

**INTERNATIONAL COUNCIL FOR  
THE EXPLORATION OF THE SEA**

C.M. 1988/B:14  
Fish Capture Committee



**ECONOMICAL NOISE CONTROL  
ON DUTCH BEAM TRAWLERS**

by

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## **Abstract**

The compact design of the modern Dutch fishing cutters, beam trawlers or so-called beamers, with increased machinery and propeller performances stress the need applying a range of measures to reduce the high noise levels with 5-10 dB(A). So resulting in an economic solution and acoustical acceptable environment of 65-70 dB(A) in the accommodation spaces.

For this no radical changes in the design and traditional beamer layout are necessary, but the major reducing treatment should be taken in the receiving compartments (floating floor systems) and in the sound transmission paths (resiliently mounting of machineries).

Because there aren't yet noise regulations for fishing vessels, the costs will play a dominant role in choosing the final noise control packages.

A modern new building beamer of 1500 kW(2000 hp) with required noise levels of 65-70 dB(A) stands for an extra investment of 1-2 percent of the total costprice. Further noise reducing implies an excess of costs, radical changes in the design and application of new noise control techniques, (acoustically optimised propeller and aftship hullform or resiliently mounting of complete deckhouses).

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- 4. Economical noise control**
- 5. Conclusion**

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## 1. INTRODUCTION

The Technical Research Department of the Netherlands Institute for Fishery Investigations (RIVO) have been carried out noise measurements since 1984.

These results were already presented in a ICES paper (CM 1987/B.21 "Noise levels and sources by F.A. Veenstra), which clearly show that all accommodation spaces had excess by as much as 10-15 dB(A) in relation to IMO statutory noise regulations for merchant marine vessels and the 8 hour hearing damage risk criterion.

Based on the RIVO measurements a coöperative contract research study (CMO B5.4) was started in 1986 and finished in 1987 by RIVO (fishery engineers) and the Ship Acoustics Department of the Institute of Applied Physics TNO-TH (acoustical engineers).

By means of quayside and steaming measurements the airborne and structure borne sound transmission paths were investigated and also the relative contributions of the major noise sources to the high noise levels.

For this two representative Dutch beamers were used, a vessel type which is from the acoustical point of view a very difficult one: "a smaller up-to medium sized fishing vessel, overpowered in relation to the main dimensions and with the major noise sources adjacent to the operating and living spaces (see also Annex I-III)".

The final results of this study is aiming at acoustical design guidelines for new building beamers with acceptable noise levels.

However the fishing industry is still reserved in applying noise control packages. On the one hand side there aren't yet statutory regulations or recommendations for fishing vessels and on the other hand because of less knowledge of the shipacoustical possibilities and particularly of the costs in relation to the required noise levels.

By means of discussions with skipper-owners / yards / designers and RIVO publications in the Dutch Fishing News something was done introducing these matters, while in coöperation with some shipyards RIVO tried to allocate the costbenefits of the potential noise control packages as is given in this paper.

## 2. NOISE LEVELS AND SOURCES

The RIVO noise readings have been measured in accordance with Recommendations of the Dutch Shipping Inspectorate (SI) for merchant marine vessels. For the sound pressure levels a precision grade sound level meter, Bruel & Kjaer, type 2230 was used. The measurements were carried out as decibel readings with a A weighing filter and if possible also followed by an octaveband analysis in the frequencyrange of 31.5-8000 Hz. Before and after each series of measurements the sound level meter was calibrated.

### Noise levels / limits

In graphic 1-5 the noise levels of 20 beamers have been given in dB(A) and in graphic 6-9 the sound pressure levels in dB(octave bands) for a representative Dutch beamer (1500 kW, 2000 hp). Both for the steaming conditions and in the following locations (fig. 1):

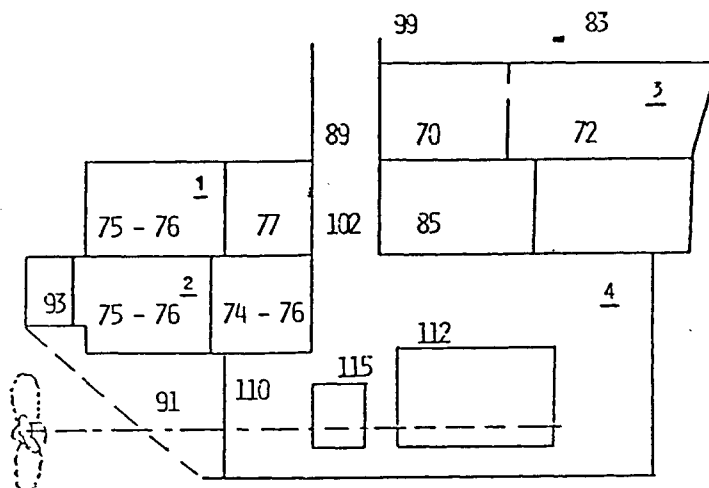


Fig. 1 (1) messroom/galley  
(2) accommodation/cabin  
(3) wheelhouse  
(4) engine-room

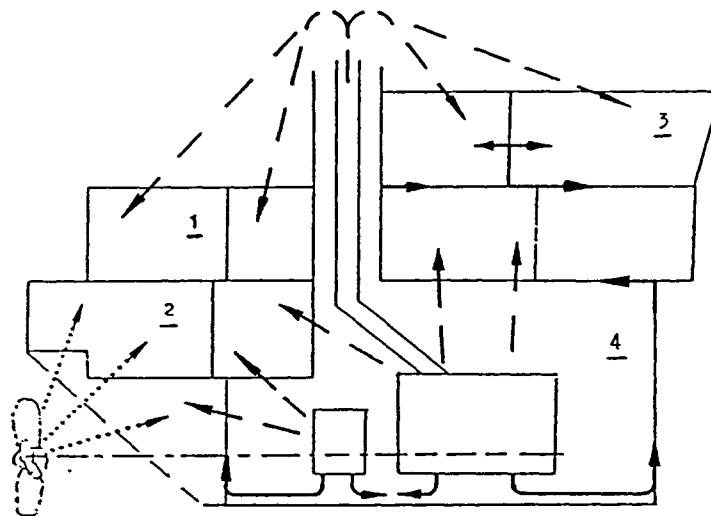


Fig. 2 ..... propeller noise  
—— airborne noise machinery  
—— structure born noise machinery

The results of the survey clearly show that almost all the 20 fishing vessels and also recent measurements, exceed the IMO and SI regulations with 10-15 dB(A) in the accommodation spaces.

However noise limits for larger seagoing vessels but from a health and safety point of view standing for an acceptable acoustical environment (well being crew, less risk of hearing damage, stress and communication disorder).

Still it is evident that limits originally intended for larger ships will hardly be possible to comply with on smaller vessels, particularly fishing vessels. Nowadays the economic situation requires more than accurate results either to avoid excess of requirements or the application of excessive or inadequate measures.

#### **Noise sources / transmission paths**

The major noise sources onboard Dutch beamers are:

- main propulsion engine, incl. exhaust systems;
- gear box;
- propeller;
- dieselgenerator sets;

and to a lesser extent:

- winches;
- hydraulics.

From these sources the noise travels by air and through the ships structure to reach the ear in the receiving compartments, defined as airborne noise and structure borne noise (fig.2.).

Similar to many other ship types the propulsion engine and propeller are the dominant noise sources onboard of the beamers.

In table 1 a summary is given of the mostly installed machineries in the Dutch fisheries with a specification of the contributing sound propagation factors and taken noise measures.

The structure borne noise from the hardmounted propulsion diesel adversely impacted all the living and operating spaces, particularly in the low frequency range, 63-125 Hz. The main cause for propeller induced vibration and noise is pressure fluctuations on the aftship hullform, propagated by the ships structure and radiated as airborne noise in the receiving spaces.

The dieselgenerator sets are already often resiliently mounted and have no explicit contribution to the high noise levels, the same for the gearbox, steering gear, compressors and ventilators.

The airborne noise from the engineroom as well as the exhaustsystem to the adjacent spaces is far less representative.

However in the wheelhouse the airborne noise in the higher frequencies and from the exhaustsystem have an important contribution.

### 3. NOISE CONTROL PACKAGES

For an effective noise control the measures to be taken should be considered in an early design stage and supervised adequately during the building and fitting out phase of the vessel. Curing afterwards is always very difficult and expensive to which it is mostly impossible to solve the basic errors.

An economic and reproducible solution means careful planning and calculation in comparative studies of various possibilities. Up to now hardly any measures have been taken on the beamers.

#### Noise control (general)

Noise control treatment can be done in three ways, viz.:

- at the noise sources
- in the sound transmission paths
- in the receiving compartments.

The measures at the sources have the great advantage of effecting the receiving spaces simultaneously with one package. The measures in the transmission paths and the accommodation only have their effect in the controlled compartments. Therefore especially the measures at the sources should be studied carefully to obtain the maximum result, including the selection of machinery with minimum noise source levels. The quietest machine for a given performance gives a significant improvement.

Besides a thorough noise prediction in the design stage gives the essential data for selecting the major effect areas for noise control packages, of which sources and transmission paths are responsible for excess of requirements.

#### Noise control on beamers

This last mentioned was done in the coöperative studies by RIVO and especially by TPD-TNO. Up to now it is a common beamer design practice to apply the measures mainly in the accommodation areas (receiving spaces), to which the skipper-owner doesn't want any radical changes in the general layout and machinery set-up. From the acoustical point of view a very illogical arrangement:

- the most noise sensitive compartments are located between the major noise sources, the propulsion diesels and propeller.
- the aft engineroom bulkhead and the exhaust uptakes are directly separating the machinery spaces from the accommodation.
- the exhaust and intake openings are very closely located near the wheelhouse and accommodation.

Based on the traditional beamer layout (Annex I-III, table 1) and the absence of statutory noise regulations for fishing vessels, 4 noise control packages will be given to attain noise level limits of 75 dB(A), 70 dB(A), 65 dB(A) and 60 dB(A) in the accommodation spaces.

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#### 1. Noise control package with design goal 75 dB(A), max. 80 dB(A)

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These noise levels are already common practice for various Dutch shipyards. To which only measures were taken based on the IMO fire protection regulations for fishing vessels (B15/A30 decks and bulkheads with carpentry).

However for a conceptual noise level limit of 75 dB(A) the following additional noise measures should be taken in the receiving spaces:

- 1 a) non combustible floors to be applied as a semi-floating floor system
- 1 b) decoupling of non combustible linings and the hull deckhouse construction as much as possible but at any rate in the living space below deck decoupling of the floor and aft bulkhead
- 1 c) application of absorbent material, c.q. mineral wool behind the linings and with a relative heavy specific weight.

Besides the engineroom boundaries should attenuate the airborne noises down to 70 dB(A).

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## 2. Noise control package with design goal 70 dB(A), max. 75 dB(A)

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Reducing the noise level limits in the accommodation with 5 dB(A), from 75 --> 70 dB(A), the measures in the receiving spaces should be extended and completed with some measures in the sound transmission paths:

- 2 a) complete floating floor (fig. 3)
- 2 b) acoustical decoupling of floors, linings and ceilings from the construction (fig. 3)
- 2 c) application of absorbent material in airgaps behind linings and ceilings and upper engineroomcladding
- 2 d) flexible connections of pipes, especially the exhaustpipe, between the diesel engines and the above laying deck (fig. 4)
- 2 e) installation of a correct chosen exhaust silencer (type, dimensions, configuration), resiliently mounted in the engineroom uptakes (fig. 5)

Besides the engineroom boundaries should attenuate the airborne noises down to 65 dB(A).

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## 3. Noise control package with design goal 65 dB(A), max 70 dB(A)

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Reducing the beamer noise levels with another 5 dB(A), from 70 --> 65 dB(A), additional measures to package 2 should be taken, viz. extended attenuation in the transmission paths and measures at the noise sources:

- 3a-3e) package 2
- 3 f) stiffening of engine and shaft coupling foundation
- 3 g) stiffening of the hull scantlings above the propeller
- 3 h) only flexible connections between aft engineroom bulkhead and the propulsion machinery
- 3 i) only flexible piping and wiring connections between the diesel engines and the above laying deck and also the machinery foundation (fig. 6)
- 3 j) resiliently mounting of the diesel generator sets (fig. 7)
- 3 k) resiliently mounting of the propulsion diesel (fig. 8)



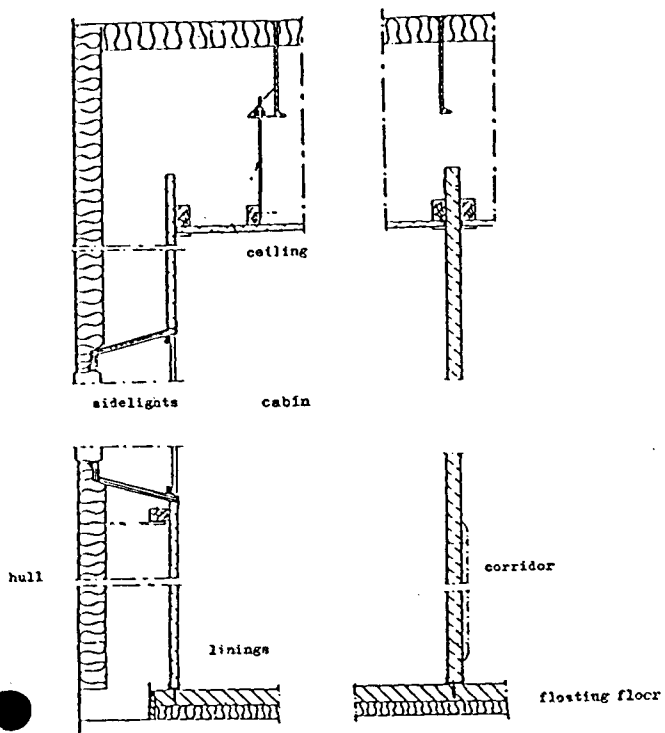


Fig. 3 floating floor system

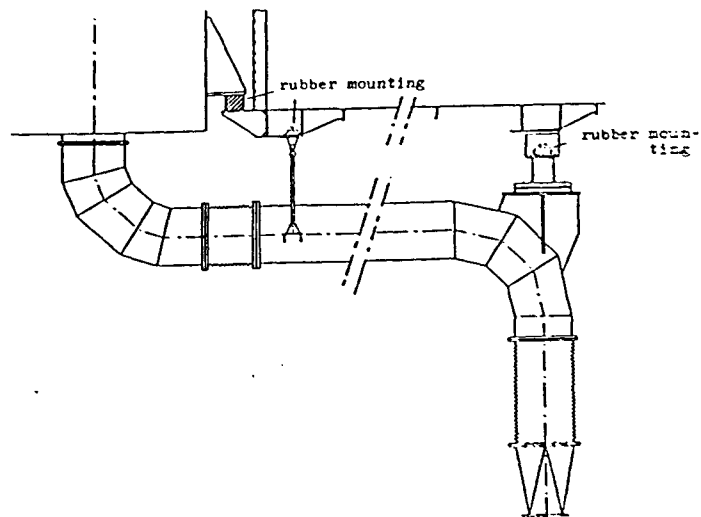


fig. 4 flexible pipe connection

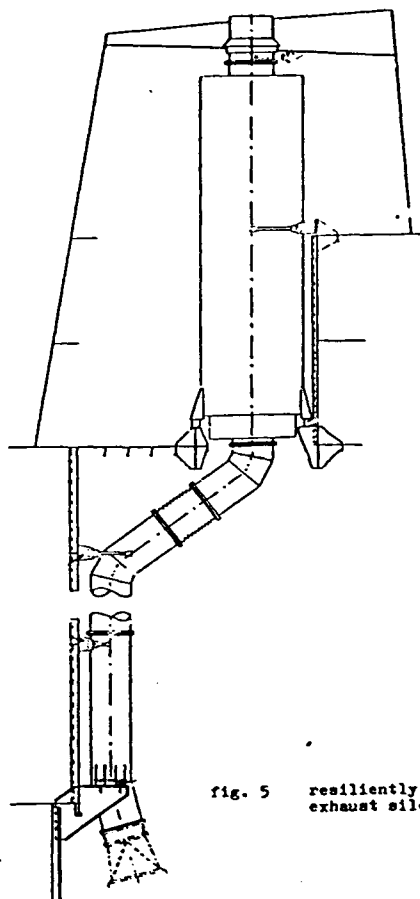


fig. 5 resiliently mounting of exhaust silencer

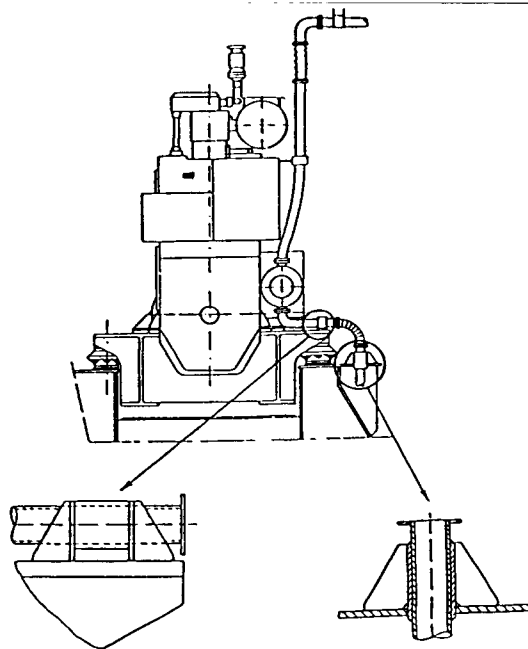


fig. 6 flexible piping and wiring connection to foundation

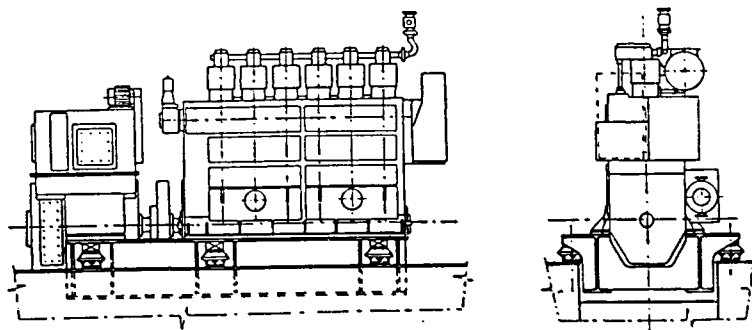


fig. 7 resiliently mounting diesel generator set

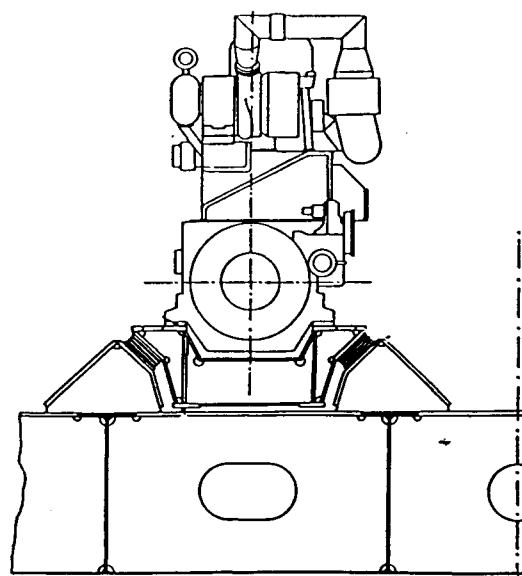


fig. 8 resiliently mounting medium speed propulsion diesel

Besides the engineroom boundaries and floating floor systems should attenuate the airborne noises down to 60 dB(A) which can only be attained by carefully application of package 3.

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#### **4. Noise control package with design goal 60 dB(A), max. 65 dB(A)**

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For this type of fishing vessel (layout, machinery set-up) it is almost impossible to attain noise level limits of 60 dB(A) in the accommodation spaces particularly in the living quarters below deck.

Either additional to package 3, acoustically optimising of the propeller and aftship hullform and -structure or instead of measures at the sources resiliently mounting of the complete deckhouse is necessary.

Both solutions imply extensive research before beamer application is coming up for discussion.

- 4 a -4 k) package 3
- 4 l) an acoustical optimised propeller and natural frequencies/responses of the aftship hullconstruction or instead of package 3 and 4 l

4 alternative ) resiliently mounting of the complete deckhouse

#### 4. ECONOMICAL NOISE CONTROL

Along with all the technical details the costs will play a dominant role in the potential noise control packages. Especially for the fishing vessels because of absence of noise requirements, but there is reason to believe that for newbuildings this will change in the near future owing to the increasing EEC and Dutch labour Regulation onshore as well as offshore.

Before an economical choice can be made in providing an acoustical acceptable environment on board the beamers, a better understanding is needed of the costs in relation to the noise levels and total investment of a modern beamer of 1500 kW (2000 hp) in 1988, viz. Dfl. 6.000.000.

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##### Costs in relation to noise levels

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design dB(A)	noise control measures				newbuilding Dfl. 6.000.000	
goal	in receiving spaces	in transmission paths	at sources	* additional	extra investments Dfl.	percent
75-80	-	-	-	-	-	-
75	package 1 ----->				20.000	0.3
70	package 2 ----->				70.000	1.2
65	package 3 ----->				120.000	2.0
60	package 4 ----->				150.000	>2.5

\* optimum propeller/aftship hullform and -structure or a resiliently mounted deckhouse.

The herementioned extra investments are including increased engineering and supervision hours for the first newbuildings but without intensive accompanying of an acoustical engineer.

Similar to other vessel types the costs involved in noise reducing measures increased exponential with the noise reduction achieved. However limited to the design goal of 65 dB(A), one can speak of an economical cost-benefit solution. Reducing the accommodation noise levels with another 5 dB(A) leads to unknown acoustical and cost aspects but particularly to radical changes in the beamer design. This can result in declining fishing efforts, e.g. less propeller performance owing to a acoustical needed greater tipclearance.

The same can be said about the alternative: resiliently mounting of the complete deckhouse, a very expensive technical solution (at least Dfl. 100.000,--) with great disadvantages, e.g. annoyance crew and extra maintenance costs.

Before these additional measures are coming up for discussion, extensive research is needed to prevent excessive, unnecessary and even non-effective measures which will change the fishing effort of the Dutch beamer considerable.

**To the authors opinion a beamer design goal of 65 dB(A), max. 70 dB(A) is an economical and acoustical acceptable solution without radical changes in the traditional but very effective beamer design.**

**This means a cost-increase of ca. 1 - 2 percent of the total newbuilding investment.**

## 5. CONCLUSION

Although there aren't Dutch or international noise level requirements for fishing vessels, the measured noise readings (75-80 dB(A)) are clearly showing that nobody can speak of an acceptable acoustical environment onboard of the Dutch beamers (well-being, hearing damage, safety).

Up to now these resulting noise levels are accepted as the state of the art with no economically acceptable and well proven solutions.

One should inevitably live with the high noise levels and even some fishermen appraised these levels: "Shipnoise means power and fishing effort."

However things are changing, on the one hand side owing to more knowledge of the noise levels (state of the art, RIVO) and noise control possibilities (economic and reliable solutions, RIVO, TPD-TNO) and on the other hand anticipating the inevitable (near) future requirements (shipyards) but also more skippers are asking for lower accommodation noise levels (crew annoyance).

Based on the experiences and comparative studies of the last 4 years and seeing the acoustical progress made onboard of similar vessels, one may conclude that even for fishing vessels acceptable noise levels are attainable, for reasonable costs in relation to the total investment, viz. 1 - 2 percent. To which no radical changes in the beamer design are necessary with accommodation noise levels of 65 - 70 dB(A). To the authors opinion leads a further reduction of the noise levels to an excess of costs and excess of intervening in the beamtrawling fisheries.

### Acknowledgement

The author would like to thank all shipyards, especially Visser (Den Helder), Metz (Urk), Damen (Gorinchem) with regard to the costs in relation to noise levels.

Besides the author wants to express his gratitude to TPD-TNO, the Shipsacoustics Department, especially to mr. M.J.A. de Regt, the acoustical engineer of the beamer noise control packages.

### References

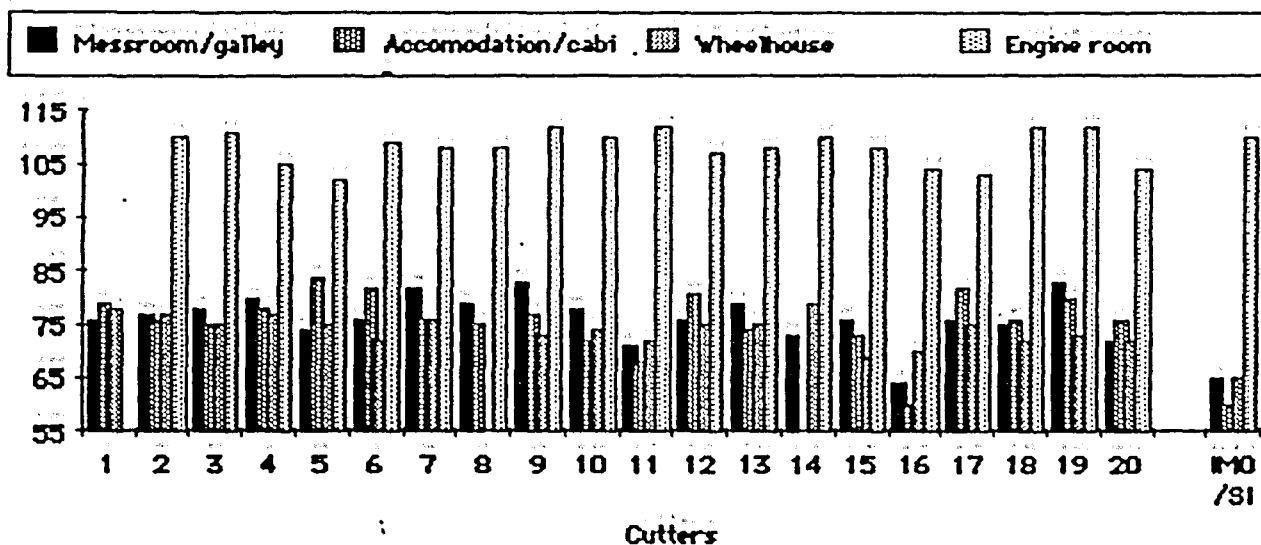
1. Noise levels and sources onboard Dutch fishing cutters, ICES paper C.M. 1987/B:21 Fish Capture Committee by F.A. Veenstra, Netherlands Institute For Fishery Investigations, IJmuiden.
2. Marine Engineering and noise control, Institute of Applied Physics TNO-TH Delft, Holland. By H.F. Steenhoek.
3. Noise control in Tug design, a theoretical and practical approach, Damen Shipyards, Gorinchem Holland by J. Jansen.
4. Manual on shipboard noise control, Institute of Applied Physics TNO-TH, Delft Holland. By J. Buitens and M.J.A. de Regt (in Dutch).
5. Noise levels on seagoing fishing cutters, part I,II,III. By M.J.A. de Regt, CMO 1986B5.4 (in Dutch).

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TABLE 1 - CHARACTERISTICS/MAKE OF MAJOR MACHINES

Noise sources	Sound propagation	220 kW (300 hp) beamer	1500 kW (2000 hp) beamer	Noise control measures
Main propulsion diesel engines	. structure - borne noise . airborne noise . exhaust noise	number: 1 manufacturer: . Mitsubishi . Deutz . Caterpillar . Scania . Mercedes . Cummins . Guascor . Stork Type: high speed Rev's: 1500 - 1800 rpm Blower: --	number: 1 manufacturer: . Stork . MAX . Deutz . Crepelle . Bolnes . Man Type: medium speed Rev's: 600-1000 rpm Blower: BBC	. no specific noise control . exhaust silencer
Gear box	. structure - borne noise	number: 1 manufacturer: . Masson  Type: elastic/hydraulic coupling Reduction: 1 : 4.5-9.9 pto: hydropump	number: 1 manufacturer: . Rhenania . Lohmans . Reintjes . Sempres Type: elastic with hydraulic reverse coupling Reduction: 1 : 3-6 pto: generator	. no noise control
Propeller	. structure - borne noise	number: 1 manufacturer: . van Voorden . Lips Type: f.p. with nozzle Blades: 3-4 Diameter: 1400-1900 mm	number: 1 manufacturer: . van Voorden . Lips Type: f.p. with nozzle Blades: 4 Diameter: 2700-3000 mm	. no noise control
Diesel generator set	. structure - borne noise . airborne noise	number: 1-2 manufacturer: . Mitsubishi . Daf . Scania . Volvo . Valmet Type: high speed Rev's: 1500 rpm Power: 30-60 kW	number: 1-2 manufacturer: . Mitsubishi . Daf . Scania . Volvo Type: high speed Rev's: 1500 rpm Power: 110-250 kW	. resilient mounting . soundproofing separation
Winches	. structure - borne noise	number: 1 manufacturer: . Padmos . Maaskant . Luyt Type: 6 drum Power: Hydraulic/electric drive	number: 1 manufacturer: . Maaskant . Ridderinkhof Type: 8 drum Power: electric drive	no noise control
Hydraulics	. structure - borne noise . fluid-borne noise	. pto's . deck equipment . Remijnhof	--	no noise control

# Noise measurements onboard Dutch fishing cutters in dBA



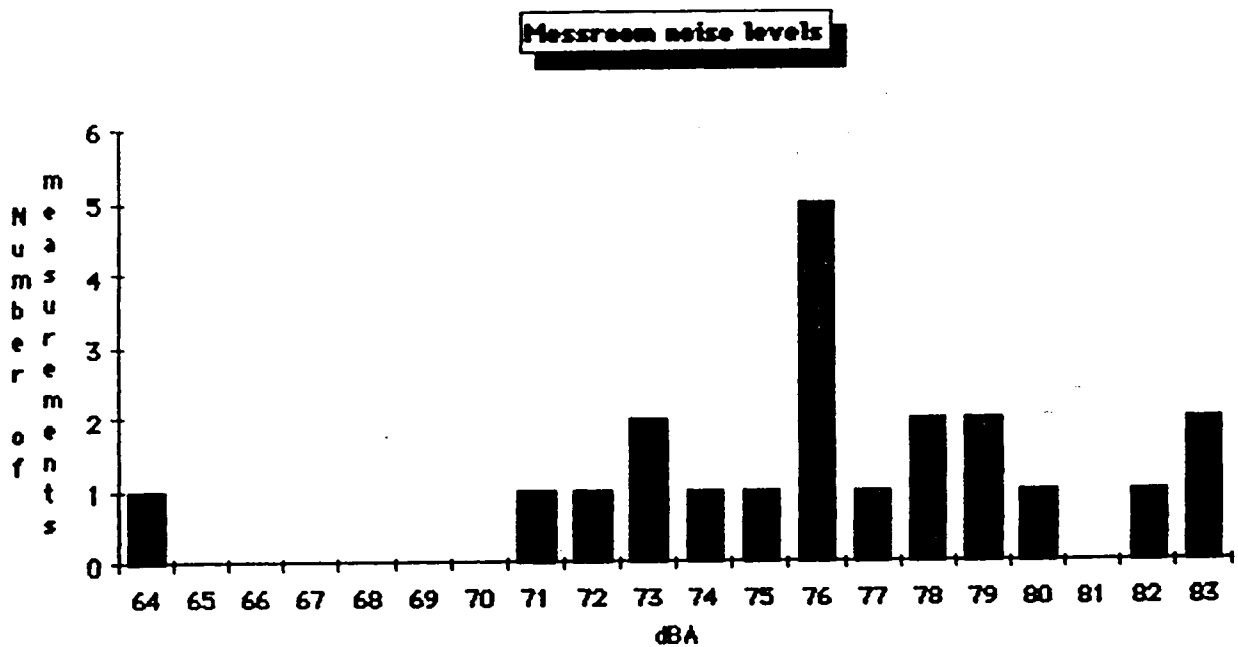
Compartment	Main group dBA levels (average)	Exceed dBA value	IMO-recommendation
Messroom	76 dBA	10 dBA	65 dBA
Accommodation	75-76 dBA	15 dBA	60 dBA
Wheelhouse	75 dBA	10 dBA	65 dBA

Design goal	dBA values - new fishing cutters
messroom	65 dBA, max. 70 dBA (above main deck)
accommodation	65 dBA, max. 70 dBA (below main deck, aft end)
wheelhouse	65 dBA, max. 70 dBA (above winchhouse)
engine room	110 dBA (unmanned)





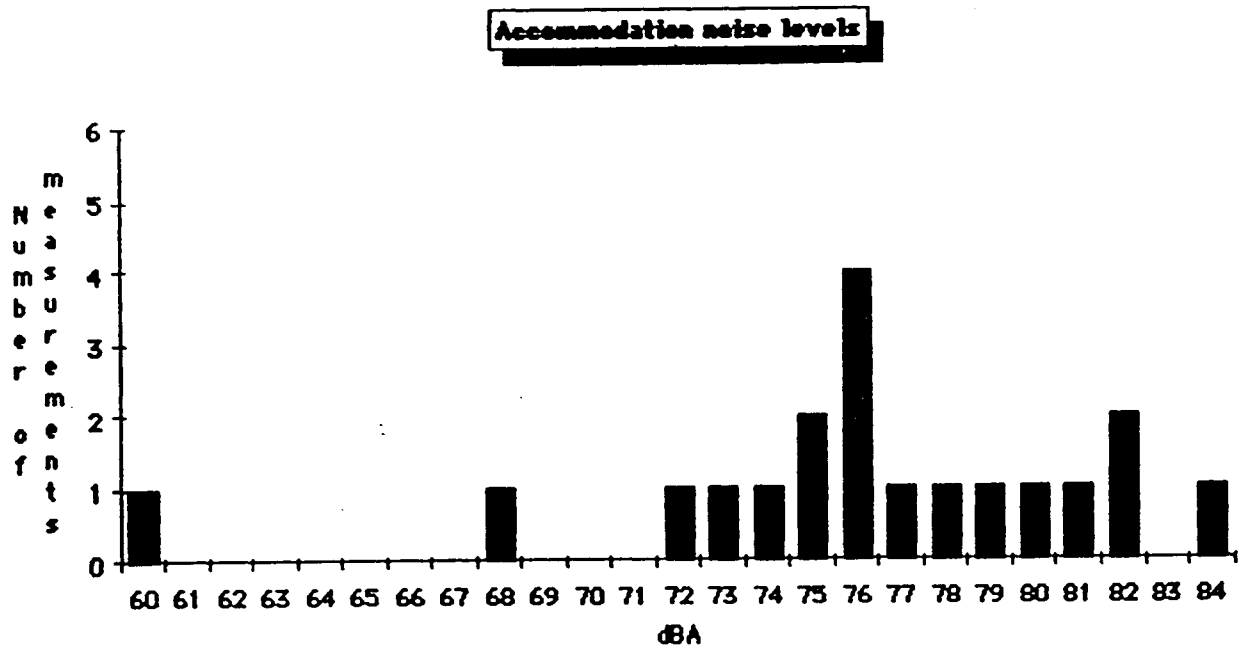
## Messroom noise levels



Main group	Number of vessels	Minimum	Maximum	Total number of vessels
71-80 dBA	17	64 dBA	83 dBA	20



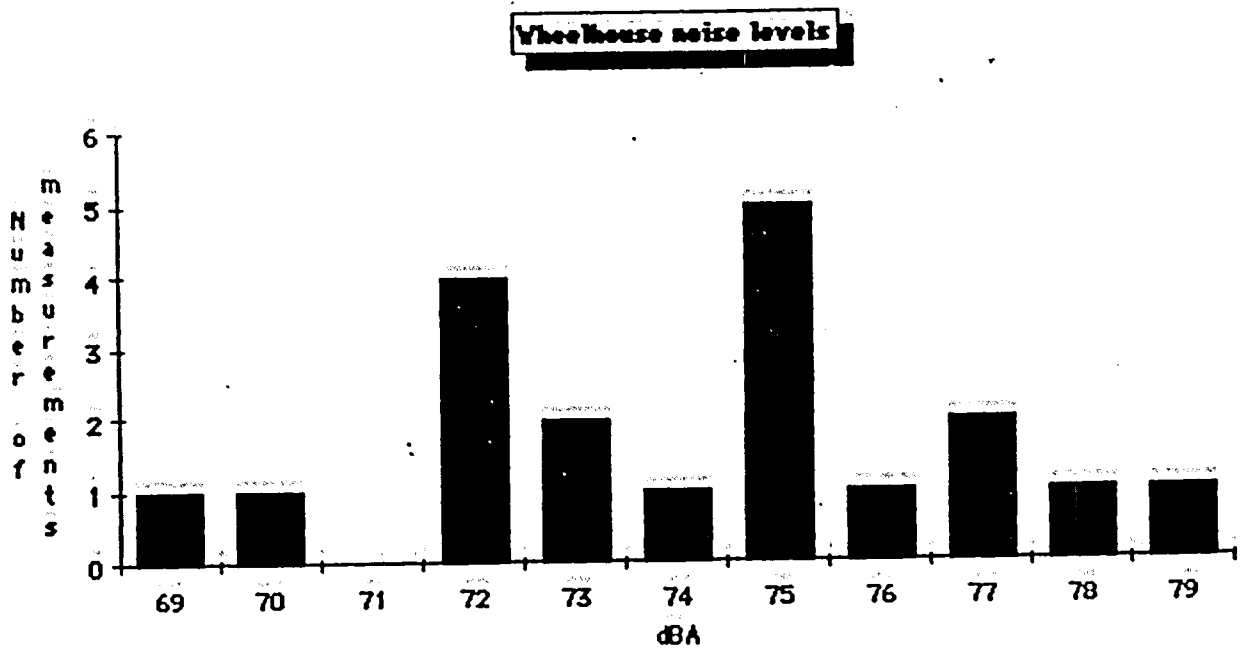
## Accommodation noise levels



Main group	Number of vessels	Minimum	Maximum	Total number of vessels
72-82 dBA	16	60 dBA	84 dBA	19

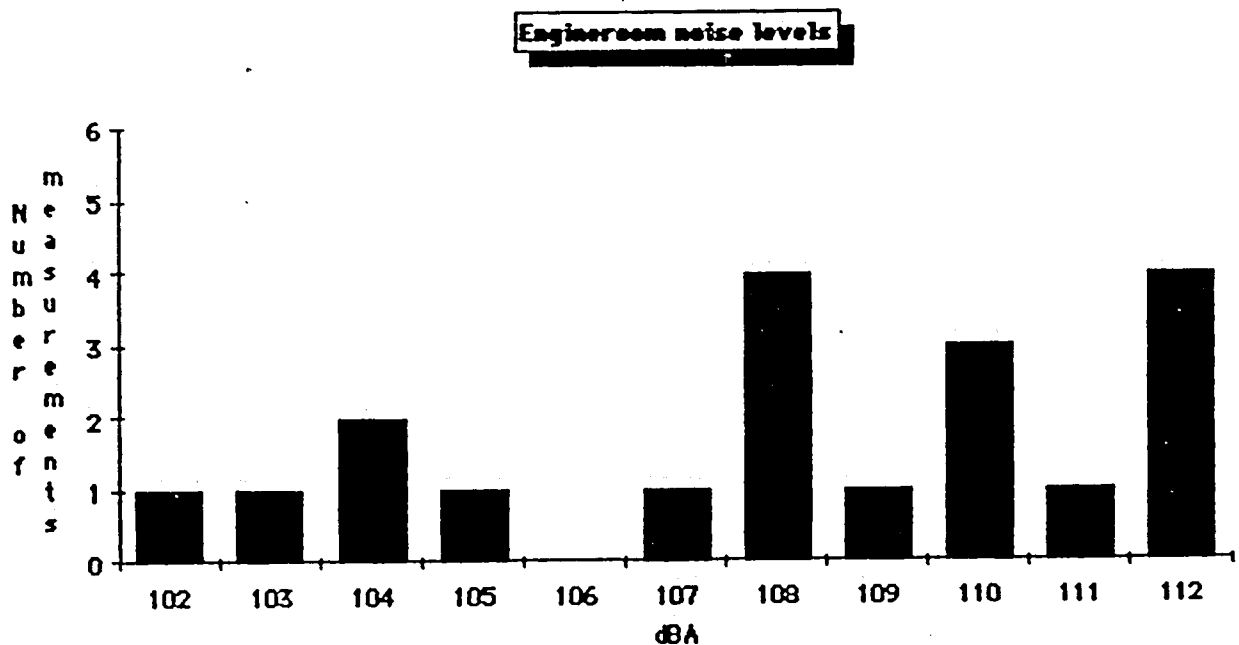


# Wheelhouse noise levels

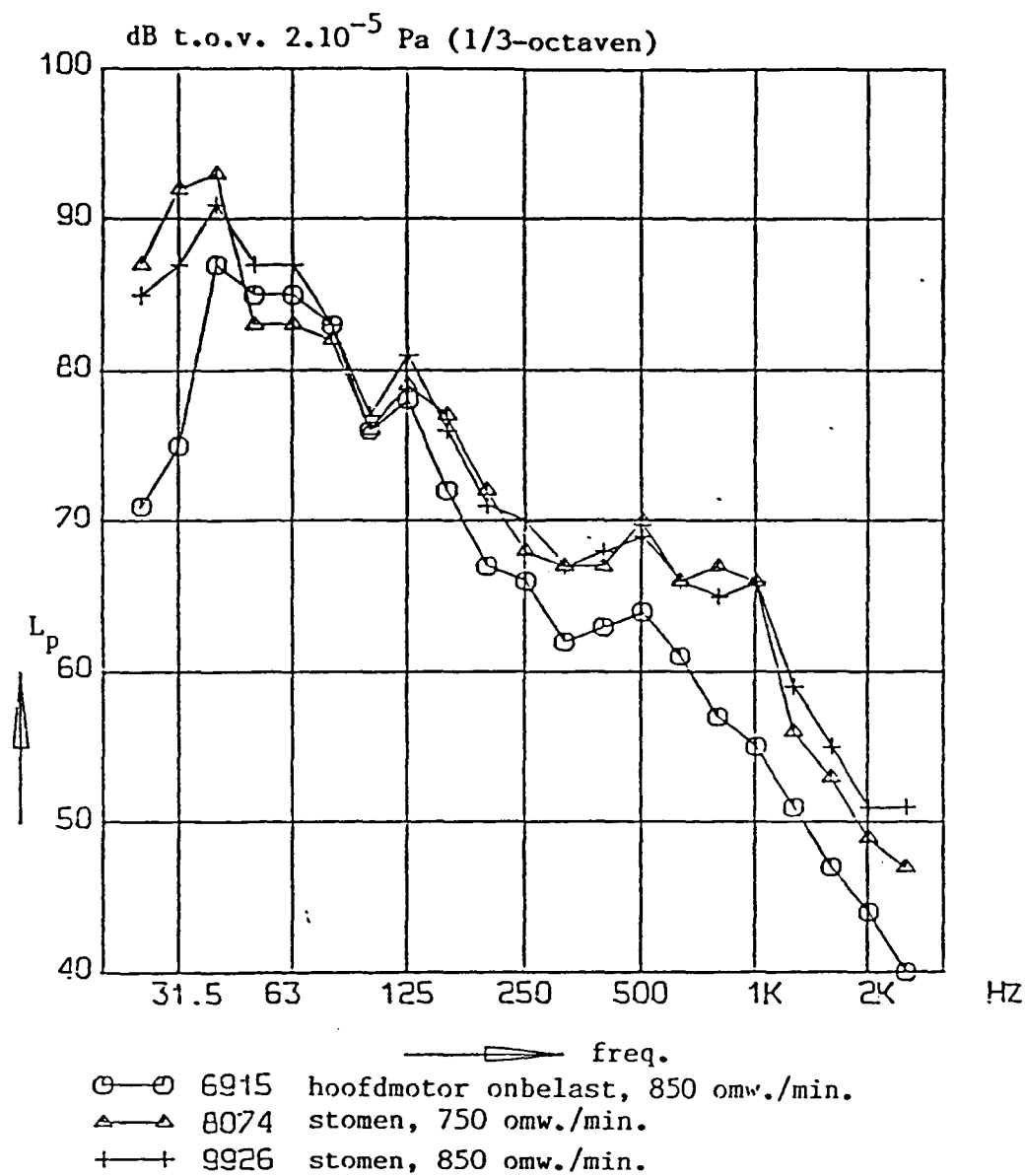


Main group	Number of vessels	Minimum	Maximum	Total number of vessels
72-78 dBA	17	69 dBA	79 dBA	19

# Engineroom noise levels



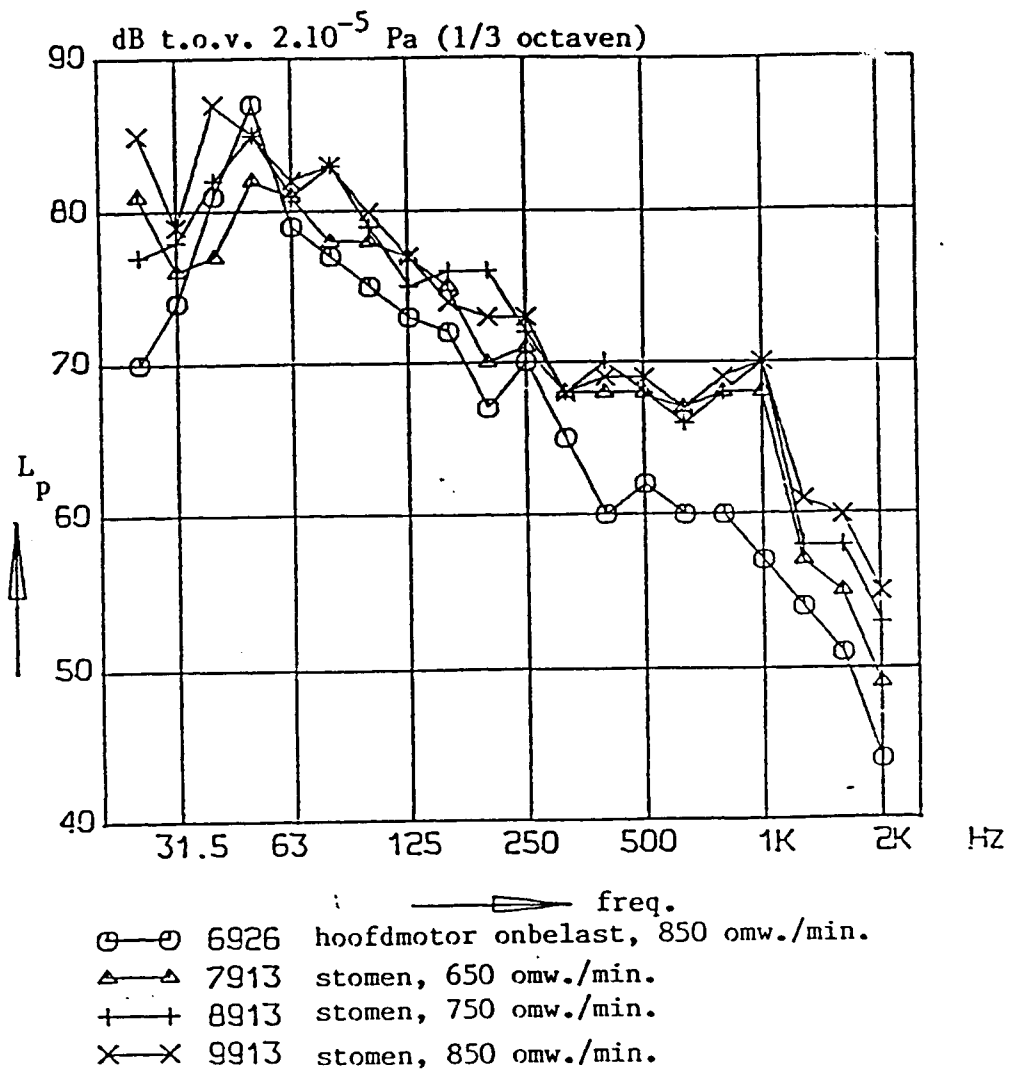
Main group	Number of vessels	Minimum	Maximum	Total number of vessels
107-112 dBA	14	102 dBA	112 dBA	19



Sound pressure levels in messroom (1)

TPD

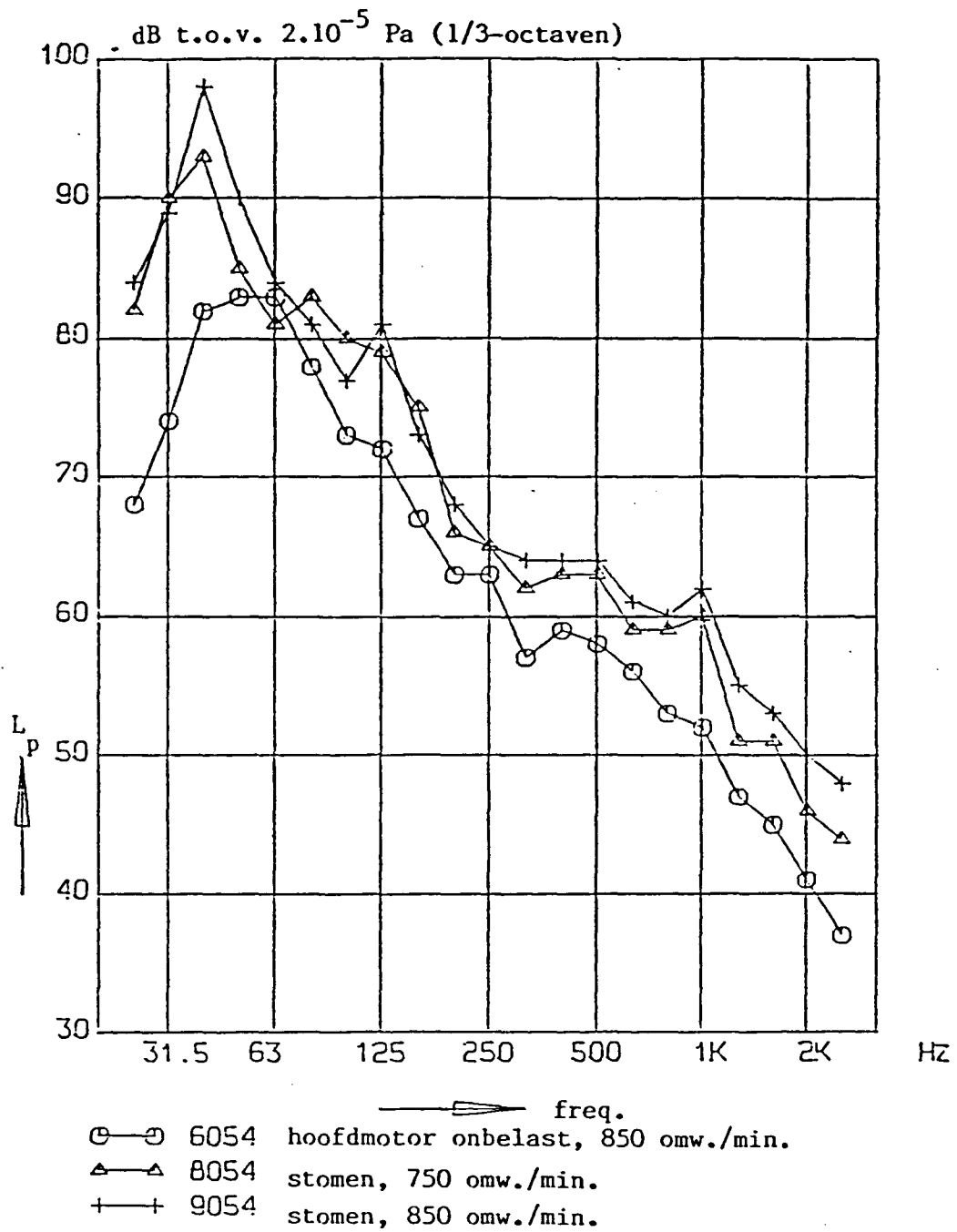
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Sound pressure levels in accommodation (2)

TPD

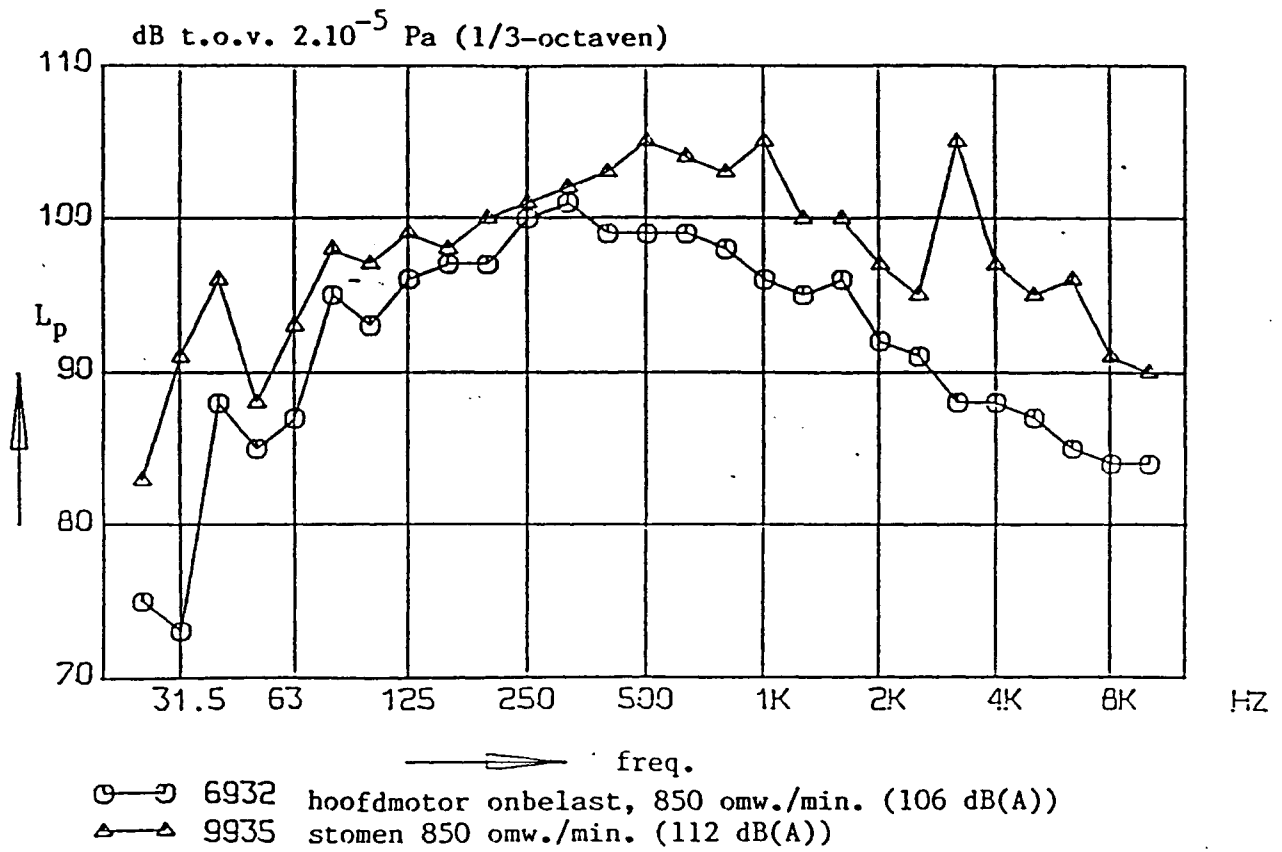
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Sound pressure levels in wheelhouse (3)

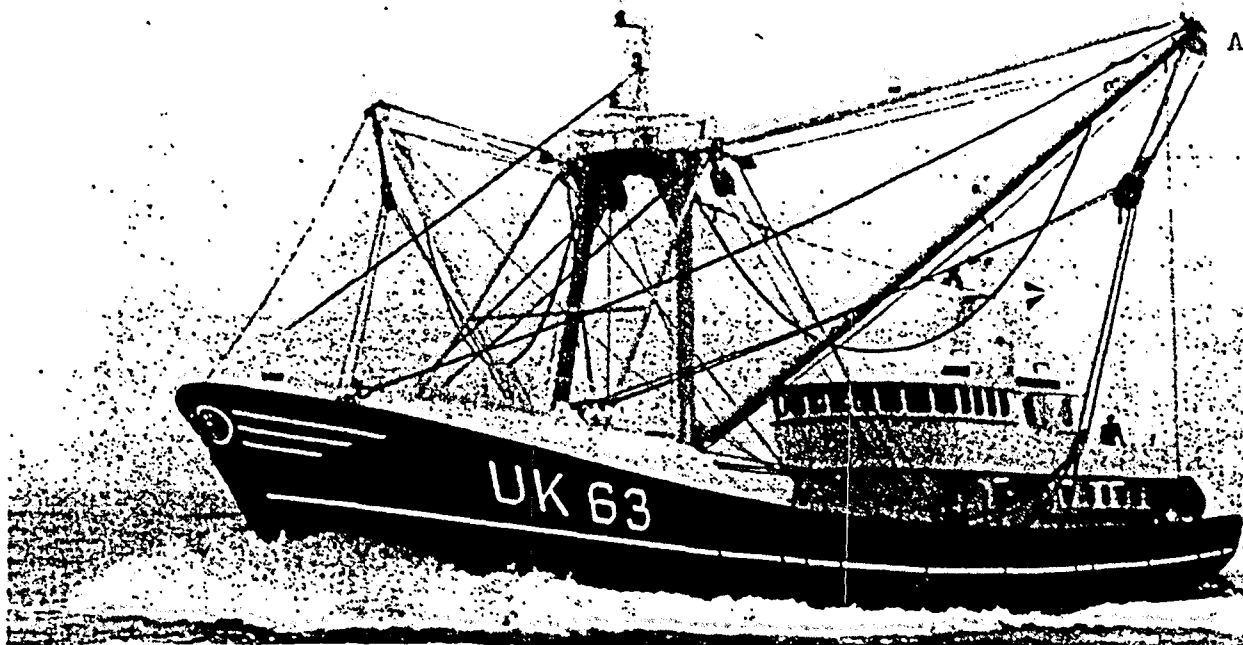
TPD

nummer 622.024 /1

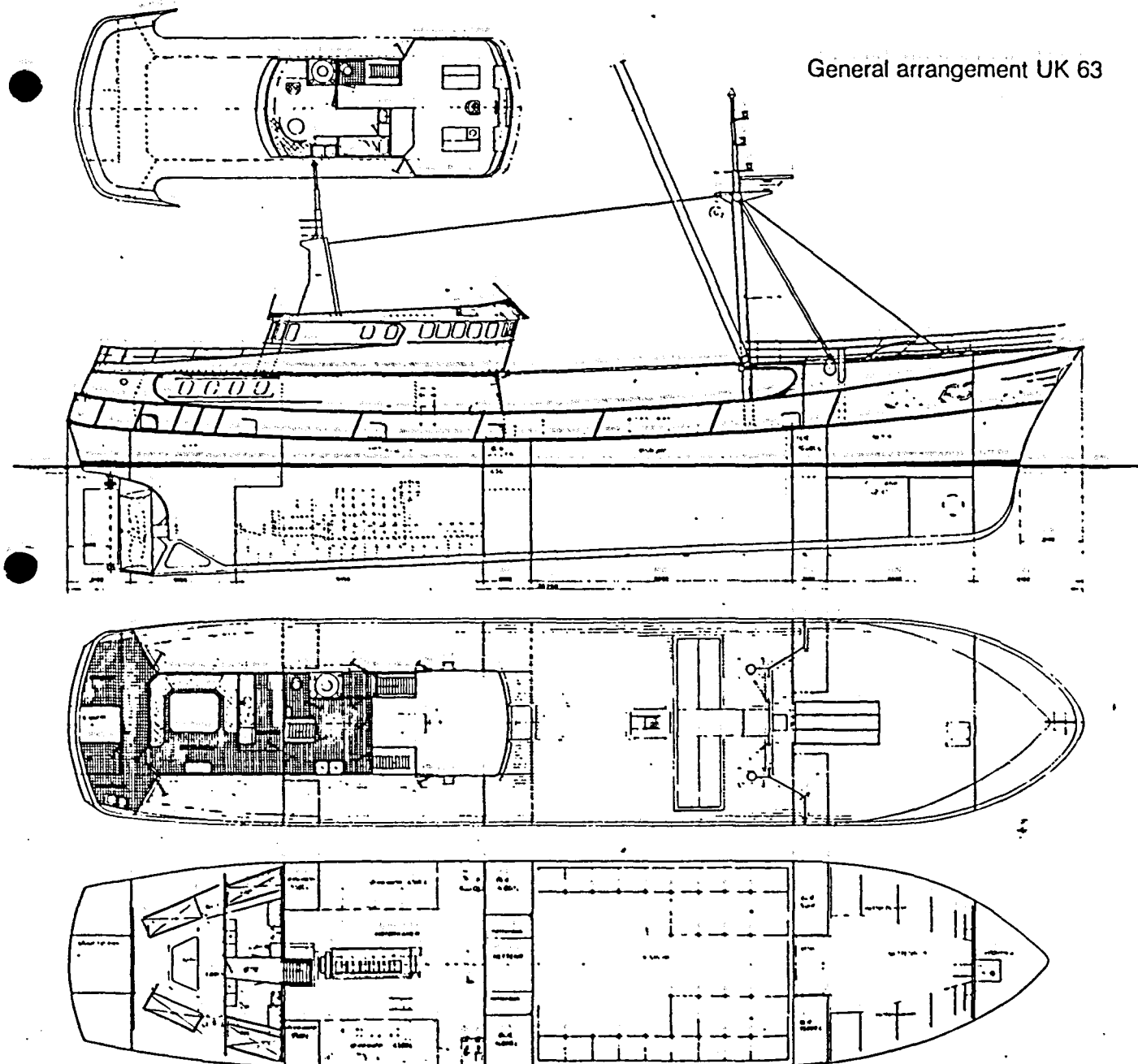


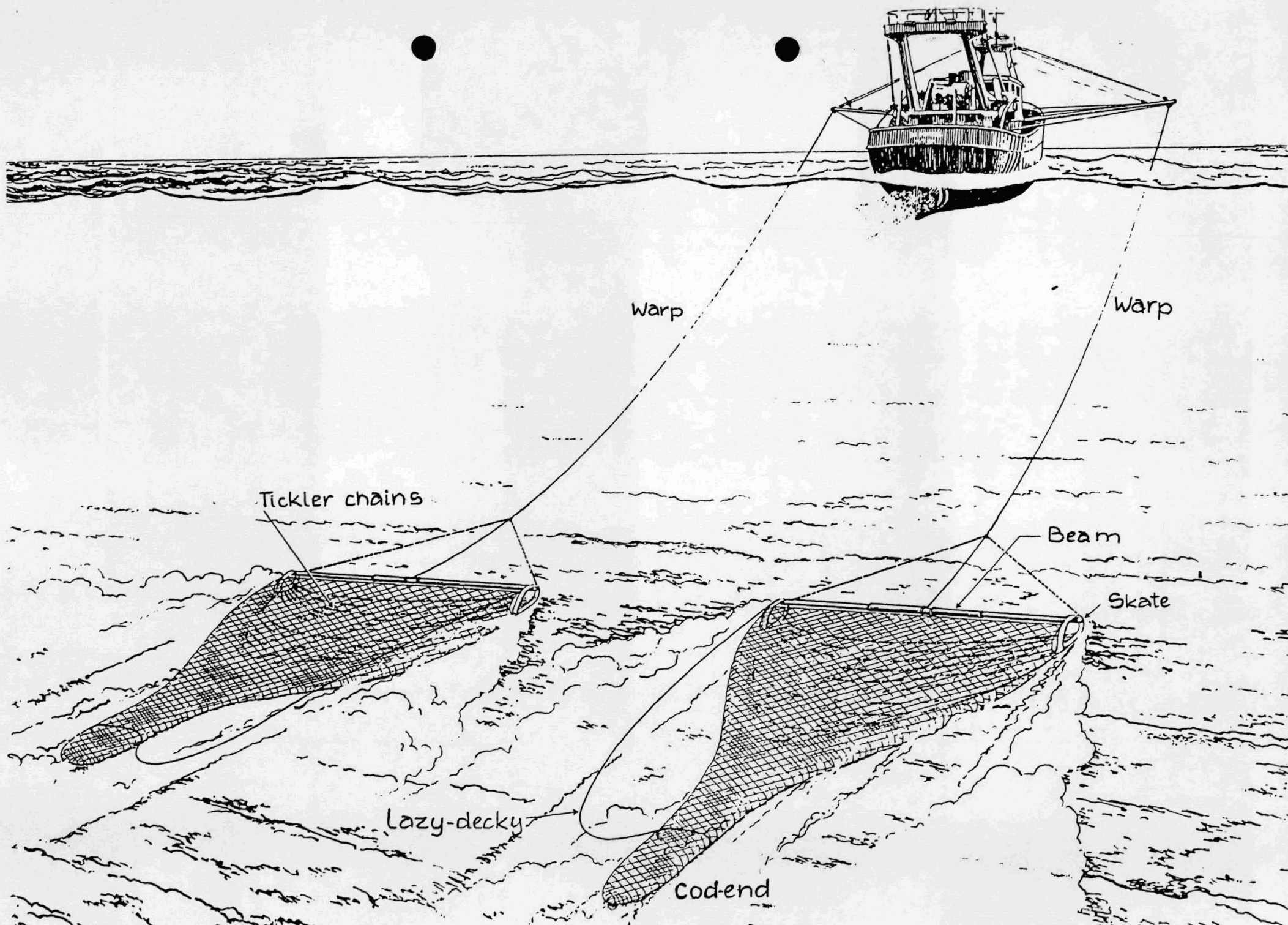
Sound pressure levels in engineroom (4)





General arrangement UK 63





### Appendix III

#### General arrangement, installations and equipment Dutch beamer.

As the major part of the 600 Dutch fishing cutters is of the beamtrawler type, the cutter will be featured here on the basis of a beamer.

In figure 1 (general arrangement) and figure 2 (beam trawling) it can be seen that the applied fishing method dictates the lay-out to a greater extent.

All existing flatfish beamtrawlers are towing two trawlnets by means of booms or so-called outriggers perpendicular to the shipsides and supported by a heavy gantry mast on the foreship. The characteristic construction is a single deck hull with design trim and extended forecastle and aftward the superstructure with the crew's accommodation, wheelhouse and winchroom. The accommodation comprises cabins, washroom, shower, toilet, galley, messroom and mostly also crew's quarters below deck in the aft end. The quarters are suitable for a complement of 4-7 persons.

Below the main deck the hull is often subdivided in:

- fore peak (chainlocker, bowthruster, ballast);
- auxiliary machinery space (harbour set, oil- and freshwater bunkers);
- fishhold (insulated, crush ice machine, ice and fish box-storage, bunkers below);
- net store (oil bunkers below);
- main engine room (medium or high speed diesel engines, pto's and/or diesel generator set(s), reverse/reduction gear box, separators, hydrophore, heating and refrigerating plant);
- crew's quarters (tanks);
- aftpeak (steering gear, nozzled f.p. propeller below).

As usual the forecastle runs well aft to form a large sprayhood protecting the fishermen working on the main deck.

Below this sprayhood are the stainless steel fish sorting, stripping and washing machinery, to which the fish is transported by means of a conveyor belt, out of the flush fish dumping pound in the forward main deck. Over the shipsides the codend contents is dumped into this pound. To which extent the above mentioned fish processing equipment is fitted depends on the skipper-owner and stability requirements. The stripped and cleaned fish is transported via a flush hatch into the fishhold below deck. Here the fish is stored with crush ice in the plastic fishboxes (40 kg), stacked upto 4-5 boxes.

Increasingly the 4 or 5 stacked boxes will be discharged in the harbour by means of a separate hoist winch.

The midship section of the maindeck is a large yang or teakwood covered deck area (40-80 mm) for fish gear handling and net storage after fishing.

The trawl winch is installed in the winchroom in the forward part of the superstructure and below the wheelhouse. The number of fishline openings in the front bulkhead is depending on the winch type, mostly 6-8 drums. The winches are electric driven and pneumatic controlled, in the wheelhouse as well as locally on deck. However onboard the 220 kW (300 hp) beamers the winch is usually hydraulic driven.

The wheelhouse is characteristic for this type of fishing vessel: spacious with good visibility on the working deck and horizon but less aftward owing to the skippers cabin on this deck. The engines, generators and trawlwinch are bridge-controlled in front- and side panels, between which the skipper has a central position.

Besides modern navigational aids and communication equipment, sophisticated electronic fish finding systems are installed, mostly double.

In the engine room a main propulsion diesel engine (medium or high speed) is installed which drives, coupled to a reverse and reduction gear (3.5 - 9 : 1), a fixed pitch nozzled propeller (3-4 blades). These fixed pitch propellers are designed for the fishing condition, maximum pull at a 4-7 knots speed. Only incidentally a 4 blade controllable pitch propeller is installed.

Characteristic for the here concerning fishing method is the continuously varying engine loads, because of fishing weeks of 100 hours with about every two hours hauling.

Upto 600 kW (800 hp) the diesels are electrically started.

The electrical installation of beamtrawlers consists of two ship's mains, a continuous current (110 V/D.C.) and three phase current (220-380 V/A.C.) with a 24 V/D.C. emergency installation.

The D.C.-main supplies electricity to the fishwinch and bowthruster, while the A.C.-main is indispensable for the auxiliarily machineries of the propulsion plant and for the ship's safety.

Both mains are generated independently, either diesel engine driven (high speed) and (partly)/or diesel main engine driven (power take offs).

Depending on the choice of the fuel operation (gas oils - 180 cSt), a more or less sophisticated oil treatment equipment is necessary. However the decreasing and varying quality of the presentday fuels stress the need for separators, both for gas- and marine diesel oils.

A fully automatic cool- and crush ice unit is installed in the fish hold, resp. for maintaining a fishhold temperature of appr. 0°C and making crush ice or flake ice for storing the flatfish in the fish boxes.

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For heating the accommodation a boiler is installed in the engine room with sometimes also a heat exchanger connected to the main engine cooling water system, while a hydrophore is supplying fresh water.

The beamers are designed and built according the Rules and Regulations of the Dutch Shipping Inspectorate for Seagoing Cutters ("Voorschriften Vissersvaartuigen 1970").