FINAL REPORT

Meinhardt Consulting Engineers Ltd

HAECO Aircraft Engine Test Cell Facility at Tseung Kwan O: *Environment Impact Assessment*

29 September 1995

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CONSULTING SERVICES BY ENVIRONMENTAL RESOURCES MANAGEMENT

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For and on behalf of ERM-Hong Kong, Ltd

Approved by: [signature]

Position: Technical Director

Date: 29 September 1995

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EXECUTIVE SUMMARY

This Environmental Impact Assessment (EIA) addresses the impacts associated with the construction and operation of phase 1 of the HAECO aircraft engine test facility at Tseung Kwan O. The study has been carried out in response to the EPD comments on an initial EIA completed in August 1994, and the EPD study brief prepared there after.

For the construction phase, the remote location of the site over 2.5 km from the nearest sensitive receiver, implies that noise and dust emissions will not be problematical. Recommendations have been made to limit the potential nuisance of liquid and solid wastes that will be generated by the construction works.

During the operational phase, testing of the aircraft engines may be required at any time of the day or night. Detailed modelling of the noise emissions from the test cell has shown that the proposed design, incorporating substantial stack silencer baffles and 800 mm thick concrete walls, is adequate to control noise levels to meet the appropriate planning standard at all sensitive receivers. Air emissions from the exhaust stack, modelled for worst case meterological conditions, are predicted to be well within the Air Quality Objective standards.

Waste arisings from the operation of the proposed facility have been estimated with reference to the current HAECO operation at Kai Tak. It is anticipated that the mobile waste treatment plant currently in use at Kai Tak will be suitable for treating waste generated by the phase 1 development, although the separation of the two sites may necessitate a second similar plant. It is therefore considered that construction of the proposed permanent waste treatment plant can be delayed until phase 2.

The study concludes that all the identified potential environmental impacts can be mitigated to acceptable levels.

1 INTRODUCTION

1.1 BACKGROUND

The Hong Kong Aircraft Engineering Company (HAECO) are required to move their operation from Kai Tak to make way for the redevelopment of the Airport area after 1997. The aircraft engine testing facility is to be relocated to the new Tseung Kwan O Industrial Estate, just north of Junk Island. The relocation will be in two phases with phase 1 becoming operational in 1996.

An initial EIA was completed in August 1994 in which the feasibillity of the proposed site was established in terms of key Environmental Impacts. This EIA is prepared on behalf of HAECO and draws on information supplied by the design team which is lead by Meinhardt Consulting Engineers Ltd and includes Aero Systems Engineering Inc, from Minnesota USA who are the Specialist Aeronautical Consultants.

1.2 SCOPE AND STRUCTURE OF THE EIA

The Environmental Protection Department have issued a study brief for the EIA as well as comments on the Initial EIA. Together these form the scope of the study. All relevant Environmental issues are considered for the construction and operation of the facility, with noise and air emissions from the operation of the engine test cell being the key issues.

Environmental Monitoring and Auditing recommendations are included where necessary to ensure the efficiency of the proposed mitigation measures.

The study covers only phase 1 of the HAECO facilities to be relocated to Tseung Kwan O. Phase 2, which will include additional engineering workshop facilities and associated buildings, would be the subject of a separate EIA, if required by the EPD.

Following this introduction the report is structured as follows:

Section 2	:	Describes the environment and the existing and proposed development in the surrounding area
Section 3	:	Assesses impacts during the construction phase
Section 4	:	Assesses impacts during the operational phase
Section 5	:	Summarises the conclusions of the study

1.3 *THE PROPOSED DEVELOPMENT*

The proposed phase 1 development comprises two buildings and car parking space as shown in *Figure 1a*. A 100 m long aircraft engine test cell will be used to run the engines under test. The test cell has inlet and exhaust stacks at either end, with a central testing chamber and augmentor tube, a control room, and staff facilities. The test cell incorporates substansive acoustic silencers in the stacks and is a solid concrete building. The second building is an engine strip and build workshop used to prepare the engines for testing, as well as routine maintenance operations.

Aircraft engines will be delivered to the site by lorry, to the strip and build workshop, where they will be prepared for testing before being manoevered into the test cell via overhead monorail. Testing takes about 2½ hours, and comprises a run–up procedure at various engine thrust settings.

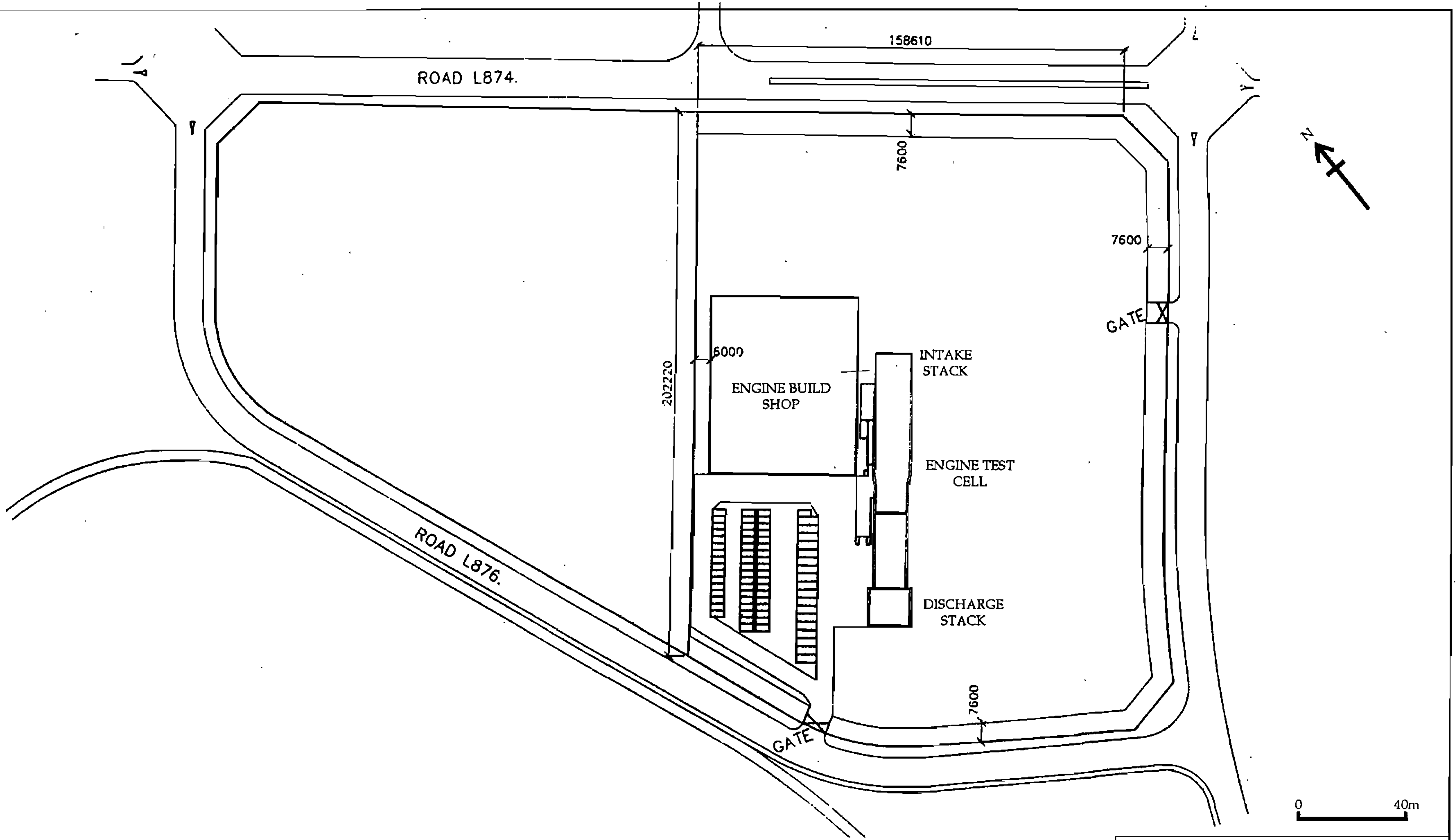

FIGURE 1a - PHASE 1 ENGINE TEST CELL FACILITY SITE LAYOUT

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2 SURROUNDING ENVIRONMENT AND DEVELOPMENT

The site of the engine test cell facility is on the edge of the newly formed Tseung Kwan O reclamation at the southern end of the proposed Tseung Kwan O Industrial Estate, located where the northeast coast of Junk Island meets the reclamation. Chai Wan, on Hong Kong Island, is about 2.5 km to the South of the site, beyond Junk Island and open water. A similar distance to the West are scattered dwellings and villages. The SENT landfill is to the East of the site beyond the reclamation. *Figure 2a* shows the site location.

The new reclamation in Tseung Kwan O will not only be the site of a large Industrial Estate, but will allow the development of Tseung Kwan O new Town further North, about 3 km from the site. *Figure 2a* shows some key features of Outline Zoning Plan for the area with the proposed new town and it's associated infrastructure.

As a result of the large scale of the reclamation, new town, and other developments, the environment of the area is changing substantially. The rural nature of the area will be lost to industrial and townscape settings. The scattered villages on Junk Island and on the old coastline around the South East New Territories (SENT) Landfill have already been relocated to make way for the development of the area.

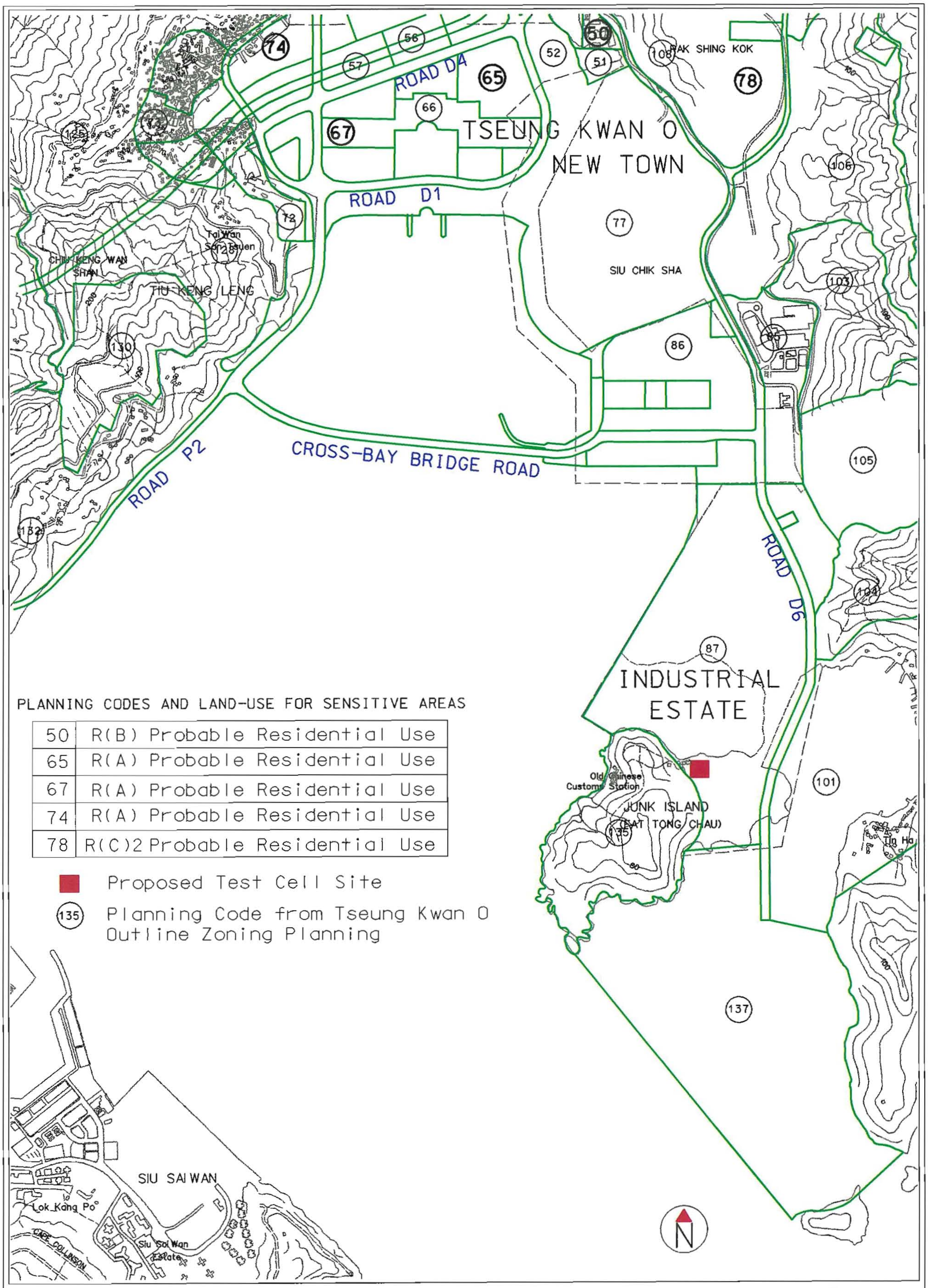

Figure 2A Site Location and Surrounding Area

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3 CONSTRUCTION PHASE

3.1 CONSTRUCTION NOISE

3.1.1 *Introduction*

Although the proposed site is in a remote location, construction noise may have the potential to generate impacts at nearby NSRs, particularly if evening and night-time working is required. These potential impacts are assessed in this section.

A methodology for assessing noise from the construction of the proposed HAECO Jet Engine Test Cell Facility has been developed based on the *Technical Memorandum on Noise From Construction Work Other Than Percussive Piling (TM1)* and the *Technical Memorandum on Noise from Percussive Piling (TM2)*. In general, the methodology is as follows:

- locate NSRs that may be affected by the worksite;
- calculate distance attenuation and barrier corrections to NSRs from worksite notional noise source point;
- predict construction noise levels at NSRs in the absence of any mitigation measures; and,
- calculate maximum total site sound power (SWL) level for construction activities such that $L_{Aeq, period,}$ noise levels at NSRs comply with appropriate noise criteria for day, evening and night time.

The practicability of achieving the aforementioned maximum total site sound power level is then considered since this might offer a preferred form of mitigation. Other mitigation measures are then considered and recommended as appropriate.

3.1.2 *Environmental Legislation and Guidelines*

In Hong Kong the control of construction noise outside of daytime, weekday working hours (0700-1900, Monday through Saturday) is governed by the Noise Control Ordinance (NCO) and the subsidiary *TM1* and *TM2*. These TM establish the permitted noise levels for construction work depending upon working hours and the existing noise climate.

The NCO criteria for the control of noise from powered mechanical equipment (PME) are dependant upon the type of area containing the NSR rather than the measured background noise level. As the NSRs surrounding the proposed test cell fall into mainly urban fringe areas, the Area Sensitivity Rating (ASR) for these NSRs, according to *TM1*, is specified as 'B'. The NCO requires that noise levels from construction at affected NSRs be less than a specified Acceptable Noise Level (ANL) which depends on the ASR.

It is intended that the construction activities of the proposed works should be planned and controlled in accordance with the NCO. Works requiring the use of PME during restricted hours (i.e. outside of 0700-1900 Monday through Saturday and during public holidays) and particularly at night, will require a Construction Noise Permit (CNP) and will need to achieve the applicable ANL. The ANL is derived from the Basic Noise Levels (BNL) by applying corrections for the duration of the works and the effect of any other nearby sites operating under a CNP. For this assessment these corrections are assumed to be zero. As a result, the ANLs are equal to the BNLs. These are shown in *Table 3.1a* below.

Table 3.1a *Acceptable Noise Levels (ANL, $L_{Aeq,5min}$ dB(A))*

Time Period	ASR-A	ASR - B
All days during the evening (1900-2300) and general holidays (including Sundays) during the day and evening (0700-2300)	60	65
All days during the night-time (2300-0700)	45	50

Although the NCO does not provide for the control of construction activities during normal working hours, a limit of $L_{Aeq, 30 min}$ 75 dB is proposed in the "Practice Note For Professional Persons, PN2/93" issued by the Professional Persons Environmental Consultative Committee (ProPECC) in June 1993. This limit has been applied on major construction projects in recent months, and is now generally accepted in Hong Kong, and will therefore be adopted in this study in order to protect NSRs to an appropriate extent.

According to *TM2* a CNP will be required from EPD for carrying out any percussive piling works. In determining whether the permit should be issued, EPD will compare the calculated Corrected Noise Level (CNL) with the ANL. In the event that the CNL exceeds the ANL, EPD will impose restrictions on the permitted hours of piling operation. As percussive piling may be needed for the foundations of the proposed buildings, this assessment will consider the likely restrictions to the hours of working, if necessary, for unmitigated piling activities.

For NSRs with windows or other openings but without central air conditioning systems (ie typical residential dwellings) the ANL for percussive piling is $L_{Aeq,30min}$ 85 dB. More sensitive noise receivers, such as hospitals, medical clinics, educational institutions, and courts of law are stipulated to have an ANL of 75 dB(A); unless they have central air conditioning, in which case the ANL is relaxed to 80 dB(A).

3.1.3 *Baseline Conditions and Noise Sensitive Receivers*

Existing Conditions

The HAECO jet engine test cell facility is to be located on an area of mainly reclaimed land adjacent to Fat Tong Chau (Junk Island) on the Tseung Kwan O Industrial Estate. At the present there are several infrastructure development projects under construction in the area. These include the formation of the reclamation for the Tseung Kwan O New Town, the construction of the Tseung Kwan O Industrial Estate, the construction of Tseung Kwan O New Town, road and infrastructure construction and the completion of the SENT Strategic Landfill. As a result, though the region is not urban or fully developed, the noise environment is affected by construction and road traffic.

Future Conditions

After the completion of the current infrastructure projects, the Tseung Kwan O region will contain a large Industrial Estate, a New Town, new roads, bridges and the operational SENT Landfill. With the reduction in construction noise levels it is anticipated that the local noise climate will become dominated primarily by noise from road traffic and industrial operations.

Noise Sensitive Receivers

NSRs, as defined by HKPSG and the NCO, have been identified with reference to previous environmental studies undertaken in the region of the Tseung Kwan O Industrial Estate, and have been updated by site surveys and by referring to survey sheets and development plans.

The local NSRs and their respective distances to the notional centre of the site are given in *Table 3.1b* below.

Table 3.1b *Noise Sensitive Receivers*

NSR	Location	Distance (m)	ASR
Area 50	Tseung Kwan O	3100	A
Haven of Hope Hospital	Tseung Kwan O	4100	A
Area 73 Villages	Tseung Kwan O	3300	A
Heng Fa Chuen Estate	Chai Wan	3400	B
Tsai Wan Estate	Chai Wan	3500	B
Siu Sai Wan Estate	Chai Wan	2600	B

Currently, there are no influencing factors in the TKO area, so NSRs in this area have been given an ASR of 'A'. NSRs in Chai Wan area are affected by road traffic and industrial activity and so have been assigned an ASR of 'B'.Information from Planning Department has indicated that both the Shek Miu Wan villages and the villages on Junk Island have already been relocated due to works associated with the South East New Territories (SENT) Landfill and the Tseung Kwan O Industrial Estate and Reclamation, respectively. As a result, these areas have not been included in this assessment.

3.1.4 *Potential Sources of Impact*

As the test cell facility will be constructed primarily on reclamation and the facility will be built primarily above ground, there will be little necessity for site clearance or site excavation. As a result, these typical construction operations have not been assessed for this project. Communication with the Design Engineers has indicated that there will be two primary construction operations which will have the potential to create significant noise impact at the nearby NSRs. These operations are:

- foundation construction; and
- building superstructure construction.

The assumed plant teams for these two operations are shown in the tables that follow. It should be noted that the assumed number and types of plant is based on the estimates of the Design Engineers and so should be considered fairly accurate.

Foundation Construction

The buildings will be anchored and supported by percussively piling a steel pile foundation. For this operation, it has been assumed that three diesel hammers driving steel piles (each with a sound power level of 132 dB(A)) will be employed. As a result, the total site sound power level will be 137 dB(A).

Building Superstructure Construction

Once the foundations have been piled, the buildings themselves will be constructed. For this operation the plant inventory in *Table 3.1c*, below, has been assumed.

Table 3.1c *Superstructure Construction Plant Inventory*

Plant	Number	TM Reference Number	Sound Power Level (dB(A))
Tower Crane	2	CNP 049	95+3
Concrete Truck	2	CNP 044	109+3
Concrete Vibrator	4	CNP 170	113+6
Handtools	Various	N/A	105
Compressor	2	CNP 001	104+3
Generator	1	CNP 101	108

The total sound power level calculated for all plant acting at one notional point is 120 dB(A).

3.1.5 *Prediction of Impact*

As distances to NSRs are over 300m, specific formulae for distance attenuation, approved by EPD have been used for assessing impacts from percussive piling and superstructure activities. These formulae are:

- Percussive piling: 23.27*log(distance) + 5.269; and
- Superstructure: 20*log(distance) + 5.0.

It should be noted that the percussive piling formula includes air absorption, while that for superstructure construction does not. As a result, the values, in the table below, for superstructure construction should be considered worst–case.

The predicted impacts at each NSR from the two major construction operations are shown in *Table 3.1d* below.

Table 3.1d *Predicted Façade Noise Levels (LAeq,5min) at each NSR*

NSR	Percussive Piling	Building Construction
Area 50	51	45
Haven of Hope Hospital	48	43
Area 73	50	45
Heng Fa Chuen	50	44
Tsai Wan Estate	49	44
Siu Sai Wan	52	47

These results indicate that there are no predicted exceedances of any of the applicable noise criteria, from piling or superstructure activities, at any of the nearby NSRs. As a result, no mitigation measures have been recommended for these activities.

3.1.6 Mitigation Measures

As no exceedances of the normal daytime (0700-1900, Monday through Saturday) noise criteria (percussive and non-percussive) have been predicted, no mitigation measures, outside of good site practice are recommended for these activities. In addition, as no exceedances of the restricted hours criteria have been predicted to occur at any of the assessed NSRs, mitigation measures are not recommended as necessary for evening, night-time or Public Holiday (including Sundays) works, although a CNP will be required.

As a general rule, good site practice can reduce the impact of a construction site's activities on nearby NSRs. In view of the potential for cumulative impacts from various construction works in the area, the following measures should be followed during each phase of construction:

- only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction programme;
- machines and plant (such as trucks) that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum;
- plant known to emit noise strongly in one direction, should, where possible, be orientated so as to directed away from nearby NSRs;
- silencers or mufflers on construction equipment should be utilised and should be properly maintained during the construction programme; and
- material stockpiles and other structures should be effectively utilised, where practicable, to screen noise from on-site construction activities.

In light of the prediction of no exceedances at nearby NSRs during any time period from either of the main construction activities, no noise monitoring is recommended for the construction phase of the jet engine test cell facility.

3.2 CONSTRUCTION AIR QUALITY

As the nearest sensitive receivers to the proposed HAECO jet engine test facility are more than 2.5 km distant, no air quality impacts are anticipated from the construction of the facility. No further assessment of potential construction air quality impacts has been carried out.

3.3 CONSTRUCTION PHASE WATER QUALITY

3.3.1 *Introduction*

The proposed jet engine testing facility will be located on newly reclaimed land. Potential water quality impacts arising during the construction, and recommended mitigation measures are discussed in the following section.

3.3.2 *Government Legislation and Planning Standards*

Under the Water Pollution Control Ordinance (WPCO), Hong Kong waters are subdivided into 10 Water Control Zones (WCZ). Each WCZ has a designated set of statutory Water Quality Objectives (WQO). For this study, the marine waters of Junk Bay will be the receiving waters for discharges from the Tseung Kwan O site. The WQO for Junk Bay WCZ were declared in 1989.

3.3.3 *Surrounding Environment*

Existing Environment

The water quality in Junk Bay is well documented by the EPD marine water quality monitoring programme. A summary of EPD monitoring data (for 1992) is given in *Table 3.3a*.

In general the data indicates the mean water quality is poor. Dissolved oxygen depth profiles with large gradients are found in inner Junk Bay during the summer, where oxygen depletion is particularly obvious in the bottom waters of these enclosed bays. Weak turbulent mixing and the large amount of organic matter resulting from domestic sewage that is discharged into the water body cause this oxygen depletion. In addition, high BOD_5 levels in the water column were measured in inner Junk Bay due to the local organic discharges, and high numbers of E.coli occur on occasions.

Table 3.3a *Summary Statistics Water Quality of Junk Bay (1992)*

Determinant		Inner Junk Bay	Outer Junk Bay	
		JM2	JM3	JM4
Number of samples		12	12	12
Temperature (°C)	Surface	22.4 (15.5 – 29.3)	22.4 (15.6 – 29.3)	22.4 (15.6 – 29.2)
	Bottom	22.1 (15.5 – 28.8)	22.0 (15.6 – 28.7)	21.9 (15.6 – 28.7)
Salinity (ppt)	Surface	31.3 (27.1 – 33.0)	31.4 (27.6 – 33.0)	31.4 (27.4 – 32.9)
	Bottom	31.8 (29.6 – 33.0)	31.9 (29.9 – 33.0)	32.0 (30.0 – 33.6)
DO (% satn.)	Surface	86 (56 – 132)	86 (68 – 100)	82 (54 – 102)
	Bottom	72 (42 – 105)	77 (50 – 112)	78 (57 – 114)
pH value		8.1 (7.9 – 8.3)	8.1 (7.8 – 8.3)	8.0 (7.8 – 8.3)
Secchi Disc (m)		2.1 (1.5 – 2.6)	1.7 (1.3 – 2.6)	1.6 (0.8 – 2.6)
Turbidity (NTU)		3.9 (2.2 – 5.2)	4.3 (2.3 – 7.3)	6.3 (2.5 – 14.7)
Suspended Solid (mg/l)		4.2 (2.0 – 7.5)	5.1 (3.0 – 8.2)	9.2 (2.3 – 28.0)
BOD_5 (mg/l)		1.4 (0.5 – 2.4)	1.0 (0.5 – 1.6)	1.0 (0.4 – 1.8)
Inorganic N (mg/l)		0.31 (0.18 – 0.51)	0.31 (0.51 – 0.53)	0.27 (0.14 – 0.56)
Total N (mg/l)		0.64 (0.37 – 1.03)	0.62 (0.27 – 1.22)	0.55 (0.27 – 0.94)
PO_4 -P (mg/l)		0.04 (0.01 – 0.12)	0.03 (0.01 – 0.06)	0.03 (0.01 – 0.05)
TP (mg/l)		0.15 (0.05 – 0.48)	0.13 (0.06 – 0.21)	0.14 (0.03 – 0.28)
Chlorophyll a (μg/l)		2.93 (0.25 – 10.50)	1.08 (0.20 – 3.43)	0.69 (0.20 – 2.37)
E. coli (no./100ml)		133 (12 – 975)	453 (74 – 1667)	622 (313 – 1800)

Note: 1. Except as specified, data presented are depth average data.
2. Data presented are annual means except for *E. coli* data which are annual geometric means.
3. Data enclosed in brackets indicate the ranges.

Future Conditions

The level of organic pollution is expected to decrease in the future with the progressive implementation of the various government pollution abatement measures including the Stage I of the Strategic Sewage Disposal Scheme (SSDS). With the gazetting of Victoria Harbour WCZ and the implementation of Stage II of the SSDS, there will be an improvement in the baseline water quality in the Territory, with reduced pollutant loading and considerable improvement in averaged DO concentrations throughout the harbour for any of a number of reclamation scenarios.

Sensitive Receivers

The nearest biological sensitive receiver of the site is Tung Lung Chau mariculture zone. However, this is located approximately 4 km south-east of the site, and it is considered that this is sufficiently removed to ensure that no water quality impacts will result from the construction and operation of the facility.

There are no other major biological sensitive receivers such as commercial fisheries, shellfisheries, or water gathering grounds within the vicinity of the study area. Therefore this assessment is based on compliance with the WQOs rather than specific criteria for specific sensitive receivers.

3.3.4 *Evaluation Criteria*

The Water Quality Objectives and the *Technical Memorandum on Effluent Standards* are the appropriate evaluation criteria.

Water quality impacts from the construction works for the jet engine testing facility are assessed with respect to the Junk Bay WQO, and in relation to the baseline data collated from the EPD monitoring records. The WQO of most relevance during the construction phase will be the suspended solids (SS) and the dissolved oxygen (DO) level parameters.

SS levels: Activities during the construction phase must not cause the natural ambient SS level to be raised by more than 30% nor give rise to accumulation of SS.

DO levels: DO levels should not be less than 2mg/l at the sea bottom and above 4mg/l at depth average.

The *Technical Memorandum (TM)*, issued under Section 21 of the Water Pollution Control Ordinance, defines acceptable discharge limits to different types of receiving waters. Under the *TM*, effluent discharged into the inshore and marine waters of the WCZ are subject to standards for particular volumes of discharge. These are defined by EPD and specified in licence conditions for any new discharge within a WCZ.

3.3.5 *Potential Sources of Impact*

The potential sources of water quality impacts that could arise from the construction of the jet engine testing facilities will be similar to those of other general construction activities.

These include:

- construction run–off and drainage;
- general construction activities; and
- sewage from on–site construction workforce.

These potential impacts on water quality are discussed in the following sections.

Construction run–off and drainage

Run–off and drainage from construction sites may contain increased loads of sediments, other SS and contaminants. Potential sources of pollution from site drainage include:

- run–off and erosion from site surfaces, drainage channels, earthworking and stockpiles;
- bentonite slurries and other grouting materials;
- concrete batching plant washout and drainage from dust suppression sprays; and
- fuel, oil and lubricants from construction vehicles and equipment.

Sewage Effluent

Based on the scale of the construction work, it is estimated that around 250 workers will be employed during the busiest periods of construction. However, this will greatly depend on the construction activities on site and will vary throughout the construction period. Assuming that each worker produces 55 litres of sewage effluent per day[(1)], the total sewage effluent discharge would be equivalent to about 13.75 m^3 per day, when the on–site workforce size is at a maximum. This quantity of effluent would require appropriate treatment, and TM standards should be applied to any sewage effluent discharges.

3.3.6 *Evaluation of Impacts*

The significance of the identified potential water quality impacts arising from the construction activities are assessed in this section.

Construction Run–off and Drainage

There are no potentially ecologically sensitive receivers within the waters in the vicinity of the site. In addition, given the purpose built nature of the industrial site on reclaimed land, and the distance of the site from the shoreline (approximately 300 m at present) it is unlikely that runoff from the construction site will have any impact on the water quality of the receiving waters provided that standard measures are implemented to control and treat the runoff prior to discharge. Appropriate measures are detailed below.

(1) Guidelines for the design of small sewage treatment plant, EPD 1990.

Sewage Effluent

In general, sewage effluent should be discharged to the public sewerage system near the works site. However, there are presently no existing foul sewers to connect to in the area although it is anticipated by Hong Kong Industrial Estate that the site sewerage will be available for mid 1996. Thus interim portable sewage treatment facilities will be necessary to pretreat the sewage arising from the on-site construction workforce, (such as chemical toilets and packaged sewage treatment facilities), before discharge to the adjacent coastal waters. *TM* standards should be applied to any sewage effluent discharges. The effect of sewage discharge provided it receives adequate treatment should not be significant.

Assuming a maximum flow rate of approximately 13.75 m^3 per day is anticipated, for which the effluent standards taken from the TM for Junk Bay are:

- Suspended Solids 30 mg/l
- Biochemical Oxygen Demand 20 mg/l

These standards should be readily achieved with the installation of packaged sewage treatment facilities as a foul sewer is not expected to be available.

3.3.7 *Measures for Mitigation*

Although land based construction activities for the HAECO site will have minimal impact on the water quality, it is important that appropriate measures be implemented to minimise the cumulative impacts associated with the ongoing construction work in the area including the full development or the industrial estate and Tseung Kwan O New Town. Proper site management is essential to minimise wash off during rainy seasons, and provision of adequate waste disposal facilities and appropriate usage of these facilities, as discussed in *Section 3.4*, to ensure that debris and rubbish cannot gain access to nearby water bodies, should be implemented. The measures below are recommended during the construction of HAECO facility to minimise impacts on the water quality.

Site Runoff

All site construction runoff should be controlled and treated to prevent high levels of SS entering surrounding waters. The following measures, which constitute good site practice, should be considered where applicable:

- Temporary ditches should be provided to facilitate runoff discharge into the appropriate watercourses, via a silt retention pond.

- Permanent drainage channels should also incorporate sediment basins or traps, and baffles to enhance deposition rates.

- All traps (temporary or permanent) should also incorporate oil and grease removal facilities.

- Sediment traps must be regularly cleaned and maintained by the Contractor. Daily inspections of such facilities should be required of the Contractor.

- Concrete batching plants should be bunded to contain the surface water runoff.
- Water from concrete batching plants must also pass through sediment traps and settlement tanks prior to runoff into watercourses. These must be regularly cleaned and maintained by the Contractor.
- Collection of spent bentonite/other grouts in a separate slurry collection system for either cleaning and reuse/disposal to landfill.
- Maintenance and plant areas should be bunded and constructed on a hard standing with the provision of sediment traps and petrol interceptors.
- All drainage facilities must be adequate for the controlled release of storm flows.
- Exposed soil areas should be minimised to reduce the potential for increased siltation and contamination of runoff.
- All chemical stores shall be contained (bunded) such that spills are not allowed to gain access to water bodies.
- Chemical toilets will be required to handle the sewage from the on-site construction workforce.
- Trapped sediments etc. should be suitably disposed of to landfill.

Debris and Litter

In order to comply with the aesthetic criteria for the Junk Bay WQO, Contractors should be required, under special conditions of contract, to ensure that site management is optimised and that disposal of any solid materials, litter or wastes should not occur to the surface and marine waters.

Oils and Solvents

All fuel tanks and store areas should be provided with locks and be sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity.

Sewage

All polluted water should be treated before discharge. Small integrated treatment units are available which combine grease traps and treatment chambers with aeration and settlement facilities. The treated effluent can subsequently be discharged to 'storm sewer', providing it complies with the TM. This level of treatment should be readily achieved by standard portable treatment units. This is considered a practical option, and there are no constraints anticipated as electricity will be supplied by an on-site generator and the portable treatment facilities are designed to be compact in nature.

Environmental Monitoring and Auditing

It is not considered necessary for water quality to be monitored during the construction phase, but it is recommended that the Contractor should be audited to check for compliance with the above recommend mitigation measures.

3.3.8 *Conclusions*

Given the distance of the site from the shoreline, it is considered that no water quality impacts in exceedance of the WQO will occur, provided the mitigation measures recommended above are implemented wherever practical. Proper site management and good construction practice, including appropriate waste disposal procedures, will be required to reduce the chance of chemical/oil spillages and the occurrence of littering and debris, and therefore ensure minimal water quality impact. Undesirable site discharges to the surrounding waters should be minimised in view of the potential cumulative effects of the numerous construction works in the area.

3.4 *CONSTRUCTION WASTE DISPOSAL*

3.4.1 *Introduction*

This section identifies potential wastes arising from the construction of the new engine test cell and engine strip and build shop, and assesses the potential environmental impacts resulting from these wastes.

The general waste characteristics, handling methods and disposal routes for wastes generated during the construction stage have been examined. Procedures for waste reduction and management are considered and mitigation measures for minimising the potential impacts are recommended.

3.4.2 *Legislation*

The following legislation covers or has some bearing upon the handling, treatment and disposal of wastes in Hong Kong:

- Waste Disposal Ordinance (Cap 354);
- Waste Disposal (Chemical Waste) (General) Regulation (Cap 354);
- Crown Land Ordinance;
- Public Cleansing and Prevention of Nuisances (Urban Council) and (Regional Council) By-laws (Cap 132); and
- Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes.

Waste Disposal Ordinance

The Waste Disposal Ordinance prohibits the unauthorised disposal of wastes, with waste defined as any substance or article which is abandoned. Construction waste is not directly defined in the Ordinance but is considered to fall within the category of "trade waste".

Trade waste is defined as waste from any trade, manufacturer or business, or any waste building, or civil engineering materials, but does not include animal waste.

Under the Ordinance, wastes can only be disposed of at a licensed site. A breach of these regulations can lead to the imposition of a fine and/or a prison sentences. The Ordinance also provides for the issuing of licences for the collection and transport of wastes. Licences are not, however, currently issued for the collection and transport of construction and/or trade wastes.

Crown Land Ordinance

Construction wastes which are wholly inert may be taken to public dumps. Public dumps usually form part of land reclamation schemes and are operated by the Civil Engineering Department. The Crown Land Ordinance requires that dumping licences are obtained by individuals or companies who deliver suitable construction wastes to public dumps. The licences are issued by the Civil Engineering Department under delegated powers from the Director of Buildings and Land.

Individual licences and windscreen stickers are issued for each vehicle involved. Under the licence conditions public dumps will accept only inert building debris, soil, rock and broken concrete. There is no size limitation on the rock and broken concrete, and a small amount of timber mixed with other suitable material is permissible. The material should, however, be free from marine mud, household refuse, plastic metal, industrial and chemical waste, animal and vegetable matter and other material considered unsuitable by the dump supervisor.

Public Cleansing and Prevention of Nuisances

These Regulations provide a further control on the illegal tipping of wastes on unauthorised (unlicensed) sites. The illegal dumping of wastes can lead to fines of up to HK$ 200,000 and imprisonment for up to 6 months.

Waste Disposal (Chemical Waste) Regulation

These Regulations relate more directly to the Operation of the facility and therefore an explanation of their role is given in *Section 4.4*.

3.4.3 *Waste Arisings and Impacts*

Sources of Wastes

Activities during the construction phase will result in the generation of a variety of wastes which can be divided into distinct categories based on their nature and the options for their disposal. These include:

- excavated and inert material suitable for reclamation and fill;
- general construction waste;
- chemical waste; and
- general refuse.

The definitions for each of these categories and the nature of their arisings and potential impacts are discussed in the following sections.

Excavated Material

It is expected that the construction will not generate significant quantities of excavated material, since little below ground work is required.

Excavated material will comprise primarily rock and marine sand which has been used as reclamation fill. Given the likely inert nature of this material, reuse on-site or at reclamations is not likely to have any significant environmental impact.

General Construction Waste

Waste will arise from a number of different activities carried out during construction which may include:

- wood from formwork;
- equipment and vehicle maintenance parts;
- materials and equipment wrappings;
- unusable cement/grouting mixes; and
- damaged or contaminated construction materials.

The volume of construction waste generated will be dependant on the operating procedures and site practices, and hence cannot be quantified at this stage.

Due to the inert nature of most construction waste, disposal is not likely to raise long term environmental concerns. In order to conserve void space at the landfill sites, construction waste must not be disposed of at a landfill site if it contains more that 20% inert material by volume. The Government, therefore, encourages segregation of wastes at construction sites. Inert materials may be disposed of at a public dump, while putrescible materials (eg wood) must be disposed of at a landfill.

If construction wastes are generated in large quantities they may hinder building operations and present a safety hazard if not removed, in addition to causing potential water quality impacts, as discussed in *Section 3.3*. The storage and stockpiling of construction waste prior to utilisation on site or disposal could also lead to the generation of dust and may be visually intrusive.

The disposal of construction wastes also have the potential result in additional noise impacts, possible congestion due to increased traffic loadings, and dust and exhaust emissions from the haul vehicles.

Chemical Waste

Chemical Waste as defined under the *Waste Disposal (Chemical Waste)(General) Regulation* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the Regulations. A complete list of such substances is provided under the Regulations. Chemical wastes likely to be generated during the construction will for the most part arise from the maintenance of plant and equipment.

These may include, but need not be limited to the following:

- spent filter cartridges containing heavy metals;
- scrap batteries or spent acid/alkali from their maintenance;
- brake clutch linings containing asbestos materials;
- used hydraulic and lubricating oil;
- spent mineral oils/cleaning fluids from mechanical machinery; and
- spent solvents/solutions, which may be halogenated, from equipment cleaning activities.

Chemical wastes pose serious environmental and health and safety hazards if not stored and disposed of in an appropriate manner. It is unlikely that any significant quantities of chemical wastes will be generated during the construction and therefore the Regulations, environmental impacts and mitigation measures are not dealt with in any detail within this section. If chemical wastes do arise during the construction they should be stored, transported and disposed of in accordance with the guidelines detailed in *Section 4.4* of this report.

General Refuse

The construction works will result in the generation of a variety of general refuse requiring disposal. General refuse may include newspapers, food wastes and packaging, and waste paper and will generally be disposed of to landfill.

The storage of general refuse has the potential to give rise to a variety of adverse environmental impacts. These include odour if waste is not collected frequently (eg. daily), windblown litter, water quality impacts if waste enters water bodies, and visual impact. The site may also attract pests and vermin if the waste storage area is not well maintained and cleaned regularly. In addition, disposal of wastes, at sites other than approved landfills, can also lead to similar adverse impacts at those sites.

3.4.4 Recycling, Treatment, Storage, Collection, Transport and Disposal Options

This section discusses the options for waste management and highlights the methodologies available for waste minimisation.

General Construction Waste

A number of measures can be introduced during the construction period relating to a high standard of design and management which will minimise the generation of general construction wastes.

The design could maximise the use of standard wooden panels in formwork so that the maximum reuse of panels can be achieved. The need to cut panels could also be minimised. Alternatives such as the use of steel formwork or plastic facing could be considered to increase the potential for reuse. It is important that wood wastes are stored separately from other general construction wastes to minimise any contamination which would render the wastes unsuitable for disposal at public dumps.

Careful planning and good site management could be employed to minimise the over ordering or mixing of concrete, mortars and cement grouts.

In addition proper storage and site practices will minimise the damage or contamination of construction materials.

Construction waste can either be disposed at a specified landfill, or at a public dumping ground. Depending on the nature of the construction wastes generated, surplus construction waste not suitable for re-use on-site will be collected by a waste collector under arrangement with the Contractor and deposited at a suitable public dump or designated landfill. The contractor should ensure that the necessary waste disposal permits have been obtained prior to the collection of the waste.

Many Port and Airport Developments (PADS) related contracts, reclamations or other public dumps have a requirement to import fill material from elsewhere. In addition, due to the limited void space at landfills for disposal of domestic and industrial waste in Hong Kong, disposal at these reclamation sites or an approved public dump would be the preferred method.

It would be advantageous for the contractor to recycle as much as possible of the construction waste on-site, in order to reduce the requirement to import additional materials. Recycling would also reduce the collection, transportation and disposal of construction waste and any associated charges by the waste haulier. At the present time, Government has not implemented a charging policy for the disposal of waste to landfill although this is currently under consideration and may be implemented for all wastes, including construction wastes, in early 1995.

On site measures may be implemented which promote the proper disposal of wastes once off site. For example having separate skips for inert (rubble, sand, stone, etc) and non-inert (wood, organics, etc) wastes would help ensure that the former are taken to public dumps, while the latter are properly disposed of at controlled landfills. Since waste brought to public dumps will not be charged, while those brought to landfill may be charged, separating waste may also help to reduce waste management costs.

If waste materials have to be collected for disposal then maximising loads will keep the number of trips to a minimum. The nearest public dumps which will be receiving wastes during the time of the construction are located at Tseung Kwan O. If landfill disposal has to be used, because of the costs of transport to the landfills and/or the adverse impacts associated with long haulage of these materials to a public dump, then the South East New Territories Landfill (SENT) or the Tseung Kwan O Landfill are available for the disposal of construction wastes. Tseung Kwan O Landfill is scheduled to close in 1995.

Chemical Wastes

Chemical wastes will arise principally as a result of maintenance activities. Again, it is difficult to quantify the amount of chemical waste which will arise from the construction activities since it will be highly dependant on the contractor's on-site maintenance requirements and the number of plant and vehicles utilised.

If chemical wastes do arise from the construction works then appropriate methods should be employed for their storage collection and disposal, as detailed in *Section 4.4*. The civil engineering contractor should contact Enviropace, the Chemical Waste Treatment Facility operator, who offer both a chemical waste collection service and supply the necessary storage containers for these wastes. In addition, the contractor should contact the EPD to ensure that the handling and disposal methods for the wastes in question are appropriate.

General Refuse

General refuse generated on-site should be stored and collected separately from other construction and chemical wastes. The contractor may arrange for the collection and disposal of the refuse by a reputable waste haulier. The removal of waste from the site should be arranged on a daily or at least on every second day by the contractor to minimise any potential odour impacts, minimise the presence of pests, vermin and other scavengers and prevent unsightly accumulation of waste.

General refuse should be stored in enclosed bins or compaction units. Compaction units assist in reducing the volumes of waste to be transported for disposal. The relatively small volumes of wastes generated during the construction may be insufficient to justify the use of compaction units. Provided appropriate handling, storage, and disposal procedures and facilities are employed during the construction stage, no unacceptable impacts resulting from waste generation are anticipated to occur.

3.4.5 *Mitigation Measures*

This section sets out ERM's recommended storage, transportation and disposal measures to avoid potentially significant environmental impacts associated with waste arisings from the construction of the facility or to reduce these to acceptable levels.

Segregation of Wastes

In order to ensure that all waste is disposed of in an appropriate manner, waste should be separated by category on-site by the civil engineering contractor. The Consultants recommend that the waste be segregated into the following previously defined categories:

- excavated material (inert) suitable for reclamation or fill;
- construction waste (inert) for disposal at public dump;
- construction waste (non inert) for landfill;
- chemical waste; and
- general refuse.

It is recommended that the segregated wastes should then be disposed of as follows:

(a) inert construction waste material when deemed suitable for reclamation or land formation should be disposed of at public dumping areas;

(b) inert material deemed unsuitable for reclamation or land formation and non-inert construction waste material should be disposed of at landfills;

(c) chemical waste as defined by *Schedule 1* of the *Waste Regulations (Chemical) 1992*, should be stored in accordance with approved methods defined in the Regulations and the chemical waste disposed of at the Chemical Waste Treatment Centre located at Tsing Yi; and

(d) general refuse should be disposed of at public landfill.

Waste Minimisation

Construction materials should be recycled or reused wherever possible. The waste management strategy to be employed should be waste minimisation at source. Where waste generation is unavoidable then the potential for recycling or reuse should explored and opportunities taken. If wastes cannot be recycled then the recommended disposal routes should be followed.

Waste reduction measures should be introduced at the design stage and carried through the construction activities, wherever possible, by careful purchasing control, reuse of formwork and good site management.

Training and instruction of construction staff should be given at the HAECO site to increase awareness and draw attention to waste management issues and the need to minimise waste generation.

Waste Treatment

It is not anticipated that there will be any waste treatment, except sewage, undertaken at the HAECO site during the construction.

Storage, Collection and Transport of Waste

Reputable waste hauliers should be used to collect and transport the wastes to the appropriate disposal points. The necessary measures to minimise adverse impacts including windblown litter and dust from the transportation of these wastes should also be instigated.

It is recommended that:

- wastes should be handled and stored in a manner which ensures that they are held securely without loss or leakage thereby minimising the potential for pollution;
- only reputable waste hauliers authorised to collect the specific category of waste concerned should be employed;
- appropriate measures should be employed to minimise windblown litter and dust during transportation by either covering trucks or transporting wastes in enclosed containers;
- the necessary waste disposal permits should be obtained from the appropriate authorities, if they are required, in accordance with the Waste Disposal Ordinance (Cap 354), Waste Disposal (Chemical Waste) (General) Regulation (Cap 354) and the Crown Land Ordinance;
- collection of general refuse should be carried out frequently, preferably daily;

- waste should only be disposed of at licensed sites and HAECO staff and the civil engineering contractor should develop procedures to ensure that illegal disposal of wastes does not occur;

- waste storage areas should be well maintained and cleaned regularly; and

- records should be maintained of the quantities of wastes generated, recycled and disposed, determined by weighing each load or other method.

Environmental Monitoring and Auditing

It is recommended that auditing of each waste stream should be carried out periodically to determine if wastes are being managed in accordance with company procedures and if waste reduction targets are being achieved and could be improved. The audits should look at all aspects of waste management including waste generation, storage, recycling, treatment, transport, and disposal. An appropriate audit programme would be to undertake a first audit at the commencement of the construction works, and then to audit quarterly thereafter.

3.4.6 Conclusions

No unacceptable impacts upon the environment, in terms of specified government regulations and guidelines, have been identified arising from the storage, handling, collection, transport and disposal of wastes from the construction of HAECO's facility at the Tseung Kwan O site. In most cases the waste material can be easily re-used on other construction sites or disposed of to landfill.

However, the mitigation measures recommended in this section should be applied to ensure that environmental nuisance does not arise from the storage, transport and disposal of the various types of waste arisings from the construction of the new engine testing facility. This is particularly pertinent in view of the large scale in the overall construction works proposed on the Tseung Kwan O reclamation.

4 OPERATIONAL PHASE

4.1 NOISE

4.1.1 *Introduction*

The operation of the jet engine test cell will introduce a very substantial noise source into the site taken by the HAECO facility on the South of the TKO Industrial Estate. The 24–hour operation of the test cell has the potential to create significant noise impacts at the surrounding NSRs.

The operational noise from the proposed HAECO jet engine test facility has been assessed using the methodology based on the *Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites (TM)*. In general, the methodology is as follows:

- locate noise sensitive receivers (NSRs) and determine the Area Sensitivity Rating (ASR) of the area;
- determine the Acceptable Noise Level (ANL) for each NSR;
- determine the noise levels from noisy operations at the test cell;
- make appropriate corrections (tonality, intermittency, impulsiveness) to the noise levels from noisy operations;
- calculate distance attenuation from the sources to the NSRs;
- predict noise levels at NSRs in the absence of any mitigation measures; and
- calculate the maximum sound power level for each source such that $L_{Aeq,period}$ noise levels at NSRs comply with appropriate noise criteria.

Mitigation measures are then considered and recommended, if necessary, to reduce the noise impact at the NSRs.

4.1.2 *Environmental Legislation and Guidelines*

Noise from Industrial Sources in Hong Kong is controlled by the *Noise Control Ordinance 1988*, and its associated *Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites (TM)*. New development in Hong Kong is also governed by the Hong Kong Planning Standards and Guidelines (HKPSG). The HKPSG recommends that for new developments the noise levels at the nearest NSRs should be 5 dB(A) below the appropriate Acceptable Noise Levels (ANL) referenced under the NCO, or equal to the prevailing background noise levels, whichever is lower.

For the operational phase, the presence of the new industrial estate and associated roads will introduce influencing factors into the TKO area. According to the *TM*, noise sensitive receivers (NSRs) which are located within a rural or an urban fringe environment in which they are indirectly affected by influencing factors (roads and industrial complexes) are given an area sensitivity rating (ASR) of 'B' (as discussed in the methodology statement issued to EPD on 20 October 1994). The ANLs for ASR 'B' are as shown in *Table 4.1a.* below.

Table 4.1a *Acceptable Noise Levels (LAeq, 30min) for Industrial Noise Sources*

Time Period	NCO Limit for ASR 'B', dB(A)	HKPSG Criterion (ANL-5 dB(A))
Daytime (0700-1900)	65	60
Evening (1900-2300)	65	60
Night time (2300-0700)	55	50

The theoretical measured noise level (MNL), calculated by standard acoustical techniques, is not compared directly with these criteria; instead, a corrected noise level (CNL) is first calculated according to the following formula:

- $CNL = MNL + c_{tone} + c_{imp} + c_{int}$ dB(A);

where:

- c_{tone} is a correction for tonality (not in excess of 6 dB(A));
- c_{imp} is a correction for impulsiveness (not in excess of 3 dB(A)); and
- c_{int} is a correction for intermittency (not in excess of 6 dB(A)).

The CNL is compared with the criteria and if exceedances are anticipated then mitigation is recommended.

Current Hong Kong statutory requirements (*Factories and Industrial Undertakings [Noise at Work] Regulation*) stipulate that the plant within occupied areas of the facility should be designed to achieve the following noise levels:

- maximum limit of $L_{Aep,d}$ 85 dB at 1 m from a single source operating alone with all facility equipment in full operation; and,

- a maximum daily noise peak of 140 dB(A).

The workforce should not be exposed to noise levels above $L_{Aep,d}$ 85 dB. If exceedances of this level are anticipated then various actions including the provision of hearing protection are required by Hong Kong law.

An assessment of internal noise levels will only be possible when detailed design information is available and therefore cannot be undertaken at this stage.

4.1.3 *Baseline Conditions and Noise Sensitive Receivers*

Existing Conditions

The existing noise climate is the same as that detailed in the construction section (*Section* 3.1.3).

Future Conditions

The future noise climate will be the same as that detailed in the construction section (*Section* 3.1.3).

Noise Sensitive Receivers

Operational phase NSRs, as defined by HKPSG and the NCO, have been identified with reference to previous environmental studies undertaken in the region of the Tseung Kwan O Industrial Estate, and have been updated by site surveys and by referring to survey sheets and development plans. The local NSRs are shown in *Figure 4.1a* and their respective distances to the notional centre of the site are given in *Table 4.1a* below.

Table 4.1b *Noise Sensitive Receivers*

NSR	Location	Distance	ASR
Area 50	Tseung Kwan O	3100	B
Area 65	Tseung Kwan O	2750	B
Area 67	Tseung Kwan O	2900	B
Area 74	Tseung Kwan O	3100	B
Area 78	Tseung Kwan O	2700	B
Heng Fa Chuen Estate	Chai Wan	3400	B
Tsai Wan Estate	Chai Wan	3500	B
Siu Sai Wan Estate	Chai Wan	2600	B

4.1.4 *Potential Sources of Impact*

The primary source of noise impact from the facility will be from the testing of engines within the jet engine test cell. It has been proposed that at most two engines will be tested per day, each for a duration of 2 hours and 45 minutes. Each test will comprise a sequence of engine runs at different loads, which should approximate the following:

- 5 minutes at maximum take-off-thrust;
- 1 hour and 50 minutes at 80% of maximum take-off-thrust;
- 25 minutes at 50% of maximum take-off-thrust; and
- 25 minutes at 30% of maximum take-off-thrust.

Testing will potentially take place at anytime during the 24-hour daily period.

Other sources of noise will include vents, ducts and chillers associated with the test cell and other buildings within the facility. These sources, however, will be minor in comparison to the test cell noise emission during a jet engine test run.

4.1.5 *Prediction of Impact*

Test Cell

Modelling Methodology

Noise levels from the proposed jet engine test cell were calculated by a two-step procedure. First, the test cell designers, Aero Systems Engineering, Inc (ASE), used their jet engine test cell model to calculate sound pressure levels and frequency level characteristics near the boundary of the cell (at 1m from the walls and the top of the stacks), with particular attention to the intake and exhaust stacks. These levels were then input into the SoundPlan Environmental Noise model, which then generated noise contours on a 3-dimensional gridded surface representing the region (approximately out to a distance of 3 km in the directions of NSRs) around the proposed test cell.

ASE's test cell acoustic model has been developed and validated through their experience in designing test cells around the world. The most recent validation was at an ASE designed test cell in Seoul, Korea for Korean Air Lines (KAL). A comparison between the theoretically predicted noise levels (by frequency) of the ASE model and the experimentally measured levels at this test cell are shown in *Annex A*. To protect the confidentiality of the model, the algorithms and procedures used in the model have not been released by ASE; however, the sources of the equations are as follows:

- Intake Design: "Noise and Vibration Control Engineering", by L.L. Beranek and Istran Ver;
- Atmospheric Attenuation: "Aerospace Recommended Practice 866A", by Society of Automotive Engineers (SAE), Inc. (3-15-75) and hemispherical spreading laws;
- Test chamber absorption and reverberation: Sabine theory for diffuse field noise in large volume chambers;
- Exhaust System Design: "Noise and Vibration Control Engineering", by L.L. Beranek and Istran Ver;
- Augmentor tube design: no attenuation is assumed from a hard wall augmentor tube (applicable to HAECO test cell); and
- Diffuser basket: based on BBN report No. 2217, "Acoustic Analysis of McDonnell Douglas Corporation 7x7 foot Transonic Wind Tunnel", pp. 29-31.

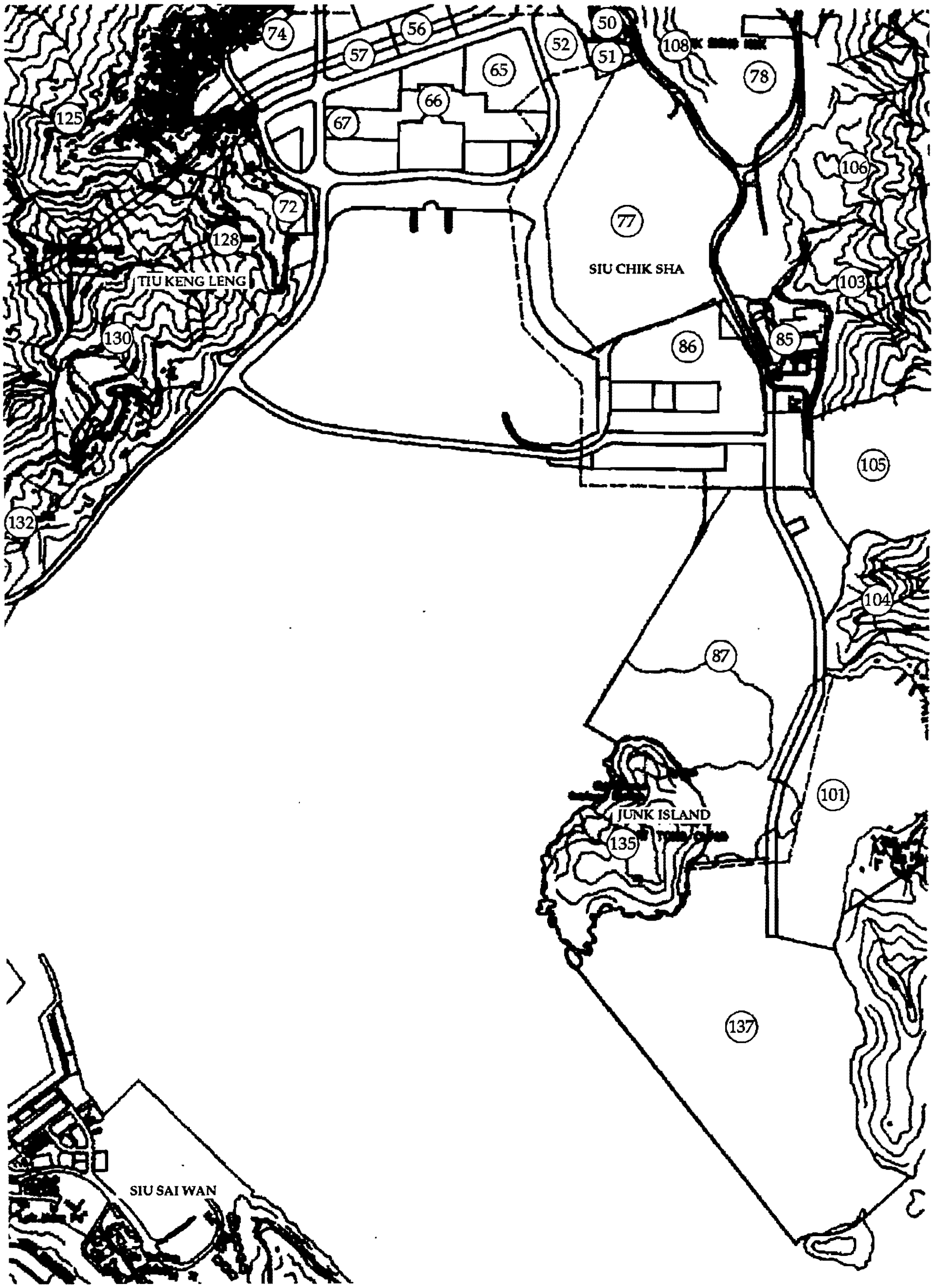

FIGURE 4.1a - NSRs NEAR THE ENGINE TEST CELL

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Hong Kong

ERM

For the ASE model all source terms are input as sound power levels which are obtained from the manufacturer of the engine from their own free field measurements. For engines which are not yet in operation, engine manufacturer's estimates or theoretical projections (based upon thrust projections) are used to develop probable engine sound power levels.

The SoundPlan noise modelling software implemented the *ISO/DIS 9613-2 Part* 2 methodology to calculate the sound pressure levels generated by the jet engine test cell during the testing of each type of Rolls Royce engine: RB211-22B, RB211-524 G/H, Trent 772 and Trent 890. The major features of this standard are that total attenuation is calculated as follows:

- $A_{total} = A_{div} + A_{atm} + A_{ground} + A_{refl} + A_{screen} + A_{misc}$;

where:

- A_{div} is the attenuation due to geometrical divergence;
- A_{atm} is the attenuation due to air absorption;
- A_{ground} is the attenuation due to ground absorption;
- A_{refl} is the correction due to reflections by obstacles;
- A_{screen} is the attenuation due to screening; and
- A_{misc}; is the attenuation due to miscellaneous other effects (foliage, housing, etc.).

In addition, directivity losses are calculated according to simple rules based on the general receiver location (discrete in 45° intervals) with respect to the emission source. The simplistic directivity correction implemented under this standard implies a 5 dB(A) correction for propagation at 90° to the intake and discharge stacks. This value, however, was considered an over simplistic assumption as the aerodynamics of the stacks (as well as standard acoustic principles) indicate that a much greater directivity loss would be generated. As a result, the actual directivity, as calculated by ASE, was used in the model rather than the value calculated by the *ISO* methodology.

After examining the output of the ASE model the jet engine test cell was divided up into 3 separate, primary sources. These were:

- the exhaust stack opening (top located at 40 m above ground);
- the intake stack opening (top located at 23 m above ground); and
- the walls of the test cell.

As the intake stack and exhaust stack propagate noise in a plane vertical to the ground (along an imaginary z-axis), directivity corrections, calculated by the ASE model, were applied to develop the sound characteristics parallel to the ground (in the x-y plane). The source terms (sound power levels per m^2), by octave band frequency, for each of the three sources, are shown in *Table 4.1c* below. No directivity corrections have been applied to these source sound power levels.

Table 4.1c *Sound Power Levels for Primary Sources (dB(A) re 1 x 10 $^{-12}$ m^{-2})*

Octave Band (Hz) Source:	Intake Stack (dB(A))	Exhaust Stack (dB(A))	Cell Wall (dB(A))
31.5	71.6	91	56.2
63	88	98	66.6
125	94	97	72.3
250	84.5	89.4	61.3
500	59.2	75.8	38.1
1000	59.3	60.4	34.1
2000	84.9	62	58.8
4000	92.8	89.2	66.2
8000	99	97.2	71.9
16000	--	--	--
Total dB(A)	**101.3**	**102.9**	**76.4**

The way in which these separate sound power levels were applied to the jet engine test cell during the modelling procedure is shown in *Figure 4.1b.*

Analysis

Free-field noise contours for the jet engine test cell are given in *Figure 4.1b.* Façade corrections (3 dB(A)) and other corrections (tonality, intermittency) must be taken into account in assessing the free-field results. This analysis is carried out below.

The measured, unattenuated frequency spectra for the engine noise from the different types of Rolls-Royce engines to be used in the test cell are shown in *Table 4.1d.* Analysis of the engine noise characteristics supplied by Rolls-Royce has revealed that these engines have a strong tonal output in the 1250-2500 Hz region and a secondary tonal character in the 4000 Hz region (in one engine). These tones are presumed to be produced at the passing frequency of the jet inlet turning vanes and its first harmonic. As a result, these engines would be expected to have a tonal output if monitored from a location with a direct line-of-sight to the engine.

For the table below, it should be noted that the first number in each column is the maximum *inlet* forward noise, while the second number in each column is the maximum *exhaust* forward noise. Frequencies showing tonality are highlighted in bold.

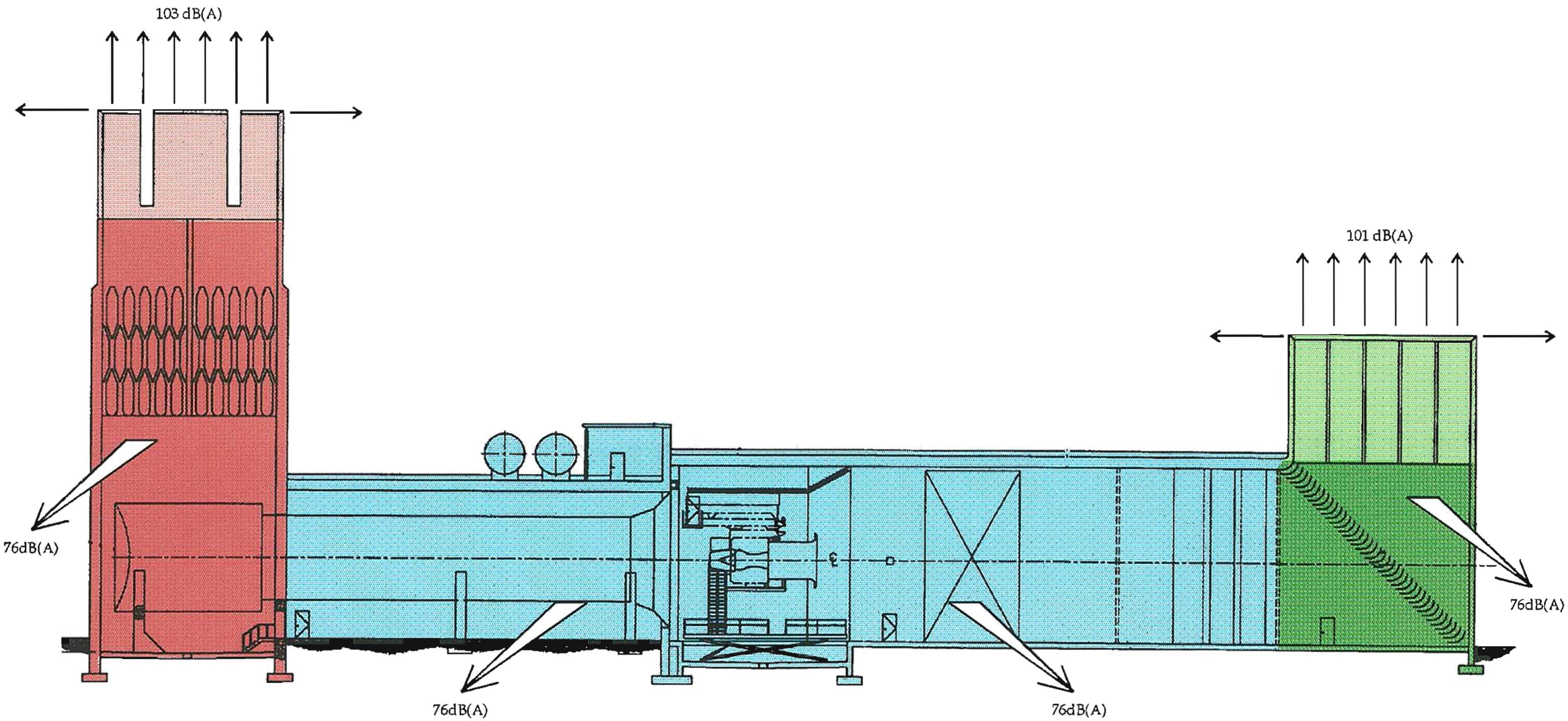

FIGURE 4.1b - SOUND PRESSURE LEVELS @ 1m

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Table 4.1d *Engine Noise Characteristics by Frequency, measured @ 50 feet (dB re 1 pw)*

Frequency (Hz)	RR RB211-22B	RR RB211-524 G/H	RR RB 211 Trent 772	RR RB 211* Trent 890
800	134 / 135	135 / 142	139 / 134	142 / 137
1000	133 / 135	134 / 141	138 / 133	141 / 136
1250	134 / 135	134 / 140	**146 / 142**	**149 / 145**
1600	136 / 136	133 / 140	138 / 133	141 / 136
2000	**140 / 141**	132 / 139	136 / 130	139 / 133
2500	136 / 136	132 / 138	**140** / 131	**143** / 134
3150	135 / 136	131 / 137	135 / 131	138 / 134
4000	137 / **140**	131 / 137	135 / 134	138 / 137
5000	135 / 137	132 / 138	134 / 134	137 / 137
6300	134 / 138	132 / 138	133 / 134	136 / 137

*Provisional data to be updated in the Final Report.

Analysis of this table indicates the following:

- the RB211–22B is tonal at 2000 Hz (both inlet and exhaust) and 4000 Hz (exhaust only);
- the RB211–524 G/H is not tonal at any frequency;
- the RB211–Trent 772 is tonal at 1250 Hz (both inlet and exhaust) and at 2500 Hz (inlet only); and
- the RB 211–Trent 890 is tonal at 1250 Hz (both inlet and exhaust) and at 2500 Hz (inlet only).

The frequency characteristics of the theoretical engine noise output from ASE's model, shown in *Table 4.1e* below, have indicated that the baffles, silencers and walls of the test cell chamber will greatly attenuate the frequencies above 1000 Hz. However frequencies above 4000 Hz show increases in power due to 'regenerated' noise effects. As a result, low and high frequency noise will tend to dominate the output frequency spectrum.

Table 4.1e *External Noise levels at Higher Frequencies (Leq,period dB @ 1m)*

Source	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Total (31.5 – 8000 Hz
Intake	65.2	62.3	86.9	94.8	103	**119.9**
Exhaust	78.8	60.4	61	88.2	98.2	**131.0**
Cell Wall	41.1	34.1	57.8	65.2	72.9	**97.9**

The result being, that though the tonal element is still present in the attenuated noise spectrum within the 1250–2500 Hz range, the noise level in this region is more than 15 dB(A) below the overall noise level from the engine. As a result, according to *Section 3.3.2(a)* of the *TM* the output in this range is not considered to be tonal in character and so no tonality correction has been added to the output. 'Regenerated' noise (at higher frequencies) will not be tonal in character, due to the random processes which create it. As a result, no tonality correction has been added to the predicted external noise levels.

Analysis of the operating pattern of the jet engine test cell has indicated that the sound output from the test cell will be neither impulsive nor intermittent in character. As a result, no corrections for impulsiveness or intermittency will be added to the theoretical data.

Results

Analysis of the free–field noise predictions, see *Figure 4.1c* for the graphical results, with the inclusion of the 3 dB(A) façade correction, has indicated that none of the nearest NSRs will receive impacts in excess of the night–time noise criterion. NSRs have been predicted to experience worst–case impacts of façade $L_{Aeq,30min}$ 47 dB, which is 3 dB(A) below the night–time noise criterion. As a result, no mitigation measures, other than those which have already been employed, are recommended.

Other Noise Sources

Individual external plant equipment (chillers, fans etc), openings, ducts and vents have not been assessed at this stage. It is not believed, however, that these sources will be capable of creating significant impacts at nearby NSRs. An individual source would need to have a sound power level in excess of 123 dB(A) in order to create significant impacts at nearby NSRs.

A complication to this scenario could exist if vents or ducts in the jet engine test cell were badly sealed leading to 'leakage' of engine sound out of the facility. To pre–empt this possibility, mitigation measures are recommended to ensure adequate sealing of all openings in the jet engine test cell.

4.1.6 *Mitigation Measures*

Test Cell

In light of the assessment above which has indicated that no exceedances of the night–time noise criterion are likely to result in the region surrounding the HAECO jet engine test cell from engine testing activities, no mitigation measures are recommended for the jet engine test facility itself.
Buildings near the test cell, however, such as the control centre and the strip and build shop, will need to be insulated such that the internal noise levels do not exceed the applicable *Noise at Work* criterion ($L_{A,ep,d}$ 85 dB). Analysis of the noise output from the test cell, in which 800 mm walls, stack splitters and acoustic doors have been assumed, has indicated that noise in the adjoining buildings should not exceed the applicable *Noise at Work* criterion. However, it is recommended that noise monitoring be carried out in the control centre and the strip and build shop to verify this prediction during the commissioning stage.

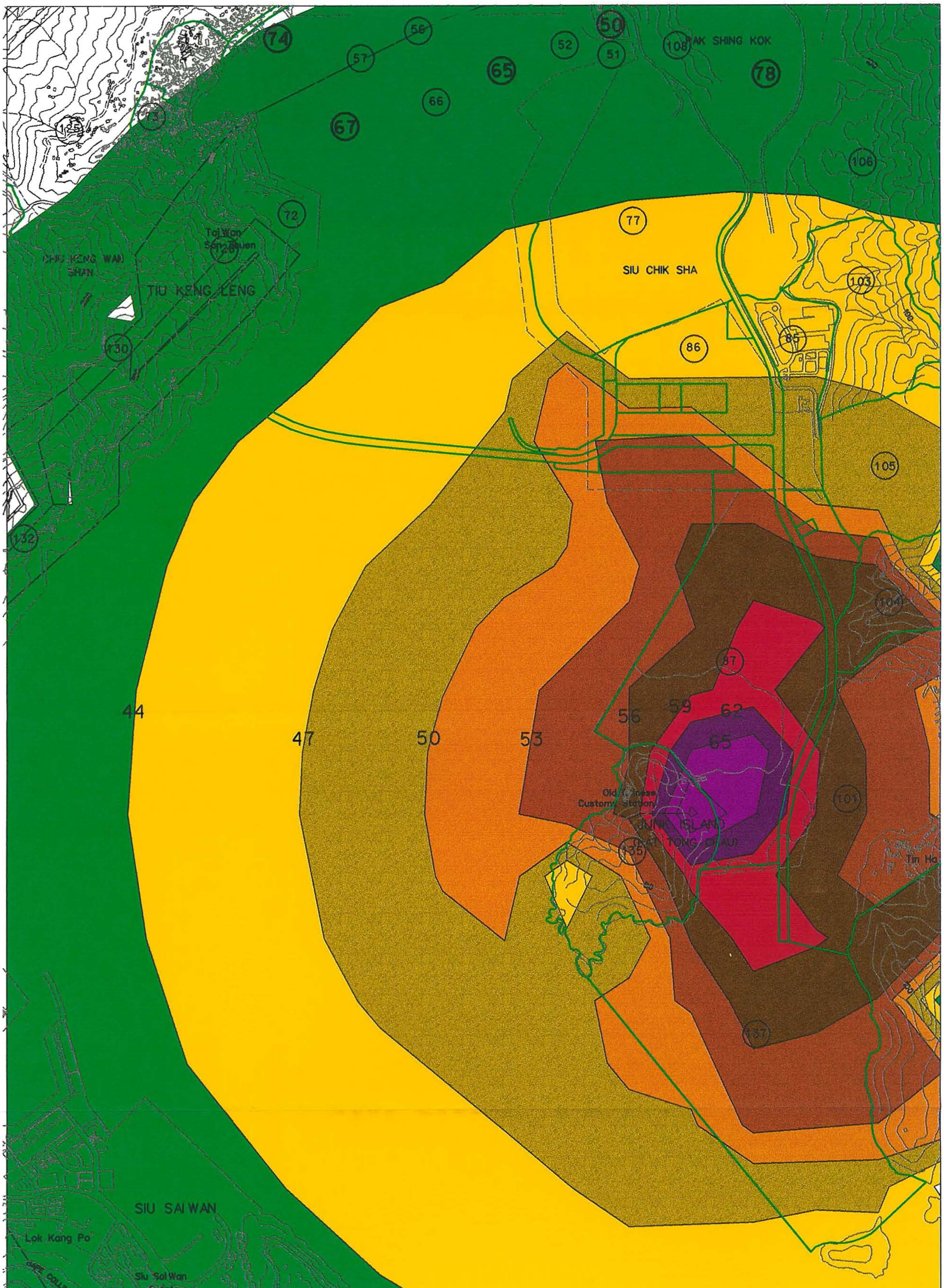

Figure 4.1 C Noise Contours for HAECO Jet Engine Test Cell

In light of the prediction for no exceedance of the NCO criteria, no noise monitoring at the surrounding NSRs is recommended during the operation of the test cell. Noise monitoring should be carried out, however, during the commissioning stage to identify any weaknesses in the cell structure which may lead to 'leakage' of sound, as well as whenever a new type of engine, outside of those assessed in this study, is tested.

Other Noise Sources

Ducts, vents and other openings in the engine test cell will need to be adequately sealed such that they do not lead to excessive 'leakage' of noise. These noise sources, as well as external plant, must be adequately silenced such that they do not cause any significant increase to the level of noise generated by the engines during testing, or any exceedance of the planning noise standards at the nearest NSRs. Limitations on noise levels can only be determined once further details are available, including the total number of noise sources, and once the frequency characteristics have been analysed to determine if tonality, intermittency or impulsiveness exist

Monitoring And Auditing

In light of the prediction of no significant impacts at nearby NSRs, noise monitoring is only recommended during the commissioning of the facility and at the inception of any new types of engines which have not been covered by this assessment. For these cases a single 30 minute, night-time sample measurement at the nearest NSRs in downwind or still weather conditions, during the testing of the worst-case or new engine under it's noisiest running condition, would be adequate monitoring, unless exceedance of the planning standard $L_{Aeq, 30 \text{ minute, night-time}}$ 50 dB level is identified.

4.1.7 *Conclusions*

Test Cell

This assessment has indicated that no exceedances of the NCO night-time noise (2300-0700) criterion are anticipated from night-time operation of the proposed HAECO jet engine test cell. Based on this assessment, mitigation measures beyond those included in the proposed design are not recommended for the test cell.

Though theoretical assessment has indicated that noise levels within the facility should not exceed any limits set by Hong Kong law, it is recommended that noise monitoring be carried out in the control centre and the strip and build shop during the commissioning stage to determine if any exceedances of the applicable *Noise at Work* criteria exist (potentially due to leakage of sound from weaknesses in wall structures, ventilation systems, etc.). Noise monitoring at NSRs is also recommended during commissioning or at the inception of new engine types.

Other Noise Sources

External ducts, vents and other openings in the engine test facility will need to be adequately sealed such that they do not lead to excessive 'leakage' of noise from the engine test cell. In addition, these noise sources and any noisy external building services plant must be adequately silenced such that they do not cause noise level exceedances at the nearby NSRs. It will be necessary to ensure that no other noise source contributes significantly to the predicted aircraft engine noise levels.

4.2 AIR QUALITY

4.2.1 *Introduction*

Although the proposed site is in a relatively remote location, operational air quality impacts may result from the testing of jet engines in the test cell. These potential impacts are assessed in this section.

4.2.2 *Environmental Legislation and Guidelines*

The principal legislation for the management of air quality in Hong Kong is the Air Pollution Control Ordinance (APCO) (Cap 311). The statutory limits of specific air pollutants and the maximum allowable number of exceedances over specific time periods are stipulated by APCO. These limits and conditions on ambient air quality are referred to as the Hong Kong Air Quality Objectives (AQOs). The AQOs are shown below in *Table 4.2a*.

Table 4.2a *Hong Kong Air Quality Objectives*

Pollutant	Concentration in micrograms per cubic metre (i)				
	Averaging Time				
	1 Hour (ii)	8 Hours (iii)	24 Hours (iii)	3 Months (iv)	1 Year (iv)
Sulphur Dioxide (SO_2)	800		350		80
Total Suspended Particulates (TSP)			260		80
Respirable Suspended P-articulates (v) (RSP)			180		55
Nitrogen Dioxide (NO_2)	300		150		80
Carbon Monoxide (CO)	30,000	10,000			

Note:

(i) Measured at 298°K (25°C) and 101.325 kPa (one atmosphere).
(ii) Not to be exceeded more than three times per year.
(iii) Not to be exceeded more than once per year.
(iv) Arithmetic means.
(v) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometres and smaller.

In addition to the above established statutory limits, it is generally accepted that an hourly average TSP concentration of 500 $\mu g/m^3$ should not be exceeded.

Such a control limit has no statutory basis and is mainly relevant to construction work and has been imposed on a number of construction projects in Hong Kong in the form of contract clauses. In this ase it has also been applied to operational emission.

Odour from malodorous materials is also controlled under the *Air Pollution Control Ordinance* and objectionable odourous emission is actionable under the Ordinance. *Air Pollution Abatement Notice* can be issued to reduce the nuisance to acceptable level.

4.2.3 *Baseline Conditions and Sensitive Receivers*

Existing Conditions

The HAECO jet engine test cell facility is to be located on a section of reclaimed land adjacent to Fat Tong Chau (Junk Island) on the Tseung Kwan O Industrial Estate. At the present there are many infrastructure development projects under construction. These include the formation of the reclamation for the Tseung Kwan O New Town, the construction of the Tseung Kwan O Industrial Estate, the construction of Tseung Kwan O New Town and the completion of the SENT Strategic Landfill. As a result, though the region is not urban or fully developed, the regional air quality is affected primarily by construction dust and road traffic emissions.

Air quality monitoring as carried out by EPD in 1992 indicates the following values for the major air quality parameters (all units are $\mu g\ m^{-3}$):

NO_2:

Annual average:	11;
Highest monthly average:	22;
Highest hour (99th percentile):	88;

SO_2:

Annual average:	24;
Highest monthly average:	31;
Highest hour (99th percentile):	108;

TSP:

Annual average:	77;
Highest monthly average:	107;

RSP:

Annual average:	44;
Highest monthly average:	67.

Comparison of these values with *Table 4.2a* above indicates that the NO_2 and SO_2 values are well within the legal limits; the values for TSP and RSP, however, are very close to the annual average legal limits. These measurements lend further confirmation to the points noted above that the area is dusty.

Future Conditions

After the completion of the current infrastructure projects the Tseung Kwan O region will contain a large New Town, new roads, bridges and the operational SENT Landfill. With the reduction in construction dust levels it is anticipated that the local air quality will be affected primarily by road traffic emissions and industrial operations.

Air Sensitive Receivers

ASRs, as defined by HKPSG, have been identified with reference to previous environmental studies undertaken in the region of the Tseung Kwan O Industrial Estate, and have been updated by site surveys and by referring to survey sheets and development plans.

The nearby ASRs and their respective distances from the proposed jet engine test facility are shown below in *Table 4.2b*.

Table 4.2b ***Air Sensitive Receivers***

ASR	Sensitive Use	Distance (m)
Area 50	Tseung Kwan O	3100
Area 65	Tseung Kwan O	2750
Area 67	Tseung Kwan O	2900
Area 74	Tseung Kwan O	3100
Area 78	Tseung Kwan O	2700
Heng Fa Chuen Estate	Chai Wan	3400
Tsai Wan Estate	Chai Wan	3500
Siu Sai Wan Estate	Chai Wan	2600

In addition, there are air sensitive receivers scattered throughout the Tseung Kwan O Industrial Estate. A nominal distance of 50 metres has been used in the assessment of the air quality at these receivers.

4.2.4 *Potential Sources of Impact*

The jet engine test facility exhaust stack gas emission will be the primary source of air quality impact within the proposed HAECO facility. The emissions of NO_x, SO_2 and CO from this facility will have the potential to affect the local air quality. There will be other potential sources of air quality impact within Phase 2 of the development, but these sources fall outside the scope of this assessment. These additional sources should therefore be assessed in an EIA of Phase 2 of the facility.

4.2.5 *Prediction of Impact*

Worst-Case Assumptions

For the jet engine test cell, gaseous emissions were modelled for the worst 1- hour period. In each run general assumptions were made about the exhaust stack.

These general assumptions were that:

- exhaust gases would occupy the full cross-section of the exhaust stack;
- the exhaust stack has an area of 169 m^2 (13m x 13m);
- expanding gases leaving the jet engine would travel approximately 80 m before exiting the exhaust stack;
- gases would cool significantly after leaving the jet engine and would have a temperature of approximately 325° K at the top of the stack.

For this calculation different run cycles of the engines were used for each pollutant.These worst-case run cycles were as follows:

For NO_x, the test run was considered to be composed of:

- 5 minutes at 100% of take-off thrust; and
- 55 minutes at 80% of take-off thrust;

For SO_2, the test run was considered to be composed of:

- 5 minutes at 100% of take-off thrust; and
- 55 minutes at 80% of take-off thrust;

For CO, the test run was considered to be composed of:

- 10 minutes at 80% of take-off thrust;
- 25 minutes at 50% of take-off thrust; and
- 25 minutes at 30% of take-off thrust.

In each of these cases, the worst case 1-hour period is composed of sequential test runs (at different percentages of take-off thrust [TOT]) for the same engine.

Emission Rates

According to HAECO, most of the engines tested at the proposed facility will come from four Rolls Royce engine series. These four engine types can be further subdivided into two categories, newer engines and older engines. The newer engines comprise the Trent 700 and Trent 800 series; while the older engines comprise the RB211-22B and the RB211-524 G/H series engines.

The relevant assumed emissions rates for the gaseous pollutants listed above, for the newer engines, the Trent 800 and Trent 700, are given in *Table 4.2c* below, in grams per kilogram of fuel consumption. The value for the Trent 800 engine is given first while that for the Trent 700 engine is given second.

Table 4.2c *Emission Rates ($g\ kg^{-1}$) for a Trent 800 /Trent 700 Jet Engines*

	Emission Rate from Jet Engine at:			
Emission	100% of TOT	80% of TOT	50% of TOT	30% of TOT
NO_x	55.6 / 47.3	39.7 / 34.9	--	--
SO_2	1.0 / 1.0	1.0 / 1.0	--	--
CO	--	0.9 / 0.8	1.8 / 1.9	2.3 / 2.3

The representative emission for each pollutant for the Trent 800 engine, given the above assumptions are:

- 76,234 g hr^{-1} for NO_2 (6925 kg of fuel: 1150 kg @ 100% TOT and 5775 kg @ 80% TOT);
- 6,925 g $hr^{-1}$for SO_2 (6925 kg of fuel: breakdown same as above); and
- 7,485 g hr^{-1} for CO (4350 kg of fuel: 1050 kg @ 80%, 2100 kg @ 50%, and 1200 kg @ 30%);

for the Trent 700 engine these values are:

- 58,420 g hr^{-1} for NO_2 (6090 kg of fuel: 980 kg @ 100% TOT and 5110 kg @ 80% TOT);
- 6,090 g $hr^{-1}$for SO_2 (6090 kg of fuel: breakdown same as above); and
- 6,674 g hr^{-1} for CO (3830 kg of fuel: 930 kg @ 80%, 1850 kg @ 50%, and 1050 kg @ 30%);

It should be noted that a conversion ratio of 26% was used between NO_x and NO_2 in calculating the figures above. In addition the fuel was assumed to have a Sulphur content of 0.1%.

The relevant assumed emissions rates for the gaseous pollutants listed above, for the older engines, the RB211-22B and the RB211-524 G/H, are given in *Table 4.2d* below, in grams per kilogram of fuel consumption. The value for the RB211-22B engine is given first while that for the RB211-524 G/H engine is given second.

Table 4.2d *Emission Rates (g kg^{-1}) for the RB211-22B and RB211-524 G/H Jet Engines*

Emission	Emission Rate from Jet Engine at:			
	100% of TOT	80% of TOT	50% of TOT	30% of TOT
NO_x	34 / 66	26 / 46	--	--
SO_2	1.0 / 1.0	1.0 / 1.0	--	--
CO	--	26 / 46	15 / 25	8.1 / 10.6

The representative emission for each pollutant for the RB211-22B engine, given the above assumptions are:

- 27,643 g hr^{-1} for NO_2 (3920 kg of fuel: 550 kg @ 100% TOT and 3370 kg @ 80% TOT);
- 3,920 g hr^{-1} for SO_2 (3920 kg of fuel: breakdown same as above); and
- 34,152 g hr^{-1} for CO (2065 kg of fuel: 615 kg @ 80%, 930 kg @ 50%, and 520 kg @ 30%);

for the RB211-524 G/H engine these values are:

- 65,408 g hr^{-1} for NO_2 (5095 kg of fuel: 860 kg @ 100% TOT and 4235 kg @ 80% TOT);
- 5,095 g $hr^{-1}$for SO_2 (5095 kg of fuel: breakdown same as above); and
- 86,134 g hr^{-1} for CO (3340 kg of fuel: 770 kg @ 80%, 1630 kg @ 50%, and 940 kg @ 30%);

As noted above, a conversion ratio of 26% was used between NO_x and NO_2 in calculating the figures above. In addition the fuel was assumed to have a Sulphur content of 0.1%.

These results indicate that for NO_2 and SO_2 emission the Trent 800 series engines have the highest emission rates, while for CO, the RB211-524 G/H series engines have the highest emission rates. As a result, in the modelling below, emission rates for NO_2 and SO_2 have been modelled on the basis of the testing of a Trent 800 series engine, while emission rates for CO have been modelled on the basis of the testing of an RB211-524 G/H series engine.

Plume Exit Velocities

Modelling of the emission plume was carried out by assuming the following stack exit velocities for the exhaust stack:

- 18.3 ms^{-1} for 100% of TOT;
- 16.2 ms^{-1} for 80% of TOT;
- 12.5 ms^{-1} for 50% of TOT; and
- 9.8 ms^{-1} for 30% of TOT.

Weighted averages for the exit velocity for each type of pollutant are as follows:

- 16.4 ms^{-1} for NO_x;
- 16.4 ms^{-1} for SO_2; and
- 12.0 ms^{-1} for CO.

Modelling Results

Modelling of the emission plume was carried out by entering the data above, along with the coordinates of the nearby receivers, into the ISCST2 (Industrial Source Calculation--Short Term) gaussian dispersion model. As engine testing could take place at any time in a 24-hour period, representative atmospheric stability classes (A, B, C, D, E, F) and winds speeds (1,3,5,10) were modelled. Eighteen separate atmospheric class/wind speed combinations were analysed. These were:

- Atmospheric class A and wind speeds of 1 and 3 ms^{-1};
- Atmospheric class B and wind speeds of 1, 3 and 5 ms^{-1};
- Atmospheric class C and wind speeds of 1, 3, 5 and 10 ms^{-1};
- Atmospheric class D and wind speeds of 1, 3, 5 and 10 ms^{-1};
- Atmospheric class E and wind speeds of 1, 3, and 5 ms^{-1}; and
- Atmospheric class F and wind speeds of 1 and 3 ms^{-1}.

Air quality modelling has indicated that at the individual receivers, emissions from the exhaust stack for any 1-hour period for any of the pollutants will be <25 $\mu g\ m^{-3}$, in the worst case. As a result, no significant air quality impacts are anticipated from the operation of the jet engine test cell. The results of this modelling at each receiver, at 30 m and 100 m above ground, are shown in *Table 4.2e* below. No receivers will exceed a height of 100 m above ground so this value is considered the worst-case.

Table 4.2e ***Predicted Worst-Case 1-Hour Air Quality Impact at Discrete ASRs ($\mu g\ m^{-3}$)***

ASR	NO_2		SO_2		CO	
	30m	100m	30m	100m	30m	100m
Area 50	7	11	2.5	4	42	64
Area 65	7	14	2.5	4.8	43	77
Area 67	7	13	2.5	4.4	43	71
Area 74	7	13	2.6	4.4	45	70
Area 78	6	13	2.2	4.4	38	70
Heng Fa Chuen	7	12	2.6	4.1	45	66
Tsai Wan Estate	7	11	2.6	3.8	43	60
Siu Sai Wan Estate	7	13	2.6	4.7	44	75
1-hr Limit	**300**		**800**		**30,000**	

Additional results for the 24-hour and 8-hour period is shown in *Table 4.2f* below. As it has been proposed that at most two engines will be tested per day, each for a duration of 1 hour, the worst-case predicted pollution concentrations for 8-hour and 24-hour averaging periods can be estimated using the 1-hour prediction results (ie. emissions for 8-hour average is equal to the emissions for 1 hour times 2 and divided by 8, and emissions for 24-hour average is equal to the emissions for 1 hour times 2 and divided by 24 hours). These results show that predicted pollutant impacts from the jet engine testing facility exhaust stack will have little or no affect on the ambient air quality. As the predicted pollution concentration for 8 and 24 hours period are very low, annual concentrations for CO, NO_2 and SO_2 will negligible and thus not be assessed.

Table 4.2f ***Predicted Worst-Case Air Quality Impacts at Discrete ASRs ($\mu g\ m^{-3}$); 24-Hour Values for NO_2 and SO_2 and 8-Hour Values for CO***

ASR	NO_2		SO_2		CO	
	30m	100m	30m	100m	30m	100m
Area 50	0.6	1	0.2	0.3	11	16
Area 65	0.6	1	0.2	0.4	11	19
Area 67	0.6	1	0.2	0.4	11	18
Area 74	0.6	1	0.2	0.4	11	18
Area 78	0.5	1	0.2	0.4	10	18
Heng Fa Chuen	0.6	1	0.2	0.3	11	17
Tsai Wan Estate	0.6	1	0.2	0.3	11	15
Siu Sai Wan Estate	0.6	1	0.2	0.4	11	19
Appropriate Limit	**150**		**350**		**10,000**	

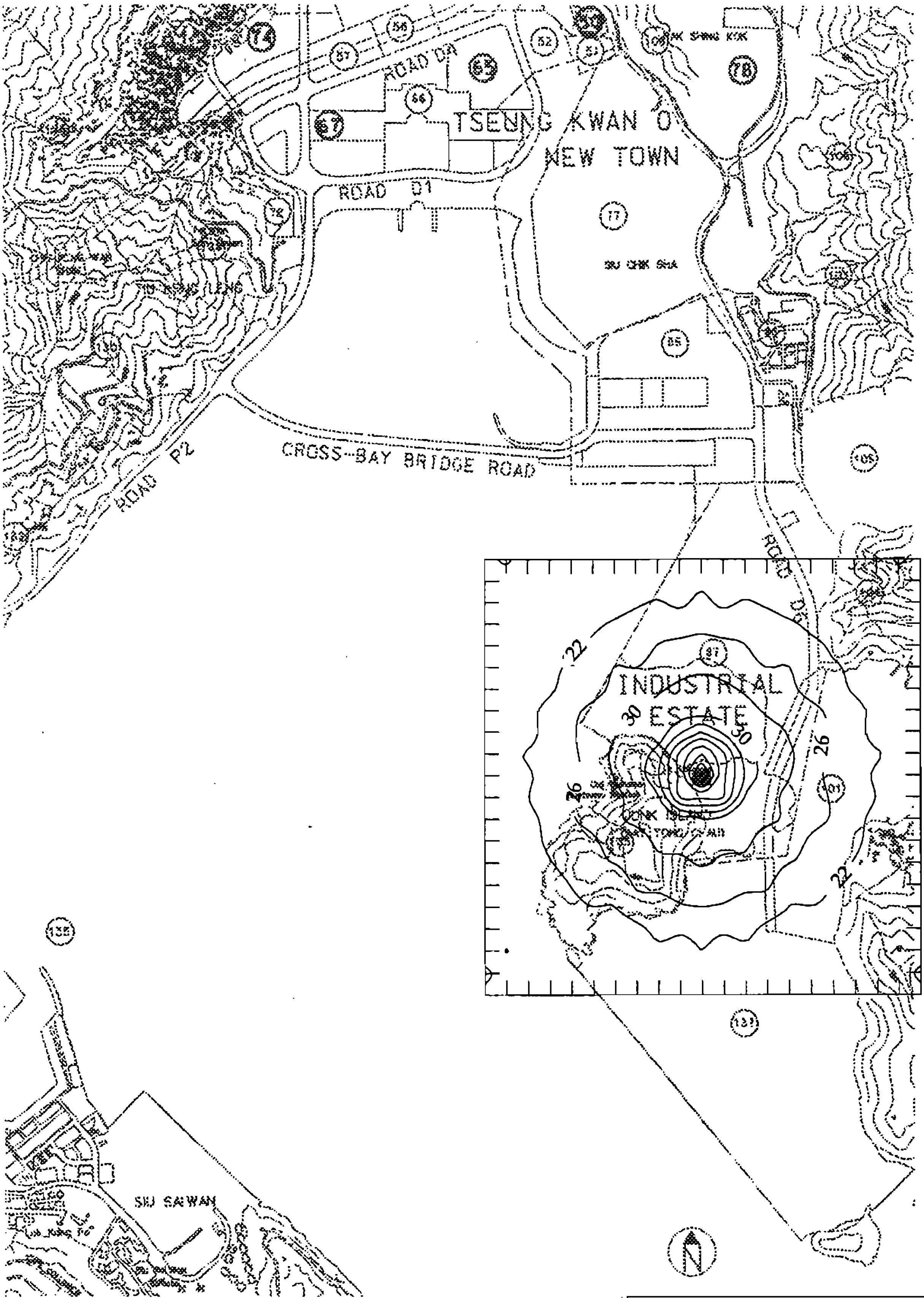

FIGURE 4.2a - ISOPLETHS OF NITROGEN DIOXIDE (100m)

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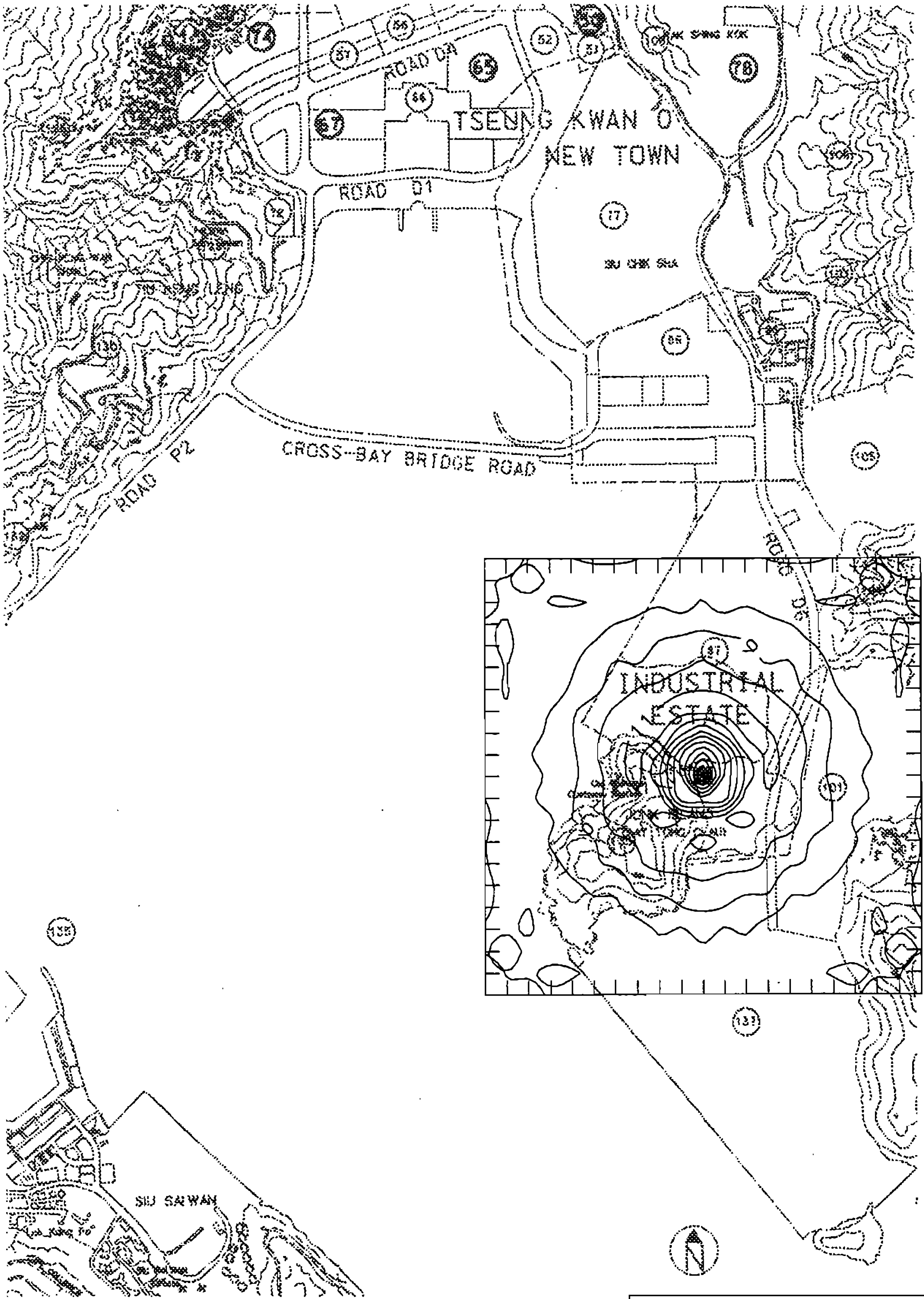

FIGURE 4.2b - ISOPLETHS OF SULPHUR DIOXIDE (100m)

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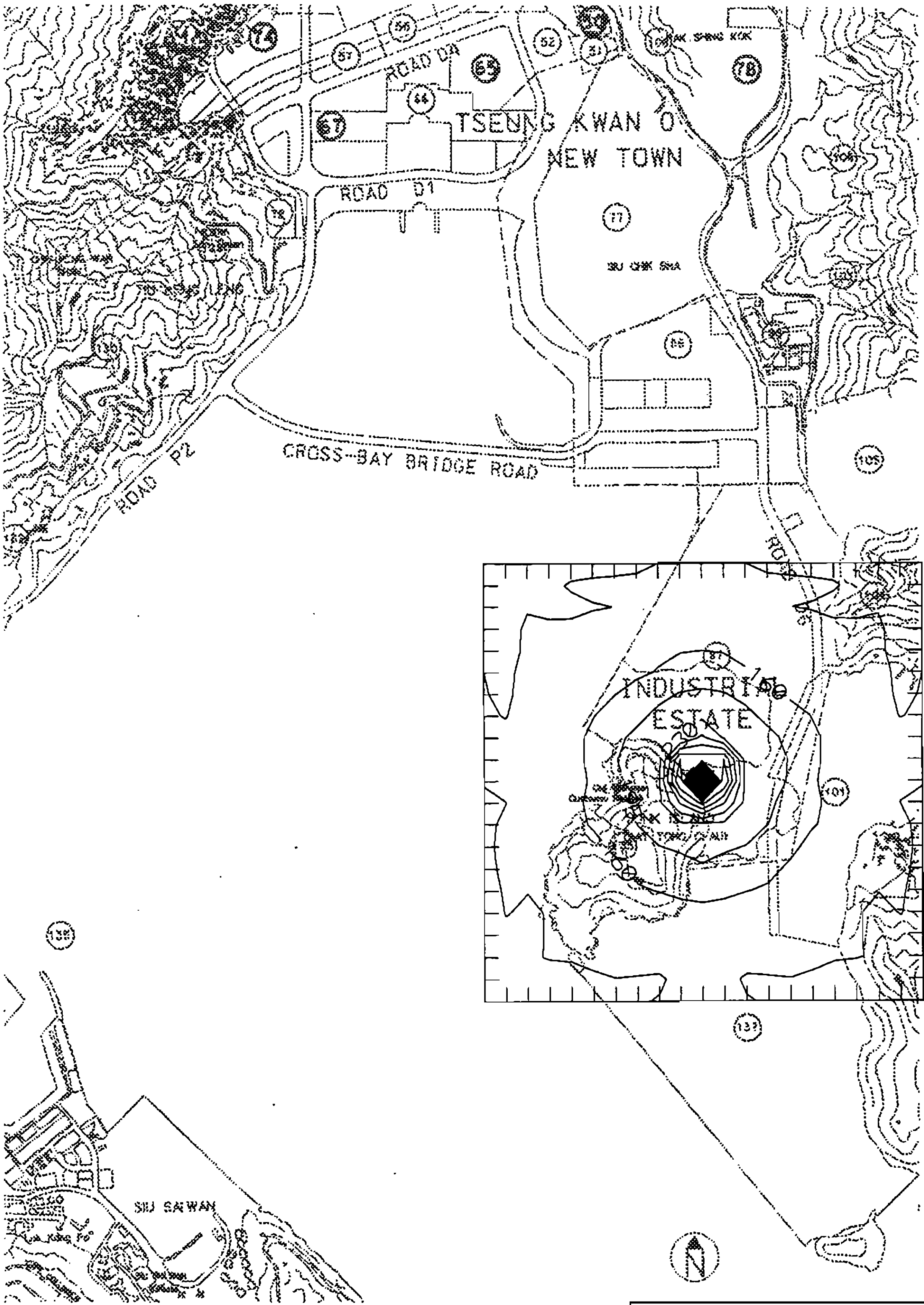

FIGURE 4.2c - ISOPLETHS OF CARBON MONOXIDE (100m)

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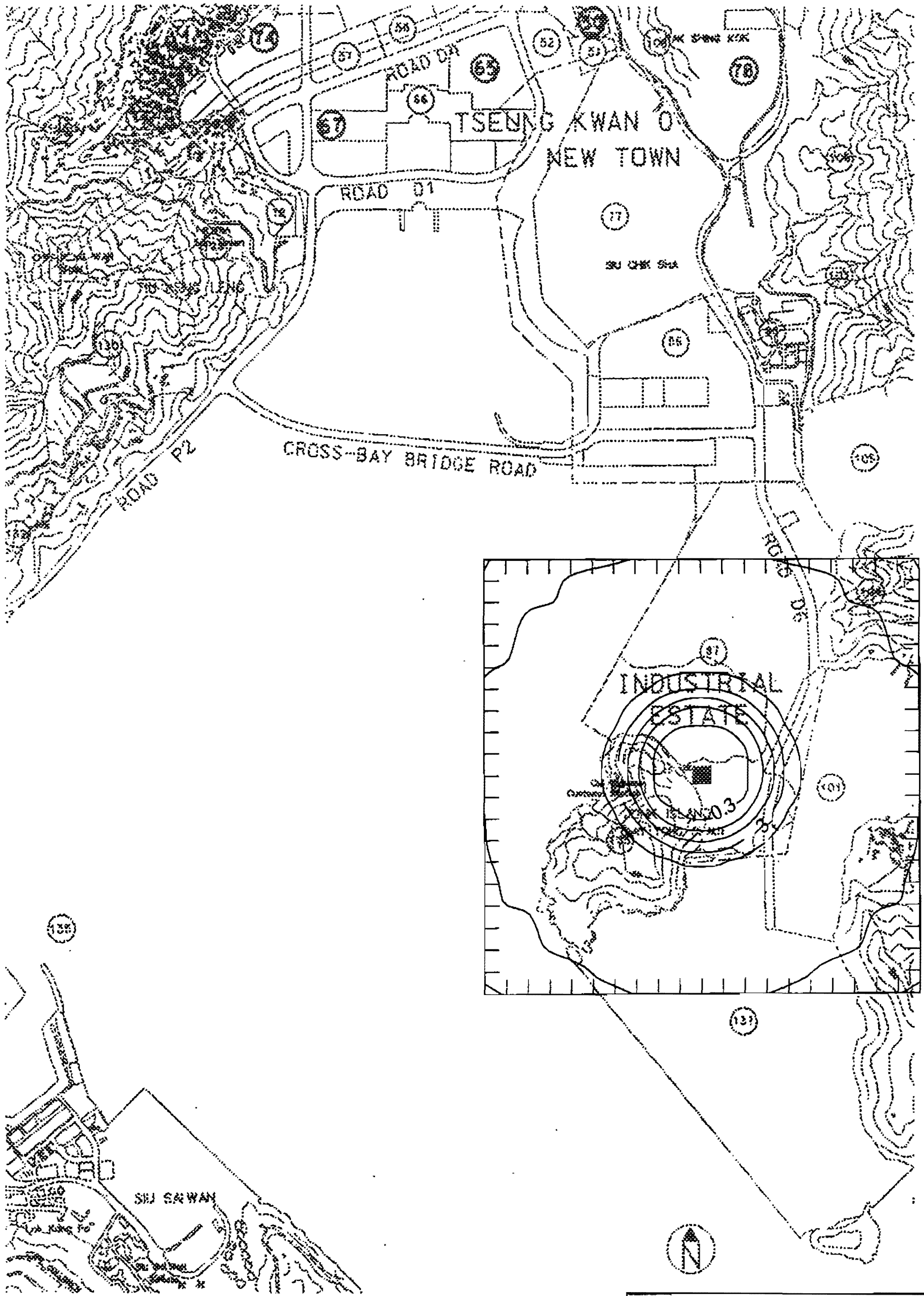

FIGURE 4.2d - ISOPLETHS OF NITROGEN DIOXIDE (GROUND LEVEL)

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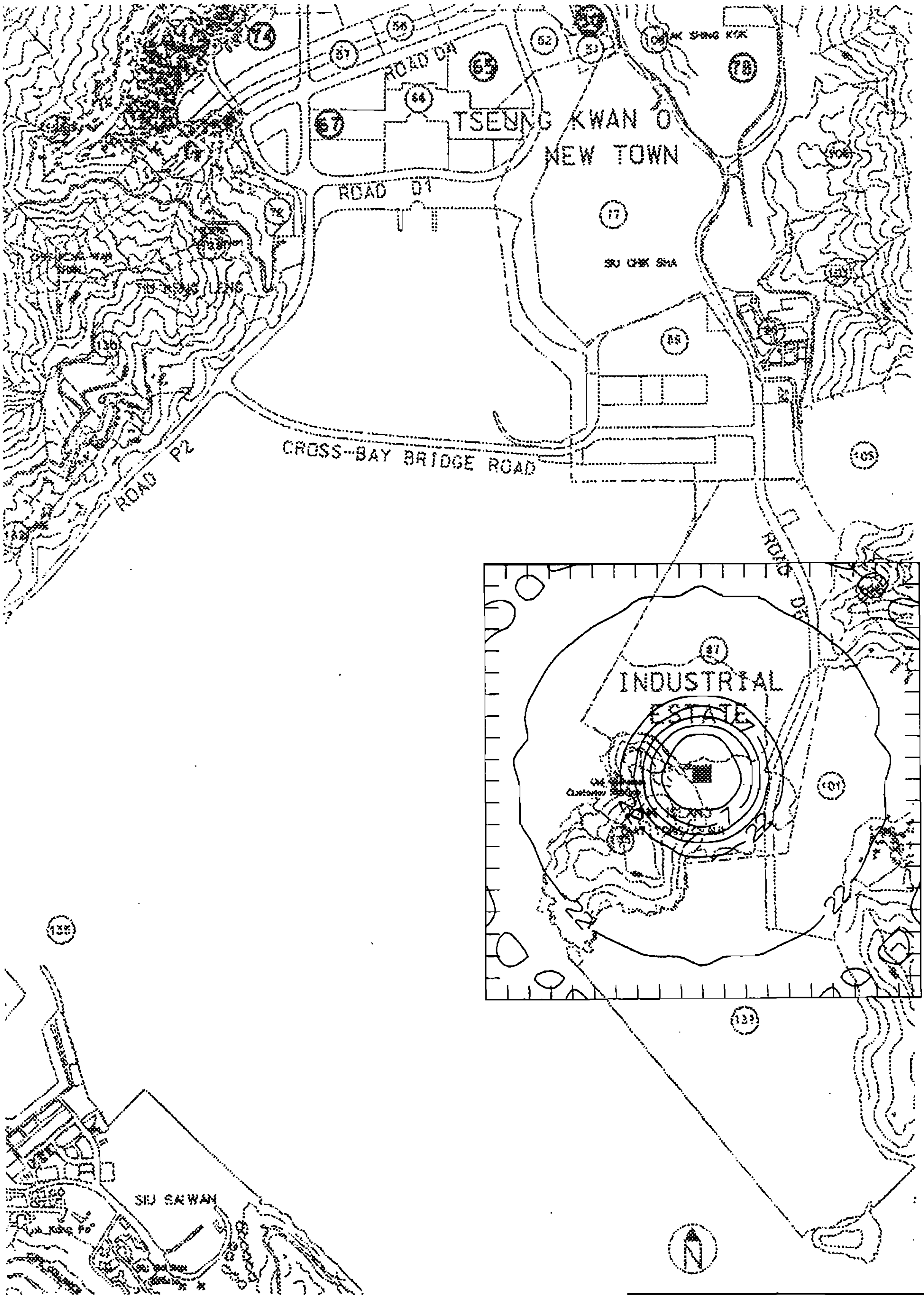

FIGURE 4.2e - ISOPLETHS OF CARBON MONOXIDE (GROUND LEVEL)

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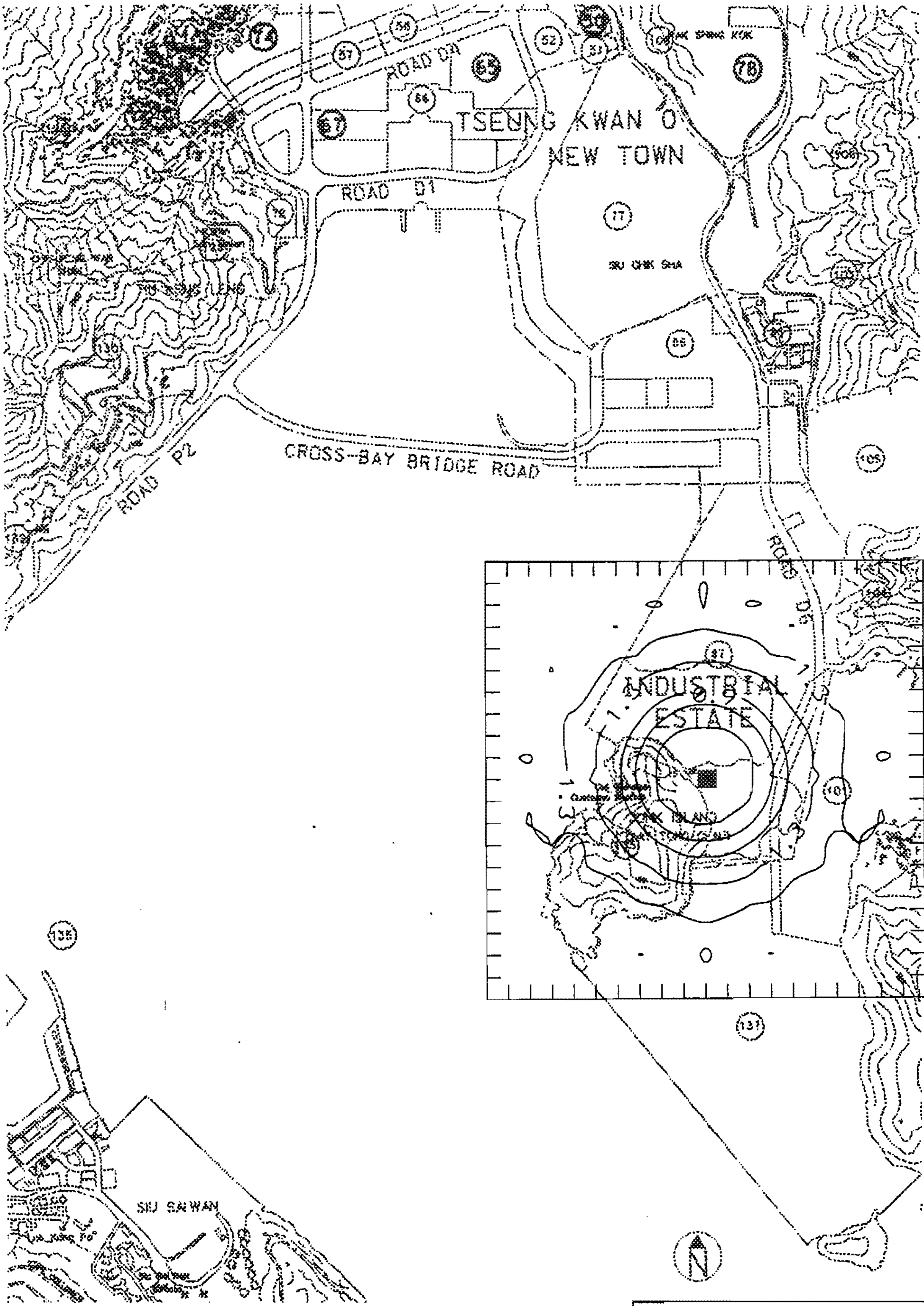

FIGURE 4.2f - ISOPLETHS OF SULPHUR DIOXICE (GROUND LEVEL)

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Modelling was carried out on a 100m grid up to a distance of 1000 metres from the test cell, at a height of 100m and ground level, to simulate ASRs in the Tseung Kwan O Industrial Estate. Due to the high ejection velocity of gases from the test cell, however, modelling results indicate that higher pollution concentrations were predicted at higher level. The isopleths of pollutants(NO_2, SO_2 and CO) at 100m and ground level are shown in *Figure 4.2a to 4.2f*. The pollution isopleths indicate that the impact to the adjancent Tseung Kwan O Industrial Estate is low when compared with the AQOs.

As a result of these predictions, no mitigation measures are recommended for the emission of exhaust gases from the jet engine test facility for the benefit of ASRs at the Tseung Kwan O Industrial Estate or for the nearest residential receivers.

4.2.6 Mitigation Measures

As no significant impacts to the air quality have been predicted, no mitigation measures are recommended for the exhaust gasses emanating from the exhaust stack. In addition, because of the lack of significant, predicted air quality impact, no air monitoring programme is recommended.

4.3 WATER QUALITY

4.3.1 Introduction

This section assesses the potential water quality impacts associated with the operation of Phase 1 of HAECO jet engine testing facility, and presents mitigation measures that may be required.

4.3.2 Baseline Conditions

The baseline conditions in the Junk Bay area in terms of water quality and the location of sensitive receptors are described in *Section* 3.3.3. These are not anticipated to change significantly and will also apply to the operational phase of the HAECO aircraft engine testing facility.

4.3.3 Potential Impacts and Their Evaluation

Phase 1 of the facility project will comprise an aircraft engine testing cell and engine assembly area. The potential sources of water quality impact that will arise from the operations of this phase are as follows:

- industrial liquid effluent;
- chemical wastes;
- sewage effluent; and
- solid waste arisings.

The potential impacts on water quality are discussed below.

Industrial Effluent

The operation of Phase 1 will generate several industrial liquid effluent as detailed in *Section 4.4*, and illustrated in *Table 4.4a*. These wastes are anticipated to be in the form of wastewater, including approximately 1.2 m^3/day of rinsing water produced from primary cleaning activities, and any contaminated run-off from the testing cell and assembly area. A total of approximately 5 m^3/day of water will be used per day.

The major pollutants in the rinsing water will be oil and grease, suspended solids, surfactant and organic solvent. In addition, runoff and drainage from the site may contain oily compounds, increased loads of suspended solids and other contaminants. Drainage water from the inlet and exhaust stacks the test cell building may contain, amongst other pollutants, dissolved sulphur compounds. An indication of the potential pollutant loads in this wastewater prior to treatment is provided by a sample of wastewater taken from the cleaning bay at the Kai Tak facility on 18 October 1994. This contained 380 mg/l of SS, 140mg/l of oil and grease, 450 mg/l of BOD^5, 71mg/l of surfactants, and 11,000 mg/l of COD. However, this is not directly comparable and will need to be verified through specific sampling of the wastewater generated from Phase I during the commissioning stage.

Without appropriate treatment these industrial effluent will have the potential to cause water quality impacts, in exceedance of the specified *TM for Effluent Discharge.* Thus, the arisings will require appropriate methods of storage, treatment, and removal from the HAECO site to prevent the potential for adverse impacts on water quality.

As detailed in *Section 4.4* it is proposed that prior to Phase 1, oil and grease interceptors will be installed in the drainage system to collect the industrial effluent not classified as chemical wastes. Having passed through the interceptors the contaminated wastewater, including the potentially contaminated run-off, will be collected in underground/surface collection tanks, and processed regularly by the existing HAECO effluent treatment truck. This treatment facility has been constructed and approved by the EPD for the treatment of aircraft paint stripping effluent from the HAECO operation at Kai Tak and is suitable for similar effluent which will be generated during Phase 2 of the project, it includes pH balancing, oil and grease extraction (mechanical belt skimming lap), and phenol removal. The treatment involves several processes illustrated in *Figure 4.3a*, as follows:

- Treatment processes include neutralisation, coagulation and flocculation with the aid of the several chemicals (NaOH, Alum, Polyelectrolyte). This reduces BOD_5, COD, grease and oil, and phenol (which will be produced during Phase 2).

- Activated carbon is then used as a final polishing stage, to absorb the COD, phenol and dichloromethane, the latter two of which will be generated during Phase 2.

The discharge from this treatment facility will be required to comply with the *TM* specifications detailed in *Table 4.3a*.

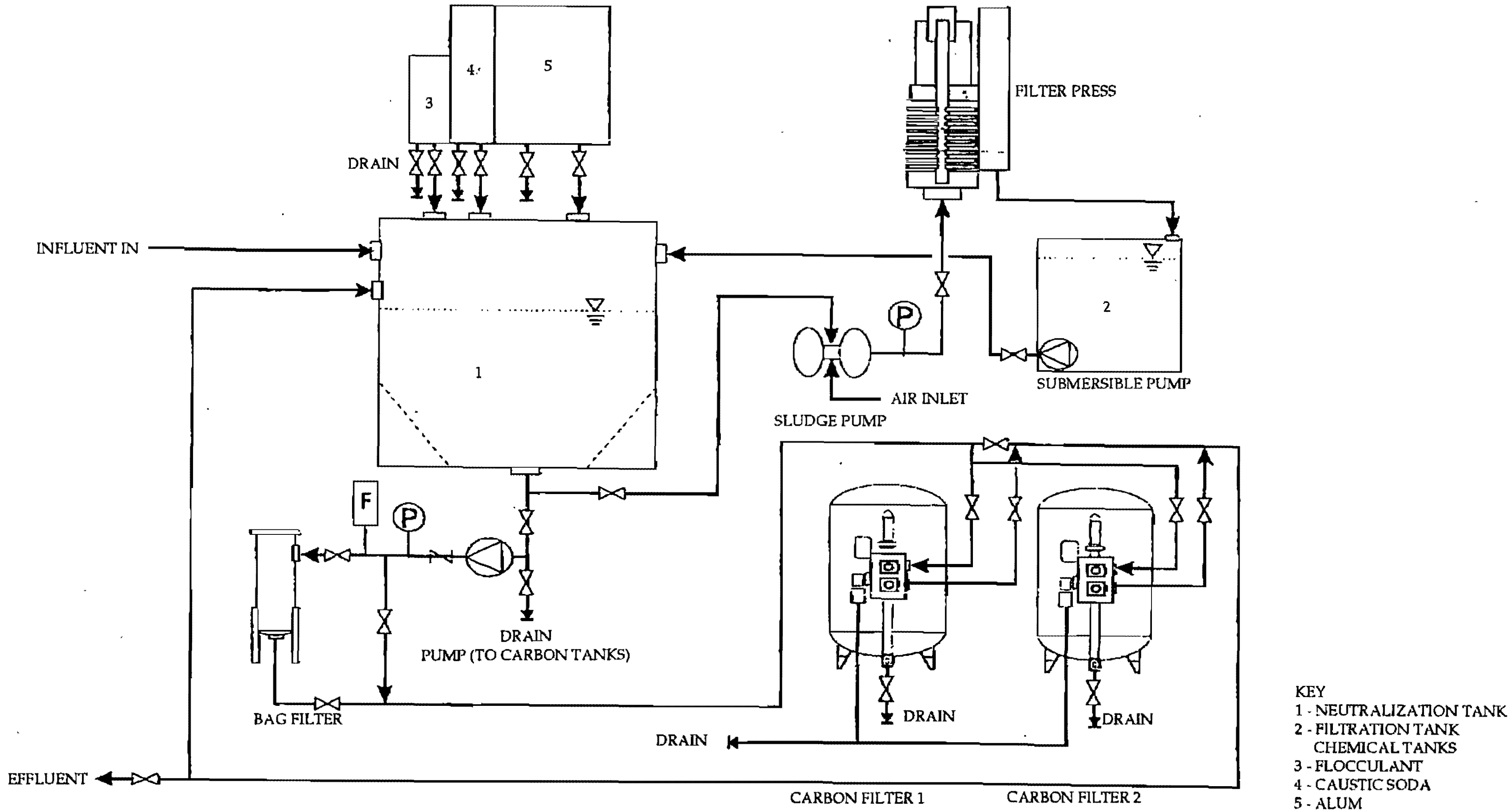

FIGURE 4.3a - FLOW DIAGRAM TO ILLUSTRATE HAECO MOBILE EFFLUENT TREATMENT TRUCK

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Table 4.3a *Standards for Effluent Discharged into Foul Sewers leading into Government Sewage Treatment Plants, as defined by TM*

Determinant	Flow rate ≤10 (m³/day)	>10 and ≤100
pH (pH units)	6–10	6–10
Temperature (°C)	43	43
Suspended solids	1200	1000
Settleable solids	100	100
BOD	1200	1000
COD	3000	2500
Oil & Grease	100	100
Iron	30	25
Boron	8	7
Barium	8	7
Mercury	0.2	0.15
Cadmium	0.2	0.15
Copper	4	4
Nickel	4	3
Chromium	2	2
Zinc	5	5
Silver	4	3
Other toxic metals individually	2.5	2.2
Total toxic metals	10	10
Cyanide	2	2
Phenols	1	1
Sulphide	10	10
Sulphate	1000	1000
Total nitrogen	200	200
Total phosphorus	50	50
Surfactants (total)	200	150

Note: All units in mg/L unless otherwise stated; all figures are upper limits unless other indicated

Based upon tests undertaken by HKPC (12/92) on the resulting effluent from the treatment process, it is anticipated that this effluent treatment truck will be able to treat these wastewaters to within the specifications of the *TM* prior to discharge. However, tests specific to the Phase 1 generated wastes will be required prior to operation to confirm the efficacy of the truck. If this is correct the potential for adverse water quality impacts from industrial effluent will be minimised to within acceptable levels.

It will also be necessary to establish if the one treatment truck can serve both sites, or if a second truck is required. The amount of effluent produced and frequency that the effluent truck is used at the Kai Tak facility are relatively small. At Kai Tak the period that each aircraft outputs waste is approximately 50 days and the actual time when the truck is used to treat painting effluent for each aircraft is approximately 24 hours. For TKO, HAECO estimate that one visit per week for a period of 3 hours will be sufficient to treat the effluent generated. Therefore, the treatment truck is not in use for the majority of the time and there is little likelihood that the two facilities will require the truck simultaneously. In addition, both Kai Tak and TKO have ground tanks for storing effluent. It is therefore considered that the truck will be able to cope with the anticipated volume of effluent generated by both facilities. In the event that the effluent treatment truck is out of service, the effluent will be collected in drums and disposed of by a licensed contractor.

Chemical Wastes

In addition to the industrial effluent, the process of testing and assembling the engines will also result in chemical waste generation in the form of organic waste. These will include engine oil, Mobil jet oil, hydraulic oil HK/jet4, kerosene, and Areo Shell Fluid, and organic solvent. It is estimated that approximately 1.3 m^3/month of chemical waste will be produced by Phase 1 of the facility.

Chemical waste produced, including concentrated solutions of rinse water, will require appropriate storage, and subsequent transportation to Chemwaste Treatment Centre on Tsing Yi Island as detailed in *Section 4.4*. Provided that these detailed recommendations are followed, no unacceptable water quality impacts are anticipated to occur from chemical wastes generated on site.

Domestic effluent

Domestic effluent will be generated by an estimated permanent staff of 110 located at the facility, from the use of washrooms and the small pantry which will be provided. Assuming that each worker produces 55 litres of sewage effluent per day[(2)], the total sewage effluent discharge will be equivalent to about 6 m^3 per day for the workforce.

It is anticipated that the Tseung Kwan O sewage network, being constructed by HK Industrial Estate, will be available by the commissioning date of Phase I in July 1996. Therefore, sewage effluent generated by the staff employed on the HAECO site will go directly to this foul sewer network, for treatment at the nearby Tseung Kwan O Sewage Treatment Works. This will ensure that any discharge from the HAECO site is adequately treated to comply with the *TM* on sewage effluent discharge.

Provided that the sewerage system is in phase with the HAECO development, sewage can be readily discharged with no unacceptable impacts on water quality. However, should there be any unexpected delay, it may be necessary to consider the installation of temporary on-site sewage treatment plant.

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(2) Guidelines for the design of small sewage treatment plant, EPD 1990.

Non-contaminated Runoff

In addition to run-off from the testing cell and assembly rain water area, a run-off will occur in other areas, such as on the roof and paved areas surrounding site buildings. It is considered this run-off will be uncontaminated and will therefore go directly to the stormwater drainage system. It is considered that no water quality impacts in exceedance of the specified WQO will occur as a result of this discharge.

Solid Waste Arisings

A number of sources of solid waste will be generated during the operation of the HAECO site including domestic waste, office waste, chemical waste and other commercial/industrial wastes. The processes that may generate these wastes are detailed in *Table 4.3a* in *Section 4.3*.

These solid wastes have the potential to cause water quality impacts, if they enter the Junk Bay WCZ, although given the distance of the site from the shoreline, which is approximately 300 m at the nearest point, it is unlikely that this will occur. However, these waste arisings will still require appropriate methods of removal from the site to prevent the potential for adverse impacts on water quality. The necessary solid waste management procedures are discussed in *Section 4.3.4*. It is anticipated that, with the enforcement of appropriate handling, storage, and removal of solid waste arisings, the potential to result in adverse water quality impacts will be minimised to within acceptable levels.

4.3.4 *Measures for Mitigation*

The operational phase of the proposed HAECO facility is unlikely to result in any significant water quality impacts, provided that appropriate mitigation and environmental monitoring and audit measures are enforced. This will ensure that discharges are strictly controlled and meet the standards stipulated in the *TM*. The following measures are recommended to mitigate potentially water quality impacts from the Phase 1 operation:

- A detection system should be installed in the underground/surface collection tanks, and regular checking for leakage should be undertaken by maintenance staff. The E&M Consultants are currently designing a suitable detection system. As at the Kai Tak facility, the HAECO maintenance team should be equipped with sump pumps and a number of spare drums. If there is any leakage or overflow detected the effluent should be pumped out and stored in the drums prior to treatment by a licensed contractor, or transferred to the effluent treatment truck as appropriate. All remaining spillage should then be wiped off with rags and disposed of as solid chemical waste.

- Industrial effluent will require appropriate treatment by the effluent treatment truck prior to discharge.

- A surface water drainage system should be provided at the site to collect run-off where oils and lubricating fluids could be spilt. Drainage systems should include traps to collect SS in drainage or runoff (including metals). Interceptors should be installed to collect oil and grease.

- The efficiency of silt traps and oil interceptors is highly dependent on regular cleaning and maintenance. These installations should be regularly cleaned and maintained in good working order. Oily contents of the traps should be collected for reuse, or transferred to an appropriate disposal facility, such as the Government Chemical Waste Treatment Facility at Tsing Yi.

- Sewage effluent are required to meet the effluent standards stipulated in the *TM*. Sewage should be properly directed to a foul sewer, or to a temporary sewage treatment facility for treatment prior to discharge if the HK Industrial Estate sewerage system is not in phase with the operation of the HAECO site.

It is not considered necessary to include the waste treatment plant within the phase 1 facility waste.

In order to ensure the efficacy of the effluent treatment truck, discharges will require regular monitoring to ensure that discharge complies fully with the *TM* on Effluent Standards.

It is considered that monitoring should be undertaken on a weekly basis during the initial stages of the project, and the frequency reviewed when sufficient monitoring data is available. The monitoring programme should include those parameters listed in *Table 4.3a*. If it can be determined that specific compounds such as certain metals are not used on site as indicated by *Table 4.3a*, and will therefore not be present in the wastewater, these could be removed from the monitoring programme. This monitoring should be undertaken at the point of discharge to storm drain and foul sewer, and should be agreed with the EPD prior to operation.

4.3.5 *Conclusion*

Effluent from the site will include industrial wastewater, chemical wastes, sewage from on-site workforce, and potential runoff from the testing cell. Testing will be required, prior to commissioning, to determine the efficacy of the mobile treatment facility on those waste arisings specific to Phase 1. In addition, regular monitoring of discharge from on-site treatment will be required to ensure that discharges are compliant with specified *TM*.

Provided these and other mitigation measures detailed above are fully implemented, no major water quality impacts are expected from the operation of the HAECO facility.

4.4 *WASTE MANAGEMENT*

4.4.1 *Introduction*

This section addresses the potential for impacts from the generation, handling, collection, transportation and disposal of wastes arising from the operation of the new engine test cell and engine build shop in Tseung Kwan O. Procedures for waste reduction and management are considered and mitigation measures for minimising the impacts associated with these wastes are recommended.

In undertaking this assessment the waste characteristics, handling methods and disposal routes for wastes generated at HAECO's existing facility at Kai Tak were examined to provide accurate forecasts of potential waste arisings at the future Tseung Kwan O site.

4.4.2 *Legislation*

The legislation covering the handling, treatment and disposal of wastes in Hong Kong was detailed in *Section 3.4*. In addition, the Regulations covering Chemical wastes are presented in greater detail below due to their particular relevance to the operation of the facility.

Chemical Wastes

Chemical wastes as defined under the *Waste Disposal (Chemical Waste) (General) Regulation* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the Regulations, if such substance or chemical occurs in such a form, quantity or concentration so as to cause pollution or constitute a danger to health or risk of pollution to the environment.

A person should not produce or cause to be produced chemical wastes unless he is registered with the Environmental Protection Department (EPD). Any person who contravenes this requirement commits an offence and is liable upon conviction to a fine of up to HK$200,000 and to imprisonment for up to 6 months. The current fee for registration is HK$200.

Producers of chemical wastes must treat their wastes utilising on-site plant licensed by EPD or have a licensed collector take the wastes to a licensed facility. For each consignment of wastes, the waste producer, collector and disposer of the wastes must sign all relevant parts of a computerised trip ticket. The transfer of wastes from cradle to grave can therefore be traced.

The Regulations and Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes prescribe the storage facilities to be provided on site including labelling and warning signs. To minimise the risks of pollution and danger to human health or life, the waste producer is required to prepare and make available written procedures to be observed in the case of emergencies due to spillage, leakage or accidents arising from the storage of chemical wastes. He must also provide employees training in such procedures.

4.4.3 *Waste Arisings and Impacts*

Sources of Wastes

The waste categories that will be generated during the operation include:

- industrial wastes;
- chemical wastes;
- sewage effluent; and
- general refuse.

The definitions for each of these categories and the nature of their arisings and potential impacts are discussed in detail in the following sections, extent sewage effluent which is discussed in *Section* 4.3.

Table 4.4a provides details of the estimated waste arisings during the operation of the facility. *Section* 4.3.3 provides an indication of the likely resulting pollutant load associated with this effluent, based on sampling at Kai Tak.

Table 4.4a *Waste Effluent generated from TKO Phase 1*

Estimation Based on HAECO Existing Experience
Engine Handled = 15 engines/month

	Processes	Waste Category	Description	Major Composition	Quantity	Existing Treatment	Proposed Treatment
WORKSHOP Engine Build & Strip	Dis mantling	Chemical	Waste oil	engine oil ESSCO2360, ATO555, Mobil Jet oil, hydraulic oil HY/JET 4	340 lit/month	collected drum & be treated by waste-treatment specialist	same as existing
		Industrial	Solid waste (metal)	locking wires (screws & nuts)	14kg/month	disposed as ordinary refuse	recycle
		Industrial	others	rubber rings/packing	1.5kg/month	disposed as ordinary refuse	same as existing
	Cleaning (Primary)	Chemical	organic solvent	CB280	230 lit/month	collected by drum & treated by waste-treatment specialist	same as existing
		Industrial	rinsing water	CB280, oil & grease, S.S., surfactant	1/2 m³/day	to sewer	by existing mobile effluent treatment track
	Assemblin g	Industrial	solid waste	locking wire end	3.5 kg/month	disposed as ordinary refuse	recycle
TEST CELL	Testing	Chemical	organic waste	engine oil ESSO2380, A TO555, Mobil jet oil 2	340 lit/month	collected by drum & treated by waste-treatment specialist	same as existing
				kerosene	140 lit/month	trapped by oil interceptor & collected by waste-treatment specialist	same as existing
				CP oil - Areo Shell fluid	205 lit/month	trapped by oil interceptor & collected by waste-treatment specialist	same as existing
ORDINARY REFUSE		general refuse	clerical, packaging & housekeeping		4 m³/day = 0.5 t/day	collected by reputable waste haulier	same as existing

Chemical Waste

During the operation of the HAECO facility, chemical wastes will be generated from the workshop activities when engines are built or stripped, and during testing activities. The chemical wastes generated include engine fuels and oils, and organic solvents used in primary cleaning. The estimated chemical waste arisings and details of their major composition are given in *Table 4.4a* above.

As discussed in *Section 3.4*, chemical wastes can pose serious environmental, and health and safety hazards if not stored and disposed of in an appropriate manner, as outlined in the *Chemical Waste Regulations*. These hazards include:

- toxic effects on workers and others;
- spills could pollute groundwater or surface water;
- odour;
- fire hazards; and
- disruption of sewage treatment works where waste enters the sewage system.

Industrial Wastes

Industrial wastes are defined for the purposes for this study as wastes arising from the operation of the engine testing facility or workshop which are not chemical wastes or general refuse. They would include such wastes as metal wastes (locking wires, screws and nuts), rubber rings, rags used for cleaning/wiping and packing materials.

Industrial wastes have the potential to cause pollution, may be odorous and could, depending on their content, attract vermin. They are also visually intrusive.

The total waste arisings of these materials, as shown in *Table 4.4a*, are very small and it is considered that they will cause minimal environmental impact, provided appropriate storage and disposal facilities are employed.

Trade effluent such as contaminated rinsing water could also be regarded as industrial wastes. These effluent, if not properly controlled and treated, could potentially contaminate surface and ground waters or the public sewer system.

General Refuse

During the operation of the facility, the general refuse generated will include office and workforce generated wastes consisting of mainly waste paper and packaging, food wastes, glass bottles, aluminium and tin cans. These materials should be separated and recycled, wherever practicable, or if this is not possible disposed of at landfill.

The potential environmental impacts arising from the storage, handling and disposal of general refuse have been examined in *Section 3.4*. These potential impacts could also arise during the operation stage in the absence of appropriate waste management facilities.

4.4.3 *Storage, Collection, Transport and Disposal Options*

This section discusses the options for waste management and highlights the methodologies available for waste minimisation.

Chemical Wastes

The Chemical Waste Regulations governing the storage and disposal of chemical wastes must be followed, in order to ensure that there are no unacceptable impacts. EPD's Code Of Practice on the Packaging, Labelling & Storage of Chemical Wastes should also be followed. The chemical waste compositions and arisings are shown in *Table 4.4a*.

HAECO should examine each of their chemical waste streams to see if alternative, less polluting or more easily treated materials could be used. The volumes of chemical waste should be kept to a minimum by separation of waste streams and good management which reduce the potential for contamination.

Containers used for the storage of chemical wastes should be suitable for the substance they are holding, resistant to corrosion and maintained in a good condition. The containers should be stored safely and securely closed. Chemical wastes should not be stored in any container with a capacity exceeding 450 litres unless the specifications have been approved by the EPD. Every container of chemical waste should display a label in English and Chinese in accordance with instructions prescribed in Schedule 2 of the Regulations.

The storage area for any containers should not be used for any purpose except for the storage of chemical wastes and should be fully labelled in accordance with the Regulations. Chemicals which are incompatible and could cause fire or explosion if they are mixed should be segregated in separate areas. The storage area should be enclosed on at least three sides by a wall, partition or fence which is at least 2m in height or the height of the tallest container, whichever is the greater. Adequate ventilation and space for the handling of containers should be provided, with the area being kept clean and dry.

Liquid chemical wastes should be stored in an area which has an impermeable floor and retention structure with the capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is the greatest. When calculating the available retaining capacity, the volume occupied by the containers being stored should be taken into consideration. Bunded areas should be kept clean and dry, possibly by covering. If water does collect within the bund it must be tested before being disposed. This requirement does not apply to large, approved below ground containers.

The Chemical Waste Treatment Centre (CWTC) located at Tsing Yi is the point of disposal for all chemical wastes in the territory. The contractor operating the chemical waste treatment facility also operates a collection service for chemical waste producers. Disposal of chemical wastes in this manner will ensure that environmental and health and safety risks are reduced to a minimum, provided that correct storage, handling and transfer procedures are instigated on-site and on the collection vehicles. At the present time there is no charge for this collection and disposal service, however, there is a registration fee of HK$200.

HAECO should contact Enviropace, the Chemical Waste Treatment Centre operator, who offer both a chemical waste collection service and supply the necessary storage media for these wastes. In addition, HAECO should contact the EPD to ensure that the handling and disposal methods for the wastes in question are appropriate.

Industrial Wastes

Appropriate storage should be provided for the holding of industrial wastes. Solid wastes should be stored in covered bins, located close to the points of waste arisings, but allowing good access for collection.

Liquid industrial wastes should be stored to the same standards as liquid chemical wastes.

It is proposed that the rinsing water effluent of $1.2m^3$/day, which are likely to contain some contamination from the organic solvent CB280, oil and grease, suspended solids and surfactant, would be processed by HAECO's existing effluent treatment truck currently used at the company's facility at Kai Tak. The need for an additional effluent treatment truck should be considered by HAECO.

Other trade effluent and surface water would pass through oil and grease interceptors installed within the drainage system. The contaminated water from the interceptors would be collected in underground/surface collection tanks. The stored effluent would then be regularly processed by the effluent treatment truck.

Industrial wastes should be collected for disposal at a regular frequency and at least before the waste storage capacity is exceeded.

General Refuse

It has been estimated that 0.5 tonnes/day or approximately $4m^3$/day of general refuse will be generated at the facility when operational.

In order to minimise wastes generated HAECO should examine waste arisings and determine if it is possible to reduce them through the introduction of waste reduction measures such as purchasing policies which target or request products with less packaging. Alternatives such as refillable containers may exist. Certain packaging may also be more amenable to recycling.

General refuse generated on-site should be stored and collected separately from industrial and chemical wastes. The removal of waste from the site should be arranged on a daily basis by HAECO to minimise any potential odour impacts, minimise the presence of pests, vermin and other scavengers and prevent unsightly accumulation of waste.

General refuse should be stored in enclosed bins or compaction units. Compaction units assist in reducing the volumes of wastes transported for disposal, and are recommended.

4.4.3 *Mitigation Measures*

This section sets out ERM's recommended storage, transportation and disposal measures to avoid potentially significant environmental impacts associated with waste arisings from the operation of the facility or to reduce these to acceptable levels.

Segregation of Wastes

In order to ensure that all waste is disposed of in an appropriate manner, waste should be separated by category on-site by HAECO. The Consultants recommend that all waste, be segregated into the following previously defined categories:

- chemical waste;
- industrial wastes; and
- general refuse.

The different categories of wastes should be segregated, stored, transported and disposed in the manner described in *Section 3.4.*

It is recommended that the segregated wastes should be disposed of as follows:

- chemical waste as defined by *Schedule 1* of the *Waste Regulations (Chemical) 1992*, should be stored in accordance with approved methods defined in the Regulations and the chemical waste disposed of at the Chemical Waste Treatment Centre located at Tsing Yi;

- industrial waste should be disposed of at public landfill; and

- general refuse should be disposed of at public landfill.

Waste Minimisation

Waste materials should be recycled or reused wherever possible. The waste management strategy to be employed should be waste minimisation at source. Where waste generation is unavoidable then the potential for recycling or reuse should explored and opportunities taken. If wastes cannot be recycled then the recommended disposal routes should be followed.

HAECO should where practicable:

- recycle waste paper generated at the administrative offices;

- recycle scrap metal and other recyclable materials; and

- set targets for waste minimisation or recycling.

Training and instruction of HAECO staff should be provided to increase awareness and draw attention to waste management issues and the need to minimise waste generation.

Regular auditing of the waste stream should be undertaken to determine if waste minimisation targets are being achieved or could be improved. The audits should look at all aspects of waste management including generation, recycling, treatment, transport and disposal to ensure procedures are being followed.

It should be noted that good waste management practices can bring significant cost savings.

Waste Treatment

The volumes and nature of the waste arisings have been considered together with the treatment and disposal options and it has been concluded that there is not an environmental requirement for a waste treatment facility within the proposed HAECO development for the phase 1 operation.

Waste Disposal

In relation to the collection and disposal of chemical wastes from the HAECO sites, HAECO should contact Enviropace (the operator of the Chemical Waste Treatment Centre at Tsing Yi) who offer both a land and marine chemical waste collection service and supply the necessary storage media for these wastes, the Contractor should also contact EPD to help ensure that the handling and disposal methods used for chemical wastes are appropriate.

Reputable waste hauliers should be used to collect and transport industrial and general refuse wastes to the public landfill. The necessary measures to minimise the adverse impacts including windblown litter and dust from the transportation of these wastes should also be instigated.

The following practices are recommended, as for the construction phase.

- wastes should be handled and stored in a manner which ensures that they are held securely without loss or leakage thereby minimising the potential for pollution;
- only reputable waste hauliers appropriate to collect the specific category of waste concerned should be employed;
- appropriate measures should be employed to minimise windblown litter and dust during transportation by either covering trucks or transporting wastes in enclosed containers;
- the necessary waste disposal permits need to be obtained from the appropriate authorities if they are required in accordance with the Waste Disposal Ordinance (Cap 354), Waste Disposal (Chemical Waste) (General) Regulation (Cap 354) and the Crown Land Ordinance;
- collection of general refuse should be carried out frequently, preferably daily;
- waste storage areas should be kept tidy, well maintained and cleaned regularly; and
- the quantity of waste for disposal should be recorded, determined by weighing each load or similar method.

HAECO have introduced formalised waste management procedures at their existing Kai Tak facility to ensure compliance with the relevant regulations and that good practices are followed. These procedures should be reviewed before being implemented at the Tseung Kwan O site and modified, where necessary, in accordance with the recommendations of this report.

It is recommended that auditing of each waste stream should be carried out periodically to determine if wastes are being managed in accordance with company procedures and if waste reduction targets are being achieved and could be improved. The audits should look at all aspects of waste management including waste generation, storage, recycling, treatment, transport, and disposal. An appropriate audit programme would be to undertake a first audit during commissioning, and quarterly thereafter.

4.4.4 *Conclusions and Recommendations*

No significant impacts upon the environment have been identified arising from the disposal of waste from the Phase 1 engine testing facility and workshops at Tseung Kwan O. In all cases provisions can be made for the waste material disposed of to landfill or the Chemical Waste Treatment Centre at Tsing Yi. Some small quantities of high value waste such as aluminium and paper can also be recycled.

The effective application of the mitigation measures recommended in the previous section will ensure that environmental nuisance will not arise from the storage, transport and disposal of the various types of waste arisings from the operation of the new engine testing facility.

5 CONCLUSIONS

The main conclusions from this Environmental Impact Assessment are summarised below.

5.1 CONSTRUCTION PHASE IMPACTS

Noise And Air Quality

No significant impacts from construction noise or dust emissions have been predicted because of the large separation of the site from any sensitive receivers.

Water Quality

No significant water quality impacts are expected because the site is about 300 m from the shoreline. However, in light of the potential for cumulative impacts due to numerous construction projects in the area, proper site management and good construction practices have been recommended to reduce the chance of chemical/oil spillages, to control site run-off, and the occurrence of littering and debris.

Waste Management

No unacceptable environmental impacts, in terms of specified government regulations and guidelines, have been identified arising from the storage, handling, collection, transport and disposal of wastes from the construction works. In most cases the waste material can be easily re-used on other construction sites or disposed of to landfill. However, in light of the scale of construction work in the area, mitigation measures have been recommended to ensure that environmental nuisance does not arise from the HAECO site.

5.2 OPERATIONAL PHASE IMPACTS

Noise

The potential for noise impacts to receivers up to 3.5 km away have been assessed by detailed computer modelling starting with the aircraft engine manufacturers noise data, using a specialist test cell acoustic model, and generating noise contours for the surrounding area. Whilst the noise levels generated inside the test cell will inevitably be extremely high, the combination of an appropriate acoustic design and the minimum separation distance of over 2.5 km to the nearest sensitive receivers ensure that predicted noise levels are below the required planning standard, and no significant noise impacts are predicted, even for night-time operation.

Air Quality

Emissions from the test cell have been modelled based on worst case engine test and meterological conditions. The predicted NO_2, SO_2, and CO levels at the nearest sensitive receivers, over 2 km away, are well below the Hong Kong Air Quality Objective levels implying that no significant impacts are expected.

Water Quality

A waste treatment plant will not be included within the Phase 1 development (but will be built in Phase 2). Instead the existing mobile treatment plant, currently used at the HAECO operation at Kai Tak, will be used. Testing will be required, prior to commissioning, to determine the efficacy of the mobile treatment plant on those waste arisings specific to Phase 1. In addition, regular monitoring of discharge will be required. It is anticipated that the existing mobile waste treatment plant will be effective (although a second plant may be needed to serve this site), and provided these and other recommended mitigation measures are implemented, no major water quality impacts are expected.

Waste Management

No significant impacts upon the environment have been identified from the disposal of waste from the engine testing facility. In all cases provisions can be made for the waste material disposed of to landfill or the Chemical Waste Treatment Centre at Tsing Yi. Some small quantities of high value waste such as aluminium and paper can also be recycled. Mitigation measures have been recommended to ensure that environmental nuisance will not arise from the storage, transport and disposal of the various types of waste arisings from the operation of the new engine testing facility.

Annex A

ASE's Acoustic Model

ASE's Acoustic Model

General Discussion:

ASE's acoustic model is a tool used to balance the attenuation characteristics of the various features of the test cell chamber to meet the "dBA at a distance" criteria. ASE's nearly 30 years of test cell design experience has identified the dominating transmission paths which are considered in the model. Source data for an engine under test is evaluated separately in cooperation with engine manufacturers, and adjusted to provide a reasonable growth path of the source.

Source Considerations:

Considerable discussion has taken place between ASE, HAECO and Rolls Royce at the engine manufacturers factories in Derby, England to define the Noise Source Spectrum. The agreed upon source is to be a spectrum generated from the highest sound power level (in full octave bands), measured from runs of any of the engines listed in the HAECO spec., or, GE90B4, or, Trent 800 engine sound power levels. For analytical use, the Trent 800 sound levels were projected to be a simple 3dBA addition to measured values of the Trent 700 engine. Engine Sound Power Levels have been furnished to ASE from HAECO.

Engines under test are fitted with different hardware than when they are fitted on wing. Many of the attenuating features, such as acousticaly lined air inlets, are not present during engine testing. For the HAECO model, the engine sound power level values are correctted for forward versus aft sound projection. This is done assuming the engine noise follows distribution patterns measured for engines of similar design.

Noise Paths/ Prediction Methodology:

The following charts define the effects of these paths quantitatively. Source characteristics are also considered, based on variations in projected noise radially from the engine. These effects are analytically combined, and reduced for atmospheric absorption effects using a commercially available spreadsheet software program to evaluate sound pressure levels at any point outside the control volume. In addition, a correction is applied for the source versus receiver size.

Transmission paths considered include:

Exhaust basket attenuation
Exhaust Baffle attenuation
Exh. Stack Exit Vertical and hoizontal directivity
Exhaust Stack Wall Transmission

Transmission Paths continued:

- Inlet Baffles
- Inlet and Cell chamber reverberation
- Cell wall and ceiling linings
- Inlet and wall transmission

Model Validity:

ASE's acoustic model has been used to evaluate existing test cells running engines of known acoustic signature. Data is presented for runs at Korean Airlines and at the US Airforce Base at Charleston, South Carolina.

A United Technology-Pratt & Whitney Aircraft Engine PW 4056 engine was run in the Korean Airlines test cell. The PW4056 engine produces 56,000 lbs of thrust at approximately 1700 lbs/sec engine airflow. This performance level is comparable to the engines to be tested at HAECO.

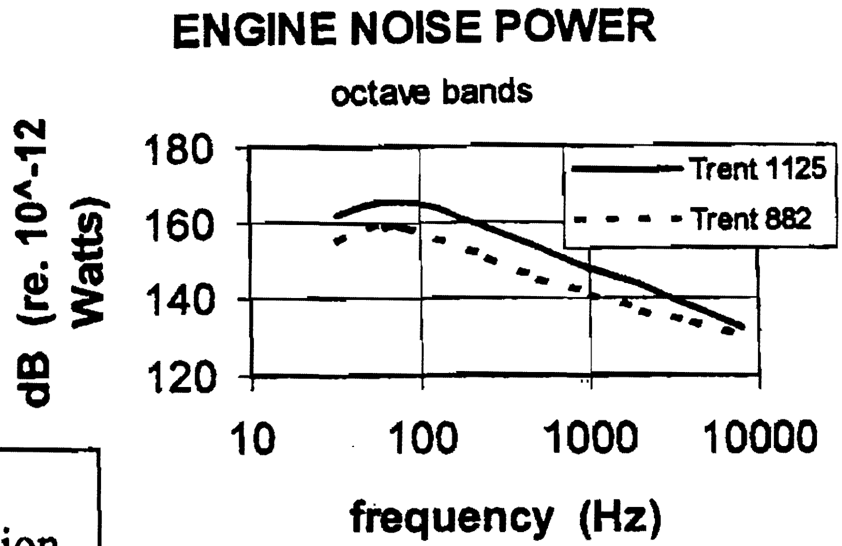
ASE staff, using recording equipment and acoustic spectrum analysis equipment manufactured by Larson & Davis collected the comparison data . A summary of the specific measured data is available for review, but not for public distribution.

Similar tests were conducted at Charleston Airforce Base using a PW-2040 engine producing nearly 40,000 lbs of thrust. This engine is comparable in performance to the smaller RB211 engines which will run at HAECO.

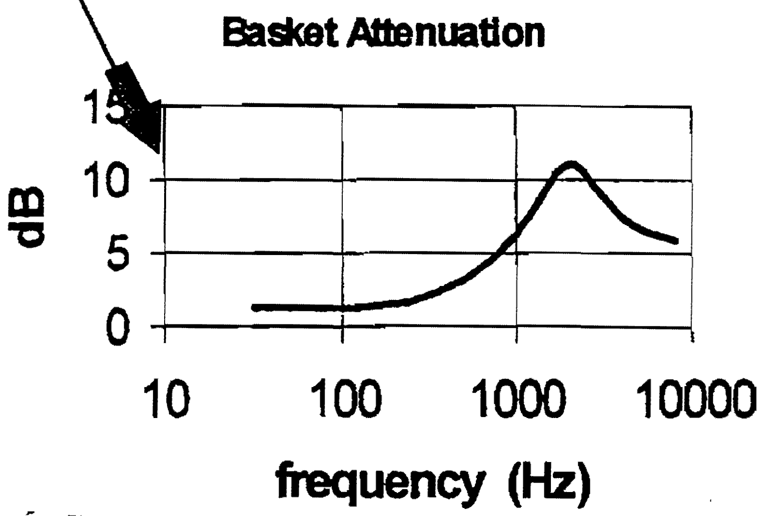
In the graphs that follow, the contribution to overall sound levels, of each test cell component is shown along with their combined effect. The comparison of the model projected sound levels to the measured values is well within measurement tolerances.

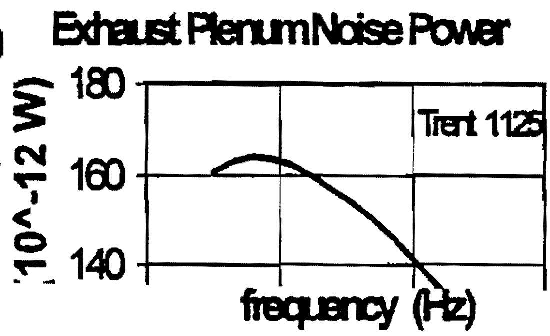
These two corelations of measured versus modeled acoustic levels validate the modeling technique for the majority of the engines to be tested at HAECO.

Exhaust Path



Augmentor:
hard walled - no attenuation

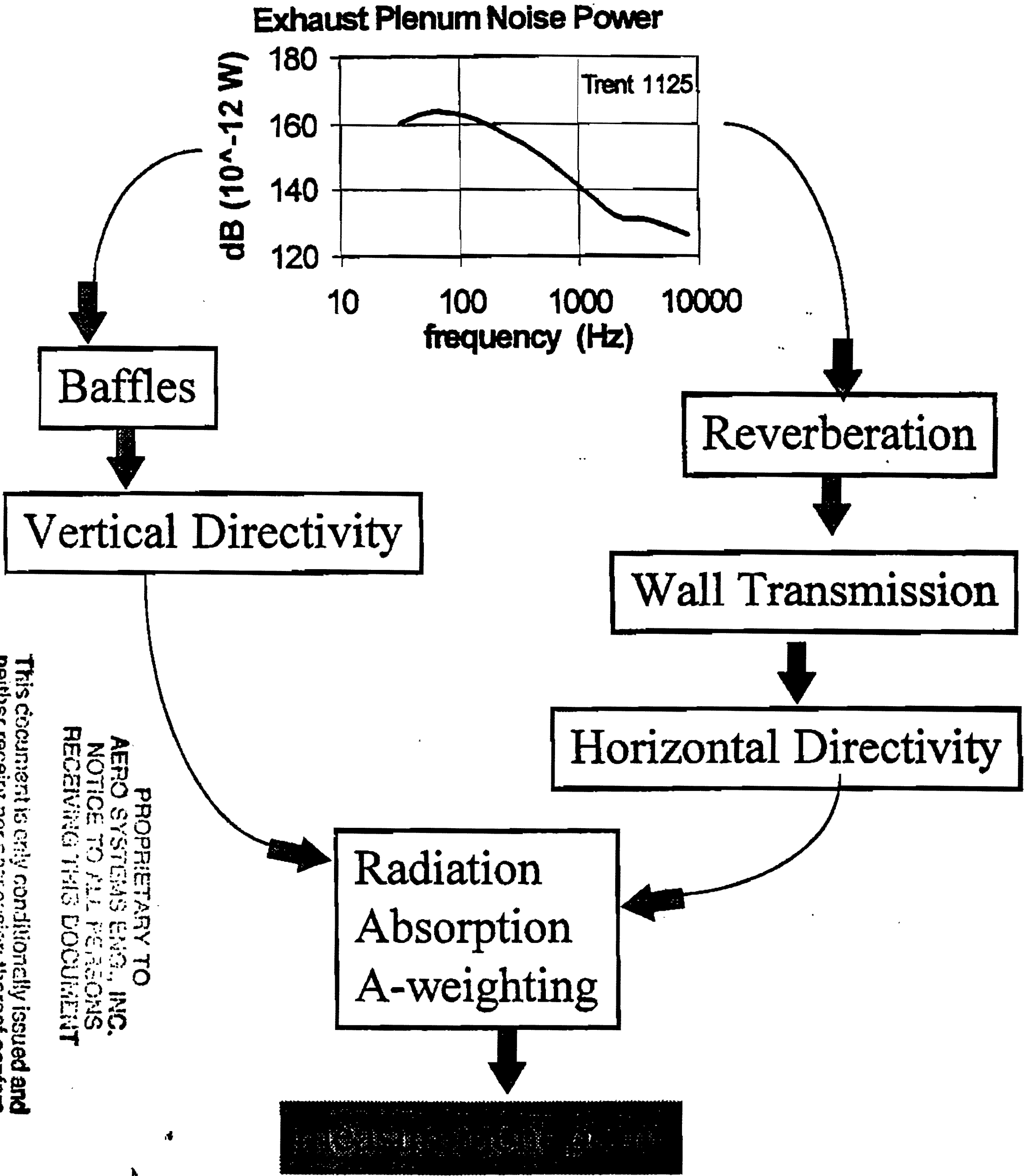




HAECO

ASE

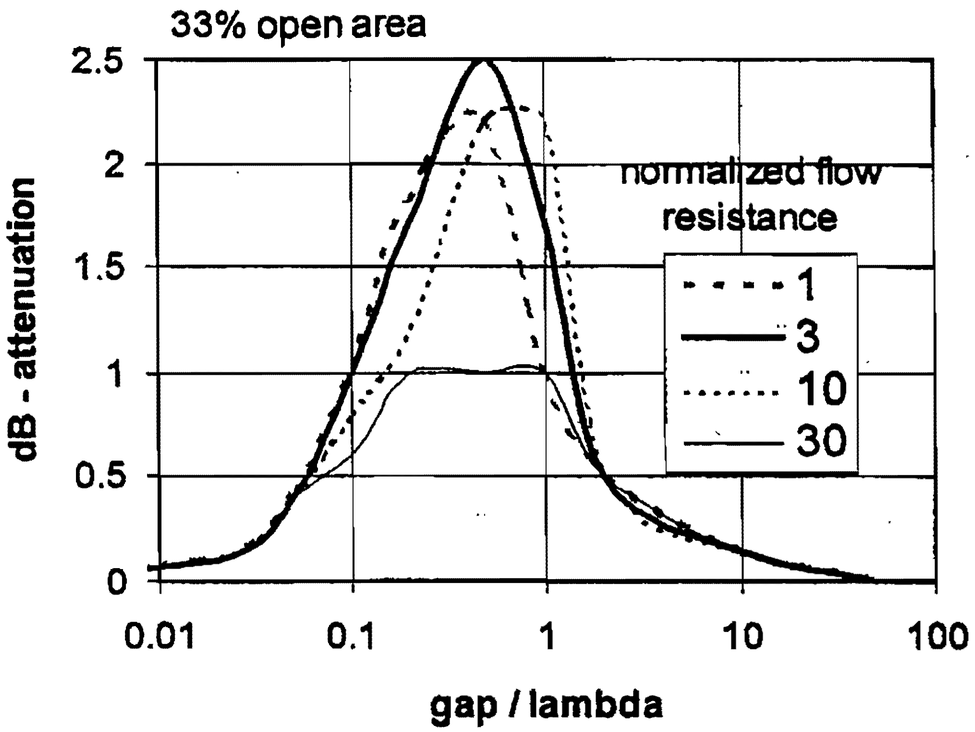
Exhaust Path (2)

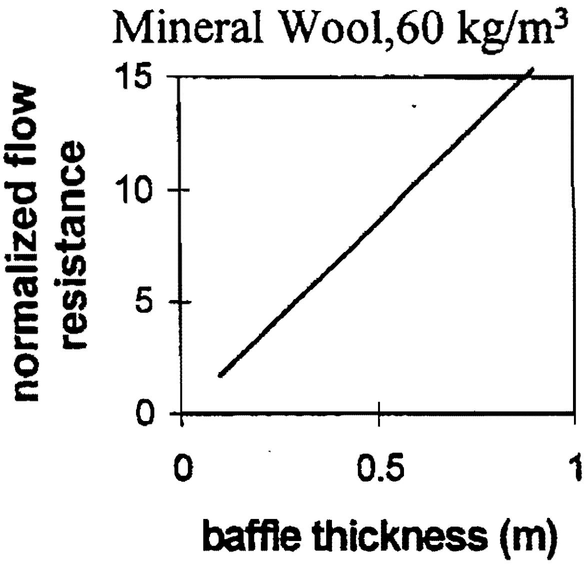


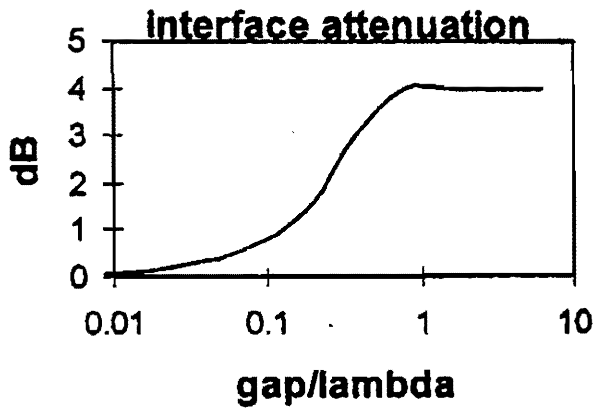
HAECO

ASE

EXHAUST BAFFLE DETAILS







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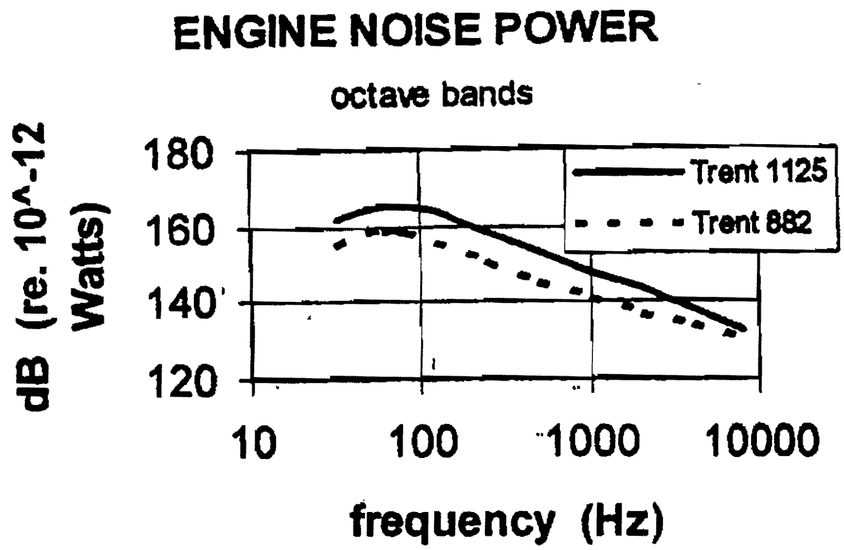
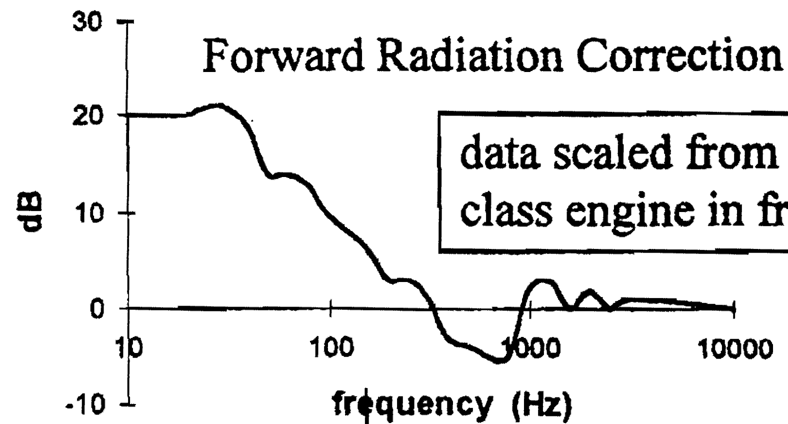
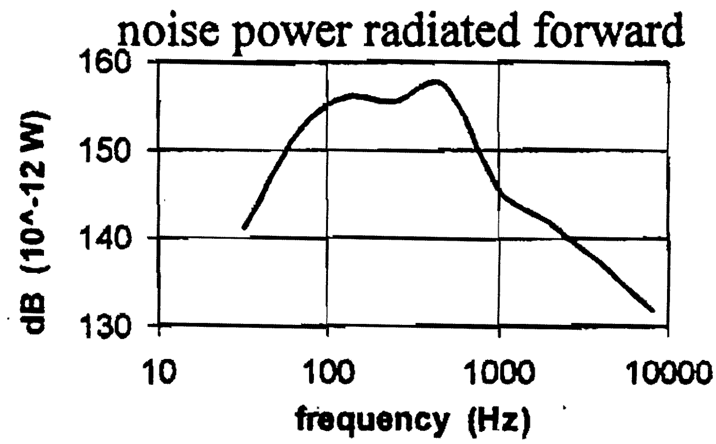
ASE

Inlet Path



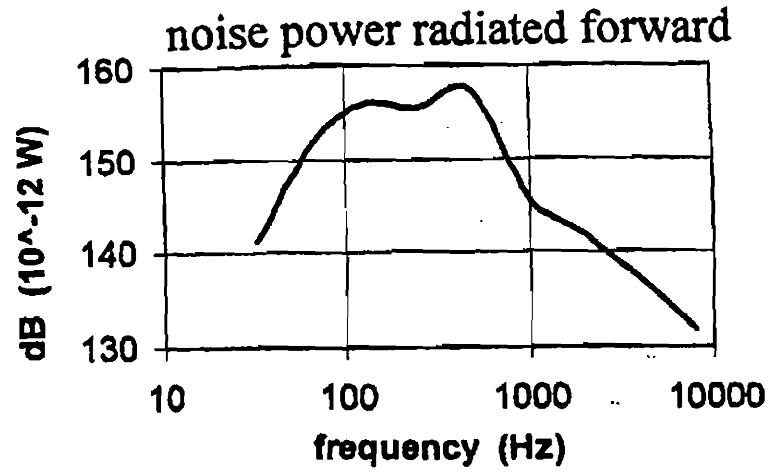




HAECO

ASE

Inlet Path (2)



Baffles

↓

Vertical Directivity

↓

Radiation
Absorption
A-weighting

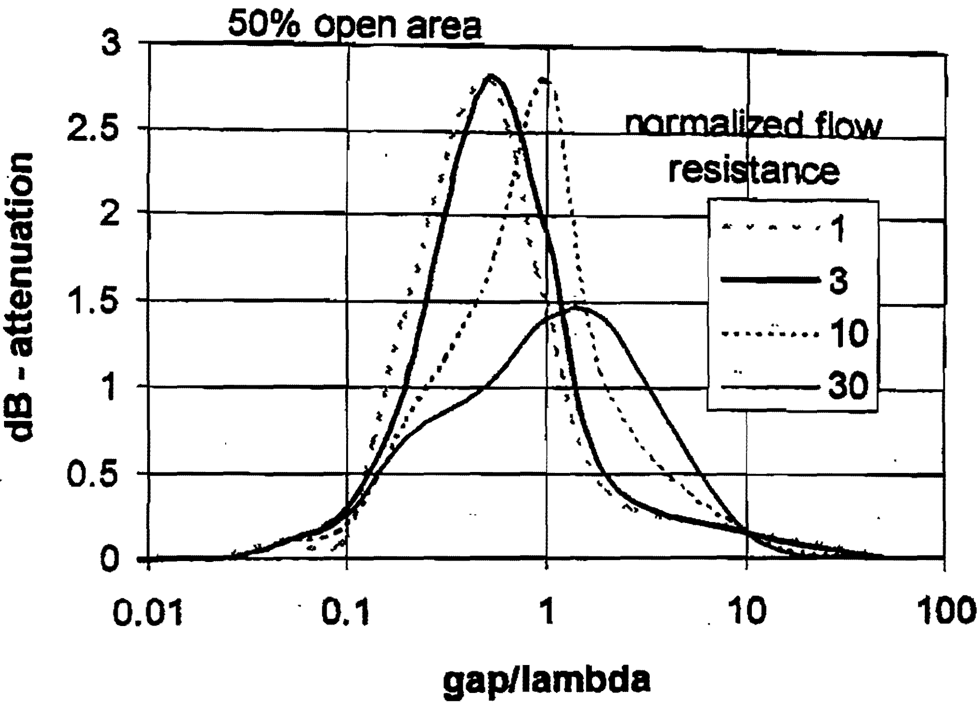
↓

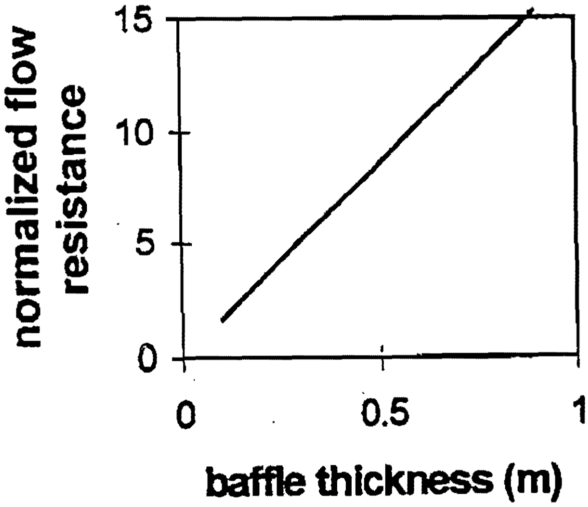
[redacted]

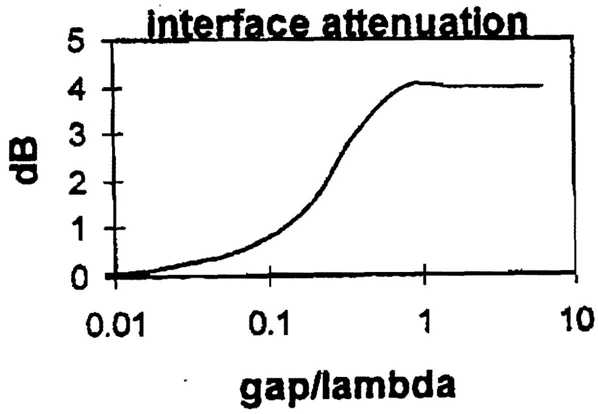
HAECO

ASE

INLET BAFFLE DETAILS



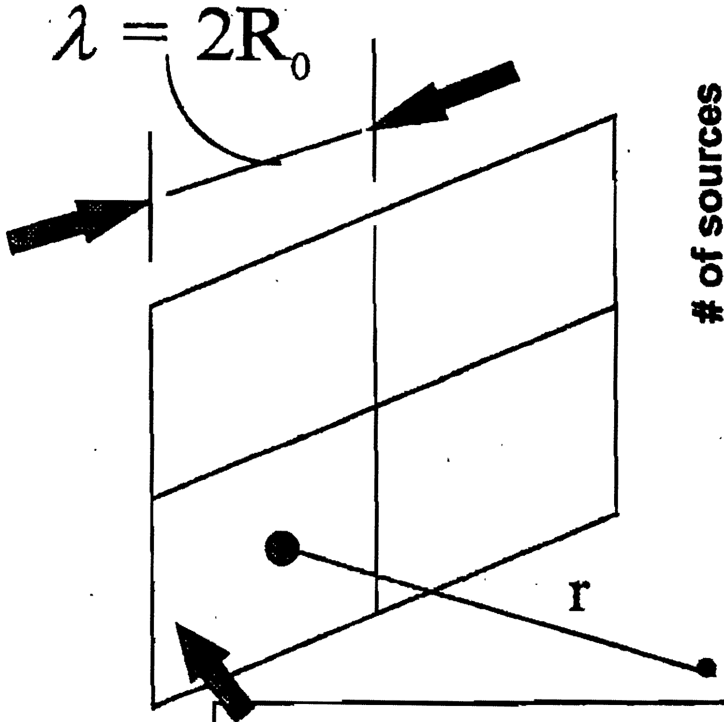


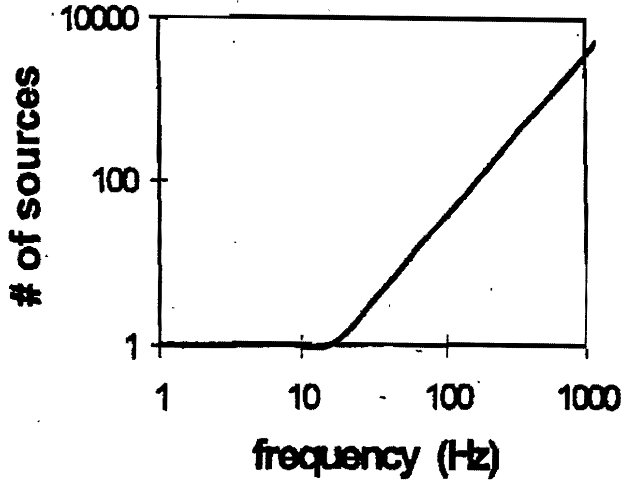


HAECO

ASE

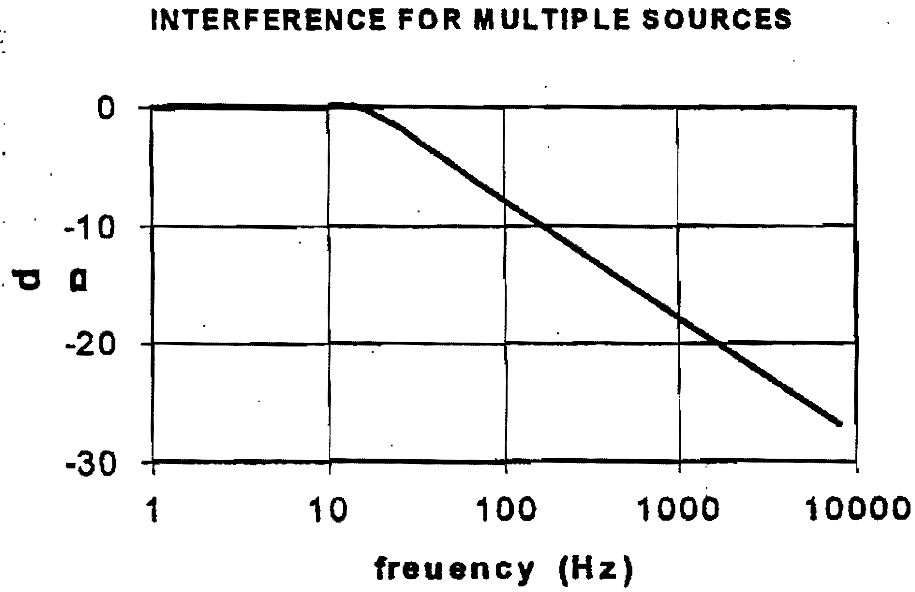
SOURCE SIZE CONSIDERATIONS





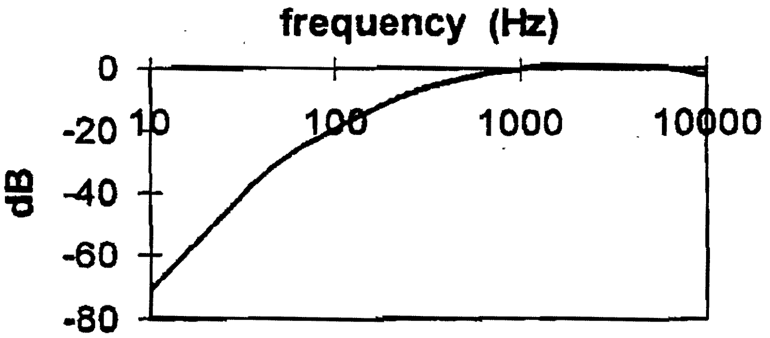
radiation correction: $\frac{S^2}{2\pi r^2}$

Radiation surface: S= 13m x 33 m

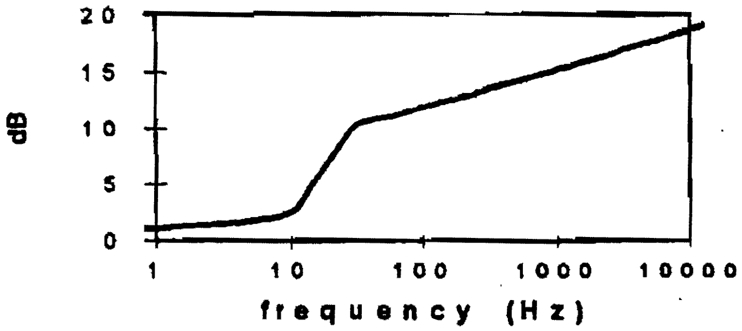


15712794 12:26

OTHER FACTORS



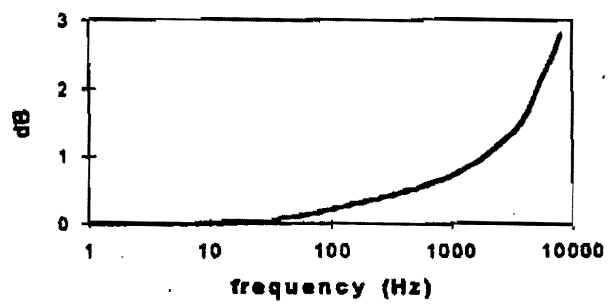
A - weighting



Vertical directivity from stack exits

Horizontal directivity from wall surfaces

$$dB = 10\log(\cos(\theta))$$



Atmospheric Absorption over 80 meters

14

SCM

OCTAVE BAND SUMMARY

68 dBA design

cell: HAECO

center frequency: 125 Hz

EXHAUST PATH

[illegible]

-12.1	directivity
-0.3	absorption
-24.1	divergence

109.6 dB SPL
131.9 dB PWL

22.1	baffles

154.0 dB PWL

-1.7	basket

155.7 dB PWL

0.0	augmentor
0.0	ring diffuser

EXHAUST PLENUM WALLS

154.0 dB PWL

-4.0	reverberation

150.0 dB SPL

-57.5	wall transmission
-8.7	source interference
-14.3	divergence
0.0	directivity

[illegible]

[illegible]

CELL WALLS

-12.3	reverberation

143.5 dB SPL

-53.2	wall transmission

-8.7	source interference
-12.1	divergence
-1.0	directivity

[illegible]

INLET PATH

-9.4	forward projection
1.4	hard bellmouth

147.8 dB PWL

-9.4	baffles

138.4 dB PWL
116.2 dB SPL

-27.8	divergence
-0.4	absorption
-12.1	directivity

[illegible]

HAECO

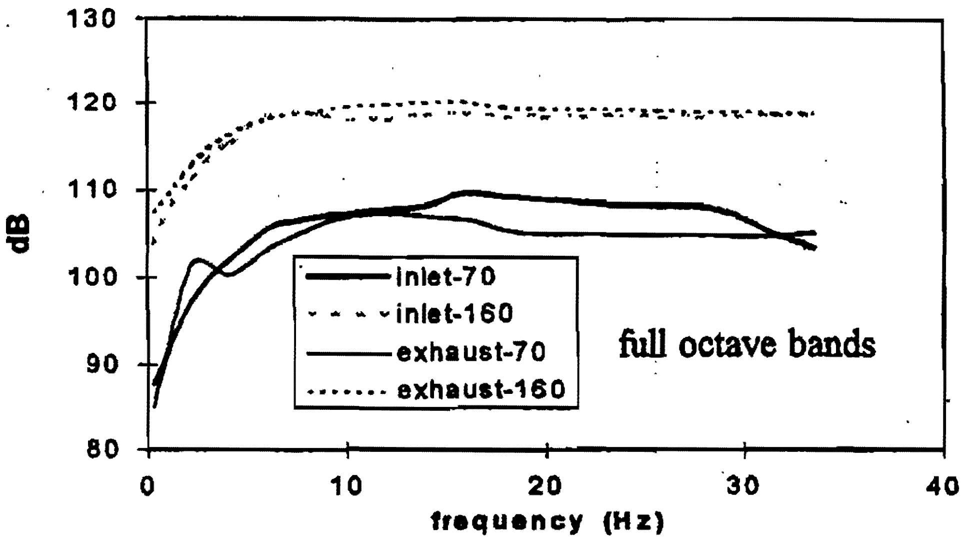
ASE

4

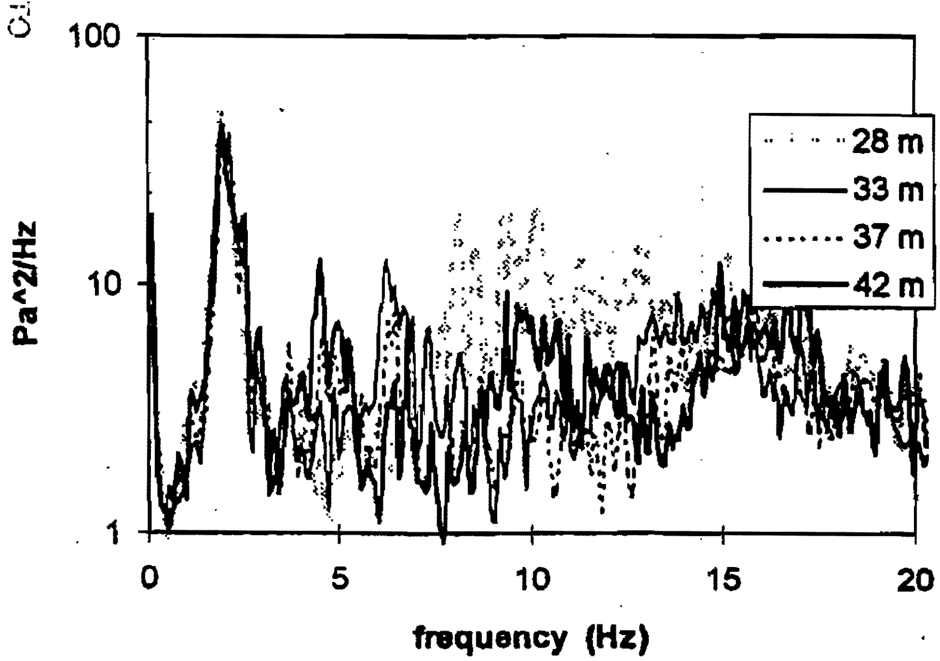
INFRASOUND

From model tests:
2 m above and 10 m away from exit plane

Thrust variation



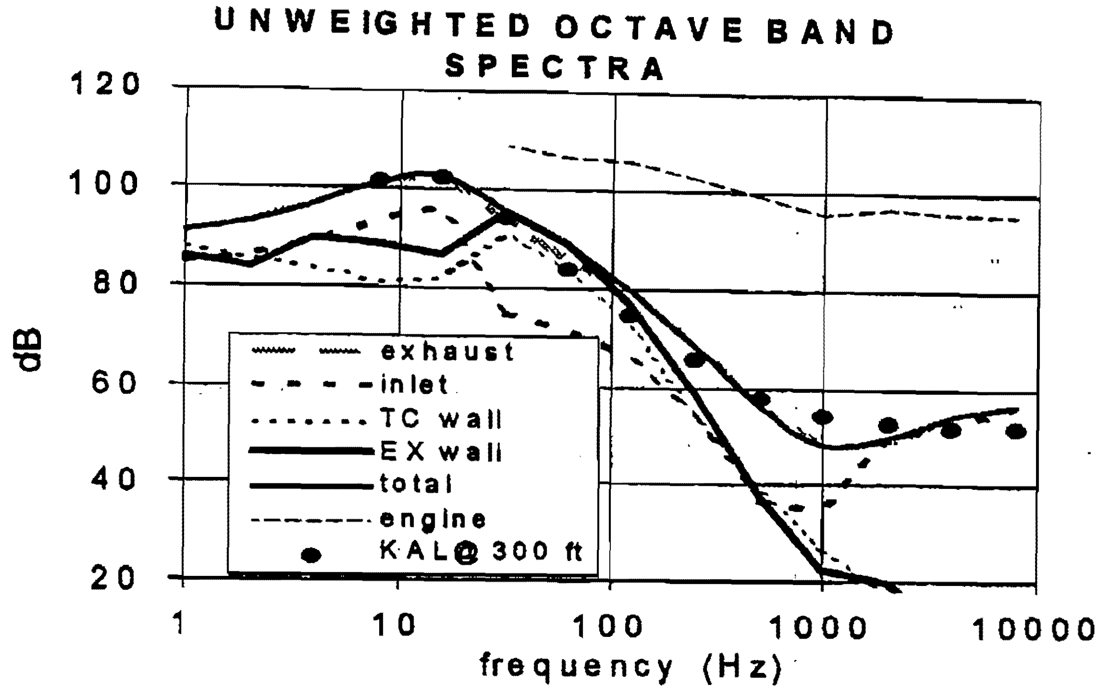
Exhaust Height Variations

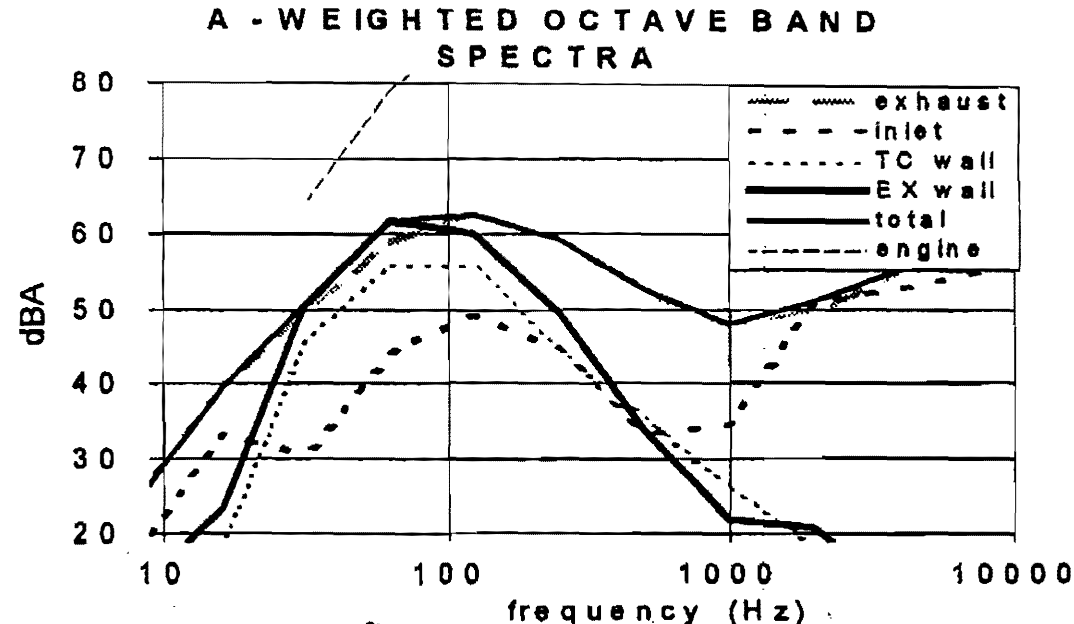


HAECO ASE

KOREAN AIR LINES 10M CELL

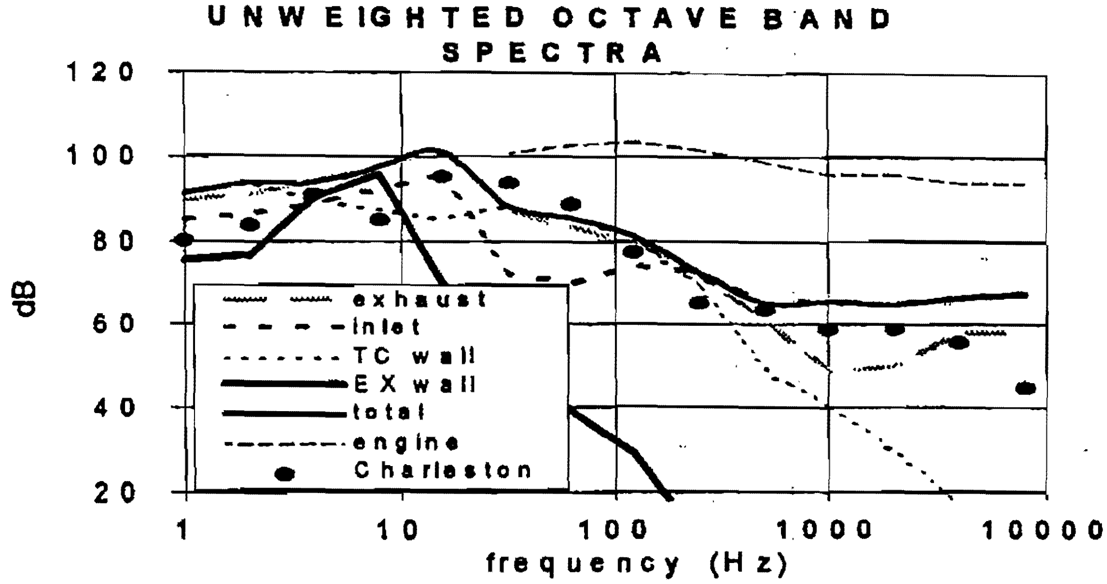
PW4000 engine 67 dBA @ 300 ft

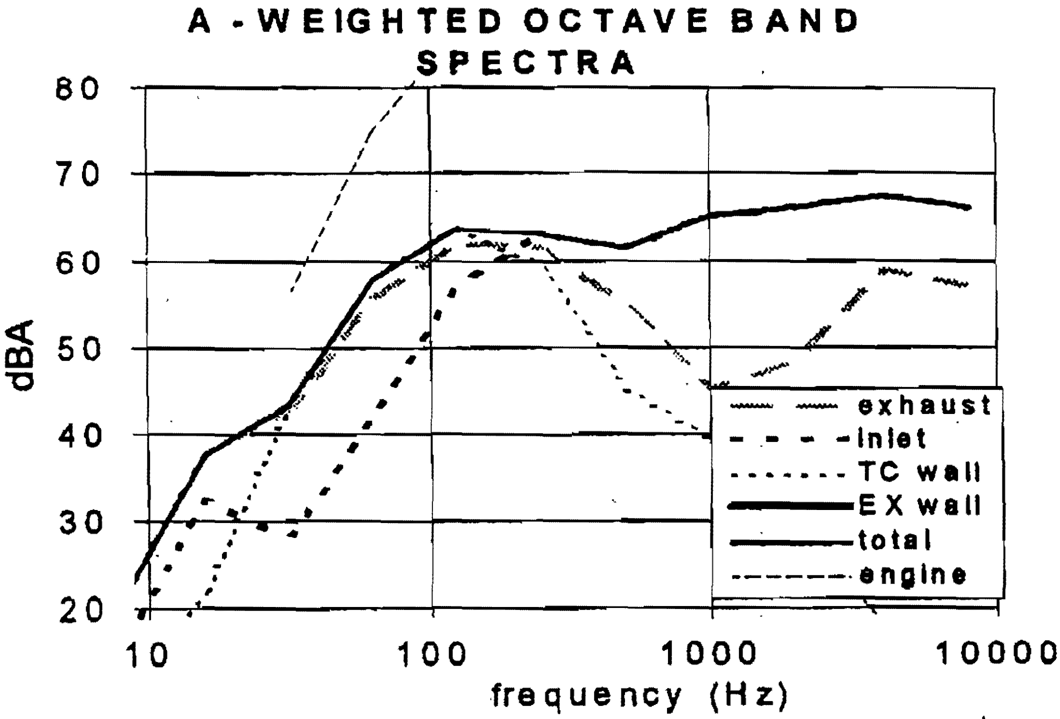




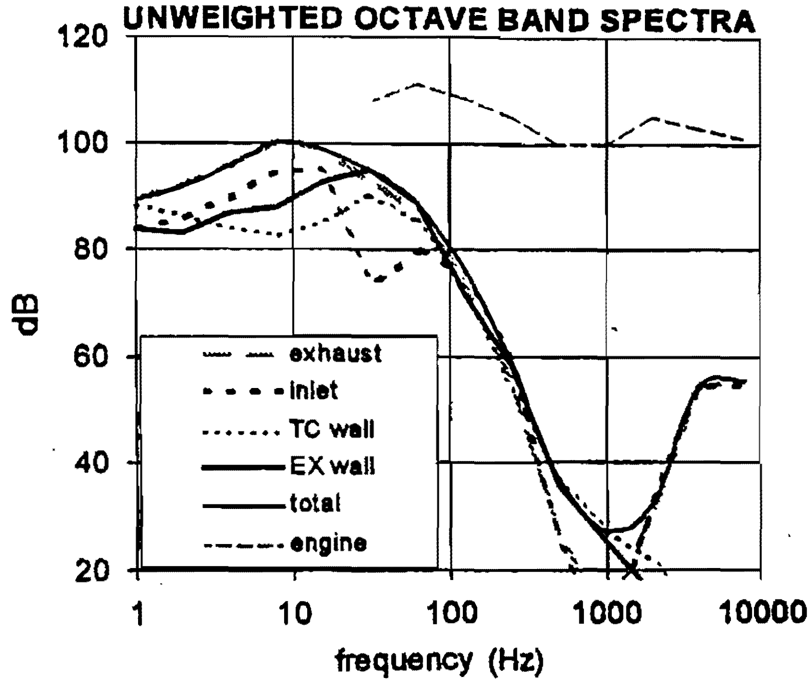
CHARLESTON AFB 10M CELL

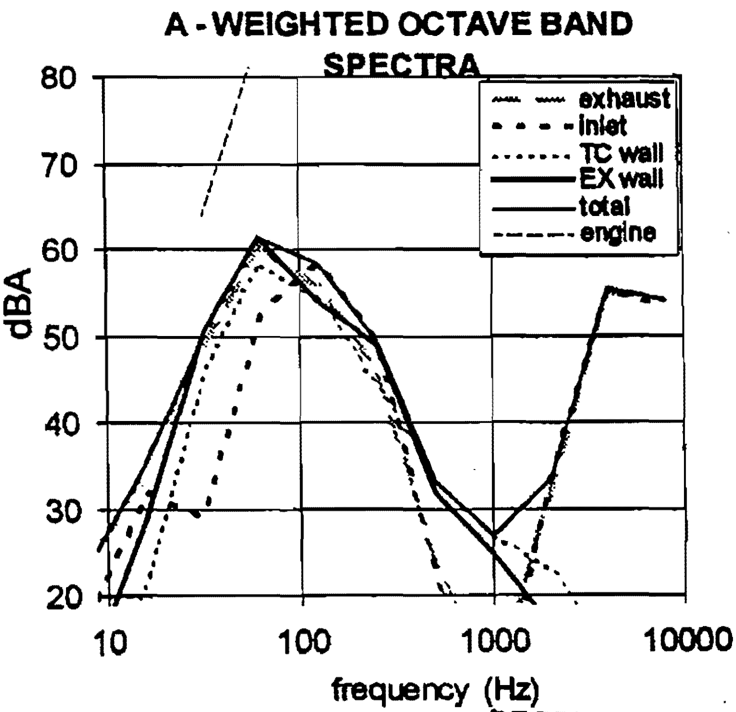
PW2037 engine 73 dBA @ 200 ft





HAECO : 68 dB design (5 dB margin)





TRENT 882, GE 90

Test Cell

- single wall
  - 0.8 m thick
  - 130 m² lining

Exhaust Train

- single wall
  - 1.2 m thick
- baffles
  - 3 rows @ 9m
  - 33% open
  - .6m thick
- stack
  - 169 m² × 36m high

Inlet Train

- baffles
  - 3 rows
  - 7 m long
  - 50% open
  - .25 m thick
  - 169 m²
- stack 28 m high

HAECO

ASE

2

Annex B

ISCST2 Airmodel File

```
ISCST2 - (DATED 93109)

IBM-PC VERSION (2.1  ) ISCST2X
(C) COPYRIGHT 1992, TRINITY CONSULTANTS, INC.
SERIAL NUMBER  9143 SOLD TO ERM HONG KONG
Run Began on  9/27/1995 at 16:05:09

*** TRINITY SOURCE FILE NAME: G:\CONTRACT\C1276\AIRMODEL\HAECO.PNT

*** TRINITY RECEPTOR FILE NAME:
G:\CONTRACT\C1276\AIRMODEL\DISCRE10.REC
CO STARTING
CO TITLEONE HAECO JET ENGINE TESTING CELL
CO TITLETWO SO2 discrete AT 100M
CO MODELOPT CONC URBAN
CO AVERTIME 1
CO POLLUTID SO2
CO HALFLIFE 14400.000000
CO TERRHGTS ELEV
CO ELEVUNIT METERS
CO FLAGPOLE 0.000000
CO RUNORNOT RUN
CO FINISHED
SO STARTING
SO LOCATION SRC1 POINT  846000.00  815724.00      5.00
SO SRCPARAM SRC1 1.920000     40.00     325.00    16.4000     12.500
SO EMISUNIT 1000000.000000 GRAMS/SEC MICROGRAMS/M**3
SO SRCGROUP ALL
SO FINISHED
RE STARTING
RE DISCCART 845550.00 818800.00     5.00 100.000
RE DISCCART 845100.00 818250.00     5.00 100.000
RE DISCCART 844600.00 818250.00     5.00 100.000
RE DISCCART 844250.00 818250.00     5.00 100.000
RE DISCCART 846100.00 818250.00     5.00 100.000
RE DISCCART 842750.00 815400.00     5.00 100.000
RE DISCCART 842750.00 814300.00     5.00 100.000
RE DISCCART 844050.00 813750.00     5.00 100.000
RE FINISHED
ME STARTING
ME INPUTFIL G:\CONTRACT\C1276\AIRMODEL\ABCDEF.MET
ME ANEMHGHT   10.000 METERS
ME SURFDATA 99999 1992 SURFNAME
ME UAIRDATA 99999 1992 UAIRNAME
ME STARTEND 1992 1 1 1 1992 12 31 24
ME WINDCATS   1.54   3.09   5.14   8.23  10.80
ME FINISHED
OU STARTING
OU RECTABLE 1 FIRST
OU PLOTFILE 1 ALL FIRST G:\CONTRACT\C1276\AIRMODEL\DSO2100.GPH 70
```

OU FINISHED

```
************************************
*** SETUP Finishes Successfully ***
************************************
```

*** ISCST2 - VERSION 93109 ***   *** HAECO JET ENGINE TESTING CELL
*** 09/27/95
*** SO2 discrete AT 100M ***
16:05:09

PAGE 1
*** MODELING OPTIONS USED: CONC URBAN ELEV FLGPOL

*** MODEL SETUP OPTIONS SUMMARY ***

- -

**Model Is Setup For Calculation of Average CONCentration Values.

**Model Uses URBAN Dispersion.

**Model Uses User-Specified Options:
1. Final Plume Rise.
2. Stack-tip Downwash.
3. Buoyancy-induced Dispersion.
4. Calms Processing Routine.
5. Not Use Missing Data Processing Routine.
6. Default Wind Profile Exponents.
7. Default Vertical Potential Temperature Gradients.

**Model Accepts Receptors on ELEV Terrain.

**Model Accepts FLAGPOLE Receptor Heights.

**Model Calculates 1 Short Term Average(s) of: 1-HR

**This Run Includes: 1 Source(s); 1 Source Group(s); and 8 Receptor(s)

**The Model Assumes A Pollutant Type of: SO2

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE: The Following Flags May Appear Following CONC Values: c for Calm Hours
m for Missing Hours
b for Both Calm and Missing Hours

**Misc. Inputs: Anem. Hgt. (m) = 10.00 ; Decay Coef. = 0.4813E-04 ; Rot. Angle = 0.0
Emission Units = GRAMS/SEC ; Emission Rate Unit Factor = 0.10000E+07
Output Units = MICROGRAMS/M**3

**Input Runstream File: g:\contract\c1276\airmodel\dso2100.dat ; **Output Print File: g:\contract\c1276\airmodel\dso2100.lst

*** MODELING OPTIONS USED: CONC URBAN ELEV FLGPOL

*** POINT SOURCE DATA ***

NUMBER EMISSION RATE   BASE   STACK STACK   STACK
STACK   BUILDING EMISSION RATE
SOURCE   PART. (USER UNITS)   X   Y   ELEV.   HEIGHT TEMP.   EXIT
VEL. DIAMETER   EXISTS   SCALAR VARY
ID   CATS.   (METERS) (METERS) (METERS) (METERS) (DEG.K)
(M/SEC) (METERS)   BY
- -

SRC1   0   0.19200E+01 846000.0 815724.0   5.0   40.00   325.00   16.40   12.50
NO

*** ISCST2 - VERSION 93109 ***   *** HAECO JET ENGINE TESTING CELL
***   09/27/95
*** SO2 discrete AT 100M   ***
16:05:09

PAGE 3
*** MODELING OPTIONS USED: CONC URBAN ELEV FLGPOL

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	SRC1 ,

*** MODELING OPTIONS USED: CONC URBAN ELEV FLGPOL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(845550.0, 818800.0, 5.0, 100.0); (845100.0, 818250.0, 5.0, 100.0);

(844600.0, 818250.0, 5.0, 100.0); (844250.0, 818250.0, 5.0, 100.0);

(846100.0, 818250.0, 5.0, 100.0); (842750.0, 815400.0, 5.0, 100.0);

(842750.0, 814300.0, 5.0, 100.0); (844050.0, 813750.0, 5.0, 100.0);

*** ISCST2 - VERSION 93109 *** *** HAECO JET ENGINE TESTING CELL *** 09/27/95
*** SO2 discrete AT 100M ***
16:05:09

PAGE 5
*** MODELING OPTIONS USED: CONC URBAN ELEV FLGPOL

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1111111111 1111111111 1111111111 1111111111 1111111111
1111111111 1111111111 1111111111 1111111111 1111111111
1111111111 1111111111 1111111111 1111111111 1111111111
1111111111 1111111111 1111111111 1111111111 1111111111
1111111111 1111111111 1111111111 1111111111 1111111111
1111111111 1111111111 1111111111 1111111111 1111111111
1111111111 1111111111 1111111111 1111111111 1111111111
1111111111 111111

METEOROLOGICAL DATA PROCESSED BETWEEN START DATE: 92 1 1 1
AND END DATE: 92 12 31 24

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00

B	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
C	.20000E+00	.20000E+00	.20000E+00	.20000E+00	.20000E+00	.20000E+00
D	.25000E+00	.25000E+00	.25000E+00	.25000E+00	.25000E+00	.25000E+00
E	.30000E+00	.30000E+00	.30000E+00	.30000E+00	.30000E+00	.30000E+00
F	.30000E+00	.30000E+00	.30000E+00	.30000E+00	.30000E+00	.30000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***

(DEGREES KELVIN PER METER)

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

*** ISCST2 - VERSION 93109 ***   *** HAECO JET ENGINE TESTING CELL
*** 09/27/95
*** SO2 discrete AT 100M ***
16:05:09

PAGE 6
*** MODELING OPTIONS USED: CONC URBAN ELEV FLGPOL

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: G:\CONTRACT\C1276\AIRMODEL\ABCDEF.MET FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1)
SURFACE STATION NO.: 99999 UPPER AIR STATION NO.: 99999
NAME: SURFNAME NAME: UAIRNAME
YEAR: 1992 YEAR: 1992

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	URBAN
92	1	1	1	0.0	1.00	298.0	1	1000.0	1000.0
92	1	1	2	0.0	3.00	298.0	1	1000.0	1000.0
92	1	1	3	0.0	1.00	298.0	2	1000.0	1000.0
92	1	1	4	0.0	3.00	298.0	2	1000.0	1000.0
92	1	1	5	0.0	5.00	298.0	2	1000.0	1000.0
92	1	1	6	0.0	1.00	298.0	3	800.0	800.0
92	1	1	7	0.0	3.00	298.0	3	800.0	800.0
92	1	1	8	0.0	5.00	298.0	3	800.0	800.0
92	1	1	9	0.0	10.00	298.0	3	800.0	800.0
92	1	1	10	0.0	1.00	298.0	4	800.0	800.0
92	1	1	11	0.0	3.00	298.0	4	800.0	800.0
92	1	1	12	0.0	5.00	298.0	4	800.0	800.0
92	1	1	13	0.0	10.00	298.0	4	800.0	800.0
92	1	1	14	5.0	1.00	298.0	1	1000.0	1000.0
92	1	1	15	5.0	3.00	298.0	1	1000.0	1000.0
92	1	1	16	5.0	1.00	298.0	2	1000.0	1000.0
92	1	1	17	5.0	3.00	298.0	2	1000.0	1000.0
92	1	1	18	5.0	5.00	298.0	2	1000.0	1000.0
92	1	1	19	5.0	1.00	298.0	3	800.0	800.0
92	1	1	20	5.0	3.00	298.0	3	800.0	800.0
92	1	1	21	5.0	5.00	298.0	3	800.0	800.0
92	1	1	22	5.0	10.00	298.0	3	800.0	800.0
92	1	1	23	5.0	1.00	298.0	4	800.0	800.0
92	1	1	24	5.0	3.00	298.0	4	800.0	800.0

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

*** ISCST2 - VERSION 93109 ***   *** HAECO JET ENGINE TESTING CELL
***   09/27/95
*** SO2 discrete AT 100M   ***
16:05:09

PAGE 7
*** MODELING OPTIONS USED: CONC URBAN ELEV FLGPOL

*** THE 1ST HIGHEST 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SRC1 ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF SO2 IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)	X-COORD (M)	Y-COORD (M)	CONC	(YYMMDDHH)
845550.00	818800.00	4.01896	(92022614)	845100.00	818250.00	4.76467	(92022601)
844600.00	818250.00	4.43911	(92022518)	844250.00	818250.00	4.35925	(92022513)
846100.00	818250.00	4.39572	(92021110)	842750.00	815400.00	4.13407	(92022301)
842750.00	814300.00	3.75102	(92022205)	844050.00	813750.00	4.66296	(92022109)

*** ISCST2 - VERSION 93109 *** *** HAECO JET ENGINE TESTING CELL
*** 09/27/95
*** SO2 discrete AT 100M ***
16:05:09

PAGE 8
*** MODELING OPTIONS USED: CONC URBAN ELEV FLGPOL

*** THE SUMMARY OF HIGHEST 1-HR RESULTS ***

** CONC OF SO2 IN MICROGRAMS/M**3
**

DATE
NETWORK
GROUP ID AVERAGE CONC (YYMMDDHH) RECEPTOR
(XR, YR, ZELEV, ZFLAG) OF TYPE GRID-ID
- -
- -

ALL HIGH 1ST HIGH VALUE IS 4.76467 ON 92022601: AT (845100.00,
818250.00, 5.00, 100.00) DC

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

*** MODELING OPTIONS USED: CONC URBAN ELEV FLGPOL

*** Message Summary For ISC2 Model Execution ***

--------- Summary of Total Messages --------

A Total of 0 Fatal Error Message(s)
A Total of 0 Warning Message(s)
A Total of 0 Informational Message(s)

******** FATAL ERROR MESSAGES ********
*** NONE ***

******** WARNING MESSAGES ********
*** NONE ***

****
*** ISCST2 Finishes Successfully ***
****