

MORAE-MANNING TEST  
TRAINING MANUAL

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Prepared for:

Alaska Fisheries Development Foundation, Inc.  
508 West Second Avenue, Suite 212  
Anchorage, Alaska 99501  
(907) 276-7315

by

Lorelie Biggs McRae  
2617 East La Madera  
Tucson, Arizona 85716  
(602) 881-1469

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Solution concentration. It is necessary to have enough thickening to measure gel strength, but to avoid actual gels forming. In order to obtain the desired viscosity, it may be necessary to adjust the concentration or the cooling temperature. If the solution is too thin, increase the concentration. It would not help to lower cooling temperatures when they are already so low. If the solution is too thick, lower the concentration or raise the cooling temperature.

Number of syringes used. It is suggested that three syringes are used for each sample, but this number could be altered. It more speed in completing the test is desired, the sample could be evaluated at only one or two of the recommended temperatures. If surimi of low gel strength is being tested, it may be desirable to eliminate evaluation at 8 C. On the other hand, if the gel strength is very high, it may be desirable to eliminate testing at 3 C.

#### AREAS OF POSSIBLE MODIFICATION

TABLE OF CONTENTS

Page

1	INTRODUCTION . . . . .	1
2	EQUIPMENT . . . . .	2
2	Transparent Sheets . . . . .	2
2	Plexiglass . . . . .	2
2	Elevation Board . . . . .	2
3	Syringes . . . . .	3
5	TEST PROCEDURE . . . . .	5
9	QUICK REFERENCE . . . . .	9
10	FACTORS EFFECTING RESULTS . . . . .	10
10	Temperature . . . . .	10
10	Heating Temperature . . . . .	10
10	Cooling Temperature . . . . .	10
10	Sample Temperature . . . . .	10
11	Laboratory Temperature . . . . .	11
11	Water Temperature . . . . .	11
11	Freezing . . . . .	11
12	6. AREAS OF POSSIBLE MODIFICATION . . . . .	12
12	Number of syringes used . . . . .	12
12	Solution concentration . . . . .	12

It is believed that surimi loses gel strength with storage time. Longer a sample is frozen, the more the gel strength deteriorates. The temperature that the surimi is held at also effects gel strength.

#### FREEZING:

The distilled water was at room temperature so the lab temperature effected the water temperature which, in turn, effected the temperature of the solution before heating. These were factors that were kept in mind when employing this test.

#### B. Water Temperature:

It was observed that gel strengths tended to be slightly higher in the morning than results from the afternoon of the same day. No definite explanation was available, but a possible theory was that the air temperature effected results. As stated previously, sample temperature was very critical. The air temperature and the time used in testing would both influence the amount of equalization that occurred between the air and the sample which would in turn effect final result. (Tests were not done in a controlled temperature lab.)

#### D. Laboratory Temperature:

The temperature of the "temperature syringe" and the actual syringe being evaluated varied as much as 1-2 C which caused considerable variance in the final results. This difference that occurred with slight variances in the temperature made the original method of monitoring temperature unacceptable. For 5% solutions, placing the mercury-in-glass thermometer directly in the syringe to be tested did not effect thickening of the supernatant.

Originally, temperature was monitored by placing a mercury-in-glass thermometer in one syringe which was designated the "temperature syringe". The remaining syringes were used for testing. This method, however, required making the assumption that all the syringes cooled at the same rate.

Exact temperature readings were necessary due to the effects of temperature on final results. Even 1 degree centigrade had significant effects on results.

## INTRODUCTION

The McKae-Hanning test was developed in order to provide a means of obtaining a quick estimation of gel strength. It was not, however, intended to replace the accuracy of the punch test.

By using the McKae-Hanning test, estimations of gel strength can be made in less than an hour. It can be used to predict higher or lower than normal gel strengths and differentiate between grade one and grade two.

The McKae-Hanning test can be used on a single lot of surimi at one time, or surimi from two or more lots can be mixed. Results from mixed surimi reflect an additive effect with results being between the results from the samples when tested separately.

The temperature of the sample varied within an individual syringe. As it cooled, the outer edges were about one half to one degree centigrade cooler than the interior. For testing, it was necessary to stir the sample slightly before reading the temperature in order to get more uniform results.

### C. Sample Temperature:

It was important to test at the precise temperature. Even a few degrees higher or lower made a considerable difference as was evident from the difference between samples when cooled to 8 C, 5 C, and 3 C. (see table 1) The temperature range was desirable because it was easy to miss the correct temperature. If this occurred, there would still be accurate results from two other temperatures. There was a high correlation between results from the three temperatures.

After the gels were prepared and removed from the water bath, they were cooled in an ice bath. The cooling temperature was a very important factor that was carefully monitored in these tests. As it cooled, the supernate thickened considerably. Even the highest quality surimi measured as low quality when samples were tested without cooling. From 90 C to 20 C very little gelling was noticed, but as it continued to cool, thickening occurred. Samples were cooled to a range from 3-8 C. This lower temperature range was used because the temperature was changing less rapidly than at 20-90 C making it easier to test at the precise temperature desired.

### B. Cooling Temperature:

A. Heating Temperature. The temperature of heating was very influential. Optimum heating occurred at 90 C. The water bath was heated to this temperature before the samples were placed in. If the temperature in the hot water bath was initially decreased to 80 C and allowed to heat to 90 C during the 20 minute cook time, gel thickness was considerably decreased. (ie. A 6% solution of high quality surimi ran off the sheet in an average of 1 minute 32 seconds when cooled to 5 C. It took only 5 seconds, however when heating began at 80 C rather than 90 C.)

One of the most critical factors was the temperature. Heating temperature, cooling temperature, and air temperature all affected final results.

### TEMPERATURE:

## FACTORS AFFECTING RESULTS

## EQUIPMENT

For the McRae-Hanning test, basic lab equipment is used. The following will be needed:

weighing trays  
A scale with an accuracy of .01 grams  
A blender and container  
Microspatulas  
Distilled water  
Thermometers  
Volumetric flask  
5 ml pipette  
Water bath  
Ice  
Stop watch

In addition, the following pieces of equipment must be prepared:

### A. Transparent sheets:

Transparent sheets were prepared as follows: Nashua xerographic transparencies XF-10 for use in plain paper copiers were obtained (Nashua, New Hampshire). Starting from a central point in the middle of the transparency, circles were drawn with a compass. The first circle had a radius of 1 cm. The next circle had the same center point and a radius of 2 cm. Each additional circle had the same center point and increased in radius by 1 cm. There were 11 circles in all with radii of 1-11 cm (See Figure 1).

### B. Plexiglass circles:

A piece of 1/4 inch thick plexiglass was cut into a 10 inch diameter circle. A "circle sheet" transparency as previously prepared with 11 circles was attached to the bottom of the plexiglass followed by a tan piece of contact paper. The purpose of the contact paper was to make the circles more visible.

The plexiglass provides a stiff smooth surface that can easily be inclined at one end and has no gulfs or raised portions to impede the natural flow of the surimi down the sheet.

### C. Elevation Board:

An "elevation board" was created by obtaining a board approximately 12 inch square and 1/2 inch thick. Two nails were spaced at equal intervals across one side of the board. The first nail was put in with 2 cm of its length remaining above the surface of the board and the second with 1 cm.

### QUICK REFERENCE OUTLINE

1. Weigh out 5 grams of partially frozen surimi.
2. Put the surimi in the blender.
3. Add 95 ml of distilled water.
4. Break apart surimi until all pieces are less than 1 cm in length.
5. Blend for 10 seconds.
6. Shake container.
7. Repeat steps 5 and 6 two times.
8. Put 10.5 grams of solution in each of 3 syringes.
9. Heat syringes for 20 min. in a 90 C water bath.
10. Remove syringes from water bath and place in an ice bath to cool.
11. When the solution in a syringe is 8 C, remove from the ice bath and evaluate in the following manner:
  - a. Invert syringe over circle sheet.
  - b. Use the black stopper in the bottom of the syringe to gently push out any sample that does not pour out on its own.
  - c. Record the spread of the sample on the circle sheet.
  - d. Identify the point of greatest spread.
  - e. Incline the edge of the circle sheet across from the point of greatest spread 2 cm.
  - f. Allow the supernate to run off the 11 cm sheet.
  - g. Record the time taken to run off the sheet.
12. When the solution in the second syringe is 5 C, remove from the ice bath and evaluate following steps 11a-g.
13. When the solution in the third syringe is 3 C, remove it from the ice bath and evaluate following steps 11 a-g.

20 cc plastic syringes are used. The syringes are cut off at the cc mark and the needle end is discarded. The solution should not come to the top of the syringe. This will allow the syringe to be placed in the water bath and ice bath up to the surimi level without having ice or water enter the syringe and ruin the sample. (Figure 2)

D. SYRINGES:

The elevation board was used to incline the plexiglass by placing one edge of the glass on the head of the nail that was the desired height and allowing the opposite edge to remain on the board. (Figure 1)

Table 1 Correlating McKae-Handing test with punch test.  
 LOT 8 C      ele 8 C      5 C      3 C      punch/s.d.  
 Temp.

LOT	ele	8 C	5 C	3 C	punch/s.d.	Temp.
1	1	1:54	3:52	5:34	745/60	25.5
2	1	0:24	0:47	2:09	561/75	
3	1	0:13	0:20	1:20	771/93	24.0
4	1	2:21	--	6:09	735/39	25.0
5	1/2	2:30/:26	2:30/1:42	3:00/2:58	1026/174	24.0
6	1/2	1:00	2:30/:06	3:00/:21	807/156	25.0
7	1/2	1:03	2:20	3:00/:20	857/100	25.0
8	1/2	0:44	1:50	3:00/1:02	718/177	25.0
9	1/2	0:49	--	--	741/87	25.0
10	1/2	2:00/:14	2:30/:49	3:00/1:42	592/178	25.0
11	1/2	0:39	2:30/1:16	3:00/:55	692/73	26.0
13	1/2	2:00/:10	2:30/:53	3:00/1:13	949/97	27.0
17	1/2	1:23	2:30/:11	0:00/1:41	555/63	28.0
18	2	--	0:59	4:33	640/110	26.0
19	2	0:33	1:20	3:26	702/106	25.0
20	2	0:54	2:34	4:00	766/96	25.5
23	2	0:23	1:13	1:36	703/74	27.0
24	2	1:02	1:51	2:03	812/122	26.0
25	2	0:24	1:02	1:41	675/87	25.5
26	2	1:09	2:28	4:33	997/316	25.5
27	2	0:15	1:36	2:01	771/181	25.0
28	1	0:08	0:22	0:35	421/72	25.5
29	1	0:31	1:36	1:58	543/128	27.5

ele = elevation in cm  
 Temp. = temperature in C  
 s d = standard deviation  
 1/2 = 1 cm and then 2 cm

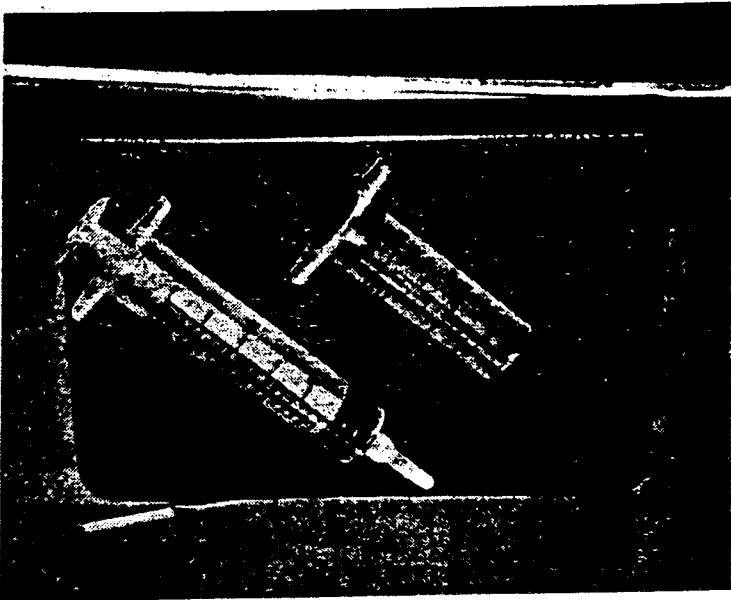


Figure 2 Modified syringe and normal syringe

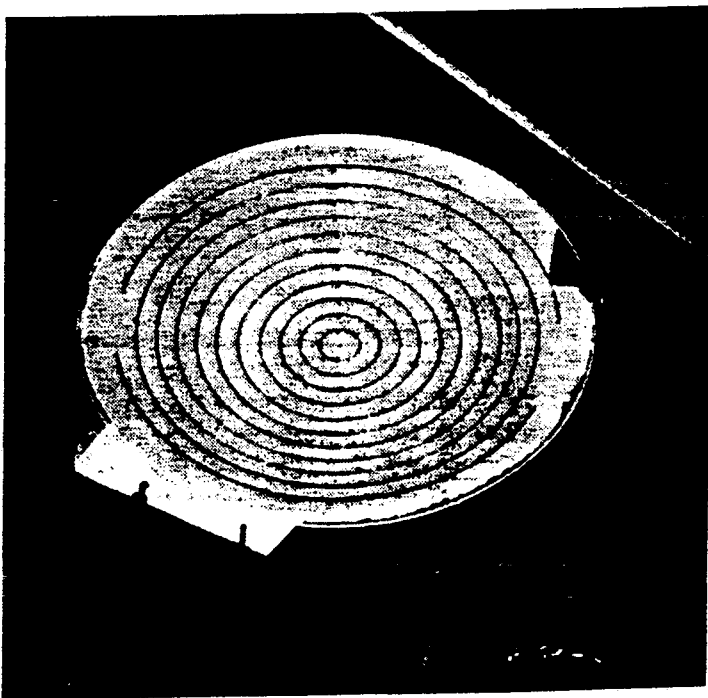


Figure 1 Plexiglass Circle Sheet on Elevation Board

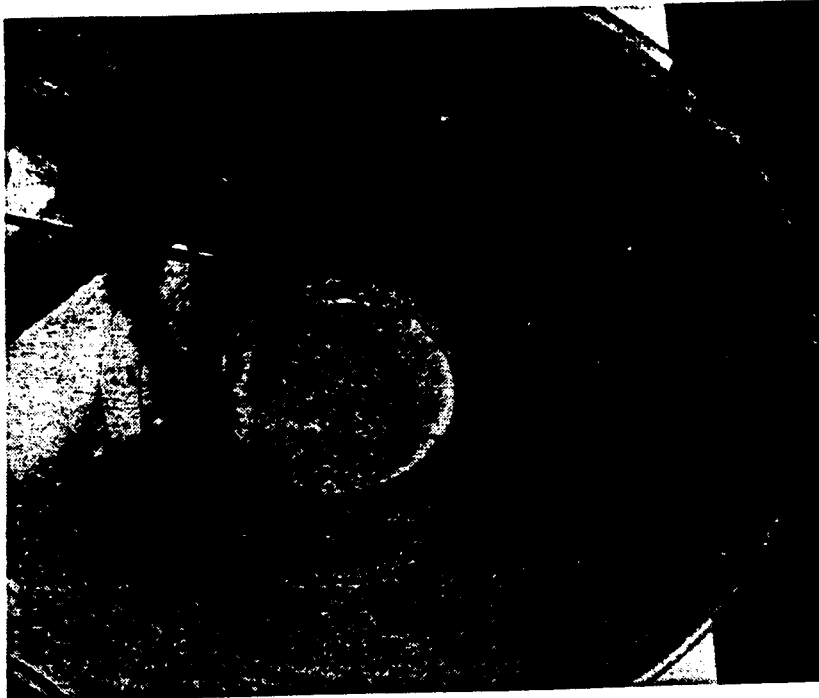


Figure 4 The Point of Greatest Spread on Circle Sheet Identified.

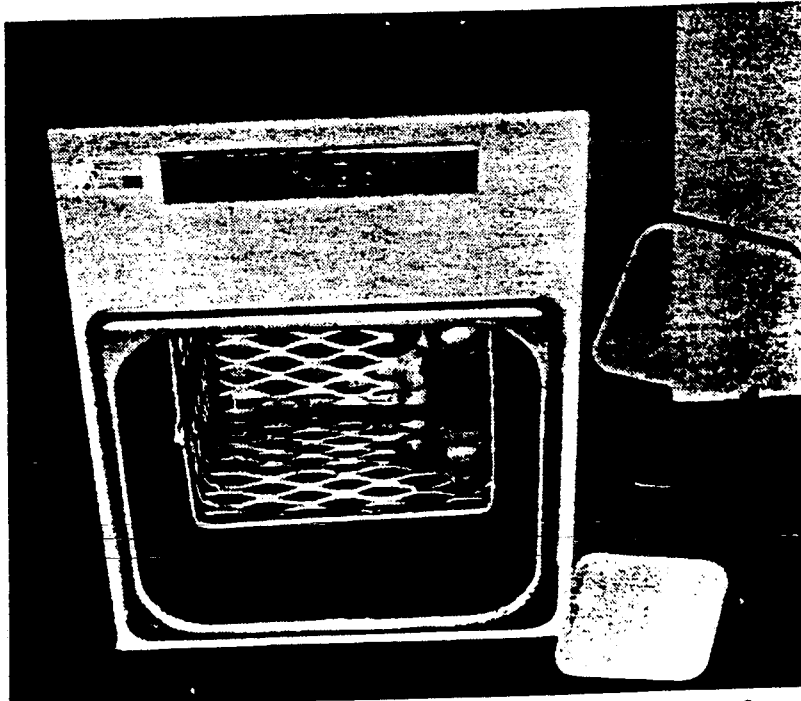


Figure 3 Syringes in Carrier in Hot Water Bath.

When surimi is mixed with water and heated, a white coagulum separates from a clear to opaque supernate. The McKae-Hanning test focuses on the supernate using it to estimate gel strengths. The supernates range in thickness from a watery liquid to a firm gel that retains the shape of the heating container. The thinner the supernate, the more it will run and spread when removed from the tube. (Results would be similar to dumping out a glass of water compared to dumping out a glass of pudding.) It is desirable to have thickening, but no gelation. Once gelation occurs, the sample will slide down the sheet as a solid mass with spreading which makes interpretation of results impossible.

For the McKae-Hanning test, 5% surimi solutions are used. These solutions are mixed by weighing out 5 grams of surimi and blending it with 95 ml of distilled water. A single speed commercial Waring blender 700 with a 250 ml stainless steel mini container work well for this step. In order to decrease the incorporation of air into the solution, it is mixed for 10 seconds. Then, the container is removed from the blender base and shaken upside down 2-3 times. This helps return any unmixed clumps to the solution that were expelled during blending. This sequence of alternately blending and shaking the solution is done three times.

After mixing is complete, 10.5 grams of solution is poured into each of three specially prepared syringes (for instructions see pg 3 of this manual). Pouring a measured weight of solution into each syringe will help eliminate any variance that is due to the incorporation of during mixing.

After the syringes were filled, they were placed uncovered in a 90 C AVR water bath (Model 1210, Phoenix, AZ) for 20 min. Syringes were stabilized in a "carrier" before putting them in the water bath. This helped eliminate sample loss due to tipped syringes. (Figure 3)

After the heating was completed, the syringes were removed from the water bath and placed in a tray of ice to cool. The level of the ice was below the top of the syringes to insure that ice did not enter into the syringes during cooling and alter results. Adding some water to the ice bath increased the rate of cooling. It was very important to monitor the temperature during cooling, because even a few degrees significantly alter the results. Therefore, a mercury-in-glass thermometer was placed in the syringe to be tested. When it indicated that the solution had cooled to the desired temperature, the solution was stirred briefly with the thermometer, and the thermometer was placed at the center of the syringe. If the solution at the center of the syringe was the desired temperature, it was removed from the ice bath for evaluation. If not, the syringe was left in the ice bath until the solution reached the desired

## TEST PROCEDURE

temperature. Due to the viscosity of the solution, the outer edges of the syringe cooled more quickly than the solution at the center. This was why the solution was stirred before reading the final temperature. The first syringe was cooled to 8 C, the second to 5 C and the third to 3 C.

When the solution had cooled to the desired temperature, the syringe was removed from the ice bath, inverted over the center of the circle sheet and the contents were allowed to pour onto the sheet. The point of greatest spread (the most cm from the center) was identified (Figure 4) and the opposite edge of the sheet was inclined 1-2 cm. The rate of spread down the sheet was timed and readings were taken every 15 seconds until the sample ran off the sheet. (Note: It was necessary to make sure the circle sheet was completely dry before using it. If there were wet spots on the sheet, the sample would run too quickly when it hit them giving false results.)

The plexiglass was inclined 1 or 2 cm depending on the concentration and quality of the surimi. Some preliminary tests were done at higher concentrations ranging as high as 15%. For the higher concentrations, elevations of 2 cm and 6.5 cm. were used.

To date, there is no industry definition for grade one surimi verses grade two. Defining each grade is left to the surimi manufacturers. The following table, however, can be used as a guide in correlating the rate of spread with the punch test.

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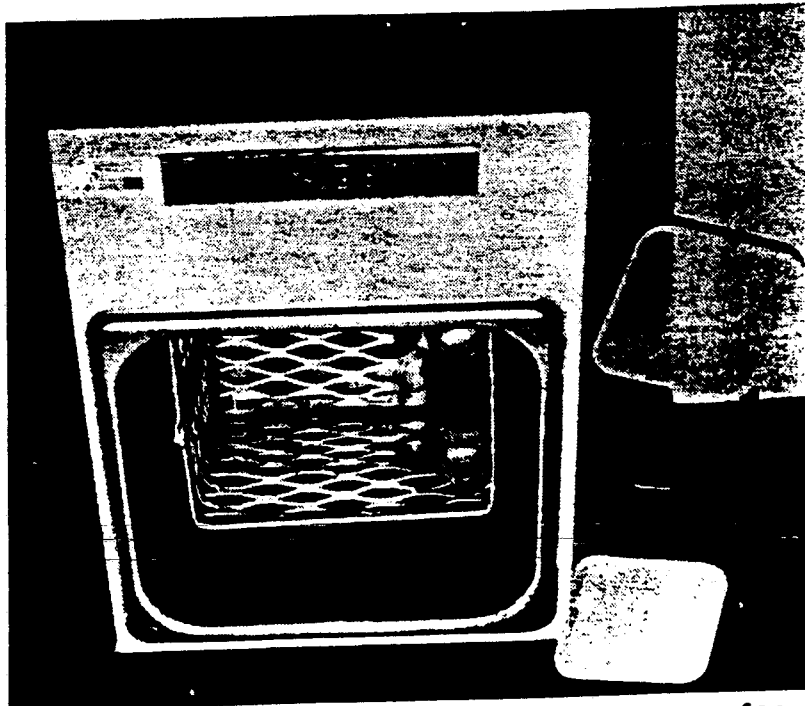


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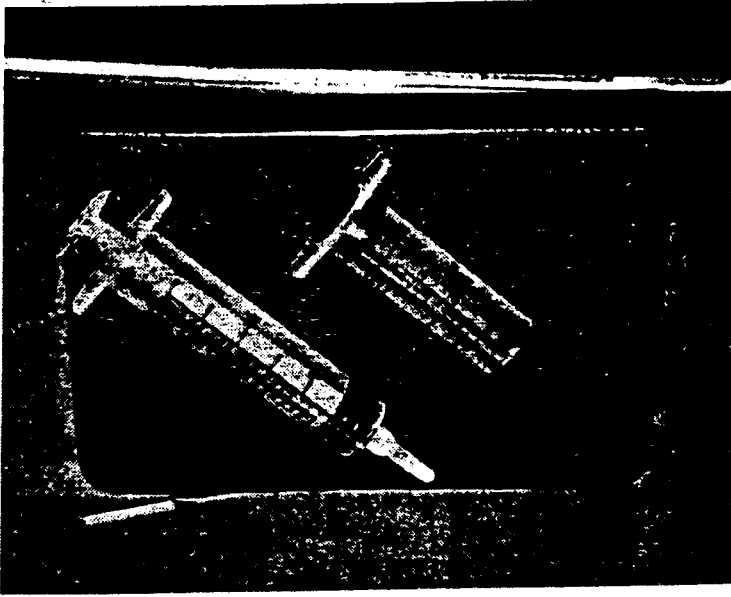


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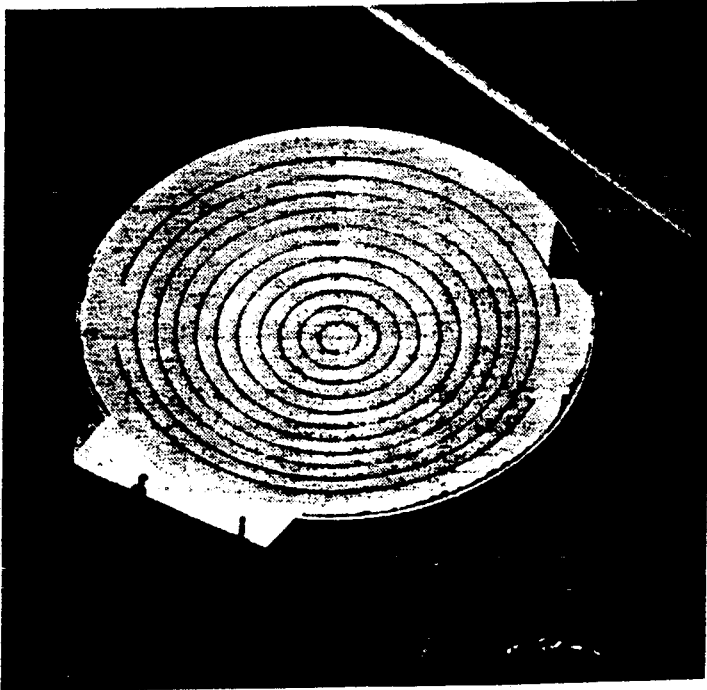


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6	1:00	2:30/:06	3:00/:21	807/156	25.0
7	1:03	2:20	3:00/:20	857/100	25.0
8	0:44	1:50	3:00/1:02	718/177	25.0
9	0:49	--	--	741/87	25.0
10	2:00/:14	2:30/:49	3:00/1:42	592/178	25.0
11	0:39	2:30/1:16	3:00/:55	692/73	26.0
13	2:00/:10	2:30/:53	3:00/1:13	949/97	27.0
17	1:23	2:30/:11	0:00/1:41	555/63	28.0
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19	0:33	1:20	3:26	702/106	25.0
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7. Repeat steps 5 and 6 two times.
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  - d. Identify the point of greatest spread.
  - e. Incline the edge of the circle sheet across from the point of greatest spread 2 cm.
  - f. Allow the supernate to run off the 11 cm sheet.
  - g. Record the time taken to run off the sheet.
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An "elevation board" was created by obtaining a board approximately 12 inch square and 1/2 inch thick. Two nails were spaced at equal intervals across one side of the board. The first nail was put in with 2 cm of its length remaining above the surface of the board and the second with 1 cm.

## FACTORS AFFECTING RESULTS

### TEMPERATURE:

One of the most critical factors was the temperature. Heating temperature, cooling temperature, and air temperature all affected final results.

A. Heating Temperature. The temperature of heating was very influential. Optimum heating occurred at 90 C. The water bath was heated to this temperature before the samples were placed in. If the temperature in the hot water bath was initially decreased to 80 C and allowed to heat to 90 C during the 20 minute cook time, gel thickness was considerably decreased. (i.e. A 6% solution of high quality surimi ran off the sheet in an average of 1 minute 32 seconds when cooled to 5 C. It took only 5 seconds, however when heating began at 80 C rather than 90 C.)

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It was important to test at the precise temperature. Even a few degrees higher or lower made a considerable difference as was evident from the difference between samples when cooled to 8 C, 5 C, and 3 C. (see table I) The temperature range was desirable because it was easy to miss the correct temperature. If this occurred, there would still be accurate results from two other temperatures. There was a high correlation between results from the three temperatures.

### C. Sample Temperature:

The temperature of the sample varied within an individual syringe. As it cooled, the outer edges were about one half to one degree centigrade cooler than the interior. For testing, it was necessary to stir the sample slightly before reading the temperature in order to get more uniform results.

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The McRae-Manning test was developed in order to provide a means of obtaining a quick estimation of gel strength. It was not, however, intended to replace the accuracy of the punch test.

By using the McRae-Manning test, estimations of gel strength can be made in less than an hour. It can be used to predict higher or lower than normal gel strengths and differentiate between grade one and grade two.

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Exact temperature readings were necessary due to the effects of temperature on final results. Even 1 degree centigrade had significant effects on results.

Originally, temperature was monitored by placing a mercury-in-glass thermometer in one syringe which was designated the "temperature syringe". The remaining syringes were used for testing. This method, however, required making the assumption that all the syringes cooled at the same rate.

The temperature of the "temperature syringe" and the actual syringe being evaluated varied as much as 1-2 C which caused considerable variance in the final results. This difference that occurred with slight variances in the temperature made the original method of monitoring temperature unacceptable. For 5% solutions, placing the mercury-in-glass thermometer directly in the syringe to be tested did not effect thickening of the supernatant.

#### D. Laboratory Temperature:

It was observed that gel strengths tended to be slightly higher in the morning than results from the afternoon of the same day. No definite explanation was available, but a possible theory was that the air temperature effected results. As stated previously, sample temperature was very critical. The air temperature and the time used in testing would both influence the amount of equalization that occurred between the air and the sample which would in turn effect final result. (Tests were not done in a controlled temperature lab.)

#### F. Water Temperature:

The distilled water was at room temperature so the lab effected the temperature of the solution before heating. These were factors that were kept in mind when employing this test.

#### FREEZING:

It is believed that surimi looses gel strength with storage time. longer a sample is frozen, the more the gel strength deteriorates. The temperature that the surimi is held at also effects gel strength.

TABLE OF CONTENTS

Page

1	INTRODUCTION . . . . .	1
2	EQUIPMENT . . . . .	2
2	Transparent Sheets . . . . .	2
2	Plexiglass . . . . .	2
2	Elevation Board . . . . .	2
3	Syringes . . . . .	3
5	TEST PROCEDURE . . . . .	5
9	QUICK REFERENCE . . . . .	9
10	FACTORS EFFECTING RESULTS . . . . .	10
10	Temperature . . . . .	10
10	Heating Temperature . . . . .	10
10	Cooling Temperature . . . . .	10
10	Sample Temperature . . . . .	10
11	Laboratory Temperature . . . . .	11
11	Water Temperature . . . . .	11
11	Freezing . . . . .	11
12	AREAS OF POSSIBLE MODIFICATION . . . . .	12
12	Number of syringes used . . . . .	12
12	Solution concentration . . . . .	12

Solution concentration. It is necessary to have enough thickening to measure gel strength, but to avoid actual gels forming. In order to obtain the desired viscosity, it may be necessary to adjust the concentration or the cooling temperature. If the solution is too thin, increase the concentration. It would not help to lower cooling temperatures when they are already so low. If the solution is too thick, lower the concentration or raise the cooling temperature.

Number of syringes used. It is suggested that three syringes are used for each sample, but this number could be altered. If more speed in completing the test is desired, the sample could be evaluated at only one or two of the recommended temperatures. If surimi of low gel strength is being tested, it may be desirable to eliminate evaluation at 8 C. On the other hand, if the gel strength is very high, it may be desirable to eliminate testing at 3 C.

#### AREAS OF POSSIBLE MODIFICATION

MORAE-MANNING TEST  
TRAINING MANUAL

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Prepared for:

Alaska Fisheries Development Foundation, Inc.  
508 West Second Avenue, Suite 212  
Anchorage, Alaska 99501  
(907) 276-7315

by

Lorelie Biggs McRae  
2617 East La Madera  
Tucson, Arizona 85716  
(602) 881-1469

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