《石油专用补偿中子刻度器校准规范》

试验报告

1. 试验日期和地点：
2. 试验日期：2023年6月
3. 试验地点：石油工业测井计量站校准实验室
4. 试验目的：

通过试验在理论上，了解补偿中子刻度器孔隙度标称值的量值溯源与传递关系，在实践上，掌握补偿中子刻度器孔隙度参数的校准，以及校准的操作要领、基本步骤和方法。

三、试验设备及环境要求：

1. 试验设备：补偿中子标准井、补偿中子量值传递仪器、补偿中子刻度器
2. 环境要求： 环境温度：5 ℃～35 ℃。

相对湿度：RH<80%。

其它要求: 无其他放射性干扰，无强震动、无强电磁干扰。

四、试验内容：

1. 通过将装源后的补偿中子量值传递仪器放入补偿中子标准井中，记录仪器在标准井中测量的长源距计数率、短源距计数率。将仪器依次放置到其它标准井中进行如上操作，建立补偿中子量值传递仪器长、短源距计数率与孔隙度值的响应关系，并计算标准不确定度。
2. 将装源后的补偿中子量值传递仪器放置于待校准刻度器的各测量点进行测量，记录各测量点测量的长源距计数率、短源距计数率，并根据计算测量点的比值计算孔隙度值和标准不确定度。

五、试验记录数据：

（一）补偿中子量值传递仪器稳定性试验记录表

表1 补偿中子量值传递仪器稳定性试验记录表

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 送校单位： | | 石油测井仪器计量站 | | | 测试时间 | 2023.6.21 | |
| 温度： | | 27℃ | | | 湿度（RH）： | 40% | |
| 井号 | | 23 | | | 量值传递仪器型号 | 行业标准井地面检定系统 2435-1 | |
| 量值传递仪器编号 | | 501945 | | | 采集时间 | 300s | |
| 序号 | 计数率 | 组号 | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | NS | 121.4117 | 121.8000 | 121.3852 | 122.2070 | 121.7933 | 122.2000 |
| NL | 54.6114 | 55.2000 | 54.5992 | 56.2126 | 55.1999 | 56.2000 |
| 2 | NS | 121.5016 | 121.3000 | 121.4892 | 122.2079 | 121.2859 | 122.2000 |
| NL | 54.9114 | 55.1000 | 54.8917 | 55.7107 | 55.0870 | 55.7000 |
| 3 | NS | 121.8061 | 121.6000 | 121.7966 | 122.5053 | 121.5925 | 122.5000 |
| NL | 55.4035 | 55.2000 | 55.3859 | 56.0002 | 55.1959 | 56.0000 |
| 4 | NS | 121.2119 | 121.6000 | 121.1882 | 122.6158 | 121.5898 | 122.6000 |
| NL | 54.7061 | 54.9000 | 54.6920 | 56.3144 | 54.8822 | 56.3000 |
| 5 | NS | 120.9066 | 121.4000 | 120.8937 | 122.8012 | 121.3908 | 122.8000 |
| NL | 54.2103 | 55.7000 | 54.1902 | 55.8158 | 55.6935 | 55.8000 |
| 6 | NS | 121.5035 | 121.7000 | 121.4871 | 122.3118 | 121.6872 | 122.3000 |
| NL | 54.9103 | 55.4000 | 54.8916 | 56.0115 | 55.3919 | 56.0000 |
| 7 | NS | 121.3087 | 121.4000 | 121.2976 | 122.7161 | 121.3854 | 122.7000 |
| NL | 55.0134 | 56.1000 | 54.9938 | 55.5063 | 56.0942 | 55.5000 |
| 8 | NS | 120.7130 | 121.5000 | 120.6854 | 122.2117 | 121.4977 | 122.2000 |
| NL | 55.2059 | 56.0000 | 55.1951 | 56.0013 | 55.9856 | 56.0000 |
| 9 | NS | 121.4973 | 121.6607 | 121.4739 | 123.1160 | 121.6601 | 123.1000 |
| NL | 54.8295 | 55.3684 | 54.8096 | 55.8049 | 55.3627 | 55.8000 |
| 10 | NS | 121.2625 | 121.3636 | 121.2606 | 122.6010 | 121.3510 | 122.6000 |
| NL | 54.9918 | 56.0544 | 54.9662 | 56.6117 | 56.0389 | 56.6000 |
| 11 | NS | 120.6881 | 121.4764 | 120.6775 | 122.2100 | 121.4722 | 122.2000 |
| NL | 55.1143 | 55.9989 | 55.0895 | 55.4142 | 55.9815 | 55.4000 |
| 平均 | NS | 121.2555 | 121.5273 | 121.2396 | 122.5004 | 121.5187 | 122.4909 |
| NL | 54.9007 | 55.5474 | 54.8822 | 55.9458 | 55.5376 | 55.9364 |
| 计数率比值 | | 8.8345 | 8.7512 | 8.8363 | 8.7585 | 8.7522 | 8.7593 |
| 计数率比值重复性误差 | | 1.3% | 1.9% | 1.3% | 1.5% | 1.9% | 1.5% |
| 比值平均值 | | | 8.7820 | | | | |
| 比值最大值 | | | 8.8363 | | | | |
| 比值最小值 | | | 8.7512 | | | | |
| 比值相对误差 | | | 1.0% | | | | |
| B类相对标准不确定度 | | | 0.0028 | | | | |
| 检定员 | |  | | 复核员 |  | | |

（二）补偿中子量值传递仪器在标准井中测量记录表

表2 补偿中子仪器校准记录表1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | **井号：** | **23** |
| 送检单位 | | 石油测井仪器计量站 | | 检定日期 | | 2023.6.21 | |
| 文 件 名 | | CN仪器检定23号井 | | 温度(℃) | | 27 | |
| 量值传递仪器型号 | | 2435-1 | | 量值传递仪器编号 | | 501945 | |
| 采集时间 | | 300s | | | | | |
| 深度点(m) | | | 1.4 | 1.3 | 1.2 | 1.1 | 1 |
|  | 1 | NS | 119.7000 | 121.3000 | 122.2000 | 121.4000 | 122.2000 |
| NL | 55.5000 | 55.2000 | 56.2000 | 55.7000 | 56.3000 |
| 2 | NS | 119.0000 | 121.4000 | 122.2000 | 122.0000 | 121.4000 |
| NL | 55.6000 | 55.0000 | 55.7000 | 55.8000 | 55.6000 |
| 3 | NS | 120.1000 | 122.6000 | 122.5000 | 122.1000 | 122.1000 |
| NL | 55.1000 | 56.0000 | 56.0000 | 57.3000 | 55.8000 |
| 4 | NS | 119.7000 | 122.2000 | 122.6000 | 122.0000 | 122.2000 |
| NL | 54.8000 | 55.1000 | 56.3000 | 56.3000 | 56.6000 |
| 5 | NS | 120.6000 | 121.8000 | 122.8000 | 122.1000 | 122.9000 |
| NL | 54.5000 | 54.9000 | 55.8000 | 57.3000 | 56.3000 |
| 6 | NS | 119.2000 | 121.9000 | 122.3000 | 122.6000 | 122.2000 |
| NL | 55.3000 | 56.1000 | 56.0000 | 57.2000 | 57.4000 |
| 7 | NS | 119.8000 | 121.5000 | 122.7000 | 122.3000 | 122.0000 |
| NL | 54.6000 | 53.5000 | 55.5000 | 56.2000 | 56.4000 |
| 8 | NS | 119.8000 | 121.2000 | 122.2000 | 121.9000 | 122.8000 |
| NL | 55.6000 | 55.5000 | 56.0000 | 56.5000 | 56.9000 |
| 9 | NS | 119.4000 | 121.6000 | 123.1000 | 121.9000 | 122.0000 |
| NL | 53.8000 | 54.6000 | 55.8000 | 57.2000 | 56.3000 |
| 10 | NS | 119.0000 | 121.9000 | 122.6000 | 122.3000 | 122.3000 |
| NL | 55.9000 | 55.7000 | 56.6000 | 57.5000 | 56.6000 |
| 11 | NS | 119.5000 | 121.7000 | 122.2000 | 122.2000 | 122.2000 |
| NL | 55.0000 | 55.7000 | 55.4000 | 57.8000 | 55.6000 |
| 计数率 平均值 | | | Nsi | 121.6255 | | | |
| NLi | 55.8709 | | | |
| 计数率 偏差 | | | σNSi | 0.0518 | | | |
| σNLi | 0.0822 | | | |
| 标准井计数率比值Ri | | | | 8.7076 | | | |
| 计数率比值A类标准不确定度σRai | | | | 0.0133 | | | |
| 计数率比值B类标准不确定度σRbi | | | | 0.0244 | | | |
| 计数率比值合成标准不确定度σRi | | | | 0.0278 | | | |
| 检定员 | |  | | | 复核员 |  | |

表3 补偿中子仪器校准记录表2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | **井号：** | **22** |
| 送检单位 | | 石油测井仪器计量站 | | 检定日期 | | 2023.6.21 | |
| 文 件 名 | | CN仪器检定22号井 | | 温度(℃) | | 27 | |
| 量值传递仪器型号 | | 2435-1 | | 量值传递仪器编号 | | 501945 | |
| 采集时间 | | 300s | | | | | |
| 深度点(m) | | | 1.4 | 1.3 | 1.2 | 1.1 | 1 |
|  | 1 | NS | 300.1000 | 317.1000 | 319.6000 | 322.4000 | 320.7000 |
| NL | 294.4000 | 308.0000 | 313.4000 | 318.5000 | 319.8000 |
| 2 | NS | 301.1000 | 319.1000 | 320.5000 | 320.9000 | 320.4000 |
| NL | 289.1000 | 310.4000 | 310.5000 | 316.1000 | 313.1000 |
| 3 | NS | 298.9000 | 318.7000 | 320.1000 | 322.1000 | 320.3000 |
| NL | 290.7000 | 310.2000 | 313.2000 | 314.0000 | 317.5000 |
| 4 | NS | 299.6000 | 318.7000 | 319.3000 | 320.6000 | 322.7000 |
| NL | 288.6000 | 310.7000 | 318.4000 | 318.6000 | 319.9000 |
| 5 | NS | 299.9000 | 318.1000 | 319.4000 | 321.8000 | 322.0000 |
| NL | 291.7000 | 309.3000 | 314.5000 | 317.7000 | 322.1000 |
| 6 | NS | 300.9000 | 318.2000 | 320.2000 | 320.7000 | 322.9000 |
| NL | 290.7000 | 306.4000 | 314.8000 | 317.7000 | 322.0000 |
| 7 | NS | 300.8000 | 318.1000 | 319.9000 | 320.9000 | 322.3000 |
| NL | 289.5000 | 307.9000 | 316.2000 | 315.9000 | 320.1000 |
| 8 | NS | 298.7000 | 317.9000 | 321.3000 | 320.8000 | 321.8000 |
| NL | 290.2000 | 308.3000 | 315.5000 | 316.8000 | 321.7000 |
| 9 | NS | 301.3000 | 317.0000 | 321.0000 | 321.1000 | 321.7000 |
| NL | 291.7000 | 306.2000 | 320.0000 | 314.1000 | 322.5000 |
| 10 | NS | 301.7000 | 317.9000 | 322.6000 | 320.2000 | 320.4000 |
| NL | 289.5000 | 305.9000 | 317.6000 | 316.4000 | 318.2000 |
| 11 | NS | 299.8000 | 318.5000 | 320.5000 | 320.7000 | 322.3000 |
| NL | 288.4000 | 310.5000 | 315.8000 | 319.7000 | 316.1000 |
| 计数率 平均值 | | | Nsi | 316.2945 | | | |
| NLi | 310.1218 | | | |
| 计数率 偏差 | | | σNSi | 0.1164 | | | |
| σNLi | 0.3022 | | | |
| 标准井计数率比值Ri | | | | 4.0796 | | | |
| 计数率比值A类标准不确定度σRai | | | | 0.0043 | | | |
| 计数率比值B类标准不确定度σRbi | | | | 0.0115 | | | |
| 计数率比值合成标准不确定度σRi | | | | 0.0122 | | | |
| 检定员 | |  | | | 复核员 |  | |

表4 补偿中子仪器校准记录表3

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | **井号：** | **24** |
| 送检单位 | | 石油测井仪器计量站 | | 检定日期 | | 2023.6.21 | |
| 文 件 名 | | CN仪器检定24号井 | | 温度(℃) | | 27 | |
| 量值传递仪器型号 | | 2435-1 | | 量值传递仪器编号 | | 501945 | |
| 采集时间 | | 300s | | | | | |
| 深度点(m) | | | 1.4 | 1.3 | 1.2 | 1.1 | 1 |
|  | 1 | NS | 99.9000 | 100.7000 | 100.7000 | 101.7000 | 101.0000 |
| NL | 35.0000 | 35.4000 | 34.8000 | 34.9000 | 35.3000 |
| 2 | NS | 99.8000 | 100.3000 | 100.8000 | 101.1000 | 101.1000 |
| NL | 35.1000 | 35.5000 | 34.4000 | 35.5000 | 34.1000 |
| 3 | NS | 99.1000 | 99.9000 | 100.2000 | 100.9000 | 101.8000 |
| NL | 34.0000 | 35.2000 | 35.0000 | 35.3000 | 39.3000 |
| 4 | NS | 99.1000 | 100.3000 | 101.2000 | 101.7000 | 101.8000 |
| NL | 34.1000 | 33.7000 | 35.8000 | 35.5000 | 34.4000 |
| 5 | NS | 99.1000 | 99.9000 | 99.8000 | 101.1000 | 100.8000 |
| NL | 34.7000 | 35.5000 | 34.8000 | 34.5000 | 35.5000 |
| 6 | NS | 99.9000 | 100.5000 | 101.0000 | 101.1000 | 101.3000 |
| NL | 35.2000 | 34.6000 | 34.4000 | 34.9000 | 34.4000 |
| 7 | NS | 99.3000 | 100.1000 | 100.5000 | 101.0000 | 101.0000 |
| NL | 33.7000 | 33.4000 | 34.3000 | 34.6000 | 35.1000 |
| 8 | NS | 99.0000 | 100.9000 | 100.6000 | 101.3000 | 102.0000 |
| NL | 34.0000 | 33.9000 | 35.3000 | 35.5000 | 35.1000 |
| 9 | NS | 99.0000 | 99.8000 | 100.9000 | 101.7000 | 101.7000 |
| NL | 34.5000 | 34.4000 | 34.5000 | 35.7000 | 34.7000 |
| 10 | NS | 99.0000 | 99.9000 | 100.7000 | 101.1000 | 100.2000 |
| NL | 34.9000 | 34.4000 | 34.6000 | 33.9000 | 35.4000 |
| 11 | NS | 98.8000 | 99.8000 | 99.8000 | 101.1000 | 100.7000 |
| NL | 34.2000 | 35.2000 | 35.6000 | 34.7000 | 34.3000 |
| 计数率 平均值 | | | Nsi | 100.5000 | | | |
| NLi | 34.8491 | | | |
| 计数率 偏差 | | | σNSi | 0.0578 | | | |
| σNLi | 0.1122 | | | |
| 标准井计数率比值Ri | | | | 11.5355 | | | |
| 计数率比值A类标准不确定度σRai | | | | 0.0377 | | | |
| 计数率比值B类标准不确定度σRbi | | | | 0.0324 | | | |
| 计数率比值合成标准不确定度σRi | | | | 0.0497 | | | |
| 检定员 | |  | | | 复核员 |  | |

表5 补偿中子仪器校准记录表4

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | **井号：** | **32** |
| 送检单位 | | 石油测井仪器计量站 | | 检定日期 | | 2023.6.21 | |
| 文 件 名 | | CN仪器检定32号井 | | 温度(℃) | | 27 | |
| 量值传递仪器型号 | | 2435-1 | | 量值传递仪器编号 | | 501945 | |
| 采集时间 | | 300s | | | | | |
| 深度点(m) | | | 1.4 | 1.3 | 1.2 | 1.1 | 1 |
|  | 1 | NS | 67.1000 | 68.0000 | 67.7000 | 68.0000 | 68.1000 |
| NL | 19.1000 | 17.8000 | 18.0000 | 18.6000 | 18.3000 |
| 2 | NS | 68.4000 | 68.7000 | 67.2000 | 67.1000 | 67.7000 |
| NL | 18.5000 | 17.6000 | 18.2000 | 19.1000 | 18.2000 |
| 3 | NS | 68.4000 | 67.6000 | 68.4000 | 67.8000 | 67.2000 |
| NL | 18.3000 | 18.2000 | 17.7000 | 18.4000 | 18.4000 |
| 4 | NS | 66.9000 | 68.6000 | 68.9000 | 67.5000 | 67.5000 |
| NL | 18.8000 | 18.7000 | 18.7000 | 18.4000 | 18.1000 |
| 5 | NS | 68.1000 | 68.1000 | 68.2000 | 68.5000 | 67.2000 |
| NL | 18.3000 | 18.5000 | 17.7000 | 18.1000 | 18.4000 |
| 6 | NS | 68.1000 | 68.0000 | 67.3000 | 68.1000 | 68.2000 |
| NL | 19.2000 | 18.7000 | 17.7000 | 18.4000 | 18.5000 |
| 7 | NS | 68.3000 | 68.2000 | 68.5000 | 67.5000 | 68.4000 |
| NL | 18.2000 | 18.9000 | 19.5000 | 19.3000 | 18.4000 |
| 8 | NS | 68.2000 | 68.3000 | 67.9000 | 68.6000 | 67.5000 |
| NL | 17.8000 | 18.5000 | 18.9000 | 17.9000 | 17.9000 |
| 9 | NS | 68.2000 | 68.2000 | 68.1000 | 68.2000 | 68.1000 |
| NL | 18.6000 | 17.5000 | 18.3000 | 18.4000 | 18.5000 |
| 10 | NS | 67.5000 | 68.5000 | 67.9000 | 68.5000 | 68.1000 |
| NL | 18.5000 | 18.5000 | 18.3000 | 18.3000 | 18.5000 |
| 11 | NS | 68.0000 | 67.5000 | 67.2000 | 67.8000 | 67.9000 |
| NL | 18.1000 | 19.2000 | 19.2000 | 17.8000 | 18.5000 |
| 计数率 平均值 | | | Nsi | 67.9582 | | | |
| NLi | 18.4018 | | | |
| 计数率 偏差 | | | σNSi | 0.0640 | | | |
| σNLi | 0.0633 | | | |
| 标准井计数率比值Ri | | | | 14.7721 | | | |
| 计数率比值A类标准不确定度σRai | | | | 0.0527 | | | |
| 计数率比值B类标准不确定度σRbi | | | | 0.0415 | | | |
| 计数率比值合成标准不确定度σRi | | | | 0.0670 | | | |
| 检定员 | |  | | | 复核员 |  | |

表6 补偿中子仪器校准记录表5

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | **井号：** | **28B** |
| 送检单位 | | 石油测井仪器计量站 | | 检定日期 | | 2023.6.21 | |
| 文 件 名 | | CN仪器检定28B号井 | | 温度(℃) | | 27 | |
| 量值传递仪器型号 | | 2435-1 | | 量值传递仪器编号 | | 501945 | |
| 采集时间 | | 300s | | | | | |
| 深度点(m) | | | 1.4 | 1.3 | 1.2 | 1.1 | 1 |
|  | 1 | NS | 120.7000 | 123.2000 | 127.7000 | 131.6000 | 134.5000 |
| NL | 61.2000 | 64.0000 | 65.2000 | 68.2000 | 74.2000 |
| 2 | NS | 121.5000 | 123.3000 | 127.3000 | 132.3000 | 134.1000 |
| NL | 62.2000 | 63.4000 | 63.2000 | 69.1000 | 74.9000 |
| 3 | NS | 120.8000 | 123.6000 | 127.4000 | 132.0000 | 135.1000 |
| NL | 60.4000 | 64.0000 | 64.6000 | 71.0000 | 73.4000 |
| 4 | NS | 120.8000 | 124.4000 | 127.8000 | 131.4000 | 135.4000 |
| NL | 61.5000 | 64.1000 | 64.4000 | 69.1000 | 73.5000 |
| 5 | NS | 121.3000 | 124.1000 | 128.2000 | 132.7000 | 135.2000 |
| NL | 62.6000 | 64.2000 | 64.8000 | 68.4000 | 73.1000 |
| 6 | NS | 121.5000 | 124.3000 | 127.3000 | 132.2000 | 135.0000 |
| NL | 61.3000 | 63.8000 | 64.6000 | 70.6000 | 73.5000 |
| 7 | NS | 122.2000 | 123.6000 | 128.2000 | 132.8000 | 135.8000 |
| NL | 61.9000 | 63.7000 | 63.0000 | 70.7000 | 73.2000 |
| 8 | NS | 121.6000 | 122.6000 | 127.5000 | 132.5000 | 133.4000 |
| NL | 62.7000 | 63.1000 | 65.1000 | 68.7000 | 73.0000 |
| 9 | NS | 121.5000 | 123.3000 | 126.2000 | 131.7000 | 135.4000 |
| NL | 61.7000 | 63.8000 | 64.4000 | 69.7000 | 73.5000 |
| 10 | NS | 121.7000 | 123.9000 | 127.7000 | 131.8000 | 135.0000 |
| NL | 61.6000 | 61.6000 | 63.3000 | 69.3000 | 73.8000 |
| 11 | NS | 121.6000 | 122.9000 | 127.3000 | 133.2000 | 135.5000 |
| NL | 62.7000 | 63.7000 | 64.3000 | 68.1000 | 72.4000 |
| 计数率 平均值 | | | Nsi | 127.9200 | | | |
| NLi | 66.5000 | | | |
| 计数率 偏差 | | | σNSi | 0.0770 | | | |
| σNLi | 0.1063 | | | |
| 标准井计数率比值Ri | | | | 7.6944 | | | |
| 计数率比值A类标准不确定度σRai | | | | 0.0131 | | | |
| 计数率比值B类标准不确定度σRbi | | | | 0.0216 | | | |
| 计数率比值合成标准不确定度σRi | | | | 0.0253 | | | |
| 检定员 | |  | | | 复核员 |  | |

表7 补偿中子仪器校准记录表6

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | **井号：** | **28A** |
| 送检单位 | | 石油测井仪器计量站 | | 检定日期 | | 2023.6.21 | |
| 文 件 名 | | CN仪器检定28A号井 | | 温度(℃) | | 27 | |
| 量值传递仪器型号 | | 2435-1 | | 量值传递仪器编号 | | 501945 | |
| 采集时间 | | 300s | | | | | |
| 深度点(m) | | | 1.4 | 1.3 | 1.2 | 1.1 | 1 |
|  | 1 | NS | 178.5000 | 185.9000 | 194.3000 | 178.8000 | 178.0000 |
| NL | 121.8000 | 132.2000 | 135.6000 | 120.9000 | 117.9000 |
| 2 | NS | 177.1000 | 186.6000 | 194.9000 | 177.4000 | 178.1000 |
| NL | 118.2000 | 130.5000 | 136.0000 | 118.8000 | 119.5000 |
| 3 | NS | 179.1000 | 187.1000 | 194.7000 | 178.8000 | 178.3000 |
| NL | 119.3000 | 131.4000 | 137.2000 | 119.4000 | 119.0000 |
| 4 | NS | 178.9000 | 186.0000 | 194.7000 | 178.4000 | 178.7000 |
| NL | 121.3000 | 132.6000 | 137.9000 | 121.6000 | 117.8000 |
| 5 | NS | 177.2000 | 186.7000 | 194.0000 | 177.6000 | 178.8000 |
| NL | 119.4000 | 131.6000 | 136.5000 | 119.9000 | 121.5000 |
| 6 | NS | 181.1000 | 185.2000 | 194.7000 | 178.3000 | 178.1000 |
| NL | 121.4000 | 131.1000 | 138.2000 | 119.1000 | 118.8000 |
| 7 | NS | 177.8000 | 187.1000 | 194.9000 | 178.6000 | 177.4000 |
| NL | 119.9000 | 130.0000 | 138.8000 | 120.8000 | 117.6000 |
| 8 | NS | 178.1000 | 186.8000 | 194.4000 | 178.3000 | 178.0000 |
| NL | 120.4000 | 131.5000 | 137.9000 | 120.4000 | 120.3000 |
| 9 | NS | 179.7000 | 187.0000 | 194.9000 | 178.4000 | 178.1000 |
| NL | 120.2000 | 131.0000 | 135.5000 | 119.8000 | 118.9000 |
| 10 | NS | 178.7000 | 186.6000 | 195.1000 | 177.5000 | 177.5000 |
| NL | 120.1000 | 131.2000 | 138.3000 | 121.3000 | 119.2000 |
| 11 | NS | 179.6000 | 186.7000 | 195.1000 | 178.8000 | 178.9000 |
| NL | 119.5000 | 132.3000 | 137.2000 | 120.1000 | 120.9000 |
| 计数率 平均值 | | | Nsi | 183.2727 | | | |
| NLi | 125.6273 | | | |
| 计数率 偏差 | | | σNSi | 0.0925 | | | |
| σNLi | 0.1408 | | | |
| 标准井计数率比值Ri | | | | 5.8354 | | | |
| 计数率比值A类标准不确定度σRai | | | | 0.0072 | | | |
| 计数率比值B类标准不确定度σRbi | | | | 0.0164 | | | |
| 计数率比值合成标准不确定度σRi | | | | 0.0179 | | | |
| 检定员 | |  | | | 复核员 |  | |

表8 补偿中子仪器校准记录表7

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | **井号：** | **20** |
| 送检单位 | | 石油测井仪器计量站 | | 检定日期 | | 2023.6.21 | |
| 文 件 名 | | CN仪器检定20号井 | | 温度(℃) | | 27 | |
| 量值传递仪器型号 | | 2435-1 | | 量值传递仪器编号 | | 501945 | |
| 采集时间 | | 300s | | | | | |
| 深度点(m) | | | 1.4 | 1.3 | 1.2 | 1.1 | 1 |
|  | 1 | NS | 502.7000 | 506.1000 | 507.1000 | 503.9000 | 504.6000 |
| NL | 819.2000 | 817.1000 | 825.9000 | 823.3000 | 823.4000 |
| 2 | NS | 505.3000 | 507.2000 | 505.1000 | 504.9000 | 504.4000 |
| NL | 825.4000 | 818.5000 | 822.7000 | 817.7000 | 820.9000 |
| 3 | NS | 508.7000 | 504.9000 | 502.4000 | 504.6000 | 505.5000 |
| NL | 821.9000 | 820.5000 | 819.8000 | 824.8000 | 828.2000 |
| 4 | NS | 502.8000 | 502.3000 | 504.7000 | 503.3000 | 505.7000 |
| NL | 816.5000 | 814.7000 | 823.1000 | 815.7000 | 817.1000 |
| 5 | NS | 504.6000 | 505.5000 | 504.4000 | 506.5000 | 504.8000 |
| NL | 814.4000 | 817.7000 | 817.1000 | 821.2000 | 819.3000 |
| 6 | NS | 505.1000 | 504.1000 | 505.6000 | 505.3000 | 506.4000 |
| NL | 823.7000 | 813.4000 | 819.7000 | 814.6000 | 822.5000 |
| 7 | NS | 506.6000 | 505.2000 | 506.7000 | 504.7000 | 504.6000 |
| NL | 823.6000 | 813.5000 | 818.6000 | 819.5000 | 824.3000 |
| 8 | NS | 504.4000 | 507.9000 | 506.7000 | 504.3000 | 503.6000 |
| NL | 823.0000 | 813.5000 | 820.6000 | 821.1000 | 823.3000 |
| 9 | NS | 503.1000 | 505.5000 | 500.8000 | 502.6000 | 504.2000 |
| NL | 822.8000 | 812.7000 | 817.8000 | 822.5000 | 824.3000 |
| 10 | NS | 504.4000 | 506.5000 | 503.3000 | 504.7000 | 502.5000 |
| NL | 817.6000 | 814.5000 | 817.2000 | 823.0000 | 824.3000 |
| 11 | NS | 502.2000 | 506.5000 | 503.6000 | 505.2000 | 506.5000 |
| NL | 822.4000 | 817.5000 | 818.5000 | 823.3000 | 823.6000 |
| 计数率 平均值 | | | Nsi | 504.8145 | | | |
| NLi | 820.0545 | | | |
| 计数率 偏差 | | | σNSi | 0.2117 | | | |
| σNLi | 0.4104 | | | |
| 标准井计数率比值Ri | | | | 2.4623 | | | |
| 计数率比值A类标准不确定度σRai | | | | 0.0016 | | | |
| 计数率比值B类标准不确定度σRbi | | | | 0.0069 | | | |
| 计数率比值合成标准不确定度σRi | | | | 0.0071 | | | |
| 检定员 | |  | | | 复核员 |  | |

表9 补偿中子仪器校准记录表8

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | **井号：** | **7** |
| 送检单位 | | 石油测井仪器计量站 | | 检定日期 | | 2023.6.21 | |
| 文 件 名 | | CN仪器检定7号井 | | 温度(℃) | | 27 | |
| 量值传递仪器型号 | | 2435-1 | | 量值传递仪器编号 | | 501945 | |
| 采集时间 | | 300s | | | | | |
| 深度点(m) | | | 1.4 | 1.3 | 1.2 | 1.1 | 1 |
|  | 1 | NS | 177.5667 | 180.8000 | 179.9369 | 178.6000 | 183.1333 |
| NL | 100.0667 | 99.8000 | 98.9521 | 96.4000 | 100.8000 |
| 2 | NS | 177.4000 | 180.0000 | 179.9566 | 178.0000 | 182.5000 |
| NL | 99.0000 | 98.2000 | 97.9959 | 96.9000 | 100.7667 |
| 3 | NS | 177.7667 | 180.9000 | 179.9373 | 179.2000 | 181.4667 |
| NL | 99.0667 | 99.6000 | 98.9918 | 97.1000 | 101.5000 |
| 4 | NS | 176.7667 | 181.6000 | 181.4546 | 178.6000 | 182.7667 |
| NL | 100.7667 | 99.0000 | 98.8434 | 97.7000 | 102.1667 |
| 5 | NS | 177.2000 | 180.2000 | 180.1101 | 178.4000 | 183.0333 |
| NL | 99.7333 | 99.0000 | 98.3686 | 96.4000 | 99.6667 |
| 6 | NS | 177.8000 | 180.0000 | 179.1769 | 179.6000 | 181.7000 |
| NL | 99.7333 | 99.7000 | 99.6013 | 97.0000 | 100.9000 |
| 7 | NS | 178.4667 | 180.6000 | 179.9939 | 179.6000 | 182.6000 |
| NL | 100.9000 | 100.5000 | 99.5227 | 97.2000 | 100.9000 |
| 8 | NS | 177.2667 | 181.0000 | 180.9245 | 178.0000 | 182.7333 |
| NL | 100.5667 | 99.4000 | 98.5589 | 96.5000 | 99.8333 |
| 9 | NS | 177.0667 | 181.5000 | 181.2403 | 178.5000 | 181.5667 |
| NL | 100.1333 | 98.0000 | 97.1299 | 97.1000 | 100.8000 |
| 10 | NS | 177.2000 | 180.0000 | 179.8514 | 179.3000 | 181.7333 |
| NL | 100.2667 | 99.4000 | 98.6960 | 97.7000 | 102.3333 |
| 11 | NS | 177.8000 | 180.0000 | 179.0011 | 178.9000 | 182.2667 |
| NL | 100.7333 | 99.9000 | 99.5090 | 96.9000 | 101.2000 |
| 计数率 平均值 | | | Nsi | 179.8670 | | | |
| NLi | 99.2255 | | | |
| 计数率 偏差 | | | σNSi | 0.0828 | | | |
| σNLi | 0.0930 | | | |
| 标准井计数率比值Ri | | | | 7.2508 | | | |
| 计数率比值A类标准不确定度σRai | | | | 0.0076 | | | |
| 计数率比值B类标准不确定度σRbi | | | | 0.0204 | | | |
| 计数率比值合成标准不确定度σRi | | | | 0.0217 | | | |
| 检定员 | |  | | | 复核员 |  | |

表10 补偿中子仪器校准记录表9

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | **井号：** | **4** |
| 送检单位 | | 石油测井仪器计量站 | | 检定日期 | | 2023.6.21 | |
| 文 件 名 | | CN仪器检定4号井 | | 温度(℃) | | 27 | |
| 量值传递仪器型号 | | 2435-1 | | 量值传递仪器编号 | | 501945 | |
| 采集时间 | | 300s | | | | | |
| 深度点(m) | | | 1.4 | 1.3 | 1.2 | 1.1 | 1 |
|  | 1 | NS | 131.0000 | 128.7000 | 132.5000 | 132.2000 | 133.1000 |
| NL | 52.2000 | 52.2000 | 54.7000 | 54.9000 | 52.8000 |
| 2 | NS | 132.2000 | 130.6000 | 131.2000 | 133.8000 | 134.1000 |
| NL | 53.7000 | 52.4000 | 52.1000 | 52.9000 | 54.0000 |
| 3 | NS | 129.7000 | 128.9000 | 131.9000 | 133.1000 | 130.8000 |
| NL | 54.4000 | 51.0000 | 52.5000 | 54.4000 | 52.8000 |
| 4 | NS | 131.2000 | 129.0000 | 132.2000 | 133.1000 | 131.2000 |
| NL | 54.2000 | 51.7000 | 53.3000 | 52.5000 | 52.3000 |
| 5 | NS | 128.8000 | 128.6000 | 132.3000 | 131.4000 | 132.3000 |
| NL | 52.4000 | 53.9000 | 52.9000 | 53.4000 | 52.3000 |
| 6 | NS | 130.8000 | 130.8000 | 131.5000 | 130.7000 | 132.2000 |
| NL | 54.3000 | 52.4000 | 52.9000 | 53.3000 | 53.8000 |
| 7 | NS | 129.7000 | 129.5000 | 131.8000 | 132.9000 | 130.5000 |
| NL | 52.6000 | 54.2000 | 54.6000 | 54.0000 | 51.2000 |
| 8 | NS | 130.0000 | 131.5000 | 130.8000 | 132.6000 | 131.2000 |
| NL | 51.7000 | 53.6000 | 54.1000 | 52.3000 | 53.8000 |
| 9 | NS | 130.6000 | 128.7000 | 131.5000 | 133.0000 | 132.0000 |
| NL | 52.8000 | 51.6000 | 52.6000 | 52.2000 | 53.0000 |
| 10 | NS | 128.9000 | 129.0000 | 132.8000 | 133.0000 | 132.2000 |
| NL | 53.2000 | 52.9000 | 50.4000 | 54.3000 | 51.8000 |
| 11 | NS | 130.3000 | 130.9000 | 132.2000 | 132.5000 | 132.5000 |
| NL | 50.2000 | 54.7000 | 54.6000 | 53.7000 | 52.6000 |
| 计数率 平均值 | | | Nsi | 131.1000 | | | |
| NLi | 53.0659 | | | |
| 计数率 偏差 | | | σNSi | 0.1368 | | | |
| σNLi | 0.1775 | | | |
| 标准井计数率比值Ri | | | | 9.8821 | | | |
| 计数率比值A类标准不确定度σRai | | | | 0.0346 | | | |
| 计数率比值B类标准不确定度σRbi | | | | 0.0277 | | | |
| 计数率比值合成标准不确定度σRi | | | | 0.0444 | | | |
| 检定员 | |  | | | 复核员 |  | |

表10 补偿中子量值传递仪器校准计算结果

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 送检单位 | | 石油测井仪器计量站 | | | 测试时间 | | 2023.6.21 | | |
| 文件名 | |  | | | B类不确定度 | | 0.0028 | | |
| 量值传递仪器型号 | | 行业标准井地面检定系统 2435-1 | | | 量值传递仪器编号 | | 501945 | | |
| 计数率比值相对标准不确定度 | | | | | | | | | |
| 井号 | 23 | 22 | 24 | 28B | 28A | 32 | 20 | 7 | 4 |
| 孔隙度值 | 30.0000 | 5.0000 | 52.9000 | 23.5000 | 13.2000 | 100.0000 | 0.1000 | 20.2000 | 37.2000 |
| Ri值 | 8.7076 | 4.0796 | 11.5355 | 7.6944 | 5.8354 | 14.7721 | 2.4623 | 7.2508 | 9.8821 |
| σRi值 | 0.0278 | 0.0122 | 0.0497 | 0.0253 | 0.0179 | 0.0670 | 0.0071 | 0.0217 | 0.0444 |
| 响应关系系数 | | | | | | | | | |
| a0 | | a1 | | a2 | | a3 | | a4 | |
| 0.0553 | | -2.8065 | | 1.4104 | | -0.1216 | | 0.0047 | |
| 响应关系系数协方差矩阵 | | | | | | | | | |
| 行列序号 | 1 | | 2 | | 3 | | 4 | | 5 |
| 1 | 8.3958 | | -5.6556 | | 1.2388 | | -0.1084 | | 0.0033 |
| 2 | -5.6556 | | 3.9025 | | -0.8701 | | 0.0772 | | -0.0023 |
| 3 | 1.2388 | | -0.8701 | | 0.1973 | | -0.0178 | | 0.0005 |
| 4 | -0.1084 | | 0.0772 | | -0.0178 | | 0.0016 | | -0.0001 |
| 5 | 0.0033 | | -0.0023 | | 0.0005 | | -0.0001 | | 0.0000 |
| 拟合优度因子 | | 5.6070 | | | | | | | |
| 检定员 | |  | | | 复核员 |  | | | |

（三）补偿中子刻度器校准记录表

表3 补偿中子刻度器校准记录表

| 补偿中子刻度器校准结果 | | | | |
| --- | --- | --- | --- | --- |
| 被校单位：中油测井西南分公司 | | | 校准日期：2023.6.28 | |
| 刻度器型号：2437XB | | | 刻度器编号：300502 | |
| 补偿中子量值传递仪器型号：行业标准井地面检定系统2435-1 | | | 补偿中子量值传递仪器编号：501945 | |
| 补偿中子量值传递仪器稳定性相对误差： | | | 1.0% | |
| 序号 | 测量点 | 校准值，p.u. | | 扩展不确定度（*k*=2），p.u. |
| 1 | 刻度点 | 25.8599 | | 0.6180 |
| 2 | 校验点1 | 73.5789 | | 3.2490 |
| 3 | 校验点2 | 42.5208 | | 1.3010 |
| 4 | 校验点3 | 17.4931 | | 0.5348 |
| 5 | 校验点4 | 7.6140 | | 0.5310 |
| 6 | 校验点5 | 3.6563 | | 0.5080 |
| 注：下次送校须带此证书。 | | | | |