SSS Calculation Result for Fixed Plant at NSR Un-mitigated

	Shunting				Long Train Idling in Shed				Shuttle Idling outside				Crane Operation				Car Washing				Loco Shunting + Idling				Total			
NSR	Leq, day	Leq, night	Leq, 24h	Lmax	Leq, day	Leq, night	Leq, 24h	Lmax	Leq, day	Leq, night	Leq, 24h	Lmax	Leq, day	Leq, night	Leq, 24h	Lmax	Leq, day	Leq, night	Leq, 24h	Lmax	Leq, day	Leq, night	Leq, 24h	Lmax	Leq, day	Leq, night	Leq, 24h	Lmax
	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
SS2	38.4	36.6	37.9	41.8	24.5	24.5	24.5	24.5	26.2	-	24.4	26.2	23.8	-	22.0	23.8	39.0	-	37.3	39.0	40.6	-	38.6	68.1	44	37	43	68
SS4	41.1	39.3	40.6	46.0	24.7	24.7	24.7	24.7	26.9	-	25.2	26.9	18.1	-	16.3	18.1	41.5	-	39.7	41.5	43.7	-	41.8	64.4	47	39	46	64
SS5	46.2	44.4	45.7	49.5	32.4	32.4	32.4	32.4	38.4	-	36.7	38.4	26.6	-	24.8	26.6	36.2	-	34.5	36.2	44.9	-	42.1	71.0	49	45	48	71
SS6	44.3	42.5	43.7	49.4	32.9	32.9	32.9	32.9	38.0	-	36.3	38.0	27.5	-	25.7	27.5	33.5	-	31.8	33.5	42.6	-	39.6	68.2	47	43	46	68
SS7	43.1	41.4	42.6	53.8	33.7	33.7	33.7	33.7	42.3	-	40.5	42.3	30.4	-	28.7	30.4	16.8	-	15.0	16.8	29.9	-	27.0	57.9	46	42	45	58
SS10	41.0	39.2	40.5	51.7	32.2	32.2	32.2	32.2	39.0	-	37.2	39.0	30.2	-	28.4	30.2	29.4	-	27.6	29.4	36.4	-	28.0	56.5	45	40	43	56
SS11a	38.0	36.2	37.5	47.5	33.9	33.9	33.9	33.9	20.8	-	19.1	20.8	26.5	-	24.7	26.5	39.5	-	37.7	39.5	54.3	-	50.0	79.9	55	38	51	80
SS12	31.1	29.3	30.6	43.2	31.0	31.0	31.0	31.0	36.5	-	34.7	36.5	29.7	-	27.9	29.7	14.0	-	12.3	14.0	36.5	-	27.4	54.4	41	33	38	54
SS14	46.5	44.7	46.0	52.2	35.0	35.0	35.0	35.0	42.2	-	40.4	42.2	29.7	-	27.9	29.7	32.7	-	30.9	32.7	43.8	-	40.3	71.0	50	45	48	71
SS15	46.5	44.7	46.0	55.6	35.8	35.8	35.8	35.8	43.2	-	41.4	43.2	30.8	-	29.0	30.8	22.3	-	20.5	22.3	42.6	-	40.3	69.5	49	45	48	70

SEL Reference for SSS Calculation

SSS Event	Assumed Speed	100m setback WR train length = 200m SEL(ref)	15m setback XRL short train length = 213.5m SEL(ref)	15m setback XRL long train length = 427m SEL(ref)
	km/h	dBA	dBA	dBA
Shunting	25	68	76.5	79.5

Remark 1: SEL of shunting are at low speed for short train. Data collected by MTRC West Rail Pat Heung noise measurement.
Remark 2: Reference level of idle train inside shed refers to spreadsheet "Idle Lw".

Leq Reference for SSS Calculation

SSS Event	Setback	Leq
	m	dBA
2 Trains Idle in Shed	-	60
2 Trains Idle outdoor	9	52
1 Train Wash	14	62

Ref: Noise measurement result at Pat Heung West Rail Depot Maintenance Shed on 23 Jan 2009 by Wilkinson Murray.

SWL Reference for SSS Calculation

SSS Event	SWL	Height
	dBA	m
Crane Operation	95	2

SSS Event	Train Type	Train Length	Maximum hourly volume of train in SSS (V/hr)			Max 30 minutes volume of train in SSS (V/30min)		
		m	Day	Night	24hr	Day	Night	24hr
Shunting (double movement)	**Short Train**	213.5	2	-	1	1	-	1
	Long Train	427	2	2	2	1	1	1
Idle outdoor	**Short Train**	213.5	2	-	1	1	-	1
Idle in Shed	**Long Train**	427	2	2	2	1	1	1

Remark: Shunting of one train set would be regarded as two movements.

SSS Calculation of Sound Power Level for Idling Trains in Maintenance Shed

Legend:
Lw: Sound Power Level dB re 10^{-12} W
SPL (or Lp): Sound Pressure Level dB re 20μPa
S: Surface area

SPL of Two Sets of Idling Train at Gate & Louvre

Leq
dBA
60

Ref: Noise measurement result at Pat Heung West Rail Depot Maintenance Shed on 23 Jan 2009 by Wilkinson Murray.

Total Lw for Two Sets Trains at Gate of Shed

Door Width	Door Height	no. of Door	S	Lw
W	H	n	WxHxn	
m	m		sq m	dBA
4	6.5	4	104.0	80.2

Total Lw for Two Sets Trains at One Set of Side Window of Shed

Window Width	Window Height	no. of Window for one set	S	Lw
W	H	n	WxHxn	
m	m		sq m	dBA
2.6	0.86	8	17.9	72.5

Remark: Windows on side wall of shed are divided into seven sets. Each set contains 2 X 4 pieces of windows.

Total Lw for Two Sets Trains at One Set of Roof Louvre of Shed

Louvre Width	Louvre Length	no. of Louvre for one set	S	Lw
W	L	n	WxLxn	
m	m		sq m	dBA
2.4	7.8	6	112.3	80.5

Remark: Roof louvre of shed are divided into seven sets. Each set contains six pieces of louvre.

Ancillary Table for SSS Calculation

Angle Correction Factor for angle between shed gate direction to NSR

Angle	Loss	Gradient
Degree	dB	dB/degree
0	0	0.111
45	5	0.078
90	8.5	0.144
135	15	0.200
165	21	0.200

SSS Calculation at NSR SS5 — Un-mitigated

NSR	No. of	Ground Level	Hr	ASR			Result:		Shunting	Idle in shed	Idle outside	Crane	Wash	Total	Criteria Leq	Status
SS5	Storey	mPD	m					Leq, day	46.2	32.4	38.4	26.6	36.2	47.4	52	OK
	3	17.3	7.5	B			After 0030	Leq, night	44.4	32.4	-	-	-	44.7	45	OK
								Leq, 24hr	45.7	32.4	36.7	24.8	34.5	46.7		
								Lmax	49.5	32.4	38.4	26.6	36.2	49.5		

Shunting — NIGHT

Remark: plus 10log(2) is for converting of Leq(30min) to Leq(1hr).

	Segment	Hor D	Angle	SEL	SEL (for 30min)	Leq (At NSR, no shield)	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Wheel Squeal	Leq, night (At NSR, incl façade)	Lmax	Shadow zone?
		m	Deg	15m	NSR	NSR		mPD	m	m	m	m	m	m			dB		NSR	
Track 1 Long Train	1	146	29.2	79.5	61.8	29.2	-	15		146			146.3	9.5	0.0	0.0	0	32.2	46.5	-
	2	146	58.4	79.5	64.8	32.2	-	15		146			146.3	9.5	0.0	0.0	0	35.2	49.5	-
	3a	146	18.5	79.5	59.8	27.2	-	15		146			146.3	9.5	0.0	0.0	6	36.2	44.5	-
	3b	146	6.5	79.5	55.2	22.6	-	15		146			146.3	9.5	0.0	0.0	0	25.6	40.0	-
	3c	146	19.9	79.5	60.1	27.5	-	15		146			146.3	9.5	0.0	0.0	6	36.5	44.8	-
	4	119	9.3	79.5	57.7	25.1	-	15		119			119.4	9.4	0.0	0.0	6	34.1	42.6	-
Track 2 Long Train	1	182	23.1	79.5	59.8	27.2	-	15		182			182.3	9.5	0.0	0.0	0	30.2	44.3	-
	2	182	58.4	79.5	63.8	31.2	-	15		182			182.3	9.5	0.0	0.0	0	34.2	48.3	-
	3a	182	12.2	79.5	57.0	24.4	-	15		182			182.3	9.5	0.0	0.0	0	27.4	41.5	-
	3b	182	26	79.5	60.3	27.7	-	15		182			182.3	9.5	0.0	0.0	6	36.7	44.8	-
	3c	218	6.7	79.5	53.6	21.0	-	15		218			218.2	9.6	0.0	0.0	0	24.0	37.9	-
	4a	123	7.3	79.5	56.5	23.9	-	15		123			123.4	9.4	0.0	0.0	6	32.9	41.4	-
	4b	123	2	79.5	50.9	18.3	-	15		123			123.4	9.4	0.0	0.0	0	21.3	35.7	-

Remark: For legend of parameters and remark for equations, please refers to the bottom of spreadsheet "SS2".

	At NSR, incl façade Leq, night	Lmax NSR
Move to shunting track	42.2	49.5
Return to stabling track	40.5	48.3

At NSR, incl façade	Night time Leq Total	Noise criteria Leq, night	Status	Lmax NSR
	44.4	45	OK	49.5

Idling in Shed — NIGHT

	Hor D	Exit Angle	Direction Correction	Lw	Leq (At NSR, no shield)	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Leq, night (At NSR, incl façade)	Shadow zone?
	m	Deg			NSR		mPD	m	m	m	m	m	m				
at Gate	211	108.6	11.2	80.2	14.5	-	15		211			211.2	9.6	0.0	0.0	17.5	-
at Side Window 1	189	-	0	72.5	19.0	-	15		189			189.3	9.5	0.0	0.0	22.0	-
at Side Window 2	188	-	0	72.5	19.0	-	15		188			188.3	9.5	0.0	0.0	22.0	-
at Side Window 3	208	-	0	72.5	18.2	-	15		208			208.2	9.6	0.0	0.0	21.2	-
at Side Window 4	244	-	0	72.5	16.8	-	15		244			244.2	9.6	0.0	0.0	19.8	-
at Side Window 5	290	-	0	72.5	15.3	-	15		290			290.2	9.6	0.0	0.0	18.3	-
at Side Window 6	341	-	0	72.5	13.9	-	15		341			341.1	9.7	0.0	0.0	16.9	-
at Side Window 7	397	-	0	72.5	12.5	-	15		397			397.1	9.7	0.0	0.0	15.5	-
at Roof Louvre 1	203	-	6	80.5	20.4	-	15		203			203.2	9.6	0.0	0.0	23.4	-
at Roof Louvre 2	202	-	6	80.5	20.4	-	15		202			202.2	9.6	0.0	0.0	23.4	-
at Roof Louvre 3	221	-	6	80.5	19.6	-	15		221			221.2	9.6	0.0	0.0	22.6	-
at Roof Louvre 4	255	-	6	80.5	18.4	-	15		255			255.2	9.6	0.0	0.0	21.4	-
at Roof Louvre 5	299	-	6	80.5	17.0	-	15		299			299.2	9.6	0.0	0.0	20.0	-
at Roof Louvre 6	349	-	6	80.5	15.6	-	15		349			349.1	9.7	0.0	0.0	18.6	-
at Roof Louvre 7	404	-	6	80.5	14.4	-	15		404			404.1	9.7	0.0	0.0	17.4	-

At NSR, incl façade	Night time Leq Total	Noise criteria Leq, night	Status	Lmax NSR
	32.4	45	OK	32.4

Idling outside — Day

	Hor D	Angle	Leq	Leq (for 30min)	Leq (At NSR, no shield, 1hr)	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Leq, night (At NSR, incl façade)	Shadow zone?
	m	Deg	9m	NSR	NSR		mPD	m	m	m	m	m	m				
Short Train	147	64.5	52	35.4	35.4	-	15		147			147.3	9.5	0.0	0.0	38.4	-

Others — Day

	Hor D	Leq	Lw	Leq (for 30min)	Leq (At NSR, no shield, 1hr)	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Leq, night (At NSR, incl façade)	Shadow zone?
	m	14m		NSR	NSR		mPD	m	m	m	m	m	m				
Crane	263		95	38.6	38.6	Mainten' Shed	15	11.15	20	243	1.5	263.1	2.1	15.0	15.0	26.6	Yes
Car Wash	385	62		33.2	33.2	-	15		385			385.1	9.7	0.0	0.0	36.2	-

Legend:

Hr: Height of highest floor at receiver
Hor D: Horizontal distance
Angle: Angle of View
Hb: Height of barrier or shield
Dsb: Horizontal distance from noise source to barrier
Dbr: Horizontal distance from barrier to receiver
Hs: Height of noise source
D: Direct path
P: Path difference=Shielded path - D
A barrier: Barrier attenuation (dB)
IL barrier: Barrier loss (dB)

Remark for Equations:

(1): plus 3dB is to adjust SEL from short train to long train.
(2): distance attenuation and angle of view adjustment.
(3): SEL conversion to Leq: Leq = SEL + 10 log V -35.6 ref: FTA Guidance Manual Table 5-2 Rail vehicle ;
plus 10log(2) is to convert Leq(30min) to Leq(1hr).
(4): Barrier effect, ref: FTA Guidance Manual, Table 6-9.
(5): Ref: Transportation Noise Reference Book equation 15.21
(6): To check whether the direct path ray is under shadow zone of shielding.
(7): Direction correction factor for angle between shed exit direction to NSR or direction correction for roof louvre to NSR.
(8): general equation for calculating sound pressure from sound power in free field.
(9): Wheel Squeal is added to the required segments, such as turnout and curve.

SSS Calculation at NSR SS14 — Un-mitigated

NSR	No. of	Ground Level	Hr	ASR			Result:		Shunting	Idle in shed	Idle outside	Crane	Wash	Total	Criteria Leq	Status
SS14	Storey	mPD	m					Leq, day	46.5	35.0	42.2	29.7	32.7	48.3	49	OK
	3	17	7.5	B			After 0030	Leq, night	44.7	35.0	-	-	-	45.2	47	OK
								Leq, 24hr	46.0	35.0	40.4	27.9	30.9	47.4		
								Lmax	52.2	35.0	42.2	29.7	32.7	52.2		

Shunting — NIGHT

Remark: plus 10log(2) is for converting of Leq(30min) to Leq(1hr).

	Segment	Hor D	Angle	SEL	SEL for 30min	Leq At NSR, no shield	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Wheel Squeal	Leq, night At NSR, incl façade	Lmax	Shadow zone?
		m	Deg	15m	NSR	NSR		mPD	m	m	m	m	m	m			dB		NSR	
Track 1 Long Train	1	92	63.8	79.5	67.2	34.6	-	15		92			92.5	9.0	0.0	0.0	0	37.6	52.2	-
	2a	92	63.8	79.5	67.2	34.6	-	15		92			92.5	9.0	0.0	0.0	0	37.6	52.2	-
	2b	92	10.2	79.5	59.2	26.6	-	15		92			92.5	9.0	0.0	0.0	6	35.6	44.2	-
	2c	92	2.5	79.5	53.1	20.5	-	15		92			92.5	9.0	0.0	0.0	0	23.5	38.1	-
	3a	170	8.7	79.5	55.8	23.2	-	15		170			170.3	9.2	0.0	0.0	6	32.2	40.4	-
	3b	170	3.5	79.5	51.9	19.3	-	15		170			170.3	9.2	0.0	0.0	0	22.3	36.5	-
	3c	170	2.7	79.5	50.8	18.2	-	15		170			170.3	9.2	0.0	0.0	6	27.2	35.4	-
	3d	64	1.1	79.5	51.1	18.5	-	15		64			64.7	8.8	0.0	0.0	0	21.5	36.2	-
Track 2 Long Train	1	128	56.2	79.5	65.2	32.6	-	15		128			128.4	9.1	0.0	0.0	0	35.6	50.0	-
	2	128	65.3	79.5	65.8	33.2	-	15		128			128.4	9.1	0.0	0.0	0	36.2	50.7	-
	3a	196	17.6	79.5	58.3	25.7	-	15		196			196.2	9.3	0.0	0.0	6	34.7	42.7	-
	3b	196	3.8	79.5	51.6	19.0	-	15		196			196.2	9.3	0.0	0.0	0	22.0	36.0	-
	3c	196	4.2	79.5	52.1	19.5	-	15		196			196.2	9.3	0.0	0.0	6	28.5	36.5	-
	3d	64	1.6	79.5	52.7	20.1	-	15		64			64.7	8.8	0.0	0.0	0	23.1	37.8	-

Remark: For legend of parameters and remark for equations, please refers to the bottom of spreadsheet "SS2".

	At NSR, incl façade Leq, night	Lmax NSR
Move to shunting track	42.5	52.2
Return to stabling track	40.7	50.7

At NSR, incl façade

Night time Leq	Noise criteria Leq, night	Status	Lmax NSR
Total			
44.7	47	OK	52.2

Idling in Shed — NIGHT

	Hor D	Exit Angle	Direction Correction	Lw	Leq At NSR, no shield	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Leq, night At NSR, incl façade	Shadow zone?
	m	Deg			NSR		mPD	m	m	m	m	m	m				
at Gate	205	134.7	15.0	80.2	11.0	-	15		205			205.2	9.3	0.0	0.0	14.0	-
at Side Window 1	173	-	0	72.5	19.8	-	15		173			173.3	9.2	0.0	0.0	22.8	-
at Side Window 2	140	-	0	72.5	21.6	-	15		140			140.3	9.2	0.0	0.0	24.6	-
at Side Window 3	133	-	0	72.5	22.0	-	15		133			133.3	9.2	0.0	0.0	25.0	-
at Side Window 4	155	-	0	72.5	20.7	-	15		155			155.3	9.2	0.0	0.0	23.7	-
at Side Window 5	196	-	0	72.5	18.7	-	15		196			196.2	9.3	0.0	0.0	21.7	-
at Side Window 6	248	-	0	72.5	16.6	-	15		248			248.2	9.3	0.0	0.0	19.6	-
at Side Window 7	304	-	0	72.5	14.9	-	15		304			304.1	9.4	0.0	0.0	17.9	-
at Roof Louvre 1	184	-	6	80.5	21.2	-	15		184			184.2	9.3	0.0	0.0	24.2	-
at Roof Louvre 2	153	-	6	80.5	22.8	-	15		153			153.3	9.2	0.0	0.0	25.8	-
at Roof Louvre 3	147	-	6	80.5	23.2	-	15		147			147.3	9.2	0.0	0.0	26.2	-
at Roof Louvre 4	167	-	6	80.5	22.1	-	15		167			167.3	9.2	0.0	0.0	25.1	-
at Roof Louvre 5	206	-	6	80.5	20.2	-	15		206			206.2	9.3	0.0	0.0	23.2	-
at Roof Louvre 6	256	-	6	80.5	18.3	-	15		256			256.2	9.3	0.0	0.0	21.3	-
at Roof Louvre 7	311	-	6	80.5	16.6	-	15		311			311.1	9.4	0.0	0.0	19.6	-

At NSR, incl façade

Night time Leq	Noise criteria Leq, night	Status	Lmax NSR
Total			
35.0	47	OK	35.0

Idling outside — Day

	Hor D	Angle	Leq	Leq for 30min	Leq At NSR, no shield, 1hr	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Leq, night At NSR, incl façade	Shadow zone?
	m	Deg	9m	NSR	NSR		mPD	m	m	m	m	m	m				
Short Train	93	97.7	52	39.2	39.2	-	15		93			93.5	9.0	0.0	0.0	42.2	-

Others — Day

	Hor D	Leq	Lw	Leq for 30min	Leq At NSR, no shield, 1hr	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Leq, night At NSR, incl façade	Shadow zone?
	m	14m		NSR	NSR		mPD	m	m	m	m	m	m				
Crane	184		95	41.7	41.7	Mainten' Shed	15	11.15	19	165	1.5	184.2	2.1	15.0	15.0	29.7	Yes
Car Wash	445	62		32.0	32.0	Vent Build	15	6.45	125	320	3	445.0	0.0	2.3	2.3	32.7	Yes

Legend:

Hr: Height of highest floor at receiver
Hor D: Horizontal distance
Angle: Angle of View
Hb: Height of barrier or shield
Dsb: Horizontal distance from noise source to barrier
Dbr: Horizontal distance from barrier to receiver
Hs: Height of noise source
D: Direct path
P: Path difference=Shielded path - D
A barrier: Barrier attenuation (dB)
IL barrier: Barrier loss (dB)

Remark for Equations:

(1): plus 3dB is to adjust SEL from short train to long train.
(2): distance attenuation and angle of view adjustment.
(3): SEL conversion to Leq: Leq = SEL + 10 log V -35.6 ref: FTA Guidance Manual Table 5-2 Rail vehicle ;
plus 10log(2) is to convert Leq(30min) to Leq(1hr).
(4): Barrier effect, ref: FTA Guidance Manual, Table 6-9.
(5): Ref: Transportation Noise Reference Book equation 15.21
(6): To check whether the direct path ray is under shadow zone of shielding.
(7): Direction correction factor for angle between shed exit direction to NSR or direction correction for roof louvre to NSR.
(8): general equation for calculating sound pressure from sound power in free field.
(9): Wheel Squeal is added to the required segments, such as turnout and curve.

SSS Calculation at NSR SS15 — Un-mitigated

NSR	No. of	Ground Level	Hr	ASR			Result:		Shunting	Idle in shed	Idle outside	Crane	Wash	Total	Criteria Leq	Status
SS15	Storey	mPD	m					Leq, day	46.5	35.8	43.2	30.8	22.3	48.5	49	OK
	3	17	7.5	B			After 0030	Leq, night	44.7	35.8	-	-	-	45.2	47	OK
								Leq, 24hr	46.0	35.8	41.4	29.0	20.5	47.6		
								Lmax	55.6	35.8	43.2	30.8	22.3	55.6		

Shunting — NIGHT

Remark: plus 10log(2) is for converting of Leq(30min) to Leq(1hr).

	Segment	Hor D	Angle	SEL	SEL for 30min	Leq At NSR, no shield	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Wheel Squeal	Leq, night At NSR, incl façade	Lmax	Shadow zone?
		m	Deg	15m	NSR	NSR		mPD	m	m	m	m	m	m			dB		NSR	
Track 1 Long Train	1	78	117.7	79.5	70.5	37.9	-	15		78			78.6	8.9	0.0	0.0	0	40.9	55.6	-
	2	78	23.8	79.5	63.6	31.0	-	15		78			78.6	8.9	0.0	0.0	0	34.0	48.7	-
	3	158	8.9	79.5	56.2	23.7	-	15		158			158.3	9.2	0.0	0.0	6	32.7	40.9	-
Track 2 Long Train	1	113	109.4	79.5	68.6	36.0	-	15		113			113.4	9.1	0.0	0.0	0	39.0	53.5	-
	2	113	22.5	79.5	61.7	29.1	-	15		113			113.4	9.1	0.0	0.0	0	32.1	46.7	-
	3	195	19.2	79.5	58.7	26.1	-	15		195			195.2	9.3	0.0	0.0	6	35.1	43.1	-

Remark: For legend of parameters and remark for equations, please refers to the bottom of spreadsheet "SS2".

	At NSR, incl façade Leq, night	Lmax NSR
Move to shunting track	42.2	55.6
Return to stabling track	41.1	53.5

At NSR, incl façade	Noise criteria				
Night time					
Leq		Leq, night	Status		Lmax
Total					NSR
44.7		47	OK		55.6

Idling in Shed — NIGHT

	Hor D	Exit Angle	Direction Correction	Lw	Leq At NSR, no shield	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Leq, night At NSR, incl façade	Shadow zone?
	m	Deg			NSR		mPD	m	m	m	m	m	m				
at Gate	221	143.8	16.8	80.2	8.5	-	15		221			221.2	9.3	0.0	0.0	11.5	-
at Side Window 1	187	-	0	72.5	19.1	-	15		187			187.2	9.3	0.0	0.0	22.1	-
at Side Window 2	142	-	0	72.5	21.5	-	15		142			142.3	9.2	0.0	0.0	24.5	-
at Side Window 3	118	-	0	72.5	23.1	-	15		118			118.4	9.1	0.0	0.0	26.1	-
at Side Window 4	126	-	0	72.5	22.5	-	15		126			126.4	9.1	0.0	0.0	25.5	-
at Side Window 5	161	-	0	72.5	20.4	-	15		161			161.3	9.2	0.0	0.0	23.4	-
at Side Window 6	211	-	0	72.5	18.0	-	15		211			211.2	9.3	0.0	0.0	21.0	-
at Side Window 7	267	-	0	72.5	16.0	-	15		267			267.2	9.3	0.0	0.0	19.0	-
at Roof Louvre 1	196	-	6	80.5	20.7	-	15		196			196.2	9.3	0.0	0.0	23.7	-
at Roof Louvre 2	154	-	6	80.5	22.8	-	15		154			154.3	9.2	0.0	0.0	25.8	-
at Roof Louvre 3	132	-	6	80.5	24.1	-	15		132			132.3	9.2	0.0	0.0	27.1	-
at Roof Louvre 4	139	-	6	80.5	23.6	-	15		139			139.3	9.2	0.0	0.0	26.6	-
at Roof Louvre 5	172	-	6	80.5	21.8	-	15		172			172.3	9.2	0.0	0.0	24.8	-
at Roof Louvre 6	219	-	6	80.5	19.7	-	15		219			219.2	9.3	0.0	0.0	22.7	-
at Roof Louvre 7	273	-	6	80.5	17.8	-	15		273			273.2	9.3	0.0	0.0	20.8	-

At NSR, incl façade	Noise criteria				
Night time					
Leq		Leq, night	Status		Lmax
Total					NSR
35.8		47	OK		35.8

Idling outside — Day

	Hor D	Angle	Leq	Leq for 30min	Leq At NSR, no shield, 1hr	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Leq, night At NSR, incl façade	Shadow zone?
	m	Deg	9m	NSR	NSR		mPD	m	m	m	m	m	m				
Short Train	78	102.1	52	40.2	40.2	-	15		78			78.6	8.9	0.0	0.0	43.2	-

Others — Day

	Hor D	Leq	Lw	Leq for 30min	Leq At NSR, no shield, 1hr	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Leq, night At NSR, incl façade	Shadow zone?
	m	14m		NSR	NSR		mPD	m	m	m	m	m	m				
Crane	163		95	42.8	42.8	Mainten' Shed	15	11.15	18	145	1.5	163.2	2.2	15.0	15.0	30.8	Yes
Car Wash	477	62		31.4	31.4	Vent Build	15	12.45	161	316	3	477.0	0.2	12.1	12.1	22.3	Yes

Legend:

Hr: Height of highest floor at receiver
Hor D: Horizontal distance
Angle: Angle of View
Hb: Height of barrier or shield
Dsb: Horizontal distance from noise source to barrier
Dbr: Horizontal distance from barrier to receiver
Hs: Height of noise source
D: Direct path
P: Path difference=Shielded path - D
A barrier: Barrier attenuation (dB)
IL barrier: Barrier loss (dB)

Remark for Equations:

(1): plus 3dB is to adjust SEL from short train to long train.
(2): distance attenuation and angle of view adjustment.
(3): SEL conversion to Leq: Leq = SEL + 10 log V -35.6 ref: FTA Guidance Manual Table 5-2 Rail vehicle ;
plus 10log(2) is to convert Leq(30min) to Leq(1hr).
(4): Barrier effect, ref: FTA Guidance Manual, Table 6-9.
(5): Ref: Transportation Noise Reference Book equation 15.21
(6): To check whether the direct path ray is under shadow zone of shielding.
(7): Direction correction factor for angle between shed exit direction to NSR or direction correction for roof louvre to NSR.
(8): general equation for calculating sound pressure from sound power in free field.
(9): Wheel Squeal is added to the required segments, such as turnout and curve.

SEL Reference for SSS Calculation

SSS Event	Reference Train Length m	Assumed Speed km/h	15m setback SEL(ref) dBA
Loco	1 car	25	85

Remark: SEL of loco running are at low speed. Data collected by MTRC Pat Heung noise measurement.

	Maximum hourly volume of train in SSS (V/hr)			Max 30 minutes volume of train in SSS (V/30min)		
SSS Event	**Day**	**Night**	**24hr**	**Day**	**Night**	**24hr**
Loco launch/arrive	-	4	4 in 24hr	-	2	2 in 24hr
Loco shunting	4	-	3	2	-	2
Loco idling in loco shed	1	0	1hr in 24hr	1	0	1hr in 24hr

SSS Calculation of Sound Power Level for Idling Loco in Loco Shed

Legend:
Lw: Sound Power Level dB re 10^{-12} W
SPL (or Lp): Sound Pressure Level dB re 20μPa
S: Surface area

SPL of One Car of Idling Loco at Gate & Louvre

Leq
dBA
78

Ref: Noise measurement result at Pat Heung West Rail Depot Maintenance Shed on 23 Jan 2009 by Wilkinson Murray.

Total Lw for One Car Loco at Gate of Shed

Door Width	Door Height	no. of Door	S	Lw
W	H	n	WxHxn	
m	m		sq m	dBA
11	6.7	1	73.7	96.7

Total Lw for One Car Loco at Side Louvre of Shed

Louvre Width	Louvre Height	no. of Louvre	S	Lw
W	H	n	WxHxn	
m	m		sq m	dBA
6	1	1	6.0	85.8

Total Lw for One Car Loco at Roof Louvre of Shed

Louvre Diameter	Louvre Area	no. of Louvre	S	Lw
Dia	s	n	sxn	
m	sq m		sq m	dBA
1.5	1.8	14	24.7	91.9

Ancillary Table for SSS Calculation

Angle Correction Factor for angle between shed gate direction to NSR

Angle	Loss	Gradient
Degree	dB	dB/degree
0	0	0.111
45	5	0.078
90	8.5	0.144
135	15	0.200
165	21	0.200

SSS Calculation at NSR SS5 — Un-mitigated

NSR	No. of	Ground Level	Hr	ASR
SS5	Storey	mPD	m	
	3	17.3	7.5	B

Loco launch / Arrive — NIGHT — Remark: plus 10log(2) is for converting of Leq(30min) to Leq(1hr).

	Segment	Hor D	Angle	SEL	SEL for 30min	Leq At NSR, no shield	Shielding	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Wheel Squeal	Leq, night At NSR, incl façade			Shadow zone?
		m	Deg	15m	NSR	NSR		mPD	m	m	m	m	m	m			dB				
Loco	1a	244	61.3	85	71.2	38.6	Mainten' Shed	15	11.15	30	214	3	244.1	1.0	15.0	15.0	0	26.6			Yes
	1b	244	15.5	85	65.2	32.7	Mainten' Shed	15	11.15	30	214	3	244.1	1.0	15.0	15.0	6	26.7			Yes
	2	238	45.7	85	70.1	37.5	-	15		238			238.2	9.6	0.0	0.0	0	40.5			-
	3	123	6	85	64.1	31.5	-	15		123			123.4	9.4	0.0	0.0	6	40.5			-

Remark: For legend of parameters and remark for equations, please refers to the bottom of spreadsheet "SS2".

At NSR, incl façade

Night time Leq Total	ASR	Leq, night	Status	Lmax 15m	Lmax Hor D	Lmax NSR
	Noise criteria					
43.7	B	50	OK	86	238	71.0

Loco Idling

	Hor D	Exit Angle	Direction Correction	Lw	Leq At NSR, no shield	Shielding	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Leq, night At NSR, incl façade			Shadow zone?
	m	Deg			NSR		mPD	m	m	m	m	m	m						
at Gate	271	62.1	6.3	96.7	33.7	-	15		271			271.2	9.6	0.0	0.0	36.7			-
at Side Louvre	282	-	0	85.8	28.8	-	15		282			282.2	9.6	0.0	0.0	31.8			-
at Roof Louvre	288	-	6	91.9	28.7	-	15		288			288.2	9.6	0.0	0.0	31.7			-

At NSR, incl façade

Total Leq, day	Leq, night	Leq, 24h	Lmax
38.8	-	25.0	38.8

Legend:

- Hr: Height of highest floor at receiver
- Hor D: Horizontal distance
- Angle: Angle of View
- Hb: Height of barrier or shield
- Dsb: Horizontal distance from noise source to barrier
- Dbr: Horizontal distance from barrier to receiver
- Hs: Height of noise source
- D: Direct path
- P: Path difference=Shielded path - D
- A barrier: Barrier attenuation (dB)
- IL barrier: Barrier loss (dB)

Remark for Equations:

(1): distance attenuation and angle of view adjustment.
plus 10log(2) is for one set of works train having a loco car at two ends.
(2): SEL conversion to Leq: Leq = SEL + 10 log V -35.6 ref: FTA Guidance Manual Table 5-2 Rail vehicle ;
plus 10log(2) is to convert Leq(30min) to Leq(1hr).
(3): Barrier effect, ref: FTA Guidance Manual, Table 6-9.
(4): To check whether the direct path ray is under shadow zone of shielding.
(5): Loco distance adjustment: 20 log (D1/D2) adjusted to point source.
(6): Direction correction factor for angle between shed exit direction to NSR or direction correction for roof louvre to NSR.
(7): general equation for calculating sound pressure from sound power in free field.

SSS Calculation at NSR SS14 — Un-mitigated

NSR	No. of Storey	Ground Level mPD	Hr m	ASR
SS14				
	3	17	7.5	B

Loco launch / Arrive — NIGHT — Remark: plus 10log(2) is for converting of Leq(30min) to Leq(1hr).

	Segment	Hor D m	Angle Deg	SEL 15m	SEL for 30min NSR	Leq At NSR, no shield NSR	Shield	Track Level mPD	Hb m	Dsb m	Dbr m	Hs m	D m	P m	A barrier	IL barrier	Wheel Squeal dB	Leq, night At NSR, incl façade		Shadow zone?
Loco	1a	190	84.1	85	73.7	41.1	Mainten' Shed	15	11.15	30	160	3	190.1	1.0	15.0	15.0	0	29.1		Yes
	1b	181	21	85	67.9	35.3	Mainten' Shed	15	11.15	21	160	3	181.1	1.4	15.0	15.0	6	29.3		Yes
	2a	220	29	85	68.4	35.8	-	15		220			220.2	9.3	0.0	0.0	0	38.8		-
	2b	220	5.3	85	61.0	28.4	-	15		220			220.2	9.3	0.0	0.0	6	37.4		-

Remark: For legend of parameters and remark for equations, please refers to the bottom of spreadsheet "SS2".

At NSR, incl façade — Noise criteria

Night time Leq Total	ASR	Leq, night	Status	Lmax 15m	Hor D	Lmax NSR	
41.7	B	50	OK	86	190	51.9	shield by mainten' shed
				86	239	71.0	no shield
						71.0	Total

Loco Idling

	Hor D m	Exit Angle Deg	Direction Correction	Lw NSR	Leq At NSR, no shield NSR	Shield	Track Level mPD	Hb m	Dsb m	Dbr m	Hs m	D m	P m	A barrier	IL barrier	Leq, night At NSR, incl façade		Shadow zone?
at Gate	275	42.3	4.7	96.7	35.2	-	15		275			275.2	9.3	0.0	0.0	38.2		-
at Side Louvre	296	-	0	85.8	28.4	-	15		296			296.2	9.3	0.0	0.0	31.4		-
at Roof Louvre	300	-	6	91.9	28.4	-	15		300			300.2	9.3	0.0	0.0	31.4		-

At NSR, incl façade

Total Leq, day	Leq, night	Leq, 24h	Lmax
39.7	-	25.9	39.7

Legend:

- Hr: Height of highest floor at receiver
- Hor D: Horizontal distance
- Angle: Angle of View
- Hb: Height of barrier or shield
- Dsb: Horizontal distance from noise source to barrier
- Dbr: Horizontal distance from barrier to receiver
- Hs: Height of noise source
- D: Direct path
- P: Path difference=Shielded path - D
- A barrier: Barrier attenuation (dB)
- IL barrier: Barrier loss (dB)

Remark for Equations:

(1): distance attenuation and angle of view adjustment.
plus 10log(2) is for one set of works train having a loco car at two ends.
(2): SEL conversion to Leq: Leq = SEL + 10 log V -35.6 ref: FTA Guidance Manual Table 5-2 Rail vehicle ;
plus 10log(2) is to convert Leq(30min) to Leq(1hr).
(3): Barrier effect, ref: FTA Guidance Manual, Table 6-9.
(4): To check whether the direct path ray is under shadow zone of shielding.
(5): Loco distance adjustment: 20 log (D1/D2) adjusted to point source.
(6): Direction correction factor for angle between shed exit direction to NSR or direction correction for roof louvre to NSR.
(7): general equation for calculating sound pressure from sound power in free field.

SSS Calculation at NSR SS15 — Un-mitigated

NSR	No. of	Ground Level	Hr	ASR
SS15	Storey	mPD	m	
	3	15.7	7.5	B

Loco launch / Arrive — NIGHT — Remark: plus 10log(2) is for converting of Leq(30min) to Leq(1hr).

	Segment	Hor D	Angle	SEL	SEL for 30min	Leq At NSR, no shield	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Wheel Squeal	Leq, night At NSR, incl façade	Shadow zone?
		m	Deg	15m	NSR	NSR		mPD	m	m	m	m	m	m			dB		
Loco	1a	168	96.6	85	74.8	42.2	Mainten' Shed	15	11.15	23	145	3	168.1	1.4	15.0	15.0	0	30.2	Yes
	1b	168	17.1	85	67.3	34.7	Mainten' Shed	15	11.15	23	145	3	168.1	1.4	15.0	15.0	6	28.7	Yes
	2a	220	19.1	85	66.6	34.0	-	15		220			220.2	8.0	0.0	0.0	0	37.0	-
	2b	220	8.1	85	62.9	30.3	-	15		220			220.2	8.0	0.0	0.0	6	39.3	-

Remark: For legend of parameters and remark for equations, please refers to the bottom of spreadsheet "SS2".

At NSR, incl façade — Night time — Noise criteria

Leq Total	ASR	Leq, night	Status	Lmax 15m	Hor D	Lmax NSR	
41.9	B	50	OK	86	159	53.5	shield by mainten' shed
				86	281	69.5	no shield
						69.5	Total

Loco Idling

	Hor D	Exit Angle	Direction Correction	Lw	Leq NSR At NSR, no shield	Shield	Track Level	Hb	Dsb	Dbr	Hs	D	P	A barrier	IL barrier	Leq, night At NSR, incl façade	Shadow zone?
	m	Deg			NSR		mPD	m	m	m	m	m	m				
at Gate	288	34.6	3.8	96.7	35.6	Mainten' Shed	15	11.15	69	219	4.7	288.0	0.3	12.9	12.9	25.7	Yes
at Side Louvre	312	-	0	85.8	27.9	-	15		312			312.1	8.1	0.0	0.0	30.9	-
at Roof Louvre	316	-	6	91.9	27.9	-	15		316			316.1	8.1	0.0	0.0	30.9	-

At NSR, incl façade

Total Leq, day	Leq, night	Leq, 24h	Lmax
34.5	-	20.7	34.5

Legend:

- Hr: Height of highest floor at receiver
- Hor D: Horizontal distance
- Angle: Angle of View
- Hb: Height of barrier or shield
- Dsb: Horizontal distance from noise source to barrier
- Dbr: Horizontal distance from barrier to receiver
- Hs: Height of noise source
- D: Direct path
- P: Path difference=Shielded path - D
- A barrier: Barrier attenuation (dB)
- IL barrier: Barrier loss (dB)

Remark for Equations:

(1): distance attenuation and angle of view adjustment.
plus 10log(2) is for one set of works train having a loco car at two ends.
(2): SEL conversion to Leq: Leq = SEL + 10 log V -35.6 ref: FTA Guidance Manual Table 5-2 Rail vehicle ;
plus 10log(2) is to convert Leq(30min) to Leq(1hr).
(3): Barrier effect, ref: FTA Guidance Manual, Table 6-9.
(4): To check whether the direct path ray is under shadow zone of shielding.
(5): Loco distance adjustment: 20 log (D1/D2) adjusted to point source.
(6): Direction correction factor for angle between shed exit direction to NSR or direction correction for roof louvre to NSR.
(7): general equation for calculating sound pressure from sound power in free field.