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ENVIRONMENTAL PROTECTION DEPARTMENT  
PRACTICE NOTE FOR PROFESSIONAL PERSONS

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**Minimizing Noise from Construction Activities**

(This Practice Note supersedes ProPECC PN1/93, PN2/93 and PN1/96.)

**Preamble**

The purpose of this Practice Note (PN) is to provide a brief summary on the existing control on noise from construction activities under the Noise Control Ordinance (NCO) and Environmental Impact Assessment Ordinance (EIAO), as well as the requirements and recommendations on the practices for minimizing construction noise.

2. This PN sets out the recommendations on practicable measures in minimizing noise from general construction activities, and serves to assist project proponents and practising professionals in deploying quieter construction methods and equipment in construction works.

**Statutory Control on Construction Noise under NCO and EIAO**

3. At present, the following construction activities are subject to control under the NCO (Cap. 400):

- percussive piling (PP)
- construction work other than percussive piling using powered mechanical equipment (PME) between the hours of 7 p.m. and 7 a.m. on any day not being a general holiday, including Sunday and at any time on a general holiday, including Sunday (i.e. restricted hours)
- the use of hand-held percussive breakers and air-compressors.

4. The NCO (i) bans the carrying out of PP during restricted hours and (ii) requires all construction work involving the use of PME and, in designated areas, the carrying out of certain noisy construction activities (i.e. Prescribed Construction Works<sup>1</sup>) to obtain a Construction Noise Permit (CNP) before such work can be carried out during restricted hours. Applications for CNP for the use of PME for carrying out general construction work are processed by the Noise Control Authority and assessed in accordance with the Technical Memorandum (TM) on "Noise from Construction Work other than Percussive Piling". A CNP will not be issued if the noise from the proposed PME exceeds the noise criteria in the relevant

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<sup>1</sup> The type of Prescribed Construction Works have been stipulated under the "Technical Memorandum on Noise from Construction Work in Designated Areas". It includes erection or dismantling of formwork or scaffolding; loading, unloading or handling of rubble, wooden boards, steel bars, wood or scaffolding material; and hammering.

- TM. Provisions are available, subject to conditions, to allow construction work which
- adopts special noise control measures, including the quietest practicable construction methods
  - has unavoidable constraints on working hours (e.g. road/rail maintenance).

5. As for PP, a CNP must also be in place before PP activities can be carried out at daytime hours (7 a.m. to 7 p.m.) on a weekday other than a general holiday, including Sunday. Through the permit conditions, the duration of PP may be restricted to 3, 5 or 12 hours during daytime, depending on the surrounding environment.

6. The NCO also prescribes that two types of construction equipment, i.e. hand held percussive breakers and air compressors, have to be used in compliance with relevant prescribed noise emission standards and with Noise Emission Labels affixed.

7. The Environmental Impact Assessment Ordinance (EIAO) provides additional control over designated projects (DP) (e.g. new town development, railway line developments, major carriageways for motor vehicles). Project proponents have to submit an Environmental Impact Assessment (EIA) Report and obtain an Environmental Permit (EP) issued by the Environmental Protection Department before construction works could be commenced. The EIA Report assesses, among others, construction noise impacts, and recommends appropriate noise mitigation measures where necessary, which may then be imposed as a requirement under the EP. For projects which are considered as DP under the EIAO, the practices under the EIAO Guidance Note “Preparation of Construction Noise Impact Assessment Under the Environmental Impact Assessment Ordinance” should be followed. This PN focuses on construction noise control for non-DP.

**Non-statutory Control on Construction Noise**

8. The noise from construction activities of the project during non-restricted hours (7 a.m. to 7 p.m. on any day not being a Sunday or general holiday) should be minimized as far as practicable and such that the construction noise at the facade of the respective noise sensitive receivers would not exceed the noise levels below:

Noise Sensitive Receivers	Leq(30min)* dB(A)
All domestic premises Temporary housing accommodation Hostels Convalescences homes Homes for the aged	75
Places of public worship Courts of law Hospitals and medical clinics	70

Educational institutions (including kindergartens and nurseries)	70 (65 during examinations)
* Note: Leq(30min) is a standard measure of noise level which means the continuous equivalent noise level over a 30 minute interval.	

### **Minimization of Construction Noise Impact for Construction Activities during Non-Restricted Hours**

9. The recommendations for minimizing construction noise impact for different types of construction activities and construction projects during non-restricted hours are set out under this PN and are summarized in **Annex A**.

#### **A. General Construction Works**

10. To minimize noise from construction works during non-restricted hours, the project proponents should follow the requirements and implement the noise control measures given under the Recommended Pollution Control Clauses for Construction Contracts ([https://www.epd.gov.hk/epd/english/environmentinhk/eia\\_planning/guide\\_ref/rpc\\_3.html](https://www.epd.gov.hk/epd/english/environmentinhk/eia_planning/guide_ref/rpc_3.html)) in EPD's website.

#### **B. Construction Works Containing Noisy Construction Activities in Close Proximity to Noise Sensitive Receivers (NSRs)**

11. In addition to the requirements under the Recommended Pollution Control Clauses for Construction Contracts, the project proponents should consider to adopt further measures for construction works containing noisy construction activities, e.g. site formation / foundation, piling, building demolition, concreting and tunneling, in close proximity to NSRs as these noisy construction activities might cause noise impacts exceeding the criteria shown in paragraph 8 even with noise barriers or quality powered mechanical equipment (QPME)<sup>2</sup>.

12. The project proponents are recommended to identify the noisy activities at the design stage of a project; make an assessment of the construction noise impact and identify the corresponding quieter construction methods and equipment through the preparation of a Construction Noise Management Plan (CNMP) as described in paragraph 13; and provide particular specifications in construction contracts for adopting these quieter construction methods and equipment. This good practice will enable the contractor to be aware of all noise mitigation requirements at the tendering stage so that proper resources, methods, measures and implementation schedule could be budgeted and put into the construction phase of the project.

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<sup>2</sup> The QPME system is an Administrative System by the EPD to reflect the state-of-the-art construction equipment items that are notably quieter, more environmentally friendly and efficient. At present, 15 types of commonly used construction equipment, including (1) tracked bulldozer; (2) wheeled bulldozer; (3) tracked loader; (4) wheeled loader; (5) excavator; (6) generator; (7) mobile crane; (8) vibratory roller; (9) road roller; (10) asphalt paver; (11) vibratory compactor; (12) power rammer; (13) hand held percussive breaker; (14) air compressor; and, (15) concrete crusher, are included in the QPME system.

In the event a project proponent envisages the project would be subject to further changes in the project design or programme (e.g. design-and-build project) that may affect the noise mitigation requirements, the project proponent shall choose to make a qualitative assessment of the construction processes anticipated, instead of preparing a full CNMP, and impose general contract specifications on noise mitigation measures as stated in **Annex B**. In any case, the project proponent shall ensure that the Contractor is well aware of the need to comply with the noise criteria shown in paragraph 8; and impose particular specifications in construction contracts for the successful tenderer to prepare a CNMP based on the final design of the project before construction works commence, and further prepare any updated CNMP(s) to address any subsequent changes that would affect the effectiveness of the noise mitigation measures. Sample of the contract specifications for noise mitigation measures<sup>3</sup> including the adoption of quieter construction methods and equipment for noisy construction activities in close proximity to NSRs is given in **Annex B**. Sample of the contract specifications for imposition of CNMP is shown in **Annex C**. The project proponents are advised to modify the contents to suit their project needs. Examples of quieter construction methods and equipment for different typical noisy construction processes are shown in **Annex D** and EPD's website about the "Good Practices on Mitigating Construction Noise" ([https://www.epd.gov.hk/epd/misc/construction\\_noise/contents/index.php/en/index.html](https://www.epd.gov.hk/epd/misc/construction_noise/contents/index.php/en/index.html)).

13. The CNMP should typically include the following information:
- Detailed Construction Noise Impact Assessment (CNIA)
    - Construction works programme and construction methodology;
    - PME list for the construction work;
    - Quantitative construction noise impact assessment; and
    - List of noise mitigation measures to be adopted.
  - The conditions to be incorporated in the tender document (if any) include the recommended mitigation measures and the relevant requirement for the submission of an updated CNMP, should there be any change to the construction noise mitigation measures and/or plant inventory recommended in the submitted CNMP.
  - Implementation schedule clearly listing out the mitigation measures, the implementation party, location and timing of implementation.
  - Any technical constraint that would hinder the use of these quieter construction methods and equipment should be evaluated and clearly recorded in the assessment.

14. In order to ensure that the parameters used for the CNIA are adequate, and the noise mitigation measures derived from the assessment results are effective, the CNMP should be prepared and checked by Certified Noise Modelling Professional as recognized by the Hong Kong Institute of Qualified Environmental Professionals Limited or equivalent as meeting the recommendations given in this PN. All mitigation measures recommended and requirements

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<sup>3</sup> All noise mitigation measures should be designed to meet relevant statutory requirements, including safety and stability of the noise barriers.

specified in the CNMP should be fully implemented. During the course of preparation of the CNMP, the project proponents should involve the construction professionals as early as possible for timely identification of noisy construction processes as well as the quiet means for achieving the project aim. A web based CNMP platform is available to facilitate the preparation of CNMP. Following the above principle and by inputting detailed information of the construction program including the full list of quieter construction equipment and method to be adopted, and follow those steps in the web platform, the CNMP report could be produced for submission.

### **Green Building Credits**

15. For building projects, it is worth to note that under the current framework of Building Environmental Assessment Method (BEAM) Plus, two bonus credits would be granted if the applicant could demonstrate quieter construction equipment/methods have been adopted and these equipment/methods could produce a significant noise reduction fulfilling the prescribed criteria under the credit - Integrated Design and Construction Management (IDCM 7b) in BEAM Plus New Buildings - Version 2.0.



(Samuel H.K. Chui)

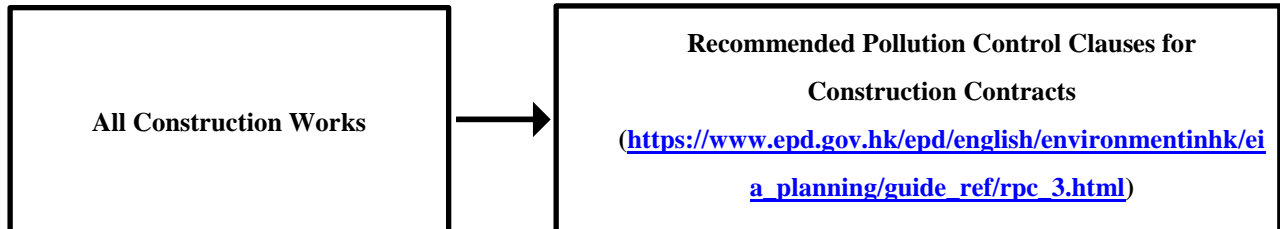
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Environmental Protection Department

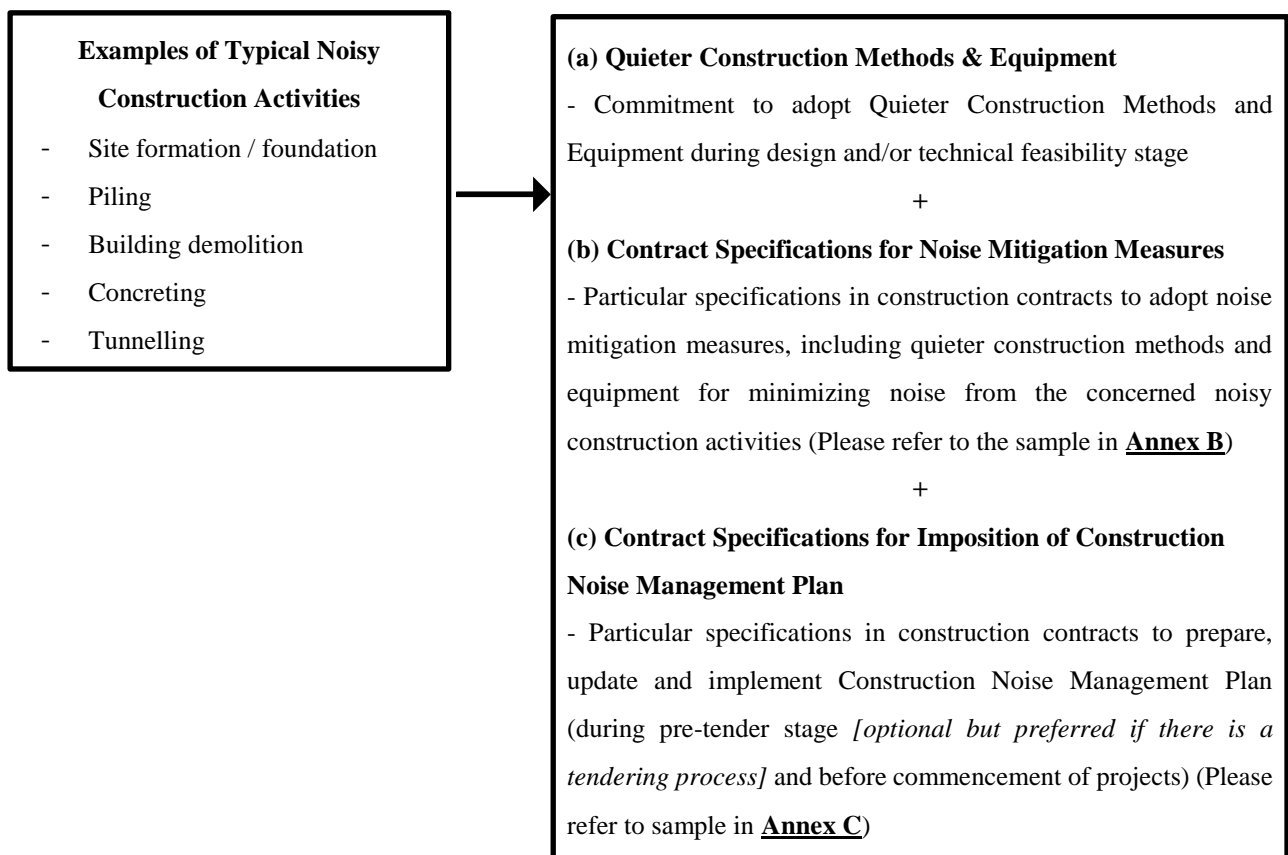
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**Summary of Measures to Minimize Construction Noise Impact  
for Construction Activities and Construction Projects  
during Non-Restricted Hours**

**(1) General measures for all construction works**



**(2) Additional measures for construction works containing noisy construction activities in close proximity to noise sensitive receivers (NSRs) (i.e. with NSRs usually within 300m from project site boundary)**



**Sample Contract Specifications for Noise Mitigation Measures**

**Noise  
Mitigation  
Measures**

- (1) The Contractor shall adopt the following general noise mitigation practices:
- i. Use non-percussive pile driving methods such as hydraulic press-in method, vibration or jacking method for installing or extracting sheet piles;
  - ii. Use non-percussive equipment such as hydraulic crusher, sawing, coring machines etc. for demolition and concrete breaking work;
  - iii. Close all hoods, cover panels and inspection hatches of powered mechanical plant such as generators, air compressors etc. during operation;
  - iv. Provide noise dampening materials inside and outside refuse chutes during building construction;
  - v. Fit mufflers or silencers, and dampening layer with steel collars to hand held pneumatic breakers; and
  - vi. Use Quality Powered Mechanical Equipment (QPME) recognized by the Environmental Protection Department (EPD) as far as practicable. Details of QPME can be found in EPD website at <http://www.epd.gov.hk/epd/english/environmentinhk/noise/qpme/index.html>. Where a QPME is used, the plant shall be registered with EPD, and a valid label issued by EPD from such registration shall be affixed on the plant at all times and kept legible.
  - vii. Use of Quieter Construction Methods as far as practicable listed in the EPD website at [https://www.epd.gov.hk/epd/misc/construction\\_noise/contents/index.php/en/home2/quieter-construction-methods.html](https://www.epd.gov.hk/epd/misc/construction_noise/contents/index.php/en/home2/quieter-construction-methods.html).
- (2) Where the noise level measured at the noise sensitive receivers (NSR) exceeds 75 dB(A) (Leq 30 min) for domestic premises, and 70 dB(A) (Leq 30 min) for schools or 65dB(A) (Leq 30 min) during school examinations, the Contractor shall provide an acoustic screen or enclosure<sup>4</sup> to shield the public or NSR from the noisy activity at source or adopt quiet process/plant, except for works under emergency or with the prior agreement of the Engineer that the provision of

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<sup>4</sup> For sample design of the purpose-built noise enclosure and barrier, please refer to Annex D.

such is not necessary, such that the noise level measured at the NSR do not exceed the limits as mentioned in this sub-clause. The detailed design / technical information including the size, material and form of the screen or enclosure shall be proposed by the Contractor and submitted to the Engineer for approval before the work commences. The acoustic screen or enclosure shall be securely fixed at the base to avoid overturning. It shall be provided and installed such that no powered mechanical equipment can be seen from the nearby noise sensitive receiver. No gap, hole nor leakage shall be found in the entire screening part of acoustic enclosure, and all joints of baffles or panels shall be well designed to prevent direct leakage of noise under the normal condition. Notwithstanding any approval given, the Contractor shall be fully liable for his design in all respects.

**Concrete  
Removal  
Works**

- (1) For construction activities involving Concrete Removal works, the Contractor shall use the best practicable means to protect nearby noise sensitive receivers from noise nuisance. If the best practicable means cannot be achieved, the Contractor shall provide detailed justifications for any other construction methods used.

The general principle in noise reduction of concrete removal works is the minimization of noise from in-situ removal of concrete by percussive breakers, reduction of noisy processes and adoption of quieter methods.

These methods of best practicable means shall include but not limited to:

- i. Use of non-explosive chemical expansion agents instead of explosive chemicals or expansive compounds;
- ii. Use of high pressure water jetting instead of traditional jackhammers and drill hammers;
- iii. Use of quieter type wire saws or diamond wire saws for cutting large areas and heavily reinforced concrete;
- iv. Use of quieter type blade saws utilizing diamond blades with higher speeds and smoother blades reduces excitation of vibration;
- v. Use of hydraulic crushers for concrete breaking instead of traditional excavator-mounted breakers;
- vi. Use of handheld concrete crushers instead of traditional jackhammers;
- vii. Use of diamond coring tools instead of traditional drilling tool; and



- viii. Use of hydraulic splitters instead of traditional jackhammers and breakers.

***Demolition Works***

- (2) For construction activities involving demolition works, the Contractor shall use the best practicable means to protect nearby noise sensitive receivers from noise nuisance. If the best practicable means cannot be achieved, the Contractor shall provide detailed justifications for any other demolition methods used.

The general principle in noise reduction of demolition works is the minimization of noise from in-situ demolition of structures by percussive breakers, reduction of noisy processes and adoption of quieter methods.

These methods of best practicable means shall include but not limited to:

- i. Use of high pressure water jetting instead of traditional jackhammers and drill hammers;
- ii. Use of hydraulic crushers for concrete breaking instead of traditional excavator-mounted breakers;
- iii. Use of quieter type wire saws or diamond wire saws for cutting large areas and heavily reinforced concrete;
- iv. Use of quieter type blade saws utilizing diamond blades with higher speeds and smoother blades reduces excitation of vibration;
- v. Use of penetrating cone fracture method instead of general chemical explosives;
- vi. Use of ex-situ demolition methods away from noise sensitive receivers; and
- vii. Use of diamond coring tools instead of traditional drilling tool.

***Site Formation / Excavation and Lateral Support / Foundation Works***

- (3) For construction activities involving site formation / excavation and lateral support / foundation works, the Contractor shall use the best practicable means to protect nearby noise sensitive receivers from noise nuisance. If the best practicable means cannot be achieved, the Contractor shall provide detailed justifications for any other construction methods used.

The general principle in noise reduction of site formation / excavation and lateral support / foundation works is the minimization of fabrication of

building elements in-situ, reduction of noisy processes and adoption of quieter methods.

These methods of best practicable means shall include but not limited to:

- i. Use of silent piling by press-in method instead of traditional massive augering and piling machines or drop hammer for sheet piling / channel planking installation work;
- ii. Use of a bursting system to replace traditional handheld percussive breakers;
- iii. Use of non-explosive chemical expansion agents instead of explosive chemicals or expansive compounds;
- iv. Use of a sheet piling noise reducer such as a suitable shock absorber to reduce collisions between sheet pile / channel planking and holding parts;
- v. Use of pile driving impact cushions to reduce noise generated by piling impact;
- vi. Pre-augering/pre-trench/boring pile holes to remove underground obstruction for avoiding hard driving / soften the ground; and
- vii. Use of crack inducers instead of traditional percussive breakers.

***General  
Building  
Works***

- (4) For construction activities involving general building works, the Contractor shall use the best practicable means to protect nearby noise sensitive receivers from noise nuisance. If the best practicable means cannot be achieved, the Contractor shall provide detailed justifications for any other construction methods used.

The general principle in noise reduction of general building works is the minimization of fabrication of building elements in-situ, reduction of noisy processes and adoption of quieter methods.

These methods of best practicable means shall include but not limited to:

- i. Use of prefabricated structure / sections to replace in-situ construction to reduce the amount of mechanical equipment used on site;
- ii. Use of self-compacting concrete (without the aid of a vibrator e.g. poker for compaction) for in-situ concreting;

- iii. Use of formwork made of recyclable light-weight modules, so that the pre-fabricated formwork system could be assembled and dismantled without the need of in-situ cutting and hammering; and
- iv. Use of crack inducers instead of traditional percussive breakers.

***Underground  
Utility and  
Piping Works***

- (5) For construction activities involving installation of underground utility and piping works, the Contractor shall use the best practicable means to protect nearby noise sensitive receivers from noise nuisance. If the best practicable means cannot be achieved, the Contractor shall provide detailed justifications for any other construction methods used.

The general principle in noise reduction of underground utility and piping works is the avoidance of using cut and cover methods, reduction of noisy processes and adoption of quieter methods.

These methods of best practicable mean shall include but not limited to:

- i. Use of the spiral wound rehabilitation technology (SPR<sup>TM</sup>PE) instead of traditional cut and cover methods;
- ii. Use of Cured-In-Place-Pipe (CIPP) lining instead of “open, cut and replace” method; and
- iii. Use of pipe-jacking or micro-tunnelling technology.

***Tunnelling  
Works***

- (6) For construction activities involving tunnelling works, the Contractor shall use the best practicable means to protect nearby noise sensitive receivers from noise nuisance. If the best practicable means cannot be achieved, the Contractor shall provide detailed justifications for any other construction methods used.

The general principle in noise reduction of tunnelling works is the avoidance of using cut and cover methods, reduction of noisy processes and adoption of quieter methods.

These methods of best practicable means shall include but not limited to:

- i. Use of Tunnel Boring Machine instead of cut and cover method using excavator-mounted breaker.

***Rail Track  
Maintenance  
Works***

- (7) For construction activities involving rail track maintenance works, the Contractor shall use the best practicable means to protect nearby noise sensitive receivers from noise nuisance. If the best practicable means cannot be achieved, the Contractor shall provide detailed justifications for any other construction methods used.

The general principle in noise reduction of rail track maintenance works is the avoidance of using noisy grinding machines, reduction of noisy processes and adoption of quieter methods.

These methods of best practicable mean shall include but not limited to:

- i. Use of Railhead and Rail Groove Grinding Machines by installation of noise enclosure on grind wheel with a CCTV installed to monitor the operation.

**Sample Contract Specifications for Imposition of  
Construction Noise Management Plan**

**NOISE CONTROL*****Noise control  
– general  
requirements***

The Contractor shall submit a Construction Noise Management Plan (CNMP) for the Client's agreement, based on the latest project design no later than two months before the commencement of any construction work on site. A CNMP usually contains the following basic information:

- Construction works programme and construction methodology;
- Powered Mechanical Equipment (PME) list for the construction work;
- Quantitative construction noise impact assessment; and
- List of noise mitigation measures to be adopted.

Under the circumstances that a CNMP has already been prepared before the construction contract is awarded to a contractor, the Contractor has to verify if there is any change (including the construction noise mitigation measures and/or plant inventory recommended in the previous CNMP, design parameters, etc.) in the course of project implementation. If there is any such change, an updated CNMP shall be submitted to the Client, no later than one month before the implementation of any of such change.

The CNMP / updated CNMP shall include an implementation schedule clearly listing out the mitigation measures, the implementation party, location and timing of implementation. All mitigation measures recommended and requirements specified in the CNMP / updated CNMP shall be fully implemented.

The CNMP / updated CNMP shall be prepared and checked by Certified Noise Modelling Professional as recognized by the Hong Kong Institute of Qualified Environmental Professionals Limited or equivalent.

In the event a construction project is tendered on basis of a design and CNMP already approved by the Client, the tender documents should best be accompanied with the approved CNMP for identification of necessary noise mitigation measures for implementation. There should also be a tender condition to require the Contractor to produce an updated CNMP no later than one month before the implementation of any change should there be any changes in project design, plant inventory for different construction phases, noise mitigation measures, etc.

**Examples of Quieter Construction Methods and Equipment for  
Different Typical Noisy Construction Processes**

Quieter Construction Alternatives

Processes	Conventional Practices	Alternative Quieter Construction Methods / Equipment
Tunnelling (large scale)	Cut and cover method using excavator-mounted breaker	- Use of tunnel boring machine
Laying or replacement of large diameter pipe	Cut and cover method using excavator-mounted breaker	- Pipe jacking using micro tunnel boring machine
Rehabilitation of underground pipe	Cut and cover method using excavator-mounted breaker	- Quiet pipe rehabilitation methods (e.g. Cured-In-Place-Pipe lining, Ribline spiral wound method)
Site formation (concrete or rock breaking)	Drill and break method using excavator-mounted breaker	- Use of hydraulic splitter, hydraulic crusher/ quieter type saw (e.g. diamond wire saw, noise reducing diamond blade saw) - Non-explosive chemical expansion agent (soundless chemical demolition agent) - Pulse plasma rock fragmentation technology
Excavation and Lateral Support (installation of sheet pile / channel planking)	Percussive piling (e.g. percussive hammer), Vibrating hammer	- Use of silent piling construction method such as hydraulic press-in method
Piling for foundation works	Percussive piling	- Use of non-percussive pile types (e.g. bored pile, socketed steel H-pile, mini-pile, etc.)
Building / structure demolition (large scale)	Excavator-mounted breaker	- Use of hydraulic crusher / water jet - Non-explosive chemical expansion agent (soundless chemical demolition agent) - Use of quieter type saw (e.g. diamond wire saw, noise reducing diamond blade saw)
Building /	Excavator-	- Use of quieter type saw (e.g. diamond

Processes	Conventional Practices	Alternative Quieter Construction Methods / Equipment
structure modification works	mounted breaker	wire saw, diamond blade saw) - Robot-type hydraulic crusher or handheld concrete crusher
Road works (concrete structure demolition/ trench opening)	Excavator-mounted breaker	- Use of hydraulic crusher - Use of quieter type saw (e.g. diamond wire saw, diamond blade saw)
Road works (concrete compacting)	Vibratory poker	- Self-compacting concrete or rubber head poker vibrator
Building works (superstructure)	In-situ construction	- Use of pre-casting and prefabrication technology
Formwork Installation	Timber formwork by hammer and drilling	- Modular lightweight formwork

### Purpose-built Noise Enclosure and Barrier

Other than the above quiet measures, the project proponents could also evaluate the practicability to provide the best mitigation measures in the form of purpose-built noise enclosure to cover the equipment as fully as possible. The noise enclosure could also be internally lined with commonly used sound absorbing materials such as mineral wool, polyester fibre, foam or fiberglass. Any opening or gap in the enclosure will tend to compromise the noise reduction effect and should therefore be minimized. Where access and forced ventilation is required for the enclosure, proper acoustic door and suitably designed silencers fitted with the air intake and outlet should be installed.

Noise barrier is another effective way to abate construction noise impact, provided that the barrier is designed and installed to a width and height such that no part of the noise source will be visible from the noise sensitive receiver being protected. In addition, the length of a straight vertical barrier should generally be at least five times greater than its height.

In general, if there is no direct line of sight between the noise source and the noise sensitive receiver, and the material of surface mass of the noise enclosure and barrier is in excess of  $7\text{kg/m}^2$  or STC 27 (indicative only, subject to actual needs for the project), to minimize noise transmission, an overall reduction of at least 5 dB(A) can be achieved at the receiver side. On the other hand, for consideration of further noise reduction, the noise reduction can be obtained in accordance with ISO 9613-2 "Acoustics - Attenuation of sound during propagation outdoors". The following material could be used for the noise enclosure and barrier design:

- Steel (painted, galvanized, stainless)
- Aluminium
- Polycarbonate or acrylic sheets
- Concrete, brick or glass fibre reinforced concrete (GRC)
- Proprietary-made acoustic panels
- Landscaped earth berm.

For materials other than the above with innovative noise screening mechanism, the desired effect should be considered on a case-by-case basis. Professional judgment should be applied in the design and selection of materials, while good workmanship and supervision on the construction of the noise enclosure and barrier are equally important. Attention should be given to the design of the noise enclosure/barrier so as to avoid sound leakage from any gaps or holes of the noise enclosure/barrier. A sound absorptive panel should be used if there is noise sensitive receiver on the opposite side of the noise barrier.