sources which would cause impacts. It was recommended that Instruments should be not less than 40m from Midland Road or 30m from Brill Place / Ossulston Street. The building design also took account of the modelled AC ELF / DC field effects from the FCI building plant, lifts, switchgear, risers etc.

Factors were applied to the measured effects for design purposes, but the main external mitigation measure was to maximise distance from identified significant sources of impact. In addition, further mitigation was provided for the most demanding instruments through the installation of shielding and compensation systems, for example the electron beam tools required a full 6-sided DC magnetic shielding with an ACS (active compensation system).

The FCI EMI performance requirements which were included in the building Specification were designed to accommodate the latest high performance research imaging tools now and, through discussions with manufacturers, the next 15 to 20 years. It is absolutely essential to achieve an environment with the 0.1 mGp-p (10 nT) performance requirement in the Bx, By and Bz axis for AC 50 Hz (and higher harmonic) and quasi-static DC magnetic field levels measured at the tool columns at 1 and 2 metre elevations which is the industry standard for high resolution ion beam imaging tools.

During construction, the Contractor will need to consider and assess the EMI flux density due to both the permanent and temporary construction work and provide details to the FCI on any activities that are considered to potentially increase fields at the outside of the FCI northern perimeter wall.

The proposed works likely to impact the EMI are currently considered to be the new substation/transformer unit within the new building, vehicle and large plant movements adjacent to the FCI may also cause EMI impacts which may need to be assessed to confirm that they will have minimal impact on the FCI.

The contractor, having regard to the thresholds identified above, should discuss any potential EMI risks with the FCI and in the event a risk is identified, will consult with the FCI to establish appropriate mitigation measures and, if applicable, a monitoring regime.