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# DEVELOPMENTS IN NOISE STANDARDS

# THE IMPLICATIONS FOR THE SHIPPING INDUSTRY

by

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## 1. PURPOSE

(a) The purpose of this brief presentation is to draw attention to developments in Australian Standards on Noise, which will have significant effects on the design and operation of the future Australian merchant fleet.

(b) Deliberate emphasis is given to the merchant fleet because this presentation is concerned solely with airborne noise as opposed to the underwater radiated noise problems peculiar to warship designs. Of course, this does not imply that warships are free from airborne noise problems or that advances in one field are not beneficial to the other.

## 2. WHAT IS A STANDARD?

(a) Before proceeding further, it is worth examining the purpose of a standard. A national or international standard has no arbitrary significance but is published as a guide to good practice. It only becomes mandatory for a particular project by inclusion in the specification and contract.

(b) For example, certain noise criteria are currently specified in contracts by the Department of the Navy for the procurement of warship equipment. To a lesser degree, a similar situation occurs in the merchant ship field.

(c) To ensure both a satisfied customer and supplier, it is necessary that the criteria and the methods of determining the criteria are correctly specified and more important, that the criteria are in fact relevant to the particular item of equipment. This is where standards, such as those published by the Standards Association of Australia, are particularly valuable.

## 3. CURRENT NOISE STANDARDS RELEVANT TO SHIPS

(a) SLIDE 1 lists ten noise standards which are currently available in Australia and are considered relevant to the Shipping industry. One is a definition of acoustical terms; three are concerned with the quality and calibration of instrumentation; three describe the methods of measuring airborne noise; and three are concerned with defining community noise criteria. Reference will be made to these standards throughout the presentation.

(b) Now that these basic standards are available, attention is being focussed on establishing noise criteria for the major industries. The Standards Association of Australia has, at the moment, eighteen technical committees working on noise standards, including a committee responsible for examining the noise in ships.

(c) The members of the Ship Committee are representative of:-

(i) Shipbuilders.

(ii) Shipowners.

(iii) Various Regulatory Authorities such as the Department of Transport and Bureau Veritas.

(iv) Department of the Navy.

(v) Consultants experienced in Acoustics.

There is also a Liaison Officer to service all the noise committees.

(d) This committee will be meeting shortly and the first items for consideration as Australian Standards will be the two draft ISO standards. DIS 2922 and 2923. Very few difficulties are forseen in adopting these standards as Australian Standards and in conjunction with the other standards listed on SLIDE 1, a firm basis will then be achieved to enable measurements to be taken with confidence and reliability.

## 4. FEATURES OF A TYPICAL SOUND LEVEL METER

(a) The actual measurement of the sound level in a compartment is a relatively simple procedure, provided it is carried out with discipline and in accordance with well-defined guidelines. However, to obtain an understanding of the methods for assessing noise, it is necessary to discuss briefly the instrumentation required for measuring the noise.

A sketch of a typical sound level meter conforming with the instrumentation standards AS Z38 and AS Z41 is shown in SLIDE 2. A microphone converts the sound pressure variations to electrical energy which passes through a filter to an amplifier, which is controlled by a switch to produce a meter reading. The sound pressure level corresponds to the sum of the switch setting and meter reading.

(c) Because the human ear is sensitive to a very wide range of sound pressures (up to $10^6$ times the sound pressure at the threshold of hearing), a logarithmic scale based on the decibel unit is used to measure the sound pressure level. Further details of the decibel and other acoustical terms are explained fully in AS. 1698, but essentially the decibel is the ratio of the sound pressure to a reference level. The international reference level for sound pressure measurements is set at $2 \times 10^{-5}$ pascals.

## 5. FILTER CHARACTERISTICS

(a) Various filters are available for analysing the sound but the most important are the 'A' weighted filter and the octave band filters as these are the most commonly used to establish noise criteria.

(b) The characteristics of the 'A' weighted filter are shown in SLIDE 3. Generally, the measurement of industrial noise using the 'A' weighted filter is found to give a good correlation with annoyance, but, as can be seen on SLIDE 3, this method is deficient when low frequency sounds form important components of the noise spectrum, i. e. on ships. Provision is therefore made

in the standards for an octave band analysis of the noise.

(c) Octave band filters, defined by AS Z41, are a series of filters which are switched sequentially to analyse the sound spectrum. The characteristics of each filter are identical as shown in SLIDE 4. Each filter is centred on a particular frequency with a passband, i. e. no attenuation, corresponding to one octave. For convenience the filters are referred to by numbers; thus octave band filter No. 6 has a centre frequency of 1000 Hz.

(d) Whereas only one reading is obtained to define a sound level using the broad-band 'A' weighted filter, as many as nine readings are obtained for the same sound using the octave filters to give a better definition of the sound spectrum.

## 6. NOISE RATING CURVES

(a) The octave band readings are assessed against the standard rating curves given in AS 1469 to obtain a Noise Rating for the sound. An example is shown on SLIDE 5 where the results of an octave band analysis are plotted as point levels at the mid-frequency of each filter. The noise rating (NR) number, of the particular noise spectrum measured, is that of the noise rating curve which lies just above the spectrum, in this case NR 93 dB.

(b) The equivalent reading using the 'A' weighted filter is 98 dB'A' and follows the general rule that the dB'A' reading is approximately 5dB higher than the NR number.

(c) Because low frequency sounds form significant components of the noise spectrum on ships, it is expected that criteria for ships will be defined using the noise rating method, although the existing community noise criteria (AS 1055 and DR 72084) are based on the 'A' weighted system.

## 7. COMMUNITY NOISE CRITERIA

(a) The most important community noise criteria is that relating to hearing conservation, as defined by DR 72084, and this criteria will certainly be applied to existing as well as new ships. The main points made in the standard are summarised on SLIDE 6.

(b) For a forty-hour working week in a noise environment, i. e. eight hours continuous exposure per day for five days, the maximum recommended noise level is 75 dB'A' (NR 70) to avoid noise induced hearing damage. Up to a level of 85 dB'A' (NR 80) periodic audiometry monitoring of the persons exposed is recommended but, when the noise level is above 85 dB'A' (NR 80), hearing conservation procedures must be introduced.

(c) Also shown on SLIDE 6 are some residential noise criteria as defined by AS 1055. The base acceptable noise level for residential areas is 40 dB'A' (NR 35) and adjustments are made according to the time of day and type of district. The levels considered relevant to ships are those relating to residential areas within predominantly industrial areas where the

recommended acceptable levels are:-

(i) Daytime on a weekday - 70 dB'A' (NR 65)

(ii) Nightime on a weekday - 55 dB'A' (NR 50)

NOTE: The noise rating values given in brackets are determined in accordance with paragraph 6 (b).

(d) For comparison purposes some typical environments are listed, ranging from a suburban home (40 dB'A') to a jet aircraft at takeoff (120 dB'A').

8. NOISE LEVELS ON SHIPS

(a) The 1972 Department of Transport statistics indicate that there are over 900 vessels registered in the Australian merchant fleet, excluding fishing boats and pleasure craft. A general breakdown of this figure is:-

| | |
|---|---|
| Cargo and Passenger Ships | 131 |
| Tugs | 242 |
| Dredgers | 95 |
| Off-shore Supply Vessels | 44 |
| Miscellaneous small traders (<200 tons) | 98 |
| Passenger Ferries | 323 |

(b) Excluding the passenger ferries, it is estimated that annually over a quarter of a million people are on board these vessels for significant periods. Quite a sizeable community, even though it also excludes the inumerable fishing and pleasure boat community.

(c) Practically no data is available on the environment to which these people are a captive audience. Overseas experience would suggest that at least 10% of the vessels involved are subject to significant noise problems, and this is a very conservative estimate.

(d) Again resorting to overseas sources, an analysis of published data is given on SLIDE 7. The forty deep-sea ships are not rogue vessels, they can essentially be treated as a random selection based on availability at the time the surveys were undertaken. Similar comments apply to the harbour craft which are mostly tugs and dredgers. There is no reason due to the method of construction or machinery installation why the average Australian vessel should be different from these overseas vessels.

(e) The three locations chosen on each ship reflect the three major ship noise environments:-

(i) Engine room----------Hearing conversation

(ii) Accommodation----------Rest and recreation

(iii) Wheelhouse----------Speech Communication

A comparison with the recommended levels shown on SLIDE 6 indicates that significant modification in design procedures will be necessary if community noise criteria are to be applied in these areas.

(f) One of the main functions of the Standards Association Committee on Ship Noise is to ensure that a compromise is obtained between the ideal and the practical. In cases where the noise level constitutes a health hazard, as in the engine rooms of the ships investigated, such compromises cannot be justified. For existing ships the most probable solution is to designate areas as 'noise dangerous' and limit the exposure time without ear defenders according to the table given in - DR 72084. Similar procedures are already in operation on RAN Ships.

(g) Other areas requiring remedial action are:-

(i) The accommodation relating to rest which, because of the watch system on ships, is a 24 hour per day requirement.

(ii) The Bridges on small ships when the data indicates that intelligible speech communication is difficult to achieve.

(h) Basically, the procedures in order of priority for overcoming a noise problem are:-

| | | |
|---|---|---|
| (i) | Rectify at source | Correct balance, resilient mounts, flexible connections, etc. |
| (ii) | Isolate sound | Acoustic hoods and enclosures, unmanned enginerooms, etc. |
| (iii) | Protect personnel | Acoustic enclosure, e.g. control room; provision of hearing protection devices. |

Appropriate measures to achieve points (i) and (ii) are best applied in the design stages, when the additional expenditure due to changes from previous accepted practice has been shown to be less than 0.2% of the cost of a ship.

(j) Time does not permit further elaboration on the sources and types of noise problems experienced on board ship, or the many remedial measures that can be applied. These could well be the subject of another presentation at a later date.

## 9. CONCLUSIONS

(a) Undue noise is becoming widely accepted as a community problem and standards are being developed and applied to the major pollutant - Industry.

(b) The shipping industry should not ignore these developments but, as this presentation attempts to show, major efforts will be required if ships are to comply with noise criteria acceptable to the community. It is in the design process that the most cost-effective measures can be taken and the ship designer

has a responsibility to ensure that these measures are applied to the best advantage of his client - the ship operator.

(c) If these developments are ignored, then the possibility of industrial action by the community, in particular the unions, should not be overlooked.

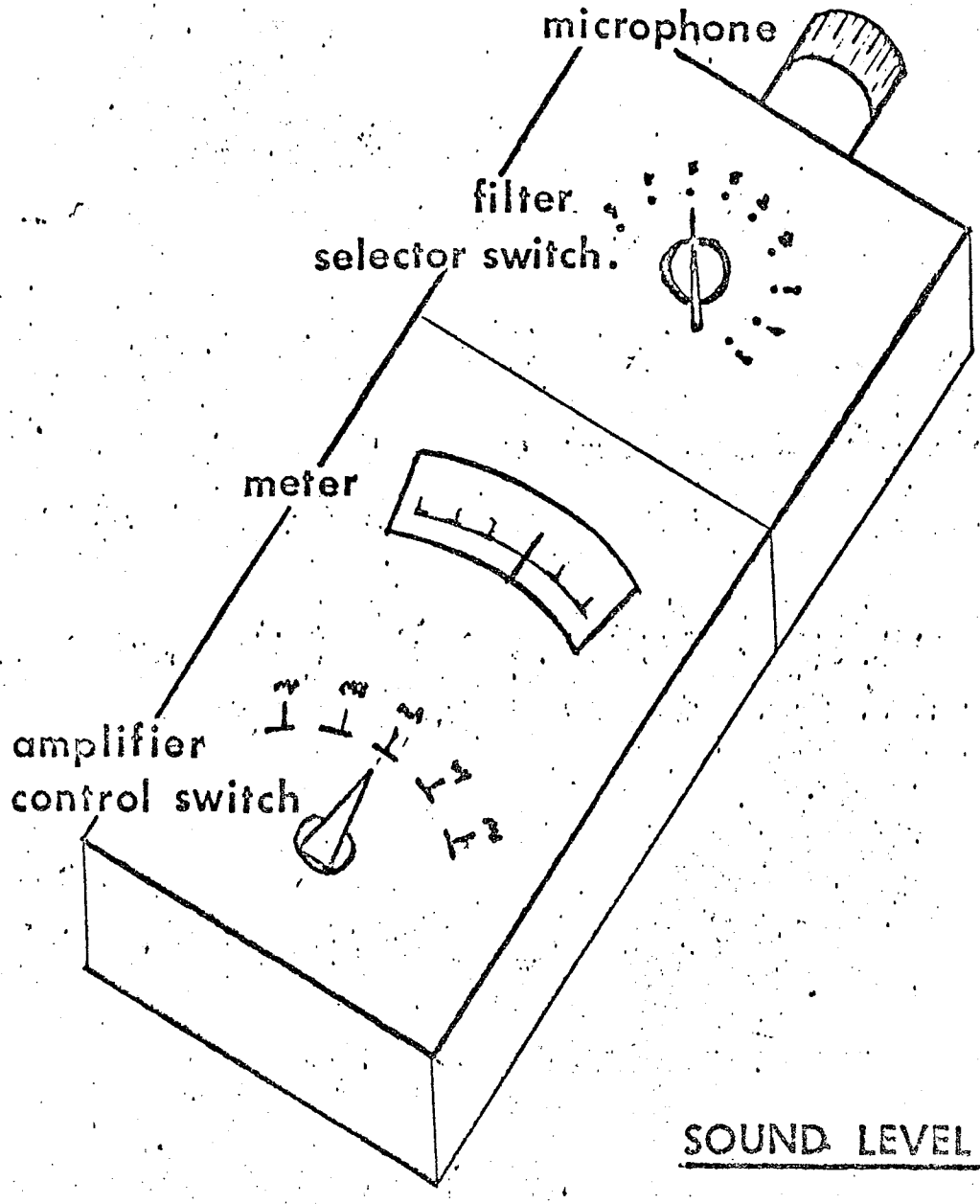
SLIDE 1

# NOISE STANDARDS RELEVANT TO SHIPS

| Standard | Subject | Classification |
|---|---|---|
| AS 1698 | GLOSSARY OF ACOUSTICAL TERMS | |
| AS Z38 | SOUND LEVEL METERS | INSTRUMENTATION |
| AS Z41 | FILTER CHARACTERISTICS | INSTRUMENTATION |
| DR 72035* | HEARING PROTECTION | INSTRUMENTATION |
| AS 1217 | NOISE FROM MACHINES | MEASUREMENT TECHNIQUES |
| DIS 2922* | NOISE FROM SHIPS | MEASUREMENT TECHNIQUES |
| DIS 2923* | NOISE ON SHIPS | MEASUREMENT TECHNIQUES |
| AS 1055 | RESIDENTIAL AREAS | NOISE CRITERIA |
| DR 72084* | HEARING CONSERVATION | NOISE CRITERIA |
| AS 1469 | RATING CURVES | NOISE CRITERIA |

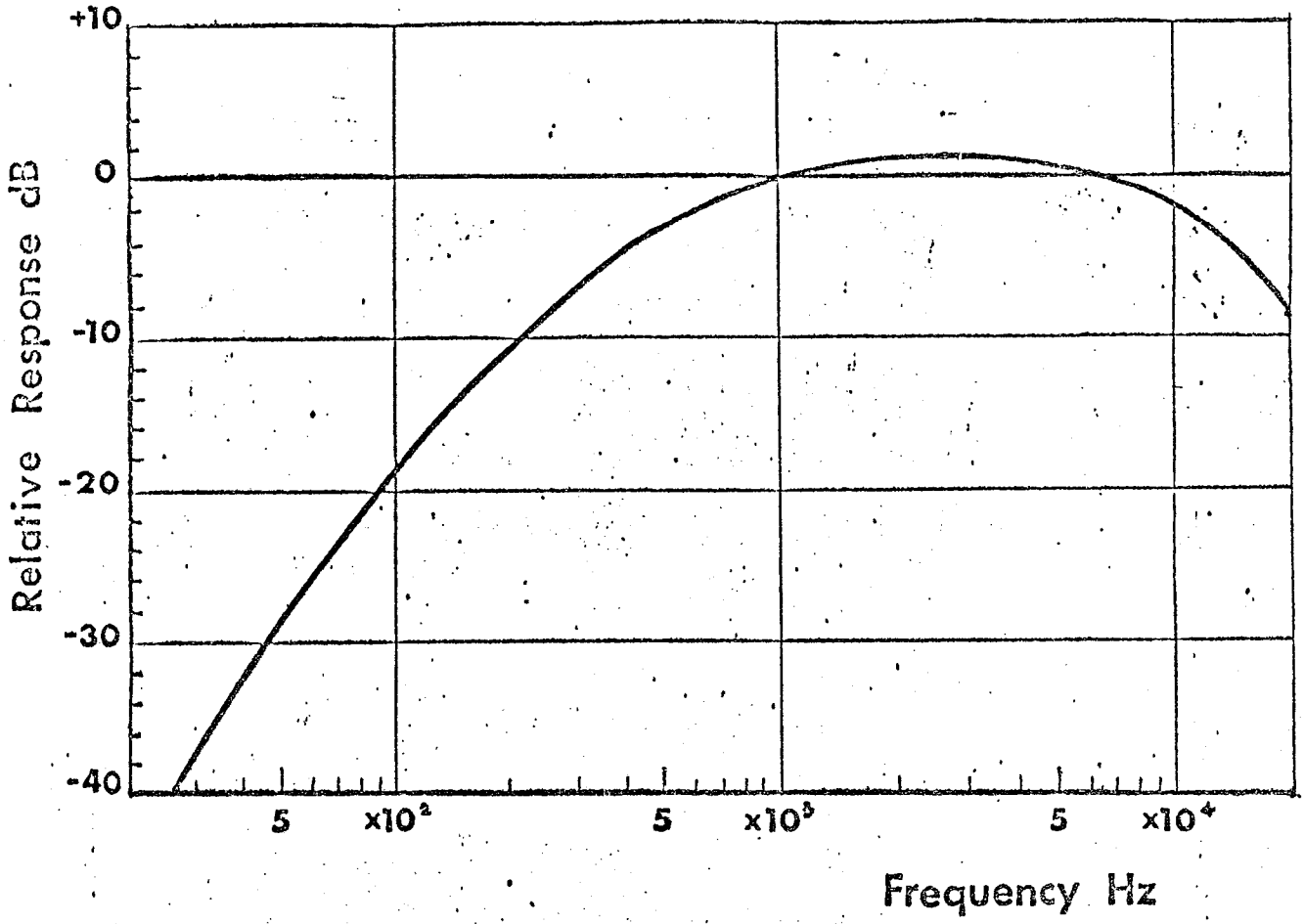
* Draft Standard

SLIDE 2.



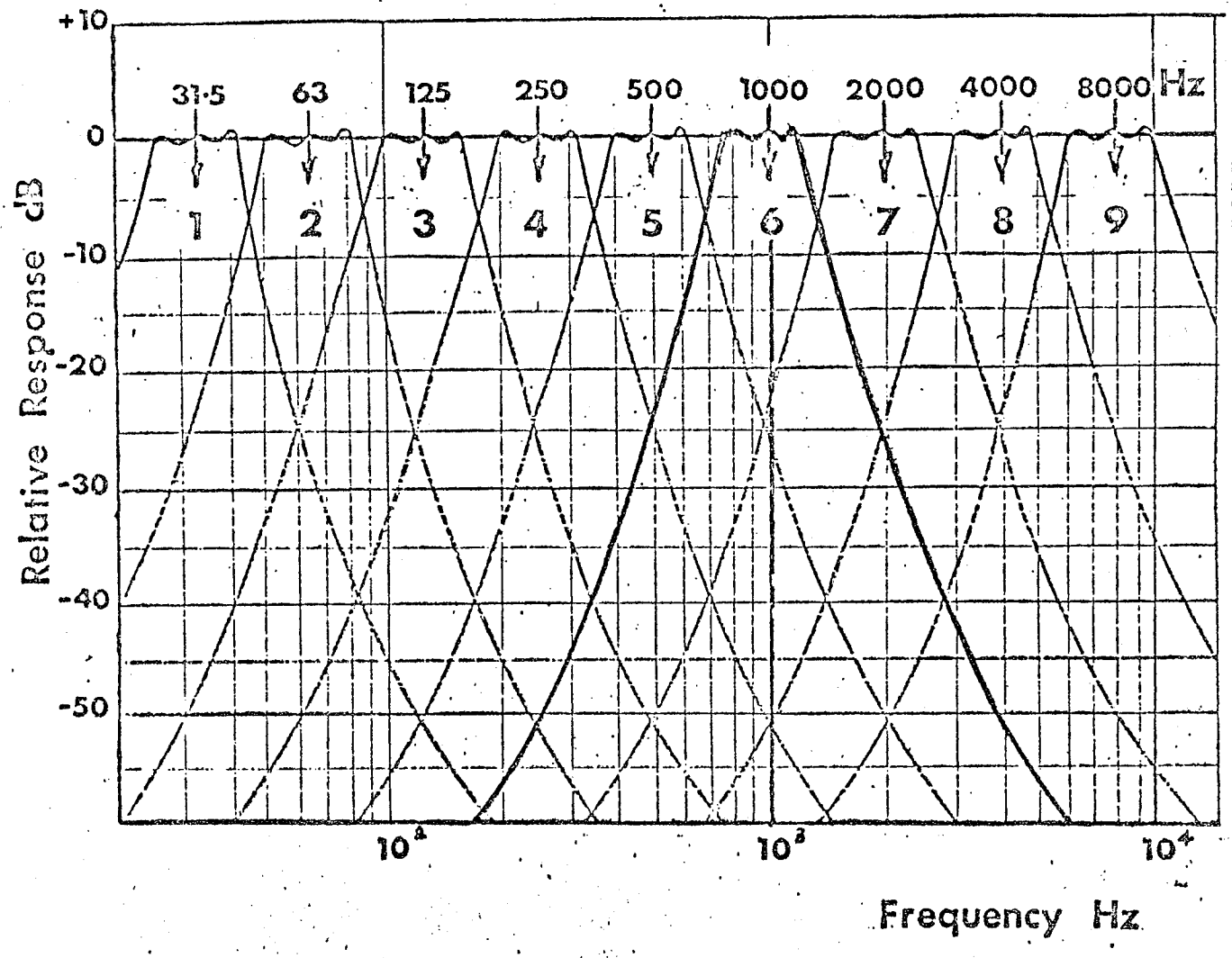

SOUND LEVEL METER

SLIDE 3.



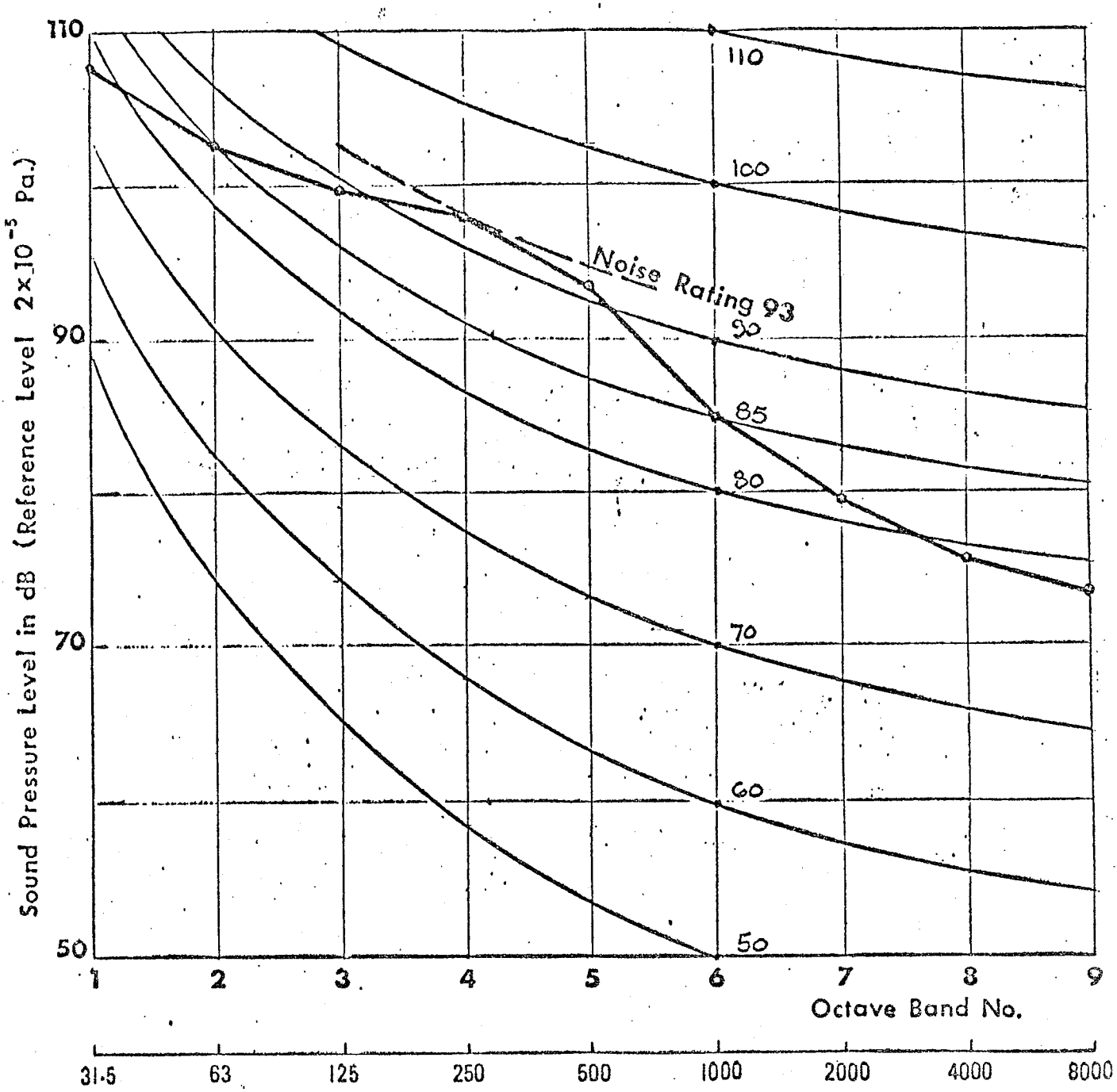

'A' WEIGHTED FILTER

SLIDE 4.




OCTAVE BAND FILTERS

SLIDE 5



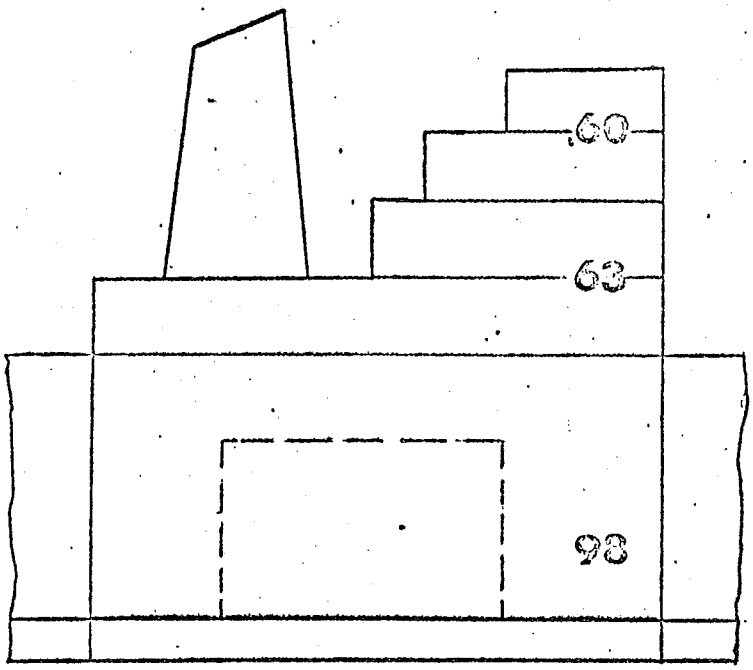

SEGMENT OF NOISE RATING CURVES

SLIDE 6.

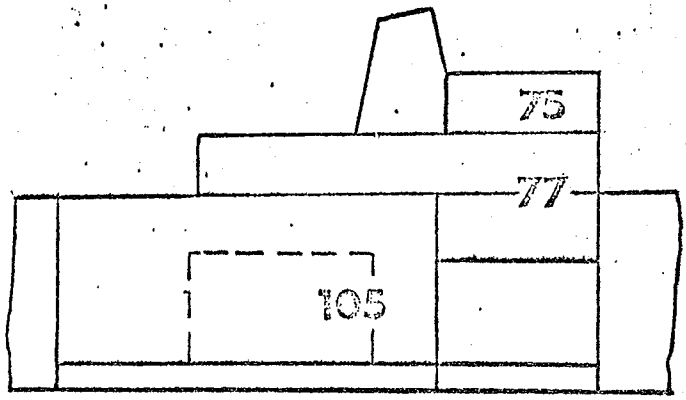
| Standard | dB 'A' Noise Level | Physical Criteria | Equivalent Environm |
|---|---|---|---|
| DR 72084<br>HEARING CONSERVATION | 120 | Hearing Protection Necessary | JET AIRCRAFT - TAKE OFF |
| | 85 | Audiometry Monitoring Advisable | CITY STREET - PEAKHOUR |
| | 75 | | CITY BUS |
| AS 1055<br>RESIDENTIAL NOISE | 70 | Maximum Industrial Daytime | URBAN TRAIN |
| | 55 | Maximum Industrial Nightime | AVERAGE OFFICE |
| | 40 | Base Level | SUBURBAN HOME |

COMMUNITY NOISE CRITERIA

SLIDE 7.




Forty Deep-Sea Vessels




Twenty-Six Harbour Vessels

AVERAGE dB 'A' NOISE LEVELS ON SHIPS