Experimental Use of Calcium Magnesium Acetate

Final Report
Iowa Highway Research Board
Project HR-253

June 1983

Office of Materials
Highway Division

Iowa Department of Transportation

Disclaimer

The contents of this report reflect the views of the author and do not necessarily reflect the official views of the Iowa Department of Transportation. This report does not constitute a standard, specification or regulation.

FINAL REPORT

IOWA HIGHWAY RESEARCH BOARD

RESEARCH PROJECT HR-253

EXPERIMENTAL USE OF CALCIUM MAGNESIUM ACETATE

BY

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IOWA DEPARTMENT OF TRANSPORTATION

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INTRODUCTION

The Iowa Department of Transportation has been actively investigating calcium magnesium acetate (CMA) for use as a road deicer since its introduction by Bjorksten Laboratories in 1980. This chemical is a promising alternative to sodium or calcium chloride deicers.

Early in the investigation, Materials Laboratory personnel developed a process to produce a deicer consisting of sand grains coated with CMA. As part of research project HR-243, ten tons of this CMA/sand deicer were produced in a pilot operation by using a small concrete mixer as the mixing and chemical reaction chamber. This material was used in late winter (April) of 1982 under regular deicing conditions with favorable results. It was also confirmed that mildly alkaline CMA has no scaling effect on PC concrete.

Since there is no commercial source for CMA, a need exists to develop commercial interest in a CMA deicer. The HR-243 report recommended that additional CMA/sand deicer be made using contracted facilities that are better equipped to produce larger quantities. The report also recommended that the additional deicer be used for evaluation and development during the full 1982-1983 winter season. Research project HR-253 was established to carry out these recommendations

OBJECTIVES

The objectives of this study were:

A. To obtain, under contract, 100 tons of CMA/sand deicer produced by an independent contractor in Iowa.
B. To further evaluate and develop the deicing capabilities of CMA/sand deicer.

CONTRACT PROCEDURE

A. Pre-Bid Conference

A pre-bid conference, on October 25, 1982, familiarized interested parties with CMA/sand deicer, production procedures, and provisions of a contract proposal to produce 100 tons. Eight potential bidders attended the meeting in response to solicitation of contractors from the fertilizer and ready-mix concrete industries. The full agenda for this conference is given in Appendix A.

B. Contract Proposal and Letting

The special provisions called for production of 95 tons of the deicer at a CMA to sand ratio of 1:2 by weight and 5 tons made with expanded shale aggregate at a CMA to agggregate ratio of 1:1. The contractor was required to provide the facilities, equipment, inside storage, and labor for the work except for pump and spray equipment to handle acetic acid and safety supplies. Raw materials were purchased by the

Iowa DOT and delivered to the production site. Technical assistance including formulations, handling of chemicals, and quality control of the product were provided to the contractor by DOT personnel.

Separate bid items for mobilization or set-up, manufacture, and delivery were established in the schedule of prices. The proposal also included a questionaire covering the bidders facilities and equipment that were available at the proposed production site. The letting was held on November 1, 1982. The proposal is given in Appendix B

C. Contract Award

The contract was awarded on the recommendation of a selection committee based on costs and plant capabilities. Facilities of the low bidder were inspected prior to making the recommendation.

PRODUCTION METHODS

A. Equipment

1. Two truck-mounted, ready-mix concrete units, with 8 cubic foot capacity mixing drums. Internal surfaces of the drums were coated with graphite paint. A flange mounted, pillow block, bearing was fastened to the center of the back end of the drum to support the end of the acid lance and allow drum rotation without lance rotation.
2. Acid spray lance, 16 feet long, made of 1-inch standard black pipe and fitted with 24 spray nozzles spaced to provide uniform application of acid to the sand and lime mixture. Neoprene hose was used to convey the acid from the containers to the lance.
3. Diaphram pump constructed of stainless steel with Teflon diaphrams and joints and operated with 80 psi compressed air.
4. Rotary drum sand drier.
5. Sand hopper and conveyor fitted with digital read-out load cell.
6. Portable lime hopper fitted with vibrator.
7. Small, hand-held Hudson sprayer.
8. Conveyors, loaders, and trucks for handling materials.

B. Materials

1. Glacial acetic acid, packaged in 55 gallon drums.
2. Hydrated lime containing 40% magnesium hydroxide, packaged in 50 pound bags.
3. Concrete sand meeting Iowa DOT specifications (Section 4110).
4. Expanded shale aggregate, #2 Haydite, packaged in 2 cubic foot bags.
5. Cement grinding aides supplied by W. R. Grace Co.

C. Production Batch Weights

1. The following amounts of raw materials were used for the standard production batch:
   Dried concrete sand or Haydite - 6361 pounds
   Hydrated lime - 2700 pounds (54 bags)
   Acetic acid - 9 drums (4140 pounds)
   Grinding aide - 1500 milliliters

D. Production Procedures

1. The concrete sand was dried, transferred to the weighing hopper, and the batch weight amount conveyed to the ready-mix truck mixing drum. The Haydite aggregate, used in lieu of the sand, did not require drying.
2. Grinding aide was applied to the batched sand by Hudson sprayer, as the sand was delivered to the truck. The grinding aide was further distributed on the sand particles by slow rotation of the mixing drum for 10-15 minutes.
3. Fifty-one bags of hydrated lime were transferred to the portable hopper and the hopper was covered with polyethylene sheeting. The lime was then transferred from the hopper to the slowly rotating mixing drum. This final transfer required from 20-25 minutes.
4. The batch amount of acetic acid was then sprayed into the mixer through the in-place spray lance at a rate of 5 gallons per minute. During this operation and throughout the reaction time period the mixing drum was rotated at maximum speed of 25 rpm.
5. When the reaction temperature reached maximum and began to drop, the 3 additional bags of lime were added. Mixing was continued for about 30 minutes and the resulting product was then discharged into a dump truck.
6. The truck was tarped and the material remained stored in the truck until shipment.

E. Size Reduction Procedure

The delivered product contained 10 to 15 percent oversized spherical lumps up to about 2 inches in diameter. These lumps were removed and crushed by the following procedure:

1. The lumps of oversized material were scalped on a 4'x8' vibrating 3/8 inch mesh screen.
2. The scalped material was spread on pavement, crushed with a steel drum roller, and returned to the screen until all material passed through the screen.

F. Storage

The CMA deicer was stored in a fully enclosed salt shed with an asphalt paved floor.

FIELD EVALUATION PROCEDURES

Test sections of highway for field trials were identical to those used in the HR-243 project. These consisted of a section of four-lane, divided U.S. 30 in the Ames vicinity and a section of two-lane U.S. 69 south of Ames. Locations of these test areas are shown on the map given in Appendix C.

Application of the CMA deicer was made by Ames maintenance forces using a hopper spreader calibrated to deliver 300 lbs per lane mile. On U.S. 30, CMA deicer was applied to the westbound lanes and regular 1 to 1 mix of sand and salt was applied at the same rate to the eastbound lanes.

The U.S. 30 test section involves one bridge over water and two overpasses. CMA deicer was used for frost runs on these bridges at a rate of 1000 lbs. per lane mile.

Observations of performance, weather conditions, etc. were made by the maintenance foreman and the principal investigator.

SUMMARY OF RESULTS

The following information is a summary of the major results and observations of this study. For further details and explanation concerning these findings, see the "Discussion of Results" section of this report.

A. Tabulation of Bids

Bidder	Set-Up	Mfg./Ton	Frt./Ton	Total
W.G. Block Co. P.O. Box 3010 Davenport, IA 52808	$100	$11.55	$15.80	$2,835
W.G. Block Co. (Bulk lime alternate)	100	9.95	15.80	2,675*
Consumers Coop Society P.O. Box 1108 Iowa City, IA 52244	1000	50.00	15.00	7,500
Roland-Nevada Coop R.R#2 Nevada, IA 50201	1000	71.00	6.00	8,735
C.E.I. Truck & Ag. Equip. (Alternate-Equip. rental only) 1641 Edgewood Rd. S.W. Cedar Rapids, IA 52505				8,500*

*Note: Alternates not acceptable

The contract was awarded to W. G. Block Co.

B. Production Amounts and Costs

1. Delivered product:

CMA/sand (1:1)	56.41 tons
CMA/lt. wt. agg. (1:1)	4.15 tons
TOTAL	60.56 tons

2. Catagorized Costs:

Misc. supplies & Equip.:		
Graphite paint	$135.83	
Pipe, nozzles, uniform, etc.....	486.96	$622.79
Raw Materials:		
Acetic acid	$13,413.99	
Hydrated lime	1,658.08	
Concrete sand	218.40	
Lightweight agg.....	325.44	15,615.91
Production and Delivery		3,421.97
	GRAND TOTAL	$19,660.67

3. Delivered Unit Costs:

Average	$324.65 per ton
1:1, CMA/sand (prorated)	319.54 per ton
1:1, CMA/lt. wt. agg. (prorated).....	394.09 per ton

C. Field Performance

Thirteen general applications and numerous frost runs on bridges were made with CMA deicer throughout the 1982-1983 winter season. Highway conditions were either frosty, icy, or snow packed and temperatures varied from 18 to 34 deg. F. The following statements summarize observations of field performance:

1. In the presence of traffic, the deicing performance of CMA deicer was virtually the same as regular sand/salt deicer. In the absence of traffic, CMA deicer was slow to react and did not perform as well as sand/salt.
2. When used for bridge frost runs, CMA deicer performed equally as well as sand/salt but CMA caused the deck to remain wet longer.
3. There were no performance differences between CMA/lt. wt. agg. and CMA/sand deicers.
4. The CMA deicers, including the crushed particles, did not present any storage problems. Because of exposure to moisture or snow, some caking did occur in a partially loaded truck stored in a heated garage between runs.
5. The spreading properties of CMA deicer were equal to those of sand/salt.
6. Dust was a major problem during application and handling of CMA deicer.
7. A noticeable, residual odor of acetic acid was observed during handling and application of the CMA deicer.

D. Corrosion Tests

Total immersion tests with cold-rolled steel indicate that CMA is not a rust inhibitor, however, it may not be a rust promoter such as sodium chloride.

DISCUSSION OF RESULTS

A. Comments on Contract Production

The contractor, W. G. Block Co., is a large ready-mix firm with plants at several locations in Iowa. The other companies submitting acceptable bids are involved in the production of fertilizers. The company bidding equipment rental, sells equipment for producing fertilizer.

The CMA deicer was produced at the Acme Sand & Gravel facility in Muscatine, Iowa. The facilities, equipment, and man-power for the work were excellent and full cooperation was given to those providing technical assistance. All operations went smoothly.

Ready-mix plants, because of wide distribution and resulting lower freight costs, offer an economic advantage over a specialized plant with fixed location. The experience of this project shows that most ready-mix plants can produce CMA deicer with minimal modification of equipment. They have the proportioning and mixing equipment, can furnish dry concrete sand locally, and have the facilities and equipment to handle raw materials and finished product.

B. Comments on Production Process

It was originally intended that 100 tons of CMA deicer be produced at a CMA to sand ratio of 1:2 and the quantities of raw materials needed were purchased accordingly. It was decided, however, to attempt a 1:1 ratio for the initial trial batch to see if additional CMA could be successfully coated onto the sand. This would produce a product with the same deicing chemical to sand ratio as the regular sand/salt mixture. The trial batch being successful, it was further decided to produce the remaining batches at the 1:1 ratio, realizing that the yield of finished product would be considerably less than 100 tons.

The CMA/sand ratio has a decided effect on the unit cost of the finished product. Using prorated costs from this study, unit costs for various ratios are:

Pure CMA	$498 per ton
1:1 CMA/sand	320 per ton
1:2 CMA/sand	213 per ton
1:3 CMA/sand	160 per ton

In the HR-243 project, 1:3 CMA/sand was found to be an effective deicer, so it is difficult to justify additional CMA unless performance is significantly improved. This study indicates the performance was not improved by the higher CMA content, although the comparison is not fully valid because of other product differences.

The production of the CMA deicer was generally successful but there were two related problems of basic concern that remained unresolved: (1) determining the amount of lime required to produce an alkaline product without excessive unreacted lime, and (2) eliminating the formation of spherical lumps requiring subsequent size reduction.

The formula used called for an excess of 8% lime based on the assumption that reaction with all acetic acid would be complete. This produced the desired alkaline product with a pH slightly above 9 but resulted in an excessive amount of unreacted lime. The excess lime was a major contributor to formation of lumps and reduced the effectiveness of the product as a deicer.

The amount of lime that reacts depends primarily on the ambient temperature and the reactivity of the magnesium component. The ambient temperature during production was about 50 deg. F., causing rapid dissipation of heat needed to sustain the reaction. Summertime or early fall is obviously the preferred time for production from this stand point. Also, it has since been learned that the lime used contained an appreciable amount of unreactive magnesium and that a more reactive lime made by a different process is available.

Because of these variables and others such as mixing action, the amount of lime used in this process must be determined by trial and error based initially on lime reactivity and ambient conditions. A lower CMA content in the deicer would make this determination easier. The ultimate goal being to use the minimum amount of lime needed to produce an alkaline product.

Wet unreacted lime is a sticky substance that would easily coat solid particles under the rolling action in a concrete mixer. Examination of the lumps formed during production revealed a build-up of successive layers indicating such a process. Furthermore, the outer layer hardened with age as would happen with the slow conversion of lime to carbonates when exposed to air. There is also evidence of the hardened, insoluble layer on smaller particles.

Several procedural changes did minimize lump formation. Holding out 3 bags of lime at the start of each batch allowed the mix to remain acid for maximum time so that more of the magnesium component would react. Operating the mixer at maximum speed during the reaction period and discharging the product before complete cooling also helped. Use of heated sand, however, increased lump formation.

The graphite paint coating on the internal surfaces of the mixer did prevent caking on the sides of the mixer during this limited production. Because it is not abrasion resistant, it would not be suitable for prolonged use. A polyethylene sheeting that provides an abrasion resistant and cling-free surface is available for this purpose.

C. Comments on Field Performance

The abrasion of traffic was needed to start the melting action of CMA deicer. This is also true of the sand/salt mixture but to a lesser degree.

Reasons for this observed performance difference are: (1) application of dry CMA deicer being compared with application of wet sand/salt deicer, and (2) the insoluble, outer layer of lime on the CMA deicer particles.

It is well established that all deicers are more effective in the presence of initial moisture. The nearly insoluble layer on the CMA deicer will disintegrate slowly when in contact with moisture. Therefore, if moisture is present, the effect of the layer is to retard the melting process and not to stop it.

Dry particles of CMA deicer were observed in contact with an ice film on the pavement at 26 deg. F. with no evidence of melting. In contrast to this, simulated tests in a laboratory freezer set at 25 deg. F. demonstrated the ability of precooled CMA deicer particles to melt through an ice film. An explanation for this performance difference is not apparent unless it is assumed that the ice film in the freezer was damp because of temperature variations and the ice film on the pavement was dry.

Dust and odor were problems during handling and spreading. During application, the odor was disagreeable to the truck operator and was discernable when standing along the road. It is believed that the odor comes from the dust and that prewetting the deicer would solve both problems. Original plans called for prewettng some of the CMA deicer as it was being applied; however, the equipment was not immediately available and was never installed.

The time and place that prewetting would be most effective needs to be determined in practice. For example, prewetting of newly produced CMA deicer at the plant with a saturated solution of CMA might solve both dust and odor problems. Prewetting at the time the deicer is being applied would improve deicing performance and may adequately solve the dust and odor problems during application but would do nothing to solve the dust problem during handling. Both times should be tried.

D. Comments on Corrosion Tests

Rusting of steel specimens did occur when immersed in an alkaline, 2% solution of CMA (pH 9+). This indicates that CMA is not an effective rust inhibitor such as sodium chromate and sodium borate, although it may not be an active promoter of steel corrosion like sodium chloride.

There are many factors that can affect the results of corrosion tests and for this reason these simple tests are not considered conclusive. The results do point out the need for a study by corrosion specialists as is being contemplated by the Federal Highway Administration.

CONCLUSIONS

1. An effective CMA/sand deicer can be produced by most ready-mix concrete plants with minimal modifications of equipment.
2. Further development of the process for producing CMA/sand deicer

in ready-mix equipment is needed to obtain an alkaline product with minimum residual of hydrated lime.

3. Development and evaluation of techniques for prewetting the CMA/sand decier with saturated CMA solution are needed to eliminate a major problem with dust.
4. There is no performance advantage for CMA deicer made with lightweight aggregate over that made with concrete sand.
5. At costs with present technology, CMA/sand deicer is not an economically attractive alternative to sodium chloride for general deicing on highways.

RECOMMENDATIONS

It is recommended that 10 to 20 tons of additional CMA/deicer with a 1 to 2 CMA-sand ratio be made as a continuation of this project in order to further develop the production process. It is also recommended that the Federal Highway Administration be encouraged and supported in their efforts to establish a metal corrosion study of CMA.

ACKNOWLEDGEMENT

Research project HR-253 was sponsored by the Iowa Highway Research Board and the Highway Division of the Iowa Department of Transportation (DOT). Funding for this project was from the Primary Road Research Fund in the amount of $60,000.

Wallace Rippie, Chemist with the Iowa DOT, was the principal investigator and has developed the production methods. He also provided technical assistance to the contractor in the calcium magnesium acetate production for this project.

The author wishes to express appreciation to Brian Nagle and the W. G. Block Company for excellent cooperation.

Henry Hayes of the Iowa DOT provided excellent assistance in equipment modification. The author also extends appreciation to Messrs. Don Anderson, Charles Huisman, Robert Humphrey, Don Schumann, Paul Durham, Paul Ferleman, Bernhard Ortgies, Richard Smith, and Vernon Marks of the Iowa DOT for their participation.

APPENDIX A

Pre-Bid Conference Agenda

IOWA DEPARTMENT OF TRANSPORTATION

PRE-CONTRACTURAL MEETING
ON
PRODUCTION OF CMA DEICER
October 25, 1982

I PRELIMINARY REMARKS

A. Introductions and Registration

B. Purpose and Objectives

The purposes of the meeting are to familiarize interested parties with CMA deicer and its production and to explain the provision in a contract proposal to produce 100 tons. The objective is to generate interest in production of CMA deicer.

C. Format

D. Printed Material

1. Report on research project HR-243 which covers the initial study on production and field use of CMA deicer.

2. Contract proposal for CMA deicer production.

II DESCRIPTION AND HISTORY OF CMA

A. Definitions

1. CMA is the abbreviation for calcium magnesium acetate which is a mixture of salts formed by chemical reaction of dolomitic hydrated lime and acetic acid.

2. CMA deicer is a product intended for deicing roadways that consists of fine aggregate particles coated with a layer of CMA.

B. Bjorksten Research

1. Scope

In a 1979 study sponsored by the FHWA, the Bjorksten Research Laboratories reviewed all types of chemical compounds to replace sodium chloride for road deicing.

2. Motivation

The motivation for this study was the numerous drawbacks associated with the prevalent use of sodium chloride for deicing.

3. Findings

CMA was found to be the most likely candidate to replace sodium chloride. It had the same deicing properties as sodium chloride and was found to be a corrosion inhibitor, a benefit to most soils, and non-harmful to drinking supplies.

4. Conclusions

(a) CMA has predominantly superior properties to sodium chloride as a decier.

(b) Neutralized CMA causes scaling of concrete but mildly basic CMA was not expected to have this effect.

(c) Production processes for CMA should be studied.

C. Iowa DOT Research

1. Laboratory evaluation.

CMA produced in the laboratory was found to be a light, fluffy material which appeared unsatisfactory for distribution on roads by conventional methods. Mildly basic CMA was found to have no effect on concrete.

2. CMA deicer development.

A method was developed to coat sand particles with CMA thus producing a deicer with adequate particle weight for distribution on roads.

3. Production and Field Use of CMA Deicer.

About 10 tons of CMA deicer was produced in the laboratory using a small cement mixer. This material was used for field trials. The production process and field use were both successful.

D. Other Research

1. Stanford Research Institute

This federally funded research involves development of a manufacturing process for producing CMA and production of 200 tons of material. Their main concern is with production of low cost acetic acid by biological methods.

2. California DOT

This federally funded research involves study of the environmental impact of CMA.

3. Other DOT's

South Dakota has funded a study at their school of mines to develop methods to produce CMA. All states with deicing problems are highly interested but the extent of their individual activities is unknown.

III IOWA DOT PRODUCTION PROCESS

A. Raw Materials

The raw materials required are: (1) dolomitic hydrated lime, (2) glacial acetic acid, (3) concrete sand, and (4) a propietary coating agent.

B. Equipment

The equipment needed includes: (1) a rotary drum mixer, (2) batching hopper, (3) weighing devices and, (4) pump and spray nozzle for handling acetic acid.

C. Process Steps

The coating agent is first blended into the aggregate followed by addition of the lime. After complete mixing, the acetic acid is added through a spray nozzle and the reaction is allowed to continue to completion.

D. Formulation

Formulations depend on the desired ratio of CMA to aggregate which would normally be 1:2. The amount of lime used is slightly more than required to neutralize the acid so that an alkaline product is produced. The coating agent required is 0.01% by weight of the aggregate.

IV CONTRACT DOCUMENTS

A. Special Provisions

The special provisions describe the facilities, equipment, labor, and work items to be provided by the contractor. They also describe specific requirements and limitations for the work.

B. Contract Proposal

This document describes all contract details including instructions to bidders.

V OPEN DISCUSSION

APPENDIX B

Proposal

Form 132026
8-82

Bid on Production of CMA Deicer

Date of Letting November 1, 1982

Hour for Opening Bids 3:00 P.M.

Bidders File Copy

PROPOSAL

Proposal of _____
(Name of Bidder)

of _____
(Name of Town) (Address) (State) (Zip Code)

for ~~furnishing~~ manufacture and delivery of calcium magnesium acetate (CMA) deicer.

To Department of Transportation:

We hereby certify that we are the only person or persons, interested in this proposal as principals; that an examination has been made of the instructions to bidders, the specifications and contract form, including the supplmental specifications and special provisions contained herein.

We hereby certify that we are an "Equal Opporunity Employer" as defined in the "Civil Rights Act of 1964" and in "Iowa Executive Order Number Fifteen".

We propose to furnish all materials and/or equipment specified, in the manner and the time prescribed, and at prices hereinafter set out.

We certify that in the submission of this proposal, we are not in violation of the provisions of Sec. 314.2, Code of Iowa.

We propose to indemnify and save harmless that State of Iowa and the Iowa Department of Transportation against all claims for infringement of, and/or royalties claimed under, patents on materials and equipment furnished under this bid.

We further propose to enter into formal contract within fifteen days after award or forfeit the proposal guaranty furnished herewith.

We propose to complete the contract within the contract period, or pay liquidated damages stipulated below, for each calendar day the contract remains uncompleted after the stipulated completion date.

Enclosed in separate envelope, is certified check, cashier's check or a Contractor's Bid Bond (Form 650001), drawn on a solvent bank, in the sum of $ 1,000.00 , payable to the Iowa Department of Transportation, as a proposal guaranty. We understand this guaranty may be retained by the State if we fail to execute a formal contract within fifteen days after award is made to us, or if we fail to comply with Chapter 494 or 496A of the Code of Iowa.

Proposal Guaranty	Date To Begin	Date Of Completion	Liquidated Damages Per Calendar Day
$1,000.00	Not later than November 29, 1982	December 31, 1982	NONE

In compliance with Title VI of the 1964 Civil Rights Act, the Iowa Department of Transportation is restricted to procuring services, materials, and supplies only from those firms operating as Equal Opportunity Employers.

By virtue of statutory authority preference will be given to products and provisions grown and coal produced within the State of Iowa, (Chap. 73, Code of Iowa).

The Iowa Department of Transportation reserves the right to reject any or all bids and to accept that bid which, in the opinion of the Department of Transportation Commissioners, is in the best interst of the State of Iowa.

Signed _____
(Name of Company)

By _____

See Attached Sheet for Description of Items and Schedule of Prices

IOWA DEPARTMENT OF TRANSPORTATION

SCHEDULE OF PRICES
for
Production of CMA Deicer

BID ITEMS

Item	Description	Unit	Quantity	Unit Price	Total
1.	Mobilization (set-up)	Lump Sum			
2.	Manufacture	Ton	100		
3.	Delivery	Ton	100		

Total: _____

These prices will be held firm until _____

Actual quantities ordered may vary considerably from contracted quantity based on results obtained.

Company_____

By_____

Address_____

_____
City State Zip

Phone Number _____

FACILITY QUESTIONNAIRE

1. Production Site:

   Company _____

   Address _____

   _____

   Plant Location _____

   Number of Personnel Available _____

2. Facilities:

   Protected and hard surfaced area _____ sq. ft.

   Heated storage area _____ sq. ft.

   Power:

   220 volt - yes _____ no _____

3. Equipment:

   Mixer: Size _____

   Type _____

   Charging Method _____

   Proportioning:

   Scales: Capacity _____ pounds

   Type _____

   Air Compressor:

   Pressure _____ psi

   Volume _____ CFM

   Materials Handling:

   Conveyors - yes _____ no _____

   End Loaders - yes _____ no _____

   Other _____

IOWA DEPARTMENT OF TRANSPORTATION

INSTRUCTIONS TO BIDDERS
For
Production of Calcium Magnesium Acetate Deicer
October 25, 1982

Sealed bids will be received until 3:00 P.M. November 1, 1982 by the Iowa Department of Transportation, at its office in Ames, Iowa for production of calcium magnesium acetate (CMA) deicer.

Specifications Applicable

Standard Specifications of the Iowa Department of Transportation Series of 1977.

Special Provisions dated October 25, 1982 (see attached).

Requirements of Bidders

Firms submitting Bids must be an "Equal Opportunity Employer" as defined in the "Civil Rights Act of 1964" and in "Iowa Executive Order Number Fifteen".

Preparation of Proposals

Only signed proposals, submitted on forms furnished by the Department of Transportation will be considered, and the bidder will be assumed to have familiarized himself with the requirements of any and all special provisions by reference made a part of these specifications. Any unauthorized changes in or additions to the proposal form, including any reservations, will be considered sufficient grounds for rejection.

Proposal Guarantee

Each bid must be supported by a Proposal Guarantee in the sum of $1,000.00. A cashier's check, certified check, or a contractor's bid bond (Form 650001) will be acceptable as proposal guarantee. Cashier's check shall be made payable either to the Iowa Department of Transportation or to the contractor, and where made payable to the contractor shall contain an unqualified endorsement to the Iowa Department of Transportation signed by the contractor or his authorized agent. A certified check must be stamped with the word "Certified" and signed by an official of the bank. Contractor's Bid Bond form must be submitted on Iowa Department of Transportation Form No. 650001.

Filing Proposal

The proposal and supporting proposal guarantee must be filed in separate but attached envelopes furnished by the Iowa Department of Transportation. The proposal shall be filed with the Department of Transportation at Ames, Iowa, prior to the time for the opening of bids.

Taxes

Prices quoted shall not include state or federal taxes from which the State is exempt. The necessary exemption certificates will be furnished by the Department of Transportation upon request by the contractor.

Discounts

Quantity discounts or discounts for early payment are not permitted.

Ties and Reservations

No ties or reservations by the bidder are permitted.

Facility Questionnaire

The attached Facility Questionnaire shall be completed and returned with the bid.

Liquidated Damages or Cancellation

Liquidated damages of $ NONE per day will be assessed for each calendar day the contract remains uncompleted after _____.

The contract may be subject to cancellation due to failure to initiate production by the specified date or exhibit reasonable effort toward completion of the contract.

Contract Award

A contract may be awarded for the production of CMA deicer based on the recommendation of a selection committee. The award will be based on costs and plant capability, as ascertained by the selection committee. The award will be made by 2:00 P.M. November 8, 1982.

Payment

Payment for items will be made promptly after they have been performed and accepted by the State. Requests for payment for partial delivery will be honored when appropriate and when properly documented.

Inspection

The contractor shall notify the Materials Engineer when technical assistance is desired and when production is to begin.

Delivery by Truck

Material shipped by truck shall be delivered to the Iowa Department of Transportation, and may be delivered only between 8:00 A.M. and 4:00 P.M. on any day except Saturday, Sunday, or a holiday.

Contact for Technical Information

Wallace Rippie, Chief Chemist, Iowa Department of Transportation, 800 Lincoln Way, Ames, Iowa 50010. Phone (515)239-1163.

IOWA DEPARTMENT OF TRANSPORTATION

IOWA DEPARTMENT OF TRANSPORTATION
Ames, Iowa

Special Provisions
for
PRODUCTION OF CALCIUM MAGNESIUM ACETATE (CMA) DEICER

October 25, 1982

DESCRIPTION OF WORK

This work shall consist of producing and delivering 100 tons of calcium magnesium acetate deicer. Concrete sand shall be used to produce 95 tons of the deicer at a CMA to sand ratio of 1:2. The remaining 5 tons shall be produced with expanded shale aggregate at a CMA to aggregate ratio of 1:1.

The contractor shall provide the facilities, equipment, inside storage, and labor necessary for the work except for pump and spray equipment required to handle acetic acid. Raw materials and technical assistance shall be provided to the contractor by the contracting authority.

DEFINITIONS

1. Calcium magnesium acetate is a mixture of salts formed by chemical reaction of dolomitic hydrated lime and acetic acid. CMA is the common abbreviation.

2. CMA deicer is a product intended for deicing roadways that consists of fine aggregate particles coated with a layer of CMA.

MATERIALS

All raw materials used to produce the CMA deicer will be purchased by the contracting authority and delivered FOB to the production site. Unused raw materials shall remain the property of the contracting authority. Required raw materials are:

1. Dolomitic hydrated lime containing not less than 40% magnesium hydroxide. The lime shall be packaged in 50 pound bags.

2. Glacial acetic acid packaged in 55 gallon plastic drums.

3. Coating agent used to promote adhesion of CMA to aggregate particles. The agent shall be packaged in 5 gallon pails.

4. Dry concrete sand meeting requirements of Section 4110.

5. Dry expanded shale aggregate, all passing the 1/4 inch sieve.

The contractor shall furnish inside storage for all raw materials that will keep them dry and unexposed to outside weather. The facility for storing the acetic acid shall be heated and maintained at an ambient temperature of not less than 65 degrees F.

EQUIPMENT

The processing equipment shall consist of a rotary drum mixer with a minimum capacity of 4 tons. The mixer shall be fed by conveyor belt from a batch hopper or directly from a batch hopper, either with provisions for batch weighing of dry ingredients.

The contracting authority shall provide the contractor with an air-powered, double diaphragm pump and spray equipment for handling the acetic acid and dispensing equipment for the coating agent. The contractor will be responsible for proper operation of the pump and proportioning the acetic acid. The contractor shall furnish compressed air at a minimum pressure of 60 psi and minimum volume of 60 CFM to operate the pump.

PROCESS DESCRIPTION

A weighed amount of dry aggregate is delivered to the mixer followed by addition of a measured amount of coating agent through a spray nozzle. These materials are mixed until the coating agent is evenly distributed throughout the aggregate, requiring about 20 minutes. A weighed amount of lime is then delivered to the mixer and is mixed in with the aggregate for about 20 minutes. A measured amount of acetic acid is then pumped through a spray nozzle into the rotating mixer. Mixing is continued until evidence is obtained that the material has started to cool. The material is then discharged from the mixer and delivered to a truck for transport.

DEICER FORMULATIONS

Formulations for CMA deicer depend on the desired ratio of CMA to aggregate. The amounts of lime and acetic acid are calculated to produce CMA at the desired pH. The amount of lime required is slightly more than that theoretically required to neutralize the acid. The amount of coating agent required is 0.01% by weight of the aggregate. As a guide, 4 tons of CMA deicer made with CMA-sand ratio of 1:2 might be produced by the following amounts of raw materials:

5335 pounds of sand

1850 pounds of acetic acid

1070 pounds of hydrated lime

0.53 pounds of coating agent

Note: The apparent excess of ingredient weight represents water formed by the reaction.

Formulations will be calculated by the contracting authority to suit the batch size and conditions involved. Proportioning bythe contractor shall be within 0.5%.

WEATHER LIMITATIONS

The deicer shall not be produced when the ambient temperature at the mixer is less than 25 degrees F. If the ambient temperature at the mixer is below 40 degrees F., the mixer shall be fully protected from wind before any production is started. These restrictions are given as guides to prevent excessive heat loss during the process reaction. In any event, the deicer shall not be produced under any weather or ambient temperature conditions that, in the opinion of the engineer, are not conducive to production of a satisfactory product.

TECHNICAL ASSISTANCE

Technical assistance concerning chemical aspects of the production of the deicer including formulations, handling of chemicals, and quality control of the finished product shall be provided to the contractor by the contracting authority. The contractor shall allow the engineer or his representatives free access to the production facility for inspection and assistance purposes, and every facility shall be extended to them for these purposes.

If modification of the contractor's equipment is deemed necessary by the contracting authority in order to produce a satisfactory product, such modification shall be made by the contractor at the expense of the contracting authority. Modifications shall be made only with full written agreement of the contractor and shall be of a type that allows restoration of the equipment to its original form. Required modifications that are not made, may be grounds for cancellation of the contract.

PRODUCT ACCEPTANCE

Satisfactory CMA deicer shall be in granular form and shall indicate a pH of not less than 9 when a distilled water solution is tested. CMA deicer produced in accordance with contracting authority instructions, regardless of its condition, shall be accepted as part of the required contract production. Unsatisfactory deicer, not produced according to contracting authority instructions shall not be acceptable. The contractor shall dispose of unsatisfactory deicer in accordance with the contracting authority's request.

PRODUCT DELIVERY

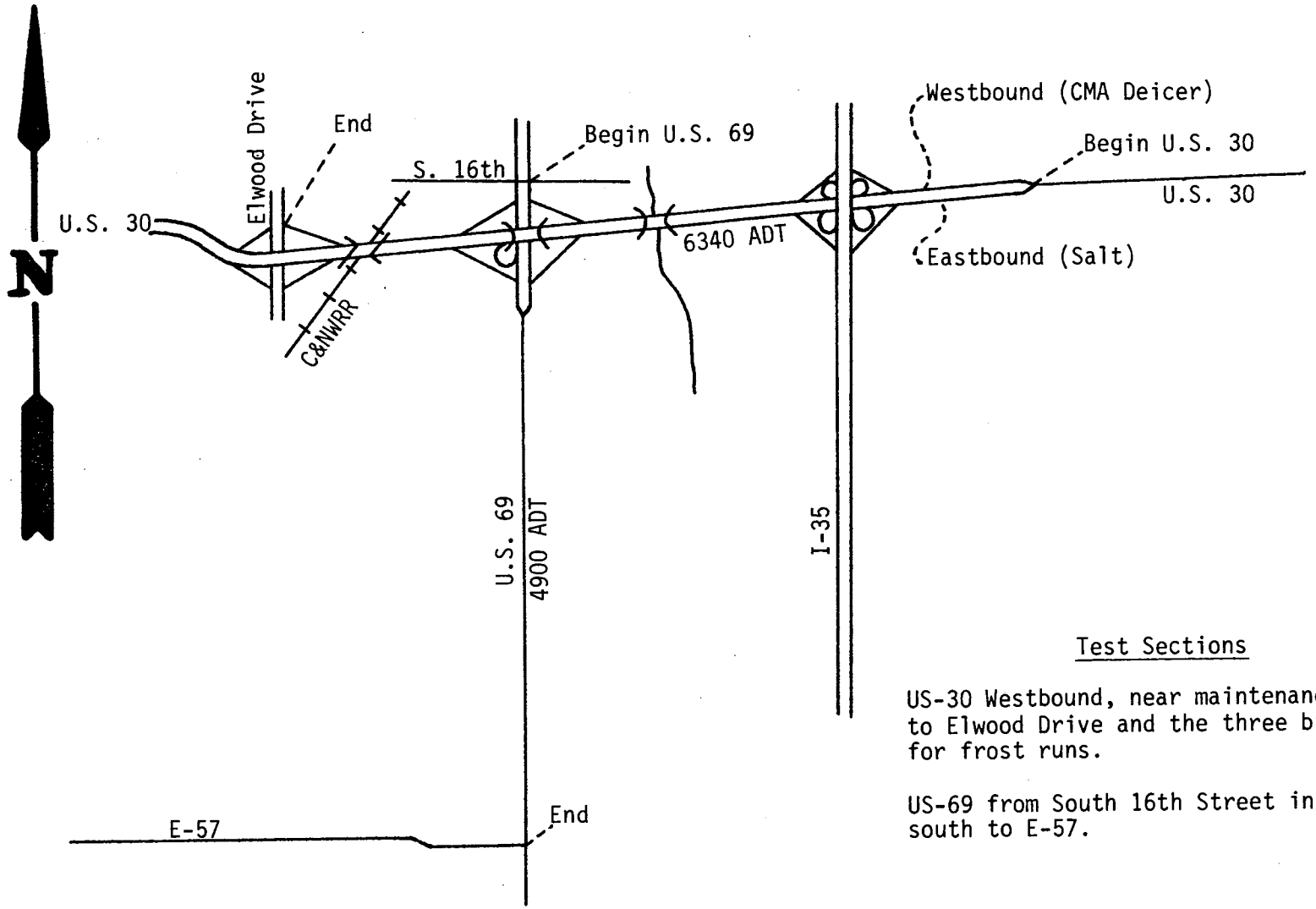
Satisfactory CMA deicer shall be delivered by the contractor to a designated storage shed on the Department of Transportation headquarters grounds in Ames, Iowa. Deliveries shall be made in a tarp covered or otherwise enclosed truck that assures delivery of dry product. Deliveries may be made only between 8:00 A.M. and 4:00 P.M. on any day except Saturday, Sunday or a holiday. All delivered loads shall be weighed before delivery is made.

PAYMENT

Payment for mobilizations cost as bid may be made in two payments. A 50% payment will be made following a reasonable effort to fulfill all contract items and the final 50% at the satisfactory completion of the contract. The contractor shall be paid the manufacturing cost per ton for all delivered acceptable product. The delivery cost per ton shall be paid regardless of the acceptability of the product if an actual delivery is made.

APPENDIX C

CMA Deicer Test Location Map



Test Sections

US-30 Westbound, near maintenance garage to Elwood Drive and the three bridges for frost runs.

US-69 from South 16th Street in Ames south to E-57.

CMA DEICER TEST LOCATIONS

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