

# **On Site Well Log Quality Control\***

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See similar article [Search and Discovery Article #41627 \(2015\)](#)

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## **Abstract**

Well Logs form the foundation upon which Oil and Gas reserves are based. Logging vendors are responsible for delivering data that has been acquired with instruments what were calibrated and run properly, providing documentation of this in both delivered hard and soft copy data. However, the client is responsible to see that this is done.

The wellsite is the front line of well log quality. The client representative needs to verify that well log products meet quality standards, before signing the vendor invoice, as the logging witness. Failure to do so can have severe repercussions, if “Stated Reserves” include data from miscalibrated and/or improperly run logs.

Unfortunately operators often send the most junior member of their staff to “catch the logs”, without adequate training on the responsibilities of a “Log Witness”. The complexity of modern wireline and LWD logs, with several pages of logging job parameters and calibrations do not make these duties any easier.

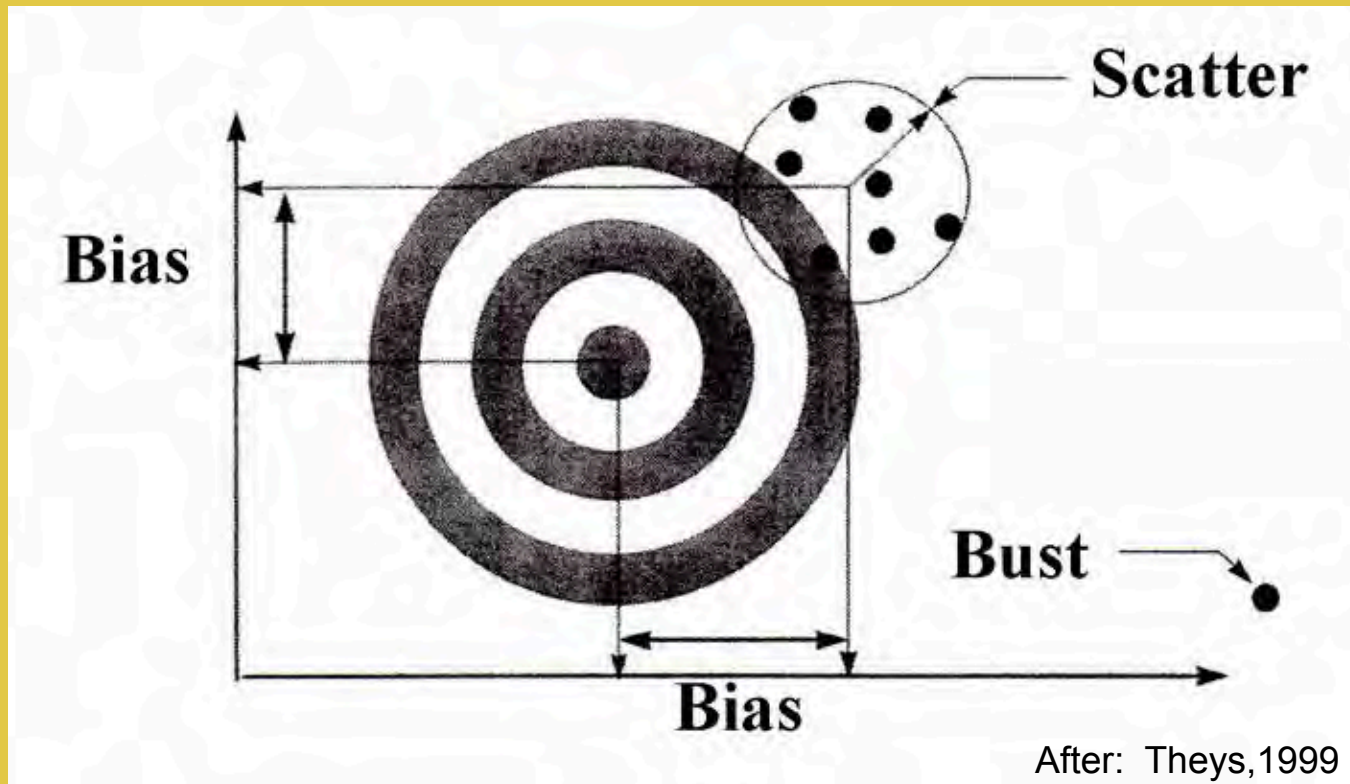
Simple, straight forward, wellsite techniques can allow the client representative to quickly determine if the vendor has properly done their job. These techniques can avoid later embarrassing and costly revelations, for both vendor and client.

## **Reference Cited**

Theys, P., 1999, Log Data Acquisition and Quality Control, 2<sup>nd</sup> edition: Editions Technip, Paris France, 453 p.

# On Site Well Log Quality Control

*What you don't know CAN hurt you!*



# Why Is Log QC Important?

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- Well Logs are the foundations upon which Reserves are estimated.
- Reserves are the Bank Accounts for Petroleum E&P organizations.
- E&P organizations that *do not replace produced reserves* are not long for this world.
- A Junior E&P firm developing a World Class Heavy Oil Resource had **Billions** of Bbl Oil Stated Reserves called into question because of Log Quality Problems.



# Reserves

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$$STOOIP = \frac{7758 Ah\phi(1 - S_w)}{B_{oi}}$$

- STOOIP: Stock Tank Original Oil In Place
- A: Area of Structural Closure, in Acres
- h: Average Reservoir Net Thickness, in ft
- $\phi$ : Average Reservoir (fractional) Porosity
- $S_w$ : Average Reservoir (fractional) Water Saturation
- $B_{oi}$ : Initial Oil Formation Volume Factor



# Log QC Responsibilities

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- Vendors are responsible for delivering data that was measured with instruments that were working correctly and properly calibrated.
- Clients and/or their representatives are responsible for seeing that this is done.
- Clients that accept the vendor products at face value, ***probably get what they deserve.***



# How Petrophysicists Spend Their Time

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- Clients often criticize Petrophysicists for taking too long and costing too much.
- A recent LinkedIn Petrophysics discussion thread revealed that Petrophysicists spend, on average, between **50% - 75%**, of their time doing data Quality Control:
  - If anything, modern logs have increased this load because there is so much more to review.
  - Digital files, without paper prints, only make the situation worse, because they often lack critical information.



# Foundations of Well Log Product Quality

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Data Consistency & Concise Presentation

Tool Calibration & Reliability

Contractor Performance

**>>> *Client Preparation* <<<**



# Wellsite is the Front Line for QC

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- While the equipment is on site and the well bore is open, Back-up sondes can be run.
- Once the well has been cased, the best the vendor can usually do is offer discounts against future work.





# Don't Keep the Vendor in the Dark



- Notify the vendor at spud-in, with the expected logging date.
- Provide the vendor with frequent up-dates.
- Request current calibrations and back-up tools.
- Have the vendor ready when the “Call-Out” is issued.



# Written Protocols

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- Well Location
- Services Requested
- Who will “call Out” the vendor
- Logging sequences and tool stacks
- Standard and extra calibrations expected
- Logging operations
- Displays
- Back-up and special equipment
- Specialist Engineer
- Hard and soft copy delivery
- Special conditions



# Calibration Philosophy

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Well Logging Tools are Calibrated by Adjusting their Response to Read some Predetermined value, in a Situation for which the Response is: Known

## ***Corollary-1***

The Only Time We know, for Certain, that Logging Tool is Working Properly, is During Calibration

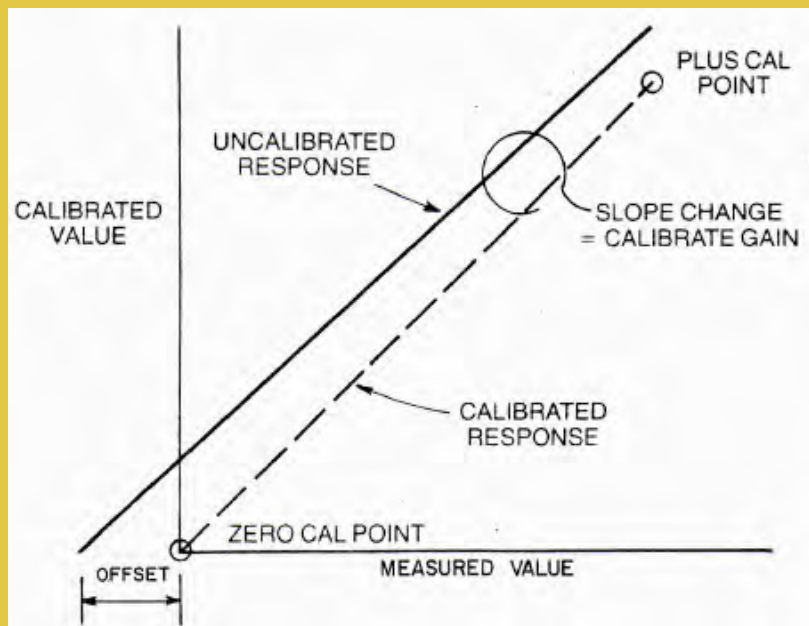
## **Corollary-2**

***Calibrate and Check Calibrations Often***

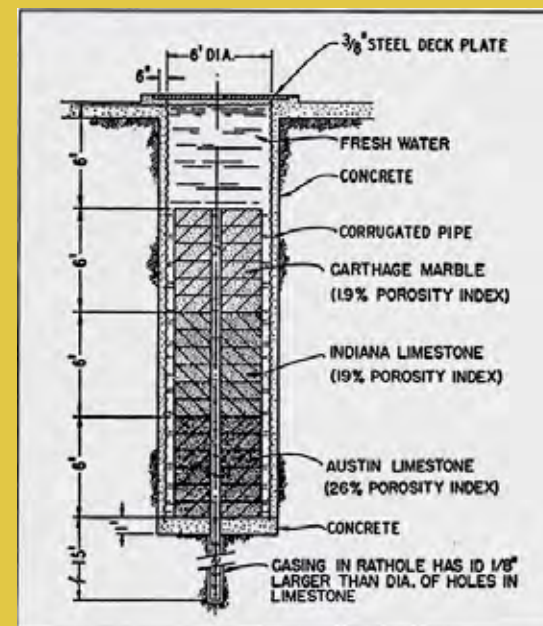


# Log Calibration - 1

## Linear Calibration Concept



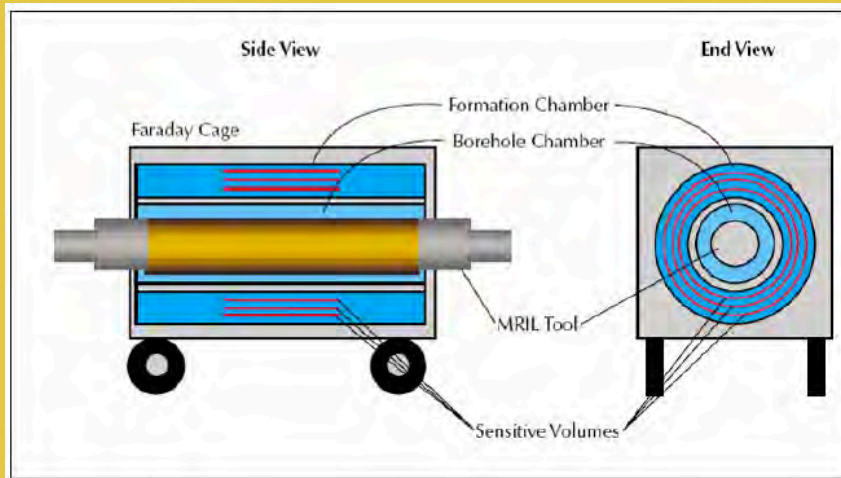
## Primary Porosity Tool calibration Test Pit



# Shop Calibration

## NUMAR/HES NMLR Shop Calibrator

## Schlumberger LDT Shop Calibration Record



BACK: 30-MAR-88 10:01      JIG: 30-MAR-88 10:10      COMP:

LDTD                      DETECTOR CALIBRATION SUMMARY

DRS SONDE NUMBER                      : 2828  
 NUCLEAR SERVICE CARTRIDGE NUMBER : 1811  
 POWERED DETECTOR HOUSING NUMBER : 1891  
 POWERED GAMMA-GAMMA DETECTOR NUMBER : 1917  
 LDT LOGGING SOURCE NUMBER         : 6813  
 LDT CALIBRATION MODE                : WATE  
 MUD DENSITY                            : 10.4500      LB/G

	M E A S U R E D			UNITS
	BKGD	AL+FE	AL	
LL	18.7	76.0	86.7	CPS
LU	71.7	114.9	131.1	CPS
LS	54.5	133.5	152.3	CPS
LITH	5.5	36.4	56.0	CPS
SS1	14.1	135.2	153.9	CPS
SS2	9.6	220.5	245.2	CPS

HV SETTINGS  
 HV LS 1466.4 V  
 HV SS 1421.8 V



# Not all Shop Calibrators are Equal

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# Field Calibrators

## Schlumberger CNL & GR Field Calibrators



## Schlumberger CNL/LDT & GR Pre-Log Calibration

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BEFORE SURVEY CALIBRATION SUMMARY

PERFORMED: 30-MAR-88 10:14
PROGRAM FILE: GTS (VERSION 30.4A 88/02/22 87/10/86)

SGTL DETECTOR CALIBRATION SUMMARY

      MEASURED
      BKGD  JIG
      12    175
CALIBRATED
      165
UNITS
      GAPI
BACK: 30-MAR-88 09:52 JIG: 30-MAR-88 10:13 COMP: 30-MAR-88 10:14

CNTH DETECTOR CALIBRATION SUMMARY

EQUIPMENT:
NCCN (NEUTRON COMPENSATED CARTRIDGE #): 218
NSSN (NEUTRON SOURCE SERIAL #): 1287
TNH (THERMAL HOUSING #): 2562
TCNB (THERMAL CALIBRATOR NEUTRON BOX #): 2582

      INPUT  PLUS  SHDP  SHDP  BEFORE  GAIN
      REFERENCE  TANK  JIG
      COUNTS  COUNTS  COUNTS  COUNTS
CNTC  6031.00  6075.03  -3267.99  3255.93  .993
CFTC  2793.00  2647.01  1456.92  1456.03  1.055

      RATIO  2.159  2.295  2.252  2.236

BACK: 30-MAR-88 10:01 JIG: 30-MAR-88 10:13 COMP:

LDTD DETECTOR CALIBRATION SUMMARY

DRS SONDE NUMBER           : 2028
NUCLEAR SERVICE CARTRIDGE NUMBER : 1811
POWERED DETECTOR HOUSING NUMBER  : 1891
POWERED GAMMA-GAMMA DETECTOR NUMBER : 1917
LDT LOGGING SOURCE NUMBER       : 6813
LDT CALIBRATION ROSE           : WATE
MUD DENSITY                  : 16.4500 LB/G

M E A S U R E D
BKGD  AL-FC  AL  UNITS
LL  18.7  76.0  86.7  CPS
LU  71.7  114.9  131.1  CPS
LS  84.5  133.5  152.3  CPS
LETH  5.5  36.4  56.0  CPS
SS1  14.1  135.2  153.9  CPS
SS2  9.6  220.5  245.2  CPS

HV SETTINGS
HV LS 1466.4 V
HV SS 1421.8 V
    
```



# Logging Job Calibration Protocol

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- Shop Calibration:
  - Should be as recent as possible (request to have it done before the unit leaves the shop).
  - Do not accept tools with a shop calibration over **30 days old**.
- Pre-Log Calibration Check:
  - Check against drift from Shop Calibration.
- Logging Trip Calibration Checks:
  - Repeats, Casing Signal, Evaporite Beds, etc.
- Post Log Calibration Check:
  - Check against drift from Pre-Log Calibration Check.
- Calibrations and calibration checks **Must Be** Documented on Detailed Log Prints, **including** tool serial Numbers.





# Logging Jobs and Products

No Vendor wants to Deliver Bad Data

Not All Logging Jobs are Routine

*Engineer was so afraid of this product, that he cut the trade back off film*

*Quality Control Dept.*

### BOREHOLE COMPENSATED SONIC LOG

COMPANY *OKLAWA*

WELL \_\_\_\_\_  
 FIELD \_\_\_\_\_  
 COUNTY \_\_\_\_\_ STATE *OKLAHOMA*

LOGGING NO. \_\_\_\_\_ DATE \_\_\_\_\_

Permanent Datum: *GC* Elev. *524.00* Elev. *KB 524.1*  
 Log Measured From: *GC* *56* Ft. Above Perm. Datum D.P. \_\_\_\_\_  
 Drilling Measured From: *GC* D.R. *524.1*

Run No.	7								
Depth - Driller	22.22								
Depth - Logger (Cum.)	24.77								
Bot. Log Interval	22.25								
Top Log Interval	9.20								
Coiling - Driller	70' @ 3.20' / MIN								
Coiling - Logger	5.00'								
Bit Size	6.50"								
Type Fluid in Hole	WATER								
Dens. - Visc.	8.5 - 1.00								
pH - Fluid Loss	- - -								
Source of Sample	LOGGING								
Run @ Mean Temp.	62.5° F	0	1	0	1	0	1	0	1
Run @ Mean Temp.	62.5° F	0	1	0	1	0	1	0	1
Run @ Mean Temp.	62.5° F	0	1	0	1	0	1	0	1
Source	LOGGING								
Run @ Bot.	62.5° F	0	1	0	1	0	1	0	1
Circulation Stopped	LOGGING								
Logger on Bottom	LOGGING								
Max. Res. Temp.	LOGGING								
Equip. Location	LOGGING								
Recorded By	LOGGING								
Witnessed By	LOGGING								



# However

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- How much sleep has your logging crew had, before they logged your well?
  - Anne Schlumberger-Doll described being introduced to a logging Engineer who she thought was terribly rude – only to learn that he had not slept in 6 days.
  - I once arrived at the well-site to find the logging crew draped over the fenders of the logging unit, like trophies from a deer hunt.
  - I once opened the cab of a logging unit in the middle of the night to find the Engineer curled up on the floor, sound asleep.



# Check The Equipment-1

FAC CAL OR CAL RUN 81/05/97

COMPANY: W-14 OTHER SERVICES- DEL BHC 50

WELL: W-14

FIELD: SERRA

LOCATION: NORTH SEA

SEC: TWP: RSE:

PERMANENT BATHY: WEL ELEVATION: PROGRAM TYPE NO: 100 MEASURED FROM: 808 SP: 140.8' SEC 2

DATE: 18 JUN 1993

DEPTH-BATTERY: 804.2' CASING-LOGGER: 804.5' WTM. LOG INTERVAL: 805.0' TOP LOG INTERVAL: 806.0' CASING-BATTERY: 140' 400' CASING-LOGGER: 18.4 50.4 LOGS: 87.00 LB/F 87.00 LB/F BIT SIZE: 82 82.5 18.00

TYPE FLUID IN HOLE: NCL POLYMER

VELOCITY: 10.0 L/S

VELOCITY: 47.0 S

FLOW LOSS: 0.0 S

SOURCE OF SAMPLE: P11

RMV: 0.100 DMM AT 84.0 SF

RMV: 0.100 DMM AT 82.0 SF

RMV: 0.000 DMM AT 80.0 SF

SOURCE RMV/RMCI: PRESS/PRESS

RMV AT BHT: 0.070 DMM AT 100.0 SF

RMV AT BHT: 0.048 DMM AT 100.0 SF

RMV AT BHT: 0.000 DMM AT 100.0 SF

TIME LOGG. STOPPED: 00:10 UT

TIME LOGG. ON STR.: 00:20 UT

WAS. REC. TEMP: 100.0 SF

LOGGING UNIT NO: 73

LOGGING UNIT LOC: 100

RECORDED BY: A. HENNET.

WITNESSED BY: C. MURKIN

EQUIPMENT NUMBERS-

LOG JC 100 P&S EC 20 P&S ER 700

SHOP SUMMARY

PERFORMED: 81/05/97

PROGRAM FILE: SHOP (VERSION 20.0 81/1/90)

PUTE

DETECTOR CALIBRATION SUMMARY

	BLOCK	MEASURED	CALIBRATED	MEASURED	JIG	CALIBRATED	UNITS
FFBC	305	307	301	301	303	303	7.2 CFS
HFBC	608	608	594	594	615	615	7.0 CFS

(POS: 00 + PSH: 000 + 000:0000 + 0000-100)

SHOP SUMMARY

PERFORMED: 81/05/93

PROGRAM FILE: SHOP (VERSION 20.0 81/1/90)

ONTA

DETECTOR CALIBRATION SUMMARY

	TANK	MEASURED	CALIBRATED	MEASURED	JIG	CALIBRATED	UNITS
NRAT	0.200	0.150	0.201	0.201	0.150	0.200	0.000

TCN: 1501 + 000:000

1. Density Shop Calibration is expired.
2. Density Field Calibrator is not listed on header.
3. Neutron Field Calibrator is not listed on header.
4. Neutron Cartridge on header is NOT cartridge on Shop Calibration.



# Check The Equipment-2

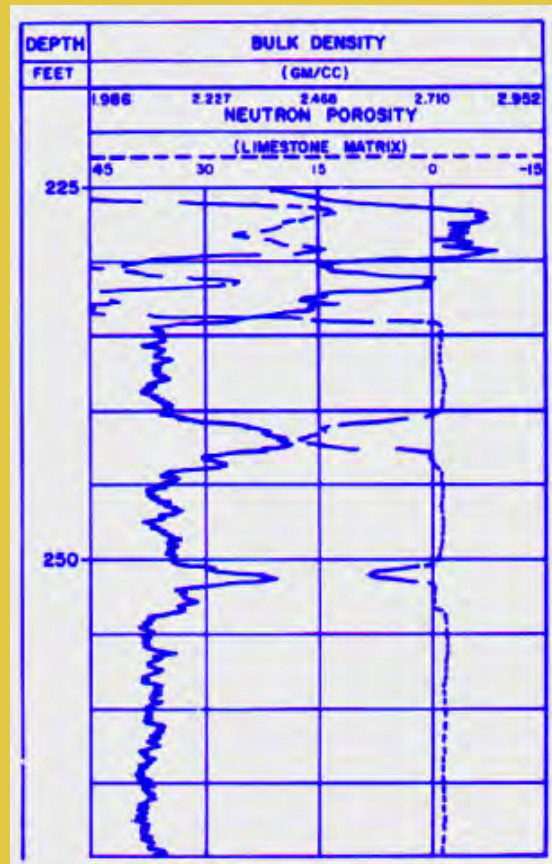
COMPANY: JAMES BECKETT & CO  
 MOBILE: W-81  
 FIELD: NORM  
 COUNTY: DEWITT  
 LOCATION: PLATON # 100  
 DATE: 02/03/29  
 PERFORMED BY: A. BENNETT  
 WITNESSED BY: R. GRIFFITHS  
 REMARKS: MAXIMUM DEVIATION @ 0.475  
 EQUIPMENT NUMBERS:  
 CMC 54P UMS82 456 474 P22 P25  
 POC 763 GCR 1308 100 475 10P 109

PERFORMED: 02/03/29  
 PROGRAM FILE: SHDP (VERSION 20.2 01/1/20)  
 CNTA DETECTOR CALIBRATION SUMMARY  
 TANK MEASURED CALIBRATED MEASURED CALIBRATED  
 MRAT 2.248V 2.158V 2.250V 2.159V  
 (CHC1347 : CHB1502 : )  
 SHDP SUMMARY  
 PERFORMED: 02/03/29  
 PROGRAM FILE: SHDP (VERSION 20.2 01/1/20)  
 SHDP SUMMARY O'BAN J.W. GREEN  
 PERFORMED: 02/01/29  
 PROGRAM FILE: SHDP (VERSION 20.2 01/1/20)  
 PGTC DETECTOR CALIBRATION SUMMARY  
 BLOCK MEASURED CALIBRATED MEASURED CALIBRATED UNITS  
 FFDC 428 337 386 -1.4% 303 -1.0% CPS  
 NFDC 048 528 773 -8.5% 481 -8.8% CPS  
 (P031795 : PSH1798 : GSR:2549 : GCSC:11909)

1. Density Shop Calibration is expired.
2. Density Source, Skid & Field Calibrator are not listed on header.
3. Neutron Field Calibrator is not listed on header.
4. Neutron Source is not listed on Shop Calibration.



# Massive Anhydrite Density & Neutron Check

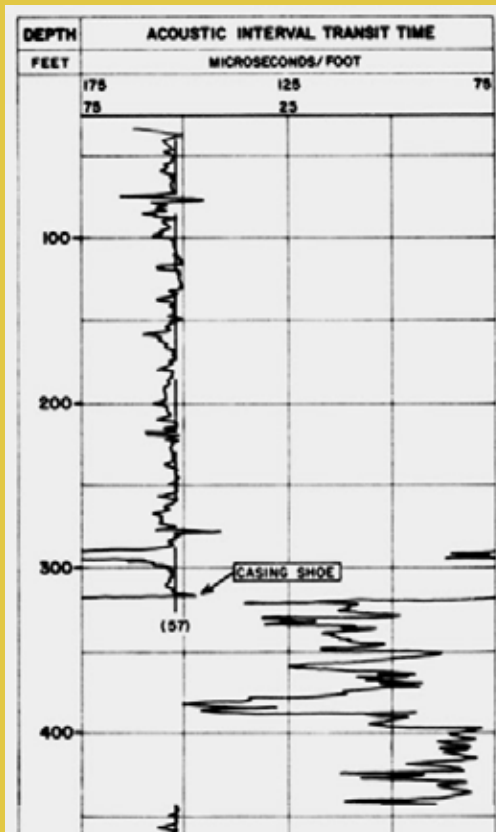


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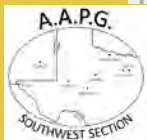
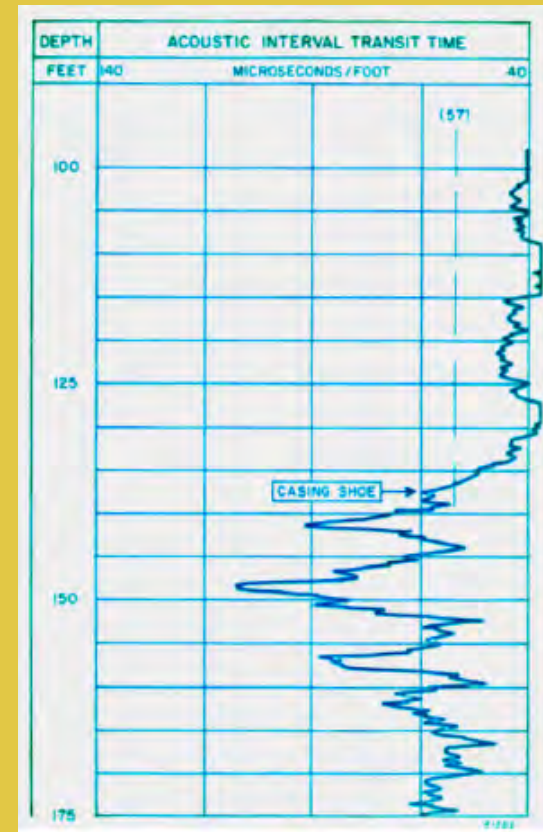
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# Acoustic Log Casing Check

## Good Csg. Check

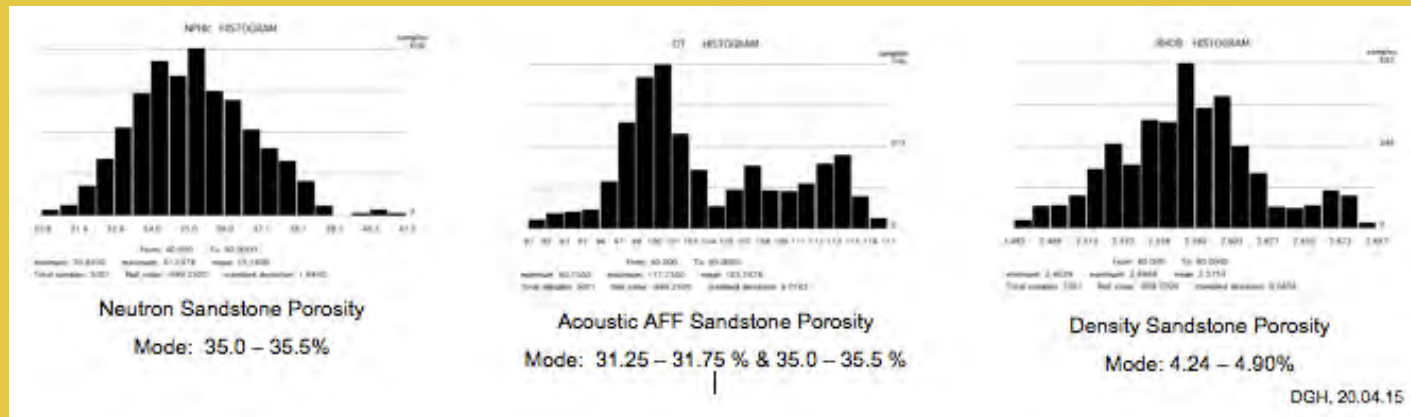


## Bad Csg. Check





# Do Your Porosity Logs Agree?

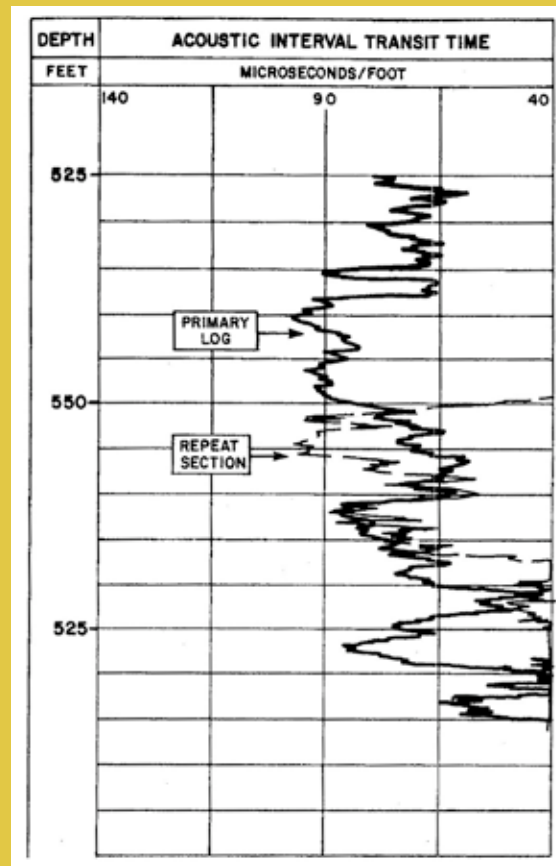


- Client Comment: ***“The Vendor should have caught this”***.
- Vendor Comment: ***“The Client should have caught this”***.



# Do Your Logs Repeat?

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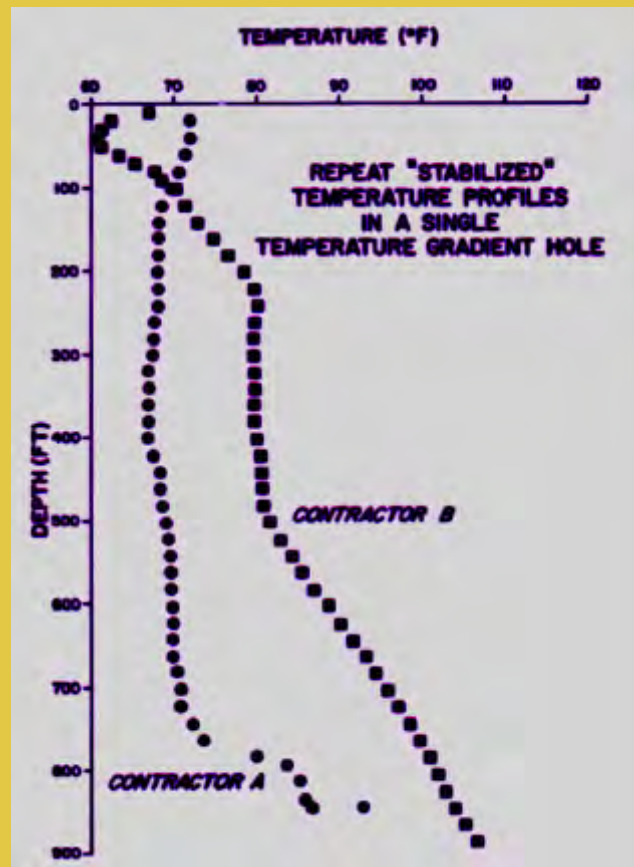


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# Two Versions of Truth



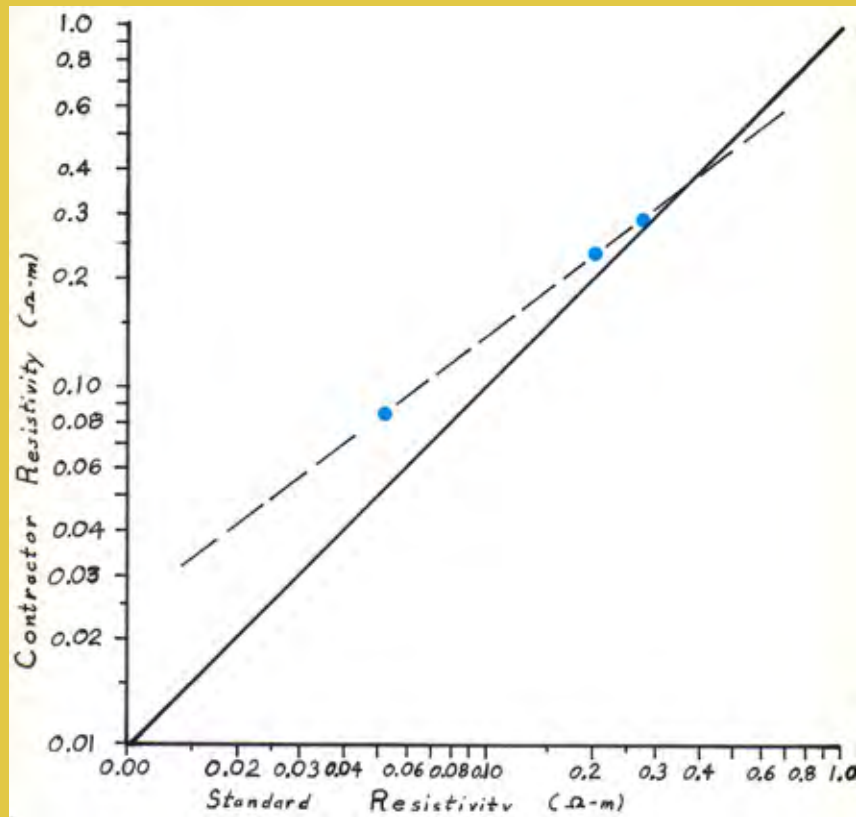
# Gamma Ray Drift

SSSTE		TOOL CHECK				
GR	BEFORE 165	AFTER 226	UNITS GAPI	$\Delta$ + 61 API		
MODB		TOOL CHECK				
CALI	BEFORE 6.0	SMALL AFTER 6.2	$\Delta$ +0.2 in	LARGE BEFORE 12.0	AFTER 12.2	$\Delta$ +0.2 IN
		22				

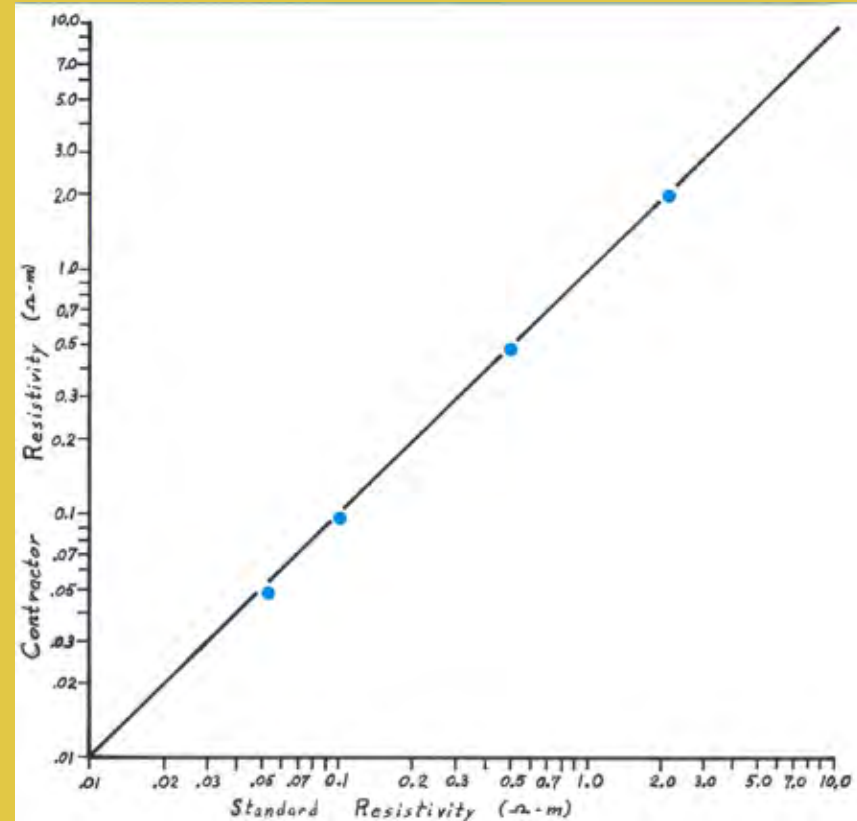


# Fluid Resistivity Bridge Check

## Bad Calibration

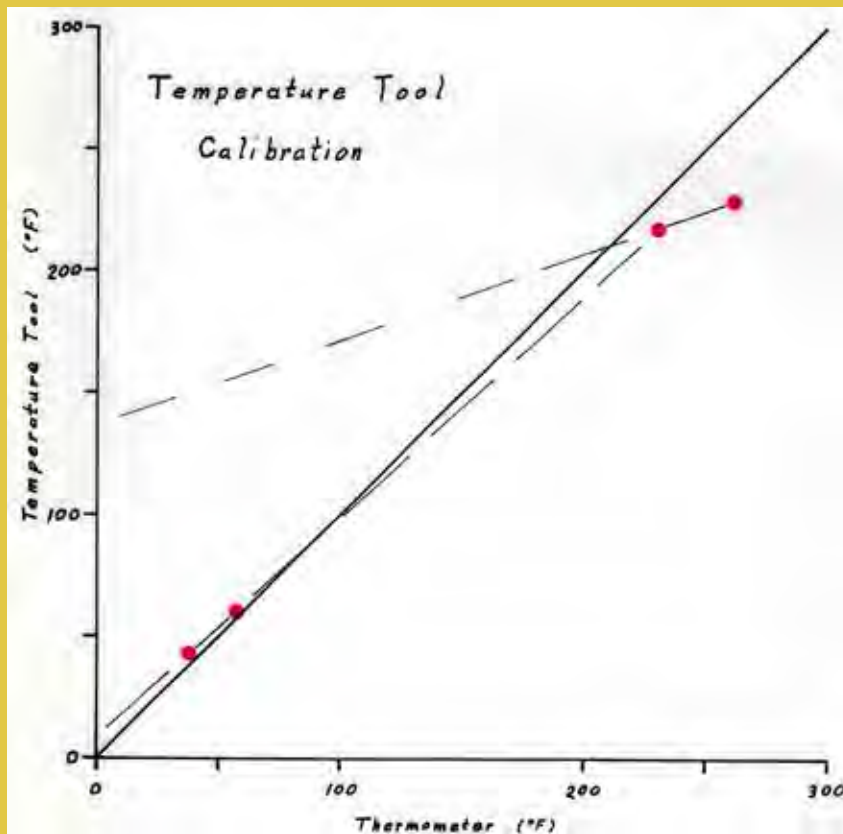


## Good Calibration

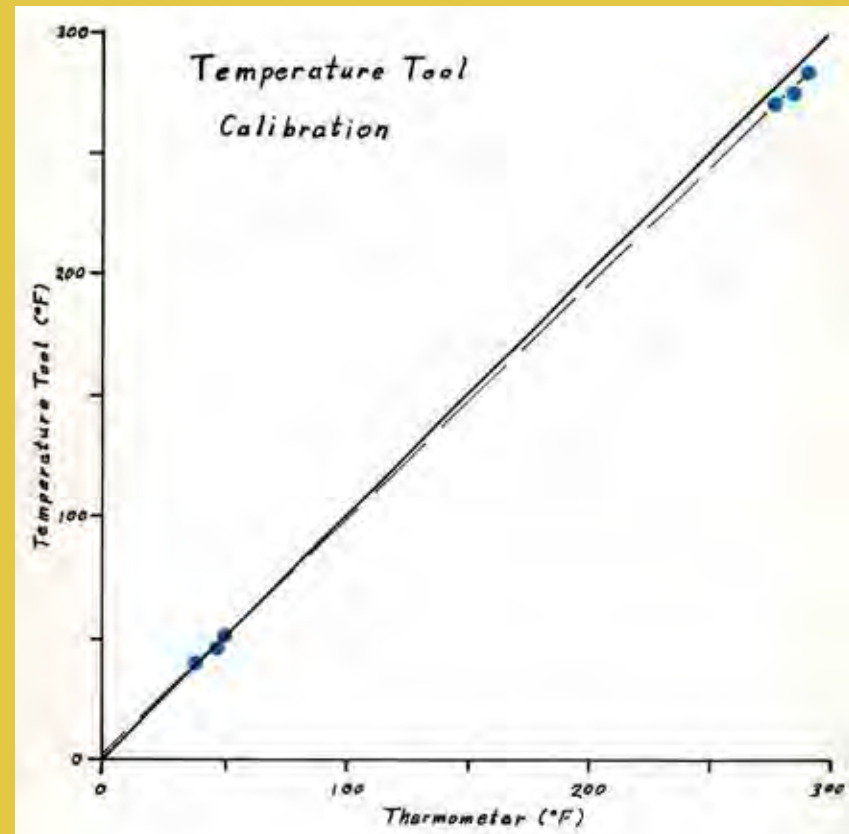


# Temperature Tool Calibration

## Bad Calibration



## Good Calibration



# Log QC Summary

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- It's NOT Rocket Science.
- You **Do** need to know what should happen, **and make certain that it does.**
- It sometimes takes a little creativity.
- It can make a **BIG** difference in the quality of your reserves estimates.



# Thank you for your Attention

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