



FACULTAD DE INGENIERÍA UNAM
DIVISIÓN DE EDUCACIÓN CONTINUA



Mecánica e Industrial

CURSOS ABIERTOS

DIPLOMADO DE RECIPIENTES A PRESIÓN

CA-326 INSPECCIÓN Y PRUEBAS DE RECIPIENTES A PRESIÓN

TEMA

INSPECCIÓN Y PRUEBAS DE RECIPIENTES A PRESIÓN

EXPOSITOR: ING. ORLANDO R. RIVERA
DEL 1 AL 5 DE AGOSTO DEL 2005
PALACIO DE MINERÍA

UNIVERSIDAD NACIONAL AUTONOMA DE MÉXICO
FACULTAD DE INGENIERIA
DIVISIÓN DE EDUCACIÓN CONTINUA

CURSO / MODULO

INSPECCION Y PRUEBAS

DE

RECIPIENTES A PRESION

CONFORME A SECCION VIII, DIV.1 DEL CODIGO ASME

Instructor : Ing. Orlando R. Rivera
Duración Total: 20 Horas
Lunes a Viernes de 17:00 a 21:00 Horas

UNIVERSIDAD NACIONAL AUTONOMA DE MÉXICO
FACULTAD DE INGENIERIA
DIVISIÓN DE EDUCACIÓN CONTINUA

CURSO / MODULO

INSPECCION Y PRUEBAS

DE

RECIPIENTES A PRESION

CONFORME A SECCION VIII, DIV.1 DEL CODIGO ASME

Este curso / módulo está enfocado a la formación de profesionales que deseen desempeñar una de las actividades más demandadas dentro del campo de los recipientes sujetos a presión. El programa incluye los temas de actualidad del Código ASME y los de mayor aplicación dictados por la industria del ramo

OBJETIVO GENERAL:

Proporcionar los conocimientos mínimos requeridos para inspeccionar y probar cualquier recipiente sujeto a presión conforme a los requisitos obligatorios establecidos en la Sección VIII, División 1 del Código ASME.

DIRIGIDO A:

El curso / módulo esta dirigido a firmas de ingeniería, fabricantes, compañías de inspección, empresas de consultoría, y en general a todos los ingenieros, personal técnico y profesionistas que deseen especializarse o actualizar sus conocimientos en estos temas del Código ASME.

THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

OBJECTIVES

THE OBJECTIVES OF THE NATIONAL BOARD ARE TO PROMOTE:

- UNIFORM ADMINISTRATION AND ENFORCEMENT OF BOILER AND PRESSURE VESSEL LAWS.
- STANDARDIZE CONSTRUCTION.
- STANDARDIZE OPERATION.
- STANDARDIZE INSPECTOR QUALIFICATION.
- SAFETY VALVE TESTING FOR VALVES BUILT TO THE A.S.M.E.

NATIONAL BOARD COMMISSION

THE COMMISSION OBTAINED BY AUTHORIZED INSPECTORS IS ISSUED BY THE NATIONAL BOARD. IT IS ISSUED BASED ON A WRITTEN EXAMINATION. THE COMMISSION IS RENEWED ANNUALLY. VARIOUS ENDORSEMENTS MAY BE OBTAINED AFTER FURTHER TESTING. EXAMPLES OF THESE ENDORSEMENTS ARE THE N, THE B AND S ENDORSEMENTS.

LOSS OF THE N.B. NATIONAL BOARD COMMISSION

NATIONAL BOARD COMMISSIONS MAY BE LOST BY AN INSPECTOR FOR:

- FALSIFICATION OF ANY INFORMATION ON THE APPLICATION.
- NEGLECT OF DUTIES SPELLED OUT IN ANY A.S.M.E. CODE.
- FALSIFICATION OF ANY DATA REPORT.

CERTIFICATE OF COMPETENCY (ISSUED BY THE STATES)

A CERTIFICATE OF COMPETENCY MAY BE ISSUED BY A JURISDICTION BASED ON THE SUCCESSFUL COMPLETION OF THE NATIONAL BOARD EXAMINATION. SOME JURISDICTIONS HAVE ADDITIONAL REQUIREMENTS SUCH AS AN ORAL EXAMINATION. THIS CERTIFICATE IS GENERALLY REQUIRED TO PERFORM INSERVICE INSPECTIONS IN A JURISDICTION.

DUTIES OF THE AUTHORIZED INSPECTOR

THE SPECIFIC DUTIES OF THE A.I. ARE DESCRIBED IN THE VARIOUS CODES AS WELL AS IN THE NATIONAL BOARD BY-LAWS. THEY INCLUDE, BUT ARE NOT LIMITED TO:

- VERIFY THAT THE MANUFACTURER HAS A VALID CERTIFICATE OF AUTHORIZATION.
- MONITORING THE IMPLEMENTATION OF THE QUALITY CONTROL SYSTEM AND TO ACCEPT CHANGES TO THAT SYSTEM.
- VERIFY THAT THE MANUFACTURER HAS THE APPROPRIATE CODE BOOKS, ADDENDA AND ANY APPLICABLE CODE CASES.
- VERIFY THAT THE APPLICABLE DESIGN CALCULATIONS ARE AVAILABLE.
- VERIFY THAT ALL MATERIALS MEET CODE REQUIREMENTS.
- VERIFY MATERIAL IDENTIFICATION.
- VERIFY ALL CUT EDGES ARE EXAMINED.
- VERIFY THAT THE W.P.S. AND P.Q.R. MEET CODE REQUIREMENTS.
- VERIFY THAT ALL WELDERS ARE PROPERLY QUALIFIED.
- VERIFY ONLY QUALIFIED WELDERS AND PROCEDURES ARE USED.

DUTIES OF THE AUTHORIZED INSPECTOR

(CONTINUED)

- VERIFY ANY WELD REPAIRS ARE MADE USING QUALIFIED PROCEDURES AND WELDERS.
- VERIFY THAT REQUIRED HEAT TREATMENTS MEET THE CODE AND ARE RECORDED PROPERLY.
- VERIFY THAT REQUIRED N.D.E. IS PERFORMED PROPERLY BY QUALIFIED PERSONNEL AND RECORDED AS REQUIRED.
- PERFORM AN INTERNAL INSPECTION PRIOR TO CLOSURE.
- WITNESS THE PRESSURE TEST IF REQUIRED.
- VERIFY ALL CODE NONCONFORMANCES ARE PROPERLY CLOSED.
- VERIFY THAT THE NAMEPLATE DATA IS CORRECT AND ATTACHED TO THE PROPER VESSEL.
- REVIEW THE DATA REPORT FOR CLARITY AND CORRECTNESS AND IF ACCEPTABLE, SIGN THE REPORT AFTER THE CERTIFICATE HOLDER.

MATERIAL INSPECTIONS

UG-93

UG-93 COVERS WHAT IS NORMALLY REFERRED TO AS "RECEIVING INSPECTION". IT GIVES THE REQUIREMENTS THE MATERIAL MUST MEET PRIOR TO A FABRICATOR USING IT IN A CODE VESSEL. REQUIREMENTS ARE:

- PLATE: AN M.T.R. OR C. of C. AS REQUIRED BY THE SPECIFICATION.
- OTHER PRODUCT FORMS: EACH PIECE MUST BE MARKED WITH THE SPECIFICATION, GRADE, TYPE AND CLASS WHEN THE SPECIFICATION COVERS SUCH MARKING. TUBING MAY BE MARKED BY BUNDLE.

RELATIVE TO THIS PARAGRAPH, THE A.I. MUST:

- EXAMINE THE M.T.R. OR C. of C. AND VERIFY THAT THE MATERIAL MARKING IS COMPATIBLE OR,
- VERIFY THE MATERIAL IS MARKED AS REQUIRED BY THE SPECIFICATION.

THE FABRICATOR MUST ALSO VERIFY THOSE ITEMS DESCRIBED ABOVE, BEFORE THE A.I. BUT, IN ADDITION, HE MUST:

- EXAMINE DIMENSIONS AND,
- FURNISH TEMPLATES TO THE A.I. AS REQUESTED.

UG-84(j) REJECTION

UG-84(j) STATES "IF THE VESSEL TEST PLATE FAILS TO MEET THE IMPACT REQUIREMENTS, THE WELDS REPRESENTED BY THE PLATE SHALL BE UNACCEPTABLE. REHEAT TREATMENT AND RETESTING ARE PERMITTED.

REPAIRS OF MATERIALS

REPAIRS TO MATERIALS ARE PERMITTED BY VARIOUS PARAGRAPHS IN THE CODE. SOME OF THESE PARAGRAPHS ARE:

- UG-78: STATES THAT THE ACCEPTANCE OF THE A.I. IS REQUIRED.
- UCS-56: GIVES THE P.W.H.T. REQUIREMENTS AND ALTERNATIVES FOR REPAIRS.
- UCI-78: DOES NOT ALLOW WELDED REPAIRS TO CAST IRON MATERIALS.
- UCD-78: DOES NOT ALLOW WELDED REPAIRS TO CAST DUCTILE MATERIALS.

MATERIAL IDENTIFICATION

UG-77

UG-77 GIVES REQUIREMENTS FOR MATERIAL CONTROL ONCE THE MATERIAL IS RECEIVED AND ACCEPTED BY THE FABRICATOR. THE FABRICATOR:

- MUST MAINTAIN IDENTIFICATION OF THE MATERIAL UNTIL THE VESSEL IS COMPLETE.
- MAY USE A CODED MARKING IN LIEU OF THE ORIGINAL MARKING. THIS CODED MARKING MUST BE ACCEPTABLE TO THE A.I.
- TRANSFER ANY MARKING, WHETHER IT IS A CODED MARKING OR THE ORIGINAL WHEN THAT MATERIAL IS DIVIDED OR MACHINED.

MATERIAL TEST REPORT

A MATERIAL TEST REPORT IS A DOCUMENT THAT:

- IS ISSUED BY THE MATERIAL MANUFACTURER.
- REPORTS THE REQUIREMENTS OF THE SPECIFICATION SUCH AS:
 - RESULTS OF TESTS OR EXAMINATIONS
 - ANY REPAIRS TO THE MATERIAL
 - HEAT TREATMENTS PERFORMED
 - SUPPLEMENTARY REQUIREMENTS
 - IDENTIFICATION OF THE MATERIAL
 - HEAT NUMBER IF APPLICABLE

MATERIAL TEST REPORT UG-93

A MATERIAL TEST REPORT IS REQUIRED
PER UG-93 FOR:

- PLATE MATERIAL AS INDICATED IN THE MATERIAL SPECIFICATION,
- SOME MATERIAL SPECIFICATION REQUIREMENTS ARE PERFORMED BY OTHER THAN THE MATERIAL MANUFACTURER,
- TIMES WHEN THE REQUIREMENTS OF SECTION VIII, DIVISION 1 EXCEED OR SUPPLEMENT THE REQUIREMENTS OF THE MATERIAL SPECIFICATION.

CERTIFICATE OF COMPLIANCE

A CERTIFICATE OF COMPLIANCE IS SIMPLY A WRITTEN STATEMENT ISSUED BY A MATERIAL MANUFACTURER OR SUPPLIER CERTIFYING THAT THE MATERIAL FURNISHED IS IN COMPLIANCE WITH THE MATERIAL SPECIFICATION.

P NUMBERS TO WATCH

IN ADDITION TO ZIRCONIUM, P NUMBER 61 AND TITANIUM, P NUMBERS 51 AND 52, CARE SHOULD BE TAKEN WHEN WELDING NICKEL WHICH HAS A P NUMBER OF 11.

INSPECTION OF WELDS

THE CODE REQUIRES THAT CERTAIN CRITERIA BE MET DURING WELDING OF ITEMS. IN ORDER TO ASSURE THESE CRITERIA ARE MET, INSPECTIONS MUST BE MADE. SOME INSPECTIONS ARE:

- THAT THE MATERIALS ARE ACCEPTABLE TO THE CODE AND MEET THE DESIGN CRITERIA.
- THAT THE FITUP GEOMETRY MEETS THE REQUIREMENTS OF THE W.P.S. AND THAT TACK WELDS ARE ACCEPTABLE.
- THE ROOT PASS SHOULD BE INSPECTED BY WELDING PERSONNEL TO AVOID PROBLEMS LATER IN THE LIFE OF THE JOINT.
- INSPECT BACK-GOUGING TO ASSURE SOUND METAL IS REACHED PRIOR TO WELDING FROM THE SECOND SIDE.
- VISUAL OF THE COMPLETED WELD BOTH INSIDE AND OUT.
- ANY REQUIRED N.D.E.
- THAT ALL APPROPRIATE DOCUMENTATION IS AVAILABLE AND CORRECT.

RADIOGRAPHY REQUIREMENTS

SECTION VIII, DIVISION 1

WHEN RADIOGRAPHY IS TO BE USED IN BUILDING A CODE VESSEL, INFORMATION MAY BE FOUND IN:

- UW-2: SPECIFIC DESIGNS AND SERVICE RESTRICTIONS.
- UW-9: STAGGERED JOINTS.
- UW-11: DEFINITIONS AND APPLICATIONS.
- UW-12: EFFICIENCY REQUIREMENTS.
- UW-42: REPAIRS AND BUILD-UP.
- UW-51: REQUIREMENTS FOR FULL R.T..
- UW-52: REQUIREMENTS FOR SPOT R.T..

MISCELLANEOUS INFORMATION MAY BE FOUND IN UCS-57, UNF-57, UHA-33, UCL-35 AND 36, UHT-57, ULW-56 AND ULT-57.

TABLE UCS-57

THICKNESS ABOVE WHICH FULL RADIO-
GRAPHIC EXAMINATION OF BUTT WELDED
JOINTS IS MANDATORY

P-No. & Gr. No. Classification of Material	Nominal Thickness Above Which Butt Welded Joints Shall Be Fully Radiographed, in.
1 Gr. 1, 2, 3	1 $\frac{1}{4}$
3 Gr. 1, 2, 3	$\frac{3}{4}$
4 Gr. 1, 2	$\frac{3}{8}$
5 Gr. 1, 2	0
9A Gr. 1	$\frac{5}{8}$
9B Gr. 1	$\frac{5}{8}$
10A Gr. 1	$\frac{3}{4}$
10B Gr. 2	$\frac{5}{8}$
10C Gr. 1	$\frac{5}{8}$
10F Gr. 6	$\frac{3}{4}$

UW-51 FULL R.T.

UW-51 GIVES THE REQUIREMENTS FOR FULL R.T.

- PERSONNEL MUST BE QUALIFIED USING SNT-TC-1A AS A GUIDE.
- NO REQUIREMENT FOR A WRITTEN PROCEDURE IS INDICATED.
- ACCEPTANCE CRITERIA.
- RECORD RETENTION NOT REQUIRED.

FULL RADIOGRAPHY ACCEPTANCE CRITERIA

THE ACCEPTANCE CRITERIA FOR FULL R.T. ARE:

- LINEAR INDICATIONS:
 - NO CRACK OR ZONE OF INCOMPLETE FUSION OR PENETRATION.
 - ANY ELONGATED SLAG INCLUSION GREATER THAN:
 - $1/4"$ FOR $t < 3/4"$
 - $1/3"$ FOR $t = 3/4"$ TO $2 1/4"$ INCLUSIVE
 - $3/4"$ FOR $t > 2 1/4"$
 - ANY GROUP OF SLAG INCLUSIONS IN LINE GREATER THAN t IN A $12t$ LENGTH EXCEPT WHEN THE DISTANCE BETWEEN INCLUSIONS IS GREATER THAN THE 6 TIMES THE LENGTH OF THE LONGEST INCLUSION.
- ACCEPTANCE CRITERIA FOR ROUNDED INDICATIONS ARE FOUND IN APPENDIX 4.

UW-52 SPOT R.T.

UW-52 GIVES THE REQUIREMENTS FOR SPOT R.T.

- PERSONNEL MUST BE QUALIFIED USING SNT-TC-1A AS A GUIDE.
- NO REQUIREMENT FOR A WRITTEN PROCEDURE IS INDICATED.
- ACCEPTANCE CRITERIA: **NO (M) LOW ERYT**
- RECORD RETENTION NOT REQUIRED.

SPOT RADIOGRAPHY ACCEPTANCE CRITERIA

THE ACCEPTANCE CRITERIA FOR SPOT R.T. ARE:

- LINEAR INDICATIONS:
 - NO CRACK OR ZONE OF INCOMPLETE FUSION OR PENETRATION.
 - ANY ELONGATED SLAG INCLUSION GREATER THAN:
 - $2/3t$
 - ANY GROUP OF SLAG INCLUSIONS IN LINE GREATER THAN t IN A $6t$ LENGTH AND THE DISTANCE BETWEEN THE LONGEST INDICATIONS CONSIDERED IS GREATER THAN $3L$, WHERE L IS THE LONGEST INCLUSION.
- ROUNDED INDICATIONS:

ROUNDED INDICATIONS ARE NOT A FACTOR IN SPOT RADIOGRAPHY.

UHA-21 WELDED JOINTS

MATERIAL PARAGRAPHS CAN AFFECT THE N.D.E. OF AN ITEM. FOR EXAMPLE, UHA-21 STATES "WHEN RADIOGRAPHIC EXAMINATION IS REQUIRED FOR BUTT-WELDED JOINTS BY UHA-33, JOINTS OF CATEGORY A AND B (SEE UW-3) SHALL BE OF TYPE NO. (1) OR NO. (2) OF TABLE UW-12".

ULT-57 EXAMINATION

ANOTHER MATERIAL PARAGRAPH THAT AFFECTS THE N.D.E. OF AN ITEM IS ULT-57. IT STATES:

- (a) ALL BUTT JOINTS SHALL BE EXAMINED BY 100% RADIOGRAPHY, EXCEPT AS PERMITTED IN UW-11(a)(7).
- (b) ALL ATTACHMENT WELDS, AND ALL WELDED JOINTS SUBJECT TO PRESSURE NOT EXAMINED BY RADIOGRAPHY OR ULTRASONIC TESTING, SHALL BE GIVEN A LIQUID PENETRANT EXAMINATION EITHER BEFORE OR AFTER HYDROTEST. RELEVANT INDICATIONS ARE THOSE WHICH RESULT FROM IMPERFECTIONS. ANY RELEVANT LINEAR INDICATION GREATER THAN 1/16 IN. SHALL BE REPAIRED OR REMOVED.

WHEN A PNEUMATIC TEST IS REQUIRED BY ULT-99(b), THESE LIQUID PENETRANT EXAMINATIONS SHALL BE PERFORMED PRIOR TO PNEUMATIC TEST.

ULTRASONIC REQUIREMENTS

SECTION VIII, DIVISION 1

WHEN ULTRASONIC EXAMINATION IS TO BE USED IN BUILDING A CODE VESSEL, INFORMATION MAY BE FOUND IN:

- UW-11: FINAL CLOSURE SEAMS.
- UW-53: TECHNIQUES.
- APP. 12: TECHNIQUES.

MISCELLANEOUS INFORMATION MAY BE FOUND IN ULW-57 AND ULT-57.

APPENDIX 12 ULTRASONICS

APPENDIX 12 GIVES THE REQUIREMENTS FOR U.T.

- PERSONNEL MUST BE QUALIFIED USING SNT-TC-1A AS A GUIDE.
- A WRITTEN AND QUALIFIED PROCEDURE IS REQUIRED.
- ACCEPTANCE CRITERIA.
- RECORD RETENTION REQUIRED FOR 5 YEARS.
- SPECIFIC REQUIREMENTS FOR UNCORRECTED AREAS.

P.T. AND M.T.

SECTION VIII, DIVISION 1

WHEN P.T. OR M.T. IS TO BE USED IN BUILDING A CODE VESSEL, INFORMATION MAY BE FOUND IN:

- UW-42: REPAIR OR BUILDUP.
- UW-50: PRIOR TO PNEUMATIC TESTING.
- APP. 6: MAGNETIC PARTICLE.
- APP. 8: LIQUID PENETRANT.

MISCELLANEOUS INFORMATION MAY BE FOUND IN UNF-58, UHA-34, UHT-57 AND 85, ULW-56 AND 57 AND ULT-57.

APPENDIX 8 P.T.

APPENDIX 8 GIVES THE REQUIREMENTS FOR P.T.

- PERSONNEL NEED NOT BE QUALIFIED USING SNT-TC-1A. CERTIFICATION BY THE MANUFACTURER FOR:
 - VISUAL
 - COMPETENCE IN THE P.T. DISCIPLINE
- ACCEPTANCE CRITERIA.
- WRITTEN AND QUALIFIED PROCEDURES ARE REQUIRED PER ARTICLE 6 OF SECTION V.

UHA-34 LIQUID PENETRANT EXAMINATION

ANOTHER MATERIAL PARAGRAPH THAT HAS AN INFLUENCE ON N.D.E. OF CODE ITEMS IS UHA-34. IT STATES:

- (a) ALL AUSTENITIC CHROMIUM-NICKEL ALLOY STEEL WELDS, BOTH BUTT AND FILLET, IN VESSELS WHOSE SHELL THICKNESS EXCEEDS 3/4 IN., AND ALL 36% NICKEL STEEL WELDS, BOTH BUTT AND FILLET, REGARDLESS OF THICKNESS, SHALL BE EXAMINED FOR THE DETECTION OF CRACKS BY THE LIQUID PENETRANT METHOD. THIS EXAMINATION SHALL BE MADE FOLLOWING HEAT TREATMENT IF HEAT TREATMENT IS PERFORMED. ALL CRACKS SHALL BE ELIMINATED.

APPENDIX 6 M.T.

APPENDIX 6 GIVES THE REQUIREMENTS FOR M.T.

- PERSONNEL NEED NOT BE QUALIFIED USING SNT-TC-1A. CERTIFICATION BY THE MANUFACTURER FOR:
 - VISUAL
 - COMPETENCE IN THE M.T. DISCIPLINE
- ACCEPTANCE CRITERIA.
- WRITTEN AND QUALIFIED PROCEDURES ARE REQUIRED PER ARTICLE 7 OF SECTION V.

REQUIRED N. D. E.

IN SUMMARY, N.D.E. IS REQUIRED BY THE CODE AS FOLLOWS:

- R.T. OF WELDING AS REQUIRED FOR SPECIAL SERVICE OR DESIGN (UW-11, 12, ETC.).
- P.T. OR M.T. PRIOR TO PNEUMATIC TESTING (UW-50).
- P.T. OR M.T. OF REPAIRS OR WELD METAL BUILD-UP (UW-42).
- VISUAL OF THE PRESSURE TEST (UG-99).

N.D.E. PROCEDURE QUALIFICATIONS

WHEN IT IS REQUIRED TO QUALIFY AN N.D.E. PROCEDURE, THE FOLLOWING PROVIDE THE INFORMATION NEEDED. REMEMBER, AN R.T. PROCEDURE IS NOT REQUIRED FOR SECTION VIII, DIVISION 1. USUALLY, THIS IS A REQUIREMENT OF THE Q. C. MANUAL.

- R.T. PER ARTICLE 2 OF SECTION V.
- M.T. PER APPENDIX 6 OF SECTION VIII.
- P.T. PER APPENDIX 8 OF SECTION VIII.
- U.T. PER APPENDIX 12 OF SECTION VIII.

N.D.E. PERSONNEL QUALIFICATIONS

TO QUALIFY N.D.E. PERSONNEL, REQUIREMENTS
MAY BE FOUND IN:

- SNT-TC-1A, AS A GUIDE FOR R.T.
- SNT-TC-1A, AS A GUIDE FOR U.T.
- APPENDIX 6 OF SECTION VIII FOR M.T.
- APPENDIX 8 OF SECTION VIII FOR P.T.

RECERTIFICATION OF N.D.E. PERSONNEL

AN EMPLOYER'S WRITTEN PRACTICE MUST COVER
THE RECERTIFICATION OF N.D.E. PERSONNEL.
PERSONNEL MUST BE RECERTIFIED:

- EVERY 3 YEARS BY:
 - CONTINUED SATISFACTORY PERFORMANCE
 - RE-EXAMINATION
- WHEN THERE IS REASON TO QUESTION THEIR
PERFORMANCE BY EITHER Q.C. PERSONNEL OR
THE AUTHORIZED INSPECTOR.
- RE-EMPLOYMENT

NOTE: AN ANNUAL VISION EXAMINATION, INCLUD-
ING A COLOR TEST, IS REQUIRED.

PRESSURE TESTING

PRESSURE TESTS ARE USED TO DETERMINE STRUCTURAL INTEGRITY. THEIR PURPOSE IS TO DETECT GROSS DEFECTS IN DESIGN AND VESSEL FABRICATION. THERE ARE TWO TYPES OF PRESSURE TESTING GIVEN IN SECTION VIII, DIVISION 1. THEY ARE:

- HYDROSTATIC
- PNEUMATIC

WHAT MUST BE HYDRO TESTED?

ALL SECTION VIII, DIVISION 1 PRESSURE VESSELS MUST BE HYDROSTATICALLY TESTED, EXCEPT THOSE PNEUMATICALLY TESTED. TESTING REQUIREMENTS ARE FOUND IN:

- UG-99 HYDROSTATIC TESTING
- UG-100 PNEUMATIC TESTING
- UG-101 PROOF TESTING

HYDRO TEST TEMPERATURE

UG-99(h)

"IT IS RECOMMENDED THAT THE METAL TEMPERATURE DURING HYDROSTATIC TEST BE MAINTAINED AT LEAST 30 F. ABOVE THE MINIMUM DESIGN METAL TEMPERATURE (SEE UG-20) TO MINIMIZE THE RISK OF BRITTLE FRACTURE. THE TEST PRESSURE SHALL NOT BE APPLIED UNTIL THE VESSEL AND ITS CONTENTS ARE AT ABOUT THE SAME TEMPERATURE".

MINIMUM HYDROSTATIC TEST PRESSURE

NORMALLY, HYDRSTATIC TEST PRESSURE IS DETERMINED BY THE FORMULA:

$$P = (M.A.W.P.)(1.5)(\text{LOWEST STRESS RATIO})$$

WHERE: M.A.W.P. IS THAT STAMPED ON THE VESSEL AND,

$$\text{STRESS RATIO} = \frac{S_a \text{ AT TEST TEMP.}}{S_a \text{ AT DESIGN TEMP.}}$$

PL 20

COMBINATION UNITS

FOR COMBINATION UNITS, HYDROSTATIC TESTS WOULD BE PERFORMED AS FOLLOWS:

- FOR ADJACENT CHAMBERS THAT WILL OPERATE INDEPENDANTLY:
 - HYDROSTATICALLY TEST EACH UNIT AS A SEPARATE VESSEL.
- FOR ADJACENT CHAMBERS DESIGNED FOR A DIFFERENTIAL PRESSURE, AND THE DIFFERENTIAL PRESSURE IS MORE THAN THE M.A.W.P. FOR EACH UNIT, YOU MUST TEST EACH UNIT USING A PRESSURE CALCULATED AS FOLLOWS:
 - DIFFERENTIAL PRESSURE (1.5) (STRESS RATIO). NOTE: THIS TEST MUST AT LEAST MEET THE PRESSURE OF UG-99(b) OR (c).
- FOR ADJACENT CHAMBERS DESIGNED FOR A DIFFERENTIAL PRESSURE, AND THE DIFFERENTIAL PRESSURE IS LESS THAN THE M.A.W.P. FOR EITHER UNIT, YOU MUST TEST EACH UNIT USING A PRESSURE CALCULATED AS FOLLOWS:
 - DIFFERENTIAL PRESSURE (1.5) (STRESS RATIO). THEN TEST EACH UNIT IN ACCORDANCE WITH UG-99(b) OR (c).

CAST IRON VESSELS

FOR CAST IRON VESSELS, THE TEST MUST BE CONDUCTED USING A PRESSURE DETERMINED AS FOLLOWS:

- FOR M.A.W.P. LESS THAN OR EQUAL TO 30 P.S.I.:
 - 2.5 (M.A.W.P.); IN NO CASE MAY THIS EXCEED 60 P.S.I..
- FOR M.A.W.P. GREATER THAN 30 P.S.I.:
 - 2 (M.A.W.P.)

INSPECTION OF THE HYDROSTATIC TEST

ONCE THE HYDROSTATIC TEST PRESSURE IS REACHED, THE PRESSURE WILL THEN BE REDUCED BY 1/3. AT THAT TIME, AN INSPECTION WILL BE MADE OF ALL WELDS AND CONNECTIONS.

NEVER INSPECT AT FULL TEST PRESSURE.

INSPECTION OF THE PNEUMATIC TEST

ONCE THE PNEUMATIC TEST PRESSURE IS REACHED, THE PRESSURE WILL THEN BE REDUCED BY 1/5. AT THAT TIME, AN INSPECTION WILL BE MADE OF ALL WELDS AND CONNECTIONS.

NEVER INSPECT AT FULL TEST PRESSURE.

WITNESSING OF THE PNEUMATIC TEST

THE PNEUMATIC TEST MUST BE WITNESSED BY THE AUTHORIZED INSPECTOR. THIS IS REQUIRED IN ALL BUT ONE CASE FOR ANY VESSEL TO BE STAMPED WITH THE "U" SYMBOL STAMP. THE ONE EXCEPTION IS FOR MULTIPLE, DUPLICATE VESSELS BUILT IN ACCORDANCE WITH UG-90(c)(2). THE AUTHORIZED INSPECTOR SHALL WITNESS THE TEST AT 4/5 OF THE TEST PRESSURE. HE SHOULD NOT WITNESS A TEST AT THE PNEUMATIC TEST PRESSURE.

TEST GAUGES

UG-102

UG-102 COVERS TEST GAUGES. IT STATES THAT GAUGES MUST BE:

- CONNECTED DIRECTLY TO THE VESSEL.
- VISIBLE TO THE OPERATOR.
- GRADUATED TO A RANGE ABOUT DOUBLE THAT OF THE TEST PRESSURE BUT, IN NO CASE, LESS THAN 1 1/2 NOR MORE THAN 4 TIMES THAT PRESSURE.
- CALIBRATED AGAINST A DEAD-WEIGHT TESTER OR A CALIBRATED MASTER GAUGE.
- CALIBRATED WHENEVER ERROR IS SUSPECTED. THERE IS NO ESTABLISHED FREQUENCY IN THE CODE FOR GAUGE CALIBRATION. THIS IS USUALLY COVERED IN A Q. C. SYSTEM.

STAMPING DIRECTLY ON THE VESSEL

WHEN CODE STAMPING IS APPLIED DIRECTLY ON THE VESSEL, STAMPING MUST:

- BE DONE USING LETTERS AND FIGURES AT LEAST 5/16" HIGH.
- BE ARRANGED PER FIGURE UG-118 WHERE SPACE PERMITS.

UNIVERSIDAD NACIONAL AUTONOMA DE MÉXICO
FACULTAD DE INGENIERIA
DIVISIÓN DE EDUCACIÓN CONTINUA

DATOS DEL INSTRUCTOR

ING. ORLANDO R. RIVERA

Tel. / Fax: (55) 5776-6524 ; E-mail: orlanriver@hotmail.com

Es Ingeniero Mecánico Titulado egresado de la Escuela Superior de Ingeniería Mecánica y Eléctrica del Instituto Politécnico Nacional. Cuenta con una experiencia profesional de más de 20 años en diseño, fabricación, inspección, prueba, certificación, montaje y reparación de calderas, recipientes a presión, sistemas de tubería y componentes nucleares. Ha calificado ante el Gobierno de Texas, Ohio, Pennsylvania y The National Board of Boiler and Pressure Vessel Inspectors de Norte America como Inspector Autorizado, Supervisor de Inspectores Autorizados e Inspector Nuclear Autorizado de ASME. Ha sido asesor de más de 40 empresas en México, Colombia, Venezuela, Brasil y Argentina en Sistemas y Certificaciones de ASME y National Board. Ha impartido el Diplomado de Ingeniería de Calderas y Recipientes a Presión en la División de Educación Continua de la Facultad de Ingeniería de la Universidad Nacional Autónoma de México, y ha presentado ponencias en Talleres Internacionales de Capacitación en Calderas, Recipientes a Presión y Temas Afines de la Asociación Mexicana de Ingenieros Mecánicos y Electricistas, A.C. (AMIME). Actualmente es Presidente del Comité de Calderas y Recipientes a Presión de AMIME y Consultor de varias compañías nacionales e internacionales.

2004.