



# MEXICAN EXPERIENCES ON RPV SURVEILLANCE MATERIALS

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- AGEING MANAGEMENT PROGRAM
- RPV SURVEILLANCE PROGRAM
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# GENERAL DATA

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- Laguna Verde general data:
  - Two units X 682.44 net MWe
  - Reactor type: Boiling Water reactor (BWR 5)
  - Nominal pressure: 79.69 Kg/cm<sup>2</sup>
  - Control: 109 SS control rods with Boron carbide
  - Steam flow: 3961.3 ton/hr
  - Feed water flow: 3950 ton/hr
  - Vessel: made of carbon steel internally clad with stainless steel. Total height= 20.8 m,  $\phi$ = 5.30 m and Thickness from 13 to 18 cm.



# GENERAL DATA (cont.)

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- Vessel specification and design: welded construction. Design by GE and manufactured by Chicago Bridge & Iron
- Designed, fabricated, tested and inspected in accordance with ASME code, section III. Reactor and its support system meet seismic category I.
- Shell & bottom head section were made of low alloy steel and were internally clad with SS 304



# Service conditions

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- OPERATING POWER:  
2027 MWt (105 % of nuclear rated power)  
120% EPU programmed for 2010 both units.
- VESSEL DOME PRESSURE:  
79.69 Kg/cm<sup>2</sup>
- TEMPERATURE  
282°C
- STEAM FLOW  
3961.3 Ton/h (105% of nuclear boiler rated steam flow).



# Materials & fabrication

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- Constructed from low alloy, high strength steel plate and forging
  - Plate of SA 533 Gr. B Cl1, forgings of SA 508 class 2.
  - Studs, nuts and washers for main closure flange are of SA 540 Gr.B23 or B24
- Submerged arc and manual electrode welding processes were employed.

# AMP's for both units.

**COMISIÓN FEDERAL DE ELECTRICIDAD  
GERENCIA DE CENTRALES NUCLEOELÉCTRICAS  
LAGUNA VERDE  
SUBGERENCIA DE INGENIERÍA**

**DISCIPLINA**                    **ANÁLISIS DE INGENIERÍA**  
**GRUPO**                        **INGENIERÍA DE MATERIALES**  
**UNIDAD**                        **1 y 2**  
**REPORTE**                      **RMEM-001 R0**

**PROYECTO:  
MANEJO DEL CICLO DE VIDA PARA LA CENTRAL LAGUNA VERDE**

**Revisión de Manejo de Envejecimiento en  
Sistemas Mecánicos-Vasija del Reactor**

**RS**

REV	FECHA	PREPARADO POR:	REVISADO POR:	APROBADO POR:
0	23-07-08	Ing. Mar. Magdalena Griz C.	Ing. J. Martínez López Lugo	Ing. Andrés Vargas Arellano

# MATRIX COMPONENT-AGING MECHANISM

COMPONENT	Aging Mechanism			Remarks/documents for review
	Neut. Embrit	Fatigue	IGSCC & IASCC	
Beltline plates & welds	Signific.			Surveillance program, compare with others plants programs. Participation of LV in ISP
Top head	N/A	N/A	N/A	Review nonconformance reports/ potential FAC/ external operational experience.
Bottom head	N/A	N/A	N/A	
Main closure flange	N/A	Potential	N/A	Review usage factor
Nozzles (full penetration)	LPCI	CRDRL & FW	N/A	Verify return line/ conditions of NUREG 0619/ BWRVIP
Nozzle welds CRD (3)	N/A	Potential	Potential	Review materials, conditions & programs (IVVI's)



# LAGUNA VERDE SURVEILLANCE PROGRAM

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- BELTLINE PLATES & WELDS
  - SURVEILLANCE PROGRAM BASED ON APPENDIXES H & G OF 10CFR50 AND RG 1.99 R.2
  - BOTH UNITS ORIGINALLY CONTAIN 3 SURVEILLANCE HOLDERS
    1. 36 Charpy & 10 tension specimens and a dosimeter with Fe, Ni & Cu wires
    2. 24 Charpy & 6 tension specimens
    3. 24 Charpy & 8 tension specimens

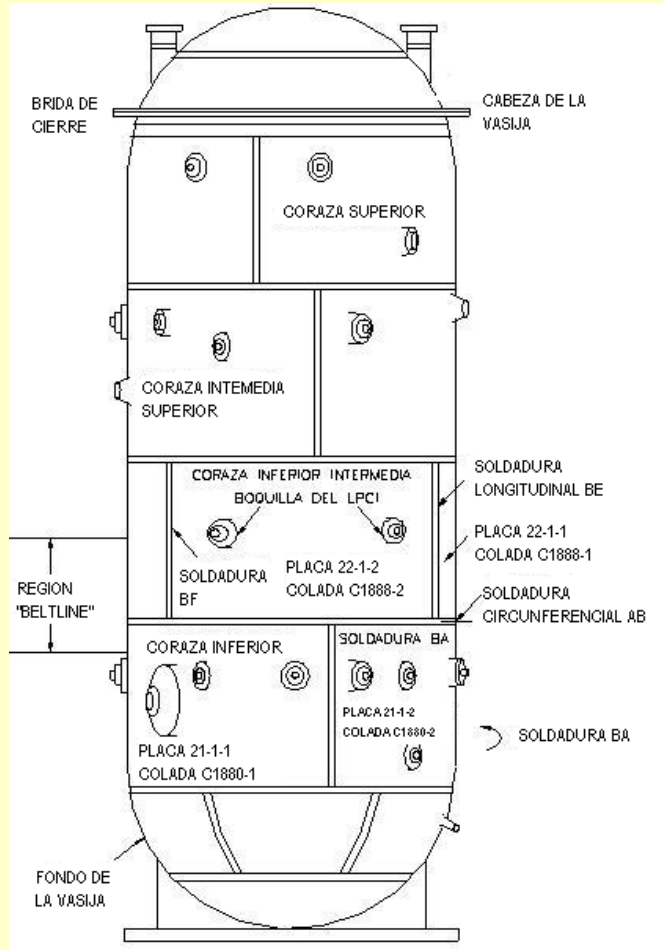


# LAGUNA VERDE SURVEILLANCE PROGRAM

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- CAPSULES WAS RETIRED:
  - UNIT 1: 1997 (6<sup>th</sup> RFO)
  - UNIT 2: 2003 (6<sup>th</sup> RFO)
  - UNIT 1: 2008 (13<sup>th</sup> RFO)
- BOTH WERE REINSTALED ON THE 7<sup>th</sup> OUTAGE , WITH RECONSTITUTED SPECIMENS FOR EXTENDING CURRENT PROGRAM (in order to have surveillance material for License Renewal). LAST WILL BE RECONSTITUTED AND REINSTALED FOR THE 14<sup>th</sup> RFO OF UNIT 1.

# Beltline plates & welds for unit 1 identification



## SURVEILLANCE SPECIMENS

BASE METAL HEAT:  
C-1888-2

WELD METAL HEAT:  
3P4966Linde124lot1214

# Beltline plates & welds for unit 2 identification

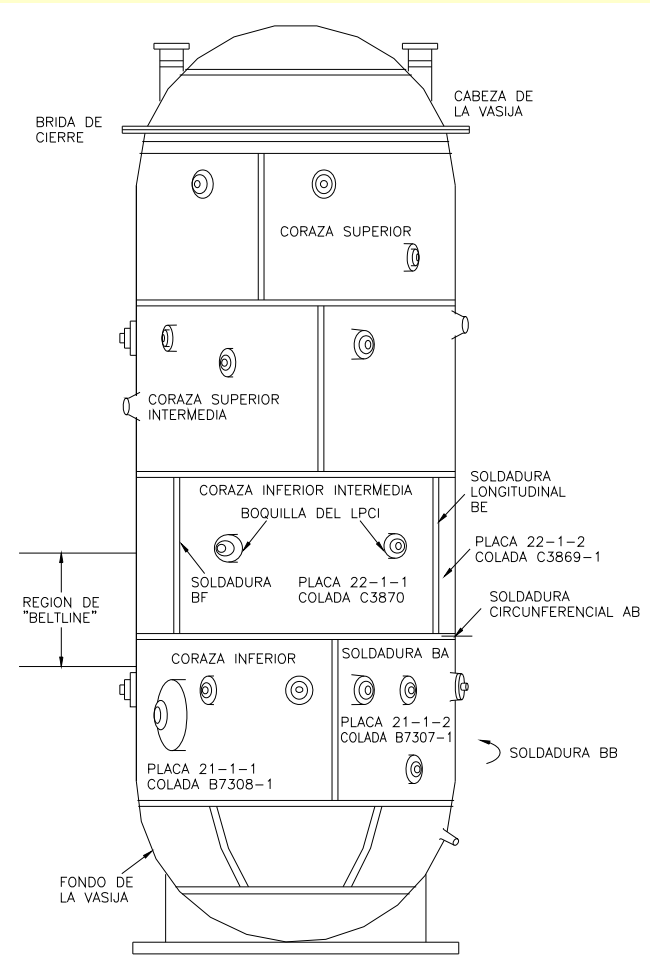
## SURVEILLANCE SPECIMENS

BASE METAL HEAT:


C-3869-1

WELD METAL HEAT:

5P6771 Linde 124 Lot 0342

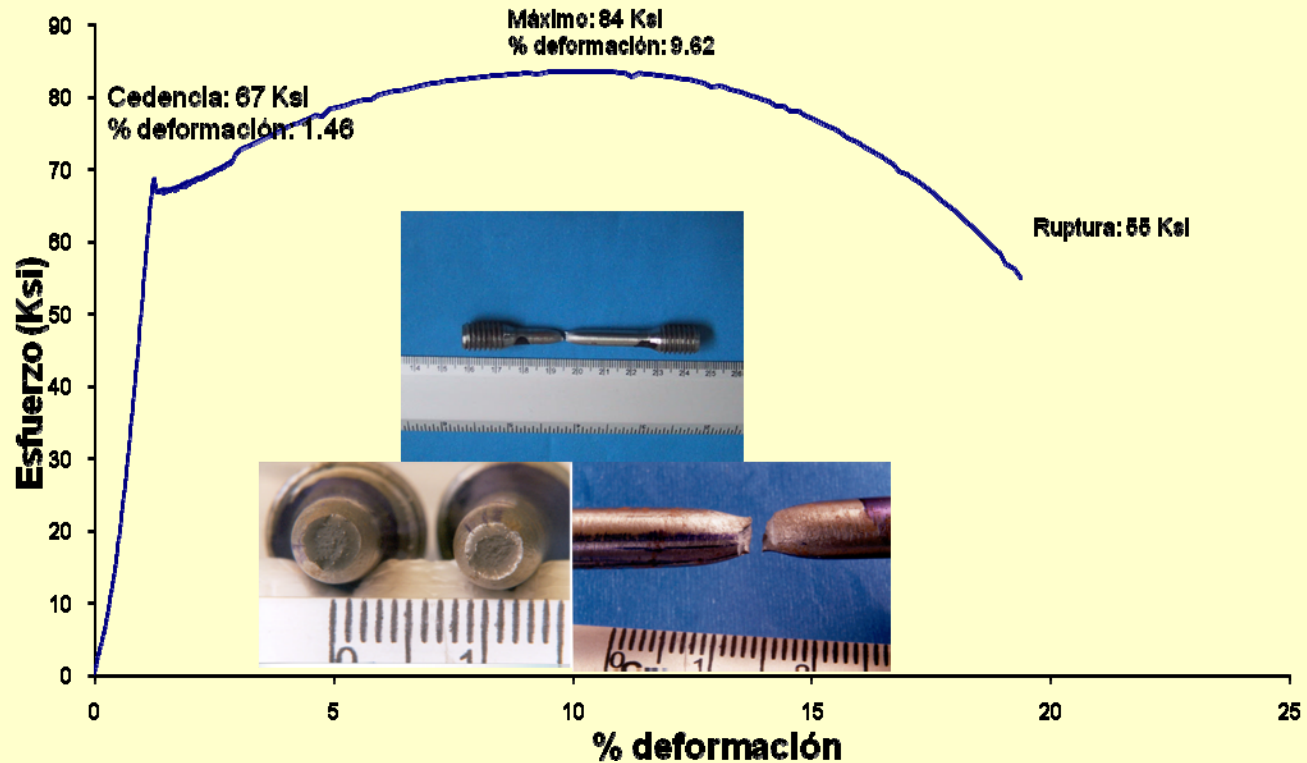


# CHARPY TEST

CHARPY SAMPLE	PICTURE
<p data-bbox="498 715 697 743">BASE METAL</p> <p data-bbox="465 786 730 815">LCCC93P1-POS9</p> <p data-bbox="510 858 685 886">TEMP: 55 °f</p> <p data-bbox="446 929 749 958">ENERGY: 116.4 ft-lbf</p> <p data-bbox="417 1001 778 1029">LATERAL EXP. 70.9 mils</p> <p data-bbox="401 1072 794 1100">DUCTIL FRACTURE : 45%</p>	 A photograph showing two Charpy test samples, which are small, rectangular metal pieces with a V-shaped notch. They are positioned on a white surface above a ruler marked in centimeters. The ruler shows markings from 0 to 3 cm. The samples are dark and appear to be fractured, with a rough, granular surface. The background is a solid blue color.

# TENSION TEST

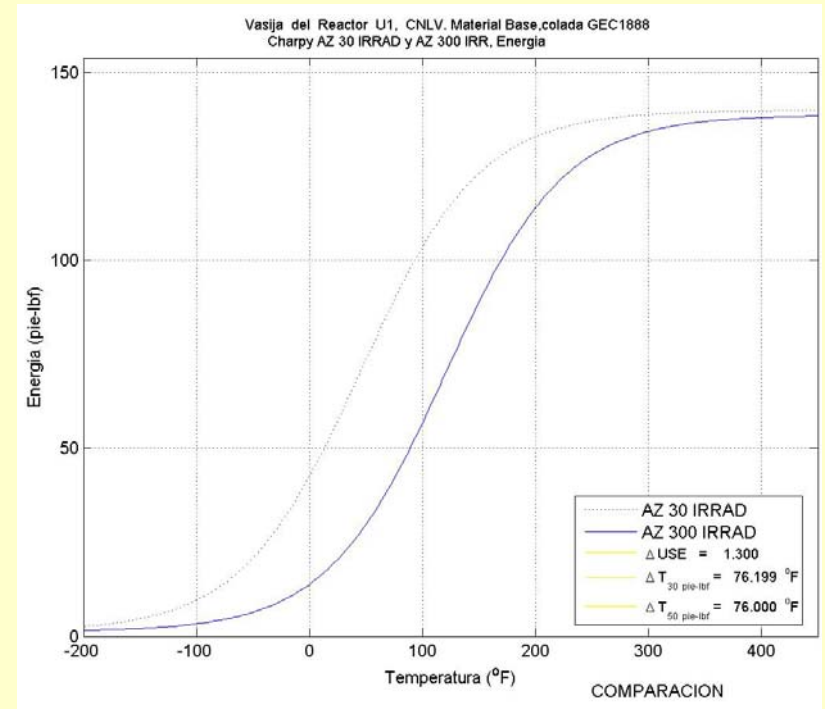
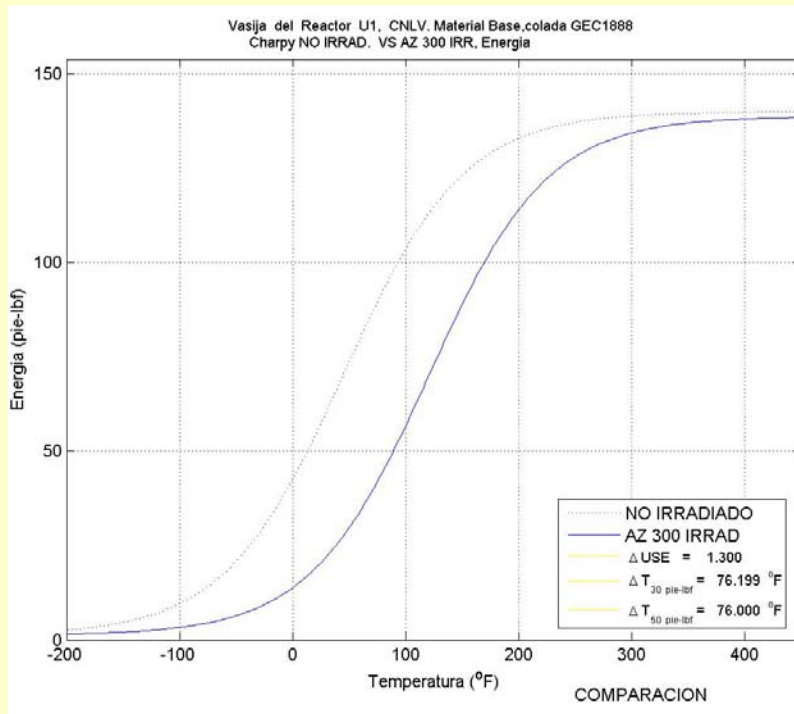
**Esfuerzo vs Deformación, 21/10/03, Probeta 93 P2,  
Posición 10, Soldadura, T = 74.5 °F**



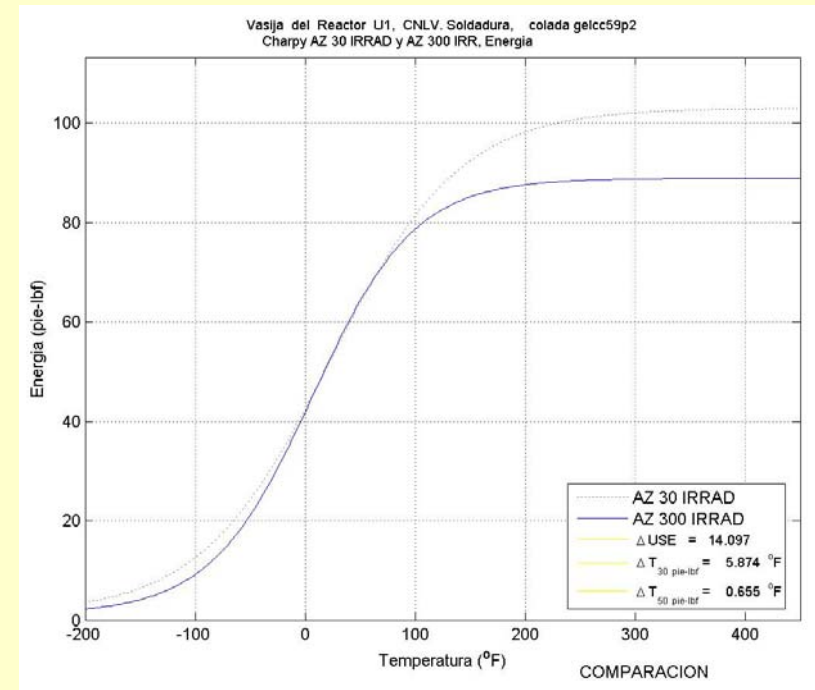
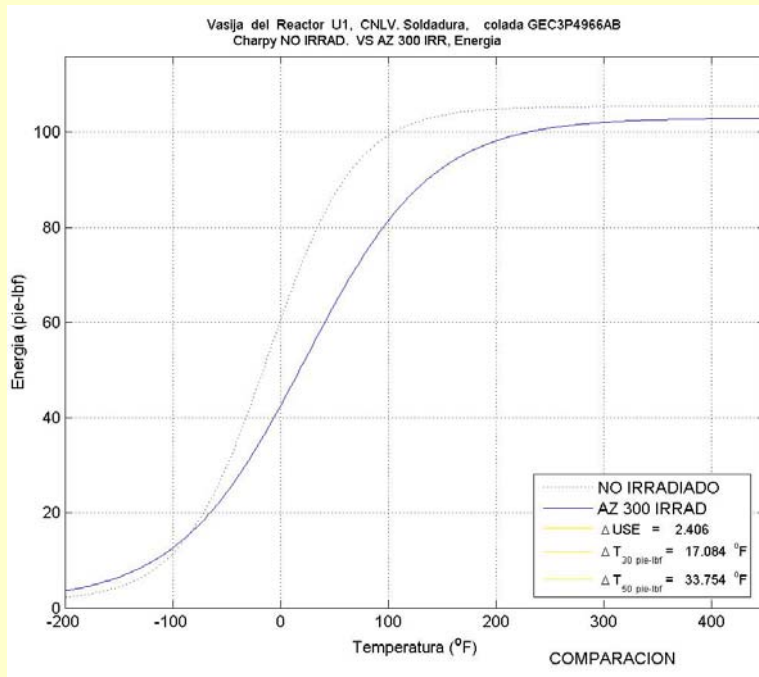
# LAGUNA VERDE SURVEILLANCE PROGRAM

UNIT/ PLATE	HEAT	COMP./ Cu- Ni(%)	INITIAL RT <sub>NDT</sub> °F	ART °F (EFPY)	NEUTRON FLUENCE
U1/22-1-2	C1888-2	0.15/0.51	-20	34 (12 EFPY)	8.625 X 10 <sup>17</sup> n/cm <sup>2</sup>
				54.8 (15.15 EFPY)	1.19X10 <sup>18</sup> n/cm <sup>2</sup>
U1/WELD	3P4966LINDE 124LOT1214	0.03/0.9	-6	16.6 (12 EFPY)	8.625 X 10 <sup>17</sup> n/cm <sup>2</sup>
				26.2 (15.15 EFPY)	1.19X10 <sup>18</sup> n/cm <sup>2</sup>
U2/22-1-2	C3869-1	0.12/0.65	-10	41.4	7.35 X 10 <sup>17</sup> n/cm <sup>2</sup>
U2/WELD	5P6771LINDE 124LOT0342	0.03/0.88	-48	-22.9	7.35 X 10 <sup>17</sup> n/cm <sup>2</sup>

# LAGUNA VERDE SURVEILLANCE PROGRAM



# LAGUNA VERDE SURVEILLANCE PROGRAM



# LAGUNA VERDE P-T CURVES

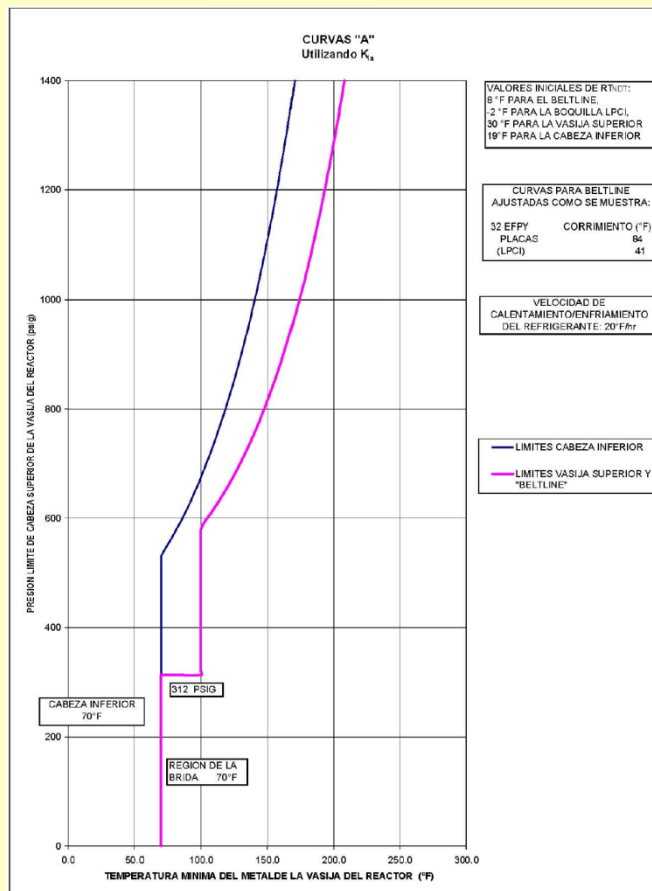


Fig. 1. Curvas de Prueba de Presión (Curvas A), para la Unidad 1, con Método Actual, para 32 EPFY

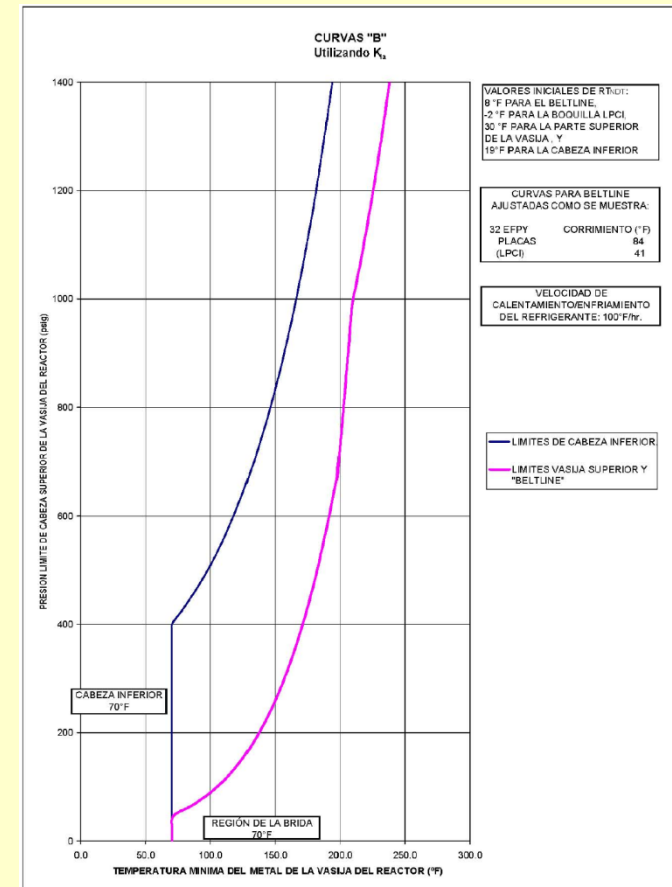
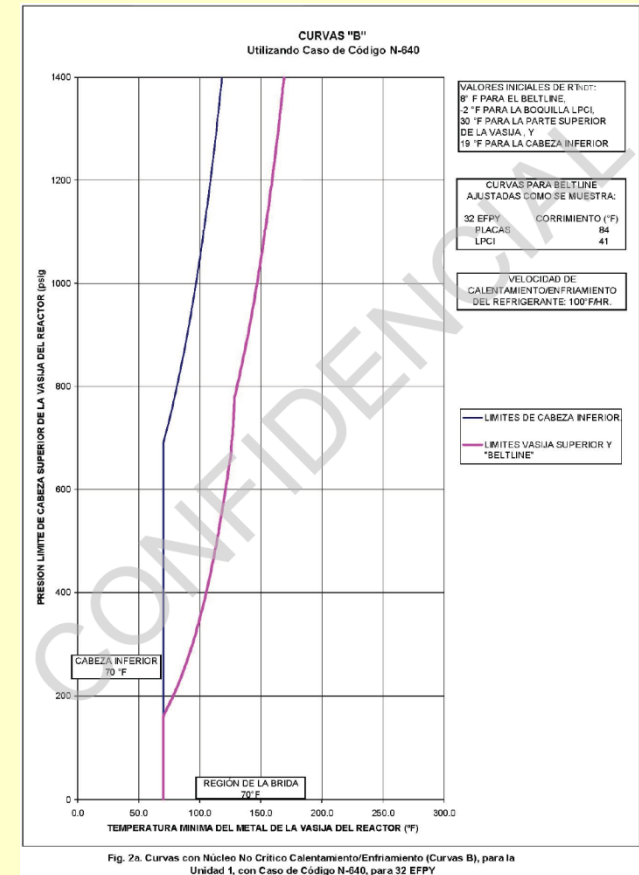
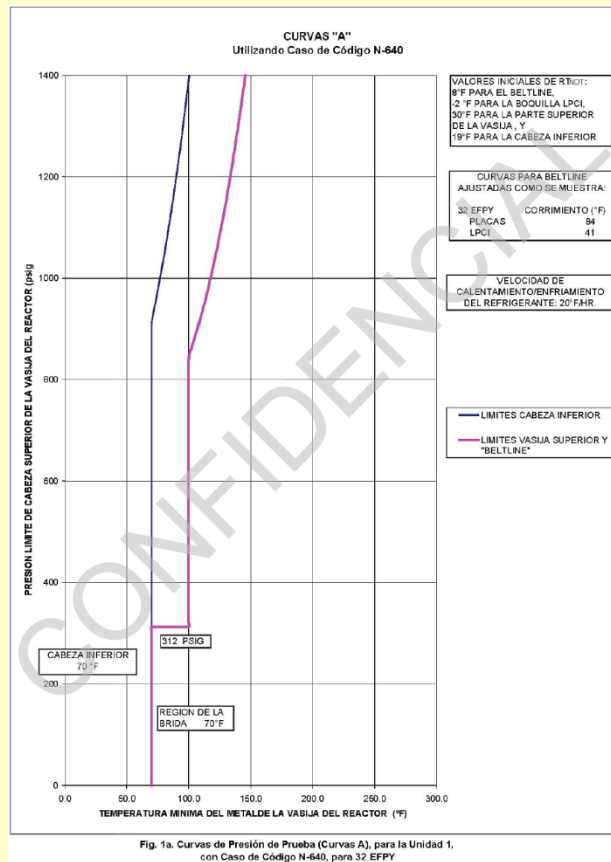


Fig. 2. Curvas de Operación con Núcleo No Crítico Calentamiento/Enfriamiento, para la Unidad 1, con Método Actual, para 32 EPFY

# LAGUNA VERDE P-T CURVES CODE CASE N-640





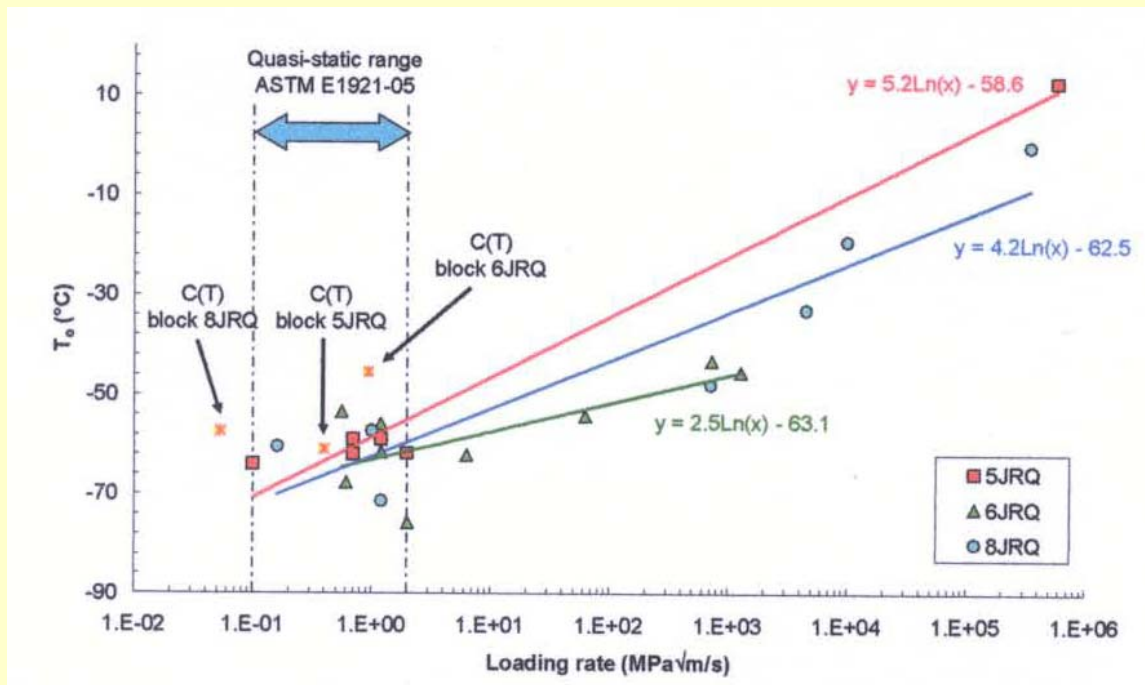
# CURRENT ACTIVITIES

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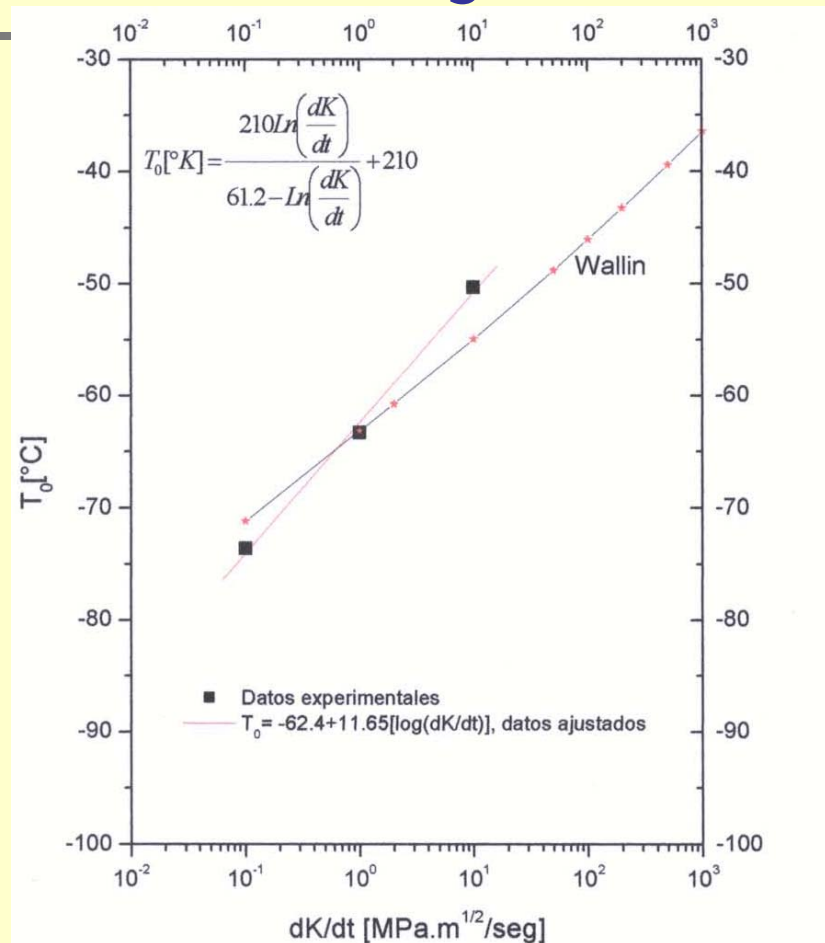
- We are reconstituting the Charpy tested samples by stud welding process.
- Sub-size tension test specimens will be obtained from original tested tension samples.
- Regulatory body is analyzing the extended power uprate proposal for both units. Here there are several analysis about EPU effect on surveillance program.

# CRP 8 OIEA PROJECT ACTIVITIES

- Load rate effect on the reference temperature  $T_0$  in a RPV Steel.



# CRP 8 IAEA Project activities





# CONCLUSIONS

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- Transition reference temperature indexed to 30 ft-lbf for Unit 1 and 2 CNLV materials; base metal, weld and HAZ, is in agreement with RG 1.99 Rev.2 predictions and it is not higher than 200 °F.
- In all cases USE magnitude is bigger than 50 ft-lb, this meet with 10CFR50 Apendix G.
- According to results of 2nd surveillance capsule from Unit 1 and 1st surveillance capsule from Unit 2, RPV materials ductility has not had significant changes.