UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CAROLINA POWER & LIGHT COMPANY	)	
AND NORTH CAROLINA EASTERN	)	Docket No. 50-400 OL
MUNICIPAL POWER AGENCY	)	
	)	
(Shearon Harris Nuclear Power Plant)	)	
	)	

AFFIDAVIT OF M.C. ADAMS ON EPJ-1

County of Wake	)	
	)	SS.
State of North Carolina	)	

M. C. Adams, being duly sworn, deposes and says:

1. I am M. C. Adams, Manager of Maintenance and Equipment Branch, Division of Highways, North Carolina Department of Transportation, Highway Building, Raleigh, North Carolina 27601.

2. I have been with the North Carolina Department of Transportation (NCDOT) for 22 1/2 years and in my current position for 4 1/2 years. As Manager of the Maintenance and Equipment Branch, I am responsible for overseeing and maintaining roadways throughout the state of North Carolina including Harnett, Wake, Chatham and Lee Counties. A statement of my experience and qualifications is attached hereto as Attachment 1.

3. Contention EPJ-1 states in pertinent part:

> Insufficient consideration has been given in the off-site emergency plans to the effects of severe snow and ice conditions on . . . capabilities to clear evacuation routes.

Specifically, it is stated:

> Section IV.E.8 of the State plan (at 50) is deficient because the State does not have enough snowplows in this area to effectively clear the roads of snow or ice in a reasonable amount of time.

4. The NCDOT is one of the primary response organizations listed in the North Carolina Emergency Response Plan (ERP). It is the responsibility of the NCDOT to keep roadways in our state clear of hazards. It is the purpose of my affidavit to demonstrate the road clearing capabilities of the NCDOT both within the plume exposure Emergency Planning Zone (EPZ) and on the evacuation routes outside that area.

5. Departmental policies, standard operating procedures, and general information regarding NCDOT snow removal operations are contained in "Maintenance Bulletin, Function 431, Snow & Ice Control" ("Maintenance Bulletin") attached hereto as Attachment 2. As indicated in the Affidavit of Brian D. McFeaters and in our Maintenance Bulletin at page 431-8, instances of adverse weather requiring snow or ice removal are relatively rare — occurring in the four counties within the EPZ on the average of two to three times per year. Snowfalls are not usually heavy but generally will meet the Intervenors' definition of "severe snow and ice conditions" as being "anything more than 1/2 inch of snow in a 24-hour period."

6. Prior to considering the specifics of snow removal in the event of an accident at the Shearon Harris Nuclear Power Plant, it should be kept in mind that the timing of any emergency situation at the plant in regard to the current weather conditions is very important. Only a few days, if any, during each year may require snow or ice removal. In addition, the NCDOT works closely with the National Weather Service to track all possible adverse weather conditions which may affect roadways in North Carolina. The Department stays abreast of all weather events through a National Oceanographic & Atmospheric Administration (NOAA) weather wire which transmits weather forecasts for each of North Carolina's seventeen weather zones to the Department's Central Office

located in Raleigh. Via computer terminals these forecasts can be simultaneously transmitted to each of the NCDOT's 35 district offices and 14 division offices.

7. Whenever a snow situation becomes imminent, at least a minimum crew is maintained at county DOT offices, and DOT vehicles for clearing roads are dispatched to pre-assigned points along major transportation routes where clearing is to begin. Thus, tandem trucks are scheduled to be in the field ready to salt the roads as snow first begins to fall. Should an accident take place at the Harris Plant while snow is falling, work would have already begun to salt and scrape the roads. This would be true whether the situation arose during normal working hours or after hours since DOT maintenance employees are always "on call" for such work.

8. The plume exposure EPZ contains portions of Harnett, Wake, Chatham and Lee Counties. The North Carolina Department of Transportation has a separate office in each of those counties. The responsibility for clearing roads within each county is under the jurisdiction of that county's DOT office, and equipment for snow and ice removal is maintained at each such office. In snow and ice removal operations, each county office follows procedures set forth by the Maintenance and Equipment Branch in Raleigh. (See, for example, the Departmental policies and standard operating procedures contained in Attachment 2.)

9. The following is a current listing of the NCDOT's snow-removal equipment in each of the four counties:

	Wake County (Raleigh)	Chatham County (Siler City)	Lee County (Sanford)	Harnett County (Lillington)
Tandem Trucks*	13	2	1	3
Motor Graders	12	6	2	6
Dump Trucks**	33	8	7	17

*Tandem trucks include plows and salt spreaders.
**Equipped with snow plows.

10. In the event of snow or ice, the NCDOT uses the above equipment to clear all state maintained roads in each of the four counties. This is normally done according to a

priority system whereby highways of the U.S. Interstate System and other four-lane divided highways are cleared first, followed by other primary routes, paved secondary routes, and finally unpaved secondary routes.

11. However, if an accident should take place at the Harris Plant during a snowfall, the NCDOT has already assigned 50 pieces of the above-listed snow plowing equipment to perform snow removal solely within the 10 mile EPZ and on primary evacuation routes outside the EPZ.

12. In addition, the entire EPZ and the primary evacuation routes outside the EPZ have been designated as a priority area for snow removal. Roads will not be cleared in a certain order but rather all routes will be cleared simultaneously.

13. Also, the DOT will begin plowing and salting immediately with tandem trucks. In this way, the snow will be cleared in the most expeditious manner possible, with the trucks plowing the snow in front while spreading salt behind.

14. The NCDOT has more than sufficient personnel to operate all the necessary equipment for snow and ice removal operations in the event of a Harris Plant emergency. Wake County has 95 snow removal personnel, Chatham County 50, Lee 21 and Harnett 51. In most instances, there will be two persons assigned to each snow plow for the priority clearing discussed above.

15. Employing these emergency procedures will greatly facilitate snow and ice removal and, accordingly, evacuation throughout the EPZ and on major routes outside the 10 mile zone. The 50 pieces of snow removal equipment constitute approximately one unit for each 12 miles of road. This ratio will enable the roads in the EPZ and major transportation routes outside the zone to be cleared within the following time frames:

Roads in Chatham County	-	4 hours
Roads in Lee County	-	4 hours
Roads in Wake County	-	3 hours
Roads in Harnett County	-	2.5 hours

This means that within a maximum of four hours, the roadway system of the entire EPZ and other major routes leading from the zone will have been cleared.

16. By use of the term "cleared," it is meant that every road within the 10 mile EPZ will be scraped once, and that primary U.S. and N.C. routes (including evacuation routes to the evacuation shelters) will be scraped twice.

17. These clearing times are based on an assumption of average snowfalls as discussed in the affidavit of Mr. Bryan McFeaters. These times are accurate for clearing up to 6 inches of fallen snow. However, if the weather is expected to be more severe or if the situation warrants, the equipment and manpower assigned to the priority clearing can easily be substantially increased.

18. In conclusion, the NCDOT is responsible for keeping the roadways in North Carolina clear of hazards — including snow and ice. If an emergency situation were to occur at the Harris Plant, its timing in relation to the status of any snow or ice storm would be important. However, because of the excellent communications between the National Weather Service and the NCDOT, the DOT is usually very well prepared for any adverse weather condition. In snow alert situations, the DOT has scheduled tandem trucks which include both plows and salt spreaders to be in the field ready to begin clearing operations as soon as snow begins to fall. For any plant emergency, the NCDOT has assigned 50 pieces of snow removal equipment and sufficient operating personnel to clear all evacuation routes and other state-maintained roads within the 10 mile EPZ and all major evacuation routes outside the EPZ. The NCDOT will have all those routes cleared (secondary routes scraped once, major U.S. and N.C. routes including primary evacuation routes outside the zone scraped twice) within a maximum of four hours. If more equipment and personnel are needed to meet this time limit, they will be made available.

This 6th day of December, 1984.

M. C. Adams
M. C. ADAMS

Sworn to and subscribed before me,

this 6th day December, 1984.

Notary Public

My Commission Expires: May 28, 1988

MORRIS CLIFTON ADAMS
BRANCH MANAGER-MAINTENANCE & EQUIPMENT BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS

EDUCATION: North Carolina State University - BSCE
June, 1951

PROFESSIONAL STATUS: Registered Professional Engineer - 1966
North Carolina

EXPERIENCE:

1951-1961 Worked as project engineer and general superintendent for highway contractors, constructing bridges and highways in Virginia, North Carolina, and South Carolina.

During 1953-1957 worked as field engineer for the Calcium Chloride Institute, Washington, D. C. This involved consultant work with highway departments in Tennessee, Virginia, West Virginia, and North Carolina developing methods, procedures, and specifications for the use of calcium chloride for snow removal operations.

1961-Present Working with the North Carolina Department of Transportation with construction engineer responsibilities (11 years) and maintenance and administrative responsibilities (12½ years). Current responsibilities include overall Statewide responsibility for management of bridge maintenance, highway maintenance, and equipment operations.

MAINTENANCE BULLETIN
FUNCTION 431
SNOW & ICE CONTROL

DEFINITION

Mobilization; removal of ice and snow from a roadway, bridge, drainage inlet or channel; placement and removal of deicing chemicals or abrasives; removal of trees and limbs as a result of snow and ice. Installation, maintenance, or removal of snow fences; also includes the cost of equipment calibration and "dry runs". All work accomplished is reported in units of man hours.

OBJECTIVES

Insofar as possible and practical, it is the objective of all snow and ice removal activities to:

(1) keep traffic moving;
(2) keep commerce and industry going at a near normal pace;
(3) reduce the possibility of accidents, injuries, and deaths; and
(4) provide near normal movement of emergency vehicles such as ambulances, fire trucks, etc.

RELATED POLICIES AND/OR STATUTES AFFECTING THE ACTIVITY

(1) G.S. 20-116(g) - Loaded trucks shall be covered, or the load against the walls shall not extend above a horizontal line six inches below the sides, and the truck shall not exceed the legal weight limits.
(2) Policy for Maintenance of System Streets within Municipalities, section 5B - It is the policy of the Division of Highways not to remove snow and ice from sidewalks, nor is it the policy to clear driveways and/or driveway entrances of snow and ice.
(3) It is the policy of the Division of Highways to provide for the removal of snow and ice in the following order of priority:
   (a) Those routes included in the Bare Pavement System (See page 5).
   (b) Other US & NC Routes not included in the Bare Pavement System.
   (c) Other paved Secondary Routes not included in the Bare Pavement System.
   (d) Unpaved Secondary Routes.
(4) The Bare Pavement Policy provides for the direct application of deicing chemicals to those routes included in the Bare Pavement System. This policy also requires that these routes will be the first cleared of snow and ice following a storm. Insofar as is possible and

practical, traffic will be kept moving on these routes during a storm; however, it is not the policy to maintain a "bare pavement" throughout the course of all storms. Those routes not on the Bare Pavement System will be cleared by plowing operations and without direct application of deicing chemicals except in cases of extreme emergency. These emergencies will normally be limited to specific locations (shaded areas on hills, superelevated curves, etc.) where extremely hazardous conditions exist.

(5) It is the policy of the Division of Highways that all sites used for the storage of deicing chemicals will be located so as to avoid contamination of local wells and to minimize the possibility of damage to the environment. At all storage locations, precautions will be taken to see that they are properly covered and that drainage in and around these facilities prevents runoff into adjacent streams and properties. (See Appendix I.)

(6) It is the policy of the Division of Highways that the application of chlorides to the travelways of the system shall be consistent with our objectives to protect the environment. The recommended application rates (see page 9) are considered to be correct and proper for the various weather and highway conditions indicated and heavier applications are discouraged. Road Maintenance Supervisors should identify environmentally sensitive areas within their individual areas of responsibility that may require alternative application rates and devise special instructions for snow and ice removal techniques for roads adjacent to these locations.

CONDITIONS WHICH WARRANT SCHEDULING THE ACTIVITY

Anytime the prevailing weather conditions or forecasts indicate highways and bridges may become slippery and/or obstructed by snow and ice, maintenance forces will be mobilized in accordance with prescribed plans and policies.

SAFETY PROCEDURES

The purpose of snow and ice removal is to provide for the safe travel of motorists. In doing this, maintenance forces should endeavor to protect themselves as well as the traveling public by following proper safety procedures.

(1) The North Carolina Sign Supplement to the MUTCD should be periodically reviewed for proper implementation.
(2) All equipment should be checked before and after each storm to insure the operational status of lights, brakes, windshield wipers, exhaust systems, tires, chains, steering, and other preventive maintenance items.
(3) Operators should resist the urge to "get the job done in a hurry"
(4) Operators should obey all traffic laws while performing snow and ice removal duties.
(5) Operators should provide assistance to stranded motorists when at all possible, especially in situations where stranded vehicles pose a traffic hazard to other moving vehicles. Operators should use their best judgment when aiding stranded motorists, always being careful to prevent damage to other vehicles. The maintenance vehicle should be kept clear of the travelway whenever possible.
(6) During extended storm periods, Road Maintenance Supervisors should take measures to avoid extreme fatigue among operators. When it becomes obvious that storms will continue for long periods of time, steps should be taken to divide maintenance forces into shifts for 24-hour surveillance of the roadways. If necessary, all available personnel resources within the Division may be utilized by the Division Engineer in order to provide sufficient manpower for shifts.

PRE-WINTER PLANNING

In preparation for each winter season, the Division Engineer, District Engineers, and the Road Maintenance Supervisors should review, develop, coordinate, and/or conduct the following activities and operations:

(1) A complete inventory of deicing chemicals and abrasives should be completed in order to assure an adequate supply of materials will be available at the beginning of the season.
(2) A thorough inspection should be made of all salt storage facilities to determine their adequacy for storage of materials and protection of the surrounding environment from runoff. Guidelines for the design and location of storage facilities are contained in Appendix I.
(3) A review of those routes included in the Bare Pavement System should be conducted. Additions or deletions to the

Bare Pavement System should be coordinated from county to county and district to district in order to insure the continuity of the bare pavement routes. These bare pavement routes constitute Phase I of the total snow and ice control plan. Those paved routes not included in the Bare Pavement System should constitute Phase II and the unpaved routes should constitute Phase III. All equipment that is not allotted to the Bare Pavement System will be assigned to operators and areas of responsibility for snow and ice control on Phase II and III routes. Once the Bare Pavement System is clear, personnel and equipment can be transferred to Phase II and III routes to assist in plowing operations.

(4) Snow and ice removal shall be performed on State System roads only, with the exception of school drives, drives to hospital emergency rooms, and public cemetery drives when necessary. Snow and ice removal within municipalities should be reviewed by municipal officials.

(5) Appropriately sized segments of bare pavement routes should be assigned to specific individuals and pieces of equipment. Each segment should be sized to the capacity of its assigned truck based on a maximum chemical application rate plus contingency allowances. (See page 6). Assignments should be designed to allow the driver to be as near a stockpile as possible after completion of his route. All segments, with individual assignments and vehicle equipment numbers, should be marked on county maps then posted at the maintenance yard and the District office. Periodic reviews of assignments should be conducted to make needed corrections for personnel turnover and truck transfers.

(6) Consistent with the overall personnel resources available, assignments should include someone riding "shotgun" in a single-vehicle operation, and one "shotgun" rider in a multivehicle operation.

(7) Plans for the erection and location of snow fences are an important part of the pre-winter planning operation. Proper placement of snow fences can eliminate or reduce drifting in problem areas, thereby saving time and effort when storms occur. When it is necessary to erect snow fences off the right of way, the permission of property owners must be obtained.

(8) Plans should be developed to effect the efficient flow of information to and from maintenance forces during storm periods. These plans should include dissemination of weather report information as it is received from local radio stations, independent weather forecasters, the National Weather Service, and the Maintenance Unit - Central Administration. Steps should be taken to insure a smooth flow of information from the individual operator by assigning individuals with radio-equipped vehicles to pre-established sections of the Bare Pavement System. These persons will be responsible for making periodic contact with each operator in his assigned area to provide assistance, and to report road and traffic conditions.

(9) Each District Engineer should develop a list of fully-operated privately-owned equipment that is available for rent during periods of extreme weather.

(10) Accurate calibration of all chemical spreaders should be completed each fall in accordance with the guidelines and instructions shown in Appendix II. This effort will conserve materials, protect the environment, and provide the operator with the information required to comply with the application recommendations. Spreaders should be checked to be sure they are equipped with side shields or baffles in order to retain the spread within approximately 12'.

(11) Training sessions for all employees should be conducted to insure that they understand:
   (a) the operation and maintenance of snow removal equipment.
   (b) each individual's assigned area of responsibility with respect to Phase I, II, and III operations.
   (c) the use and application of deicing chemicals.
   (d) when and under what conditions the roads should be plowed.
   (e) the safety procedures related to snow and ice removal.

(12) All employees and equipment should be mobilized and participate in a "dry run" to insure that plans are understood and complete. This should be done immediately after completion of training activities.

BARE PAVEMENT SYSTEM

The Bare Pavement System should consist of all Interstate and four-lane divided Primary routes and other primary and secondary

routes considered to be essential to the fulfillment of the overall objectives of snow and ice removal - the movement of intrastate traffic. The routes included in the Bare Pavement System should be reviewed annually by the Division Engineer. He will include new routes and delete old routes as deemed necessary. He will assure continuity of the bare pavement routes from county to county and district to district within the division. Once the Bare Pavement System is finalized, it will be submitted to the Maintenance Unit - Central Administration. The Maintenance Unit will assure the continuity of bare pavement routes from division to division.

BARE PAVEMENT SYSTEM EQUIPMENT REQUIREMENTS

Equipment support for the Bare Pavement System is extremely important. Effective chemical application must be done as soon as there is enough accumulation to hold the chemicals on the road, preferably before the accumulation of 1/8 inch, and always before the accumulation of 1/2 inch. To assist in planning equipment requirements, the following criteria is offered:

(1) Maximum Salt Application Rate/Lane Mile. The maximum recommended application rate for salt is 250#/Lane Mile. If timely applications are made, it is estimated that two applications per storm will be required; therefore, 500# of salt per lane mile per storm represents an adequate planning base.

(2) Estimated Chemical Capacity of Equipment. It is estimated that the average salt payload for the following combinations of equipment will be:

(a) 24,000 GVW Dump with Tailgate Spreader - 4.5 tons/Load
(b) 24,000 GVW Dump with 5 cu. yd. Drop-in Spreader - 5 tons/Load
(c) 50,000 GVW Dump with 8-10 cu. yd. Drop-in Spreader - 8 tons/Load

(3) Bare Pavement - Segment Lengths. Based on the preceding data, the assigned segment lengths for the various combinations of equipment used on the Bare Pavement System should be:

(a) 24,000 GVW Dump with Tailgate Spreader

$$\frac{4.5 \text{ tons}}{250\#/\text{Lane Mile}} = 36 \text{ Lane Miles}$$

(b) 24,000 GVW Dump with 5 cu. yd. Drop-in Spreader

$$\frac{5.0 \text{ tons}}{250\#/\text{Lane Mile}} = 40 \text{ Lane Miles}$$

(c) 50,000 GVW Dump with 8-10 cu. yd Spreader

$$\frac{8 \text{ tons}}{250\#/\text{Lane Mile}} = 64 \text{ Lane Miles}$$

By using the preceding data to determine the required equipment for the Bare Pavement System, the District Engineers will be assured that sufficient spreader capacity is available to cover the entire Bare Pavement System at the maximum application rate without interruption for reloading.

There is another major concern for the District Engineer and that relates to his available storage capacity for salt. It is recommended that each county have a minimum salt storage capacity equaling one-half its anticipated annual requirement. The illustration on page 8 depicts the average number of snow storms for each county in the state. This information, together with the previously discussed assumptions and recommendations, can be used to estimate the required storage requirements. It is also recommended that salt storage capacity planning include a 25% contingency to cover multiple applications that might be necessary on bridges, hills, intersections, and etc. For example, a county with a Bare Pavement System of 265 lane miles with an annual storm frequency of 6 would require 248 tons of salt storage capacity. (265 lane miles of bare pavement x (250# salt/lane mile x 1.25) x 2 applications/storm x 3 storms = 248 tons of salt storage capacity.)

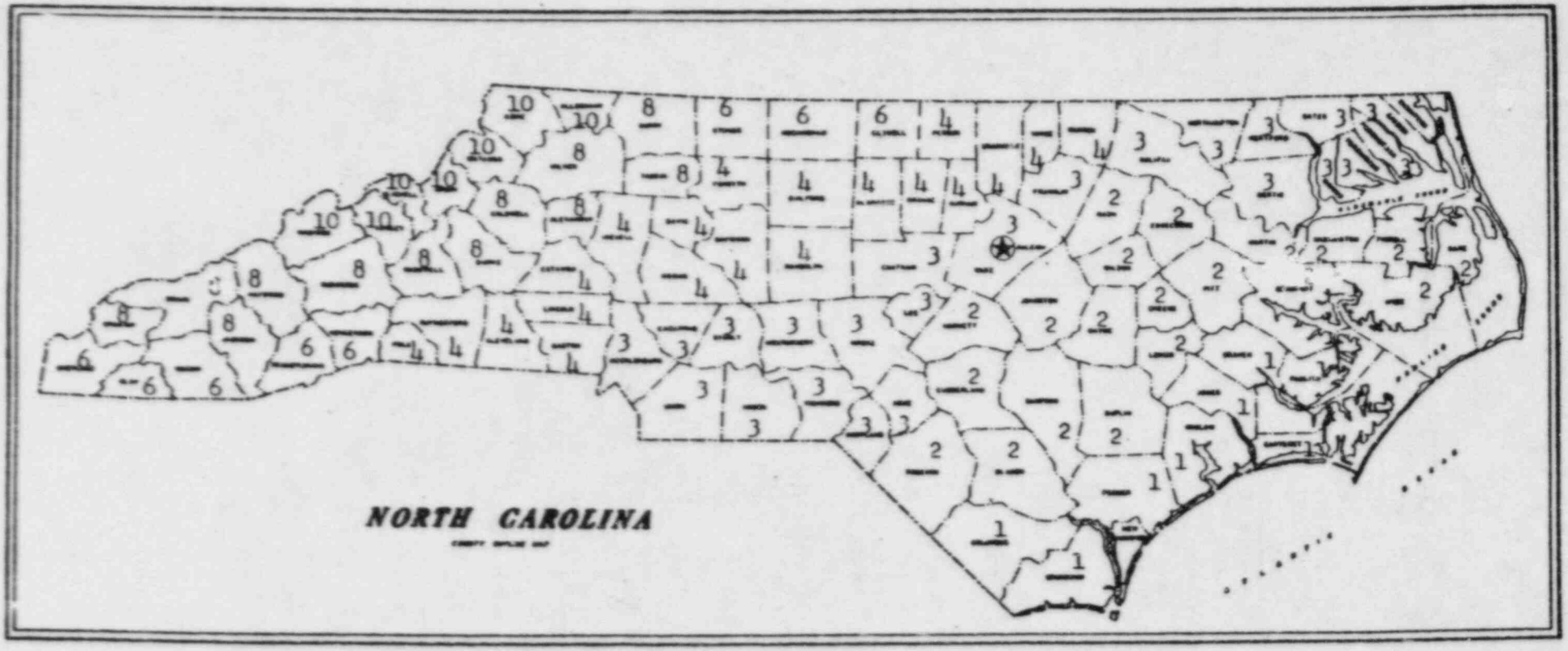
APPLICATION OF DEICING CHEMICALS

The chart on page 9 represents the recommended application rates for the various weather conditions that might be encountered. Applied as recommended, deicing chemicals will enhance the safe movement of traffic during adverse winter weather. In order that full advantage may be taken of chemical applications, the following actions should be taken:

(1) Spreader trucks and operators should be mobilized prior to the commencement of frozen precipitation. Motor grader and plow operators may be mobilized after precipitation has begun.

(2) Bridges should be treated early. Normally, bridges will freeze before the roadway and prompt treatment of bridge decks will avoid many accidents.

AVERAGE SNOW AND ICE REMOVALS PER SEASON



GUIDELINES FOR CHEMICAL APPLICATION

Temp.	Pavement Condition	Type of Precipitation	Per Two-Lane Mile of Bare Pavement System	Instructions
30°F. (-1°C.) & Above	Wet	Snow	300 lbs. of Salt	Do not plow as long as the salt is working. When the slush begins to stiffen, plow and re-apply at 200# salt as required.
30°F. (-1°C.) & Above	Wet	Sleet or Freezing Rain	200 lbs. of Salt	Re-apply salt at 200# as required.
25° to 30°F. (-4° to -1°C.)	Wet	Snow or Sleet	500 lbs. of Salt	Do not plow until slush begins to stiffen. After plowing, re-apply salt at 200#/two-lane mile.
25° to 30°F. (-4° to -1°C.)	Wet	Freezing Rain	300 lbs. of Salt	If subsequent applications are required, re-apply at 200# per two-lane mile.
20° to 25°F. (-7° to -4°C.)	Wet	Snow or Sleet	500 lbs. of Salt	Plow only when the slush begins to stiffen. Re-apply salt as required at a rate of 250# per two-lane mile.
15° to 20°F. (-9° to -7°C.)	Dry	Dry Snow	PLOW ONLY!!!	Do not apply chemicals. Treat hazardous areas with 1200 lbs. of 20:1 sand/salt or calcium chloride.
15° to 20°F. (-9° to -7°C.)	Wet	Wet Snow or Sleet	500 lbs. of 3:1 salt/calcium chloride mixture or salt moistened with calcium chloride	Do not plow until slush begins to stiffen. If roads become packed, treat hazardous areas with 1200# of 20:1 sand/salt or calcium chloride.
Below 15°F. (-9°C.)	Dry	Dry Snow or Sleet	PLOW ONLY!!!	Do not apply chemicals. Treat hazardous areas with 1200# of 20:1 sand/salt or calcium chloride.

CHEMICAL APPLICATION METHODS

1. Two-Lane Facility - Spread salt from the center of the road with offset tailgate spreader.
2. Superelevated Curves - Apply salt on the high side to allow brine solution to flow across the roadway.
3. Four-Lane Divided Facility with Roof-Type Crown - Spread salt from the center of the road.
4. Four-Lane Divided Facility with Slope from Median - Spread salt from a point slightly left of centerline except where superelevated curves dictate otherwise.
5. Multi-Lane Facilities - Spread salt on the high side and work down the slope by making sufficient passes to cover all travel lanes.
6. Operators should "play the wind" when applying chemicals during strong winds in order to put salt where it will do the most good.

PLOWING METHODS

1. Two-Lane Facility - Plow all two-lane facilities with a right-hand plow.
2. Multi-Lane Divided Facility with Roof-Type Crown - Plow left lane with a left-hand plow or a motor grader followed by a truck with a right-hand plow and a spreader.
3. Multi-Lane Divided Facility with Slope from Median - Same as roof-type crown, with an additional pass with the left-hand plow on the median shoulder.

(3) Early treatment of busy intersections and interchanges will help to keep traffic moving and avoid accidents.
(4) Once chemicals have been applied, always allow sufficient time before plowing (See next section).
(5) Stay aware of anticipated changes in weather conditions. Operators should be informed as soon as information on "new" weather is received. Often times, materials can be saved if weather conditions are improving or a needed "jump" on additional snow can be gained if the weather is worsening.

Chemical Application Methods are:
(1) Two-Lane Facility - Spread salt from the center of the road with an offset tailgate spreader.
(2) Superelevated Curves - Spread salt on the high side to allow brine to flow across the roadway.
(3) Four-Lane Divided Facility (Roof-type crown) - Spread salt from the center of road.
(4) Four-Lane Divided Facility (Slope from Median) - Spread salt from the left-hand lane except where superelevated curves dictate otherwise.
(5) Multi-Lane Facilities - Spread salt on the high side and work down the slope by making sufficient passes to cover all travel lanes.
(6) Operators should "play the wind" when applying chemicals during strong winds in order to put salt where it will do the most good.

Each Road Maintenance Supervisor should report road conditions and chloride usage to his respective District Engineer each morning after a storm. It is imperative that these reports be made promptly so that chemical replacement orders can be issued for the proper amounts. The District Engineer will in turn notify the Maintenance Unit - Central Administration via computer terminal of salt inventory status by stockpile location after each storm activity.

PLOWING SNOW AND ICE

Snow occurs when water vapor in an air mass is cooled below freezing. The density of snow varies. Some storms produce "wet" snow, others "dry" snow. Wet or heavy snow seals to the pavement quickly under traffic and, normally, requires chemical treatment before plowing. Dry or powdery snow can usually be plowed away if the plowing operations begin soon enough. Dry snow occurs

during very cold weather conditions (below 25°F. or -4°C.) and as long as the pavement remains dry, plowing operations can keep the surface of the road clear.

The secret is knowing when to plow and once chemicals have been applied, the operator can tell when to plow by watching the passing traffic. As long as the slush is soft and fans out behind the tires of passing vehicles, the salt is working, but when the slush begins to stiffen and is thrown directly to the rear of the tires, it is time to plow and spread more chemicals. Never apply chemicals followed immediately by a plowing operation. Salt is of no benefit on the shoulder of the road.

Recommended methods for the various types of roadways are:

(1) Two-Lane Facility - Plow all two-lane facilities with a right-hand plow.

(2) Multi-Lane Divided Facility (Roof-type crown) - Plow left lane with a left-hand plow or motor grader followed by truck with a right-hand plow. The following truck (R.H. plow) is the vehicle equipped with the spreader.

(3) Multi-Lane Divided Facility (Slope from Median) - Same as roof-type crown, with an additional pass with the left-hand plow on the median shoulder in order to move the windrow over far enough so that it does not drain back across the roadway.

It is important that plowing patterns in and around interchanges conform to the needs and physical characteristics of the individual location. Pavement obstructions such as curbs, raised button delineators, rumble strips, and the like must be considered when establishing the plowing patterns on interchanges. The most prevalent problem on interchanges is the lack of adequate area for storing snow. For this reason, specific plowing patterns for each interchange should be developed and the assigned operators thoroughly indoctrinated in the plowing sequence.

Other considerations and special attention should be given:

(1) Drainage of melting snow.
(2) Removal of windrows from ramps entrances and exits.
(3) Loss of plow path width on sharp curves.
(4) Sight distance when using gore areas for snow storage.

USE OF ABRASIVES

The most prevalent and effective use of abrasives takes place when the temperature is 20°F.(-7°C.) or below and falling. This is due to the fact that direct chemical applications lose most of

their effectiveness under these conditions and can sometimes create a hazard by virtue of the fact that the weak brine solution created by the limited melting action will refreeze.

The purpose of abrasive application is to provide traction, and is not intended primarily to remove snow and ice. Abrasives are to be applied only to ice and/or packed snow and are not to be applied routinely during the course of a storm.

In order to provide for adhesion of the abrasives to the hazardous areas, they shall always be mixed with either calcium or sodium chloride. Preferably they should be premixed in order that the abrasives will have developed a moist coating prior to being applied. The recommended mix ratio is 20 parts abrasives to 1 part chloride. An application of 1200 pounds per two-lane mile is generally sufficient. Once the abrasives have been applied, the treated areas should not be plowed until they become slushy.

Sufficient mixing can take place by constructing the stockpile of alternate layers of abrasives and chemicals in the appropriate quantities, with the first layer always consisting of abrasives. The subsequent loading, hauling, and spreading of the components will provide a reasonably uniform mixture.

Chemically-treated abrasive stockpiles should always be kept covered, and the same precautions taken as with chemical stockpiles.

CLEAN-UP AFTER A STORM

Immediately after a snow or ice storm and the pavement is bare, there still remains very much for maintenance forces to do:

(1) Shoulders should be winged back to get the snow as far from the travelway as possible.
(2) Shoulders in front of mailboxes should be plowed.
(3) Drainage structures should be cleared of obstructions so that melting snow will not be trapped on or near the travelway.
(4) Windrows of snow on bridges should be removed.
(5) Traffic medians and barriers should be cleared of snow and ice as required to avoid melting and refreezing on the pavement.
(6) Tree limbs and other debris should be removed from the right of way as soon as possible.

Immediately after each storm, all equipment should be inspected and scheduled for repairs as required. These preventive measures should include:

(1) Inspection of all spreader pumps, hosing, fittings, spinners, augers, engines, controls, and attachments.
(2) Inspection of plows for blade wear.
(3) Inspection of all flashers, lights, lenses, lamps, and other safety equipment.
(4) Replacement of needed flashlight batteries, flags, flares, and other consumable safety equipment.
(5) Removal of salt from all vulnerable surfaces of equipment and the application of fuel oil or other appropriate lubricants to these surfaces for protective coating.

SUPERVISOR'S CHECKLIST

Prior to the beginning of each winter season, the Road Maintenance Supervisor should be able to answer each of the following questions in the affirmative:

(1) Have all employees received training in snow and ice removal procedures?
(2) Has all snow removal equipment been inspected and spreaders calibrated?
(3) Has a "dry run" been conducted?
(4) Has a schedule of assignments been developed?
(5) Are all highway segments sized to the equipment assigned?

After a storm and all routes are open, the Road Maintenance Supervisor should be able to answer all of the following questions in the affirmative:

(1) Has the chloride usage been reported to the District Office?
(2) Have shoulders been winged back?
(3) Have shoulders in front of mailboxes been cleared?
(4) Are all drainage structures clear?
(5) Have windrows on bridges been removed?
(6) Has all snow removal equipment been inspected and needed repairs scheduled?
(7) Have all vulnerable surfaces on equipment been washed and treated with a protective coating?

APPENDIX I
SALT STORAGE

Storages should protect chemicals from direct precipitation at all times, and keep the material within prescribed bounds.

Storages should be large enough to hold 50-100% of seasonal requirements without overflowing, not require special handling procedures for rapid loading, allow enough vertical clearance for delivery trucks and raised loader buckets, allow maneuvering room for loaders, and be reinforced or protected at key points.

Caution should be exercised in locating storage sites. They should not be built near wells or water sources since chlorides will seep into the ground and contaminate water supplies. Storage sites should be located higher than the surrounding area to prevent water run-in. In areas with particularly vulnerable water supplies, all brine runoff must be contained in a lined collection basin from which brine is pumped out for removal to a nonsensitive area.

Storage facilities should meet all requirements in the most economic manner, and be kept in satisfactory condition. These facilities can be one of several types: elevated bins, cribs with covers, sliding-roof cribs, buildings, sheds, or a covered stockpile on a pad.

Crib floors should be paved with bituminous materials with at least 8 inches of slope from the center to each end. There should be a full apron extending ten feet beyond the end of the walls. The pavement should be a minimum of 2 1/2 inches of bituminous concrete over 6 inches of compacted ABC material. Covers should be of vinyl-coated nylon or reinforced polyethylene with grommets or eyelets for lash-down, or should be of a sliding-roof type construction.

Storage areas should be adequately lighted for night operation. They should also be adequately ventilated, particularly for indoor loading and unloading operations.

Arrangements should be made for chlorides to be delivered for storage by early October. A premixed supply of calcium chloride/salt and abrasives should be kept in stock under shelters or protected from moisture, and ready at all times for immediate use during the winter season. Mixing should be done well in advance of the winter season. Precautions should be taken that these premixed materials are never stored in elevated or gravity-type bins.

When the temperature is 20°F.(-7°C.) or below, a mixture of calcium chloride and salt may be necessary. Adequate mixing of calcium chloride with the sodium chloride can be obtained by using a force-feed loader fitted with a hopper positioned over the belt in the loading operation. Another method is to apply

calcium chloride in solution to the top of the load of salt in each truck.

Sodium chloride shall meet ASTM Standard Specification D632-72, Type 1, Grade 1 for ice and snow removal.

The moisture content shall not be greater than 2% (delivered), and shall contain a non-caking additive. When a delivery is received, the District Engineer shall notify the Division's Materials and Tests representative to secure samples for testing. Calcium chloride shall meet all requirements of the Division of Highways Standard Specifications.

Gradation requirements for Type I sodium chloride are:

SIEVE	% PASSING
1/2 in.	100
3/8 in.	95 - 100
# 4	20 - 90
# 8	10 - 60
#30	0 - 10

The following are some properties of stockpiled materials used for snow and ice control:

	Sodium Chloride	Calcium Chloride	Sand
Bulk Density (ton/cu. yd.)	1.08	0.74-0.88	1.2-1.4
Angle of Repose (from horizontal)	32°	25-30°	34°

NOTE: Rain will reduce an uncovered salt pile at a rate of 1/4% per annual inch of precipitation. (Example: 40 inches of precipitation per year on a 500-ton salt pile for six months will lose 25 tons of salt.)

Trucks and spreaders should be loaded, if possible, inside the storage shed in order to reduce spillage and clean-up problems. Before the spreader truck leaves the shed or loading area, all parts of the truck body should be cleaned off, including catwalks, top edges, tanks, roof, and fenders. The loading area should be kept clean by immediately cleaning up any salt lying on the loading pad, and then getting it back under cover. The salt should be kept dry by keeping it under cover as long as possible before loading it onto trucks. The area surrounding a stockpile

should always remain clean, with no foreign materials allowed to be disposed of in the area.

Salt should be handled as little as possible. Excessive handling causes segregation of the different particle sizes, as well as causing the large particles to break down into finer particles which reduces their effectiveness for clearing snow.

APPENDIX II

CALIBRATION OF SALT SPREADERS

Calibration of all chemical spreaders is the most important action that the Division of Highways can take to control and reduce the amount of deicing chemicals that enter the environment and could be harmful. Calibration of spreaders not only controls and reduces the amount of material used but it also saves money by providing the desired level of service with less deicing chemicals. The objectives of a thorough calibration program are very accurate knowledge of the amount of chemicals delivered by all units at each spreader setting, and identification and repair of all spreader units that cannot be controlled within the range of prescribed spreading.

Spreaders should be calibrated annually before the winter season begins, and no later than October 15. The calibration should be rechecked during the winter if any of the major parts of the hydraulic system are replaced, if the moving mechanical parts of the spreader are damaged or replaced, or if for any reason the spreading rate becomes questionable.

The calibration technique described in this section is applicable to both drop-in body spreaders and tailgate spreaders, both of which rely upon the rotation of a mechanical element (an auger shaft or flite-chain sprocket shaft) for feeding chemicals to the spreader mechanism.

EQUIPMENT REQUIRED

(a) A scale for weighing the amount of salt up to 100 lbs.
(b) A means for collecting the salt to be weighed, either by using a canvas, sack, or a large bucket.
(c) A stopwatch or watch with a second hand for timing shaft revolutions.
(d) A shaft tachometer (if unable to count the shaft revolutions).
(e) A marking pen, paint brush, or other means for marking the end of the auger or shaft.
(f) Calibration worksheets and a clipboard. (See page 21 for the worksheet.)

CALIBRATION PROCEDURE

The following procedure is recommended for the calibration of spreaders that do not have ground-speed controllers:

(1) Clean the shaft end of the auger or flite-chain sprocket shaft. Place an index mark on the end of the shaft so that the number of revolutions per minute can be counted at each dial setting. If the shaft end is not exposed, mark the auger flite sprocket.

(2) Remove the spinner disc, or bypass the spinner motor with a hydraulic line. If the spinner cannot be removed, and a bypass is not feasible, use extreme caution with the rotating spinners.

(3) With the spreader system running and empty, let the truck idle long enough to warm the hydraulic oil to normal working temperature.

(4) Place a half load of salt in the truck body to put a load on the spreader. This partial load will simulate actual working conditions.

(5) Open the throttle so the engine is running constantly at approximately working speed. If the truck is equipped with a tachometer, set the throttle at the engine speed normally used during salting.

(6) For hopper-type spreaders, open the gate to approximately 1 1/4 inches. (Note: Trial and error adjustments may have to be made in the gate opening in order to get the desired spread rate. Once this rate is achieved, the procedures may continue.)

(7) Fill the spreader auger or conveyor with salt by rotating it a few turns.

(8) Set the spinner motor control to its usual level.

(9) When the auger is full, place the canvas or the bag under the discharge opening so that all of the salt discharged is caught. Allow the auger or the sprocket to make five full turns at a low setting and collect the salt that is discharged.

(10) Weigh the salt, deducting the weight of the canvas square, bag, or other collector. Accuracy is important because this factor is used repeatedly in the calculations. Then determine the average weight per revolution by dividing the net weight by five, and enter in Column 3 of the worksheet. Once the weight per revolution has been established, that weight will remain constant throughout the calculating procedure.

(11) To determine the number of revolutions per minute (RPM), use a stopwatch or a watch with a second hand; count the number of RPM's of the auger or flite-chain sprocket shaft at each control setting. If necessary, use a hand tachometer. Record these in Column 2 of the worksheet.

CALCULATIONS

The worksheet now contains two pieces of data needed for calculation of the amount of salt that will be discharged in one

minute. Multiply Column 2 by Column 3 and enter the result (discharge rate in lb/min) in Column 4.

To complete the calculation, you need to know the number of minutes required for the truck to travel one mile at various road speeds. These are tabulated in Table 1 and shown in Columns 6-9 of the worksheet. To calculate the amount spread per mile when the truck is traveling at 15 mph, multiply Column 4 by the constant shown at the head of Column 5 and enter the result in the proper place. Likewise, to determine the amount spread at 20, 25, 30, and 35 mph multiply Column 4 by the constants at the top of Columns 6-9, respectively, and enter the results in the proper spaces. Perform these calculations for every control setting.

As an illustration of how the table is used, assume, for example, that the auger or flite-chain sprocket discharges 8 lb. of salt (Column 3) each time it makes one full revolution at control setting number 3 and that the auger turned 10 times per minute (Column 2). Obviously, the spreader will put out 80 lb. per minute at that setting (Column 2 times Column 3 and the result entered in Column 4).

At a speed of 15 mph as shown in Table 1 the truck moves one mile every 4 minutes. Therefore, 80 lb./min. multiplied by 4 minutes equals 320 lb./mi. This value is entered in Column 5 for control setting number 3. This procedure should be repeated for each control setting and at the various speeds at which the material is spread. Record all data on the worksheet.

The next set of calculations determines the distance that the spreader truck will travel for various control settings and vehicle speeds before the complete load is exhausted. These values are useful for checking the calibration and overall performance of the spreader. In Column 11 of the calibration worksheet, enter the size of the load in pounds for the material (salt and sand or mixtures thereof). This should be the weight of the material when it is loaded level with the top of the screens or the top of the spreader hopper (provided this does not exceed the vehicle's legal gross weight). This value can be obtained either from the spreader manufacturer or by weighing a truck full of material and entering the amount in the line provided in Column 11. To calculate the time required to empty the spreader for various control settings divide Column 11 by Column 4, and enter the results in Column 12. The miles that a truck will travel at 15 mph before the load is exhausted is determined by the division of Column 12 by the constant given at the top of Column 13. Likewise the miles a truck will travel before its loads are exhausted at 20-35 mph are calculated in

Columns 14 through 17, respectively, on the calibration worksheet. Results should be entered in these columns to the nearest 0.1 mile.

Table 1 VEHICLE SPEED CONVERSION FOR SPREADER CALIBRATION

Vehicle speed (mph)	Time to travel one mile (min)
10	6.00
15	4.00
20	3.00
25	2.40
30	2.00
35	1.71
40	1.50
45	1.33
50	1.20
55	1.09
60	1.00

TRUCK CALIBRATION CARD

The last step in the calibration of spreaders is to transfer the results of the calculation onto a calibration card, which will be carried in the cab of the truck.

The calibration worksheet should be placed on file either in the maintenance record for the truck or in the district office. The truck calibration card should be placed in a convenient location in the truck so that it is available for quick reference during a storm.

APPENDIX II

N. C. DIVISION OF HIGHWAYS

SALT SPREADER - CALIBRATION WORKSHEET

DIVISION_____ COUNTY_____ DATE_____ BY:_____

TRUCK EQUIPMENT #_____ SPREADER EQUIPMENT #_____

(1) Control Setting	(2) Loaded RPM	(3) Dischg. Rate (Lb/Rev)	(4) Dischg. Rate (Lb/Min)	(5) 15 MPH X 4.00	(6) 20 MPH X 3.00	(7) 25 MPH X 2.40	(8) 30 MPH X 2.00	(9) 35 MPH X 1.71
				AMOUNT SPREAD PER MILE TRAVELED				
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								

(10) Control Setting	(11) Size of Load (Lb)	(12) Min. Required to Empty	(13) 20 MPH ÷ 4.00	(14) 20 MPH ÷ 3.00	(15) 25 MPH ÷ 2.40	(16) 30 MPH ÷ 2.00	(17) 35 MPH ÷ 1.71
			MILES TRAVELED PER LOAD				
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							