# UNIVERSITY OF NORTH CAROLINA

# SEA GRANT PROGRAM



## INSULATING ICE BUNKERS AND FISH HOLDS OF OLDER FISHING VESSELS

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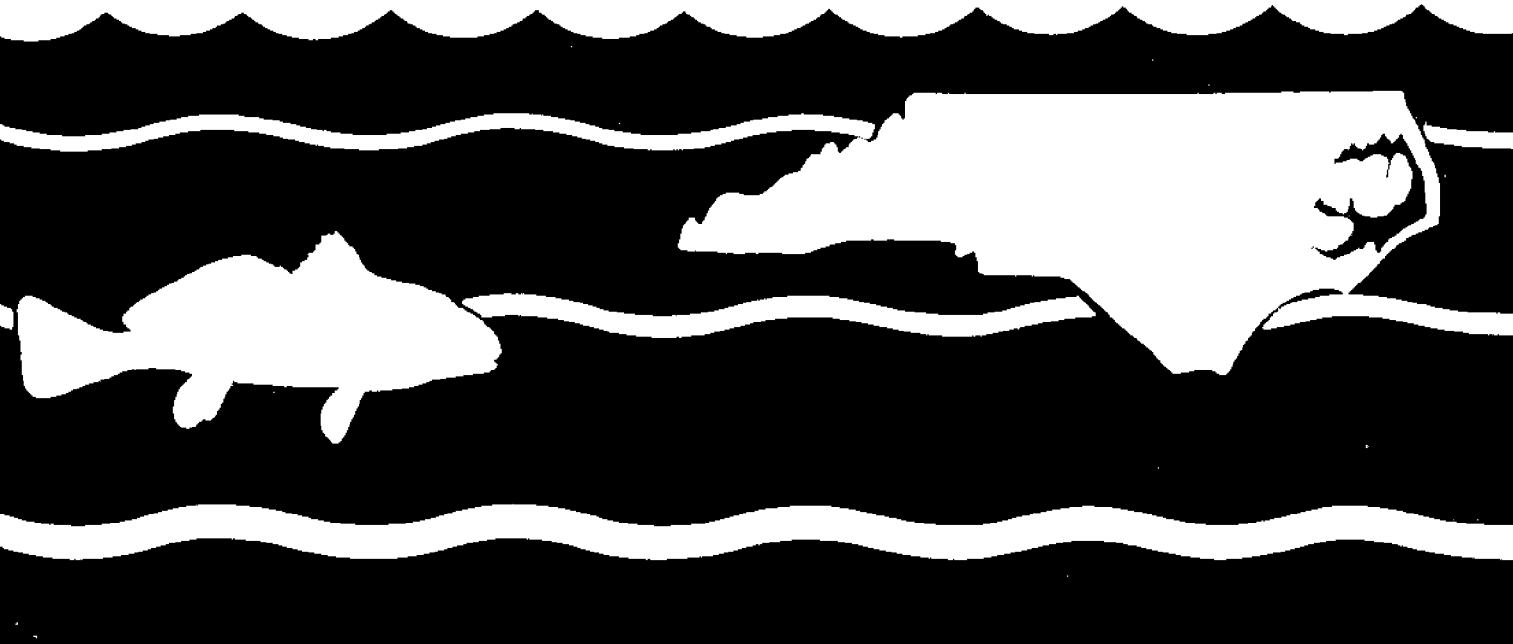

# INSULATING ICE BUNKERS AND FISH HOLDS OF OLDER FISHING VESSELS

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## A. STATEMENT OF THE PROBLEM

To develop a method of insulating the fish holds and ice bunkers of older fishing vessels. To accomplish the following:

A. Reduce ice consumption thus reducing operational cost.

B. Provide an improved fish holding and keeping capability, to extend fishing range/time, improve product quality.

The methods/materials used must not require highly skilled labor and utilize readily available materials. The vessel downtime required to complete installation must be held to a minimum.

## B. INTRODUCTION

The involvement of the Marine Engineering Advisory Services stemmed from direct contact and a working involvement with the commercial fishing industry/vessels.

One of the serious limitations of a large number of North Carolina's fishing vessels is their ice holding and fish keeping capabilities. The lack of insulation of the ice bunkers and fish holds is the primary reason for this limitation.

The cost of ice is a significant factor in the operational costs of a fishing vessel, particularly during summer shrimping operations.

Improvements in quality as a result of proper insulation and icing techniques and the sealed inner liner of the compartments would permit effective wash down, thus, improving vessel sanitation and product quality.

Staff personnel evaluated the problem and recommended the use of sprayed in-place polyurethane foam as the insulating material. This material exhibited several characteristics favorable to the intended application i.e., high insulating quality, ease of application, low water absorption and the forming of a permanent surface bond.

C. WORK PERFORMED

The work accomplished can best be described in four (4) phases:

1. Hull and Surface Preparation
2. Application and Trimming of Insulation
3. Sealing Off and Painting
4. Performance and Economic Evaluation

PHASE I - Hull and Surface Preparation

The compartments to be insulated were thoroughly scrubbed with strong detergents and hosed down.

Forced drying was accomplished by a torpedo heater (kerosene fired) and a circulating fan. The torpedo heater (in common use in the construction trades) is safe and economical to use, providing simple precautions are taken. The heater must be attended at all times and fire extinguishers strategically placed. Since this heater is electrically ignited, provisions for remote quick disconnect must be made.

The thorough cleaning and drying of the inner hull is a major prerequisit to permit the proper bonding of the polyurethane foam to the wood inner hull.

The nailing in place of fairing strips was the next step in hull preparation and served a dual purpose. First, to serve as a guage to maintain uniform thickness of the polyurethane foam. Second, to provide a suitable mounting surface for the sheet metal sheathing covering the insulation. All inner hull surfaces, bulkheads and the lower deck in the fish keeping compartments were fitted with 2" x 2" salt treated pine strips. The bulkhead common to the engine room and ice bunker was fitted with 2" x 3" strips, permitting an additional inch of insulation to be applied. It was not necessary to fit fairing strips to the overheads, the main deck timbers served adequately. The overhead insulation thickness varied from $7\frac{1}{2}$" in the ice bunker to 4" over the fish holds and companion way. The hatch cover was rebuilt and closely fitted with 6" of insulation sprayed in. The reason for these variations in insulation thickness was to accommodate the large temperature gradient created by engine room and topside deck temperatures.

Standard flush type floor drains were installed to drain through the inner hull into the bilge to accommodate the runoff of ice melt and wash down water.

The drive tunnel and bilge access boards were removed and drop-in removable panels were made and fitted in place. This was necessary in order to apply 2" of insulation over the shaft and to permit access to the bilge, shaft, aft pillow block and the fresh water line.

The last step in surface-hold preparation consisted of a sprayed application of a resin based moisture barrier primer to all surfaces.

The hull and surface preparation phase required two men full time, four days.

PHASE II - Application and Trimming of the Sprayed In-Place Polyurethane Foam Insulation

The actual operation of the spray equipment and application of the insulating material to the designated surfaces was accomplished by a commercial insulation company. The operation of the spray equipment is not difficult and very good control of layer thickness as the foam expands can be maintained. Care must be taken however, to avoid covering the fairing strips or other surfaces to which the protective sheeting will be attached. The taping of the fairing strips etc., with a heavy duty tape such as duct tape will greatly facilitate the removal of any accidental overspray, common masking tape is not heavy enough for this purpose.

The trimming of excess material on or around the fairing strips and other bearing surfaces was accomplished with a rotating air knife. Also a common draw knife and butcher knife will be required in close quarters.

The trimming and smoothing operation is time consuming and tedious. Care must be taken to assure that all areas are smooth and level. This is an important requirement to obtain a proper and tight fit of the sheathing material.

The insulation spraying and trimming required three days, two men full time.

PHASE III - Sealing Off and Painting

The entire insulated hold area was sheeted with galvanized sheet metal. Particular attention was given to adequate fastening and the water proofing of all seams, overlaps and joints.

The load bearing portions of the fish holds, ice bunker and the companionway was covered with 22 guage sheet metal. All joints and seams were sealed with a silicone sealing compound (equivalent DuPont 101) to provide a water tight joint and prevent damage to the insulating material. This is an important step and must be carefully done. The sheet metal was overlapped 1½ inches and fastened to the fairing strips or other supporting members with #10 pan head cadmium plated screws.

The inner hull surfaces, above the second knuckle, and all overheads were fitted with 24 guage metal and sealed and fastened as described above.

The sheeting operation was the most difficult of the entire project. Careful prior planning is necessary to minimize the number of seams and material waste. A light duty sheet metal brake, if available, would be a welcome tool during this phase. However, an adequate bending frame can be constructed of 2" angle iron mounted on two sturdy sawhorses.

The painting and finishing of the insulated areas consisted of the application of a metal etching agent to condition the metal surface to receive and retain paint. During the application of the etching solution adequate ventilation must be maintained and protective gloves worn. Personnel must also be cautioned to carefully apply the solution to avoid splashing on exposed skin surfaces or into eyes. Most good etching agents have a very short pot life and should not be activated or opened until ready for use.

One coat of white base paint followed by a white enamel finish coat concluded the work on the vessel.

All metal sheathing work required four days two men full time, painting and finishing work required three days two men half time. The total number of working days required to complete the project was fourteen while the total man days was twenty-five. The total cost of this project including labor was $1,610.00. The total square footage that was insulated

was 1,167.10 square feet. This results in a cost of approximately $1.38 per square foot of area insulated. For a break down of material cost and insulated areas see Appendix A and B.

PHASE IV - Performance and Economic Evaluation

To provide a realistic and comprehensive evaluation, four vessels of wood construction were selected for the study.

Vessel "A", "Edna Faye", the project vessel, wood construction, 83 foot, sprayed in-place polyurethane foam, sheet metal lined.

Vessel "B", "Kirby Allen", wood construction, 60 feet, totally uninsulated other than double hull construction. (Furnished supporting comparative data.)

Vessel "C", "Miss Hattie", wood construction, 65 feet, block styrofoam insulation five years old, sheeted out with plywood.

Vessel "D", "Swallow", wood construction, 65 feet, totally uninsulated, single hull construction.

Vessels A, C and D supplied concurrent temperatures, ice consumption and landed product data. (See Appendix C-1 and 2). Also, the cost of ice per vessel for the survey period was compiled. The ice cost information was related to the amount of rough and headed shrimp landed.

The information taken from 1970 records, concerning Vessel B, (Appendix C-1) was included to broaden the comparative base. This vessel was owned and operated by the captain of the project vessel, Vessel A during the 1970 season.

D. CONCLUSIONS

From the survey data obtained (Appendix C-1) the insulating material as installed maintained the low temperatures required of a refrigerated atmosphere.

The temperatures maintained had the following effects:

1. The more efficient utilization of ice by reducing the melt rate both in the ice holding bunker and on the shrimp in the fish holds. The "Edna Faye" - Vessel A, used 32.5% less ice per 100# of shrimp tails than the "Miss Hattie" - Vessel B, during the same fishing period. This resulted in a direct savings of $256.00 for 25,800 pounds of shrimp tails marketed. The "Miss Hattie" was insulated with block styrofoam, evidently a less effective insulating material than sprayed in-place polyurethane foam. The complete filling of voids with the sprayed in-place product thus eliminating hot spots along the inner hull could be the principal reason for higher efficiency.

Like comparisons made between Vessel A - "Edna Faye" and Vessel D - "Swallow" an uninsulated vessel indicated that Vessel A consumed 67% less ice per 100# of shrimp tails than Vessel D during the same fishing period. This resulted in a direct savings of $1,032.00 for 25,800 pounds of shrimp tails marketed.

It should be noted that the evaluation was conducted over a three month period only and are not representative of the possible total annual savings. However the time period used was the most critical as far as ice consumption is concerned for a North Carolina fishing vessel. Also, since Vessel A was a totally uninsulated vessel prior to this project, all the above comparisons are valid and can be considered real savings in operating cost. A graphical display of the data accumulated, from the four vessels, can be found in Appendix D-1 and 2.

2. A higher quality product landed was also a very apparent result. Particular attention was paid to this portion of the evaluation by staff personnel. A very circumspect examination of shrimp landed by all of the vessels involved was conducted. The shrimp landed by Vessel A was superior in all cases to the other vessels. The greatest difference of course was between Vessel A and D. The captain of Vessel A - "Edna Faye" reported at

the end of the shrimping season that, his shrimp retained their weight, due to the quick chilling, and ran 10 to 15% heavier than any he had landed prior to this season.

3. That since the requirement for ice on/under the product is reduced, icing techniques will have to be modified to accommodate the colder hull conditions. If the insulation job is well done it may be necessary to spray water on the product to stimulate ice melt which will prevent freeze burn or product discoloration.

4. The use of sprayed in-place polyurethane foam has other distinct advantages i.e., ease of installation, readily used on any shaped surface to include areas impossible to reach with a roll or block formed product, and it increases the structural strength of the surface to which applied. The insulating method employed is pictorially described in Appendix E.

E. RECOMMENDATIONS

1. That vessels engaged in commercial fishing requiring the capability of refrigerated storage can be insulatec advantagecusly with sprayed in-place polyurethane foam.

2. That the use of well sealed exterior plywood be considered as a sheathing material, also portland cement, and fiber glass should be considered. However, the use of either cement or fiber glass will normally not be within the capability of the vessel crew or reacily available local help.

APPENDIX A

## VESSEL INSULATION PROJECT COST SHEET

| | | |
|---|---|---|
| Insulating Material | | $ 256.18 |
| Sheet Metal | | 450.24 |
| Metal Etching Agent | | 4.68 |
| Paint | | 30.00 |
| Salt Treated Lumber | | 91.75 |
| Hardware (Nails, Screws, Brushes) | | 17.55 |
| Air Compressor Rental | | 25.00 |
| | TOTAL | $ 875.40 |
| Labor Cost: 14 Working Days or 25 Man Days | | $ 734.60 |
| | TOTAL | $1,610.00 |

APPENDIX B

AREAS INSULATED

| | | | |
|---|---|---|---|
| 1. Ice Bunker | | | |
| Bulkheads | (18'7" x 6'9½") x 2 | = | 252.10 sq. ft. |
| Overhead | 18'7" x 7'6" | = | 126.30 sq. ft. |
| | stringer surface | | - 45.00 sq. ft. |
| Floor | 18'7" x 7'6" | = | 126.30 sq. ft. |
| Walls | ( 7'6" x 7' ) x 2 | = | 99.00 sq. ft. |
| | | TOTAL #1 | 558.70 sq. ft. |
| 2. Fish Holds | | | |
| Walls | ( 4'2" x 6' ) x 6 | = | 150.00 sq. ft. |
| Floor | ( 4'2" x 4'3½")x 6 | = | 106.20 sq. ft. |
| Overhead | ( 4'2" x 6'8") x 6 | = | 166.00 sq. ft. |
| | | TOTAL #2 | 422.20 sq. ft. |
| 3. Aft Bulkhead | 18'7" x 6'9½" | = | 126.00 sq. ft. |
| | | TOTAL #3 | 126.00 sq. ft. |
| 4. Companionway | | | |
| Overhead | 4'4½" x 9'5" | = | 41.20 sq. ft. |
| Hatch | 4'4" x 4'5" | = | 19.00 sq. ft. |
| | | TOTAL #4 | 60.20 sq. ft. |
| | | TOTAL | 1,167.10 sq. ft. |

APPENDIX C

COMPARATIVE SUMMARY OF ICE COSTS PER 100 POUNDS
OF SHRIMP LANDED AND HOLD TEMPERATURES

Vessel (A) EDNA FAYE 1971

| Period 1971 | Cost of Ice Per 100# Rough | Cost of Ice Per 100# Tails | Boxes Rough | Boxes Tails | Average Ambient Temp. | Ice Bunker Temp. | Fish Hold Temp. | Companion Way Temp. |
|---|---|---|---|---|---|---|---|---|
| 12-15 Jul | $1.47 | $2.24 | 38 | 25 | 83 | 52 | 54 | 58 |
| 19-22 Jul | 1.87 | 2.80 | 45 | 30 | 78 | 46 | 45 | 54 |
| 26-30 Jul | 1.15 | 1.76 | 52 | 34 | 81 | 44 | 51 | 54 |
| 2-6 Aug | 1.06 | 1.52 | 72 | 50 | 83 | 45 | 49 | 51 |
| 9-11 Aug | 1.29 | 1.94 | 54 | 36 | 87 | 43 | 51 | 53 |
| 16-20 Aug | 1.62 | 2.45 | 47 | 31 | 79 | 46 | 49 | 54 |
| 23-26 Aug | 1.32 | 2.00 | 38 | 25 | 79 | 47 | 54 | 58 |
| 30-3 Sep | 1.61 | 2.44 | 41 | 27 | 85 | 46 | 51 | 55 |
| Avg. Cost | $1.42 | $2.14 | | | | | | |

Vessel (B) KIRBY ALLEN 1970

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Jul | $3.29 | $4.94 | 14 | 9.3 | 91 | -- | -- | -- |
| Jul | 3.13 | 4.63 | 16 | 10.8 | 88 | -- | -- | -- |
| Jul | 1.60 | 2.42 | 25 | 16.5 | 92 | -- | -- | -- |
| Aug | 1.80 | 2.57 | 28 | 18.6 | 92 | -- | -- | -- |
| --- | ---- | ---- | -- | ---- | -- | -- | -- | -- |
| Aug | 2.77 | 4.11 | 18 | 12.1 | 89 | -- | -- | -- |
| Aug | 1.41 | 2.11 | 17 | 11.1 | 84 | -- | -- | -- |
| Sep | 1.90 | 2.85 | 21 | 14 | 91 | -- | -- | -- |
| Avg. Cost | $2.27 | $3.36 | | | | | | |

Vessel (C) MISS HATTIE 1971

| Period 1971 | Cost of Ice Per 100# Rough | Cost of Ice Per 100# Tails | Boxes Rough | Boxes Tails | Average Ambient Temp. | Ice Bunker Temp. | Fish Hold Temp. | Companion Way Temp. |
|---|---|---|---|---|---|---|---|---|
| 2-6 Aug | $2.68 | $3.66 | 41 | 30 | 83 | 46 | 42 | 64 |
| 9-11 Aug | 1.55 | 2.43 | 58 | 37 | 87 | 41 | 41 | 61 |
| 16-20 Aug | 2.58 | 4.00 | 31 | 20 | 77 | 41 | 44 | 62 |
| 23-26 Aug | 1.85 | 2.53 | 41 | 30 | 79 | 50 | 40 | 63 |
| Avg. Cost | $2.16 | $3.16 | | | | | | |

Vessel (D) SWALLOW 1971

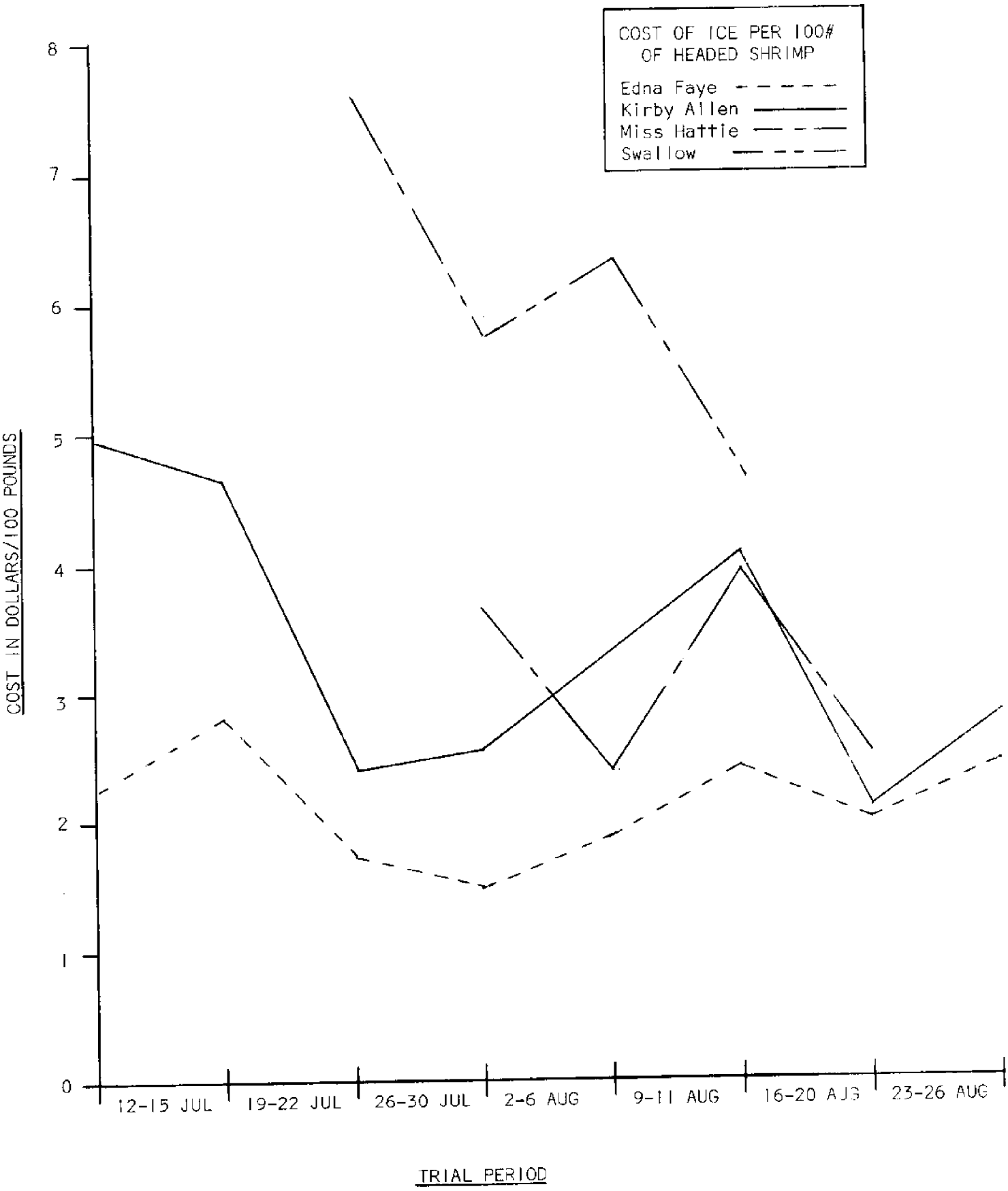
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 26-29 Jul | $5.08 | $7.63 | 24 | 16 | 81 | 69 | 66 | -- |
| 31-4 Aug | 3.77 | 5.74 | 35 | 23 | 83 | 65 | 72 | -- |
| 9-11 Aug | 4.25 | 6.38 | 24 | 16 | 87 | 58 | 73 | 75 |
| 14-16 Aug | 3.05 | 4.57 | 21 | 14 | 75 | 57 | 71 | 76 |
| Avg. Cost | $4.04 | $6.08 | | | | | | |

OVERALL SUMMARY

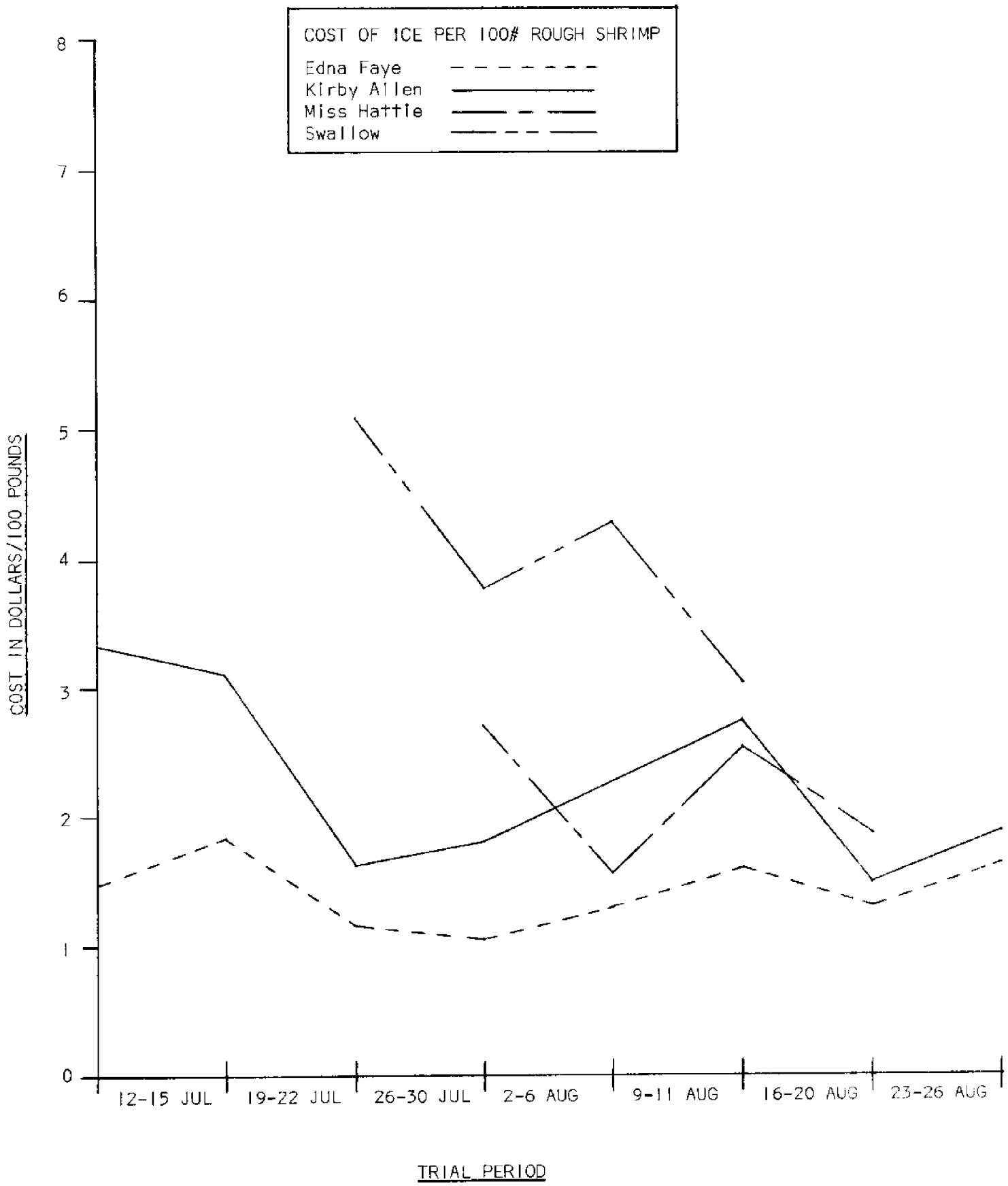
| | Lbs. Shrimp Tails | Cost of Ice | Ice Cost Per 100 lbs. Tails |
|---|---|---|---|
| Edna Faye (A) | 25,800 | $534.00 | $2.07 |
| Kirby Allen (B) | 9,250 | 300.00 | 3.24 |
| Miss Hattie (C) | 11,700 | 356.00 | 3.04 |
| Swallow (D) | 6,900 | 420.00 | 6.08 |

NOTE: Cost of ice per 100 pounds is the same for each vessel.

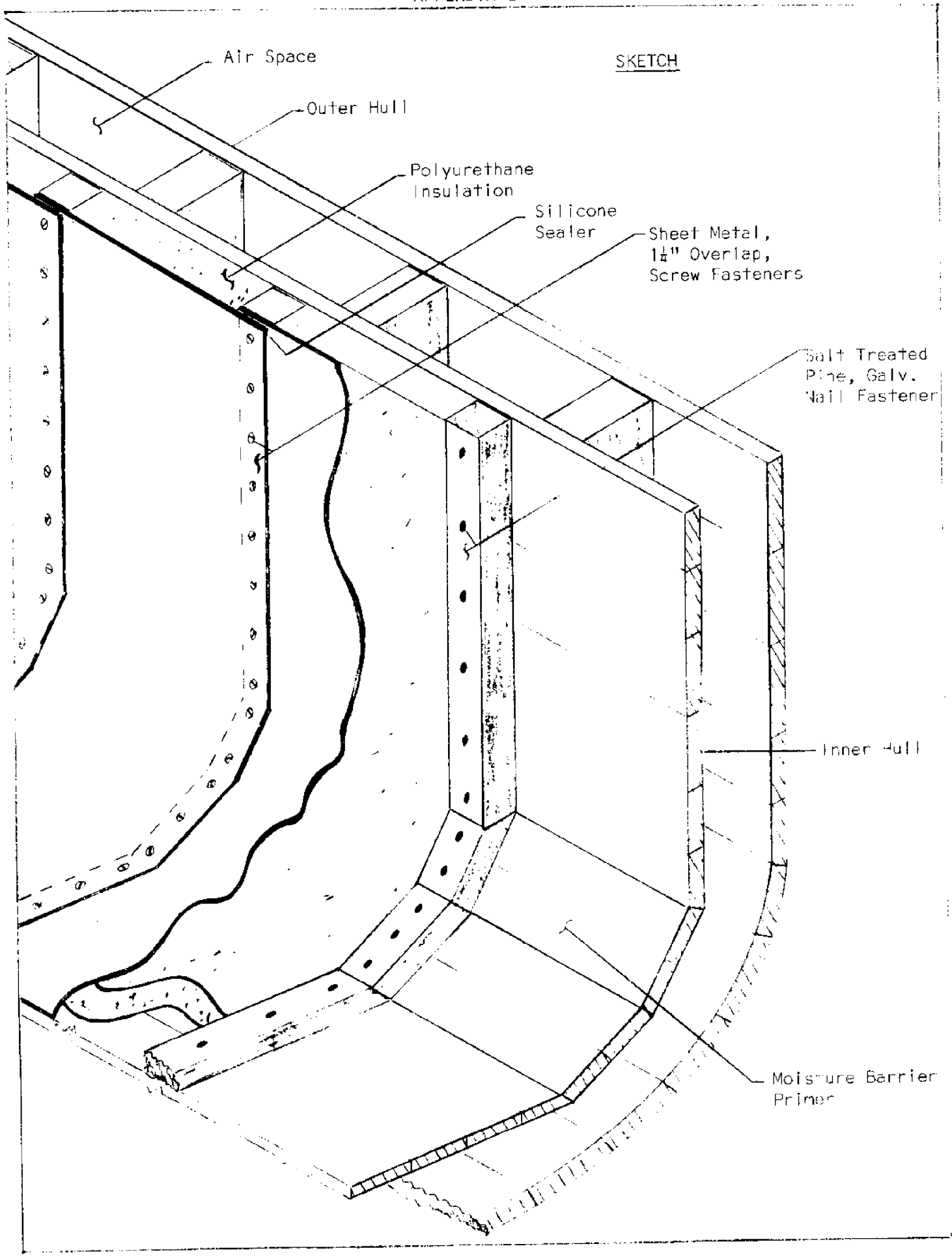
APPENDIX D-1


COST OF ICE PER 100# OF HEADED SHRIMP
Edna Faye
Kirby Allen
Miss Hattie
Swallow
COST IN DOLLARS/100 POUNDS
0
1
2
3
4
5
6
7
8
12-15 JUL
19-22 JUL
26-30 JUL
2-6 AUG
9-11 AUG
16-20 AUG
23-26 AUG
TRIAL PERIOD

APPENDIX D-2


COST OF ICE PER 100# ROUGH SHRIMP
Edna Faye
Kirby Allen
Miss Hattie
Swallow
8
7
6
5
4
3
2
1
0
COST IN DOLLARS/100 POUNDS
12-15 JUL
19-22 JUL
26-30 JUL
2-6 AUG
9-11 AUG
16-20 AUG
23-26 AUG
TRIAL PERIOD

APPENDIX E


SKETCH
Air Space
Outer Hull
Polyurethane Insulation
Silicone Sealer
Sheet Metal, 1¼" Overlap, Screw Fasteners
Salt Treated Pine, Galv. Nail Fastener
Inner Hull
Moisture Barrier Primer

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* Available from: Sea Grant Program, School of Public Health, University of North Carolina, Chapel Hill, N. C. 27514.