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Noise and Vibration as Viewed by a Maritime Union

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The problems associated with shipboard vibration and noise are becoming more frequent in the administration of collective bargaining agreements between the seafaring union and the ship operator or owner. The evergrowing competition in the maritime transportation industry has encouraged the development of high capital cost vessels striving for greater levels of productivity.

To achieve higher levels of productivity, new types of vessels, such as high speed container vessels or Ro-Ro vessels, giant tankers, barge carriers, and LNG carriers have been developed. New hull designs and higher power propulsion plants appear to result in vessels that are prone to vibration problems. Today's ships in terms of productivity are monuments to their builders; however, in terms of offering a workplace and abode away from home for a career seafarer, today's high productivity vessels are very unattractive. For months the seafarer will find himself on a vessel that is very noisy, continuously vibrating (some vibrate even when anchored) coupled with quick-turn around times with minimum shore leave, reduction of shipboard services and longer hours of work. It is not the intent of the Union in this paper to involve itself in rectifying specific design problems, but rather to call the attention of those problems to those who are responsible for the designs in an effort to develop a better vessel that will be an attractive place to work and live.

The seafaring unions in representing their members are confronted with a wider range of problems than their shoreside counterparts primarily because of the seafarer's restrictive job which virtually confines a seafarer to a vessel 24 hours a day, day in, day out. The job is a combination workplace and home for our member. Since there is little time available to the seafarer in domestic ports to rectify shipboard problems, the seafarers have participated in the formation of unions to act as their representatives in matters affecting benefits, working conditions and shipboard living conditions. Therefore, there is much rapport between seafarers and their union. Normally, our members will point out ship deficiencies in the form of a grievance. Grievances are discussed between the Union and the companies and generally there is an amiable solution to the problem. In the event a series of common grievances occur, or if the problem persists, or if the problem poses a hazard affecting the safety or health of the seafarer, then at the next negotiation of the collective bargaining agreement, provision will be made to either prohibit certain operational practices or provisions will be made to pay penalties because of failure to meet contractual requirements setting up standards for the workplace or living accommodations. It is quite feasible that the Union may require a vessel to operate at reduced speeds to reduce vibration. Or the Union may require modification of a ship's structure or machinery to reduce vibration or noise. For example, a typical grievance was resolved under the safety provisions of the collective bargaining agreement.

The MEBA members called the attention of the Union to a specific vibration problem on an LNG tanker. The pumping systems for the cargo had in its original design suffered from extreme cavitational problems to the extent that hammer and vibration in the cargo systems was so severe that all the flanges in the cargo discharge

lines had to be retightened after each discharge. Since the vessel was under guarantee, there was much finger-pointing between the shipyard who cited inadequate training and improper operation and the company who cited poor design. This problem was solved by the simple addition of a check valve in the suction lines to maintain a better suction head.

The solution of the problem was simple, the component pump as per specifications was capable of doing the job; however, when performing as part of a system, it fell short of its specifications. Understanding the interaction of a component and the remainder of the system was the solution.

The problems presented by hull vibration appear to be the basis of many grievances pertaining to vibration. As a Union of marine engineering officers, our members are aware that hull vibration on newer vessels is generally due to using higher horsepower propulsion machinery and more flexible hull designs than was found in older ships.

The older ships were built with components having a large "factor of safety" primarily to contend with unforeseen situations within a system during the life of the vessel. Modern technology has enabled the designer to use components that are designed closer to the "mark" with full knowledge of their interactions within a system. Because of hull vibration problems in the modern ship, it is becoming apparent that the interaction between systems such as between the propulsion system and the hull must be taken fully into consideration in the design and construction of a vessel.

In the preparation of this paper, the Union at its training school held a one-day "think session" to discuss "nuts and bolts" problems pertaining to work-related problems due to vibration and noise.

The participants were seasoned ships engineers with many years of experience; all in attendance were sailing either as Chief Engineer or First Assistant Engineer. Their comments were directed to about 50 vessels currently in operation and with an average age of less than seven years. To paraphrase their comments without naming specific vessels, they went as follows:

<u>On Vibration. Hull or Propeller Related</u>

The underway vibration in the forward part of the vessel was excessive. The midshiphouse structure was subject to severe vibration making it difficult for the deck officers to obtain any sleep. The underway vibration in the steering gear room was so severe that it was necessary to repair the hydraulic piping used in the steering system several times during the course of a voyage.

On another vessel the vibration within the housing structure was so severe that several engineers left the employ of the vessel due to extreme fatigue associated with the lack of sleep.

On a similar vessel, the officers did not use the ship's lounge and also found it very uncomfortable using the saloon because of excessive underway vibration. This class of vessel appeared to have resonant pockets within the superstructure, one ship would have excess vibration in select public areas, another ship would have its vibration concentrated either in the deck officers' quarters or the engineers' quarters.

Another ship vibrated so badly underway that the hangers and brackets on some of the steam or drain lines would fracture during the course of a voyage.

One class of vessel when operated under light load condition was required to reduce speed because the deck cargo handling equipment would vibrate like tuning forks.

(Recently, the Union received a complaint from a ship owner who was negotiating a contract with the Union for the manning of a gas carrier. His complaint was that the hull design was so "tender" that the vessel vibrated even while at anchor. The Union to date has had no feedback from its membership on this vessel.)

Vibration Problems Associated With Machinery Systems

A group of officers reported that on one vessel the vibration resulting from the dropping and hoisting of the anchor will wake up the sleeping off-duty personnel.

Another group of officers reported the fans that are located in or adjacent to the quarters are generally a vibration problem on some ships. It was specifically noted that when forced draft fans are operated at maximum speed there would be a vibration problem in the ship's housing.

On Noise

To the ship's engineers, noise and vibration are generally synonymous; the category of complaints fell in the following areas:

When asked in general what units are the noisiest, the engineers will list the following units in order: the main engine, specifically the reduction gears, the ship's generators, air compressors and the fuel oil transfer pumps.

When asked to describe specific problems in the machinery space on ships they have sailed, the following comments were submitted:

On diesel vessels it is both the main propulsion diesel and the ship's service generator's diesels that generate a noise level exceedingly high, making verbal communication virtually impossible in the machinery spaces. Most of the U. S. flag ocean-going diesel vessels do not have soundproof control rooms. Generally, the engine department personnel on these ships are required to wear hearing protection devices for general safety; however, the engineers believe that they are subject to hearing losses even with the use of ear plugs.

On one steam vessel, the noise level from the ship's service generator was so severe that several engineers grieved to the company that they suffered hearing losses because of the high noise level.

One modern high speed container vessel has very noisy main feed pumps. The most frequent complaints were from the Second Assistant Engineers because they are required to do all the boiler water chemistry and feed water treatment from a station that is located adjacent to the feed pumps. A discussion with the company resulted in a program of replacing the main feed pumps with the pumps of another manufacturer.

The same class of vessel during the recent fuel crisis reduced the speed of their vessel for reasons of fuel economies. At reduced speeds the turbine's steam extraction pressures were too low for use and the steam reducing stations were used to supply auxiliary steam to the various systems. The high demand on the reducing station resulted in very high levels of noise making it unbearable to be in the vicinity of the reducing stations. This problem is compounded by the fact that the reducing stations are located on a bulkhead adjacent to the crews' quarters.

On several tankers during cargo discharge or ballasting operations, the operation of the cargo pumps resulted in excessive noise and vibration in the pump room and in the quarters located nearby.

On dry cargo vessels the cargo handling equipment when used in port became a major noise and vibration problem. The house may be used as the base or foundation for several cargo winches transmitting noise through the housing structure.

The most frequent grievance, however, is not from excessively loud noises, but from relatively loud sounds. This occurs in the quarters of a vessel due to the lack of insulation in the bulkheads isolating the occupants. Normal levels of conversation can be heard through the bulkheads.

To summarize the seafarer views on the effect of vibration and noise:

Of primary concern is excess noise in ships living spaces, shipboard personnel believe that the lack of proper rest may reduce their effectiveness as watchstanders in maintaining a safe watch. They further believe that the combined effect of noise and vibration is cumulative in its effect on shipboard personnel. Shipboard vibration and noise is a continuous condition (unlike shoreside jobs where one is subjected to eight hours exposure per day)

the seafarer is subjected to 24 hours a day exposure. Most of the ship's personnel are concerned when subjected to conditions that reduce their effectiveness and, therefore, many of the grievances submitted to the Union pertaining to noise and vibration stem from deficiencies in the quarters of a vessel. (Unfortunately, the United States Coast Guard has only required standards for the machinery spaces of gas turbine vessels, and the Maritime Administration has formulated specifications for minimum noise levels, which, if adhered to, would in our opinion subject many career seafarers to noise levels that would cause major hearing loss.) Therefore, the collective bargaining between the Union and the companies contain provisions providing for a Committee to evaluate the specifications affecting the quarters of a vessel prior to letting contracts for all new construction, conversion or major overhauls which includes or affects the quarters of the crew.

Unfortunately, the industry or the government has not to date developed any meaningful standards. By meaningful standards for quarters, we are not referring to the standards developed under the administration of the Occupational Safety and Health Act for other industries, but rather a standard to make the shipboard living quarters habitable. Perhaps one of the study groups or panels of this society can develop a factor for noise insulation in much the way the housing industry has developed factors for thermal insulation.

The Unions are concerned with the excessive hours of overtime their members are required to work. Severe vibration problems can increase maintenance work loads.

Piping Systems--Pipe joints tend to fatigue, crystallize and break, brackets are subject to breakage, gaskets are subject to blowing.

Machinery--Bearing brinnelling, bolts loosen, couplings wear out, gears are damaged. Calibrations on controls require frequent settings, etc.

The intensity of noise and vibration in the workplace also presents problems affecting the health and safety of the seafarer. To date, the U. S. seafarer does not have the minimum protection guaranteed by the government to the nation's labor force. The United States Coast Guard is charged to give the U. S. seafarer the protection offered under the Occupational Safety and Health Act has not to date formulated the regulations to enforce the Act. It is now almost eight years since the "Act of 1970) establishing a bill of rights guaranteeing the American worker, by law, a safe and healthy workplace. The Union contends that the apathy of United States Coast Guard is not only detrimental to the seafarer but also to the development of our industry. Shipowners building ships today may find themselves facing added costs in the future to meet the mandate of the "Act of 1970". It is the Union's intention to inform the public and the industry through forums such as this, of the failure of the government to provide the seafarer with the basic rights enjoyed by other U. S. workers. The MEBA also contends that OSHA standards should be developed for the uninspected vessels broadening the scope of those covered guarantees of the "Act of 1970". This industry has the know-how to provide our nation with safe and economical vessels for its commerce.

In anticipation of greater use of medium speed diesel engines in U. S. flag oceangoing vessels, the MEBA established a Joint Committee to develop programs for the decrease of noise aboard vessels. To date, the Union is still seeking to have the United States Coast Guard, the agency charged to establish safety and health standards for seamen, to initiate a program outlining guidelines to provide the seafarer with proper protection.

Other unions representing seafarers on towboats have taken more assertive action because diesel powered towboats tend to be very noisy. The union was aware of the harmful effects of noise. Through independent research, they learned about the health hazards and fatigue resulting from excess noise.[1,2,3,4 & 5] Furthermore, they discovered that substantial reduction in the decibel level would increase the total cost of a vessel by a nominal amount.[6,7 & 8]

The Inland Boatmen's union contract is the first major collective bargaining agreement to establish noise

[1,2,3,4,5,6,7 & 8] See end of text.

level requirements. To quote from the contract:

"The desirable objective in reference to newly constructed vessels being to limit the noise levels to a maximum of 70 decibels (DB-A) in the sleeping quarters and 75 decibels (DB-A) in the galley and mess area."

The agreement is maintained with a requirement of 15 dbA below the 90 dbA established as the maximum permissible level for hearing damage for an eight-hour day as established under the Occupational Safety and Health Act.

The Towboat Industrial Relations Association of British Columbia Agreement provides for noise reduction on existing boats:

"Immediately following the completion of the project pertaining to the SEASPAN PLANET[9] and analysis of the finding, the Companies shall introduce individual programs to reduce towboat noise to levels attainable through application of the project methods, the desirable objective being to reduce noise to a maximum of seventy (70) decibels in the accommodation area and seventy-four (74) decibels in the galley and mess area."

In addition, the agreement provides for Noise Level Standards for New Construction using a Society of Naval Architects and Marine Engineers paper as a guideline.[10]

The Canadian collective bargaining agreement calls for an additional 20% reduction in sound energy in the stewards' department work spaces.

It is interesting to note that towboats are generally below 200 tons and, therefore, are not inspected annually by the Coast Guard. Left to their own devices labor and management can agree on standards of 75 dbA for the workplace. The engineers' union is seriously considering working out a similar arrangement for the ships' engine rooms.

To determine the long term effect of noise and vibration on the health of seafarers, the MEBA commissioned several studies by the medical staff in its Diagnostic Clinics.

The first study was to outline the long term effects of vibration and noise upon the marine engineer officers. The second study, based upon the medical records available, was made to see if there was any noticeable commonality of medical problems that could be job related.

Over the past twelve (12) years the union and companies have jointly maintained clinics in major seaport cities of New York, Baltimore, New Orleans and San Francisco. At these clinics several doctors and their associated medical staffs perform annual diagnostic examinations similar to the annual checkup given to the executives of many companies. In addition, the clinics perform, for many companies, pre-employment physicals. Outside of the U. S. Public Health Service and marine hospitals which have administered to the seafarers for almost two centuries, these Diagnostic maintain the most complete file of medical records on marine engineer officers serving on U. S. flag vessels.

Our reports on vibration exposure based on a search of existing literature, indicated that most of the previous studies of industrial vibration in Eastern and Western Europe showed, in general, abnormal vascular, gastric and neurological conditions, enzyme changes, bone changes, liver changes, headaches and backaches. The National Institute of Occupational Safety, in its outline for Developing Industrial Vibration Exposure Criteria[11 & 12] states, "Industrial vibration appears to be a potential safety and health hazard to workers in various work situations." The National Institute of Occupational Safety, under PL 91-596, has the responsibility for developing safety and health standards criteria for the nation's working population. The criteria for vibration is due for release during fiscal 1980. The extent to which this criteria will affect seafarer is still under study. Consider the career of a seafarer who works 30 years and averages 35 weeks of shipboard employment a year. He can receive up to 176,400 hours of possible vibration exposure. Further study is clearly needed on vibration and its effect on the seafarer.

The report on the effects of noise as a health hazard states as fact that exposure to loud noise can impair hear-

9 & 10 See end of text.

11 & 12 See end of text.

ing; however, it is less commonly known that noise also affects a number of vital body functions. Upon exposure to noise, the body undergoes autonomic reactions affecting blood circulation, increased hormonal secretions, among many other effects (Welch and Welch, 1970). The effects can be reportedly measured in humans at noise levels from about 60 db in short time exposure, which is about the acceptable noise levels for shipboard living spaces under the SNAME HS-7 panel guidelines.

Labor also questions the tolerable noise level standard established by the U. S. government. (Table 1) We believe it is much too high. Most Western countries use more or less the recommendations of ISO 1999 (International Standards Organization) which has as a basis 85 dbA as the upper limit of tolerable noise level for 8 hours of exposure. At this level, greater than acceptable hearing loss occurs in only a few individual cases. The acceptable hearing loss standard set in the U.S.A (Table 1) came about as a definition of a handicap in workmen's compensation cases for loss in earning power.[13] Why use a standard which implies a significant degree of disability as a limit for acceptable hearing loss in establishing noise level standards?

TABLE 1 PERMISSIBLE NOISE EXPOSURE

Duration Per Day, Hours	Sound Level dbA Slow Response
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

To determine the impact of industrial noise upon our members, the audiometer tests normally performed on our members undergoing a physical examination clearly indicates that 33% of our seagoing members have sustained moderate hearing losses. The age of the ships' engineers ranged from 22 years to 67 years, their average age was 43 years. (Table 2) Further study will be undertaken to determine a corrolary between age and sea service and its effect upon hearing. Many of our members when interviewed assumed that impaired hearing was due to degeneration due to the onset of middle age. According to our medical staff, in papers written by Dr. Samuel Rosen, consulting ear surgeon at New York's Mount Sinai Hospital, he contends there is nothing "natural" about hearing loss among the elderly. A study of Eskimos, Egyptians, Finns, Yugoslavs and aborigines from the Sudan, lead Dr. Rosen to conclude that hearing loss is directly related to the noise level in one's environment. In the nearly noise-free surroundings of the Sudan, he found 90 year old men who could hear as well as 10 year old boys.

TABLE 2 HEARING LOSS AMONG THE ENGINEER WORK FORCE

Age	Percent With Moderate Hearing Loss
Up to 25	4
25-30	10
31-35	12
36-40	21
41-45	30
46-50	42
51-55	42
Over 55	52

Another study relating to vibration and its generation of airborne pollution and its effect upon ships engineer officers was requested by MEBA. A preliminary tabulation of data from the classification of films from more than 1100 members to determine the prevalence rate of various abnormalities shown in the most recent x-ray film for each member was made. The chest films were classified according to the ILO U/C International Classification of Radiographs or Pneumoconioses.

The preliminary figures indicate that between 20-25% of the sample members have plural abnormalities that can be attributed to asbestos. The typical U. S. merchant vessel has much of its insulation on steam lines fabricated of asbestos, much of the material used in the living quarters contain asbestos. MARAD is currently involved in a program to determine the amount of airborne asbestos there is in the working environment and living spaces. The amount of asbestos used in current shipboard construction has been drasti-

[13] See end of text.

cally reduced because of the activity of the shipyard worker in protecting their health. Is the substitution of another material for asbestos the only solution? It took almost seventy years to detect the dangers of asbestos, must the workplace be used as a laboratory for testing asbestos substitutes?

It is not the intent of the Union in this paper to find fault, but rather to discuss the problems related to vibration and to challenge the maritime industry to provide a safer and healthier workplace for our nation's seafarers.

FOOTNOTES

1. "Noise, The Silent Enemy", International, October 1968, published by Seafarers International Union of North America, AFL-CIO.

2. "Noise, The Environmental Problem, A Guide to OSHA Standards", U. S. Department of Labor, Occupational Safety and Health Administration, OSHA 2007.

3. "Noise and Noise Control Standards", L. A. Hansen, Ph.D., State of Washington Department of Labor and Industries, Division of Safety.

4. "Occupational Noise Exposure", Federal Register, Vol. 37, No. 202, Wednesday, October 18, 1972.

5. "Shipboard Noise and the Walsh Healy Act", Lundgaard B., Society of Port Engineers of Puget Sound, September, 1970.

6. "Noise Survey", Inland Boatmen's Union of the Pacific, Robin M. Towne and Associates, Consultants in Acoustics, May 13, 1969.

7. "Noise Control on Diesel Tugs", Thomas R. Dyer, Bertel Lundgaard, presented to Northwest Section of the Society of Naval Architects and Marine Engineers, January 11, 1973.

8. "Report No. 7415-1, MV Pathfinder Noise Survey", Diehl and Lundgaard, Inc., Acoustic and Vibration Consultants, April 5, 1974.

9. Excerpts from the "Noise Reduction Program" Section of The Canadian Towboat Operators Contract. (See Appendix 1)

10. Excerpts from the "Noise Level Standards for New Construction" Section of The Canadian Towboat Operators Contract. (See Appendix 2)

11. "The NIOSH Plan for Developing Industrial Vibration Exposure Criteria", Wasserman, Donald F. and Badger, Donald W., Journal of Safety Research, December 1972, Vol. 4, No. 4.

12. "Biological Effects of Segment Vibration", Norman Williams, Ph.D., Journal of Occupational Medicine, Vol. 17, No. 1, January, 1975.

13. "Noise as a Health Hazard", Møller, Aagg, R., Ph.D., Karolinsaka Institutet, Stockholm, Sweden, IMF World Conference on Health and Safety, Oslo, August 16-19, 1976.

APPENDIX 1

Excerpts from the "Noise Reduction Program" Section of The Canadian Towboat Operators Contract (Footnote 9)

The Company undertakes to further intensify efforts to reduce noise on towboats to tolerable levels, as follows:

1. The project on the "Seaspan Planet" be reinstitued and carred through to completion as soon as possible following the signing of the Agreement, the project findings to be provided to the Towboat Accommodations Standards Committee within thirty (30) days of completion.

2. Immediately following the completion of the project and analysis of the findings the Companies shall introduce individual programs to reduce towboat noise to levels attainable through application of the project methods, the desirable objective being to reduce noise to a maximum of seventy (70) decibles in the accommodation area and seventy-four (74) decibels in the galley and mess area.

3. First priorities in vessel modification shall be applied to those vessels with the highest existing noise levels (e.g. eighty-five (85) decibels or more).

4. Vessels covered by this program shall include continuous operating vessels, and twelve (12) hour and eight (8) hour shift vessels.

5. The Committee shall receive and review progress reports every six (6) months following completion of the project.

6. The Committee shall have the right to examine completed work and/or work in progress at any time.

7. The Company and the Union will jointly petition the MoT to implement regulations governing noise levels base based on the results of the "Seaspan Planet" project.

APPENDIX 2

Excerpts from the "Noise Level Standards for New Construction" Section of The Canadian Towboat Operators Contract (Footnote 10)

NOISE LEVEL STANDARDS:

1. To reduce the noise level at its source, through engineering design and controls, prior to the vessel construction.

2. Also the continuation of an "on-going" program to lessen noise levels that are excessive on presently existing vessels.

3. Use of Society of Naval Architects and Marine Engineers, Pacific Northwest Section, report of January 11, 1973, as a guideline related to "Noise Control on Diesel Tugs."

4. The desirable objective in reference to newly constructed vessels being to limit the noise levels to a maximum of 70 decibles (DB-A) in the sleeping quarters and 75 decibles (DB-A) in the galley and mess area.

5. Periodic noise exposure testing of crew members by professional audiological consultants, utilizing the method of wearing on their person a "dose-meter" device for a 24-hour period of time.

6. A glassed in "sound proof" booth shall be installed in the lower engine room on newly constructed ocean and coastwise operating vessels.

7. Installation of "Fabreeka Isolators," or a comparable product, between the vessels engines, reduction gears, compressors and other machinery, and the vessels engine bed or girder.

8. Installation of adequate mufflers, through oversizing or tandem mufflers, to prevent excessive noise levels on open decks of vessel.

9. Hydraulic noises: Prevention of transmission of noise through vessel by use of hoses or other modern technology.

10. Installation of fiberglass insulation on engine room bulkheads and overhead. Use of acoustic tile, lead shielding or other types of modern

technology to prevent transmission of air carried noises throughout the vessel.

11. Design of vessel to incorporate a noise buffer zone between the engine room and the living spaces. Installation of fuel tanks between engine room and living spaces. Installation of storage areas between the engine room and living spaces. Installation of passageway with double doors between engine room and living spaces.