Pressure Testing Requirements
for
Hazardous Liquid Pipelines
in
California

CSFM

February 18, 2009 revision

Introduction

To assist hydrostatic testing personnel and pipeline operators in understanding the requirements of the hydrostatic testing provisions of Chapter 5.5 of the California Government Code, the Office of the California State Fire Marshal (CSFM), has developed this Student Manual.

The information contained in this supplement is not new. Reporting procedures contained in this publication merely identify these requirements in a single easy-to-use student manual.

Comments or recommendations concerning this document are welcome and encouraged. Please send your comments to:

CDF/ State Fire Marshal
Pipeline Safety Division
P.O. Box 944246
Sacramento, California 94244-2460

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Subpart E- Hydrostatic Testing

§195.300 Scope

This subpart prescribes minimum requirements for the pressure testing of steel pipelines. However, this subpart does not apply to the movement of pipe under §195.424.

195.302 General Requirements

(a) Except as otherwise provided in this section and in §195.305(b) , no operator may operate a pipeline unless it has been pressure tested under this subpart without leakage. In addition, no operator may return to service a segment of pipeline that has been replaced, relocated, or otherwise changed until it has been pressure tested under this subpart without leakage.
(b) Except for pipelines converted under §195.5, the following pipelines may be operated without pressure testing under this subpart:

(1) Any hazardous liquid pipeline whose maximum operating pressure is established under §195.406(a)(5) that is-

(i) An interstate pipeline constructed before January 8, 1971;
(ii) An interstate offshore gathering line constructed before August 1, 1977;
(iii) An intrastate pipeline constructed before October 21, 1985; or
(iv) A low-stress pipeline constructed before August 11, 1994, that transports HVL.

(2) Any carbon dioxide pipeline constructed before July 12, 1991, that-

(i) Has its maximum operating pressure established under §195.406(a)(5); or
(ii) Is located in a rural area as part of a production field distribution system.

(3) Any low-stress pipeline constructed before August 11, 1994, that does not transport HVL.

(4) Those portions of older hazardous liquid and carbon dioxide pipelines for which an operator has elected the risk-based alternative under Sec. 195.303 and which are not required to be tested based on the risk-based criteria.

(c) Except for pipelines that transport HVL onshore, low-stress pipelines, and pipelines covered under Sec. 195.303, the following compliance deadlines apply to pipelines under paragraphs (b)(1) and (b)(2)(i) of this section that have not been pressure tested under this subpart:

(1) Before December 7, 1998, for each pipeline each operator shall-
(i) Plan and schedule testing according to this paragraph; or
(ii) Establish the pipelines maximum operating pressure under §195.406(a)(5).

(2) For pipelines scheduled for testing, each operator shall-
(i) Before December 7, 2000, pressure test-

(A) Each pipeline identified by name, symbol, or otherwise that existing records show contains more than 50 percent by mileage of electric resistance welded pipe manufactured before 1970; and
(B) At least 50 percent of the mileage of all other pipelines; and
(ii) Before December 7, 2003, pressure test the remainder of the pipeline mileage.

195.303 Risk-based alternative to pressure testing older hazardous liquid and carbon dioxide pipelines.

(a) An operator may elect to follow a program for testing a pipeline on risk-based criteria as an alternative to the pressure testing in Sec. 195.302(b)(1)(i)-(iii) and Sec. 195.302(b)(2)(i) of this subpart. Appendix B provides guidance on how this program will work. An operator electing such a program shall assign a risk classification to each pipeline segment according to the indicators described in paragraph (b) of this section as follows:
(1) Risk Classification A if the location indicator is ranked as low or medium risk, the product and volume indicators are ranked as low risk, and the probability of failure indicator is ranked as low risk;
(2) Risk Classification C if the location indicator is ranked as high risk; or
(3) Risk Classification B.

(b) An operator shall evaluate each pipeline segment in the program according to the following indicators of risk:

(1) The location indicator is-

(i) High risk if an area is non-rural or environmentally sensitive \1\; or
(ii) Medium risk; or
(iii) Low risk if an area is not high or medium risk.

(2) The product indicator is (See Appendix B-1 , Table 4).

(i) High risk if the product transported is highly toxic or is both highly volatile and flammable;
(ii) Medium risk if the product transported is flammable with a flashpoint of less than 100 deg. F, but not highly volatile; or
(iii) Low risk if the product transported is not high or medium risk.

(3) The volume indicator is-
(i) High risk if the line is at least 18 inches in nominal diameter;
(ii) Medium risk if the line is at least 10 inches, but less than 18 inches, in nominal diameter; or
(iii) Low risk if the line is not high or medium risk.

(4) The probability of failure indicator is-
(i) High risk if the segment has experienced more than three failures in the last 10 years due to time-dependent defects (e.g., corrosion, gouges, or problems developed during manufacture, construction or operation, etc.); or
(ii) Low risk if the segment has experienced three failures or less in the last 10 years due to time-dependent defects.

(c) The program under paragraph (a) of this section shall provide for pressure testing for a segment constructed of electric resistance-welded (ERW) pipe and lapwelded pipe manufactured prior to 1970 susceptible to longitudinal seam failures as determined through paragraph (d) of this section. The timing of such pressure test may be determined based on risk classifications discussed under paragraph (b) of this section. For other segments, the program may provide for use of a magnetic flux leakage or ultrasonic internal inspection survey as an alternative to pressure testing and, in the case of such segments in Risk Classification A, may provide for no additional measures under this subpart.

(d) All pre-1970 ERW pipe and lapwelded pipe is deemed susceptible to longitudinal seam failures unless an engineering analysis shows otherwise. In conducting an engineering analysis an operator must consider the seam-related leak history of the pipe and pipe manufacturing information as available, which may include the pipe steel's mechanical properties, including fracture toughness; the manufacturing process and controls related to seam properties, including whether the ERW process was high-frequency or low-frequency, whether the weld seam was heat treated, whether the seam was inspected, the test pressure and duration during mill hydrotest; the quality control of the steel-making process; and other factors pertinent to seam properties and quality.

(e) Pressure testing done under this section must be conducted in accordance with this subpart. Except for segments in Risk Classification B which are not constructed with pre-1970 ERW pipe, water must be the test medium.
(f) An operator electing to follow a program under paragraph (a) must develop plans that include the method of testing and a schedule for the testing by December 7, 1998. The compliance deadlines for completion of testing are as shown in the table below:

Table. - Sec. 195.303--Test Deadlines Risk

Pipeline segment	Classification	Test deadline
Pre-1970 Pipe susceptible to longitudinal seam failures[defined in Sec. 195.303(c) & (d)].	C or B	12/7/2000.
	A	12/7/2002.
All Other Pipeline Segments	C	12/7/2002.
	B	12/7/2004.
	A	Additional testing not required.

(g) An operator must review the risk classifications for those pipeline segments which have not yet been tested under paragraph (a) of this section or otherwise inspected under paragraph © of this section at intervals not to exceed 15 months. If the risk classification of an untested or uninspected segment changes, an operator must take appropriate action within two years, or establish the maximum operating pressure under Sec. 195.406(a)(5).

(h) An operator must maintain records establishing compliance with this section, including records verifying the risk classifications, the plans and schedule for testing, the conduct of the testing, and the review of the risk classifications.

(i) An operator may discontinue a program under this section only after written notification to the Administrator and approval, if needed, of a schedule for pressure testing.

§195.304 Test Pressure

The test pressure for each pressure test conducted under this subpart must be maintained throughout the part of the system being tested for at least 4 continuous hours at a pressure equal to 125 percent, or more, of the maximum operating pressure and, in the case of a pipeline that is not visually inspected for leakage during test, for at least an additional 4 continuous hours at a pressure equal to 110 percent, or more, of the maximum operating pressure.

§195.305 Testing Components

(a) Each pressure test under §195.302 must test all pipe and attached fittings, including components, unless otherwise permitted by paragraph (b) of this section.

(b) A component, other than pipe, that is the only item being replaced or added to the pipeline system need not be hydrostatically tested under paragraph (a) of this section if the manufacturer certifies that either-

(1) The component was hydrostatically tested at the factory; or

(2) The component was manufactured under a quality control system that ensures each component is at least equal in strength to a prototype that was hydrostatically tested at the factory.

195.306 Test Medium

a) Except as provided in paragraph (b), (c), and (d) of this section, water must be used as the test medium.
(b) Except for offshore pipelines, liquid petroleum that does not vaporize rapidly may be used as the test medium if-

(1) The entire pipeline under test is outside of cities and other populated areas;
(2) Each building within 300 feet of the test section is unoccupied while the test pressure is equal to or greater than a pressure which produces a hoop stress of 50 percent of specified minimum yield strength;
(3) The test section is kept under surveillance by regular patrols during the test; and,
(4) Continuous communication is maintained along entire test section.

(c) Carbon dioxide pipelines may use inert gas or carbon dioxide as the test medium if-

(1) The entire pipeline section under test is outside of cities and other populated areas;
(2) Each building within 300 feet of the test section is unoccupied while the test pressure is equal to or greater than a pressure that produces a hoop stress of 50 percent of specified minimum yield strength;
(3) The maximum hoop stress during the test does not exceed 80 percent of specified minimum yield strength;
(4) Continuous communication is maintained along entire test section; and,

(5) The pipe involved is new pipe having a longitudinal joint factor of 1.00.

(d) Air on inert gas may be used as the test medium in low-stress pipelines.

195.307 Pressure Testing aboveground breakout tanks

(a) For aboveground breakout tanks built to API Specification 12F and first placed in service after October 2, 2000, pneumatic testing must be in accordance with section 5.3 of API Specification 12F.
(b) For aboveground breakout tanks built to API Standard 620 and first placed in service after October 2, 2000, hydrostatic and pneumatic testing must be in accordance with section 5.18 of API Standard 620.

(c) For aboveground breakout tanks built to API Standard 650 and first placed in service after October 2, 2000, hydrostatic and pneumatic testing must be in accordance with section 5.3 of API Standard 650.

(d) For aboveground atmospheric pressure breakout tanks constructed of carbon and low alloy steel, welded or riveted, and non-refrigerated and tanks built to API Standard 650 or its predecessor Standard 12C that are returned to service after October 2, 2000, the necessity for the hydrostatic testing of repair, alteration, and reconstruction is covered in section 10.3 of API Standard 653.
(e) For aboveground breakout tanks built to API Standard 2510 and first placed in service after October 2, 2000, pressure testing must be in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or 2.

195.308 Testing of tie-ins.

Pipe associated with tie-ins must be pressure tested, either with the section to be tied in or separately.

§195.310 Records

(a) A record must be made of each pressure test required by this subpart, and the record of the latest test must be retained as long as the facility tested is in use.
(b) The record required by paragraph (a) of this section must include:

(1) The pressure recording charts;
(2) Test instrument calibration data;
(3) The name of the operator, the name of the person responsible for making the test, and the name of the test company used, if any;
(4) The date and time of the test;
(5) The minimum test pressure;
(6) The test medium;
(7) A description of the facility tested and the test apparatus;
(8) An explanation of any pressure discontinuities, including test failures, that appear on the pressure recording charts; and,

(9) Where elevation differences in the section under test exceed 100 feet, a profile of the pipeline that shows the elevation and test sites over the entire length of the test section.

Excerpts from the California Government Code
Pertaining to Hydrostatic Testing

§51013.5 Required Testing

(a) Every newly constructed pipeline, existing pipeline, or part of a pipeline system that has been relocated or replaced, and every pipeline that transports a hazardous liquid substance or highly volatile liquid substance, shall be tested in accordance with Subpart E (commencing with Section 195.300) of Part 195 of Title 49 or the Code of Federal Regulations.

(b) *NA*
(c) *NA*

(d) Every pipeline over 10 years of age and provided with effective cathodic protection shall be hydrostatically tested every five years, except for those on the State Fire Marshal's list of higher risk pipelines which shall be hydrostatically tested every two years.

(e) Piping within a refined products bulk loading facility served by pipeline shall be tested hydrostatically at 125 percent of maximum allowable operating pressure utilizing the product ordinarily transported in that pipeline if that piping is operated at a stress level of 20 percent or less of the specified minimum yield strength of the pipe. The frequency for pressure testing these pipelines shall be every five years for those pipelines with effective cathodic protection and every three years for those pipelines without effective cathodic protection. If that piping is observable, visual inspection may be the method of testing.

(e) Beginning on July 1, 1990, and continuing until the regulations adopted by the State Fire Marshal pursuant to subdivision (g) take effect, each pipeline within the State Fire Marshal's jurisdiction which satisfies any of the following sets of criteria shall be placed on the State Fire Marshal's list of higher risk pipelines until five years pass without a reportable leak due to corrosion or defect on that pipeline. Initially, pipelines on that list shall be tested by the next scheduled test date, or within two years of being placed on the list, whichever is first. On July 1, 1990, pipeline operators shall provide the State Fire Marshal with a list of all their pipelines, which satisfy the criteria in this subdivision as of July 1, 1990. If any pipeline become eligible for the list of higher risk pipelines after that date, the pipeline company shall report that fact the State Fire Marshal within 30 days, and the pipeline shall be placed on the list retroactively to the date on which it became eligible for listing. Pipelines, which are found to belong on the list, but are not so reported by the operator to the State Fire Marshal, shall be placed on the list retroactively. Operators failing to properly report their pipelines shall be subject to penalties under Section 51018.6. Pipelines not covered under the risk criteria developed pursuant to subdivision (g) shall be deleted from the list when

(f) regulations are adopted pursuant to that subdivision. For purposes of this subdivision, a leak which is traceable to an external force, but for which corrosion is partly responsible, shall be deemed caused by corrosion, "defect" refers to manufacturing or construction defects, and "leak" or "reportable leak" means a rupture required to be reported pursuant to Section 51018. As long as all pipelines are tested in their entirety at least as frequently as standard risk pipelines under subdivisions (c) and (d), it shall suffice for additional tests on higher risk pipelines to cover 20 pipeline miles in all directions along an operator's pipeline from the position of the leak or leaks which led to the inclusion or retention of that pipeline on the higher risk list. The interim list shall include pipelines, which meet any of the following criteria:

(1) Have suffered two or more reportable leaks, not including leaks during a certified hydrostatic pressure test, due to corrosion or defect in the prior three years;

(2) Have suffered three or more reportable leaks, not including leaks during a certified hydrostatic pressure test, due to corrosion, defects, or external forces, but not all due to external forces, in the prior three years;

(3) Have suffered a reportable leak, except during a certified hydrostatic pressure test, due to corrosion or defect of more than 50,000 gallons, or 10,000 gallons in a standard metropolitan statistical area, in the prior three years; or have suffered a leak due to corrosion or defect which the State Fire Marshal finds has resulted in more than 42 gallons of a hazardous liquid within the State Fire Marshal's jurisdiction entering a waterway in the prior three years; or have suffered a reportable leak of a hazardous liquid with a flashpoint of less than 140 degrees Fahrenheit, or 60 degrees centigrade, in the prior three years.

(4) Are less than 50 miles long, and have experienced a reportable leak, except during a certified hydrostatic pressure test, due to corrosion or a defect in the prior three years. For the purposes of this paragraph, the length of a pipeline with more than two termini shall be the longest distance between two termini along the pipeline.

(5) Have experienced a reportable leak in the prior five years due to corrosion or defect, except during a certified hydrostatic pressure test, on a section of pipe more than 50 years old. For pipelines which fall in this category, and no other category of higher risk pipeline, additional tests required by this subdivision shall be required only on segments of the pipe more than 50 years old as long as all pipe more than 50 years old which is within 20 pipeline miles from the leak in all directions along an operator's pipeline is tested.

(g) The State Fire Marshal shall study indicators and precursors of serious pipeline accidents, and, in consultation with the Pipeline Safety Advisory Committee, shall

(h) develop criteria for identifying which hazardous liquid pipelines pose the greatest risk to people and the environment due to the likelihood of, and likely seriousness of, an accident due to corrosion or defect. The study shall give due consideration to research done by the industry, the federal government, academia, and to any other information which the State Fire Marshal shall deem relevant, including, but not limited to, recent leak history, pipeline location, and material transported. Beginning January 1, 1992, using the criteria identified in that study, the State Fire Marshal shall maintain a list of higher risk pipelines, which exceed a standard of risk to be determined by the State Fire Marshal, and which shall be tested as required in subdivisions (c) and (d) as long as they remain on the list. By January 1, 1992, after public hearings, the State Fire Marshal shall adopt regulations to implement this subdivision.

(h) In addition to the requirements of subdivisions (a) to (e) inclusive, the State Fire Marshal may require any pipeline subject to this chapter to be subjected to a pressure test, or any other test or inspection, at any time, in the interest of public safety.

(i) Test methods other than the hydrostatic tests required by subdivisions (b), (c) (d) and (e), including inspection by instrumented internal inspection devices, may be approved by the State Fire Marshal on an individual basis. If the State Fire Marshal approves an alternative to a pressure test in an individual case, the State Fire Marshal may require that the alternative test be given more frequently than the testing frequencies specified in subdivisions (b), (c) (d) and (e).

(j) The State Fire Marshal shall adopt regulations before January 1, 1992, to establish what the State Fire Marshal deems to be an appropriate frequency for tests and inspections, including instrumented internal inspections, which, when permitted as a substitute for tests required under subdivisions (b), (c) and (d) do not damage pipelines or require them to be shut down for the testing period. That testing shall in no event be less frequent than is required by subdivisions (b), (c) and (d). Each time one of these tests is required on a pipeline, it shall be approved on the same individual basis as under subdivision (i). If it is not approved, a hydrostatic test shall be carried out at the time the alternative test would have been carried out, and subsequent tests shall be carried out in accordance with the time intervals prescribed by subdivision (b), (c) or (d), as applicable.

§51014 Testing procedure pursuant to Section 51013.5; Test pressure

(a) The pressure tests required by subdivisions (b), (c) and (d) of Section 51013.5 shall be conducted in accordance with Subpart E (commencing with Section 195.300) of Part 195 of Title 49 of the Code of Federal Regulations, except that

(b) an additional four-hour leak test, as specified in subsection (c) of Section 195.302 of Title 49 of the Code of Federal Regulations, shall not be required under subdivisions (b), (c) and (d) of Section 51013.5. The State Fire Marshal may authorize the use of liquid petroleum having a flashpoint over 140 degrees Fahrenheit or 60 degrees centigrade as the test medium. The State Fire Marshal shall make these authorizations in writing. Pressure tests performed under subdivisions (b), (c) and (d) of Section 51013.5 shall not show an hourly change for each section of the pipeline under test at the time in excess of either 10 gallons or the sum of one gallon and an amount computed at a rate in gallons per mile equivalent to one-tenth of the nominal internal diameter of the pipe in inches.

(b) Test pressure shall be at least 125 percent of the actual pipeline operating pressure.

§51014.3 Notice to State Fire Marshal prior to hydrostatic test

(a) Each pipeline operator shall notify the State Fire Marshal and the local fire department having fire suppression responsibilities at least three working days prior to conducting a hydrostatic test, which is required by this chapter. The notification shall include all of the following information:

(1) The name, address and telephone number of the pipeline operator.

(2) The specific location of the pipeline section to be tested and the location of the test equipment.

(3) The date and time the test is to be conducted.

(4) An invitation and a telephone number for local fire departments to call for further information on what they should do in event of a leak during testing.

(5) The test medium

(6) The name and telephone number of the independent testing firm or person responsible for certification of the test results.

(b) The State Fire Marshal may observe tests conducted pursuant to this chapter.

§51014.5 Certification and submission of test results

(a) When hydrostatic testing is required by Section 51013.5, the test results shall be certified by an independent testing firm or person who is selected from a list, provided by the State Fire Marshal, of independent testing firms or persons approved annually by the State Fire Marshal. The State Fire Marshal may charge a fee for consideration and approval of an independent testing firm or

person pursuant to this subdivision, not to exceed the reasonable costs of that consideration and approval.

(b) The results of the tests required by Section 51013.5 shall be submitted by the independent testing firm or person within 30 days after completion of the test to the State Fire Marshal, who may review the results. The report shall show all of the following information:

(1) The date of the test

(2) A description of the pipeline tested including a map of suitable scale showing the route of the pipeline.

(3) The results of the test

(4) Any other test information that may be specifically requested by the State Fire Marshal.

(b) The State Fire Marshal shall not supervise, control or otherwise direct the testing.

Excerpts from Title 19
California Code of Regulations Concerning Hydrostatic Testing

§2040. Fees In order to implement Chapter 5.5 of the Government Code, California Pipeline Safety Act of 1981, the following fees will be assessed on a fiscal year basis:

(a) Intrastate Pipelines
- (1) Pipeline operator $3,000
- (2) Charge per mile of pipeline operated $150
- (3) Independent Hydrostatic Testing Firm $1,500

(b) Interstate Pipelines
- (1) Pipeline Operator $3,000
- (2) Charge per mile of pipeline operated $100

Date of Test

Pipelines which are required to be tested by subdivisions (b), (c) and (d) of Section 51013.5 shall be tested within 90 days after the anniversary date of the last hydro-test. Requests for a waiver to this requirement must be made in writing to the address listed below. Each request will be reviewed on an individual basis and the operator will receive a written response from CSFM.

CDF/ State Fire Marshal
Pipeline Safety Division
3950 Paramount Blvd. #210
Lakewood, California 90712

Notification of Test to the CSFM

It is the responsibility of the *pipeline operator t*o notify the CSFM Pipeline Safety Division by telephoning (562) 497-9100 as appropriate *at least three working days prior to a pressure test date.*

The notification requirement is satisfied only for the date the test is first scheduled and any consecutive days as long the testing process continues. If the testing process is postponed or delayed to a later date, the operator must notify the CSFM and local fire department of the new test date.

Each test will be given a test identification number which must be included with the results of the test.

In an emergency, a notification period of less than three working days may be allowed if approved in advance by CSFM.

Notification of the Local Fire Department

It is the responsibility of the *pipeline operator* to notify the local authority having fire suppression authority *at least three working days prior to each hydrostatic test*.

Method of Testing

Pressure tests performed in compliance with Subdivisions (b), (c), and (d) of Section 51013.5, California Government Code, shall not show an hourly change for each pipeline segment under test in excess of either 10 gallons or the sum of one gallon and an amount computed at a rate in gallons per mile equivalent to one-tenth of the nominal internal diameter of the pipe in inches.

Allowable Hourly Change in Gallons (not to exceed 10 gallons) =

$$1 + \left[\frac{ID(inches)}{10} X \frac{L(ft)}{5280(ft)} \right]$$

ID: the internal diameter of the pipe segments.

Hourly Change: that amount of fluid that cannot be accounted for by direct measurement or through temperature/pressure/volume calculations. In other words, after accounting for fluid measurements and temperature change, the amount of unaccounted fluid loss is limited to the above formula.

Measurement of Pressure

A deadweight tester capable of measuring to 1psi increments shall be present during each test. The deadweight may be used either continuously throughout the test or at the beginning and at the end of the test. The deadweight tester shall be calibrated to a standard acceptable to the State Fire Marshal at least once every two years.

REQUIREMENTS:

1. Deadweight pressure readings shall be taken at a minimum of 1 hour increments.

2. A pressure recording chart shall continuously record the pressure on the pipe during the test. The pressure recording chart shall be calibrated prior to every test.

3. Except for pre-tested pipe, a pressure gauge or similar device shall be provided at each end of the test segment to indicate that the entire test segment is pressurized.

Measurement of Temperature

The temperature measuring devices shall be placed so as to provide a representative sample of the pipeline segment under test.

Responsibilities of Independent Hydrostatic Testing Company

The role of the independent hydro-testing testing company's representative is to witness the pressure test for the prescribed time, ascertain the extent of the test, record the necessary data and forward the results to the CSFM.

Section 51014.5, California Government Code requires that each hydrostatic test be certified by an independent testing firm or person approved by CSFM. It does not require nor authorize the testing firm or person to approve the test. *It is the pipeline operators responsibility and decision to verify and certify the test results.*

The name of the hydrostatic testing company's employee approved to witness the testing must be included on the current CSFM list of Approved Hydrostatic Testing Companies.

The witness must be present for the entire required test period. The required test periods are:

Newly constructed pipelines and pipelines where any segment is not entirely visible.....8 hours

Pipelines tested per DOT Integrity Management Program… ..8 hours

Pipelines where each segment under test is entirely visible.....4 hours

Pipelines tested solely for CA Government Code .....4 hours

Pipeline Operator is responsible for determining type of test and length of test.

The independent testing firm shall not witness or certify a test conducted on a pipeline on which they have performed new construction or repair work. This does not prohibit a testing firm or person from certifying test results on a pipeline they previously performed

work on. The requirement is designed to prevent a company from witnessing and/or certifying results for pipeline segments where the company has performed the repair or installation.

Minimum Requirements for Independent Testing Company

1. Determine the extent of the test. Verify that the entire test segment is under test.

2. Account for any fluid added to or drained from the pipeline. If a flange leaks during the test, measurement of the amount must be taken into account.

3. Observe and document the test pressure for the required test period. Record the minimum test pressure observed during the test. (This is critical since the pipelines operating pressure is based on this pressure.)

4. Provide a sketch or drawing or map of the pipeline segment tested.

5. Each witness should be qualified and be familiar with the minimum testing requirements.

6. Any testing inconsistencies should be brought to CSFM's attention immediately.

Test Results

Only the Test results required by CSFM shall be submitted in the format included in Appendix B-2. Test results shall be mailed to:

CDF/ State Fire Marshal
Pipeline Safety Division
3950 Paramount Blvd., Suite 210
Lakewood, California 90712

Facsimile or computer generated reports are also acceptable.

The test results submitted to the CSFM for review must include any calculations made to adjust for changes in volume due to temperature, pressure and elevation changes. Calculations used must represent commonly accepted standards such as those used by the American Petroleum Institute (API), industry or university level engineering courses. The operator may use test calculations provided by the independent testing firms.

If no calculations are provided, CSFM staff will evaluate the test results utilizing a standard formula and constants listed in Appendix C-2.

The CSFM test I.D. number should be placed in the upper right hand corner of every page of the hydrotest paperwork submitted for review. Test results will be reviewed by CSFM to insure the allowable hourly change criteria are met. If a test result is submitted without supporting calculations and shows an hourly loss greater than allowed, the operator must retest the pipeline or provide additional data or calculations.

Pre-tested Pipe

Pre-tested pipe is piping which has been hydrostatically tested prior to installation.

Hydrostatic testing of pre-tested pipe shall be witnessed by a approved representative of a certified independent hydrostatic testing company for a minimum of 4 hours.

The following information shall be marked on the outside of the pre-tested pipe at **intervals of approximately five feet:**

CSFM Test ID No.
Date of Test
Test Pressure.

Leaks Occurring During Hydrostatic Testing

Except for failures of pre-tested pipe, any leak on a pipeline undergoing a pressure test shall immediately be reported to the local fire department and to the California Office of Emergency Services (OES). The 24-hour emergency telephone number for OES is **1-800-852-7550**.

Except for small leaks on pipe valves or flange gaskets, all leaks occurring on the pipeline as a result of the testing process must be reported to CSFM on the hydrostatic test form. Information must include the location and cause of the failure.

How to Become a CSFM Approved Hydrostatic Testing Company

Section 51014.5, California Government Code, requires that all hydrostatic testing results submitted to the State Fire Marshal must be certified by an independent testing firm or person approved by the State Fire Marshal. Each year, the State Fire Marshal publishes a list of companies and persons who are approved to certify and witness hydrostatic tests for the following fiscal year.

Companies wishing to conduct hydrostatic testing or certify test results must make application to the State Fire Marshal using the form found in the Initial Application Approval as an Independent Hydrostatic Testing Firm form and pay the appropriate fee. Application form is available on SFM website: http://www.osfm.fire.ca.gov.

Engineering staff will examine the completed application and evaluate the qualifications, experience and training of the applicant's employees. An on-site evaluation will be conducted of the company's business location to determine if adequate equipment is available.

The applicant will be notified in writing of the approval or denial of the application. Approved applicants and their staff will be included on the State Fire Marshal's annual list of Approved Hydrostatic Companies.

Renewal of Annual Hydrostatic Testing Approval

Approved hydrostatic testing companies must submit application for renewal of their approved status to the State Fire Marshal each year. The State Fire Marshal will send each approved company an invoice and renewal form during May. Application and fees must be received prior to the beginning of the fiscal year. Companies who do not renew their approved status in a timely fashion may not be included in the annual publication of the State Fire Marshal's Approved Hydrostatic Testing Company list.

Pressure Tests Using Liquid Petroleum with a Flashpoint Over 140°F as the Test Medium

CSFM may authorize the use of liquid petroleum having a flashpoint over 140°F (60°C) as the test medium. All pressure tests using a liquid petroleum, which exceeds the maximum operating pressure, must be approved by the State Fire Marshal. *These includes tests, which are not required by the California Government Code.*

Note: Testing performed to comply with the DOT Integrity Management Rule must meet the requirements of Part 195.306 Test Medium. A written waiver to use product may be required. This process takes 60-90 days. Plan ahead.

The pipeline operator must apply in writing to:

CDF/State Fire Marshal
Pipeline Safety Division
3950 Paramount Blvd. Suite 210
Lakewood, California 90712

The request must contain the API or specific gravity and flashpoint of the test medium and all of the following data:

1. Necessity to use a product other than water

2 Proposed product to be used for testing

3. Test pressure (% of SYMS)

4. Pressure test procedures, which, at a minimum, address the following:

   (a) Communication along the entire pipeline route.
   (b) Personnel stationed at sensitive areas.
   (c) Procedures to follow in the event of a leak.
   (d) Notification of local fire departments.

5. CSFM personnel will observe each test where possible.

CSFM will review the application and provide a written response to the pipeline operator. CSFM staff may observe the testing at any time.

OFFICE OF THE STATE FIRE MARSHAL
PIPELINE SAFETY DIVISION
P.O. Box 944246
Sacramento, CA 94244-2460
Tel: (916)445-8477

NOTIFICATION OF PROPOSED PIG RUN OR HYDROSTATIC TEST

Date:

CSFM ID#:	Request Date:	Test Date:	Start Test Time:	Report Due Date:

Est. Time of Test: ☐ 4 Hours ☐ 8 Hours	Independent Testing Firm:
Facility ID#:	☐ **Notify the local Fire Department at least 3 working days prior to the Hydrostatic Test.**
Line ID #:	INSP Unit #:

Kind of Test: ☐ 2 Yrs ☐ 5 Yrs (CA) ☐ New Line ☐ Part 195 ☐ Pre-Tested Pipe ☐ Replacement/ Relocation ☐ Station Pipe (inc. Valve, Receiver)

Hydrotest: ☐ Yes ☐ No	Test Medium: ☐ Water ☐ Jet Fuel ☐ Diesel ☐ Fuel Oil ☐ Crude ☐ Other ☐ None/ Unknown
Pig Run: ☐ Yes ☐ No	Pig Run Code: ☐ Deformation ☐ Metal Loss ☐ Other ☐ None/Unknown

Test Length (in Feet):	Test Pressure (psig):	MOP Max. Pressure (psig):	Test Cycle (yrs):

Lat/Long Position: (Require Information must be include on the report.)
Begin from: Lat.: Long.:
End To: Lat.: Long.:

Test Equipments Location:

if other than water, has waiver been granted?: ☐ Yes ☐ No	Waiver Date:

Comments (additional Information):

Office of Pipeline Safety Use Only.

Assigned to Engineer Date:	Engineer:	Review Date:	Responsed Date:
Report Received Date:	Report Overdue:	Next Test Date:	

Test Result: ☐ Pass ☐ Fail ☐ Unknown	Leak During Hydro/Pig Run Test: ☐ Yes ☐ No ☐ Unknown
Call Received By:	Person Calling:
	Phone #: Fax #:

**** Return this form with the report to the Office of the State Fire Marshal - Pipeline Safety Division***

APPENDIX B-1
APPENDIX B TO PART 195 – RISK-BASED ALTERNATIVE TO PRESSURE TESTING OLDER HAZARDOUS LIQUID AND CARBON DIOXIDE PIPELINES
RISK-BASED ALTERNATIVE

This Appendix provides guidance on how a risk-based alternative to pressure testing older hazardous liquid and carbon dioxide pipelines rule allowed by Sec. 195.303 will work. This risk-based alternative establishes test priorities for older pipelines, not previously pressure tested, based on the inherent risk of a given pipeline segment. The first step is to determine the classification based on the type of pipe or on the pipeline segment's proximity to populated or environmentally sensitive area. Secondly, the classifications must be adjusted based on the pipeline failure history, product transported, and the release volume potential.

Tables 2-6 give definitions of risk classification A, B, and C facilities. For the purposes of this rule, pipeline segments containing high risk electric resistance-welded pipe (ERW pipe) and lapwelded pipe manufactured prior to 1970 and considered a risk classification C or B facility shall be treated as the top priority for testing because of the higher risk associated with the susceptibility of this pipe to longitudinal seam failures.

In all cases, operators shall annually, at intervals not to exceed 15 months, review their facilities to reassess the classification and shall take appropriate action within two years or operate the pipeline system at a lower pressure. Pipeline failures, changes in the characteristics of the pipeline route, or changes in service should all trigger a reassessment of the originally classification.

Table 1 explains different levels of test requirements depending on the inherent risk of a given pipeline segment. The overall risk classification is determined based on the type of pipe involved, the facility's location, the product transported, the relative volume of flow and pipeline failure history as determined from Tables 2-6.

Table 1. Test Requirements-Mainline Segments Outside of Terminals, Stations, and Tank Farms

Pipeline segment	Risk classification	Test deadline [1]	Test medium
Pre-1970 Pipeline Segments susceptible to longitudinal seam failures [2].	C or B	12/7/2000 [3] …….	Water only.
	A	12/7/2002 [3] …….	Water only.
All Other Pipeline Segments ……	C	12/7/2002 [4] …….	Water only.
	B	12/7/2004 [4] …….	Water/Liq. [5]
	A	Additional pressure testing not required	

[1] If operational experience indicates a history of past failures for a particular pipeline segment, failure causes (time-dependent defects due to corrosion, construction, manufacture, or transmission problems, etc.) shall be reviewed in determining risk classification (See Table 6) and the timing of the pressure test should be accelerated.

[2] All pre-1970 ERW pipeline segments may not require testing. In determining which ERW pipeline segments should be included in this category, an operator must consider the seam-related leak history of the pipe and pipe manufacturing information as available, which may include the pipe steel's mechanical properties, including fracture toughness; the manufacturing process and controls related to seam properties, including whether the ERW process was high-frequency or low-frequency, whether the weld seam was heat treated, whether the seam was inspected, the test pressure and duration during mill hydrotest; the quality control of the steel-making process; and other factors pertinent to seam properties and quality.

[3] For those pipeline operators with extensive mileage of pre-1970 ERW pipe, any waiver requests for timing relief should be supported by an assessment of hazards in accordance with location, product, volume, and probability of failure considerations consistent with Tables 3, 4, 5, and 6.

[4] A magnetic flux leakage or ultrasonic internal inspection survey may be utilized as an alternative to pressure testing where leak history and operating experience do not indicate leaks caused by longitudinal cracks or seam failures.

[5] Pressure tests utilizing a hydrocarbon liquid may be conducted, but only with a liquid which does not vaporize rapidly.

Using LOCATION, PRODUCT, VOLUME, and FAILURE HISTORY ``Indicators'' from Tables 3, 4, 5, and 6 respectively, the overall risk classification of a given pipeline or pipeline segment can be established from Table 2. The LOCATION Indicator is the primary factor which determines overall risk, with the PRODUCT, VOLUME, and PROBABILITY OF FAILURE Indicators used to adjust to a higher or lower overall risk classification per the following table.

Table 2.-Risk Classification

Risk Classification	Hazard location indicator	Product/volume indicator	Probability of failure indicator
A ……..	L or M ……	L/L ……	L.
B ……..		Not A or C Risk Classification	
C ……..	H ……	Any ……..	Any.

H=High M=Moderate L=Low.

Note: For Location, Product, Volume, and Probability of Failure Indicators, see Tables 3, 4, 5, and 6.

Table 3 is used to establish the LOCATION Indicator used in Table 2. Based on the population and environment characteristics associated with a pipeline facility's location, a LOCATION Indicator of H, M or L is selected.

Table 3.-Location Indicators-Pipeline Segments

Indicator	Population [1]	Environment [2]
H ……..	Non-rural areas …….	Environmentally sensitive [2] areas.
M	…….	
L …….	Rural areas …….	Not environmentally sensitive [2] areas.

[1] The effects of potential vapor migration should be considered for pipeline segments transporting highly volatile or toxic products.
[2] We expect operators to use their best judgment in applying this factor.
Tables 4, 5 and 6 are used to establish the PRODUCT, VOLUME, and PROBABILITY OF FAILURE Indicators respectively, in Table 2. The PRODUCT Indicator is selected from Table 4 as H, M, or L based on the acute and chronic hazards associated with the product transported. The VOLUME Indicator is selected from Table 5 as H, M, or L based on the nominal diameter of the pipeline. The Probability of Failure Indicator is selected from Table 6.

Table 4.-Product Indicators

Indicator	Considerations	Product examples
H ……..	(Highly volatile and flammable)…..	(Propane, butane, Natural Gas Liquid (NGL), ammonia)
	Highly toxic ……..	(Benzene, high Hydrogen Sulfide content crude oils).
M ……..	Flammable – flashpoint < 100F ….	(Gasoline, JP4, low flashpoint crude oils)
L ……..	Non-flammable – flashpoint 100+F..	(Diesel, fuel oil, kerosene, JP5, most crude oils).
	Highly volatile and non-flammable/non-toxic	Carbon Dioxide.

Considerations: The degree of acute and chronic toxicity to humans, wildlife, and aquatic life; reactivity; and, volatility, flammability, and water solubility determine the Product Indicator. Comprehensive Environmental Response, Compensation and Liability Act Reportable Quantity values can be used as an indication of chronic toxicity. National Fire Protection Association health factors can be used for rating acute hazards.

Table 5.-Volume Indicators

Indicator	Line size
H ……..	>= 18”.
M ……..	10” – 16” nominal diameters.
L ……...	<= 8” nominal diameter.

H=High M=Moderate L=Low.

Table 6 is used to establish the PROBABILITY OF FAILURE Indicator used in Table 2. The ``Probability of Failure'' Indicator is selected from Table 6 as H or L.

Table 6.-Probability of Failure Indicators [in each haz. location]

Indicator	Failure history (time-dependent defects) [2]
H[1] …….	> Three spills in last 10 years.
L …….	<= Three spills in last 10 years.

H=High L=Low.

[1] Pipeline segments with greater than three product spills in the last 10 years should be reviewed for failure causes as described in subnote [2]. The pipeline operator should make an appropriate investigation and reach a decision based on sound engineering judgment, and be able to demonstrate the basis of the decision.

[2] Time-Dependent Defects are defects that result in spills due to corrosion, gouges, or problems developed during manufacture, construction or operation, etc.

[Amdt 195-65 , 63 FR 59475, Nov 4, 1998, as amended by Amdt 195-65A, 64 FR 6814, February 11, 1999]

Appendix B-2 – Test Results Format

CALIFORNIA STATE FIRE MARSHAL

PIPELINE SAFETY DIVISION

HYDROSTATIC TEST RESULTS

PIPELINE DATA

Test Date	CSFM Test ID #
Pipeline Operator	Independent Testing Firm

Kind of Test [ ] Annual [ ] 2 Year [ ] 3 Year [ ] 5 Year [ ] 10 Year

Pipeline Identification (description, line number, name, pre-tested pipe, etc.)

[ ] Pre-tested pipe [ ] New [ ] Replacement or relocation [ ] Station piping

Pipeline Location (mile post, street, station, etc.)

CSFM #: 00000-0000	From: To:

Normal Product Transported

Test Medium [ ] Water [ ] Diesel [ ] Fuel Oil [ ] JP-5 [ ] Other

Location of Deadweight Tester	Elevation

Elevation of Pipeline - High Point Low Point

Maximum Operating Pressure (Based on 80% of Minimum Test Pressure)

PIPE DATA

Pipe O.D.	Wall Thickness	Specification & Grade (SYMS)	Length of Pipe Being tested (ft.)	Volume (Barrels)

TEST EQUIPMENT

Make of Deadweight Tester	Serial #	Date Last Calibrated
Make of Pressure Chart Recorder	Serial #	Date Last Calibrated
Make of Temperature Recorder	Serial #	Date Last Calibrated

COMMENTS (additional Information)

GPS LOCATIONS:

Beginning Location: Latitude: Longitude:	**Ending Location:** Latitude: Longitude:

TEST DATA					CSFM TEST ID #			
Date	**Time**	**Deadweight Pressure (psig)**	**Chart Pressure (psig)**	**Pipe Wall Temp**	**Ambient Temp**	**Medium Temp.**	**Test Medium Change (+) Added (-) Drained**	**Comments**
Net Change:								

LIST ALL LEAKS ON LINE PIPE RESULTING FROM UNSUCCESSFUL TEST ATTEMPTS	
LOCATION	CAUSE

CERTIFICATION	
Name of Company Conducting Test	
Name of Independent Testing Firm Witnessing Test	
Name of Certified Independent Witness on Site	Date
Pipeline Operator's Representative on Site	Date
Name of Person Certifying Test Data for Witnessing Firm	Date

APPENDIX C-1

IMP Rule section 195.450-(Appendix C)

This Appendix gives guidance to help an operator implement the requirements of the integrity management program rule in §§ 195.450 and 195.452. Guidance is provided on:

(1) Information an operator may use to identify a high consequence area and factors an operator can use to consider the potential impacts of a release on an area;
(2) Risk factors an operator can use to determine an integrity assessment schedule;
(3) Safety risk indicator tables for leak history, volume or line size, age of pipeline, and product transported, an operator may use to determine if a pipeline segment falls into a high, medium or low risk category;
(4) Types of internal inspection tools an operator could use to find pipeline anomalies;

(5) Measures an operator could use to measure an integrity management program's performance; and
(6) Types of records an operator will have to maintain.
(7) Types of conditions that an integrity assessment may identify that an operator should include in its required schedule for evaluation and remediation.

I. Identifying a high consequence area and factors for considering a pipeline segment's potential impact on a high consequence area.

A. The rule defines a High Consequence Area as a high population area, an other populated area, an unusually sensitive area, or a commercially navigable waterway. The Office of Pipeline Safety (OPS) will map these areas on the National Pipeline Mapping System (NPMS). An operator, member of the public, or other government agency may view and download the data from the NPMS home page http://www.npms.rspa.dot.gov. OPS will maintain the NPMS and update it periodically. However, it is an operator's responsibility to ensure that it has identified all high consequence areas that could be affected by a pipeline segment. An operator is also responsible for periodically evaluating its pipeline segments to look for population or environmental changes that may have occurred around the pipeline and to keep its program current with this information. (Refer to §195.452(d)(3).) For more information to help in identifying high consequence areas, an operator may refer to:

(1) Digital Data on populated areas available on U.S. Census Bureau maps.
(2) Geographic Database on the commercial navigable waterways available on http://www.bts.gov/gis/ntatlas/networks.html.
(3) The Bureau of Transportation Statistics database that includes commercially navigable waterways and non-commercially navigable waterways. The database can be downloaded from the BTS website at http://www.bts.gov/gis/ntatlas/networks.html.

B. The rule requires an operator to include a process in its program for identifying which pipeline segments could affect a high consequence area and to take measures to prevent and

mitigate the consequences of a pipeline failure that could affect a high consequence area. (See §§ 195.452 (f) and (i).) Thus, an operator will need to consider how each pipeline segment could affect a high consequence area. The primary source for the listed risk factors is a US DOT study on instrumented Internal Inspection devices (November 1992). Other sources include the National Transportation Safety Board, the Environmental Protection Agency and the Technical Hazardous Liquid Pipeline Safety Standards Committee. The following list provides guidance to an operator on both the mandatory and additional factors:

(1) Terrain surrounding the pipeline. An operator should consider the contour of the land profile and if it could allow the liquid from a release to enter a high consequence area. An operator can get this information from topographical maps such as U.S. Geological Survey quadrangle maps.
(2) Drainage systems such as small streams and other smaller waterways that could serve as a conduit to a high consequence area.
(3) Crossing of farm tile fields. An operator should consider the possibility of a spillage in the field following the drain tile into a waterway.

(4) Crossing of roadways with ditches along the side. The ditches could carry a spillage to a waterway.
(5) The nature and characteristics of the product the pipeline is transporting (refined products, crude oils, highly volatile liquids, etc.) Highly volatile liquids becomes gaseous when exposed to the atmosphere. A spillage could create a vapor cloud that could settle into the lower elevation of the ground profile.
(6) Physical support of the pipeline segment such as by a cable suspension bridge. An operator should look for stress indicators on the pipeline (strained supports, inadequate support at towers), atmospheric corrosion, vandalism, and other obvious signs of improper maintenance.

(7) Operating conditions of the pipeline (pressure, flow rate, etc.). Exposure of the pipeline to an operating pressure exceeding the established maximum operating pressure.
(8) The hydraulic gradient of the pipeline.
(9) The diameter of the pipeline, the potential release volume, and the distance between the isolation points.
(10) Potential physical pathways between the pipeline and the high consequence area.

(11) Response capability (time to respond, nature of response).
(12) Potential natural forces inherent in the area (flood zones, earthquakes, subsidence areas, etc.)

II. Risk factors for establishing frequency of assessment.

A. By assigning weights or values to the risk factors, and using the risk indicator tables, an operator can determine the priority for assessing pipeline segments, beginning with those segments that are of highest risk, that have not previously been assessed. This list provides some guidance on some of the risk factors to consider (see §195.452
(e)). An operator should also develop factors specific to each pipeline segment it is assessing, including:

(1) Populated areas, unusually sensitive environmental areas, National Fish Hatcheries, commercially navigable waters, areas where people congregate.
(2) Results from previous testing/inspection. (See §195.452(h).)
(3) Leak History. (See leak history risk table.)
(4) Known corrosion or condition of pipeline. (See §195.452((g).)
(5) Cathodic protection history.
(6) Type and quality of pipe coating (disbonded coating results in corrosion).

(7) Age of pipe (older pipe shows more corrosion–may be uncoated or have an ineffective coating) and type of pipe seam. (See Age of Pipe risk table.)
(8) Product transported (highly volatile, highly flammable and toxic liquids present a greater threat for both people and the environment) (see Product transported risk table.)
(9) Pipe wall thickness (thicker walls give a better safety margin)
(10) Size of pipe (higher volume release if the pipe ruptures).
(11) Location related to potential ground movement (e.g., seismic faults, rock quarries, and coal mines); climatic (permafrost causes settlement–Alaska); geologic (landslides or subsidence).

(12) Security of throughput (effects on customers if there is failure requiring shutdown).
(13) Time since the last internal inspection/pressure testing.
(14) With respect to previously discovered defects/anomalies, the type, growth rate, and size.
(15) Operating stress levels in the pipeline.
(16) Location of the pipeline segment as it relates to the ability of the operator to detect and respond to a leak. (e.g., pipelines deep underground, or in locations that make leak detection difficult without specific sectional monitoring and/or significantly impede access for spill response or any other purpose).

(17) Physical support of the segment such as by a cable suspension bridge.
(18) Non-standard or other than recognized industry practice on pipeline installation (e.g., horizontal directional drilling).

B. Example: This example illustrates a hypothetical model used to establish an integrity assessment schedule for a hypothetical pipeline segment. After we determine the risk factors applicable to the pipeline segment, we then assign values or numbers to each factor, such as, high (5), moderate (3), or low (1). We can determine an overall risk classification (A, B, C) for the segment using the risk tables and a sliding scale (values 5 to 1) for risk factors for which tables are not provided. We would classify a segment as C if it fell above 2/3 of maximum value (highest overall risk value for any one segment when compared with other segments of a pipeline), a segment as B if it fell between 1/3 to 2/3 of maximum value, and the remaining segments as A.

i. For the baseline assessment schedule, we would plan to assess 50% of all pipeline segments covered by the rule, beginning with the highest risk segments, within the first 3½ years and the remaining segments within the seven-year period. For the continuing integrity assessments, we would plan to assess the C segments within the first two (2) years of the schedule, the segments classified as moderate risk no later than year three or four and the remaining lowest risk

segments no later than year five (5).

ii. For our hypothetical pipeline segment, we have chosen the following risk factors and obtained risk factor values from the appropriate table. The values assigned to the risk factors are for illustration only.

Age of pipeline: assume 30 years old (refer to "Age of Pipeline" risk table)–
Risk Value=5
Pressure tested: tested once during construction–
Risk Value=5
Coated: (yes/no)–yes
Coating Condition: Recent excavation of suspected areas showed holidays in coating (potential corrosion risk)–
Risk Value=5
Cathodically Protected: (yes/no)–yes–Risk Value=1
Date cathodic protection installed: five years after pipeline was constructed (Cathodic protection installed within one year of the pipeline's construction is generally considered low risk.)–Risk Value=3

Close interval survey: (yes/no)–no–Risk Value =5
Internal Inspection tool used: (yes/no)–yes. Date of pig run? In last five years–Risk Value=1
Anomalies found: (yes/no)–yes, but do not pose an immediate safety risk or environmental hazard–Risk Value=3
Leak History: yes, one spill in last 10 years. (refer to "Leak History" risk table)–Risk Value=2
Product transported: Diesel fuel. Product low risk. (refer to "Product" risk table)–Risk Value=1

Pipe size: 16 inches. Size presents moderate risk (refer to "Line Size" risk table)–Risk Value=3

iii. Overall risk value for this hypothetical segment of pipe is 34. Assume we have two other pipeline segments for which we conduct similar risk rankings. The second pipeline segment has an overall risk value of 20, and the third segment, 11. For the baseline assessment we would establish a schedule where we assess the first segment (highest risk segment) within two years, the second segment within five years and the third segment within seven years. Similarly, for the continuing integrity assessment, we could establish an assessment schedule where we assess the highest risk segment no later than the second year, the second segment no later than the third year, and the third segment no later than the fifth year.

III. Safety risk indicator tables for leak history, volume or line size, age of pipeline, and product transported.

LEAK HISTORY

Safety risk indicator	Leak history (Time-dependent defects)1
High	> 3 Spills in last 10 years
Low	< 3 Spills in last 10 years

1. Time-dependent defects are those that result in spills due to corrosion, gouges, or problems developed during manufacture, construction or operation, etc.

LINE SIZE OR VOLUME TRANSPORTED

Safety risk indicator	Line size
High	= 18"
Moderate	10"–16" nominal diameters
Low	= 8" nominal diameter

AGE OF PIPELINE

Safety risk indicator	Age Pipeline condition dependent1
High	> 25 years
Low	25 years

1 Depends on pipeline's coating & corrosion condition, and steel quality, toughness, welding.

PRODUCT TRANSPORTED

Safety risk indicator	Considerations1	Product examples
High	(Highly volatile and flammable)	(Propane, butane, Natural Gas Liquid (NGL), ammonia).
	Highly toxic	(Benzene, high Hydrogen Sulfide content crude oils).
Medium	Flammable-flashpoint <100F	(Gasoline, JP4, low flashpoint crude oils).
Low	Non-flammable–flashpoint 100+F	(Diesel, fuel oil, kerosene, JP5, most crude oils).

1 The degree of acute and chronic toxicity to humans, wildlife, and aquatic life; reactivity; and, volatility, flammability, and water solubility determine the Product Indicator. Comprehensive Environmental Response, Compensation and Liability Act Reportable Quantity values may be used as an indication of chronic toxicity. National Fire Protection Association health factors may be used for rating acute hazards.

IV. Types of internal inspection tools to use.

An operator should consider at least two types of internal inspection tools for the integrity assessment from the following list. The type of tool or tools an operator selects will depend on the results from previous internal inspection runs, information analysis and risk factors specific to the pipeline segment:

(1) Geometry Internal inspection tools for detecting changes to ovality, e.g., bends, dents, buckles or wrinkles, due to construction flaws or soil movement, or other outside force damage;
(2) Metal Loss Tools (Ultrasonic and Magnetic Flux Leakage) for determining pipe wall anomalies, e.g., wall loss due to corrosion.
(3) Crack Detection Tools for detecting cracks and crack-like features, e.g., stress corrosion cracking (SCC), fatigue cracks, narrow axial corrosion, toe cracks, hook cracks, etc.

V. Methods to measure performance.

A. General.

(1) This guidance is to help an operator establish measures to evaluate the effectiveness of its integrity management program. The performance measures required will depend on the details of each integrity management program and will be based on an understanding and analysis of the failure mechanisms or threats to integrity of each pipeline segment.
(2) An operator should select a set of measurements to judge how well its program is performing. An operator's objectives for its program are to ensure public safety, prevent or minimize leaks and spills and prevent property and environmental damage. A typical integrity management program will be an ongoing program and it may contain many elements. Therefore, several performance measure are likely to be needed to measure the effectiveness of an ongoing program.

B. Performance measures. These measures show how a program to control risk on pipeline segments that could affect a high consequence area is progressing under the integrity management requirements. Performance measures generally fall into three categories:

(1) Selected Activity Measures–Measures that monitor the surveillance and preventive activities the operator has implemented. These measure indicate how well an operator is implementing the various elements of its integrity management program.
(2) Deterioration Measures–Operation and maintenance trends that indicate when the integrity of the system is weakening despite preventive measures. This category of performance measure may indicate that the system condition is deteriorating despite well executed preventive activities.

(3) Failure Measures–Leak History, incident response, product loss, etc. These measures will indicate progress towards fewer spills and less damage.

C. Internal vs. External Comparisons. These comparisons show how a pipeline segment that could affect a high consequence area is progressing in comparison to the operator's other pipeline segments that are not covered by the integrity management requirements and how that pipeline segment compares to other operators' pipeline segments.

(1) Internal–Comparing data from the pipeline segment that could affect the high consequence area with data from pipeline segments in other areas of the system may indicate the effects from the attention given to the high consequence area.
(2) External–Comparing data external to the pipeline segment (e.g., OPS incident data) may provide measures on the frequency and size of leaks in relation to other companies.

D. Examples. Some examples of performance measures an operator could use include–

(1) A performance measurement goal to reduce the total volume from unintended releases by -% (percent to be determined by operator) with an ultimate goal of zero.
(2) A performance measurement goal to reduce the total number of unintended releases (based on a threshold of 5 gallons) by ____-% (percent to be determined by operator) with an ultimate goal of zero.

(3) A performance measurement goal to document the percentage of integrity management activities completed during the calendar year.

(4) A performance measurement goal to track and evaluate the effectiveness of the operator's community outreach activities.
(5) A narrative description of pipeline system integrity, including a summary of performance improvements, both qualitative and quantitative, to an operator's integrity management program prepared periodically.
(6) A performance measure based on internal audits of the operator's pipeline system per 49 CFR Part 195.
(7) A performance measure based on external audits of the operator's pipeline system per 49 CFR Part 195.

(8) A performance measure based on operational events (for example: relief occurrences, unplanned valve closure, SCADA outages, etc.) that have the potential to adversely affect pipeline integrity.
(9) A performance measure to demonstrate that the operator's integrity management program reduces risk over time with a focus on high risk items.
(10) A performance measure to demonstrate that the operator's integrity management program for pipeline stations and terminals reduces risk over time with a focus on high risk items.

VI. Examples of types of records an operator must maintain.

The rule requires an operator to maintain certain records. (See §195.452(l)). This section provides examples of some records that an operator would have to maintain for inspection to comply with the requirement. This is not an exhaustive list.

(1) a process for identifying which pipelines could affect a high consequence area and a document identifying all pipeline segments that could affect a high consequence area;
(2) a plan for baseline assessment of the line pipe that includes each required plan element;
(3) modifications to the baseline plan and reasons for the modification;
(4) use of and support for an alternative practice;
(5) a framework addressing each required element of the integrity management program, updates and changes to the initial framework and eventual program;

(6) a process for identifying a new high consequence area and incorporating it into the baseline plan, particularly, a process for identifying population changes around a pipeline segment;
(7) an explanation of methods selected to assess the integrity of line pipe;
(8) a process for review of integrity assessment results and data analysis by a person qualified to evaluate the results and data;
(9) the process and risk factors for determining the baseline assessment interval;

(10) results of the baseline integrity assessment;
(11) the process used for continual evaluation, and risk factors used for determining the frequency of evaluation;

(12) process for integrating and analyzing information about the integrity of a pipeline, information and data used for the information analysis;
(13) results of the information analyses and periodic evaluations;
(14) the process and risk factors for establishing continual re-assessment intervals;
(15) justification to support any variance from the required re-assessment intervals;

(16) integrity assessment results and anomalies found, process for evaluating and repairing anomalies, criteria for repair actions and actions taken to evaluate and repair the anomalies;
(17) other remedial actions planned or taken;
(18) schedule for evaluation and repair of anomalies, justification to support deviation from required repair times;
(19) risk analysis used to identify additional preventive or mitigative measures, records of preventive and mitigative actions planned or taken;

(20) criteria for determining EFRD installation;
(21) criteria for evaluating and modifying leak detection capability;

(22) methods used to measure the program's effectiveness.

VII. Conditions that may impair a pipeline's integrity.

Section 195.452(h) requires an operator to evaluate and remediate all pipeline integrity issues raised by the integrity assessment or information analysis. An operator must develop a schedule that prioritizes conditions discovered on the pipeline for evaluation and remediation. The following are some examples of conditions that an operator should schedule for evaluation and remediation.

A. Any change since the previous assessment.
B. Mechanical damage that is located on the top side of the pipe.
C. An anomaly abrupt in nature.
D. An anomaly longitudinal in orientation.
E. An anomaly over a large area.
F. An anomaly located in or near a casing, a crossing of another pipeline, or an area with suspect cathodic protection.

[Amdt. 195-70, 65 FR 75378, Dec. 1, 2000; Amdt. 195-74, 67 FR 1650. Jan 14, 2002]

Appendix C-2 – Standard Formulas used for Pressure / Temperature Calculations

CSFM Standardized formula for performing pressure – temperature calculations to determine volume change.

Basic Formula: $\Delta V / V = Kp\Delta P + Kt\Delta T$

Where: $Kp = [(D / t)(5 / 4 - \mu) / E] + 1 / \beta = (1.9 D / 2 E t) + 1 / \beta$

And: $Kt = 3a - g$

ΔP	=	Liquid Pressure Change
ΔT	=	Liquid Temperature Change
ΔV	=	Liquid Volume added to that inside the pipe (negative if flows out)
V	=	Nominal Pipe Volume = $\pi D^2 L / 4$
D	=	Inside Pipe Diameter
L	=	Pipe Length
t	=	Pipe wall thickness
μ	=	Poisson's ratio = 0.3
E	=	Young's Modulus = 30 * 10^6 psi
β	=	Liquid Bulk Modulus, a function of Pressure and Temperature
g	=	Liquid Volumetric expansion coefficient, a function of Pressure and Temperature
a	=	Linear coefficient of Thermal Expansion = 6.5 * 10^ -6 1/ ^{0}F

Appendix C-2 – Standard Formulas used for Pressure / Temperature Calculations

Name of Range: BULK

Bulk Modulus Values for water x 10^3

	Temperature																	
Pressure	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
14.70	306.50	307.50	308.40	309.10	310.00	310.70	311.20	312.00	312.70	313.20	314.00	314.60	315.20	315.70	316.20	316.90	317.50	318.00
100	306.97	307.50	308.40	309.10	310.00	310.70	311.20	312.00	312.70	313.20	314.00	314.60	315.20	315.70	316.20	316.90	317.50	318.00
200	307.44	307.50	308.40	309.10	310.00	310.70	311.20	312.00	312.70	313.20	314.00	314.60	315.20	315.70	316.20	316.90	317.50	318.00
300	307.91	307.50	308.40	309.10	310.00	310.70	311.20	312.00	312.70	313.20	314.00	314.60	315.20	315.70	316.20	316.90	317.50	318.00
400	308.38	307.50	308.40	309.10	310.00	310.70	311.20	312.00	312.70	313.20	314.00	314.60	315.20	315.70	316.20	316.90	317.50	318.00
500	308.85	307.50	308.40	309.10	310.00	310.70	311.20	312.00	312.70	313.20	314.00	314.60	315.20	315.70	316.20	316.90	317.50	318.00
600	309.32	307.50	308.40	309.10	310.00	310.70	311.20	312.00	312.70	313.20	314.00	314.60	315.20	315.70	316.20	316.90	317.50	318.00
700	309.79	307.50	308.40	309.10	310.00	310.70	311.20	312.00	312.70	313.20	314.00	314.60	315.20	315.70	316.20	316.90	317.50	318.00
800	310.26	307.50	308.40	309.10	310.00	310.70	311.20	312.00	312.70	313.20	314.00	314.60	315.20	315.70	316.20	316.90	317.50	318.00
900	310.73	307.50	308.40	309.10	310.00	310.70	311.20	312.00	312.70	313.20	314.00	314.60	315.20	315.70	316.20	316.90	317.50	318.00
1000	311.20	312.00	312.70	313.60	314.50	315.30	316.00	316.60	317.60	318.30	319.20	320.00	320.50	321.00	322.00	322.50	323.00	323.50
1100	311.20	312.00	312.70	313.60	314.50	315.30	316.00	316.60	317.60	318.30	319.20	320.00	320.50	321.00	322.00	322.50	323.00	323.50
1200	311.20	312.00	312.70	313.60	314.50	315.30	316.00	316.60	317.60	318.30	319.20	320.00	320.50	321.00	322.00	322.50	323.00	323.50
1300	311.20	312.00	312.70	313.60	314.50	315.30	316.00	316.60	317.60	318.30	319.20	320.00	320.50	321.00	322.00	322.50	323.00	323.50
1400	311.20	312.00	312.70	313.60	314.50	315.30	316.00	316.60	317.60	318.30	319.20	320.00	320.50	321.00	322.00	322.50	323.00	323.50
1500	311.20	312.00	312.70	313.60	314.50	315.30	316.00	316.60	317.60	318.30	319.20	320.00	320.50	321.00	322.00	322.50	323.00	323.50
1600	311.20	312.00	312.70	313.60	314.50	315.30	316.00	316.60	317.60	318.30	319.20	320.00	320.50	321.00	322.00	322.50	323.00	323.50
1700	311.20	312.00	312.70	313.60	314.50	315.30	316.00	316.60	317.60	318.30	319.20	320.00	320.50	321.00	322.00	322.50	323.00	323.50
1800	311.20	312.00	312.70	313.60	314.50	315.30	316.00	316.60	317.60	318.30	319.20	320.00	320.50	321.00	322.00	322.50	323.00	323.50
1900	311.20	312.00	312.70	313.60	314.50	315.30	316.00	316.60	317.60	318.30	319.20	320.00	320.50	321.00	322.00	322.50	323.00	323.50
2000	316.00	317.00	317.90	319.00	319.60	320.20	321.00	322.00	322.80	323.50	324.50	325.20	326.00	326.50	327.10	328.00	328.50	329.00
2100	316.00	317.00	317.90	319.00	319.60	320.20	321.00	322.00	322.80	323.50	324.50	325.20	326.00	326.50	327.10	328.00	328.50	329.00
2200	316.00	317.00	317.90	319.00	319.60	320.20	321.00	322.00	322.80	323.50	324.50	325.20	326.00	326.50	327.10	328.00	328.50	329.00
2300	316.00	317.00	317.90	319.00	319.60	320.20	321.00	322.00	322.80	323.50	324.50	325.20	326.00	326.50	327.10	328.00	328.50	329.00
2400	316.00	317.00	317.90	319.00	319.60	320.20	321.00	322.00	322.80	323.50	324.50	325.20	326.00	326.50	327.10	328.00	328.50	329.00
2500	316.00	317.00	317.90	319.00	319.60	320.20	321.00	322.00	322.80	323.50	324.50	325.20	326.00	326.50	327.10	328.00	328.50	329.00
2600	316.00	317.00	317.90	319.00	319.60	320.20	321.00	322.00	322.80	323.50	324.50	325.20	326.00	326.50	327.10	328.00	328.50	329.00
2700	316.00	317.00	317.90	319.00	319.60	320.20	321.00	322.00	322.80	323.50	324.50	325.20	326.00	326.50	327.10	328.00	328.50	329.00
2800	316.00	317.00	317.90	319.00	319.60	320.20	321.00	322.00	322.80	323.50	324.50	325.20	326.00	326.50	327.10	328.00	328.50	329.00
2900	316.00	317.00	317.90	319.00	319.60	320.20	321.00	322.00	322.80	323.50	324.50	325.20	326.00	326.50	327.10	328.00	328.50	329.00
3000	320.60	321.80	322.50	323.70	324.40	325.20	326.10	327.05	327.90	328.90	329.30	330.30	330.90	331.50	332.40	332.90	333.70	334.10

Bulk Modulus of Water as a Function of Pressure and Temperature

Appendix C-2 – Standard Formulas used for Pressure / Temperature Calculations

Name of Range: BULK

Bulk Modulus Values for water x 10^3

Temperature

Pressure	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
14.70	318.60	319.00	319.50	320.00	320.50	321.00	321.50	321.80	322.30	322.50	322.70	323.00	323.50	323.90	324.00	324.50	324.90	325.00
100	318.60	319.00	319.50	320.00	320.50	321.00	321.50	321.80	322.30	322.50	322.70	323.00	323.50	323.90	324.00	324.50	324.90	325.00
200	318.60	319.00	319.50	320.00	320.50	321.00	321.50	321.80	322.30	322.50	322.70	323.00	323.50	323.90	324.00	324.50	324.90	325.00
300	318.60	319.00	319.50	320.00	320.50	321.00	321.50	321.80	322.30	322.50	322.70	323.00	323.50	323.90	324.00	324.50	324.90	325.00
400	318.60	319.00	319.50	320.00	320.50	321.00	321.50	321.80	322.30	322.50	322.70	323.00	323.50	323.90	324.00	324.50	324.90	325.00
500	318.60	319.00	319.50	320.00	320.50	321.00	321.50	321.80	322.30	322.50	322.70	323.00	323.50	323.90	324.00	324.50	324.90	325.00
600	318.60	319.00	319.50	320.00	320.50	321.00	321.50	321.80	322.30	322.50	322.70	323.00	323.50	323.90	324.00	324.50	324.90	325.00
700	318.60	319.00	319.50	320.00	320.50	321.00	321.50	321.80	322.30	322.50	322.70	323.00	323.50	323.90	324.00	324.50	324.90	325.00
800	318.60	319.00	319.50	320.00	320.50	321.00	321.50	321.80	322.30	322.50	322.70	323.00	323.50	323.90	324.00	324.50	324.90	325.00
900	318.60	319.00	319.50	320.00	320.50	321.00	321.50	321.80	322.30	322.50	322.70	323.00	323.50	323.90	324.00	324.50	324.90	325.00
1000	324.00	324.90	325.30	326.00	326.30	326.80	327.00	327.50	327.90	328.20	328.80	329.10	329.50	329.70	330.00	330.20	330.50	330.80
1100	324.00	324.90	325.30	326.00	326.30	326.80	327.00	327.50	327.90	328.20	328.80	329.10	329.50	329.70	330.00	330.20	330.50	330.80
1200	324.00	324.90	325.30	326.00	326.30	326.80	327.00	327.50	327.90	328.20	328.80	329.10	329.50	329.70	330.00	330.20	330.50	330.80
1300	324.00	324.90	325.30	326.00	326.30	326.80	327.00	327.50	327.90	328.20	328.80	329.10	329.50	329.70	330.00	330.20	330.50	330.80
1400	324.00	324.90	325.30	326.00	326.30	326.80	327.00	327.50	327.90	328.20	328.80	329.10	329.50	329.70	330.00	330.20	330.50	330.80
1500	324.00	324.90	325.30	326.00	326.30	326.80	327.00	327.50	327.90	328.20	328.80	329.10	329.50	329.70	330.00	330.20	330.50	330.80
1600	324.00	324.90	325.30	326.00	326.30	326.80	327.00	327.50	327.90	328.20	328.80	329.10	329.50	329.70	330.00	330.20	330.50	330.80
1700	324.00	324.90	325.30	326.00	326.30	326.80	327.00	327.50	327.90	328.20	328.80	329.10	329.50	329.70	330.00	330.20	330.50	330.80
1800	324.00	324.90	325.30	326.00	326.30	326.80	327.00	327.50	327.90	328.20	328.80	329.10	329.50	329.70	330.00	330.20	330.50	330.80
1900	324.00	324.90	325.30	326.00	326.30	326.80	327.00	327.50	327.90	328.20	328.80	329.10	329.50	329.70	330.00	330.20	330.50	330.80
2000	329.50	330.00	330.50	331.00	331.80	332.20	332.50	333.00	333.50	334.00	334.50	335.00	335.40	335.90	336.20	336.50	336.90	337.10
2100	329.50	330.00	330.50	331.00	331.80	332.20	332.50	333.00	333.50	334.00	334.50	335.00	335.40	335.90	336.20	336.50	336.90	337.10
2200	329.50	330.00	330.50	331.00	331.80	332.20	332.50	333.00	333.50	334.00	334.50	335.00	335.40	335.90	336.20	336.50	336.90	337.10
2300	329.50	330.00	330.50	331.00	331.80	332.20	332.50	333.00	333.50	334.00	334.50	335.00	335.40	335.90	336.20	336.50	336.90	337.10
2400	329.50	330.00	330.50	331.00	331.80	332.20	332.50	333.00	333.50	334.00	334.50	335.00	335.40	335.90	336.20	336.50	336.90	337.10
2500	329.50	330.00	330.50	331.00	331.80	332.20	332.50	333.00	333.50	334.00	334.50	335.00	335.40	335.90	336.20	336.50	336.90	337.10
2600	329.50	330.00	330.50	331.00	331.80	332.20	332.50	333.00	333.50	334.00	334.50	335.00	335.40	335.90	336.20	336.50	336.90	337.10
2700	329.50	330.00	330.50	331.00	331.80	332.20	332.50	333.00	333.50	334.00	334.50	335.00	335.40	335.90	336.20	336.50	336.90	337.10
2800	329.50	330.00	330.50	331.00	331.80	332.20	332.50	333.00	333.50	334.00	334.50	335.00	335.40	335.90	336.20	336.50	336.90	337.10
2900	329.50	330.00	330.50	331.00	331.80	332.20	332.50	333.00	333.50	334.00	334.50	335.00	335.40	335.90	336.20	336.50	336.90	337.10
3000	335.10	335.80	336.00	337.00	337.50	337.90	338.40	338.95	339.20	339.80	340.30	340.70	340.95	341.20	341.90	342.30	342.50	342.90

Bulk Modulus of Water as a Function of Pressure and Temperature

Appendix C-2 – Standard Formulas used for Pressure / Temperature Calculations

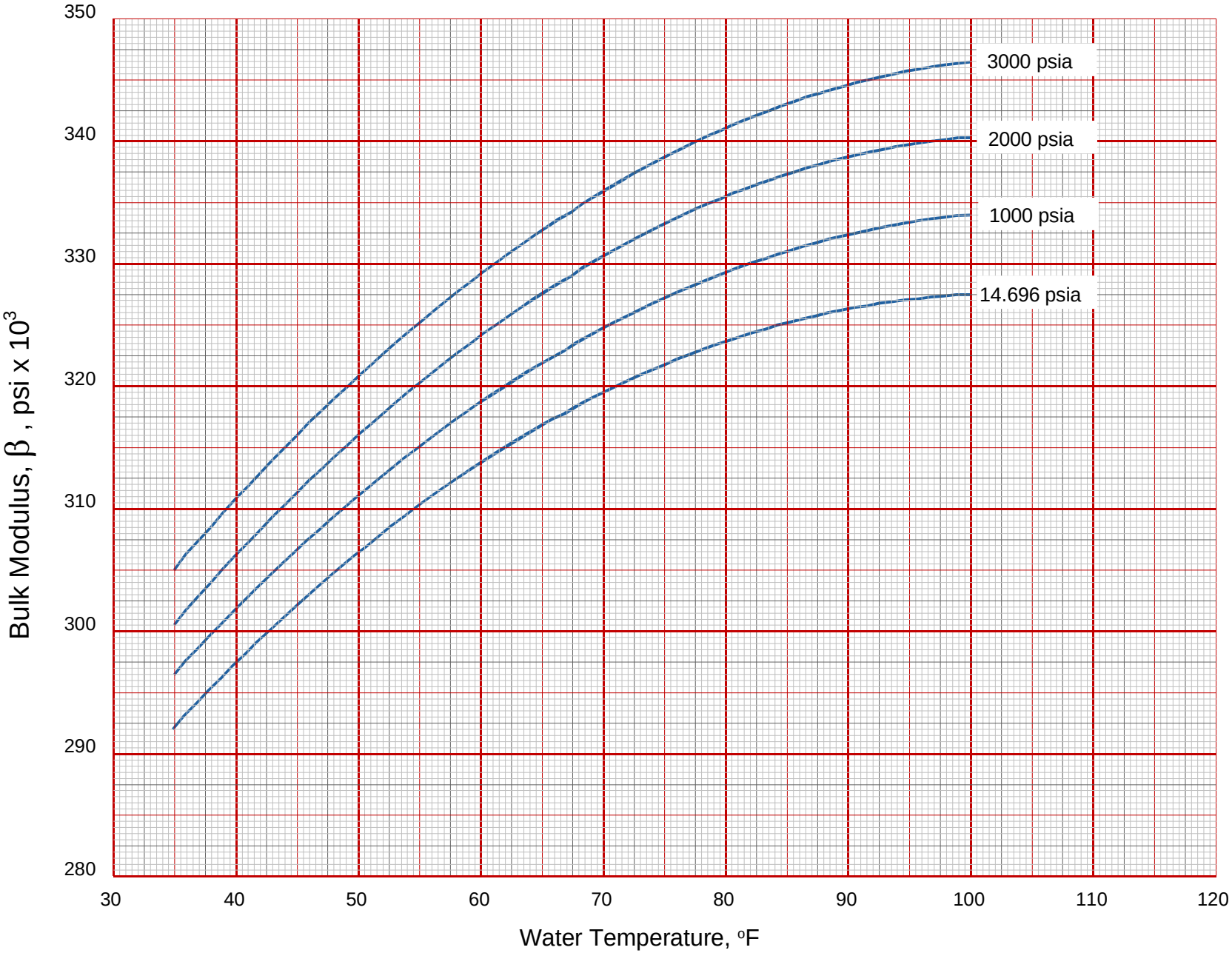
Name of Range: BULK

Bulk Modulus Values for water x 10^3

Pressure	Temperature 86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
14.70	325.30	325.50	325.70	325.90	326.00	326.20	326.50	326.60	326.70	326.90	327.10	327.30	327.50	327.70	327.80
100	325.30	325.50	325.70	325.90	326.00	326.20	326.50	326.60	326.70	326.90	327.10	327.30	327.50	327.70	327.80
200	325.30	325.50	325.70	325.90	326.00	326.20	326.50	326.60	326.70	326.90	327.10	327.30	327.50	327.70	327.80
300	325.30	325.50	325.70	325.90	326.00	326.20	326.50	326.60	326.70	326.90	327.10	327.30	327.50	327.70	327.80
400	325.30	325.50	325.70	325.90	326.00	326.20	326.50	326.60	326.70	326.90	327.10	327.30	327.50	327.70	327.80
500	325.30	325.50	325.70	325.90	326.00	326.20	326.50	326.60	326.70	326.90	327.10	327.30	327.50	327.70	327.80
600	325.30	325.50	325.70	325.90	326.00	326.20	326.50	326.60	326.70	326.90	327.10	327.30	327.50	327.70	327.80
700	325.30	325.50	325.70	325.90	326.00	326.20	326.50	326.60	326.70	326.90	327.10	327.30	327.50	327.70	327.80
800	325.30	325.50	325.70	325.90	326.00	326.20	326.50	326.60	326.70	326.90	327.10	327.30	327.50	327.70	327.80
900	325.30	325.50	325.70	325.90	326.00	326.20	326.50	326.60	326.70	326.90	327.10	327.30	327.50	327.70	327.80
1000	330.90	331.10	331.40	331.80	332.00	332.20	332.50	332.70	332.80	333.00	333.10	333.30	333.50	333.70	333.90
1100	330.90	331.10	331.40	331.80	332.00	332.20	332.50	332.70	332.80	333.00	333.10	333.30	333.50	333.70	333.90
1200	330.90	331.10	331.40	331.80	332.00	332.20	332.50	332.70	332.80	333.00	333.10	333.30	333.50	333.70	333.90
1300	330.90	331.10	331.40	331.80	332.00	332.20	332.50	332.70	332.80	333.00	333.10	333.30	333.50	333.70	333.90
1400	330.90	331.10	331.40	331.80	332.00	332.20	332.50	332.70	332.80	333.00	333.10	333.30	333.50	333.70	333.90
1500	330.90	331.10	331.40	331.80	332.00	332.20	332.50	332.70	332.80	333.00	333.10	333.30	333.50	333.70	333.90
1600	330.90	331.10	331.40	331.80	332.00	332.20	332.50	332.70	332.80	333.00	333.10	333.30	333.50	333.70	333.90
1700	330.90	331.10	331.40	331.80	332.00	332.20	332.50	332.70	332.80	333.00	333.10	333.30	333.50	333.70	333.90
1800	330.90	331.10	331.40	331.80	332.00	332.20	332.50	332.70	332.80	333.00	333.10	333.30	333.50	333.70	333.90
1900	330.90	331.10	331.40	331.80	332.00	332.20	332.50	332.70	332.80	333.00	333.10	333.30	333.50	333.70	333.90
2000	337.50	337.80	338.00	338.40	338.70	339.00	339.20	339.40	339.50	339.70	339.85	340.00	340.10	340.20	340.30
2100	337.50	337.80	338.00	338.40	338.70	339.00	339.20	339.40	339.50	339.70	339.85	340.00	340.10	340.20	340.30
2200	337.50	337.80	338.00	338.40	338.70	339.00	339.20	339.40	339.50	339.70	339.85	340.00	340.10	340.20	340.30
2300	337.50	337.80	338.00	338.40	338.70	339.00	339.20	339.40	339.50	339.70	339.85	340.00	340.10	340.20	340.30
2400	337.50	337.80	338.00	338.40	338.70	339.00	339.20	339.40	339.50	339.70	339.85	340.00	340.10	340.20	340.30
2500	337.50	337.80	338.00	338.40	338.70	339.00	339.20	339.40	339.50	339.70	339.85	340.00	340.10	340.20	340.30
2600	337.50	337.80	338.00	338.40	338.70	339.00	339.20	339.40	339.50	339.70	339.85	340.00	340.10	340.20	340.30
2700	337.50	337.80	338.00	338.40	338.70	339.00	339.20	339.40	339.50	339.70	339.85	340.00	340.10	340.20	340.30
2800	337.50	337.80	338.00	338.40	338.70	339.00	339.20	339.40	339.50	339.70	339.85	340.00	340.10	340.20	340.30
2900	337.50	337.80	338.00	338.40	338.70	339.00	339.20	339.40	339.50	339.70	339.85	340.00	340.10	340.20	340.30
3000	343.10	343.40	343.80	344.00	344.20	344.60	344.90	345.10	345.30	345.50	345.70	345.90	346.10	346.30	346.50

Bulk Modulus of Water as a Function of Pressure and Temperature

Appendix C-2 - Standard Formulas used for Pressure / Temperature Calculations



Bulk Modulus of Water as a Function of Pressure and Temperature

Appendix C-2 – Standard Formulas used for Pressure / Temperature Calculations

Name of Range: Expand

	Temperature																	
Pressure	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
14.70	4.55	5.00	5.50	5.90	6.30	6.50	7.00	7.50	8.00	8.30	8.60	9.00	9.45	9.75	10.00	10.50	10.75	11.10
100	4.55	5.00	5.50	5.90	6.30	6.50	7.00	7.50	8.00	8.30	8.60	9.00	9.45	9.75	10.00	10.50	10.75	11.10
200	4.55	5.00	5.50	5.90	6.30	6.50	7.00	7.50	8.00	8.30	8.60	9.00	9.45	9.75	10.00	10.50	10.75	11.10
300	4.55	5.00	5.50	5.90	6.30	6.50	7.00	7.50	8.00	8.30	8.60	9.00	9.45	9.75	10.00	10.50	10.75	11.10
400	4.55	5.00	5.50	5.90	6.30	6.50	7.00	7.50	8.00	8.30	8.60	9.00	9.45	9.75	10.00	10.50	10.75	11.10
500	4.55	5.00	5.50	5.90	6.30	6.50	7.00	7.50	8.00	8.30	8.60	9.00	9.45	9.75	10.00	10.50	10.75	11.10
600	4.55	5.00	5.50	5.90	6.30	6.50	7.00	7.50	8.00	8.30	8.60	9.00	9.45	9.75	10.00	10.50	10.75	11.10
700	4.55	5.00	5.50	5.90	6.30	6.50	7.00	7.50	8.00	8.30	8.60	9.00	9.45	9.75	10.00	10.50	10.75	11.10
800	4.55	5.00	5.50	5.90	6.30	6.50	7.00	7.50	8.00	8.30	8.60	9.00	9.45	9.75	10.00	10.50	10.75	11.10
900	4.55	5.00	5.50	5.90	6.30	6.50	7.00	7.50	8.00	8.30	8.60	9.00	9.45	9.75	10.00	10.50	10.75	11.10
1000	5.50	6.00	6.40	6.60	7.00	7.45	8.00	8.40	8.65	9.00	9.35	9.50	10.00	10.40	10.65	11.00	11.40	11.75
1100	5.50	6.00	6.40	6.60	7.00	7.45	8.00	8.40	8.65	9.00	9.35	9.50	10.00	10.40	10.65	11.00	11.40	11.75
1200	5.50	6.00	6.40	6.60	7.00	7.45	8.00	8.40	8.65	9.00	9.35	9.50	10.00	10.40	10.65	11.00	11.40	11.75
1300	5.50	6.00	6.40	6.60	7.00	7.45	8.00	8.40	8.65	9.00	9.35	9.50	10.00	10.40	10.65	11.00	11.40	11.75
1400	5.50	6.00	6.40	6.60	7.00	7.45	8.00	8.40	8.65	9.00	9.35	9.50	10.00	10.40	10.65	11.00	11.40	11.75
1500	5.50	6.00	6.40	6.60	7.00	7.45	8.00	8.40	8.65	9.00	9.35	9.50	10.00	10.40	10.65	11.00	11.40	11.75
1600	5.50	6.00	6.40	6.60	7.00	7.45	8.00	8.40	8.65	9.00	9.35	9.50	10.00	10.40	10.65	11.00	11.40	11.75
1700	5.50	6.00	6.40	6.60	7.00	7.45	8.00	8.40	8.65	9.00	9.35	9.50	10.00	10.40	10.65	11.00	11.40	11.75
1800	5.50	6.00	6.40	6.60	7.00	7.45	8.00	8.40	8.65	9.00	9.35	9.50	10.00	10.40	10.65	11.00	11.40	11.75
1900	5.50	6.00	6.40	6.60	7.00	7.45	8.00	8.40	8.65	9.00	9.35	9.50	10.00	10.40	10.65	11.00	11.40	11.75
2000	6.40	6.75	7.10	7.50	7.95	8.20	8.55	9.00	9.40	9.55	10.00	10.40	10.60	11.00	11.40	11.65	12.00	12.35
2100	6.40	6.75	7.10	7.50	7.95	8.20	8.55	9.00	9.40	9.55	10.00	10.40	10.60	11.00	11.40	11.65	12.00	12.35
2200	6.40	6.75	7.10	7.50	7.95	8.20	8.55	9.00	9.40	9.55	10.00	10.40	10.60	11.00	11.40	11.65	12.00	12.35
2300	6.40	6.75	7.10	7.50	7.95	8.20	8.55	9.00	9.40	9.55	10.00	10.40	10.60	11.00	11.40	11.65	12.00	12.35
2400	6.40	6.75	7.10	7.50	7.95	8.20	8.55	9.00	9.40	9.55	10.00	10.40	10.60	11.00	11.40	11.65	12.00	12.35
2500	6.40	6.75	7.10	7.50	7.95	8.20	8.55	9.00	9.40	9.55	10.00	10.40	10.60	11.00	11.40	11.65	12.00	12.35
2600	6.40	6.75	7.10	7.50	7.95	8.20	8.55	9.00	9.40	9.55	10.00	10.40	10.60	11.00	11.40	11.65	12.00	12.35
2700	6.40	6.75	7.10	7.50	7.95	8.20	8.55	9.00	9.40	9.55	10.00	10.40	10.60	11.00	11.40	11.65	12.00	12.35
2800	6.40	6.75	7.10	7.50	7.95	8.20	8.55	9.00	9.40	9.55	10.00	10.40	10.60	11.00	11.40	11.65	12.00	12.35
2900	6.40	6.75	7.10	7.50	7.95	8.20	8.55	9.00	9.40	9.55	10.00	10.40	10.60	11.00	11.40	11.65	12.00	12.35
3000	7.45	7.95	8.30	8.60	8.90	9.20	9.50	9.90	10.10	10.40	10.80	11.10	11.40	11.70	12.00	12.35	12.50	12.90

Volumetric Expansion Coefficient Table of Water as a Function of Pressure and Temperature

Appendix C-2 – Standard Formulas used for Pressure / Temperature Calculations

Name of Range: Expand

Pressure	Temperature 68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
14.70	11.45	11.80	12.25	12.50	12.90	13.00	13.60	13.90	14.20	14.50	14.70	15.00	15.40	15.60	15.90	16.20	16.55	16.80
100	11.45	11.80	12.25	12.50	12.90	13.00	13.60	13.90	14.20	14.50	14.70	15.00	15.40	15.60	15.90	16.20	16.55	16.80
200	11.45	11.80	12.25	12.50	12.90	13.00	13.60	13.90	14.20	14.50	14.70	15.00	15.40	15.60	15.90	16.20	16.55	16.80
300	11.45	11.80	12.25	12.50	12.90	13.00	13.60	13.90	14.20	14.50	14.70	15.00	15.40	15.60	15.90	16.20	16.55	16.80
400	11.45	11.80	12.25	12.50	12.90	13.00	13.60	13.90	14.20	14.50	14.70	15.00	15.40	15.60	15.90	16.20	16.55	16.80
500	11.45	11.80	12.25	12.50	12.90	13.00	13.60	13.90	14.20	14.50	14.70	15.00	15.40	15.60	15.90	16.20	16.55	16.80
600	11.45	11.80	12.25	12.50	12.90	13.00	13.60	13.90	14.20	14.50	14.70	15.00	15.40	15.60	15.90	16.20	16.55	16.80
700	11.45	11.80	12.25	12.50	12.90	13.00	13.60	13.90	14.20	14.50	14.70	15.00	15.40	15.60	15.90	16.20	16.55	16.80
800	11.45	11.80	12.25	12.50	12.90	13.00	13.60	13.90	14.20	14.50	14.70	15.00	15.40	15.60	15.90	16.20	16.55	16.80
900	11.45	11.80	12.25	12.50	12.90	13.00	13.60	13.90	14.20	14.50	14.70	15.00	15.40	15.60	15.90	16.20	16.55	16.80
1000	12.00	12.30	12.65	13.00	13.40	13.70	14.00	14.30	14.60	14.80	15.00	15.40	15.60	15.90	16.20	16.50	16.75	17.00
1100	12.00	12.30	12.65	13.00	13.40	13.70	14.00	14.30	14.60	14.80	15.00	15.40	15.60	15.90	16.20	16.50	16.75	17.00
1200	12.00	12.30	12.65	13.00	13.40	13.70	14.00	14.30	14.60	14.80	15.00	15.40	15.60	15.90	16.20	16.50	16.75	17.00
1300	12.00	12.30	12.65	13.00	13.40	13.70	14.00	14.30	14.60	14.80	15.00	15.40	15.60	15.90	16.20	16.50	16.75	17.00
1400	12.00	12.30	12.65	13.00	13.40	13.70	14.00	14.30	14.60	14.80	15.00	15.40	15.60	15.90	16.20	16.50	16.75	17.00
1500	12.00	12.30	12.65	13.00	13.40	13.70	14.00	14.30	14.60	14.80	15.00	15.40	15.60	15.90	16.20	16.50	16.75	17.00
1600	12.00	12.30	12.65	13.00	13.40	13.70	14.00	14.30	14.60	14.80	15.00	15.40	15.60	15.90	16.20	16.50	16.75	17.00
1700	12.00	12.30	12.65	13.00	13.40	13.70	14.00	14.30	14.60	14.80	15.00	15.40	15.60	15.90	16.20	16.50	16.75	17.00
1800	12.00	12.30	12.65	13.00	13.40	13.70	14.00	14.30	14.60	14.80	15.00	15.40	15.60	15.90	16.20	16.50	16.75	17.00
1900	12.00	12.30	12.65	13.00	13.40	13.70	14.00	14.30	14.60	14.80	15.00	15.40	15.60	15.90	16.20	16.50	16.75	17.00
2000	12.50	12.90	13.30	13.60	13.90	14.20	14.50	14.70	14.90	15.10	15.50	15.70	16.00	16.40	16.60	16.80	17.10	17.50
2100	12.50	12.90	13.30	13.60	13.90	14.20	14.50	14.70	14.90	15.10	15.50	15.70	16.00	16.40	16.60	16.80	17.10	17.50
2200	12.50	12.90	13.30	13.60	13.90	14.20	14.50	14.70	14.90	15.10	15.50	15.70	16.00	16.40	16.60	16.80	17.10	17.50
2300	12.50	12.90	13.30	13.60	13.90	14.20	14.50	14.70	14.90	15.10	15.50	15.70	16.00	16.40	16.60	16.80	17.10	17.50
2400	12.50	12.90	13.30	13.60	13.90	14.20	14.50	14.70	14.90	15.10	15.50	15.70	16.00	16.40	16.60	16.80	17.10	17.50
2500	12.50	12.90	13.30	13.60	13.90	14.20	14.50	14.70	14.90	15.10	15.50	15.70	16.00	16.40	16.60	16.80	17.10	17.50
2600	12.50	12.90	13.30	13.60	13.90	14.20	14.50	14.70	14.90	15.10	15.50	15.70	16.00	16.40	16.60	16.80	17.10	17.50
2700	12.50	12.90	13.30	13.60	13.90	14.20	14.50	14.70	14.90	15.10	15.50	15.70	16.00	16.40	16.60	16.80	17.10	17.50
2800	12.50	12.90	13.30	13.60	13.90	14.20	14.50	14.70	14.90	15.10	15.50	15.70	16.00	16.40	16.60	16.80	17.10	17.50
2900	12.50	12.90	13.30	13.60	13.90	14.20	14.50	14.70	14.90	15.10	15.50	15.70	16.00	16.40	16.60	16.80	17.10	17.50
3000	13.10	13.50	13.80	14.05	14.40	14.60	14.80	14.90	15.20	15.50	15.75	16.00	16.40	16.60	16.80	17.00	17.40	17.60

Volumetric Expansion Coefficient Table of Water as a Function of Pressure and Temperature

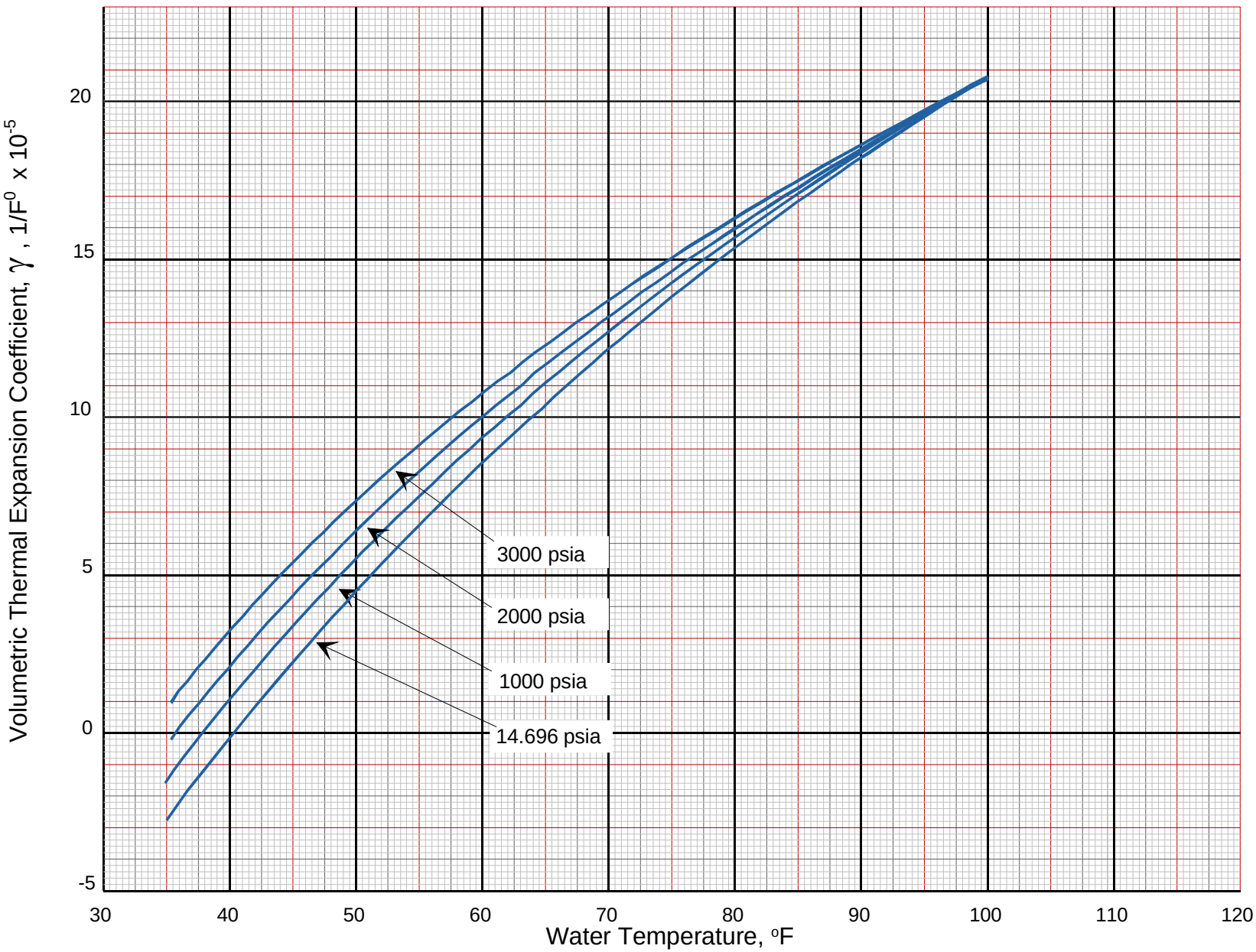
Appendix C-2 – Standard Formulas used for Pressure / Temperature Calculations

Name of Range: Expand

Pressure	Temperature 86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
14.70	17.10	17.50	17.75	18.00	18.25	18.60	18.80	19.20	19.40	19.60	19.70	20.00	20.30	20.50	20.80
100	17.10	17.50	17.75	18.00	18.25	18.60	18.80	19.20	19.40	19.60	19.70	20.00	20.30	20.50	20.80
200	17.10	17.50	17.75	18.00	18.25	18.60	18.80	19.20	19.40	19.60	19.70	20.00	20.30	20.50	20.80
300	17.10	17.50	17.75	18.00	18.25	18.60	18.80	19.20	19.40	19.60	19.70	20.00	20.30	20.50	20.80
400	17.10	17.50	17.75	18.00	18.25	18.60	18.80	19.20	19.40	19.60	19.70	20.00	20.30	20.50	20.80
500	17.10	17.50	17.75	18.00	18.25	18.60	18.80	19.20	19.40	19.60	19.70	20.00	20.30	20.50	20.80
600	17.10	17.50	17.75	18.00	18.25	18.60	18.80	19.20	19.40	19.60	19.70	20.00	20.30	20.50	20.80
700	17.10	17.50	17.75	18.00	18.25	18.60	18.80	19.20	19.40	19.60	19.70	20.00	20.30	20.50	20.80
800	17.10	17.50	17.75	18.00	18.25	18.60	18.80	19.20	19.40	19.60	19.70	20.00	20.30	20.50	20.80
900	17.10	17.50	17.75	18.00	18.25	18.60	18.80	19.20	19.40	19.60	19.70	20.00	20.30	20.50	20.80
1000	17.40	17.60	17.90	18.20	18.40	18.70	18.90	19.20	19.40	19.60	19.80	20.00	20.30	20.50	20.80
1100	17.40	17.60	17.90	18.20	18.40	18.70	18.90	19.20	19.40	19.60	19.80	20.00	20.30	20.50	20.80
1200	17.40	17.60	17.90	18.20	18.40	18.70	18.90	19.20	19.40	19.60	19.80	20.00	20.30	20.50	20.80
1300	17.40	17.60	17.90	18.20	18.40	18.70	18.90	19.20	19.40	19.60	19.80	20.00	20.30	20.50	20.80
1400	17.40	17.60	17.90	18.20	18.40	18.70	18.90	19.20	19.40	19.60	19.80	20.00	20.30	20.50	20.80
1500	17.40	17.60	17.90	18.20	18.40	18.70	18.90	19.20	19.40	19.60	19.80	20.00	20.30	20.50	20.80
1600	17.40	17.60	17.90	18.20	18.40	18.70	18.90	19.20	19.40	19.60	19.80	20.00	20.30	20.50	20.80
1700	17.40	17.60	17.90	18.20	18.40	18.70	18.90	19.20	19.40	19.60	19.80	20.00	20.30	20.50	20.80
1800	17.40	17.60	17.90	18.20	18.40	18.70	18.90	19.20	19.40	19.60	19.80	20.00	20.30	20.50	20.80
1900	17.40	17.60	17.90	18.20	18.40	18.70	18.90	19.20	19.40	19.60	19.80	20.00	20.30	20.50	20.80
2000	17.70	17.90	18.10	18.40	18.60	18.80	19.00	19.20	19.60	19.70	19.90	20.10	20.40	20.50	20.80
2100	17.70	17.90	18.10	18.40	18.60	18.80	19.00	19.20	19.60	19.70	19.90	20.10	20.40	20.50	20.80
2200	17.70	17.90	18.10	18.40	18.60	18.80	19.00	19.20	19.60	19.70	19.90	20.10	20.40	20.50	20.80
2300	17.70	17.90	18.10	18.40	18.60	18.80	19.00	19.20	19.60	19.70	19.90	20.10	20.40	20.50	20.80
2400	17.70	17.90	18.10	18.40	18.60	18.80	19.00	19.20	19.60	19.70	19.90	20.10	20.40	20.50	20.80
2500	17.70	17.90	18.10	18.40	18.60	18.80	19.00	19.20	19.60	19.70	19.90	20.10	20.40	20.50	20.80
2600	17.70	17.90	18.10	18.40	18.60	18.80	19.00	19.20	19.60	19.70	19.90	20.10	20.40	20.50	20.80
2700	17.70	17.90	18.10	18.40	18.60	18.80	19.00	19.20	19.60	19.70	19.90	20.10	20.40	20.50	20.80
2800	17.70	17.90	18.10	18.40	18.60	18.80	19.00	19.20	19.60	19.70	19.90	20.10	20.40	20.50	20.80
2900	17.70	17.90	18.10	18.40	18.60	18.80	19.00	19.20	19.60	19.70	19.90	20.10	20.40	20.50	20.80
3000	17.90	18.10	18.40	18.60	18.80	19.00	19.30	19.50	19.75	19.90	20.20	20.40	20.50	20.75	20.90

Volumetric Expansion Coefficient Table of Water as a Function of Pressure and Temperature

Appendix C-2 - Standard Formulas used for Pressure / Temperature Calculations



Volumetric Expansion Coefficient Table of Water as a Function of Pressure and Temperature

California Department of Forestry and Fire Protection
OFFICE OF THE STATE FIRE MARSHAL
PIPELINE SAFETY DIVISION

INITIAL APPLICATION

Approval as an Independent Hydrostatic Testing Firm

INSTRUCTIONS:

1. Complete all sections of this form. Entries must be in ink or typed. If the submitted form is not legible it will be returned. Please note that this form must be notarized.

2. The completed form must be accompanied by the required fee of $1,500.00. Payment may be made by check or money order drawn on a United States bank. Checks/money orders drawn on foreign banks are not acceptable. The State Fire Marshal cannot accept credit cards or purchase orders as payment.

3. All data must be submitted to the address listed below:

   California State Fire Marshal
   Pipeline Safety Division
   PO Box 944246
   Sacramento, CA 94244-2460

4. Answers to questions regarding this application may be obtained by mail at the above address or by telephoning (916) 445-8477

1.	Name of Company:	
2.	Mailing Address:	
3.	Physical Location Address: *(do not use PO Box)*	
4.	Business Telephone:	( )
5.	Business Fax:	( )
6.	This application is made the firm Listed above doing business as *(check one)*	Sole Owner/Individual Corporation Partnership

7.	**Responsible Parties:** Identify all owners, partners, and/or officers of the company. If additional space is necessary, please attach a separate sheet.		
	SOLE OWNER	Print Name	
		Signature	
		Date	
	CORPORATION OFFICERS	Print Name	
		Signature	
		Date	
		Print Name	
		Signature	
		Date	
	ALL MEMBERS OF THE PARTNERSHIP	Print Name	
		Signature	
		Date	
		Print Name	
		Signature	
		Date	
		Print Name	
		Signature	
		Date	
8.	**Work History:** Attach three Hydrostatic Test Pressure Reports made within the past three years. All Hydrostatic Test Reports must comply with the California Government Code and Part 195.310, Title 49, Code of Federal Regulations.		
9.	**Character References:** Submit three letters attesting to the character, financial responsibility and integrity of administrative, managerial and supervisorial personnel. Letters must include the name and address of each reference AND must include the name of the applicant. These letters must be received by the California State Fire Marshal within 60 days of application submittal.		

10.	**Hydrostatic Testers:** Attach a completed Hydrostatic Testers form (Form #1-HYD). Provide the names of the persons who will be conducting hydrostatic testing in the name of your company. List all pertinent contractor licenses, professional degrees and other similar data. ***Please submit one form per person.***
11.	**Certification/Notarization:** I certify under penalty of perjury that the foregoing information is true. Print Name: _____ Title: _____ Signature: _____ Date: _____ Place: _____

NOTARY

California Department of Forestry and Fire Protection
OFFICE OF THE STATE FIRE MARSHAL
PIPELINE SAFETY DIVISION

FORM #1-HYD

EMPLOYEES AUTHORIZED TO CONDUCT HYDROSTATIC TESTING

Name of Firm: _____ Date: _____

Employee Name: _____
(one name per form)

This employee is authorized to perform the following in the name of the firm listed above:
Witness hydrostatic testing operations
Certify hydrostatic testing result

Authorized by: _____
(signature of company officer)

License/Professional Degree	Date Issued

Pipeline, Petrochemical or Related Qualifying Experience

Return completed form to:

California State Fire Marshal
Pipeline Safety Division
PO Box 944246
Sacramento, CA 94244-246