Mr. Manuel Gutierrez
Secretary, Gas Piping Standards Committee
American Society of Mechanical Engineers
United Engineering Center
345 East 47th Street
New York, Street 10017

Dear Mr. Gutierrez:

You letter of July 7, 1976, asks the status of the petitions to revise 49 CFR Part 192, Sections 192.121 and 192.123, as proposed by Mr. M.R. Green, Managing Director, Research, Codes, and Standards of ASME, in his October 23, 1972, letter. This letter enclosed a proposal from the Gas Piping Standards committee for increasing the 100❍F temperature restriction to permit operation under certain conditions up to 140❍F and adopting a single design factor of f=0.32 for use with thermoplastic pipe in natural gas piping systems.

The Committee's proposal did not provide back up material to support their proposal. It was found that data available to the Office of Pipeline Safety Operations (OPSO) on the characteristics of plastics at temperatures above 100❍F was limited and that there was no reliable data available on the actual plastic pipe temperatures measured at a sufficient number of locations across the nation to predict the maximum temperatures that may be anticipated in a given geographic location. Thus, processing was delayed pending search for and review of any information that was or became available. Also, as we advised you in our letter of September 20, 1974, the staffing limitations of our Office were causing further delays in the processing of all proposals for rulemaking received from the public.

Some data on the high temperature performance of certain plastics was obtained from work done for the American Gas Association by Battelle Memorial Institute and other work by the Plastics Pipe Institute on hot water applications. A contract study performed for OPSO on the "Pipeline Industry's Practices Using Plastic Pipe in Gas Pipeline Facilities and the Resulting Safety Factors" listed some other sources of data on thermoplastic materials at elevated temperatures. At about this same time, the DuPont Company began a series of tests at representative locations across the lower 48 States of the temperature of plastic service risers installed in steel pipe casing and has made all of their data from this study available to OPSO. Data gathered during three summers in this study shows a maximum temperature of 128❍F measured on a thermocouple installed at midwall on polyethylene pipe inside a model of a typical plastic service riser using a protective casing of steel pipe. These tests were conducted under severe climate conditions in the Arizona and California desert regions.

In our review of the available data on the elevated temperature characteristics of plastic materials, it was discovered that some researchers were finding what they called a "critical temperature" at which the physical characteristics were more severely affected than at lower temperatures. This critical temperature seems to occur on some thermoplastic materials in the range of 125°F to 130°F.

Based upon the above information, it appears appropriate to consider a new maximum temperature at some level below the requested 140°F. It is our intention to issue a notice of proposed rule making proposing that the temperature design bases of plastic pipe be revised in a manner that will recognize the various plastic material properties at different operating temperature ranges. This notice will also consider modification of the design factor for plastic pipe as recommended in your October 23, 1972, petition.

It is anticipated that a notice or notices of proposed rule making on temperature design limitations and design factors for plastic pipe will be issued in the fall of 1976.

Thank you for your interest in our pipeline safety program.

Sincerely,

Cesar DeLeon
Acting Director
Office of Pipeline
Safety Operations

DB
WP51\INTERPRT\192\121\76-09-30

Mr. Cesar DeLeon
Office of pipeline Safety Operations
Department of Transportation
2100 2nd Street, S.W.
Washington, DC 20590

Dear Mr. DeLeon:

By letter of October 23, 1972, Mr. M.R. Green, ASME Managing Director, Research, Codes and Standards, sent a proposal from the Gas Piping Standards Committee to your Office. This proposal recommended revisions to CFR 49, Part 192.121 and 192.123. The proposals included the establishment of four temperature bases of 73❍F, 100❍F, 120❍F, and 140❍F as a refinement and extension of the existing single temperature basis of 100❍F. There was additional material on the development of a new single design factor instead of the four presently specified.

Recently, I have received many questions from operators as to the status of this proposal. These operators are especially concerned with the changes in the temperature bases due to a growing problem with the use of plastic service line risers. As the result of the 100❍F temperature basis presently specified, the operators are currently required to sleeve that portion of the service line riser where it comes out of the ground and up to the meter set assembly. Usually, this service line riser is made of steel and as a result, must be cathodically protected. This is usually accomplished through the mechanism of a galvanic anode. Since this galvanic anode constitutes a form of a cathodic protection system, some agencies believe that it should be monitored. This presents some very substantial problems. First, in many locations, the service line from the stop valve up through the meter set assembly is owned by the customer. Therefore, there is a question of the company's obligation to monitor that galvanic anode. Secondly, there is the problem of the sheer numbers of these installations and the practicality of checking each one.

Therefore, we would like to know what your anticipated schedule is in terms of submitting this advance Notice of Proposed Rulemaking.

Thank you very much.

Very truly yours,

Manuel Gutierrez
Secretary
Gas Piping Standards Committee

DB
WP51\INTERPRT\192\121\76-09-30

Mr. Paul J. Cory
Office of Pipeline Safety (TES-32)
U.S. Department of Transportation
Washington, D.C. 20590

Subject: Proposed Revisions of DOT-OPS Federal Standards 192.121 and 192.123.

Dear Mr. Cory:

Per your telephone request this afternoon, I have enclosed a copy of the following material for your files:

Letter, Joseph C. Caldwell to M.R. Green, November 20, 1972.
Letter, M.R. Green to Joseph C. Caldwell, October 23, 1972.

I trust this correspondence will complete your files on this subject.

Sincerely,

Harvey Miller
Standards Engineer

DB
WP51\INTERPRT\192\121\76-09-30

Mr. M. R. Green
Managing Director
Research, Codes and Standards
The American Society of
  Mechanical Engineers
345 E. 47th Street
New York, New York 10017

Dear Mr. Green:

This will acknowledge receipt of your letter of October 23, 1972, which petitioned this Office to consider the recommendations concerning limitations on plastic pipe operating temperatures and design factors for a Notice of Proposed Rule Making.

This matter is being studied for further action.

Sincerely,

Joseph C. Caldwell
Director
Office of Pipeline Safety

Mr. Joseph C. Caldwell
Director
Office of Pipeline Safety
Department of Transportation
400 6th Street, S.W.
Washington, D. C. 20590

Dear Mr. Caldwell:

At the August meeting of the ASME Gas Piping Standards Committee the attached proposal was unanimously approved for submission to your office. What this proposal represents is an updating and refinement of the basic design philosophy for plastic pipe. When the original plastic design concept were developed for conclusion in the 1968 edition of the B31.8 Code there was little operating experience and little laboratory testing available. Therefore, certain assumptions and judgments had to be made which by necessity were grossly over-simplified and ultra-conservative.

In the years since the adoption of that first plastic pipe design system; thousands of miles of plastic pipe of various types have been designed, installed and operated successfully. Also, thousands of dollars of research have been conducted by A.G.A. at the Battelle Memorial Institute, by the Plastic Pipe Institute, and by the various manufacturers. All of these data and experience have been applied to a refinement of the plastic pipe design methods, with the result that a significant improvement has been made in the precision of plastic pipe design. However, it should be noted that this does not represent a wholesale increase in plastic pipe operating pressures. It is merely the utilization of experience and testing data to refine the methodology.

We recommend the adoption of this proposal since it represents a substantial advance in plastic pipe technology. Thank you very much.

Very truly yours,

M.R. Green
Managing Director, Research, Codes and Standards

Enclosure

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PROPOSED REVISIONS OF DOT - OPS FEDERAL
STANDARDS 192.121 AND 192.123

Summary of Proposed Revisions

1. Establish four temperature design bases of 73F, 100F, 120F and 140F as a refinement and extension of the existing single temperature design basis of 100F.

2.* Use a single design factor of 0.32 instead of one of four (0.20 to 0.32) currently specified. The design factor would be applied to the long-term hydrostatic strength of the selected material at one of the temperature design bases outlined in (1) above.

NOTE: To allow pipe producers sufficient time to develop the required test data at 100F to meet the proposed revision, a factor of 0.25 would be permitted to extend the present 73F date to a design temperature basis of 100F until 1975 or two years from adoption; whichever is greater.

Reasons

1. More efficient use of thermoplastic pipe will be accomplished by allowing the design engineer to equate material properties to design requirements over an extended temperature range.

2. The overall quality of thermoplastic piping will be improved because the proposed design concept will discriminate against pipe compounds which do not have satisfactory properties for the anticipated operating conditions.

3. Reliability and safety will be enhanced in the use of large size polyethylene pipe because of improved structural properties in underground service. Existing design requirements may result in excessively heavy pipe walls in some applications, which causes the pipe to behave more like a rigid structure than a flexible one. A flexible structure is more capable of adjusting to soil movement or other secondary loads. Also, it becomes more difficult to manufacture a product free from thermal stresses as the wall thickness is increased.

Justification for Revision #1

1. There are applications for the use of plastic pipe where the temperatures exceed 100F. Ground temperature at pipe depth in most of the United States would not exceed 73F. In the southwest, however, ground temperatures could exceed 100F at service line depth. Also, service lines brought above ground through protective sleeves could be subject to temperatures about 100F in many areas of the country. The existing regulation provides for a maximum of 100F in all systems. Existing requirements make no provision for the use of thermoplastics at temperatures in excess of 100F where selected products can provide safe service.

2. Strengths of thermoplastics are generally reduced as their temperature increases. The reduction in strength for thee plastics used for gas pipe is approximately 20% as the temperature increases from 73F to 100F. At temperatures above 100F, some thermoplastic compounds are capable of providing satisfactory service, while others are not. This is because the properties of all thermoplastic materials are temperature dependent, but not to the same degree (or better, perhaps, not of the same order of magnitude). Test data show that specific commercial compounds having the same material designation code (PVC 2110, PE 2306, etc) differ sufficiently among themselves at temperatures above 100F that it is impractical to use a single derating factor even for the same given type of material. The difference between different plastic materials (i.e., polyethylene vs. PVC) is even greater. To assure satisfactory performance, design pressures for specified design temperature bases must be based on actual long term hydrostatic strength tests made on specific plastic compounds at a temperature equal to or greater than the anticipated operating temperature. Extrapolation of data to a higher temperature design basis is unsound. ASTM D-2837, "Standard Method for Obtaining Hydrostatic Design Basis for Therm-plastic Pipe Materials," warns against this practice.

Justification for Revision #2

1. From the standpoint of sound engineering design, it is appropriate that known variables be accounted for directly, where feasible, and that the design factor be limited to variables not otherwise determinable. If the design pressure is based on strength values determined at or above the anticipated operating temperature, as proposed, there is not need to compensate for temperature in the design factor. On this basis, a design factor of 0.32 provides a level of safety at least as great as the presently believers that the proposed 0.32 design factor is still conservative but also believes its use is appropriate for all class locations, for the following reasons:

a. Extensive field surveys by the A.G.A. Plastic Pipe Committee over the past several years have not revealed a single incident attributable to stresses developed from allowable internal pressures. The potential problems associated with the stored energy contained in highly compressed gas in steel pipe are controlled by the design factors for the various class locations. Control for plastic piping is provided by minimum pipe wall requirements and the limitation on the design pressure for distribution systems of 100 psi contained in 192.123(a). With this kind of control, the additional limitation provided by different design factors for the four class locations is not needed.

b. The design factors for plastic pipe are applied to the minimum wall thicknesses specified in ASTM D2513. The actual wall thickness of plastic pipe is normally greater than the minimum because of the nature of the manufacturing process; i.e., the extruder must set his median wall thickness someplace above the minimum.

c. The result of 12 years of research on plastic pipe at Battelle Memorial Institute and additional research at other laboratories show that the long-term hydrostatic strength of plastic pipe obtained in tests with natural gas at 73.4F is essentially the same as that obtained with water. A design factor of 0.50 is used for water.

d. A gas design factor for polyethylene pipe slightly higher than 0.50 is used successfully in Europe and Australia.

e. For a typical plastic pipe installation, the maximum seasonal diurnal temperature would occur for only a few days or few hours per day for only part of the year. The strength data used to calculate the hydrostatic design basis are obtained with the walls of the plastic pipe maintained at the designated temperature continuously for the entire test period. This provides an additional conservative design bias from the hoop stress standpoint.

f. Plastic pipe, unlike more rigid piping materials, does not rely entirely on beam strength to resist the effect of secondary loading but to some extent on flexibility and plasticity. The effect of soil movement or superimposed external forces on plastic pipe are less severe than those associated with more rigid pipe. Paradoxically, the use of overly conservative design factors reduces safety by increasing the external stresses that arise from secondary loading. Because of the excessive wall thickness required, the pipe becomes more rigid and thus less able to compensate for soil movement and other sources of secondary loads.

<u>Historical Background</u>

Historically, the design factors given in Section 192.121(b) were developed in ASA B31.8 in 1864 based on consideration of the following:

1. With limited background and experience, it was decided to adopt a conservative approach and use a design strength for gas which was one-half the design strength then in use for water. The design strength for water had been established as one-half the long term hydrostatic strength of the pipe. The 0.50 design factor for water adopted in 1964

was based on experience gained in the early use of plastic pipe. Its use eliminated the burst type failures which had previously occurred occasionally, and since 1964 has been shown to be an appropriate design factor for water. The basic design factor, then, for natural gas was 0.25 of the long term hydrostatic, strength. There were two reasons for the selection of a more conservative design factor for natural gas. The first was the fact that long term test data obtained at 73.4F would be used to establish design pressures for operation at temperatures up to 100F. This aspect was based on test data which showed that the appropriate amount of derating for this temperature difference is about 20%. The second was to compensate for the then little-known effects of natural gas on plastics. This allowance was quite conservative, being based primarily on the requirements of CAB which for all practical purposes is no longer being specified for gas service. Both PE and PVC are a great deal more chemically inert than CAB in natural gas services.

2. Prior to the inclusion of plastic pipe provisions in the B31.8 Code, a gas design factor of 0.40 was used in the equivalent to Class 2 and 3 locations. It provided satisfactory performance. Based on satisfactory field experience for all materials, a design factor higher than 0.25 was indicated.

192.123 DESIGN LIMITATIONS FOR PLASTIC PIPE

(a) The design pressure may not exceed 100 psi for plastic pipe used in:

(1) Distribution systems; or
(2) Class 3 and 4 locations

(b) Plastic pipe may not be used where operating temperatures of the pipe will be:

(1) below minus 20F; or
(2) Above 140F for thermoplastic pipe or above 150F for reinforced thermosetting plastic pipe

(c) The wall thickness for thermoplastic pipe may not be less than 0.062 inches.

(d) The wall thickness for reinforced thermosetting plastic pipe may not be less than those listed in the following table:

Nominal Size in Inches	Minimum Wall Thickness in Inches

2	0.060
3	0.060
4	0.070
6 0.100	