

XX IMEKO World Congress  
Metrology for Green Growth  
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**NATIONAL INTERCOMPARISON IN FORCE**

**“UNIAXIAL TESTING MACHINE CALIBRATION “**

Laboratorio Designado Magnitud Fuerza (LD-F)  
Instituto de Investigaciones y Control del Ejército - IDIC

**SUMMARY**

This constitutes the fifth comparison in the magnitude of force accomplished by Calibración's Laboratorios of Fuerza and the Designate Laboratory Magnitude in force ( LD F ) of Chile.

This is comparison the continuation belongs to the developed last year because of the errors in the calculations detected in some of the participating laboratories.

A uniaxial testing machine INSTRON utilized like standard of this comparison in compression, 100 kN's reach of measurement, 0.01 kN's resolution itself for comparison, the same that was utilized in the previous work. The team was made easy by the LCPN Force, IDIC - Chile, the activity came true within the frame of cooperation with Normalización's National Institute ( INN ) and Metrología's National Network( RNM ) to the development of the magnitude at the country..

## INTRODUCTION

Trazability chain of the measurements of the industry must be sold off with levels made suitable of uncertainty according to the own needs out of every country. The participation in the comparisons between the Laboratories of calibration, it allows assuring the grade of equivalency of the measurements between the Laboratories like a correct dissemination of the magnitude. It can be said for the above than solidity and confidence, so much inside the national and the international, of the systems of measurement they become stronger with the comparisons between Laboratorios. The results that here present itself correspond to the fourth comparison accomplished between the Laboratories of calibration of magnitude coerce nationals and the LCPN Forces of IDIC designated officially the national employer's custodian Laboratory. The participation in this comparison of the Laboratories of the country allows knowing the compatibility of the measurements and the competition of the staff authorized at the integrating Laboratories of Metrología's Net, supervised by the INN, besides could have corrected the errors found in the work of comparison developed beforehand.

## 2. OBJETC

Accomplishing a comparison in the magnitude of force between the Laboratories of Chile, with the aim of estimating the levels of concordance for the realization of the magnitude of force in a machine of essays between the participating Laboratories, including deviation and correlated uncertainty. Complementarily, it was attempted to unite the method of calibration at the Laboratories when 2598 ( ISO 7500 ) and knowing utilized the same standard of reference, NCh how this Standard between the Laboratories is applied, the referential moral values were proposed by the Pilot Laboratory and making the improvements to the results obtained of the first work of comparison utilizing the same measuring, the measuring of the calibration of the machine the error of the low instrument was calibration in relation to the value of reference of the participating Laboratory..

The comparison took effect during the month of December 2011, the calibrations that the LCPN sold off F they went for the start, in the middle and at the end of the essay.

## 3. CHARACTERISTICS OF COMPARISON

### 3.1 GENEERAL DATAS

Standard used :  
Testing machinne

Testing Machinne			
Marc	Model	serial number	Resolution
INSTRON	5582	5582P8704	0,01 kN

Scope of measurement in the comparison :  
from 10 to 100 kN

Calibracton Méthod : comparasi6n

Measurement Points of calibration:  
10 kN, 20 kN, 30 kN, 40 kN, 50 kN, 60 kN, 70 kN, 80 kN 90 kN y 100 kN

Participants Laboratories

The participating Laboratories indicate in the board N themselves 1, they utilized his own employers of calibration ( transducers of force, charging cells, etc.) For this comparison.

Laboratorio Calibraci6n
CESMEC S.A.
SERVICIO DE METROLOGÍA INTEGRAL Ltda.
UNIVERSIDAD DE CHILE IDIEM
UNIVERSIDAD CENTRAL LEMUC

UNIVERSIDAD DEL BIO - BIO
INSTITUTO DE INVESTIGACIONES Y CONTROL DEL EJÉRCITO

Tabla Nº1 Participants

Schedule of comparason

The comparison came true in the following stages:

- to) Preparation. The LCPN F accomplished the previous measurements. The one with which the general guidelines of comparison were established.
- b) The LCPN F and the INN establish the host documentation and the activities to realize.
- c) The bases of protocol become established .
- d) A mark of communication between the LCPN F establishes, INN and the Laboratories in order to take care of consultations on comparison.
- and) The participating Laboratories accomplished the correspondent measurements according to the programmed dates.
- f) LCPN F executed second measurement in the team used for comparison, according to the nested procedure in comparison, seeing figure 1.

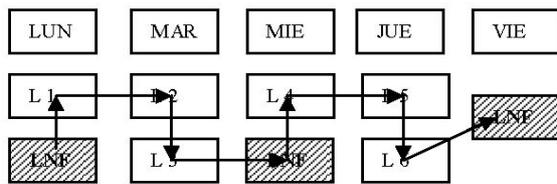


FIG. 1 comparison schedule

4. RESULTS

The following sheets present the results of the measurements accomplished by the Laboratories, according to the sent information the LCPN I work F. East you considered the evaluation of the results of calibration of the participating Laboratories, and the application of the standard.

For intentions of this work, it was used for the evaluation of the results, Normalized Error's value (  $E_n$  ), which can calculate itself with the following model:

$$E_n = \frac{X_{lab} - X_{lab_{ref}}}{\sqrt{U_{lab}^2 + U_{lab_{ref}}^2}}$$

Where:

- $X_{lab}$  : The value is of the relative error obtained by the participating Laboratory
- $X_{ref}$  : The value is of reference ( pilot Laboratory ).
- $U_{lab}$  : the expanded uncertainty calculated by the participating laboratory..

$U_{ref}$  : the expanded uncertainty calculated by the pilot Laboratory.

According to the model of normalized error if  $|E_n| \leq 1$  he results between both Laboratories are compatible if  $|E_n| \geq 1$  results are not acceptable .

They mention situations in a general way in the final section than according to the evaluation of the results once the Laboratories were sent for, they can be cause of errors in the measurement in the calculations of his results or. The above has for objective that Laboratories check their results and identify possible improving opportunities.

4.1 BEHAVIOR OF THE EMPLOYER OF COMPARISON

The National Laboratory accomplished a study of the behavior of the employer of comparison. The initial measurements came true to the start of comparison, between Laboratories and at the end of the round. The obtained data present itself graphically and they find themselves labeled with 1 Calib, 2 Calib, 3 Calib, of all these measurements himself work with the average ( AVERAGE ).

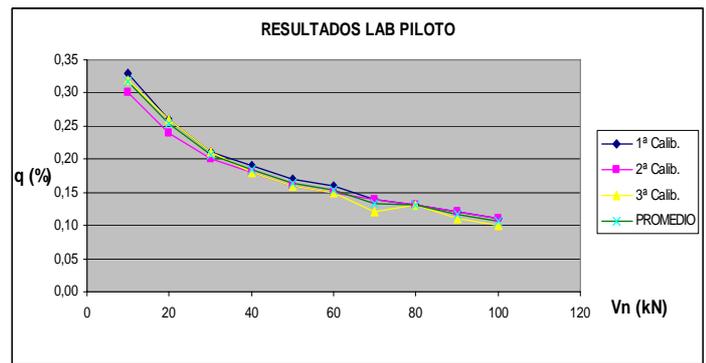
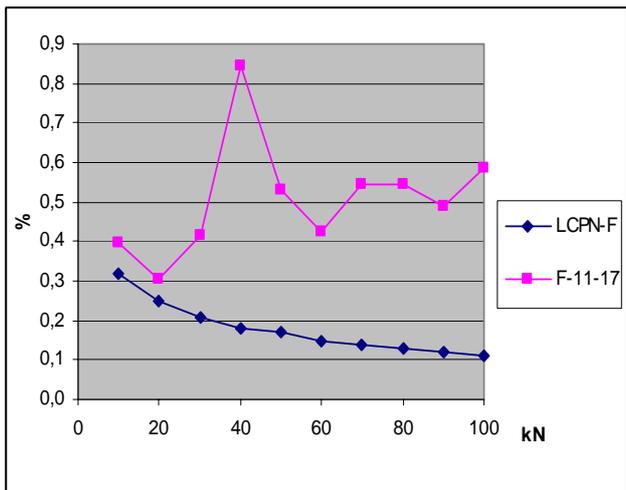


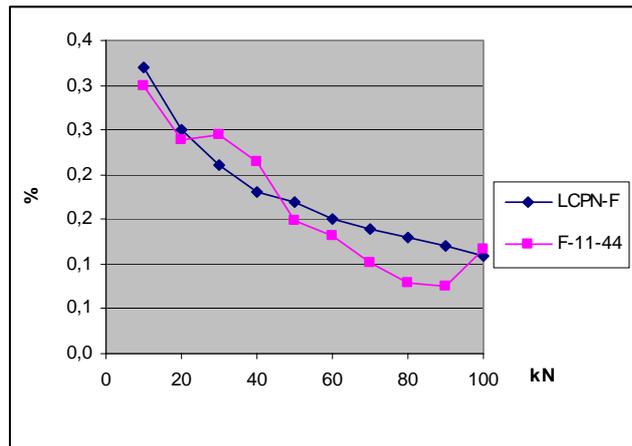
Gráfico Nº 1 midlle value (q)

The blended value of the readings of the LCPN F is the average of the three calibrations ( initial, intermediate and ending ). Postulate is the uncertainty of the pilot Laboratory them uncertainty of the three calibrations and of the drift observed in the machine of essays.

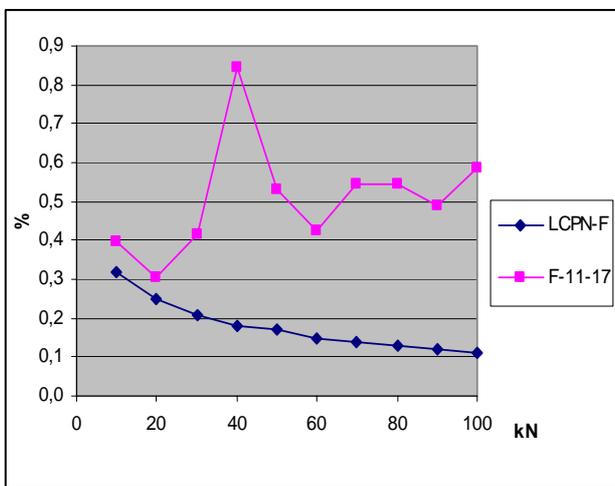
The following graphics represent the results of calibration ( error of exactness q ) calculated by each Laboratories v/s the LCPN F.



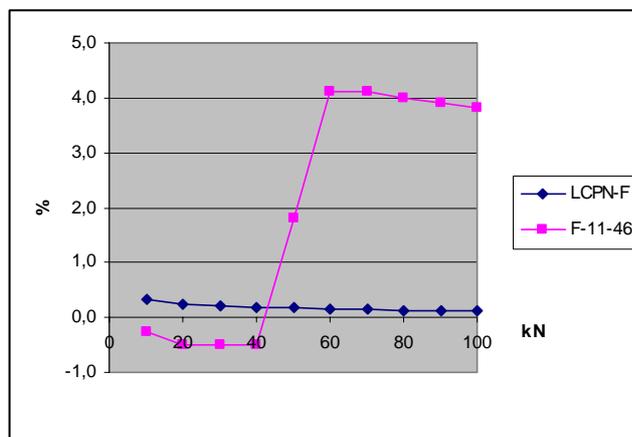
**Graphic Nº 2**  
Error de exactitud (q)



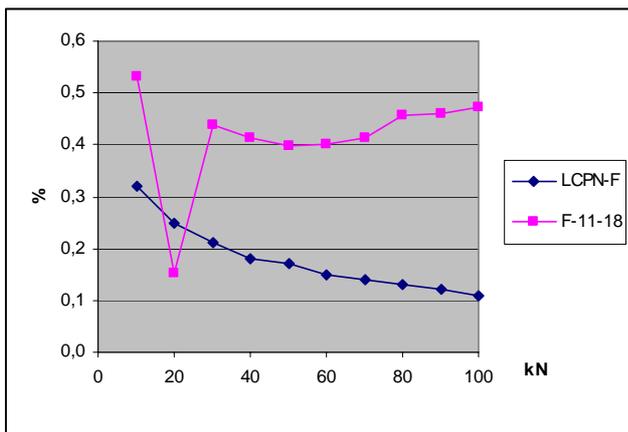
**Graphic Nº 5**  
Error de exactitud (q)



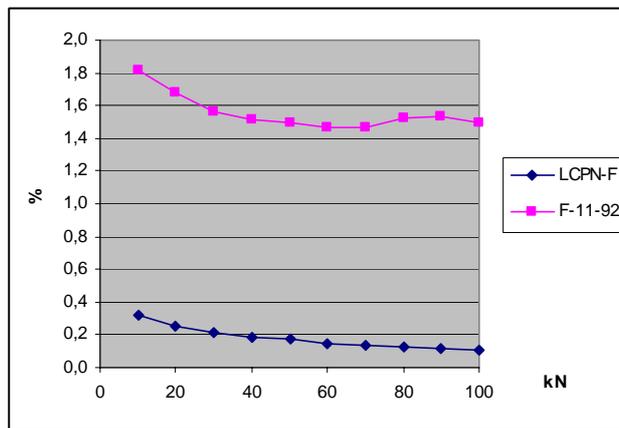
**Graphic Nº 3**  
Error de exactitud (q)



**Graphic Nº 6**  
Error de exactitud (q)

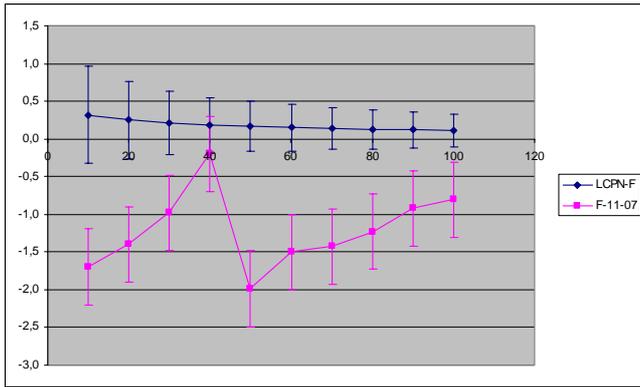


**Graphic Nº 4**  
Error de exactitud (q)

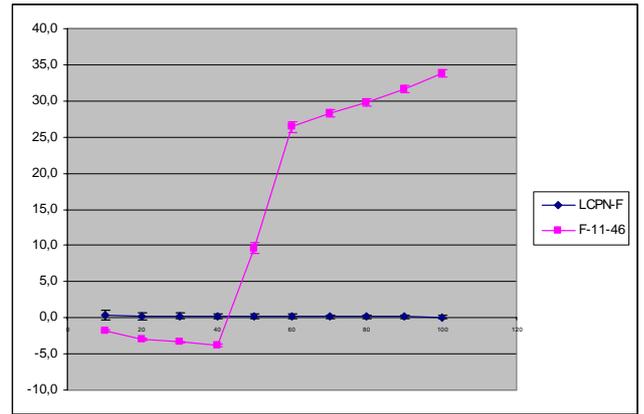


**Graphic Nº 7**  
Error de exactitud (q)

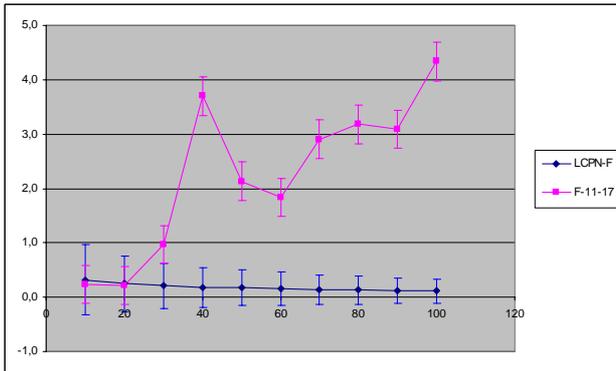
The following graphics represent the relative errors of calibration out of each Laboratory v/s the LCPN F, including besides his correspondent uncertainties.



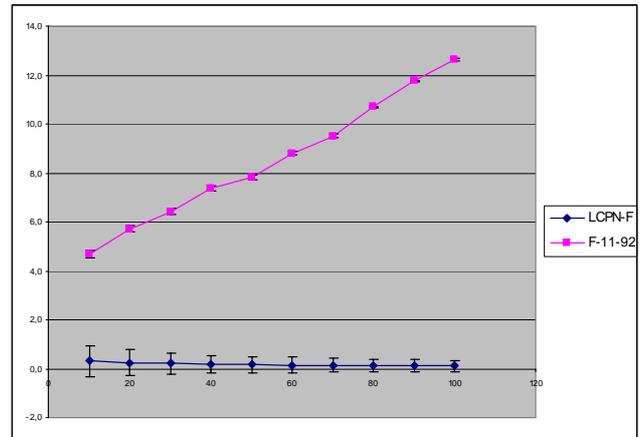
**Graphic Nº 8**  
Error relativo con incertidumbre



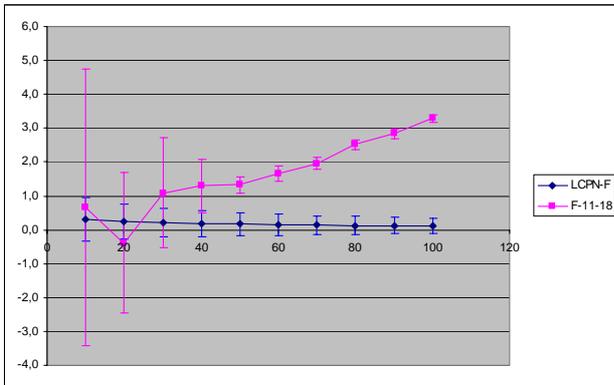
**Graphic Nº 12**  
Error relativo con incertidumbre



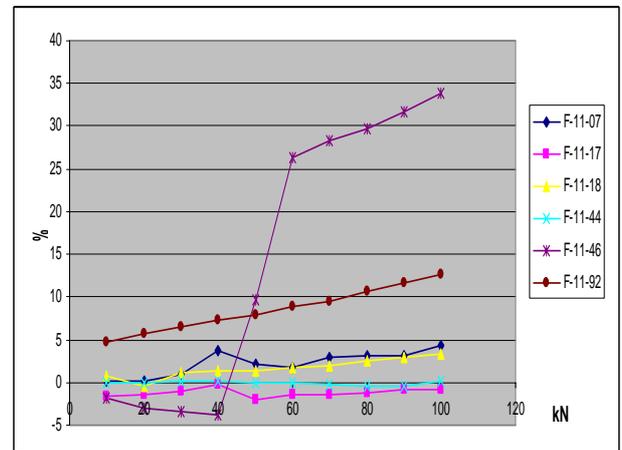
**Graphic Nº 9**  
Error relativo con incertidumbre



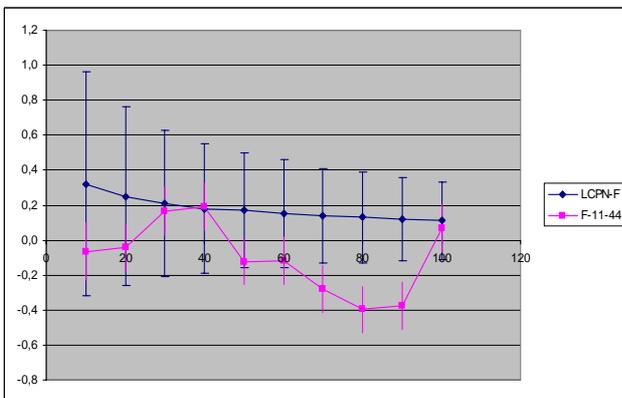
**Gráfico Nº 13**  
Error relativo con incertidumbre



**Gráfico Nº 10**  
Error relativo con incertidumbre



**Graphic Nº 14**  
Errores relativos



**Graphic Nº 11**  
Error relativo con incertidumbre

## Normalized Error

$V_n$	F-11-17	F-11-07	F-11-18	F-11-44	F-11-46	F-11-92
10	0,1	0,7	0,1	0,0	0,9	2,3
20	0,1	0,5	0,0	0,0	1,4	2,7
30	0,4	0,3	0,1	0,1	1,6	3,1
40	1,3	0,1	0,3	0,1	1,7	3,5
50	0,8	0,6	0,6	0,1	2,0	3,9
60	0,6	0,4	0,7	0,1	5,0	4,1
70	0,9	0,4	0,8	0,1	7,4	4,8
80	0,9	0,3	1,1	0,2	7,3	5,3
90	0,9	0,2	1,2	0,2	7,3	5,8
100	1,2	0,2	1,5	0,0	7,3	6,3

Tabla N°2 N° Results

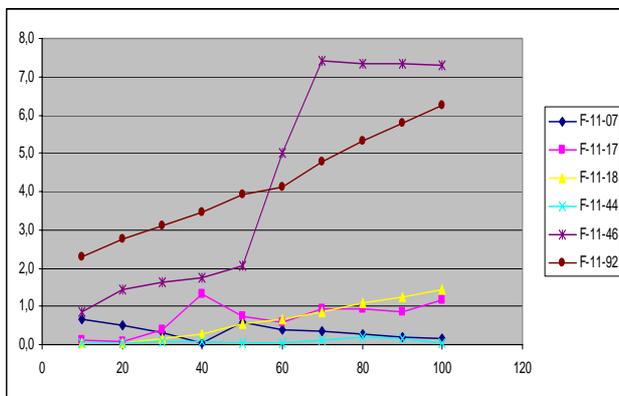


Gráfico N° 15 Normalized Errors

## 5. CONCLUSIONS

Of the results that you obtained the Pilot Laboratory in the different calibrations, it can be observed::

1) The calibrations accomplished during the period of comparison evidence a good stability of the ( machine of essays ) short-term team without existing, bigger variations of reading correlated to the changes of temperature. This can see in the graph 1, curved LCPN1, LCPN2 and LCPN3 clearly, where the mentioned calibrations came true in different dates with small variations of atmospheric pressure and of humidity. This study demonstrates the transparency of the team once these effects was utilized like employer of comparison and the reliability for the stability of the same for the intentions of this comparison.

2) The participating Laboratories show trazability to the LCPN F.

3) A good compatibility in the calibration of this type of instruments between the Laboratories that they cut in on comparison, this does not exist the N can appraise in the board 2 and his respective graphics itself, being coincidentally the same of the previous comparison.

4) The results calculated by some Laboratories do not agree with the moral values calculated by the LCPN F.

5) The results of uncertainties calculated by some Laboratories do not correspond to the minimal value of uncertainty of calibration of employers ( according to ISO 376 ) given up by the LCPN F, corresponding to class 1.

6) In spite of repeating the work of previous comparison, considering the same parameters of comparison and including a bigger number of points of calibration, it is perceived that to date some laboratories continue estimating the errors indicated by the standard around erroneous form NCh 2598 ( ISO 7500 ).

7) It is proposed making a workout individualized with those laboratories that desados in this work obtained results not .

## REFERENCES

- [1] NCh ISO 2598/1. Of 2009: Materiales metálicos – Verificación de máquinas de ensayos estáticos uniaxiales – Parte 1: Máquinas de ensayo tracción / compresión – Verificación y calibración del sistema de medición de fuerza..
- [2] Guide ISO/IEC 43 -Development and Operation of Laboratory Proficiency Testing.
- [3] ISO 376: 2011 -Metallic materials – ISO Calibration of force-proving instruments used for the verification of uniaxial testing machines..
- [4] NCh 2450. Of 1998 -Vocabulario de Términos – NCh 2450. Of 1998 -Vocabulario de Términos.
- [5] NCh 2451. Of. 1999 -Guía para la elaboración de Certificados de Calidad..