THE NEW RULES FOR AMMONIA HIGHWAY TANK TRANSPORTS

Transporters have had difficulty complying with the new rules adopted by DOT without notice. Some problems still are not solved and probably will not be until more is learned about the causes.

Edwin A. Olsen
Compressed Gas Association, Inc.
New York, N.Y.

Since January, 1968, industry has been in a frenzy trying to comply with, and clearly understand, the meaning of an admendment the U.S. Department of Transportation adopted to the Hazardous Materials Regulations.

Tank truck transporters of anhydrous ammonia and LP-Gas are still paying the price of these new rules, and no one can be fully certain of the safety benefits they have brought to the industry and public.

The admendment took effect the same day it was published and could have put the ammonia industry out of business during the fertilizer season last spring. In explaining its extraordinary action of making the admendment effective immediately without notice DOT stated: "As a situation exists which demands immediate adoption of this regulation in the interests of public safety, it is found that notice and public procedure hereon are impractical and good cause exists for making this admendment effective without notice and in less than 30 days."

This is only a first step and there very likely will be further regulations in this area. It is this threat, and the uncertainty of the adequacy of existing rules and standards, that make this subject of utmost importance to those whose responsibilities involve the safe handling of anhydrous ammonia. In the following discussion the reason given for these rule changes thus should be kept in mind: namely, stress corrosion cracking of cargo tank trucks made of quenched and tempered steels and used to transport anhydrous ammonia.

What the amendment requires

Among the several things required by the DOT admendment were:

1. Cargo tank trucks made to specifications MC-330 and MC-331, constructed of quenched and tempered (QT) steels, may be used only for ammonia having minimum water content of 0.2% by weight, or for ammonia of at least 99.995% purity. Other grades of ammonia would have to be moved in tanks of other than quenched and tempered (NQT) steels.
2. Tanks going into ammonia service which have been in other service or have been open for any reason shall be cleaned of the previous product and shall be purged of air before loading.
3. For ammonia shipments in QT cargo tanks, shipping papers must show either "0.2%" or "99.995%" to indicate they qualify for shipment in such tanks.
4. All MC-330 and MC-331 cargo tanks must be marked "QT" or "NQT" to indicate the type of steel used for construction. *All of the above rules became effective on the day the amendment was published in the Federal Register.*

In addition, a timetable was set for internal inspection by the wet fluorescent magnetic particle method of all MC-330 and MC-331 cargo tanks made of quenched and tempered steels which have been in anhydrous ammonia or liquefied petroleum gas service. The wet fluorescent magnetic particle inspection had to be preformed on all internal welds and areas extending 2 in. from such welds, on similar areas opposite all exterior welds, and on the entire interior surface of tank heads. If any crack whatsoever is found, the entire interior surface of the tank must also be inspected by the wet fluorescent magnetic particle method.

The schedule of testing of QT tanks required by the order issued Jan. 31, 1968 was as follows:

1. To use a tank for LP-Gas that has at any time been used for ammonia—it must be tested by March 31, 1968.
2. To use a tank for any other flammable compressed gas or for anhydrous ammonia that has at any time been used for ammonia—it must be tested by April 30, 1968.
3. To use a tank for any flammable compressed gas that has at any time held LP-Gas (but not anhydrous ammonia)—it must be tested by Dec. 1, 1968.

Exceptions were provided when carriers could prove that tanks had been used exclusively in "specification grade services" and thereby were not subject to stress corrosion cracking.

The amendment further required that: "All cracks and other defects found shall be repaired in accordance with the repair procedures described in Section 8, of the edition of the ASME code under which the tank was built." Any tank requiring welding repairs was required to have such repairs post-weld heat treated. Comprehensive reporting of the cargo tanks in service and the results of the inspection and repair program was also required.

While the amendment indicates the rules were promulgated without notice, this is not exactly true, since it was industry representatives through various interested trade associations who prepared the first draft on which the DOT amendment was based. Various associations alerted their members as to what was happening so they could prepare themselves for the eventual amendment of the rules.

What prompted the unusual action?

Agricultural ammonia nurse tank failures in the 1950's? A propane transport explosion in Berlin, New York in 1962?

Or a failure of a QT tank undergoing hydrostatic test after repair of defects? The correct answer would be probably all of these and other related incidents over the years.

The rash of nurse tank failures in the 1950's prompted the Agricultural Ammonia Institute to conduct a study at Georgia Institute of Technology. This resulted in a report in 1956 recommending that tanks for ammonia service either have hot formed heads, stress relieved cold formed heads, or full stress relief of the entire tank following fabrication.

A follow up to this work was presented to this very meeting at Lake Placid in September, 1961. The report was presented by Longinow and Phelps of U.S. Steel Corp. and confirmed the earlier recommendation concerning the need for stress relief, or the use of hot formed or stress relieved heads. Since that time, these rules have generally been in effect for ammonia tank fabrication. In addition, the 1961 report recommended purging of ammonia vessels that have been opened to the atmosphere to eliminate air contamination. Another proposal of the 1961 report was to require a minimum water content of 0.2% as an inhibitor against stress corrosion cracking.

These two recommendations of the 1961 report were quickly made a part of the new rules—not necessarily because those concerned were convinced they would solve the problem, but because they represented the only suggestions on record that seemed to offer any help under the circumstances. Some ammonia producers supported these proposals and took action to implement them. Others questioned the applicability of the findings to their practices.

Early experiences with QT steels

In early 1967, industry became aware of a quenched and tempered tank transport that had developed a leak and was returned to the manufacturer for repair. The repair was made, a hydrostatic test applied, and the tank failed. This brought about a meeting in Dallas in April 1967 organized by a highway vehicle carrier in order to present his problem and to solicit the help of others concerned.

This meeting brought out the fact that certain other leaking tanks had been discovered and some signs of cracking detected. We should keep in mind that the total number of defective tanks numbered about a dozen. There were no failures in service that caused any casualties. But there was enough evidence to cause industry to take steps to correct the situation.

The Dallas meeting initiated a flurry of industry activity. This brought various associations together to attempt to evaluate the seriousness of the problem and determine what, if any, recommendations should be offered. From then on, the National Tank Truck Carriers, the Agricultural Nitrogen Institute, National LP-Gas Association, and the Compressed Gas Association worked closely together to pool information and to develop recommendations. From Dallas in April, industry meetings were held in New York, Memphis, and St. Louis.

It was on Nov. 28, 1967 that industry was called to meet in Washington with the Department of Transportation which then announced that something was going to be done. A joint industry meeting was already planned for St. Louis on December 7. This made the purpose of the meeting quite clear; namely produce an industry developed draft of DOT regulatory changes. The alternative was to have rules prepared in the Office of Hazardous Materials of DOT without industry participation.

A near panic situation existed and under the circumstances, the industry did remarkably well in preparing a draft which was turned over to DOT the very next week following the St. Louis meeting.

Initial impact of amendment

The industry in general supported most of the requirements in the DOT regulations, but the few changes made in the Office of Hazardous Materials resulted in a Jan. 31 amendment with which industry found it impossible to comply. Industry proposed a year to complete the inspection program. DOT required most tanks to be inspected within two and three months of the effective date. While industry supported the use of the wet fluorescent magnetic particle test, which had been used recently to uncover defects, no one could fully appreciate the varied problems of interpretation that would result when the published amendment was eventually put into effect.

The amendment states that all cracks and other defects must be repaired. Taken literally, some available reports indicate that most tanks thoroughly examined would show some "cracks" or other defects. Most would be harmless and may only be surface scratches which can be readily removed by grinding. Many indications found are believed to have been there from the time of fabrication and are considered to be best left untouched. Less than expert attempts at repair could do more harm than good! However, the literal interpretation would demand that all such defects be repaired and subjected to postweld heat treatment following any welded repair.

On Feb. 15, CGA submitted a proposed amendment of the rules to DOT. Also submitted were recommended guidelines for inspection and repair of the tanks covered by the amendment with an urgent plea for immediate action in order to make it possible for industry to comply with the amendment. We again pointed out the impossible time table, the need for changes, and the need for information on inspection and repair in order to avoid a wide variation in methods of inspection and repair that could make the order meaningless. The CGA proposal would eliminate the requirement for postweld heat treatment following welded repair and modify to some degree the requirements for inspection.

There followed a series of conferences and correspondence with DOT in the hopes that some guidelines—even on the inspection phase alone—could be made available to those responsible for performing the inspections. This proved to be impossible and nothing further was done until DOT eventually amended its rules on May 21, 1968, eliminating the requirement for postweld heat treatment.

The CGA Guidelines on Inspection were again revised to be consistent with the new regulations and consideration given to publishing them even at this late date. This has been coordinated with the other interested groups involved and the material in December was in the printing stage and was to be released shortly. The feeling is that even though much of the testing has been done, the guidelines will be helpful for industry to have for future reference and to serve as a guide for those still performing the inspections.

Results of testing program

This brings developments to the present. What has been the result of the testing program and has it served its intended purpose? The Regulations require two reports. The first is an inventory report indicating the number of MC-330 and MC-331 tanks in each carrier's service, and an indication of whether these are made of quenched and tempered steel or of non-quenched and tempered steels. As of the end of August, DOT received reports indicating the existence of 7,821 such

tanks of which 3,820 are made of quenched and tempered steel.

All of these tanks will not necessarily require testing, but of these, reports have been received on inspections of 1,833 tanks. About 21%, or 381, of these were reported to show some defect. There is no detailed information concerning the nature of these defects so at this point it is difficult to evaluate the findings. We would not expect the reports on repairs to be too revealing without intensive investigation.

One thing is generally acknowledged. This is that there have been two extremes of inspections performed in the field. Those that have been conscientiously carried out to the letter of the requirements have resulted in reports showing many tanks with some indication of defect. Most of these defects are felt to be of little or no concern, but the literal interpretation would indicate that all defects must be repaired.

On the other extreme, some testing groups have been established to perform this work who will virtually guarantee a "no defect report." In between, there are many conscientious operators who are interpreting the indications found and reporting those they believe to be stress corrosion cracking.

The Department of Transportation has made field inspections to several carriers to verify their inspection reports. No conclusions have been reached. DOT is accumulating additional data before any decisions can be reached concerning the need for reinspecting tanks already checked or the need for possible court action. All testing was to be completed by Dec. 1, 1968, and we are hopeful DOT will publish a summary of the inspection and repair reports at that time.

At this time all shippers should be using QT tanks only for ammonia having 0.2% water or 99.995% purity. Guidelines on the addition of water or aqua ammonia to obtain the 0.2% water content were released by CGA earlier this year. These were mailed to all ammonia producers.

Where do we go from here?

What can we learn as a result of the new rules? Unfortunately, there is no base from which to make comparisons. The findings as a result of the wet fluorescent magnetic particle inspection cannot be compared to the testing performed on a new tank which requires that welds on QT tanks be examined by the magnetic particle method. A dry type inspection is permissable and has generally been used. The wet fluorescent method will disclose indications not found by the dry technique.

One proposal under consideration by CGA and other interested associations is to recommend amendment of cargo tank specification MC-331 to require testing of welds in QT tanks by the wet fluorescent magnetic particle method. However, the lack of uniformity of inspections under the new rules will make it difficult to intelligently compare periodic results.

CGA has been urging its member companies in the ammonia business to support some program of testing or data accumulation to provide the kind of information on which sound future proposals can be made. No one can predict what the DOT will do next. But if there should be another incident involving truck movement of ammonia or possibly propane, the kind of inspection program recently written into the rules—which is only a one-shot operation—may be required on a repeat basis.

We have urged our members to test a sampling of containers periodically. Also to subject other than quenched and tempered steel containers to the wet fluorescent magnetic particle inspection in order to help develop information which will pinpoint as much as possible the real areas of concern. Some rail cars are understood to have been inspected but we have seen no reports.

If a tank were to violently disassemble itself today, it is doubtful if industry would be in a much better position than it was on Dec. 7, 1967, when it put together the basis for the current regulations. Many chemical companies are deeply involved in this problem and it could go beyond quenched and tempered steel cargo tank trucks.

Needed additional information

Information is still needed to better pinpoint the source of corrosive contaminants, and the real effect of hauling only specification product if this turns out to be a practical and realistic safety requirement. Among the information needed are:

1. What contaminants in ammonia produce stress corrosion cracking in containers constructed of various grades of steel.
2. What are the most suitable materials for construction of containers for *various grades* of ammonia, including ammonia containing various contaminants.
3. What is the effectiveness of water as an inhibitor of ammonia producing stress corrosion cracking, and the optimum amount to be used with various grades of ammonia.
4. What items—if any—other than water would effectively inhibit stress corrosion.
5. What effect does interchangeability of equipment, such as between propane and ammonia, have on stress corrosion

Another area where work is needed is to establish criteria to distinguish the "good" cracks from the "bad" cracks in tanks, in order to separate those that should be repaired immediately from those that may not represent any real hazard.

While industry can criticize DOT for issuing an order which invites people to ignore it, the industry will be subject to criticism if it fails to take some positive steps toward a constructive program that will develop the kind of information needed to answer some of these questions should some future unhappy experience occur.

Summary

To summarize the present situation, the need for more information is evident in order to evaluate the effect on containers of various grades of products, and to assist in better evaluating the various types of defects that are now being found by the newer and more sophisticated methods of inspection to determine those that must be corrected and those that are not serious. More information also is needed concerning the effect of various grades of product on other than quenched and tempered steels.

What can we do collectively as the ammonia industry and what can be done individually as an employee of a company in the ammonia business? The CGA is continuing to work with its industry and other interested associations and companies in order to accumulate information on an orderly basis. This then can be documented to serve a useful purpose for the future protection of the industry and the public. This is imperative if we are to avoid the panic type situation that resulted in the development of the existing rules in a record length of time that was measured in days.

There have been suggestions made that industry underwrite a test program at a well respected national research organization in order to develop some of these data. One proposal is for 38 companies to contribute $1,000 each to support research to learn more about large refrigerated storage of ammonia and the possible hazards of large spills. For less than $1,000 per company, undoubtedly many of the questions concerning stress corrosion cracking of ammonia containers could be answered better than they are today.

Discussion

A. J. P. TUCKER, African Explosives & Chemical Industries, Ltd., Johannesburg, South Africa: I have a number of questions, but first of all I should like to mention a few of our own investigation results. We became interested in possible stress corrosion cracking of ammonia storage vessels, or should I say ammonia containers because we can include here road tankers, ammonia high, and atmospheric, pressure storage tanks, high pressure cylinders and so on. And we have had an opportunity to examine a number of failed items of equipment which have failed through abuse of some sort.

These have principally been carbon steel ammonia cylinders. We have examined these very carefully on a number of occasions. We have never found anything in the way of stress corrosion cracking in carbon steel, and we have examined from time to time various horizontal high pressure storage tanks and storage cylinders when we have been modifying them for various reasons and we've had to cut out various bits and pieces. And we've looked at these samples for stress corrosion cracking and we have never found it.

And we have only recently specified anything in the way of quenched and tempered steel, although we don't know yet in this whether we're going to have any trouble. In fact, we haven't had to put these new tanks into service yet. As far as some questions are concerned, Mr. Olsen asked nearly all the questions I was going to ask, and I thought he would give us the answers. It appears he won't. But I would like to perhaps amend one or two of his questions, and put the following three:

Has stress corrosion cracking actually been identified in LPG tankers? Has it been identified in other types of container, for example spheres, horizontal stock tanks, cylinders and so on? Has it been identified in atmospheric pressure storage tanks?

OLSEN: Yes, stress corrosion cracking has been identified in liquefied petroleum gas highway transports. The new DOT Regulations apply to LP-Gas that does not meet National Gas Processers' Asso. Specification 2140 (1962 edition), as well as to anhydrous ammonia. I am not aware of stress corrosion problems involving storage containers or cylinders.

Q. It was suggested that the owners might subsidize, or underwrite an extensive investigation of the parameters which surround stress corrosion cracking of steel in ammonia environments. If this is the case, would there be some prospect of having the carriers meet the requirements or recommendations that might come out of any such work undertaken?

OLSEN: Yes, I believe that most of the quenched and tempered steel tank trucks are owned by common carriers who haul various types of product. I might add that the common carriers, as represented by the National Tank Truck Carriers, Inc., have practically all of their MC-330 and 331 tanks made of QT steels.

The motor carriers have been quite concerned with this problem since they see the reliability of their equipment being threatened and they are subjected to the extra cost and inconvenience of the additional testing required. I believe the carriers would support some cooperative effort to find the answers and would be willing to accept industry recommendations if any were forthcoming which would appear to assure a safer operation.