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II-A-162

AN EVALUATION OF STRATEGIES TO CONTROL NOISE FROM GRAIN DRYERS

DECEMBER 1981

U. S. ENVIRONMENTAL PROTECTION AGENCY
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16. ABSTRACT

This report deals with the investigation of each of the noise control alternatives for grain dryers in the State of Maryland. The elements of the grain dryer report included: (1) sample identification through survey of grain dryer locations, zoning and noise levels; (2) analysis of background and operational noise levels for the sample selected for study; (3) use of aggressive abatement procedures: citing of violators, modification of existing equipment, property acquisition and mechanical permits; (4) exploration of the impact of operational curfews, and (5) development of an incentive and information program. The primary objective of this study was to furnish and verify information with recommendations for future approaches to grain dryers noise control which would be of assistance to other juridictions, faced with grain dryers noise problems, as well as, references to other studies which may be helpful.

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NOISE CONTROL GRAIN DRYERS		

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Foreword

In October, 1976, the U.S. Environmental Protection Agency (EPA) contracted with the Metropolitan Washington Council of Governments (COG) to develop a plan to evaluate specific noise control strategies in a major metropolitan area. During the performance of that contract, staff from COG and six of its area jurisdictions, identified noise source targets for study and developed a series of potential strategies for evaluation. The overall plan was then presented to EPA for their consideration for funding of the implementation phase.

The contract for the implementation phase of the study was awarded in September, 1977. Specific work elements included the development of two educational modules and the investigation of control strategies for grain dryers, air conditioning/refrigeration equipment, minibikes and refuse collection vehicles. For each specific noise source to be studied, a jurisdiction within the metropolitan Washington area was selected to work with COG in the investigation.

This report on the noise from grain dryers is one of a series describing each of the activities undertaken. The format for each report details the strategies evaluated and assesses the experiences encountered. Each is designed to provide guidance for other state and local noise programs faced with similar noise problems. Hence, emphasis is placed on the practical aspects of attempting to implement innovative approaches.

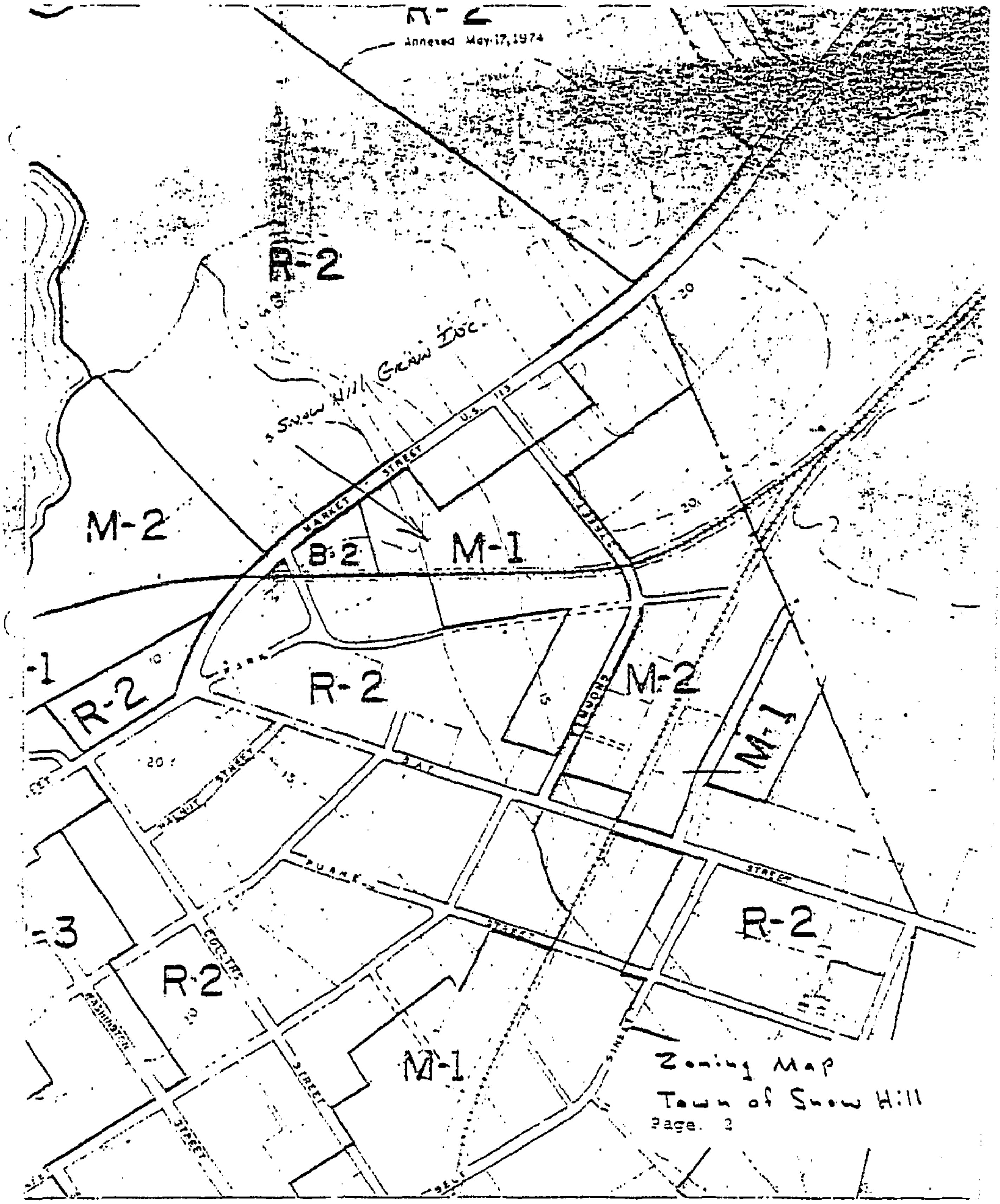
The investigation of grain dryer noise in the State of Maryland was completed by the Environmental Health Administration's Division of Noise Control staff under subcontract to the Metropolitan Washington Council of Governments. A summary of the State of Maryland's noise control program is presented in Appendix 1. The elements of the grain dryer report include: (1) sample identification through a survey of grain dryer locations, zoning and noise levels; (2) analysis of background and operational noise levels for the sample selected for the study; (3) use of aggressive abatement procedures: citing of violators, modification of existing equipment, property acquisition and mechanical permits; (4) exploration of the impact of operational curfews, and (5) development of an incentive and information program.

Introduction

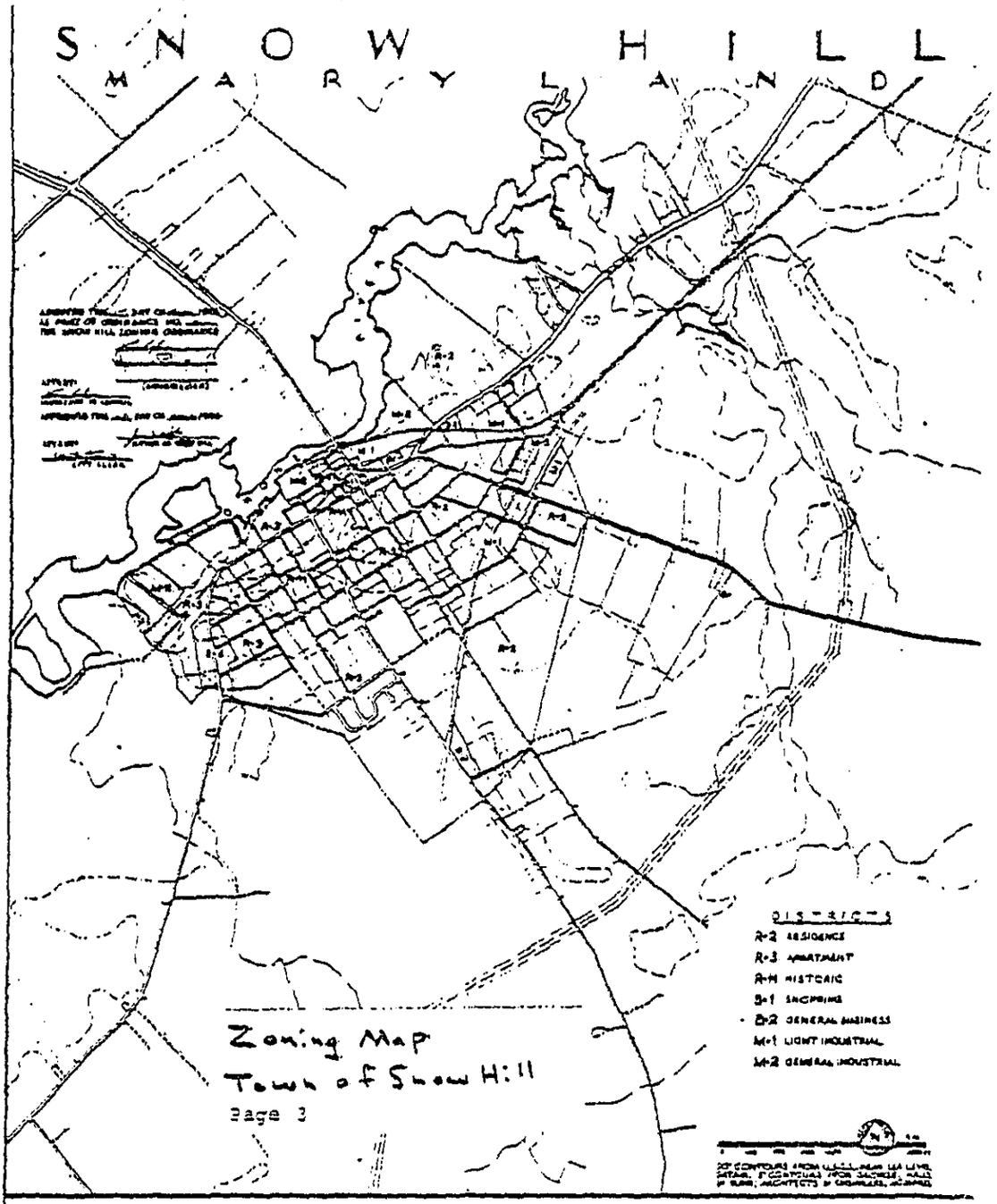
Grain dryers are located in and are integral parts of grain receiving and handling facilities. These facilities are usually located near railroads, major highways and navigable waterways to expedite shipment of grain to urban marketing centers. Local zoning codes usually permit such activity in light-to-medium industrial districts. In rural areas, it is not unusual to find industrial districts separated from residential districts by a street, railroad tracks, a river, or even an imaginary line, such as seen in the Town of Snow Hill shown on the next two pages.

Grain dryers are used primarily in Maryland to dry corn, soybeans and limited amounts of other small grains such as barley. Rather simple in design, they consist primarily of a warm air fan, oil or gas-fired burner, cooling fan and conveyance system. Grain enters from the top through spouts from elevator apparatus and flows by gravity downward through columns of woven wire mesh or perforated sheet metal. Warm (130°) air supplied by the fan and heated by flame from the burner passes through the columns of grain, removing moisture trapped inside the corn, grain or bean. In the lower third of the dryer, air from the cooling fan passes through the grain, reducing the temperature to a level suitable for storage and/or shipment.

The entire process is necessitated by the fact that corn and certain field grains retain moisture within the kernel during the



Annexed May 17, 1974
R-2
Snow Hill Grain Inc.
U.S. 113
MARKET STREET
M-2
B-2
M-1
PARK
R-2
M-2
M-1
WALNUT STREET
R-2
STREET
COLLINS
WASHINGTON
STREET
M-1
BELT
Zoning Map
Town of Snow Hill
Page. 2


S N O W H I L L
M A R Y L A N D
DISTRICTS
R-2 RESIDENCE
R-3 APARTMENT
R-H HISTORIC
B-1 NEIGHBORHOOD
B-2 GENERAL BUSINESS
M-1 LIGHT INDUSTRIAL
M-2 GENERAL INDUSTRIAL
Zoning Map
Town of Snow Hill
Page 3
ZONING MAP
TOWN PLANNING COMMISSION

maturation process. At harvest, corn may contain 25-35% moisture. This moisture, coupled with other biological and chemical factors, prevents storage of grain. Corn, for example, can be stored 48 hours or less at field moisture content, and is dried to 14-15 1/2% moisture for long-term storage. Prompt drying also prevents the production of Aflatoxins, which render the grain useless and dangerous.

The grain dryer produces noise from its fans, burners and the movement of grain by mechanical means. The noise of the fans and burners is low-frequency, around 200-400 Hz. Typical levels at 100 feet range from 60 to 85 dBA. In the height of the season, grain dryers operate 24 hours per day, six or seven days a week. This continues for four to six weeks, depending on the magnitude of the harvest, the weather and other factors.

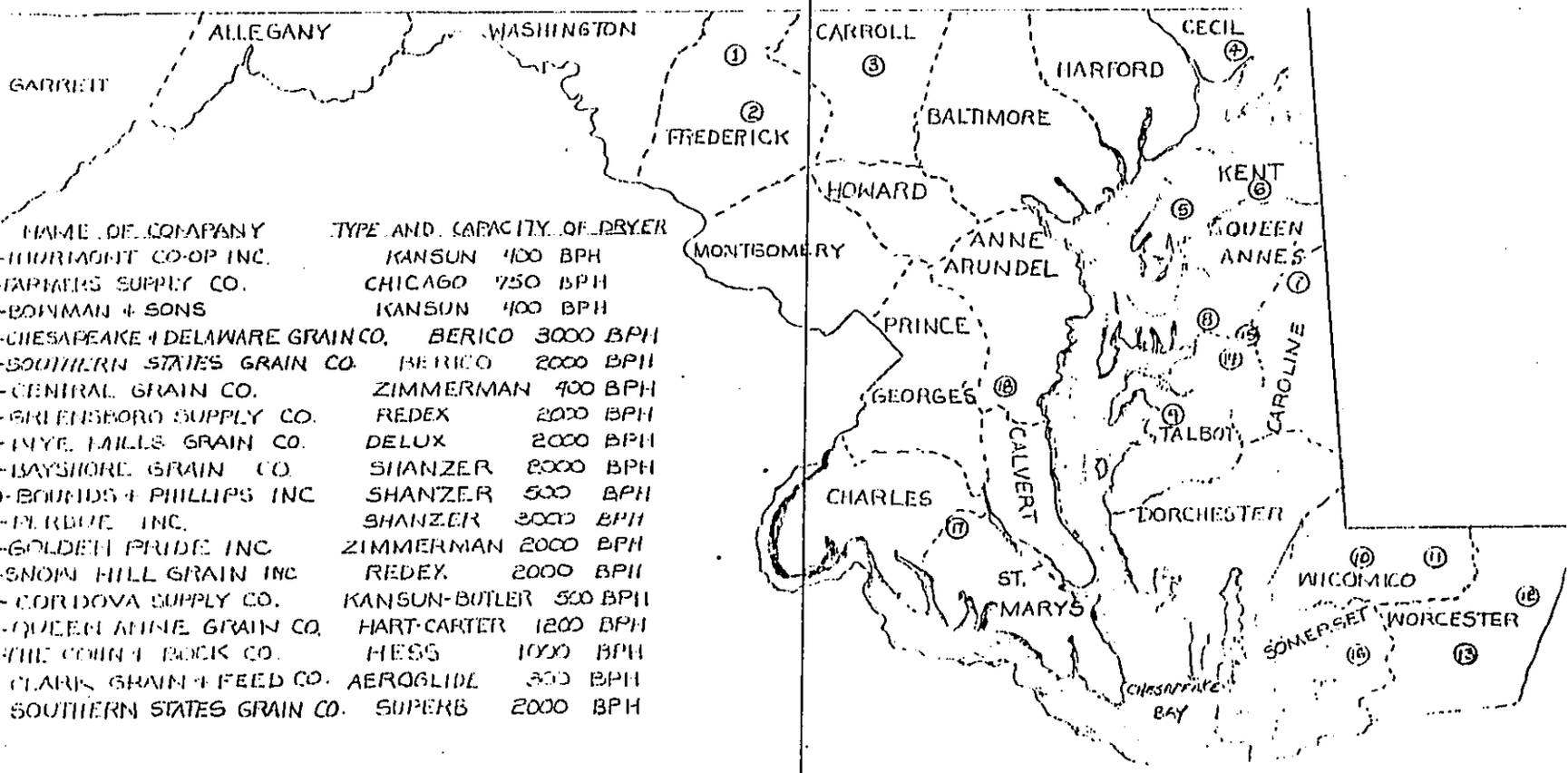
Report of Investigations and Findings

In this section, each of the noise control alternatives for grain dryers which was investigated is described. In the discussion, information which would be of assistance to other jurisdictions, faced with grain dryer noise problems, is presented, as well as, references to other studies which may be helpful.

Sample Identification and Measurement of Background and Operational Noise Levels:

Grain dryers registered with the Maryland Bureau of Air Quality Control were located as closely as possible on a State of Maryland highway map. After considerable delay, locations were identified through the use of tax maps prepared by the State Department of Assessment and Taxation. Site visits were made to ascertain location, address and exact name of each facility. County and/or local zoning maps were used to obtain zoning classification for surrounding properties. Many grain facility locations were unsuitable for this study. Reasons for rejection included: no residential property near dryer and/or high background noise or conflicting noise source activity such as construction. Figure 1 is a map of the 18 locations that were selected for the sample.

During the spring and summer of 1979, each sample location was visited and baseline noise levels were obtained without the grain dryer operating. Measurements were obtained using a Metrosonics



NAME OF COMPANY	TYPE AND CAPACITY OF DRYER
HIGHLAND CO-OP INC.	KANSUN 400 BPH
FARMERS SUPPLY CO.	CHICAGO 750 BPH
BONMAN & SONS	KANSUN 400 BPH
CHESAPEAKE & DELAWARE GRAIN CO.	BERICO 3000 BPH
SOUTHERN STATES GRAIN CO.	BERICO 2000 BPH
CENTRAL GRAIN CO.	ZIMMERMAN 400 BPH
GREENSBORO SUPPLY CO.	REDEX 2000 BPH
RYE MILLS GRAIN CO.	DELUX 2000 BPH
BAYSHORE GRAIN CO.	SHANZER 8000 BPH
BOUNDS & PHILLIPS INC.	SHANZER 500 BPH
HERBUE INC.	SHANZER 3000 BPH
GOLDEN PRIDE INC.	ZIMMERMAN 2000 BPH
SNOW HILL GRAIN INC.	REDEX 2000 BPH
CORDOVA SUPPLY CO.	KANSUN-BUTLER 500 BPH
QUEEN ANNE GRAIN CO.	HART-CARTER 1200 BPH
THE COHN & ROCK CO.	HESS 1000 BPH
CLARK GRAIN & FEED CO.	AEROGLIDE 300 BPH
SOUTHERN STATES GRAIN CO.	SUPERB 2000 BPH

FIGURE 1

GRAIN DRYER SURVEY LOCATIONS

dB-602 Community Noise Analyzer equipped with a half-inch Gen-Rad microphone. Noise from intrusive sources such as aircraft flyovers was not included. Data were gathered for one hour, after which the analyzer was interrogated to obtain L_n, P_1 and L_{eq}.

L_n = the sound pressure level, 'L' that is exceeded 'n' percent of the measurement period.

P_1 = the percentage of time, 'P' that the sound was measured to be at the sound pressure level, 'l'.

L_{eq} = the energy equivalent sound pressure level. This is the level of a constant sound that has the same acoustic energy as an actual time-varying sound.

In September, the grain drying season began. At each of the 18 locations, the same procedures were used to obtain a set of measurements with the grain dryers in full operation. The make and capacity of each dryer was also obtained at locations which had been closed during the earlier phase of the study. Figure 2 contrasts the operational L_{eq} levels to the baseline L_{eq} levels obtained. Figures 3 through 6 depict the percentage of exceedance with and without the grain dryers, for four different locations. Figures 7 through 10 show basically the same information as Figures 3 through 6 except that P_1 values are displayed. Figure 11 illustrates the probability of exceeding any particular L_{eq} at the sampling locations. It shows that 23% of the sample exceed the daytime regulations and all would exceed the nighttime regulations when in operation. Photographs of the various locations and equipment used in the survey are included in Appendix 2.

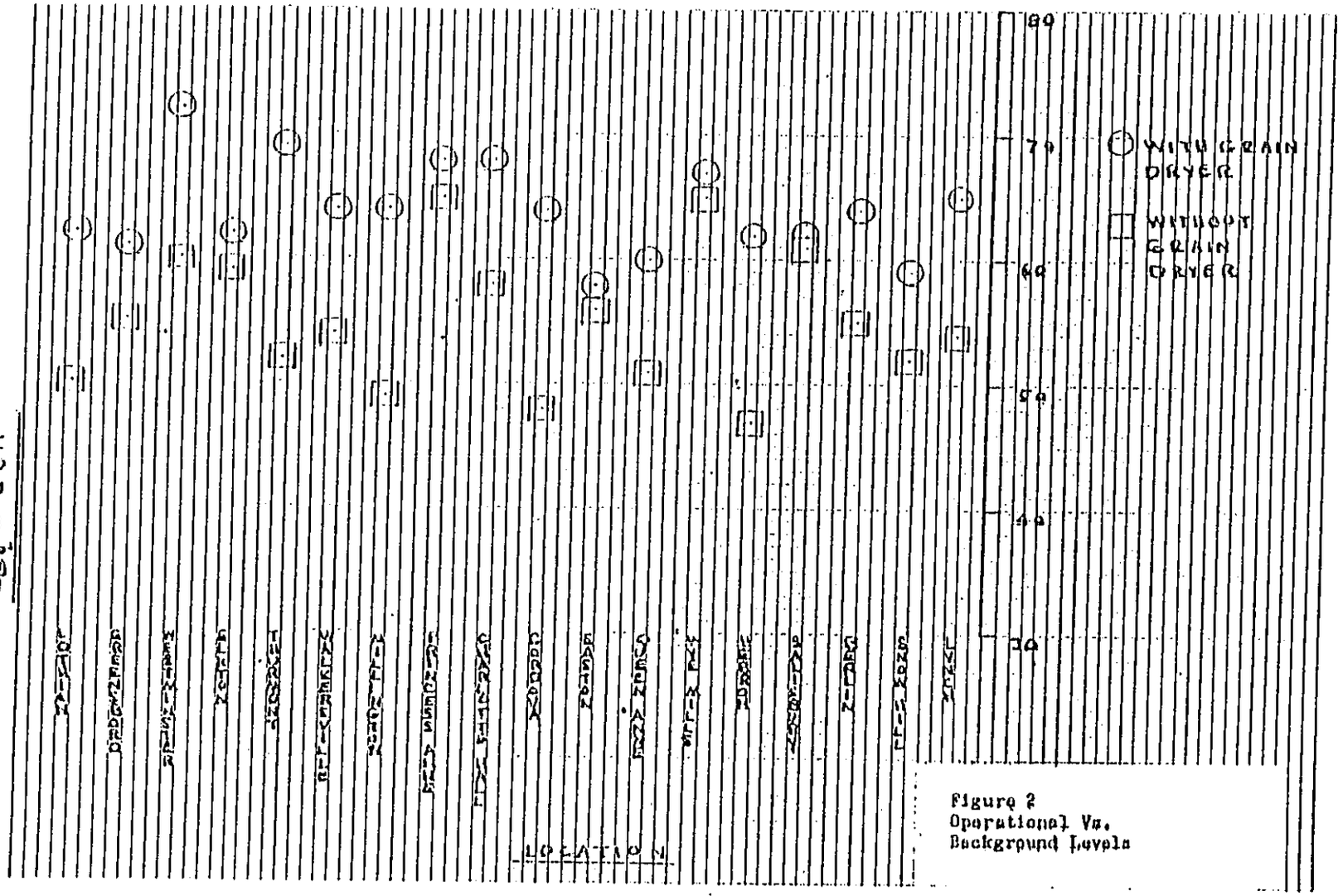


Figure 2
Operational Vs.
Background Levels

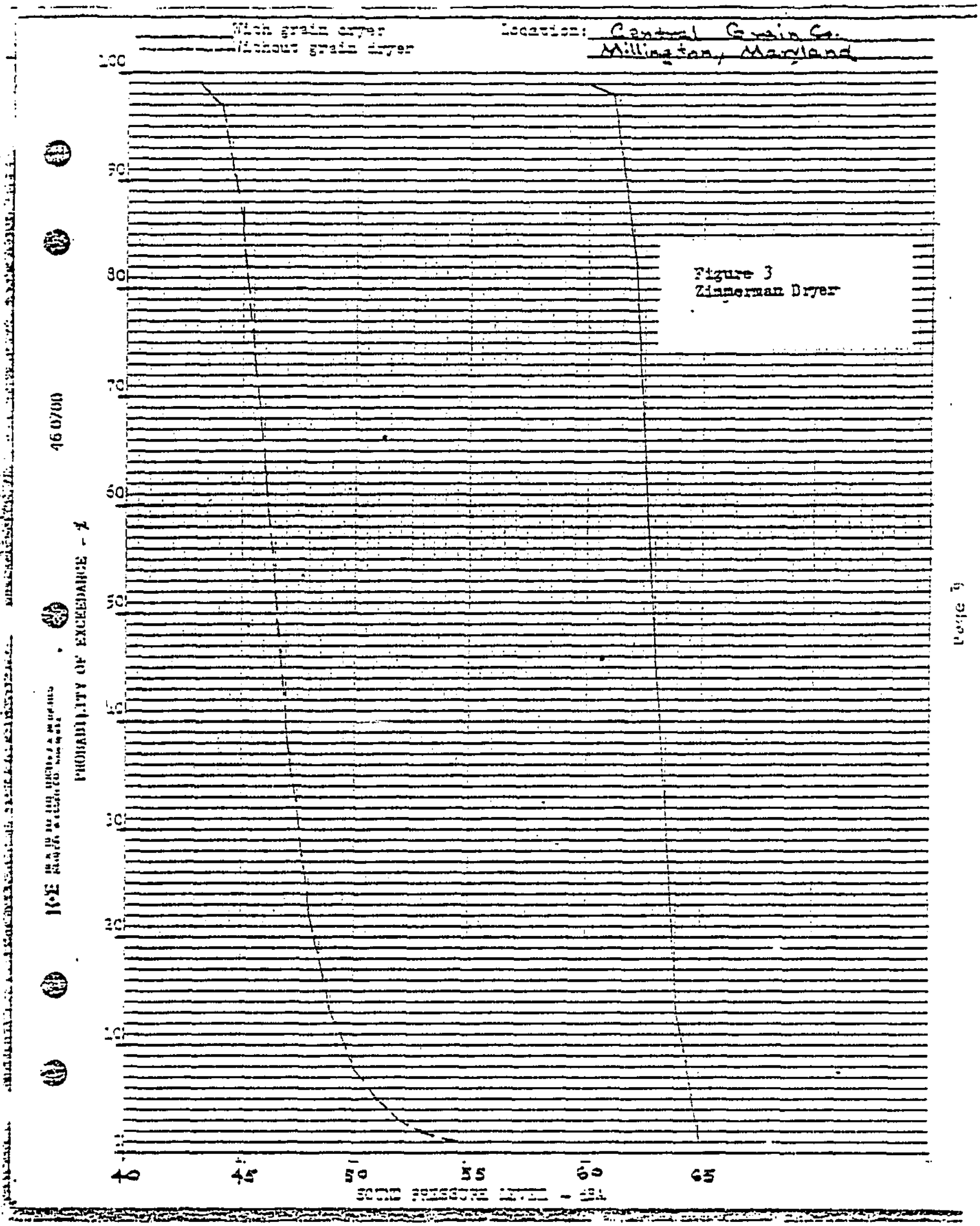


Figure 3
Zimmerman Dryer

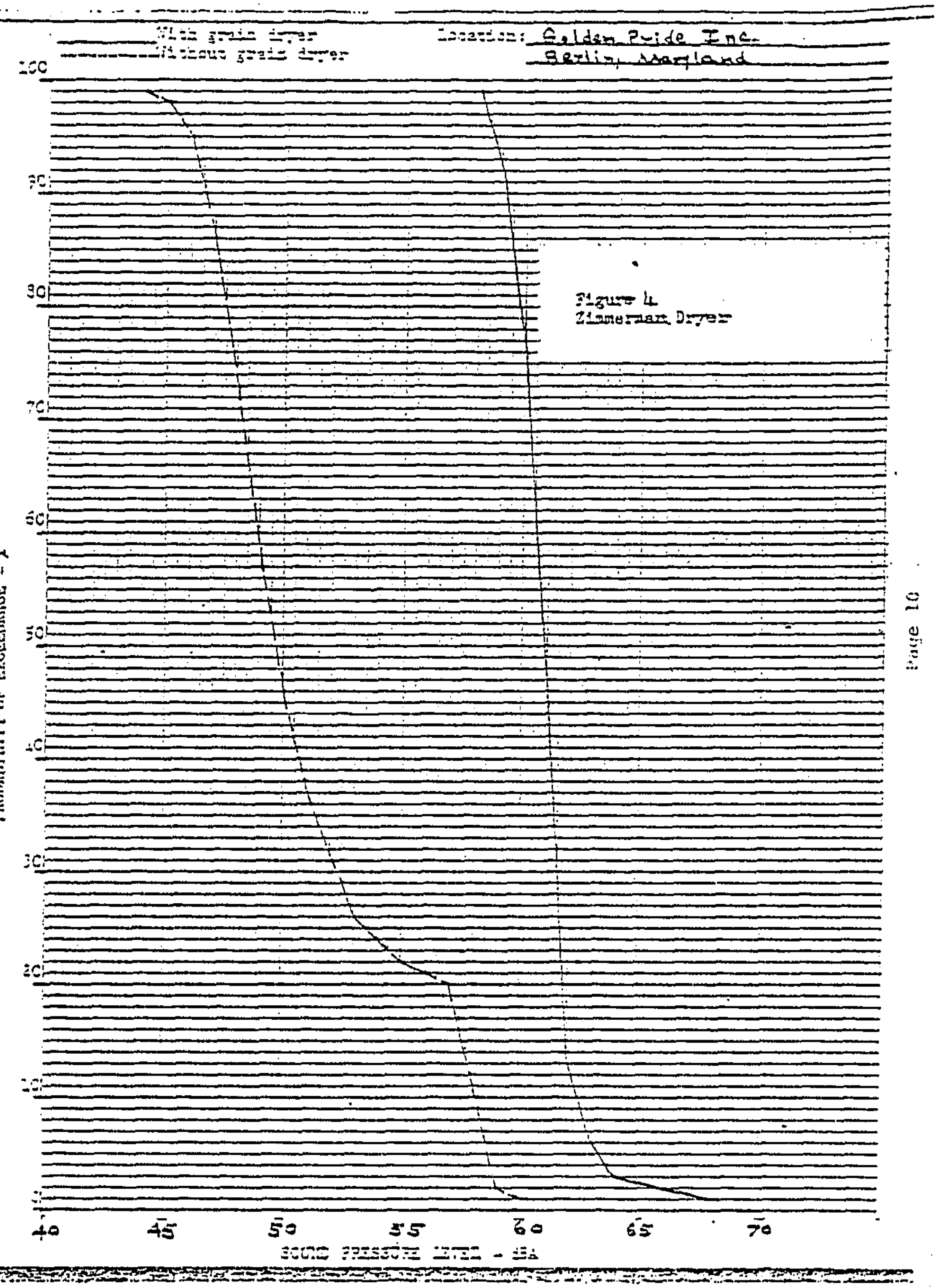
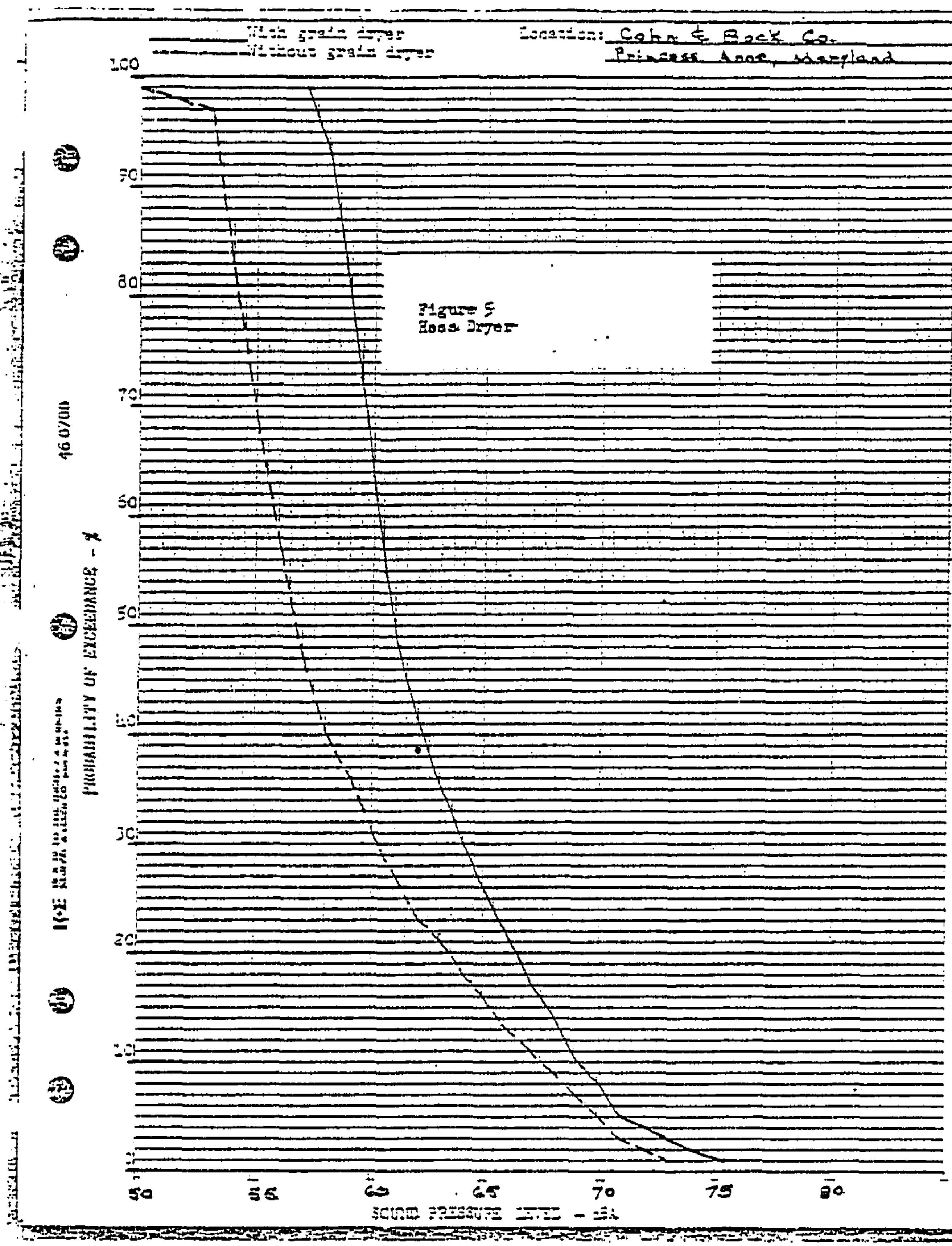


Figure 4
Zimmerman Dryer



With grain dryer
Without grain dryer
Location: Cohn & Bock Co.
Princess Anne, Maryland
Figure 5
Hess Dryer
PROBABILITY OF EXCEEDANCE - %
100
90
80
70
60
50
40
30
20
10
50
55
60
65
70
75
80
SOUND PRESSURE LEVEL - dBA

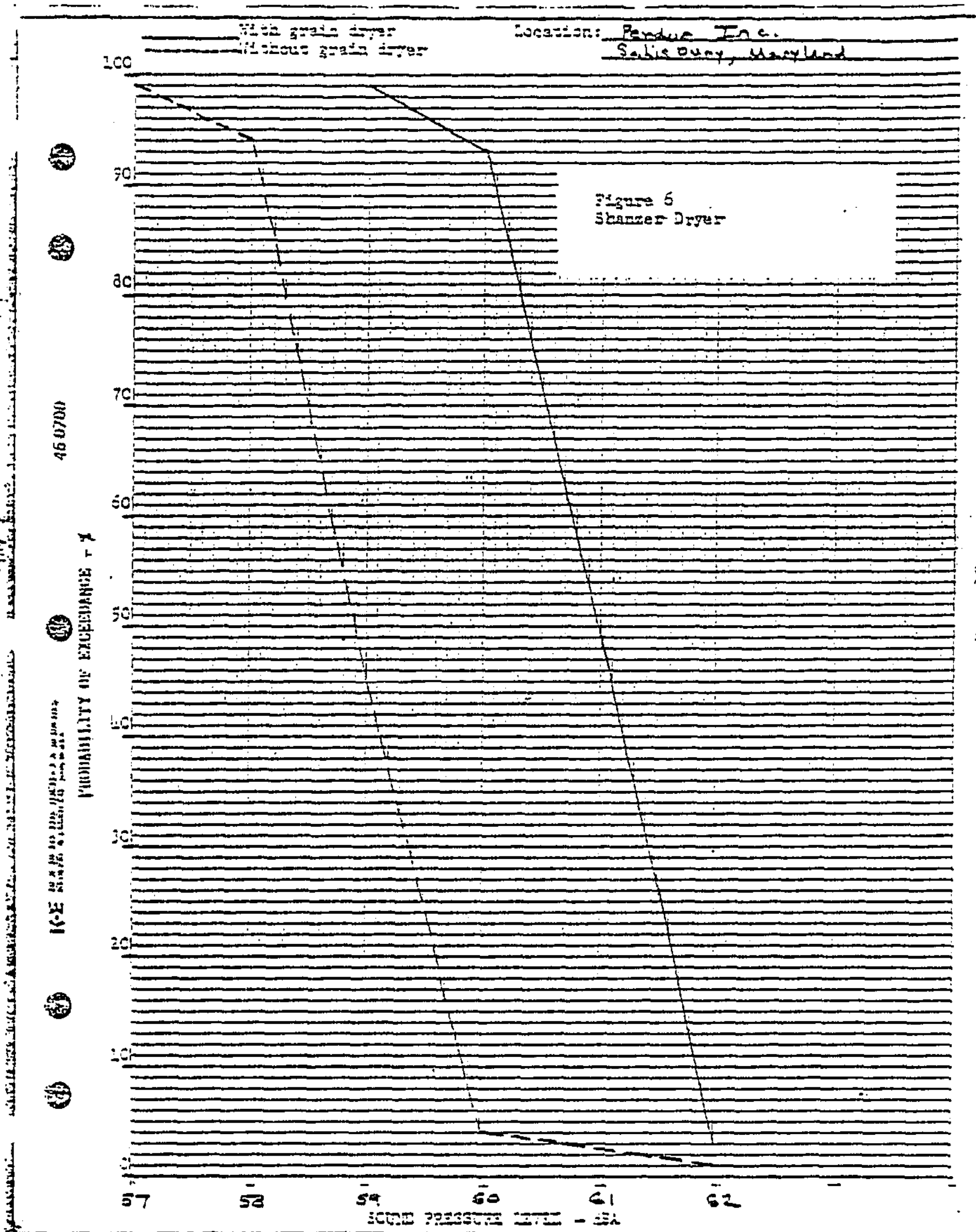


Figure 6
Shanzer Dryer

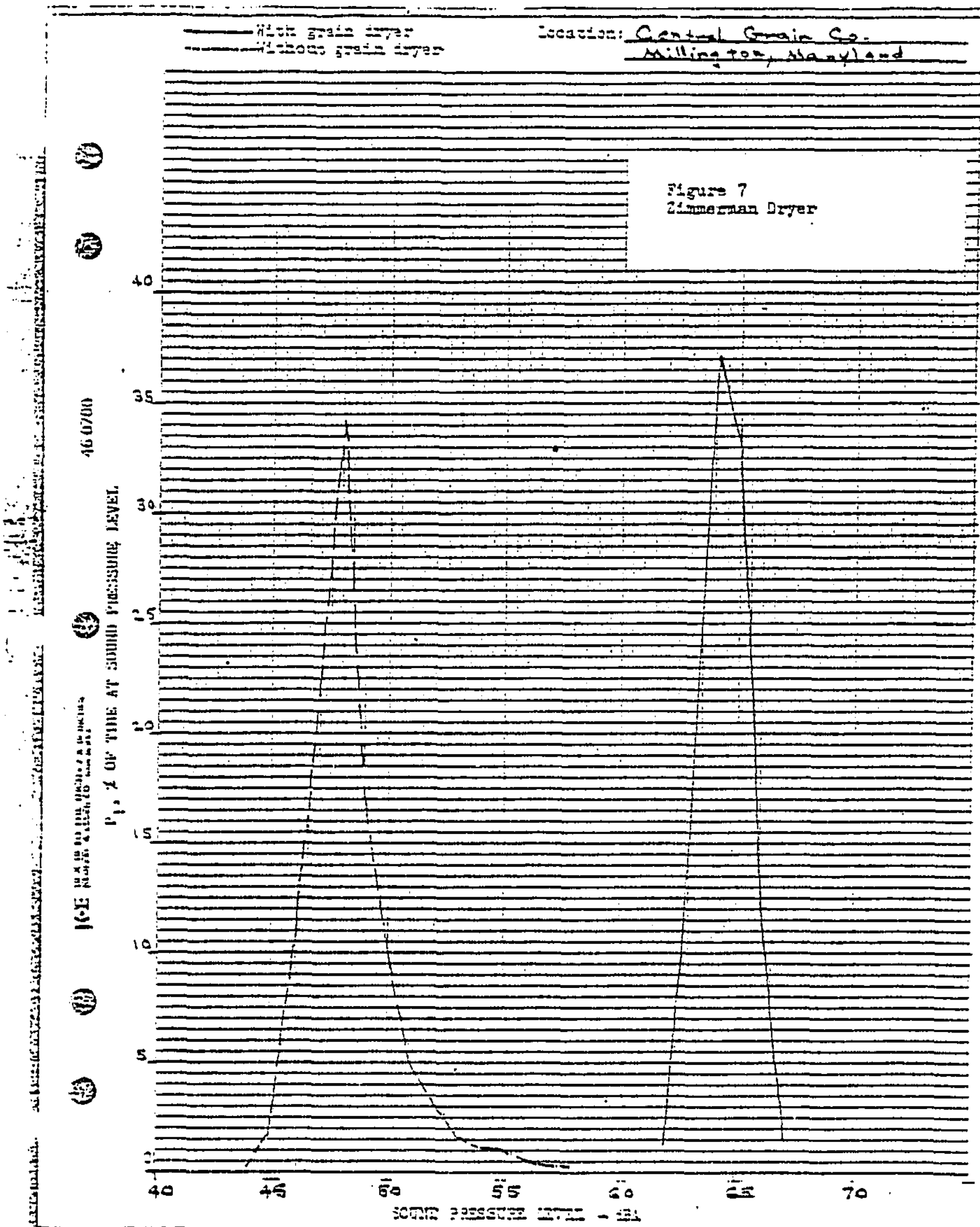


Figure 7
Zimmerman Dryer

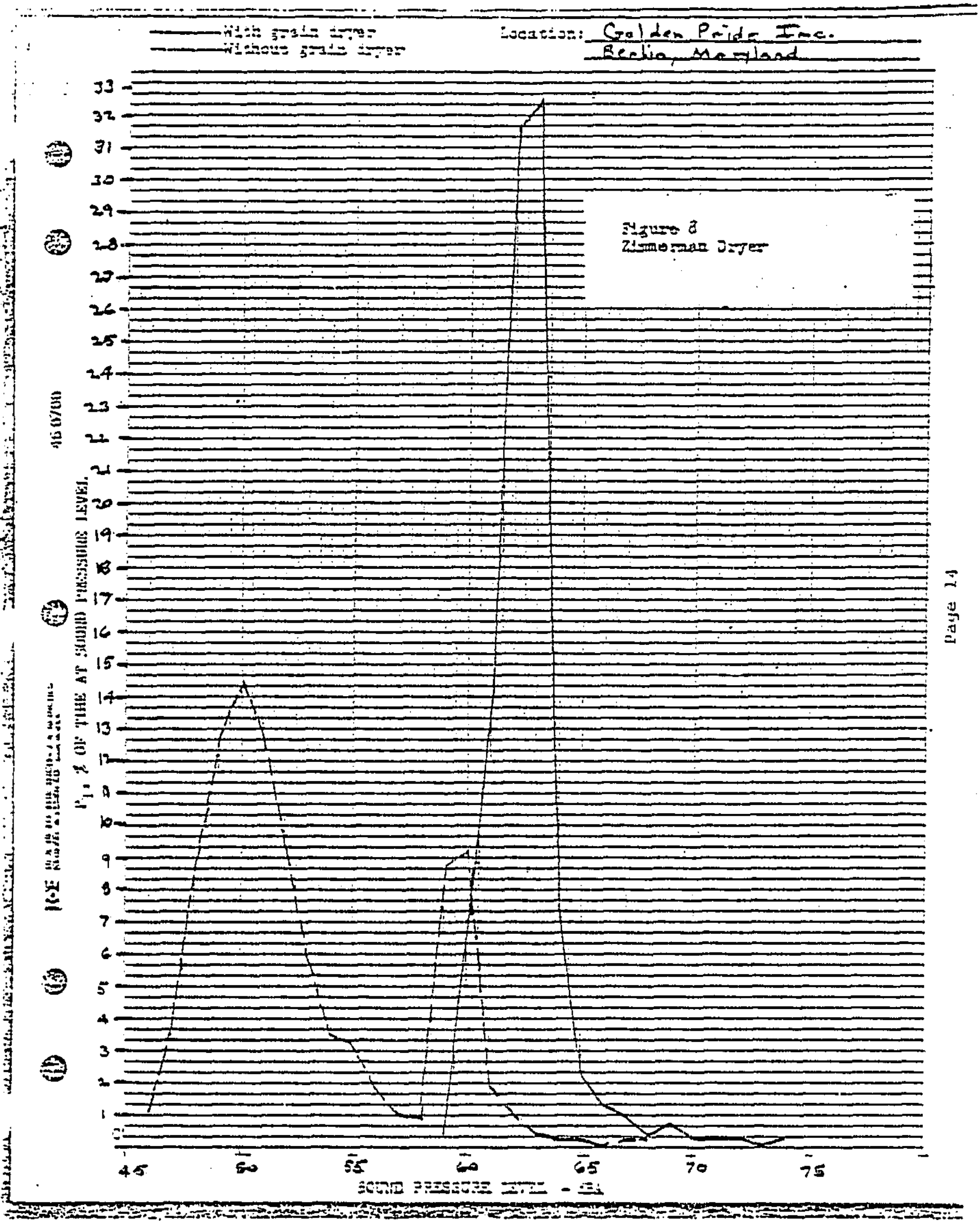


Figure 8
Zimmerman Dryer

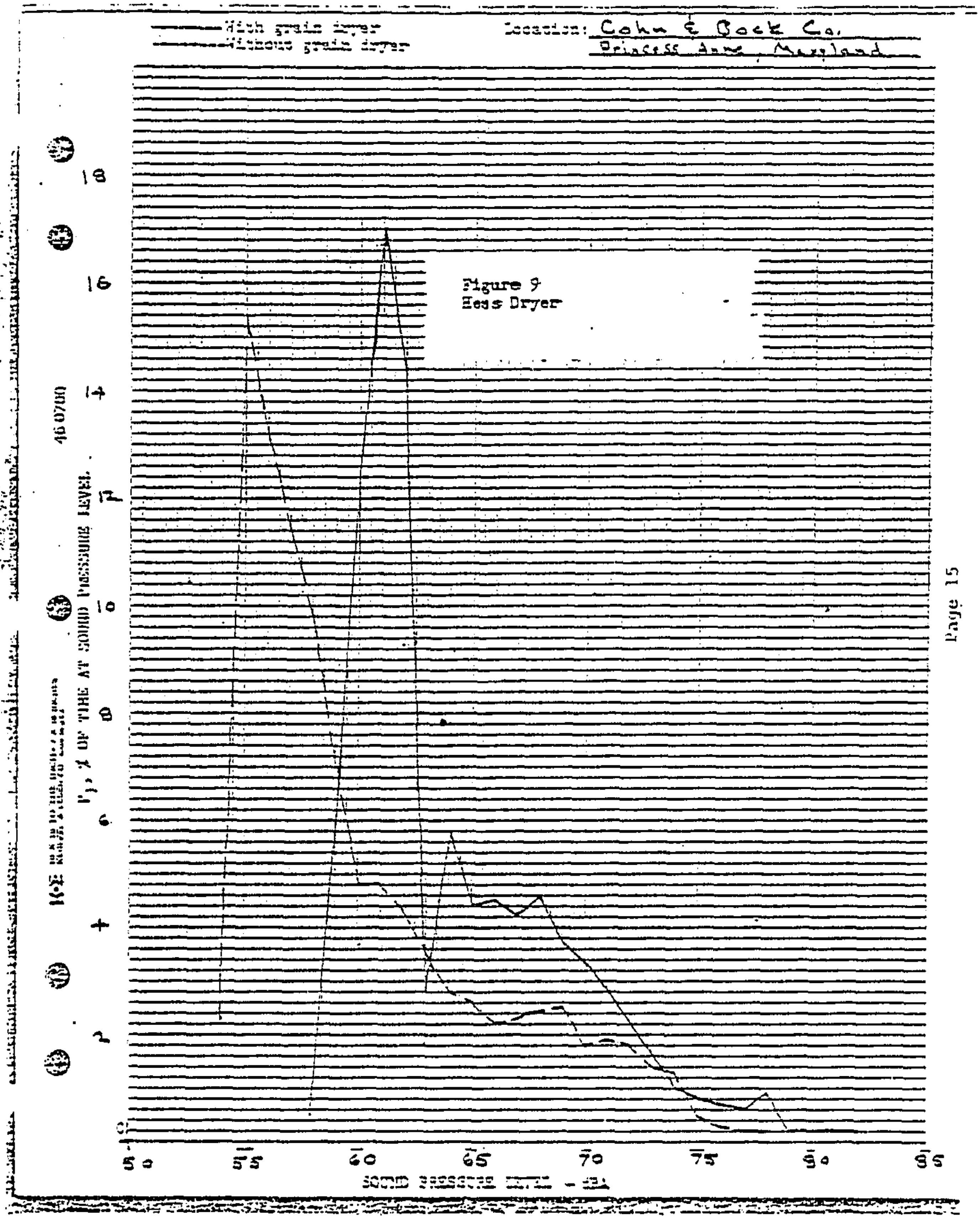


Figure 9
Hess Dryer

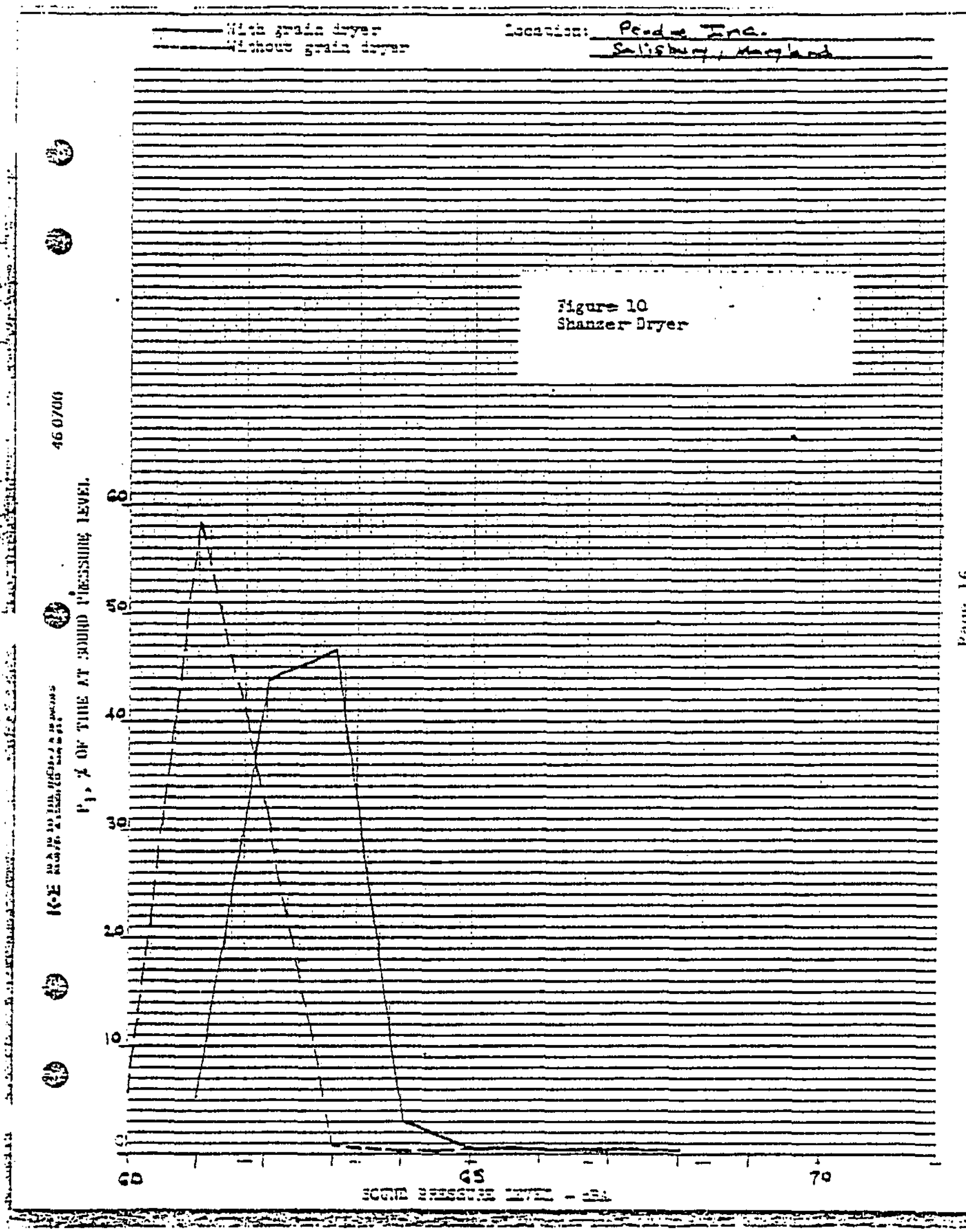


Figure 10
Shanzer Dryer

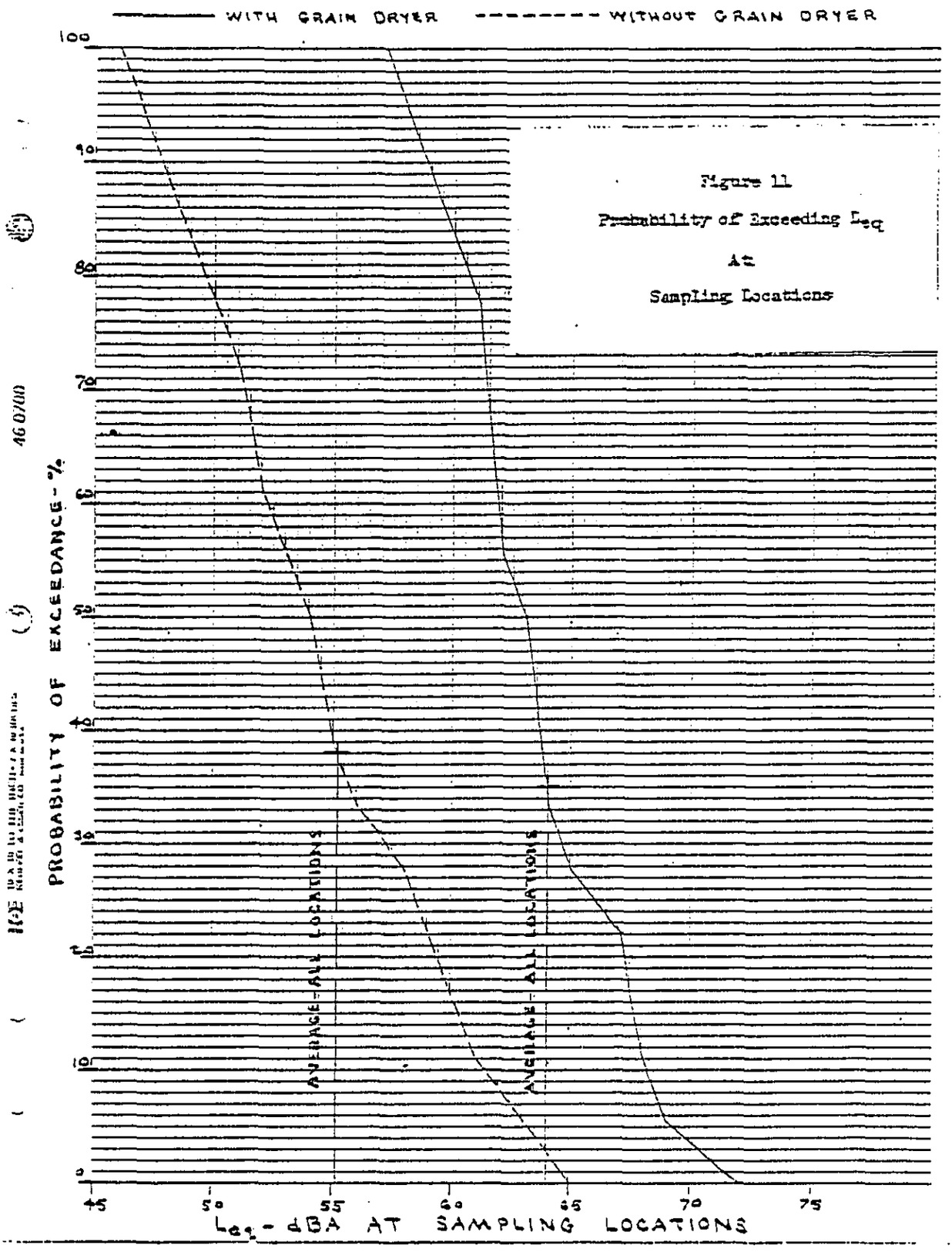


Figure 11

Probability of Exceeding L_{eq}

At

Sampling Locations

Abatement Procedures: Citing of Violators:

Measured noise levels in excess of those currently permitted by Regulation 10.20.01, "Rules and Regulations Controlling Noise Pollution in Maryland," were evaluated to determine that the particular grain facility under study was indeed the primary, if not sole, contributor to the measured levels. Operating personnel at the facility were verbally informed of the levels obtained at adjacent residential property. Written notification, the first formal step in the abatement process, followed in the form of a certified letter and standard form, "Report of Observation of Violation," Appendix 3, which notified the owner of the facility of the nature and extent of the violation, and proposed a general abatement timetable for corrective action or established a date on or before which such a timetable was to be submitted.

Careful attention is required during the previously described process because of the language of the Environmental Noise Act of 1974, which specifically requires that violators be given a "reasonable" period of time to comply prior to instituting legal action; and that violations be established as "willful." The time allowed for corrective action is determined by the judgment of the noise control personnel, with or without obtaining third party (consultant) evaluation of the situation. Establishing a willful violation is accomplished by the certified letter, which establishes a time period for either correction or the submittal of an abatement plan, beyond which any continuing violation will be considered willful in nature and subject to the penalty provisions of the Act.

Alternatives exist for the procedure beyond the establishment of a willful violation. The principal ones are the administrative order, the formal plan for compliance and the variance. The administrative order may be issued by the Director, Environmental Health Administration or by the Secretary, Department of Health and Mental Hygiene, as the case dictates. This order directs the violator to take specific action during a given time period, or to face prosecution and/or penalty.

The Plan for Compliance (PFC) is a legally binding agreement between the executive(s) of a facility in violation of noise regulations and the Department in which specific abatement actions are prescribed over a period of time in order to spread the costs of compliance over several months. Default in the terms of the PFC may result in immediate legal action.

Where the PFC exists to ease costs of modifications, the variance procedure exists for situations for which practical, state-of-the-art solutions do not currently exist. The applicant for a variance must advertise for a public hearing, declare his reasons why control is impractical, and agree to take action as technology becomes available. Variances are granted by the Secretary and are renewable if necessary, upon presentation of documented evidence in support of such action.

Abatement Procedures: Modifications to Existing Equipment: Property Acquisition: Mechanical Permits:

As previously discussed, the grain dryer produces noise from its fans, burners and the movement of grain by mechanical means. There are modifications which can be employed to reduce the noise. In this study, approaches to noise-reducing modifications were explored so that noise personnel could discuss possible control options with grain dryer operators.

A literature search revealed that a program of noise abatement at a midwest grain elevator employed the placement of equipment behind natural barriers, silencers and decouplers on aeration fans, enclosures for the drying fans and wrapping the grain chutes with loaded vinyl.[1] Noise level reductions of up to 20 dB were attained in the one through eight Kilohertz range. Reductions of 5-10 dB were achieved at lower frequencies. Unit costs of noise control were about $0.02 per bushel processed as amortized over one year.

Researchers at the University of Wisconsin found that a grain dryer fan and burner could be modified to include low noise features such as acoustically treated inlet and exit ducts and an acoustic cylinder around the burner pipe.[2] Reductions on the order of 20 dB could be expected from these modifications. Although no figures were given, costs were described as "relatively inexpensive."

During this investigation, the authors identified one grain dryer facility - Snow Hill - where a new Redex dryer was to be installed and fitted with a noise-reduction kit which was developed by the manufacturer and purchased at additional cost to the owner. Plans were made to obtain noise measurements after the completion of the installation. Unfortunately, a fire at the facility, resulting from "beeswings" which is the red chaff attached to the corncob, eliminated this possibility. The noise staff plans to make these measurements next year when repairs are completed.

Control of grain dryer noise through a noise-related mechanical permits requirement was judged unnecessary in the State of Maryland. To implement this approach, it would be necessary to obtain legislative authority which would be a time-consuming process. Currently any new grain dryer facility must meet existing State noise regulations; therefore, there is no need for an additional permit procedure.

In Maryland, the option of purchasing property that is adversely affected by high grain dryer noise is generally only a theoretically available option. For example, assume that a grain dryer produces 85 dBA at a distance of 100 feet. Under conditions of spherical radiation, approximately 0.3 square miles would be necessary for the noise to be attenuated to the 55 dBA presently required in residential areas in Maryland during nighttime hours. Obviously, this much property is not likely to be for sale in the vicinity of a grain dryer. It should also be obvious that this would not be a preferable or attractive alternative under any circumstances.

Exploration of the Operational Curfew Strategy:

In the investigation of a nighttime curfew for reducing noise impact of grain dryers on nearby residential areas, the researchers recognized the need to collect information from a wide variety of individuals. These included: grain dryer manufacturers, grain dryer owners/operators, the Maryland Department of Agriculture and the Maryland Grain Handlers Association. Copies of the survey letters developed and the responses received are shown in Appendix 4.

Fourteen grain dryer manufacturers were asked to provide information regarding the impact of a curfew; seven responses were received. Specifically, the manufacturers were asked about the possible impact of starting a cold dryer in low ambient temperatures, fuel considerations and for any other comments that should be considered.

The general answer to the question about fuel requirements was that it varied with the grain processing capacity of the grain dryer. However, one manufacturer's equipment brochure did indicate that fuel consumption was dependent on operating temperature and varied in proportion to outside air temperature. Another company pointed out that the recirculating dryer uses about one-third less fuel than the non-recirculating type. Typical fuel consumption for a dryer processing 2,000 bushels per hour and removing 5 percentage points of moisture is 50 to 80 gallons per hour of oil.

Reported operating temperatures varied between 135 and 220° F. The controlling variables appear to be grain type and moisture content. The emphasis is put on obtaining a uniform product rather than the strict necessity of operating the dryer at any particular temperature.

The time required from initial start with a cold dryer until a satisfactory operating temperature is obtained was reported to be between ten minutes and one and one-half hours. The primary variable would be the grain entry temperature. A secondary factor would be the outside air temperature because it controls the heat lost through the dryer walls. Another consideration is that gas supply pressures tend to fall as the air temperature falls primarily because of increased consumption. This drop in the gas supply pressure may tend to prevent attainment of the desired operating temperature and consequently lengthen the start-up period.

One manufacturer stated that ambient temperature does not seriously affect restart capability. Another company recommended 20°F as the minimum practical temperature from which the grain dryer could be satisfactorily restarted. No company claimed that restart from low ambient air conditions was infeasible, if fuel at suitable pressure is available. However, several pointed out that there was a definite economic penalty involving fuel and electricity during the unproductive startup period. It was stated that batch dryers used on individual farms should only be shut down at the end of a complete operating cycle if the grain is to be properly dried.

Generally, the manufacturers' comments about noise on the practicality of a curfew were numerous and informative. These are summarized below:

1. Noise is controlled primarily by the fan type. A centrifugal fan is preferable to the axial type;
2. A recirculating dryer is quieter than a non-recirculating dryer;
3. Grain has to be dried within 48 hours after it is harvested. Otherwise, spoilage or Alflatoxin (a mold that can be transmitted to humans) can develop;
4. A curfew might cause additional fuel usage by extending the drying season into colder weather;
5. Government should only specify acceptable noise levels and not dictate operating hours; and
6. A curfew is an important economic consideration but is not an operational consideration.

In conclusion, the manufacturers felt that a nighttime curfew would impose some economic penalties on grain dryer operation, that it might prevent satisfactory operation in some cases and that it might cause a health hazard if it restricted operating hours to the point that grain was not dried within 48 hours of harvest. No one felt that a curfew was the preferred method of achieving noise control goals.

In addition to the manufacturers, approximately 50 grain dryer operators that are registered with the Air Quality Programs of the Environmental Health Administration were contacted by mail and asked to comment on a curfew for grain dryers. They were also asked to supply as many facts to support any position they might care to take.

The general response was that 24 hour operation was essential during the harvest season if all the grain produced was to be dried. The only option available to the grain dryer operators if they had to comply with a curfew would be to purchase additional drying capacity. The respondents were unanimous in their opinion that they could not do this and remain competitive with producers in areas that did not have to comply with a curfew.

The State Department of Agriculture supplied both agricultural statistics related to grain and comments on the practicality of a grain dryer curfew.

The statistics supplied showed that cash receipts from farming during 1976 were $683.4 million dollars. During the same period, the revenues from corn produced for grain and soybean production totaled $192.7 million dollars. For comparison purposes, the Gross State Product for 1973 was $24.8 billion dollars.

Production of corn for grain in 1977 was 43.2 million bushels with a value of $86.4 million dollars.[3/] During the same period, 8.3 million bushels of soybeans with a value of $45.8 million dollars were produced.

Production of corn for grain during 1977 was about 25 percent lower than the record production year of 1976. Production of soybeans during 1977 was about equal to the production during 1976, but was down significantly from the record achieved during 1973 when 10.1 million bushels were produced. The long-term production rate for both grains appears to be increasing slightly.

Corn and soybeans are produced in varying quantities in most Maryland counties as is shown in Appendix 5. It is significant to note in these figures that grain production (and, consequently, grain drying) occurs to some extent in the heavily populated counties of Prince Georges, Montgomery, Howard, Carroll, Baltimore and Harford The major production is in the relatively sparsely populated Eastern Shore counties of Kent, Queen Annes, Caroline, Talbot, Dorchester, Wicomico, Somerset and Worcester.

The Maryland Department of Agriculture offered the following comments regarding a curfew:

1. It is important to keep the harvest season as short as possible to prevent losses from insect and disease, pests or adverse weather;
2. It is extremely important to dry the grain as soon as possible because of the problem that has been experienced with Aflatoxins in the last year or two. Spoilage is also an important consideration; and
3. It is imperative that commercial elevators run as near to capacity as possible to prevent loss of product or bottlenecks in the marketing channels.

In summary, the Department of Agriculture stated that health and economic penalties are likely to be associated with a curfew for commercial grain dryers.

From a purely noise control oriented point of view, a nighttime curfew imposed on grain dryers with noise levels that infringe on nearby residential property, has several advantages. It can be implemented rapidly and will provide immediate relief to impacted residents. Also, it would be completely effective and would not require any capital expenditures by the owner to achieve compliance with the State noise regulations. There would be little need for night surveillance by noise control personnel except in response to complaints of curfew violation. Finally, in those extreme cases where facilities are unable to comply with noise regulations, even after modifications, the curfew is, undoubtedly, preferable to the only other remaining options.

However, this investigation of the overall practicality of an operational curfew has revealed a number of additional considerations.

1. Grain production is important in the economy of Maryland. Noise control measures should not be undertaken that will unavoidably disrupt this productive effort;
2. Grain dryer operation causes a significant increase in ambient noise levels and grain drying is a significant noise complaint area;
3. Significant reduction in the operating noise level is possible through the application of engineering control techniques;

4. A curfew would be an effective control technique;
5. There are likely to be some economic penalties associated with a curfew; and
6. There are likely to be crop losses and health hazards if a general curfew for grain dryers is imposed.

In view of this wide range of considerations, a curfew does not seem practical. However, it must be realized that a curfew could be applied to any particular grain dryer if there were other dryers in the same area that could process an additional amount of grain equal to the loss in capacity of the dryer with the curfew. Because a determination that any particular grain dryer could be subject to a curfew would vary with grain production forecasts, it would perhaps be best to consult State agricultural officials regarding the appropriateness of a curfew on an individual basis.

Because of the economic factors, the curfew should be considered only in a case of last resort or offered as one of several alternatives when presenting a case for abatement to company officials.

Incentive and Informational Program:

Many factors involved in this study have contributed to an incentive and informational program. First, this comprehensive grain dryer study represented the initiation of an aggressive approach to noise control in Maryland. Previously, the focus of the program had been on responding to complaints received. The letters sent to the grain dryer operators in the State regarding the curfew and noise control in general provided an alerting mechanism regarding the need for concern about the impact of noise generated by the grain dryers. In addition, knowledge that an operational curfew was being considered provided an incentive to grain dryer owners to place maximum attention on voluntarily controlling noise. The measurement program further fostered the operator's information about problem dryers. Discussion with noise staff members conducting the survey provided an opportunity to learn about possible control approaches.

To maximize the dissemination of some of the information obtained during this study, a brochure, "Grain Dryers: An Owner's Guide to Noise Control," was prepared. The authors are indebted to Mr. Jon Crosby, Public Health Administration Associate, for his invaluable technical and design assistance in the preparation of the brochure. The brochure describes noise and its effects; provides examples of sound pressure levels produced by various activities; delineates the Maryland noise control regulations and provides general tips on how to reduce noise. A copy of the brochure is included in Appendix 6.

The brochure was developed primarily for distribution to grain dryer operators. It will, however, also be used as a source of information for persons complaining about grain dryer noise. Other distribution plans include local Chambers of Commerce, the Maryland Department of Agriculture and the Maryland Grain Handlers Association. The costs associated with the production of the brochure were relatively low. It provides a mechanism to reach a large audience when staff time precludes individual personal contacts. Other jurisdictions could easily modify the brochure for their use by the insertion of applicable noise regulations in their area. If funds are not available for brochures, the information could simply be typed and reproduced for distribution.

The State of Maryland's study of grain dryer noise resulted in the development of a miniature Each Community Helps Others (ECHO) exchange between Maryland noise staff and the State of Illinois' Environmental Protection Agency. Illinois provided a copy of its report, "Case Study of the Noise Abatement Program at a Midwest Grain Elevator," and some unpublished survey data throughout the State. The report provided contained an outline of the technical and economic feasibility of the compliance program at one grain elevator. Concentration was placed on control measures for aeration fans, grain dryers, chutes and augers. The report may be obtained by writing Mr. John A. Paulauskis, Illinois Environmental Protection Agency. The courtesy extended by the State of Illinois will be returned by sending them a copy of this study. A further opportunity to share

this study was offered at the EPA Regional Noise Conference in Morgantown, West Virginia, where a presentation of the methodology and findings was given by Mr. Tom Towers.

To further the informational exchange program through this report, the results of a literature search conducted for the authors by the U.S. EPA/Region III, is shown in Appendix 7. This clearly indicat that the existing research base is somewhat limited.

Discussion of Problems Encountered: Recommendations for Future Approaches to Grain Dryer Noise Control:

Some difficulties were experienced in the completion of this study. Major problems were unsatisfactory weather, which delayed both the baseline measurement phase and the operational grain dryer season. Also the intrusion of extraneous noise sources necessitated frequent switching of the noise analyzer to standby thereby prolonging time involved. In addition, the residents of properties adjacent to the dryer sometimes noticed the survey activity and would demand that some action be taken against the dryer operator regardless of whether the noise levels exceeded Maryland regulations. Thus, it was necessary to spend time explaining regulatory constraints.

The identification of the zoning status of the properties involved in the survey usually required a trip to the appropriate local zoning office. This was necessary since it was not always possible to sufficiently delineate the specific properties to obtain that information by phone. Initially it appeared that tax maps, prepared by the State Department of Assessments and Taxation, would have to be used to locate the properties of interest prior to visiting the zoning office to obtain zoning classifications. However, it was later found that a simple sketch of the property was sufficient. Much valuable time was lost trying to rely on the tax map method of determining zoning status.

A highly concentrated effort was necessary to complete this study because of the seasonal nature of grain drying. The harvest season normally runs from mid-August through late November. However, most corn is harvested in September and October. The weather this season delayed the harvest period. During the completion of this study, the Division of Noise Control was forced to cope with other ongoing responsibilities such as maintaining the office and responding to citizen complaints. The following recommendations are made as a result of this study:

1. Any future study of grain dryer noise might use a shorter sampling period, frequency analysis and/or tape recording. The capability of obtaining frequency data is useful in diagnosing problem noise areas. A useful project would be to install all available control measures at the installation and to gain the cooperation of one owner/operator to study the incremental effects of each installed noise reducing control.
2. Copies of this study should be distributed to the regional EPA representatives and announced in Vibrations and other noise related publications.

3. The information in the brochures developed as a part of this study should be modified by other jurisdictions as an aid to controlling grain dryer noise in their localities. Distribution should include owner/operators, Grain Handler's Association, Department of Agriculture, Future Farmers of America, local Farm Bureaus, and Chambers of Commerce.

4. The Maryland Grain Handler's Association should be encouraged to distribute the developed brochures to its members each year prior to the onset of the drying season..

5. Since this study has demonstrated a basic incompatibility between grain dryers and residential areas, new facilities should be located away from residential areas. This approach will also lessen the air pollution impact.

6. Wherever noise problems exist, modifications should be implemented as soon as possible.

7. The use of operational curfews should be limited to only the most extreme cases when all other remedies have been exhausted.

References

1. "Case Study of the Noise Abatement Program at a Midwest Grain Elevator," Noise Expo Proceedings, Chicago, Illinois, 1977.

2. "Noise Control of a Grain Dryer Fan," Peter J. Sherman and John Bollinger, Noise Expo '76 Proceedings.

3. Letter from State of Maryland Department of Agriculture shown in Appendix 4.